DIVISION OF BIOTECHNOLOGY

LIST OF NEW COURSES

Sl. No	Course Code	Course Name	Hours per week L	T	P	Credits
1	23BT2001	Artificial Intelligence in Smart Agriculture	3	0	0	3
2	23BT2002	Artificial Intelligence for Energy and Environment	3	0	0	3
3	23BT2003	Artificial Intelligence in Drug Design and Clinical Studies	3	0	0	3
4	23BT2004	Artificial Intelligence in Healthcare and Biosciences	3	0	0	3
5	23BT2005	Fundamental laboratory practices	0	0	2	1
6	23BT2006	Industrial design and layout	0	0	2	1
7	23BT2007	Medical laboratory practices	0	0	2	1
8	23BT2008	Bioproduct development	0	0	2	1
9	23BT2009	Molecular diagnostics	0	0	2	1
10	23BT2010	Quality control and management	0	0	2	1
11	23BT2011	Entrepreneurship Development	3	0	0	3

LIST OF REVISED COURSE

Course Code	Course Title	Credits L	T	P	C
20BT3007	Genetic Engineering Lab (Version 1.1)	3	0	0	3

Course Code	Artificial Intelligence in Smart Agriculture	L	T	P	C
23BT2001		3	0	0	3

Course Objectives:

Enable the student to:

1. Examine the role of AI in agriculture
2. Evaluate the process of monitoring the crops
3. Facilitate farmers in the implementation of AI in crop monitoring

Course Outcomes:

The student will be able to:

1. Describe tools used in AI in agriculture farming
2. Conclude manmade intelligence and Artificial intelligence in agriculture
3. Interpret the results of smart agriculture process
4. Evaluate AI based monitoring for pest and disease management
5. Predict the yield of the agriculture products and their quality
6. Formulate AI implementation with farmers

Module: 1	AI in Farming	8 Hours

Introduction to AI, Applications of AI in Precision Agriculture, Drones for Mapping for field planning and seed planting, Soil Quality and plant disease assessment, Crop monitoring. Optical sensors, Location sensors, NPK Sensors.

Module: 2	Green House Monitoring	7 Hours

Background and driving forces, Operating principle, System architecture and technology equipment, System and equipment specification.

Module: 3	Cloud Computing in Agriculture	7 Hours

The Cloud-Computing Models for Smart Agriculture, Smart agriculture process, Disruptive technologies. Limitations and future scope.

Module: 4	Farmer's Advisory and Communication	7 Hours

Curtailing Challenges of AI in Agriculture, Man-Made Intelligence and ML-Based Advising System for Farmers Crop Production, Artificial Intelligence Found Farmer Supporter Chatbot		
Module: 5	**Plant Disease and Pest Detection**	**7 Hours**
Disease Detection in Plants by Different Imaging Sensors, Tomogrphy, thermography, Thermal Imaging. Applications of Artificial Intelligence in Pest Management.		
Module: 6	**Artificial Intelligence-Aided Phenomics**	**8 Hours**
Introduction to Phenomics, Fields of AI in Agriculture sector, Robotics in Agriculture, Advancement in irrigation system, Crop health monitoring, Status of AI innovation for Agriculture in India. High-Throughput Stress Phenotyping of Plants		
Total Lectures		**45 Hours**

Text Books	
1.	Kose, U V B., Prasath, S., Mondal, M R M., Podder, P and Bharati S, (2022) "Artificial Intelligence and Smart Agriculture Applications", Ist Ed., Auerbach Publications, ISBN 9781003311782.
2.	Naresh R.K, (2022) "Artificial Intelligence in Indian Agriculture". Ist ed., ISBN: 9789390611959.
Reference Books	
1.	Singh, R., Geholt, A., Prajapat, M K. and Singh, B, (2022), "Artificial Intelligence in Agriculture" Ist ed., CRC Press. ISBN: 9781032158105.
2.	Abraham, A., Dash, S., Joel, J P C., Acharya, B. and Pani, S K, (2021) "AI edge and IoT- based smart Agriculture", Ist ed., ISBN: 9780128236949.
3.	Dutta,S., Sinha, A. and Basu, D, (2022) "Role of Artificial Intelligence in Agriculture : Current Scenario and Future Prospects", Ist ed., New Delhi Publishers, ISBN NO:9788194899358.
4.	*Rathore, N S., Joshi, S., Choudhary, N, (2021) "Digital Technologies for Agriculture", Ist ed., New India Publishing agency, ISBN 9789390591916.*
5.	*Javaid M., Haleem A., Khan I. H. and Suman R, (2023) "Understanding the potential applications of Artificial Intelligence in Agriculture Sector", Advanced Agrochem, Vol 2(1).*

Recommended by Board of Studies	15 Apr 2023
Approved by Academic Council	03 June 2023

Course Code	**Artificial Intelligence for Energy and Environment**	**L**	**T**	**P**	**C**
23BT2002		3	0	0	3

Course Objectives:

Enable the student to:

1. Describe the principles of AI in Bio efficiency.
2. Illustrate knowledge of AI in Bioenergy, and Environment.
3. Investigate the facts on sustainable development goals in AI

Course Outcomes:

The student will be able to:

1. Describe the basics and search algorithms in Artificial Intelligence.
2. Identify AI tools for substrate optimization, fermentation and production process.
3. Discuss AI prediction model for biofuel and electricity generation.
4. Determine AI techniques for the feedstock cultivation process and bioenergy supply chain.
5. Analyze AI based monitoring techniques for environmental challenges.
6. Formulate AI approaches for climate change and environmental sustainability

Module: 1	**Exploration of Artificial Intelligence**	**8 Hours**

Overview of Artificial intelligence, Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms, Knowledge Representation – First order predicate logic, Artificial Neural Network, Convolutional Neural network, Support vector machine algorithms.		
Module: 2	**AI process in Bioenergy Production Process**	**7 Hours**
Role of artificial intelligence in the advancement of bioenergy, prediction of biomass feedstock properties, the prediction of process performance of biomass conversion including pathways and technologies, AI studies on hydrolysis and fermentation.		
Module: 3	**AI Based Optimization for Bioconversion of Green Energy**	**8 Hours**
AI for Anaerobic conversion of green biomass into high-calorie liquid, Anaerobic processing of organic waste: general characteristics of fermentation, AI for Optimization of organic waste in a biogas plant, multilevel optimization in sustainable energy economics.		
Module: 4	**AI applications in Bioenergy**	**8 Hours**
AI applications to bioenergy end-use systems, bio-energy used for heat and electricity generation, bioenergy supply chain, integration of the machine-learning informed semi-continuous algal cultivation (SAC) and aggregation-based sedimentation (ABS) for biofuel production.		
Module: 5	**Tackling Environmental Challenges**	**7 Hours**
Current environmental problems and use of artificial intelligence, Monitoring methane emissions, tracking air quality, Measuring environmental footprints, Reducing ICT emissions.		
Module: 6	**Climate Change and Environmental Sustainability**	**7 Hours**
Smarter decision-making for decarbonising industries, the ecosystem for information and communications technology, Greening cities, AI to address Environmental Challenges, Artificial intelligence (AI) applications in water resource, Biodiversity and Conservation, health oceans, weather and disaster management. Social and Economic outcomes.		
Total Lectures		**45 Hours**

Text Books

1.	Russell .S and Norvig .P, (2016) “Artificial Intelligence: A Modern Approach”, Prentice Hall, Third Edition, ISBN-1537600311, 97-81537600314.
2.	Mason. C. L., (2020) “Artificial Intelligence and The Environment: AI Blueprints for 16 Environmental Projects Pioneering Sustainability”

References

1.	Manish Meena, Shubham Shubham, Kunwar Paritosh, Nidhi Pareek, Vivekanand, (2021) “Production of biofuels from biomass: Predicting the energy employing artificial intelligence modelling”, Bioresource Technology, Volume 340.
2.	Mochen Liao, Yuan Yao, (2021) “Applications of artificial intelligence-based modeling for bioenergy systems: A review”, GCB Bioenergy 13:774–802.
3.	Emmanuel Kwame Nti, Samuel Jerry Cobbina, Eunice Efua Attafuah, Evelyn Opoku, Michael Amoah Gyan, (2022) “Environmental sustainability technologies in biodiversity, energy, transportation and water management using artificial intelligence: A systematic review”, Sustainable Futures, Volume 4.
4.	Pandian Vasant, Gerhard-Wilhelm Weber, Joshua Thomas, José Antonio Marmolejo-Saucedo, Roman Rodriguez-Aguilar, (2022) “Artificial Intelligence for Renewable Energy and Climate Change”, ISBN: 9781119768999, Scrivener Publishing LLC.
5.	Pandian Vasant, Joshua Thomas,Elias Munapo Gerhard-Wilhelm Weber, (2022) “Advances of Artificial Intelligence in a Green Energy Environment”, ISBN 978-0-323-89785-3.

Recommended by Board of Studies	15 Apr 2023
Approved by Academic Council	03 June 2023

Course Code	Artificial Intelligence in Drug Design and Clinical Studies	L	T	P	C
23BT2003		3	0	0	3

Course Objectives:

Enable the student to:

1. Describe the concepts of Artificial Intelligence.
2. Apply Artificial Intelligence in Drug Discovery
3. Introduce the concepts of machine learning for various applications

Course Outcomes:

The student will be able to:

1. Infer to problems in health care that are amenable to solution by AI methods.
2. Demonstrate the various Artificial Intelligence methods to solve problems in clinical studies.
3. Illustrate a given problem in the language/framework by Artificial Intelligence
4. Examine machine learning integration in knowledge inference
5. Acquire knowledge on Networks and tools
6. Formulate AI based solutions in Drug Discovery

Module: 1	Introduction	7 Hours

Introduction to AI, History of Artificial Intelligence and Chemistry, Chemical Topic Modeling – An Unsupervised Approach Originating from Text-mining to Organize Chemical Data, Deep Learning and Chemical Data

Module: 2	AI in Drug Discovery	7 Hours

Definition, Drug Discovery Process, Applications of Machine Learning in Drug Discovery, Applications of AI in Drug Discovery, drug classifications, Target selection and validation, Compound screening and lead optimization, Preclinical studies, Clinical trials and Trial master file.

Module: 3	Drug Designing	7 Hours

Role of AI in Drug Product Designing, Development & Manufacturing: Tapping into the drug discovery potential, driven by data, lifecycle of pharmaceutical products, drug screening, and designing drug molecules.

Module: 4	AI in Pharmaceutics	8 Hours

AI in advancing pharmaceutical product development, quality control and quality assurance, clinical trial design, nanorobots for drug delivery, advanced pharmaceutical product development, combination drug delivery and synergism/antagonism prediction

Module: 5	AI in Computational Drug Designing	8 Hours

Concepts and Applications of Conformal Prediction in Computational Drug Discovery, Predicting Protein-ligand Binding Affinities, Virtual Screening with Convolutional Neural Networks

Module: 6	Machine Learning	8 Hours

Machine Learning in the Area of Molecular Dynamics Simulations, Compound Design Using Generative Neural Networks, Junction Tree Variational Autoencoder for Molecular Graph Generation, AI via Matched Molecular Pair Analysis, Active Learning for Drug Discovery and Automated Data Curation

Total Lectures	45 Hours

Text Books

1.	Nathan Brown Artificial Intelligence in Drug Discovery, (2020). United Kingdom: Royal Society of Chemistry.

2.	Anil Philip, Aliasgar Shahiwala, Mamoon Rashid, Md Faiyazuddin (2023) "A Handbook of Artificial Intelligence in Drug Delivery", United States: Elsevier Science.
Reference Books	
1.	Alexander Heifety, (2022) "Artificial Intelligence in drug design",Springer US.
2.	Alex Zhavoronkov and Jianfeng, (2021) "Artificial Intelligence for drug discovery and development",Frontiers Media SA.
3.	Dominic Magirr, Jacob Bradley, Roberta Dousa, Ayaka Shinozaki, John Cassidy, Kristofer Linton-Reid, Steve Gardner, Sayoni Das, Krystyna Taylor Edited by John W. Cassidy and Belle Taylor, (2020) "Artificial Intelligence in Oncology Drug Discovery and Development", IntechOpen.
4.	Ruby Srivastava, (2021) "Transformation of Drug Discovery towards Artificial Intelligence: An in Silico Approach", IntechOpen. ISBN: 978-1-83969-845-3.
5.	Szolovits, P. (Ed.). (2019) "Artificial intelligence in medicine", Routledge.
Recommended by Board of Studies	15 Apr 2023
Approved by Academic Council	03 June 2023

Course Code	**Artificial Intelligence in Healthcare and Biosciences**	**L**	**T**	**P**	**C**
23BT2004		3	0	0	3

Course Objectives:

Enable the student to:

1. Summarize the integration of AI in health care and biosciences.
2. Apply Artificial Intelligence in technological and industrial environments to improve quality and productivity.
3. Interpret the applications of AI and ML in healthcare and bioscience.

Course Outcomes:

The student will be able to:

1. Explain the core elements of AI and ML
2. Evaluate the Programming and Descriptive Statistics and carry out Statistical Analysis
3. Restate basics and applications of AI and ML
4. Evaluate the AI data mining technologies and their application in healthcare and Biosciences
5. Discuss Ethical framework of AI when applied in medicine.
6. Effectively communicate and disseminate knowledge in any science or engineering domain in the context of computing, systems, and/or biomedical applications.

Module: 1	**AI Foundation and Introduction**	**7 Hours**
Introduction to Artificial Intelligence, AI fundamentals, Use-cases and applications of AI, Issues concerning AI in business, ethics and bias, jobs and scope. Brief history of AI and ML in Healthcare and Pharmacy, Machine Learning workflow and terminologies, computational models of intelligence.		
Module: 2	**Data Management and Visualization**	**8 Hours**
Introduction to Data Science, Flow of Data Science, NumPy, Pandas: Data Frames, operations, Pandas built-in data visualization, Matplotlib, Matplotlib visualization. Power BI and ChatGPT		
Module: 3	**Machine Learning and Medical bio-sensors**	**8 Hours**
ML in micro biosensors and devices for electronic data capture (ECG, Actigraphy, Oximetry), data disambiguation techniques, Bayesian ML, SVM-optimal mix, Shallow learning, Ensemble Learning, anomaly detection.		
Module: 4	**Machine Learning for Healthcare**	**7 Hours**

Fundamental concepts and principles of machine learning as it applies to medicine and healthcare Machine learning approaches, medical use cases, metrics unique to healthcare, as well as best practices for designing, building, and evaluating machine learning applications in healthcare.		
Module: 5	**AI and Data Analytics in Physiology and Biomedicine**	**8 Hours**
Successes and limitations of applications of artificial intelligence (AI) in physiology and biomedicine. Bioimage diagnostic tools, medial risk assessment and prognosis, individualized medicine, drug discovery, protein folding, and classification of microbial communities. Theoretical and practical challenges in ML and AI, convolutional neural networks on digital pathology for diagnostic and outcome prediction and personalized treatment schemes.		
Module: 6	**AI application and Case Studies in Bioscience**	**7 Hours**
AI and Data science in biology: Molecular data produced methods of transcriptomics, proteomics and metabolomics. Unix analysis of large genome sequence data. AI data analytics in ecology and Evolutionary biology. Frontiers of research and development in the application of AI methods in the biosciences. Overview of successes and limitations of applications of artificial intelligence (AI) in physiology and biomedicine.		
Total Lectures		**45 Hours**

Text Books	
1.	Russell, Norvig, (2010) "Artificial Intelligence: A Modern Approach", Third edition, Prentice Hall.
2.	Tony J. Cleophas and Aeilko H. Zwinderman, (2015) "Machine Learning in Medicine - a Complete Overview", Springer.
Reference Books	
1.	Hastie, Tibshirani, Friedman (2009) "The elements of statistical learning", Second edition, Springer.
2.	Daphne Koller and Friedman (2009) "Probabilistic Graphical Models - Principles and Techniques", The MIT Press.
3.	Natarajan, Prashant, John C. Frenzel, and Detlev H. Smaltz (2017) "Demystifying big data and machine learning for healthcare" CRC Press.
4	Catania, Louis J (2020) "Foundations of Artificial Intelligence in Healthcare and Bioscience: A User Friendly Guide for IT Professionals, Healthcare Providers, Researchers, and Clinicians", Academic Press.
5.	Stuart Russell and Peter Norvig, (2009) "Artificial Intelligence: A Modern Approach", 3rd ed. Prentice Hall Press.

Recommended by Board of Studies	15 Apr 2023
Approved by Academic Council	03 June 2023

Course Code	**Genetic Engineering Lab**	**L**	**T**	**P**	**C**
20BT3007	(Version 1.1)	0	0	4	2

Co-requisite: Lab in Molecular Biology

Course Objectives:

To impart knowledge on

1. Isolation of nucleic acids and proteins.
2. Qualitative and Quantitative analysis of nucleic acids.
3. Genetic manipulation of nucleic acids for protein production.

Course Outcomes:

After completing the course the students will be able to

1. Isolate the nucleic acids
2. Perform electrophoresis of nucleic acids and proteins.
3. Interpret DNA manipulation and transformation techniques.
4. Evaluate RNA expression by reverse transcription

5. Analyze nucleic acid amplifications using PCR 6. Illustrate the purification of recombinant proteins
List of Experiments
1. Isolation of plasmid DNA and restriction digestion to estimate molecular weight by Agarose Gel electrophoresis 2. Isolation of total RNA from E.coli 3. Isolation of total RNA from Yeast 4. Isolation of RNA from mammalian cells. 5. Reverse Transcriptase PCR of target gene & Agarose Gel electrophoresis to estimate molecular weight. 6. RAPD- PCR 7. Restriction Analysis - RFLP 8. Preparation of competent E.coli and transformation of the cloned plasmid and selection of recombinant clones. 9. Extraction and purification of target protein using column chromatography. 10. Analysis of expressed protein using SDS-PAGE. 11. Western blotting analysis for confirmation of purity and quality of expressed protein 12. Spectrometric quantification of nucleic acids.

Course Code	Fundamental Laboratory Practices	L	T	P	C
23BT2005		0	0	2	1

Course Objectives:	
Enable the student to: 1. Apply the laboratory guidelines in reagent preparations. 2. Develop hands on skills in operation of instruments. 3. Demonstrate different techniques in laboratory practices.	
Course Outcomes:	
The student will be able to: 1. Solve calculations for the preparation of solutions. 2. Prepare reagents and media for various biological experiments. 3. Operate basic laboratory equipment. 4. Calculate the concentration of unknown samples. 5. Adopt various sterilization techniques. 6. Demonstrate different microbial culture techniques.	
List of Experiments: 1. Safety guidelines for laboratory experiments in biotechnology. 2. Collection techniques and volumetric analysis of samples. 3. Preparation of solutions in terms of Normality, Molarity, % (w/w), % (w/v) and % (v/v). 4. Calibration of pH meter. 5. Preparation of buffers. 6. Colorimetric determination of the glucose concentration. 7. Handling the instruments; centrifuges, incubators, LAF, microscope 8. Dry and wet heat sterilization techniques. 9. Media preparation and inoculation of bacteria. 10. Procedure for fumigation of laboratory	
Total Lectures	**15 Hours**
Text Books	
1.	Seidman, L.A., Moore C.J. and Mowery, J, (2021), “Basic Laboratory Methods for Biotechnology”, CRC Press, ISBN: 9781000480764.

2.	Seidman, L.A., (2021), “Basic Laboratory Calculations for Biotechnology”, CRC Press, ISBN: 9781000480795.
Reference Books	
1.	Bonner, P.L.R., Hargreaves, A.J (2022), “Basic Bioscience Laboratory Techniques”, CRC Press, ISBN: 9781119663485.
2.	Seidman, L.A., Kraus, M.E., Brandner, D.L., Mowery, J. (2022) “Laboratory Manual for Biotechnology and Laboratory Science”, CRC Press, ISBN: 9781000750119.
3.	Jani, A., Agarwal, J. and Venkatesh, V. (2020) “Microbiology Practical Manual”, Elsevier Science, ISBN: 8131253546.
4.	Olaniyan, M., (2017) “Laboratory Instrumentation and Techniques”, Create Space Independent Publishing Platform, ISBN: 9781547012220.
5.	Sabari, G., Avasthi, Sharma, A. (2018) “Fundamentals of Bioanalytical Techniques and Instrumentation”, 2nd Edition, PHI Learning Pvt. Ltd., ISBN: 9789387472402.
Recommended by Board of Studies	02 Aug 2023
Approved by Academic Council	25 Aug 2023

Course Code	**Industrial Design and Layout**	**L**	**T**	**P**	**C**
23BT2006		0	0	2	1

Course Objectives:

Enable the student to:

4. Acquire knowledge on the fundamentals of Engineering Design.
5. Develop skills in AutoCAD for plant layout.
6. Design industrial biotech equipment.

Course Outcomes:

The student will be able to

7. Classify unit operation symbols, letters and plant layout.
8. Identify suitable materials for the fabrication of parts.
9. Apply engineering design tools in industrial design.
10. Develop plant layouts for pharma and biotech industries.
11. Differentiate various reactors.
12. Design heat exchangers, evaporators and distillation column.

List of Experiments

1. Customization drawing aids, page setup and printing, engineering letters, lines and numbering
2. Introduction to basic shapes used in industrial design
3. Basics of various unit operation symbols
4. Generate the layout of pharmaceutical industry plant
5. Develop biotech industry plant layout
6. Design of batch reactor
7. Design of airlift fermenter
8. Design of shell and tube heat exchanger
9. Design of single effect evaporator
10. Design of fractional distillation column

Total Lectures	**15 Hours**

Text Books	
1.	Ganesan G., (2018), “Basic Computer Aided Design and Drafting using AutoCAD 2015”, McGraw Hill.
2.	Sham T., (2014), “AutoCAD 2015 for Engineers and Designers”, Dream Tech Press.
Reference Books	
1.	Elliot G., (2014), “Up and Running with AutoCAD 2015”, 2D and 3D Drawing and Modeling.

	Academic Press.
2.	Gary R. B., Eric N. W., (2014) “Fundamentals of Graphics Communication”, McGraw Hill,.
3.	Mccabe, W. L.,Smith, J. C., Harriott,P., (2022), “Unit Operations of Chemical Engineering”, McGraw Hill, NewYork, 7th Edition.
4.	Randy H. S., (2023) ‘AutoCAD 2023 Tutorial: 2D Fundamentals’, SDC Publications, New Delhi.
5.	Natarajan, K.V., (2022), “Engineering Drawing and Graphics”, Dhanam Publication, 25th Edition.

Recommended by Board of Studies	02 Aug 2023
Approved by Academic Council	25 Aug 2023

Course Code	**Medical Laboratory Practices**	**L**	**T**	**P**	**C**
23BT2007		0	0	2	1

Course Objectives:

Enable the student to:

1. Illustrate the principles in biochemical analysis.
2. Perform clinical analysis of body fluids.
3. Assess body vitals.

Course Outcomes:

The student will be able to:

1. Adopt standard procedures in analysis of clinical samples.
2. Perform routine clinical laboratory procedures in Hematology.
3. Analyse urine sample for various biochemical parameters.
4. Evaluate the samples for respiratory tract infections.
5. Compare normal and abnormal clinical observations.
6. Interpret the results for medical diagnosis.

List of Experiments

1. Determination of Serum cholesterol.
2. Analysis of Serum Sugar.
3. Quantification of Urine albumin
4. Estimation of total platelet count.
5. Quantification of Urine Bile salt.
6. Estimation of Urine sugar.
7. Collection of throat and nasal swabs.
8. Measurement of blood pressure.
9. Determination of blood clotting time.
10. Estimation of bleeding time.

Total Lectures	**15 Hours**

Text Books

1.	Erkmen, O.,(2021), “Laboratory Practices in Microbiology”. Netherlands, Elsevier Science.
2.	Lynne, S G., (2020), “Clinical Laboratory Management. United States”, Wiley, 2nd Edition.

Reference Books

1.	Nagarajan, P., Gudde, R., Srinivasan, R., (2021), “Essentials of Laboratory Animal Science: Principles and Practices”, Springer Nature Singapore.
2.	Marzinke, M., Clarke, W., (2020), “Contemporary Practice in Clinical Chemistry”. Netherlands, Elsevier Science, 4th Edition.
3.	Donaldson, L., Tartaglia, R., Sheridan, S., Ricciardi, W., (2020) “Textbook of Patient Safety and Clinical Risk Management”, Springer International Publishing, Germany.
4.	Sandhya, B., Apurba, S., (2021) “Essentials of Medical Microbiology”, Jaypee Brothers Medical Publishers Pvt. Limited, India, 3rd Edition.

5.	Rifai, N., (2018), "Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics", Elsevier, India, 8th Edition.

Recommended by Board of Studies	02 Aug 2023
Approved by Academic Council	25 Aug 2023

Course Code	**Bioproduct Development**	**L**	**T**	**P**	**C**
23BT2008		0	0	2	1

Course Objectives:

Enable the student to:

1. Demonstrate processes involved in bio-product development.
2. Identify key parameters that enhance the quality of bioproducts.
3. Formulate personal care products.

Course Outcomes:

The student will be able to:

1. Ascertain upstream requirements for formulation of bioproducts.
2. Identify experimental requirements for development of bioproducts.
3. Evaluate the optimal process parameters.
4. Assess the quality of bioproducts.
5. Formulate scale up strategies.
6. Analyze cost estimation.

List of Experiments

1. Evaluation of sugar content in wine.
2. Preparation of beer and evaluation of its turbidity.
3. Mushroom cultivation.
4. Cultivation of Azolla.
5. Demonstration of Vermi technology.
6. Preparation of herbal oil for dandruff treatment.
7. Preparation of herbal face pack.
8. Development of herbal mosquito repellent candle
9. Large scale preparation of liquid biocontrol formulation.
10. Determination of calcium content in prepared health mix

Total Lectures	**15 Hours**

Text Books

1	Peter F S., Allan W., Stephen H., (2016). "Principles of Fermentation Technology". 3rd Edition. ISBN: 9780080999531.
2.	Sharma A., (2017). "Food Product Development. CBS publishers". ISBN: 9789386827951

Reference Books

1.	Manickavasagan, A., Loong-Tak L., Amanat A., eds. (2022). "Plant Protein Foods". Cham: Springer International Publishing.
2.	Amaresan, N., Dhanasekaran, D., Olubukola, O. B., eds. (2023). "Agricultural Microbiology Based Entrepreneurship". Vol. 39. Singapore: Springer Nature Singapore.
3.	Verma, P., ed. (2022). "Industrial Microbiology and Biotechnology". Singapore: Springer Singapore
4.	Baskar, C., Seeram R., Shikha B., Rashmi S., Amutha C., Rashmi S., eds. (2022). "Handbook of Solid Waste Management". Singapore: Springer Nature Singapore.
5.	Chen, G., Randall J. W., Stacy D. S., eds. (2018). "Plant Bioproducts". Springer, New York.

Recommended by Board of Studies	02 Aug 2023
Approved by Academic Council	25 Aug 2023

Course Code	**Molecular Diagnostics**	**L**	**T**	**P**	**C**

23BT2009		0	0	2	1

Course Objectives:

Enable the student to:

1. Identify the role of rapid diagnostic techniques.
2. Apply the principle and techniques in disease diagnosis.
3. Develop rapid methods for specific disease diagnosis.

Course Outcomes:

The student will be able to:

1. Apply the fundamentals of molecular diagnostics.
2. Articulate the diagnostic characteristics for detection of disease.
3. Appraise the concepts of rapid detection.
4. Adopt molecular techniques in diagnosis of diseases
5. Demonstrate immunodiagnostic techniques.
6. Develop novel diagnostic techniques for disease detection.

List of Experiments

1. Collection of blood through Venipuncture.
2. Diagnosis of Dengue using serum
3. Polymerase Chain Reaction: Basic Protocol and setting up
4. Blotting as a diagnostic method - Demonstration of Southern Blotting
5. Study the principal components of DoT-COVID 19 Kit
6. Kit assay for diagnosis of Malaria
7. Detection of human chorionic gonadotropin (HCG) in urine sample
8. Quantification of genetic material using nanodrop
9. RT-PCR - Demonstration
10. Development of simple disease diagnosis kit

Total Lectures	**15 Hours**

Text Books

1.	Chang-Hui, S., (2023), "Diagnostic Molecular Biology", 2nd Edition, Academic Press, ISBN: 9780323917889
2.	Laura, A., (2018), "Rapid Test: Advances in Design, Format and Diagnostic Applications", BoD – Books on Demand, ISBN: 978-1789239010

Reference Books

1.	Diwakar, S., Suthur, K.P., Mehtha, R., (2020) "Molecular Diagnostics A Practical Manual", New India Publishing Agency (NIPA), ISBN: 9789389571905
2.	Ford, M., (2019), "Medical Microbiology: Fundamentals of Biomedical Science", 3rd edition, Oxford University Press, ISBN: 9780198818144
3.	Robert, R. R., (2018), "Clinical Immunology: Principles and Practice" 5th edition, Elsevier, 978-0702068966
4.	Sandeep, K. V., Luong, J., (2018), "Handbook of Immunoassay Technologies Approaches, Performances, and Applications", Academic Press, ISBN: 9780128117620
5.	Michael, R. G., Sambrook, J., (2012), "Molecular Cloning -A Laboratory Manual", 3rd Edition, Cold Spring Harbor Laboratory Press, ISBN 978-1-936113-41-5

Recommended by Board of Studies	02 Aug 2023
Approved by Academic Council	25 Aug 2023

Course Code	Quality Control and Management	L	T	P	C
23BT2010		0	0	2	1

Course Objectives:

Enable the student to: 1. Acquire knowledge on the principles of quality control in the Biotechnology industry. 2. Implement quality control and management strategies. 3. Assess product service quality.
Course Outcomes:
The student will be able to: 1. Comprehend the significance of documentation. 2. Categorize the quality certifications applicable to biotech industries. 3. Evaluate internal and external audits. 4. Appraise on standard operating protocols. 5. Analyze influence of environment on product quality. 6. Investigate the compliance towards quality standards.
List of Experiments 1. Standard Operating Procedure (SOP) and Standard Test Procedure (STP) preparation based on Schedule M /Monographs/ISO. 2. Quality Management System (QMS) documentation for testing lab according to Schedule M/ISO. 3. Environmental Monitoring in Clean Room Area for Sterility. 4. Microbial contamination analysis. 5. Handling and disposal of hazardous microorganisms and waste management. 6. Analytical data review and release. 7. Conduction/setting up of inspection and audits. 8. Corrective actions for non-conformity of quality issues. 9. Investigation on customer complaints. 10. Addressing Internal and External Quality Issues – Complying with regulatory guidelines.

Total Lectures	**15 Hours**

Text Books	
1	Jimenez, L., (2019), " Microbial Contamination Control in the Pharmaceutical Industry", CRC Press; Floroda, USA. ISBN-10 : 0367393948
2	Goel, P. R., Potdar, M. A., Shaikh, S. K., (2021), "Audit And Regulatory Compliance For Master Of Pharmacy (QAT) Students", Nirali Prakashan Publishers, ISBN: 9789354511813
Reference Books	
1.	Yamini, R., (2019), "Quick Reference Guide - ISO 9001:2015: Quality Management System", White Falcon Publishing, ISBN: 1097424146, 9781097424146.
2.	Ljungqvist, B., Reinmuller, B., (2019), "Clean Room Design Minimizing Contamination Through Proper Design", CRC Press, Floroda, USA. ISBN:1-57491-032-9.
3.	Lawrence, K., Yung-Tse H. W., Nazih K. S., (2010), "Handbook of advanced industrial and hazardous wastes treatment Boca Raton", CRC Press. ISBN : 9786612336188
4.	Rodriguez, J., (2016), "CAPA in the Pharmaceutical and Biotech Industries", Elsevier Publication. DOI: https://doi.org/10.1016/C2013-0-18185-8
5.	Potdar, M. A., Dubey, R. (2018), "cGMP Current Good Manufacturing Practices for Pharmaceuticals", 2nd Edition, Pharmamed press/Bsp books, pp854.

Recommended by Board of Studies	02 Aug 2023
Approved by Academic Council	25 Aug 2023

Course Code	**Entrepreneurship Development**	**L**	**T**	**P**	**C**
23BT2011		3	0	0	3

Course Objectives:
Enable the student to: 1. Develop an entrepreneurial mindset

2. Analyze practical aspects in promotion of a start- up. 3. Design innovative products	
Course Outcomes:	
The student will be able to: 1. Recognize the requirements of an entrepreneurial endeavour 2. Identify critical factors involved in real case studies 3. Develop product concepts, design and prototype fabrication 4. Apply lean start-up techniques in development of business idea. 5. Analyze go-to -market strategy required for a start-up. 6. Evaluate the action plan for successful entrepreneurial career.	
Module 1: Basics of Entrepreneurship and types	**8 Hours**
Concepts of Entrepreneurship and Product Development - Evolution of the concept of Entrepreneur-Entrepreneur Vs. Intrapreneur, Entrepreneur Vs. Entrepreneurship, Entrepreneur Vs. Manager –Types of entrepreneur-Type of Business-Use of Technology-New generations of entrepreneurship viz. Social entrepreneurship, Ideapreneurship, Health Entrepreneurship-Tourism Entrepreneurship-Women entrepreneurship. Success and failure stories of Entrepreneurs and Product development.	
Module 2: Creating Entrepreneurial Venture	**5 Hours**
Business Planning Model- Environmental Analysis - Search and Scanning Identifying problems and opportunities- Defining Business Idea- Basic Government Procedures to be complied with Entrepreneurship.	
Module 3: Project Management & Resource Mobilization 8 Hours	
Technical, Financial, Marketing, Personnel and Management Feasibility- Estimating and Financing funds requirement - Schemes offered by various commercial banks and financial institutions like IDBI, ICICI, SIDBI, SFCs-Venture Capital Funding-raising funds (including Angel investor).	
Module 4: Government & Organization Assistance	**5 Hours**
Role of Central Government and State Government in promoting Entrepreneurship - Introduction to various incentives, subsidies and grants - Export Oriented Units - Fiscal and Tax concessions available	
Module 5: Role of agencies in Entrepreneurship Development	**10 Hours**
District Industries Centers (DIC), Small Industries Service Institute (SISI), Entrepreneurship Development Institute of India (EDII), National Institute of Entrepreneurship & Small Business Development (NIESBUD), National Entrepreneurship Development Board (NEDB), Carry on Business (COB) license-MSME Act Small Scale Industries-National Small Industries Corporation (NSIC)-Quality Standards with special reference to ISO. Directorate General of Supplies and Disposals (DGS& D)- Registration with DGS & D -Registration Categories-Registration Procedure.	
Module 6 : Support to Entrepreneurs	**9 Hours**
Sickness in small Business: Concept, Signals, Symptoms, Magnitude, Causes and Consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in Small Scale Enterprise – Institutional Support to Entrepreneurs: Need and Support -Taxation Benefits to Small Scale Industry: Need, Depreciation, Rehabilitation, Investment.	
Total Lectures	**45 Hours**

Text Books

1.	Robert D. H., Michael P P., Dean A. S., (2010), "Entrepreneurship", McGraw Hill, ISBN: 0077434862
2.	Thomke, S., Ashok N., (2000), "IDEO Product Development." Boston, MA: Harvard Business School Case, 9-600-143

Reference Books

1.	Donald F K., (2023), "Entrepreneurship: Theory, Process and Practice", Cengage Learning Custom Publisher, 12th Edition.
2.	Srinivasan, N.P., Gupta G.P., (2020), "Entrepreneurial Development", Sultanchand & Sons.
3.	Satish Taneja, (2014) "Entrepreneur Development ", New Venture Creation.

4.	Vasanth D., (2011), “Dynamics of Entrepreneurial Development and Management”, Himalaya, ISBN 9350244543
5.	Ulrich, K., Eppinger, S., (2003), “Product Design and Development’ 3rd Edition. McGraw- Hill. ISBN: 9780072471465

Recommended by Board of Studies	02 Aug 2023
Approved by Academic Council	25 Aug 2023

DEPARTMENT OF BIOTECHNOLOGY

LIST OF NEW COURSES

S No	Course Code	Course Title	Hours per week L	T	P	Credit
1	22BT2070	Total Quality Management and Process Economics	3	0	0	3
2	22BT2071	Good Manufacturing and Laboratory Practice	3	0	0	3
3	22BT2072	Metabolic Engineering	3	0	0	3
4	22BT2073	Cheminformatics and Medicinal Chemistry	2	1	0	3
5	22BT2074	Bioprocess Engineering	3	0	0	3
6	22BT2075	Bioprocess Lab	0	0	3	1.5
7	22BT2076	Data analysis and Simulations	3	0	0	3
8	22BT2077	Big Data Analytics	2	1	0	3
9	22BT2078	Biosimilars Technology	3	0	0	3
10	22BT2079	Waste Management and Upcycling	3	0	0	3
11	22BT2080	Gene Expression and Transgenics	3	0	0	3
12	22BT2081	Rational Drug Discovery	2	1	0	3
13	22BT2082	Precision Medicine and Wellness	3	0	0	3
14	22BT2083	Nano Biotechnology	3	0	0	3
15	22BT2084	Structural Biology	3	0	0	3
16	22BT2085	Synthetic and Systems Biology	2	1	0	3
17	22BT2086	Molecular Pharmaceutics	3	0	0	3
18	22BT2087	Computer Aided Drug Design	3	0	0	3
19	22BT2088	Drug Formulation Development Lab	0	0	3	2
20	22BT2089	Genome engineering in Livestock and Agriculture	3	0	0	3
21	22BT2090	Genome Editing for Therapy	3	0	0	3
22	22BT2091	Genetic Manipulation Lab	0	0	3	2
23	22BT2092	Pharmacogenomics	3	0	0	3
24	22BT2093	Precision Medicine	3	0	0	3
25	22BT2094	Precision Medicine Lab	0	0	3	2
26	22BT2095	Biomaterials in Biotechnology	3	0	0	3
27	22BT2096	Bioterrorism and National Security	3	0	0	3
28	22BT2097	Comprehensive Practices	0	0	3	1.5

22BT2070	TOTAL QUALITY MANAGEMENT AND PROCESS ECONOMICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To make students understand the importance of quality management and the role of human resources management in ensuring quality.
2. To familiarize the students with the statistical tools used in quality management, market structure and failure.
3. To gain insights into quality management systems and process equipment economics.

Course Outcome:

At the end of the course the students will be able to

1. Understand the quality management in manufacturing and servicing organization
2. Understand the Framework of TQM
3. Appraise the implementation process for TQM
4. Evaluate process control tools for better quality management and control charts
5. Analyze process equipment economics and market structure.
6. Enumerate cost entities in estimation and costing of bioreactors.

Module I: Introduction (7 hrs)

Differences between manufacturing and service organizations – cost of quality – evolution of TQM – concepts of TQM Philosophy – Seven tools of quality control

Module II: TQM Concepts (7 hrs)

Gurus of TQM, TQM framework, Defining Quality, Benefits of TQM- Leadership: Definitions, Characteristics of Quality Leaders, The Deming Philosophy, Quality council- Customer satisfaction: Customer perception of Quality, Translating needs into requirements

Module III: Continuous Process Improvement **(7 hrs)**
Juran Trilogy, PDSA Cycle, Kaizen – Supplier Partnership: Principles of Supplier relationship, Supplier selection, Supplier certification, Supplier rating- Performance measures, Quality costs- Benchmarking: Definition and process

Module IV: Quality Management Systems and Statistical Process Control **(8 hrs)**
ISO, Benefits of ISO - Implementation, Documentation, Internal Audits, Registration – Environmental Management System: Concept of Quality Function Deployment – The QFD. Pareto diagram, Process flow diagram, Cause and Effect diagram, Check Sheets, Histograms, Control charts for Attributes, Control charts for Variables, Process capability- Taguchi's Loss Function, Malcom Balridge Award, Deming Prize.

Module V: Market Structure and Failure **(8 hrs)**
Market Structure: Perfect Competition – Characteristics – Price and output determination in short run and long run – Monopoly – Price Discrimination –Monopolistic Competition – Product Differentiation – Oligopoly and Duopoly. Market Failure: Causes – Type of Goods – Rivalrous and Non-rivalrous goods – Excludable and Non-excludable goods – Solutions – Government Intervention.

Module VI: Process Economics **(8 hrs)**
Types of Bioreactors - Introduction to cost diagrams, application of cost diagrams, Introduction to Project Economics, Process Selection and Site Survey, Project Cost estimation, Time Value of Money, Interest and Depreciation, Project Finance & Profitability Analysis.

Text Books

1. Besterfield,D.H(2004), Total Quality Management (3 rd edn.), Pearson education: New Delhi
2. Subburaj Ramasamy (2011), Total Quality Management, Tata McGraw Hill, New Delhi.
3. Joshi, M.V, "Process Equipment Design", MacMillan, 3rd edition, 2004.
4. Premvir Kapoor, "Sociology & Economics for Engineers", Khanna Publishing House, 2018.

Reference Books

1. Charantimath, 2010. Total Quality Management. Pearson,
2. Paul A Samuelson & William, "Economics", 2012. Tata McGraw Hill, New Delhi, 2012.
3. Principles, Practice and Economics of Plant and Process Design. 2007. Gavin Towler and Ray Sinnott. Elsevier.

22BT2071	GOOD MANUFACTURING AND LABORATORY PRACTICES	L	T	P	C
		3	0	0	3

Course objectives:

1. To understand the importance of documentation practices and record-keeping
2. To appreciate the importance of quality control
3. To recognize the scope of quality certifications applicable to Food and Pharmaceutical industries.

Course Outcome:
Upon completion of this course the student should be able to

1. Understand the key regulatory and compliance elements with respect to Good Manufacturing Practices, Good Laboratory Practices and Good Clinical Practices.
2. Formulate check lists and SOPs for various assessment and accreditation process
3. Implement Good laboratory and manufacturing practices in Food and Pharma Industries
4. Organize readiness in conduct of audits and trials
5. Assess biological safety and hazards
6. Gain knowledge on regulatory affairs

Module 1: Introduction to GxP (GMP, GLP, GCP) **(6 Hours)**
GxP-Introduction, definitions, requirements and historical background, WHO guidelines on GLP and GMP, Quality assurances in Good Laboratory Practices, Principles for documentation (SOP).

Module 2: Quality Standards and Quality Assurances (6 Hours)
Quality Standards- Advantages and Disadvantages, Concept of Quality Control Quality Assurance- Their functions and advantages, Quality assurance and quality management in industry, Customer requirement of quality

Module 3: Good Manufacturing Practices in Pharmaceutical and Food Industries **(12 Hours)**
Types of validation in Pharma industry Scope and importance of Validation, Limitations, Validation of Analytical Procedures as per ICH Guidelines, Hygienic design of food plants and equipment's, Sanitation in warehousing, Principles of quality by design (QBD), Introduction to the concept of Design of Experiment

(DOE), Application of QBD principles in Biotech product development. Case studies: Example of QBD and DOE in Process Development, Example of DOE in analytical development

Module 4: Quality Control **(8 Hours)**

Introduction to Quality control and Total Quality Control in the food industry, Food Inspection and Food Law, Critical Control Points in Food Industries: Critical Quality control point in different stages of production including raw materials and processing materials, Food Quality and Quality control including the HACCP system, ISO 9000 & ISO14000: Overview, Benefits, Elements, steps for registration, NABL accreditation: Principles and procedure

Module 5: Biosafety **(8 Hours)**

Introduction: Historical Background, Biosafety in Laboratory/ institution. Laboratory associated infections and other hazards, Assessment of Biological Hazards and levels of biosafety, Primary Containment of Biohazards, Biosafety Levels, Recommended Biosafety Levels for Infectious Agents and Infected Animals Biosafety guidelines, Government of India Guidelines; Industrial hygiene: Check for microbial contaminants, evaluation and control

Module 6: Regulation on Clinical and Preclinical Studies **(5 Hours)**

Regulation on Clinical and Preclinical Studies, Formulation, Production, Management, Authorization and marketing of drugs, Guidelines on animal studies

Textbooks:

1. Emmet P. Tobin, cGMP starter guide: Principles in Good Manufacturing Practices for Beginners, , Createspace Independent Publishing Platform, April 2016.
2. Cooper BN, Good Manufacturing Practices for Pharmaceuticals: GMP in Practice, Createspace Independent Publishing Platform, July 2017.
3. Sarwar Beg and Md Saquib Hasnain, Pharmaceutical Quality by design: Principles and application, Academic press, March 2019.
4. Andrew Teasdale, David Elder, Raymond W. Nims, ICH quality guidelines- An implementation guide, Dec 2017.

Reference Books:

1. Gajendra Singh, Gaurav Agarwal an Vipul Gupta, Drug regulatory affairs, CBS publication, 2005.
2. Ron S. Kenett, Shelemyahu Zacks, Daniele Amberti, Modern Industrial Statistics: with applications in R, MINITAB and JMP, 2nd Edition, Wiley, January 2014.
3. Marc P. Mathieu, New Drug Development: A regulatory overview, Nov 2000.

22BT2072	METABOLIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To develop skills in the area of metabolic engineering
2. To impart knowledge on complex regulatory mechanisms to control the dynamics of the cellular metabolism
3. To familiarize advanced molecular techniques to enhance the product yield

Course Outcomes:

At the end of course student will be able to

1. Comprehend modern biology with engineering principles
2. Recall the principles and regulation of metabolic pathways
3. Construct suitable metabolic flux models using available metabolic engineering tools
4. Familiarize with the conceptual framework involved in metabolic control analysis
5. Appreciate the process of bioconversion to produce commercial product
6. Describe the industrial applications of metabolic engineering in the field of medicine, energy, and environment

Module 1: Introduction to metabolic engineering and its importance **(8 hours)**

Introduction to metabolism, catabolism, anabolism; Key differences between metabolic controls of prokaryotes and eukaryotes; Improvement of cellular properties, altering transport of nutrients including carbon and nitrogen; Methods for metabolic characterization: Genome, Transcriptome, Proteome

Module 2: Regulation of Metabolic Pathways **(6 hours)**

Induction-Jacob Monod Model and its regulation, differential regulation by isoenzymes, concerted or cumulative feedback regulation. Regulation in branched pathways, Mutants which do not produce feedback inhibitors or repressors- auxotrophs-lysine, purine nucleotides; trophophase- idiophase relationship

Module 3: Metabolic Flux Analysis (10 Hours)
Metabolic flux analysis; Building stoichiometric matrix; Steady state and pseudo steady state assumptions; Methods for experimental determination of metabolic fluxes by isotope labeling metabolic fluxes using GC-MS

Module 4: Metabolic Control analysis (8 Hours)
Metabolic Control analysis (MCA); control coefficients, MCA of linear and branched pathways, control of flux distribution at branch point, grouping of reactions, optimization of flux amplification

Module 5: Bioconversion (6 hours)
Bioconversion- Factors affecting bioconversion, mixed or sequential bioconversions- Co metabolism, Product inhibition, Conversion of insoluble substances, Applications of Bioconversions

Module 6 Applications of Metabolic Engineering (7 hours)
Strategies for overproduction of commercially important primary and secondary metabolites (e.g. amino acids, organic acids, alcohols and therapeutic compounds), industrially relevant enzymes and recombinant proteins

Textbooks:

1. Gregory N. Stephanopoulos, Aristos A. Aristidou & Jens Nielsen, "Metabolic Engineering: Principles and Methodologies", Academic Press, An Imprint of Elsevier India Pvt. Ltd., 1st edition, 1998.
2. Cortassa S., Aon M.A., Iglesias A.A. and Llyod D., "An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Co. Pte. Ltd, 2002.
3. Smolke, C.S. (2010) Metabolic Pathway Engineering Handbook: Fundamentals. 1st ed. New York: CRC Press.

Reference Books:

1. Freemont, P.S and Kitney, R.I. (2012). Synthetic Biology – a Primer. World Scientific Publishing Co pvt Ltd
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 3rd edition, 2016
3. Crueger W. and Crueger A., "A Text Book of Industrial Microbiology", Panima Publishing Corporation, 2005
4. Cheng Q. "Microbial Metabolic Engineering: Methods and Protocols", Humana Press, First Edition (2011).

22BT2073	CHEMINFORMATICS AND MEDICINAL CHEMISTRY	L	T	P	C
		2	1	0	3

Course Objectives:

1. To introduces the small molecule-ligand-oriented in silico physico-chemical aspects of rational drug design.
2. To represent of chemical information, chemical databases and data mining, molecular drawing and interactive visualization can able to understand the novel concept of new drug discovery.
3. To build ligand ab initio or from similar ligands, with and without known macromolecules, assessing activity and toxicity and drugability.

Course Outcomes:

At the end of course student will be able to

1. Investigate chemicals and materials that are not practical for laboratory analysis
2. Develop individual model molecules or the behaviors of chemical compounds within the natural world
3. create a catalog, categorize, organize, and search the structures of chemicals
4. Describe the computational chemistry to simplify problems and make calculations that are used in laboratory experimentation.
5. Understand the concepts of rational drug discovery on medicinal chemistry.
6. Create the skills on basics of biophysical properties and biological activity parameters of anti-inflammatory drugs.

Module 1: Chemistry and Information technology (8hrs)
Overview of pharmaceutical chemistry , Ligands and Targets, in-silico representation of chemical information.

Module 2: Chemical Databases **(7hrs)**
Data Mining, Chemical/biochemical data collation, retrieval, analysis and interpretation.
Module 3: Computer-Aided Drug Design **(8hrs)**
Overview, Structural Homology Modelling Tools, Docking Tools and Screening Tools, Artificial intelligence in chemistry, Simulation methods for molecules and materials.
Module 4: Structural molecular mechanism **(7hrs)**
Stereochemistry and mechanism, coordination chemistry for drug design, in silico tools for medicinal chemistry (docking, MD, de novo drug design), Organic reaction mechanism, Logic in organic synthesis, QSAR, pharmacological screening, chemistry of drug action, Pharmaceutical Preformulation, Solid State Pharmaceutics, Drug metabolism, pharmacokinetics, pharmacodynamics.
Module 5 : Medicinal chemistry **(8 hrs)**
History and development of medicinal chemistry, Physicochemical properties in relation to biological action Ionization, Solubility, Partition Coefficient, Hydrogen bonding, Protein binding, Chelation, Bioisosterism, Optical and Geometrical isomerism, Drug metabolism, Drug metabolism principles- Phase I and Phase II. Factors affecting drug metabolism including stereo chemical aspects
Module 6: Anti-inflammatory agents **(7 hrs)**
Sodium salicylate, Aspirin, Mefenamic acid*, Meclofenamate, Indomethacin, Sulindac, Tolmetin, Zomepriac, Diclofenac, Ketorolac, Ibuprofen*, Naproxen, Piroxicam, Phenacetin, Acetaminophen, Antipyrine, Phenylbutazone.
Text Book:
1. Muthukumarasamy Karthikeyan and Renu Vyas. Practical chemoinformatics. Springer, soft-cover ISBN 9788132234913, 2014.
2. Silverman, Richard B., and Mark W. Holladay. The organic chemistry of drug design and drug action. Academic Press, 2014.

Reference Book:
1. Bajorath, Jurgen. Chemoinformatics for Drug Discovery. John Wiley & Sons, 2013.
2. Cramer, C.J., Essentials of Computational Chemistry, 2nd Ed., John Wiley & Sons Ltd., 2004.
3. Essentials of Foye's Principles of Medicinal Chemistry – 2016. An Introduction to Medicinal Chemistry, by Graham L. Patrick.

22BT2074	BIOPROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:
1. This course aims at making the students understand the fundamental principles and concepts of Bioprocess engineering.
2. This will help the student understand stoichiometric calculations, models of growth and product formation
3. To understand the basics of oxygen transfer in microbial bioreactors

Course Outcome:
The students will be able to
1. Gain knowledge on principles of stoichiometry and concepts of bioreactor engineering
2. Understand the growth kinetics and enzyme kinetics in fermentation process
3. Apply bioreactor design fundamental in scale up process
4. Evaluate the oxygen requirement in aerobic culture and oxygen limited growth
5. Analyze various bioreactors for fermentation process.
6. Evaluate application of enzymes and the techniques of immobilization

Module 1: Enzyme Kinetics and Inhibition **(8 hrs)**
Kinetics of enzyme catalyzed reactions. Importance and estimation of Michelis – Menten parameters, Enzyme inhibition types and models- Competitive, Noncompetitive and Uncompetitive inhibitions. Inhibition kinetics- substrate, product and toxic compound
Module 2: Stoichiometry of Cell Growth and Product Formation **(6 hrs)**
Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, various yield coefficients of biomass and product formation, oxygen consumption and heat evolution in aerobic cultures.
Module3 Simple Unstructured Kinetic Models For Growth **(6hrs)**

Simple unstructured kinetic models for microbial growth, Monod model, Substrate uptake kinetics and maintenance coefficient, growth of filamentous organisms, product formation kinetics - Leudeking- Piret models, substrate and product inhibition on cell growth and product formation. Determination of kinetic parameters for Monod equation.

Module 4: Oxygen Transfer in Microbial Bioreactors (6 hrs)

Oxygen transfer in microbial bioreactors; oxygen uptake rates and determination of oxygen transfer coefficients (kLa) by correlations and experimental methods; Mass transfer in heterogeneous biochemical reaction system, role of aeration and agitation in oxygen transfer and types of aerators and agitators.

Module 5: Bioreactors for Free and Immobilized Cells (12 hrs)

Bioreactors for free cells – batch, continuous, fed batch, chemostat, Bubble column, air lift loop reactor. Physical and chemical techniques for enzyme immobilization, Design of Bioreactors for immobilized cells: packed – bed and fluidized bed bioreactors, and membrane reactors., comparison of the productivity in batch and continuous culture, concept of HRT, SRT, OLR in CSTR,

Module 6: Scale up and scale down criteria for bioreactors (7 hrs)

Power requirements in mixing under aerated and non-aerated conditions, effects of heterogeneity and bases for scale-up. Mechanistic background of dimensional analysis, the use of dimensionless groups for scaling up, Scale up procedure from laboratory to pilot scale, Fermentation process scale down: benefits of process scale down, regime analysis and strategies for scale down experimentation

Text Books

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2015.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2016.

Reference Books

1. Panda, Tapobrata. Bioreactors: Process and Analysis. India, Tata McGraw Hill Education, 2011.
2. S.Liu, Bioprocess Engineering: Kinetics, Biosystems, Sustainability, and Reactor Design, Elsevier, 2016
3. Najafpour, Ghasem. Biochemical Engineering and Biotechnology. Netherlands, Elsevier Science, 2015.

22BT2075	BIOPROCESS LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To learn the culturing of microbes and quantifying biomass production
2. To provide extensive knowledge on enzyme kinetics and growth kinetics
3. To learn immobilization techniques

Course Outcomes:

The students will be able to

1. Acquire knowledge in the process of fermentation.
2. Illustrate medium optimization
3. Demonstrate enzyme assay qualitatively and quantitatively
4. Apply methods to estimate mass transfer coefficient
5. Utilize solid state fermentation for production of fermented products
6. Assess the growth kinetics and enzyme kinetics during fermentation

List of Experiments:

1. Culturing of Different Types of Microorganism in Batch Reactor
2. Estimation of Biomass Production by Wet Weight and Dry Weight Method
3. Comparative study between Free & Immobilized Enzyme
4. Determination of MM Parameters
5. Determination of volumetric mass transfer coefficient using sulphite oxidation method.
6. Immobilization of Enzyme and microbe by entrapment method
7. Medium Optimization Plackett Burmann method
8. Citric acid production by Solid State Fermentation
9. Qualitative Assay of enzyme α-amylase- Starch Plate Technique
10. Quantitative Assay of enzyme α-amylase
11. Production of Wine

12. Growth kinetics of Baker's Yeast

Reference Books:

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2014.
2. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2016.

22BT2076	DATA ANALYSIS AND SIMULATIONS	L	T	P	C
		2	1	0	3

Course Objectives:

1. To understand and implement the principles and methods of statistical analysis for a range of real-world data sets.
2. To provide a basic understanding of data analysis using statistics and to use computational tools on problems of applied nature.
3. To apply data science techniques such as machine learning, deep learning to biological data.

Course Outcomes:

At the end of course student will be able to

1. Evaluate the correlation among data sets and adapt data visualization
2. Apply relevant statistical analysis to real-time data
3. Analyze associations, or causal structures from data sets
4. Apply machine learning techniques to healthcare and biological data
5. Adapt ANN based models for biological data
6. Evaluate quality of models developed using machine learning tools

Module 1: Data preprocessing and visualization (7 hours)

Types of data, dealing with missing data, data visualization: Scatter Plot, histogram, group plots, box plots etc., dimensionality reduction.

Module 2: Data analysis (7 hours)

Statistical analysis, hypothesis testing, significance of p-value, chi-square, T-test, Interval, Estimation for the Comparison of Means, tutorials using softwares such as SPSS, Stata, SAS.

Module 3: Mining Frequent Patterns (7 hours)

Associations and correlations, classification: decision tree classifiers, Bayesian classifiers, and rulebased classifiers , cluster analysis : Fuzzy clustering and probabilistic model-based clustering, outlier detection.

Module 4: Machine learning (9 hours)

Supervised learning, unsupervised learning, logistic regression, Support Vector Machines (SVMs), decision trees, clustering and model evaluation.

Module 5: Artificial neural networks (ANN) (8 hours)

Introduction to ANNs, Types of ANN: feedforward neural networks, recurrent neural network, convolutional neural network, case studies for the application of deep learning in biology and health care research.

Module 6: Model selection and validation (7 hours)

Model class selection, Overfitting, Cross-validation, Information Criteria (AIC, BIC)

Total hours: 45

Text Books:

1. Introduction to Machine Learning using Python, Jeeva Jose, Khanna Publishing House, 2019.
2. Data Mining: Concepts and Techniques, Jiawei Han, Micheline Kamber, and Jian Pei, Elsevier; Third Edition, 2012

References:

1. Data Visualization – A Practical Introduction by Kieran Healy, Princeton University Press, 2019.
2. Deep Learning – Rajiv Chopra, Khanna Publishing House, 2019.
3. Deep Learning by Ian Goodfellow, Yoshua Bengio, MIT Press 2017.

22BT2077	BIG DATA ANALYTICS	L	T	P	C
		2	1	0	3

Course Objectives:

1. To inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.

2. To equip the student with skills to analyze problems, formulate an hypothesis, evaluate and validate results.
3. To prepare students for pursuing research or careers in industry in mathematical sciences and allied fields.

Course Outcomes:

The student should be able to:

1. Understanding of basic characteristics application and challenge of bigdata analytics.
2. Describe the traditional about storage, organization, and manipulation of structured data.
3. Understand the challenges associated with modified enzyme systems using big data computing.
4. Able to analyse learn the risk, safety, and ethics of gene editing tools.
5. Develop the perspective of the complexity to establish models through Hadoop.
6. Illustrate and implement the concepts by taking an application problem.

Module 1: Introduction (8hrs)

Data Storage and Analysis - Characteristics of Big Data – Big Data Analytics - Typical Analytical Architecture – Requirement for new analytical architecture – Challenges in Big Data Analytics – Need of big data frameworks

Module 2: Traditional methods (7hrs)

Overview of traditional methods: homologues recombination for gene knockout. RNAi system, Cre-LoxP and Flp-FRT systems.

Module 3: Engineered enzyme systems (8hrs)

Zinc finger nucleases (ZFNs), transcription-activator like effector nucleases (TALEN), meganucleases and the clustered regularly interspaced short palindromic repeats (CRISPR/Cas9) system.

Module 4: Gene editing (8hrs)

Design of sgRNA. Multiplex Automated Genomic Engineering (MAGE). Applications in Targeted gene mutation, Gene therapy, creating chromosome rearrangement

Module 5: Hadoop Ecosystem (7hrs)

Introduction to Hadoop ecosystem technologies: Serialization: AVRO, Co-ordination: Zookeeper, Databases: HBase, Hive, Scripting language: Pig, Streaming: Flink, Storm

Module 6: Application of Big data analysis (7hrs)

Application in biofuel production and in bioremediation. Ethics, safety and risk of targeted gene editing.

Text Books:

1. Foundations of Systems Biology, Hiroaki Kitano (Editor),MIT Press, 2001
2. Computational Modeling of Genetic and Biochemical Networks, James M. Bower, Hamid Bolouri, MIT Press,2000.
3. Gene Regulation and Metabolism: Postgenomic Computational Approaches, Julio Collado-Vides (Editor), Ralf Hofestadt (Editor),MIT Press,2002

Reference Books:

1. Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, 2/e, CRC Press, (2006).
2. Kitano et al., Systems Biology: A Brief Overview, Science, (2002), 295, 1662-1664.
   John Ross et al., Complex Systems: From Chemistry to Systems Biology, PNAS, (2009), 106, 6433–6434.

22BT2078	BIOSIMILARS TECHNOLOGY	L	T	P	C
		3	0	0	3

Course objective:

1. To describe biotechnologies used for biologics production and delivery.
2. To explain the specific aspects of biologics in pharmacodynamics and pharmacokinetics.
3. To describe the advancements and challenges for using gene therapy to treat various disorders.

Course Outcomes:

Students completing this class will be able to:

1. Demonstrate appropriate depth and breadth of knowledge in Biologics.
2. Understand the concept and characteristics of biologics, biosimilars, and bioequivalence.
3. Distinguish the differences and similarity between biologics and chemical drugs.
4. Describe and apply the principles of the biotechnologies
5. Describe the procedure and techniques for target identification and validation for biologics

6. Compare/contrast the pharmacodynamics and pharmacokinetics of biologics versus chemical drugs.

Module 1: Introduction to Biopharma (8hrs)

Generics in Biopharma, definition of biologics, biosimilars, super biologics, differences between chemical genetics and biosimilars, The developmental and regulatory challenges in biosimilar development, Prerequisites for Biosimilar development, Biosimilar market potential.

Module 2: Types of biosimilar drugs (8hrs)

Peptides, proteins, antibodies, Enzymes, Vaccines, Nucleic acid based therapies (DNA, RNA, etc), Cell based therapies (including stem cells)

Module 3: Characterization methods (7hrs)

Aggregation- precipitation, floccule strength, precipitate ageing & kinetics, adsorption of proteins & peptides on surfaces, effect of temperature on protein structure, hydration & thermal stability of proteins - solid powders, suspension on non-aqueous solvents, reversed micelles, aqueous solution of polyols, analytical and spectrophotometric characterization of proteins, protein sequencing and structure determination

Module 4: Bioequivalence studies (8hrs)

Immunogenicity & allergenicity of biosimilars; factors affecting immunogenicity - structural, post-translational modifications, formulations, impurities, manufacturing and formulation methods for biosimilars; types of bioequivalence (average, population, individual), experimental designs & statistical considerations for bioequivalence studies (Non-replicated designs – General Linear Model, Replicated crossover designs), introduction to “ORANGE BOOK” & “PURPLE BOOK”.

Module 5: Case studies (7hrs)

Indian companies working in this space & their product pipeline (Biocon, Intas, Dr Reddy’s, Reliance, Bharat Biotech, Lupin, Cipla, Shanta, etc); products - Erythropoietin, growth hormone, granulocyte stimulating factors, interferons, streptokinase, monoclonal antibodies.

Module 6: Therapeutic Biologic Applications (BLA) (7hrs)

Biological products, like other drugs, are used for the treatment, prevention or cure of disease in humans. Public Health Service (PHS) Act, FDA’s Center for Drug Evaluation and Research (CDER) and Center for Biologics Evaluation and Research (CBER)

Text Books:

1. Laszlo Endrenyi, Paul Declerck and Shein-Chung Chow, Biosimilar Drug Development, Drugs and Pharmaceutical Sciences, Vol 216, CRC Press.
2. Cheng Liu and K. John Morrow Jr., Biosimilars of Monoclonal Antibodies: A Practical Guide to Manufacturing, Preclinical and Clinical Development, Wiley, Dec 2016.

Reference Books:

1. Schoenwald, R.D., “Pharmacokinetics in Drug Discovery and Development”, CRC Press,2002.
2. Niazi, Sarfaraz K. “Handbook of Biogeneric Therapeutic Proteins: Regulatory,Manufacturing, Testing, and Patent Issues”. CRC Press, 2006.
3. Glick B.R. and Pasternak J.J. “Molecular Biotechnology: Principles and applications ofrecombinant DNA” 3rdEdition., ASM Press, 2003.

20BT2079	WASTE MANAGEMENT AND UPCYCLING	L 3	T 0	P 0	C 3

Course Objectives:

1. To understand the basic concept of waste and its sustainable management.
2. To inculcate knowledge and skills in the collection, transport, treatment, disposal and recycling process for solid and liquid wastes.
3. To acquire knowledge on how waste can be converted to wealth in a sustainable way.

Course Outcomes:

The students will be able to:

1. Categorize different types of wastes and develop concepts in the field of waste management.
2. Relate the characteristics features of different wastes and influencing factors.
3. Analyze suitable techniques to transport and disposal of wastes.
4. Compare among various waste processing technologies.
5. Formulate treatment process of wastewater and sludge disposal.
6. Develop sustainable technologies for waste conversion into value-added products.

Module 1: Classification of Wastes and it's Management (8 hrs)
Types and sources of solid and hazardous wastes; Need for solid and hazardous waste management; Salient features of Indian legislations on management and handling of municipal solid wastes, nuclear wastes, electronic wastes, plastics and fly ash; Financing and public private participation for waste management; Induction of 5R's in waste management-Refuse, reduce, reuse, repurpose, recycle.
Module 2: Waste Characterization and Source Reduction (7 hrs)
Waste generation rates and variation; composition, physical, chemical and biological properties of solid wastes; Hazardous characteristics-TCLP tests; Waste sampling and characterization plan; Source reduction of wastes, waste exchange, extended producer responsibility; Collection of municipal solid wastes, Handling and segregation of wastes at source-storage.
Module 3: Transport and Disposal of Wastes (7 hrs)
Transfer stations optimizing waste allocation; Compatibility, storage, labelling and handling of hazardous waste; Hazardous waste manifests and transport; Waste disposal options; Disposal in landfills, landfill classification, types and methods; Site selection; Design and operation of sanitary landfills, secure landfills and landfill bioreactors; Leachate and landfill gas management; Landfill closure and environmental monitoring.
Module 4: Waste Processing Technologies (9 hrs)
Material separation and processing technologies; Biological and chemical conversion technologies; Methods and controls of composting; Thermal conversion technologies and energy recovery; Incineration, solidification and stabilization of hazardous wastes; Treatment of biomedical wastes; Health considerations in the context of operation of facilities, handling of materials and impact of outputs on the environment.
Module 5: Wastewater Reuse and Residual Management (8 hrs)
Individual and Common effluent treatment plants; Joint treatment of industrial and domestic wastewater; Zero effluent discharge systems; Quality requirements for wastewater reuse; Industrial reuse, present status and issues; Disposal on water and land; Residuals of industrial wastewater treatment; Quantification and characteristics of sludge; Thickening, digestion, conditioning, dewatering and disposal of sludge; Management of RO rejects.
Module 6: Sustainable Technologies for Waste Conversion into Value-added Products (6 hrs)
Waste biomass into bioenergy, Liquid form of biofuels-Bioethanol, Gaseous form of biofuels-Biohydrogen; Conversion of waste into nanoparticles, Application of waste nanomaterials into the environmental sectors; Textile waste upcycling; Upcycling of chicken wastes into fibers; Circular bioeconomy.
Text Books:
1. M.J. Rogoff, "Solid Waste Recycling and Processing" Elsevier, 2nd Edition, 2013.
2. Jonathan W. C. Wong; Rao Y. Surampalli; Tian C. Zhang; Rajeshwar D. Tyagi; and A. Selvam "Sustainable Solid Waste Management, ASCE, First edition, 2016.

Reference Books:
1. A.Virginia, "Industrial wastewater management, treatment & disposal", Water Environment Federation, 3rd Edition, 2008.
2. O.P. Gupta, "Elements of Solid & Hazardous Waste Management", Khanna Publishing House, New Delhi, 2019.

22BT2080	GENE EXPRESSION AND TRANSGENICS	L	T	P	C
		3	0	0	3

Course Objectives:
1. Provide the technical details and use of different gene expression systems for overexpression of recombinant proteins.
2. Develop technical skills in purification of proteins expressed in different expression systems.
3. Impart knowledge about the use transgenic animals in research.

Course Outcomes:
The students will be able to
1. Define the concepts in gene expression system
2. Relate and evaluate the use of cloning vectors and promoters in genetic engineering.
3. Understand and analyze the process of purification of proteins
4. Discuss and appraise the strategy and applications of gene cloning
5. Analyze the importance of transgenesis in biotechnological research.
6. Comprehend the current status of genome sequencing projects

Module 1: Recombinant protein expression vectors and protein purification (8 hrs)
Vectors with tags -His, GST, MBP. Cleavable tag and non-cleavable tags. Vectors for tag free protein expressions. Over-expression of integral membrane proteins. Plasmid vectors for expression in plants.
Module 2: Over expression for protein production in various organisms (9 hrs)
Overexpression in E. coli, B. subtilis, Corynebacterium, Pseudomonas fluorescens, yeasts like S. cerevisiae and Pichia pastoris, insect cell lines like Sf21 and Mammalian cell line like Chinese Hamster ovary (CHO) and Human embryonic kidney (HEK), Plant single cell.
Module 3: Cell free protein Expression systems (7 hrs)
Cell free protein Expression-Cell free extracts from *E. coli*, rabbit, wheat germ, insect. Purification of tagged and tag-free proteins.
Module 4: Methods for creation of transgenic organisms (7 hrs)
Microinjection, Embryonic stem cell-mediated gene transfer, Retrovirus-mediated gene transfer. Microprojectile bombardment, electroporation, Agrobacterium mediated gene transfer.
Module 5: Application of Transgenic Organisms (7 hrs)
Transgenic plants in crop improvement, transgenic products in plants, transgenic animals in medical research, in toxicology, in mammalian developmental genetics, in the pharmaceutical industry, in biotechnology, in aquaculture and in xenografting. Humanized animal models
Module 6: Functional genomics (7 Hrs)
Introduction to Functional genomics, Microarrays, EST, Serial Analysis of Gene expression (SAGE), Subtractive hybridization, TOGA, Proteogenomics and relevant Web resources.

Total: 45 hrs

Text Books

1. Desmond S. T. Nicholl, "An Introduction to Genetic Engineering", 3rd Edition Cambridge University Press; South Asian edition, 2010.
2. Gene Cloning and DNA Analysis, 6th Edition, Blackwell Publishing Ltd 2010
3. Barry R. Schaller "Understanding Bioethics and the Law: The Promises and Perils of the Brave New World of Biotechnology" Praeger Publishers Inc, 2007.

Reference Books

1. Sandy B. Primrose, Richard Twyman "Principles of Gene Manipulation and Genomics" Backwell Scientific Publications 2010.
2. Sandhya Mitra, "Genetic Engineering Principles and Practice", Macmillan Publications, 2008.
3. Richard Sherlock, John D. Morrey "Ethical Issues in Biotechnology" Rowman & Littlefield Publishers, 2002.
4. Regulation of Gene Expression, By Perdew, Gary H., Vanden Heuvel, Jack P., Peters, Jeffrey M. Springer 6th Edition 2007.

22BT2081	RATIONAL DRUG DISCOVERY	L	T	P	C
		2	1	0	3

Course Objectives:
1. To explore the process of drug development, from target identification to final drug registration.
2. To provide the knowledge in drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening.
3. To develop skills in specialized areas related to bioavailability, clinical trials, and the essentials of patent law

Course Outcomes:
The students will be able to
1. Understand the process of drug discovery and development
2. Discuss the challenges faced in each step of the drug discovery process
3. Classify the computational methods used in drug discovery
4. Organize information into a clear report
5. Demonstrate their ability to work in teams and communicate scientific information effectively
6. Construct, review and evaluate preclinical and clinical pharmaceutical studies.

Module 1: Drug and their Interaction (8 Hours)
Introduction to Drugs: Drug nomenclature, Routes of drug administration and dosage forms, Principles of Pharmacokinetics and Pharmacodynamics: ADME, Bioavailability of drugs -Lipinski's rule; how drugs work -Drug targets, drug-target interaction and dose-response Relationships.

Module 2: Drug design pipeline **(8 Hours)**
New Drug Discovery & Development: Overview of new drug discovery, development, cost and time lines. Target Identification & Validation. Lead Discovery: Rational and irrational approaches -Drug repurposing, Natural products, High-throughput screening (HTS), Combinatorial chemistry and computer aided drug design (CADD).

Module 3: Fundamental of Drug Actions **(8 Hours)**
Inter and intramolecular interactions: Weak interactions in drug molecules; Chirality and drug action; Covalent, ion, ion-dipole, hydrogen bonding, C-H hydrogen bonding, dihydrogen bonding, van der waals interactions and the associated energies. Cation-and-OH interactions. Receptorology: Drug-receptor interactions, receptor theories and drug action; Occupancy theory, rate theory, induced fit theory, macromolecular perturbation theory, activation-aggregation theory. Topological and stereo chemical consideration.

Module 4: Drug toxicity, Assays and testing **(7 Hours)**
Preclinical Testing of New Drugs: Pharmacology -In vitro/in vivo Pharmacokinetics and Pharmacodynamics testing; Toxicology-Acute, chronic, carcinogenicity and reproductive toxicity testing; Drug formulation testing. Clinical Trial Testing of New Drugs. Good clinical practice (GCP) guidelines - Investigators brochures, Clinical trial protocols and trial design; Ethical issues in clinical trials -How are patient rights protected?

Module 5: Drug Regulatory Agencies **(7 Hours)**
US Food & Drug Administration (US FDA) and Central Drugs Standard Control Organization (CDSCO), India. Regulatory Applications & New Drug Approval: Investigational new drug (IND) application & New drug application (NDA); Regulatory review and approval process. Regulatory Requirements for Drug Manufacturing: Current Good manufacturing practice (cGMP) and GMP manufacturing facility inspection & approval.

Module 6: Drug review intellectual rights (IPR) **(7 Hours)**
IPR Definition and implications for discovery & development. Forms of IPR Protection-Copyright, Trademark and Patents. International organization and treaties for IPR protection –World Trade Organization (WTO) & Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreements. Controller General of Patents, Designs & Trade Marks, India (CGPDTM), World Intellectual Property organization (WIPO)-Patent Cooperation Treaty (PCT).

Text Books:

1. Rick NG. Drugs: From discovery to approval 2nd Ed Wiley Blackwell (2009)
2. TripathiKd. Essentials of Medical Pharmacology, 6th Edition, Publisher: Jaypee Brothers (2013)
3. Burger’s Medicinal Chemistry and Drug discovery. Volume 2, Wiley-Interscience; Volume 2 edition (2003)

Reference Books:

1. Prankrishna Pal. Intellectual Property Rights In India: General Issues And Implications Publisher: Deep & Deep Publications Pvt.Ltd (2008)
2. Stromgaard, Kristian, PovlKrogsgaard-Larsen, and Ulf Madsen. Textbook of drug design and discovery. CRC Press, (2009).
3. Katzung, Bertram G., Susan B. Masters, and Anthony J. Trevor. Basic and Clinical Pharmacology (LANGE Basic Science). McGraw-Hill Education,(2012).
   Spriet, Alain, et al. Methodology of clinical drug trials. Basel: Karger, (2004).

22BT2082	PRECISION MEDICINE AND WELLNESS	L	T	P	C
		3	0	0	3

Course objective:
1. The course will teach the students about use of modern omics techniques and systems biology in providing personalized medicine and preventive health care.
2. To explore the the possibilities, promises, and pitfalls of precision medicine, using real-world examples.
3. To provide students with knowledge about prolonging health and treating disease that will empower them to make shared informed decisions with their physicians

Course Outcomes:
The students will be able to
1. Explain how the HGP has advanced technology in biomedical research.

2. Understand how the diversity of life evolves over time by processes (leading to) of genetic change, particularly the role of genetic and genomic variation throughout the genome in health and disease.
3. Describe recent advances in disease risk prediction, molecular diagnosis and progression of diseases, and targeted therapies for individuals.
4. Understand how to translate research findings and technology into healthcare delivery that benefits the general public.
5. Discuss the ethical, legal, and social implications of health privacy and policy laws for precision medicine.
6. Critically evaluate primary and secondary precision medicine research.

Module 1: Omics application for clinical practice (8hrs)
Use of genomics, transcriptomics, proteomics and metabolomics in understanding disease condition. Biomarker identification and validation of a disease state.

Module 2: Concept of Immunotherapeutics (7hrs)
Introduction to Immunology, Molecular mechanisms in immune cell differentiation and function, Transplant, autoimmunity and tumour immunology, Inflammation and cell migration, Basic concept of cancer treatment and immune response, Chimeric antigen receptor engineering and clinical studies.

.**Module 3: Pharmacogenomics (7hrs)**
Pharmacogenomic testing for drug selection, dosing and predicting adverse effects of commonly prescribed drugs, Tumor profiling, Patient data and clinical decisions.

Module 4: Precision Oncology (8hrs)
Pharmacogenomic testing for drug selection, dosing and predicting adverse effects of commonly prescribed drugs, Tumor profiling, Patient data and clinical decisions.

Module 5: Artificial Intelligence Applications in Precision Health (8hrs)
Concepts and ideas in artificial intelligence (AI) and machine learning -- including statistical approaches, visualization, and human-computer interactions. Applications of AI techniques and software tools.

Module 6: Indian traditional medicine and formulation (7hrs)
Indian traditional medicine history and natural formulations, Ayurveda system of Prakriti and Agni.

Text Books:
1. Genomic and Precision Medicine, 3rd Edition, Geoffrey Ginsburg and Huntington Willard, 2016
2. The Language of Life: DNA and the Revolution in Personalized Medicine, Francis S. Collins, 2010

Reference Books:
1. Genetics and Genomics in Medicine: Tom Strachan, Judith Goodship, Patrick Chinnery ISBN: 9780815344803, 2014, 1st edition
2. Ferryman, Kadija, and Mikaela Pitcan. "Fairness in precision medicine." Data & Society 1 (2018).
3. The Language of Life: DNA and the Revolution in Personalized Medicine, Francis S. Collins.

		L	T	P	C
22BT2083	**NANO-BIOTECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objective:
This course will make the students
1. To get familiarized with the chemistry of biological molecules
2. To learn biophysical principles and dynamics involved in biological systems
3. To apply knowledge on basic techniques involved in the study of biological systems, biotechnology and culturing techniques

Course Outcome:
The students will be able to
1. Learn the basic Properties of Nano composites.
2. Gain knowledge on structural and functional principles of biomolecular motors.
3. Recognize the structural and functional principles of bio-nanotechnology.
4. Acquire knowledge on basic techniques involved in the study of biological systems, biotechnology and culturing techniques
5. Distinguish the biomedical applications of bio-anotechnology.
6. Apply adequate knowledge in nano composites food materials.

Module I Nanobiomaterials and Biocompatibility (9 hours)
Surface and Bulk of bio-materials, Nano Biomaterials, Nano Ceramics, Nano Polymers, Nano Silica, Hydroxy apatite, Carbon Based Nanomaterials, Surface modification, Textured and porous Materials,

Surface immobilized biomolecules, Cell -biomaterial interactions, immune response, In Vitro and In Vivo assessment of tissue compatibility.

Module II Structural & Functional Principles of Bio Nanotechnology. (9 hours)

Lipid Bilayers, Liposomes, neosomes, Polysaccharides, Peptides, Nucleic acids, DNA scaffolds, Enzymes, Biomolecular Motors: linear, rotary motors, immunoconjugates, limitations of natural biomolecules.

Module III Protein and DNA Based Nanostructures (9 hours)

Nanocircuitry – S-layer proteins: structure, chemistry and assembly, lipid chips, S-layer as Templates, engineered nanopores, DNA -protein Nanostructures, DNA-templated Electronics, DNA- based Metallic Nanowires and Networks, DNA-Gold-Nanoparticle Conjugates, DNA-templated Electronics, DNA Nanostructures for Mechanics and computing.

Module IV Nanobio-Analytics (9 hours)

Luminescent Quantum Dots for biological Labelling, Nanoparticle Molecular Labels, Surface Biology: Analysis of Biomolecular Structure by Atomic Force Microscopy and Molecular Pulling, Force Spectroscopy, Biofunctionalized Nanoparticles for Surface, Enhanced Raman Scattering and Surface Plasmon Resonance, Bio-conjugated Silica Nanoparticles for Bioanalytical Applications.

Module V Techniques in Biomedical Imaging and Nano Structuring (9 hours)

Immuno Fluorescent Biomarker Imaging- Immuno gold labeling- Nanoprobes- Bio- Photonics- Diagnostic Biosensors- Catalyst- Functionalized Metallic Nanoparticle and their Applications in Colorimetric Sensing- Dip stick Tests- Nanoparticles as Catalysts for Signal Generation and Amplification- Iron Oxide Nanoparticles in Magnetic Resonance Imaging- Optical nanoparticles sensors for quantitative intracellular imaging. Cancer imaging- Nano photonics. Design aspects of Nanostructures-Lithographic techniques- Nanoimprinting- Near Field Optical Methods of fabrication- Nano polishing with diamond and etching of nanostructures- Nano indendation Focused Ion beam.

Module VI Nanotechnology in Food, Medicine, and Health Science (9 hours)

Nano particle Based Drug Delivery System, Ultra sound triggered Nano/Microbubbles, Regenerated Medicine, Biosensors -optical Biosensors based on Nano-plasmonics, Nano biosensors, Nano medicinal Foods and cosmetics, Bioavailability and delivery of Nutraceuticals and functional foods Using Nanotechnology, Polymer -Based Nanocomposites for Food Packaging, Toxicity and environmental risks of Nanomaterials.

Text Books

1. C. M. Niemeyer, "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley – VCH, 2006.
2. David S Goodsell, "Bionanotechnology", John Wiley & Sons, 2004.

Reference Books.

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, "Biomaterials Science: An Introduction to Materials in Medicine", Academic Press, 2012.
2. Debasis Bagchi, Manashi Bagchi, Hiroyoshi Moriyama, Fereidoon Shahidi, "Bio-Nanotechnology: A Revolution in Food, Biomedical and Health Sciences" Wiley- Blackwell, 2013.
3. Jain K.K, Nanobiotechnology in Molecular Diagnostics – Current Techniques and Applications, Taylor and Francis Publications 2006.

		L	T	P	C
22BT2084	**STRUCTURAL BIOLOGY**	**3**	**0**	**0**	**3**

Course Objectives:

1. To understand the principles of protein structural elucidation and validity
2. To ensure students to have a strong knowledge on the Biomolecular atomic configuration and structural analysis
3. To provide facts on structural dynamics and simulations.

Course Outcomes:

The students will be able to

1. Explain the relationship between protein sequence and protein structure and experimental techniques.
2. Describe protein purification and structural characterization.
3. Estimate the validity of information in macromolecular structure using various high throughput technologies.

4. Understand the Use on-line structural databases and tools to predict the properties, structure and function of proteins.
5. Describe mechanisms of protein folding and the roles of natively unstructured proteins in biology.
6. Understand the evolution of protein structural modification and simulation associate this with function.

Module 1: Protein structural biology (8 hrs)
Structural features of biomolecules; techniques used to determine the structure of biomolecules; Methods for single crystal X-ray Diffraction of macromolecules; molecular replacement method and direct method – Fiber diffraction; analysis of structures and correctness of structures; submission of data to PDB; atomic coordinates and electron density maps

Module 2: Protein structure and analysis (7 hrs)
Principles of soluble and membrane protein purification, Phase diagram and separation, crystallization, Use of robotics in crystallization, Space groups and symmetry, structure determination; NMR sample preparation, Sample preparation for Cryo EM, Structure validation and best practices on the use of protein structures from protein data bank; Protein fold-function relationships, Protein Data Bank (PDB) and EM Data Bank, BioMagResBank (BMRB)

Module 3: Methods for atomic-resolution structure determination (8 hrs)
Solution- and solid-state NMR spectroscopy, Single particle Cryo Electron Microscopy, XRay Free-Electron Laser (XFEL). Anisotropy? Use of Circular Dichroism, Steady-state and time-resolved fluorescence spectroscopy, FRET, Single molecule fluorescence, Electron Paramagnetic Resonance spectroscopy.

Module 4: DNA and RNA structure prediction (8 hrs)
DNA and RNA secondary structures (duplex, triplex, quadruplexes and aptamers), RNA secondary structure prediction.

Module 5: Structural dynamics: (7 hrs)
Forces that determine protein and nucleic acid structure, basic problems, polypeptide chains geometrics, potential energy calculations, observed values for rotation angles, hydrogen bonding, hydrophobic interactions and water structures ionic interactions, disulphide bonds.

Module 6: Structural simulations (7 hrs)
Protein functional dynamics, Protein dynamics studies by MD simulations; Protein dynamics studies by biophysical techniques.

Total Hours: 45

Text Book
1. Biophysical Chemistry vol I, II and III by Charles R. Canter and Paul R. Shimmel. 1980
2. Introduction to Protein Structure by Branden and Tooze, Garland Science; 2nd edition 1999.

Reference Book:
1. The Art of Molecular Dynamics Simulation by D. C. Rapaport Cambridge University Press; 2nd edition 2004.
2. Cantor R., Schimmel P.R., Biophysical Chemistry, Vol. I, II, W.H. Freeman & Co., 1985.
   RNA Sequence, Structure, and Function: Computational and Bioinformatic Methods by Walter L. Ruzzo, Jan Gorodkin, Springer 2014.

22BT2085	SYNTHETIC AND SYSTEMS BIOLOGY	L	T	P	C
		2	1	0	3

Course Objectives:
1. To know large-scale methods used in systems biology research and their basic data types
2. To Compare different systems biology approaches in their advantages and disadvantages
3. To make students understand dynamical modeling techniques used in contemporary Systems Biology research.

Course Outcomes:
The student should be able to:
1. Describe how naturally system organisms regulate the expression of their genes
2. Understand the regulation of the genes and properties
3. Infer synthetic biology alters the properties of the cell or the organism
4. Apply a algorithm for sensitivity analysis and parameter fitting
5. recognize, exemplify and explain typical network motifs for signaling pathways
6. Develop synthetic cell model to recognize the cell-cell communications.

Module 1: Introduction of systems biology **(8hrs)**
Introduction - System-level Understanding of Biological Systems - Advanced Measurement Systems Modeling Genetic Networks
Module 2: systems modeling **(8hrs)**
Modeling the Activity of Single Gene - A Probabilistic Model of a Prokaryotic Gene and its Regulation.Modeling Biochemical Networks - Atomic-Level Simulation and Modeling of Biomacromolecules
Module 3: Recognition cell regulation model **(7 hrs)**
Kinetic Models of Excitable Membranes and Synaptic Interactions - Stochastic Simulation of Cell Signaling Pathways -Analysis of Complex Dynamics in Cell Cycle Regulation
Module 4: Cell to cell communication in development of embryos **(7 hrs)**
Induction and competence, paracrine factors, Signal transduction pathways, Juxtacrine signaling, crosstalk pathways.
Module 5: Synthetic model simulation **(7 hrs)**
Modeling Large Biological Systems from Functional Genomic Data: Parameter Estimation - Cellular Simulation - Towards a Virtual Biology Laboratory - Computational Cell Biology : The Stochastic Approach
Module 6: Computation tools for cell model **(8 hrs)**
Computer Simulation of the Whole Cell - Computer Simulation of the Cell: Human Erythrocyte Model and its Application - Software for Modeling and Simulation – E-CELL, V-CELL and GROMOS
Text Books:
1. Foundations of Systems Biology, Hiroaki Kitano (Editor),MIT Press, 2001
2. Computational Modeling of Genetic and Biochemical Networks, James M. Bower, Hamid Bolouri, MIT Press,2000.
3. Gene Regulation and Metabolism: Postgenomic Computational Approaches, Julio Collado-Vides (Editor), Ralf Hofestadt (Editor),MIT Press,2002

Reference Books:
1. Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, 2/e, CRC Press, (2006).
2. Kitano et al., Systems Biology: A Brief Overview, Science, (2002), 295, 1662-1664.
3. John Ross et al., Complex Systems: From Chemistry to Systems Biology, PNAS, (2009), 106, 6433–6434.

22BT2086	MOLECULAR PHARMACEUTICS	L 3	T 0	P 0	C 3

Course Objective:
Students can be understand
1. The various approaches for development of novel drug delivery system
2. The criteria for selection of drugs and polymers for the development of NTDS
3. The formulation and evaluation of novel drug delivery

Course Outcome:
The students will be able to
1. Acquire knowledge on Drug delivery systems and understanding.
2. Describe the characterization and preparation of various drug targeting methods with liabilities.
3. Utilize enterprise-wide information assets in support of various pharmaceutical micro capsules and spears.
4. Explain concepts of nasal drug delivery systems and physiological mechanism.
5. Elaborate the Bimolecular based drug delivery methods and function
6. Describe functional principle of enzyme inhibitors

Module I Targeted Drug Delivery Systems **(8 hrs)**
Concepts, Events and biological process involved in drug targeting. Tumor targeting and Brain specific delivery.
Module II Targeting Methods: **(7 hrs)**
Introduction preparation and evaluation. Nano Particles & Liposomes: Types, preparation and evaluation.
Module III Micro Capsules / Micro Spheres **(7 hrs)**
Types, preparation and evaluation , Monoclonal Antibodies ; preparation and application, preparation and application of Niosomes, Aquasomes, Phytosomes, Electrosomes.

Module IV Pulmonary Drug Delivery Systems **(7 hrs)**
Aerosols, propellents, Containers Types, preparation and evaluation, Intra Nasal Route Delivery systems; Types, preparation and evaluation.

Module V Nucleic acid based therapeutic delivery system **(8 hrs)**
Gene therapy, introduction (ex-vivo & in-vivo gene therapy). Potential target diseases for gene therapy (inherited disorder and cancer). Gene expression systems (viral and nonviral gene transfer). Liposomal gene delivery systems. Biodistribution and Pharmacokinetics. knowledge of therapeutic antisense molecules and aptamers as drugs of future.

Module VI Rational Design of Enzyme Inhibitors **(8 hrs)**
Enzyme kinetics & Principles of Enzyme inhibitors, Enzyme inhibitors in medicine, Enzyme inhibitors in basic research, rational design of non-covalently and covalently binding enzyme inhibitors.

Text Books

1. Y W. Chien, Novel Drug Delivery Systems, 2nd edition, revised and expanded,Marcel Dekker, Inc., New York, 1992.
2. S.P.Vyas and R.K.Khar, Controlled Drug Delivery **-** concepts and advances, Ballabh Prakashan, New Delhi, First edition 2002.
3. N.K. Jain, Controlled and Novel Drug Delivery, CBS Publishers & Distributors, NewDelhi, First edition 1997 (reprint in 2001)

Reference Books :

1. An Introduction to Medicinal Chemistry, Graham L.Patrick, III Edition 2017, Oxford University Press, USA.
2. Biopharmaceutics and pharmacokinetics, DM.Brahmankar, Sunil B. Jaiswal II Edition, 2014, Vallabh Prakashan, New Delhi.
3. Peptidomimetics in Organic and Medicinal Chemistry by Antonio Guarna and Andrea Trabocchi, First edition 2016, Wiley publishers.

22BT2087	COMPUTER AIDED DRUG DESIGN	L 3	T 0	P 0	C 3

Course Objectives:
At completion of this course it is expected that students will be able to

1. understand rRole of CADD in drug discovery, Techniques and their application
2. Various strategies to design and develop new drug like molecules
3. Working with molecular modeling software's to design new molecule and virtual screening protocols

Course Outcomes:
The students will be able to

1. Explain the various stages of drug discovery
2. Demonstrate the concept modern drug discovery process and validation
3. Describe physicochemical Properties and the techniques involved in QSAR
4. Learn introduction to Bioinformatics and Cheminformatics role in molecular docking studies
5. Contrast the methods in molecular and quantum mechanics in molecular properties
6. Explain various structure based drug design methods in denova virtual ligands screening

Moldule I Introduction to Computer Aided Drug Design (CADD) **(8 hrs)**
History, different techniques and applications. Quantitative Structure Activity Relationships: Basics History and development of QSAR: Physicochemical parameters and methods to calculate physicochemical parameters: Hammett equation and electronic parameters (sigma), lipophilicity effects and parameters (log P, pi-substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physicochemical parameters.

Moldule II An overview of modern drug discovery process: **(7 hrs)**
Target identification, target validation, lead identification and lead Optimization. Economics of drug discovery. Target Discovery and validation-Role of Genomics, Proteomics and Bioinformatics. Role of Nucleic acid microarrays, Protein microarrays, Antisense technologies, siRNAs, antisense oligonucleotides, Zinc finger proteins. Role of transgenic animals in target validation.

Moldule III Quantitative Structure Activity Relationships: **(8 hrs)**

Applications Hansch analysis, Free Wilson analysis and relationship between them, Advantages and disadvantages; Deriving 2D-QSAR equations. 3D-QSAR approaches and contour map analysis. Statistical methods used in QSAR analysis and importance of statistical parameters.

Moldule VI Molecular Modeling and Docking (8 hrs)

a) Molecular and Quantum Mechanics in drug design. b) Energy Minimization Methods: comparison between global minimum conformation and bioactive conformation c) Molecular docking and drug receptor interactions: Rigid docking, flexible docking and extraprecision docking. Agents acting on enzymes such as DHFR, HMG-CoA reductase and HIV protease, choline esterase (AchE & BchE)

Moldule V Molecular Properties and Drug Design (7 hrs)

a) Prediction and analysis of ADMET properties of new molecules and its importance in drug design. b) De novo drug design: Receptor/enzyme-interaction and its analysis, Receptor/enzyme cavity size prediction, predicting the functional components of cavities, Fragment based drug design. c) Homology modeling and generation of 3D-structure of protein.

Moldule VI Pharmacophore Mapping and Virtual Screening (7 hrs)

Concept of pharmacophore, pharmacophore mapping, identification of Pharmacophore features and Pharmacophore modeling; Conformational search used in pharmacophore mapping. In Silico Drug Design and Virtual Screening Techniques Similarity based methods and Pharmacophore based screening, structure based In-silico virtual screening protocols.

Text Books:

1. Computational and structural approaches to drug discovery, Robert M Stroud and Janet. F Moore, RCS Publishers.
2. Introduction to Quantitative Drug Design by Y.C. Martin, CRC Press 2010, Taylor & Francis group..
3. Drug Design by Ariens Volume 1 to 10, Academic Press, 1975, Elsevier Publishers.

Reference Books

1. Principles of Drug Design by Smith and Williams, CRC Press 2017, Taylor & Francis.
2. The Organic Chemistry of the Drug Design and Drug action by Richard B. Silverman, Elsevier Publishers 2013.
3. Computational and structural approaches to drug design edited by Robert M Stroud and Janet. F Moore 2012
4. Wilson and Gisvold‟s Text book of Organic Medicinal and Pharmaceutical Chemistry, Ippincott Williams & Wilkins 2011.

22BT2088	DRUG FORMULATION AND DEVELOPMENT LAB	L 0	T 0	P 3	C 2

Course Objectives:

At completion of this course it is expected that students will be able to understand

1. The various physica and physicochemical properties of drug pharmulations
2. The bioorganic principles involved in dosage forms/formulations
3. The Theory and practical components of the subject help the student to get a better insight into various areas of formulation research and development

Course Outcomes:

The students will be able to

1. Understand various physicochemical properties of drug molecules in the designing the dosage forms
2. Know the principles of chemical kinetics & to use them for stability testing nad determination of expiry date of formulations
3. Demonstrate use of physicochemical properties in the formulation development and evaluation of dosage forms.
4. To perform various processes involved in pharmaceutical manufacturing process.
5. To know various unit operations used in Pharmaceutical industries.
6. To appreciate the various preventive methods used for corrosion control in Pharmaceutical industries.

List of Experiments

1. Formulation development of compressed tablets.
2. Formulation development of topical preparations.
3. Formulation development of oral liquids.

4. Formulation development of stable suspensions and dry suspensions.
5. Formulation development of emulsions.
6. Formulation development of small volume parenterals.
7. Formulation development of ophthalmic preparations.
8. Assessment of stability studies according to ICH guidelines.
9. Evaluation of packaging materials.
10. Product development of sustained release dosage forms.
11. Preparation of 4-chlorobenzhydrylpiperazine. (an intermediate for cetirizine HCl).
12. Calculation of ADMET properties of drug molecules and its analysis using softwares Pharmacophore modeling
13. Identification of organic compounds using FT-IR, NMR, CNMR and Mass spectra

Reference Books:

1. Fahr, Alfred. Voigt's pharmaceutical technology. John Wiley & Sons, 2018.
2. Armstrong, N. Anthony. Pharmaceutical experimental design and interpretation. CRC Press, 2006.
3. Gibson, Mark, ed. Pharmaceutical preformulation and formulation: a practical guide from candidate drug selection to commercial dosage form. CRC Press, 2016.
4. Roy, Jiben. An introduction to pharmaceutical sciences: Production, chemistry, techniques and technology. Elsevier, 2011.

22BT2089	GENOME ENGINEERING IN LIVESTOCK AND AGRICULTURE	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide insights into Genome Engineering.
2. To impart knowledge in animal and plant breeding employing genome engineering technology.
3. To equip students with advancement in livestock enhancement and crop improvement.

Course outcomes:

The student will be able to

1. Describe the basic concepts in Genome Engineering.
2. Relate and identify the areas of improvement in livestock through molecular techniques.
3. Explain the role of genetic engineering and genome engineering.
4. Identify strategies for crop improvement.
5. Demonstrate a capacity for understanding the social impact of genome engineering.
6. Relate the ethical implications of genome engineering.

Module I: Introduction to Genome and Genome Engineering (6 hrs)

Organization and Structure of Genomes; Nuclear genes, mitochondrial genes, plastid genes; Construction of recombinant DNA; Preparation of cDNA and genomic libraries in vector systems; Genome Engineering; Gene modification in animals and plants – Practical applications.

Module II: Genetic Characterization and Gene Transfer Methods in Animals (6 hrs)

Genetic characterization of livestock breeds, Marker assisted breeding of farm animals; Gene transfer methods in Animals: Microinjection, ES cell mediated gene transfer, Retroviral gene transfer, Gene transfer by sperm vector method.

Module III: Gene Targeting And Transgenic Animals (9 hrs)

Gene targeting - Homologous recombination and Conditional targeting; Genome editing in livestock - Transgenic technology - Milk modification, Meat production (composition and quality), Disease resistance; Transgenic Cattle, sheep, goat, pig and chicken; Molecular pharming - production of recombinant proteins.

Module IV: Genetic Modification in Plants (8 hrs)

Genetic Modification in plants – Transgenic, Cisgenic, Subgenic and Multiple trait integration; Pyramiding of genes; Gene editing tools in plants –PTGS, ZFNs, TALENs, and CRISPR/Cas9; Progress and challenges of gene editing in plants.

Module V: Strategies for Plant Improvement (9 hrs)

Engineering plants for drought tolerance, salt tolerance and freeze tolerance; Targeted approaches to engineer stress tolerance; Improving the nutritional quality and functional properties of seed proteins, carotenoids and flavonoids; Improvement of shelf life of fruits and flowers; Insect and Herbicide resistance in plants; Improving photosynthesis, growth, taste and color; Reducing the effect of Viral disease in plants: VIGS - Virus Induced Gene Silencing.

Module VI: Ethical Implications and Biosafety Regulations **(7hrs)**
Impact of genome engineering on livestock breeding and agriculture; Ethical issues related to Livestock cloning; Public perspective on GM foods; Terminator Technology; Patenting Biological Material; Biosafety measures and regulation.

Total hours: 45

Text Books:
1. Primrose S.B and Twyman R.M. "Principles of Gene Manipulation and Genomic", Blackwell Publishing Company, Oxford, UK Third Edition (2006).
2. Ausubel F.M, Brent R, Kingston R.E and Moore D.D. "Current Protocols in Molecular Biology" John Wiley & Sons, New York, First Edition (1987).

Reference Books:
1. Slater A, Scott N.W and Fowler M.R. "Plant Biotechnology: The Genetic Manipulation of Plants", Oxford University Press, Third Edition (2008).
2. Voytas D.F and Gao C (2014) Precision Genome Engineering and Agriculture: Opportunities and Regulatory Challenges, Plos One. 12, e1001877.
3. Guimaraes et. al, "Marker-Assisted Selection: Current Status and Future Perspectives In Crops-Livestock- Forestry and Fish", FAO Publication, (2007).
4. Collard et al (2008) Rice Molecular Breeding Laboratories in the Genomics Era: Current Status and Future Considerations, International Journal of Plant Genomics, 2008: 524847.

22BT2090	GENOME EDITING FOR THERAPY	L	T	P	C
		3	0	0	3

Course Objectives:
1. To provide understanding of the technology of Genome Engineering.
2. To equip students with the knowledge of the tools employed in genome engineering.
3. To make aware the ethical considerations of genome editing.

Course outcomes:
The student will be able to
1. Describe the basic concepts in human genome organization and genetic diseases.
2. Understand the tools used in genome editing.
3. Identify various strategies in genome editing for therapy.
4. Understand thoroughly the technique of CRISPR in therapeutics.
5. Demonstrate a capacity for understanding the social impact of genome engineering.
6. Perceive the ethical implications of genome editing.

Module I: The Human Genome and Genetic Analysis **(6 hrs)**
Genome and genome organization; Genetic Diseases; Types of genetic variations and analysis; PCR and its types - Real Time PCR. Genome editing – Introduction; Genome Analysis - DNA sequencing and its types.

Module II: Gene Editing Tools **(6 hrs)**
Transgenesis and site-specific recombination: Lentiviral system, Cre-Lox, Phi31 integrase; Genome editing: ZFNs, TALENs, Multi-gene assemblies and high-throughput DNA assembly techniques.

Module III: CRISPR-Based Gene Therapy **(9 hrs)**
Origin of CRISPR; Mechanism of the classical CRISPR/Cas9 system; CRISPR Knock-out Basics (Experimental Design, Guide RNA design, Delivery into Cells, Genotyping, Validation); CRISPR Knock-in (Inserting or Mutating DNA Sequences in the Genome); CRISPR Editing in Bacteria, Yeast and Animal Models (Knockout and Knock-in Strategies); CRISPR Screens (High throughput applications of CRISPR); CRISPR Interference (dCas9 Fusions Inhibition or Activation).

Module IV: RNA Therapeutics **(7 hrs)**
Silencing of gene expression by small RNAs, RNAi, long noncoding RNAs, siRNA, Role of non-coding RNAs in gene regulation and therapy; shRNA, miRNA, microRNA, snoRNA & siRNA,

Module V: Gene Editing and Diseases **(10 hrs)**
Gene editing and delivery strategies: ex vivo editing therapy (HIV); in vivo editing therapy (Haemophilia B); Gene editing technique in basic research, diagnosis, and therapy of cancer; Using CRISPR/Cas9 library for screening functional genes in cancer cells; Gene editing in hematologic disorders; Gene editing in brain diseases; Factors Influencing Therapeutic Efficacy; Fitness of Edited Cells; Challenges to Clinical Translation.

Module VI: The Future of Gene Editing Tools and Ethical Considerations (7 hrs)
Gene editing tools - Applications, Limitations, and Implications for the future; Gene editing and ethics; CRIPSR in the Clinic; CRISPR Babies; Case-Studies; WHO recommendations on human genome editing for the advancement of public health.

Total hours: 45

Text Books:
1. Brown T.A. "Gene Cloning and DNA Analysis an Introduction", Wiley Blackwell, UK. Seventh Edition (2016).
2. Gardner A and Davies T. "Human Genetics" Viva Books, Second Edition (2012).

Reference Books:
1. Young I.D. "Medical Genetics" Oxford University Press, UK. First Edition (2005).
2. Arsham M.S and Barch M.J. "The AGT Cytogenetics Laboratory Manual" Wiley- Blackwell", New Jersey, USA, Fourth Edition (2017).
3. Donnai D and Read A. "New Clinical Genetics", Scion Publishing Limited, Oxford, UK, Third Edition (2015).
4. Nussbaum R.L, McInnes R.R, Willard H.F and Hamosh A. "Genetics in Medicine", Elsevier, USA, Eighth Edition (2016).

22BT2091	GENETIC MANIPULATION LAB	L	T	P	C
		0	0	3	1.5

Course Objective:
1. To impart technical knowledge on genetic manipulation.
2. To enable the students to understand the principles of Genome editing.
3. To impart the knowledge on various techniques and methods in Genome engineering.

Course Outcome:
The student will be able to
1. Understand the handling of biomolecules such as nucleic acids.
2. Demonstrate the principles, techniques and applications of gene manipulation
3. Describe the instrumentation and techniques for qualitative and quantitative analysis of nucleic acids.
4. Design primers, siRNA, lentiviral vectors and CRIPR Guide RNA.
5. Explain the determination of pH and their applications in buffer preparations
6. Demonstrate the applications of CRISPR/CAS technology in prokaryotes and eukaryotes.

List of Experiments
1. Isolation of Plasmid DNA.
2. RNA isolation.
3. Quantification of nucleic acids using Nanodrop.
4. Primer design and analysis.
5. Reverse transcriptase PCR for cDNA synthesis.
6. Polymerase Chain Reaction
7. Agarose gel electrophoresis of Plasmids and PCR products
8. Analysis of gene expression using Real-time PCR.
9. CRISPR Guide RNA design.
10. Lentiviral vectors design.
11. Demonstration of CRISPR/Cas technology in bacteria.
12. Demonstration of CRISPR/Cas technology in yeast.

Reference:
1. Michael R. Green, Joseph Sambrook, Molecular Cloning: A Laboratory Manual (Fourth Edition), 2012
2. Web resources

22BT2092	PHARMACOGENOMICS	L 3	T 0	P 0	C 3

Course Objectives:
1. To providing basic understanding of discipline of pharmacogenomics.
2. Understanding of the genetic basis of variability in drug response can contribute to drug efficacy and toxicity, adverse drug reactions and drug-drug interaction. As such, pharmacists need a thorough understanding of the genetic component of patient variability to deliver effective individualized pharmaceutical care.
3. To get better knowledge and manage the new genomics based diagnostic tools as they become available as well as make best treatment choices.

Course Outcomes:
The students will be able to
1. Explain the basic principles of human genetics and heredity as they apply to inter-individual variation in treatment response
2. Apply the principles of molecular and cellular biology to explain the genetic basis of variability in drug response.
3. Outline how genetic variability in genes encoding drug metabolizing enzymes, drug transporting proteins, and drug receptors (targets) can contribute to variability in drug disposition and action, leading to changes in pharmacokinetics, pharmacodynamics, and clinical outcome
4. Understand the impact of Pharmacogenomics in different therapeutic areas. Discuss case studies reporting the clinical consequences of pharmacogenomics on therapeutic efficacy or toxicity.
5. Recognize the societal and ethical implications of clinical trials and the resultant individualization of drug therapy.
6. Summarize the current methods and technology on clinical trials and drug discovery.

Module 1: Pharmacogenomics **(8 Hours)**
Introduction, Concepts of genetic diseases. Personalized medicine- introduction and importance. The genetics of therapeutic targets and gene-based targets. Pharmacogenomics necessity in drug designing.

Module 2: Polymorphisms **(8 Hours)**
Introduction, types and importance in Drug targets. Prediction of structural changes among sequences by the influence of polymorphisms.

Module 3: Pharmacogenomics dose response **(8 Hours)**
Drug response to patients, Structural influence in the Drug response. Efficacy and metabolism of drugs. Pharmacogenomics vs. Structural Pharmacogenomics. Drug metabolism pathways and adverse drug reactions.

Module 4: Pharmacogenomics tools **(7 Hours)**
Tools for pharmacogenomic analysis. Pharmacokinetics (PK), Pharmacodynamics (PD). Process in Structural Pharmacogenomics - Target Structure optimization, Validation, lead identification, ADME prediction, synthesis, assays and Clinical trials.

Module 5: Clinical Applications of Pharmacogenomics in precision medicine **(7 Hours)**
Contributions of pharmacogenomics to variability in drug metabolism, use of pharmacogenomics to identify patients at risk for adverse drug reactions, and clinical use of pharmacogenomic data in drug therapy for multiple therapeutic areas, including cardiovascular, oncology, pain management, neurologic, psychiatric, transplantation, and infectious diseases

Module 6: Regulatory Process **(7 Hours)**
Implementation of clinical trial protocol, source documents, data entry, Developing Standard Operating Procedures (SOP), Person to Person differences in drug metabolism-importance for drug therapy, Overview of Investigational drug services and role of research pharmacist. Role of FDA and IND application process

Total Hours: 45

Text Books
1. Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis. Thailand: Cold Spring Harbor Laboratory Press.
2. Baxevanis, A.D., Francis Ouellellette, B.F. (1998). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. (1998). Germany: Wiley.

Reference Books
1. Rapley, R., Harbron, S (2004), “Molecular analysis and Genome discovery”; John Willey & Sons, Ltd.

2. Machin, D., Fayers, P. M. (2010). Randomized Clinical Trials: Design, Practice and Reporting. Germany: Wiley.
3. Friedman, L. M., Granger, C. B., Furberg, C. D., Reboussin, D. M., DeMets, D. L. (2015)Fundamentals of Clinical Trials. Germany: Springer International Publishing.
4. Piantadosi, S. (2005). Clinical trials : a methodologic perspective. Germany: Wiley.

22BT2093	PRECISION MEDICINE	L 3	T 0	P 0	C 3

Course Objectives

1. To explore the possibilities, promises, and pitfalls of precision medicine, using real-world examples.
2. To bridge the gap between basic and translational research and its practical clinical applications, which will help prepare any student interested in research or health professions careers.
3. To provide students with knowledge about prolonging health and treating disease that will empower them to make shared informed decisions with their physicians.

Course Outcomes

Upon successful completion of this course, students will be able to:

1. Explain how the HGP has advanced technology in biomedical research.
2. Understand how the diversity of life evolves over time by processes of genetic change leading to health implications.
3. Describe recent advances in disease risk prediction, molecular diagnosis and progression of diseases, and targeted therapies for individuals.
4. Understand how to translate research findings and technology into healthcare delivery that benefits the general public.
5. Discuss the ethical, legal, and social implications of health privacy and policy laws for precision medicine.
6. Critically evaluate primary and secondary precision medicine research

Module 1: Introduction to precision medicine (7 Hours)

Overview on Precision Medicine, the Human Genome, and Human Genomic Variation. Pharmacogenome: Whole Genome Sequencing (WGS). Epigenome: DNA Methylation, Histone Modifications and Chromatin Remodeling Factors. Transcriptome. Proteome. Metabolome. Microbiome.

Module 2: Medical Molecular genetics (7 Hours)

Human genetics/genomics, including pedigree analysis, non-Mendelian genetics, cytogenetics, polymorphism analysis, physical mapping and the human genome, mutation analysis and pathogenesis, genomic imprinting, viral and non-viral gene therapy.

Module 3: Applications of precision medicine (7 Hours)

Applications of precision medicine in diagnosis and treatment considerations of concepts in monogenic diseases and complex diseases. Important concepts include susceptibility genomics, diagnostic approaches, laboratory testing, and treatment considerations for genomic medicine. Diseases include cystic fibrosis, monogenic diabetes, Marfan syndrome, Huntington’s disease, as well as cardiovascular, metabolic, neurologic, mental health disorders and addiction, and others.

Module 4: Clinical applications of precision medicine: Precision oncology (7 Hours)

Cancer marker analysis; Approaches and technologies in diagnosing or treating cancer, including the genetics of cancer, targeted cancer treatments, somatic testing, current and future research and clinical trends, and other information on precision oncology

Module 5: Clinical Trials (7 Hours)

Basics of Clinical Trials: Need for clinical trials, History of Clinical Trials, Glossary in clinical Trials-Clinical Research, Healthy Volunteer, Inclusion/Exclusion Criteria, Informed Consent, Patient Volunteer, Phases of Clinical Trials, Placebo, Protocol, Principal Investigator, Randomization, Single- or Double-Blind, Studies, Types. Clinical Trials: Developing Evidence for PM & Designing PM Clinical Trials; Implementation Science & Costs of PM; Educating the Public and Providers

Module 6: AI for precision medicine (7 Hours)

Practicing precision medicine with intelligently integrative clinical and multi-omics data analysis, Human gene and disease associations for clinical-genomics and precision medicine, Robotic surgery, Use robot to monitor effectiveness of treatment.

Text Books:

1. Genomic and Precision Medicine, 3rd Edition, Geoffrey Ginsburg and Huntington Willard, 2016

Reference Books:

1. The Language of Life: DNA and the Revolution in Personalized Medicine, Francis S. Collins, 2010

22BT2094	PRECISION MEDICINE LAB	L	T	P	C
		0	0	3	2

Course objective

1. To identify genomic regulatory features of tobacco and menthol metabolizing genes and to assess their mutations, copy number variations, and gene expression in lung cancer patients
2. To identify and validate population-specific SNPs in tobacco and menthol metabolizing genes
3. To adapt the methods used in molecular detection of diseases and therapeutic index.

Course outcomes

Students will be able to

1. Utilize modern human genomic and transcriptomic methods to analyze health and disease data in dry and wet lab settings.
2. Understand the role of genetic and genomic variation throughout the genome in health and disease.
3. Demonstrate the disease risk prediction
4. Analyze the methods of molecular diagnosis
5. Understand the methods of evaluation of disease progression and therapy
6. Evaluate primary and secondary precision medicine research

List Experiments

1. DRY LAB: World Tour of the Human Genome I: Exploring the Human Genome and ENCODE with the UCSC Genome Browser
2. DRY LAB: World Tour of the Human Genome II: Exploring Human Genomic Variation and 1000 Genomes Project (1KG) WGS Data with the Ensembl Genome Browser
3. DRY LAB: World Tour of the Human Genome III: Exploring WES Data with the Exome Aggregation Consortium (ExAC) Browser and NHLBI Exome Sequencing Project Exome Variant Server (EVS)
4. DRY LAB: Mining the The Cancer Genome Atlas (TCGA) with cBioPortal, Broad GDAC Firehose, and Firebrowse
5. DRY LAB: CURE Clinic I - Data Summary and Hypothesis Refinement (5)
6. DRY LAB: qRT-PCR primer design (5)
7. WET LAB (control reaction): RNA isolation, DNase-treatment, and RNA quantification
8. WET LAB (control reaction): cDNA synthesis
9. WET LAB (control reaction): Semi-quantitative Reverse Transcription PCR (RT-PCR)
10. WET LAB (control reaction): RT-PCR product analysis
11. WET LAB (control reaction): quantitative Reverse Transcription PCR (qRT-PCR)
12. WET LAB (experimental + control reaction): qRT-PCR analysis / Polymorphism analysis of DNA using PCR

Reference Books:

1. Genomic and Precision Medicine, 3rd Edition, Geoffrey Ginsburg and Huntington Willard, 2016

22BT2095	BIOMATERIALS IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

The students will be able to

1. Understand the basic concepts in biomaterials.
2. Understand the use of implants and cell-interfacing materials.
3. Demonstrate the application of biomaterials in field of Biotechnology.

Course Outcomes:

The Student will be able to

1. Classify the structural distinctions in biomaterials.
2. Categorize the various properties of biomaterials and Immunology.
3. Appraise the methods for using implants and testing.
4. Recognize the Interfacing materials and biomimetics.

5. Understand the nuances of lab organs and prosthetics.
6. Evaluate manufacturing processes of biomaterials in biotechnology and their Ethical implications.

Module-I: Structural Distinctions in Biomaterials (9 Hours)

Structure of bio materials and bio compatibility- Mechanical properties, Physical characterization, Surface characterization, Thermal characterization. Definition and Classification of Biomaterials, Function of Biomaterials, Biocompatibility and Biomaterials, Properties of Biomaterials, Body response to implants.

Module-II: Immune response and Inflammation (7 Hours)

Wound-healing, Implant Response resolution, Blood compatibility – Skin Regeneration, Inflammatory Response, Interaction of Biomaterials with Blood, Circulatory System

Module-III: Implants used in Biotechnology (9 Hours)

Metallic Implant materials – Types, Characteristics and Functions, Biodegradable polymers; Natural polymers, Polymeric Implant materials – Types, Polyurethanes and Polythenes, Soft Tissue and Hard Tissue replacement, Soft Tissue and Hard Tissue replacement, smart materials for medical applications- tissue replacement implants-Sutures, Surgical tapes, Adhesive, Percutaneous and skin implants, Maxillofacial augmentation, Joint replacements.

Module-IV: Interfacing Materials in Biotechnology and Biomimetics (8 Hours)

Blood interfacing materials, Methods of testing implants for biological performance, Biocompatibility – Toxicology, Biocompatibility, Biomimetic synthesis, Direct molding Technique, Advanced 3D fabrication techniques.

Module-V: Artificial Organs and Entrepreneurship (6 Hours)

Artificial organs - Introduction to Artificial Organs, Artificial Organs - The Future, Artificial Heart Vs Natural Heart, Heart valves – Types, Characteristics Features, Functions, Durability, Oxygenators and Dialysers, Dental implants. Entrepreneurship and Bio technocrats, Biomaterials market in India.

Module 6: Manufacturing Biomaterials for Biotechnological Applications (6 Hours)

Basic principles of engineering manufacturing, methods and applications of common manufacturing processes, milling, grinding, finishing, rolling, forging, Biomaterials for the 21st Century, Biomaterial and Biocompatibility Testing Laboratory Setup according to India Human Resources, Layout and Controls, Equipment and Instruments.

Text Books:

1. Biomaterials: An Introduction- J. Bo. Park.
2. Sujata V. Bhatt, “Biomaterials” Second Edition ,Narosa Publishing House,2005.

Reference Books:

1. Biomaterials Science - An Introduction to Materials in Medicine, Buddy Ratner Allan Hoffman Frederick Schoen Jack Lemons, ISBN: 9780080470368, Academic Press, 2004.
2. Michael Lysaght and Thomas Webster, “Biomaterials for artificial Organs”, Woohead Publishing series in biomaterials, 2010.
3. Research Papers:
    a. Prosthesis and Intersection of Biology and Engineering - George M.Whitesides and Amy P.Wong,.
    b. Foreign Body Reaction To Biomaterials - James M.Anderson, Analiz Rodriguez, and David T. Chang,

22BT2096	BIOTERRORISM AND NATIONAL SECURITY	L 3	T 0	P 0	C 3

Course Objective:

1. To understand terrorism employing biological pathogens
2. To familiarize issues involved and threats facing society due to bioterrorism
3. To impart knowledge on various approaches to tackle bioterrorism

Course Outcome:

1. Formulate security policy in relation to disease-related security challenges.
2. Categorize different agents and phases of bioterrorisms in public health
3. Analyze infectious diseases affecting man, animal and agriculture
4. Evaluate epidemiological aspects of bioterrorism
5. Mitigate the threats due to bioterrorism
6. Manage the ethical issues pertaining to bioterrorism

Module 1: Terrorism and Bioterrorism **(7 Hours)**
Definition-Traditional terrorists-New terrorists-Nuclear, chemical, and radiological weapons-Psychology of Bioterrorism-Historical perspective

Module 2: Microbes and Immune System **(6 Hours)**
Primary classes of Microbes-bacteria, virus, and other Agents-Immune system- Interaction between microbes and the immune system.

Module 3: Bioterrorism and Public Health **(6 Hours)**
Classification of bioterrorism agents- Category A, B and C, Clinical syndromes caused by bioterrorism agents, Phases of bioterrorist attack- preparedness phase, early morning phase, notification phase, response phase and recovery phase

Module 4: Bioterrorism Weapons and Techniques **(10 hours)**
Characteristics of microbes and the reasons for their Use-Symptoms-Pathogenicity Epidemiology-natural and targeted release-Biological techniques of dispersal, case studies of Anthrax, Plague-Botulism, Smallpox, and Tularemia and Viral Hemorrhagic Fevers (VHF); Biological attack on Agriculture-Animals as sentinels of bioterrorism agents

Module 5: Prevention and Control of Bioterrorism **(9 Hours)**
Surveillance and detection- equipment and sensors –Diagnosis-Treatment Vaccinations-Supplies-Effectiveness-Liability-Public Resistance-Response-First Responders-Infectious Control-Hospital-Prevention- Protection-Decontamination Notification-Role of Law Enforcement-Economic impact

Module 6: Bioterrorism Management **(7 Hours)**
Ethical issues: personal, national, the need to inform the public without creating fear, cost-benefit analysis-Information Management-Government control and industry Support-Microbial forensics.

Text Books:

1. Donald A. Henderson, Thomas V., M.D. Inglesby, Tara O'Toole, Bioterrorism: Guidelines for Medical and Public Health Management, American Medical Association, 1st Edition, 2002.
2. Lederberg J, Biological Weapons: Limiting the Threat (BCSIA Studies in International Security), MIT Press, 1999.
3. Fong IW, and Kenneth A, Bioterrorism and Infectious Agents: A New Dilemma for the 21st Century (Emerging Infectious Diseases of the 21st Century), , Springer,2005.

Reference Books:

1. Richard Preston, The Demon in the Freezer: A True Story, Fawcett Books, 2003.
2. Leonard A Cole, The Anthrax Letters: A Medical Detective Story, Joseph Henry Press, 2003.
3. Biotechnology research in an age of terrorism: confronting the dual use dilemma, National Academies of Science, 2003.
4. Das S and Kattaria VK, Bioterrorism: A public health perspective, , Medical Journal of Armed forces India, 66 (3) 255-260; 2010

22BT2097	COMPREHENSIVE PRACTICES	L 0	T 0	P 3	C 1.5

Course Objective

1. To understand the recent literature on cutting edge technologies
2. To integrate the learning in different domains of biotechnology
3. To develop a holistic view on the different domains of biotechnology

Course Outcome

1. To acquire knowledge on cutting edge technologies from published literature
2. To understand the recent developments in Biochemistry, Microbiology, Cell biology
3. To apply logical skills to adapt concepts learnt in classroom
4. To apply analytical skills to assimilate the concepts learnt in classroom
5. To analyze the concepts in Bioprocess Principles, Bioprocess Engineering
6. To evaluate the recent developments in Bio-analytical Techniques, Metabolic Engineering

Comprehensive Practices will be conducted in a lab mode with 10 evaluation components, viva voce and end semester examination. Various cutting edge technologies or recent trends in the different courses would be identified and discussed.

List of Revised Courses for 2022 Batch (2020 Version 1.1)

Program: B.Tech. Biotechnology

S.No	Course Code	Course Title	L	T	P	C
1	20BT2048	Molecular Forensics	3	0	0	3

Program: M.Sc. Biotechnology

S.No	Course Code	Course Title	L	T	P	C
1	20BT3052	Plant Secondary Metabolites And Pharmaceutics	3	0	0	3
2	20BT3054	Microbiology And Molecular Genetics	3	0	0	3
3	20BT3055	Animal Biotechnology And Immunology	3	0	0	3

20BT2048	MOLECULAR FORENSICS	L	T	P	C
		3	0	0	3

(Version 1.1)

Course Objectives:

1. Provide knowledge in the field of forensic science and crime scene investigations.
2. To ensure students gain knowledge about the recovery of human remains.
3. Impart technical skills to know the procedures involved in the identification of the criminals usingmolecular tools

Course Outcomes:

1. Explain the steps involved in forensic investigation
2. Identify the methods involved in the collection of biological samples for molecular analysis
3. Interpret the results of molecular techniques for the identification of the criminals and the victims
4. Appraise the knowledge in paleo biology and anthropology and its importance in Forensics
5. Design experiments in molecular techniques and implementation in forensic science
6. Analyze forensic case studies

Module 1: Introduction to Forensic Science (9 hrs)

Introduction to crime laboratories, Responsibilities of the forensic scientist, Securing and Searching the Crime Scene, Recording and collection of crime scene evidence, Document examination, Ethics and Integrity

Module 2: Discovery and Recovery of Human Remains (9 hrs)

History of Forensic Genetics, Biological sample collections, The Autopsy and handling of a Dead Body, The Stages and factors of decomposition, Determining the Age and Provenance of Remains, Asphyxia, Gunshot Wounds, Bite Marks

Module 3: Pattern Analysis (8 hrs)

Biological Evidence Overview, Body Fluids - Peripheral blood, Saliva, Semen, Urine, and Sweat, Blood, Markers for Evidence, Study of Hair, Study of Fibre. Detecting thePresence of Blood, Bloodstain Pattern Analysis.

Module 4: Methods of Identification (9 hrs)

Forensic anthropology, Paleontology, Drug Identification and Toxicology, Methods used in forensic for human identification: Autosomal STR Profiling, Analysis of Ychromosome, Analysis of Mitochondrial DNA.

Module 5: Sequencing Methods in Forensics (5 hrs)

Rules and Principles of Identification under Criminal Justice System, Autosomal single-nucleotide polymorphisms (SNP) typing, Biomarkers in forensic identification, Polymorphic Enzymes, DNA Finger Printing- RFLP. PCR directed Y chromosome sequences, PCR Amelogenein Gene, Next generation Sequencing

Module 6: Forensic Case Studies (5 hrs)

Case studies of Royal Romanov Family, Ice Man, King Tut (Tuttenkhamun), The Hitler Diaries, Criminal investigations revolutionized by DNA. Study of Kinship by DNA Profiling, Paternity disputes, Illegalhunting case identification using Molecular markers; detection of narcotics in body fluids.

Text Books:

1. Lincoln PJ & Thomson J, "Forensic DNA Profiling Protocols", Humana Press. 2011.
2. Sandy B. Primrose, Richard Twyman "Principles of Gene Manipulation and Genomics" Backwell Scientific Publications 2010

References Books:

1. Rudin N & Inman K. "An Introduction to Forensic DNA Analysis", 2nd Ed. CRC Press. 2002.
2. Brown T.A, Gene Cloning and DNA Analysis, 6th Edition, Blackwell Publishing Ltd 2010

20BT3052	PLANT SECONDARY METABOLITES AND PHARMACEUTICS	L	T	P	C
		3	0	0	3

(Version 1.1)

Course Objectives

1. To recall the myriad of different secondary metabolites produced by plant
2. To analyze the biosynthesis and metabolic engineering of plant secondary metabolites
3. To formulate various products and their dosage forms

Course Outcomes

The students will be able to

1. Enumerate major plant secondary metabolites and its uses.
2. Illustrate the biosynthesis and regulation of plant secondary metabolites
3. Infer the different methods of production of secondary metabolites.
4. Interpret the biochemical pathways for improved secondary metabolite production.
5. Enumerate the pharmaceutical procedures for preformulation studies
6. Examine the development of formulation and dosage forms

Module I: Plant Secondary Metabolites (6 Hours)

Definition and systematics of secondary metabolites. Structures, functions and commercial significance of secondary metabolites: alkaloids, terpenoids/isoprenoids, flavonoids and phenolics. Secondary metabolites in chemical defense of plants, ecological functions, and biological activities

Module II:Biosynthesis and Regulation of Secondary Metabolite (8 Hours)

Integration of primary and secondary metabolism. Shikimate and PHA pathways of alkaloid biosynthesis. MEP pathway of terpenoid biosynthesis. Biosynthesis of flavonoids and polyphenol (lignin). Regulation: metabolic channeling, compartmentalization, cross-talk/exchange of intermediates between biochemical pathways. Precursor feeding, genetic regulation of key enzymes, developmental, seasonal and environmental factors

Module III: Production Technologies (9 Hours)

Production of secondary plant metabolites from higher plants: Tissue cultures, organ cultures, hairy root cultures. Roles of Endophytes in production of secondary metabolites; Bioreactors: scaling up of production of secondary metabolites. Effects of precursors and elicitors. Production of pharmaceutically important secondary metabolites such as Taxol, Berberine and rubber

Module IV: Metabolic Engineering of secondary metabolic pathways (8 Hours)

Cloning and characterization of enzymes of the Shikimate and MEP pathway; functional genomics approaches for improvement of secondary metabolite production. Metabolic engineering of yeast for the production of plant secondary metabolites.

Module V: Pharmaceutics – Preformulation Studies (7 Hours)

Goals of preformulation, preformulation parameters, methodology, Solubility and Partition coefficient, drug excipient compatability. Excipients used in pharmaceutical dosage forms:Properties and selection criteria for various excipients like surfactant, viscosity promoters, diluents, coating materials, plasticizers, preservatives, flavours and colours

Module VI:Powder and Liquid dosage forms (7 Hours)

Formulation development and manufacture of powder dosage forms for internal and external use including inhalations dosage forms, Formulations, production and evaluation of hard and soft gelatin capsules. Manufacturing of monophasic dosage forms. Recent advances in formulation aspects and manufacturing of suspensions and dry syrups

20BT3054	MICROBIOLOGY AND MOLECULAR GENETICS	L	T	P	C
		3	0	0	3

(Version 1.1)

Course Objectives:

1. To familiarize students with conventional and molecular characterization of microorganisms
2. To illustrate the role of microbes in health care, agriculture and environment
3. To exemplify the importance of genetic composition in microbial inheritance and mutations

Course Outcomes:
The students will be able to:

1. Analyze the classification, diversity, and ubiquity of major categories of microorganisms
2. Demonstrate the structural, physiological differences of microorganisms and their growth control
3. Evaluate the interactions between microbes, hosts and environment.
4. Acquire knowledge on prokaryotic, eukaryotic genome organization and the process of replication
5. Interpret the epigenetic effects on transposons in genes of interest
6. Describe the causes and consequences of mutations on microbial evolution and the generation of diversity

Module I: Microbial diversity and Molecular Taxonomy (9 hours)
Concepts of species and hierarchical taxa – Bergey‟s system of classification– Classification of Bacteria, Fungi, and Viruses; Modern methods to study microbial diversity: NGS – MiSeq; Molecular Taxonomy-16S rRNA gene sequencing, Phylogenetic grouping. Fatty Acid Methyl Ester (FAME) analysis, ITS; Methods to study microbial community: DGGE, SSCP, T-RFLP.

Module II: Microbial Physiology and Metabolism (8 Hours)
Morphology, structure and functions of prokaryotic and eukaryotic cells, Control of Microbial growth – Physical and Chemical, Metabolic Pathways: Anaerobic Carbon metabolism: Anaerobic respiration, Sulphate respiration, Methane oxidizing and Methanogenic bacteria, Aerobic Carbon metabolism: TCA cycle alternative metabolic pathways; Quorum sensing: Vibrio fischeri, virulence- Pseudomonas aeruginosa, Staphylococcus aureus, Preservation and maintenance of microbes

Module III: Clinical, Agricultural and Environmental Microbiology (9 Hours)
Clinical Microbiology- Survey of disease causing microbes; Bacterial Diseases: Mycobacterium tuberculosis, Salmonella, Viral Diseases: HINI, Fungal Diseases: Candida, Protozoan Diseases: Malaria, Antibiotics and their targets, Human Microbiome- gut microbiota, Microbes and Agriculture: Symbiotic Nitrogen fixation Rhizobium, Cyanobacteria (Anabaena, Azolla etc.), Mycorrihizae; Environmental Microbiology: Xenobiotic degrading consortia, Bioremediation; Biofilm and its ecological implication

Module IV: Genetics of bacteriophages and Yeast (6 Hours)
Genetics of bacteria and bacteriophages: Mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers. Yeast genetics: Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios.

Module V: Transposons and epigenetics (7 Hours)
DNA-based Transposons in bacteria, Eukaryotic Transposons (DNA-based), Retrotransposons and Retroviruses (eukaryotes); Epigenetics: RNA-based silencing, X-chromosome inactivation.

Module VI: Microbial Mutation (6 Hours)
Molecular basis of mutation, mutagen and origin of spontaneous mutations- Fluctuation test – inference of function of genes based on isolation of mutations – various types of mutations – missense – nonsense – frameshift, Conditional Lethal - mutagens – physical and chemical agents – Mode of action of important mutagens (5BU, 2AP, NTG, Hydroxylamine, Nitrous acid) – use of mutagenic chemicals in isolation of mutants and their advantages.

Textbooks:

1. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 2001
2. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15th Edition. Pearson Education. 2018.
3. Modern Microbial Genetics by U.N. Streips and R.E. Yasbin, 2nd edition; Wiley Publishers; 2002

References

1. Lim D, “Microbiology”, Second Edition, WCB-Mc Graw Hill, 2001.
2. Weaver, Robert Franklin, Molecular biology. 5thedition. McGraw Hill, New York. 2012
3. Bergey‟s Manual of Systematic Bacteriology. Volumes 1-5. Williams & Wilkins
4. ErkoStackebrandt. Molecular identification, systematics, and population structure of prokaryotes. Springer-Verlag Berlin Heidelberg. 2006
5. Lewin's GENES X, Volume 10 Benjamin Lewin, Jocelyn Krebs, Stephen T. Kilpatrick, Elliott S. Goldstein Jones & Bartlett Learning, 2011

20BT3055	ANIMAL BIOTECHNOLOGY AND IMMUNOLOGY	L	T	P	C
		3	0	0	3

(Version 1.1)

Course Objectives:

1. To provide insights into animal biotechnology
2. To impart knowledge in animal breeding
3. To equip students with advancement in immunology and immunotechnology

Course outcomes:

The students will be able to

1. Explain the role of cryopreservation of embryos and embryo sexing.
2. Describe the basic concepts in animal biotechnology and its importance in livestock improvement.
3. Relate and identify the genetic defects in animal embryos through molecular techniques.
4. Identify the cellular and molecular basis of immune responsiveness through antigen and antibody interactions.
5. Describe the roles of the immune system in both maintaining health and contributing to disease.
6. Demonstrate a capacity for problem-solving about immune responsiveness.

Module I: Embryo Cryopreservation (8 Hours)

Introduction to Animal Biotechnology, Cryopreservation of Sperms, Ova of livestock, Artificial Insemination, Super Ovulation, In Vitro fertilization, Culture of embryos, Cryopreservation of Embryos, Embryo transfer, Embryo splitting, Embryo sexing.

Module II: Germplasm Preservation and Livestock Improvement (7 Hours)

In situ and ex situ preservation of germplasm, In utero testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, Genetic characterization of livestock breeds, Marker assisted breeding of livestock,

Module III: Transgenic Animals (7 Hours)

Transgenic animal production and application in expression of therapeutic proteins, Animal model for diseases, Detection of meat adulteration using DNA based methods.

Module IV: Organs and Cells of the Immune System (7 Hours)

Organs of the immune system, Primary Lymphoid organs, Secondary Lymphoid organs, Formation of Lymph, The Lymphatic vessels and circulation, Cells of the immune system, Granulocytes and Agranulocytes, Lymphocytes & its sub-types, Extravasation. Signaling in the Immune system.

Module V: Antibodies and Antibody Engineering (6 Hours)

Immunoglobulins - Structure and Classes, Immunization and Antibody generation, Monoclonal Antibody production, Antibody Engineering and its outcomes.

Module VI: The Immune Response (10 Hours)

Antigen Presentation, MHC Class-I, MHC Class-II, Antigen Procession-Endogenous pathway, Antigen Procession-Exogenous pathway, T-Cell Activation, Vaccination & Vaccine Types, The social Impact of Immunology.

Total: 45 Hours

Text Books

1. Ian Freshney B. Culture of Animal cells & Manual of basic technique, 6^{th} ed., Wiley – liss publication, 2011.
2. Kuby J, “Immunology”, 7^{th} ed., WH Freeman & Co., 2013.

Reference Books

1. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF,. *New Generation Vaccines*. 3rd Ed. Informa Healthcare, 2004.
2. Animal Cell Culture by John R.W. Masters 3^{rd} ed., Oxford University Press, 2009.
3. David Male Jonathan BrostoffDavid Roth Ivan Roitt, Immunology. 8th ed., Elsevier, 2012
4. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th ed., Blackwell Publishing, 2002
5. Goldsby , R.A., Kindt, T.J., Osbome, B.A. and Kerby J. Kuby Immunology, 6th ed., W.H. Freeman, 2005

DEPTARTMENT OF BIOTECHNOLOGY

LIST OF NEW COURSES

S.No	Course Code	Course Title	Hours / Week	Credits
1	21BT1001	Fundamentals of Biology	3:0:0	3
2	21BT2108	Fundamentals of Cell Biology and Microbiology	3:0:0	3
3	21BT2109	Basic Cell Biology and Microbiology Lab	0:0:4	2
4	21BT2110	Biochemistry and Molecular Biology	3:0:0	3
5	21BT2111	Basics in Biochemistry and Molecular Biology Lab	0:0:4	2
6	21BT2112	Fundamentals of Biotechnology	4:0:0	4
7	21BT2113	Fundamentals of Biotechnology Lab	0:0:4	2

21BT1001	FUNDAMENTALS OF BIOLOGY	L	T	P	C
		3	0	0	3

Credits: 3:0:0

Course Objective:

1. To impart the knowledge on biological evolution, microbial welfare and its applications
2. To appraise on cellular processes and diversity
3. To familiarize the concepts in biological function, classification and interactions of biomolecules.

Course Outcome:

The students will be able to

1. Understand the concepts of biological classification and diversity
2. Recall the various biomolecules and cell structures
3. Recognize the organ systems of plant
4. Understand the Theory of evolution
5. Outline the animal physiology
6. Discuss the principles, tools and techniques of genetic engineering

Module I: Biological Diversity - 4 hours

Biodiversity in the living world - taxonomic - Binomial nomenclature; Biological classification - Kingdom Monera - Protista - Fungi - Plantae - Animalia; Conservation - In situ conservation and Ex situ conservation.

Module II: Introduction to Biochemistry and Microbiology- 10 hours

History of biochemistry - Dissociation of water, concepts of pH; Biomolecules - carbohydrates - Monosaccharides - Oligosaccharides - Polysaccharides; proteins - Classification of amino acids - Structure of proteins; nucleic acids - structure of DNA and RNA.

History of microbiology - Principle of compound microscope - Structure of prokaryotic and eukaryotic cell - cell division. Nutritional requirements of bacteria and different media used for bacterial culture.

Module III: Plant Physiology - 5 hours

Flower - Angiosperms; Pre-fertilisation process - Stamen - Microsporangium - Megasporangium - Pollen grain - Embryo sac; Post-fertilisation; Pollination - Autogamy - Geitonogamy - Xenogamy; Photosynthesis: photophosphorylation- C4 and C3 pathway.

Module IV: Evolution and Genetics - 7 hours

Origin of life, Evolution theory - Miller's Experiment, Adaptive radiation, Darwinian Theory of evolution, Hardy-weinberg Principle.

Genetics - Principles of inheritance - Mendel's law of inheritance; Sex determination in humans and honey bee; Chromosomes; Mutation - Genetic disorders - Pedigree analysis - Chromosomal disorders.

Module V: Animal Physiology - 10 hours

Digestive system – Structure of tongue, teeth, oesophagus, stomach, small intestines and liver; Respiratory system – structure of nasal cavity, pharynx, trachea and lungs; Circulatory system – Components of circulatory system – Types of blood vessels – Structure of heart; Excretory system – Structure of kidneys and nephron; Reproductive system – male and female reproductive organs.

Module VI: Concepts in Biotechnology - 9 hours

Principles of Biotechnology - Genetic engineering - Tools of recombinant DNA Technology - Restriction enzymes - DNA replication in prokaryotes - origin of replication - cloning - plasmid - Polymerase Chain Reaction - Denaturation, Annealing, Extension; Bioprocess engineering - Bioreactor - Simple stirred - tank bioreactor - Sparged stirred - tank bioreactor; Microbes in Biotechnology and its applications.

Text Books:

1. Text book of Biology Central Board of Secondary Education First and Second year, New Delhi NCERT Publication, First edition, 2019.

2. Text book of Biology (Botany & Zoology), Higher Secondary First and Second year Tamil Nadu Text Book Coporation, First edition, 2019.

References:

1. U. Satyanarayana, Biochemistry, Fourth edition, Uppala Author Publishers Interlinks 2013.
2. Prescott LM, Harley JP, Klein DA, Microbiology, Ninth Edition, Wm. C. Brown Publishers, 2009.

21BT2108	FUNDAMENTALS OF CELL BIOLOGY AND MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To appraise students on basic concepts in cell biology
2. To understand the microbial growth and their control
3. To familiarize the role of microbes in public health

Course Outcome:

1. Exhibit a basic knowledge in cell structure, organelles and their functions
2. Outline the process involved in cell cycle and cell division
3. Describe the principles of cell culture techniques
4. Appreciate the importance of microscopy and staining techniques
5. Formulate nutritional requirements for microbial growth and their control
6. Explain the interactions among microorganisms, food and environment

Module I: Cells and organelles (9 Lecture hours)

Structure of prokaryotic and eukaryotic cells; plant and animal cells. Plasma membrane, Nuclear membranes, Organelle membranes. Nucleus, nucleolus, ribosome, mitochondria, chloroplast, vacuole, endoplasmic reticulum, golgi apparatus, peroxisome, lysosome.

Module II: Cell Cycle and Cell Division (7 Lecture hours)

Cell division in prokaryotes and eukaryotes-Cell division and cell cycle: mitosis, Meiosis, Cell cycle regulation, steps and control of cell cycle, Stem cells – sources and applications

Module III: Cell culture techniques (7 Lecture hours)

Aseptic conditions, media preparation, primary culture, passaging, trypsinization. Fundamentals of Stem cells

Module 1V: Basics in Microbiology (7 Lecture hours)

An overview of microbiology including a historical perspective of microbiology-Microscopy – light microscopy - principles of different staining techniques - Gram staining, acid fast, capsular staining, flagellar staining and spore staining

Module V: Nutrition and Control of Microbes (8 Lecture hours)

Nutritional requirements of bacteria, Types of Media: Selective Media, Differential Media Growth curve; Physical methods – sterilization: Moist heat, dry heat, radiation and filtration. Chemical methods: Disinfection, phenol, alcohol and detergents; Antibiotics- antibacterial agents, anti-fungal agents, anti-viral agents

Module VI: Public Health and Food Microbiology (7 Lecture hours)

Normal flora of human healthy host, nosocomial infections (hospital borne) Food and water borne infections caused by bacteria - botulism and cholera, Probiotics and their significance, Industrial Production of cheese

Total Hours: 60

Text Books

1. Pelczar MJ, Chan ECS and Krein NR, (2007). Microbiology, Tata McGraw Hill Edition, New Delhi, India.
2. Geoffrey M. Cooper and Robert E. Hausman, (2015). The Cell: A Molecular Approach, Fifth Edition, ASM Press and Sinauer Associates, Inc., USA.

Reference Books

1. Talaron K, Talaron A, Casida, Pelczar and Reid. (2001). Foundations in Microbiology, W.C.Brown Publishers.
2. Prescott LM, Harley JP, Klein DA, (2001). Microbiology, 3rd Edition, Wm. C. Brown Publishers.
3. De Robertis& De Robertis (2010). Cell Biology, 4th Edition, 2010.

21BT2109	BASIC CELL BIOLOGY AND MICROBIOLOGY LAB	L	T	P	C
		0	0	4	2

Course Objective:

1. To apprise basic laboratory techniques involved in cell biology
2. To recognize the basic principles involved in isolation of microorganisms
3. To identify microorganisms using various staining techniques

Course Outcome:

1. Distinguish between live and dead cells

2. Identify the various stages of cell division
3. Identify blood groups using immunological technique
4. Acquire transfer process of living microbes using aseptic techniques
5. Develop media for cultivation of microorganisms
6. Demonstrate microbial isolation and staining techniques for identification of microorganism

LIST OF EXPERIMENTS

1. Sterilization and Preparation of Media- Nutrient Agar and Nutrient Broth
2. Isolation of microorganisms from soil – pour plate
3. Staining Techniques-Gram staining and Negative staining
4. Hanging Drop Technique
5. Lactophenol Cotton staining
6. Antibiotic Sensitivity Test- Kirby Bauer Disk Diffusion Test
7. Enumeration of cells using haemocytometer
8. Staining of onion for mitotic stages
9. ABO Blood Grouping
10. Cell viability testing using Trypan blue assay

Reference Book

1. James G. Cappuccino, Microbiology: A Laboratory Manual, 10th Edition, Pearson publisher, 2014

21BT2110	BIOCHEMISTRY AND MOLECULAR BIOLOGY	L	T	P	C
		3	0	0	3

Course Objective

1. To acquire knowledge on structure, properties and function of various biomolecules.
2. To understand the basics of molecular biology
3. To recognize the importance of DNA replication and transcription process

Course Outcome

1. Remember the structure of carbohydrates, lipids, nucleic acid and proteins
2. Classify the biomolecules and understand their specific roles in biological system.
3. Analyze the properties of biomolecules
4. Recall the fundamental concepts of the prokaryotic and eukaryotic genome organization
5. Understand the process of DNA replication in prokaryotes
6. Distinguish the process of transcription in prokaryotes and eukaryotes

Module-I: Carbohydrates (8 Lecture hours)

Classification, structure, properties and functions of carbohydrates (Mono, Di, Oligo and polysaccharides) Monosaccharides, Disaccharides, Oligosaccharides-examples; Polysaccharide – classes- homo and hetero polysaccharides

Module-III: Amino Acids, Peptides and Proteins (7 Lecture hours)

Amino acids- structure and classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides; Proteins- classification and structures - primary, secondary, tertiary and quaternary.

Module-III: Fatty Acids and Lipids (8 Lecture hours)

Fatty acids- basic structure, types, properties, functions and essential fatty acids; ketone bodies, Classes, structure, properties and functions of lipids: Simple lipid-fat and wax, Compound lipid-Phospholipid, sphingolipid, ether lipid and glycolipid, Derived lipid – cholesterol.

Module IV: Chromosome Organization (8 Lecture Hours)

Chromosome organization in prokaryotes and eukaryotes, Molecular structure of DNA - forms, RNA - types. Classical experiments Grifith, Hershey and chase; Avery McLeod & McCarty. Transformation, Transduction, and Conjugation. Lytic and lysogeny.

Module V: DNA Replication – Prokaryotes (7 Lecture Hours)

DNA replication- Semi conservative replication, Meselson stahl experiment, Enzymes in replication, Replication in prokaryotes

Module VI: Transcription (7 Lecture Hours)

RNA polymerase, features of promoters and enhancers, transcription factors, Prokaryotic and eukaryotic transcription, inhibitors

Total Hours: 60

Text Books

1. Lehninger, A. L, NelsonD. L and Cox, M. M, (2005). “Principles of Biochemistry”, 4th Edition, Freeman Publishers, New York
2. David Friefelder (2003). “Molecular Biology”, 6th edition, Narosa Publication House.

Reference Books

1. Jain and Jain (2016). "Biochemistry", Chand publication
2. David R. Hyde, (2010). "Genetic and Molecular Biology", 4th Edition, Tata McGraw Publications, New Delhi

21BT2111	BASICS IN BIOCHEMISTRY AND MOLECULAR BIOLOGY LAB	L	T	P	C
		0	0	4	2

Course Objective

1. To develop skills in identifying and quantifying various biomolecules
2. To acquaint students with various basic techniques in molecular biology
3. To understand isolation of DNA from various sources

Course Outcome

1. Understand the basic concept involved in the estimation of biomolecules
2. Apply the basic reaction principle in estimation of different biomolecules
3. Analyze various tests to identify the carbohydrates, amino acids and lipids.
4. Understand the buffers and chemicals used in DNA extraction
5. Knows the isolation of DNA from plant, animal and microbial sources
6. Demonstrate the qualitative and quantitative measurements on nucleic acids.

LIST OF EXPERIMENTS

1. Estimation of carbohydrate by anthrone method
2. Qualitative identification of starch by iodine method
3. Estimation of protein by Lowry's method or Bradford Assay
4. Estimation of amino acid by Ninhydrin method
5. Tests for lipids: - Fats and cholesterol
6. Isolation of genomic DNA from plant tissue
7. Isolation of genomic DNA from animal liver
8. Isolation of genomic DNA from microorganism (E-coli)
9. Quantitative analysis of isolated genomic DNA using spectrophotometer
10. Agarose gel electrophoresis of DNA

Reference Book

1. Michael R. Green, Joseph Sambrook (2018). Molecular Cloning a Laboratory Manual, 4th ed., Chsl Press, New York.

21BT2112	FUNDAMENTALS OF BIOTECHNOLOGY	L	T	P	C
		4	0	0	4

Course Objective:

Enable the student to

1. To acquire knowledge on structure of various biomolecules
2. To recognize the importance of organization of chromosomes, DNA replication and transcription process
3. To understand the microbial growth and their control

Course Outcome:

The student will be able to

1. Remember the structure of carbohydrates, lipids and proteins
2. Outline the properties and classification of enzymes
3. Recall the fundamentals of chromosomal organization in prokaryotes and eukaryotes
4. Understand the process of DNA replication and transcription
5. Appreciate the importance of microscopy and staining techniques
6. Formulate nutritional requirements for microbial growth and their control

MODULE I: Basics in Biochemistry (12 Lecture Hours)

Classification and structure of Carbohydrates, Lipids, Proteins-primary, secondary, tertiary, and quaternary structure, Introduction to Enzymes- Chemical nature of enzymes, General properties; Nomenclature and classification

MODULE II: Chromosome Organization (10 Lecture Hours)

Chromosome organization in prokaryotes and eukaryotes, Molecular structure of DNA - forms, RNA - types. Classical experiments Grifith, Hershey and chase; Avery McLeod & McCarty. Transformation, Transduction, and Conjugation. Lytic and lysogeny.

MODULE III: DNA Replication – Prokaryotes (10 Lecture Hours)

DNA replication- Semi conservative replication, Meselson stahl experiment, Enzymes in replication, Replication in prokaryotes

MODULE IV: Transcription (10 Lecture Hours)
RNA polymerase, features of promoters and enhancers, transcription factors, Prokaryotic and eukaryotic transcription, inhibitors

Module V: Basics IN Microbiology (9 Lecture hours)
Overview of microbiology-historical perspectives-Microscopy – light microscopy - Staining techniques - Gram staining, acid fast, capsular staining, flagellar staining and spore staining

MODULE VI: Nutrition and Control of Microbes (9 Lecture hours)
Nutritional requirements of bacteria, Types of Media: Selective Media, Differential Media Growth curve; Sterilization- Physical methods: Moist heat, dry heat, radiation and filtration. Chemical methods: Disinfection, phenol, alcohol and detergents; Antibiotics- antibacterial agents, anti-fungal agents, anti-viral agents

Text Books

1. Lehninger, A. L, NelsonD. L and Cox, M. M, “Principles of Biochemistry”, Freeman Publishers, New York, fourth edition, 2005.
2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.2007
3. David Friefelder, “Molecular Biology”, Narosa Publ. House. 6th edition 2003

References Books

1. Jain and Jain “Biochemistry”, Chand publication, 2016.
2. David R. Hyde, “Genetic and Molecular Biology”, Tata McGraw Publications, New Delhi, 4th edition, 2010.
3. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 2001.

21BT2113	FUNDAMENTALS OF BIOTECHNOLOGY LAB	L	T	P	C
		0	0	4	2

Course Objective:
Enable the student to

1. To develop skills in identifying various biomolecules
2. To understand the isolation of DNA from plants and microbes
3. To recognize the basic principles involved in isolation and identification of microorganisms using suitable techniques

Course Outcome:
The student will be able to

1. Understand the basic concept involved in the estimation of different biomolecules
2. Analyze various tests to identify carbohydrates and amino acids
3. Understand the buffers and chemicals involved in DNA extraction
4. Isolate DNA from plant and microbial sources
5. Develop media for cultivation of microorganisms
6. Demonstrate isolation and staining techniques for identification of microbes

LIST OF EXPERIMENTS

1. Estimation of carbohydrate by Anthrone method
2. Qualitative identification of starch by Iodine method
3. Estimation of protein by Lowry’s method
4. Estimation of amino acid by Ninhydrin method
5. Isolation of genomic DNA from plant tissue
6. Isolation of genomic DNA from microorganism (*E.coli*)
7. Quantitative analysis of isolated genomic DNA using Spectrophotometer
8. Separation of DNA by Agarose Gel Electrophoresis
9. Sterilization and Preparation of Media- Nutrient Agar and Nutrient Broth
10. Isolation of microorganisms from soil – pour plate
11. Gram staining (*Staphylococcus aureus* and *E.coli*)
12. Negative staining (*Klebsiella pneumonia* and *E.coli*)

Text Books

1. Sawhney S. K., Randhir Singh, Introductory practical Biochemistry. Narosa publishers, 2006
2. Michael R. Green, Joseph Sambrook, Molecular Cloning a Laboratory Manual, 4th ed., CHSL Press, New York.2018.
3. Dubey RC and Maheswari DK. Practical Microbiology 1st Edition, S.Chand & Company Ltd., New Delhi, 2004
4. James G. Cappuccino, Microbiology: A Laboratory Manual, 10th Edition, Pearson publisher, 2014

DEPTARTMENT OF BIOTECHNOLOGY

LIST OF NEW COURSES (2020)

Sl.No	Course Code	Course Title	Credits [L:T:P:C]
1.	20BT1001	Engineering Design and Drawing Lab	0:0:2:1
2.	20BT1002	Basics of Python Programming	2:0:2:3
3.	20BT2001	Chemistry of Biomolecules	3:0:0:3
4.	20BT2002	Chemistry of Biomolecules Laboratory	0:0:2:1
5.	20BT2003	Cell Biology	3:0:0:3
6.	20BT2004	Workshop Practices in Biotechnology	0:0:2:1
7.	20BT2005	Basics of Industrial Biotechnology	3:0:0:3
8.	20BT2007	Bio-analytical Techniques	3:0:0:3
9.	20BT2008	Bio-analytical Techniques Lab	0:0:3:1.5
10.	20BT2009	Biochemistry	3:0:0:3
11.	20BT2010	Biochemistry Lab	0:0:3:1.5
12.	20BT2011	Microbiology	3:0:0:3
13.	20BT2012	Microbiology Lab	0:0:3:1.5
14.	20BT2013	Fluid Mechanics	3:1:0:4
15.	20BT2014	Fluid Mechanics and Heat transfer Lab	0:0:3:1.5
16.	20BT2015	Bioprocess Principles	3:0:0:3
17.	20BT2016	Bioprocess Lab	0:0:3:1.5
18.	20BT2017	Molecular Biology	3:0:0:3
19.	20BT2018	Genetic Engineering	3:0:0:3
20.	20BT2019	Molecular Biology and Genetic Engineering Lab	0:0:3:1.5
21.	20BT2020	Bioprocess Engineering	3:0:0:3
22.	20BT2021	Enzyme Engineering and Technology	3:0:0:3
23.	20BT2023	Downstream Processing	3:0:0:3
24.	20BT2024	Downstream Processing Lab	0:0:3:1.5
25.	20BT2025	Immunology	3:0:0:3
26.	20BT2026	Cell Biology and Immunology Lab	0:0:3:1.5
27.	20BT2029	Biochemical Thermodynamics	3:0:0:3
28.	20BT2030	Concepts of Bioinformatics	2:0:2:3
29.	20BT2052	Plant and Animal Tissue Culture Lab	0:0:4:2
30.	20BT2054	Environmental Biotechnology	3:0:0:3
31.	20BT2057	Bioethics, IPR and Biosafety	3:0:0:3
32.	20BT2059	IoT in Biotechnology	2:0:0:2
33.	20BT2068	Principles of Plant Biotechnology and Applications	3:0:0:3
34.	20BT2069	Advances in Animal Biotechnology	3:0:0:3
35.		**Professional Electives**	
36.	20BT2006	Bioprocess Calculations	3:0:0:3
37.	20BT2022	Heat and Mass Transfer	3:1:0:4
38.	20BT2027	Chemical Reaction Engineering	3:1:0:4
39.	20BT2028	Mass Transfer and Chemical Reaction Engineering Lab	0:0:3:1.5
40.	20BT2032	Industrial safety and Hazard analysis	3:0:0:3
41.	20BT2033	Environmental Pollution Control Engineering	3:0:0:3

42.	20BT2034	Process Equipment Design and Economics	3:0:0:3
43.	20BT2035	Process Dynamics and Control	3:0:0:3
44.	20BT2036	Mechanical Operations	3:0:0:3
45.	20BT2037	Mechanical Operations Lab	0:0:3:1.5
46.	20BT2038	Biochemical Engineering Lab	0:0:2:1
47.	20BT2039	Cancer Biology	3:0:0:3
48.	20BT2040	Clinical Database Management	3:0:0:3
49.	20BT2041	Clinical Database Management Lab	0:0:3:1.5
50.	20BT2042	Plant and Animal Biotechnology	3:0:0:3
51.	20BT2043	Stem Cell Technology	3:0:0:3
52.	20BT2044	Biopharmaceutical Technology	3:0:0:3
53.	20BT2045	Agricultural Biotechnology	3:0:0:3
54.	20BT2046	Metabolic Engineering	3:0:0:3
55.	20BT2047	Research Methodology	3:0:0:3
56.	20BT2048	Molecular Forensics	3:0:0:3
57.	20BT2049	Protein Engineering	3:0:0:3
58.	20BT2050	Plant Tissue Culture	3:0:0:3
59.	20BT2051	Animal Biotechnology and Cell Culture	3:0:0:3
60.	20BT2053	Biomass and Bioenergy	3:0:0:3
61.	20BT2055	Matlab Programming	3:0:0:3
62.	20BT2056	Entrepreneurship for Bioengineers	3:0:0:3
63.	20BT2058	Tissue Engineering	3:0:0:3
64.	20BT2060	Developmental Biology	3:0:0:3
65.		**Open electives**	
66.	20BT2061	Biology for Engineers	3:0:0:3
67.	20BT2062	Role of Biotechnology in Environment	3:0:0:3
68.	20BT2063	Fundamentals of Biochemistry	3:0:0:3
69.	20BT2064	Pathology and Microbiology	3:0:0:3
70.	20BT2065	Human Anatomy and Physiology	3:0:0:3
71.	20BT2066	Cell Biology and Immunology	3:0:0:3
72.	20BT2067	Molecular Biology for Biomedical Engineers	3:0:0:3
73.		**M.Tech.Biotechnology**	
74.	20BT3001	Advances in Biopolymer and Applications	3:0:0:3
75.	20BT3002	Genetic Engineering and Recombinant Products	3:0:0:3
76.	20BT3003	Bioprocess Modelling and Simulation	3:0:0:3
77.	20BT3004	Biochemical Analysis Lab	0:0:4:2
78.	20BT3005	Animal and Plant Tissue Culture Lab	0:0:4:2
79.	20BT3006	Advanced Process Equipment Design and Drawing Lab	0:0:4:2
80.	20BT3007	Genetic Engineering Lab	0:0:4:2
81.		**Professional Electives**	
82.	20BT3008	Enzyme Technology and Industrial Applications	3:0:0:3
83.	20BT3009	Microbial Biotechnology	3:0:0:3
84.	20BT3010	Agriculture and Food Biotechnology	3:0:0:3
85.	20BT3011	Big Data Analytics	3:0:0:3
86.	20BT3012	Bioethics and Biosafety	3:0:0:3

87.	20BT3013	Chemical Process Technology	3:0:0:3
88.	20BT3014	Immunotechnology	3:0:0:3
89.	20BT3015	Computational Biology	3:0:0:3
90.	20BT3016	Metabolic Regulation and Engineering	3:0:0:3
91.	20BT3017	Clinical Trials and Bioethics	3:0:0:3
92.	20BT3018	Sustainable Bioprocess Development	3:0:0:3
93.	20BT3019	Advanced Animal Biotechnology and Tissue Culture	3:0:0:3
94.	20BT3020	Molecular Diagnostics	3:0:0:3
95.	20BT3021	Drug Design and Discovery	3:0:0:3
96.	20BT3022	Introductory AI in Biotechnology	3:0:0:3
97.	20BT3023	Transport Phenomena	3:0:0:3
98.	20BT3024	Pharmaceutical Biotechnology	3:0:0:3
99.	20BT3025	Bioreactor Engineering	3:0:0:3
100.	20BT3026	Stem Cell Therapeutics	3:0:0:3
101.	20BT3027	Nanobiotechnology	3:0:0:3
102.	20BT3028	Advanced Plant Biotechnology	3:0:0:3
103.	20BT3029	Cancer Management Techniques	3:0:0:3
104.	20BT3030	Genomics and Proteomics	3:0:0:3
105.	20BT3031	Advanced Environmental Biotechnology	3:0:0:3
106.	20BT3032	Entrepreneurship and Management	3:0:0:3
107.		**Open Electives**	
108.	20BT3033	Industrial Waste Management	3:0:0:3
109.	20BT3034	Industrial Safety	3:0:0:3
110.		**M.Sc. Biotechnology**	
111.	20BT3051	Biochemistry	3:0:0:3
112.	20BT3052	Plant Secondary Metabolites and Pharmaceutics	3:0:0:3
113.	20BT3053	Molecular Biology and Cell Signaling	3:0:0:3
114.	20BT3054	Microbiology and Molecular Genetics	3:0:0:3
115.	20BT3055	Animal Biotechnology and Immunology	3:0:0:3
116.	20BT3056	Research Methodology and Applied Statistics	2:0:0:2
117.	20BT3057	Bioprocess and Downstream Processing	3:0:0:3
118.	20BT3058	Molecular Medicine and Diagnostics	3:0:0:3
119.	20BT3059	Lab- III Microbial Technology Lab	0:0:4:2
120.	20BT3060	Lab- V Bioprocess and Downstream Processing Lab	0:0:4:2
121.	20BT3061	Lab-VI Immunological Techniques Lab	0:0:4:2
122.		**Professional Electives**	
123.	20BT3062	Industrial Biotechnology	3:0:0:3
124.	20BT3063	Pharmaceutical Technology and Clinical Trial	2:0:2:3
125.	20BT3064	Bioinformatics and Basics of R Programming	2:0:2:3
126.	20BT3065	NGS Data Analysis	3:0:0:3
127.	20BT3066	Algae Biotechnology	2:0:2:3
128.	20BT3067	Tissue Engineering and Stem Cell Technology	3:0:0:3
129.	20BT3068	Metabolic Engineering for Industrial Production	3:0:0:3
130.	20BT3069	Human Anatomy, Physiology and Health Education	3:0:0:3
131.	20BT3070	Vaccine Technology	3:0:0:3

20BT1001	ENGINEERING DESIGN AND DRAWING LAB	L 0	T 0	P 2	C 1

Course Objectives:

1. To learn engineering design and its place in society
2. To get exposure to the visual aspects of engineering design and graphicsstandards
3. To design plant layout using AutoCAD

Course Outcome:

The student will be able to

1. Remember the unit operation symbol, letters and plant layout
2. Understand a system, component, or process to meet desired needs within realistic constraints and sustainability.
3. Apply techniques, skills, and engineering design tools necessary for engineering practice
4. Optimize material required in fabrication of parts.
5. Analyze assembly of system with fewer parts.
6. Create drawings on plant layout in biochemical industries

List of Experiments:

1. User interface
2. Customization and drawing aids, page setup and printing
3. Engineering Letters
4. Lines and numbering
5. Drawing polylines, ellipses, polygons
6. Basics of various unit operation symbols
7. Plant layout of a biotechnology Industry
8. Plant layout of a biochemical Industry
9. Text fonts, formatting text and setting title box for drawing template.
10. Design of a Batch reactor
11. Design of a Airlift Fermenter
12. Demonstration of a simple team design project

Reference Books:

1. Ganesan G., "Basic Computer Aided Design and Drafting using AutoCAD 2015", McGraw Hill, 2018.
2. Sham Tickoo, "AutoCAD 2015 for Engineers and Designers", Dream Tech Press, 2014.
3. Elliot Gidis, "Up and Running with AutoCAD 2015", 2D and 3D Drawing and Modeling. Academic Press,2014
4. Gary R. Bertoline and Eric n. Wiebe, "Fundamentals of Graphics Communication", McGraw Hill, 2002.
5. Mccabe, W. L.,Smith, J. C., and Harriott,P., "Unit Operations of Chemical Engineering", McGraw Hill,NewYork,6^{th}Edition,2004

20BT1002	BASICS OF PYTHON PROGRAMMING	L 2	T 0	P 2	C 3

Course Objectives:

To impart knowledge on

1. Fundamental programming constructs such as variables, arrays, loops, subroutines and input/output in Python.
2. Concepts of modules in Python and Biopython.
3. Utilization of Biopython packages in big data analytics

Course Outcomes:
The students will be able to

1. Understand, write, compile, and run Python programs.
2. Analyze Python structures that implement decisions, loops, and store arrays and use these structures in a well designed, OOP program.
3. Create Python programs that make use of various modules and packages
4. Understand regular expressions and extract required information from file and databases.
5. Relate and arrange information from multiple files
6. Apply the principles of object-oriented programming and well-documented programs in the Python language, including use of the Bio-python packages in big data analytics

Module 1: Install and run Python program **(8 Hours)**
System command lines and files, module imports and reloads. The IDLE user interface, Numeric type's basis, Numbers in action, Comparison, Decimal and Fraction type, Sets, Booleans

Module 2: Strings **(8 Hours)**
String literals, Strings in action, String methods, the original string module, String formatting expressions

Module 3: Lists and files **(8 Hours)**
Lists, Lists in action, basic operations, comprehensions, indexing, slicing, matrixes

Module 4: Tuples **(6 Hours)**
Tuples in action, compare list and tuples, files and examples.

Module 5: Control statement in python **(8 Hours)**
If statement, Python syntax rules, truth test, while loop, break, continue, pass, for loops, loop coding techniques, examples.

Module 6: Modules and package **(7 Hours)**
Module creation, module usage, package import basics and examples, Bio-python.

Lists of Experiments:

1. Demonstrate the working of 'id' and 'type' functions.
2. Write a Python program to find all prime numbers within a given range
3. Write a Python program to print 'n terms of Fibonacci series using iteration
4. Write a Python program demonstrate use of slicing in string.
5. Write a Python program to compute the frequency of the words from the input.
6. Write a Python program that accepts a comma separated sequence of words as input and prints the words in a comma-separated sequence after sorting them alphabetically.
7. Write a Python program to get a string from a given string where all occurrences of its first char have been changed to '$', except the first char itself
8. Write a Python program to demonstrate use of list & related
9. Write a Python program to demonstrate use tuple, set & related
10. Biopython packages uses in big data analytics

Text Book:

1. Alex Martelli and David Ascher, "Python cookbook", O'Reilly,USA, 2ndEdition 2002.
2. Randal L. Schwartz, brian d foy, Tom Phoenix, "Learning Perl" O'Reilly Media, Inc., 2016
3. Mark Lutz, "Learning Python" "O'Reilly Media, Inc.", 2013

Reference Book:

1. Jason Kinser, "Python for bioinformatics" Jones and Bartlett Publishers,UK,1st edition, 2009
2. Martin Jones, "Python for Biologists: A programming course of complete beginners" Copyright © 2013

20BT2001	CHEMISTRY OF BIOMOLECULES	L T P C 3 0 0 3

Course Objectives:

1. To gain knowledge on structure, composition, bonding and function of various biomolecules.
2. To illustrate the basic nature and properties of biomolecules which are involved in the metabolic pathways
3. To articulate the significance of these biomolecules and to apply these fundamentals in biotechnology

Course Outcomes:

The students will be able to

1. Recall the chemical bonding and properties of biomolecules
2. Understand the biochemistry at the atomic level, and to draw the basic structures of biomolecules.
3. Recognize the significance of biomolecules in the proper functioning of living cells
4. Illustrate the structure and functions of conjugated biomolecules – proteoglycans, glycoproteins and glycolipids.
5. Discuss the applications of biomolecules in biotechnology industries
6. Analyze the clinical and biological significance of biomolecules

Module 1: Chemical bonding (5 hrs)

Matter and its nature, Dalton's atomic theory, concept of atom, molecule, element and compound. Principles of Chemical Bonding, Water- chemical properties, function as medium of cellular reactions and activities. Acids and Bases, Buffer systems of the blood, Buffering against pH changes in Biological Systems.

Module 2: Carbohydrates (8 hrs)

Classification, structure, properties and functions of carbohydrates: Monosaccharides –classes, examples, Disaccharides – classes- homo and hetero, examples. Oligosaccharides-examples; Polysaccharide – classes, examples; complex and conjugated carbohydrates- proteoglycan, glycoprotein, glycolipid. Industrial and clinical significance of carbohydrates- a review

Module 3: Lipids and fatty acids (8 hrs)

Fatty acids- basic structure, types, properties, functions and essential fatty acids; ketone bodies, Classes, structure, properties and functions of lipids: Simple lipid- examples, Compound lipid- examples, ether lipid, Derived lipid – cholesterol. Review on industrial and clinical significance of fatty acids and lipids.

Module 4: Amino acids and Proteins (8 hrs)

Amino acids- basic structure, classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides. Review on industrial and clinical significance of amino acids, peptides and proteins.

Module 5: Nucleic acids (8 hrs)

Nucleotides- composition, structure, properties and functions; Nucleic acids- types (RNA, DNA), DNA structure-composition, RNA types, structure and functions, properties of nucleic acids

Module 6: Significance of Vitamins, Minerals and Nutraceuticals (8 hrs)

Classification of Vitamins; biological functions of Vitamins – roles in metabolism and regulatory pathways, anti-oxidant roles; clinical symptoms of Vitamin deficiency;Biological significance of minerals; Vitamin and mineral supplementations-nutraceuticals.

Text Books

1. Lehninger, A.L, Nelson D.L and Cox, M.M, "Principles of Biochemistry", Freeman Publishers, New York, 7th edition, 2017.
2. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.

References Books

1. Lubert Stryer, "Biochemistry", WH Freeman & Co., 4th edition, 2000.
2. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.

3. Jain and Jain "Biochemistry", Chand publication, 4th edition, 2008.

20BT2002	CHEMISTRY OF BIOMOLECULES LAB	L 0	T 0	P 2	C 1

Course Objectives:
1. To understand the basic units and measurements of biochemical solutions
2. To acquaint students with the concepts in biochemical analysis
3. To articulate the skills of quantifying the various biomolecules

Course Outcomes:
1. Understand the basic concept, applications of tests, titrations and estimations of biomolecules
2. Demonstrate the basic lab skill in preparing different solutions of different concentrations and their measurement tools with representing units
3. Apply the basic reaction principle in estimation of different biomolecules using suitable method
4. Analyze the various tests and identify the different carbohydrate, amino acid and lipid molecules present in the given sample solution.
5. Explain the suitable extraction methods for the estimation of different biomolecules.
6. Evaluate the level of biomolecules in different food materials

List of Experiments:
1. Study of biochemical solutions, units and measurements
2. Preparation of buffers
3. Qualitative analysis of carbohydrates
4. Tests for lipids: - Fats and cholesterol
5. Qualitative analysis of amino acids
6. Tests for phytochemicals
7. Dry ashing of food materials and colorimetric estimation of phosphorus
8. Estimation of ascorbic acid content in foods
9. Analysis of nucleic acid by spectrophotometer
10. Estimation of beta carotene in carrot
11. Titration of amino acid
12. Analysis of clinical samples- Blood sugar

Reference Book:

1. Sawhney S. K., Randhir Singh, Introductory practical Biochemistry. Narosa publishers, 2006

20BT2003	CELL BIOLOGY	L 3	T 0	P 0	C 3

Course Objective:
1. To acquaint students with the concepts in Cell Biology.
2. To appraise on cellular processes and regulation
3. To familiarize the recent trends in cell and molecular research

Course Outcome:
1. Exhibit a knowledge base in cell structure, organelles and their functions
2. Outline the process that control cell cycle, and cell death
3. Relate how cell movement and cell to cell communication occur and discuss mechanisms of signal transduction
4. Link the rapid advances in cell and molecular biology to a better understanding of diseases including cancer
5. Evaluate and apply knowledge of recent techniques in cellular biology
6. Crtique and professionally present literature articles in cell and molecular biology

Module 1: Cell and Molecular Organization of Cell Membrane (8)
Brief overview of cell and cell organelles, Membrane organization of cell membrane-Functions and Models, Components of membrane - lipids and protein, Fluid and Dynamic membrane, Diffusion across membranes

Module 2: Membrane Transport (8)
Facilitated diffusion and active transport, Voltage gated channels and transmission of action potential in neurons. Endomembrane systems - Protein synthesis, targeting and trafficking, Glycosylation, Quality control and vesicular transport. Endocytosis and Exocytosis, Entry of virus and toxins into the cells.
Module 3: Cell Mobility (7)
Cytoskeleton and Microtubule based movement, Intracellular transport, Motile appendages, Microfilament based movement, Actin filament based movement – Sliding filament theory and Actin myosin interactions in muscular contractions.
Module 4: Cellular Communications (10)
Modes of signal transmission, ECM, Cell-ECM interactions, ECM and cancer metastasis, Cell-cell interactions, Cell signaling and signal transduction - Signaling molecules, Cytosolic, nuclear and membrane bound receptors. G-protein coupled receptor - Role of cyclic AMP, cyclic GMP and Inositol triphosphate (IP3) in signal transduction, Enzyme linked receptors -Receptor Tyrosine kinases andTGFβ signaling.
Module 5: Cell Cycle and Cancer (6)
Cell cycle and molecules that control cell cycle, Regulation of cell cycle. Cell aging and apoptosis, Properties of cancer cells, Transformation of cells in culture.
Module 6: Current Trends in Cell Biology (6)
Stem cells and progress in stem cell therapy. Cell imaging techniques: Fluorescence microscopy and Confocal microscopy, FACS. Breakthrough in cell biology – review on the research of Nobel prize winners 2015-2019

Text Books

1. Geoffrey M. Cooper and Robert E. Hausman, The Cell: A Molecular Approach, Fifth Edition, ASM Press and Sinauer Associates, Inc., USA, 2015.
2. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, Molecular Biology of the cell, fifth edition, Taylor and Francis group, 2012.

Reference Books

1. De Robertis & De Robertis, Cell Biology, 4th Edition, 2010.
2. Lodish, H. and D. Baltimore, Cell Biology, W.H. Freeman publishers, 2012.
3. Gerald Karp, Cell and Molecular Biology, John Wiley and sons Inc, 2013.

20BT2004	WORKSHOP PRACTICES IN BIOTECHNOLOGY	L	T	P	C
		0	0	2	1

Course Objectives:
1. To impart knowledge ongood Laboratory Practices
2. To impart knowledge on planning and procedures to develop models in biotechnology laboratories.
3. To impart knowledge on sequence of operations adopted in laboratories to fabricate models.

Course Outcomes:
1. Understand various laboratory tools and their applications.
2. Prepare basic solutions for chemical applications and their disposal.
3. Learn basic electrical processes involved in equipment and their trouble shooting.
4. Understand plumbing
5. Design and fabricate the various objects in sheet metal using hand tools.
6. Apply manufacturing process for various biotech applications.

List of Experiments:
1. Measurements, tools and its usages
2. Fundamental electricals, electronics and trouble shooting
3. Basics of laboratory safety, first aid and disposal process
4. Basics of calculations and measurements
5. Introductory plumbing
6. Computer hardware and installations

7. Sheet metal fabrication and carpentry

20BT2005	BASICS OF INDUSTRIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To ensure students have a base on the History of Biotechnology and its source of origin and the analysis on the different kinds of microorganisms which could be deployed for industrial biotechnology.
2. To facilitate knowledge for the various production strategies of bio products employed for sustainable bioprocess development
3. To ensure the need to know various production strategies of bio products employed for better sustainable bioprocessdevelopment on an industrial scale.

Course Outcome:

At the end of the course students will be able to

1. Remember the use of microbes for developing industrial products and processes.
2. Understand the techniques for genetic improvement of micro-organisms to improve yield of bio-products.
3. Explain the technical issues related with microorganisms in the production of bio products.
4. Analyze industrial-market value of these bio products and relate them with the scope of biotechnology
5. Relate the clinical and biological significance of these bio products for sustainable bioprocess engineering
6. Evaluate the difference in manufacturing commercial bio products and all the ethical issues involved in it.

Module 1: Introduction to Industrial Bioprocess (9)

Historical overview of industrial bioprocess: Fermentation – Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology – A brief survey of organisms, reactors, processes, products, media- design of experiment. Basic concepts of upstream and downstream processing, process flow sheeting – block diagrams, pictorial representation and the future perspectives in Industrial Biotechnology.

Module 2: Production of Primary Metabolites (9)

Primary metabolites; Industrial production of commercially important organic acids, amino acids, alcohols and Vitamins.

Module 3: Production of Secondary Metabolites (9)

The production of secondary metabolites of high commercial value like antibiotics and steroids: Penicillin V, Streptomycin and Ampicillin sodium salt and steroids.

Module 4: Production of Enzymes and other Products (9)

Production of industrial enzymes such as lipases, cellulase, lysozyme, bio preservatives (Nisin), cheese, biopolymers (xanthan gum, PHB), bio-flavours and bio-pigments-luciferin, carotene,antioxidant – glutathione.

Module 5: Production of Modern Biotechnological Products (5)

Production of recombinant fine bio products for pharmaceutical applications like monoclonal antibodies and vaccines. Products from plant and animal cells.

Module 6: Production of Target Specific Fine Bioproducts: (4)

Production of Single Cell Proteins; Bio-fertilizers, Plant Products of Industrial Importance-Synthetic Seeds, Arbutin. Animal Products of Industrial importance-Gelatin, spray dried yolk powder. Bioremediation and Bioenergy-fuel from biomass, biogas, bio-refineries, Microbial Enhanced Oil Recovery (MEOR).

Text Books

1. Prescott and Dunn, Industrial Biotechnology, Agro bios (India), 2005.
2. A.H.Patel, Industrial Microbiology, 2nd Edition, 2011.

3. P.F. Stanbury and Whitaker, Fermentation Technology, Second Edition, 2009.

References Books

1. Elmar Heinzle, Sustainable Bioprocess Development, 2008.
2. Robert H. Perry, Handbook of Chemical Engineering, 2000.
3. Glazer AN, Nikaido H, The process of Microbial Enhanced Oil Recovery and Microbial Leaching Text books, 2007.
4. Poonam Kushwaha, Handbook of Pharmaceutical Technology, Jaypee Digital, 2015.

20BT2006	BIOPROCESS CALCULATIONS	L 3	T 0	P 0	C 3

Course Objective:

1. To develop skills of students in principles and basic calculations
2. To familiarize in material balance for both with and without chemical reactions
3. To conceptualize energy balance for reactive and non-reactive systems

Course Outcome:

The students will be able to

1. Understand the importance and inter conversion of different units
2. Remember the concept of material balances for with and without chemical reactions
3. Relate the concept of stoichiometry in real-time problem
4. Distinguish the properties of ideal gases and gas mixtures
5. Evaluate flow diagram and the concept of recycle, purge and bypass in a process
6. Analyze the concept of energy balances for closed and open system

Module 1:Systems(8)

Units systems, basic units, derived units, dimension analysis, force, pressure, work, heat, conversion of units, Mass and volumetric flux.

Module 2:Stoichiometry (9)

Stoichiometry, Avogadro number, molarity, molality and normality, molecular weight, equivalent weight, mass fraction, mole fraction, concept of limiting & excess reactants, fractional conversion, stoichiometry of microbial growth and product formation.

Module 3: Ideal Gases and Gas Mixtures (10)

Ideal Gases, Standard temperature and pressure, partial pressure, Ideal Gas Equation, Gas laws: Boyle's Law, Charles' law, Amagat's law and Daltons law, Density and molecular weight related problems.

Module 4:Material Balance (10)

Fundamental of material balance, Basics of calculation, approach of solving material balance problems, Mixing, Tie element, Evaporation, Crystalization, Drying, Absorption, Extraction.

Module 5:Energy Balance (5)

Basic Energy Concepts, types of Energy, Internal energy, Enthalpy, General Energy-Balance Equations, Heat Transfer, Heat transfer equipment.

Module 6:Material Balance Involving Recycle (3)

Flow sheet, Bypass, Recycle,Purge, closed and open system.

Text Book

1. Narayanan K.V., Lakshmikutty B., "Stoichiometry and Process Calculations", PHI Learning Private Limited, 4th edition, 2014

Reference Books

1. Felder, R.M., Rousseau R.W., "Elementary Principle of Chemical Processes", John Wiley and Sons Publication 3rd edition, 2000.
2. BI Bhatt & SM Vora "Stoichiometry", Tata Mcgraw- Hill, 4th edition, 2004.
3. Venkataramani.V and Anantharaman.A., "Process Calculations", PHI learning Pvt. Ltd, 2003.
4. David Mautner Himmelblau, James B. Riggs., 'Basic Principles and Calculations in Chemical Engineering' Prentice Hall of India, 4th editon. 2004

20BT2007	BIO-ANALYTICAL TECHNIQUES	L 3	T 0	P 0	C 3

Course Objectives:

1. To provide the students an ability to understand the principles of instrumentation
2. To impart the knowledge of different techniques and methods in biotechnology
3. To improve the understanding of applications of techniques in the field of biotechnology

Course Outcomes:

The students will be able to

1. Understand the concepts of calibration and testing
2. Illustrate the different methods of analytical techniques for quantitative analysis
3. Explain importance of centrifugation and chromatography as analytical techniques
4. Demonstrate the gel electrophoresis and thermal analytical techniques
5. Analyze the methods of structural elucidation of different compounds
6. Illustrate importance of radioactive isotopes in modern research

Module 1:Basics of Bio-Analytical Techniques (9)

Classification of instrumental methods; Concepts of accuracy, precision and limits of detection (LOD); Types of errors–random and systematic; Calibration of instrumental methods comparison with standards, Buffers, pH – pH meter and applications, Extraction techniques–Principle of solid extraction (Soxhlet)

Module 2:Spectroscopy Techniques (9)

Basic principle of Spectroscopy -Beer-Lambert's law, Principle, Instrumentation and applications of colorimeter, Fluorimeter, Flame photometer, Nephelometer, Conductivity meter, spectrofluorometric and Spectrophotometer: types– UV – visible – NIR spectroscopy, Raman spectroscopy.

Module 3:Analytical Centrifugation (6)

Basic principle of centrifugation- centrifugal force, sedimentation coefficient, Svedberg units (S), Instrumentation for centrifugation- ultracentrifuges. Application of centrifugation, analytical and preparative centrifugation, Comparison of differential, zonal and isopycnic centrifugation methods, Safety and rules of operation.

Module 4:Chromatography Techniques (9)

Principle, types and applications of analytical chromatography- Thin layer, Normal phase chromatography, reversed phase chromatography, Ion exchange chromatography, gel permeation chromatography, Chiral chromatography, Bioaffinity chromatography, hydrophobic interaction chromatography, Chromatogram analysis for quantitation GC and HPLC.

Module 5:Electrophoresis &Thermal Analytical Techniques (7)

Principle, Types and applications of Electrophoresis– agarose gel, polyacrylamide gel (PAGE), SDS-PAGE–principle, instrumentation and applications; Quantitative electrophoresis, isoelectric focusing–principle and applications; Thermo gravimetric analysis (TGA)-Principle, instrumentation and applications

Module 6:Structural Elucidation and Radioisotope Methods (5)

Mass spectrometry–principle, instrumentation (electron spray ionization [ESI] & chemical ionization [CI]) and applications; nuclear magnetic resonance (NMR) –principle, instrumentation and applications, Radioactive isotopes, GM counter, Scintillation counter, Applications in Medicine & Diagnosis.

Text Books:

1. Willard and Merrit, Instrumental Methods and Analysis. VI Edition, CBS Publishers & Distributors; 2002.

Reference Books:

1. Gurdeep R. Chatwal and Sham K. Anand. Instrumental Methods of Chemical Analysis. 5th Edition. Himalaya Publishing House, India. (2012).
2. Sharma B.K.. Instrumental Methods of Chemical Analysis. 24th revised and enlarged edition. GOEL Publishing House, India. (2014).
3. Keith Wilson and John WalkerPrinciples and Techniques of Practical Biochemistry and Molecular Biology. 7th Edition. Cambridge University Press, U.K. (2010).

4. Douglas A. Skoog, F.James Holler and Stanley R. Crough. Instrumental Analysis. 6th Edition. Brooks Cole Publishing Company. USA, (2007).
5. Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath. Biophysical Chemistry: Principles and Techniques. Himalaya Publsihing House Pvt. Ltd. India, (2014).

20BT2008	BIO ANALYTICAL TECHNIQUES LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To impart technical knowledge about the working principle and applications of different equipment related to biotechnology experiments.
2. To enable the students to understand the principles of instrumentation
3. To impart the knowledge of different techniques and methods in biotechnology

Course Outcome:

1. Understand the basic measurement methods and its applications in biotechnology
2. Describe the instrumentation and applications of different spectroscopic techniques
3. Demonstrate the principles, techniques and applications of chromatography.
4. Explain the determination of pH and their applications in buffer preparations
5. Understand different purification techniques of primary and secondary metabolites
6. Examine the applications of equipment involved in experimental biotechnology

List of Experiments

1. Verification of Beers Law and Construction of Beers Law plot
2. Determination of analytical wavelength for given sample
3. Calculation of LOD and LOQ of an analytical technique
4. Estimation of Polyphenol by Colorimetric method
5. Preparation of buffer solution with Henderson-Hasselbach equation and its verification with pH meter
6. Titration curves of Acetic acid and Citric Acid using pH meter
7. Determination of protein molecular weight by SDS-PAGE
8. Identification of amino acids by ascending paper chromatography
9. Determination of turbidity by nephelometry
10. Conductivity measurement in titration
11. Separation of secondary metabolites by Silica gel column chromatography and quantification using spectrophotometer
12. Extraction of secondary metabolites from plant samples using Soxhlet apparatus and quantification using spectrophotometer

References:

1. R. Mahesh, Sajeev C, N. Sridhar, Laboratory manual on “Instrumental Methods of Analysis” – EDD Notes. 4 thEdition. 2003.
2. B. K. Sharma. “Instrumental Methods of Chemical Analysis”, 27th Edition. Goel Publishing House, Meerut. 2011

20BT2009	BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To facilitate strong knowledge on metabolic pathways and their regulations
2. To articulate the importance of bioenergetics
3. To gain knowledge on the various inborn errors of metabolism.

Course Outcomes:

The students will be able to

1. Acquire knowledge on the metabolic pathways

2. Summarize the biosynthesis and degradation pathways of amino acids
3. Explain the importance of bioenergetics and energy rich compounds.
4. Understand the metabolic reactions of nucleotides
5. Learn the various inborn errors of metabolism
6. Analyze the anabolic and catabolic reactions of lipids

Module 1: Carbohydrate metabolism (8 hrs)

Introduction to metabolism and bio-catalysis, Glycolysis, TCA cycle Pentose phosphate pathway, Glycogenesis and Glycogenolysis; Glycogen storage diseases; Photosynthesis – C3,C4 and CAM.

Module 2: Amino acid metabolism (8 hrs)

Transamination and urea cycle. Biodegradation of selected amino acids- Ala, Thr, Leu, Ile, Tyr, Phe, Trp. Biosynthesis of amino acids- tyrosine. phenylalanine and tryptophan and inborn errors of amino acid metabolism.

Module 3: Fatty acid metabolism (8 hrs)

Biosynthesis and oxidation of fatty acids, ketogenesis, energetics of Beta oxidation, cholesterol biosynthesis and degradation, inborn errors of lipid metabolism

Module 4: Nucleic acid metabolism (8 hrs)

Anabolism of purines and pyrimidines, catabolism of purines and pyrimidines, regulatory pathways, inborn errors of purine and pyrimidine metabolism

Module 5: Bioenergetics (5 hrs)

Definition, redox biochemistry. Energy rich compounds. Respiratory chain and Oxidative phosphorylation.

Module 6: Integration of metabolic pathways and regulation (8 hrs)

Overview of integrated metabolic pathways – primary and secondary metabolites; Coordinated Regulation of Glycolysis and Gluconeogenesis, The Metabolism of Glycogen, Coordinated Regulation of Glycogen Synthesis and degradation.

Text Book:

1. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 4th edition, 2008.

Reference Books

1. Lehninger, David L. Nelson & Michael M. Cox, “Principles of Biochemistry”, Freeman Publishers,7th edition, 2017.
2. Lubert Stryer, “Biochemistry”, WH Freeman & Co., 4th edition, 2000.
3. Voet and Voet, “Biochemistry”, John Wiley & Sons Inc., 2nd Edition, 2013.

20BT2010	BIOCHEMISTRY LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To acquire knowledge on the various biochemical analysis
2. To facilitate for understanding the skills of the students in Qualitative and Quantitative Analysis of biomolecules.
3. To articulate the various estimation techniques

Course Outcomes:

1. Understand the basic concept, applications of tests, titrations and estimations of biomolecules
2. Demonstrate the basic lab skill in preparing different solutions of different concentrations and their measurement tools with representing units
3. Apply the basic reaction principle in estimation of different biomolecules using suitable method
4. Analyse the various tests and identify the different carbohydrate, amino acid and lipid, DNA, RNA, enzymes and antioxidant molecules present in the given sample solution.
5. Apply suitable extraction methods for the estimation of different biomolecules.
6. Evaluate the level of biomolecules in different food materials

List of Experiments

1. Estimation of total carbohydrate by Anthrone method
2. Estimation of reducing sugars by Di Nitro Salicylic acid method
3. Estimation of cholesterol by Zak's method
4. Estimation of protein by Lowry's/ Bradford's method
5. Enzyme assay – Alkaline phosphatase
6. Enzyme assay - Amylase
7. Estimation of amino acid by Ninhydrin method
8. Estimation of DNA by diphenylamine method
9. Estimation of RNA by orcinol method
10. Antioxidant assay
11. Estimation of starch
12. TLC separation of phytochemicals

Reference Book:

1. Sawhney S. K., Randhir Singh, Introductory practical Biochemistry. Narosa publishers, 2006

		L	T	P	C
20BT2011	**MICROBIOLOGY**	**3**	**0**	**0**	**3**

Course Objective:

1. To highlight the functions and characteristics of microorganisms
2. To study the growth of microorganisms and the impact of environment on their growth
3. To evaluate explicitly, the metabolic pathways, role of microbes in public health; insight into the physical and chemical control of microorganisms

Course Outcome:

The students will be able to;

1. Recall the basic knowledge on the development of microbiology
2. Recognize the fundamental concepts pertaining to the structure and functions of microbes
3. Appraise the importance of microscopy, staining techniques and classify the microorganisms
4. Apply appropriate physical and chemical methods to control the growth of microbes
5. Formulate the nutritional requirements for microbial growth and their metabolism
6. Compare and categorize the interactions of microorganisms with humans and animals

Module 1: History and Classification (9)

Historical perspectives of microbiology, Classification-systemic and numerical classification, 16Sr RNA classification, Microscopy – light, phase, fluorescent and electron microscopy (SEM and TEM), Confocal Laser Scanning Microscopy (CLSM)- principles of different staining techniques - Gram staining, acid fast, capsular staining and spore staining.

Module 2: Microbial Structure and Multiplication (7)

Cell Morphology and Structure of Prokaryotes-bacterial cell wall,–Multiplication of bacteria, Life cycles-viruses (bacteriophage), algae (Chamydomonas), protozoa (Plasmodicum vivax), fungi (Rhizopus stolonifer), yeast (Neurospora crassa) and actinomycetes, Lichen symbiosis.

Module 3: Microbial Nutrition, Growth and Control (7)

Nutritional requirements of microorganisms, factors affecting the growth of microorganisms, Bacterial Growth- Growth curve pattern, measuring the bacterial growth, Growth kinetics, mathematical nature and expression of growth, concept of geometric & arithmetic nature of growth, asynchronous and synchronous cultures, diauxic growth-

Module 4: Control of Microorganisms (6)

Prevention of bacterial growth- Physical and chemical control of organisms, Antibiotics- antibacterial agents, anti-fungal agents and anti-viral agents, Antibiotic susceptibility test. -

Module 5: Medical Microbiology (8)
Normal flora of human healthy host, Common diseases caused by microbes: Bacterial diseases: Typhoid, Diphtheria, Cholera, Tuberculosis, Leprosy, Plague, Syphilis, Gonorrhea; Viral diseases: Herpes, Polio, Hepatitis, AIDS, Rabies, SARS, H1N1, Ebola and Covid-19; Protozoan diseases: Malaria: common types of fungal infections-Candidiasis.

Module 6: Soil, Environmental and Food Microbiology (8)
Soil microflora and biogeochemical cycles, Bio fertilizers: VAM and Rhizobium, Aerosols, fresh water microflora, Microbiology of potable water, purification and sewage disposal, Significance of microbes in food- Probiotics and fermented products-sauerkraut, cheese.

Text Books

1. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.2007
2. Ananthanarayanan and Panicker, "Microbiology" Orientblackswan, 2015.

Reference Books

1. Talaron K, Talaron A, Casida, Pelczar and Reid. Foundations in Microbiology, W.C.Brown Publishers, 2001.
2. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 2001.
3. Lim D, "Microbiology", Second Edition, WCB-Mc Graw Hill, 2001.

20BT2012	MICROBIOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To enable the students to understand the basic principles involved in the isolation of different kinds of microorganisms and gain accurate handling of microorganisms
2. To learn the different parts of microscopes and their functions
3. To identify the microorganisms using various staining techniques and biochemical tests

Course Outcomes:

1. Understand the basic knowledge on microbiological lab safety guidelines
2. Recognize the parts/functions of microscopes
3. Experiment with transfer of living microbes using aseptic technique
4. Develop media for cultivation of microorganisms
5. Demonstrate microbial isolation and staining techniques for identification of microorganism
6. Analyze different kinds of microorganisms present in clinical and environmental samples

List of Experiments:

1. Lab safety method and Regulations, Sterilization techniques- Autoclave, Hot air oven, Filter sterilization
2. Media preparation- Nutrient broth, Nutrient agar, slants, soft agar
3. Culturing of microorganisms– in broth and in plates (pour plates, streak plates)
4. Staining Techniques (Simple, Gram staining and negative staining)
5. Exposing the Sabouraud's agar plate in different location -Fungal identification by LPCD mount
6. Motility test by Hanging drop method
7. Antibiotic sensitivity assay – Disc and Well diffusion method
8. Effect of Disinfectants- Phenol Coefficient
9. Enumeration of micro-organisms- Serial dilution plating
10. Biochemical test -Gram negative –Indole test, Methyl red test, Voges Proskauer test, Citrate test, Triple sugar iron test
11. Biochemical test -Gram positive – Catalase test, Coagulase test, Starch hydrolysis test
12. Growth Curve in Bacteria and preservation of bacterial culture

Reference Books:

1. James G. Cappuccino, Microbiology: A Laboratory Manual, 5th Edition, Benjamin Science Publishing, 2009.
2. Amita Jain, Jyotsna Agarwal and Vimala Venkatesh, Microbiology Practical Manual, First Edition, Elsevier, 2018

20BT2013	FLUID MECHANICS	L 3	T 1	P 0	C 4

Course Objective:

1. To develop skills of students related to the fundamental calculations involved to measure the properties of fluids, measurement of fluid flow
2. To ensure students to have a strong knowledge related to types of fluids, instrument used in fluid flow mechanism
3. To make student understand the fluid flow processes involved in different sections in industrial operations

Course Outcomes

The students will be able to

1. Understand the nature of fluids, statics and dynamics of fluid flow
2. Summarize the principles for flow in transportation of fluids in the problems related to the process engineering
3. Relate flow through pipe and flow past immersed object
4. Analyze the equations of fluid flow
5. Evaluate principles of fluid flow phenomena in scale up
6. Create empirical relations using dimensional analysis to understand fluid flow phenomena

Module 1: Properties of Fluid (12)

Fluid definition- compressible, in compressible fluids, fluid properties – Density, specific weight, specific volume, Specific gravity, Viscosity, Newtonian and Non-Newtonian fluids**,** Types of fluids, Surface Tension and Capillarity, Hydrostatic Equilibrium, Hydrostatic Equilibrium in a centrifugal field- application in centrifugation mechanism

Module 2: Fluid pressure at a ppoint and nature of fluid flow (12)

Different types of pressure – Absolute Pressure, Gauge Pressure, Vacuum Pressure, Measurement of Pressure, Instruments used for measurement of pressure- Manometers-Piezometer, U-tube Manometer, Single Column Manometer, Differential Manometer, turbulence, boundary layer, Differential analysis of fluid motion – continuity, Fluid flow phenomena- laminar flow-application in determination of fluid flow pattern in reactor system

Module 3: Dynamics of Fluid Flow (12)

Equation of motions, Reynold's equation of motion, Navier –Stokes Equitation, Euler's equation of motion, Bernoulli's equation from Euler's Equation, Bernoulli's equation for real fluid, Practical application of Bernoulli's Equation- Venturimeter, Orifice meter, Pitot tube, Classifications of Orifices, Hydraulic Coefficients and relationship between them , application in determination fluid flow rate in pipe line

Module 4: Flow through pipes (8)

Loss of energy in Pipes, Loss of energy due to friction, Chezy's Formula for loss of head due to friction, Minor Energy (Head) Losses – Losses of head due to sudden Enlargement, Losses of Head due to sudden Contraction, Loss of head due to different obstruction like bend in pipe, pipe fittings, Velocity measurement techniques; pipes, fittings, Types, characteristics and sizing of valves- application how to regulate valve to control fluid flow rate

Module 5: Agitation and Mixing of Liquids (8)

Agitated vessels, Blending and mixing, Agitator selection and scale up, application in reactor designing

Module 6: Dimensional Analysis and Similitude (8)
The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi-theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies (example : reactor)

Text Books

1. Bansal, RK," Fluid Mechanics and Hydraulic Machines", Revised 9th Edition, Laxmi Publications, 2015
2. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 5th Edition", John Wiley, 2006
3. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", Second Edition, McGrawHill, (1991).

References

1. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999
2. James O Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers' Prentice Hall PTR (International series in Chemical Engineering) (1999)
3. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2005

20BT2014	FLUID MECHANICS AND HEAT TRANSFER LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To provide extensive knowledge on various unit operations in bioprocess industries
2. To ensure students to have a strong knowledge on various flow measuring equipments involved in bioprocess industries
3. To make student understand the fluid flow processes involved in different sections in industrial operations

Course Outcome:

The students will be able to

1. Understand the heat transfer concept and its applications.
2. Estimate the importance of fluid mechanics in different applications.
3. Analyze various flow meters for wide range of applications in industrial biotechnology
4. Demonstrate the friction factor for wide range of applications in industrial biotechnology
5. Evaluate the thermal conductivity of materials for wide range of applications in heat exchangers
6. Relate annular pipe for wide range of applications in industry.

List of Experiments

1. Determinations of Minor Losses in Pipes Due to Sudden Expansion
2. Estimation of Coefficient of Discharge of Venturimeter
3. Calculation of Darcy's Friction Factor
4. Determination of Friction Factor Losses Coefficient in Helical Pipe
5. Estimation of Friction Factor in Annular Pipe
6. Determinations of Minor Losses in Pipes Due to Sudden Contraction
7. Calculation of Coefficient of Discharge of Orifice Meter
8. Estimation of Coefficient of Discharge of Rotameter
9. Estimation of Thermal Conductivity of Composite Wall
10. Determine the overall heat transfer coefficient in Double pipe Heat Exchanger (Parallel and Counter Flow)
11. Evaluate the overall heat transfer coefficient in Shell and Tube Heat Exchanger
12. Flow measurement using pitot tube

Reference Books:

1. McCabe W, Smith J and Harriot P "Unit operations in Chemical Engineering", McGrawHill,VII Edition, 2005

20BT2015	BIOPROCESS PRINCIPLES	L T P C 3 0 0 3

Course Objectives:

1. To understand the principles of bioprocessing and appreciate its applications in Bioprocess Technology
2. To ensure students to have a strong knowledge on the importance of medium formulations and optimization
3. To provide facts on sterilization kinetics

Course Outcomes:

The students will be able to

1. Understand the process of fermentation and its requirements
2. Remember the process of media formulation and medium optimization for fermentation process
3. Analyze the kinetics of sterilization process
4. Apply knowledge on isolation and storage of industrially important microbes
5. Analyze parameters to control during fermentation process
6. Evaluate the process of sterlization by filtration

Module 1: Overview of Fermentation Process (6 hrs)

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermenter and ancillaries, aseptic condition and containment, Sampling

Module 2: Parameters to be Monitored and Controlled in Fermentation Processes (6 hrs)

Basic configuration of fermenter and ancillaries, main parameters to be monitored and controlled in Fermentation processes- Temperature, pressure, flow measurement, rate of stirring, shaft power, weight, Dissolved Oxygen, pH, inlet and exit gas analysis.

Module 3: Medium Formulation and Optimization (12 hrs)

Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation for optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations, medium optimization

Module 4: Sterilization Kinetics (9 hrs)

Thermal death kinetics of microorganisms, Death kinetics problems, Design of sterilization time- batch and continuous heat sterilization of liquid media, design of sterilization equipment - batch and continuous.

Module 5: Filter Sterilization of Air and Media (6 hrs)

Filter sterilization of liquid media, air sterilization and design of depth filters and problems

Module 6: Selection of Seed Culture for Industrial Fermentation (6 hrs)

Screening and selection of industrially important microbes- primary screening- Crowded plate technique, Auxonography, enrichment culture and indicator dye, screening based on desired characteristics, preservation and storage of industrially important microbes, Quality control of preserved stock cultures.

Text Book:

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.

Reference Book:

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2002

20BT2016	BIOPROCESS LAB	L T P C 0 0 3 1.5

Co-requisite: 20BT2012- Bioprocess Principles

Course Objectives:

1. To learn the culturing of microbes and quantifying biomass production
2. To provide extensive knowledge on enzyme kinetics
3. To learn immobilization techniques

Course Outcomes:

The students will be able to

1. Acquire knowledge in the process of fermentation.
2. Demonstrate enzyme assay qualitatively and quantitatively
3. Examine specificity of enzyme activity.
4. Apply methods to estimate mass transfer coefficient
5. Utilize solid state fermentation for production of fermented products
6. Assess the growth kinetics of microbes.

List of Experiments:

1. Inoculation and culturing of Different Types of Microorganism in broth
2. Estimation of Biomass Production by wet weight and dry weight method
3. Comparative study between Free & Immobilized Enzyme
4. Determine the substrate dependent enzyme specificity using α-Amylase
5. Estimation of volumetric mass transfer coefficient using sulphite oxidation method.
6. Study of thermal death kinetics
7. Plackett Burmann method
8. Citric acid production by Solid State Fermentation
9. Qualitative Enzyme Assay- Starch Plate Technique
10. Quantitative Enzyme Assay
11. Production of Wine
12. Growth kinetics of Baker's Yeast

Reference Books:

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2014.
2. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2016.

20BT2017	MOLECULAR BIOLOGY	L T P C 3 0 0 3

Course Objectives:

1. To understand the basics of molecular biology and gene expression.
2. To understand DNA damage and repair systems
3. To impart an overview on the regulation of gene expression

Course Outcomes:

The students will be able to

1. Recall the fundamental concepts of the prokaryotic and eukaryotic genome organization, its replication and gene expression
2. Understand the process of replication, transcription and translation
3. Recognize common mutations, their natural repair systems and inhibitors of gene expression
4. Distinguish the process of replication, transcription and translation of prokaryotes and eukaryotes
5. Appraise the post-synthesis modifications for transcription and translation
6. Comprehend the role of genetic code, chromatin, operons and cis/trans elements in gene regulation

Module 1: Genome Organization (8 hrs)
Classical experiments to prove genetic material: Griffith, Hershey and chase; Avery McLeod & McCarty. Genome organization in prokaryotes and eukaryotes – Molecular structure of DNA and RNA, Forms of DNA and RNA; Bacterial Recombination: Transformation, Transduction –types and Conjugation.
Module 2: DNA Replication – Prokaryotes (9 hrs)
DNA replication- Semi conservative replication - Meselson Stahl experiment, Enzymes in replication, Replication in prokaryotes-E.coli, D-loop and rolling circle mode of replication, regulation of replication, replication in virus - linear viral DNA replication, RNA replicase, Reverse transcriptase.
Module 3: DNA Replication – Eukaryotes and Mutations (5 hrs)
Replication in eukaryotes and telomere replication. Mutation: types, DNA repair systems - methylation, mismatch repair, Photo reactivation repair, SOS repair, recombination repair.
Module 4: Transcription (9 hrs)
RNA polymerase, features of promoters and enhancers, transcription factors, Prokaryotic and eukaryotic transcription, post-transcriptional modification - RNA splicing and RNA editing, Inhibitors.
Module 5: Genetic Code and Translation (7 hrs)
Elucidation of genetic code - salient features, Process of translation in prokaryotes and eukaryotes, Post-translational modifications, Inhibitors.
Module 6: Regulation of Gene Expression (7 hrs) Regulation of gene expression: In prokaryotes - lac and trp operons. Regulation in eukaryotes – cis and trans elements, chromatin re-organization in gene regulation, Regulation at transcription and Translation
Review on loss of regulation and defect in DNA repair system leading to genetic disorders and diseases.
Text book:

1. David Friefelder, "Molecular Biology", Narosa Publ. House. 6th edition 2003.

Reference books:

1. David R. Hyde, "Genetic and Molecular Biology", Tata McGraw Publications, New Delhi, 4th edition, 2010.
2. Lehninger, A. L, Nelson. D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.

20BT2018	GENETIC ENGINEERING	L T P C 3 0 0 3

Course Objective:

1. Acquaint students with the concepts in Genetic engineering.
2. Develop technical skills about different types of restriction enzymes, types of vectors used for cloning.
3. Impart knowledge in the applications in genetic engineering through transgenesis

Course Outcome:
The students will be able to

1. Describe the basics of genetic engineering
2. Understand the basic tools employed in genetic engineering.
3. Relate and evaluate the use of cloning vectors in genetic engineering.
4. Comprehend the concept of polymerase chain reaction and its applications.
5. Discuss and appraise the strategy and applications of gene cloning.
6. Analyze the importance of transgenesis in biotechnological research.

Module 1: Restriction Enzymes (9)
Restriction enzymes- Classification-nomenclature;Endonucleases, Exonucleases, Ligases- Modifying enzymes; Linkers, Adapters and Homopolymer tailing.
Module 2: Cloning and Expression Vectors (9)
Properties of ideal vectors, Plasmids as vectors- PBR322- pUC vectors--M13-Lambda phage vectors, Cosmid vectors, Phagemids, Shuttle vectors, Expression vectors, YAC, BAC, Mammalian cells-SV40

Module 3: Polymerase Chain Reaction and Hybridization Techniques (9)
Mechanism of Polymerase chain reaction, types of PCR, Inverse PCR, Nested PCR, Molecular beacons, RACE PCR, RAPD, RFLP. Probe Preparation and methods of Labeling, Southern hybridization-Northern hybridization; Western blotting, Autoradiography; DNA finger printing.

Module 4: Construction of Recombinant DNA (5)
Construction of recombinant DNA: Preparation of competent cell-Transformation (Physical, chemical and biological methods of Transformation), transfection- Recombinant selection and screening of Recombinant DNA

Module 5: Gene Sequencing, Libraries and rDNA Applications (9)
Gene Sequencing, Chromosome Walking, Gene Editing- CRISPR-CAS, Genomic Libraries, cDNA libraries, DNA Finger printing.

Module 6: Transgenesis and Bioethics (4)
Transgenic principles in Plant and Animal, Ethical, moral and societal issues pertaining to rDNA technology

Text Books

1. Desmond S. T. Nicholl, “An Introduction to Genetic Engineering”, 3rd Edition Cambridge University Press; South Asian edition, 2010.
2. Gene Cloning and DNA Analysis, 6^{th} Edition, Blackwell Publishing Ltd 2010
3. Barry R. Schaller "Understanding Bioethics and the Law: The Promises and Perils of the Brave New World of Biotechnology" Praeger Publishers Inc, 2007.

Reference Books

1. Sandy B. Primrose, Richard Twyman “Principles of Gene Manipulation and Genomics” Backwell Scientific Publications 2010.
2. Sandhya Mitra, “Genetic Engineering Principles and Practice”, Macmillan Publications, 2008.
3. Richard Sherlock, John D. Morrey "Ethical Issues in Biotechnology" Rowman & Littlefield Publishers, 2002.

		L	T	P	C
20BT2019	**MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB**	**0**	**0**	**3**	**1.5**

Course Objectives:

1. Develop comprehensive understanding in the salient features involved in the isolation of Nucleic acids
2. Provide technical skills about cloning methods in genetic engineering
3. Impart knowledge about recombinant molecules and its applications

Course Outcomes:

1. Define the basic concepts involved in the nucleic acid isolation from plant, animal and microorganism sources
2. Explain the principles of quantification of nucleic acids and molecular weight analysis
3. Demonstrate the methods involved in restriction digestion, ligation and transformation
4. Interpret and report the data both quantitatively and qualitatively
5. Knowledge in the amplification of DNA using PCR
6. Design experiments for basic research in rDNA technology and adapt biosafety rules of the labortory

List of Experiments:

1. Isolation of genomic DNA from plant and animal tissue
2. Isolation of genomic and plasmid DNA from microorganism (E-coli)
3. Isolation of RNA by Orcinol method
4. Quantitative and qualitative analysis of isolated genomic DNA using spectrophotometer
5. Agarose gel electrophoresis of DNA and analysis of their molecular weights by gel documentation
6. Amplification of DNA using Polymerase Chain Reaction

7. Restriction enzyme digestion of DNA samples confirmation through agarose gel electrophoresis
8. Ligation of DNA fragments and confirmation through agarose gel electrophoresis
9. Competent bacterial cell preparation
10. Transformation of DNA into competent cells
11. Extraction of proteins from plant or animal tissue and confirmation with qualitative tests
12. Separation and identification of proteins by SDS-PAGE using Coomassie Brilliant Blue stain

Reference

1. Michael R. Green, Joseph Sambrook, Molecular Cloning a Laboratory Manual, 4th ed., Chsl Press, New York.2018.

20BT2020	BIOPROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. This course aims at making the students understand the fundamental principles and concepts of Bioreactor engineering.
2. This will help the student understand stoichiometric calculations, models of growth and product formation
3. To understand the basics of oxygen transfer in microbial bioreactors

Course Outcome:

The students will be able to

1. Understand various methods of isolation and preservation of Industrially important microbes
2. Remember principles of stoichiometry and concepts of bioreactor engineering.
3. Understand kinetic models of growth and product formation.
4. Apply methods to calculate volumetric mass transfer coefficients in bioreactors
5. Analyze various bioreactors for fermentation process.
6. Evaluate application of various reactors in fermentation processes.

Module 1: Inoculum Development (7 hrs)

Isolation of industrially important microbes- primary screening methods, preservation and storage of industrially important microbes, Quality control of preserved stock cultures and development of inoculum for industrial fermentation

Module 2: Simple Kinetic Models For Growth (9 hrs)

Simple unstructured kinetic models for microbial growth, Monod model, Substrate uptake kinetics and maintenance coefficient, growth of filamentous organisms, product formation kinetics - Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Determination of kinetic parameters for Monod equation.

Module 3: Stoichiometry Of Cell Growth And Product Formation (10 hrs)

Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction ofsubstrate and biomass, available electron balances, various yield coefficients of biomass and product formation, oxygen consumption and heat evolution in aerobic cultures

Module 4:Oxygen Transfer In Microbial Bioreactors (9 hrs)

Oxygen transfer in microbial bioreactors; oxygen uptake rates and determination of oxygen transfer coefficients (k_La) by correlations and experimental methods; Mass transfer in heterogeneous biochemical reaction system, role of aeration and agitation in oxygen transfer and types of aerators and agitators.

Module 5: Bioreactors for free cells (5 hrs)

Bioreactors for free cells – batch, continuous, fed batch, chemostat with recycle and multi stage chemostat systems, air lift loop reactor. Applcation of free cell bioreactor in industries

Module 6: Bioreactors for Immoblized cells (5 hrs)

Bioreactors for immobilized cells: packed – bed, fluidized bed and hollow – fibre membrane bioreactors. Application of immobilized bioreactors in fermentation industry.

Text Books

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2005.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005.

Reference Books

1. Lee, J.M, "Biochemical Engineering", 1st Edition, Prentice Hall, 2001.
2. Blanch, H.W and Clark, D.S, "Biochemical engineering", Marcel Dekker, 1997.

20BT2021	ENZYME ENGINEERING AND TECHNOLOGY	L 3	T 0	P 0	C 3

Course Objectives

1. To learn the significance of enzyme, classification, application
2. To provide knowledge on kinetics based on different models and theories,
3. To learn on quantification of enzymes, and their immobilization.

Course outcome

The students will be able to

1. Understand enzymes and enzymatic reactions
2. Relate the application of enzymes in various industries
3. Apply enzymes in free and immobilized form for various reaction
4. Analyze the enzyme kinetics
5. Evaluate the processing and purification of enzymes
6. Hypothesize model for enzyme kinetics and inhibition types

Module 1:Classification and Characteristics of Enzyme (7 hrs)

Brief introduction to enzymes, nomenclature and classification of enzymes, mechanisms of enzyme action, specificity of enzyme action, the structure–functionality relationships, concept and determination of enzyme activity, Effect of physical and chemical factors on enzyme activity, concept of active site and energetics of enzyme substrate complex formation;

Module 2: Enzyme Kinetics and Inhibition (12 hrs)

Kinetics of enzyme catalyzed reactions. Importance and estimation of Michelis – Menten parameters, Multi substrate reactions- mechanism and kinetics, Allosteric regulation of enzymes, Enzyme inhibition types and models- Competitive, Noncompetitive and Uncompetitive inhibitions. Inhibition kinetics- substrate, product and toxic compound; deactivation kinetics.

Module 3: Principles of Enzyme Assays (7 hrs)

Detection and Estimation methods-Suitability of a Detection Method, Direct or Indirect Detection, Enzyme Reaction Time Course, Precautions and Practical Considerations- Purity of Assay Components, Stability of Assay Components, Quantification of Catalysis and Measures of Enzyme Purity- Enzyme Units, Specific Activity, and Turnover Number, Enzyme Purification and Characterization, Interpreting a Purification Table: Criteria of Enzyme Purity

Module 4: Immobilization of Enzymes (7 hrs)

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, Encapsulation, cross-linking, covalent binding - examples, advantages and disadvantages of different immobilization techniques. Design of immobilized enzyme reactors – Packed bed, Plug flow reactor, Fluidized bed and Membrane bioreactors

Module 5:Enzyme Biosensors (6 hrs)

Enzyme based biosensors and their application: electrochemical enzyme-based biosensor, optical enzyme-based biosensors.

Module 6: Enzyme Applications (6 hrs)
Biotransformation application of enzymes- Hydrolytic, Reduction reactions, Oxidation reactions, Enzymes in organic synthesis, Application of enzyme in different industries, Nanobiocatylyst designing strategies, application of nanobiocatylyst

Text Book

1. T Palmer, "Enzymes", Harwood Publishing Series, 2001. 6th edition, 2006.

Reference Books

1. Martin Chaplin and Christopher Bucke, "Text book on Enzyme Technology", Cambridge University Press, 4th edition, 2004.
2. Punekar, N. S. (2018). *Enzymes: catalysis, kinetics and mechanisms*. Springer.Shuler, M.L. and Kargi, F, "Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd., 2nd edition, 2002.

20BT2022	HEAT AND MASS TRANSFER	L	T	P	C
		3	1	0	4

Course Objective:

1. To ensure students to acquire strong fundamental knowledge about heat transfer operations
2. To introduce them to the heat and mass transfer calculations for bioprocess and biochemical industries
3. To understand the industrial application and significance of these equipment in biotechnology

Course Outcome:

At the end of the course students will be able to

1. Understand the basic principles of heat transfer and mass transfer
2. Apply the principles of heat and mass transfer in bioprocess
3. Analyze the performance of heat exchanger and evaporator
4. Design and analyze reactor cooling and heating systems
5. Analyze and design distillation and absorption coloumns
6. Evaluate the performance of heat transfer and mass transfer operations

Module 1: Conduction (9 hrs)
Introduction- Modes of heat transfer- physical origins and rate equation, relevance of heat transfer. Conduction-Heat transfer by conduction-General heat conduction equation -Thermal diffusivity and thermal conductivity -Linear one-dimensional steady state conduction, conduction through plane walls, cylinders, spheres and composite walls.

Module 2: Convection and Radiation (12 hrs)
Convection– Types of convection-Individual and overall heat transfer coefficient Natural convection–Forced convection, dimensional analysis, heat transfer in condensation of single vapours, Radiation-blackbody radiation-Planck's Distribution Law , wien's law, Stefan Boltzman Law, Absorption, reflection and transmission by real surfaces, Kirchoff's Law , gray surface

Module 3:Heat Exchanger and Evaporators (8 hrs)
Heat exchanger-Types of heat exchange equipment and overall heat transfer coefficient, heat exchanger analysis–Logarithmic mean temperature difference, fouling factor, the effectiveness- NTU method Concept of evaporation-types of evaporators - single effect evaporator, performance of tubular evaporators- evaporator capacity, evaporator economy and effectiveness.

Module 4:Mass Transfer (6 hrs)
Theory of Diffusion,Fick's Law of diffusion, steady state molecular diffusion in fluids under stagnent and laminar flow conditions, mass transfer coefficient, mass transfer theories, equimolar counter diffusion of A& B, correlation of convective mass transfer coefficient.

Module 5: Distillation (6 hrs)
Vapor Liquid Equillibria, single stage operation, differential or simple distillation, continuous rectification, , McCabe –Thiele methods.

Module 6: Absorption (6 hrs)
Theories of absorption and design. packings and packed tower design, absorption in plate coloumns

Text Book

1. Incropera, F. P., & DeWitt, D. P. "Fundamentals of heat and mass transfer". New York: J. Wiley, (2002).
2. Robert Treybal, Mass Transfer Operations, McGraw Hill Education; 3 edition (1 July 2017)

Reference Book

1. Mccabe,W.L.,Smith,J.C., andHarriott,P. Unit Operations of Chemical Engineering, McGraw Hill,NewYork, 6th Edition,2004
2. Geankoplis, J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003
3. Holman, J. P., Heat Transfer, 9th Edition, McGrawHill, Singapore, 2002
4. Donald Q. Kern,ProcessHeatTransfer,TataMcGrawHill, New Delhi,1997

20BT2023	DOWNSTREAM PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know characteristics of cell types and their disruption methods.
2. To understand the principles of isolation, separation and purification of bioproducts
3. To analyze the different polishing methods available for bioproducts.

Course Outcome:
The students will be able to

1. Understand the fundamentals of product isolation and separation techniques.
2. Distinguish various techniques for product recovery and isolation.
3. Explain operating principles across different solid(liquid)-liquid separation process
4. Analyze product recovery in solid-liquid separation processes.
5. Compare the performances of different extraction techniques
6. Apply separation techniques for bio product recovery.

Module 1:Overview Of Bioseparations (6 hrs)
Broad classification of bio products, characteristics of fermentation broths and bio products. Cell disruption and pretreatment: Analysis of various physical, chemical, enzymatic and mechanical methods for release of intracellular products, case studies related to choose cell-disruption techniques

Module 2:Product Recovery (10 hrs)
Filtration: Equipments for conventional filtration- filter media, pretreatment methods, general filtration theory- Darcy's law, compressible and incompressible filter cakes, filtration cycle. Continuous filtration equipments in industries, Sedimentation: Mechanisms of theory, thickeners, classifiers, applications in downstream processing. Centrifugal bio separations: Theory of Tubular-bowl centrifuges- maximum efficiency, centrifuge selection-RCF, scale up of centrifuges- sigma factor analysis, equivalent time, efficiency.

Module 3:Isolation of Bioproduct (11 hrs)
Adsorption: Adsorption kinetics, isotherm, assessment of adsorption capacity, Extraction, aqueous two-phase extraction, Extraction efficiency in multi-stage extractor, NH4SO4 based protein fractionation, Membrane separation processes: Membrane, materials and fabrication, reverse osmosis

Module 4:Purification (7 hrs)
Chromatographic separations, Classification of techniques, elution chromatography- retention theory, Ion exchange chromatography, gel permeation chromatography, gel filtration techniques for molecular weight determination, affinity chromatography, Reverse phase, hydrophobic interaction chromatography

Module 5: Product Polishing and Stabilization (5 hrs)
Crystallization: Basic principles- nucleation and crystal growth- supersaturation theory- commercial crystallizers Product drying: Heat and mass transfer in drying- types of commercial dryers- vacuum dryers, freeze dryers, spray dryers
Module 6: Process Simulation and Case Study (6 hrs)
Insulin Case Study: State-of-the-art in downstream processing of monoclonal antibodies, citric acid, penicillin, lactic acid, Process trends in design and validation

Text Books

1. Paul A Belter, EL Cussler, Wei-shou Hu, Bioseparations: Downstream Processing for Biotechnology - Wiley Interscience, 2011.
2. Sivasankar B, Bioseparations: Principles and Techniques, Prentice-Hall of India Pvt. Ltd., 2008.

Reference Books

1. Roger G. Harrison, Paul Todd, Scott R. Rudge, Demetri P. Petrides, “Bioseparations science and Engineering” Oxford University Press, 2015.
2. Krishna Kant Prasad, Nooralabettu “Downstream Process Technology: A new Horizon in Biotechnology” PHI learning Private Limited, 2010.
3. Coulson JM and Richardson JF, Chemical Engineering, Volume 2: Particle technology and separation processes” Butterworth Heinemann, 2006.
4. Christie john Geankoplis “Transport Processes and Separation Process Principles: Includes Unit Operations” prentice hall of India private limited, 2006.

20BT2024	DOWNSTREAM PROCESSING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To strengthen principles of the unit operations involved in the separation and purification of a biological product
2. To learn on cell disruption techniques, solid liquid separation
3. To learn about product isolation, purification and polishing

Course Outcome
The students will be able to

1. Remember cell disruption techniques for intracellular product recovery.
2. Understand the separation methods to recover microbial cells from aqueous suspensions
3. Apply techniques of bulk product isolation.
4. Design purification strategy based on product characteristics.
5. Evaluate finishing operations.
6. Analyze scale up operations.

List of Experiments

1. Calculation of area of thickener using batch sedimentation data.
2. Estimation of Sigma-factor in batch centrifuge.
3. Calculation of specific cake-resistance in batch Filtration process
4. Estimation of degree of cell disruption in physical techniques (sonication, homogenizer)
5. Estimation of protein recovery involving solvent precipitation technique.
6. Determination of partition coefficient of organic acid between water-chloroform
7. Estimation of protein recovery in ammonium sulfate precipitation technique
8. Determination of equilibrium moisture content in batch drying technique.
9. Separation of phytochemicals using column chromatography
10. Analysis of isotherm parameters for citric acid adsorption onto charcoal
11. Effect the coagulant dose in flocculation efficiency
12. Determination of theoretical plates equivalent in packed-bed distillation.

Text Books:

1. Paul A Belter, EL Cussler, Wei-shou Hu, Bioseparations: Downstream Processing for Biotechnology - Wiley Interscience, 2011.
2. Sivasankar B, Bioseparations: Principles and Techniques, Prentice-Hall of India Pvt. Ltd., 2008.

Reference Books:

1. Roger G. Harrision; Paul W. Todd; Scott R. Rudge, "Bioseparations Science and Engineering" Oxford University Press, 2015.
2. Don W. Green; Nooralabettu Krishna Prasad "Downstream Process Technology: A New Horizon in Biotechnology" phi learning private limited, 2010.
3. Richardson J.F.; Harker J.H.; Backhurst J.R. "Coulson and Richardson Chemical Engineering volume 2: Particle Technology and Separation Processes" Butterworth-Heinemann, 2006

20BT2025	**IMMUNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

1. Aims to impart basic knowledge in Immunology encompassing, history, development, trend and its impact on society.
2. To help the students familiarize with the organs and cells of the immune system, the immune response and molecular interactions involved in immune response.
3. To make the students aware of the applications of immunology such as, immunodiagnosis and immunotherapy.

Course Outcome:

The students will be able to

1. Learn the history and development and controversies of the field of immunology.
2. Recognizes the types of immunity, the basic plan of the immune of the immune system and the organs of the immune system.
3. Identify the cells of the immune system and their functions.
4. Understand the functioning of the innate and adaptive immune system
5. Interpret the cellular & molecular interactions, physiology and the pathology of the immune system.
6. Infer of the applications of immunology in diagnosis and treatment of diseases.

Module 1: Immune System (7)

Introduction and an overview of immunology, History of immunology, Types of Immunity - Innate and acquired immunity, Cell mediated and humoral immunity; Design of immune system- recognition & response. Organs of the immune system: Lymphoid organs - primary and secondary.

Module 2:Cells of the Immune System (9)

Granulocytes and Agranulocytes, T and B Lymphocytes, NK cells, macrophage and dendritic cells their structure, characteristics, function and their identification. Haematopoiesis, extravasation, phagocytosis.

Module 3:Humoral System (7)

Molecular nature and function of ; Antigens, epitopes, haptens; Adjuvants. Antibody – structure, Classes, Antibody diversity. Antigen Antibody reactions; Neutralization, Opsonization. Complement system.

Module 4: Adaptive Immunity - Recognition, Responses & Regulation (7)

Major histocompatibility complex; antigen processing and presentation, T-Cell activation and the cellular immune response. Cytokines

Module 5:Immune Function and Dysfunction (8)

Immunity to infections: immunity to virus, prokaryotic (Bacteria), & eukaryotic pathogens (parasites & fungi); Transplantation, graft rejection Immunosuppression –Immune Dysfunction: Autoimmunity, Allergy, Hypersensitivity& Immunodeficiency.

Module 6: Application and Impact of Immunology (7)
Diagnostics; Haemagglutination, ELISA, Immunofluorescence & Immunohistochemistry. Therapeutics and prophylactics; Abzymes, Monoclonal Antibody production, Chimeric & humanized antibodies. Vaccines, anti-vaccination movement and its impact.

Total Hours: 45

Text Books:

1. Roitt I, Male, Brostoff, "Immunology", Elsevier Saunders, 17th September 2012
2. S.R. Ramesh "Immunology", McGraw Education -Hill, 2017
3. Kuby J, "Immunology", WH Freeman & Co., January 2019

Reference Books:

1. Richard Coico, Geoffrey Sunshine, Immunology: A Short Course 7th Edition, Wiley-Blackwell; 7 edition (April 27, 2015)
2. Kenneth Murphy and Casey Weaver, Janeways Immunobiology 9th Edition by Kenneth Murphy and Casey Weaver, Garland Exclusive, June 2016

20BT2026	CELL BIOLOGY AND IMMUNOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To enable the students to understand the principles of immunology through experimentation.
2. To impart practical knowledge about the working of the immune system using fish as a model system.
3. To impart the knowledge on the application of immunology in diagnostic and therapeutics.

Course Outcomes:

1. Understand the behaviour of cells
2. Demonstrate the basic skill in preparation of antigen and administering
3. Demonstrate the skill in collecting blood and separating serum.
4. Evaluate the generation of antibodies through different experimental methods.
5. Analyze the effect of adverse immune reactions.
6. Apply skill in screening epitopes and production of antibodies.

List of Experiments

1. Blood Grouping
2. Detection of Typhoid Antigens using Widal Test
3. Stages of Mitosis & Meiosis
4. Study of Tonicity using RBC model
5. Maintenance of Fish & Dissection of Lymphoid organs
6. Preparation and Administration of Antigen.
7. Drawing Blood and separation of Serum.
8. Estimation of specific Antibodies using Haemagglutination.
9. Estimation of specific Antibodies using immunodiffusion
10. Graft Rejection
11. Delayed type hypersensitivity in Fish
12. Immunoinformatics & Epitope Prediction using online software.

Reference:

1. Dinakaran Michael R, Immunological Techniques Using Fish Model- A Laboratory Manual, Year, Notion Press.

20BT2027	CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	1	0	4

Course Objectives:

1. To provide knowledge on estimation of kinetic parameter

2. To establish core foundation for the analysis and design of chemical reactors
3. To impart the knowledge of reaction rate

Course Outcomes:

The students will be able to

1. Understand the kinetics of reactions
2. Remember the design equations and the performance of ideal reactors
3. Create various models for describing non- ideal behaviour of reactors
4. Analyse performance of reactors
5. Explain adsorption and desorption phenomena in heterogeneous systems.
6. Design of various fermenter / bioreactors

Module 1: Homogeneous Reactions in Ideal Reactors (10 hrs)

Overview of Chemical Reaction Engineering; Homogeneous Reactions, The Rate Equation, The reaction rate and reaction mechanisms, Temperature-Dependent and concentration dependent Term of a Rate Equation,

Module 2: Reaction mechanism (10 hrs)

Searching for a Mechanism- reaction mechanisms and rate laws, reactive intermediate and steady state approximation in reaction mechanisms, rate limiting step.

Module 3: Interpretation of Batch reactor data (12 hrs)

Constant volume batch reactor - integral method of analysis of data, differential method of analysis of data.

Module 4: Performance of Bioreactors (10 hrs)

Broad outline of chemical reactors, Performance equations for single batch reactor, ideal CSTR, ideal PFR-Application to design, Industrial scale reactors.

Module 5: Single reactions and multiple reactor systems (10 hrs)

Size comparison of single reactions, plug flow reactors in series or in parallel, mixed flow reactors in series, autocatalytic reactions

Module 6: Non ideal flow reactors (10 hrs)

The residence time distribution, State of aggregation of the flowing stream, Earliness of mixing, Experimental methods (Nonchemical) for finding E, conversion in non-ideal flow reactions, reactor performance with non-ideal flow, Tank in seres model

Text Books:

1. Levenspiel, Octave "Chemical Reaction Engineering", 3rd Edition, John – WileySons, 2006.
2. Fogler, H. Scott. *Essentials of Chemical Reaction Engineering*, Pearson Education, 2010.

Reference Books:

1. Missen, R.W. etal., "Chemical Reaction Engineering and Kinetics", John – Wiley, 1999.
2. Davis, Mark E., and Robert J. Davis. *Fundamentals of chemical reaction engineering*. Courier Corporation, 2013.
3. Li, Shaofen, Feng Xin, and Lin Li. *Reaction engineering*. Butterworth-Heinemann, 2017.

20BT2028	MASS TRANSFER AND CHEMICAL REACTION ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To learn chemical engineering principles
2. To provide knowledge on practical applications in the areas of mass transfer
3. To provide knowledge on reaction engineering and particle mechanics.

Course Outcome:

The students will be able to

1. Ability to plan experiments and present the experimental data meaningfully
2. Ability to apply theoretical concepts for data analysis and interpretation

3. Capability to visualize and understand chemical engineering unit operations related to fluid and particle mechanics
4. Understand the experimental techniques related to chemical reaction engineering
5. Understand the basic laws of mass transfer.
6. Learn to operate various reactors

List of Experiments

1. Extraction of acetic acid by Liquid –liquid Extraction
2. Leaching of oils from solids
3. Study on drying characteristics of sample using light.
4. Precipitation of Casein from milk
5. Determination the HETP of the packed column by McCabe Thiele method
6. Efficiency Analysis of simple distillation
7. Analyze the efficiency of Absorption column
8. Determination of rate constant for the saponification of Ethyl acetate in a batch reactor
9. Determination of rate constant for a Semi batch reactor
10. Estimation of reaction kinetics in a Continuous stirred tank reactor
11. Estimation of reaction kinetics in a Plug flow reactor
12. Residence time distribution in a PFR

Reference Books:

1. Robert Treybal, Mass Transfer Operations, McGraw Hill Education; 3 edition, 2017.
2. Mccabe,W.L.,Smith,J.C., andHarriott,P. Unit Operations of Chemical Engineering, McGraw Hill,NewYork, 6th Edition,2013
3. Levenspiel Octave “Chemical Reaction Engineering”, 3rd Edition, John – WileySons, 2012.

20BT2029	BIOCHEMICAL THERMODYNAMICS	L 3	T 0	P 0	C 3

Course Objectives:

1. To have strong foundation on the thermodynamic laws and concepts relevant to biochemical process.
2. To understand fundamental concepts such as enthalpy, entropy, fugacity, free energy, and chemical potential in biological system
3. To introduce behavior of pure fluid, partial molar properties

Course Outcomes:

The students will be able to

1. Explain the basic concepts of thermodynamics in process industry.
2. Recognize the significance of laws of thermodynamics.
3. Explain concepts of thermodynamic properties of fluids & demonstrate various equations of state & their applications
4. Illustrate the importance of partial molar properties & the concepts of phase equilibrium
5. Solve mathematical problem involving volumetric, thermodynamic properties of real fluids
6. Illustrate the concepts of chemical reaction equilibrium.

Module 1: Basic Concepts & Laws of Thermodynamics: (8)

System, Surrounding & Processes, Closed and Open systems, State Properties, Intensive & Extensive Properties, State and Path functions, Enthalpy, Internal Energy, specific heat capacities at constant pressure, constant volume; Reversible and Irreversible processes. General statement of First law of Thermodynamics, General statements of the second law of thermodynamics, Heat engines, Entropy, Entropy changes of an ideal gas. Numericals.

Module 2: PVT Behaviour and Heat Effects: (6)
PVT Behavior of pure fluids, equations of state & ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic & polytrophic processes, Equations of state for real gases: Vander Waals equation, virial equation, Numericals. Heat Effects: Sensible Heat Effects, Internal Energy of ideal gases, Latent heat of pure substances, Standard heat of reaction, formation, combustion, Heat of reaction at higher temperature, Heat effects of Industrial reactions.
Module 3: Properties of Pure Fluids (6)
Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, modified equations for internal energy (U) & enthalpy (H), Effect of temperature on U, H & Entropy (S). Numericals.
Module 4: Properties of Solutions (7)
Chemical potential –effect of temperature and pressure, Partial molar properties of solution and its determination, Numericals.
Concept of Fugacity, Fugacity coefficient, Determination of fugacity of pure gases, solids and liquids, Activity: Effect of temperature and pressure on activity. Numericals.
Fugacity in solutions: lewis–randall rule, Raoults law for ideal solutions, Activity in solutions, Activity coefficients, calculation of activity coefficients using Gibbs-Duhem equation. Numericals.
Module 5: Phase Equilibria (10)
Criteria of phase Equilibria, Duhem’s thepramcriterion of stability, Duhem's theorem, Vapour-Liquid Equilibria, Pahse diagram in binary solutions, P-x-y diagram, VLE in ideal solutions, Non-Ideal solutions, Consistency test for VLE data, Azeotropes. Activity coefficient calculation: van Laaar, Margules, Wilson equations. Numericals.
Module 6: Chemical and Reaction Thermodynamics (8)
Introduction to Chemical Reaction Equilibrium, Equilibrium criteria for homogeneous chemical reactions; Evaluation of equilibrium constant and effect of pressure and temperature on equilibrium constant; Calculation of equilibrium conversions and yields for single and multiple chemical reactions. Standard heat of reaction, formation, combustion, effect of temperature on standard heat of reaction, Coupled reactions and energy rise compounds, Le – chatelier’s principle, liquid phase reactions, heterogeneous bioreaction equilibria. Lc-Chatelier Principles. Liquid phase reactions, heterogenous inequilibria.

Text Books:

1. Introduction to Chemical Engineering thermodynamics - Joseph Mauk Smith, Hendrick C. Van Ness, Michael M. Abbott, McGraw-Hill, 2005
2. Thermodynamics of Biochemical Reactions - Robert A. Alberty, Wiley Inderscience, 2003.
3. Biochemical Calculations, by Irwin H.Segel, John Wiley & Sons, 2nd Ed,(1976)

References Books:

1. Chemical and Engineering Thermodynamics, Stanley I Sandler, 4th Ed., John Wiley & Sons, Inc. 2006.
2. Chemical Engineering Thermodynamics By Y.V.C. Rao, New Age International.
3. Biological Thermodynamics, Donald T. Haynie, Cambridge University Press.

		L	T	P	C
20BT2030	**CONCEPTS OF BIOINFORMATICS**	**2**	**0**	**2**	**3**

Course Objectives:
1. To learn and understand specific databases and perform effective database searches.
2. To learn and perform various *Insilco* analysis for gene and protein structure and function identification
3. To learn and perform target identification for drug-designing and to have a platform for interchange and exchange of knowledge with academia and industry.

Course Outcomes:

Students are able to

1. Gain knowledge on Biological databases and tools.
2. Understand the significance of biological databases and their utilization.
3. Apply the knowledge of Bioinformatics skill to solve the biological problems in Genomics and Proteomics
4. Analyse different types of Biological databases and resources.
5. Evaluate the vital role drugs interacting to the target.
6. Constructphylogenetic tree based on Molecular data

Module 1: Introduction to Bioinformatics (5)

Introduction to Bioinformatics, Importance and uses of Bioinformatics Scope of Bioinformatics. Genebank file format, SwissProt File format, Protein Databank file format

Module 2: Biological Databases (5)

Introduction to Biological databases, organization and management of databases, Primary sequence databases, Secondary databases- nucleic acid sequence databases - Protein sequence data bases.

Module 3:Sequencing Alignment and Dynamic Programming (5)

Sequence Alignment, Local alignment, Global alignment, pairwise Alignment, multiple sequence alignments. Dynamic programming in sequence alignment: Needleman-Wunsch Algorithm, Smith Waterman Algorithm, Amino acid Substitution matrices (PAM, BLOSUM).

Module 4: Applied Bioinformatics Tools and Data Resources (5)

Entrez, ExPASy, EMBL-EBI tools and Data Resources: DNA/RNA Sequence Analysis tools, Gene Expression, Protein Sequence Analysis, Primer Design, Tools for Primer Design, Primer Design Application.

Module 5: Computational Genomics and Proteomics (6)

Genomics databases, Proteomics databases, Comparative genomics and Proteomics; Understanding DNA microarrays and protein arrays, Gene and protein prediction strategies, Molecular Evolution and Phylogeny, Molecular data of Phylogenetic Tree, Distance Based Treen Reconstruction Methods, UPGMA, Neighbor Relation, Neighbor joining, Character based Tree Reconstruction method, Maximum Parsimony Method, Maximum Likelihood method.

Module 6: Molecular Modeling and Simulation (4)

Basic concepts of Homology, threading, ab-initio protein structural modeling, Energy Minimization methods and Applications, Molecular simulation methods and applications, target identification and validation.

Total Hours: 30

Text Books:

1. Dan Gusfield, "Algorithms on Strings Trees and Sequences", Cambridge University Press, Cambridge, 2017.
2. David Mount W., "Bioinformatics sequence and genome analysis", CBS Publishers, New Delhi, 2nd Edition, 2013.
3. D.W. Mount. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbour Laboratory Press, New York, 2012.

References Books:

1. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, Wiley and Sons, 2012
2. S.C. Rastogi and N. Mendiratla and P.Rastogi. Bioinformatics methods and applications- Genomics, Proteomics and Drug Discovery. Prentice Hall India, 2013
3. A.M. Lesk. Introduction to Bioinformatics. Oxford University Press India, 2017.

List of experiments:

1. NCBI Database
2. ExPASy Database

3. EMBOSS pairwise Sequence Alignment
4. Freiburg RNA Tools Smith-Waterman
5. Swiss-Prot Database
6. Gene Prediction
7. Protein Familes –SCOP,Pfam and CATH
8. Secondary Structure prediction
9. EMBL-EBI database
10. Analysing the geometry of protein and visualize the protein using protein databank and swiss-pdb viewer.
11. Homology Modelling Using Modeller Protein
12. Tree Reconstruction based on Molecular Phylogeny Data

Reference Books:

1. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, Wiley and Sons, 2012
2. Rastogi S.C. and N. Mendiratla and P.Rastogi. Bioinformatics methods and applications-Genomics, Proteomics and Drug Discovery. Prentice Hall India, 2013
3. Lesk A.M. Introduction to Bioinformatics. Oxford University Press India, 2017.

20BT2032	**INDUSTRIAL SAFETY AND HAZARD ANALYSIS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

1. To inculcate the knowledge among students about safety procedures
2. To understand the risk analysis and assessment
3. To learn and understand hazard identification

Course Outcome:

The students will be able to

1. Understand plant safety in selection and layout of process plants and the usage of safety codes.
2. Distinguish different types of hazards
3. Relate the occupational diseases
4. Analyze the bio medical and engineering response to health hazards
5. Evaluate the effective process control and instrumentation methods
6. Create awareness the usage of safety measures

Module 1:Need for Safety (9)

Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxicants, chemicals; safe handling

Module 2:Safety Procedures (9)

Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety

Module 3:Hazard Identification (4)

Process hazard checklist, hazard surveys, hazard and operability studies

Module 4:Risk Assessment (5)

Event trees, fault trees, Quantitative risk assessment - rapid and comprehensive risk analysis; Layer of protection analysis, Risk due to Radiation, explosion due to over pressure.

Module 5:Hazard Control (9)

Eliminate or substitute hazard, Engineering controls, Administrative controls, Personal Protective Equipment

Module 6:Process Safety in Bioprocess Manufacturing Facilities (9)

The Need for Bioprocess Safety Management Systems, Bioprocessing Safety Management Practices**,** Identifying Bioprocess Hazards**-** Key Considerations for Assessing Risk to Manage Bioprocess Safety**,** Bioprocess Risk Assessment**,** The Effects of Emerging Technology on Bioprocessing Risk Management

Text Books:

1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 3rd edn. 2011.
2. American Institute of Chemical Engineers. Center for Chemical Process Safety. *Guidelines for process safety in bioprocess manufacturing facilities*. Wiley-AIChE, (2011).
3. Lees, F. *Lees' Loss prevention in the process industries: Hazard identification, assessment and control*. Butterworth-Heinemann, (2012).

Reference Books:

1. King, R. W., & Magid, J. (2013). *Industrial Hazard and Safety Handbook:(Revised Impression)*. Elsevier.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
3. Deshmukh, Y. S. (2006). Hazard identification and risk control–industrial safety management.

<table>
<tr><td rowspan="2">20BT2033</td><td rowspan="2">ENVIRONMENTAL POLLUTION CONTROL ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Course Objectives:

1. To give an exposure to various control acts
2. To study the advantages and disadvantages of impact assessment methods
3. To study the methods of reducing the waste and reusing it

Course Outcomes:

The students will be able to

1. Understand basics of environmental pollution
2. Remember Pollution control acts and regulations.
3. Apply bio safety principles in pollution control.
4. Evaluate cleaner technology on pollution control.
5. Evaluate various approaches for biomedical waste treatment and disposal
6. Analyse various biosafety measures

Module 1: Pollution Control Acts (8)

The water (prevention and control of pollution) act 1974 and rules 1975- CPCB-form XIII,XIV,XV,The air (prevention and control of pollution) act 1981 and rules 1982,CPCB-form I,VI. National ambient air quality standards.

Module 2: Environment Protection (9)

Environmental impact assessment (EIA), definitions and concepts, rationale, environmental impact statement, environmental appraisal, environmental impact factors and areas of consideration, measurement of environmental impact, organization, scope and methodologies of EIA, status of EIA in India,Environmental audit

Module 3: Environment Protection Act (8)

The environment (protection) act 1986, rules 1986-definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous, standards of emission or discharge of environmental pollutants. Form V

Module 4: Cleaner Technologies (6)

Clean technology, cleanup technology, industrial symbiosis, material reuse and waste reduction

Module 5: Biosafety (7)

The manufacture, use, import, export and storage of hazardous microorganisms genetically engineered organisms or cells rules, 1989-definitions, competent authorities, animal and human pathogens

Module 6: Biomedical Waste Disposal (7)

Biomedical waste (management and handling) 1998,-categories of biomedical waste, colour coding and type of container for disposal of biomedical wastes. Transport of biomedical waste containers/bags (schedule IV), standards for treatment and disposal of biomedical wastes (schedule V), waste management facilities like incinerator/autoclave/microwave system, form-I,II,III.

Text book:

1. Rao. C. S., Environmental Pollution Control Engineering, New Age International, 2007

Reference Books:

1. Peter Wathern, “Environmental Impact Assessment theory and practice”, Unwin Hyman Ltd. Routledge, 1990,
2. L. Lee Harrison , “Environmental Health and Safety Auditing Handbook”, 2nd edition, McGraw Hill, Inc., New York, 1995
3. Kirkwood, R. C. and Longley, A. J., “Clean Technology and Environment”, Chapman Hall, 1995.

20BT2034	PROCESS EQUIPMENT DESIGN AND ECONOMICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To design safe and dependable processing facilities.
2. This course focus on plant layout and design of piping systems
3. This will provide the basic knowledge to carryout design process cost effectively.

Course Outcomes:

The students will be able to

1. understand principles of process equipment design and safety considerations
2. Understand design of storage vessel and pressure vessel asper ASME and ISI codes
3. Apply the Scale up criteria of bioreactors
4. Analyze the plant layout.
5. Design various bioreactors and their applications
6. Evaluate process economics

Module 1: Introduction to Process Design (5)

Introduction. General design information for chemical biochemical processes plants. Development of flow sheet. Design of the equipments as per ASME, ISI codes.

Module 2: Heat Exchangers, Evaporators (9)

Shell and tube heat exchanger, double pipe heat exchanger, Single effect evaporator and vertical tube evaporation

Module 3:Design of Separation Processes (9)

Design &Construction details and assembly drawing of distillation column; absorption Towers

Module 4:Design of flow measuring and control Device (9)

Design of venturimeter, double pipe heat exchanger, Design of gate, design of globe valve

Module 5:Economics (4)

Introduction to cost diagrams, application of cost diagrams, Introduction to Project Economics, Process Selection and Site Survey, Project Cost estimation, Time Value of Money, Interest and Depreciation, Project Finance & Profitability Analysis

Module 6: Design and Applications of Bioreactors (9)

The use of equipments designed for biotechnology industry for different purposes: Bioeactors, Airlift, Fluidized Bed, Packed bed reactor, CSTR

Text Book:

1. Joshi, M.V, “Process Equipment Design”, MacMillan, 3rd edition, 2004.

Reference Books:

1. Peters, Max S.,K.D. Timmerhaus and R.E. West,Plant Design and Economics for Chemical Engineers (5th Ed), McGraw-Hill International Editions (Chemical Engineering Series), New York, USA (2003)
2. Mahajani,V.V., Chemical Project Economics, Macmillan Indian Ltd., New Delhi, India (2005)
3. Smith, R., Chemical Process: Design and Integration, John Wiley and Sons, West Sussex, UK (2005)

4. McCabe, W.L., J.C. Smith and P. Harriott "Unit Operations of Chemical Engineering", 6th edition, McGraw-Hill, 2001.
5. Wnell, L.E, & Young, E.H.: Process Equipment Design, Wiley Eastern, New Delhi, 2000.
6. Ludwig, E.E.: Applied Process Design for Chemical & Petrochemical Plants, Vols. I, II & III, (2nd Ed.), Gulf Publishing Company, Texas, 1977, 1979, 1983.
7. Perry, R.H. & Green, D.W.: Perry's Chemical Engineers' Handbook, (7th Ed.),McGraw Hill (ISE), 2000.

20BT2035	PROCESS DYNAMICS AND CONTROL	L	T	P	C
		3	0	0	3

Course Objectives:
1. To control and measure the processing facilities in a cost effective manner.
2. To focus on plant layout control and piping systems
3. To provide knowledge on control systems

Course Outcomes:
The students will be able to
1. Understand the basic concept of control systems
2. Apply the knowledge of linear loop systems
3. Interpret the principle of control systems
4. Analyse Frequency response and correlate with advanced control systems
5. Evaluate Digital controllers
6. Combine different control modes for process equipment.

Module 1: Instrumentation (9)
Instrumentation - principles, Introduction to flow, pressure, temperature and liquid level measurements, measurement of important physico-chemical and biochemical parameters, methods of on-line and off-line biomass estimation, flow injection analysis for measurement of substrates, products and other metabolites. Dynamics and control of bioreactors & sterilizers. On-line data analysis for state and parameter estimation techniques for biochemical processes.

Module 2:First Order Systems (8)
Process characteristics, Laplace transforms, first order systems – examples, mercury in glass thermometer, liquid level system, linearization, response of first order system for step, impulse and sinusoidal changes in input, conceptual numerical. Interacting and non-interacting systems and their dynamic response to step, inputs; conceptual numerical.

Module 3: Second Order Systems (8)
Second order systems with transfer functions (spring-damper, control valve, U-tube manometer), response of second order system to step, impulse and sinusoidal input – Overdamped, underdamped and critically damped condition of second order system, transportation lag.

Module 4: Controllers and Final Control Elements (8)
Actuators, Positioners, Valve body, Valve plugs, Characteristics of final control elements, controllers – two position control, proportional control, derivative control, integral control, P-I (proportional-integral) control, P-D (proportional- derivative) control, P-I-D (proportionalintegralderivative) control, Block diagrams for servo and regulatory problems , conceptual numerical.

Module 5: Controller Design and Stability (8)
Criteria for stability, Routh test; Root locus (basics), Introduction to frequency response, Qualitative discussion about Bode criteria and Nyquist criteria; Conceptual numerical.

Module 6: Process control in Bioprocess (4)
Computer control of chemical processes, Control of distillation Column and heat exchanger, PID Control system in bioreactor

Text Books:

1. Coughnowr, D. R., Process Systems Analysis and Control, Mc Graw Hill, New York, 2nd Edition,2001.
2. George Stephanopolous, Chemical Process Control, Prentice-Hall of India Pvt-Ltd., New Delhi, 2002.
3. D.E. Seborg, T.E. Edgar, D.A. Mellichamp. Process Dynamics and Control, Wiley India Pvt. Ltd., Fourth Edition, 2016.

Reference Books:

1. Doeblin Ernest, Measurement Systems, Mc Graw Hill, New York , 2005
2. A.Suryanarayanan, "Chemical instrumentation and process control", Khanna Publishers, 2nd edition, New Delhi , 1995
3. Process Control – Modeling, Design & Simulation, B. Wayne Bequette
4. B. Ogunnaike and W.H. Ray, Process Dynamics, Modelling and Control, Prentice Hall. Oxford University Press, (1994).
5. Marlin, T. E., "Process Control ", IInd Edn, McGraw Hill, New York, 2000.
6. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control",IInd Edn., John Wiley, New York, 1997.

20BT2036	MECHANICAL OPERATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To ensure students have strong fundamental knowledge about various unit operations
2. To introduce them to characterize particles and perform size reduction and size analysis of particles
3. To understand the industrial application and significance of these equipment in biotechnology

Course outcomes:

The students will be able to

1. Characterize particles and perform size reduction and size analysis of particles
2. Identify conveyors & storage vessels for particular applications
3. Explain the principle, construction and operation of various classification equipments
4. Apply the principles of agitation and mixing
5. Evaluate the parameters of filtration
6. Compare different separation process

Module 1: Size Reduction and Solid Particles (15)

Particle size and shape: Measurement and analysis; Screening and screen analysis; Screen effectiveness; Design of industrial screening equipment. Size Reduction: Crushing, grinding, pulverization, ultrafine grinding, grindability; Crushing efficiency, power requirement and equipment selection.

Module 2: Transportation and Conveying (11)

Conveying of bulk solids: Classification of conveyors - Selection of conveyors - Storage of solids in bulk protected and unprotected piles - Bins - Silos - Hoppers - Mass flow and funnel flow bins. Solid handling: Storage of solids- bins, cellos, hoppers; Transport of solids- screw and belt conveyors, pneumatic and hydraulic transport.

Module 3: Classification of Solid Particles (9)

Particle separation: Sedimentation; Free and hindered settling; Thickeners and settling chambers; Characteristics of rotating fluids; Centrifuges, cyclone separators, bag filters; Electrostatic precipitator. Flow through porous media; Constant pressure and constant rate filtration; Compressible and incompressible cakes; Filtration rate calculation; Filtration equipment

Module 4:Mixing Blending (5)

Mixing of solids, solid- liquid mixing, blending, kneading, impeller -Design of agitator- power of agitation - Correlations for power consumption.

Module 5:Filteration and Devices (5)
Filtration - Batch and continuous filtration, compressible and incompressible filter cakes. Flow through porous media; Constant pressure and constant rate filtration; Compressible and incompressible cakes; Filtration rate calculation;
Module 6:Theories on Filter Resistances (5)
Calculations for specific cake resistance, filter medium resistance - Industrial filters - Centrifugal filtration. Filtration equipment
Text Books:
1. Mccabe, W. L., Smith, J. C., and Harriott, P., Unit Operations of Chemical Engineering, McGraw Hill, New York, 6th Edition, 2004
2. Geankoplis, C.J.,Transport ProcessesandSeparationProcess Principles (IncludesUnit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003

Reference Book:
1. Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., Coulson and Richardson's Chemical Engineering, Volume I, Butterworth Heinemann, Oxford, 5th Edition, 2002

20BT2037	MECHANICAL OPERATIONS LAB	L	T	P	C
		3	0	0	1.5

Course Objectives:
1. The students are provided knowledge on properties of solids
2. To determine and analyze on various size reduction techniques
3. To introduce the students to know all the aspects of Downstream operations of Mechanical Equipments and to infer the results obtained by experimentation.

Course Outcomes:
The students will be able to
1. To Understand the properties of solids and analyses the best screening equipment necessary in chemical industries.
2. To acquire knowledge on different types of size reduction principles and various types of equipment used in it.
3. To gain knowledge in the working principle of filtration equipment.
4. Imparting knowledge on solid transportation processes.
5. To evaluate the parameters necessary to process the various stages of packing material.
6. To apply the analytical method to estimate batch operation modes.

List of Experiments
1. Calculation of the Mixing index using a Ribbon mixer
2. Calculation of the Mixing index using a Sigma mixer
3. To evaluate water removal capacity using a dewatering centrifuge.
4. To evaluate drying efficiency using a Cross Flow Dryer.
5. To evaluate drying efficiency using a Through Flow Dryer.
6. To evaluate size reduction of solid particles by Ball mill and to evaluate surface area.
7. Analyzing the angle of repose of food products.
8. To evaluate cake resistance using a plate and frame filter press.
9. To calculate HETP in packed distillation process.
10. To evaluate energy balances in a continuous CSTR operation.
11. To calculate the screening efficiency of different sieve sizes for solid particles
12. Sparkling Filter (Demo)

Text Books:
1. Mccabe, W. L., Smith, J. C.,and Harriott, P., Unit Operations of Chemical E ngineering, McGraw Hill, New York, 6th Edition, 2004.

2. Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003.

Reference Book:

1. Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., Coulson and Richardson's Chemical Engineering, Volume I, Butterworth Heinemann, Oxford, 5th Edition, 2002

20BT2038	BIOCHEMICAL ENGINEERING LAB	L T P C 0 0 2 1

Course Objectives:

1. To determine the rates of enzyme catalyzed reactions and to provide knowledge on the immobilization of enzymes.
2. To provide knowledge regarding cell growth pattern and bioreactors.
3. To study the enzyme kinetics and inhibition models

Course Outcomes:

The students will be able to

1. Understand chemical and biochemical processes
2. Estimate growth kinetics models
3. Illustrate various enzyme kinetics
4. Design batch and continuous Process
5. Analyze batch reactors
6. Apply enzymes in bioprocesses

List of Experiments:

1. Production of amylase by submerged fermentation
2. Effect of Substrate Concentration on Growth of *E-coli*
3. Effect of pH on Enzyme Activity
4. Effect of Temperature on Enzyme Activity
5. Immobilization of Enzyme and microbe by entrapment method
6. Production of single cell protein in solid state fermentation of rice bran
7. Determination of MM Parameters
8. Estimation of growth kinetics of *E-coli*
9. Estimation of volumetric mass transfer coefficient using oxygen balance technique
10. Estimation of OTR using sulphite oxidation method

Reference Books:

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2014.
2. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2016.

20BT2039	CANCER BIOLOGY	L T P C 3 0 0 3

Course Objectives:

1. To understand the complexity and regulatory networks involved in cancer development process
2. To impart knowledge on the mechanism involved at cellular and molecular level so as to develop new strategies of therapy.
3. To understand the current strategies of cancer detection, prevention and treatment.

Course Outcomes:

The students will be able to

1. Remember the epidemiology of cancer and principles of carcinogenesis
2. Outline the different forms of cancer and the principles of their development

3. Understand the complex pathways and molecular switches involved in the transformation of a normal cell to a cancer cell.
4. Relate the cell biology with the regulatory imbalance in carcinogenesis, detection and therapy
5. Recognize the molecular mechanism of cancer spread, its markers and therapy.
6. Evaluate the current strategies of cancer diagnosis, prevention and treatment to develop new drugs.

Module 1: Fundamentals of Cancer Biology (9 hrs)

Cancer: Definition, causes, Characteristics, Benign Vs Cancer – Nomenclature, and classification-incidence; Cell Cycle: Regulation of cell cycle, cell proliferation, differentiation and apoptosis, Apoptosis pathways, Modulation of cell cycle in cancer, Cancer metabolism, Cancer inflammation & immunology, Cancer death.

Module 2: Principles of Carcinogenesis (6 hrs)

Theory of carcinogenesis- Multi-stage theory of carcinogenesis, Chemical carcinogenesis, Physical carcinogenesis- UV, X-ray, Biological carcinogenesis; Epigenetics of cancer.

Module 3: Molecular Cell Biology of Cancer (9 hrs)

Signal targets and cancer: Growth factors related to Transformation - Activation of kinases, Oncogenes: c-Myc, Ras, Bcl-2 family, Retroviruses and oncogenes – Tumor suppressor genes: Rb, p53, APC, BRCA paradigms, Role of signal transduction pathways and signal switches in apoptosis, Telomerases.

Module 4: Principles of Cancer invasion and Metastasis (6 hrs)

Clinical significances of invasion - Three step theory of invasion and metastasis cascade- Role of cell adhesion molecules, and proteinases - Angiogenesis: VEGF signaling

Module 5: Cancer Detection Techniques (7 hrs)

Cancer screening – sampling methods: Tumor markers; Physical Examination, Symptoms, Bioassays, Imaging techniques, Biopsy examination, Clinical interpretation on stages/grades, Cancer screening and early detection, Advances in cancer detection: Molecular markers-oncogenes activity detection method, tumour suppressors and other molecular markers.

Module 6: Cancer Therapy (8 hrs)

Different forms of therapy: Chemotherapy, Radiation therapy, Immunotherapy, Molecular therapy, Use of signal targets towards therapy of cancer, Gene therapy, Cancer prevention and palliative care strategies.
Review on any one type of cancer; Recent advancements in cancer management.

Text Books:

1. Stella Pelengaris, Michael Khan, The molecular Biology of Cancer, Blackwell Publishing, 1st edition, 2006.
2. Robert A. Weinberg, The Biology of Cancer, Garland Science, 2nd edition, 2014

References Books:

1. Macdonald F and Ford CHJ. “Molecular Biology of Cancer”, Bios Scientific Publishers, 2002.
2. Robert G, Mckinnell, Ralph E. Parchment, Alan.O. Perantoni, G. Barry Pierce, “The Biological Basis of Cancer”, Cambridge University Press, New York. 2003.

		L	T	P	C
20BT2040	**CLINICAL DATABASE MANAGEMENT**	**3**	**0**	**0**	**3**

Course Objectives:

1. To learn and understand clinical data management and its role in clinical research.
2. To impart clear understanding on various essential elements of Clinical Research and Clinical Data Management.
3. To train you on different aspects and activities involved: CRF Designing, Data entry, Data Collection, AE Management, and Report Creation etc.

Course Outcomes:

The students will be able to

1. Outline on clinical trials, data management and preparation
2. Describe the analytics and decision support using various tools.

3. Utilize enterprise-wide information assets in support of organizational strategies and objectives.
4. Inspect the concepts of database architecture and design.
5. Interpret the roles and responsibilities of healthcare workspace commodities.
6. Elaborate the reliability and accuracy of secondary data sources.

Module 1: Introduction of Clinical Trials (9)

Basic statistics for clinical trials, Roles & Responsibilities of Key Stakeholders, Preparations & Planning for Clinical Trials, Essential Documentation in Clinical Research & Regulatory Submissions, Clinical Trials Project Planning & Management, Study Start Up Process, Clinical Monitoring Essentials, Compliance, Auditing & Quality Control in Clinical Research

Module 2: Clinical Data Management (9)

Introduction to Data Management, Data Definition & Types, Study Set Up, CRF Design Considerations, Data Entry, Remote Data Entry, Identifying and Managing Discrepancies, Medical Coding, Database Closure, Data Management Plan, Electronic Data Capture, Tracking CRF Data, Managing Lab Data, Collecting Adverse Event Data, Creating Reports and Transferring Data, Enterprise Clinical Data Management Tools.

Module 3: Clinical Data Analysis and Management (9)

Study set-up, Introduction to Clinical Database , Documents, guidelines used in CDM, Data Entry, Data Review/Data Validation, Query Management, Data management plan, Project management for the clinical data manager, Vendor selection and management, Data management standards in clinical research, Design and development of data collection, Edit check design principles

Module 4: Clinical Case Report Forms (9)

CRF Completion Guidelines, CRF printing and vendor selection, Data validation, programming and standards, Laboratory data handling, External data transfer, Patient –reported outcomes, CDM presentation at investigator meetings, Metrics for clinical trials, Systems Software Validation Issues Clinical Trials Database Environment

Module 5: Clinical Quality Audit (4)

Audit –Definition, types & procedures, Audit standards, Audit trail & its role in authenticity of data, Audit plan, Audit by regulatory authorities,

Module 6: Clinical Logistics and Regulations (5)

GMP, GDP & logistics, Preparing and delivering audit reports, what makes a good audit, New product development & GxP Regulations.

Text Books

1. Susanne Prokscha, Practical Guide to Clinical Data Management, Third Edition, CRC Press; 3 edition, 2011.
2. Richard K Rondel (2000) Clinical Data Management, Second Edition. Wiley Publishing House, 2000.

Reference Books

1. Rondel, R.K., Varley, S.A. and Webb, C.F. eds., Clinical data management. New York: Wiley, 2000
2. Smith, Jonathan A., ed. Qualitative psychology: A practical guide to research methods. Sage, 2015.
3. Machin, D., Day, S. and Green, S. eds., Textbook of clinical trials. John Wiley & Sons, 2007.

		L	T	P	C
20BT2041	**CLINICAL DATABASE MANAGEMENT LAB**	**0**	**0**	**3**	**1.5**

Course Objectives:

1. To understand the types of clinical data, samples, and software
2. To develop the skills to analyze the clinical trial data management.
3. To develop the skills to evaluate clinical data management

Course Outcomes:

The students will be able to

1. Rephrase medical terminology, clinical data management to develop databases for health care.
2. Demonstrate clinical data submission and interpret the clinical results.
3. Explain skills to analyze clinical data.
4. Organize the health care skills to validate data.
5. Examine the Case Report Forms to store clinical data.
6. Gain skilful knowledge of the management of clinical data used in clinical trials.

List of experiments:

1. Contribute to the design of protocols, forms, and data collection process Queries based on Biological databases
2. Comprehensive database programming
3. Create data validation checks
4. Issue and resolve data queries
5. Create and maintain data management plans
6. Full data integration (eCRF, images, laboratories, and other instrumentation)
7. Manage and document study specific change control process
8. EDC and other data management systems
9. SAE reconciliation
10. Medical term coding (i.e. adverse events, medications)
11. Serious adverse Event Management
12. Data Extract and SAS Extract Locking and Freezing

Reference Books:

1. Leiner, Florian, Wilhelm Gaus, G. Wagner, Reinhold Haux, and Petra Knaup-Gregori, eds. *Medical data management: a practical guide*. Springer Science & Business Media, 2003.
2. Prokscha, Susanne. *Practical guide to clinical data management*. CRC Press, 2011.
3. Leiner, Florian, Wilhelm Gaus, G. Wagner, Reinhold Haux, and Petra Knaup-Gregori, eds. *Medical data management: a practical guide*. Springer Science & Business Media, 2003.

20BT2042	PLANT AND ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To create awareness in Plant and Animal biotechnology.
2. To impart knowledge in micromanipulation techniques in cell culture.
3. To understand the principles of transgenic plants and animals.

Course Outcomes:

1. Acquire knowledge in plant biotechnology and its applications.
2. Gain the knowledge about to increase the production in agriculture products.
3. Prepare them to work in the Agriculture industries.
4. Demonstrate *In vitro* fertilization and the manipulation of embryo done for genetic screening will provide wider understating among the students and create awareness
5. Development of transgenic animals for breed development for enhanced milk production
6. Adapt appropriate ethical guidelines in animal biotechnology

Module 1: Plant Cell and Tissue Culture techniques (9 hrs)

Tissue Culture media, Callus and suspension culture, Somoclonal Variation, Micro propagation, Organogenesis, Somatic embryogenesis, transfer and establishment of whole plants in soil, green house technology

Module 2: Plant Genetic Transformation (7 hrs)

Plant Genetic Transformation Methods: Features of Ti and Ri Plasmids and its use as vectors,
Use of reporter genes and marker genes, gene transfer methods in plants: direct and indirect DNA transfer, Chloroplast transformation and its advantages.

Module 3: Application of Plant Genetic Transformation (6 hrs)
Application of Plant Genetic transformation: Herbicide resistance: Insect resistance, Disease resistance antifungal proteins, PR proteins.
Module 4: Design of gene construct and advanced technologies (9 hrs)
Factors influencing transgene expression – designing gene constructs - Promoters and polyA signals; Protein targeting signals; Plant selectable markers; Reporter genes; Positive selection; Selectable marker elimination; Transgene silencing; Strategies to avoid transgene silencing; Analysis of transgenic plants - Advanced technologies – cis genesis and intragenesis; RNAi technology, genome editing technology, CRISPR/Cas.
Module 5: Introduction to Animal Cell Culture (9 hrs)
Chemically defined and serum free media. Laboratory design, Primary cell culture, Establishment of cell line, Maintenance and Preservation of cell line. Characterization, Cross contamination, Scale up of Cell cultures for Product development.
Module 6: Micromanipulation and Transgenic Animals (9 hrs)
Embryo transfer- Micromanipulation technology, germ cell manipulation, sperm and embryo sexing, *In Vitro* fertilization, Transgenic Animals and their significance. Ethical issues in Animal Biotechnology
Text Books:

1. *Introduction*. R. *Ian Freshney*. *Culture* of Animal *Cells*: A Manual of Basic Technique and Specialized Applications, Sixth Edition. *Publisher*, John Wiley & Sons, 2011.
2. Animal cell culture 3rd ed., by John R.W. Masters A Practical Approach Oxford University press New York 2005
3. Chawala. H.S., Introduction to plant Biotechnology, Oxford and IBH Publishing Co. Pvt. LTD.New Delhi 2002.

Reference Books:

1. Bojwani, S.S. “Plant Tissue Culture: Applications and Limitations”, Elsevier science publishers, 2001.
2. Ian Freshney, “Culture of Animal Cells”, Wiley-Liss, 5th edition, 2005
3. Grierson,D. “Plant Biotechnology in Agriculture Prospects for the 21st Century”, Academic press, 2012
4. Doyle, A.R. Hay and B.E. Kirsop, “Living Resources for bio technology”, Cambridge University press, Cambridge, 1990
5. Ed. John R.W. Masters, “Animal Cell Culture - Practical Approach”, Oxford University Press, 3rd edition, 2000.
6. Dunmock N.J and Primrose S.B., “Introduction to Modern Virology”, Blackwell Scientific Publications, 2002

		L	T	P	C
20BT2043	**STEM CELL TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives:

1. This course will take students on a journey into the stem cell biology and biotech revolution.
2. This course will provide details regarding social implications associated with stem cell technology.
3. The course offers an opportunity to understand the basics of stem cells, embryonic stem cells, adult stem cells and genetic engineering of stem cells and their applications.

Course Outcomes:
The students will be able to

1. Explore the technique and the pros and cons of animal cell culture.
2. Understand the definition of stem cell and the features that distinguish it from other cells.
3. Recognize the different types of stem cells and their properties.
4. Analyze the residence of the stem cells and the factors that affect its function.
5. Learn the isolation and application of stem cells.

6. Explores the ethical aspects of stem cell technology.

Module 1: Introduction (4)

Overview of Stem cell technology; Introduction to Cell Culture; Pros & Cons of Cell culture; Primary and Secondary cultures & Hayflicks limit, telomerase;

Module 2: Techniques (5)

Aseptic Technique and Cell culture Lab equipments & etiquette.

Module 3: Types of Stems Cells (9)

Totipotency, Pleuripotency**,** Types of Stems Cells; Embryonic stem cells; Pleuripotent Stem Cells; Adult Stem cells; Induced Pleuripotent Stem Cells

Module 4: Isolation of Stem Cells (9)

Growth factors; chord cells; Derivation & differentiation of ES Cells; Derivation & differentiation of Pleuripotent Cells; Induced Pluripotent cell-Methods; Genetic & epigenetic reprogramming. iPSC vs Trans-differentiation, FACS

Module 5: Applications of Stem Cell Technology (9)

Use of stem cells in Neurological disorders; Use of stem cells in cardiac disease; Use of stem cells in Cancer; Stem cells for organ generation; Use of stem cells in tissue engineering & Gene therapy.

Module 6: Ethical Concerns of Stem Cell Technology (9)

Problems and perspectives in stem cell technology; Alternatives to stem cells; Deeper concerns in stem cell technology-, longevity, ageing & Immortality.

Text Book

1. Robert Lanza Handbook of Stem Cells edited by Anthony Atala,. (Vol-1) Second edition. Academic press, 2013.

References Books:

1. Stem Cell Biology - edited by Daniel R Marshak, Richard L Gardener, David Gottlieab, Cold Spring Harbor Press.
2. Kursad and Turksen, "Embryonic Stem cells", Humana Press, 2002.

20BT2044	**BIOPHARMACEUTICAL TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To demonstrate the fundamentals of biopharmaceutical technology to undergraduate students.
2. To motivate the students in understanding and analyzing the metabolism and mode of action of drugs.
3. To elaborate the process of formulations of drugs and to apply them in clinical trials as per the regulations.

Course Outcomes:

The students will be able to

1. Recall the steps in preparation of biopharmaceutical products.
2. Illustrate knowledge on drug development, principles and mechanism of actions of drug.
3. Compare various pharmaceutical products available commercially.
4. Infer various testing and quality assurance procedures in drug formulation.
5. Evaluate the advances in drug manufacturing process.
6. Relate the regulations in clinical trial and management.

Module 1:Drugs (9)

Introduction - Development of Drugs and Pharmaceutical Industry. Drug Metabolism and Pharmacokinetics - Drug Metabolism – Physico-Chemical Principles –Pharmacodynamics – Action of drugs in humans.

Module 2: Manufacturing Principles (9)
Manufacturing Principles - Compressed tablets – wet granulation, – Dry granulation – Direct compression – Tablet presses formulation – Coating – Pills – Capsules sustained, action dosage forms. Quality control tests for tablets and capsules. Packaging of solid dosage forms.
Module 3: Formulations (9)
Manufacturing Principles – Parental, solutions – Oral liquids – injections – Ointments. Quality control tests for semisolid and liquid dosage forms. Packaging of semisolid and liquid dosage forms.
Module 4: Pharmaceutical Products – Vitamins and Antiseptics(4)
Pharmaceutical Products- Vitamins – Cold remedies – Laxatives –Analgesics –External Antiseptics – Antacids, ayurvedic formulations.
Module 5:Antibiotics and rDNA Products (5)
Antibiotics – Biologicals – Hormones. Recent advances in the manufacture of drugs using r-DNA technology. BIOTECHNOLOGY.
Module 6:Trials & Regulations (9)
Clinical Trials & Regulations - Clinical Trials – Design, double blind studies, placebo effects. FDA regulations (General) and Indian Drug regulations- highlight. General Good Laboratory Practice, General Good manufacturing practice.
Text Books :

1. Brahmankar D M, Sunil B Jaiswal, "Biopharmaceutics and Pharmacokinetics-A Treatise", Vallabh prakashan, 2017.
2. Ansel, H., Allen, L., Popovich, N, "Pharmaceutical Dosage Forms and Drug Delivery Systems", Williams & Wilkins, 9thEdition, 2010.

Reference Books :

1. Lippincott, "Remington's Science and Practice of Pharmacy", Williams & Wilkins publishers, 2005.
2. Goodman & Gilman's, "The pharmacological basis of therapeutics" by Joel Griffith Hardman, Lee E. Limbird, Alfred G. Gilman.2005
3. Tripathi KD, "Essential of Medical pharmacology", Jaypee Brothers Medical Publishers 2003.

20BT2045	AGRICULTURAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To demonstrate the basics of genes, genomes and breeding principles.
2. To motivate students in analyzing techniques in tissue culture and genetic engineering.
3. To elaborate the understanding of biodiversity and IPR issues in agricultural crops.

Course Outcome:
The students will be able to

1. Acquire knowledge on plant breeding
2. Outline the principles of plant breeding and its techniques
3. Demonstrate various tools involved in genetic engineering
4. Illustrate the different strategies for biodiversity conservation
5. Acquire knowledge on IPR and its importance in patent rights
6. Demonstrate different tools of plant genome analysis

Module 1: Plant Biotechnology Concepts (9)
Basic concepts and history of biotechnology, Different branches of biotechnology, Tools of Genetic Engineering: Cloning vehicles, Restriction enzymes, Modifying enzymes, DNA ligase, Polymerase etc. Cloning Vectors, Recombinant DNA technology
Module 2: Plant Breeding Techniques (9)
Significance of plant breeding in crop development. Methods of plant breeding in self and cross pollinated crops. Clonal selection, population improvement programme. Heterosis, Genetical and physiological basis.

Interspecific/ Intergeneric hybridization, Heterosis inbreeding depression. Polypliody its types. Mutation breeding Gene actions, heritability, genotype and environmental interactions.

Module 3: Plant Cell and Tissue Culture (9)

Scope and importance of tissue culture in crop improvement , totipotency and morphogeneis, Organogenesis, Rhizogeneisis, Embryogenesis, Nutritional requirement of in vitro cultures, Different techniques of in-vitro culture. Protoplast isolation, culture Manipulation and fusion. Cybrids, Products of somatic hybridization, Cryopreservation of germplasm. Secondary metabolites production

Module 4: Biodiversity Conservation (6)

Geographical causes of diversity. Types of diversity. Biodiversity and centers of origins of plant. Hot spots in India. Principles of conservation biology. Biosphere concept, Genetical and evolutionary principles of conservation. Collection Maintenance and conservation of biodiversity. endangered plants, endemism and Red Data Book

Module 5: Intellectual Property Rights (3)

Intellectual Property Rights and legal concerns of Bio-resources. Case study on Basmati Rice, Turmeric and Neem

Module 6: Genome Analysis (9)

Genome projects, Genome Annotation, Biological Data Bases, Data base search engines, Sequence Analysis and Molecular Phylogeny. Gene analysis using DNA sequence data

Text Books:

1. Chawla H S, Introduction to Plant Biotechnology, 3Ed Oxford & IBH Publishing 2020
2. B.D.Singh, Plant Breeding Principles and Methods, Kalyani Publisher 2018
3. Razdan M K, Introduction to Plant Tissue Culture, Oxford & IBH Publishing 2019
4. Satish Kumar Sinha, Plant Tissue Culture: Theory and Practice, Oxford Book Company 2012
5. Jeyabalan Sangeetha, Devarajan Thangadura, Goh Hong Ching, Saher Islam. Biodiversity and Conservation, Apple Academic Press, 2019
6. Ram Kumar, Intellectual Property Rights-Demystified, New India Publishing House, New Delhi. (2008).
7. Satish Kumar Sinha, Elementary Bioinformatics , Oxford Book Company, 2012

Reference Books:

1. TA Brown, Gene Cloning and DNA analysis, an introduction, Fourth edition, Blackwell science, 2001.
2. From Genes to clones, Introduction to gene Technology. Panima Publishing Corporation, 2003.
3. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, Lewin's Genes XII, 2017

20BT2046	METABOLIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To develop skills of the students in the area of metabolic engineering to alter the existing metabolic pathway
2. To impart basic knowledge in the field of synthetic biology
3. To learn advanced molecular techniques in order to enhance the product yield

Course Outcomes:

1. Comprehend modern biology with engineering principles
2. Recall the basic principles and regulation of metabolic pathways
3. Construct suitable metabolic flux models using available metabolic engineering tools
4. Identify the appropriate host and/or metabolic pathways to produce a desired product
5. Compare the potential metabolic engineering strategies using quantitative metabolic modelling
6. Apply the concept of synthetic biology in interdisciplinary research

Module 1: Cell Metabolic Engineering (6 Hours)
Improvement of cellular properties, altering transport of nutrients including carbon and nitrogen; Methods for metabolic characterization: Genome, Transcriptome, Proteome

Module 2: Regulation of Metabolic Pathways (7 Hours)
Feedback control systems, alteration of feedback regulation for enhanced production of primary metabolites: glutamic acid, Mutants which do not produce feedback inhibitors or repressors- auxotrophs-lysine, purine nucleotides; trophophase- idiophase relationship; secondary metabolites- Antibiotics, Mycotoxins

Module 3: Manipulation of Metabolic Pathways (8 Hours)
Pathway manipulation strategies for overproduction of various metabolites, examples of ethanol overproduction, overproduction of intermediates in main glycolytic pathway and TCA cycle like pyruvate, succinate; Tools for multiple genomic modifications examples- TALENS CRISPR-Cas systems as well as traditional systems of gene knock ins and knock outs and promoter engineering.

Module 4: Metabolic Flux Analysis (10 Hours)
Metabolic flux analysis; Building stoichiometric matrix; Steady state and pseudo steady state assumptions; Methods for experimental determination of metabolic fluxes by isotope labeling metabolic fluxes using various separation-analytical techniques; GC-MS for metabolic flux analysis

Module 5: Basics of Synthetic Biology (6 Hours)
Synthetic biology - definitions and concepts. History and evolution of synthetic biology and engineering perspectives. Natural vs Engineering systems. Tools of synthetic biology -Key enabling technologies in synthetic biology. BioBricks - Definition of a BioBrick

Module 6: Applications of Metabolic Engineering and Synthetic Biology (8 Hours)
Product over production examples: amino acids, By-product minimization of acetate in recombinant *E. coli*, Extension of substrate utilization range for organisms such as *S. cerevisae* for ethanol production; Application of synthetic biology with a case study.

Textbooks:

1. Gregory N. Stephanopoulos, Aristos A. Aristidou & Jens Nielsen, “Metabolic Engineering: Principles and Methodologies”, Academic Press, An Imprint of Elsevier India Pvt. Ltd., 1st edition, 1998.
2. Cortassa S., Aon M.A., Iglesias A.A. and Llyod D., “An Introduction to Metabolic and Cellular Engineering”, World Scientific Publishing Co. Pte. Ltd, 2002.
3. Smolke, C.S. (2010) Metabolic Pathway Engineering Handbook: Fundamentals. 1st ed. New York: CRC Press.

Reference Books:

1. Freemont, P.S and Kitney, R.I. (2012). Synthetic Biology – a Primer. World Scientific Publishing Co pvt Ltd
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, “Principles of Fermentation Technology”, Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 3rd edition, 2016
3. Crueger W. and Crueger A., “A Text Book of Industrial Microbiology”, Panima Publishing Corporation, 2005
4. Cheng Q. “Microbial Metabolic Engineering: Methods and Protocols”, Humana Press, First Edition (2011).
5. Lehninger, A. L, Nelson D. L and Cox, M. M, “Principles of Biochemistry”, Freeman Publishers, New York, Seventh edition, 2017.

20BT2047	RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To intend the knowledge about the basic research methods, applications in conducting research, various data collection and analysis techniques.
2. To gain insights into scientific research.
3. To help in critical review of literature and assessing the research trends, quality and extension potential of research and equip students to undertake research.

Course Outcomes:

1. Understand the basic principles of research and its formulation
2. Illustrate the different methods of research designs and its specific applications
3. Classify the various techniques of data collection and statistical analysis
4. Elaborate the steps involved in preparation of different technical report and articles
5. Comprehend the bioethical and biosafety procedures in research
6. Gain knowledge on formulation, execution and evaluation of application oriented research

Module 1: Research Problems (7 hrs)

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process. Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance

Module 2: Research Design and Experimental Design (7 hrs)

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

Module 3: Sample Design, Measurement and Scaling Techniques (9 hrs)

Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non-Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

Module 4: Collection, Processing and Analysis of Data (9 hrs)

Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. SPSS.

Module 5: Manuscript/Thesis Writing (9 hrs)

Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Bioscience, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Bioscience discipline. Impact factor

Module 6: Use of tools / techniques for Research (7 hrs)

Methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism

Text Book:

1. Kothari C.R., “Research methodology, Methods and techniques”, New Age International (P) Ltd, Publishers, 2nd edition, 2000.

Reference Books:

1. Donald Cooper & Pamela Schindler,Business Research Methods – TMGH, 9th edition
2. Alan Bryman & Emma Bell, Business Research Methods – Oxford University Donald
3. H. McBurney, "Research methods", Thomson Asia Pvt. Ltd. 2002
4. Ranjit Kumar, "Research methodology", Sage Publications, London, 2006.
5. Raymond – Alain, "Doing Management research", Sage publications, 2001.

20BT2048	MOLECULAR FORENSICS	L T P C 3 0 0 3

Course Objectives:

1. Provide knowledge in the field of forensic science and crime scene investigations.
2. To ensure students gain knowledge about the recovery of human remains.
3. Impart technical skills to know the procedures involved in the identification of the criminals using molecular tools

Course Outcomes:

1. Explain the steps involved in forensic investigation
2. Identify the methods involved in the collection of biological samples for molecular analysis
3. Interpret the results of molecular techniques for the identification of the criminals and the victims
4. Appraise the knowledge in paleo biology and anthropology and its importance in Forensics
5. Design experiments in molecular techniques and implementation in forensic science
6. Analyze forensic case studies

Module 1: Introduction to Forensic Science (9)

Introduction to crime laboratories, Responsibilities of the forensic scientist, Securing and Searching the Crime Scene, Recording and collection of crime scene evidence, Document examination, Ethics and Integrity

Module 2: Discovery and Recovery Of Human Remains (9)

History of Forensic Genetics, Biological sample collections, The Autopsy and handling of a Dead Body, The Stages and factors of decomposition, Determining the Age and Provenance of Remains, Asphyxia, Gunshot Wounds, Bite Marks

Module 3: Pattern Analysis (8)

Human Tissues, Body Fluids and Waste Products, Fingerprints, Hair, Teeth, Blood, Detecting the Presence of Blood, Bloodstain Pattern Analysis , Forensic anthropology, Paleontology, Toxicology

Module 4: Methods of Identification (9)

Methods used in forensic for human identification: Autosomal STR Profiling, Analysis of Y chromosome, Analysis of Mitochondrial DNA, Autosomal single-nucleotide polymorphisms (SNP) typing, Biomarkers in forensic identification, Polymorphic Enzymes, DNA Finger Printing- RFLP.

Module 5: Sequencing Methods in Forensics (5)

PCR directed Y chromosome sequences, PCR Amelogenein Gene, Next generation Sequencing

Module 6: Forensic Case Studies (5)

Case studies of Royal Romanov Family, Study of Kinship by DNA Profiling, Paternity disputes, Illegal hunting case identification using Molecular markers; detection of narcotics in body fluids.

Text Books:

1. Lincoln PJ & Thomson J, "Forensic DNA Profiling Protocols", Humana Press. 2011.
2. Sandy B. Primrose, Richard Twyman "Principles of Gene Manipulation and Genomics" Backwell Scientific Publications 2010

References Books:

1. Rudin N & Inman K. "An Introduction to Forensic DNA Analysis", 2nd Ed. CRC Press. 2002.
2. Brown T.A, Gene Cloning and DNA Analysis, 6th Edition, Blackwell Publishing Ltd 2010

20BT2049	PROTEIN ENGINEERING	L T P C 3 0 0 3

Course Objectives:

1. To ensure the strong knowledge in protein architecture to understand the protein structure and function relationship.
2. To use the knowledge for structure prediction and design of novel proteins.
3. To learn different techniques for the protein engineering and its application in biotechnology Industry.

Course Outcome:

The students will be able to,

1. Understand the basic protein structure and various interactions affecting it.
2. Review of factors significant for protein folding processes and stability
3. Utilize the computational methods to understand and predict unknown protein structure and its characteristics.
4. Apply the knowledge and techniques of protein engineering to design and production of new proteins with enhanced stability and enzymatic activity.
5. Analyse and characterize the new protein with modern analytical techniques like NMR etc.
6. Understand and use advanced biophysical techniques for protein analysis, including the capacity to discuss their relative merits and interpret data from those techniques.

Module 1: Introduction to Protein Structure 9

Primary structure (peptid bonds, polypeptide chains), secondary structure (helices (α, 310, Π) , β sheets, β turns & loops/coil; Ramachandran plots), tertiary structure (fold, domain & motif; classification – globular (myoglobin) membrane (collagen) & fibrous (bacteriorhodopsin)), quaternary structure (protein assembly; globular arrangement; symmetry considerations- cyclic, dihedral & cubic symmetry; helical quaternary structures). Amino acids and its properties (size, solubility, charge, pKa), Different interactions in protein (ionic, hydrophobic, hydrogen bonding, covalent, vander wall, co-ordinate bonds), Protein folding, molten globule structure, characterization of folding pathways. Post translation modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

Module 2: Protein Structure Prediction and Design 9

Strategies for design of novel proteins-strategies for the design of structure and function: computer methods in protein modelling. Protein sequence comparison, multiple sequence alignment, data bank scanning, pattern matching; sequence structure comparison. secondary structure prediction, surfaces & volumes, molecular dynamics simulations, free energy perturbation. Incorporation of Binding Sites into de Novo Proteins, Design of Catalytically Active Proteins.

Module 3: Approaches of Protein Engineering 6

Introduction and scope of Protein Engineering. Different approaches of protein engineering: Random mutagenesis, Mutagenesis by rational design. Effect of mutation on protein structure, stability and folding, phi value analysis. Invitro mutagenesis- principles & variations, invitro chemical mutagenesis, Oligonucleotide based mutagenesis, Cassette Mutagenesis, PCR-based mutagenesis, Types of template, Saturation mutagenesis, Applications of mutagenesis

Module 4: Strategies for the Production of Novel Proteins 6

Site and strategies for heterologous expressions: methods for expressing recombinant proteins in yeast, in vitro mutagenesis. Proteolytic processing, Alteration in the chain termini, Genetic considerations in expression, post translational modifications, Sites of expression. Advantages of using yeast for protein production, Methods for expressing recombinant protein in yeast. Analysis of Yeast Transformants Expressing Heterologous Proteins, Optimization of Protein Production, Recovery and Processing.

Module 5: Analysis and Characterization of Proteins 9

Protein identification Protein structural and biochemical characterization using NMR (Principles, Types of NMR), FTIR, mass spectrometry, Protein Crystallography- X-Ray Diffraction Pattern, Crystallization of proteins, Phase determination, Electron Density Map Interpretation, Spectroscopic - Circular dichroism, CD spectrum of proteins, Near-UV Circular Dichroism of Proteins, FT-IR spectroscopy, Raman spectroscopy Calorimetric methods- differential scanning calorimetry- reversible & irreversible transitions

Module 6: Application of Protein Engineering 6

Design of polymeric biomaterials, nicotinic acetylcholine receptors as a model for a super family of ligand - gated ion channel proteins. oxidation-resistant proteases, Engineered TPA (Tissue Plasminogen Activator), Recombinant insulin (Engineered Fast and Slow Acting Insulin)

Text books

1. Cleland and Craik, Protein Engineering, Principles and Practice, Vol 7, Springer Netherlands 1998.
2. Paul R Carey, Protein Engineering and Design, 1996, Elsevier publisher.
3. Permington S R , Dunn M J,"Proteomics from Protein sequence to function" , Viva Books Pvt. Ltd.,New Delhi, 2002
4. Walsh G, "Proteins Biochemistry and Biotechnology" John Wiley and sons (2003).

Reference book

1. Park S. J. and Cochran J. R., Protein Engineering and Design, 1st Edn., CRC, 2009. Oxford, UK
2. Gregory A. Petsko and Dagmar Ringe—Protein Structure and Function, second Edition, OxfordUniversity Press USA, 2004
3. Koehrer, Caroline, RajBhandary, Uttam L., Protein Engineering, Springer, 2009

20BT2050	PLANT TISSUE CULTURE	L	T	P	C
		3	0	0	3

Course Objectives:

1. To create awareness in plant biotechnology.
2. To impart knowledge in micromanipulation techniques in cell culture.
3. To understand the principles of transgenic plants.

Course Outcomes:

1. Acquire knowledge in cell and tissue culture techniques.
2. Gain the knowledge about to plant genetic engineering tools.
3. Learn the various applications of plant tissue culture.
4. Understand the molecular concepts of disease resistance factors in plants.
5. Study the development of transgenic plants on abiotic and biotic factors
6. Assess about the scope and applications in plant biotechnology

Module 1: Cell and Tissue Culture (9 hrs)

Definition and need; Types of Methods in plant Biotechnology; Cell and Tissue Culture; Micro propagation; Callus Culture; Somatic Embryogenesis; Hairy Root Culture; Culture Medias.

Module 2: Plant Genetic Engineering Tools (9 hrs)

Vectors and Genetic Engineering; Agro bacterium mediated gene transfer and cloning; Agro bacterium types; Plant viruses and Genetic Engineered viruses as a tool of deliver foreign DNA; major plant viruses, Camv, TMV, BBTV, Gemini viruses etc.

Module 3: Application of Plant Biotechnology (9 hrs)

Hairy Root Cultures and Secondary Metabolite production; Plant as Bioreactors- edible Vaccines; Germplasm conservation; Gene Banks; Crop improvement; legume symbiosis, N_2 Fixation; Regulation of NIF and NOD Genes.

Module 4: Secondary metabolite production in tissue culture: (5 hrs)

Culture initiation, biotransformation, elicitation, hairy root culture, immobilization, permeabilization.

Module 5: Green house operation and management: (4 hrs)

Hardening and acclimatization of tissue cultured plants

Module 6: Transgenics – Biotic Factors (9 hrs)

Bioreactors: In-Process control (IPC), determination of plant cell growth: Illumination, Types of bioreactors for plant cell suspension culture, Re- and multi usable bioreactors for plant cell suspension culture, Single-use and disposable bioreactors for plant cells and tissue cultures, Re- and multi usable bioreactors for root culture, Single use vs re- and multiusable bioreactors. Advantages and disadvantages.

Total Hours: 45

Text Books:

1. Mantal S.H., Mathew J.A.,Mickee R.A., Principles of Plant Biotechnology. An Introduction to Genetic Engineering in Plants, Blackwell Scientific Publication, 2006.
2. Marx J.L., Revolution in Biotechnology, Cambridge University Press, 2002.

Reference Books:

1. Dodds J.H., Plant Genetic Engineering, Cambridge University Press, 2005.
2. R.C. Dubay and Maheswari. Introduction to Microbiology, S.Chand, 2002.

20BT2051	ANIMAL BIOTECHNOLOGY AND CELL CULTURE	L 3	T 0	P 0	C 3

Course Objective:

1. Develop skills of the students in the area of animal biotechnology
2. To impart technical knowledge in cell culture techniques
3. Provide knowledge in the various applications in cell culture and tissue engineering

Course Outcome:

1. Define the basic concepts in cell culture techniques
2. Recognize the importance of scaling up of cell culture for production of products
3. Interpret the applications of Tissue engineering and 3D cell culture techniques
4. Relate the need of genetic screening for *In vitro* fertilization
5. Appraise the knowledge of live stock improvement using transgenesis
6. Assess the scope, applications and ethical issues in animal biotechnology

Module 1: Introduction to Cell Culture (9)

Layout of cell culture laboratory, Introduction to basic culture techniques, chemically defined, serum and serum free media. Primary cell culture and types of primary culture, Establishment of cell line, Maintenance and preservation of cell line. Types of cell line, Availability of cell line

Module 2: Cell Separation and Characterization (9)

Cell separation by density gradient, Fluorescent activated cell sorting, Characterization: Morphology, Chromosome analysis, Isoenzymes

Module 3: Scaling Up of Cell Cultures and Tissue Engineering (9)

Scaling up of Adherence and Suspension Cultures, Continuous flow culture, Cell culture as a source of various Products- Vaccine Production, 3D culturing, Protocols for 3D culturing of cells, Tissue Engineering applications with examples and Protocols

Module 4: Micromanipulation of Embryos (9)

Micromanipulation technology, Enrichment of X and Y bearing sperms from semen samples of animals: Artificial insemination and germ cell manipulation, *In vitro* fertilization and Embryo transfer technology.

Module 5: Transgenic Animals (5)

Molecular Diagnosis of animal diseases, Concepts of Transgenic Animal technology: Strategies for the development of Transgenic animals and their importance in Biotechnology,

Module 6: Stem Cell Technology and Ethics (4)

Stem cells growth and maintenance, Stem cells in the development of transgenic animals, Ethical issues in Animal Biotechnology

Text Books:

1. Ian Freshney R.. Introduction to Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.
2. Advances in Animal Biotechnology by Birbal Singh, Gorak Mal, Sanjeev K Goutam. Springer; 1st ed. 2019 edition

Reference Books:

1. Animal Biotechnology 1**.** Niemann**,** Heiner, Wrenzycki, Christine .ed., Springer Publishing. 2018.
2. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare
3. Animal Cell Culture by John R.W. Masters 3rd ed., Oxford University Press, 2009.

20BT2052	PLANT AND ANIMAL TISSUE CULTURE LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To learn the basic techniques of animal cell culture
2. To impart the technical skills of plant tissue culture
3. To develop the knowledge of preservation and conservation techniques in cell culture

Course Outcomes:

1. Gain knowledge in Animal cell culture technique
2. Understand the sterilization techniques and its importance
3. Analyze and determine the growth of cells in *in vitro*conditions
4. Evaluate the viability cells in animal cell culture
5. Apply the propagation methods for commercially important plants
6. Adapt *in vitro* techniques in animal and plant cell cultures for product development

List of Experiments:

1. Basics of tissue culture laboratory design and maintenance.
2. Packing and Sterilization of glass and plastic wares for cell culture.
3. Passaging of cell line
4. Cryopreservation
5. Membrane integrity assay- Trypan Blue Staining
6. Metabolic activity assay- LDH assay
7. Media preparation and sterilization techniques.
8. Callus induction from explant
9. Shoot induction by axillary bud breaking method
10. Establishment of hairy root culture from explant
11. Cell Suspension Culture for metabolite production and growth kinetic studies
12. Preparation of synthetic seeds.

References:

1. Satish Kumar Sinha, Plant Tissue Culture: Theory and Practice, Oxford Book Company 2012
2. Bojwani, S.S. “Plant Tissue Culture: Applications and Limitations”, Elsevier science publishers, 2001.
3. Ian Freshney R.. Introduction to Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.

20BT2053	BIOMASS & BIOENERGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To make aware of various renewable feedstocks available for bioenergy
2. To elaborate on the concept of biofuel production from biomass
3. To analyze the policies & legislation in bioenergy sector

Course Outcome:

The students will be able to

1. Understand the fundamental concepts of energy
2. Relate the principles underlying the design and operation of biomass to energy

3. Identify the bioconversion techniques and limitations in Biomass processing
4. Compare Biomass conversion processes
5. Analyze research issues in biodiesel production
6. Measure the Environmental impacts of biofuels and legislation

Module 1:Energy Concepts (9)

Fundamental concepts in understanding biofuel/bioenergy production, Renewable feedstocks and their production, Feedstocks availability, characterization and attributes for biofuel/bioenergy production,

Module 2: Biomass Feedstocks and Processing (9)

Biomass Conversion Technologies - Biorefinery Concept , Hydrolysis, enzyme & acid hyrolysis – Fermentation, Anaerobic digestion - Trans-esterification, Various biofuels/bioenergy from biomass

Module 3: Biomass Conversion Technologies (9)

Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion, Biomass conversion to biofuel: thermochemical conversion, syngas fermentation, Biochemical conversion to ethanol: biomass pretreatment, Different enzymes, enzyme hydrolysis, and their applications in ethanol production

Module 4:Biodiesel (9)

Biodiesel production from oil seeds, waste oils and algae, Environmental impacts of biofuel production Value-added processing of biofuel residues and co-products, Emissions of biomass

Module 5:Waste to Energy (5)

Waste composition and Classification: Organic municipal waste, clinical waste, sewage sludge, agricultural waste, Waste& biomass materials handling.

Module 6:Policies and Legislation (4)

Pollutants arising from waste/biomass to energy plants, Energy processing from waste/biomass, Bio-energy policies & legislation at national and international level

Text Books:

1. Vaughn C. Nelson, Kenneth L. Starcher, Introduction to Renewable Energy. CRC Press; 2 edition 2016
2. Simona Ciuta, Demetra Tsiamis, Gasification of Waste Materials. Marco J. Castaldi. Academic Press (2017)
3. P. Chartier G.L. Ferrero U.M. Henius S. Hultberg J. Sachau M., Biomass for Energy and the Environment. Wiinblad. Pergamon (1997)
4. Bioenergy and Biochemicals Production from Biomass and Residual Resources, Editors: DimitarKarakashev and Yifeng Zhang MDPI Publisher 2018

Reference Books:

1. Jianzhong Sun, Shi-You Ding, Joy D. Peterson, Laurie Peter, Heinz Frei, Ferdi Schuth, Tim S. Zhao, Tao Ling. Biological Conversion of Biomass for Fuels and Chemicals: Explorations from Natural Utilization Systems. Royal Society of Chemistry; 1 edition (2013).
2. Jens Holm-Nielsen, Ehiaze Augustine Ehimen Biomass Supply Chains for Bioenergy and Biorefining.. Woodhead Publishing (2016).

		L	T	P	C
20BT2054	**ENVIRONMENTAL BIOTECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives:

1. To acquire the knowledge of environmental problems and develop technologies
2. To develop skills in bioreactors and biotreatment methods of industrial wastewater
3. To find solution to create green and clean environment

Course Outcomes:

The students will be able to

1. Infer the biotechnological solutions to address environmental issues including pollution, mineral, renewable energy and water recycling
2. Appraise the opportunities for incorporating environmental quality into products, processes and projects.
3. Develop technologies for bioremediation and biodegradation
4. Acquaint oneself with the pertinent legislation and methodology of pollutants
5. Demonstrate the professional responsibility towards protecting the environment
6. Apply scientific solutions for the development of environmental sustainable products

Module1: Environmental Monitoring (8 hrs)
Major types of environmental pollutants, Sampling, physical, chemical and biological analysis, Removal of toxicants from contaminated sources by bioadsorption techniques.

Module2: Wastewater Treatment (9 hrs)
Characteristics of wastewater, Primary treatment by sedimentation, Secondary treatment by suspended growth reactors - Activated sludge process, Aerobic – digestion, Anaerobic processes and Lagoons. Attached growth reactors **-** Trickling filter, Rotating Biological Contactor, Fluidized bed biological reactors, up flow anaerobic sludge blanket reactor, Biological nutrient removal and Sequential batch reactor. Tertiary treatment- Polishing operations: Sand filtration, adsorption by activated carbon and chlorination.

Module3: Air Pollution and Control Technology (7 hrs)
Classification of pollutants, Effects of air pollution, Control devices for particulate and gaseous contaminants: Settling chambers, Cyclone separator, Venturi scrubber, Biofiltration, Fabric filters, Electrostatic precipitators, absorption, adsorption, condensation and flaring.

Module4: Solid Waste Treatment and Management (8 hrs)
Types, sources and properties of solid waste, Collection of solid wastes, Transfer and transport, solid waste treatment methods: incineration, vermicomposting, land filling, conversion of solid waste into useful products: *in situ and ex situ* bioremediation, Reuse, Recycle and Recovering (3Rs).

Module5: Hazardous Waste Treatment and Biowaste Management (6 hrs)
Types of hazardous waste, Xenobiotic compounds, recalcitrance, biodegradation of xenobiotics and oil spills, biological detoxification, Genomic tools for bioremediation

Module6: Development of Bio products and Technologies (7 Hrs)
Bioleaching, Bio pesticide, Bio fertilizer, Biodegradable plastics, integrated bio-digester for biogas and electricity generation, biosensor for environmental monitoring, quorum sensing.

Total Hours: 45

Text Books:

1. Jogdand, S.N. Environmental Biotechnology Himalaya Publishing House, New Delhi,2012
2. Prescott, Harley and Klein, "Microbiology", 5th edition, McGraw Hill, 2014.

Reference Books:

1. Karnely D. Chakrabarty K. Ovnen G.S. Biotechnology and Biodegradation, Advances in Applied Biotechnology series, Vol. Gulf Publications Co. London, 2009.
2. Graty. C.P.L., Daigger, G and Lim, H.C, Biological Wastewater Treatment. 3rd Edition, Marcel Dekker, 2008
3. Piasecki, B.W., Fletcher, K. A. and Mendelson, F. J. 2010. Environmental Management and Business Strategy John Wiley & Sons, 2010.

		L	T	P	C
20BT2055	**MATLAB PROGRAMMING**	**3**	**0**	**0**	**3**

Course Objective:

1. To impart knowledge on matlab installation, configuration and basic syntax.
2. To introduce them to various matrix, vector, data and string operations, functions and advanced matlab operations for multivariate data analysis, modelling, optimization tool
3. To understand the applications of Matlab for various biological data analysis.

Course Outcome:

1. Identify installation, configuration and environmental setup of Matlab.
2. Demonstrate the usage of basic syntax and structure of Matlab
3. Apply knowledge of data types, operators and control structures to pseudocode
4. Analyze script functionality and offer improved performance in structure
5. Appraise structural validity, reproducibility of used Matlab functions
6. Formulate biological applications in areas such as sequence processing, sequence analysis.

Module 1:Fundamentals (7)

Matlab Local Environment Setup, Different window interface: script, and command prompt; working directory, Variables, Naming Variables, Workspace variables, clearing variables, and command windows, output formats, Creating Vectors - Creating Matrices. Basic structure of matlab scripts, main function

Module 2:Matlab Commands (9)

Commands for Managing a Session - Commands for Working with the System-Input and Output Commands (on screen input output for text, numeric data), data import from txt, xls, website data, exporting data into txt file, structure, Vector, Matrix and Array creation, manipulation, searching, arithmetic operation, statistical summary, Cell array, M-Files Creating and Running Script File. Data input and output to and from matlab script, environment.

Module3:Data Types, Operators (6)

Data Types Available in MATLAB (Cell, character, datetime, floating-point, integer, logical, string, structure, table, timetable) Data Type Conversion - Determination of Data Types, storing data into cell and extracting from cell, Operators, Arithmetic, relational, and logical operators, Data structure, Table operation

Module4:Control Structures (6)

Control structures - Decision Making, Loops and conditional Statements, ‘for’, ‘if else’, ‘while’ Switch Case. String comparison, terminating control structure: Continue, pause, break, return

Module 5:Advanced Matlab (7)

Functions, anonymous function, function without input or output arguments, specialized inbuild functions (e.g. crossval, bootstrp). Primary and Sub-Functions, Nested Functions, Private Functions, Global Variables, Matlab Plotting: line, scatter, bar plot, histogram, box-plot, subplot, figure attributes and properties

Module 6:Matlab for Biological Applications (10)

Processing biological sequences with MATLAB– Sequence acquisition, Operations on nucleotide sequences, Joining sequences, Restriction site detection, Information retrieval from biological databases. Application example: detect cancer using mass spectrometry data on protein profiles using ANN, Accessing NCBI Data from the MATLAB® Workspace, Exploring Primer Design,
https://in.mathworks.com/solutions/biological-sciences/genomics.html

Text Books:

1. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg “A Guide to MATLAB” Cambridge University Press, 2014
2. Timmy Siauw, Alexandre M. Bayen “An Introduction to MATLAB Programming and Numerical Methods for Engineers” Academic Press, Elsevier, 2015
3. Amos Gilat “Matlab an introduction with applications” 6th Edition, Wiley, 2016.

References Books:

1. Stephen J. Chapman, “Essentials of MATLAB Programming”, CL Engineering, Second Edition, 2008.
2. William J. Palm III, “Introduction to MATLAB for Engineers”, McGraw-Hill Education, 2010.
3. Rafael E. Banchs, “Text Mining with MATLAB”, Springer, 2012.

20BT2056	ENTERRENEURSHIP FOR BIOENGINEERS	L T P C 3 0 0 3

Course Objectives:

1. To impart various aspects of product design and development
2. To inculcate concept generation and selection
3. To understand technology behind the product of the service

Course Outcomes:

The students will be able to

1. Understand the principles of product design, basic management techniques, entrepreneurial skills and funding agencies.
2. Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.
3. Induce entrepreneurial intent as well as innovation, scalability and marketing of the product.
4. Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career.
5. Assess the commercial viability of a new technology based idea to prototype.
6. Transform research based ideas into feasibility business plans and IPR.

Module 1: Concept of Entrepreneurship (7 hrs)

Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs, types of Entrepreneurship, stages in entrepreneurial process, entrepreneurship in India, Creativity and Entrepreneurial personality, Entrepreneurship in Biotechnology.

Module 2: Societal Role in Entrepreneurship (6 hrs)

Role of society and family in the growth of an entrepreneur. Challenges faced by women in entrepreneurship, Role of SSI in economic development, Government support for SSI. pillars of bio-entrepreneurship and major start-ups in Biotechnology, Government schemes for commercialization of technology (eg. Biotech Consortium India Limited).

Module 3: Product Design and Prototype (8 hrs)

Identification of business opportunities, project selection, contents, formulation, guidelines by planning commission for project report. Product design, product development process, sources of ideas for designing new products, stages in product design. Creativity and innovation, generation of ideas, technical and market feasibility study, business plan preparation, execution of business plan, conversion of ideas to prototype. IPs of relevance to biotechnology and few case studies

Module 4: Start up support and financial analysis (8 hrs)

Case study on Startup village, Kochi; 10000 Start-ups of NASSCOM and Silicon Valley, USA, Startup policies of Central Government and some leading State Governments Technology Business Incubator (TBI), Role of National Science and Technology Entrepreneurship Development Board (NSTEDB), DBT-BIRAC, DST guidelines for Seed Support System (SSS) for Startups in Incubators. Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process.

Module 5: Funding of biotech business (8 hrs)

Financing alternatives, Venture Capital funding, funding for biotech in India, Exit strategy, licensing strategies, valuation, support mechanisms for entrepreneurship, Bioentrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, funding agencies in India, biotech policy initiatives.

Module 6: Biotech enterprises (8 hrs)

Desirables in start-up, Setting up Small, Medium and Large scale industry, Quality control in Biotech industries, Location of an enterprise, steps for starting a small industry, incentives and subsidies, exploring export possibilities, import- export license of biotech and agro products.

Text Books:

1. Jayshree Suresh, “Entrepreneurial Development”, 5th Edition, Margham Publications, 2011.
2. Robert D. Hisrich, “Entrepreneurship”, 6th Edition, Tata McGraw Hill Publications.2012.

Reference Books:

1. Donald F. Kuratko, “Entrepreneurship: Theory”, Process and Practice 9th Edition, Cengage Learning, 2011.
2. Craig Shimasaki Biotechnology Entrepreneurship, Academic Press is an imprint of Elsevier, 2014
3. Hyne D. and John Kapeleris, Innovation and entrepreneurship in biotechnology: Concepts, theories and cases, 2006.

20BT2057	BIOETHICS, IPR AND BIOSAFETY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand Biosafety regulations and IPR
2. To know ethical reasons behind transgenics and human genome projects
3. To know ethical issue of organ transplantation and transgenic animals

Course Outcomes:

The students will be able to

1. Recall different rDNA technology of transgenic in animals, humans and microorganisms
2. Understand the various biosafety regulations in transgenics
3. Illustrate IPR and patent procedures
4. Comprehend on various techniques of genome, stem cells and organ research in humans
5. Aware of modern rDNA research and its ethical procedures
6. Comprehend on recent ethical, legal and social economic impacts of rDNA research in biotechnology and its applications

Module 1: Biosafety (6 hrs)

Introduction – biosafety issues in biotechnology - historical background. Biological Safety Cabinets, Primary Containment for Biohazards. Biosafety Levels - Levels of Specific Microorganisms, Infectious Agents and Infected Animals.

Module 2: Biosafety Guidelines(8 hrs)

Guidelines and regulations (National and International including Cartegana Protocol) – operation of biosafety guidelines and regulations of Government of India; Definition of GMOs & LMOs. Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture. Environmental release of =GMOs - Risk - Analysis, Assessment, management and communication

Module 3: Intellectual Property Rights (9 hrs)

Introduction to IPR, Types of IP - Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications. Importance of IPR – patentable and non patentables, patenting life, legal protection of Biotechnological inventions. Agreements and Treaties - History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments. IPR and WTO regime - Consumer protection and plant genetic resources

Module 4: Patents and Patent Laws (9 hrs)

Objectives of the patent system - Basic, principles and general requirements of patent law. Biotechnological inventions and patent law - Legal development - Patentable subjects and protection in Biotechnology. Patent Filing Procedures - National & PCT filing procedure, Time frame and cost, Status of the patent applications, Precautions while patenting, disclosure/ nondisclosure, financial assistance for patenting, introduction to existing schemes. Patent licensing and agreement. Patent infringement - meaning, scope, litigation, case studies

Module 5: Bioethics (9 hrs)

Bioethics: Introduction to ethics and bioethics, framework for ethical decision making. Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. Ethical implications of GM crops, GMO’s, human genome project, human cloning, designer babies, biopiracy and biowarfare. Eugenics and its possible approaches. Animal right activities - Blue cross in India- society for prevention of cruelty against animals. Ethical limits of Animal use. Green peace - Human Rights and Responsibilities

Module 6: Organs Transplantation in Human Beings (5 hrs)

Organs Transplantation in Human Beings, Ethics in Xenotransplantation, Bioethical Issues.

Text Books:

1. Sree Krishna. Bioethics and Biosafety in Biotechnology. New Age International Publishers, New Delhi, 2007
2. Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)

Reference Books:

1. Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).
2. Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons Inc. (2005).

20BT2058	TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. Provide knowledge about cell culture, cell signaling and growth factors
2. Inculcate the importance of characterization in cell culture for the identification
3. Impart technical skills in tissue implants and tissue engineering

Course Outcomes:

The students will be able to

1. Recall the fundamental concepts about types of cells and culturing procedures
2. Analyze the cellular interaction and molecular aspects of cell differentiation.
3. Design scaffolds, tissue implants and its use in tissue engineering
4. Apprise about 3D culture mechanism and cell interactions
5. Evaluate the tissue engineering applications in the field of medicine
6. Adapt the regulatory and ethical issues in tissue Engineering

Module 1: Introduction to Tissue Culture :(9)

Introduction, Cell Culture Media, Quantification of Cells, Cell cycle Time, Cell Migration, Microbial Contamination

Module 2: Characterization and Differentiation: (9)

Characterization~~:~~ Morphology, Chromosome Analysis, Enzyme Activity. Differentiation: Proliferation, Lineage, Markers of Differentiation, Genetic Instability

Module 3: Biomaterials and Organs for Transplants (9)

Scaffolds, Biomaterials for Tissue Engineering, Collagen, Silk and Polylactic Acid, Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells in tissue engineering

Module 4: Specialized cells and 3D Culturing (9)

Epithelial Cells, Mesenchymal Cells, Neuroectodermal cells, Hematopoietic cells, 3D cell culture of different types of cells, cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering.

Module 5: Applications in Medical Fields (5)

Product development using tissue Engineering, Current scope of development of tissue engineering in therapeutics and in-vitro testing, Artificial blood vessel, Artificial Liver tissue engineering.

Module 6: Regulatory Issues (4)

Ethical, FDA and regulatory issues of tissue engineering,

Total Hours:45

Text Books:

1. Ian Freshney R.. Introduction to Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.

2. Bernhard Palsson, Jeffery A. Hubbell, Robert Plonsey, Joseph D. Bronzino, Tissue Engineering, CRC Press, 2019**.**

Reference Books:

1. Robert. P.Lanza, Robert Langer & William L. Chick, Principles of tissue engineering, , Academic press, 2002
2. Joseph D. Bronzino, The Biomedical Engineering –Handbook, CRC press, 4th ed. 2014
3. Palsson B., Hubbell J.A., Plonsey R.& Bronzino J.D., Tissue Engineering, CRC- Taylor & Francis, 2006.

20BT2059	IoT IN BIOTECHNOLOGY	L	T	P	C
		2	0	0	2

Course Objectives:

1. To learn the basics of IOT.
2. To identify the various components and application of Biotechnology in IOT.
3. To integrate concepts for research and development in biotechnology using IOT.

Course Outcomes:

The students will be able to

1. Understand the history and basic concepts of IOT.
2. Identify the various components of IOT.
3. Use IOT for different biotechnological applications.
4. Categorize IOT to different pharmaceutical applications.
5. Justify significance of IOT in research and development.
6. Plan IOT with future trends in biotechnology.

Module 1: Historical background of IoT [4 Hours]

The concept, The idea of connected device - “embedded internet” or “pervasive computing”. Pioneering work done by Kevin Ashton at Procter & Gamble in 1999 in the field of supply chain management by RFID technology. Gap until 2010. Emergence from 2011 as a technology, Concept - “The Internet of Things”.

Module 2: Components of IoT [5 Hours]

Sensors & Actuators, Transceivers, Communication platforms - Ethernet, cellular, and Wi-Fi. Processors & Boards, Power Supplies - Conventional thin film batteries; photovoltaic panels and energy harvesting modules, Gateways & Routers, Devices & Equipment Products used by end users - enabled equipment, wearables, hand-held scanners, and tracking devices.

Module 3: IoT in Biotechnology [6 Hours]

IoT in Agricultural Biotechnology - the demand of more food with other challenges including extreme climatic and weather conditions, reducing ground water supply and associated environmental impact, development of smart sensors, automated hardware’s and vehicles, robotics control systems, Agricultural farming - variable rate irrigation optimizer (VRI), soil moisture probes, virtual optimizer PRO and other IoT based systems. Soil fertility. Smart green houses, Drones for aerial monitoring of land. Cloud computing in agriculture.

Module 4: IoT in Pharmaceutical Biotechnology [5 Hours]

Discovery of novel drugs and biologics, Challenges - product instability and subsequent recalls, GMP and GDP regulations, supply chain management. Concept of “Organ in a Chip”, Smart warehouses, 2D bar-coding, RFID tags, Automatic Information Data Collection (AIDC) in packaging, Complete digital foot print - cold chains for the temperature-sensitive drugs during the transport.

Module 5: IoT in Research and Development in Biotechnology – Case Studies [5 Hours]

Era of “omics” - high evolutionary pace of novel microbial strains, phages and other biological breakthroughs, acquisition of reproducibility and consistency, Challenge of reproducibility, Case Study - Healthcare leader Bayer, Amgen. Negative Case Study - Amyris (bioreactors). IoT enabled instruments with intelligence, interconnected communication protocols - RF and Bluetooth low energy, high end sophisticated sensors, Cloud servers, Case Study - Laboratory automation - Synbio. (Europe British) enhancing productivity, accuracy and reproducibility, Automated smart labs (USA), Case Study - Ginkgo Bio-works.

Module 6: Current Challenges and Future Prospects [5 Hours]

The emergence of IoT paradigm, Innovation, invention and productivity in biotechnological research for the successful implementation at global scale, Challenges - The complex configurations of IoT devices, Acceptance in biotech industry, End users, Security interfaces, Auditing and logging. Future perspectives - Establishment of network integrity in the R&D laboratory, Networking. Automation in the laboratory.

Text Book:

1. Tripathy B.K., Anuradha J. Internet of Things (IoT), Technologies, Applications, Challenges, and Solutions. CRC Press London. 2018.

Reference Books:

1. Michael Miller. The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World. 2015.
2. Dieter Uckelmann, Mark Harrison, Florian Michahelles. Architecting the Internet of Things. 2011.
3. Sean Dodson and Rob van Kranenburg. The Internet of Things. 2008.

20BT2060	DEVELOPMENTAL BIOLOGY	L 3	T 0	P 0	C 3

Course Objectives:

1. To provide with fundamentals and concepts of developmental biology.
2. To make students understand about the events involved in the formation of embryo.
3. To impart the knowledge in the environmental assaults in human embryonic development and ethical issues.

Course Outcomes:

The students will be able to

1. Describe the basics of early development of embryos
2. Relate the role of genes and its expression during the process of the development of organs in the embryo and its development
3. Interpret about Cell to communication and the role of hormones for the embryonic development
4. Appraise the knowledge of organs in the embryo
5. Describe the role of gene expression in embryonic development
6. Analyze about the environmental impact on embryo development and ethical issues on the same.

Module 1: Early Drosophila Development (7)

Cleavege, Gastrulation, Origin of anterior-posterior polarity, maternal effector genes, Segmentation genes, gene pattern, body plan.

Module 2: Internal fertilization in mammals (8)

Getting gametes into oviduct: Translocation and capacitation Hyperactivation, thermotaxix and chemotaxis Recognition at Zona pellucida- Gamete Fusion and Prevention of Polyspermy Fusion of genetic material

Module 3: Cell to cell communication in development of embryos (7)

Induction and competence, paracrine factors, Signal transduction pathways, Juxtacrine signaling, crosstalk pathways.

Module 4: Early mammalian development: (9)

The unique mammalian cleavage, compaction escape from zona pelucida, Gastrulation in mammals, modification and development, formation of extra embryonic membrane, organogenesis

Module 5: Gene expression and human disease (9)

In born errors of nuclear RNA Processing, In born errors of translation, Diagnosis infertility, In vitro fertilization procedure, prenatal diagnosis, preimplantation genetics.

Module 6: **Environment assaults on Human development (5)**
Endocrine disruptors and human development, Teratogenic agents, ethical issues in *In vitro* development of embryo.

Text Books

1. Scott F. Gilbert, "Developmental Biology, 9th edn. Sinauer Associates, Incorporated,USA. 2010.

Reference Books:

1. Willium. J. Larsen, Human Embryology 3rd ed. Churchill Livingstone, 1998
2. Bruce M. Carlson, Human Embryology and Developmental Biology, 5th ed.,Saunders Publication, Elsevier 2013.

20BT2061	BIOLOGY FOR ENGINEERS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To comprehend the fundamental principles and concepts of human Health and Well-being.
2. To impart knowledge and implications of Biotechnology in daily Life.
3. To ensure knowledge transfer in applications of biomolecules and trends in biology.

Course Outcomes:
The students will be able to

1. Define Life and Life forms.
2. Recognize the importance of Human health, disease and Comorbidities.
3. Analyze biomolecules and enzymes in biological processes.
4. Appraise the Significance of entrepreneurship and industry.
5. Design a sustainable idea that is a trend for drug resistance.
6. Evaluate ethics and honors for research in Biology.

Module 1: Life and Life-Forms (8 hrs)
Brief Introduction about the Course. Evolution, Origin of Universe, Origin of Life, Evolution of Life Forms, Evidences of Evolution, Adaptive Radiation, Theories of Evolution, Biological Evolution, Hardy–Weinberg Principle, A Brief Account of Evolution. A History of Biology in 20 Objects Case Study – Neanderthals to Homo-Sapiens.

Module 2: Health and Well-Being and Stress Management (9 hrs)
Eukaryotic Cells, Cell Cycle and Cell Division, M Phase, Meiosis, Cell Differentiation, Nutrition in Humans – Macronutrients and Micronutrients. The Human Body during Health and Disease – Example – Two Systems – Circulatory and Digestive. Stress - Symptoms, Types, Causes and Treatment. Depression – Symptoms, Types, Causes and Treatment. Alcohol Abuse and Drug Abuse - Symptoms, Types, Causes and Treatment. Case Study – Substance Abuse and Social Responsibility.

Module 3: Molecules that make us (7 hrs)
Biomolecules (Carbohydrates, Proteins, Lipids, and Nucleic Acids) – Types and Properties. Enzymes, Classification and Nomenclature of Enzymes, Co-Factors, Importance of Enzymes. Case Study - Crime Scene Investigation.

Module 4: Biotechnology at Home and in Industry (7 hrs)
Microorganisms, Growth Kinetics, Culture Media, Sterilization, Microscopy, Applications of Microbiology, Immunology and Immunity, Cancer Biology, Stem Cell. Bread, Beer and Batter. The Fermentation Industry – Principles, Processes and Products. Case Study – Kraft Beer Industry.

Module 5: Trends in Genetics and Drug Resistance (8 hrs)
Genetics - Mendelian Law, Mendel's Laws of Inheritance, Gene Interaction, Multiple Alleles, Chromosomal Theory of Inheritance, Linkage, Recombination (Crossing Over), Chromosome, Mapping, Genetic Disorders, Biofuels. Human Cloning. Drug Resistance.

Module 6: Ethics and Genetic Code (5 hrs)
Biosafety and Ethics. Central Dogma of Molecular Biology, Transcription, Genetic code, Translation, Regulation of Gene Expression.

Text Books:

1. G. K. Suraish Kumar, Biology for Engineers, Oxford University Press, 2019.
2. Rajiv Singal, Gaurav Agarwal, Ritu Bir, Biology for Engineers, CBS Publishers and Distributers Pvt. Ltd.

References Books:

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005.
2. Arthur C Guyton, "A Textbook of Human Physiology", Elsevier Saunders, International Edition, 11th Edition, 2006.
3. Peter Raven et al "Biology", McGraw-Hill Education; 10th Edition, 2013.

20BT2062	ROLE OF BIOTECHNOLOGY IN ENVIRONMENT	L 3	T 0	P 0	C 3

Course Objectives:

1. To learn the importance of biotechnology
2. To impart knowledge on environment
3. To understand the significance of conservation

Course Outcomes:

The students will be able to

1. Acquire knowledge on the scope of biotechnology
2. Classify the health hazards of various pollutants
3. Explain importance of waste water treatment
4. Understand the significance of waste management
5. Outline the various bioremediation techniques
6. Adapt the conservation of biodiversity

Module 1: **Scope of Environmental Biotechnology (9 hrs)**

Environmental Pollution; Types, Causes and Effects of Soil, air, water, oil and heavy metal. Pollution, control measures. Social Issues- Green House Gases, Global Warming, Acid Rain, Ozone depletion, nuclear accidents and holocaust.

Module 2: **Industrial Waste Water Management (9 hrs)**

Purification of waste water; Aerobic and anaerobic treatments; Management of radioactive pollutants in water, VOC, COD BOD and BOD sensors. Bio accumulation – Bio magnification. Biological control. Principles of environment Impact. Assessment and environmental monitoring.

Module 3: **Biomass, Energy and Solid Waste Management (9 hrs)**

Biomass waste as renewable source of energy; Methods of energy production; Conversion of Solid Waste to Methane; Biogas production; Biofuels, Management of Sludge and Solid waste treatment- Land filling, lagooning, Composting and Vermi Composting.

Module 4: **Biodiversity Types (5 hrs)**

Definition, Types, Genetic, Species, Ecosystem; Biodiversity at Global Levels; Values of Biodiversity; Hotspots in Biodiversity; Loss of Biodiversity and its causes threats to Biodiversity; A general account on multilateral treaties- the role of CBD, IUCN, GEF, IBPGR, NBPGR, WWF, FAO, UNESCO and CITES-Bioresources

Module 5: **Bioremediation and Biodegradation (9 hrs)**

Types- Ex situ and In situ , Bioremediation genetically Engineered Microbes for Bioremediation. Applications of genetic engineering- Transgenic animals-cow, sheep and rabbit

Module 6: IPR and Biosafety (4)

IPR, patenting, biosafety - levels of biosafety, guidelines for biosafety and principles of biosafety

Text Books:

1. Dubey, R.C. "Text Book of Biotechnology", S. Chand & Co, 2nd edition, 2004.
2. Chatterjee, Introduction to Environmental Biotechnology, PHI Learning Pvt Ltd,3rd Edition 2011

3. Indu Shekhar Thakur Environmental Biotechnology: Basic Concepts and Applications, IK International Publishing House Pvt Ltd, 2011

Reference Books:

1. Foster C.F; Johnware D.A, “Environmental Biotechnlogy”, Ellis Harwood Ltd.3rd edition, 2003.
2. Gupta P.K. “Elements of Biotechnology”, Rastogi Publications, 2004.

20BT2063	FUNDAMENTALS OF BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To ensure students to have strong foundation in structure, composition and function of various biomolecules.
2. To introduce them to the basic nature and properties of nucleic acids
3. To understand the significance of these biomolecules

Course Outcomes:

The students will be able to

1. Acquire knowledge on structure, properties and biological functions of Primary metabolites which help them to understand the significance of biomolecules
2. Acquire knowledge on nucleic acids structure
3. Assess the significance of vitamins and minerals
4. Relate the biomolecules with the biomedical significance
5. Justify the clinical and biological significance of these biomolecules
6. Understand the conjugates of different biomolecules and their importance

Module 1:Carbohydrates (9)

Definition, Nomenclature, Classifications and Structures of sugars. Structural features of polysaccharides. Glycolysis, glycogen breakdown and synthesis, Gluconeogenesis,

Module 2:Fatty Acids (9)

Fatty acids- basic structure, types, isomers, properties, functions and essential fatty acids; Classes, structure, properties and functions of lipids: Simple lipid- examples, Compound lipid- examples, ether lipid, Derived lipid –Metabolism of lipids: Fatty acid biosynthesis and oxidations.

Module 3:Amino Acids (9)

Amino acids- basic structure, isomers, classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides –examples; Proteins- structure / conformation levels, Ramachandran plot, classification, properties and functions of proteins-

Module 4:Enzymes (9)

Enzymes and co-enzymes, IUB classification and nomenclature of enzymes, regulation of enzyme activity, active sites, activators and inhibitors; Isoenzymes, allosteric enzymes.

Module 5:Nucleotides (5)

Nucleotides- composition, structure, properties and functions; Nucleic acids- types (RNA, DNA), DNA structure-composition, stabilizing bonds, protein –DNA interactions; RNA types, structure and functions; properties of nucleic acids

Module 6: Vitamins (4)

Vitamins: classification, source, daily requirement, functions and deficiency symptoms, review on nutraceuticals and Vitamin supplementations;

Text Book:

1. Lehninger, A.L, Nelson D.L and Cox, M.M, “Principles of Biochemistry”, Freeman Publishers, New York, 7th edition, 2017.

Reference Books:

1. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 2008.
2. Lubert Stryer, “Biochemistry”, WH Freeman & Co., 4th edition, 2000.

3. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.
4. Jain and Jain "Biochemistry", Chand publication, 4th edition, 2008.

20BT2064	PATHOLOGY AND MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course objectives:

1. To learn the medical aspects of bacteriology, virology, mycology and parasitology along with concepts of symptoms, pathogenesis, transmission, prophylaxis and control
2. To understand how disease processes affect physiological function of the host
3. To analyze how disease processes can result in specific clinical signs and symptoms

Course Outcomes:

The students will be able to

1. Recognize the basic elements concerning cell injury and death, tumors and the mechanisms of response to tissue injury
2. Compare different clinical manifestations of different types of pathogens
3. Compare and contrast experimental approaches with their advantages/disadvantages of each approach for specific pathogens.
4. Adapt the physical and chemical methods to control the growth of microbes
5. Evaluate immunopathology, oncology, general and organ-specific pathophysiology
6. Critically analyse the standards of practice of medical laboratory science in clinical/research microbiology laboratories including laboratory safety standards

Module 1: General Pathology (9 Hours)

Cellular adaptation- atrophy, hypertrophy; Cell Injury- necrosis and apoptosis; Inflammation and repair (Healing); Thrombosis and embolism, Oedema, Haemorrhage, Shock, Infarction, Amyloidosis, Hyperlipidaemia and lipidosis, Neoplasia: Benign and Malignant; Carcinoma and Sarcoma. Tumor immunology. Laboratory diagnosis: Cytology, Biopsy, Tumor markers, Immunity: innate and specific immunity

Module 2: Systemic Pathology (5 Hours)

General overview of the diseases: Cardiovascular system, Kidney and lower urinary tract, Male reproductive system and prostate, Female genitalia and breast, Eye, ENT and neck, Respiratory system, Gastro Intestinal System, Skin and soft tissue

Module 3: Basics of Microbiology (8 Hours)

Organization and function of prokaryotic and eukaryotic cells; Structure and function of cell organelles-surface structure, special organelles, cellular reserve materials; Microscopy- Bright field, Scanning Electron Microscopy – Bacterial Staining: Gram; Cultivation- Media for growth; pure culture concept and cultural characteristics; Control of microorganisms by physical and chemical agents

Module 4: Bacterial diseases (8 Hours)

Normal microflora (microbiome) of human body and its role – Skin, mouth and respiratory tract, intestinal tract, urogenital tract; Pathogenesis and virulence factors - Koch's postulates, Adherence and invasion, Toxins, Enzymes- Clostridium spp., Staphylococcal infections, E. coli, Helicobacter pylori, Mycobacterium spp. Antibacterial chemotherapy (with few examples of antibiotics) - antimicrobial activity *in vitro*

Module 5: Viral, Fungal and protozoan infections (8 Hours)

Viral Pathogenesis - Routes of entry, Viral spread (local and systemic infection); Dengue, Influenza virus-Swine flu, HIV/AIDS; Emerging viral diseases – Ebola, Chikungunya; Fungal infections: Types of Mycoses (with specific example of causative fungi) – Superficial, Cutaneous, Sub-cutaneous; Endemic and Opportunistic; Mycotoxins- Aflatoxins; Protozoan diseases - Amoebiasis, Infection by Helminths – Nematodes

Module 6: Collection and Transportation of Specimen (7 Hours)

General Principles, Containers, Rejection, Samples- Urine, Faeces, Sputum, Pus, Swab; Care and Handling of Laboratory Animals- Fluid, Diet, Cleanliness, Cages, ventilation, Temperature, Humidity; Disposal of Laboratory/Hospital Waste- Non-infectious waste, Infected sharp waste disposal, infected non-sharp waste disposal.

Textbooks:

1. KC Carroll, SA Morse, T Mietzner, S Miller. (2016), Jawetz, Melnick and Adelbergs's Medical Microbiology, 27th edition, McGraw Hill.
2. V Kumar, AK. Abbas and JC Aster, (2015), Robbins & Cotran Pathologic Basis of Disease, 9th Edition, Elsevier.
3. Ramzi S Cotran, Vinay Kumar and Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB Saunders Co. 2010.

Reference Books:

1. Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2014.
1. Prescott, Harley and Klein, "Microbiology", 8th edition, McGraw Hill, 2013.
2. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 5rd edition, 2010
3. Ananthanarayanan and Panicker, "Microbiology" Orient blackswan, 2015.

20BT2065	HUMAN ANATOMY AND PHYSIOLOGY	L	T	P	C
		3	0	0	3

Course objectives:

1. Provide the basics on the structure of cell and organelles
2. To ensure the students study the structure of different organ systems
3. Impart knowledge in the human anatomy and physiology

Course Outcomes:

The students will be able to

1. Define the basic concepts of cells, their functions and membrane transportation
2. Discuss the importance in body fluids and its role in homeostasis.
3. Appraise the function and the components of respiratory and cardiovascular systems.
4. Comprehend the role of neurons and its application
5. Illustrate the structure and functions of nervous system and parts of brain of Human system
6. Analyze the physiological conditions of the human body and understand the symptoms pertaining to any disease

Module 1: Cellular and Tissue Organization (7)

Structure and organelles, function of each component. Cell membrane, transport across membrane, cell membrane potential, action potential.

Module 2: Blood Composition (8)

Functions of blood, functions of RBC, WBC types and their functions, blood groups, importance of blood groups, identification of blood groups, blood flows factors regulating blood flow such as viscosity, radius, density etc.

Module 3. Components of Respiratory System (7)

Structure and function of trachea, bronchi, bronchioles and alveoli, lungs- position, associated structure pleura and pleural cavity, cycle of respiration, Lung volume and capacity. -

Module 4. Heart and Its Regulation (8)

Heart- position, structure pericardium, myocardium, endocardium, interior of the heart, flow of blood through the heart, blood supply to heart, Conducting system of the heart, factors affecting heart rate, the Cardiac cycle, cardiac output, blood pressure, control of blood pressure, pulse and factors affecting the pulse rate. Circulation of the blood- pulmonary circulation, systemic circulation aorta

Module 5: Structure of a Neuron (7)

Synaptic conduction. Conduction of action potential in neuron. Parts of brain cortical localization of functions, EEG. Simple reflexes, with drawls reflexes. Autonomous nervous system and its functions

Module 6: Structure of Visual Pathways and Excretion system(8)
Structure of Eye, Ear, auditory and visual pathways. Structure of kidney and nephron, Mechanism of Urine formation and base regulation. Dialysis.

Text Books:

1. Guyton and Hall, "Text book of Medical Physiology", 11th edition Saunders, an imprint of Elsevier Inc. Philadelphia. 2011.
2. Anne Waugh, Allison Grant, "Ross and Wilson: Anatomy and Physiology in health and Illness", Churchil Livingston Elsvier 2010.

Reference Books:

1. Elaine. N. Marieb, "Essentials of Human Anatomy and Phsiology" 8th edition, Pearson education, New Delhi 2007
2. William F Ganang "Review of Medical physiology" 2nd edition McGraw Hill, New Delhi, 2000.

20BT2066	CELLBIOLOGY AND IMMUNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart basic knowledge in cell biology & Immunology,
2. To help the students familiarize with the organs and cells of the immune system, the immune response and molecular interactions involved in immune response.
3. To make the students aware of the importance of cell organelles and immunity

Course Outcomes:
The students will be able to

1. Relate the characteristic features of cell organelles and immune systems
2. Classify various cellular organelles and their functions.
3. Analyze the possible mechanism of cell signaling in immune systems
4. Compare the origin, maturation process, and general functions of immune cells.
5. Comprehend the cellular/molecular pathways in health and disease.
6. Apply the principles of immunology in disease protection and immune disorders.

Module 1: Features of cell (8 hrs)
History of cytology and cell theory, Prokaryotes and Eukaryotes (plant cell and animal cell), Membranes of the cell: Plasma membrane, Nuclear membranes, Organelle membranes. Outline of organelles: Nucleus, nucleolus, ribosome, mitochondria, chloroplast, vacuole, endoplasmic reticulum, golgi apparatus, lysosome, centriole, cilia and flagella.

Module 2: Cytoskeleton and Cell Transport (8 hrs)
Microtubules, microfilaments, intermediate filaments and their binding proteins, Cell- cell communications, Passive and active transport, pumps and gated channels, co-transport: symport, antiport. Vesicular transport: Endocytosis, Exocytosis, Protein glycosylation in eukaryotes and protein sorting.

Module 3: Signaling Molecules and Signal Transduction (7 hrs)
Signaling molecules: autocrine, paracrine and endocrine and its mode of action in cell signaling. G-protein coupled receptor and protein tyrosine kinases receptor for cell signaling, different models of signal amplifications: role of cyclic AMP, cyclic GMP and G proteins in signal transduction

Module 4: Overview of Immunology (5 hrs)
Types of Immunity - Innate and acquired immunity, Cell mediated and humoral immunity; Organs of the immune system: Lymphoid organs - primary and secondary.

Module 5: Cells of the Immune System, Antigen-Antibody Complex (9 hrs)
Granulocytes & Agranulocytes, Haematopoisis,. Antigens- chemical and molecular nature; Haptens; Adjuvants. Antibody – structure and classes, Antigen-Antibody reactions: Neutralization, Opsonization, Phagocytosis, Complement, Cytokines.

Module 6: **Immune Responses to Infections (8 hrs)**
Major Histocompatibility Complex; antigen processing and presentation, T-Cell activation and the cellular immune response. Immunity to pathogens; Immune dysfunction, Autoimmunity, hypersensitivity, Immunodeficiency. Immunosupression and Transplantation:

Text Books:

1. Alberts, Molecular Biology of the Cell, Garland Sciences, 6th edition, 2012.
2. Roitt I, Male, Brostoff, "Immunology", Mosby Publishers, 5th edition, 2011.

Reference Books:

1. Geoffrey M. Cooper, Robert E. Hausman, The Cell, A Molecular Approach – 6th Edition Sinauer Associates, Inc.. 2015
2. Tizard, "Immunology", Saunders college publication, 6th Edition, 2010.
3. Kuby J, "Immunology", WH Freeman & Co., 2013.

		L	T	P	C
20BT2067	**MOLECULAR BIOLOGY FOR BIOMEDICAL ENGINEERS**	**3**	**0**	**0**	**3**

Course Objectives:

1. To understand the basics of molecular biology and gene expression.
2. To understand DNA damage and repair systems
3. To get an overview on the regulation of gene expression

Course Outcomes:
The students will be able to

1. Recall the fundamental concepts of the organization of genome and central dogma
2. Understand the process of replication, transcription and translation
3. Recognize common mutations, their natural repair systems and inhibition of gene expression
4. Distinguish the process of replication of prokaryotic and eukaryotic DNA
5. Appraise the synthesis of RNA and post-transcriptional modifications
6. Comprehend the role of operons and cis/trans elements in gene regulation

Module 1: Chromosome Organization (9 hrs)
Chromosome organization in prokaryotes and eukaryotes, Different forms of DNA, Classical experiments Grifith, Hershey and chase; Avery McLeod & McCarty. Transformation, Transduction, and Conjugation. Lytic and lysogeny.
Module 2: DNA Replication – Prokaryotes (4 hrs)
DNA replication- Semi conservative replication, Meselson stahl experiment, Enzymes in replication, Replication in prokaryotes,
Module 3: DNA Replication – Eukaryotes and Mutations (5 hrs)
Replication in eukaryotes and telomere replication. Mutation: types, DNA repair mechanism
Module 4: Transcription (9 hrs)
RNA polymerase, features of promoters and enhancers, transcription factors, Prokaryotic and eukaryotic transcription, inhibitors, post-transcriptional modification - RNA splicing
Module 5: Translation (9 hrs)
Elucidation of genetic code-salient features, Process of translation in prokaryotes and eukaryotes, Post-translational modifications, Inhibitors.
Module 6: Regulation of Gene Expression (9 hrs)
Regulation of gene expression: In prokaryotes - lac and trp operons. Regulation in eukaryotes – cis and trans elements. Regulation at transcription and translation in eukaryotics.
Review on loss of regulation and defect in DNA repair system leading to genetic disorders and diseases.

Text Book:

1. David Friefelder, "Molecular Biology", Narosa Publ. House. 6th edition 2003.

Reference Books:

1. David R. Hyde, “Genetic and Molecular Biology”, Tata McGraw Publications, New Delhi, 4th edition, 2010.
2. Lehninger, A. L, NelsonD. L and Cox, M. M, “Principles of Biochemistry”, Freeman Publishers, New York, fourth edition, 2005.
3. Gardner, Simmons and Snustad, “Principles of Genetics”, John Wiley, 8th edition, 2000

20BT2068	PRINCIPLES OF PLANT BIOTECHNOLOGY AND APPLICATIONS	L 3	T 0	P 0	C 3

Course Objectives:

1. To recall the plant tissue culture techniques and its applications.
2. To examine the plant transformation and breeding techniques
3. To employ the drug production strategies in plant biotechnology

Course Outcomes:

The students will be able to

1. Summarize cell and tissue culture techniques.
2. Illustrate the knowledge on plant genetic engineering tools.
3. Enumerate the different vectors used in plant transformation
4. Employ different methods of in vitro drug production techniques
5. Examine the principles of plant breeding and protection
6. Assess the different bioreactors and its applications in plant biotechnology

Module 1: Plant Tissue Culture (8 hrs)

History-tissue culture lab - establishing aseptic conditions -types of media and their preparation plant hormones -organogenesis–direct and indirect (meristem/shoot apex culture, callus and suspension culture), Significance and application of anther culture, ovule culture, embryo culture-somatic embryogenesis-protoplast fusion-somaclonal variation-artificial seeds-micropropagation. Hardening and acclimatization of tissue cultured plants

Module 2: Plant Genetic Engineering Tools (8 hrs)

Biology of Agrobacteriumtumefaciens-plant transformation methods-stable and transient-Agrobacterium-mediated,biolistic,PEG/liposome-mediated,electroporation,chloroplast Transformation, protoplast transformation, site directed integration of transgene (zinc finger).

Module 3: Vectors in plant transformation (8 hrs)

Binary and co-integrate vectors-gateway vectors-promoters-selectable and screenable markers-marker free transgenics-significance and applications. Plant as Bioreactors- edible Vaccines; Germplasm conservation; Gene Banks; Crop improvement; legume symbiosis, N_2 Fixation; Regulation of NIF and NOD Genes.

Module 4: Secondary metabolite production in tissue culture: (6 hrs)

Callus culture initiation, biotransformation, elicitation, hairy root culture, immobilization, permeabilization.

Module 5: Plant Breeding and Protection (6 hrs)

Sexual hybridization Mutagenesis – Polyploidy, Genetic resources for breeding, Germplasm conservation, Marker assisted selection, cultivar release and commercial seed production, Biotic stress factors and natural disease resistance pathways, Abiotic stress factors - tolerance mechanisms.

Module 6: Bioreactors for drug production (9 hrs)

Bioreactors: In-Process control (IPC), determination of plant cell growth: Illumination, Types of bioreactors for plant cell suspension culture, Re- and multi usable bioreactors for plant cell suspension culture, Single-use and disposable bioreactors for plant cells and tissue cultures, Re- and multi usable bioreactors for root culture, Single use vs re- and multiusable bioreactors. Advantages and disadvantages.

Text Books:

1. Adrian Slater, Nigel W. Scott, Mark R. Fowler,“Plant Biotechnology-TheGenetic Manipulation of Plants”third edition, Oxford University Press, 2008.

2. Mantal S.H., Mathew J.A.,Mickee R.A., Principles of Plant Biotechnology. An Introduction to Genetic Engineering in Plants, Blackwell Scientific Publication, 2006.

Reference Books:

1. Dodds J.H., Plant Genetic Engineering, Cambridge University Press, 2005.
2. C Neil Stewart Jr. "Plant Biotechnology and Genetics "- John Wiley & Sons, Inc., New Jersey 2008

20BT2069	ADVANCES IN ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart technical knowledge in cell culture techniques and development of skills for *In vitro* culture of cells and its products
2. To conceptualize tissue engineering techniques for organ transplantation
3. To acquaint learners with the development of transgenic animals, and debate on the boon and bane of Genetically Modified Organisms

Course Outcomes:

Students will be able to:

1. Demonstrate the cell culture techniques for maintenance of cell lines
2. Recognize the importance of scaling up of cell culture for development of cell culture products
3. Interpret the applications of tissue engineering and 3D cell culture techniques
4. Relate the need of genetic screening for *In vitro* fertilization
5. Apply the knowledge of livestock improvement using transgenesis
6. Assess the scope, applications and ethical issues in animal biotechnology

Module 1: Cell Culture, Cell Separation and Characterization (12 hrs)

Layout of cell culture laboratory, Introduction to culture techniques, chemically defined media, serum and serum free media. Primary cell culture and types, Establishment of cell lines, maintenance and preservation, Cell separation by density gradient, Fluorescent activated cell sorting, Characterization: Morphology, Chromosome analysis, Isoenzymes, Cell Banks.

Module 2: Scaling up of Cell Cultures and Product Development (6hrs)

Scaling up of adherence and suspension cultures, Continuous flow culture, Cell culture as a source of various products-Vaccines, Enzymes and Hormones.

Module 3: Tissue Engineering :(7hrs)

3D culturing, protocols for 3D culturing of cells, Scaffolds as biomaterials for tissue engineering, Stem cells in tissue engineering, Organs for transplantation protocols (Skin, Bone, Nerve and Cardiovascular Tissue)

Module 4: Nutritional Biotechnology (5hrs)

Bio conservation of lignocellulose (high quality dietary fiber), Genetic manipulation of microbes for improved feed utilization and health, Fermentation process of milk and meat

Module 5: Micromanipulation of Embryos (7hrs)

Micromanipulation technology, Enrichment of X and Y bearing sperms from semen samples of animals, Artificial insemination and germ cell manipulation, *In vitro* fertilization and embryo transfer technology.

Module 6: Transgenic Animals and Live Stock Improvement (8hrs)

Molecular diagnosis of animal diseases, Concepts of transgenic animal technology: Strategies for the development of transgenic animals and their importance in Biotechnology, Stem cells in the development of transgenic animals, Marker assisted selection, Gene knock out in animals, gene banking, Use of Artificial Intelligence in Animal monitoring, Ethical and Regulatory issues in Animal Biotechnology.

Text Books:

1. Ranga M.M. Animal Biotechnology. 3rd ed., Agrobios. 2007.
2. *R. Ian Freshney*. *Introduction to Culture of Animal Cells:* A Manual of Basic Technique and Specialized Applications, 6thed.,.*Publisher*, John Wiley & Sons, 2011.

3. Birbal Singh, Gorak Mal, Sanjeev K Goutam. Advances in Animal Biotechnology, 1st ed. Springer, 2019.

Reference Books:

1. Animal Biotechnology 1**. Niemann,** Heiner, **Wrenzycki**, Christine .ed., Springer Publishing. 2018.
2. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. *New Generation Vaccines*. 3rd Ed. Informa Healthcare. 2004.
3. Animal Cell Culture by John R.W. Masters 3rd ed., Oxford University Press, 2009.

20BT3001	**ADVANCES IN BIOPOLYMER AND APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

To improve knowledge on

1. Application of biopolymers in the field of pharma and food industries.
2. Interaction of biopolymers and their structure – function relationship
3. Recent trends in biopolymers research

Course Outcomes:

The students will be able to

1. Recall the basic structure, composition and functions of biopolymers.
2. Demonstrate the applications of biopolymers in medical, pharma, food and agro industries
3. Apply technologies such as protein engineering, glysosylation engineering, enzyme engineering, antibody engineering to study the biomolecules
4. Compare and contrast the structure functional relationship of different biomolecules
5. Appraise the applications of biomolecules as biomarkers in diagnosis of diseases and as biosensors
6. Compile, discuss and critically review the recent updates / progress in biopolymers research and their applications

Module 1: Glycans and Glycobiology (10 Hours)

Glycoconjugates – glycoproteins, glycolipids and lipopolysaccharides; Glycans and blood groups, Lectins and interaction with glycoconjugates; Glycans in biotechnology and pharmaceutical industry: as components of vaccines and small molecule drugs, glycosylation engineering, therapeutic glycans.

Module 2: Protein and Enzyme technology (10 Hours)

Structure- function relationship in fibrous and globular proteins, industrially significant peptides; Protein Engineering Methods - Applications of proteins: Food industry, Environmental, Medical. Enzyme markers in disease diagnosis – hepatobiliary diseases, myocardial disorders, atherosclerosis, renal dysfunction. Oxidative stress and cancer; Enzyme based biosensors; Enzymes in food, and pharmaceutical industries. Enzyme immobilization techniques and its applications.

Module 3: Hormones and Antibodies (6 Hours)

Mechanism of actions of chemically diverse hormones, Hormone therapy, Applications of hormones in anti-ageing medicine. Antibody engineering, Abzymes

Module 4: Lipid Technology and Applications (7 Hours)

Industrial applications of fatty acids and lipids, role of lipids in pharmaceutical industry, Structured Lipids for Food and Nutraceutical Applications

Module 5: Nucleic Acid Biopolymer (6 Hours)

Applications of nucleic acid polymer in diagnosis and therapy - nucleic acid probes in clinical laboratory; Review on current status of gene therapy research.

Module 6: Recent trends in Biopolymer applications (6 Hours)

Applications of biopolymers in food and packaging industry, Biopolymer scaffolds and tissue engineering, Biopolymers and bioremediation, Liposomes and their novel applications in nanobiotechnology and medicine.

Text book:

1. Lehninger A. L, Nelson D. L. and CoxM. M. "Principles of Biochemistry" Seventh Edition (Freeman Publishers), New York, 2017.

Reference Books:

1. Varki A, Cummings R.D, Esko J.D, Freeze H.H, Stanley P, Bertozzi C.R, Hart G.W,Etzler M.E., " Essentials of Glycobiology", Second edition; Published by Cold Spring Harbor Laboratory Press, New York, 2009
2. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2015.
3. Donald Voet and Judith G. Voet . "Biochemistry" – Volume 1, Biomolecules, Mechanisms of Enzyme Action and Metabolism, John.Willey and sons, 2010.
4. BurcuTuranli-Yildiz, CerenAlkim and Z. PetekCakar (2012).

20BT3002	GENETIC ENGINEERING AND RECOMBINANT PRODUCTS	L	T	P	C
		3	0	0	3

Course Objectives:

To gain knowledge about

1. The history and future of genetic engineering
2. The techniques employed in Genetic Engineering in the field of medicine and the biotech industry.
3. The techniques involved in generating transgenic microbes, plants and animals.

Course Outcomes:

The students will be able to

1. Understand the basic concepts in Genetic engineering.
2. Recognize the usage of the tools of genetic engineering.
3. Choose the techniques employed in genetic manipulation of microbes.
4. Analyze the techniques employed in the genetic manipulation of plants for crop improvement
5. Illustrate the techniques employed in the genetic manipulation of animals for commercial purposes.
6. Discuss the genetic manipulation techniques employed in the production of therapeutics.

Module 1: Introduction to Genetic engineering and the market of r-DNA products (4 Hours)

Impact of r-DNA products in food, drug, agriculture, and industry.

Module 2: Tools employed in Genetic engineering: Vectors & Enzymes (7 Hours)

Properties of ideal vectors, Cloning vectors & Expression Vectors. Vectors for Bacteria; plasmids, cosmids and Phagemids, BAC and YAC. Shuttle vectors, Expression vectors for bacteria, yeast, animal/mammalian cells and plants.

Module 3: Polymerase Chain Reaction (6 Hours)

Types of PCR, Inverse PCR, Nested PCR, RACE PCR, Reverse Transcriptase PCR, Real Time PCR, Nucleic acid sequencing methods.

Module 4: Construction & Analysis of recombinant DNA (10 Hours)

Construction of Genomic DNA libraries & cDNA libraries, PCR Cloning of DNA for Expression in E.coli, Yeast, Plant & Mammalian cells. Physical, chemical and biological methods of transferring recombinant DNA into target cells. Restriction analysis, Probe preparation and labeling methods, hybridization methods

Module 5: Protein and Nucleic Acid products of rDNA technology (9 Hours)

Production of hormones, enzymes for therapeutics and diagnostics. Recombinant enzymes for industrial applications.DNA oligonucleotides for Antigene applications, Gene editing tools: Meganuclease, CRISPER-CAS. ZFN, TALEN; RNA decoys, siRNA, micro RNA

Module 6: Application of Genetically Modified Organisms (9 Hours)

Improved crop varieties GMOs: drought resistant, pest resistant, virus resistant salinity tolerant, Terminator technology, Biofortified crops, Plantibodies and Vaccines production in plants. Genetically enhanced animals, hypoallergenic cows.

Text Books:

1. Berhard R. Glick, Chery L. Patten, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 5th edition, 2010
2. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski, Recombinant DNA: Genes and Genomes, W.H. Freeman, 2007

Reference Books:

1. GodbeyW T, **An Introduction to Biotechnology** ,AP, 2014
2. Kadema Carter, Biomedical Applications of DNA Recombinant Technology, Koros, 2014
3. Lilia Alberghina, **Protein Engineering For Industrial Biotechnology**, Hardwood Academic Press, 2000
4. Nigel W. Scott, Mark R. Fowler, Adrian Slater, **Plant Biotechnology**: **The genetic manipulation of plants**,2nd Edition, 2008
5. Carl A. Pinkert, **Transgenic Animal Technology**: A Laboratory Handbook, 2012.

20BT3003	BIOPROCESS MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3

Course Objectives:

1. Principles and frameworks of data driven modeling
2. Mathematical models relevant to industrial and environmental bioprocess systems
3. Basics of MATLAB required for formalization of Bioprocess models and its simulation

Course Outcomes:

The students will be able to

1. Recognize the different stages and their inter-relationship in bioprocess modelling
2. Relate modelling, simulation and parameter estimation
3. Develop bioprocess system models from experimental data using Matlab tool
4. Examine the suitability of developed models in a quantitative manner
5. Interpret the bioprocess modelling outcome for refinement of model structure
6. Formulate simplification strategies and simulate bioprocess models with relevant examples

Module 1: Introduction to Bioprocess modelling **(7 Hours)**

Basic modeling principles – Purpose of modelling transient or steady state behavior – deterministic, stochastic, population based, mechanistic and empirical models. Fundamental laws guiding modelling framework – mass and energy balance, charge balance, equilibrium states and chemical kinetics, continuity equation.

Module 2: Mathematical formalization of Bioprocess **(7 Hours)**

Representation of Bioprocess (with examples) in terms of key mathematical expression, Data availability and designing data collection. Identifying key variables, parameters, number of equations, Kinetic expression, Conversion of algebraic to differential form for mass balance equations. Numerical modelling algorithm – initial value problem.

Module 3: Matlab basics for modelling **(10 Hours)**

Basics of Matlab environments, import from web, xls, txt file, variables, vector-matrices operations, Matlab functions, Numerical integration, Euler and fourth order Runge-Kutta method, Matlab ODE solver, choice of numerical solvers ode45, ode15s, ode23. Curve fitting toolbox for kinetic models simulating a bioprocess with known process parameters

Module 4: Matlab application in bioprocess modelling **(5 Hours)**

Solving problems by numerical integration. Modelling simple microbial growth, substrate consumption and product formation kinetics in batch Process. Incorporating substrate and product inhibition, multi-substrate growth models

Module 5: Parameter Estimation and sensitivity analysis, model fitness **(11 Hours)**
Parameter estimation from experimental and modelled data, least square regression, Use of local and global optimization tool for parameter estimation (Genetic algorithm). Cross-validation test for over-fitting, external validation, parameter Sensitivity and confidence interval estimation using boot-strapping

Module 6: Advanced Bioprocess Modelling examples **(5 Hours)**
Modelling and Simulation of Citric Acid Production from Corn Starch Hydrolysate, Mathematical modelling of ethanol production, Dynamic Modelling of Complex Enzymatic Reactions, Dynamic modeling of nutrient removal

Text Books:

1. Verma, Ashok Kumar, Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering, CRC Press, (2014).
2. Dunn, Irving J. Biological reaction engineering: dynamic modelling fundamentals with simulation examples, Wiley-VCH, (2003).

Reference Books:

1. Nicoletti, Maria Carmo, Computational Intelligence Techniques for Bioprocess Modelling, Supervision and Control. Springer, (2009)
2. Snape, Jonathan B. Dunn, Irving J., Ingham John, Prenosil Jiri E. ,Dynamics of Environmental Bioprocesses: Modelling and Simulation, John Wiley & Sons, (2008)

20BT3004	BIOCHEMICAL ANALYSIS LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. Clinical role of biochemical metabolites in biological sample.
2. Importance of biochemical metabolites and their assays
3. Advanced biochemical characterizationand structure prediction techniques

Course Outcomes:

The students will be able to

1. Recall the basic concepts and principles of different assays
2. Understand the protocol for extraction of biomolecules from various sources
3. Experiment with the assay procedures of acid phosphatase. Glucose, hexosamine, and antioxidants assays
4. Infer the results and draw conclusion
5. Compare the different methods of extraction of phytochemicals, and exposed to latest techniques on determination and structure prediction using advanced techniques
6. Propose and apply the above learnt experimental skills in their project work

List of Experiments:

1. Assay of acid phosphatase
2. Assay of lipid peroxidation (LPO) in plasma
3. Estimation of glucose by glucose oxidase and peroxidase (GOD – POD) method
4. Estimation of serum hexosamine by Wagner method
5. Determination of peroxide value of oil
6. Isolation and preparation of lecithin from egg
7. Determination of total antioxidant capacity by phosphomolybdenum method
8. Modified hydroxyl radical scavenging assay
9. Solvent extraction of phytochemicals and qualitative screening
10. Separation of phytochemicals by HP-TLC
11. Determination of molecular mass of phytochemicals by Mass spectrometry
12. Biomolecular structure prediction using X-Ray diffraction

Reference Books:

1. S.Sadasivam and A.Manickam, Biochemical Methods. 2nd edition, New Age International publishers, New Delhi, 2005
2. S.K. Sawhney and Randhir singh, Introductory Practical Biochemistry, Narosa Publishers, 2005

		L	T	P	C
20BT3005	**ANIMAL AND PLANT TISSUE CULTURE LAB**	**0**	**0**	**4**	**2**

Course Objectives:

1. To know Plant tissue culture and transformation techniques
2. To know Animal tissue culture and assays
3. To carryout Sterilization techniques on Plant and Animal Tissue Culture

Course Outcomes:

1. Demonstrate media preparation on Plant and Animal Tissue Culture
2. Comprehend on sterilization techniques
3. Experiment plant transformation techniques
4. Performin vitro animal cell culture techniques
5. Demonstrate cell viability assays using different types of animal cells
6. Analyze the cell toxicity of drugs

List of Experiments:

1. Media preparation and Axillary bud breaking method
2. Establishment of banana explant and Multiplication
3. Cell Suspension Culture for secondary metabolite production and growth kinetic studies
4. Establishment of hairy root culture for secondary metabolite production
5. Agrobacterium mediated gene transfer in *in vitro* plantlets
6. Passaging of cell line
7. Cryopreservation
8. Membrane integrity assay- Trypan Blue Staining
9. Metabolic activity assay- LDH assay
10. Functional assay- MTT/XTT
11. DNA assay- COMET
12. Micropropagation of medicinal plant

References:

1. Plant Tissue Culture: Theory and Practice Satish Kumar Sinha Oxford Book Company 2012
2. Bojwani, S.S. “Plant Tissue Culture: Applications and Limitations”, Elsevier science publishers, 2001.
3. R. Ian Freshney. Introduction to Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.

		L	T	P	C
20BT3006	**ADVANCED PROCESS EQUIPMENT DESIGN AND DRAWING LAB**	**0**	**0**	**4**	**2**

Course Objectives:

1. To design safe and dependable processing facilities.
2. To design plant layout and selection using AutoCAD.
3. To provide the basic knowledge to carry out process equipment design and cost effect.

Course Outcomes:

1. Understand the unit operation symbol, letters and plant layout
2. Summarize the effect of heat exchangers and evaporators
3. Recognize batch reactor

4. Evaluate the efficiency of distillation
5. Analyze the process of filtration and absorption
6. Comprehend the uses of valves in flow measuring devices

List of Experiments:

1. Engineering Letters, Lines and numbers.
2. Basics of various unit operation symbols
3. Design of Pharmaceutical Industry Plant layout
4. Design of Chemical Industry Plant layout
5. Design of Shell and tube heat exchanger
6. Design of Single effect evaporator
7. Design of Batch reactor
8. Design of Airlift Fermentor
9. Design of Fractional distillation column
10. Design of Rotary drum filter
11. Design of Absorption column
12. Design of Venturi meter

Reference Books:

1. Donald Q.Kern, "ProcessHeatTransfer",TataMcGrawHill, New Delhi, 2007.
2. Mccabe, W. L.,Smith, J. C., and Harriott,P., "Unit Operations of Chemical Engineering", McGraw Hill,NewYork,6thEdition,2004

20BT3007	GENETIC ENGINEERING LAB	L	T	P	C
		0	0	4	2

Co-requisite: Lab in Molecular Biology

Course Objectives:

To impart knowledge on

1. The basic laboratory techniques employed in a genetic engineering Lab
2. The extraction and analysis of nucleic acids and proteins.
3. Genetic manipulation of Nucleic acids for protein production.

Course Outcomes:

After completing the course the students will be able to

1. Isolate nucleic acids
2. Perform electrophoresis of nucleic acids and proteins.
3. Experiment the DNA manipulation and transformation techniques.
4. Evaluate RNA expression by reverse transcription
5. Analyze nucleic acid amplifications using PCR
6. Express, purify and analyze recombinant protein

List of Experiments:

1. Isolation of plasmid DNA and restriction digestion to estimate molecular weight by Agarose Gel electrophoresis
2. Isolation of total RNA from E.coli
3. Isolation of total RNA from mammalian cells
4. Isolation of mRNA from mammalian cells using poly T beads.
5. Reverse Transcriptase PCR of target gene & Agarose Gel electrophoresis to estimate molecular weight.
6. RE digestion of the PCR product & cloning the digested PCR product into E.coli Expression vector by ligation
7. Preparation of competent E.coli and transformation of the cloned plasmid and selection of recombinant clones.
8. Induction of expression using IPTG and extraction of expressed protein.

9. Analysis of expressed protein using SDS-PAGE.
10. Midi scale expression of target protein
11. Extraction and purification of target protein using affinity beads/column.
12. Western blotting analysis for confirmation of purity and quality of expressed protein

Reference Book:

1. Michael R. Green, Joseph Sambrook, Molecular Cloning: A Laboratory Manual (Fourth Edition), 2012

20BT3008	**ENZYME TECHNOLOGY AND INDUSTRIAL APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To understand the mechanism of biocatalyst
2. To learn the kinetics of enzymatic reaction
3. To learn about applications of enzymes

Course Outcomes:

The students will be able to

1. Understand the concept of kinetics of immobilization
2. Understand molecular understanding of enzymes
3. Apply enzymes in sterospecific reactions
4. Evaluate application of enzymes
5. Analyze commercial production of enzyme
6. Create inhibition kinetics of the enzymatic reactions

Module 1: Introduction to enzymes (7 hours)

Brief history of enzyme engineering, quantification of enzyme activity and specific activity, Enzyme in action & specificity, Enzyme stability, monomer & oligomeric enzymes. Structure of enzymes-ray crystallography of enzymes, control of Enzyme activity

Module 2: Enzyme kinetics &modeling of enzymatic systems (7 hours)

Kinetics of multisubstrate enzyme catalyzed reaction, relation of kinetic parameters, microenvironmetal effects on enzyme kinetics, Enzyme Inhibition – Substrate, Product and Toxic compound inhibition, types and derivation. Enzyme deactivation kinetics. Allosteric regulation of enzymes, Monod changeuxwyman model

Module 3: Immobilized enzymes (7 hours)

Introduction, kinetics of immobilized enzymes, Analysis of film and Pore diffusion, Reactor systems and Engineering considerations

Module 4: Industrial enzymes (9 hours)

Few industrial nzymes like glucose-isomerase, cellulases, Pectinases, protease etc. Their importance, source production, optimization of fermentation medium, assay, extraction and purification, Characterization, genetic manipulation etc. Applications of enzymes in analysis; Design of enzyme electrodes

Module 5: Molecular Understanding of Enzymes (7 hours)

Enzyme catalysis- mechanism of enzyme activity, enzyme dynamics and flexibility; specificity of enzymes-substrate specificity, enantioselectivity of enzymes; thermodynamics and stability

Module 6: Enzyme in Organic Synthesis (8 hours)

Enzymes like DHAP aldolase, pyruvate aldolase, tyrosine kinase & their uses, Uses of mutagenesis to increase substrate specificity. Producing catalytic antibodies.

Text Books:

1. Palmer, T., & Bonner, P. L. *Enzymes: biochemistry, biotechnology, clinical chemistry*. Elsevier, 2007
2. Punekar, N. S. *Enzymes*. Springer, 2018

Reference Books:

1. Guisan, J. M. (Ed.). *Immobilization of enzymes and cells* (Vol. 22). Totowa, NJ: Humana Press, 2006
2. Price and Lewis Stevens. Fundamentals of Enzymology, Oxford, United Kingdom, 2000
3. Yoo, Y. J., Feng, Y., Kim, Y. H., &Yagonia, C. F. J. *Fundamentals of enzyme engineering*. Springer, 2017
4. Liu, S. *Bioprocess engineering: kinetics, sustainability, and reactor design*. Elsevier, 2020

20BT3009	MICROBIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study the role of microorganisms in medicine, agriculture, and the environment.
2. To impart knowledge concerning genomics and proteomics in biotechnology
3. To develop value added microbial based products for commercialization

Course Outcomes:

The students will be able to

1. Gain knowledge about recent advances in microbial biotechnology
2. Apply the concept of genomics and proteomics in biotechnology with regard to microorganisms
3. Acquire practical exposure to recombinant DNA technology in microbes to enhance animal health and production
4. Demonstrate and evaluate the interactions between microbes, hosts and environment.
5. Give an account of important microbial/enzymatic industrial processes in food and fuel industry.
6. Critically analyze any microbial products from an economics/market point of view

Module 1: Introduction to microbial technology (5 Hours)

Microbial technology in human welfare; Isolation and screening of microbes important for industry – advances in methodology and its application; Strain improvement to increase yield of selected molecules, e.g., antibiotics, enzymes, biofuels

Module 2: Microbial Genomics (9 Hours)

Introduction to Microbial genomes -Genome sequencing of different microbes; Microbial genomics for discovery of novel enzymes, drugs/ antibiotics-Multi Drug Resistance, Metagenomics and metatranscriptomics – their potential, methods to study and applications/use (animal and plant health, environmental clean-up, global nutrient cycles & global sustainability), Phylogenetic relationships between various genera of microbes; Global metagenomics initiative - surveys/projects and outcome

Module 3: Microbial Proteomics (8 Hours)

Introduction to microbial proteomics, 2D gel profiling, MALDI – ToF, Protein purification work station of various microbes, Microbial pathogenesis at the proteome level, Structural proteomics and computational analysis, Proteome research for novel drug targets, High throughput proteomic screening for novel enzymes

Module 4: Microbial interactions (6 Hours)

Interactions of microorganisms with plants, animals and humans- The gut microbiota; Bacteriophages in control of bacteria, Thermal adaptation of decomposer communities to global warming, Gene manipulation of useful microbes, Microbial communication system- Quorum sensing

Module 5: Microbes in food and agriculture (9 Hours)

Food processing and food preservation- Temperature, Food additives, Irradiation, Food Borne Intoxications- Clostridium botulinum, Staphylococcus aureus, Listeria monocytogenes, Mycotoxins, Production of bacteriocins from lactic acid bacteria and their applications in food industry; Non-recombinant ways of introducing desirable properties in Generally recognized as safe (GRAS) microbes to be used in food (e.g., Yeast); Bioinsecticides, biofertilizers, Mycorrhiza

Module 6: Production of Microbial Metabolites (8 Hours)

Production, recovery, stability and formulation of bacterial and fungal enzymes-penicillin acylase, glucose isomerase and Cell based biotransformations of steroids, antibiotics, alkaloids, enzyme/cell electrodes; Microbial fuel cells; Prebiotics and Probiotics; Microbiologically produced food colours and flavours;

Biofuel production from microalgae, Production of recombinant bacterial/ viral vaccines against important animal diseases

Textbooks:

1. Ian Humphery-Smith and Michael Hecker, Microbial Proteomics: Functional Biology of Whole Organisms by Publisher: Wiley-Interscience; 1st edition, 2010.
2. Thomas J. Dougherty and Steven J. Projan, Microbial Genomics and Drug Discovery by Publisher: CRC; 1st ed. 2013.
3. Stanbury, P. F., Whitaker and Hall, A. S. J., Principles of Fermentation Technology. Butterworth-Heinemann, 2009.

Reference Books:

1. Shuler, M.L. and Karg, I F., Bioprocess Engineering Basic Concepts, 2010.
2. Crueger W. and Crueger, A., Biotechnology. A Textbook of Industrial Microbiology, Sinauer Associates, 2008.
3. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.
4. Glazer AN, Nikaido H. 2007. Microbial Biotechnology: Fundamentals of Applied Microbiology. Cambridge University Press
5. Lin YK, Microbial Biotechnology: Principles and Applications. 3rd Ed. World Scientific

20BT3010	AGRICULTURE AND FOOD BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To enhance knowledge on principles of Agriculture and plant breeding
2. To analyze the biotechnology processing of food and packaging
3. To elaborate the understanding of marketing of agricultural produce.

Course Outcomes:

The students will be able to

1. Acquire knowledge on basics of biotechnology in Agriculture
2. Outline the applications of microbes in Agriculture
3. Understand the concept of industrial Biotechnology processes
4. Relate the technological applications in food processing
5. Evaluate the advances in Food processing and Packaging
6. Analyze Marketing and Export of Food Products

Module 1: Agriculture Biotechnology (8 Hours)

Plant derived Biotechnological Products, Plant tissue culture and Genetic engineering, integrated pest and nutrient management, poly house technology, Scenario of Biotech industries & Institutes, Concepts of Biotech Park. Entrepreneurship biotechnology

Module 2: Microbes in Agriculture (7 Hours)

Microbes of agricultural importance, Microbe based biofertilizers, Soil microbes and plant growth substances, biocontrol agents, Induced systemic resistance (ISR), Plant growth promoting rhizobacteria (PGPR)

Module 3: Industrial Perspectives (7 Hours)

Screening of microorganisms for new products. Fermentation process development. Shake flask, Scale up of process and bioreactors. Genetically engineered microbes (GEMs). Production of secondary metabolites. Process and types of bioreactors. Various methods of fermentation.

Module 4: Technological Applications in Food Processing (8 Hours)

Recent trends in food processing. Techniques and applications of immobilized enzymes in food industry. Single cell proteins for human food consumption. Biotechnology for natural and artificial flavor and fragrance production. Safety issues related processed foods, bio-preservation/ Natural preservation.
Aseptic packaging/ vaccum packaging, biodegradable plastics, extrusion cooking.

Module 5: Food processing and Packaging (8 Hours)

Scope and importance of food processing. National and international perspectives. Principles and methods of food preservation, Storage of food, Packaging operations, shelf life of packaged foodstuff, methods to extend shelf-life, Food packages and containers

Module 6: Marketing and Export of Food Products (7 Hours)

Food spoilage causes and prevention, Food borne infections and intoxication, immobilization of microbial and cultured plant cells. External trade in Agricultural products, Present status, policy and prospects under WTO regime. Quality parameters and quarantine procedures of export

Text Books:

1. Chawla H S, Introduction to Plant Biotechnology, 3Ed Oxford & IBH Publishing 2020
2. AkhilMathur, Food processing packaging by Anmol publisher (2012)
3. Acharya S.S., Agricultural marketing in India by Oxford & IBH publishing; 6th revised edition edition (2019)
4. William C. Frazier, Dennis C. Westhoff, N.M. Vanitha, Food Microbiology by. McGraw Hill Education; Fifth edition (2017)

Reference Books:

1. Megh R. Goyal, Hafiz AnsarRasul Suleria, Shanmugam Kirubanandan, Technological Processes for Marine Foods, From Water to Fork: Bioactive Compounds, Industrial Applications, and Genomics (Innovations in Agricultural & Biological Engineering) by Apple Academic Press; 1 edition (25 June 2019)
2. Byong H. Lee, Fundamentals of Food Biotechnology (2015).
3. Jeyabalan Sangeetha, DevarajanThangadurai, SomboonTanasupawat, PradnyaPralhadKanekar,Biotechnology of Microorganisms: Diversity, Improvement, and Application of Microbes for Food Processing, Healthcare, Environmental Safety, and Agriculture by Apple Academic Press; 1 edition (2019).
4. Philip E. Nelson, Principles of Aseptic Processing and Packaging, Purdue University Press, (2010)

20BT3011	BIG DATA ANALYTICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. Fundamental concepts and methods of Big data analysis.
2. Data exploration, visualization and statistical analysis for given data set.
3. Managing big data analytics for Biological data set.

Course Outcomes:

The students will be able to

1. Know various types of big data platform and cloud computing model.
2. Understand the fundamentals of big data technologies
3. Apply the big data tools and software in handling the biological data.
4. Evaluate variety of big data analytics tools.
5. Explore use of R platform for biological big data analysis.
6. Design and develop Biological models based on big data techniques.

Module 1: Introduction (8 Hours)

Big data analytics overview, Data life cycle, Traditional Data mining Life cycle, CRISP, Big Data life cycle methodologies

Module 2: Data Exploration and Visualization (7 Hours)

Problem Definition, Data Collection, Data Pre-processing, Data Cleaning – Homogenization, Heterogenization, Summarizing data, Data Exploration and Visualization.

Module 3: Big Data Methods **(9 Hours)**
Introduction to R programming, Data Frames, Atomic vectors, Factors, Data types, Variables, Functions, working with excel files, Data interface.

Module 4: Charts & Graphs **(6 Hours)**
Develop pie chart, 3D pie chart, Histograms, Bar chart, Group bar chart, Stacked Bar chart, Line graph, Multiline graph and Box plot.

Module 5: Statistical Methods **(9 Hours)**
Regression models, Linear Regression, Multiple regression, Logistic regression, Mean, Median, Mode, Chi-Square test, T-Test.

Module 6: Big data analytics for Health care **(6 Hours)**
Big data analytics in bioinformatics, Health care, Data mining using RNA seq data, Text mining on complex biomedical literature, Biological sequence motifs and patterns.

Text Books:

1. VenkatAnkam, “Big Data analytics”, Packt publishing 2016
2. Parag Kulkarni, ng JoshiSara, “PHI learning 2016 ,”Big Data analytics
3. Wang, Baoying, Big Data Analytics in Bioinformatics and Healthcare, IGI global edition, 2014

Reference Books:

1. Mark Gardener. Beginning R: The Statistical Programming Language. John Wiley & Sons, 2012.
2. Avril Coghlan, A Little Book of R For Bioinformatics, Release 0.1, 2017
3. Robert Gentleman, R Programming for Bioinformatics, CRC press, Taylor & Francis,2008

		L	T	P	C
20BT3012	**BIOETHICS AND BIOSAFETY**	**3**	**0**	**0**	**3**

Course Objectives:

1. To Understand Biosafety regulations and IPR
2. To discuss environmental containments of GMO and ethics of stem cell research
3. To appraise ethical issue of transgenics in plant, animal and microorganisms

Course Outcomes:
The students will be able to

1. Recall different rDNA technology of transgenic in animals, humans and plants
2. Understand the various biosafety regulations in transgenics
3. Illustrate IPR and patent procedures
4. Comprehend on various techniques of genome, stem cells and organ research in humans
5. Aware of modern rDNA research and its ethical procedures
6. Comprehend on recent ethical, legal and social economic impacts of rDNA research in biotechnology and its applications

Module 1: Legal Impacts of Biotechnology - Biosafety Regulations and Bioethics (7 hrs)
National and International Level Biosafety Regulations, Trials On-field, Upscaling of Field Trials, Coordination and Capacity Establishment, Screen–A Newsletter on Biosafety, Hazardous Materials Used in Biotechnology—Handling and Disposal, Good Manufacturing Practices, Good Laboratory Practices, Good Laboratory Practice Principles. Bioethics: Introduction to ethics and bioethics, framework for ethical decision making. Ethical, legal and socioeconomic aspects of gene therapy.

Module 2: Intellectual Property Rights (9 hrs)
Introduction to IPR, Types of IP - Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications, Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; Procedure for filing a PCT application, Patenting and the Procedures Involved in the Application for Grading of a Patent, Steps to a Patent, Examples of Patents in Biotechnology

Module 3: Environmental containments of GMO and Farmers rights (9 hrs)
The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance. Key to the environmentally responsible use of biotechnology. Environmental aspects of biotech applications. Use of genetically modified organisms and their release in environment. Discussions on recombinant organisms and transgenic crops, with case studies of relevance. Plant breeder's rights. Legal implications, Biodiversity and farmers rights. Ethical implications of GM crops and GMO's.
Module 4: Stem Cell Research (8hrs)
Introduction**,** Applications of Stem Cells, Ethics Involved in Stem-cell Research, Use of Cell-cultures as Alternatives to Use of Animals, Replacement, Use of Animals for Research and Testing, Animal Cloning, Ethics and Animal Cloning, Human Cloning, Why Cloning Humans is Ethically Unacceptable?, Controlling Someone Else's Genetic Makeup, Instrumentality, Infertility–An Exception to Instrumentality.
Module 5: Organs Transplantation in Human Beings (8 hrs)
Organs Transplantation in Human Beings, Ethics in Xenotransplantation, Bioethical Issues, Transgenesis, Informed Consent, Allocation of Health Care Resources, Patentability and Xenotransplantation, Organ Culture, Ethical Issues.
Module 6: Transgenic guidelines (5 hrs)
DBT - rDNA guidelines and regulatory affairs for transgenics- plants, animals and microorganisms
Text Book:

1. Sree Krishna. Bioethics and Biosafety in Biotechnology. New Age International Publishers, New Delhi, 2007

.**Reference Books:**

1. Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).
2. Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons Inc. (2005).

		L	T	P	C
20BT3013	**CHEMICAL PROCESS TECHNOLOGY**	**3**	**0**	**0**	**3**

Course objectives:

1. To address designing new process and product development.
2. To understand the processes technologies of various organic and inorganic process industries for manufacturing chemicals.
3. To associated troubleshoot.

Course Outcomes:
The students will be able to

1. Remember the process flow diagram for various chemical process
2. Understand the steps in manufacturing process of organic and inorganic chemicals
3. Classify various chemical, agrochemical and fermentation products
4. Illustrate the process flow diagram of carbohydrates, oils, fats etc.
5. Analyze various chemical process to solve engineering problems during production
6. Evaluate major engineering problems and in order to provide technological solutions in chemical process industries.

Module 1:Process Flow Diagram (8 hrs)
Basic philosophy of a process flow diagram (PFD). Elements of a PFD. General discussion on Influence of various parameters on deciding process for a product and method of drawing PFD. Nitric acid, sulphuric acid, phosphoric acid and urea
Module 2: Industrial Production (8 hrs)
Caustic chlorine industry - membrane and diaphragm cells. Hydrochloric acid and important chlorine compounds sodium bicarbonate, cement , Glass & ceramic industries

Module 3: Oils and Fats (7 hrs)
Process description and flowsheet of extracting vegetable oils. Hydrogenation of oils, major engineering problems and recent technology.
Module 4: Sugar Derivatives (8 hrs)
Manufacturing process with flow diagram for Sugar and starch industries and their different by-products; Glucose, Pulp and paper Industries
Module 5: Fermentation Products (7 hrs)
Fermentation industries: Industrial Alcohol, Absolute Alcohol; their production process with flow diagram.
Module 6: Agrochemical Industries (7 hrs)
Elementary ideas on Pesticides, Insecticides, Fungicides, Herbicides, DDT manufacturing process with flow sheet.
Text Book:

1. Dryden, C. E., and Rao, M.G. (Ed.), Outlines of Chemical Technology Affiliated East West Press.2010

Reference Books:

1. Austins, G.T., Sherve's Chemical Process Industries, MGH,2012.
2. Venkateswarlu, S. (Ed.) Chemtech (II) Chemical Engineering Development Centre, IIT, Madras, 2009.
3. Ghoshal, S. K. Sanyal and S. Datta, Introduction to Chemical Engineering, Tata McGraw Hill, New Delhi, 2010.
4. Kirk &Othmer (Ed.), Encyclopedia of Chemical Technology, 2011.

20BT3014	IMMUNOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:
1. Aims to impart basic knowledge in Immunology,
2. To help the students familiarize with the organs and cells of the immune system, the immune response and molecular interactions involved in immune response.
3. To make the students aware of the applications of immunology such as, immunodiagonosis and immunotherapy.

Course Outcomes:
The students will be able to
1. Account for the structure and function of the immune system both at the molecular and cellular level.
2. Account for polyclonal, monoclonal and humanized antibodies and production of these.
3. Describe immunization/vaccination, immunological disease and immunotherapy.
4. Plan, carry out and present achieved results of immunological serum analyses by means of different immunotechniques.
5. Discuss immunological techniques and on the instrumentation involved.
6. Implement various immnotechniques in immunology related applications.

Module 1:Immune System(9)
Introduction and an overview of immunology, History of immunology, Types of Immunity - Innate and acquired immunity, Cell mediated and humoral immunity; Organs of the immune system: Lymphoid organs - primary and secondary.
Module 2:Immune Response(9)
Granulocytes and Agranulocytes, haematopoiesis, extravasation, phagocytosis. T and B Lymphocytes & NK cells. Major histocompatibility complex; antigen processing and presentation, T-Cell activation and the cellular immune response.

Module 3:Antigen Antibody Reactions(9)
Antigens- chemical and their molecular nature; Haptens; Adjuvants. Antibody – structure, Classes, Genes and Antibody diversity. Antigen Antibody reactions; Neutralization, Opsonization. Complement, Cytokines. Vaccines.
Module 4: Autoimmunity, Hypersensitivity(4)
Tolerance and Autoimmunity, Types and mechanism of autoimmune diseases, Hypersensitive reactions, Primary and secondary immunodeficiency, AIDS
Module 5:New Generation Antibodies (5)
New Generation Antibodies; Multigene organization of immunoglobulin genes, Ab diversity; Chimeric antibodies, Antibody engineering; Phage display libraries; Antibodies as in vitro and in vivo probes. Large scale manufacture of antibodies for immunodiagnostics.
Module 6:Immunotechniques (9)
Diagnostics; immunodiffusion, Haemagglutination, ELISPOT assay, immunofluorescence, Surface plasmon resonance, flow cytometry and immunoelectron microscopy. PCR based technology for Antibody generation, Plamsa based therapy, Monoclonal Antibody production, Vaccine development and case studies on Immuno compromising and treatment.
Text Book
1. Roitt I, Male, Brostoff, "Immunology", Mosby Publishers, 2002.

Reference Books:
1. Tizard, "Immunology", Saunders college publication, 5th Edition. 2004.
2. Kuby J, "Immunology", WH Freeman & Co., 2000.
3. Ashim K. Chakravarthy, "Immunology", TataMcGraw-Hill, 2001

		L	T	P	C
20BT3015	**COMPUTATIONAL BIOLOGY**	**3**	**0**	**0**	**3**

Course Objectives:
1. To understand the fundamental concepts, tools and resources in Computational Biology.
2. To improve knowledge on machine learning and data mining concepts and techniques relevant to biological data along with practical implementation of machine learning techniques.
3. To facilitate the specialized areas related to Computational Biology which will enable high throughput data processing and analysis.

Course Outcomes:
The students will be able to
1. Understand the principles of, biological data and interpretation.
2. Demonstrate high throughput biological data and perform statistical analysis.
3. Make use of advanced data mining and machine learning techniques
4. Create skills on molecular modeling and simulation, whole cell modeling, drug discovery, and Systems Biology
5. Clarify the implementation of algorithms which may help them design their own.
6. Explain the theory and practical aspects of important computational experimental techniques.

Module 1: Biomolecular Computing (10 Hours)
DNA Structure, and Processing , Computational operations and Step involve in DNA computing, Bio-soft Computing Based on DNA Length, Beginnings of Molecular ComputingAdelman Experiment. RNA secondary structure prediction: Base pair maximisation and the Nussinov folding algorithm, Energy minimisation and the Zuker folding algorithm, Design of covariance models, Application of RNA fold.
Module 2: MolecularMechanics:**(7 Hours)**
Introduction, The Morse Potential, The Harmonic Oscillator Model for Molecules, Comparison of Morse and Harmonic Potential, Two atoms connected by a bond, Poly atomic Molecules, Energy due to Stretch, Bend, Stretch-Bend, Torsional strain, van der Waals and Dipole-Diploe interactions. Types of Potentials:

Lennard-Jones, Truncated Lennard-jones. Types of Force Fields: AMBER, CHARMM, Merck Molecular Force Field, Consistent Force Field, MM2, MM3 and MM4 force fields.

Module 3: Molecular Dynamics Simulation (7 Hours)

Introduction, Radial distribution functions, Pair Correlation function, Newtonian dynamics, Integrators-Leapfrog and Verlet algorithm, Potential truncation and shifted-force potentials, Implicit and explicit Solvation models, Periodic boundary conditions, Temperature and pressure control in molecular dynamics simulations.

Module 4: Next generation sequencing (7 Hours)

NGS Platforms: Introduction to NGS, Roche/454 FLX, Illumina/Solexa Genome Analyzer, Applied Biosystems SOLiD system, HelicosHeliscope, Pacific Biosciences/single molecule real time (SMRT) sequencing. Biological applications of NGS: Whole-genome sequencing, Exome sequencing, Transcriptome sequencing, Epigenome sequencing, Interactome sequencing, methylome sequencing.

Module 5: Data Mining and Data warehousing (7 Hours)

Need for data warehouse, definition, goals of data warehouse, Data Mart, Data warehouse architecture, extract and load process, clean and transform data, Designing fact tables, partitioning, Data warehouse and OLAP technology. Importance of Data Mining, Relational Databases, Data Warehouses, Transactional Databases, Advance Database Systems and Applications, Data Mining Functionalities, Classification of Data Mining Systems, Major issues in Data Mining.

Module 6: Systems Biology and protein network analysis (7 Hours)

Systems Biology Networks- basics of computer networks, Biological uses and Integration. Basic properties of Network: Degree, average degree and degree distribution. Adjacency matrix, weighted and unweighted networks, Bipartite network, Paths and distances. Metabolic reconstruction, Application.

Text Books:

1. Neil C. Jones, Pavel Pevzner. An introduction to bioinformatics algorithms MIT Press ,(2011)
2. Alan Hinchliffe, Molecular Modelling for Beginners, (2nd Edition) John Wiley & Sons Ltd. (2008)
3. Stuart M. Brown, Next-generation DNA sequencing Informatics, Cold Spring Harbor Laboratory, (2013).

Reference Books:

1. Andrew R. Leach, Molecular Modeling Principles and Applications, Second Edition, Prentice Hall. (2001)
2. Jonathan Pevsner. Bioinformatics and Functional Genomics, 2nd Edition. John Wiley & Sons Inc (2015)
3. Kriete A. Kriete, R.Eils,, R.Eils, Computational systems biology, Academic Press. (2005)
4. Pengcheng Fu, Systems Biology and Synthetic Biology Sven Panke, Wiley InterScience. (2009)
5. Greg Gibson and Spencer V. Muse. A Primer of Genome Science, Third Edition. Sinauer Associates, Inc; (2009)

20BT3016	METABOLIC REGULATION AND ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. Impart skills to amend the existing metabolic pathways through metabolic engineering and synthetic biology
2. Enable the students to use molecular techniques to enhance the yield of industrially important product
3. Understand the quantitative basis of metabolic networks

Course Outcomes:

The students will be able to

1. Identify the appropriate metabolic pathways to produce a desired product
2. Characterize the metabolic pathways and propose relevant metabolic engineering strategies to enhance an economically viable products

3. Construct metabolic flux models using available tools
4. Design 13C-labeling strategies and perform metabolic flux analysis to determine metabolic pathway
5. Construct a mathematical representation of a metabolic network, and calculate the internal fluxes based on external measurements.
6. Adapt suitable synthetic biology tools to build and design new pathways, cells and systems

Module 1: Metabolic Pathways and integrated database (6 Hours)

Metabolic pathways database, KEGG, Roche Biochemical Pathways, Pathway of Cellular respirations, Glycolysis, Krebs Cycle, Fermentative Pathways, Metabolism of Proteins and Lipids, Stoichiometry of cellular reactions, reaction rate and flux, dynamic mass balance

Module 2: Regulation of Metabolic Pathways (5 Hours)

Feedback control systems, alteration of feedback regulation for enhanced production of primary metabolites, Regulation of enzyme concentration-lac operon- Metabolic networks-branch point classification

Module 3: Metabolic Flux and Control Analysis (12 Hours)

Flux Analysis basics, Dynamic steady state, Estimation of intracellular metabolic flux, Determined, over determined and under determined system, use of linear programming; Isotopic substrate composition, 13C MFA experimentation, Detection of 13C labelling patterns, Construction of a metabolic model for 13C flux analysis; Coefficients of control analysis, elasticity coefficient, Flux control coefficients, Summation theorem, FC connectivity theorems

Module 4: Synthesis and Engineering Tools in Synthetic Biology (9 hours)

Introduction to Synthetic Biology- New Tools for Cost-Effective DNA Synthesis- Oligonucleotide Synthesis- microarray oligonucleotide synthesis, Microfluidic and fluidic systems; Quality Control-hybridization selection; 'BioBricks: a standard for physical DNA composition; Protein Engineering Methods- Site directed diversification, Screening and selection, high throughput screening in microtitre plates

Module 5: Pathway Engineering as Enabling Synthetic Biology Tool (7 hours)

Introduction-Design and construction of pathways- Pathway design tools; Pathway optimization-strategies for optimizing a metabolic pathway based on gene expression, strategies for optimizing a metabolic pathway based on protein level Ex *E.coli* (*Molecular Systems Biology 7; Article number 515; doi:10.1038/msb.2011.46)

Module 6: Applications of Metabolic Engineering and Synthetic Biology (6 Hours)

Product over-production examples: polyhydroxyalkanoic acids, Extension of substrate utilization range for organisms such as S. cerevisae and Z. mobilis for ethanol production, metabolic engineering of Enterobacter aerogenes; metabolic engineering of microalgae for biofuel production

Textbooks:

1. Christina Smolke*ed.*, The Metabolic Pathway Engineering Handbook: Fundamentals, CRC Press, 2009.
2. Gregory N. Stephanopoulos, Aristos A. Aristidou & Jens Nielsen, “Metabolic Engineering: Principles and Methodologies”, Academic Press, An Imprint of Elsevier India Pvt.Ltd., 1st edition, 1998.

Reference Books:

1. S. Cortassa, M.A.Aon, A.A.Iglesias and D.Llyod, “An Introduction to Metabolic and Cellular Engineering”, 2nd Edition, World Scientific Publishing Co. Pte. Ltd, 2012.
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, “Principles of Fermentation Technology”, Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005
3. Eva-Kathrin Ehmoser-Sinner, Cherng-Wen Darren Tan Lessons on Synthetic Bioarchitectures: Interaction of Living Matter with synthetic structural analogues, Springer International Publishing, 2018

20BT3017	CLINICAL TRIALS AND BIOETHICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To Explain key concepts in the design of clinical trials
2. To identify key issues in data management for clinical trials.
3. To describe the roles of Regulatory Affairs in clinical trials.

Course Outcomes:

The students will be able to

1. Understands the principles and methodology of clinical trials
2. Comprehend the theory and practical aspects of important techniques
3. Develop analytical skills and expertise to formulate and implement a research oriented real time problem.
4. Asses in major high throughput statistical methods in clinical research.
5. Evaluate experimental component to undertake interdisciplinary work.
6. Equips skills to pursue a career either in academia or industry.

Module 1: Introduction to Drug Discovery and Development (9 Hours)

Origin and History of Clinical Research, Introduction to Drug Discovery and drug Development, Clinical Trials in India–The National Perspective, Clinical Trial Phase I, Clinical Trial Phase II, Clinical Trial Phase III, Clinical Trial Phase IV –methods, Principles of sampling -Inclusion and exclusion criteria, Methods of allocation and randomization, Termination of trial.

Module 2: Ethical Regulation (8 Hours)

Historical guidelines in Clinical Research -Nuremberg code, Declaration of Helsinki, Belmont report, Research ethics and Bioethics –Principles of research ethics; ethical issues in clinical trials; Use of humans in Scientific Experiments; the informed consent; Introduction to ethical codes and conduct; Introduction to animal ethics; Animal rights and use of animals in the advancement of medical technology

Module 3: Regulation in clinical research (7 Hours)

International Conference on Harmonization (ICH) Brief history of ICH, Structure of ICH, ICH Harmonization Process, Responsibilities of Stakeholders: Sponsors, Investigators, CROs, Monitors, Institutional ethics committee

Module 4: Clinical trial important documentation (7 Hours)

Essential Documents in Clinical Trials: SOP, Clinical Trial Protocol and 95Protocol Amendment(S), Investigator Brochure, Master Files, Informed Consent Forms, Consort statement, Case Record Form

Module 5: Clinical trial data management (8 Hours)

Project management in clinical trials -principles of project management; Application in clinical trial management; Risk assessment Pharmacovigilance, Project Auditing, Inspection.

Module 6: Clinical data monitoring (7 Hours)

CRF Review & Source Data Verification, Drug Safety Reporting, Drug Accountability Work, Routine Site Monitoring, Site Close Out Visit.

Case study in recent epidemics-clinical trials.

Text Books:

1. Lee, Chi -Jen; etal.,“Clinical Trials or Drugs and Biopharmaceuticals.” CRC / Taylor &Francis, (2011)
2. Matoren, Gary M. “The Clinical Research Process in the Pharmaceutical Industry” Marcel Dekker, (2001).
3. Spriet A., Dupin-Spriet T., Simon P. Methodology of Clinical Drug Trials, 2ndEdition. Publisher: Karger. (1997)

Reference Books:

1. Shein-Chung Chow, Jen-Pei Liu.Design and Analysis of Clinical Trials: Concepts and Methodologies, 3rd Edition. Publisher: Wiley. (2014)

2. Lionel D. Edwards, Anthony W. Fox, Peter D. Stonier. Principles and Practice of Pharmaceutical Medicine, 3rdEdition. Publisher: Wiley-Blackwell. (2011)
3. Murray Longmore, Ian Wilkinson, Andrew Baldwin, and Elizabeth Wallin.Oxford Handbook of Clinical Medicine, 9th Edition. Oxford Medical Handbooks.(2014)

20BT3018	SUSTAINABLE BIOPROCESS DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on design and operation of fermentation processes with all its prerequisites.
2. To familiar the students with the basics of microbial kinetics and reactor design
3. To develop bioengineering skills for the production of value added product using integrated biochemical processes

Course Outcomes:

The students will be able to

1. Develop growth model based on the microbial characteristics
2. Understand working procedure of bioprocess industries
3. Analyze the diversity and nature of bio-products
4. Evaluate enzyme reaction and its kinetics
5. Understand different configurations of bioreactors
6. Understand the sustainability assessment methods

Module 1: Bioprocess and nature of bio-products (6 Hours)

Microbial diversity, Major products of biological processing, Component parts of fermentation process, Concept of Upstream, downstream processing and scale up

Module 2: Bioreactor Design (8 Hours)

Mixing, Mixing Equipment, Flow pattern, Mechanism of Mixing, Power requirement for mixing, Bioreactor Configurations (Different Bioreactors), Membrane bioreactor

Module 3: Modeling and Simulation of Bioprocesses (9 Hours)

Microbial growth model, Problem Structuring, Process Analysis, and Process Scheme, leudeking-piret models, Models with growth inhibitors, oxygen transfer model, volumetric mass transfer coefficient, Uncertainty Analysis- Sensitivity Analysis, error analysis, Application-cellulase based catalysis process

Module 4: Sustainability Assessment (7 Hours)

Sustainability, Economic Assessment- Capital-Cost Estimation, Operating-Cost Estimation, Profitability Assessment, Environmental Assessment, case study

Module 5: Reactor Operation (8 Hours)

Batch Operation of a Mixed Reactor, Fed-Batch Operation of a Mixed Reactor, Continuous Operation of a Mixed Reactor, Chemostat Operation, Operation of Plug-Flow reactor

Module 6: Advanced Bioprocessing (5 Hours)

Bioprocess Consideration in plant cell cultures, Bioprocess Consideration in animal cell cultures, Industrial Bioprocess, Advanced Membrane bioreactor to facilitate both upstream and downstream processing simultaneously

Text Book:

1. Heinzle E, Biwer AP and Cooney CL, "Development of Sustainable Bioprocesses Modeling and Assessment" 2006 John Wiley & Sons, Ltd

Reference Books:

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2015.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.

3. Pauline M. Doran, Bioprocess Engineering Principles, Elsevier Science & Technology Books, 2nd edition, 1995

20BT3019	ADVANCED ANIMAL BIOTECHNOLOGY AND TISSUE CULTURE	L	T	P	C
		3	0	0	3

Course Objectives:

1. To Provide insights into Animal Biotechnology
2. Impart knowledge in manipulation of embryos and animal breeding
3. To make students understand the significance of trangenesis and its importance in livestock improvement

Course Outcomes:

The students will be able to

1. Define concepts in Animal Biotechnology
2. Describe the importance of Cryopreservation of embryos and embryo sexing in animals
3. Relate and evaluate the genetic defects in animal embryos through molecular diagnosis
4. Experiment the technology used for animal breeding
5. Comprehend the fundamental concepts of mammalian cell and generation of cell line and to demonstrate tissue engineering applications for implantable materials.
6. Design the strategies for livestock improvement through transgenesis with ethical concern.

Module 1: CryopreservationOf Embryos and Artificial Insemination (8 Hrs)

Introduction to Animal Biotechnology, Cryopreservation of Sperms, Ova of livestock, Artificial Insemination, Super Ovulation, In Vitro fertilization, Culture of embryos, Cryopreservation of Embryos, Embryo transfer, Embryo splitting, Embryo sexing,

Module 2: Germplasm Preservation and Genetic Diagnosis (7 Hrs)

In situ and ex situ preservation of germplasm, In utero testing of foetus for genetic defects, Pregnancy diagnostic kits, Gene knock out technology and animal models for human genetic disorders, Mouse model for COVID 19.

Module 3: Transgenic Animals (7 Hrs)

Transgenic manipulation of animal embryos, different applications of transgenic animal technology, Animal cloning from- embryonic cells and adult cells, cloning for conservation of endangered species, anti-fertility animal vaccines, Ethical, social and moral issues related to cloning

Module 4: Live Stock Improvement (8 Hrs)

Genetic characterization of livestock breeds, Marker assisted breeding of livestock, Transgenic animals and application in expression of therapeutic proteins, Detection of meat adulteration using DNA based methods.

Module 5: Cell Culture (8 Hrs)

Application of animal cell culture for *In vitro* testing of drugs, Cytotoxicity and viability assays, Characterization, Cell line preservation and authentication. Scaling up of cell culture - Adherence and suspension type, Cell culture products.

Module 6: Tissue Engineering (7 Hrs)

Tissue Engineering: Biomaterials in tissue engineering and scaffold fabrication, Artificial blood vessel, Artificial pancreas and liver tissue engineering, 3D Culture with different type of cells with examples and protocols. Spheroid culture.

Text Books:

1. R. Ian Freshney. Introduction to Culture *of* Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. *Publisher*, John Wiley & Sons, 2011.
2. John R.W. Masters, Animal cell culture 3rd ed., A Practical Approach Oxford University press New York 2009
3. Birbal Singh, Gorak Mal, Sanjeev K Goutam. Advances in Animal Biotechnology Springer; 1st ed. 2019 edition.

Reference Books:

1. Niemann, Heiner, Wrenzycki, Christine, Animal Biotechnology, Springer Publishing. 2018.
2. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. New Generation Vaccines. 3rd Ed. Informa Healthcare
3. John R.W. Masters, Animal Cell Culture 3rd ed., Oxford University Press, 2009.

20BT3020	MOLECULAR DIAGNOSTICS	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. History and Traditional diagnostics in genetic disease.
2. Principles and performance of DNA and RNA isolation, amplification, hybridization, and analysis.
3. Applications in microbiology, diagnosis, cancer, transplantation, and forensic medicine.

Course Outcomes:

The students will be able to

1. Understand the basic principles of molecular diagnosis
2. Demonstrate the working mechanism of different traditional and molecular diagnostic methods
3. Categorize genetic diseases and metabolic disorders
4. Apply appropriate diagnostic methods for the diagnosis of genetic and molecular diseases
5. Develop a new diagnostic kit for the emerging diseases
6. Adapt ethical guidelines for molecular test results

Module 1: Introduction to Diagnostics (7 Hours)

Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases, Infection – mode of transmission of infections, clinical sample - method of collection, transport and processing of samples and Interpretation.

Module 2: Traditional Diagnostic Methods (8 Hours)

Diagnosis of infections: Bacteria: *Staphylococcus*, *Streptococcus, Mycobacterium E.coli, Salmonella, Shigella, and Vibrio*, Fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. DNA and RNA viruses- Pox viruses, Rhabdo Viruses, Corona Viruses, and Retroviruses. Protozoan diseases: Amoebiasis, Malaria, Leishmaniasis. Helminthic diseases- Ascarislumbricoides, Filariasis- Wuchereriabancrofti.

Module 3: Major Metabolic and genetic disorders (7 Hours)

Traditional methods for the diagnosis, Inborn metabolic errors – Glucose, Lipid, Amino Acid, Protein. Genetics of cancer - chronic myeloid leukemia, colon, breast, and lung cancer. Genetic disorders- Sickle cell anemia, Duchenne muscular Dystrophy, and Cystic Fibrosis**.**

Module 4: Molecular Diagnosis (8 Hours)

Duchenne muscular Dystrophy (Creatine phosphokinase-CPK), PKU (phenylketoneurea) – Amino acid deficiency - Inborn error, G6PD deficiency syndrome (G6PD), PCR diagnosis of Sickle cell anemia, Tuberculosis and COVID-19, Prenatal screening of Cystic Fibrosis. RT-PCR based diagnosis of Cancer, Tumor Metabolome. Biomarkers – PSA and KRAS (Oncogene markers).

Module 5: Hybridization and Sequencing (8 Hours)

Southern, Northern, in-situ- FISH, Western Blot. Principles, Methods and Instrumentation- Advances in DNA sequencing- New Generation sequencing Methods, Pyrosequencing, Personalized Medicine-Pharmacogenomics (ADMET).

Module 6: New Trends in Diagnostics (7 Hours)

Lab on a Chip - DNA chips, Diagnosis of neonatal genetic disorders, human genome project, ethical implications. Different Levels of Biosafety and Containment. Molecular Forensics – DNA profiling RFLP, VNTR, STR and PCR. DNA fingerprinting - The CODIS concept, Ethical and legal issues in genetic counselling.

Text Book:

1. Betty A. Forbes , Daniel F. Sahm, Alice S. Weissfeld, Bailey & Scott's Diagnostic Microbiology (2012), Ernest A. Trevino, Published by C.V. Mosby

Reference Books:

1. David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Fundamentals of Molecular Diagnostics (2010). Saunders Group.
2. Lele Buckingham and Maribeth L. Flaws, Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007).
3. Coleman W.B., Molecular Diagnostics for the Clinical Laboratorian 2Ed. 2006, Humana Press.

20BT3021	DRUG DESIGN AND DISCOVERY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To explore the process of drug development, from target identification to final drug registration.
2. To provide the knowledge in drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening.
3. To develop skills in specialized areas related to bioavailability, clinical trials, and the essentials of patent law

Course Outcomes:

The students will be able to

1. Describe the process of drug discovery and development
2. Discuss the challenges faced in each step of the drug discovery process
3. Classify the computational methods used in drug discovery
4. Oorganize information into a clear report
5. Demonstrate their ability to work in teams and communicate scientific information effectively
6. Construct, review and evaluate preclinical and clinical pharmaceutical studies.

Module 1: Drug and their Interaction (8 Hours)

Introduction to Drugs: Drug nomenclature, Routes of drug administration and dosage forms, Principles of Pharmacokinetics and Pharmacodynamics: ADME, Bioavailability of drugs -Lipinski's rule; how drugs work -Drug targets, drug-target interaction and dose-response
Relationships.

Module 2: Drug design pipeline (8 Hours)

New Drug Discovery & Development: Overview of new drug discovery, development, cost and time lines. Target Identification & Validation. Lead Discovery: Rational and irrational approaches -Drug repurposing, Natural products, High-throughput screening (HTS), Combinatorial chemistry and computer aided drug design (CADD).

Module 3: Fundamental of Drug Actions: (8 Hours)

Inter and intramolecular interactions: Weak interactions in drug molecules; Chirality and drug action; Covalent, ion, ion-dipole, hydrogen bonding, C-H hydrogen bonding, dihydrogen bonding, van der waals interactions and the associated energies. Cation-and-OH interactions. Receptorology: Drug-receptor interactions, receptor theories and drug action; Occupancy theory, rate theory, induced fit theory, macromolecular perturbation theory, activation-aggregation theory. Topological and stereo chemical consideration.

Module 4: Drug toxicity, Assays and testing (7 Hours)

Preclinical Testing of New Drugs: Pharmacology -In vitro/in vivo Pharmacokinetics and Pharmacodynamics testing; Toxicology-Acute, chronic, carcinogenicity and reproductive toxicity testing; Drug formulation testing. Clinical Trial Testing of New Drugs. Good clinical practice (GCP) guidelines -Investigators brochures, Clinical trial protocols and trial design; Ethical issues in clinical trials -How are patient rights protected?

Module 5: Drug Regulatory Agencies (8 Hours)

US Food & Drug Administration (US FDA) and Central Drugs Standard Control Organization (CDSCO), India. Regulatory Applications & New Drug Approval: Investigational new drug (IND) application & New drug application (NDA); Regulatory review and approval process. Regulatory Requirements for Drug Manufacturing: Current Good manufacturing practice (cGMP) and GMP manufacturing facility inspection & approval.

Module 6: Intellectual Property Rights (IPR) (8 Hours)

IPR Definition and implications for discovery & development. Forms of IPR Protection-Copyright, Trademark and Patents. International organization and treaties for IPR protection –World Trade Organization (WTO) & Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreements. Controller General of Patents, Designs & Trade Marks, India (CGPDTM), World Intellectual Property organization (WIPO)-Patent Cooperation Treaty (PCT).

Text Books:

1. Rick NG. Drugs: From discovery to approval 2nd Ed Wiley Blackwell (2009)
2. TripathiKd. Essentials of Medical Pharmacology, 6th Edition, Publisher: Jaypee Brothers (2013)
3. Burger's Medicinal Chemistry and Drug discovery. Volume 2, Wiley-Interscience; Volume 2 edition (2003)

Reference Books:

1. Prankrishna Pal. Intellectual Property Rights In India: General Issues And Implications Publisher: Deep & Deep Publications Pvt.Ltd (2008)
2. Stromgaard, Kristian, PovlKrogsgaard-Larsen, and Ulf Madsen. *Textbook of drug design and discovery*. CRC Press, (2009).
3. Katzung, Bertram G., Susan B. Masters, and Anthony J. Trevor. *Basic and Clinical Pharmacology (LANGE Basic Science)*. McGraw-Hill Education,(2012).
4. Spriet, Alain, et al. *Methodology of clinical drug trials*. Basel: Karger, (2004).

20BT3022	INTRODUCTORY AI IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To Study the concepts of Artificial Intelligence.
1. To learn the methods of solving problems using Artificial Intelligence.
2. To introduce the concepts of Expert Systems and machine learning on various applications.

Course Outcome:

The students will be able to

1. Infer problems that are amenable to solution by AI methods.
2. Demonstrate appropriate AI methods to solve a given problem.
3. Formalise a given problem in the language/framework of different AI method
4. Develop an understanding of Machine learning integration in knowledge inference
5. Acquire knowledge on advanced intelligence computing techniques.
6. Formulate AI based solutions for industrial and healthcare applications.

Module 1: Introduction to al and production systems [9 hours]

Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics -Specialized production system- Problem solving methods – Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing-Depth first and Breath first, Constraints satisfaction – Related algorithms, Measure of performance and analysis of search algorithms.

Module 2 : Representation of knowledge [9 hours]

Game playing – Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge.

Module 3: Knowledge inference [9 hours]

Knowledge representation -Production based system, Frame based system. Inference – Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning – Certainty factors, Bayesian Theory-Bayesian Network-Dempster – Shafer theory.

Module 4: Planning and machine learning [8 hours]

Basic plan generation systems – Strips -Advanced plan generation systems – K strips -Strategic explanations -Why, Why not and how explanations. Learning- Machine learning, adaptive Learning.

Module 5: Expert systems [5 hours]

Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON, Expert systems shells.

Module 6: AI for Health care and Industrial Applications [5 Hours]

Maintaining medical records and other data,doing repetitive jobs,Treatment design,Digital Consultation,Virtual Nurses,Medication Management,Drug Creation,Precision Medicine,Health Monitoring,and Health Care System Analysis. Application of AI in Pharmaceutical industry- Biofuel industry- Food industry- Water technology-Bio fertilizers- Bio control.

Text books:

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", McGraw Hill- 2008.
2. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007.

References:

1. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007.
2. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007.
3. Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 2013.

20BT3023	TRANSPORT PHENOMENA	L	T	P	C
		3	0	0	3

Course Objectives:

1. To give an overview of mass, momentum and energy transport, present the fundamental equations and illustrate how to use them to solve problems.
2. To describe mass, Momentum and energy transport at molecular, microscopic and macroscopic level, to determine velocity, temperature and concentration profiles.
3. The study also focuses on how operations related with fluids and how temperature plays a pivotal role in a drug or a chemical plant.

Course Outcome:

The students will be able to

1. Understand the molecular transport of Momentum, Heat, and mass.
2. Interpret and solve shell momentum, Heat, and mass balances for one dimensional steady state problems.
3. Develop dimensional analysis and knowledge of the dimensional numbers that are important in Momentum, Heat, and mass transfer applications.
4. Analyse inter phase transport problems which involve friction factors, drag coefficients, heat and mass transfer coefficients.
5. Evaluate the problems related with diffusivities and convection.
6. Construct molecule energy related phases in bioengineering.

Module 1: Introduction to Transport Processes (9 Hours)

Basic Mass, Momentum and Energy transport processes; micro and macroscopic views; phenomenological laws; driving forces; transport coefficients. Definition of fluxes; conservation principles; differential elementary volumes and coordinate systems; boundary conditions; dimensionless numbers. Molecular mass transport – Fick's law of binary diffusion; binary gaseous diffusion coefficient – kinetic theory; diffusion in liquids and solids. Effective transport properties (diffusion in suspensions and through a pack of spheres). Steady and transient diffusion processes– examples and application to transport problems.

Module 2: Momentum Transport and Viscous Flows (7 Hours)

Newton's law of viscosity; molecular theory of viscosity of dilute gases and liquids; Couette and falling film flow; Momentum as a flux and as a force – viscous stress tensor; Shell momentum balance and laminar flows – principles; Poiseuille flow; flow in an annulus; creeping flow around a sphere.

Module 3: Macroscopic balances for momentum transport (7 Hours)

Turbulent flows, Reynolds experiment, drag forces; turbulence and eddy flow (similarities with molecular transport) and atmospheric fluxes (eddy covariance method).

Module 4: Energy Transport Heat, Radiation and Phase Change (7 Hours)

Fourier's law of heat conduction; thermal conductivity - molecular and effective; heat flow in one and multi-dimensional geometries; steady-state and transient analytical solutions to Heat conduction; heat flow and convection; nonlinear cooling, macroscopic energy balance. Radiative energy transport– Stefan-Boltzmann law; black body exchange, principles and examples ; radiation through the atmosphere and greenhouse effect.

Phase change and coupled heat and mass transport (falling film, evaporating water drop)

Module 5: Mass Transport in Solid and Laminar I (Film) (6 Hours)

Flow Shell mass balances: boundary conditions, diffusion through a stagnant gas film, diffusion with heterogeneous chemical reaction, diffusion with homogeneous chemical reaction, diffusion into a falling liquid film forced.

Module 6: Mass Transport in Solid and in Laminar-II (Porous Support) (6)

convection mass transfer, diffusion, and chemical reaction inside a porous catalyst: the "effectiveness factor". Analogies between Heat, mass and Momentum and transfer

Text Book

1. Christie John Geankoplis, "Transport Processes and Separation Process Principles", 4th Edition, PHI Learning Private Limited., 2013.
2. Bird R.B., Stewart, W. E. and Lightfoot, E. N., "Transport Phenomena", 2nd Edn.John Wiley and Sons, 2002.
3. Welty, J.R., Wicks, C. E. and Wilson, R. E., "Fundamentals of Momentum, Heat Mass Transfer", 5th Edn., John Wiley and Sons, 2007.

Reference Books

1. Brodkey, R. S. and Hershey, H. C., "Transport Phenomena – A Unified Approach", Brodkey Publishing, 2003.
2. John C Slattery, "Momentum, Energy and Mass transfer in continua", McGraw Hill, Co. (1972).
3. Robert S Brodkey and Harry C Hersing, " Transport Phenomena a Unified approach" McGraw Hill Book Co. (1988).

20BT3024	PHARMACEUTICAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide the student well versed with recent advances in the field of Pharmaceutical Biotechnology.
2. To make foundation for understanding the various events at molecular level, keeping a balance between health and disease.
3. To enabling the student to gain in-depth knowledge in fundamental and applied aspects of Microbiology and Immunology.

Course Outcome:

The students will be able to

1. Understand and evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market.

2. Aanalyze Screening, isolation, characterization and scale-up of Biological products.
3. Understand the legal steps involved in progressing a new drug to market and their science
4. Develop skills in molecular immunotherapeutics and immunotherapy.
5. Expertise in pharmaceutical drug delivery methods and analysis.
6. Gain knowledge in physicochemical properties, pharmacology and the formulation

Module 1: Introduction to Biopharmaceuticals and Biogenerics. (9 Hours)

Introduction to Biopharmaceuticals and pharmaceutical biotechnology, Biopharmaceuticals: current status and future prospects, generic and branded biopharmaceuticals, overview of life history for development of biopharmaceuticals. Discovery of protein or peptide based therapeutics: In-silico, pharmaco-informatics. Pre-clinical toxicity assessment, Clinical trial phases and design, clinical data management, concept of Pharmacovigilance

Module 2: Impact of omics in Drug Discovery (7 Hours)

Pharmacogenetics, Pharmacogenomics and proteomics, structural, functional and comparative genomics, DNA & oligonucleotides microarrays, genetically engineered animals, Integration of personalized and systems medicines, pharmacogenomics in preclinical and clinical development of drugs

Module 3: Pharmacokinetics and Pharmacodynamics of Biopharmaceuticals (7 Hours)

Definition, rationales, absorption, distribution and metabolism pathway. Factors governing absorption of drug. Pharmacokinetics and Pharmacodynamics of therapeutic peptides. Dose response relationship, interspecies scaling, and heterogeneity of therapeutic proteins.Chemical modification of therapeutic proteins

Module 4: Immunotherapeutic & Immunodiagnostics(7 Hours)

Overview of antibody based therapeutics, biologics for autoimmunity and inflammation, vaccine- adjuvant technology, genetically engineered vaccines. Principles of immunodiagnostic assay based on solid phase system: Malarial & HIV diagnostic kits as case study. Fluorescent ligands and radio-isotope tracers, principles and instrumentation for molecular diagnostics (Time resolved fluorescence immunoassay, light scattering principles), PCR and nucleic acid based diagnostics, imaging techniques.

Module 5: Biopharmaceuticals Based Delivery Systems (7 Hours)

Novel drug delivery systems for biopharmaceuticals (rate controlled and site specific), Nanotechnology based miniaturization of biopharmaceuticals and therapeutics, peptides for intracellular targeting, delivery of nucleic acids and therapeutic peptides, concept of responsive or smart drug delivery system.

Module 6: Formulation of Biopharmaceuticals (7 Hours)

Rational for formulation of biotherapeutics, formulation recipients: solubility enhancers, anti aggregating agents, buffers, cryoprotectants, antioxidants and preservatives etc significance with relevant examples. Methods to enhance shelf life protein based therapeutics. Packaging techniques and quality analysis of product

Text Books

1. Gary Walsh (2003) Biopharmaceuticals: Biochemistry and Biotechnology, 2nd Edition, John Wiley & Sons, Inc. 2.Daan J A Crommelin (2010),
2. Pharmaceutical Biotechnology, 2nd Edition, Taylor & Francis Group. 3.Rodney J. Y. Ho (2013)
3. Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, 2ndEdition, John Wiley & Sons, Inc. (2008)

Reference Books

1. Gary Walsh Pharmaceutical Biotechnology: Concepts and Applications. John Wiley & Sons, Inc., (2007).
2. Oliver Kayser, HeribertWarzecha Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, 2nd Edition. John Wiley & Sons, Inc.(2012)

20BT3025	BIOREACTOR ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. Aims to understand the principles and concepts of Bioreactor engineering.
2. To understand structured models of growth and product formation
3. To understand the oxygen transfer parameters to be monitored and controlled in bioreactors

Course Outcomes:

The students will be able to

1. Develop knowledge on various bioreactors.
2. Classify modern biotechnological process in host vector systems.
3. Understand methods to calculate oxygen and mass transfer coefficients in bioreactors.
4. Assess on-line data analysis for measurement of important physico-chemical and biochemical parameters in bioreactors.
5. Analyze structured models for analysis of various bioprocesses.
6. Design of various instrumentation for monitoring and control of bioreactors.

Module 1: Design and Analysis of Bioreactors (7 hrs)

Design and operation of novel bioreactors-Air-lift loop reactors, Fluidized bed-bioreactors, packed bed reactor, Bubble column reactor, stability analysis of bioreactors

Module 2: Bioreactor Scale-Up (7 hrs)

Oxygen mass transfer in bioreactors - microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed, other scale up criteria

Module 3: Monitoring of Bioprocesses (7 hrs)

On-line data analysis for measurement of important physico-chemical and biochemical parameters; State and parameter estimation techniques for biochemical processes.

Module 4: Modern Biotechnological Processes (8 hrs)

Recombinant cell culture processes, guidelines for choosing host-vector systems, plasmid stability in recombinant cell culture, limits to over expression, Modelling of recombinant bacterial cultures; bioreactor strategies for maximizing product formation; Bioprocess design considerations for plant and animal cell cultures

Module 5: Modelling and Simulation of Bioprocesses (8 hrs)

Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

Module 6: Mixing Effectiveness (8 hrs)

Mixing equipment, Types of Impeller based on solution viscosity, Mechanism of Mixing, Assessing Mixing Effectiveness, Power requirement in mixing, Improving mixing efficiency, Sparging, Stirring and Bubble, Parameters to be monitored and controlled during fermentation process.

Text Book:

1. Michael Shuler, FikretKargi, “Bioprocess Engineering Principles”, Second edition, Prentice Hall, 2008.

Reference Books:

1. P.Stanbury, A.Whitaker,SJ Hall “Principles of fermentation technology”, Second edition, ElsvierPergamon Press,2010.
2. Pauline Doran,”Bioprocess Engineering Principles”, Academic Press, 2010.
3. ElmarHeinzle, Arno P.Biwer, “Development of Sustainable Bioprocess: Modelling and Assessment”, Wiley, 2007.
4. Bjorn K.Lyderson, Nancy Ade’lia and Kim Nelson,”Bioprocess engineering *(handcover)”,*Wiley Interscience, 2014.

20BT3026	STEM CELL THERAPEUTICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. The history and future of the emerging field of Stem Cell Therapy
2. The impact of Stem Cell therapy in health care system.
3. The impact of Stem Cell Therapy in Human civilization.

Course Outcome:

The students will be able to

1. Understand the basic concepts in culturing animal and mammalian cells
2. Understand the aspects of cellular ageing
3. Understand the types of Stem cells, their development and function.
4. Learn the various methods to isolate and culture Stem cells
5. Learn the various therapeutic applications of stem cells
6. Appreciate the bigger picture of Stem Cell Technology and their impact of society and civilization.

Module 1: Culturing Cells in the laboratory (5 Hours)

Overview of Stem Cells. Introduction to Cell Culture, Pros & Cons of Cell culture, Primary and Secondary cultures, Aseptic Technique and Cell culture Lab equipments& etiquette

Module 2: Stem cell-Types (5 Hours)

Types of Stems Cells, Embryonic stem cells, Pleuripotent Stem Cells, Adult Stem cells, Induced Pleuripotent Stem Cells, Transit amplifying cells, Symmetry during cell division in Stem cells.

Module 3: Location, Nature & culturing of stem cells (10 Hours)

Stem Cell Niche, Isolation of Stem Cells, & Growth factors, chord cells, Derivation & differentiation of ES Cells, Derivation & differentiation of Pleuripotent Cells

Induced Pluripotent cell-Methods & Genetic & epigenetic reprogramming. Transdifferentiating, FACS

Module 4: Applications of Stem cell Technology (8 Hours)

Application of stem cells in disorders of nervous system, Stem cells of the skin- Wound healing & cosmetics, Application of Stem cells in Cancer, Application of stem cells in autoimmune disorders.

Module 5: Stem cell in tissue engineering & Regenerative medicine (7 Hours)

Scaffolds, types & topology and effect on tissues, Tissue regeneration and angiogenesis Organoids and organ generation, Organ on Chip, Body on Chip

Module 6: Ethical Implications of Stem cell therapeutics. (10 Hours)

Benefits, Problems and perspectives of stem cell therapy. Beginning of human life, legal, scientific, ethical, Religio-spiritual explanations. Treating infertility, multiple parents, Somatic Cell Nuclear Transfer & Human cloning, Extinction prevention, Stem cells and meat production, Alternatives to stem cells. Deeper concerns in stem cell technology- Ageing longevity, Immortality.

Text Book:

1. Robert Lanza, Handbook of Stem Cells edited by Anthony Atala,. (Vol-1) Second edition. Academic press, 2013.

Reference Books:

1. Paul Knoepfler, Stem Cells - An Insider's Guide, 30 July 2013.
2. Robert Lanza and Anthony Atala, Essentials of Stem Cell Biology, Second Edition, Academic Press, 2013.
3. Satish Totey and Kaushik D. Deb, Stem Cell Technologies: Basics and Applications, 16 March 2010.
4. Warburton David, Stem Cells, Tissue Engineering an Regenerative Medicine, 1^{st} Edition, 15 December 2014.

20BT3027	NANOBIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective

1. To introduce the concepts and fundamentals of nanotechnology
2. To understand the synthesis and characterization of nanomaterials and their application in biomedical fields
3. To identify the risk assessments involved nanomaterials in biological application and the impact on environment.

Course Outcome

The students will be able to

1. Understand the basic principles of nanotechnology
2. Understanding the application of various techniques characterization and interpreting the properties of nanomaterials as per required application.
3. Understand and apply the knowledge of nanomaterials and nanobiomaterials to enable health sector advancements.
4. Design devices and systems for various biological applications.
5. Conceptualize the design and development aspects in the domains like NEMS/BIOMEMS
6. Enlighten with comprehensive knowledge of toxicity associated with nanomaterials and Optimize the synthesis for better biocompatibility of Nanomaterials

Module 1 Fundamentals of Nanoscience and Engineering 6 Hrs

History, Types of nanomaterials: Fullerenes, Nanoshells, Quntum dots, Dendrimers, Nanocarriers, Nanofibers, Approaches of Fabrication: TopDown and Bottom-up methods of nanofabrication and Nanosynthesis, Biosynthesis of Nanoparticles, Microbial Nanoparticle production Biomineralization, Magnetosomes. Nanolithography: hard and soft lithography. Characterization of nanomaterials using spectroscopic (UV-Vis, FTIR and Raman) and microscopic methods (SEM, TEM, STM and AFM).

Module 2 Nanobiomaterials 8 Hrs

DNA and Protein based Nano structures. Biomaterial nanocircuitry; Protein based nanocircuitry; Neurons for network formation. DNA nanostructures for mechanics and computing and DNA based computation; DNA based nanomechanical devices. Function and application of DNA based nanostructures. Bionanomaterials in Nature: Lotus leaf as a model self cleansing system. Gecko foot as a case study for biological generation of adhesive forces. Diatoms as an example for silicon biomineralization. Mussel inspired nanofiber for tissue engineering. Biomechanical strength properties of Spider silk

Module3: Micro & Nano Electromechanical systems and Microfluidics 10 Hrs

BioMEMS/BioNEMS: Types of transducers: mechanical, electrical, electronic, magnetic and chemical transducers. Nano sensors: Types: Electronic nose and electronic tongue, magnetic nanosensors. mechanical nanosensors: Cantilever Nanosensors, Microfludics: Laminar flow, Hagen-Peouiselleequation, basic fluid ideas, Special considerations of flow in small channels, micro mixing, microvalves&micropumps, Body on a chip and lab on a chip.

Module 4 :Nanosensors 8 hrs

Nanofabricated devices to separate and interrogate DNA, Interrogation of immune and neuronal cell activities through micro- and nanotechnology based tools and devices. Types of Nanosensors and their applications. Electromagnetic nanosensors: Electronic nose and electronic tongue, Magnetic nanosensors. Mechanical nanosensors: Cantilever Nanosensors, NanoBiosensors: NanoBiosensors in modern medicine

Module 5: Medical Nano biotechnology: 9Hrs

Nanomaterials in Diagnostics, therapeutics, drug delivery, Nano Surgery and Tissue Engineering. Drug Delivery Applications, Bioavailability, Sustained and targeted release. Benefits of Nano drug delivery system. Use of Microneedles and nanoparticles for targeted and highly controlled drug delivery. Nano robots in drug delivery and cleaning system. Design of nanoparticles for oral delivery of peptide drugs. Nanotoxicity assessment: In-vitro laboratory tests on the interaction of nanoparticles with cells.

Module 6. Nano Safety Issues 4Hrs

Nanotoxicology: Toxicology health effects caused by Nanoparticles, Ethics, Challenges and Future.

Text Books

1. Vo-Dinh T, editor. Nanotechnology in biology and medicine: methods, devices, and applications. CRC Press; 2017.
2. Binns C. Introduction to nanoscience and nanotechnology. John Wiley & Sons; 2010.
3. Rosenthal SJ, Wright DW, editors. Nanobiotechnology protocols. Totowa: Humana Press; 2005.
4. Wilson M, Kannangara K, Smith G, Simmons M, Raguse B. Nanotechnology: basic science and emerging technologies. CRC press; 2002.

Reference Books

1. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications. R.S. Greco, F.B.Prinz and R.L.Smith, Nanoscale Technology in Biological Systems, CRC press, 2005.
2. B. Bhushan , Springer Handbook of Nanotechnology: Volume 1&2, Springer-Verlag. Second ed., 2007.
3. Sandra J Rosethal, David W Wright, Nanobiotechnology Protocols, Series Methods in Molecular Biology, 2005.
4. Christof M. Neimeyer, Chad.A.Mirkin (eds.,) Nanobiotechnology II: More Concepts, and Applications, Wiley VCH Weinheim (2007).

		L	T	P	C
20BT3028	**ADVANCED PLANT BIOTECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives:

1. To introduce plant genetic materials and molecular biology techniques
2. To know plant metabolic engineering and its importance
3. To understand the plant transformation techniques and GM crops

Course Outcome:

The students will be able to

1. Understand the plant genome and its molecular mechanisms
2. Interpret additional genomic materials in plant cells
3. Comprehend on metabolic engineering of plant cell metabolites
4. Summarize plant transformation techniques
5. Interpret on mechanisms of plant virus vectors
6. Comprehend on GM crops and its ethical issues

Module 1: Introduction to Plant Molecular Biology (6 hrs)

Genetic material of plant cells, nucleosome structure and its biological significance; transposons, alternative and trans splicing, constitutive and differentially expressed genes in plants

Module 2: Chloroplast and Mitochondria (7 hrs)

Structure, function: Light and dark reaction and genetic material; rubisco synthesis and assembly, coordination, regulation and transport of proteins. Mitochondria: Genome, cytoplasmic male sterility and import of proteins, comparison and differences between mitochondrial and chloroplast genome, chloroplast transformation

Module 3: Plant Metabolism and Metabolic Engineering (7 hrs)

Nitrogen fixation, Nitrogenase activity, nod genes, nif genes, bacteroids, plant nodulins, production of secondary metabolites, flavanoid synthesis and metabolic engineering

Module 4: DNA delivery methods (7 hrs)

Agrobacterium mediated method - Agrobacterium biology; Ti plasmid-based transformation; super virulence and monocot transformation, binary vector; Floral dip transformation; Direct DNA delivery methods - protoplasts using PEG; electroporation; particle bombardment; Chloroplast transformation and transient expression by viral vectors

Module 5: Design of gene construct and advanced technologies (9 hrs)
Factors influencing transgene expression – designing gene constructs - Promoters and polyA signals; Protein targeting signals; Plant selectable markers; Reporter genes; Positive selection; Selectable marker elimination; Transgene silencing; Strategies to avoid transgene silencing; Analysis of transgenic plants - Advanced technologies – cis genesis and intragenesis; RNAi technology, genome editing technology, CRISPR/Cas etc.

Module 6: Application of transgenic technology (9 hrs)
Applications of transgenic crop technology - Herbicide resistance; Pest resistance, Bt toxin, synthetic Bt toxin; Crop Engineering for disease resistance; genetic improvement of abiotic stress tolerance, Engineering for nutritional quality - Improved seed storage proteins; Improving and altering the composition of starch and plant oils; enhancement of micro-nutrients – beta carotene, vitamin E, iron; Molecular pharming - production of antibodies and pharmaceuticals in plants

Text Book:

1. Slater A et al. Plant Biotechnology : The Genetic Manipulation of Plants, Oxford University Press, (1st and 2nd edition), 2008
2. Paul Christou and Harry Klee. Handbook of Plant Biotechnology, 2nd volume set, Wiley publisher, (2004).

Reference Book:

1. Athar Ali, Usha Kiran, Malik ZainulAbdin.PlantBiotechnology: Principles and Applications Springer Publications, 2017

20BT3029	CANCER MANAGEMENT TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the pathology, grades and molecular biology of cancer
2. To analyze cancer type specific symptoms and early diagnostic markers
3. To develop skills in the cancer management techniques like detection, treatment, prevention and palliative care

Course Outcomes:
The students will be able to

1. Understand the pathology and metabolism of cancers and their reporting systems.
2. Recall the molecular pathways and relate them in cancer development, progression, detection and therapy.
3. Identify the potential molecular and cellular targets for diagnosis and therapy
4. Evaluate the technologies available for early diagnosis-prevention, targeted therapy and for effective management of post therapy – palliative care
5. Analyze the challenges in the present cancer management methods
6. Apply the knowledge and discuss new means of cancer management, prevention strategies and modes of palliative care to prolong the life of cancer cases.

Module 1: Pathology and types of cancer (8 hrs)
Benign and cancer tumor; Characteristics and hallmarks of cancer; Histopathology of cancer, Cancer malignancy – spread, invasion and metastasis; Cancer classes and types; Cancer inflammation, Cancer immunology, Cancer stem cells, Cancer death - obstructions.

Module 2: Molecular Cell Biology of Cancer (8 hrs)
Cell growth regulation abnormalities in cancer – Alteration in Growth factors and cell signaling pathways, signal targets; Cell adhesion defects in cancer; Cell migration promoters in cancer-Proteases; Metastatic spread promoters, cancer cells mimicking inflammatory immune cells; Apoptosis regulation defects in cancer; Angiogenesis promoters in cancer.

Module 3: Cancer Symptoms, Metabolism and Markers (7 hrs)
Cancer Symptoms – General and specific; Cancer metabolism – Metabolic alterations and role of mitochondria; Cancer Markers – Proteins – Enzymes, Antigens, Antibodies, Hormones; Testing samples - Urine, Blood, Stool, Tumor tissue, other body fluids; Genetic markers – DNA, mRNA and Protein expressions.
Module 4: Cancer Detection Methods and Techniques (8 hrs)
Cancer Screening: Clinical Examination; Laboratory Tests for cancer markers;- Immunodetection techniques (Shift before imaging); Imaging Techniques – Ultra sound and Endoscopic Examinations; X-ray; CT, and MRI scans; Nuclear and isotopic techniques - PET scans; Confirming cancer by pathologic report - Biopsy and Smear examinations; Cancer staging and grading; Genetic marker Testing Techniques – PCR, RT-PCR, qPCR, Microchip; Scope for early diagnosis: Early diagnostic methods – Mammography, PAP test
Module 5: Cancer Therapeutics (7 hrs)
Combination Therapy; Adjuvant-Neoadjuvant therapy- Chemotherapy, Radiotherapy; Targeted therapy – Targeted drug delivery, targeted therapy drugs; Molecular therapy, Immunotherapy –Antibody, Interferon, Gene therapy; Hormone therapy; Treatment fatigue; Clinical trials. Review on cancer stem cells.
Module 6: Cancer Prevention and Palliative Care (7 hrs)
Cancer risk factors; Food and lifestyle in cancer prevention; Post treatment recurrence preventive measures; Paliative care; Herbal remedies and plant derived cancer drugs.
Review on recent advancements in cancer management- Role of IoT, Theranostics, Nano-therapy.
Text Books:

1. Stella Pelengaris, Michael Khan, The molecular Biology of Cancer, Blackwell Publishing, 1st edition, 2006.
2. Robert A. Weinberg, The Biology of Cancer, Garland Science, 2nd edition, 2014

Reference Books:

1. Macdonald F and Ford CHJ. “Molecular Biology of Cancer”, Bios Scientific Publishers, 2002.
2. Richard Pazdur, Kevin A. Camphausen, Lawrence D. Wagman, William J. Hoskins, Cancer Management: A Multidisciplinary Approach**,** 11th illustrated edition, Oncology Publishers, 2003
3. Thomas N. Sayfried, Cancer as a Metabolic Disease: On the Origin, Management, and Prevention of Cancer 1st Edition, Wiley Publications; 2012

20BT3030	**GENOMICS AND PROTEOMICS**	**L**	**T**	**P**	**C**
		3	0	0	3

Course Objectives:
To improve knowledge on

1. Genomics and Proteomics including fundamentals, current techniques and applications.
2. To propose appropriate methods for analysis of given sample type with respect to purpose of analysis
3. Recent trends in Genomics and Proteomics research

Course Outcomes:
The students will be able

1. Relate and comprehend the concepts in genome organization, genomics and proteomics.
2. Explain some of the current genomics technologies and illustrate how these can be used to study gene function.
3. Apply interdisciplinary knowledge (e.g. chemistry, biophysics) to solve problems in proteomics and genomics
4. Analyze and infer genomes and proteomes by employing database search, algorithms and tools.
5. Appraise the applications of genomics and proteomics in medicine

6. Compile, discuss and critically review the recent updates / progress in genomics and proteomics research

Module 1: Introduction to Genomics **(8 Hours)**
Introduction to Genomics, Genome Organization of prokaryotes and Eukaryotes, Gene Structure of Bacteria, Archaebacteria and Eukaryotes, Human Genome Project

Module 2: DNA sequence and mapping **(8 Hours)**
Methodology for DNA sequencing, Contig Assembly, Genetic Mapping- Mendel's Laws of Inheritance, Partial Linkage, DNA Markers and its types, Physical Mapping and its types

Module 3: Functional Genomics and its applications **(7 Hours)**
Introduction to Functional Genomics, Genome Annotation- traditional routes of gene identification, Detecting Open Reading Frames, Software programs for finding genes, identifying the function of new gene, Gene Ontology. Pharmacogenomics, Comparative genomics

Module 4: Introduction to Proteomics **(7 Hours)**
Proteomics- Introduction, The proteome, Genomics vs Proteomics, Proteomics and the new biology

Module 5: Analytical Proteomics **(8 Hours)**
2 Dimensional Polyacrylamide Gel Electrophoresis, Mass Spectrometry for Protein and Peptide Analysis (MALDI-TOF and ESI-Tandem MS), Designing Microarray experiments, Types of Microarrays

Module 6: Applications of Proteomics **(7 Hours)**
Applications of Proteomics- Mining Proteomes, Protein Expression Profiling, Mapping Post-translational Modification, Peptide Mass Fingerprinting. Proteomics and Medicine.

Text Books:

1. Brown T.A., "Genomes", BIOS Scientific Publishers Ltd, Oxford, 4th Edition, 2018.
2. Daniel C. Liebler, "Introduction to Proteomics: Tools for the New Biology", Humana Press, Totowa, New Jersey, 2002

Reference Books:

1. Sandor Suhai, "Genomics and Proteomics- Functional and computational Aspects", Springer, New York, 2000.
2. Malcolm Campbell A. and Laurie J. Heyer, "Discovering genomics, proteomics and Bioinformatics", Pearson/Benjamin Cummings, New Delhi, 2006.
3. Mount, D. "Bioinformatics; Sequence and Genome Analysis", Cold Spring Harbor Laboratory Press, New York, 2004

20BT3031	ADVANCED ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To analyse environmental problems and find solutions through innovations
2. To develop bioreactors and biotreatment methods of industrial wastewater
3. To learn novel technologies for remediation of environmental pollution

Course Outcome:

The students will be able to

1. Create an awareness of professional responsibility towards protecting the environment.
2. Learn environmental issues involved engineering and resources projects
3. Study the natural and engineered bio-treatment methods to remediate the pollutants
4. Develop treatment methods and create awareness about opportunities in environmental management
5. Future challenges for bioremediation and biodegradation process
6. Investigate the opportunities for incorporating environmental quality into products, processes and projects

Module 1: Environment and Ecosystem (8 hrs)
Current status of biotechnology in environmental protection and its future prospects. Characteristics of wastewater, Classification of pollutants, Impact of pollutants on biotreatment.
Environment pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, microbial ecology.

Module 2: Environmental Pollution (7 hrs)
Current research on environment of Soil pollution, Water pollution, Air pollution**,** Oil pollution, Heavy metal pollution – case studies and technology development aspects

Module 2: Bioreactors for Wastewater Treatment (7 hrs)
Design and evaluation of suspended growth reactors, Activated sludge, Biological nutrient removal, Bio filtration, Aerobic digestion, anaerobic processes and lagoons , Design and evaluation of attached growth reactors, Trickling filter, Rotating Biological Contactor, Fluidized bed biological reactors, Up flow anaerobic sludge blanket reactor ,Hybrid reactor, Sequential batch reactor , Techniques for Evaluating Kinetics and Stoichiometric parameters.

Module 3: Biotreatment of Industrial Wastewater (8 hrs)
Wastewater treatment of effluents from dye, tannery, dairy and food industries, Wastewater treatment of effluents from pharmaceutical, distilleries, polymer, electrochemical industries, Wastewater treatment of effluents from explosive, pesticide and petrochemical industries, Treatment of industrial gaseous pollutants and Vocs. Medical waste and solid waste management.

Module 4: Bioremediation and Biodegradation (8 hrs)
Biostimulation of naturally occurring microbial activities, Bioaugmentation, *In situ, ex situ* and engineered bioremediation, Microbial system for heavy metal accumulation , Biosorption, Bioleaching, Detoxification of chlorinated hydrocarbons, aromatics and DIOXINS, Biodesulphurisation of crude petroleum , Future challenges, fate and effects of xenobiotic organic chemicals
Methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects of bioremediation (in situ, ex situ) Application of bacteria and fungi in bioremediation: White rot fungi vs specialized degrading bacteria; Phytoremediation

Module 5: Biomass and Biofuels (7 hrs):
Production of Biofuels: Biogas; bioethanol; biodiesel; biohydrogen; Industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

Module 6: Novel Biotechnology Methods for Pollution Control(7 hrs)
Application of nanobiotechnology in environment, Vermitechnology, Genomic tools in bioremediation, Aerobiotechnology, Development of biodegradable and ecofriendly products, Biosensor, Quorum sensing, Global environmental problems: Ozone depletion, UV-radiation, Greenhouse gases, acid rain and biotechnological approaches of their management.

Text Books:

1. Metcalf and Eddy, "Waste water Engineering Treatment, Disposal and Reuse". McGraw Hill, 2013.
2. Prescott, Harley and Klein, "Microbiology", 5th edition, McGraw Hill, 2014.
3. Graty. C.P.L., Daigger, G and Lim, H.C, "Biological Wastewater Treatment". 4th Edition, Marcel Dekker, 2011

Reference Books:

1. Jogdand, S.N. "Environmental Biotechnology". Himalaya Publishing House, New Delhi, 2012.
2. Karnely D. Chakrabarty K. Ovnen G.S. "Biotechnology and Biodegradation, Advances in Applied Biotechnology series", Gulf Publications Co. London 2011
3. R. C. Dubey A Textbook of Biotechnology, S.Chand publications, 4th edition, 2014

4. InduShekhar Thakur, “Environment Biotechnology basic concepts and applications”, IK International, 5th edition, 2016

20BT3032	ENTREPRENEURSHIP AND MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart various aspects of product design and development
2. To inculcate concept generation and selection
3. To understand technology behind the product of the service

Course Outcome:

The students will be able to

1. Understand the principles of product design, basic management techniques, entrepreneurial skills and funding agencies.
2. Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.
3. Induce entrepreneurial intent as well as innovation, scalability and marketing of the product.
4. Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career.
5. Assess the commercial viability of a new technology based idea to prototype.
6. Transfer technology and process of the product for commercialization

Module 1: Introduction and Product Design (8 hrs)

Entrepreneurship and economic development. evolution of entrepreneurship, stages in entrepreneurial process, entrepreneurship in India, Role of SSI in economic development, Government support for SSI. Product design and development Process, sources of ideas for designing new products, stages in product design. Guidelines of DBT for formulating project and financing.

Module 2: Innovation and Prototype (7 hrs)

Creativity and innovation, generation of ideas, technical and market feasibility study, opportunity assessment, business plan preparation, execution of business plan, conversion of ideas to prototype, risk taking-concept; types of business risks.

Module 3: Start Up Process (7 hrs)

Procedure for getting license and registration, challenges and difficulties in starting an enterprise, host institution support, Funding agencies – BIRAC, NEN, STEP, DST-NIMAT, TSDB; The role of technology/social media in creating new forms of firms, organizations, networks and cooperative clusters. Market- traditional and E-commerce, expanding markets: local to global.

Module 4: Innovation and entrepreneurship in Bio-business (8 hrs)

Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, strategic dimensions of patenting & commercialization strategies.

Module 5: Bio markets - business strategy and marketing (7 hrs)

Negotiating the road from lab to the market, Pricing strategy, Challenges in marketing in bio business (market conditions and segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills. Angel investors and venture capitalist.

Module 6: Technology management (8 hrs)

Technology – assessment, development and upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

Text Books:

1. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra, Information Solution Pvt. Ltd., 2007.
2. Donald F. Kuratko, “Entrepreneurship: Theory”, Process and Practice, 9th Edition, Cengage Learning, 2011.
3. Kanka S.S, Entrepreneurship Development, S.Chand and Co, New Delhi 2007.

Reference Books:

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
2. Anupam Singh and Ashwani Singh. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), NPH, New Delhi (2010)
3. Jayshree Suresh, “Entrepreneurial Development”, 5th Edition, Margham Publications, 2008.
4. Robert D. Hisrich, “Entrepreneurship”, 6th Edition, Tata McGraw Hill Publications.2009.

		L	T	P	C
20BT3033	**INDUSTRIAL WASTE MANAGEMENT**	**3**	**0**	**0**	**3**

Course Objectives:

1. To know problems of different kind of hazardous waste from industrial process.
2. To Engineer and technical options for site specific waste management
3. To know cleaner Industrial process and zero waste sustainable initiatives

Course Outcomes:

The students will be able to

1. List out different industrially relevant waste and their challenges in management
2. Infer suitability of available treatment options depending on nature of waste
3. Make use of bio-chemical reactions to develop optimal treatment system
4. Examine energy and eco-efficiency of solid waste and waste-water treatment
5. Recommend advanced treatment technologies with different Industrial Scenarios
6. Formulate cleaner production and waste management technologies

Module 1: Introduction to Industrial Waste Management System (9 hrs)

Uses of water by industry-Sources and types of industrial wastewater; regulatory requirements for treatment of industrial wastewater-Industrial waste survey Industrial Wastewater generation; Treatment Evaluation for Air Emission and Solid waste; Waste Characterization and classification;

Module 2:Solid Waste Treatment and Disposal (7 hrs)

Categories and Characterization, Solid waste land fill, Land-fill cover and Cap, Waste stabilization, Management of Organic industrial waste, Incineration strategies and Energy recovery, Composting Industrial waste.

Module 3:Industrial Waste Water Treatment (10 hrs)

Equalization- Neutralization- Oil separation Flotation-Precipitation-Heavy metal Removal - Refractory organics separation by adsorption. Aerobic and anaerobic biological treatment sequencing batch reactors; Oxidation –Ozonation. Photo catalysis, Wet Air Oxidation-Evaporation Ion Exchange-Membrane Technologies – Nutrient removal.

Module 4:Case Studies with Different Industrial Scenarios (7 hrs)

Tanneries-pulp and paper-metal finishing; Petroleum Refining-Pharmaceuticals-Sugar and Distilleries; Food Processing-Thermal Power Plants.

Module 5: Environmental aAudits and Clean up Technology (5 hrs)

Environmental audits, waste audit, life cycle assessment, industrial symbiosis, clean technology and Clean up technology, materials reuse, waste reduction.

Module 6:Cleaner Production and Newer Management Strategies (7 hrs)

Waste management Approach – Volume and strength reduction – Material and process modifications – Recycle, reuse and byproduct recovery – Applications, Zero discharge attainment strategies, Naturally Evolving Industrial complexes.

Text Book:

1. Woodard Frank (2001) *Industrial Waste treatment Handbook*, Butterworth Heinemann

Reference Books:

1. Nelson Leonard Nemerow, Industrial Waste Treatment: Contemporary Practice and Vision for the Future, Elsevier, (2010).
2. Wang Lawrence K., Hung Yung-Tse, Lo Howard H., Constantine Yapijakis, Hazardous Industrial Waste Treatment, CRC Press, (2006)
3. John Pichtel, Waste Management Practices: Municipal, Hazardous, and Industrial, Second Edition, CRC Press, 2014.
4. Wang Lawrence K., Hung Yung-Tse, Shammas Nazih, K. Handbook of Advanced Industrial and Hazardous Wastes Treatment, CRC Press, (2009).

20BT3034	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide a general concept in the dimensions of disasters caused by nature beyond the human control
2. To know the disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.
3. To improve knowledge about rescue methods

Course Outcomes:

The students will be able to

1. Learn the different safety aspects in industries and daily life
2. Learn safety procedure followed in industries
3. Learn the different types of rescues
4. Know the procedure for risk analysis
5. Know different type of disaster
6. Know procedure for damage assessment

Module 1: Safety Management (8 hrs)

High pressure-high temperature operation- dangerous and toxic chemicals, highly radioactive materials safe handling and operation of materials and machineries. Work environment-noise-effect of noise-unit of sound-noise levels in industries-control of noise

Module 2: Disaster Management (8 hrs)

Introduction on Disaster Different Types of Disaster: Natural Disaster Man-made Disaster Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc. Causes, effects and practical examples for all disasters. Major industrial accidents in India and in other countries,

Module 3: Accident Prevention and Risk Analysis (8 hrs)

Identification and analysis of causes of injury to men and machineries-accident prevention-accident proneness-vocational guidance, fire prevention and fire protection-personal protective equipments. Occupational, industrial health hazards –health standards and rules-safe working environments.

Module 4: Responsibility of Engineers (8 hrs)

Role of Engineers on Disaster Management. Response- Disaster Response : Introduction, Disaster Response Plan, Communication, Participation, and Activation of Emergency Preparedness Plan, Search, Rescue, Evacuation and Logistic Management, Role of Government, International and NGO Bodies, Psychological Response and Management (Trauma, Stress, Rumor and Panic) , Medical Health Response to Different Disasters

Module 5: Reconstruction and Recovery (7 hrs)

Rehabilitation, Reconstruction and Rehabilitation as a Means of Development, Damage Assessment, Post Disaster effects and Remedial Measures, Creation of Long-term Job Opportunities and Livelihood Options, Disaster Resistant House Construction , Sanitation and Hygiene,

Module 6: Safety Awareness (6 hrs)
Education and Awareness, Dealing with Victims' Psychology, Long-term Counter Disaster Planning, Role of Educational Institute, Role of Government, safety organization, management and trade unions in promoting industrial safety- on site and off site safety provisions.

Text Book:

1. Crowl D A, Louvar J F, "Chemical Process Safety Fundamentals with applications", 2nd Prentice Hall, NJ (2002).

Reference Books:

1. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services2005
2. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
3. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
4. Cheremisinoff, N. P., Practical Guide to Industrial Safety: Methods for Process Safety Professionals, CRC Press, 2001.

		L	T	P	C
20BT3051	**BIOCHEMISTRY**	3	0	0	3

Course Objectives:

1. To ensure students will have strong foundation in structure, properties and function of various biomolecules.
2. To provide knowledge regarding the basic structure of biomolecules which are involved in metabolic pathways
3. To articulate the significance of biomolecules

Course Outcome:
The students will be able to

1. Acquire knowledge on structure, properties and biological functions of carbohydrates, lipids and proteins
2. Assess the significance of nucleic acid structure, properties and functions
3. To impart knowledge on the significance of Vitamins and mineral functions
4. Integrate the metabolic pathways of synthesis and degradation of biomolecules
5. Justify the clinical and biological significance of biomolecules
6. Classify the biomolecules and understand their specific roles in biological system.

Module 1: Carbohydrates (9 Hours)
Classification, structure, properties and functions of carbohydrates: Monosaccharides, Disaccharides, Oligosaccharides-examples; Polysaccharide – classes- homo and hetero polysaccharides, glycolysis,TCA cycle, Pentose Phosphate Pathway, bioenergetics and oxidative phosphorylation

Module 2: Fatty Acids and Lipids (9 Hours)
Fatty acids- basic structure, types, properties, functions and essential fatty acids; ketone bodies, Classes, structure, properties and functions of lipids: Simple lipid-fat and wax, Compound lipid-Phospholipid, sphingolipid, ether lipid and glycolipid, Derived lipid –, fatty acid biosynthesis and degradation, biosynthesis of triacylglycerol, Inborn errors of lipid metabolism.

Module 3: Amino Acids, Peptides and Proteins (9 Hours)
Amino acids- classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides –examples; Proteins- structure / conformation levels-primary, secondary, tertiary and quaternary, Biosynthesis of aromatic amino acids-tyr,trp,phe, biodegradation of leucine, isoleucine and threonine, urea cycle,.

Module 4: Nucleotides and Nucleic Acids **(9 Hours)**
Nucleotides- composition, structure, properties and functions; Nucleic acids- types (RNA, DNA), DNA structure-Chargaff's rule on DNA base composition, unusual forms of DNA, RNA types, structure and functions, biosynthesis of purines and pyrimidines and its degradation, Inborn errors of nucleic acid metabolism - Review.

Module 5: Vitamins **(4 Hours)**
Vitamins: classification (A, D, E, K, and B-complex members), basic structure, source, daily requirement, functions and deficiency symptoms,

Module 6: Minerals – Functions and Disorders **(5 Hours)**
Minerals: classification- macro elements and microelements, sources, biochemical functions, dietary requirements and deficiency disorders, review on vitamins and mineral supplementations.

Text books

1. Lubert Stryer Jeremy M. Berg , John L. Tymoczko , Gregory J. Gatto Jr., Biochemistry, 9th Edition, Kindle Edition,2019.
2. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.

Reference Books

1. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, seventh edition, 2017
2. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 31st Edition,2018.
3. Jain and Jain "Biochemistry", Chand publication, 2016.Revised Edition

20BT3052	PLANT SECONDARY METABOLITES AND PHARMACEUTICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To recall the myriad of different secondary metabolites produced by plant
2. To analyze the biosynthesis and metabolic engineering of plant secondary metabolites
3. To formulate various products and their dosage forms

Course Outcome:

The students will be able to

1. Enumerate major plant secondary metabolites and its uses.
2. Illustrate the biosynthesis and regulation of plant secondary metabolites
3. Infer the different methods of production of secondary metabolites.
4. Interpret the biochemical pathways for improved secondary metabolite production.
5. Enumerate the pharmaceutical procedures for preformulation studies
6. Examine the development of formulation and dosage forms

Module 1: Plant Secondary Metabolites **(6 Hours)**
Definition and systematic of secondary metabolites. Structures, functions and commercial significance of secondary metabolites: alkaloids, terpenoids/isoprenoids, flavonoids and phenolics. Secondary metabolites in chemical defense of plants, ecological functions, and biological activities

Module 2: Biosynthesis and Regulation of Secondary Metabolite (8 Hours)
Integration of primary and secondary metabolism. Shikimate and PHA pathways of alkaloid biosynthesis. MEP pathway of terpenoid biosynthesis. Biosynthesis of flavonoids and polyphenol (lignin). Regulation: metabolic channeling, compartmentalization, cross-talk/exchange of intermediates between biochemical pathways. Application of specific enzyme inhibitors. Precursor feeding, genetic regulation of key enzymes, developmental, seasonal and environmental factors

Module 3: Production Technologies **(9 Hours)**
Production of secondary plant metabolites from higher plants: Tissue cultures, organ cultures, hairy root cultures. Roles of Endophytes in production of secondary metabolites; Bioreactors: scaling up of production

of secondary metabolites. Effects of precursors and elicitors. Production of pharmaceutically important secondary metabolites such as Taxol, Camptothecin, Berberine and rubber

Module 4: Metabolic Engineering of secondary metabolic pathways (8 Hours)

Cloning and characterization of enzymes of the Shikimate and MEP pathway; functional genomics approaches for improvement of secondary metabolite production. Metabolic engineering of yeast for the production of plant secondary metabolites, such as flavonoids, terpenoids and plant-origin alkaloids in yeasts.

Module 5: Pharmaceutics – Preformulation Studies (7 Hours)

Goals of preformulation, preformulation parameters, methodology, Solid state properties, Solubility and Partition coefficient, drug excipient compatability. Excipients used in pharmaceutical dosage forms:Properties and selection criteria for various excipients like surfactant, viscosity promoters, diluents, coating materials, plasticizers, preservatives, flavours and colours

Module 6: Powder and Liquid dosage forms (7 Hours)

Formulation development and manufacture of powder dosage forms for internal and external use including inhalations dosage forms, Formulations, production and evaluation of hard and soft gelatin capsules. Recent advances in formulation aspects and manufacturing of monophasic dosage forms. Recent advances in formulation aspects and manufacturing of suspensions and dry syrups

Text Books:

1. Y. M. Shukla, Plant Secondary Metabolites. New India Publishing Agency, ISBN-10: 8190851225, ISBN-13: 9788190851220, (2009).
2. R. Verpoorte, A. Wilhelm Alfermann, Metabolic Engineering of Plant Secondary Metabolism. Springer Science and Business Media. (2000).

Reference Books

1. David S. Seigler, Plant Secondary Metabolism, Springer Science and Business Media, ISBN: 0412019817, 9780412019814, (1998).
2. Liberman, HA &lachman L Pharmaceutical dosage forms: Disperse systems vol I , II & III (1996)
3. Carstensen JT, Theory of Pharmaceutical systems academic press New York and London. (1972)

20BT3053	**MOLECULAR BIOLOGY AND CELL SIGNALING**	**L**	**T**	**P**	**C**
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Core principles and applications of molecular biology
2. Gene expression and Cell signaling mechanisms and their regulation
3. Recent trends in biomedical research

Course Outcome:

The students will be able to

1. Exhibit a knowledge base in DNA replication, transcription, translation and Cell signaling
2. Summarize the process of gene expression and its regulation in prokaryotes and eukaryotes
3. Experiment with model organisms in gene expression studies and cancer research
4. Compare and contrast the different molecular processes in gene expression, signalling processes and cancer mechanism
5. Engage in review of scientific literature in the areas of biomedical sciences
6. Critique and professionally present primary literature articles in the general biomedical sciences field

Module 1: DNA replication, repair and recombination (7 Hours)

Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.

Module 2: Gene expression (10 Hours)

RNA synthesis and processing - transcription factors and machinery, RNA polymerases, formation of initiation complex, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, Protein synthesis and processing - Genetic code, aminoacylation of tRNA, Ribosome, Initiation, elongation and termination, translational inhibitors, Post- translational modification of proteins.

Module 3: Regulation of Gene expression (6 Hours)

Role of Promoters, Enhancers, Silencers in gene regulation. Regulation in Phages - Lytic and Lysogeny. Regulation in Bacteria – operons. Regulation in Eukaryotes - role of chromatin in gene expression and gene silencing (RNA interference). Epigenetic modifications

Module 4: Cell signaling and cellular communication (10 Hours)

Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways. General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix.

Module 5: Molecular basis of Cancer (6 Hours)

Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, apoptosis, therapeutic interventions of uncontrolled cell growth.

Module 6: Review on recent advances in research (6 Hours)

Noble prize research work on Physiology and Medicine – Cells sense and adapt to oxygen availability (2019), Cancer therapy by inhibition of negative immune regulation (2018), Molecular mechanisms controlling the circadian rhythm (2017), Mechanisms for autophagy (2016), Novel therapy against infections caused by roundworm parasites(2015).

Text books

1. Harvey Lodish, Arnold Berk, Paul Matsudaira, "Molecular cell biology", WH Freeman & Company, New York, 6th edition, 2017.
2. Geoffrey M. Cooper and Robert E. Hausman, The Cell: A Molecular Approach, Fifth Edition, ASM Press and Sinauer Associates, Inc., USA, 2015.

References

1. David R Hyde, "Genetic and Molecular Biology", Tata McGraw Hill Publications, New Delhi, 2010.
2. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, Molecular Biology of the cell, fifth edition, Taylor and Francis group, 2012.
3. Lehninger, A. L, Nelson D. L and Cox, M. M, “Principles of Biochemistry”, Freeman Publishers, New York, Seventh edition, 2017

		L	T	P	C
20BT3054	**MICROBIOLOGY AND MOLECULAR GENETICS**	3	0	0	3

Course Objectives:

1. To familiarize students with conventional and molecular characterization of microorganisms
2. To illustrate the role of microbes in health care, agriculture and environment
3. To exemplify the importance of genetic composition in microbial inheritance and mutations

Course Outcomes:

The students will be able to:

1. Analyze the classification, diversity, and ubiquity of major categories of microorganisms
2. Demonstrate the structural, physiological differences of microorganisms and their growth control
3. Evaluate the interactions between microbes, hosts and environment.
4. Acquire knowledge on prokaryotic, eukaryotic genome organization and the process of replication
5. Interpret the epigenetic effects on transposons in genes of interest
6. Describe the causes and consequences of mutations on microbial evolution and the generation of diversity

Module I: Microbial diversity and Molecular Taxonomy (9 Hours)
Concepts of species and hierarchical taxa – Bergey‟s system of classification– Classification of Bacteria, Fungi, and Viruses; Modern methods to study microbial diversity: NGS – MiSeq; Molecular Taxonomy- 16S rRNA gene sequencing, Phylogenetic grouping. Fatty Acid Methyl Ester (FAME) analysis, ITS, peptidoglycan, Isoprenoid, quinines; Methods to study microbial community: DGGE, SSCP, T-RFLP.

Module II: Microbial Physiology and Metabolism (8 Hours)
Morphology, structure and functions of prokaryotic and eukaryotic cells, Control of Microbial growth – Physical and Chemical, Metabolic Pathways: Metabolic versatility of microbes, Anaerobic Carbon metabolism: Anaerobic respiration, Sulphate respiration, Methane oxidizing and Methanogenic bacteria, Aerobic Carbon metabolism: TCA cycle alternative metabolic pathways; Quorum sensing: Vibrio fischeri, virulence- Pseudomonas aeruginosa, Staphylococcus aureus, Preservation and maintenance of microbes – Microbial Culture Collection centers – India and International organizations

Module III: Clinical, Agricultural and Environmental Microbiology (9Hours)
Clinical Microbiology**-** Survey of disease causing microbes; Bacterial Diseases: Mycobacterium tuberculosis, Salmonella, Viral Diseases: HINI, Fungal Diseases: Candida, Protozoan Diseases: Malaria, Antibiotics and their targets, Human Microbiome- gut microbiota, Microbes and Agriculture: Symbiotic Nitrogen fixation Rhizobium, Cyanobacteria (Anabaena, Azolla etc.), Mycorrihizae; Environmental Microbiology: Xenobiotic degrading consortia, Bioremediation; Biofilm and its ecological implication

Module IV: Genetics of bacteriophages and Yeast (6 Hours)
Genetics of bacteria and bacteriophages: Mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers. Yeast genetics: Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch

Module V: Transposons and epigenetics (7 Hours)
DNA-based Transposons in bacteria, Eukaryotic Transposons (DNA-based), Retrotransposons and Retroviruses (eukaryotes); Epigenetics: RNA-based silencing, X-chromosome inactivation, transcriptional memory, silencing of ancient transposons

Module VI: Microbial Mutation (6 Hours)
Molecular basis of mutation, mutagen and origin of spontaneous mutations- Fluctuation test – inference of function of genes based on isolation of mutations – various types of mutations – missense – nonsense – frameshift, Conditional Lethal - mutagens – physical and chemical agents – Mode of action of important mutagens (5BU, 2AP, NTG, Hydroxylamine, Nitrous acid) – use of mutagenic chemicals in isolation of mutants and their advantages – dominant and recessive nature of mutations with examples

Total: 45 Hours

Text Books

1. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 2001
2. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15th Edition. Pearson Education. 2018.
3. Modern Microbial Genetics by U.N. Streips and R.E. Yasbin, 2nd edition; Wiley Publishers; 2002

Reference Books

1. Lim D, "Microbiology", Second Edition, WCB-Mc Graw Hill, 2001.
2. Weaver, Robert Franklin, Molecular biology. 5thedition. McGraw Hill, New York. 2012
3. Bergey‟s Manual of Systematic Bacteriology. Volumes 1-5. Williams & Wilkins
4. ErkoStackebrandt. Molecular identification, systematics, and population structure of prokaryotes. Springer-Verlag Berlin Heidelberg. 2006
5. Lewin's GENES X, Volume 10 Benjamin Lewin, Jocelyn Krebs, Stephen T. Kilpatrick, Elliott S. Goldstein Jones & Bartlett Learning, 2011

20BT3055	ANIMAL BIOTECHNOLOGY AND IMMUNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide insights into animal biotechnology
2. To impart knowledge in animal breeding
3. To equip students with advancement in immunology and immunotechnology

Course outcomes:

The students will be able to

1. Explain the role of cryopreservation of embryos and embryo sexing
2. Describe the basic concepts in animal biotechnology and its importance in livestock improvement
3. Relate and identify the genetic defects in animal embryos through molecular techniques.
4. Identify the cellular and molecular basis of immune responsiveness through antigen and antibody interactions
5. Describe the roles of the immune system in both maintaining health and contributing to disease,
6. Demonstrate a capacity for problem-solving about immune responsiveness.

Module 1: Embryo Cryopreservation (8 Hours)

Introduction to Animal Biotechnology, Cryopreservation of Sperms, Ova of livestock, Artificial Insemination, Super Ovulation, In Vitro fertilization, Culture of embryos, Cryopreservation of Embryos, Embryo transfer, Embryo splitting, Embryo sexing.

Module 2: Germplasm Preservation and Live stock Improvement (7 Hours)

In situ and ex situ preservation of germplasm, In utero testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, Genetic characterization of livestock breeds, Marker assisted breeding of livestock,

Module 3: Transgenic Animals (7 Hours)

Transgenic animal production and application in expression of therapeutic proteins, Animal model for diseases, Detection of meat adulteration using DNA based methods.

Module 4: Antigen-Antibody Interaction (7 Hours)

In vitro antigen-antibody reactions, Isolation of antibodies, assays for complement, immunoelectrophoresis, ELISA, RIA and immunoblotting, Immunofluorescence, Flow cytometry & sorting, T & B cell subset analysis.

Module 5: Antibodies (9 Hours)

MAb through hybridoma technology, MAb without hybridoma technology, viral transformation of B cell line, plant as expression systems: plantibodies, applications. Production of abzymes, immunotoxins, chimeric antibodies, bi specific antibodies, diabodies, tetrabodies, intrabodies, plastibodies and their applications

Module 6: Immunity and Infection Mechanism (7 Hours)

Tissue injury and Inflammation, Immunosuppression, Immunological Tolerance, Immunity to infectious agents: bacteria, virus, fungi and parasites, Transplantation, Autoimmunity, Tumor Immunology, Vaccines: Conventional Molecular vaccines, Types of vaccines, Recent developments in Immunology of Infectious diseases.

Text Books

1. Ian Freshney R. Culture of Animal cells & Manual of basic technique, 6th ed., Wiley – liss publication, 2011.
2. Kuby J, “Immunology”, 7th ed., WH Freeman & Co., 2013.

Reference Books

1. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF,. *New Generation Vaccines*. 3rd Ed. Informa Healthcare, 2004.
2. Animal Cell Culture by John R.W. Masters 3rd ed., Oxford University Press, 2009.
3. David Male Jonathan BrostoffDavid Roth Ivan Roitt, Immunology. 8th ed., Elsevier, 2012
4. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th ed., Blackwell Publishing, 2002

5. Goldsby , R.A., Kindt, T.J., Osbome, B.A. and Kerby J. Kuby Immunology, 6th ed., W.H. Freeman, 2005

20BT3056	RESEARCH METHODOLOGY AND APPLIED STATISTICS	L	T	P	C
		2	0	0	2

Course Objectives:

1. Empower students to formulate research questions and develop a sufficiently coherent research design
2. Apprehend the need and review the guidelines for good research and publication ethics
3. Enable the students to understandthe need of statistical data analytic techniques in biological research

Course Outcome:

The students will be able to

1. Design their experiment keeping in mind the appropriate statistical test to be adopted in support of research hypothesis
2. Understand key steps to transform a wobbly idea into a convincing research proposal report - connecting the small objectives to big-picture
3. Perform hypothesis testing based on parametric and non-parametric approach in statistical package, office tools
4. Analyze the need of literature, experimental data, and supporting information in realm of research publication
5. Practice good-research and publication ethics
6. Understand the need of statistical analysis pertinent to their experimental data

Module 1: Research Methodologies: strategies, planning (4 Hours)

Resources or search engines available for gathering information and literature in related area, Critical review of available literature, Problem Identification Formulation (finding research gaps),

Module 2: Research Concepts and Data Collection (5 Hours)

Definition of Research, Qualities of Researcher, Components of Research Problem, Various Steps in Scientific Research, **Types of Research**; Hypotheses Research Purposes - Research Design – Survey Research. **Sources of Data**: Primary Data, Secondary Data; Procedure. Questionnaire - **Sampling** Merits and Demerits - Experiments - Kinds - Procedure; **Control Observation** - Merits - Demerits - Kinds – Procedure. Research conditions: repeatability and reproducibility, bias, measurement and source of error: Type-I Error - Type-II Error, experimental controls, Association versus causality

Module 3: Crafting Scientific publication (6 Hours)

Types of publications - their purpose and readers, Choosing Appropriate Journal/Publisher - available tools, Steps in drafting reports, editing and evaluation of final draft, evaluating the final draft; Good Research Report, observation and research report., *Component of an articles*: Introduction, M&M, Results, Discussion, and Conclusion. Brevity in scientific writing, *Authors guidelines* in scientific publications, Language polishing, Citation style and editor, uniformity.

Module 4: Research, publication, and ethics (3 Hours)

Scientific conduct and misconduct, fabrication, falsification, duplicate-publication, Plagiarism and self-plagiarism, Erratum, Retraction, *Authorship and issues*, statement of authors contribution, Corresponding authors role and responsibility, Need for Acknowledgement, Conflict of interest, Plagiarism, COPE guidelines, *Publication models* - subscription *vs.* open access, Authors right, Editorial process and publication life-cycle.

Module 5: Advanced and Applied statistics (9 Hours)

Hypothesis Testing: One-Sample Test for the Mean of a Normal Distribution, Hypothesis Testing and Confidence Intervals, Interval Estimation for the Comparison of Means, Two-Sample *t* Test, Paired *t* test, One-way and two-way ANOVA,**Non-parametric** *Wilcoxon Signed-Rank Test*,

Module 6: Correlation and regression analysis (3 Hours)

The Method of Least Squares, Regression coefficient, Correlation Coefficient, Multiple Regression

Text Books

1. Kothari C.R., 2004. Research Methodology Methods and Techniques, New Age international (P) Limited, New Delhi
2. Rosner, B. (Ed.), Fundamentals of Biostatistics, 8th ed. Cengage Learning, Boston, 2016.

Reference Books

1. Laake, P., Benestad, H.B., Olsen, B.R., 2007. Research methodology in the medical and biological sciences, 1st ed. Academic Press.
2. Blackwell, J, Martin J 2011. A Scientific Approach to Scientific Writing, Springer

20BT3057	BIOPROCESS AND DOWNSTREAM PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the principles of upstream and downstream processing in Bioprocess Technology
2. To illustrate knowledge on the requirement of media formulations, sterilization and inoculum development
3. To acquire knowledge on microbial growth and product formation

Course Outcomes:

The students will be able to;

1. Understand the process of fermentation and its requirements
2. Recall the media formulation, medium optimization and sterilization process
3. Illustrate the importance of microbial screening and preservation in bioprocessing
4. Discuss the cell growth and product formation
5. Apply knowledge on various unit operations in downstream processing
6. Analyze industrial product development in fermentation process

Module 1: Overview of Fermentation Process (6 Hours)

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermenter, main parameters to be monitored and controlled in Fermentation processes- Temperature, pH, pressure, flow measurement, rate of stirring, biomass weight, Dissolved Oxygen

Module 2: Medium Formulation, Optimization and sterilization (10 Hours)

Criteria for good medium, medium requirements for fermentation processes, examples of simple and complex media, design of various commercial media for industrial fermentations, medium optimization methods, liquid heat and filter sterlization of media

Module 3: Isolation of Industrially Important Microbes and Inoculum development (6 Hours)

Isolation of industrially important microbes- primary screening, preservation and storage of industrially important microbes, Inoculum development for Industrial fermentation process

Module 4: Cell Growth and Product formation (7 Hours)

Cell number and Cell mass calculations, growth model- Monod model, Effect of Substrate and product inhibition on growth, Product formation model- Leude king piret model, Factors affecting microbial growth

Module 5: Cell separation and Extraction (8 Hours)

Cell disruption for product release, separation of cells from fermented broth- sedimentation, Filtration, Centrifugation , Extraction of product, leaching, adsorption and precipitation of proteins.

Module 6: Purification and Finishing (8 Hours)

Chromatography adsorption, reverse phase, ion exchange, size exclusion, bio affinity and pseudo affinity, crystallization, drying and lyophilization, packaging, case studies of downstream Processing - Baker's yeast, Ethanol, Citric acid, Penicillin.

Text Books:

1. Shuler M.L. and Kargi F., Bioprocess Engineering: Basic Concepts, Prentice-Hall (2001).

2. Stanbury, P.F., Principles of Fermentation Technology, Book News, Inc. (1992).
3. Vogel H. C.and Haber C. C., Fermentation and Biochemical Engineering Handbook, Noyes Publications (2001).

Reference Books:

1. Bailey, J.E. and Ollis, D.F., Biochemical Engineering Fundamentals, McGraw-Hill (1986).
2. Wang D.C. and Humphrey, L, Fermentation and Enzyme Technology, John Wiley (1989).
3. Doran P M, Bioprocess Engineering Principles, Academic Press (1995).

20BT3058	MOLECULAR MEDICINE AND DIAGNOSTICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. Learn to self-reliantly analyze and understand research results and technologies.
2. Learn techniques for emerging novel molecular diagnostics and therapies.
3. Be able to study applications in healthcare, research and industry.

Course Outcome:

The students will be able to

1. Recognize molecular mechanisms in development of disease
2. Predict the use of molecular genetic methods in the detection, identification and quantification of different microorganisms.
3. Apply the principles of molecular diagnostics and advantages/limitations of its applications
4. Develop technological integration of chemistry, physics and molecular biology for use in bioanalysis relevant for biomedical research and diagnostics.
5. Design advanced study in the theoretical and practical aspects of the genetic basis and diagnosis of disease from both human and pathogen perspectives.
6. Appraise the knowledge of molecular testing to the most commonly performed applications in the clinical laboratory such as: nucleic acid extraction, resolution and detection, analysis and characterization of nucleic acids and proteins, nucleic acid amplification and DNA sequencing.

Module 1: Introduction to Molecular medicine, Nanomedicine (7 Hours)

Extracellular and intracellular signaling systems. Methods of DNA analysis and gene technology. Nanomedicine - Overview. Identification of genes and variants in the genome and gene mapping.

Module 2: Molecular and Medical Microbiology (7 Hours)

Molecular methods for detection and characterization of microorganisms, Primer and probe design. Databases - Molecular genetic assays, genotypic assays for molecular epidemiology.

Module 3: Cell Imaging and Biobanking (8 Hours)

Cell Imaging: Preparation and microscopy of biological specimens, tissue and cell morphology. Biobanks: classifications, common and distinctive features of the different types of biobanks. National regulations, international conventions, use of human biological materials and personal data, Research biobanks, Ethical aspects, role of Research Ethics Committees, consent for biobanking, alternatives to consent, Logistics and quality management, quality assurance and quality control of collection, storage, retrieval and use of samples, Role of biobanks in health surveys like HUNT, Mother-Child etc.,

Module 4: Introduction to Molecular diagnostics (7 Hours)

Introduction and History of diagnostics, Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites. · Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples, Interpretation of results, Normal microbial flora of the human body, Host - Parasite relationships.

Module 5: Diagnostic tests and diseases (8 Hours)

Duchenne muscular Dystrophy (Creatine phosphokinase-CPK), Amino acid deficiency - PKU (phenylketonuria) –- Inborn error, G6PD deficiency syndrome (G6PD), Sickle cell anemia, PCR diagnosis of Tuberculosis, Prenatal screening of Cystic Fibrosis. Endocrine disorders related to thyroid and reproduction (TSH, T3, T4, Estradiol, Testosterone, LH, FSH). Pyrosequencing. Lab on a Chip. Personalized Medicine - Pharmacogenomics.

Module 6: Genetic Disorders and Immunodiagnostics (8 Hours)

Major Metabolic disorder, Genetic disorders, Bone and blood disorders. Overview of immune system, Major Histocompatibility Complex (MHC), HLA typing, monoclonal and polyclonal antibodies, Immunoassays – types [Chemiluminescent IA, FIA] and specific applications; Immunohistochemistry – principle and techniques. Good Laboratory Practices. Different Levels of Biosafety, Containment. Future trends.

Text Books

1. Textbook of Molecular medicine, Jones and Bartlett Publishers, 2008
2. Jawetz, Melnick, &Adelberg's Medical Microbiology (2004), Geo F. Brooks, Stephen A. Morse, Janet S. Butel.

Reference Books

1. Principles of Biochemistry (Lehinger) (5th edition), MM Cox and DL Nelson, CBS Publishers, 2013.
2. Molecular Cell Biology: Darnell J, Lodish H and Baltimore D, 5th Edition, 2003.
3. Principles of Immunology and Immunodiagnostics: Ralph Michael Aloisi. Lippincott Williams and Wilkins, 1988.
4. Genomes (3rd edition) TA Brown, Garland Science Publishing, 2006.

20BT3059	MICROBIAL TECHNOLOGY LAB	L	T	P	C
		0	0	4	2

Course Objective:

1. To introduce students to experiments of microbial analysis – Growth curve
2. To deliver hands-on experience on various enzymatic assays
3. Provide idea about quantification of DNA, RNA and protein from microbial samples

Course Outcome:

1. Perform suitable technique to analyse growth curve of bacteria
2. Hands on skills of quantification of DNA, RNA and protein from bacterial cells and its visualization by performing agar electrophoresis.
3. Gain hands-on experience in screening microbial enzymes and assays
4. Apply appropriate technique for the isolation and identification of mutant strains
5. Demonstrate the sensitivity of microbial pathogens to various available drugs.
6. Construct phylogenetic trees using distance-based methods.

Experiments:

1. Establishment of bacterial growth curve
2. Screening of microbes for the production of enzymes - chitinase, protease, lipase, cellulase
3. Antimicrobial Sensitivity Test- Minimum Inhibitory Concentration
4. Quantification of Biofilm using microtitre plate (TCP) method
5. Phylogenetic analysis of microbes using UPGMA method
6. Isolation and quantification of total DNA from bacteria and fungi
7. Isolation and quantification of RNA.
8. Isolation and quantification of microbial protein
9. Replica plating technique- Ames Technique
10. Photoreactivation of UV irradiated *E. coli.*
11. Development of auxotrophic mutants employing Ethyl Methane Sulfonate
12. Blue and white colony selection employing X-gal-IPTG

Reference Books:

1. James G. Cappuccino Chad T. Welsh, Microbiology: A Laboratory Manual, 11th edition, Pearson, 2017

2. Dubey and Maheshwari, Practical Microbiology, S Chand Publishing, 2010
3. ApurbaSankarSastry, Sandhya Bhat, Essentials of Practical Microbiology, 2018

20BT3060	BIOPROCESS AND DOWNSTREAM PROCESSING LAB	L 0	T 0	P 4	C 2

Course Objectives:
1. To acquire knowledge about principles of growth of microbes, importance of maintaining the cultures, techniques used for enhancing the yield
2. To design criteria for fermenter and operation of bioreactor, solid state fermentation
3. To produce different metabolites from microbial culture

Course Outcomes:
The student will be able to:
1. Understand the growth kinetics of microorganism.
2. Understand various factors affecting the growth
3. Illustration of fermentation in production of primary and secondary metabolites
4. Application of Immobilization technique in production of metabolites
5. Analyze the various operations in product recovery and isolation
6. Evaluate the purification and polishing of the bioproducts

List of Experiments.
1. Laboratory fermenter, sterilization and operations.
2. Revival of culture from frozen vial to shake flask culture
3. Standardization of conditions for scale up of the culture in fermenter
4. Optimization of growth of bacteria in batch cultivation by statistical method
5. Immobilization of bacteria using alginate and agar
6. Study on growth kinetics and toxic compound inhibition kinetics
7. Solid state fermentation for the production of bioproducts
8. Cell disruption study
9. Isolation of product from the broth by extraction
10. Partial purification of enzymes by ammonium sulphate precipitation
11. Chromatographic techniques (column) for the product purification.
12. Product drying by lyophilization

Text Books
1. Kargi, Michael Shuler L. Fikret, and Matthew DeLisa. Bioprocess engineering: basic concepts. Prentice Hall, 2017.
2. Stanbury, Peter F., Allan Whitaker, and Stephen J. Hall. Principles of fermentation technology. Elsevier, 2013.
3. Doble, Mukesh, and Sathyanarayana N. Gummadi. Biochemical engineering. PHI Learning Pvt. Ltd., 2007

Reference Books
1. Todaro, Celeste M., and Henry C. Vogel, eds. Fermentation and biochemical engineering handbook. William Andrew, 2014.
2. Bailey, J.E. and Ollis, D.F., Biochemical Engineering Fundamentals, Tata McGraw-Hill (2010)

20BT3061	IMMUNOLOGICAL TECHNIQUES LAB	L 0	T 0	P 4	C 2

Course Objectives:
1. To deliver hands-on experience on various immunological techniques
2. To impart technical skills in the preparation of antigen
3. To provide knowledge in the production of antibodies and antibody titre assays

Course Outcomes:
1. Understand the procedure for antigen preparation

2. Categorize the methods of immunization
3. Identify the steps involved for the production of antibodies
4. Perform purification of the antibodies
5. Evaluate the methods involved for antigen and antibody reactions
6. Analyze and interpret the results obtained by the immunological experiments

List of Experiments:

1. Acclimatization of Fish & Chicken
2. Preparation of Antigen
3. Administration of Antigen in Fish & Chicken
4. Isolation of Lymphocytes from lymphoid organs.
5. Drawing Blood and separation of Serum from fish
6. Visualization of immune cells in blood smears.
7. Isolation of IgY antibodies from Chicken egg
8. Molecular weight identification of antibodies using SDS Page analysis
9. Estimation of specific Antibodies using Haemagglutination.
10. Estimation of specific Antibodies using immunodiffusion
11. Graft Rejection
12. Delayed type hypersensitivity in Fish

Reference Books:

1. Frank C Hay, Olwyn M.R. West Wood. Practical Immunology, 4th ed., Wiley- Blackwell,2008
2. David Male, JonathanBrost, David Roth, Ivan Roitt. Immunology. 8th ed., Elsevier, 2012.

20BT3062	INDUSTRIAL BIOTECHNOLOGY	L T P C 3 0 0 3

Course Objectives:

1. To inculcate knowledge on history of biotechnology, origin and analysis of different kinds of microorganisms for industrial biotechnology.
2. To elaborates on the process of industrial biotechnology
3. To facilitate various production strategies of bio products employed for sustainable bioprocess development

Course Outcome:

The students will be able to

1. Acquire knowledge on industrial bioprocess and process flow diagrams.
2. Remember various types of bioproducts and steps in fermentation technology.
3. Understand the problems related to handling microorganisms and selection of microbial culture for specific kind of bioproducts
4. Analyze industrial-market value of the bio products and relate them with the scope of biotechnology
5. Justify the clinical and biological significance of these bio products for sustainable bioprocess engineering,
6. Illustrate the difference in manufacturing commercial bioproducts and the ethical issues related to entrepreneurial aptitude.

Module 1: Introduction to Industrial Bioprocess (10 Hours)

Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.

Module 2: Production of Primary Metabolites (8 Hours)

Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids and alcohols.

Module 3: Production of Secondary Metabolites (8 Hours)
Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.
Module 4: Production of Enzymes and other Bioproducts (11 Hours)
Production of Industrial Enzymes (Amylase, Laccase), Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, Mushroom culture, Bioremediation.
Module 5: Production of Modern Biotechnology Products (4 Hours)
Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.
Module 6: Production of Target Specific Fine Bioproducts (4 Hours)
Single Cell Proteins and fine bio products for pharmaceutical applications like monoclonal antibodies.
Text Books
1. Prescott and Dunn, Industrial Microbiology, Fourth Edition, 2004.
2. Stanbury P.F. and Whitaker, Fermentation Technology, Third Edition, 2016.

References Books
1. ElmarHeinzle,Sustainable Bioprocess Development, John Wiley & Sons,2008.
2. Robert H. Perry, Handbook of ChemicalEngineering, McGraw-Hill Education 2019.

20BT3063	PHARMACEUTICAL TECHNOLOGY AND CLINICAL TRIAL	L	T	P	C
		2	0	2	3

Course Objectives:
1. To understand the impact of pharmaceutical technology and manufacturing process of drug formulation.
2. To learn and work on pharmaceutical laboratory process on multidisciplinary tasks.
3. To explore an ability to design an experiment, component or process as per needs and specifications.

Course Outcome:
The students will be able to
1. Distinguish to excel in research and to succeed in Biopharmaceutical technology profession through global, rigorous post graduate education.
2. Contrast students with a solid foundation in pharmacology, scientific and engineering fundamentals required to solve biopharmaceutical related problems.
3. Understand students with good scientific and technical knowledge so as to comprehend novel products and solutions for the health care issues.
4. Articulate in scientific & professional ethics on biological product manufacturing process.
5. Discover scientific methods and SOPs in clinical trials and fundamentals in new drug discovery process.
6. Develop academic environment aware of excellence in new drug discovery and patenting professional career.

Module 1: Introduction of drug action (7 Hours)
History & Definition of Drugs- Sources of Drugs - Plant, Animals, Microbes and Minerals- Different dosage forms- Routes of drug administration- Pharmacodynamics- Physico-Chemical Principles. Mechanism of drug action- drug receptors- and Physiological receptors- structural and functional families -Pharmacokinetics- Drug absorption- factors that affect the absorption of drugs-Distribution of drugs-Biotransformation of drugs- Bioavailability of drugs.
Module 2: Important Unit Processes and their Applications (6 Hours)
Chemical conversion processes – Alkylation – Carboxylation – Condensation and Cyclization – Dehydration, Esterification (Alcoholysis) – Halogenation – Oxidation, Sulfonation – Complex Chemical Conversions – Fermentation

Module 3: Manufacturing Principles (7 Hours)

Compressed tablets – wet granulation – Dry granulation or slugging – Direct compression – Tablet presses formulation – Coating – Pills – Capsules sustained action dosage forms – Parental solutions and injections – Oral liquids –ointments – standard of hygiene and good manufacturing practice.

Module 4: Biopharmaceutical products (7 Hours)

Antibiotics – Biological hormones – Vitamins – preservation- Analytical methods and tests for various drugs and pharmaceuticals- Packing – Packing Techniques – Quality Control - Recent advances in the manufacture of drugs using r-DNA technology.

Module 5: Drug delivery systems (6 Hours)

Biomaterials and their applications-Controlled and sustained delivery of drugs- Biomaterial for the sustained drug delivery- Liposome mediated drug delivery- Drug delivery methods for therapeutic proteins.

Module 6: Drug discovery and Clinical trials (6 Hours)

Glossary of terms in clinical trials, history, requirements, new drug development process, need for new drug, selection of a chemical compound as a potential drug, screening of chemical compounds, translation medicine, assessment of preclinical data. Phases of clinical trials.

Text Books

1. Sathoskar R.S., Bhandrkar S.D., Ainapure S.S., "Pharmacology and pharmacotherapeutics "17th edition, Popular Prakashan pub. (2001)
2. Remington, The Science and Practice of Pharmacy, Lippincot Williams & Wilkins pub.(2014)
3. Leon Lachman, Herbert A. Lieberman and Joseph L. Kanig, Theory & Practice of Industrial Pharmacy, (3rd ed.) Varghese Pub. 2013

References Books

1. Googman and Gilman's The pharmacological Basis of Therapeutics,13th Edition 2017
2. Methodology of Clinical Drug Trials, 2nd Edition. Spriet A., Dupin-Spriet T., Simon P. Publisher: Karger. 2010.

Lab

Course Objective:

1. To prepare students to excel in research and to succeed in Biopharmaceutical technology profession through global, rigorous post graduate education.
2. To train students with good scientific and technical knowledge so as to comprehend, analyze, design, and create novel products and solutions for the health related problems
3. To provide students with a solid foundation in statistical, scientific and engineering fundamentals required to solve biopharmaceutical related problems

Course Outcome:

The students will be able to,

1. Demonstrate to design and conduct experiments, analyze and interpret data.
2. Develop an experiment, component or process as per needs and specifications
3. Construct to visualize and work on laboratory and multidisciplinary tasks.
4. Organize to employ modern technology, software and equipment to analyze problems.
5. Classify to identify, formulate and solve health related issues.
6. Create impact of pharmaceutical technology on the society and also will be aware of contemporary issues

List of experiments:

1. Introduction to CDS (cleaning, decontamination and sanitization) protocols as per GLP norms.
2. Sterility testing of finished biopharmaceutical products (Injectable / freeze dried formulations).
3. Isolation, screening and quantification of bioactive compounds from natural source. Comet assay: single cell gel electrophoresis.
4. Separation and purification of isolated bioactive components.
5. Determination of pharmacokinetic (PK) release profile of biopharmaceuticals.
6. Preparation and evaluation of controlled release formulation.

7. Clinical data integration (eCRF, images, laboratories, and other instrumentation)

Reference Books:

1. Gary Walsh, Biopharmaceuticals: Biochemistry and Biotechnology, 2nd Edition. John Wiley & Sons, Inc, (2003).
2. Rodney J. Y. Ho, Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, 2nd Edition. John Wiley & Sons, Inc.(2013)
3. Gary Walsh, Pharmaceutical Biotechnology: Concepts and Applications. John Wiley & Sons, Inc.(2007)
4. Oliver Kayser, HeribertWarzecha, Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, 2nd Edition. John Wiley & Sons, InC, (2012).

20BT3064	BIOINFORMATICS AND BASICS OF R PROGRAMMING	L	T	P	C
		2	0	2	3

Course Objectives:

1. To explore various tools and database to understand the Biomolecules at structural and functional level
2. To perform big data analytics for Biological data set.
3. To familiarize with Predictive Analytics and Data Visualization.

Course Outcome:

The students will be able to

1. Familiarized with various biological database and software tools
2. Predict the structure and functions of biomolecules
3. Apprehend the knowledge on ligand and structure based drug design
4. Enable to write, compile, and run R programs.
5. Analyze data from different interfaces
6. Develop R script for various biological problems.

Module 1: Biological Databases (6 Hours)

Nucleotide databanks – Genbank, NCBI, EMBL, DDBJ – protein databanks –sequence databanks – PIR, SWISSPROT, TrEMBL- structural databases – PDB, SCOP, CATH.

Module 2: Sequencing Alignment and Dynamic Programming (6 Hours)

Local, Global alignment, pairwise and multiple sequence alignments. Alignment algorithms. Dynamic programming in sequence alignment: Needleman-Wunsch Algorithm and Smith Waterman Algorithm, Aminoacid Substitution matrices (PAM, BLOSUM).

Module 3: Molecular Modeling and Drug Discovery (3 Hours)

Basic concepts of Molecular modeling, Structure Identifications and Validations, Computer Aided Drug Design, HTVS, QSAR

Module 4: Introduction & R Objects (6 Hours)

R console, CRAN, Installation, configuration, R studio environment setup, Basic syntax, Data types, Variables, Operators, Vectors , Lists, Matrices, Arrays, Factors , Data frames

Module 5: R Packages & Data interfaces (6 Hours)

Installing a package from CRAN, Manual installation and configuration of a package, loading package to library, Exploring R packages for Bioinformatics applications

Module 6: Big data analytics for Health care (3 Hours)

Big data analytics in bioinformatics, Health care, Data mining using sequence data, Chemical mining, Biological sequence motifs and patterns.

Lab

Course Onjectives

1. To explore various tools and databases to understand the Biomolecules at sequential, structural and functional level
2. To performing big data analytics for Biological data set.

3. To familiar with practical knowledge in recent techniques like Predictive Analytics and Data Visualization to plot

Course Outcome:

The students will be able to

1. Analyze Biomolecules using biological databases, software/tools and online
2. Understand and exhibit the knowledge vital role for new drug design by various methodologies to save the human health
3. Recognize the need for independent and lifelong learning experience in bimolecular analysis and application
4. Enable to write, compile, and run R programs.
5. Analyze data from different data interfaces
6. Ability to develop R script for various biological problems.

List of experiments:

1. Biological Databases with Reference to Expasy and NCBI
2. Sequence similarity searching using BLAST
3. Overview of Protein and their interaction with ligand
4. Protein structure modeling, verification and validation.
5. Creation Data frames
6. Creating a pie chart using the R
7. Regression analysis using R
8. Protein data analysis by using R Programming from external sources like Protein Databank (PDB)
9. *ChemmineR*: Cheminformatics Toolkit for R
10. Read and analyse a genome sequence file using seqinr package.

Text Book:

1. A.M. Lesk. Introduction to Bioinformatics. Oxford University Press India, 2017.
2. S.C. Rastogi and N. Mendiratla and P.Rastogi. Bioinformatics methods and applications-Genomics, Proteomics and Drug Discovery. Prentice Hall India, 2013
3. Wang, Baoying, Big Data Analytics in Bioinformatics and Healthcare, IGI global edition

Reference Book:

1. VenkatAnkam, “Big Data analytics”, Packt publishing 2016
2. Parag Kulkarni, Sarang Joshi, “Big Data analytics”, PHI learning 2016
3. D.W. Mount. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbour Laboratory Press, New York, 2012.

20BT3065	NGS DATA ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To improve the knowledge of the NGS data analysis
2. To learn NGS data and analyze these in an UNIX/Linux working environment.
3. To solve computational genomics problems using advanced statistical methods.

Course Outcome:

The students will be able to

1. Summarize the applications of the different NGS technologies, including the weakness and strengths of the approaches.
2. Demonstrate the steps involved in a general NGS data analysis.
3. Record key theoretical concepts of alignment and de novo assembly.
4. Synthesize and formulate a project and relevant question within the field.
5. Illustrate the basics of NGS data analysis.
6. Infer analytical and reflective skills in analyzing results from individual steps and the final project.

Module 1: UNIX Operating System (7 Hours)
General purpose utilities; Navigating the File system; Handling ordinary files; The Shell; The Vi Editor; The Environment-Basic File Attributes

Module 2: File Attributes (8 Hours)
System Administration-The Routine Duties; The Regular Expressions and The grep family-The Process; Communication and Electronic mail; Shell Programming

Module 3: NGS Data Analysis (7 Hours)
Next Generation Sequencing: Early Stage NGS data analysis, Computing needs for NGS data management and analysis

Module 4: Application specific NGS data analysis (9 Hours)
Transcriptomics, Genotyping and Genomic Variation discovery by whole genome resequencing

Module 5: Metagenomics (7 Hours)
Metagenome analysis by NGS, changing landscape of NGS, Epigenomics data analysis:*De novo* genome assembly from NGS reads

Module 6: RNA and ChIP Sequencing Analysis (7 Hours)
Mapping Protein-DNA interactions with ChIP-seq, RNA Sequencing Analysis

Text Books

1. Xinkun Wang, "Next-Generation Sequencing Data Analysis" CRC Press 2016
2. Sumitabha Das, Unix – Concepts and Applications, Tata McGraw Hill, 2ndEdition.

Reference Books

1. Next-Generation DNA Sequencing Informatics [Kindle Edition] by Stuart Brown, Cold Spring Harbor Laboratory Press Newyork, 2013.
2. Tag-based Next Generation Sequencing by Matthias Harbers and GuenterKahl (Wiley Blackwell Germany 2012
3. Wong, Lee-Jun C., Next Generation Sequencing- Translation to Clinical Diagnostics, Springer, 2013

20BT3066	ALGAE BIOTECHNOLOGY	L	T	P	C
		2	0	2	3

Course Objective:

1. Impart the knowledge of different techniques employed in alage technology
2. Improve the understanding of applications and products derived from microalgae
3. Illustrate the characterization of algae using biochemical and molecular tools

Course Outcome:

The students will be able to

1. Understand the importance of algae and their culture techniques
2. Summarize the value added products of algae
3. Outline the application of algae in Industry and environment.
4. Elaborate the cell characteristics of microalgae
5. Investigate different products from algal sources through technological interventions
6. Infer algal characterization using molecular tools

Module 1: Algae cells (4 hours)
Algae and its culture - Isolation Techniques (Downstream Techniques) - Growth curve – Microscopy – Streaking - Culture Collection and Maintenance.

Module 2: Culture medium/nutrients and Condition (6 hours)
Culturing Media – Types of Media (BB, CFTRI, Fog's Medium, Shibin, Guillard's F/2 medium, Walne Medium) – Media Modification – Maintaining Conditions (Temperature, pH, Light, Salts etc).

Module 3: Phycoremediation (5 hours)
Adsorbing – Application in Environmental Clean up – Heavy Metal uptake, Wastewater treatment – Dye remediation –Agricultural application

Module 4: Value Added compounds **(6 hours)**
Oils and fatty acids – PUFA – Single Cell Protein – Biofilms – Secondary metabolites – Pigments – Proteins – Feed and Food - Biofuels

Module 5: Characterization **(3 hours)**
GC of Fatty acid – MS in Result analysis – FTIR – SEM

Module 6: Genomic studies **(6 hours)**
Molecular Techniques – DNA isolation – PCR – Molecular Identification – Phylogentic analysis – Pathway Analysis – Biomarkers.

List of Experiments:

1. Isolation of algae cells by serial dilution and microscopic observation
2. Culture Media preparation, sterilization and plating techniques
3. Maintenance of the isolated microalgal cells using synthetic
4. Growth curve measurement of alga cells using spectrophotometer
5. Effect of temperature on biomass generation
6. Dye decolourization studies using microalgae
7. Phycoremediation of waste water using microalgae
8. Solvent extraction of bio-oil from algal biomass
9. Algae bioinformatics – data base search and phylogenetics
10. GC-MS/FID profiling of the Fatty acid obtained from algal biomass

Text Books

1. M. Arumugam, S. Kathiresan., N. Subramani, Applied Algal Technology. Nova Science Publishers, New York, (2020).
2. AVSS Sambamurthy A Textbook of Algae, I.K. International Pvt. Ltd. New Delhi, (2017)
3. C. Vanden Hoek, D.G. Mann and H.M. Jahns . Algae – An introduction to Phycology, Cambridge University Press, (1995).
4. Kristian N. Hagen, Algae - Nutrition, Pollution Control and Energy Sources, Nova Science Publishers, 2009

Reference Books:

1. FaizalBux, Yusuf Chisti. Algae Biotechnology: Products and Processes, Springer International Publishing, Switzerland, 2016.
2. Gokare A. Ravishankar, Ambati Ranga Rao. Handbook of Algal Technologies and Phytochemicals, CRC Press, Taylor and Francis Group, 2019.

20BT3067	TISSUE ENGINEERING AND STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To inculcate knowledge in cell culture techniques
2. To develop technical skills in tissue implants and transplants and understand its regulation in tissue engineering
3. To impart the clinical potential, significance and ethics of stem cells

Course Outcome:

The Students will be able to:

1. Explain the concepts in cell culture techniques
2. Understand the importance of 3D cell culture and its applications
3. Analyze tissue engineering process and applications in the field of medicine
4. Categorize different types of stem cells and its functions
5. Examine the methods involved in the isolation of stem cells.
6. Justify the clinical potential, significance and ethics of stem cells

Module 1: Cell Culture **(7 Hours)**
Commercial scale production of animal cells, Application of animal cell culture for in vitro testing of drugs, Cytotoxicity and viability assays, Cell line preservation and authentication.
Module 2: 3D Culturing **(8 Hours)**
3D cell culturing and protocols involved for the 3D cell culture of different types of cells cell transplantation for liver, Multicellular tumor Spheroids, Experimental tissue modeling. Current research in tissue modeling
Module 3: Tissue Engineering **(7 Hours)**
Tissue Engineering, Design stages for tissue engineering, Cell substrate and support materials, Cell sources, Orientation, Different methods and steps involved in cell seeding of implantable materials
Module 4: Stem cell-Types **(7 Hours)**
Types of stems cells, Embryonic stem cells, Pleuripotent stem cells, Adult stem cells, Induced pleuripotent stem cells, Transit amplifying cells, Symmetry during cell division in Stem cells.
Module 5: Isolation and culturing of stem cells **(8 Hours)**
Isolation of Embryonic stem cells, Mesenchymal stem cells, Pleuripotent stem cells, Cord cells, Cord blood banking advantages and dis advantages, Differentiation of stem cells into osteoblast cells with protocols.
Module 6: Applications of Stem cell Technology **(8 Hours)**
Application of stem cells: Stem cells in Cancer treatment, Stem cells in wound healing, Stem cells in tissue engineering & organ regeneration, Stem cells in autoimmune disorders. Ethical and social concern of stem cell technology.

Text Books

1. Ian Freshney B. Culture of Animal cells & Manual of basic technique, 6th ed., Wiley – liss publication, 2011.
2. Bernhard Palsson, Jeffery A. Hubbell, Robert Plonsey, Joseph D. Bronzino, Tissue Engineering, 7th ed., CRC Press, 2019.

Reference Books

1. Robert Lanza and Anthony Atala, Essentials of Stem Cell Biology, 3rd ed., Elsevier 2014
2. Satish Totey and Kaushik D. Deb, Stem Cell Technologies: Basics and Applications, McGraw-Hill, 2010
3. Warburton David, Stem Cells, Tissue Engineering and Regenerative Medicine, 2015

20BT3068	**METABOLIC ENGINEERING FOR INDUSTRIAL PRODUCTION**	**L**	**T**	**P**	**C**
		3	0	0	3

Course Objectives:
1. To understand the basic concepts of metabolism playing role in industrial productions
2. To evaluate the possible mechanisms of metabolic alterations for improved production
3. To analyze the significance and ways of effective bioconversion by metabolic engineering

Course Outcome:
The students will be able to

1 Understand the concepts of metabolism in the industrial productions of bio-products
2 Outline the current status of industrial production and the challenges to improve it
3 Analyze the possible engineering ways of metabolic pathways and their effects in products
4 Evaluate the basic normal and the altered metabolic pathways in industrial bioprocesses
5 Apply the knowledge on the ways of alteration in metabolic pathways in case studies
6 Propose a model of metabolic alteration for improved industrial production process

Module 1: Metabolism overview **(6 Hours)**
Basic concept of metabolic engineering, Overview of cellular metabolism: Transport of molecules across plasma membrane, Fueling Reactions, Biosynthesis, Polymerization.
Module 2: Regulation of Metabolic Pathways **(9 Hours)**
Metabolism regulation at enzyme level, Metabolism regulation at whole cell level. Jacob Monod model for gene expression regulation-Lac operon, catabolite regulation/repression- glucose effect- cAMP deficiency.

Feed back regulation/repression, regulation in branched pathways- differential regulation by isoenzymes, concerted feed back regulation, cumulative feed back regulation, permeability control: passive diffusion, active transport, group transportation.

Module 3: Metabolic Engineering for Primary Metabolites production (9 Hours)

Role of metabolic engineering in Strain improvement and selection, improving fermentation. Auxotrophic mutants for high yield, Alteration of feedback regulation, limiting accumulation of end products, feedback resistant mutants, alteration of permeability for metabolites. Induction, feed- back repression, mutants resistant to repression for enzyme production.

Module 4: Metabolic Engineering for Secondary Metabolites production (9 Hours)

Producers of secondary metabolites, trophophase - idiophase relationship, Auxotrophic Mutants for high yield, Inducer and enhancer for secondary metabolites- an example, resistant to precursor effects, resistant to toxic compounds and toxic effects of secondary metabolites, Revertant mutant for secondary metabolite production. Metabolic engineering for production of plant secondary metabolites

Module 5: Bioconversions (6 Hours)

Advantages of bioconversions, specificity, yields, factors affecting bioconversion, Xenobiotic degradation, mutation, permeability, co-metabolism, avoidance of product inhibition, mixed or sequential bioconversions, conversion of insoluble substances.

Module 6: Applications and Advancements of Metabolic Engineering (6Hours)

Self - Learning: Applications in different fields, Case studies of metabolic engineering, Review on advancements - designing models.

Text Books:

1. Del Carmen Cortassa, S., Aon, MA(2011) *An Introduction to Metabolic and Cellular Engineering* (2nd Edition). World Scientific.
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Second Edition, Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2005

Reference Books

1. Nielsen J and Villadsen J, “Bioreaction Engineering Principles”, Springer, 2007.
2. Christiana D Smolke, “The Metabolic Pathway Engineering Handbook Fundamentals”, CRC Press Taylor & Francis Group, 2010.
3. Boris N Kholodenko and Hans V Westerhoff, “Metabolic Engineering in the Post Genomic Era”, Horizon Bioscience, 2004.
4. Stephanopoulos, G.N., Aristidou, A.A., Nielsen, J.(2000). *Metabolic Engineering: Principles and Methodologies*. Academic Press.

20BT3069	HUMAN ANATOMY, PHYSIOLOGY AND HEALTH EDUCATION	L	T	P	C
		3	0	0	3

Course Objectives:

1. To explain the gross morphology, structure and functions of various organs of the human body.
2. To describe the various homeostatic mechanisms and their imbalance
3. To identify the various communicable pandemic disease and healthcare precautions on different systems of human body

Course Outcome:

The students will be able to

1. Recall the anatomical terminology to identify and describe locations of major organs of each system covered.
2. Explain interrelationships among molecular, cellular, tissue and organ functions in each system.
3. Summaries the interdependency and interactions of the systems
4. Enumerate contributions of organs and systems to the maintenance of homeostasis.
5. Describe the physiological role of CVS system on human body.

6. Infer to aware of excellence in health education and first aid and to describe modern technology and tools used to study for excellent education carrier and well beings.

Module 1: Introduction to Human body (7 Hours)

Introduction to human body & organization of human body. b. Functional & structural characteristics of cell. c. Detailed structure of cell membrane & physiology of transport process. Structural & functional characteristics of tissues- epithelial, connective, muscle and nerve.

Module 2: Human Skeletal system (6 Hours)

Divisions of skeletal system, types of bone, salient features and functions of bones of axial and appendicular skeletal system Organization of skeletal muscle, physiology of muscle contraction, neuromuscular junction.

Module 3: Body fluids and blood (7 Hours)

Body fluids, composition and functions of blood, hemopoeisis, formation of hemoglobin, anemia, mechanisms of coagulation, blood grouping, Rh factors, transfusion, its significance and disorders of blood, Reticuloendothelial system.

Module 4: Lymphatic system (8 Hours)

Lymphatic organs and tissues, lymphatic vessels, lymph circulation and functions of lymphatic system Peripheral nervous system: Classification of peripheral nervous system: Structure and functions of sympathetic and parasympathetic nervous system. Origin and functions of spinal and cranial nerves.

Module 5: Cardiovascular system (8 Hours)

Heart – anatomy of heart, blood circulation, blood vessels, structure and functions of artery, vein and capillaries, elements of conduction system of heart and heart beat, its regulation by Autonomic nervous system, cardiac output, cardiac cycle. Regulation of blood pressure, pulse, electrocardiogram and disorders of heart

Module 6: Health education (9 Hours)

Concepts of health and disease. Disease causing agents and prevention of disease.Nutrition: Balanced diet, deficiency disorders of various nutrients, their prevention and treatment. Communicable diseases: The causative agents, modes of transmission and prevention of chicken pox, measles, diphtheria, tuberculosis, malaria, poliomyelitis, filariasis, rabies, tetanus, STD and AIDS. Vaccination schedule. First Aid: Emergency treatment of shock, snakebite, burns, poisoning, fractures and resuscitation methods. Family planning: Different measures of family planning in male and female

Text Books

1. Gray's Anatomy: The Anatomical Basis of Clinical Practice, 41th Ed (2015)
2. Guyton A.C. Hall J.E. Text book of Medical Physiology. (2016)
3. Best and Tailor's "Physiological basis of Medical Practice". (1979)

Reference Books

1. C.C. Chatterjee. Human Physiology (2019)
2. Cyril A. Keek, Eric Neil and Norman Joels, Samson Wright's Applied Physiology. (2008)
3. J.E. Park and K. Park,.Textbook of Preventive and Social Medicine (2015)

20BT3070	VACCINE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on the role vaccination in improving the immune system.
2. To gain an understanding of recent developments in vaccine technology.
3. To make aware about the commercialization and regulatory guidelines in vaccine production

Course Outcome:

The students will be able to

1. Describe the role of immune cells and their mechanism and concept of vaccination.
2. Categorize the different types of vaccines available for diseases.
3. Understand the modern strategies and routes of immunization.
4. Apply the concept of vaccine technology for development of vaccines.

5. Evaluate various delivery methods suitable for vaccines.
6. Relate the quality control and regulatory guidelines involved in vaccine production.

Module 1 Basics of Immune system (6 Hours)

Overview of the immune system and basic aspects of immune response(s) to vaccines. Active and passive immunity. Humoral and cell mediated immunity. Antibody production mechanism and factors affecting it. Cytokines, Primary and secondary immune response. Monoclonal and polyclonal antibodies. Super-antigens, Induction of cell mediated immunity.

Module 2 Introduction to vaccination (6 Hours)

Vaccination: Introduction, history and principles of vaccine development. Conventional and modern strategies for vaccine improvement. Immunization strategies: Active and Passive. Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Diphtheria, Tetanus, Hepatitis, Human papillomavirus.

Module 3 Classification of Vaccines and its production (9 Hours)

Types of vaccines: Live, attenuated, subunit, killed vaccines, Recombinant peptide vaccines, recombinant live vector vaccines, conjugate vaccines, toxoid vaccines, Naked DNA vaccines, cell-based vaccines, edible vaccines. Reverse vaccinology. Adjuvants: history, classification, mechanisms. Factors affecting adjuvants selection and production.

Module 4 Delivery of vaccines (7 Hours)

Controlled delivery system for vaccines: emulsions, microparticles, immune-stimulating complexes (ISCOMs, liposomes), Virosomes. Application of Nanoparticles in vaccine delivery, Induction of immune responses by nanoparticle-based vaccine. Role of polymeric nanoparticles in vaccine delivery. Transdermal vaccine delivery system.

Module 5 Vaccine Design and Development (9 Hours)

Fundamental research to rational vaccine design. Antigen identification and delivery, T-Cell expression cloning for identification of vaccine targets for intracellular pathogens, Fundamentals of Immune recognition, implications for manipulating the T-Cell repertoire, Targeting Dendritic cells; a rational approach for Vaccine development, Cellular basis of T- Cell memory, Rational design of new vectors, CpG adjuvant activity, Transcutaneous immunization.

Module 6 Commercial production and regulatory guidelines (8 Hours)

Quality control and regulations in vaccine research, In-vitro experimental validations for predictions of vaccines by software, Animal testing, Rational design to clinical trials, Large scale production, Commercialization, ethics. Overview of national and international regulatory requirements/ guidance for production of vaccines, quality control and implementation of good clinical practices. Overview of currently approved methods and alternative methods under development. Storage and handling, assessment of vaccine safety.

Text books

1. Emily P. Wen Ronald Ellis Narahari S. Pujar, Vaccine Development and Manufacturing. Wiley online, 2014
2. Jose Ronnie Vasconcelos, Vaccines & Vaccine Technologies. OMICS International, 2015
3. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.

Reference books

1. Myrone M. Levine , Myron M. Levine, Gordon Dougan , Michael F. Good , Margaret A. Liu , Gary J. Nabel , James P. Nataro, RinoRappuoli., New Generation Vaccines. Fourth Edition, 2016
2. Stanley Plotkin Walter Orenstein Paul Offit, Vaccines, 6th Edition, 2012

DEPT. OF BIOTECHNOLOGY

LIST OF NEW COURSES

Sl.No	Course Code	Name of the Course	Credits [L:T:P:C]
1.	19BT2001	Cell Biology	3:0:0:3
2.	19BT2002	Basics of Industrial Biotechnology	3:0:0:3
3.	19BT2003	Bioprocess Calculations	3:0:0:3
4.	19BT2004	Bio-analytical Techniques	3:0:0:3
5.	19BT2005	Bio-analytical Techniques Lab	0:0:3:1.5
6.	19BT2006	Biochemistry	3:1:0:4
7.	19BT2007	Biochemistry Lab	0:0:3:1.5
8.	19BT2008	Microbiology	3:0:0:3
9.	19BT2009	Microbiology Lab	0:0:3:1.5
10.	19BT2010	Fluid Mechanics	3:1:0:4
11.	19BT2011	Fluid Mechanics and Heat Transfer Lab	0:0:3:1.5
12.	19BT2012	Bioprocess Principles	3:0:0:3
13.	19BT2013	Bioprocess Lab	0:0:3:1.5
14.	19BT2014	Molecular Biology	3:0:0:3
15.	19BT2015	Genetic Engineering and Bioethics	3:0:0:3
16.	19BT2016	Molecular Biology and Genetic Engineering Lab	0:0:3:1.5
17.	19BT2017	Bioprocess Engineering	3:0:0:3
18.	19BT2018	Enzyme Engineering and Technology	3:0:0:3
19.	19BT2019	Heat and Mass Transfer	3:1:0:4
20.	19BT2020	Downstream Processing	3:0:0:3
21.	19BT2021	Downstream Processing Lab	0:0:3:1.5
22.	19BT2022	Immunology	3:0:0:3
23.	19BT2023	Cell biology and Immunology Lab	0:0:3:1.5
24.	19BT2024	Chemical Reaction Engineering	3:1:0:4
25.	19BT2025	Mass Transfer and Chemical Reaction Engineering Lab	0:0:3:1.5
26.	19BT2026	Biochemical Thermodynamics	3:1:0:4
27.	19BT2027	Basics of Bioinformatics	2:0:0:2
28.	19BT2028	Bioinformatics Lab	0:0:2:1
29.	19BT2029	Industrial safety and Hazard analysis	3:0:0:3
30.	19BT2030	Environmental Pollution Control Engineering	3:0:0:3
31.	19BT2031	Process Equipment Design and Economics	3:0:0:3
32.	19BT2032	Process Dynamics and Control	3:0:0:3
33.	19BT2033	Mechanical Operations	3:0:0:3
34.	19BT2034	Mechanical Operations Lab	0:0:3:1.5
35.	19BT2035	Biochemical Engineering	3:0:0:3
36.	19BT2036	Biochemical Engineering Lab	0:0:3:1.5
37.	19BT2037	Cancer Biology	3:0:0:3
38.	19BT2038	Clinical Database Management	3:0:0:3
39.	19BT2039	Clinical Database Management Lab	0:0:3:1.5
40.	19BT2040	Plant and Animal Biotechnology	3:0:0:3
41.	19BT2041	Stem Cell Technology	3:0:0:3
42.	19BT2042	Biopharmaceutical Technology	3:0:0:3

43.	19BT2043	Agricultural Biotechnology	3:0:0:3
44.	19BT2044	Metabolic Engineering.	3:0:0:3
45.	19BT2045	Research Methodology	3:0:0:3
46.	19BT2046	Molecular Forensics	3:0:0:3
47.	19BT2047	Protein Engineering	3:0:0:3
48.	19BT2048	Plant Tissue Culture	3:0:0:3
49.	19BT2049	Animal Biotechnology and Cell Culture	3:0:0:3
50.	19BT2050	Plant and Animal Tissue Culture Lab	0:0:3:1.5
51.	19BT2051	Role of Biotechnology in Environment	3:0:0:3
52.	19BT2052	Industrial Pollution Control	3:0:0:3
53.	19BT2053	Biomass and Bioenergy	3:0:0:3
54.	19BT2054	Environmental Biotechnology	3:0:0:3
55.	19BT2055	Matlab Programming	3:0:0:3
56.	19BT2056	Fundamentals of Biochemistry	3:0:0:3
57.	19BT2057	Pathology and Microbiology	3:0:0:3
58.	19BT2058	Human Anatomy and Physiology	3:0:0:3
59.	19BT2059	Entrepreneurship, IPR and Biosafety	3:0:0:3
60.	19BT2060	Tissue Engineering	3:0:0:3
61.	19BT2061	Cell Biology and Immunology	3:0:0:3
62.	19BT2062	Molecular Biology for Biomedical Engineers	3:0:0:3
63.	19BT2063	Biology in Everyday Life	3:0:0:3
64.	19BT2064	Workshop Practices for Biotechnologists Laboratory	0:0:2:1
65.	19BT3001	Advances in Biopolymer and Applications	3:0:0:3
66.	19BT3002	Genetic Engineering and Recombinant Products	3:0:0:3
67.	19BT3003	Bioprocess Modelling and Simulation	3:0:0:3
68.	19BT3004	Analytical Techniques in Biotechnology Lab	0:0:4:2
69.	19BT3005	Animal and Plant Tissue Culture Lab	0:0:4:2
70.	19BT3006	Advanced Process Equipment Design and Drawing Lab	0:0:4:2
71.	19BT3007	Recombinant DNA Technology Lab	0:0:4:2
72.	19BT3009	Enzyme Technology and Industrial Applications	3:0:0:3
73.	19BT3010	Microbial Biotechnology	3:0:0:3
74.	19BT3011	Agriculture and Food Biotechnology	3:0:0:3
75.	19BT3012	Big Data Analytics	3:0:0:3
76.	19BT3013	Bioethics and Biosafety	3:0:0:3
77.	19BT3014	Chemical Process Technology	3:0:0:3
78.	19BT3015	Immunotechnology	3:0:0:3
79.	19BT3016	Computational Biology	3:0:0:3
80.	19BT3017	Metabolic Regulation and Engineering	3:0:0:3
81.	19BT3018	Clinical trials and Bioethics	3:0:0:3
82.	19BT3019	Sustainable Bioprocess Development	3:0:0:3
83.	19BT3020	Advanced Animal Biotechnology & Tissue Culture	3:0:0:3
84.	19BT3021	Molecular Diagnostics	3:0:0:3
85.	19BT3022	Drug Design and Discovery	3:0:0:3
86.	19BT3023	Transport Phenomena	3:0:0:3
87.	19BT3024	Pharmaceutical Biotechnology	3:0:0:3

88.	19BT3025	Bioreactor Engineering	3:0:0:3
89.	19BT3026	Stem Cell Therapeutics	3:0:0:3
90.	19BT3027	Nanobiotechnology	3:0:0:3
91.	19BT3028	Advanced Plant Biotechnology	3:0:0:3
92.	19BT3029	Cancer Management Techniques	3:0:0:3
93.	19BT3030	Genomics and Proteomics	3:0:0:3
94.	19BT3031	Advanced Environmental Biotechnology	3:0:0:3
95.	19BT3032	Entrepreneurship and Management	3:0:0:3
96.	19BT3033	Industrial Waste Management	3:0:0:3
97.	19BT3034	Industrial Safety	3:0:0:3

		L	T	P	C
19BT2001	**CELL BIOLOGY**	**3**	**0**	**0**	**3**

Course Objective:

1. To acquaint students with the concepts in Cell Biology.
2. To understand structure and function of the organelles of cells
3. To learn the cell-cell interactions, transport mechanism and signaling pathways of cell

Course Outcome:

1. Recall the dynamic characteristics of cellular organelles
2. Relate the significance of chemical energy for cellular activities
3. Investigate the specific processes and proteins involved in membrane transport.
4. Analyze the behavior of cells in their microenvironment in multicellular organisms
5. Infer the receptor subclasses and their possible uses in cell signaling and signal transduction
6. Appraise the components of prokaryotic and eukaryotic system

Module I: FEATURES OF CELL AND ITS ORGANELLES (9)

Brief history of cytology and cell theory, Prokaryotes and Eukaryotes (plant cell and animal cell), Membranes of the cell: Plasma membrane, Nuclear membranes, Organelle membranes. Brief outline of organelles; Nucleus, nucleolus, ribosome, mitochondria, chloroplast, vacuole, endoplasmic reticulum, golgi apparatus, peroxisome, glyoxisome, lysosome, centriole, cilia and flagella.

Module II: CELL CYCLE AND ITS REGULATION (6)

Cell cycle and molecules that control cell cycle, Regulation of cell cycle. Cell cycle and cancer: Tumor suppressor genes and Oncogenes.

Module III: CYTOSKELETON AND CELLS IN THEIR SOCIAL CONTEXT (5)

Microtubules, microfilaments, intermediate filaments and their binding proteins. Cell- cell communication: Cell junction, Cell adhesion, Extra Cellular Matrix, Basal Lamina.

ModuleIV: CELL TRANSPORT AND TRAFFIC (9)

Passive and active transport, permeases, osmosis, pumps and gated channels, co transport: symport, antiport. Vesicular transport: Endocytosis, Exocytosis, Protein glycosylation in eukaryotes and protein sorting. Transport in prokaryotic cells, entry of viruses and toxins into the cell.

ModuleV: SIGNALING MOLECULES AND THEIR RECEPTORS (7)

Signaling molecules: autocrine, paracrine and endocrine and its mode of action in cell signaling. Cytosolic, nuclear and membrane bound receptors: G-protein coupled receptor, protein tyrosine kinases receptor and cytokine receptors for cell signaling.

ModuleVI: SIGNAL TRANSDUCTION (9)

Signal amplification, different models of signal amplifications: role of cyclic AMP, cyclic GMP and G proteins in signal transduction, phosphorylation and regulation in signaling: serine – threonine kinases in signaling. Role of Inositol triphosphate (IP_3) in signal transduction, calcium ion flux and its role in cell signaling.

Total Hours: 45

Text Books

1. Geoffrey M. Cooper and Robert E. Hausman, The Cell: A Molecular Approach, Fifth Edition, ASM Press and Sinauer Associates, Inc., USA, 2015.
2. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, Molecular Biology of the cell, fifth edition, Taylor and Francis group, 2012.

Reference Books

1. De Robertis& De Robertis, Cell Biology, 4^{th} Edition, 2010.
2. Lodish, H. and D. Baltimore, Cell Biology, W.H. Freeman publishers, 2012.
3. Gerald Karp, Cell and Molecular Biology, John Wiley and sons Inc, 2013.

19BT2002	BASICS OF INDUSTRIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To ensure students to have a base on the History of Biotechnology and its source of origin and the analysis on the different kinds of microorganisms this could be deployed for industrial biotechnology.
2. The paper facilitates the knowledge for understanding the various production strategies of bio products employed for sustainable bioprocess development

Course Outcome:

At the end of the course students will be able to

1. Remember the use of microbes for developing industrial products and processes.
2. Understand the techniques for genetic improvement of micro-organisms to improve yield of bio-products.
3. Explain the technical issues related with microorganisms in the production of bio products.
4. Analyse industrial-market value of these bio products and relate them with the scope of biotechnology
5. Relate the clinical and biological significance of these bio products for sustainable bioprocess engineering
6. Evaluate the difference in manufacturing commercial bio products and all the ethical issues involved in it.

Module I: INTRODUCTION TO INDUSTRIAL BIOPROCESS (9)

Introduction on the Historical overview of industrial fermentation processes on that of reactors and microscopes. The Traditional and modern biotechnology and the future perspectives in Industrial Biotechnology. Brief survey of organisms, processes, products related with modern biotechnology.

Module II: PRODUCTION OF PRIMARY METABOLITES (9)

The understanding of process flow sheeting, modelling and simulation in bioprocessing Pictorial representation of the need to know on Hypothesis and pictorial representation on the developmental process concerning upstream and downstream processing, Production of organic acids, amino acids and alcohols.

Module III: PRODUCTION OF SECONDARY METABOLITES (9)

The production of secondary metabolites of high commercial value like Antibiotics: Penicillin V, Streptomycin and Ampicillin sodium salt. Production of commercial vitamins like Vitamin B12, Vitamin E, Vitamin B. Production of steroids.

Module IV: PRODUCTION OF INDUSTRIAL ENZYMES AND OTHER PRODUCTS (9)

Production of enzymes and specialty chemicals: Production of industrial enzymes such as lipases, celluloses, bio preservatives (Nisin), cheese, biopolymers (xanthan gum, PHB etc), Bio-flavours and bio-pigments.

Module V: PRODUCTION OF MODERN BIOTECHNOLOGICAL PRODUCTS (5)

Strain improvement by using chemical mutagenesis, Bio-fertilizers, Bioenergy-fuel from biomass, production and economics of biofuels, biogas, bio-refineries, Microbial Enhanced Oil Recovery (MEOR).

Module VI: PRODUCTION OF TARGET SPECIFIC FINE BIOPRODUCTS: (4)

Single Cell Proteins and fine bio products for pharmaceutical applications like monoclonal antibodies.

Text Books

1. Prescott and Dunn, Industrial Biotechnology, Agro bios (India), 2005.
2. P.F. Stanbury and Whitaker, Fermentation Technology, Second Edition, 2009.

References Books

1. Elmar Heinzle,Sustainable Bioprocess Development, 2008.
2. Robert H. Perry, Handbook of Chemical Engineering, 2000.
3. Glazer AN, Nikaido H, The process of Microbial Enhanced Oil Recovery and Microbial Leaching Text books, 2007.

19BT2003	BIOPROCESS CALCULATIONS	L	T	P	C
		3	0	0	3

Course Objective:

1. To develop skills of students in principles and basic calculations
2. To familiarize in material balance for both with and without chemical reactions
3. To conceptualize energy balance for reactive and non-reactive systems

Course Outcome:

The students will be able to

1. Understand the importance and inter conversion of different units
2. Remember the concept of material balances for with and without chemical reactions
3. Relate the concept of stoichiometry in real-time problem
4. Distinguish the properties of ideal gases and gas mixtures
5. Evaluate flow diagram and the concept of recycle, purge and bypass in a process
6. Analyze the concept of energy balances for closed and open system

Module I SYSTEMS (8)

Units systems, basic units, derived units, dimension analysis, force, pressure, work, heat, conversion of units, Mass and volumetric flux.

Module II STOICHIOMETRY (9)

Stoichiometry, Avogadro number, molarity, molality and normality, molecular weight, equivalent weight, mass fraction, mole fraction, concept of limiting & excess reactants, fractional conversion, stoichiometry of microbial growth and product formation.

Module III Ideal Gases and Gas Mixtures (10)

Ideal Gases, Standard temperature and pressure, partial pressure, Ideal Gas Equation, Gas laws: Boyle’s Law, Charles’ law, Amagat’s law and Daltons law, Density and molecular weight related problems.

Module IV MATERIAL BALANCE (10)

Fundamental of material balance, Basics of calculation, approach of solving material balance problems, Mixing, Tie element, Evaporation, Crystalization, Drying, Absorption, Extraction.

Module V ENERGY BALANCE (5)

Basic Energy Concepts, types of Energy, Internal energy, Enthalpy, General Energy-Balance Equations, Heat capacities, Procedure for energy balance calculations.

Module VI MATERIAL BALANCE INVOLVING RECYCLE (3)

Bypass, Recycle, Purge, closed and open system

Total Hours: 45

Text Book

1. Narayanan K.V., Lakshmikutty B., “Stoichiometry and Process Calculations”, PHI Learning Private Limited, 4th edition, 2014

Reference Books

1. Felder, R.M., Rousseau R.W., “Elementary Principle of Chemical Processes”, John Wiley and Sons Publication 3rd edition, 2000.

2. BI Bhatt & SM Vora “Stoichiometry”, Tata Mcgraw- Hill, 4th edition, 2004.
3. Venkataramani.V and Anantharaman.A., “Process Calculations”, PHI learning Pvt. Ltd, 2003.
4. David Mautner Himmelblau, James B. Riggs., ‘Basic Principles and Calculations in Chemical Engineering’ Prentice Hall of India, 4th editon. 2004

19BT2004	BIO-ANALYTICAL TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide the students an ability to understand the principles of instrumentation
2. To impart the knowledge of different techniques and methods in biotechnology
3. To improve the understanding of applications of techniques in the field of biotechnology

Course Outcomes:

1. To understand the basic techniques of drug extractions from different sources
2. Illustrate the different methods of analytical techniques for quantitative analysis
3. Classify various separation and purification techniques of compounds
4. Demonstrate the gel electrophoresis and thermal analytical techniques
5. Analyze the methods of structural elucidation of different drugs
6. Asses the importance of radioactive isotopes in modern research

Module I EXTRACTION METHODS (9)

Buffers, pH – pH meter and applications, Solvent extraction –introduction and principle; Extraction techniques–batch, stripping or back, continuous and counter-current; Principle of solid extraction (Soxhlet); Types -Temperature assisted, pressurized hot water and supercritical fluids based extraction.

Module II SPECTROSCOPY TECHNIQUES (9)

Basic principle of Spectroscopy -Beer-Lambert’s law, Principle, Instrumentation and applications of Colorimeter, Flame photometry, spectrofluorometric and Spectrophotometer: types– UV – visible – Raman spectroscopy.

Module III CHROMATOGRAPHY TECHNIQUES (9)

Principle, types and applications of Chromatography- Thin layer, Adsorption, Ion-exchange, Affinity, Gel filtration, GC and HPLC.

Module IV ELECTROPHORESIS & THERMAL METHOD (9)

Principle, Types and applications of Electrophoresis– agarose gel, polyacrylamide gel (PAGE), SDS-PAGE–principle, instrumentation and applications; isoelectric focusing–principle and applications; Thermo gravimetric analysis (TGA)-Principle, instrumentation and applications

Module V STRUCTURAL ELUCIDATION TECHNIQUES (5)

Mass spectrometry–principle, instrumentation (electron spray ionization [ESI] & chemical ionization [CI]) and applications; nuclear magnetic resonance (NMR) –principle, instrumentation and applications;

Module VI RADIOISOTOPE METHODS (4)

Radioactive isotopes, radioactive decay and their types, radioactive techniques - RIA, GM counter, Scintillation counter, Applications in Medicine & Diagnosis.

Total Hours:45

Text Book

1. Willard and Merrit, Instrumental Methods and Analysis. VI Edition, CBS Publishers & Distributors; 2002.

Reference Books

1. Gurdeep R. Chatwal and Sham K. Anand. Instrumental Methods of Chemical Analysis. 5th Edition. Himalaya Publishing House, India. (2012).
2. 2 B.K.Sharma. Instrumental Methods of Chemical Analysis. 24th revised and enlarged edition. GOEL Publishing House, India. (2014).
3. 3 Keith Wilson and John WalkerPrinciples and Techniques of Practical Biochemistry and Molecular Biology. 7th Edition. Cambridge University Press, U.K. (2010).

4. 4 Douglas A. Skoog, F.James Holler and Stanley R. Crough. Instrumental Analysis. 6th Edition. Brooks Cole Publishing Company. USA, (2007).
5. 5 Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath. Biophysical Chemistry: Principles and Techniques. Himalaya Publsihing House Pvt. Ltd. India, (2014).

19BT2005	BIO ANALYTICAL TECHNIQUES LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To impart technical knowledge about the working principle and applications of different equipment related to biotechnology experiments.
2. To enable the students to understand the principles of instrumentation
3. To impart the knowledge of different techniques and methods in biotechnology

Course Outcome:

1. Understand the basic measurement methods and its applications in biotechnology
2. Describe the instrumentation and applications of different spectroscopic techniques
3. Demonstrate the principles, techniques and applications of chromatography.
4. Explain the determination of pH and their applications in buffer preparations
5. Understand different purification techniques of primary and secondary metabolites
6. Examine the applications of equipment involved in experimental biotechnology

List of Experiments

1. Estimation of Polyphenol by Colorimetric Method
2. Verification of Beers Law and Construction of Beers Law plot
3. Preparation of buffer solution with Henderson-Hasselbach equation and its verification with pH meter
4. Titration curves of Acetic acid and Citric Acid using pH meter
5. Precision and Validity of an experiment
6. Determination of analytical wavelength for given sample
7. Estimation of sugars by ascending paper chromatography
8. Identification of amino acids by ascending paper chromatography
9. Determination of turbidity by nephelometry
10. Conductivity measurement in titration
11. Gas Chromatography
12. High Performance Liquid Chromatography

19BT2006	BIOCHEMISTRY	L	T	P	C
		3	1	0	4

Course Objective:

1. To acquire knowledge on structure, properties and function of various biomolecules.
2. To know the concepts of metabolism and to study the metabolic pathways
3. To understand the significance of biomolecules in biotechnology and the metabolic disorders

Course Outcome:

The students would be able to

1. Remember the structure of carbohydrates, lipids, nucleic acid and proteins
2. Classify the biomolecules and understand their specific roles in biological system.
3. Understand the significance of conjugated biomolecules
4. Analyze the properties of biomolecules
5. Illustrate the metabolic pathways of biomolecules, bioenergetics and inborn metabolic disorders
6. Integrate the metabolic pathways of synthesis and degradation of biomolecules

Module-I CARBOHYDRATES (12)

Classification, structure, properties and functions of carbohydrates (Mono, Di, Oligo and polysaccharides) Monosaccharides, Disaccharides, Oligosaccharides-examples; Polysaccharide – classes- homo and hetero polysaccharides, Conjugated carbohydrates.

Module-II FATTY ACIDS AND LIPIDS (8)
Fatty acids- basic structure, types, properties, functions and essential fatty acids; ketone bodies, Classes, structure, properties and functions of lipids: Simple lipid-fat and wax, Compound lipid-Phospholipid, sphingolipid, ether lipid and glycolipid, Derived lipid – cholesterol.
Module-III AMINO ACIDS, PEPTIDES AND PROTEINS (12)
Amino acids- structure and classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides; Proteins- classification and structures - primary, secondary, tertiary and quaternary.
Module-IV NUCLEOTIDES AND NUCLEIC ACIDS (8)
Nucleosides and Nucleotides- composition - Structure of Purines – Pyrimidines, Structure, properties and functions of nucleotides; Nucleic acids- types: DNA- structure and forms, RNA – structure, types and functions, Nucleoprotein complexes.
Module-V METABOLISM AND INBORN METABOLIC DISORDERS (14)
Carbohydrate: Glycolysis, TCA cycle, pentose phosphate shunt, glycogen synthesis and degradation, Glycogen storage diseases. Lipids: Biosynthesis and oxidative degradation of fatty acid - ketogenesis, TG, phospholipid and cholesterol, Lipid storage diseases. Amino acids and Proteins: Protein degradation and nitrogen metabolism from amino acids-Transamination, Urea cycle, Biodegradation of aromatic amino acids (Tyr, Trp, Phe) and associated metabolic disorders. Metabolism of purine and pyrimidine and associated metabolic disorders.
Module-VI BIOENERGETICS AND INTEGRATION OF METABOLISM (6)
High energy compounds-ATP, Bioenergetics in glucose oxidation, and fatty acid oxidation, Respiratory chain and oxidative phosphorylation, Gluconeogenesis and control of blood glucose, Interconvertible metabolic fuels.

Total Hours: 60

Text Books
1. Lehninger, A. L, NelsonD. L and Cox, M. M, “Principles of Biochemistry”, Freeman Publishers, New York, fourth edition, 2005.
2. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 2008.

References Books
1. Jain and Jain “Biochemistry”, Chand publication, 2016.
2. Lubert Stryer, “Biochemistry”, WH Freeman & Co., 4th edition, 2006.
3. Voet and Voet, “Biochemistry”, John Wiley & Sons Inc., 2nd Edition, 2013.

19BT2007	BIOCHEMISTRY LAB	L	T	P	C
		0	0	3	1.5

Co-requisite: 19BT2006 -Biochemistry
Course Objective:
1. To understand the basic units and measurements of biochemical solutions
2. To develop the skills in identifying various biomolecules
3. To develop the skills of quantifying various biomolecules

Course Outcome:
The students would be able to
1. Understand the basic concept, applications of tests, titrations and estimations of biomolecules
2. Demonstrate the basic lab skill in preparing different solutions of different concentrations and their measurement tools with representing units
3. Apply the basic reaction principle in estimation of different biomolecules using suitable method
4. Analyze through various tests and identify the different carbohydrate, amino acid and lipid molecules present in the given sample solution.
5. Apply suitable extraction methods for the estimation of different biomolecules.

6. Evaluate the level of biomolecules in different food materials

List of Experiments:

1. Preparation of different biochemical solutions, study of concentration, units and measurements
2. Determination of starch in plant tissue
3. Qualitative tests for identification of carbohydrates
4. Estimation of reducing sugars by Di Nitro Salicylic acid method
5. Tests for lipids: - Fats and cholesterol
6. Estimation of cholesterol by Zak's method
7. Estimation of protein by Lowry's method or Bradford Assay
8. Qualitative analysis of amino acids for identification
9. Extraction and estimation of amino acid in different samples by Ninhydrin method
10. Estimation of DNA by diphenylamine method
11. Estimation of RNA by Orcinol method
12. Titration of amino acid

Reference:

1. Sawhney S. K., Randhir Singh, Introductory practical Biochemistry. Narosa publishers, 2006

19BT2008	MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To highlight the functions and characteristics of microorganisms
2. To study the growth of microorganisms and the impact of environment on their growth
3. To evaluate explicitly, the metabolic pathways, role of microbes in public health; insight into the physical and chemical control of microorganisms

Course Outcome:

The students will be able to;

1. Recall the basic knowledge on the development of microbiology
2. Recognize the fundamental concepts pertaining to the structure and functions of microbes
3. Appraise the importance of microscopy, staining techniques and classify the microorganisms
4. Apply appropriate physical and chemical methods to control the growth of microbes
5. Formulate the nutritional requirements for microbial growth and their metabolism
6. Compare and categorize the interactions of microorganisms with humans and animals

Module I: INTRODUCTION TO MICROBIOLOGY (9)

Historical perspectives of microbiology-classification, and nomenclature of microorganisms- Microscopy – light, phase, fluorescent and electron microscopy (SEM and TEM), Confocal Laser Scanning Microscopy (CLSM)- principles of different staining techniques - Gram staining, acid fast, capsular staining, flagellar staining and spore staining,16sr RNA sequencing

Module II: MICROBIAL STRUCTURE AND MULTIPLICATION (9)

Morphology, Structure and Functions of Prokaryotic cells, Multiplication of bacteria, Life cycles- viruses (bacteriophage), algae (Chamydomonas), protozoa (Plasmodicum vivax), fungi (Rhizopus stolonifer), yeast (Neurospora crassa) and actinomycetes

Module III: MICROBIAL NUTRITION AND METABOLISM (8)

Nutritional requirements of bacteria, Growth curve and Different methods to quantitative bacterial growth, Growth generation time and growth rate constant, factors affecting growth of microorganism. Microbial metabolism- Entner– Doudoroff and Phosphoketolase pathway

Module IV: CONTROL OF MICROORGANISMS (7)

Physical methods – sterilization: Moist heat, dry heat, radiation and filtration. Chemical methods: Disinfection, phenol, alcohol and detergents; Antibiotics- antibacterial agents, anti-fungal agents, anti-viral agents

Module V: MICROBIAL ECOLOGY (4)
Interaction between Microorganisms – Commensalism, Synergism, Mutualism (symbiosis), Lichen symbiosis, Autochthonous, Zymogenous
Module VI: MEDICAL AND FOOD MICROBIOLOGY (8)
Normal flora of human healthy host, Importance of nosocomial infections (hospital borne), mode of transmission of airborne pathogens, Medical Biofilms, Food and water borne infections caused by bacteria (botulism, cholera), Significance of microbes in food- Probiotics and fermented products-sauerkraut, cheese

Total Hours:45

Text Books

1. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.2007
2. Ananthanarayanan and Panicker, "Microbiology" Orientblackswan, 2015.

Reference Books

1. Talaron K, Talaron A, Casida, Pelczar and Reid. Foundations in Microbiology, W.C.Brown Publishers, 2001.
2. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 2001.
3. Lim D, "Microbiology", Second Edition, WCB-Mc Graw Hill, 2001.

19BT2009	MICROBIOLOGY LAB	L	T	P	C
		0	0	3	1.5

Co-requisite: 19BT2008- Microbiology
Course Objective:
The students will be able to;

1. To enable the students to understand the basic principles involved in the isolation of different kinds of microorganisms and gain accurate handling of microorganisms
2. Students will be taught about the different parts of microscopes and their functions
3. The students will learn to identify the microorganisms using various staining techniques and biochemical tests

Course Outcome:

1. Understand the basic knowledge on microbiological lab safety guidelines
2. Recognize the parts/functions of microscopes
3. Experiment with transfer of living microbes using aseptic technique
4. Develop media for cultivation of microorganisms
5. Demonstrate microbial isolation and staining techniques for identification of microorganism
6. Analyze different kinds of microorganisms present in clinical and environmental samples

List of Experiments:

1. Preparation and inoculation of media- Nutrient broth, Nutrient agar slant
2. Pure culture Techniques– streak plate
3. Enumeration of microorganisms from Soil/Water
4. Anaerobic Cultivation – Fluid Thioglycolate broth
5. Staining Techniques –Simple, Gram staining and spore staining
6. Staining of fungus – Lacto phenol cotton blue staining
7. Motility test by Hanging drop method
8. Antibiotic sensitivity assay – Disc diffusion method
9. Effect of Disinfectants- Phenol Coefficient
10. Growth Curve in Bacteria
11. Effect of pH, Temperature, UV radiation on growth Bacteria
12. Measurement of microbial Size – Micrometry

19BT2010	FLUID MECHANICS	L 3	T 1	P 0	C 4

Course Objective:

1. To develop skills of students related to the fundamental calculations involved to measure the properties of fluids, measurement of fluid flow
2. To ensure students to have a strong knowledge related to types of fluids, instrument used in fluid flow mechanism
3. To make student understand the fluid flow processes involved in different sections in industrial operations

Course Outcomes

The students will be able to

1. Understand the nature of fluids, statics and dynamics of fluid flow
2. Summarize the principles for flow in transportation of fluids in the problems related to the process engineering
3. Relate flow through pipe and flow past immersed object
4. Analyze the equations of fluid flow
5. Evaluate principles of fluid flow phenomena in scale up
6. Create empirical relations using dimensional analysis

UNIT I: BASICS OF FLUID STATICS and Fluid flow phenomena (12)

Fluid definition- compressible, in compressible fluids, fluid properties, Newtonian and Non-Newtonian fluids**,** fluid as a continuum, Classification of fluid motion, Fluid statics – basic equation – equilibrium of fluid element – pressure variation in a static fluid – application to manometry, fluid flow phenomena-laminar flow, turbulence, boundary layer

UNIT II: Basic Equations of Fluid Flow (12)

Differential analysis of fluid motion – continuity, equation of motions, Bernoulli equation and Navier-Stokes equation. Pressure loss in straight pipes – in fittings –expansion and contraction losses (applied to Newtonian Fluids only)

UNIT III: Incompressible flow in pipes and Flow past immersed Objects (12)

Reynolds number regimes, internal flow – flow through pipes – pressure drop under laminar and turbulent flow conditions, Flow past a sphere- drag and drag coefficient,– friction and pressure drag – flow through fixed bed of solids- pressure drop, fluidization- minimum fluidization velocity.

UNIT IV: Transportation and Metering of fluid (8)

Flow measurement – Constant and variable head meters; Velocity measurement techniques; pipes, fittings, Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans.

UNIT V: Agitation and Mixing of Liquids (8)

Agitated vessels, Blending and mixing, Agitator selection and scale up

Unit VI: Dimensional Analysis and Similitude (8)

The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi-theorem – non-dimensional action of the basic equations – similitude – relationship between dimensional analysis and similitude – use of dimensional analysis for scale up studies

Total hours: 60

Text Books

1. Munson, B. R., Young, D.F., Okiishi, T.H. “Fundamentals of Fluid Mechanics”, 5th Edition“, John Wiley, 2006
2. Noel de Nevers, “Fluid Mechanics for Chemical Engineers “, Second Edition, McGrawHill, 2001.

References

1. White, F.M., “Fluid Mechanics “, IV Edition, McGraw-Hill Inc., 2005

2. James O Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers' Prentice Hall PTR (International series in Chemical Engineering) 2004.
3. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2005

19BT2011	FLUID MECHANICS AND HEAT TRANSFER LAB	L 0	T 0	P 3	C 1.5

Course Objective:

1. To provide extensive knowledge on various unit operations in bioprocess industries
2. To ensure students to have a strong knowledge on various flow measuring equipments involved in bioprocess industries
3. To make student understand the fluid flow processes involved in different sections in industrial operations

Course Outcome:

The students will be able to

1. Understand the heat transfer concept and its applications.
2. Estimate the importance of fluid mechanics in different applications.
3. Analyze various flow meters for wide range of applications in industrial biotechnology
4. Demonstrate the friction factor for wide range of applications in industrial biotechnology
5. Evaluate the thermal conductivity of materials for wide range of applications in heat exchangers
6. Relate annular pipe for wide range of applications in industry.

List of Experiments

1. Determinations of Minor Losses in Pipes Due to Sudden Expansion
2. Determination of Coefficient of Discharge of Venturimeter
3. Determination of Darcy's Friction Factor
4. Determination of Friction Factor Losses Coefficient in Helical Pipe
5. Determination of Friction Factor in Annular Pipe
6. Determinations of Minor Losses in Pipes Due to Sudden Contraction
7. Determination of Coefficient of Discharge of Orifice Meter
8. Determination of Coefficient of Discharge of Rotameter
9. Determination of Thermal Conductivity of Composite Wall
10. Determine the overall heat transfer coefficient in Double pipe Heat Exchanger (Parallel and Counter Flow)
11. Determine the overall heat transfer coefficient in Shell and Tube Heat Exchanger

19BT2012	BIOPROCESS PRINCIPLES	L 3	T 0	P 0	C 3

Course Objective:

1. To understand the principles of bioprocessing and appreciate its applications in Bioprocess Technology
2. To ensure students to have a strong knowledge on the importance of medium formulations and optimization
3. To provide facts on sterilization kinetics

Course Outcome:

The students will be able to

1. Understand the process of fermentation and its requirements
2. Remember the process of media formulation and medium optimization for fermentation process
3. Analyze the kinetics of sterilization process
4. Apply knowledge on isolation and storage of industrially important microbes
5. Analyze methods to develop inoculum for various fermentation process

6. Evaluate the stoichiometry of cell growth and product formationduring fermentation

Module – I Overview of Fermentation Process (6)

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermenter and ancillaries, aseptic condition and containment, Sampling

Module – II Medium Formulation and Optimization (9)

Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation for optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations, medium optimization technique- Plackett-burmann method

Module – III Sterilization Kinetics (12)

Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of depth filters, design of sterilization equipment - batch and continuous.

Module – IV Inoculum Development (8)

Isolation of industrially important microbes, preservation and storage of industrially important microbes, Quality control of preserved stock cultures and development of inoculum for industrial fermentation

Module – V Stoichiometry of Cell Growth and Product Formation (8)

Stoichiometry of biochemical reactions, elemental balances, degrees of reduction of substrate and biomass, available electron balances.

Module –VI Yield Calculations (4)

Knowing the Priciples of product yield and calculations of yield coefficients of biomass and product formation.

Total Hours:45

Text Book

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.

Reference Book

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2002

19BT2013	BIOPROCESS LAB	L	T	P	C
		0	0	3	1.5

Co-requisite: 19BT2012- Bioprocess Principles

Course Objective:

1. To learn the culturing of microbes and quantifying biomass production
2. To provide extensive knowledge on enzyme kinetics
3. To learn immobilization techniques

Course Outcome:

The students will be able to

1. Acquire knowledge in the process of fermentation.
2. Demonstrate enzyme assay qualitatively and quantitatively
3. Examine factors affecting enzyme activity.
4. Apply methods to produce fermented products
5. Utilize solid state fermentation for production of fermented products
6. Assess the effect of substrate concentration on growth of microbes.

List of Experiments:

1. Culturing of Different Types of Microorganism
2. Estimation of Biomass Production by wet weight and dry weight method
3. Effect of Substrate Concentration on Growth of E-coli
4. Effect of pH on Enzyme Activity

5. Effect of Temperature on Enzyme Activity
6. Immobilization of α - Amylase Enzyme by entrapment method
7. Estimation of volumetric mass transfer coefficient
8. Citric acid production by Solid State Fermentation
9. Qualitative Enzyme Assay- Starch Plate Technique
10. Quantitative Enzyme Assay
11. Production of Wine
12. Production of Amylase from Bacillus subtilis and Assaying for its Activity

19BT2014	MOLECULAR BIOLOGY	L 3	T 0	P 0	C 3

Course Objective:

1. To understand the basics of molecular biology and gene expression.
2. To understand DNA damage and repair systems
3. To get an overview on the regulation of gene expression

Course Outcome:

The students will be able to

1. Recall the fundamental concepts of the prokaryotic and eukaryotic genome organization, its replication and gene expression
2. Understand the process of replication, transcription and translation
3. Recognize common mutations, their natural repair systems and inhibitors of gene expression
4. Distinguish the process of replication, transcription and translation of prokaryotes and eukaryotes
5. Appraise the post-synthesis modifications for transcription and translation
6. Comprehend the role of genetic code, chromatin, operons and cis/trans elements in gene regulation

Module I GENOME ORGANIZATION (8)

Classical experiments to prove genetic material: Griffith, Hershey and chase; Avery McLeod & McCarty. Genome organization in prokaryotes and eukaryotes – Molecular structure of DNA, Bacterial Recombination: Transformation, Transduction –types and Conjugation.

Module II DNA REPLICATION – PROKARYOTES (9)

DNA replication- Semi conservative replication - Meselson Stahl experiment, Enzymes in replication, Replication in prokaryotes-E.coli, D-loop and rolling circle mode of replication, regulation of replication, replication in virus - linear viral DNA replication, RNA replicase, Reverse transcriptase.

Module III DNA REPLICATION – EUKARYOTES AND MUTATIONS (5)

Replication in eukaryotes and telomere replication. Mutation: types, DNA repair systems - methylation, mismatch repair, Photo reactivation repair, SOS repair, recombination repair.

Module IV TRANSCRIPTION (9)

RNA polymerase, features of promoters and enhancers, transcription factors, Prokaryotic and eukaryotic transcription, post-transcriptional modification - RNA splicing and RNA editing, Inhibitors.

Module V GENETIC CODE AND TRANSLATION (7)

Elucidation of genetic code - salient features, Process of translation in prokaryotes and eukaryotes, Post-translational modifications, Inhibitors.

Module VI REGULATION OF GENE EXPRESSION (7)

Regulation of gene expression: In prokaryotes - lac and trp operons. Regulation in eukaryotes – cis and trans elements, chromatin re-organization in gene regulation.

Total Hours: 45

Text book

1. David Friefelder, "Molecular Biology", Narosa Publ. House. 6th edition 2003.

Reference books

1. David R. Hyde, "Genetic and Molecular Biology", Tata McGraw Publications, New Delhi, 4th edition, 2010.

2. Lehninger, A. L, Nelson. D. L and Cox, M. M, “Principles of Biochemistry”, Freeman Publishers, New York, fourth edition, 2005.

19BT2015	GENETIC ENGINEERING AND BIOETHICS	L 3	T 0	P 0	C 3

Course Objective:

1. Helps the student to understand the tools and steps in Genetic engineering.
2. Trains students on the strategy employed in genetic engineering.
3. Helps the student understand the application in genetic engineering and the social implications and the ethics to be followed.

Course Outcome:

The students will be able to

1. Describe the basics of genetic engineering
2. Understand the basic tools employed in genetic engineering.
3. To relate and evaluate the use of cloning vectors in genetic engineering.
4. Comprehend the concept of polymerase chain reaction and its applications.
5. Discuss and appraise the strategy and applications of gene cloning.
6. To analyze the need of Bioethics and IPR in biotechnological research.

Module I RESTRICTION ENZYMES (9)

Restriction enzymes- Classification-nomenclature; Ligases- Modifying enzymes; Probe preparation and the methods of labeling them; Southern hybridization-Northern hybridization; Western blotting, Autoradiography; DNA finger printing-RFLP Analysis-chromosome walking.

Module II IDEAL VECTORS PLASMIDS (9)

Properties of ideal vectors Plasmids as vectors- PBR322- pUC vectors--M13-Lambda phage vectors ,Cosmid vectors, Phagemids-Cloning vectors in Gram positive bacteria- streptomycetes, Shuttle vectors, Expression vectors, YAC, BAC, Mammlian cells-SV40.

Module III POLYMERASE CHAIN REACTION (9)

Mechanism of Polymerase chain reaction, types of PCR, Inverse PCR, Nested PCR, Molecular beacons, RACE PCR, RAPD, RFLP.

Module IV CONSTRUCTION OF RECOMBINANT DNA (9)

Construction of recombinant DNA: Preparation of competent cell-Transformation (Physical, chemical and biological methods of Transformation), transfection- Recombinant selection and screening of Recombinant DNA, Genomic Library, cDNA library.

Module V BIOETHICS (5)

Definitions,history & views on ethics and bioethics. Ethical issues pertaining to biology and biotechnology. Special procedures for r-DNA based product production.

Module VI BIOSAFETY GUIDELINES (4)

Biosafety regulations, r-DNA guidelines- National and international, levels of containment.

Total Hours: 45

Text Books

1. Desmond S. T. Nicholl, “An Introduction to Genetic Engineering”, 3rd Edition Cambridge University Press; South Asian edition, 2010.
2. Gene Cloning and DNA Analysis, 6th Edition, Blackwell Publishing Ltd 2010
3. Barry R. Schaller "Understanding Bioethics and the Law: The Promises and Perils of the Brave New World of Biotechnology" Praeger Publishers Inc, 2007.

Reference Books

1. Sandy B. Primrose, Richard Twyman “Principles of Gene Manipulation and Genomics” Backwell Scientific Publications 2010.
2. Sandhya Mitra, “Genetic Engineering Principles and Practice”, Macmillan Publications, 2008.

3. Richard Sherlock, John D. Morrey "Ethical Issues in Biotechnology" Rowman & Littlefield Publishers, 2002.

19BT2016	MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. The objective of the course the student will learn various basic techniques in molecular biology and genetic engineering.
2. The student will learn how to isolate DNA from various sources.
3. The student will learn to manipulate DNA.

Course Outcome:

The students will be able to

1. The student knows how to isolate DNA from Plant source.
2. The student knows how to isolate DNA from Animal source.
3. The student knows how to isolate DNA from bacterial source.
4. The student knows how to carry out qualitative and quantitative measurements on nucleic acids.
5. The student knows how to manipulate DNA using restriction and ligation techniques.
6. The student knows how to transfer DNA into bacteria by the transformation technique.

List of Experiments

1. Isolation of genomic DNA from plant tissue
2. Isolation of genomic DNA from animal liver
3. Isolation of genomic DNA from microorganism (E-coli)
4. Isolation of plasmid DNA from microorganism
5. Quantitative and qualitative analysis of isolated genomic DNA using spectrophotometer
6. Agarose gel electrophoresis of DNA and analysis of their molecular weights by gel documentation
7. Extraction of proteins from plant or animal tissue and confirmation with qualitative tests
8. Separation and identification of proteins by SDS-PAGE using Coomassie Brilliant Blue stain
9. Restriction enzyme digestion of DNA samples confirmation through agarose gel electrophoresis
10. Ligation of DNA fragments and confirmation through agarose gel electrophoresis
11. Competent bacterial cell preparation
12. Transformation of DNA into competent cells

19BT2017	BIOPROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. This course aims at making the students understand the fundamental principles and concepts of Bioreactor engineering.
2. This will help the student understand stoichiometric calculations, models of growth and product formation
3. To understand the basics of oxygen transfer in microbial bioreactors

Course Outcome:

The students will be able to

1. Remember principles of stoichiometry and concepts of bioreactor engineering.
2. Understand elemental balance equations and models of growth and product formation.
3. Classify various growth and product formation kinetics.
4. Apply methods to calculate volumetric mass transfer coefficients in bioreactors
5. Analyze various bioreactors for fermentation process.
6. Evaluate process control in Fermentation processes.

Module I STOICHIOMETRY OF CELL GROWTH AND PRODUCT FORMATION(9)
Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction ofsubstrate and biomass, available electron balances, various yield coefficients of biomass and product formation, oxygen consumption and heat evolution in aerobic cultures
Module II SIMPLE UNSTRUCTURED KINETIC MODELS (9)
Simple unstructured kinetic models for microbial growth, Monod model, Substrate uptake kinetics and maintenance coefficient, growth of filamentous organisms, product formation kinetics - Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Determination of kinetic parameters for Monod equation.
Module III OXYGEN TRANSFER IN MICROBIAL BIOREACTORS (9)
Oxygen transfer in microbial bioreactors; oxygen uptake rates and determination of oxygen transfer coefficients (k_La) by correlations and experimental methods; Mass transfer in heterogeneous biochemical reaction system, role of aeration and agitation in oxygen transfer and types of aerators and agitators.
Module IV BIOREACTORS FOR FREE AND IMMOBILIZED CELLS (9)
Bioreactors for free cells – batch, continuous, fed batch, chemostat with recycle and multi stage chemostat systems, air lift and loop reactor, Bioreactors for immobilized cells: packed – bed, fluidized bed and hollow – fibre membrane bioreactors. Basics of solid state fermentation, various scale- up criteria for bioreactors.
Module V PARAMETERS TO BE MONITORED AND CONTROLLED IN FERMENTATION PROCESSES (5)
Basic configuration of fermenter and ancillaries, main parameters to be monitored and controlled in Fermentation processes- Temperature, pressure, flow measurement, rate of stirring, shaft power, weight, Dissolved Oxygen, pH, inlet and exit gas analysis.
Module VI ANALYZING PROCESS PARAMENTERS (4)
Online data analysis of chemical parameter measurements for biochemical processes.

Total Hours: 45

Text Books

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2005.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005.

Reference Books

1. Lee, J.M, "Biochemical Engineering", 1st Edition, Prentice Hall, 2001.
2. Blanch, H.W and Clark, D.S, "Biochemical engineering", Marcel Dekker, 1997.

19BT2018	ENZYME ENGINEERING AND TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives

1. To learn the significance of enzyme, classification, application
2. To provide knowledge on kinetics based on different models and theories,
3. To learn on extraction and purification of enzymes, and their immobilization.

Course outcome
Upon successful completion of this course, students will be able to

1. Understand enzymes and enzymatic reactions
2. Relate the application of enzymes in various industries
3. Apply enzymes in free and immobilized form for various reaction
4. Analyze and solve problems related to enzymes and kinetics
5. Evaluate the processing and purification of enzymes
6. Hypothesize model for enzyme kinetics and inhibition types

Module I CLASSIFICATION AND CHARACTERISTICS OF ENZYME (7)
Brief introduction to enzymes, nomenclature and classification of enzymes, mechanisms of enzyme action, specificity of enzyme action, the structure–functionality relationships, concept and determination of

enzyme activity, Effect of physical and chemical factors on enzyme activity, concept of active site and energetics of enzyme substrate complex formation; principles of catalysis – collision theory, transition state theory; role of entropy in catalysis.

Module II ENZYME KINETICS AND INHIBITION (12)

Kinetics of enzyme catalyzed reactions. Importance and estimation of Michelis – Menten parameters, Multi substrate reactions- mechanism and kinetics, turnover number; Allosteric regulation of enzymes, Enzyme inhibition types and models- Competitive, Noncompetitive and Uncompetitive inhibitions. Inhibition kinetics- substrate, product and toxic compound; deactivation kinetics.

Module III EXTRACTION AND PURIFICATION OF ENZYMES (8)

Extraction and purification of enzymes from plant, animal and microbial sources, Extraction of soluble and membrane bound enzymes. Criteria of purity, Determination of molecular weight of enzymes, development of enzymatic assays

Module IV IMMOBILIZATION OF ENZYMES (7)

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, Encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages of different immobilization techniques. Design of immobilized enzyme reactors – Packed bed, Plug flow reactor, Fluidized bed and Membrane bioreactors

Module V ENZYME BIOSENSORS (5)

Design of enzyme electrodes and their application as biosensors in industry: healthcare and environment with example.

Module VI ENZYME APPLICATIONS (6)

Biotransformation application of enzymes- Hydrolytic, Reduction reactions, Oxidation reactions, Enzymes in organic synthesis, Application of enzyme in different industries, Modified and Artificial Enzymes

Total Hours: 45

Text Book

1. T Palmer, "Enzymes", Harwood Publishing Series, 2001. 6th edition, 2006.

Reference Books

1. Martin Chaplin and Christopher Bucke, "Text book on Enzyme Technology", Cambridge University Press, 4th edition, 2004.
2. Shuler, M.L. and Kargi, F, "Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd., 2nd edition, 2002.

19BT2019	HEAT AND MASS TRANSFER	L	T	P	C
		3	1	0	4

Course Objective:

1. To ensure students to having strong fundamental knowledge about heat transfer operations
2. To introduce them to the heat and mass transfer calculations for bioprocess and biochemical industries
3. To understand the industrial application and significance of these equipment in biotechnology

Course Outcome:

At the end of the course students will be able to

1. Understand the basic doctrine of heat transmits
2. Summarize and workout conduction effort
3. Recognize convection effort and amylase heat exchangers
4. Solve problems related to diffusion, leaching and adsorption
5. Estimate the number of stages for Distillation and absorption
6. Analyze the vertical of evaporators

Module-I – CONDUCTION (12)

Introduction- Modes of heat transfer-Thermal conductance and resistance- Temperature field and temperature gradient-mechanism of heat transfer. Conduction-Heat transfer by conduction-General heat conduction equation -Thermal diffusivity and equivalent thermal conductivity -Linear one-dimensional steady state conduction through plane, cylinders, spheres and composite walls.

Module-II CONVECTION AND RADIATION (12)

Convection– Types of convection-Individual and overall heat transfer coefficient- Reynolds's analogy-Natural convection– Forced convection, Radiation-Thermalradiation-Spectrumofelectromagneticradiation-Monochromatic Emissive Power of blackbody-Planck's Distribution Law – Kirchoff's Law - Total Emissive Power, problems on Stefan- Boltzmann's law and Wien's displacement law

Module-III HEAT EXCHANGER AND EVAPORATORS (12)

Heat exchanger-Types of heat exchange equipment and design of heat exchangers-effectiveness of heat exchangers–Logarithmic mean temperature difference –solving problems. Concept of evaporation-types - single effect evaporator -mass and energy balances, capacity, steam economics and effectiveness. Industrial evaporators.

Module –IV DIFFUSION AND INTER PHASE MASS TRANSFER (12)

Diffusion concept – types- mechanism, equimolar and non- equimolar counter diffusion- calculation and measurements, interface theory concept, mass transfer coefficient.

Module-V DISTILLATION AND ABSORPTION (8)

Raoult's law and VLE diagram and methods distillation, methods and types of distillation, calculation of number theoretical plates by McCabe –Thiele methods. Theories of absorption and design. Types of packing and merit and demerits.

Module –VI HEAT TRANSFER APPLICATIONS (4)

Concept of HTU, NTU and total height of column. Industrial application of these equipments.

Total Hours:60

Text Book

1. Holman, J. P., Heat Transfer, 9th Edition, McGrawHill, Singapore, 2002
2. Donald Q. Kern,ProcessHeatTransfer,TataMcGrawHill, New Delhi,1997

Reference Book

1. Mccabe,W.L.,Smith,J.C., andHarriott,P. Unit Operations of Chemical Engineering, McGraw Hill,NewYork, 6th Edition,2004
2. Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003

19BT2020	DOWNSTREAM PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know characteristics of cell types and their disruption methods.
2. To understand the principles of isolation, separation and purification of bioproducts
3. To analyze the different polishing methods available for bioproducts.

Course Outcome:

1. Understand the fundamentals of product isolation and separation techniques.
2. Distinguish various techniques for product recovery and polishing.
3. Explain operating principles across different solid(liquid)-liquid separation process
4. Analyze product recovery in solid liquid separation processes.
5. Compare the performances of different extraction techniques
6. Apply separation techniques for bio product recovery.

Module I OVERVIEW OF BIOSEPARATIONS (6)

Broad classification of bio products, characteristics of fermentation broths and bio products. Cell disruption and pretreatment: Analysis of various physical, chemical, enzymatic and mechanical methods for release of intracellular products, Flocculation: electrical double layer concept, mechanisms of charge dependent flocculation.

Module II PRODUCT RECOVERY (12)

Gravity sedimentation: Mechanisms of sedimentation, thickeners, classifiers, applications in downstream processing. Centrifugal bio separations: Theory of centrifugal settling- basic equations, centrifuge selection-RCF, scale up of centrifuges- sigma analysis, equivalent time.

Filtration: Equipments for conventional filtration- filter media, pretreatment methods, general filtration theory- Darcy's law, compressible and incompressible filter cakes, filtration cycle, scale up and design of filtration.

Module III ISOLATION OF BIOPRODUCT (12)

Adsorption, Extraction, aqueous two phase extraction, Precipitation, Membrane separation processes: reverse osmosis, dialysis, electro dialysis, pervaporation.

Module IV PURIFICATION (7)

Chromatographic separations, HPLC, Classification of techniques, elution chromatography- retention theory, Gas and liquid chromatography- Ion exchange chromatography, gel permeation chromatography, affinity chromatography

Module V FINISHING OPERATION (4)

Product crystallization: Basic principles- nucleation and crystal growth- supersaturation theory- commercial crystallizers- Recrystallization.

Module VI HEAT AND MASS TRANSFER IN DRYERS (4)

Product drying: Heat and mass transfer in drying- types of commercial dryers- vacuum dryers, freeze dryers, spray dryers. Lyophilization

Total Hours:45

Text Books

1. Paul A Belter, EL Cussler, Wei-shou Hu, Bioseparations: Downstream Processing for Biotechnology - Wiley Interscience, 2011.
2. Sivasankar B, Bioseparations: Principles and Techniques, Prentice-Hall of India Pvt. Ltd., 2008.

Reference Books

1. Roger g. Harrision; paul w. Todd; scott r. Rudge, “bioseparations science and engineering” oxford university press, 2015.
2. Don w. Green; nooralabettu krishna prasad “downstream process technology : a new horizon in biotechnology” phi learning private limited, 2010.
3. Richardson j.f.;harker j.h.;backhurst j.r. “coulson and richardsons chemical engineering volume 2 : particle technology and separation processes” butterworth-heinemann, 2006.
4. Christie john geankoplis “transport processes and separation process principles : includes unit operations” prentice hall of india private limited, 2006.

19BT2021	DOWNSTREAM PROCESSING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To strengthen principles of the unit operations involved in the separation and purification of a biological product
2. To learn on cell disruption techniques, solid liquid separation
3. To learn about product isolation, purification and polishing

Course Outcome

After successful completion of the course, the students will able to

1. Remember cell disruption techniques for intracellular product recovery.
2. Understand the separation methods to recover microbial cells from aqueous suspensions
3. Apply techniques of bulk product isolation.
4. Design purification strategy based on product characteristics.

5. Evaluate finishing operations.
6. Analyze scale up operations.

List of Experiments

1. Batch Sedimentation
2. Centrifugation
3. Filtration
4. Flocculation
5. Cell disruption techniques- sonication, homogenizer, solvent
6. Precipitation technique- Isoelectric precipitation, ammonium sulfate, PEG, Acetone
7. Liquid -liquid Extraction
8. Leaching
9. Batch Drying
10. Column Chromatography
11. Adsorption
12. Distillation

Text Books

1. Paul A Belter, EL Cussler, Wei-shou Hu, Bioseparations: Downstream Processing for Biotechnology - Wiley Interscience, 2011.
2. Sivasankar B, Bioseparations: Principles and Techniques, Prentice-Hall of India Pvt. Ltd., 2008.

Reference Books

1. Roger G. Harrision; Paul W. Todd; Scott R. Rudge, “Bioseparations Science and Engineering” Oxford University Press, 2015.
2. Don W. Green; Nooralabettu Krishna Prasad “Downstream Process Technology : A New Horizon in Biotechnology” phi learning private limited, 2010.
3. Richardson J.F.;Harker J.H.;Backhurst J.R. “Coulson and Richardsons Chemical Engineering volume 2 : Particle Technology and Separation Processes” Butterworth-Heinemann, 2006

19BT2022	IMMUNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To impart basic knowledge in Immunology encompassing, history, development, trend and its impact on society.
2. To familiarize with the organs and cells of the immune system, the immune response and molecular interactions involved in immune response.
3. To create awareness on the applications of immunology such as, immunodiagnosis and immunotherapy.

Course Outcome:

1. Recall the history and development and controversies of the field of immunology.
2. Recognize the types of immunity, the basic plan of the immune of the immune system and the organs of the immune system.
3. Identify the cells of the immune system and their functions.
4. Understand the functioning of the innate and adaptive immune system
5. Interpret the cellular & molecular interactions, physiology and the pathology of the immune system.
6. Infer the applications of immunology in diagnosis and treatment of diseases.

Module I IMMUNE SYSTEM (7)

Introduction and an overview of immunology, History of immunology, Types of Immunity - Innate and acquired immunity, Cell mediated and humoral immunity; Design of immune system- recognition & response. Organs of the immune system: Lymphoid organs - primary and secondary.

Module II CELLS OF THE IMMUNE SYSTEM (9)
Granulocytes and Agranulocytes, T and B Lymphocytes, NK cells, macrophage and dendritic cells their structure, characteristics, function and their identification. Haematopoiesis, extravasation, phagocytosis.
Module III HUMORAL SYSTEM (7)
Molecular nature and function of; Antigens, epitopes, haptens; Adjuvants. Antibody – structure, Classes, Genes and Antibody diversity. Antigen Antibody reactions; Neutralization, Opsonization. Complement system.
Module IV ADAPTIVE IMMUNITY - RECOGNITION, RESPONSES & REGULATION (7)
Major histocompatibility complex; antigen processing and presentation, T-Cell activation and the cellular immune response. Cytokines Injury and inflammation;
Module IV IMMUNE FUNCTION AND DYSFUNCTION (8)
Immunity to infections: immunity to virus, prokaryotic (Bacteria), & eukaryotic pathogens (parasites & fungi); Transplantation, graft rejection Immunosuppression Cancer immunology –Immune Dysfunction: Autoimmunity, Allergy, hypersensitivity & Immunodeficiency.
Module V APPLICATION AND IMPACT OF IMMUNOLOGY (7)
Diagnostics: Haemagglutination, ELISA, Western Blotting, Immunofluorescence Assay, Immunohistochemistry. Therapeutics and prophylactics; Abzymes, Monoclonal Antibody production, Chimeric & humanized antibodies. Vaccines, anti-vaccination movement and its impact.

Total Hours:45

Text Book
1. Roitt I, Male, Brostoff, “Immunology”, Mosby Publishers, 2002.

Reference Books
1. Tizard, “Immunology”, Saunders college publication, 5th Edition. 2004.
2. Kuby J, “Immunology”, WH Freeman & Co., 2000.
3. Ashim K. Chakravarthy, “Immunology”, TataMcGraw-Hill, 2001

19BT2023	CELL BIOLOGY AND IMMUNOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objective:
1. To acquaint the students with basic laboratory techniques involved in cell
2. To impart basic knowledge in Immunology,
3. To make the students aware of the applications of immunology such as, immunodiagnosis and immunotherapy

Course Outcome:
1. Student learns the effect of colligative properties on cell structure
2. Compare between live and dead cells
3. Identify the various stages of cell division
4. Perform various immunological techniques to enumerate antigen and/or antibody.
5. Student is aware of the application of immunology in diagnosis of disease.
6. Identify blood groups using immunological technique.

List of Experiments
1. Staining for Various Stages of Mitosis in Allium cepa (Onion)
2. Microscopically Identification of Cells in Permanent Fixed Slides
3. Widal Test for detecting Typhoid
4. Blood Grouping and Rh typing
5. Differentiation of Blood Cells Using Giemsa Staining
6. Osmosis and Tonicity Studies Using Red Blood Corpuscles
7. Preparation of Plasma and Serum
8. Antigen preparation.
9. Single Radial Immunodiffusion

10. Double Immunodiffusion – Ouchterlony Method
11. Immunoelectrophoresis
12. Counter Current Immunoelectrophoresis
13. Routes of immunization.

19BT2024	CHEMICAL REACTION ENGINEERING	L 3	T 1	P 0	C 4

Course Objectives

1. To provide knowledge on estimation of kinetic parameter
2. To establish core foundation for the analysis and design of chemical reactors
3. To impart the knowledge of reaction rate

Course Outcomes:

The students will be able to

1. Understand the kinetics of reactions
2. Remember the design equations and the performance of ideal reactors
3. Create various models for describing non- ideal behaviour of reactors
4. Analyse performance of combined reactors
5. Explain adsorption and desorption phenomena in heterogeneous systems.
6. Design of various fermenter / bioreactors

Module I HOMOGENEOUS REACTIONS (10)

Principles of Homogeneous reactions – and rate equations-estimation of rate constants using constant volume and constant pressure Batch reactor-data for typical reactions – Arrhenius equation-Non elementary reaction kinetics, reactions steps; resistances to rate equations.

Module IITYPES OF FLOW AND REACTIONS (9)

Ideal Flow and Non Ideal flow, RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow, Gas-Solid and Gas-Liquid reactions, Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.

Module III PERFORMANCE OF BIOREACTORS (7)

Broad outline of chemical reactors, Performance equations for single batch reactor, ideal CSTR, ideal PFR-Application to design, Industrial scale reactors.

Module IVMULTIPLE REACTOR SYSTEMS (7)

Multiple reactor systems – selection of suitable reactor systems for multiple reactions-recycle reactor-Principles in non-isothermal reaction and reactors, Semi-batch reactors,

Module V NON IDEAL REACTORS (7)

Non Ideal reactors- Non Ideal Flow-Tracer experiments and application-TIS model, Axial Dispersion model-for tubular reactors. Exchange volume and By Pass and dead volume models for CSTRS.

Module VI CATALYTIC REACTIONS (5)

Concept of effectiveness factor in Catalytic reactions-G-L-S-reactors – slurry reactor.

Total Hours: 60

Text Books

1. Levenspiel, Octave “Chemical Reaction Engineering”, 3rd Edition, John – WileySons, 2002.
2. Fogler, H.S. “Elements of Chemical Reaction Engineering”, 2nd Edition, Prentice Hall, 2002.

Reference Books

1. Missen, R.W. etal., “Chemical Reaction Engineering and Kinetics”, John – Wiley, 1999.
2. Davis, Mark E and Robert J. Davis “Fundamentals of Chemical Reaction Engineering” McGraw – Hill, 2005.
3. Harri ot, Peter “Chemical Reactor Design” Marcel Dekker, 2003.
4. Sila, Harry “Chemical Process Engineering : Design and Economics” Marcel Dekker, 2003
5. Nauman, E. Bruce “Chemical Reactor Design, Optimization, and Scaleup”, McGraw – Hill, 2002.

6. Richardson, J.E. and D.G. Peacock "Coul son & Richardson' s Chemical Engineering", Vol.3 (Chemical & Biochemical Reactors & Process control) 3rd Edition, Butterworth Heinemann/ Elsevier, 2006.

19BT2025	MASS TRANSFER AND CHEMICAL REACTION ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To learn chemical engineering principles
2. To provide knowledge on practical applications in the areas of mass transfer
3. To provide knowledge on reaction engineering and particle mechanics.

Course Outcome:

1. Ability to plan experiments and present the experimental data meaningfully
2. Ability to apply theoretical concepts for data analysis and interpretation
3. Capability to visualize and understand chemical engineering unit operations related to fluid and particle mechanics
4. Understand the experimental techniques related to chemical reaction engineering
5. Understand the basic laws of mass transfer.
6. Learn to operate various reactors

List of Experiments

1. Batch reactor
2. Semi batch reactor
3. Continuous stirred tank reactor
4. Plug flow reactor
5. Tank in series
6. Residence time distribution
7. Simple distillation
8. Single effect evaporator
9. Absorption column
10. Extraction

19BT2026	BIOCHEMICAL THERMODYNAMICS	L	T	P	C
		3	1	0	4

Course Objective:

1. To have strong foundation on the thermodynamic laws and concepts relevant to biochemical process.
2. To understand fundamental concepts such as enthalpy, entropy, fugacity, free energy, and chemical potential in biological system
3. To introduce behavior of pure fluid, partial molar properties

Course Outcome:

1. Recognize relevant thermodynamic properties of ideal and real fluids
2. Explain concept of entropy, enthalpy, partial molar property, fugacity, activity of thermodynamic system
3. Solve mathematical problem involving volumetric, thermodynamic properties of real fluids
4. Infer dependency of biochemical reaction equilibrium on pressure and temperature
5. Design solution of VLE problem with real fluid for improved recovery in bioprocess system
6. Create problems dealing with multi-phase biochemical systems.

Module – I: BASIC CONCEPTS AND VOLUMETRIC PROPERTIES OF FLUID (10)

System, Surrounding & Processes, Closed and Open systems, State Properties, Intensive & Extensive Properties, Phase rule, State and Path functions, work, heat, internal energy, specific heat, Energy Balance.

PVT behavior of pure fluids, equations of state and ideal gas law, PVT dependency. Equations of state for real gases: virial equation, Universal gas constant, virial coefficients, Application of the virial equations van-der Waals equation. Implied property relations for an ideal gas.

Module II: THERMODYNAMIC PROPERTY OF FLUIDS (8)
Fundamental property relations for a homogeneous fluid, Maxwell's equations, Enthalpy and Entropy as Functions of T and P, Gibbs Energy as a Generating Function, Residual properties, two-phase systems: Clapeyron equation.

Module III: SOLUTION THERMODYNAMICS (10)
Chemical potential and phase equilibria, partial molar property, Gibbs-Duhem equation, partial properties in binary solutions, ideal-gas mixtures, fugacity: fugacity, fugacity coefficient, fugacity of pure gases, solids and liquids. Fugacity and fugacity coefficient: species in solution, The Lewis-Randall Rule ideal solution.

Module IV: PHASE EQUILIBRIUM IN SOLUTION (8)
Criteria of phase equilibria, Duhem's theorem, Vapor-Liquid Equilibria, P*xy*, T*xy* diagrams. VLE using quantitative expression of Raoult's law, Non-Ideal solutions– activity co–efficient equation, Antoine calculation of Saturation pressure. Use of Margules equations, and the van Laar equations

Module –V: CHEMICAL EQUILIBRIUM REACTIONS (4)
Introduction to Chemical Reaction Equilibrium, Equilibrium criteria for homogeneous chemical reactions; Evaluation of equilibrium constant and effect of pressure and temperature on equilibrium constant; Calculation of equilibrium conversions and yields for single and multiple chemical reactions.

Module –VI BIOCHEMICAL THERMODYNAMICS (5)
Stoichiometry and energetic analysis of Cell Growth and Product Formation, elemental Balances, Degree of reduction concepts; available electron balances; yieldcoefficients; Thermodynamics of microbial growth.; Oxygen consumption and heat evolution, in aerobic cultures; thermodynamic efficiency of growth, Energy balance equation for free, cell culture, Reaction thermodynamics. pH dependence of a Biochemical Reaction **Total Hours: 45+15(T)**

Text Books

1. Introduction to Chemical Engineering thermodynamics - Joseph Mauk Smith, Hendrick C. Van Ness, Michael M. Abbott, McGraw-Hill, 2005
2. Thermodynamics of Biochemical Reactions - Robert A. Alberty, Wiley Inderscience, 2003.

References Books

1. Chemical and Engineering Thermodynamics, Stanley I Sandler, 4th Ed., John Wiley & Sons, Inc. 2006.
2. Chemical Engineering Thermodynamics By Y.V.C. Rao, New Age International.
3. Biological Thermodynamics, Donald T. Haynie, Cambridge University Press.

19BT2027	BASICS OF BIOINFORMATICS	L 2	T 0	P 0	C 2

Course Objective:

1. To learn and understand specific databases and perform effective database searches.
2. To learn and perform various *Insilco* analysis for gene and protein structure and function identification
3. To learn and perform target identification for drug-designing and to have a platform for interchange and exchange of knowledge with academia and industry.

Course Outcome:

Students are able to

1. Gain knowledge on Biological databases and tools.
2. Understand the significance of biological databases and their utilization.

3. Apply the knowledge of Bioinformatics skill to solve the biological problems in Genomics and Proteomics
4. Analyze different types of Biological databases and resources.
5. Evaluate the vital role drugs interacting to the target.
6. Create databases and tools of Drug like molecules.

Module I: INTRODUCTION TO BIOINFORMATICS (6)

Definition - Importance and uses of Bioinformatics- Information Technology- Systems Biology, Scope of Bioinformatics. Elementary Commands and Protocols, ftp, telnet,various file formats for biological sequences

Module II: BIOLOGICAL DATABASES (6)

Introduction to Biological databases, organization and management of databases, searching and retrieval of information from World Wide Web.-Primary sequence databases Composite sequence databases- Secondary databases- nucleic acid sequence databases - Protein sequence data bases.

Module III: SEQUENCING ALIGNMENT AND DYNAMIC PROGRAMMING (6)

Alignment-Local, Global alignment, pairwise and multiple sequence alignments. Concept of gap penalty and e-value. Alignment algorithms. Dynamic programming in sequence alignment: Needleman-Wunsch Algorithm and Smith Waterman Algorithm, Aminoacid Substitution matrices (PAM, BLOSUM).Sequence similarity search with database: BLAST and FASTA

Module IV: COMPUTATIONAL GENOMICS AND PROTEOMICS (6)

Comparative genomics and Proteomics; Understanding DNA microarrays and protein arrays, Gene and protein prediction strategies, phylogenetic analysis

Module V: MOLECULAR MODELING AND DRUG DISCOVERY (3)

Basic concepts of Homology, threading, abinition protein structural modeling, Molecular simulation,

Module VI: DRUG DISCOVERY (3)

Virtual ligands library preparation, target identification and validation, optimization of ligand, docking studies, Industrial application of CADD.

Total Hours: 30

Text Books

1. Dan Gusfield, “Algorithms on Strings Trees and Sequences”, Cambridge University Press, Cambridge, 2017.
2. David Mount W., “Bioinformatics sequence and genome analysis”, CBS Publishers, New Delhi, 2nd Edition, 2013.

References Books

1. D.W. Mount. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbour Laboratory Press, New York, 2012.
3. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, Wiley and Sons, 2012
4. S.C. Rastogi and N. Mendiratla and P.Rastogi. Bioinformatics methods and applications- Genomics, Proteomics and Drug Discovery. Prentice Hall India, 2013
5. A.M. Lesk. Introduction to Bioinformatics. Oxford University Press India, 2017.

19BT2028	BIOINFORMATICS LAB	L 0	T 0	P 1	C 1

Co-requisite:19BT2027-Basics of Bioinformatics

Course Objective:

1. To provide the necessary protocols about biological resources.
2. To teach the tools used for biological sequential data analysis and phylogenetic.
3. To understand the methods of analyzing and gene and promoter prediction.

Course Outcome:

Students are able to

1. Know the basic essential tools in bioinformatics and implementation.
2. Understand practically to carry out the protocols about Bioinformatics resources.
3. Apply hands-on experience on pair-wise, multiple sequence alignment along with molecular phylogenetic.
4. Analyze gene and promoter prediction.
5. Evaluate the biological databases resources and tools
6. Create biological databases and tools

List of experiments:

1. Biological Databases with Reference to Expasy and NCBI
2. Queries based on Biological databases
3. Sequence similarity searching using BLAST
4. Pairwise sequence alignment
5. Multiple Sequence and Phylogenetic Analysis
6. Gene Prediction
7. Protein Familes –SCOP,Pfam and CATH
8. Secondary Structure prediction
9. Tertiary Structure Predicition
10. Analysing the geometry of protein and visuavalize the protein using protein databank and swiss-pdb viewer.
11. Homology Modeling Using Modeller Protein
12. Molecular Interaction

		L	T	P	C
19BT2029	**INDUSTRIAL SAFETY AND HAZARD ANALYSIS**	**3**	**0**	**0**	**3**

Course Objective:

1. To inculcate the knowledge among students about safety procedures
2. To understand the risk analysis and assessment
3. To learn and understand hazard identification

Course Outcome:

The students will be able to

1. Understand plant safety in selection and layout of chemical plants and the usage of safety codes.
2. Distinguish the chemical, fire and explosion hazards
3. Relate the occupational diseases
4. Analyze the bio medical and engineering response to health hazards
5. Evaluate the effective process control and instrumentation methods
6. Create awareness the usage of safety codes

Module I NEED FOR SAFETY (9)

Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling

Module II SAFETY PROCEDURES (9)

Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety

Module III PLANNING AND RISK ASSESSMENT (4)

Overall risk analysis-emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies.

Module IV QUANTITATIVE RISK ASSESSMENT (5)

Quantitative risk assessment - rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

Module IV SAFETY AUDITS (9)

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras-Vizag Bopal analysis

Module V CASE STUDIES (9)
Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system.

Total Hours: 45

Text Books

1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 3rd edn. 2011.
2. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965.

References

1. Handley, W., "Industrial Safety Hand Book ", 2nd Edn., McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
3. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994.

19BT2030	ENVIRONMENTAL POLLUTION CONTROL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. To give an exposure to various control acts
2. To study the advantages and disadvantages of impact assessment methods
3. To study the methods of reducing the waste and reusing it.

Course Outcome:
The students will be able to

1. Understand basics of pollution and its types
2. Remember Pollution control acts and regulations.
3. Apply bio safety principles in pollution control.
4. Evaluate audit reports on pollution control.
5. Evaluate various approaches for biomedical waste treatment and disposal
6. Analyse various recycling methods

Module I: POLLUTION CONTROL ACTS (9)
The water (prevention and control of pollution) act 1974 and rules 1975- CPCB-form XIII,XIV,XV,The air (prevention and control of pollution) act 1981 and rules 1982,CPCB-form I,VI. National ambient air quality standards.

Module II: ENVIRONMENT PROTECTION ACT (9)
The environment (protection) act 1986, rules 1986-definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous, standards of emission or discharge of environmental pollutants. Form V

Module III: ENVIRONMENTAL IMPACT ASSESSMENT (9)
Environmental impact assessment notification, 2006-environmental clearance, list of projects, form I, general structure of EIA documents, content of summary EIA, Environment management, Environment Audit

Module IV: BIOSAFETY (9)
The manufacture, use, import, export and storage of hazardous microorganisms genetically engineered organisms or cells rules, 1989-definitions, competent authorities, animal and human pathogens

Module V: BIOMEDICAL WASTE DISPOSAL (4)
Biomedical waste (management and handling) 1998,-categories of biomedical waste, colour coding and type of container for disposal of biomedical wastes.

Module VI: TRANSFER WASTE EQUIPMENT DISPOSAL (5)

Transport of biomedical waste containers/bags (schedule IV), standards for treatment and disposal of biomedical wastes (schedule V), waste management facilities like incinerator/autoclave/microwave system, form-I,II,III.

Total Hours: 45

Text book:

1. C. S. Rao Environmental Pollution Control Engineering, New Age International, 2007

Reference Books

1. Peter Wathern, “Environmental Impact Assessment theory and practice”, Unwin Hyman Ltd. Routledge, 1990,
2. L. Lee Harrison , “Environmental Health and Safety Auditing Handbook”, 2nd edition, McGraw Hill, Inc., New York, 1995
3. Kirkwood, R. C. and Longley, A. J., “Clean Technology and Environment”, Chapman Hall, 1995.

19BT2031	PROCESS EQUIPMENT DESIGN AND ECONOMICS	L	T	P	C
		3	0	0	3

Course Objective:

1. To design safe and dependable processing facilities.
2. This course focus on plant layout and design of piping systems
3. This will provide the basic knowledge to carryout design process cost effectively.

Course Outcome:

The students will be able to

1. understand principles of process equipment design and safety considerations
2. Understand design of storage vessel and pressure vessel asper ASME and ISI codes
3. Apply the Scale up criteria of bioreactors
4. Analyze the plant layout.
5. Design various unit operation equipment
6. Evaluate process economics

Module I Introduction to Process Design & Flow sheet Development (9)

Introduction. General design information for chemical biochemical processes plants. Development of flow sheet. Design of the equipments as per ASME, ISI codes, drawing according to scale,

Module II HEAT EXCHANGERS, EVAPORATORS (9)

Shell and tube heat exchanger, double pipe heat exchanger, Single effect evaporator and vertical tube evaporation

Module III DESIGN OF SEPARATION PROCESSES (9)

Design &Construction details and assembly drawing of distillation column; absorption Towers

Module IV PIPING, PLANT LAY OUT AND DESIGN 9

Various types of Piping, material of construction, their usage; Pipe lay out; Modern Plant Design and case Studies.

Module V ECONOMICS (4)

Introduction to cost diagrams, application of cost diagrams, Introduction to Project Economics, Process Selection and Site Survey, Project Cost estimation, Time Value of Money, Interest and Depreciation, Project Finance & Profitability Analysis

Module VI APPLICATIONS (5)

The use of equipments designed for biotechnology industry for different purposes: Reactors, Airlift, Fluidized Bed, Packed bed reactor, costing of reactors

Total Hours: 45

Text Books

1. Joshi, M.V, “Process Equipment Design”, MacMillan, 3rd edition, 2004.

Reference Books

1. Peters, Max S.,K.D. Timmerhaus and R.E. West,Plant Design and Economics for Chemical Engineers (5th Ed), McGraw-Hill International Editions (Chemical Engineering Series), New York, USA (2003)
2. Mahajani,V.V., Chemical Project Economics, Macmillan Indian Ltd., New Delhi, India (2005)
3. Smith, R., Chemical Process: Design and Integration, John Wiley and Sons, West Sussex, UK (2005)
4. McCabe, W.L., J.C. Smith and P. Harriott "Unit Operations of Chemical Engineering", 6^{th} edition, McGraw-Hill, 2001.
5. Wnell, L.E, & Young, E.H.: Process Equipment Design, Wiley Eastern, New Delhi, 2000.
6. Ludwig, E.E.: Applied Process Design for Chemical & Petrochemical Plants, Vols. I, II & III, (2nd Ed.), Gulf Publishing Company, Texas, 1977, 1979, 1983.
7. Perry, R.H. & Green, D.W.: Perry's Chemical Engineers' Handbook, (7th Ed.),McGraw Hill (ISE), 2000.

19BT2032	PROCESS DYNAMICS AND CONTROL	L	T	P	C
		3	0	0	3

Course Objective

1. To control and measure the processing facilities in a cost effective manner.
2. To focus on plant layout control and piping systems
3. To provide knowledge on control systems

Course Outcomes:

The students will be able to

1. Understand the basic concept of control systems
2. Apply the knowledge of linear loop systems
3. Interpret the principle of control systems
4. Analyse Frequency response and correlate with advanced control systems
5. Evaluate Digital controllers
6. Combine different control modes for process equipment.

Module-I INSTRUMENTATION (9)

Principles of measurement and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH , concentration , electrical and thermal conductivity, humidity of gas

Module-II OPEN LOOP SYSTEMS (8)

Open loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

Module –III CLOSED LOOP SYSTEMS (8)

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element; principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability

Module-IV FREQUENCY RESPONSE (8)

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings

Module –V ADVANCED CONTROL SYSTEMS (8)

Introduction to advanced control systems, cascade control, feed forward control, model predictive control, Smith predictor controller,

Module –VI APPLICATION OF COMPUTER CONTROL (4)

Computer control of chemical processes, Control of distillation Column and heat exchanger, PID Control system in bioreactor

Total Hours: 45

Text Books

1. Coughnowr, D. R., Process Systems Analysis and Control, Mc Graw Hill, New York, 2nd Edition,2001.
2. George Stephanopolous, Chemical Process Control, Prentice-Hall of India Pvt-Ltd., New Delhi, 2002.
3. D.E. Seborg, T.E. Edgar, D.A. Mellichamp. Process Dynamics and Control, Wiley India Pvt. Ltd., Fourth Edition, 2016.

Reference Books

1. Doeblin Ernest, Measurement Systems, Mc Graw Hill, New York , 2005
2. A.Suryanarayanan, "Chemical instrumentation and process control", Khanna Publishers, 2nd edition, New Delhi , 1995
3. Process Control – Modeling, Design & Simulation, B. Wayne Bequette
4. Process Dynamics, Modelling and Control, Prentice Hall.B. Ogunnaike and W.H. Ray (1994). Oxford University Press
5. Marlin, T. E., " Process Control ", IInd Edn, McGraw Hill, New York, 2000.
6. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control",IInd Edn., John Wiley, New York, 1997.

19BT2033	MECHANICAL OPERATIONS	L	T	P	C
		3	0	0	3

Course Objective:

1. To ensure students to having strong fundamental knowledge about various unit operations
2. To introduce them to the Characterize particles and perform size reduction and size analysis of particles
3. To understand the industrial application and significance of these equipment in biotechnology

Course outcome:

At the end of the course the students would be able to

1. Understand various size reduction Techniques
2. Explain conveyors &storage vessels for particular applications
3. Illustrate the principle, construction and operation of various classification equipments
4. Apply the principles of agitation and mixing
5. Evaluate the parameters of filtration
6. Summarize different separation process

Module- I SIZE REDUCTION AND SOLID PARTICLES (13)

Introduction to unit operations and their role in bio chemical Engineering industries- Characteristics of particulate solids- Sampling techniques- Specifications- Screen analysis- Particlesizedistribution,particlesizemeasurement-Surfaceareameasurements- Relevant equations and problems. Principles of size reduction -Specific properties of solids for size reduction –Energy required for size reduction-Crushing and grinding efficiency- Laws of crushing- Classification of crushing and grinding equipment, Scope and applications-Size enlargement techniques

Module –II TRANSPORTATION AND CONVEYING (9)

Conveying of bulk solids: Classification of conveyors- Selection of conveyors- Storage of solids in bulk protected and unprotected piles- Bins-Silos- Hoppers- Mass flow and funnel flow bins- Flow assisting devices-Feeders-Weighing of bulk solids-Batch and continuous weighing techniques.

Module –III CLASSIFICATION OF SOLID PARTICLES (9)

Classification of separation methods for different type of mixtures like solid-solid, solid-gas- solid-liquid- Screening-Classification of screening equipments – Mechanical classification and classifiers-Rare and dense medium separation- Magnetic separation-Electrostatic separation- Floatation and Elutriation-Phase separation - Centrifugal separation - Electrostatic precipitators - Impingement separators - Gas solids separation-Gravity settling -Cyclone separators-Bag filters scrubbers.

Module-IV MIXING BLENDING (5)

Mixing of solids, solid- liquid mixing, blending, kneading, impeller -Design of agitator- power of agitation - Correlations for power consumption.

Module-V FILTRATION (4)

Filtration- Batch and continuous filtration, compressible and in compressible filter cakes.

Module –VI FILTRATION DEVICES (5)

Calculations for specific cake resistance, filter medium resistance-Industrial filters-Centrifugal filtration.

Total Hours: 45

Text Books

1. Mccabe,W.L.,Smith,J.C., andHarriott,P.,UnitOperationsofChemicalEngineering,McGraw Hill,NewYork,6thEdition, 2004.
2. Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4thEdition, 2003

Reference Books

1. CoulsonJ.M.,RichardsonJ.F.,BackhurstJ.R.andHarkerJ.M.,CoulsonandRichardson's Chemical Engineering, Volume I, ButterworthHeinemann,Oxford, 5th Edition, 2002
2. CoulsonJ.M.,RichardsonJ.F.,BackhurstJ.R.andHarkerJ.M., Coulsonand Richardson's Chemical Engineering, Volume II, Butterworth Heinemann,Oxford, 5th Edition, 2002

19BT2034	MECHANICAL OPERATIONS LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To ensure students to having strong fundamental knowledge about various unit operations
2. To introduce them to the Characterize particles and perform sizer education and size analysis of particles.
3. To understand the industrial application and significance of these equipment in biotechnology

Course Outcome:

At the end of the course the students would be able to

1. Characterize particles and perform size analysis
2. Evaluate the power consumption for Particle size reduction and size enlargement.
3. Evaluate the constants for crushing.
4. Design and operate filtration equipments
5. Analyze Solid liquid separation in industrial equipment based on settling, density and centrifugal force.
6. Evaluation of filtration effect medium and cake resistance.

List of experiments

1. Studies in an agitated vessel
2. Drag studies
3. Particle size distribution
4. Screening Efficiency
5. Drying characteristics using through flow dryer.
6. Determination of area of a thickener by batch sedimentation test
7. Size reduction using Jaw Crusher and Verification of crushing laws
8. Size reduction using Ball Mill and determination of specific surface area
9. Drop weight crushing and verification of crushing laws
10. Determination of specific cake resistance and filter medium resistance for leaf filtration

11. Drying characteristics using cross flow dryer
12. Determination of specific cake resistance and filter medium resistance for filtration in a plate and frame filter press.

Text Books

1. Mccabe,W.L.,Smith,J.C., and Harriott,P., Unit Operations of Chemical Engineering, McGraw Hill,NewYork,6th Edition, 2004.
2. Geankoplis, C. J, Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003.

Reference Books

1. CoulsonJ.M.,RichardsonJ.F.,BackhurstJ.R.andHarkerJ.M.,CoulsonandRichardson'sChemical Engineering, Volume I, ButterworthHeinemann,Oxford,5th Edition, 2002
2. CoulsonJ.M.,RichardsonJ.F.,BackhurstJ.R.andHarkerJ.M.,Coulsonand Richardson's Chemical Engineering, Volume II, Butterworth Heinemann,Oxford,5th Edition, 2002

19BT2035	BIOCHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. To provide the idea to determine the rates of enzyme catalyzed reactions and to provide knowledge on the immobilization of enzymes.
2. To provide knowledge regarding cell growth patterns and design of various bioreactors.
3. To study the enzyme kinetics and inhibition models

Course Outcome:

The students will be able to

1. Recognise chemical and biochemical processes
2. Understand growth kinetics and enzyme kinetics in biochemical processes.
3. Apply various growth and enzyme inhibition models in biochemical reactions.
4. Analyze the role of aeration and agitation in fermentation process.
5. Evaluation of sterilization Process
6. Compile instrumentation for monitoring and control of bioreactors.

Module I CHEMICAL AND BIOCHEMICAL PROCESSES (6)

Comparison of chemical and biochemical processes, industrially important microbial strains, preservation and storage of industrially important microbes, Quality control of preserved stock cultures

Module II ENZYME KINETICS (9)

Kinetics of single substrate reactions without inhibition- Michelis – Menten parameters, Estimation of MM parameters, Enzyme Inhibition – Substrate, Product and Toxic compound inhibition, types and derivation.

Module III UNSTRUCTURED KINETIC MODELS FOR GROWTH (12)

Simple unstructured kinetic models for microbial growth, Monod model, Substrate uptake kinetics and maintenance coefficient, growth of filamentous organisms, product formation kinetics - Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Determination of kinetic parameters for Monod equation

Module IV OXYGEN TRANSFER IN MICROBIAL BIOREACTORS (9)

Oxygen transfer in microbial bioreactors; oxygen uptake rates and determination of oxygen transfer coefficients (k_La) by correlations and experimental methods; Mass transfer in heterogeneous biochemical reaction system, role of aeration and agitation in oxygen transfer and types of aerators and agitators.

Module V BIOREACTORS FOR FREE AND IMMOBILIZED CELLS (5)

Bioreactors for free cells – batch, continuous, fed batch, chemostat with recycle and multi stage chemostat systems, air lift loop reactor,

Module VI BIOREACTOR EQUIPMENT (4)

Bioreactors for immobilized cells: packed – bed, fluidized bed and hollow – fibre membrane bioreactors.

Total Hours: 45

Text books

1. Shuler M.L and Kargi F, "Bioprocess Engineering Basic Concepts" Prentice Hall of India 4th edition, 2002.

Reference books

1. Lee, J.M, "Biochemical Engineering", Prentice Hall, 2nd Edition, 2001.
2. Blanch, H.W and Clark, D.S, "Biochemical engineering", Marcel Dekker, 1997.

19BT2036	BIOCHEMICAL ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To provide the idea to determine the rates of enzyme catalyzed reactions and to provide knowledge on the immobilization of enzymes.
2. To provide knowledge regarding cell growth pattern and bioreactors.
3. To study the enzyme kinetics and inhibition models

Course Outcome:

The students will be able to

1. Understand chemical and biochemical processes
2. Estimate growth kinetics models
3. Illustrate various enzyme kinetics
4. Design batch and continuous Process
5. Analyze batch reactors
6. Apply enzymes in bioprocesses

List of Experiments:

1. Production of citric acid
2. Comparative study between Free & Immobilized Enzyme
3. Determine the enzyme specificity using α-Amylase
4. Growth kinetics of Baker's Yeast
5. Determination of MM Parameters
6. Batch Reactor –I [Equimolar Concentration]
7. Batch Reactor – II [Non – Equimolar Concentration]
8. Semi batch Reactor
9. Mixed Flow Reactor
10. Determine the rate constant for second order reaction using Batch reactor
11. Study of thermal death kinetics
12. Plackett Burmann method

19BT2037	CANCER BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To educate students the complexity and regulatory networks involved in cancer development process
2. To learn the mechanism involved at cellular and molecular level so as to develop new strategies of therapy.
3. To understand the current strategies of cancer detection, prevention and treatment.

Course Outcome:

Upon completion of the course, the students will be able to

1. Remember the epidemiology of cancer and principles of carcinogenesis
2. Outline the different forms of cancer and the principles of their development
3. Understand the complex pathways and molecular switches involved in the transformation of a normal cell to a cancer cell.
4. Relate the cell biology with the regulatory imbalance in carcinogenesis, detection and therapy
5. Recognize the molecular mechanism of cancer spread, its markers and therapy.
6. Evaluate the current strategies of cancer diagnosis, prevention and treatment to develop new drugs.

Module I: FUNDAMENTALS OF CANCER BIOLOGY (9)

Cancer: Definition, causes, properties, and classification-incidence; Cell Cycle: Regulation of cell cycle, cell proliferation, differentiation and apoptosis – Role of signal transduction pathways and signal switches, Apoptosis pathways, Modulation of cell cycle in cancer, Cancer metabolism.

Module II: PRINCIPLES OF CARCINOGENESIS (6)

Theory of carcinogenesis- Chemical carcinogenesis, Physical carcinogenesis; X-ray radiation, Biological -mechanisms; Stages of cancer: initiation, promotion, progression. Epigenetics of cancer.

Module III: MOLECULAR CELL BIOLOGY OF CANCER (9)

Signal targets and cancer – Growth factors related to Transformation – Activation of kinases – Oncogenes: c-Myc, Ras, Bcl-2 family – Mechanism of oncogene activation – Retroviruses and oncogenes – Tumor suppressor genes: Rb, p53, APC, BRCA paradigms – Telomerases.

Module IV: PRINCIPLES OF CANCER INVASION AND METASTASIS (6)

Clinical significances of invasion - Three step theory of invasion and metastasis cascade- Role of cell adhesion molecules, and proteinases - Angiogenesis: VEGF signaling

Module V: CANCER DETECTION TECHNIQUES (4)

Cancer screening – sampling methods, clinical interpretation on stages/grades and early detection, Tumor markers; Imaging techniques, Advances in cancer detection- oncogenes/proto oncogene activity, Tumour suppressors and other molecular markers.

Module VI: CANCER THERAPY (5)

Different forms of therapy: Chemotherapy, Radiation therapy, Immunotherapy, Molecular therapy, Use of signal targets towards therapy of cancer, Gene therapy, Cancer prevention and palliative care strategies.

Total Hours: 45

Text Books

1. Stella Pelengaris, Michael Khan, The molecular Biology of Cancer, Blackwell Publishing, 1st edition, 2006.
2. Robert A. Weinberg, The Biology of Cancer, Garland Science, 2nd edition, 2014

References Books

1. Macdonald F and Ford CHJ. "Molecular Biology of Cancer", Bios Scientific Publishers, 2002.
2. Robert G, Mckinnell, Ralph E. Parchment, Alan.O. Perantoni, G. Barry Pierce, "The Biological Basis of Cancer", Cambridge University Press, New York. 2003.

19BT2038	CLINICAL DATABASE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objective:

1. To learn and understand clinical data management and its role in clinical research.
2. To impart clear understanding on various essential elements of Clinical Research and Clinical Data Management.
3. To train you on different aspects and activities involved: CRF Designing, Data entry, Data Collection, AE Management, and Report Creation etc.

Course Outcome:

The students will be able to,

1. Outline on clinical trials ,data management and preparation
2. Describe the analytics and decision support using various tools.

3. Utilize enterprise-wide information assets in support of organizational strategies and objectives.
4. Inspect the concepts of database architecture and design.
5. Interpret the roles and responsibilities of healthcare workspace commodities.
6. Elaborate the reliability and accuracy of secondary data sources.

Module I: INTRODUCTION OF CLINICAL TRIALS (9)

Basic statistics for clinical trials, Roles & Responsibilities of Key Stakeholders, Preparations & Planning for Clinical Trials, Essential Documentation in Clinical Research & Regulatory Submissions, Clinical Trials Project Planning & Management, Study Start Up Process, Clinical Monitoring Essentials, Compliance, Auditing & Quality Control in Clinical Research

Module II: CLINICAL DATA MANAGEMENT (9)

Introduction to Data Management, Data Definition & Types, Study Set Up, CRF Design Considerations, Data Entry, Remote Data Entry, Identifying and Managing Discrepancies, Medical Coding, Database Closure, Data Management Plan, Electronic Data Capture, Tracking CRF Data, Managing Lab Data, Collecting Adverse Event Data, Creating Reports and Transferring Data, Enterprise Clinical Data Management Tools.

Module III: CLINICAL DATA ANALYSIS AND MANAGEMENT (9)

Study set-up, Introduction to Clinical Database , Documents, guidelines used in CDM, Data Entry, Data Review/Data Validation, Query Management, Data management plan, Project management for the clinical data manager, Vendor selection and management, Data management standards in clinical research, Design and development of data collection, Edit check design principles

Module IV: CLINICAL CASE REPORT FORMS (9)

CRF Completion Guidelines, CRF printing and vendor selection, Data validation, programming and standards, Laboratory data handling, External data transfer, Patient –reported outcomes, CDM presentation at investigator meetings, Metrics for clinical trials, Systems Software Validation Issues Clinical Trials Database Environment

Module V: CLINICAL QUALITY AUDIT (4)

Audit –Definition, types & procedures, Audit standards, Audit trail & its role in authenticity of data, Audit plan, Audit by regulatory authorities,

Module VI: CLINICAL LOGISTICS AND REGULATIONS (5)

GMP, GDP & logistics, Preparing and delivering audit reports, what makes a good audit, New product development & GxP Regulations

Total Hours: 45

Text Book

1. Susanne Prokscha, Practical Guide to Clinical Data Management, Third Edition, CRC Press; 3 edition, 2011.
2. Richard K Rondel (2000) Clinical Data Management, Second Edition. Wiley Publishing House, 2000.

Reference Book

1. Rondel, R.K., Varley, S.A. and Webb, C.F. eds., Clinical data management. New York: Wiley, 2000
2. Smith, Jonathan A., ed. Qualitative psychology: A practical guide to research methods. Sage, 2015.
3. Machin, D., Day, S. and Green, S. eds., Textbook of clinical trials. John Wiley & Sons, 2007.

		L	T	P	C
19BT2039	**CLINICAL DATABASE MANAGEMENT LAB**	**0**	**0**	**1.5**	**1.5**

Co-requisite: 19BT2038- Clinical Database Management

Course Objective:

1. To understand the types of clinical data, samples, and software
2. To develop the skills to analyze the clinical trial data management

3. To develop the skills to evaluate clinical data management

Course Outcome:

The students will be able to,

1. Rephrase medical terminology, clinical data management to develop databases for health care.
2. Demonstrate clinical data submission and interpret the clinical results.
3. Explain skills to analyze clinical data.
4. Organize the health care skills to validate data.
5. Examine the Case Report Forms to store clinical data.
6. Gain skillful knowledge of the management of clinical data used in clinical trials.

List of experiments:

1. Contribute to the design of protocols, forms, and data collection process Queries based on Biological databases
2. comprehensive database programming
3. Create data validation checks
4. Issue and resolve data queries
5. Create and maintain data management plans
6. Full data integration (eCRF, images, laboratories, other instrumentation)
7. Manage and document study specific change control process
8. EDC and other data management systems
9. SAE reconciliation
10. Medical term coding (i.e. adverse events, medications)
11. Serious adverse Event Management
12. Data Extract and SAS Extract Locking and Freezing

		L	T	P	C
19BT2040	**PLANT AND ANIMAL BIOTECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objective:

1. To create awareness in Plant and Animal biotechnology.
2. To impart knowledge in micromanipulation techniques in cell culture.
3. To understand the principles of transgenic plants and animals.

Course Outcome:

The students will be able to

1. Acquire knowledge in plant biotechnology and its applications.
2. Gain the knowledge about to increase the production in agriculture products.
3. Prepare them to work in the Agriculture industries.
4. Demonstrate *In vitro* fertilization and the manipulation of embryo done for genetic screening will provide wider understating among the students and create awareness
5. Development of transgenic animals for breed development for enhanced milk production
6. Adapt appropriate ethical guidelines in animal biotechnology

Module I PLANT CELL AND TISSUE CULTURE (4)

Plant cell and Tissue culture: Tissue Culture media, Callus and suspension culture, Somoclonal Variation,

Module II MICROPROPAGATION AND OTHER TECHNIQUES (5)

Micropropagation, Organogenesis, Somatic embryogenesis, transfer and establishment of whole plants in soil, green house technology, Artificial seeds, Protoplast fusion and somatic hybridization, cybrids; anther, pollen and ovary culture for production of haploid plants.

Module II PLANT GENETIC TRANSFORMATION (9)

Plant Genetic Transformation Methods: Features of Ti and Ri Plasmids and its use as vectors,
Use of reporter genes and marker genes, gene transfer methods in plants: direct and indirect DNA transfer, Chloroplast transformation and its advantages.

Module III APPLICATION OF PLANT GENETIC TRANSFORMATION (9)
Application of Plant Genetic transformation: Herbicide resistance: Insect resistance, Disease resistance antifungal proteins, PR proteins, nematode resistance.
Module IV INTRODUCTION TO CELL CULTURE (9)
chemically defined and serum free media. Primary cell culture, Establishment of cell line, Maintenance and Preservation of cell line. Scale up of Cell cultures for Product development.
Module V TRANSGENIC ANIMALS (9)
In Vitro fertilization, Embryo transfer- Micromanipulation technology, germ cell manipulation, sperm and embryo sexing, Transgenic Animals and their significance. Ethical issues in Animal Biotechnology

Total Hours: 45

Text Books

1. Introduction. R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.
2. Animal cell culture 3rd ed., by John R.W. Masters A Practical Approach Oxford University press New York 2005
3. H.S. Chawala. Introduction to plant Biotechnology, Oxford and IBH Publishing Co. Pvt. LTD.New Delhi 2002.

Reference Books

1. Bojwani, S.S. "Plant Tissue Culture: Applications and Limitations", Elsevier science publishers, 2001.
2. Ian Freshney, "Culture of Animal Cells", Wiley-Liss, 5th edition, 2005
3. **Grierson,D. "Plant Biotechnology in Agriculture Prospects for the 21st Century", Academic press, 2012**
4. Doyle, A.R. Hay and B.E. Kirsop, "Living Resources for bio technology", Cambridge University press, Cambridge, 1990
5. Ed. John R.W. Masters, "Animal Cell Culture - Practical Approach", Oxford University Press, 3rd edition, 2000.
6. Dunmock N.J and Primrose S.B., "Introduction to Modern Virology", Blackwell Scientific Publications, 2002

19BT2041	STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:
1. This course will take students on a journey into the stem cell biology and biotech revolution.
2. This course will provide details regarding social implications associated with stem cell technology.
3. The course offers an opportunity to understand the basics of stem cells, embryonic stem cells, adult stem cells and genetic engineering of stem cells and their applications.

Course Outcome:
1. To student gain knowledge in Stem cell basics, growing of ES cells in lab, differentiation of stem cells and application of stem cells.
2. They understand recent advancements in the biotechnological applications using both adult and embryonic stem cells.

Module I: INTRODUCTION (4)
Overview of Stem cell technology; Introduction to Cell Culture; Pros & Cons of Cell culture; Primary and Secondary cultures & Hayflicks limit, telomerase;
Module II: TECHNIQUES (5)
Aseptic Technique and Cell culture Lab equipments & etiquette.
Module III: TYPES OF STEMS CELLS (9)
Totipotency, Pleuripotency, Types of Stems Cells; Embryonic stem cells; Pleuripotent Stem Cells; Adult Stem cells; Induced Pleuripotent Stem Cells

Module IV: ISOLATION OF STEM CELLS (9)
Growth factors; chord cells; Derivation & differentiation of ES Cells; Derivation & differentiation of Pleuripotent Cells; Induced Pluripotent cell-Methods; Genetic & epigenetic reprogramming.
Module V: APPLICATIONS OF STEM CELL TECHNOLOGY(9)
Neurogenesis; Use of stem cells in Vascular biology; Use of stem cells in cardiac disease; Use of stem cells in Cancer; Stem cells of Liver, Gut and pancreas; Use of stem cells in tissue engineering & Gene therapy.
Module VI: ETHICAL CONCERNS OF STEM CELL TECHNOLOGY (9)
Problems and perspectives in stem cell technology; Alternatives to stem cells; Deeper concerns in stem cell technology-Immortality, longevity, ageing.

Total Hours: 45

Text Book
1. Handbook of Stem Cells edited by Anthony Atala, Robert Lanza. (Vol-1) Second edition. Academic press, 2013.

References Books:
1. Stem Cell Biology - edited by Daniel R Marshak, Richard L Gardener, David Gottlieab, Cold Spring Harbor Press, 2005.
2. Kursad and Turksen, "Embryonic Stem cells", Humana Press, 2002.

		L	T	P	C
19BT2042	**BIOPHARMACEUTICAL TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objective:
1. To demonstrate the fundamentals of biopharmaceutical technology to undergraduate students.
2. To motivate the students in understanding and analyzing the metabolism and mode of action of drugs.
3. To elaborate the process of formulations of drugs and to apply them in clinical trials as per the regulations.

Course Outcome:
The students will be able to
1. Recall the steps in preparation of biopharmaceutical products.
2. Illustrate knowledge on drug development, principles and mechanism of actions of drug.
3. Compare various pharmaceutical products available commercially.
4. Infer various testing and quality assurance procedures in drug formulation.
5. Evaluate the advances in drug manufacturing process.
6. Relate the regulations in clinical trial and management.

Module I DRUGS (9)
Introduction - Development of Drugs and Pharmaceutical Industry. Drug Metabolism and Pharmacokinetics - Drug Metabolism – Physico-Chemical Principles –Pharmacodynamics – Action of drugs in humans.
Module II MANUFACTURING PRINCIPLES (9)
Manufacturing Principles - Compressed tablets – wet granulation, – Dry granulation – Direct compression – Tablet presses formulation – Coating – Pills – Capsules sustained, action dosage forms. Quality control tests for tablets and capsules. Packaging of solid dosage forms.
Module III FORMULATIONS (9)
Manufacturing Principles – Parental, solutions – Oral liquids – injections – Ointments. Quality control tests for semisolid and liquid dosage forms. Packaging of semisolid and liquid dosage forms.
Module IV PHARMACEUTICAL PRODUCTS – VITAMINS AND ANTISEPTICS (4)
Pharmaceutical Products- Vitamins – Cold remedies – Laxatives –Analgesics –External Antiseptics – Antacids, ayurvedic formulations.
Module IV ANTIBIOTICS AND rDNA PRODUCTS(5)
Antibiotics – Biologicals – Hormones. Recent advances in the manufacture of drugs using r-DNA technology.

Module V TRIALS & REGULATIONS (9)
Clinical Trials & Regulations - Clinical Trials – Design, double blind studies, placebo effects. FDA regulations (General) and Indian Drug regulations- highlight. Good Laboratory Practice, Good manufacturing practice.

Total Hours: 45

Text Books

1. DM Brahmankar, Sunil B Jaiswal, "Biopharmaceutics and Pharmacokinetics-A Treatise", Vallabh prakashan, 2017.
2. Ansel, H., Allen, L., Popovich, N, "Pharmaceutical Dosage Forms and Drug Delivery Systems", Williams & Wilkins, 9thEdition, 2010.

Reference Books

1. Lippin cott, "Remington's Science and Practice of Pharmacy", Williams & Wilkins publishers, 2005.
2. Goodman & Gilman's, "The pharmacological basis of therapeutics" by Joel Griffith Hardman, Lee E. Limbird, Alfred G. Gilman.2005
3. Tripathi KD, "Essential of Medical pharmacology", Jaypee Brothers Medical Publishers 2003.

19BT2043	AGRICULTURAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To demonstrate the basics of genes, genomes and breeding principles to the undergraduate students.
2. To motivate the undergraduate students in analyzing the tools and techniques in genetic engineering.
3. To elaborate the understanding of biodiversity and IPR issues in agricultural crops.

Course Outcome:

The students will be able to

1. Acquire knowledge on genome organization of plants
2. Outline the principles of plant breeding and its techniques
3. Demonstrate various tools involved in genetic engineering
4. Illustrate the different strategies for biodiversity conservation
5. Acquire knowledge on IPR and its importance in patent rights
6. Demonstrate different tools of plant genome analysis

Module I GENOMES AND GENES (9)
Chromatin structure, Karyotype analysis, Genome organization – C-Value para, dox, Cot curves & significance, Chromosome behaviour

Module II AGRICULTURE AND PLANT BREEDING (9)
Breeding of crops, Heterosis , Apomixis, Mutations , Polyploidy in crop improvement, Principles of integrated Pest Management

Module III TOOLS AND TECHNIQUES OF GENETIC ENGINEERING (9)
Recombinant DNA technology, Concept of Genetic makers; gene interaction, multiple allelism, pleiotropism and multiple factor inheritance. Genetic, Chromosomal and Molecular map, Techniques in genetic engineering

Module IV BIODIVERSITY (6)
Genetic diversity Molecular diversity; Species and Population biodiversity, Collection and conservation of biodiversity, endangered plants, endemism and Red Data Book, Biodiversity and centers of origins of plants; Biodiversity hot spots,

Module V INTELLECTUAL PROPERTY RIGHTS (3)
IPR in relation to Indian Flora- Basmati Rice, Turmeric and Neem

Module VI GENOME ANALYSIS (9)
Genome projects, Genome Annotation, Biological Data Bases, Data base search engines, Sequence Analysis and Molecular Phylogeny

Total Hours: 45

Text Books

1. Principles of Gene Manipulation S. B. Primorose, RM Twyman and R.W. old sixth edition Blackwell science, 2001.
2. Induction of Bioinformatics – T.K. Attwood & D.J. Parry-Smith, Pealson Education Singapore Pvt. Ltd Indian, Indian Branch, Delhi, 2002.

Reference Book:

1. Gene Cloning and DNA analysis, an introduction, Fourth edition TA Brown Blackwell science, 2001.
2. From Genes to clones, Introduction to gene Technology. Panima Publishing Corporation, 2003.
3. Lewin's Genes XII Hardcover by Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, 2017

19BT2044	METABOLIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. To develop skills of the students in the area of metabolic engineering to alter the existing metabolic pathway
2. To introduce novel metabolic pathways in microorganisms using r-DNA technology
3. To learn molecular techniques in order to enhance the product yield

Course Outcome:

The students will be able to;

1. Comprehend modern biology with engineering principles
2. Recall the basic principles and regulation of metabolic pathways
3. Adapt suitable metabolic control analysis to identify important steps in pathway control
4. Demonstrate different methods to obtain improved production strains
5. Categorize the synthesis of primary and secondary metabolites and bioconversion process
6. Apply the concept of metabolic engineering in chemical, medical, and environmental fields

Module I: CELL METABOLIC ENGINEERING (4)

Improvement of cellular properties, altering transport of nutrients including carbon and nitrogen

Module II: REGULATION OF PRIMARY METABOLIC PATHWAYS (9)

Feedback control systems, alteration of feedback regulation for enhanced production of primary metabolites: glutamic acid, Mutants which do not produce feedback inhibitors or repressors- auxotrophs- lysine, isoleucine, arginine, purine nucleotides.

Module III: REGULATION OF SECONDARY METABOLIC PATHWAYS (9)

Producers of secondary metabolites, Precursor effects, trophophase- idiophase relationship, applications of secondary metabolites

Module IV: IMPROVED PRODUCTION OF SECONDARY METABOLITES (9)

Antibiotics, vitamins, Mycotoxins- maintenance of genetic stability; Bioconversions

Module V: BASICS IN METABOLIC FLUX ANALYSIS (9)

Analysis of metabolic control in glycolysis, metabolic flux analysis and its applications in aminoacid production by glutamic acid bacterium

Module VI: APPLICATIONS OF METABOLIC ENGINEERING (5)

Product over production examples: amino acids, polyhydroxyalkanoic acids, By-product minimization of acetate in recombinant *E. coli*, Extension of substrate utilization range for organisms such as *S. cerevisae* and *Z. mobilis* for ethanol production,

Total Hours: 45

Textbooks

1. Gregory N. Stephanopoulos, Aristos A. Aristidou & Jens Nielsen, "Metabolic Engineering: Principles and Methodologies", Academic Press, An Imprint of Elsevier India Pvt. Ltd., 1st edition, 1998.

2. S. Cortassa, M.A.Aon, A.A.Iglesias and D.Llyod, "An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Co. Pte. Ltd, 2002.

Reference Books

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 3rd edition, 2016
2. W.Crueger and A. Crueger, "A Text Book of Industrial Microbiology", Panima Publishing Corporation, 2005
3. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, Seventh edition, 2017.

19BT2045	RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To intend the students with the knowledge about the basic research methods, applications in conducting research, various data collection and analysis techniques.
2. To gain insights into scientific research.
3. To help in critical review of literature and assessing the research trends, quality and extension potential of research and equip students to undertake research.

Course Outcome:

1. To understand the basic principles of research and its formulation
2. Illustrate the different methods of research designs and its specific applications
3. Classify the various techniques of data collection and statistical analysis
4. Elaborate the steps involved in preparation of different technical report and articles
5. Comprehend the bioethical and biosafety procedures in research
6. Gain knowledge on formulation, execution and evaluation of application oriented research

Module I: RESEARCH PROBLEMS (5)

Definition and characteristics of research, Basic Concepts- Validity, reliability, Variables- Dependent, Independent and Intervening, Types-Basic and applied- Interdisciplinary - formulation of research problem,

Module II: RESEARCH DESIGN AND EXPERIMENTAL DESIGN (4)

research design -Hypothesis: formulation- Types: Descriptive,relational and explanatory- Methods of Research: descriptive, comparative, experimental- clinical research- controlled clinical trials

Module III: SAMPLE DESIGN, MEASUREMENT AND SCALING TECHNIQUES (9)

Steps in sample design, Criteria for selecting a sample procedure, Characteristics of Good sampling Procedure, Types of Sample Design, Selecting Random Samples, Complex random sampling Design, Measurement Scales, Sources of Errors in measurement, Tests of Second measurement, Technique of developing Measurement Tools, Scaling-Classification and design.

Module IV: COLLECTION, PROCESSING AND ANALYSIS OF DATA (9)

Data collection: methods and types- Processing Operations-Editing, coding, tabulation, Data Analysis, Statistics in Research, Measures of Central Tendency, Dispersion, Asymmetry, relationship. Regression Analysis, Correlation Analysis, Software for statistical analysis- SPSS- features

Module V: MANUSCRIPT/THESIS WRITING (9)

Research report - Types of Research reports, steps of manuscript, thesis and review of literature, Literature citation, Impact factor of journals, Citation index of journals, H-factor, Bibliography and References, Methods of presentation of report, significance of report writing

Module VI: ETHICS AND BIOSAFETY (9)

Introduction- Scientific conduct and misconduct – Authorship issues- basic principles of human and animal research ethics- international regulation- Laboratory safety, biosafety, recombinant material safety, Standard operation protocol

Total Hours: 45

Text Book

1. C.R. Kothari, “Research methodology, Methods and techniques”, New Age International (P) Ltd, Publishers, 2nd edition, 2000.

Reference Books

1. Jerrod H. Zar, “Biostatistical analysis”, Prentice Hall International, Inc. Press, 1999.
2. Donald H. McBurney, “Research methods”, Thomson Asia Pvt. Ltd. 2002
3. Ranjit Kumar, “Research methodology”, Sage Publications, London, 2006.
4. Raymond – Alain, “Doing Management research”, Sage publications, 2001.

19BT2046	MOLECULAR FORENSICS	L 3	T 0	P 0	C 3

Course Objective:

1. The molecular forensics provides students with experiences and information that will broaden their understanding of the field of Forensic Science and crime scene investigations.
2. To ensure students in having foundation Forensics and molecular techniques in forensics.
3. A concurrent goal of the subject is to develop observational, organizational and cognitive skills so to be able to integrate their experiences and knowledge so to solve problems.

Course Outcome:

The Student will able to

1. Exhibit the current state of forensic biological testing and infer forensic investigation
2. To find evidence with proper methods of investigation through biological samples
3. To categorize the investigation and identify the criminals based on molecular based techniques for paternal disputes
4. Appraise the knowledge in paleo biology and anthropology and its importance in Forensics
5. Find evidence and identify the suspects through case studies
6. Discover the role of PCR in Forensics,

Module I: INTRODUCTION TO FORENSIC SCIENCE (9)

Introduction to Crime Laboratories, Responsibilities of the Forensic Scientist, Securing and Searching the Crime Scene, Recording and Collection of Crime Scene Evidence,Document Examination, Ethics and Integrity

Module IIDISCOVERY AND RECOVERY OF HUMAN REMAINS (9)

The Autopsy and Handling of a Dead Body, The Stages and Factors of Decomposition, Determining the Age and Provenance of Remains, Asphyxia, Gunshot Wounds, Bite Marks

Module III PATTERN ANALYSIS (9)

Human Tissues, Body Fluids and Waste Products, Fingerprints, Hair, Teeth, Blood, Detecting the Presence of Blood, Bloodstain Pattern Analysis , Forensic anthropology, Paleontology, Toxicology

Module IV FINGER PRINTING (5)

Mitochondrial, DNA, DNA Finger Printing- RFLP. STR Genotyping issues, VNTRS and STR, mt DNA analysis, Identification of suspects.

Module V RAPD IN FORENSICS (4)

RAPD in Forensics, Study of Kinnship by DNA Profilig.

Module VI FORENSIC CASE STUDIES (9)

Forensic Case studies by molecular identification, PCR directed Y chromosome sequences, PCR Amelogenein Gene, Types of sequencing; forensic significance of polymorphic enzymes, forensics in paternity disputes.

Text Book

1. Lincoln PJ & Thomson J, “Forensic DNA Profiling Protocols”, Humana Press. 2011.

References Book

1. Rudin N & Inman K. “An Introduction to Forensic DNA Analysis”, 2nd Ed. CRC Press. 2002.

19BT2047	PROTEIN ENGINEERING	L	T	P	C
		3	0	0	3

Course objectives

1. To ensure the strong knowledge in protein architecture through a detailed study of protein structure.
2. To realize the structure-functional relationships of proteins
3. To impart advance knowledge the characteristic properties of proteins and their significance in biological systems

Course Outcome:

The students will be able to,

1. Illustrate various interactions in protein architecture.
2. Describe the structure and classification of proteins
3. Outline the characteristics of individual amino acids and their effect on the solubility, structure and function of proteins
4. Inspect the factors significant for protein folding processes and stability
5. Analyse the purity and stability and modification of proteins.
6. Formulate measurements of isolated proteins and characterize their purity and stability.

Module-I BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS (9)

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure. Amino acids (three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

Module II PROTEIN ARCHITECTURE (9)

Primary structure: peptide mapping, peptide sequencing – automated Edman method & mass- spec. High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turnalpha, beta-turn- beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds.

Module III TERTIARY STRUCTURE (9)

Prediction of substrate binding sites, Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures. Quaternary structure: Modular nature, formation of complexes, protein-protein interactions and methods to study it

Module IV STRUCTURE-FUNCTION RELATIONSHIPS (4)

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers, Membrane proteins: General characteristics, Trans-membrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center

Module V IMMUNOGLOBULINS AND ENZYMES (5)

Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications

Module VI PROTEIN ENGINEERING AND PROTEIN DESIGN(9)

Protein data base analysis–methods to alter primary structure of proteins –Examples of engineered proteins –Protein design, principles and examples. Methods in Proteins engineering; Immunotoxins; mechanism and its applications; Drug designing; structure based approach, receptor based approach.

Total Hours: 45

Text Books

1. Branden C. and Tooze J., “Introduction to Protein Structure”, 2nd Edition, Garlan Publishing, 1999.

2. Creighton T.E. "Proteins: Structures and Molecular properties", 2nd Edition. W.H. Freeman, 1992.

References Books

1. Kristian M. Müller and Katja M. Arndt—Protein Engineering Protocols;, Third Edn. Humana Press, 2007
2. Gregory A. Petsko and Dagmar Ringe—Protein Structure and Function, second Edition, Oxford University Press USA, 2004

19BT2048	PLANT TISSUE CULTURE	L	T	P	C
		3	0	0	3

Course Objective:

1. To create awareness in plant biotechnology.
2. To impart knowledge in micromanipulation techniques in cell culture.
3. To understand the principles of transgenic plants.

Course Outcome:

The students will be able to

1. Acquire knowledge in cell and tissue culture techniques.
2. Gain the knowledge about to plant genetic engineering tools.
3. Learn the various applications of plant tissue culture.
4. Understand the molecular concepts of disease resistance factors in plants.
5. Study the development of transgenic plants on abiotic and biotic factors
6. Assess about the scope and applications in plant biotechnology

Module I CELL AND TISSUE CULTURE (9)

Definition and need; Types of Methods in plant Biotechnology; Cell and Tissue Culture; Micro propagation; Callus Culture; Somatic Embryogenesis; Hairy Root Culture; Culture Medias.

Module II PLANT GENETIC ENGINEERING TOOLS (9)

Vectors and Genetic Engineering; Agro bacterium mediated gene transfer and cloning; Agro bacterium types; Plant viruses and Genetic Engineered viruses as a tool of deliver foreign DNA; major plant viruses, Camv, TMV, BBTV, Gemim viruses etc.

Module IIIAPPLICATION OF PLANT BIOTECHNOLOGY (9)

Hairy Root Cultures and Secondary Metabolite production; Plant as Bioreactors- edible Vaccines; Germplasm conservation; Gene Banks; Crop improvement; legume symbiosis, N_2 Fixation; Regulation of NIF and NOD Genes.

Module IV MOLECULAR ASPECTS OF DISEASE SUSCEPTIBILITY AND RESISTANCE (9)

Transposable elements, factors influencing disease resistance and susceptibility RFLP

Module V: **TRANSGENICS – ABIOTIC FACTORS (4)**

Stress tolerance-Biotic and abiotic temperature, salinity, drought etc;

Module VI: **TRANSGENICS – BIOTIC FACTORS (5)**

Pests and insects resistance- viral resistance- development of disease resistance plants by introducing *Bacillus thuringiensis* genes.

Total Hours: 45

Text Books

1. Mantal S.H., Mathew J.A.,Mickee R.A., Principles of Plant Biotechnology. An Introduction to Genetic Engineering in Plants, Blackwell Scientific Publication, 2006.
2. Marx J.L., Revolution in Biotechnology, Cambridge University Press, 2002.

Reference Books

1. Dodds J.H., Plant Genetic Engineering, Cambridge University Press, 2005.
2. R.C. Dubay and Maheswari. Introduction to Microbiology, S.Chand, 2002.

19BT2049	ANIMAL BIOTECHNOLOGY AND CELL CULTURE	L 3	T 0	P 0	C 3

Course Objective:

1. To develop skills of the students in the area of animal biotechnology
2. To learn the protocols involved in cell culture techniques
3. To understand the applications in Cell culture and Tissue engineering

Course Outcome:

The students will be able to

1. Demonstrate practically about primary cell culture techniques, maintenance of cell line
2. Understanding the use of scaling up of cell culture and the production of products from cell cultures
3. Gaining knowledge in the latest field of Tissue engineering and to culture cells in 3D methods and its applications
4. Understand about *In vitro* fertilization and the manipulation of embryo done for genetic screening will provide wider understating among the students and create awareness
5. Study the development of transgenic animals will make the students to know more about breed development and choosing of the breeds for milk production
6. Assess about the scope and applications and ethical issues in animal biotechnology

Module I INTRODUCTION TO CELL CULTURE (9)

Layout of cell culture laboratory chemically defined and serum free media. Primary cell culture, Establishment of cell line, Maintenance and Preservation of cell line.

Module II SCALING UP OF CELL CULTURES (9)

Suspension cultures, Continuous flow cultures, Immobilized cultures, Cell culture as a source of various products – Vaccine Production

Module III TISSUE ENGINEERING (9)

3D culturing, Different stages of tissue engineering, Protocols for 3D culturing of cells, Different types of cells in matrices for tissue engineering.

Module IV MICROMANIPULATION OF EMBRYOS (9)

Micromanipulation technology, Enrichment of X and Y bearing sperms from semen samples of animals: Artificial insemination and germ cell manipulation, *In Vitro* fertilization and Embryo transfer technology.

Module V: TRANSGENIC ANIMALS (5)

Concepts of Transgenic Animal technology: Strategies for the production of Transgenic animals and their importance in Biotechnology,

Module VI: STEM CELL TECHNOLOGY AND ETHICS (4)

Stem cell cultures in the production of transgenic animals, Ethical issues in Animal Biotechnology

Total Hours: 45

Text Books

1. *R.* Ian Freshney. Introduction to Culture of Animal *Cells*: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.
2. Animal cell culture 3rd ed., by John R.W. Masters A Practical Approach Oxford University press New York 2005

Reference Books

1. Ramadass P, Meera Rani S. “Text Book of Animal Biotechnology”, Akshara Printers, 2000.
2. Ranga M.M. “Animal Biotechnology”, Agrobios India Limited, 2002
3. Methods in Biotechnology, Animal cell Biotechnology. Methods and Protocols. 2nd Ed., Edited by Rolf Portner. Humana Press. 2007.

19BT2050	PLANT AND ANIMAL TISSUE CULTURE LAB	L	T	P	C
		0	0	1.5	1.5

Course Objective:

1. To learn the basic techniques of animal cell culture
2. To impart the technical skills of plant tissue culture
3. To develop the knowledge of preservation and conservation techniques in cell culture

Course Outcome:

The students will be able to

1. Gain knowledge in Animal cell culture technique
2. Understand the sterilization techniques and its importance
3. Analyze and determine the growth of cells in *in vitro*conditions
4. Evaluate the viability cells in animal cell culture
5. Apply the propagation methods for commercially important plants
6. Adapt *in vitro* techniques in animal and plant cell cultures for product development

List of Experiments

1. Basics of tissue culture laboratory design and maintenance.
2. Packing and Sterilization of glass and plastic wares for cell culture.
3. Preparation of reagents and media for Animal cell culture.
4. Quantification and cell viability test using Tryphan blue.
5. Culturing of Spleenocytes from Spleen.
6. Isolation and culturing of Thymus cells.
7. Introduction to Plant Cell & tissue Culture.
8. Types of Sterilization in Plant Tissue Culture
9. Preparation and sterilization of different culture media.
10. Sterilization and inoculation of explants for micropropagation.
11. Sterilization and inoculation of explants for callus culture.
12. Preparation of synthetic seeds.

19BT2051	ROLE OF BIOTECHNOLOGY IN ENVIRONMENT	L	T	P	C
		3	0	0	3

Course Objective:

1. To learn the importance of biotechnology
2. To learn the importance of environment
3. To understand the significance of conservation

Course Outcome:

The students will be able to

1. Acquire knowledge on the scope of biotechnology
2. Classify the health hazards of various pollutants
3. Explain the importance of waste water treatment
4. Understand the significance of waste management
5. Outline the various bioremediation techniques
6. Adapt the conservation of biodiversity

Module I SCOPE OF ENVIRONMENTAL BIOTECHNOLOGY (9)

Environmental Pollution; Types, Causes and Effects of Soil, air, water, oil and heavy metal. Pollution, control measures. Social Issues- Green House Gases, Global Warming, Acid Rain, Ozone depletion, nuclear accidents and holocaust.

Module II INDUSTRIAL WASTE WATER MANAGEMENT (9)

Purification of waste water; Aerobic and anaerobic treatments; Management of radioactive pollutants in water, VOC, COD BOD and BOD sensors.

Module III BIOMASS, ENERGY AND SOLID WASTE MANAGEMENT (9)
Biomass waste as renewable source of energy; Methods of energy production; Conversion of Solid Waste to Methane; Biogas production; Biofuels, Management of Sludge and Solid waste treatment- Land filling, lagooning, Composting and Vermi Composting.

Module IV BIODIVERSITY TYPES (5)
Definition, Types, Genetic, Species, Ecosystem; Biodiversity at Global Levels; Values of Biodiversity; Hotspots in Biodiversity; Loss of Biodiversity and its causes threats to Biodiversity;

Module V BIODIVERSITY CONSERVATION (4)
Biodiversity and its Conservation- In situ and Ex situ

Module VI BIOREMEDIATION AND BIODEGRADATION (9)
Types- Ex situ and In situ Bioremediation; genetically Engineered Microbes for Bioremediation.

Total Hours: 45

Text Book:

1. Dubey, R.C. "Text Book of Biotechnology", S. Chand & Co, 2nd edition, 2004.
2. **Chatterjee, Introduction to Environmental Biotechnology, PHI Learning pvt ltd,3rd Edition 2011**
3. **Indu Shekhar Thakur Environmental Biotechnology: Basic Concepts and Applications, IK International Publishing House pvt Ltd, 2011**

Reference Books:

1. Foster C.F; Johnware D.A, "Environmental Biotechnlogy", Ellis Harwood Ltd.3rd edition, 2003.
2. Gupta P.K. "Elements of Biotechnology", Rastogi Publications, 2004.

19BT2052	INDUSTRIAL POLLUTION CONTROL	L	T	P	C
		3	0	0	3

Course Objective:
1. To give an exposure to various control acts
2. To study the advantages and disadvantages of impact assessment methods
3. To study the methods of reducing the waste and reusing it.

Course Outcome:
The students will be able to
1. Understand basics of pollution, its types
2. Remember Pollution control acts and regulations.
3. Illustrate preparation of EIA report
4. Evaluate audit reports on pollution control.
5. Design waste water treatment methods
6. Analyze the methods of clean and cleanup technologies

Module I: PREVENTION AND CONTROL OF POLLUTION ACTS (9)
The water (prevention and control of pollution) act 1974 and rules 1975- definitions, constitution, function and fund of central & state boards. The air (prevention and control of pollution) act 1981 and rules 1982, definitions, constitution, function and fund of central & state boards,The environment (protection) act 1986,rules 1986-definitions, constitution, function and fund of central & state boards.Environmental impact assessment notification, 2006-environmental clearance,The plastics manufacture, sale and usage rules, 1999-definitions,restriction on manufacture, sale.

Module II: ENVIRONMENT PROTECTION (9)
Environmental impact assessment (EIA), definitions and concepts, rationale, environmental impact statement, environmental appraisal, environmental impact factors and areas of consideration, measurement of environmental impact, organization, scope and methodologies of EIA, status of EIA in India,Environmental audit, definitions and concepts, partial audit, compliance audit, methodologies and regulations; introduction to ISO and ISO 14000

Module III: LIFE CYCLE ASSESSMENT (9)
Risk and Life Cycle Framework for Sustainability (Introduction, Risk, Life Cycle Frameworks, Life Cycle Assessment Tools), Life Cycle Analysis (Goal Definition, Life Cycle Inventory, Life Cycle Impact Assessment, Life Cycle Interpretation, LCA Software tools), Case studies
Module IV:INDUSTRIAL WASTE WATER ENGINEERING (7)
Standards for treated waters,Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation, Design of Activated Sludge system using biological process dynamics. Process concepts and design aspects of Trickling Filters, Rotating Biological Contactors (RBC), Fluidized bed reactor/treatment,sludge treatment and disposal
Module V: CLEANER TECHNOLOGIES (6)
Clean technology, cleanup technology, industrial symbiosis, material reuse and waste reduction
Module VI: WASTE MANAGEMENT (5)
Biomedical waste, drug industry waste, waste from dyes, pigment, pharmacy industries.

Total Hours: 45

Text book:
1. C. S. Rao Environmental Pollution Control Engineering, New Age International, 2007

Reference Books
1. Peter Wathern, "Environmental Impact Assessment theory and practice", Unwin Hyman Ltd. Routledge, 2005.
2. L. Lee Harrison , "Environmental Health and Safety Auditing Handbook", 2nd edition, McGraw Hill, Inc., New York, 2002.
3. Kirkwood, R. C. and Longley, A. J., "Clean Technology and Environment", Chapman & Hall, 2001.
4. Hendricks D, Fundamentals of Water Treatment Unit Processes, CRC Press, 2011

		L	T	P	C
19BT2053	**BIOMASS AND BIOENERGY**	**3**	**0**	**0**	**3**

Course Objective:
1. To make aware of various renewable feed stocks available for bioenergy
2. To elaborate on the concept of biofuel production from biomass

Course Outcome:
The students will be able to
1. Understand the fundamental principles of biomass and bioenergy
2. Relate the principles underlying the design and operation of biomass to energy
3. Identify the techniques and limitations of Biomass preprocessing
4. Compare Biomass conversion processes
5. Conclude current research issues in biodiesel production
6. Measure the Environmental impacts of biofuels

Module I ENERGY (9)
Current energy consumption, Energy sources, overview of biofuel/bioenergy, concepts in understanding biofuel/bioenergy production, Renewable and non-renewable feedstocks and their availability

Module II BIOMASS (9)
Biomass processing: drying, size reduction, and densification, Various biofuels/bioenergy from biomass. Non-wood, forest residues, agricultural biomass (natural fibers), and energy crops - processing, properties, and its applications - biomass utilization and reuse
Module III BIOCONVERSION PROCESS (9)
Biomass conversion: gasification, anaerobic digestion, pyrolysis, Biochemical conversion to ethanol, enzyme hydrolysis

Module IV BIODIESEL (9)

Carbon capture and sequestration, Biodiesel production from oil seeds and third generations biomass, Biodiesel production from algae – transesterification process, Environmental impact assessment of biofuel production and utilization.

Module V WASTE TO ENERGY (5)

Waste composition and Classification: Organic municipal waste, clinical waste, sewage sludge, agricultural waste, Waste & biomass materials handling.

Module VI POLICIES AND LEGISLATION (4)

Pollutants arising from waste/biomass to energy plants, Energy processing from waste/biomass, Bio-energy policies & legislation at national and international level

Total Hours: 45

Text Book

1. Robert C. Brown, Biorenewable Resources**:** Engineering New Products from Agriculture.. Wiley-Black well Publishing , 2003
2. Mdpi AG, Bioenergy and Biochemicals Production from Biomass and Residual Resources, Editors: Dimitar Karakashev and Yifeng Zhang Publisher 2018
3. Steve F Warnmer . Progress in Biomass & Bioenergy Research. ISBN: 9781600213281, 1600213286. Nova Science Publishers Inc 2007

19BT2054	**ENVIRONMENTAL BIOTECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

1. To acquire the knowledge of environmental problems and develop technologies
2. To develop skills in bioreactors and biotreatment methods of industrial wastewater
3. To find solution to create green and clean environment

Course Outcome:

1. Infer the biotechnological solutions to address environmental issues including pollution, mineral, renewable energy and water recycling
2. Appraise the opportunities for incorporating environmental quality into products, processes and projects.
3. Develop technologies for bioremediation and biodegradation
4. Acquaint oneself with the pertinent legislation and methodology of pollutants
5. Demonstrate the professional responsibility towards protecting the environment
6. Apply scientific solutions for the development of environmental sustainable products

Module I: ENVIRONMENTAL MONITORING (8)

Major types of environmental pollutants, Sampling, physical,chemical and biological analysis, Removal of toxicants from contaminated sources by bioadsorption techniques.

Module II: WASTEWATER TREATMENT (9)

Characteristics of wastewater, Primary treatment by sedimentation, Secondary treatment by suspended growth reactors - Activated sludge process, Aerobic – digestion, Anaerobic processes and Lagoons. Attached growth reactors - Trickling filter, Rotating Biological Contactor, Fluidized bed biological reactors, Upflow anaerobic sludge blanket reactor, Biological nutrient removal and Sequential batch reactor. Tertiary treatment- Polishing operations: Sand filtration, adsorption by activated carbon and chlorination.

Module III: AIR POLLUTION AND CONTROL TECHNOLOGY (7)

Classification of pollutants, Effects of air pollution, Control devices for particulate and gaseous contaminants: Settling chambers, Cyclone separator, Venturi scrubber, Biofiltration, Fabric filters, Electrostatic precipitators, absorption, adsorption, condensation and flaring; Legal and administrative systems for air pollution control.

Module IV: SOLID WASTE TREATMENT AND MANAGEMENT (8)
Types, sources and properties of solid waste, Collection of solid wastes, Transfer and transport, solid waste treatment methods: incineration, composting, land filling ,conversion of solid waste into useful products: Land farming, prepared beds, soil piles, bioventing and biosparging, Reuse, Recycle and Recovering (3Rs), Legal and administrative systems for waste control.

Module V: HAZARDOUS WASTE TREATMENT AND BIOWASTE MANAGEMENT (6)
Types of hazardous waste, Xenobiotic compounds, recalcitrance, biodegradation of xenobiotics and oil spills, biological detoxification,Genomic tools for bioremediation

Module VI: DEVELOPMENT OF BIOPRODUCTS AND TECHNOLOGIES (7)
Bioleaching, Biopesticide, Biofertilizer, Biodegradable plastics, integrated bio-digester for biogas and electricity generation, biosensor for environmental monitoring

Total Hours: 45

Text Books

1. Jogdand, S.N. Environmental Biotechnology Himalaya Publishing House, New Delhi,2012
2. Prescott, Harley and Klein, "Microbiology", 5th edition, McGraw Hill, 2014.

Reference Books

1. Karnely D. Chakrabarty K. Ovnen G.S. Biotechnology and Biodegradation, Advances in Applied Biotechnology series, Vol. Gulf Publications Co. London, 2009.
2. Graty. C.P.L., Daigger, G and Lim, H.C, Biological Wastewater Treatment. 3rdEdition, Marcel Dekker, 2008
3. Piasecki, B.W., Fletcher, K. A. and Mendelson, F. J. 2010. Environmental Management and Business Strategy John Wiley & Sons, 2010.

19BT2055	MATLAB PROGRAMMING	L	T	P	C
		3	0	0	3

Course Objective:
1. To ensure students to having strong foundation in matlab installation, configuration and basic syntax.
2. To introduce them to various string operations, functions and advanced matlab modules for plotting and graphics.
3. To understand the applications of Matlab modules for various biological applications.

Course Outcome:
1. Identify installation, configuration and environmental setup of Matlab.
2. Demonstrate the usage of basic syntax and structure of Matlab
3. Apply knowledge of data types, operators and control structures to pseudocode
4. Analyze script functionality and offer improved performance in structure
5. Appraise structural validity, reproducibility of used Matlab functions
6. Formulate biological applications in areas such as sequence processing, sequence analysis.

Module-I FUNDAMENTALS (7)
Matlab Local Environment Setup, Different window interface: script, and command prompt; working directory, Basic structure of matlab scripts, main function, Syntax - Commonly used Operators and Special Characters, Variables, Naming Variables, Multiple Assignments - Long Assignments, Creating Vectors - Creating Matrices.

Module-II MATLAB COMMANDS (9)
Commands for Managing a Session - Commands for Working with the System-Input and Output Commands-Vector, Matrix and Array creation, manipulation, data extraction. Cell array, Plotting Commands, M-Files Creating and Running Script File. Data input and output to and from matlab script, environment.

Module-III DATA TYPES, OPERATORS (6)

Data Types Available in MATLAB - Data Type Conversion - Determination of Data Types, Operators, Arithmetic, relational, and logical operators, special characters, rounding, Data structure, Table operation, display, Print,

Module-IV CONTROL STRUCTURES (7)

Control structures - Decision Making, Loops and conditional Statements, String comparison, Switch Case. Terminating control structure: Continue, pause, break, return

Module-V ADVANCED MATLAB (9)

Strings, Functions - Primary and Sub-Functions, Nested Functions, Private Functions, Global Variables, Data import, Data output, Matlab Plotting, Matlab Graphics.

Module-VI MATLAB FOR BIOLOGICAL APPLICATIONS (7)

Processing biological sequences with MATLAB modules – Sequence acquisition, Operations on nucleotide sequences, Joining sequences, Restriction site detection, Information retrieval from biological databases.

Total Hours: 45

Text Books

1. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg "A Guide to MATLAB" Cambridge University Press, 2014
2. Timmy Siauw, Alexandre M. Bayen "An Introduction to MATLAB Programming and Numerical Methods for Engineers" Academic Press, Elsevier, 2015
3. Amos Gilat "Matlab an introduction with applications" 6^{th} Edition, Wiley, 2016.

References Books

1. Stephen J. Chapman, "Essentials of MATLAB Programming", CL Engineering, Second Edition, 2008.
2. William J. Palm III, "Introduction to MATLAB for Engineers", McGraw-Hill Education, 2010.
3. Rafael E. Banchs, "Text Mining with MATLAB ", Springer, 2012.

		L	T	P	C
19BT2056	**FUNDAMENTALS OF BIOCHEMISTRY**	**3**	**0**	**0**	**3**

Course Objective:

1. To ensure students to have strong foundation in structure, composition and functions of various biomolecules.
2. To introduce them to the basic nature and properties of nucleic acids
3. To understand the significance of these biomolecules

Course Outcome:

The students will be able to

1. Remember the structure and properties of Primary metabolites
2. Understand the biological functions of metabolism
3. Acquire knowledge on vitamins
4. Relate biomolecules with the biomedical significance
5. Appraise the clinical and biological significance of these biomolecules
6. Compile the information of different biomolecules and their importance

Module-I CARBOHYDRATES (9)

Classification, structure, properties and functions of carbohydrates: Monosaccharides –classes, examples, Disaccharides – classes- homo and hetero, examples. Oligosaccharides-examples; Polysaccharide – classes and examples

Module-II FATTY ACIDS (9)

Fatty acids- basic structure, types, isomers, properties, functions and essential fatty acids; Classes, structure, properties and functions of lipids: Simple lipid- examples, Compound lipid- examples, ether lipid, Derived lipid – sterols like cholesterol, clinical significance of fatty acids and lipids –examples.

Module-III AMINO ACIDS (9)
Amino acids- basic structure, isomers, classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides –examples; Proteins- structure / conformation levels, Ramachandran plot, classification, properties and functions of proteins-
Module-IV NUCLEOTIDES (9)
Nucleotides- composition, structure, properties and functions; Nucleic acids- types (RNA, DNA), DNA structure-composition, stabilizing bonds, protein –DNA interactions; RNA types, structure and functions; properties of nucleic acids
Module-V VITAMINS (5)
Vitamins: classification, source, daily requirement, functions and deficiency symptoms, review on nutraceuticals and Vitamin supplementations;
Module-VI MINERALS (4)
Minerals: classification, specific function and deficiency disorders.

Total Hours: 45

Text Books

1. Lehninger, A.L, NelsonD.L and Cox, M.M, "Principles of Biochemistry", Freeman Publishers, New York, 4th edition, 2005.

Reference Books

1. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.
2. Lubert Stryer, "Biochemistry", WH Freeman & Co., 4th edition, 2006.
2. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.
3. Jain and Jain "Fundamentals of Biochemistry", Chand publication, 4th edition, 2016.

		L	T	P	C
19BT2057	**PATHOLOGY AND MICROBIOLOGY**	**3**	**0**	**0**	**3**

Course objectives:

1. To synthesize characteristics of disease processes based on etiology and pathogenesis
2. To understand how disease processes affect physiological function
3. To analyze how disease processes can result in specific clinical signs and symptoms

Course outcome:
The students will be able to;

1. Recognize the basic elements concerning cell injury and death, tumors and the mechanisms of response to tissue injury
2. Understand the basic elements of bacteriology, virology and transmission of infectious disease
3. Formulate experiments to identify microorganisms, interpret the data and communicate it
4. Identify the physical and chemical methods to control the growth of microbes
5. Apply the knowledge of pathogenesis for the control of infectious diseases
6. Evaluate immunopathology, oncology, general and organ-specific pathophysiology

Module I CELL INJURY, INFLAMMATION AND REPAIR (9)
Cell injury: Causes and Mechanism: Ischemic, Toxic. Reversible cell injury: Types, morphology: Swelling, vacuolation, Irreversible cell injury: Types of Necrosis. Calcification: Dystrophic and Metastatic. Acute inflammation: Inflammatory cells and Mediators, Chronic inflammation: Causes, types, non-specific and Granulomatous with examples, wound healing by primary and secondary union, healing at specific sites including bone healing
Module II NEOPLASIA AND IMMUNOPATHOLOGY (9)
Neoplasia: Classification, Histogenesis, Biologic Behaviour: Benign and Malignant; Carcinoma and Sarcoma. Malignant Neoplasia: Grades and Stages, Local and distant spread. Carcinogenesis, Tumor immunology. Laboratory diagnosis: Cytology, Biopsy, Tumor markers, Immune system: antibodies and

regulation of immune responses. Hypersensitivity, Antibody and cell mediated tissue injury: Auto-immune disorders - systemic lupus erythematosis.

Module III PRINCIPLES OF MICROBIOLOGY (9)

Normal flora of human body, host-microbe interactions, routes of transmission of microbes in the body, nosocomial infections, post-operative infections, mode of action of anti-bacterial agents, antibacterial susceptibility test

Module IV MORPHOLOGY AND STERILIZATION (9)

Morphological features and structural organization of bacteria, identification of bacteria – staining techniques, Gram positive and Gram negative cell wall, culture media and its types, culture techniques, control of microorganisms- physical and chemical.

Module V INFECTIOUS DISEASES (5)

Mycobacterial Diseases: Tuberculosis, Bacterial diseases: Typhoid, Diphtheria, Gram negative infection, Bacillary dysentery, Syphilis. Viral: Dengue, Zika, Rabies, AIDS; Fungal diseases and opportunistic infections (Candidiosis).

Module VI PARASITIC DISEASES (4)

Parasitic Diseases: Malaria, Filariasis, Kala-azar, Cysticercosis, Hydatid. Diagnostic procedures and handling of infected material and health education.

Total Hours: 45

Textbooks:

1. Ramzi S Cotran, Vinay Kumar and Stanley L Robbins, “Pathologic Basis of Diseases”, 7th edition, WB Saunders Co. 2010.
2. Dubey RC and Maheswari DK. “A Text Book of Microbiology” Chand & Company Ltd, 2014.

Reference books:

1. Prescott, Harley and Klein, “Microbiology”, 8th edition, McGraw Hill, 2013.
2. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 5rd edition, 2010.
3. Ananthanarayanan and Panicker, “Microbiology” Orient blackswan, 2015.

19BT2058	HUMAN ANATOMY AND PHYSIOLOGY	L	T	P	C
		3	0	0	3

Course objective:

1. To explain the basics on the structure animal cell and organs
2. To illustrate the different systems of the body and their functioning
3. To demonstrate the fundamentals in human anatomy and physiology

Course Outcome:

The students will be able

1. To recall facts and basic concepts of cells, their functions and membrane transportation
2. To recognize and explain the composition of blood and its function on maintaining homeostasis.
3. To demonstrate the function and the components of respiratory and cardiovascular systems.
4. Comprehend the role of neurons and its application
5. To relate the structure and functions of nervous system and parts of brain of Human system
6. To inference the structure of eye, ear and kidney and understand the facts of its functions.

Module I CELL (9)

structure and organelles, function of each component. Cell membrane, transport across membrane, origin of cell membrane potential (Nernst and Goldman and Katz equations), action potential.

Module II: BLOOD COMPOSITION (9)

Functions of blood, functions of RBC. WBC types and their functions, blood groups, importance of blood groups, identification of blood groups, blood flows factors regulating blood flow such as viscosity, radius, density etc.

Module III COMPONENTS OF RESPIRATORY SYSTEM (3)

Oxygen and carbon di oxide transport and acid base regulation

Module IV HEART AND ITS REGULATION (6)
structure of Heart, properties of cardiac muscle, cardiac muscle and pace maker potential, cardiac cycle, ECG, Heart sound, volume and pressure changes and regulation of heart rate.
Module V STRUCTURE OF A NEURON (9)
Synaptic conduction. Conduction of action potential in neuron. Parts of brain cortical localization of functions, EEG. Simple reflexes, with drawls reflexes. Autonomous nervous system and its functions
Module VI: STRUCTURE OF VISUAL PATHWAYS (9)
Structure of Eye, Ear and auditory and visual pathways. Structure of kidney and nephron, Mechanism of Urine formation and base regulation. Dialysis.

Total Hours: 45

Text Books:

1. Anne Waugh, Allison Grant, "Ross and Wilson: Anatomy and Physiology in health and Illness", Churchil Livingston Elsvier 2010.

References:

1. Elaine . N. Marieb, "Essentials of Human Anatomy and Phsiology" 8th edition, Pearson education, New Delhi 2007
2. William F Ganang "Review of Medical physiology" 2nd edition McGraw Hill , New Delhi, 2000.

19BT2059	ENTREPRENEURSHIP, IPR AND BIOSAFETY	L 3	T 0	P 0	C 0

Course Objective:

1. To impart various aspects of product design and development
2. To inculcate concept generation and selection
3. To understand technology behind the product of the service

Course Outcome:

1. Understand the principles of product design, basic management techniques, entrepreneurial skills and funding agencies.
2. Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.
3. Induce entrepreneurial intent as well as innovation, scalability and marketing of the product.
4. Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career.
5. Assess the commercial viability of a new technology based idea to prototype and biosafety.
6. Transform research based ideas into feasibility and business plans and IPR.

Module I: CONCEPT OF ENTERPRENEURSHIP (5)
Concept and evolution of entrepreneurship, development of Entrepreneurship, stages in entrepreneurial process, entrepreneurship in India, Role of SSI in economic development, Government support for SSI.
Module II: SOCIETAL ROLE IN ENTERPRENEURSHIP (4)
Role of society and family in the growth of an entrepreneur.Challenges faced by women in entrepreneurship.
Module III: PRODUCT PROCESS AND DESIGN (9)
Identification of business opportunities, project selection, contents, formulation, guidelines by planning commission for project report. Product design, importance, objectives, factors influencing product design, Product Development Process, sources of ideas for designing new products, stages in product design.
Module IV: INNOVATION AND PROTOTYPE (9)
Creativity and innovation, generation of ideas, technical and market feasibility study, opportunity assessment, business plan preparation, execution of business plan, conversion of ideas to prototype, risk taking-concept; types of business risks.
Module V: BIOSAFETY (9) Procedure for getting license and registration, challenges and difficulties in starting an enterprise, host institution support, The role of technology/social media in creating new forms

of firms, organizations, networks and cooperative clusters. Market- traditional and E-commerce, expanding markets: local to global.

Module VI: IPR AND COPYRIGHT (9)

IPR and copy right, financial opportunity identification; banking sources; non banking institutions and agencies; venture capital and angel investors, meaning and role in entrepreneurship, government schemes for promoting entrepreneurship.

Total Hours: 45

Text Books:

1. Jayshree Suresh, "Entrepreneurial Development", 5th Edition, Margham Publications, 2008.
2. Robert D. Hisrich, "Entrepreneurship", 6th Edition, Tata McGraw Hill Publications.2009.

Reference Books:

1. Donald F. Kuratko, "Entrepreneurship: Theory", Process and Practice 9th Edition, Cengage Learning, 2011.
2. Sateesh MK, Bioethics and Biosafety, IK International, 2012.
3. Anupam Singh and Ashwani Singh. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), NPH, New Delhi, 2010.

19BT2060	TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective

1. To introduce the basic concepts of tissue organisation in the human body and the theories related to normal physiology and repair
2. To inculcate knowledge on cell culture, cell signalling and molecular growth factors.
3. To develop tissue implants and transplants and understand its regulation in tissue engineering

Course Outcome

The students will be able to

1. Recall the fundamental concepts about types of cells and culturing procedures
2. Analyze the cellular interaction and molecular aspects of cell differentiation, communication and growth.
3. Design scaffolds, tissue implants and its use in tissue engineering
4. Gain knowledge in 3D culture mechanism and cell interactions
5. Acquire Knowledge in the tissue engineering applications
6. Adapt the regulatory issues and ethical issues in Tissue Engineering

Module I: Introduction to Tissue Culture :(9)

Introduction, Basic definition, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, cell culture techniques

Module II: Transplant Materials :(9)

Unit 2: Scaffold and transplant, egineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength

Module III: Organs for Transplants (5)

Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells in tissue engineering

Module IV: 3D Culturing (9)

3D cell culturing and protocols involved for the 3D cell culture of different types of cells cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering.

Module V: Applications in Medical Fields (9)

Product development using Tissue Engineering, Current scope of development and use in therapeutic and in-vitro testing,

Module VI: Regulatory Issues (4)

Ethical, FDA and regulatory issues of tissue engineering,

Total Hours:45

Text Book

1. Introduction. *R.* Ian Freshney. Culture of Animal *Cells*: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.
2. Animal cell culture 3rd ed., by John R.W. Masters A Practical Approach Oxford University press New York 2005

Reference Books

1. Robert. P.Lanza, Robert Langer & William L. Chick, Principles of tissue engineering, , Academic press, 2002
2. Joseph D. Bronzino, The Biomedical Engineering –Handbook, CRC press, 2005.
3. B. Palsson, J.A. Hubbell, R.Plonsey& J.D. Bronzino,Tissue Engineering, CRC- Taylor & Francis, 2006.

19BT2061	CELLBIOLOGY AND IMMUNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. This course aims to impart basic knowledge in cell biology & Immunology,
2. To help the students familiarize with the organs and cells of the immune system, the immune response and molecular interactions involved in immune response.
3. To make the students aware of the importance of cell organelles and immunity

Course Outcome:

1. Relate the characteristic features of cell organelles and immune systems
2. Classify various cellular organelles and their functions.
3. Analyze the possible mechanism of cell signaling in immune systems
4. Compare the origin, maturation process, and general functions of B and T lymphocytes.
5. Comprehend the cellular/molecular pathways in health and disease.
6. Apply the principles of immunology in disease protection and autoimmune disorders.

Module I: FEATURES OF CELL AND CELL CYCLE (8)

History of cytology and cell theory, Prokaryotes and Eukaryotes (plant cell and animal cell), Membranes of the cell: Plasma membrane, Nuclear membranes, Organelle membranes. Outline of organelles: Nucleus, nucleolus, ribosome, mitochondria, chloroplast, vacuole, endoplasmic reticulum, golgi apparatus, lysosome, centriole, cilia and flagella. Regulation of cell cycle and molecules that control cell cycle.

Module II: CYTOSKELETON AND CELL TRANSPORT (8)

Microtubules, microfilaments, intermediate filaments and their binding proteins, Cell- cell communications, Passive and active transport, permeases, osmosis, pumps and gated channels, co transport: symport, antiport. Vesicular transport: Endocytosis, Exocytosis, Protein glycosylation in eukaryotes and protein sorting.

Module III: SIGNALING MOLECULES AND SIGNAL TRANSDUCTION (7)

Signaling molecules: autocrine, paracrine and endocrine and its mode of action in cell signaling. G-protein coupled receptor and protein tyrosine kinases receptor for cell signaling, different models of signal amplifications: role of cyclic AMP, cyclic GMP and G proteins in signal transduction

Module IV: OVERVIEW OF IMMUNOLOGY(5)

History of immunology, Types of Immunity - Innate and acquired immunity, Cell mediated and humoral immunity; Organs of the immune system: Lymphoid organs - primary and secondary.

Module V: FEATURES OF LYMPHOCYTES, ANTIGEN-ANTIBODY COMPLEX (9)

Haematopoisis, T and B Lymphocytes & NK cells. Major histocompatibility complex; antigen processing and presentation, T-Cell activation and the cellular immune response. Antigens- chemical and their molecular nature; Haptens; Adjuvants. Antibody – structure andclasses, Antigen-Antibody reactions: Neutralization, Opsonization, Complement, Cytokines

Module VI: **IMMUNE RESPONSES TO INFECTIONS (8)**

Immunity to bacteria, and virus; Transplantation: consequences and genetics of transplantation, Cancer immunology – Tumour Associated Antigens and Tumour Specific Antigens; Autoimmunity; Autoimmune disorders, hypersensitivity, Immunosuppression and AIDS immunity.

Total Hours:45

Text Book

1. Alberts, Molecular Biology of the Cell, Garland Sciences, 6th edition, 2012.
2. Roitt I, Male, Brostoff, "Immunology", Mosby Publishers, 5th edition, 2011.

Reference Books

1. Geoffrey M. Cooper, Robert E. Hausman, The Cell, A Molecular Approach – 6th Edition Sinauer Associates, Inc.. 2015
2. Tizard, "Immunology", Saunders college publication, 6th Edition, 2010.
3. Kuby J, "Immunology", WH Freeman & Co., 2013.

19BT2062	MOLECULAR BIOLOGY FOR BIOMEDICAL ENGINEERS	L	T	P	C
		3	0	0	3

Course Objective:

1. To understand the basics of molecular biology and gene expression.
2. To understand DNA damage and repair systems
3. To get an overview on the regulation of gene expression

Course Outcome:

The students will be able to

1. Recall the fundamental concepts of the organization of genome and central dogma
2. Understand the process of replication, transcription and translation
3. Recognize common mutations, their natural repair systems and inhibition of gene expression
4. Distinguish the process of replication of prokaryotic and eukaryotic DNA
5. Appraise the synthesis of RNA and post-transcriptional modifications
6. Comprehend the role of operons and cis/trans elements in gene regulation

Module I CHROMOSOME ORGANIZATION (9)

Chromosome organization in prokaryotes and eukaryotes, Different forms of DNA, Classical experiments Grifith, Hershey and chase; Avery McLeod & McCarty. Transformation, Transduction, and Conjugation. Lytic and lysogeny.

Module II DNA REPLICATION – PROKARYOTES (4)

DNA replication- Semi conservative replication, Meselson stahl experiment, Enzymes in replication, Replication in prokaryotes,

Module III DNA REPLICATION – EUKARYOTES AND MUTATIONS (5)

Replication in eukaryotes and telomere replication. Mutation: types, DNA repair mechanism

Module IV TRANSCRIPTION (9)

RNA polymerase, features of promoters and enhancers, transcription factors, Prokaryotic and eukaryotic transcription, inhibitors, post-transcriptional modification - RNA splicing

Module V TRANSLATION (9)

Elucidation of genetic code-salient features, Process of translation in prokaryotes and eukaryotes, Post-translational modifications, Inhibitors.

Module VI REGULATION OF GENE EXPRESSION (9)

Regulation of gene expression: In prokaryotes - lac and trp operons. Regulation in eukaryotes – cis and trans elements

Total Hours: 45

Text book

1. David Friefelder, "Molecular Biology", Narosa Publ. House. 6th edition 2003.

Reference books

1. David R. Hyde, "Genetic and Molecular Biology", Tata McGraw Publications, New Delhi, 4th edition, 2010.
2. Lehninger, A. L, NelsonD. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.
3. Gardner, Simmons and Snustad, "Principles of Genetics", John Wiley, 8th edition, 2000.

19BT2063	BIOLOGY IN EVERYDAY LIFE	L 3	T 0	P 0	C 3

Course Objective:

1. To comprehend the fundamental principles and concepts of human Health and Well-being.
2. To impart knowledge and implications of Biotechnology in daily Life.
3. To ensure knowledge transfer in applications of biomolecules and trends in biology.

Course Outcome:

1. Define Life and Life forms.
2. Recognize the importance of Human health and welfare.
3. Apply biological processes to engineer Molecules.
4. Debate the Significance of entrepreneurship and industry.
5. Design a sustainable idea that defines research as a trend for the future.
6. Evaluate ethics and honors for research in Biology.

Module I: LIFE AND LIFE-FORMS (9)

Brief Introduction about the Course. Classification of Life forms. Body plan and Design of Life Forms – Evolution. Biodiversity. A History of Biology in 20 Objects Case Study – Neanderthals to Homo-Sapiens.

Module II: HEALTH AND WELL-BEING AND STRESS MANAGEMENT (9)

Nutrition in Humans – Macronutrients and Micronutrients. The Human Body during Health and Disease – Example – Three Systems – Digestive, Nervous and Excretory. Stress - Symptoms, Types, Causes and Treatment. Depression – Symptoms, Types, Causes and Treatment. Alcohol Abuse and Drug Abuse - Symptoms, Types, Causes and Treatment. Case Study – Substance Abuse and Social Responsibility.

Module III: MOLECULES THAT MAKE US (9)

Biomolecules (Carbohydrates, Proteins, Lipids, and Nucleic Acids) – Types and Properties. From Molecules to Cells. Genes, Evolution and Development. Case Study - Crime Scene Investigation (FBI and CBI).

Module IV: BIOTECHNOLOGY AT HOME AND IN INDUSTRY (9)

Microorganisms – An overview The Good, the Bad and the Ugly Microbes. Bread, Beer and Batter. The Fermentation Industry – Principles, Processes and Products. Antibiotics –Mechanism Immunotherapeutics,

Module V: ADVANCED TRENDS IN BIOLOGY (4)

Genetically Modified Organisms (GMO) – Plants, Animals and Microbes (Two Examples Each). Microbes as Fertilizer, Organisms as Pesticides, Biofuels. Human Cloning. Stem Cells Depot. Drug Resistance and Pathogens. Case Study: A GMO study.

Module VI: ETHICS AND INTERDISCIPLINARY RESEARCH (5)

Biosafety and Ethics. Nobel Prizes in Medicine and Physiology (Current Affairs). Careers in Biosciences – Survey and Interdisciplinary research.

Total Hours: 45

Text Books

1. G. K. Suraish Kumar, Biology for Engineers, Oxford University Press, 2019.
2. Alberts B et al. Essential Cell Biology 5th Edition Garland Science, 2009.
3. Coyne, JA. Why Evolution is True. Oxford University Press, 2009.

References Books

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005.

2. Arthur C Guyton, "A Textbook of Human Physiology", Elsevier Saunders, International Edition, 11th Edition, 2006.
3. Peter Raven et al "Biology", McGraw-Hill Education; 10^{th} Edition, 2013.

19BT2064	WORKSHOP PRACTICES FOR BIOTECHNOLOGISTS	L	T	P	C
		0	0	2	1

Co-requisite: Nil

Course Objective: To impart knowledge on
1. Good Laboratory Practices
2. Planning and procedures to develop models in biotechnology laboratories.
3. Sequence of operations adopted in laboratories to fabricate models.

Course Outcome: After completing the course the student will be able to
The students will be able to
1. Understand various laboratory tools and their applications.
2. Prepare basic solutions for chemical applications and their disposal.
3. Learn basic electrical processes involved in equipment and their trouble shooting.
4. Understand plumbing
5. Design and fabricate the various objects in sheet metal using hand tools.
6. Apply manufacturing process for various biotech applications.

List of Experiments
1. Measurements, tools and its usages
2. Fundamental electricals, electronics and trouble shooting
3. Basics of laboratory safety, first aid and disposal process
4. Basics of calculations and measurements
5. Introductory plumbing
6. Computer hardware and installations
7. Sheet metal fabrication and carpentry

19BT3001	Advances in Biopolymer and Applications	L	T	P	C
		3	0	0	3

Course Objectives:
To improve knowledge on
1. Application of biopolymers in the field of pharma and food industries.
2. Interaction of biopolymers and their structure – function relationship
3. Recent trends in biomolecules research

Course Outcome:
The students will be able to
1. Recall the basic concepts in biomolecules (carbohydrates, Proteins, enzymes, hormones, nucleic acids) and their function.
2. Compare and demonstrate the applications of biomolecules in medical, pharma, food and agro industries
3. Choose and apply techniques in protein engineering, glysosylation engineering, enzyme engineering, antibody engineering to study the biomolecules
4. Compare and contrast the structure functional relationship of different biomolecules
5. Appraise the applications of biomolecules as biomarkers in diagnosis of diseases and as biosensors
6. Compile, discuss and critically review the recent updates / progress in biomolecules research

Module 1 Glycobiology (10 Hours)
Glycoconjugates – Glycan structure of proteoglycan, glycoproteins, glycolipids and lipopolysaccharides; Glycans and blood groups, Scope of Glycobiology; Lectins use and interaction with glycoconjugates;

Glycans in biotechnology and pharmaceutical industry: as components of vaccines and small molecule drugs, glycosylation engineering, therapeutic glycans.

Module 2 Protein Engineering (8 Hours)

Structure- function relationship in fibrous and globular proteins, industrially significant peptides; Protein associated diseases and protein marker in disease diagnosis, Protein Engineering Methods - Applications of proteins: Food industry, Environmental, Medical.

Module 3 Enzyme Technology and Applications (8 Hours)

Enzyme markers in disease diagnosis – hepatobiliary diseases, myocardial disorders, atherosclerosis, renal dysfunction, oxidative stress and cancer; enzyme based biosensors; Enzymes in food, and pharmaceutical industries; Application of enzymes in agriculture and environment protection; enzyme immobilization techniques and its applications.

Module 4 Hormones and Antibodies (6 Hours)

Mechanism of actions of chemically diverse hormones, Regulation of hormone release-by signals; Hormone drugs and their actions; applications of hormones in anti-ageing medicine. Hormone and antibody based biosensors; Antibody engineering, Abzymes

Module 5 Lipid Technology and Applications (7 Hours)

Industrial applications of fatty acids and lipids; liposomes and their novel applications, role of lipids in pharmaceutical industry, Techniques for the extraction of lipid from natural origin, Structured Lipids for Food and Nutraceutical Applications

Module 6 Nucleic Acid Biopolymer (6 Hours)

Applications of nucleic acid polymer in diagnosis and therapy - nucleic acid probes in clinical laboratory; Review on current status of gene therapy research.

Reference Books

1. Varki A, Cummings R.D, Esko J.D, Freeze H.H, Stanley P, Bertozzi C.R, Hart G.W,Etzler M.E., “ Essentials of Glycobiology”, Second edition; Published by Cold Spring Harbor Laboratory Press, New York, 2009
2. LehningerA. L, NelsonD. L. and CoxM. M. “Principles of Biochemistry” Fourth Edition (Freeman Publishers), New York, 2005.
3. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 2008.
4. Donald Voet and Judith G. Voet . “Biochemistry” – Volume 1, Biomolecules, Mechanisms of Enzyme Action and Metabolism, John.Willey and sons, 2005.
5. BurcuTuranli-Yildiz, CerenAlkim and Z. PetekCakar (2012). Protein Engineering Methods and Applications, Protein Engineering, Prof. Pravin Kaumaya (Ed.), ISBN: 978-953-51-0037-9

19BT3002	Genetic Engineering and Recombinant Products	L	T	P	C
		3	0	0	3

Course Objectives:

To gain knowledge about

1. The history and future of genetic engineering
2. The techniques employed in Genetic Engineering in the field of medicine and the biotech industry.
3. The techniques involved in generating transgenic microbes, plants and animals.

Course Outcome:

The students will be able to

1. Understand the basic concepts in Genetic engineering.
2. Recognize the usage of the tools of genetic engineering.
3. Choose the techniques employed in genetic manipulation of microbes.
4. Analyze the techniques employed in the genetic manipulation plants for crop improvement
5. Illustrate the techniques employed in the genetic manipulation animals for commercial purposes.

6. Discuss the genetic manipulation techniques employed in the production of therapeutics.

Module 1: Introduction to Genetic engineering and the market of r-DNA products (4 Hours)
Impact of r-DNA products in food, drug, agriculture, and industry.

Module 2: Tools employed in Genetic engineering: Vectors & Enzymes (7 Hours)
Properties of ideal vectors, Cloning vectors & Expression Vectors. Vectors for Bacteria; plasmids, cosmids and Phagemids, BAC and YAC. Shuttle vectors. Expression vectors for bacteria, yeast, animal/mammalian cells and plants.

Module 3: Polymerase Chain Reaction (6 Hours)
Types of PCR, Inverse PCR, Nested PCR, RACE PCR, Reverse Transcriptase PCR, Real Time PCR, Nucleic acid sequencing methods.

Module 4: Construction & Analysis of recombinant DNA (10 Hours)
Construction of Genomic DNA libraries & cDNA libraries, PCR Cloning of DNA for Expression in E.coli, Yeast, Plant & Mammalian cells. Physical, chemical and biological methods of transferring recombinant DNA into target cells. Restriction analysis, Probe preparation and labeling methods, hybridization methods,

Module 5: Protein and Nucleic Acid products of rDNA technology (9 Hours)
Production of hormones, enzymes for therapeutics and diagnostics. Recombinant enzymes for industrial applications. Vaccines, Chimeric & humanized antibodies, and immune modulators. DNA vaccines, Gene therapy. DNA oligonucleotides for Antigene applications, DNAzymes, ribozymes, aptamers, RNA decoys, siRNA, micro RNA and CRISPER-CAS.

Module 6: Genetically Modified Organisms (9 Hours)
Improved crop varieties GMOs: drought resistant, pest resistant, virus resistant salinity tolerant, Terminator technology, Biofortified crops, Plantibodies and Vaccines production in plants. Genetically enhanced animals, hypoallergenic cows.

References

1. Berhard R. Glick, Chery L. Patten, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 5th edition, 2010
2. W T Godbey, An Introduction to Biotechnology ,AP, 2014
3. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski, Recombinant DNA: Genes and Genomes, W.H. Freeman, 2007
4. Kadema Carter, Biomedical Applications of DNA Recombinant Technology, Koros, 2014
5. Lilia Alberghina, Protein Engineering For Industrial Biotechnology, Hardwood Academic Press, 2000
6. Nigel W. Scott, Mark R. Fowler, Adrian Slater, Plant Biotechnology: The genetic manipulation of plants,2nd Edition, 2008
7. Carl A. Pinkert, Transgenic Animal Technology: A Laboratory Handbook, 2012.

19BT3003	BIOPROCESS MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3

Course Objectives:
To improve knowledge on

1. Principles and frameworks of data driven modeling
2. Mathematical models relevant to industrial and environmental bioprocess systems
3. Basics of MATLAB required for formalization of Bioprocess models and its simulation

Course Outcome:
The students will be able to

1. Recognize the different stages and their inter-relationship in bioprocess modelling
2. Relate modelling, simulation and parameter estimation modules
3. Develop bioprocess system models from experimental data using Matlab tool

4. Examine the suitability of developed models in a quantitative manner
5. Interpret the bioprocess modelling outcome for refinement of model structure
6. Formulate simplification strategies and simulate bioprocess models with relevant examples

Module 1: Introduction to Bioprocess modelling (7 Hours)

Basic modeling principles – Purpose of modelling transient or steady state behavior – types of mathematical models and modelling approaches. Fundamental laws guiding modelling framework – mass and energy balance, charge balance, equilibrium states and chemical kinetics, continuity equation. Model parameter and complexity

Module 2: Mathematical formalization of Bioprocess (7 Hours)

Representation of Bioprocess (with examples) in terms of key mathematical expression, Data availability and designing data collection. Parameter identifiability, estimations and redundancy. Kinetic, stochiometric relations in terms of coupled differential or algebraic equations. Numerical modelling algorithm – initial value problem.

Module 3: Matlab basics for modelling (8 Hours)

Basics of Matlab environments, data import and export, variables, vector-matrices operations, Matlab functions, Numerical integration, Euler and fourth order Runge-Kutta method, Matlab ODE and DAE solvers. Simulating a bioprocess with known process parameters

Module 4: Matlab application in bioprocess modelling (9 Hours)

Solving problems by numerical integration using MATLAB. Modelling simple microbial growth, substrate consumption and product formation kinetics in batch Process. Dynamic simulation of CSTR.

Module 5: Parameter Estimation and sensitivity analysis, model fitness (7 Hours)

Parameter estimation from experimental and modelled data, least square regression techniques -exercise, Embedding numerical bioprocess model into constrained multivariable optimization problem. Sensitivity and confidence interval estimation using boot-strapping

Module 6: Advanced Bioprocess Modelling examples (7 Hours)

Kinetic model for simultaneous saccharification and fermentation, Mathematical modelling of anaerobic digestion, Modelling and Simulation of Citric Acid Production from Corn Starch Hydrolysate, Enzymatic hydrolysis of lignocellulose

References

1. Verma, Ashok Kumar (2014) Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering, CRC Press
2. Dunn, Irving J. (2003) Biological reaction engineering : dynamic modelling fundamentals with simulation examples, Wiley-VCH
3. Nicoletti, Maria Carmo (2009) Computational Intelligence Techniques for Bioprocess Modelling, Supervision and Control. Springer
4. Snape, Jonathan B. Dunn, Irving J., Ingham John, Prenosil Jiri E. (2008) Dynamics of Environmental Bioprocesses: Modelling and Simulation, John Wiley & Sons

19BT3004	Analytical Techniques in Biotechnology Lab	L	T	P	C
		0	0	4	2

Co-requisite: 20BT3001 Advances in Biopolymer and Applications

Course Objectives:

To improve knowledge on

1. Clinical role of biomolecules in biological sample.
2. Importance of biomolecules with the cells and organs of the body
3. Advanced analytical techniques

Course Outcome:

The students will be able to

1. Recall the basic concepts and principles of different assays

2. Understand the protocol for isolation and extraction of biomolecules from various sources
3. Experiment with the assay procedures of acid phosphatase. Glucose, hexosamine, and antioxidants assays
4. Infer the results and draw conclusion
5. Compare the different methods of extraction of phytochemicals, and exposed to latest techniques on determination and structure prediction using sophisticated techniques
6. Propose and apply the above learnt experimental skills in their project work

List of Experiments

1. Assay of acid phosphatase
2. Assay of lipid peroxidation (LPO) in plasma
3. Estimation of glucose by glucose oxidase and peroxidase (GOD – POD) method
4. Estimation of serum hexosamine by Wagner method
5. Determination of peroxide value of an oil
6. Isolation and preparation of lecithin from egg
7. Determination of total antioxidant capacity by phosphomolybdenum method
8. Modified hydroxyl radical scavenging assay
9. Solvent extraction of phytochemicals and qualitative screening
10. Separation of phytochemicals by HPLC
11. Determination of molecular weight of phytochemicals by Mass spectrometry
12. Biomolecular structure prediction using X-Ray diffraction

19BT3005	**Animal and Plant Tissue Culture Lab**	**L**	**T**	**P**	**C**
		0	0	4	2

Course Objectives:

To impart knowledge on

1. Plant tissue culture and transformation techniques
2. Animal tissue culture and assays
3. Sterilization techniques on Plant and Animal Tissue Culture

Course Outcome:

After completing the course the students will be able to

1. Demonstrate media preparation on Plant and Animal Tissue Culture
2. Comprehend on sterilization techniques
3. Experiment plant transformation techniques
4. Perform in vitro animal cell culture techniques
5. Demonstrate cell viability assays using different types of animal cells
6. Analyze the cell toxicity of drugs

List of Experiments

1. Sterilization Techniques – Media and Explants
2. Callus induction from explants
3. Cell Suspension Culture for metabolite production and growth kinetic studies
4. Bacterial transformation and Raising of *in vitro* plantlets
5. Agrobacterium mediated gene transfer in *in vitro* plantlets
6. Preparation of reagents for tissue culture
7. Preparation of growth medium for cell culture
8. Isolation of macrophages from mouse peritoneum
9. Quantification and checking viability of cells (thymocytes or spleenocytes or macrophages) using trypan blue dye exclusion method.
10. Isolation of lymphocytes from thymus
11. Isolation of spleenocytes from mouse spleen
12. MTT Assay

19BT3006	Advanced Process Equipment Design and Drawing Lab	L	T	P	C
		0	0	4	2

CO- request: Process equipment Design

Course Objectives:

1. To design safe and dependable processing facilities.
2. This course focuses on plant layout and selection.
3. This will provide the basic knowledge to carry out process equipment design and cost effect.

Course Outcome:

The students will be able to

1. Understand the unit operation symbol, letters and plant layout
2. Summarize the effect of heat exchangers and evaporators
3. Recognize batch reactor
4. Evaluate the efficiency of distillation
5. Analyze the process of filtration and absorption
6. Comprehend the uses of valves in flow measuring devices

List of Equipments:

1. Basics of various unit operation symbols
2. Plant layout
3. Engineering Letters, Lines and numbers.
4. Shell and tube heat exchanger
5. Single effect evaporator
6. Batch reactor
7. Air lift Fermentor
8. Fractional distillation column
9. Rotary drum filter
10. Absorption column
11. Gate Valves
12. Venturi meter

References:

1. Donald Q.Kern, “ProcessHeatTransfer”,Tata Mc Graw Hill, New Delhi, 2007.
2. Mccabe, W. L.,Smith, J. C., and Harriott,P., “Unit Operations of Chemical Engineering”, McGraw Hill,NewYork,6th Edition,2004

19BT3007	Recombinant DNA Technology Lab	L	T	P	C
		0	0	4	2

Co-requisite: Lab in Molecular Biology

Course Objectives:

To impart knowledge on

1. The basic laboratory techniques employed in a genetic engineering Lab
2. The extraction and analysis of nucleic acids and proteins.
3. Genetic manipulation of Nucleic acids for protein production.

Course Outcome:

After completing the course the students will be able to

1. Isolate nucleic acids
2. Perform electrophoresis of nucleic acids and proteins.
3. Experiment the DNA manipulation and transformation techniques.
4. Evaluate RNA expression by reverse transcription
5. Analyze nucleic acid amplifications using PCR

6. Express, purify and analyze recombinant protein

List of Experiments

1. Isolation of plasmid DNA and restriction digestion to estimate molecular weight by Agarose Gel electrophoresis
2. Isolation of total RNA from E.coli
3. Isolation of total RNA from mammalian cells
4. Isolation of mRNA from mammalian cells using poly T beads.
5. Reverse Transcriptase PCR of target gene & Agarose Gel electrophoresis to estimate molecular weight.
6. RE digestion of the PCR product & cloning the digested PCR product into E.coli Expression vector by ligation
7. Preparation of competent E.coli and transformation of the cloned plasmid and selection of recombinant clones.
8. Induction of expression using IPTG and extraction of expressed protein.
9. Analysis of expressed protein using SDS-PAGE.
10. Midi scale expression of target protein
11. Extraction and purification of target protein using affinity beads/column.
12. Western blotting analysis for confirmation of purity and quality of expressed protein

		L	T	P	C
19BT3009	**Enzyme Technology and Industrial Applications**	3	0	0	3

Course Objective:

1. To understand the mechanism of biocatalyst
2. To learn the kinetics of enzymatic reaction
3. To learn about applications of enzymes

Course Outcome:

The students will be able to

1. Understand the concept of immobilization
2. Understand extraction and purification of enzymes
3. Create inhibition kinetics of the enzymatic reactions
4. Evaluate application of enzymes
5. Apply protein engineering of enzymes
6. Analyze commercial production of enzyme

Module 1: Introduction to enzymes (7 hours)

Classification of enzymes, quantification of enzyme activity and specific activity, Enzyme in action & specificity, Enzyme stability, monomer & oligomeric enzymes. Structure of enzymes-ray crystallography of enzymes, control of Enzyme activity

Module 2: Enzyme kinetics & modeling of enzymatic systems (7 hours)

Kinetics of multisubstrate enzyme catalyzed reaction, relation of kinetic parameters, microenvironmetal effects on enzyme kinetics, Enzyme Inhibition – Substrate, Product and Toxic compound inhibition, types and derivation. Enzyme deactivation kinetics. Allosteric regulation of enzymes, Monod changeux wyman model

Module 3: Immobilized enzymes (8 hours)

Introduction, Methods of immobilization, kinetics of immobilized enzymes, Analysis of film and Pore diffusion & application in production of L-amino acids, & other uses, enzyme biosensors (design of E electrodes & application.).

Module 4: Industrial enzymes (8 hours)

Few industrial nzymes like glucose-isomerase, cellulases, Pectinases, protease etc. Their importance, source production, optimization of fermentation medium, assay, extraction and purification, Characterization, genetic manipulation etc. Applications of enzymes in analysis; Design of enzyme electrodes

Module 5: Protein Engineering of Industrial enzymes (7 hours)

Introduction, targets by Chemo enzymatic Synthesis, rational design methods, site directed mutagenesis, Chemical modification and unnatural amino acids, Random method like molecular evolution, DNA shuffling, sequence space, method for mutagenesis, for recombination, sequence homology independent recombination, screening and selection

Module 6: Enzyme as tools for stereo specific c- c bond formation in Monosaccharide & analogues (8 hours)

Enzymes like DHAP aldolase, pyruvate aldolase, tyrosine kinase & their uses, Uses of mutagenesis to increase substrate specificity. Producing catalytic antibodies.

References:

1. Palmer T, P.L. Bonner, "Enzymes: Biochemistry", "Biotechnology", "Clinical chemistry", 2nd Edn, Harwood Publishing Ltd. 2007.
2. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2002
3. Bailey J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals", McGraw Hill,2000.
4. Ashok Pande, Colin Webb, Carlos Richard, Cristian Larroche. Enzyme Technology, 2006, Springer
5. Price and Lewis Stevens. Fundamentals of Enzymology, Oxford, United Kingdom, 2000

19BT3010	Microbial Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn bacterial genetics and techniques for genetic engineering.
2. To study the role of microorganisms in medicine, agriculture, and the environment.
3. To develop value added microbial based products for commercialization

Course Outcome:

The students will be able to

1. Analyze microbial growth and product formation in batch and continuous culture
2. Demonstrate the complex events involved in the development of genetically modified organisms
3. Apply the concept of genomics and proteomics in biotechnology with regard to microorganisms
4. Develop industrially important products theta benefits human, animal and environment
5. Compare and categorize the interactions of microorganisms with plants, animals and viruses
6. Analyze and evaluate the scientific data in research paper and develop critical thinking for future research direction

Module 1: Introduction (8 Hours)

Microbial life: Microbial Cell Cultivation Systems, Culture media- types, components and formulations. Sterilization: Batch and continuous sterilization, Types of fermentations- Aerobic and anaerobic fermentation, Submerged and solid state fermentation; Factors affecting submerged and solid state fermentation

Module 2: Microbial Genomics (8 Hours)

Introduction to Microbial genomes, Genome sequencing of different microbes and their importance, Techniques for genome research (chromosome walking, RFLP etc.), Metagenomics; Application of microbial genomic variability for utilizing in human welfare, Phylogenetic relationships between various genera of microbes, Methods to Compare Genomes, Evolution by Genome Expansion and Reduction

Module 3: Microbial Proteomics (8 Hours)

Introduction to microbial proteomics, 2D gel profiling, MALDI – ToF, Protein purification work station of various microbes, Microbial pathogenesis at the proteome level, Structural proteomics and computational analysis, Proteome research for novel drug targets, High throughput proteomic screening for novel enzymes

Module 4: Microbes in agriculture **(8 Hours)**
Microbes as biocontrol agents (Baculoviruses, entomopathogenic fungi, *Bacillus thurinigiensis*, *Bacillus sphaericus,Bacillus popilae*, Microbe derived inhibitors, preparation of different types of inoculants (nitrogen fixers, phosphate solubilizers, plant growth promoting rhizobacteria (PGPR), composting, biopesticides.

Module 5: Microbial interactions **(7 Hours)**
Interactions with microorganisms, plants and animals, Bacteriophages in control of bacteria, The gut microbiota, Thermal adaptation of decomposer communities to global warming, Gene manipulation of useful microbes

Module 6: Commercial products **(6 Hours)**
Organic acids- citric acid, Solvents- acetone-butanol , Beverages- beer, wine biopolymers, enzyme, vitamins, antibiotics, biosensors, biosurfactants

References

1. Ian Humphery-Smith and Michael Hecker, Microbial Proteomics: Functional Biology of Whole Organisms by Publisher: Wiley-Interscience; 1st edition, 2010.
2. Thomas J. Dougherty and Steven J. Projan, Microbial Genomics and Drug Discovery by Publisher: CRC; 1st ed. 2013.
3. Rajhi Gupta, Jagjit Singh, T.N. Lakhanpal, and J.P. Jewari, Advances in Microbial Biotechnology by Publisher: A.P.H. Pub. Corp. 2005.
4. Stanbury, P. F., Whitaker and Hall, A. S. J., Principles of Fermentation Technology. Butterworth-Heinemann, 2009.
5. Shuler, M.L. and Karg, I F., Bioprocess Engineering Basic Concepts, 2010.
6. Crueger W. and Crueger, A., Biotechnology. A Textbook of Industrial Microbiology, Sinauer Associates, 2008.

19BT3011	Agriculture and Food Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

1. To improve knowledge on principles of Agriculture and plant breeding
2. To analyze the Food processing and packaging techniques
3. To elaborate the understanding of biodiversity and IPR issues in agricultural crops.

Course Outcome:

The students will be able to

1. Acquire knowledge on basics of Agriculture and Plant Breeding
2. Outline the principles Agriculture Microbiology
3. Understand the concept of Agriculture Biotechnology
4. Relate Biodiversity and intellectual property rights
5. Evaluate the advances in Food biotechnology
6. Analyze Food processing and Packaging techniques

Module 1: Basics of Agriculture and Plant Breeding **(8 Hours)**
Factors effecting agriculture and agricultural classification of plants, Origin of cultivated plants and plant indication, Methods of breeding self-pollinated and vegetatively propagated plants, breeding of crops pollinated plants

Module 2: Agriculture Microbiology **(7 Hours)**
Microbes of agricultural importance, Microbe based biofertilizers, Soil microbes and plant growth substances, biocontrol agents, Induced systemic resistance (ISR), Plant growth promoting rhizobacteria (PGPR)

Module 3: Agriculture Biotechnology **(8 Hours)**
Plant derived Biotechnological Products, Plant tissue culture and Genetic engineering, integrated pest and nutrient management, poly house technology, Biotech industries & institutes in India & world, Concepts of Biotech Park. Entrepreneurship biotechnology

Module 4: Biodiversity and intellectual property rights **(8 Hours)**
Genetic diversity, Molecular diversity; Species and Population biodiversity, Collection and conservation of biodiversity, endangered plants, endemism and Red Data Book, Biodiversity and centers of origins of plants; Biodiversity hot spots, IPR in relation to Indian Flora

Module 5: Food biotechnology **(7 Hours)**
Food spoilage causes and prevention, Food borne infections and intoxication, immobilization of microbial and cultured plant cells. Principles of downstream processing, industrial production of various food products

Module 6: Food processing and Packaging **(7 Hours)**
Scope and importance of food processing. National and international perspectives. Principles and methods of food preservation, Storage of food, Packaging operations, shelf life of packaged foodstuff, methods to extend shelf-life, Food packages and containers

References

1. Principles of Gene Manipulation and Genomics (2006) Sandy B. Primrose and Richard Twyman
2. Gene Cloning and DNA Analysis: An Introduction (2010) by T. A. Brown
3. Understanding biodiversity: Life, sustainability, and equity (1997) by Ashish Kothari
4. Plant Breeding (2014) by Jack Brown and Peter Caligari
5. Soil Microbiology, Ecology and Biochemistry, Fourth Edition (2014) by Eldor A. Paul
6. Fundamentals of Food Biotechnology (2015) by Byong H. Lee
7. Food Biotechnology (2012) by Vinod K. Joshi and R. S. Singh
8. Principles of Aseptic Processing and Packaging (2010) by Philip E. Nelson
9. Food Microbiology (2008) by Frazier

19BT3012	Big Data Analytics	L	T	P	C
		3	0	0	3

Course Objectives:
To improve knowledge on
1. Fundamental concepts and methods of Big data analysis.
2. Data exploration, visualization and statistical analysis for given data set.
3. Managing big data analytics for Biological data set.

Course Outcome:
The students will be able to
1. Know various types of big data platform and cloud computing model.
2. Understand the fundamentals of big data technologies
3. Apply the big data tools and software in handling the biological data.
4. Evaluate variety of big data analytics tools.
5. Explore use of R platform for biological big data analysis.
6. Design and develop Biological models based on big data techniques.

Module 1: Introduction **(8 Hours)**
Big data analytics overview, Data life cycle, Traditional Data mining Life cycle, CRISP, Big Data life cycle methodologies, Machine learning implementation, Recommender system, Dashboard, Ad-Hoc analysis**.**

Module 2: Data Exploration and Visualization **(7 Hours)**
Problem Definition, Data Collection, Data Pre-processing, Data Cleaning – Homogenization, Heterogenization, Summarizing data, Data Exploration and Visualization.

Module 3: Big Data Methods **(9 Hours)**
Introduction to R programming, Data Frames, Atomic vectors, Factors, Data types, Variables, Functions, working with excel files, Data interface.

Module 4: Charts & Graphs **(6 Hours)**
Develop pie chart, 3D pie chart, Histograms, Bar chart, Group bar chart, Stacked Bar chart, Line graph, Multiline graph and Box plot.

Module 5: Statistical Methods (9 Hours)
Regression models, Linear Regression, Multiple regression, Logistic regression, Mean, Median, Mode, Chi-Square test, T-Test.
Module 6: Big data analytics for Health care (6 Hours)
Big data analytics in bioinformatics, Health care, Data mining using RNA seq data, Text mining on complex biomedical literature, Biological sequence motifs and patterns.

References Books

1. Venkat Ankam, "Big Data analytics", Packt publishing 2016
2. Parag Kulkarni, Sarang Joshi, ""Big Data analytics, PHI learning2016
3. Wang, Baoying, Big Data Analytics in Bioinformatics and Healthcare, IGI global edition, 2014
4. Mark Gardener. Beginning R: The Statistical Programming Language. John Wiley & Sons, 2012.
5. Avril Coghlan, A Little Book of R For Bioinformatics, Release 0.1, 2017
6. Robert Gentleman, R Programming for Bioinformatics, CRC press, Taylor & Francis,2008

19BT3013	Bioethics and Biosafety	L	T	P	C
		3	0	0	3

Course Objectives:
To improve knowledge on
1. Biosafety regulations and IPR
2. Human genome project and stem cell research
3. Ethical issue of organ transplantation and transgenic animals

Course Outcome:
The students will be able to
1. Recall different rDNA technology of transgenic in animals, humans and plants
2. Understand the various biosafety regulations in transgenics
3. Illustrate IPR and patent procedures
4. Comprehend on various techniques of genome, stem cells and organ research in humans
5. Aware of modern rDNA research and its ethical procedures
6. Comprehend on recent ethical, legal and social economic impacts of rDNA research in biotechnology and its applications

Module 1: Legal and Socio-economic Impacts of Biotechnology - Biosafety Regulations (7 Hours)
National and International Level Biosafety Regulations, Trials On-field, Upscaling of Field Trials, Coordination and Capacity Establishment, Screen–A Newsletter on Biosafety, Hazardous Materials Used in Biotechnology—Handling and Disposal, Good Manufacturing Practices, Good Laboratory Practices, Good Laboratory Practice Principles
Module 2: Intellectual Property Rights (9 Hours)
Intellectual Property Rights, World Trade Organisation (WTO), WTO Agreements, General Agreement on Tariffs and Trade (GATT), General Provisions and Basic Principles, Patenting and the Procedures Involved in the Application for Grading of a Patent, Steps to a Patent, Compulsary Licenses, Patent Cooperation Treaty (PCT), Examples of Patents in Biotechnology, Patenting of Living Organisms, Bioethics in Biodiversity
Module 3: Human Genome Project (7 Hours)
Human Genome Project**,** Ethical Issues of the Human Genome Project, The Human Genome Diversity Project, The Need for a Strategic Framework, Foetal Sex Determination The Indian Law on Abortion, Social Implications of the Act, Ethical Issues in MTP, Ethical Issues Leading to Legal Issues, Genetic Studies on Ethnic Races.
Module 4: Stem Cell Research (9 Hours)
Introduction**,** Applications of Stem Cells, Ethics Involved in Stem-cell Research, Use of Cell-cultures as Alternatives to Use of Animals, Replacement, Use of Animals for Research and Testing, Animal Cloning,

Ethics and Animal Cloning, Human Cloning, Why Cloning Humans is Ethically Unacceptable?, Controlling Someone Else's Genetic Makeup, Instrumentality, Infertility–An Exception to Instrumentality.

Module 5: Organs Transplantation in Human Beings (8 Hours)

Organs Transplantation in Human Beings, Ethics in Xenotransplantation, Bioethical Issues, Transgenesis, Informed Consent, Allocation of Health Care Resources, Patentability and Xenotransplantation, Organ Culture, Ethical Issues.

Module 6: Transgenic Animals (6 Hours)

CCAC Guidelines on Transgenic Animals (1997), CCAC Guidelines on Animal Welfare, Laboratory Animal Management, the need for Ethical Review

References

1. Sree Krishna. Bioethics and Biosafety in Biotechnology. New Age International Publishers, New Delhi, 2007

19BT3014	Chemical Process Technology	L	T	P	C
		3	0	0	3

Course objectives

1. This course will give powerful approach in designing new process and product development.
2. This course will be helpful to understand the processes technologies of various organic and inorganic process industries for manufacturing chemicals.
3. This course will be helpful to associated troubleshoot.

Course Outcome

The students will be able to

1. Remember the process flow diagram for various chemical process
2. Understand the steps in manufacturing process of organic and inorganic chemicals
3. Classify various chemical, agrochemical and fermentation products
4. Illustrate the process flow diagram of carbohydrates, oils, fats etc.
5. Analyze various chemical process to solve engineering problems during production
6. Evaluate major engineering problems and in order to provide technological solutions in chemical process industries.

Module 1: Process Flow Diagram (8 Hours)

Basic philosophy of a process flow diagram (PFD). Elements of a PFD. General discussion on Influence of various parameters on deciding process for a product and method of drawing PFD. Nitric acid, sulphuric acid, phosphoric acid and it's important salts

Module 2: Industrial Production (8 Hours)

Caustic chlorine industry - mercury, membrane and diaphragm cells. Hydrochloric acid and important chlorine compounds. Soda ash, sodium bicarbonate.Lime, cement and plasters, Glass & ceramic industries

Module 3: Oils and Fats (7 Hours)

Methods of extracting vegetable oils (Process Description and Flow sheet). Hydrogenation of oils (Process description & flow sheet), major engineering problems and improved technology.

Module 4: Sugar Derivatives (8 Hours)

Sugar and starch industries: Manufacturing process with flow diagram, Sugar refining, manufacturing process of starch and their different by-products; Glucose, Sorbitol & Polyols.. Pulp and paper Industries, technology and manufacturing methods

Module 5: Fermentation Products (7 Hours)

Fermentation industries: Industrial Alcohol, Absolute Alcohol; their production process with flow diagram.

Module 6: Agrochemical Industries (7 Hours)

Elementary ideas on Pesticides, Insecticides, Fungicides, Herbicides, DDT manufacturing process with flow sheet.

References:

1. Dryden, C. E., and Rao, M.G. (Ed.), Outlines of Chemical Technology Affiliated East West Press.2010
2. Austins, G.T., Sherve's Chemical Process Industries, MGH,2012.
3. Venkateswarlu, S. (Ed.) Chemtech (II) Chemical Engineering Development Centre, IIT, Madras, 2009.
4. S. K. Ghoshal, S. K. Sanyal and S. Datta, Introduction to Chemical Engineering, Tata McGraw Hill, New Delhi, 2010.
5. Kirk & Othmer (Ed.), Encyclopedia of Chemical Technology, 2011.

19BT3015	**Immunotechnology**	**L**	**T**	**P**	**C**
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Immune systems and techniques in immunology.
2. Concepts in immunotechnology
3. Advancement in immunology and immunotechnology

Course Outcome:

The students will be able to

1. Recall the basics in functions of immune systems.
2. Compare the types of antibodies and the interaction between antigen and antibodies
3. Apply skills and competence in specialized immunological techniques in the diagnosis and management of health related disorders.
4. Infer research methods employing immunological techniques for application in biomedical and clinical research
5. Evaluate immunological techniques to manage the immunological diseases
6. Develop modern technology in diagnosis and treatment of cancer

Module 1: THE IMMUNE SYSTEM (8 Hours)

Introduction - Cells of the Immune system - Innate and Acquired immunity - Primary and secondary lymphoid organs – Nature of antigens - Chemical and molecular basis of antigenecity – Immunogenecity - Haptens-Adjuvants - Primary and Secondary Immune Responses - Theory of Clonal selection. Preparation of antigens for raising antibodies**,**

Module 2: ANTIGEN-ANTIBODY INTERACTION (8 Hours)

In vitro antigen-antibody reactions, Isolation of antibodies, assays for complement, immunoelectrophoresis. ELISA, RIA and immunoblotting, Immunofluorescence, flow cytometry & sorting, T & B cell subset analysis, immuno-electron microscopy.

Module 3: ANTIBODIES (8 Hours)

MAb through hybridoma technology, MAb without hybridoma technology – viral transformation of B cell line, plant as expression systems – plantibodies, applications. Production of abzymes, immunotoxins, chimeric antibodies, bi specific antibodies, single chain Fc, diabodies, tetrabodies, intrabodies; plastibodies; applications. Plaque Forming Cell Assay

Module 4: CELLULAR IMMUNOLOGY (7 Hours)

PBMC seperation from the blood; identification of lymphocytes based on CD markers; FACS; Lymphoproliferation assay; Mixed lymphocyte reaction; Cr51 release assay; macrophage cultures; cytokine bioassays- IL2, gamma IFN, TNF alpha.; HLA typing.

Module 5: IMMUNITY AND INFECTION MECHANISM: **(7 Hours)**

Tissue injury and Inflammation – Immunosuppression - Immunological Tolerance - Immunity to infectious agents – bacteria, virus, fungi and parasites. Transplantation – Autoimmunity - Tumor Immunology - Vaccines: Conventional Molecular vaccines -Types of vaccines - Recent trends in Immunology of Infectious diseases.

Module 6: TRANSPLANTATION AND TUMOR IMMUNOLOGY (7 Hours)
Transplantation: genetics of transplantation; laws of transplantation; tumor immunology, Autoimmunity; Autoimmune disorders and diagnosis. Cell Cytotoxicity, mixed lymphocyte reaction, Apoptosis, Cytokine expression; Cell cloning, Reporter Assays, In–situ gene expression techniques;

References

1. David Male Jonathan BrostoffDavid Roth Ivan Roitt, Immunology. 8th Edn., Elsevier, 2012
2. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002
3. Goldsby , R.A., Kindt, T.J., Osbome, B.A. and Kerby J. Kuby Immunology, 6th ed., W.H. Freeman, 2005
4. Weir DM and Stewart, J., Immunology, 10th Edn. Churchill Livingston, New York, 2000.

19BT3016	Computational Biology	L	T	P	C
		3	0	0	3

Course Objectives:
1. To provide foundation in fundamental concepts, tools and resources in Computational Biology.
2. To introduce machine learning and data mining concepts and techniques relevant to biological data along with practical implementation of machine learning techniques.
3. To develop skills in specialized areas related to Computational Biology which will enable high throughput data processing and analysis.

Course Outcome:
The students will be able to
1. Understand the principles of biological data and interpretation.
2. Demonstrate high throughput biological data and perform statistical analysis
3. Make use of advanced data mining and machine learning techniques
4. Create skills on molecular modeling and simulation, whole cell modeling, drug discovery, and Systems Biology
5. Clarify the implementation of algorithms which may help them design their own.
6. Explain the theory and practical aspects of important experimental techniques.

Module 1: Introduction (10 Hours)
Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications

Module 2: Phylogentic analysis (7 Hours)
Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.

Module 3: Bio molecular structure modelling and simulation (7 Hours)
Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

Module 4: Machine learning methods and analysis (7 Hours)
Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to Systems Biology and its applications in whole cell modelling, Microarrays and Clustering techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA Computing.

Module 5: Perl for Bioinformatics (7 Hours)
Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation

Module 6: Systems Biology and protein network analysis (7 Hours)
Systems Biology Networks- basics of computer networks, Biological uses and Integration. Micro array – definition, Applications of Micro Arrays in systems biology. Self-organizing maps and Connectivity maps - definition and its uses. Networks and Pathways – Types and methods. Metabolic networks.

References

1. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
2. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
3. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press.2010
4. Andrew R. Leach, Molecular Modeling Principles And Applications, Second Edition, Prentice Hall. 2001
5. Jonathan Pevsner. Bioinformatics and Functional Genomics, 2nd Edition. John Wiley & Sons Inc 2015
6. Computational systems biology by A.Kriete, R.Eils, Academic Press. 2005
7. Systems Biology and Synthetic Biology by Pengcheng Fu, Sven Panke, Wiley InterScience. 2009
8. Greg Gibson and Spencer V. Muse. A Primer of Genome Science, Third Edition. Sinauer Associates, Inc; 3 edition 2009

		L	T	P	C
19BT3017	**Metabolic Regulation and Engineering**	3	0	0	3

Course Objective:
1. To develop skills of the students in the area of metabolic regulation and engineering to amend the existing metabolic pathways
2. To enable the students to use molecular techniques to enhance the product yield and also to produce industrially important products in a cost effective manner.
3. To understand the quantitative basis of metabolic networks using enzyme kinetics

Course Outcome:
The students will be able to
1. Identify the appropriate metabolic pathways to produce a desired product
2. Characterize the different metabolic pathways and propose relevant metabolic engineering strategies to obtain improved and enhanced economically viable products.
3. Adapt suitable metabolic control analysis to identify important steps in pathway control.
4. Construct genome-scale metabolic flux models using available tools and software and perform simulations
5. Design 13C-labeling strategies and perform metabolic flux analysis to determine metabolic pathway utilization
6. Construct a mathematical representation of a metabolic network, and calculate the internal fluxes based on provided external measurements.

Module 1: REVIEW OF CENTRAL METABOLISM (6 Hours)
Enzyme catalyzed reaction, Pathway of Cellular respirations, Glycolysis, Krebs Cycle, Fermentative Pathways, Metabolism of Proteins and Lipids

Module 2: CELLULAR REACTION AND METABOLIC FLUX ANALYSIS (12 Hours)
Stoichiometry of cellular reactions, reaction rate and flux, dynamic mass balance, Flux Analysis basics, Dynamic steady state, Estimation of intracellular metabolic flux, Determined, overdetermined and under determined system, use of linear programming, Elucidation of extreme Pathways

Module 3: EXPERIMENTAL METABOLIC FLUXES BY ISOTOPE LABELING (8 Hours)
Limitation of Stoichiometric MFA, Isotopic substrate composition, 13C MFA experimentation, Carbon-transition network, Isotopic mass distribution, Detection of 13C labelling patterns, Construction of a metabolic model for 13C flux analysis, FiatFlux® (Matlab)

Module 4: METABOLIC CONTROL ANALYSIS (6 Hours)
Coefficients of control analysis, elasticity coefficient, Flux control coefficients, Summation theorem, FC connectivity theorems, Concentration control connectivity, calculating control coefficients, MCA example, predicting the results of perturbation, predicting the results of perturbation, MCA Linear approximation

Module 5: REGULATION OF METABOLIC PATHWAYS (6 Hours)
Feedback control systems, alteration of feedback regulation for enhanced production of primary metabolites, Operon model – *trp, lac* operon, Inhibition of enzyme and selectivity

Module 6: APPLICATIONS OF METABOLIC ENGINEERING (7 Hours)
Product over production examples: polyhydroxyalkanoic acids, Extension of substrate utilization range for organisms such as *S. cerevisae* and *Z. mobilis* for ethanol production, metabolic engineering of *Enterobacter aerogenes*

References

1. Christina Smolke *ed.*, The Metabolic Pathway Engineering Handbook: Fundamentals, CRC Press, 2009.
2. Gregory N. Stephanopoulos, Aristos A. Aristidou & Jens Nielsen, "Metabolic Engineering: Principles and Methodologies", Academic Press, An Imprint of Elsevier India Pvt.Ltd., 1st edition, 1998.
3. S. Cortassa, M.A.Aon, A.A.Iglesias and D.Llyod, " An Introduction to Metabolic and Cellular Engineering", 2nd Edition, World Scientific Publishing Co. Pte. Ltd, 2012.
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005

19BT3018	Clinical Trials and Bioethics	L	T	P	C
		3	0	0	3

Course Objectives:

1. To Explain key concepts in the design of clinical trials
2. To Identify key issues in data management for clinical trials.
3. To describe the roles of Regulatory Affairs in clinical trials.

Course Outcome:

The students will be able to

1. Uunderstands the principles and methodology of clinical trials
2. Comprehend the theory and practical aspects of important techniques
3. Develop analytical skills and expertise to formulate and implement a research oriented real time problem.
4. Asses in major high throughput statistical methods in clinical research.
5. Evaluate experimental component to undertake interdisciplinary work.
6. Equips skills to pursue a career either in academia or industry.

Module 1: Introduction to Drug Discovery and Development (9 Hours)
Origin and History of Clinical Research, Introduction to Drug Discovery and drug Development, Clinical Trials in India–The National Perspective, Clinical Trial Phase I, Clinical Trial Phase II, Clinical Trial Phase III, Clinical Trial Phase IV –methods, Principles of sampling -Inclusion and exclusion criteria, Methods of allocation and randomization, Termination of trial.

Module 2: Ethical Regulation (8 Hours)
Historical guidelines in Clinical Research -Nuremberg code, Declaration of Helsinki, Belmont report, Research ethics and Bioethics –Principles of research ethics; ethical issues in clinical trials; Use of humans in Scientific Experiments; the informed consent; Introduction to ethical codes and conduct; Introduction to animal ethics; Animal rights and use of animals in the advancement of medical technology

Module 3: Regulation in clinical research **(7 Hours)**
International Conference on Harmonization (ICH) Brief history of ICH, Structure of ICH, ICH Harmonization Process, Responsibilities of Stakeholders: Sponsors, Investigators, CROs, Monitors, Institutional ethics committee

Module 4: Clinical trial important documentation **(7 Hours)**
Essential Documents in Clinical Trials: SOP, Clinical Trial Protocol and 95Protocol Amendment(S), Investigator Brochure, Master Files, Informed Consent Forms, Consort statement, Case Record Form

Module 5: Clinical trial data management **(8 Hours)**
Project management in clinical trials -principles of project management; Application in clinical trial management; Risk assessment Pharmacovigilance, Project Auditing, Inspection.

Module 6: Clinical data monitoring **(7 Hours)**
CRF Review & Source Data Verification, Drug Safety Reporting, Drug Accountability Work, Routine Site Monitoring, Site Close Out Visit

References

1. Lee, Chi -Jen; etal.,"Clinical Trials or Drugs and Biopharmaceuticals." CRC / Taylor &Francis, 2011
2. Methodology of Clinical Drug Trials, 2ndEdition.Spriet A., Dupin-Spriet T., Simon P. Publisher: Karger. 1997
3. Design and Analysis of Clinical Trials: Concepts and Methodologies , 3rdEdition.Shein-Chung Chow, Jen-Pei Liu. Publisher: Wiley. 2014
4. Principles and Practice of Pharmaceutical Medicine, 3rdEdition. Lionel D. Edwards, Anthony W. Fox, Peter D. Stonier. Publisher: Wiley-Blackwell. 2011
5. Oxford Handbook of Clinical Medicine, 9 thEdition. Murray Longmore, Ian Wilkinson, Andrew Baldwin, and Elizabeth Wallin.Oxford Medical Handbooks.2014.

<table>
<tr><td rowspan="2">19BT3019</td><td rowspan="2">Sustainable Bioprocess Development</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Course Objectives:
1. To impart knowledge on design and operation of fermentation processes with all its prerequisites.
2. To familiar the students with the basics of microbial kinetics and reactor design
3. To develop bioengineering skills for the production of value added product using integrated biochemical processes

Course Outcome:
The students will be able to
1. Develop growth model based on the microbial characteristics
2. Understand Immobilization techniques
3. Analyze the mass transfer during different biochemical reactions
4. Evaluate enzyme reaction and its kinetics
5. Understand different configurations of bioreactors
6. Understand the involvement of bioprocess engineering in other related areas

Module 1: Introduction **(6 Hours)**
Microbial diversity, Cell construction, Major products of biological processing, Component parts of fermentation process, Concept of Upstream, downstream processing and scale up.

Module 2: Microbial Growth and Quantifying Growth kinetics **(8 Hours)**
kinetics of microbial growth, Substrate-limited growth, substrate uptake and product formation- monod model, leudeking-piret models, Models with growth inhibitors , oxygen transfer in microbial bioreactors, volumetric mass transfer coefficient, Measurement of k_La

Module 3: Enzyme Engineering **(7 Hours)**
Enzyme, How enzyme work, Enzyme kinetics, Enzyme immobilization, Industrial utilization of enzyme, Hheterogeneous Reactions in Bioprocessing, Internal Mass Transfer and Reaction

Module 4: Bioreactor Design **(9 Hours)**
Mixing, Mixing Equipment, Flow pattern, Mechanism of Mixing, Power requirement for mixing, Bioreactor Configurations (Different Bioreactors), Membrane bioreactor

Module 5: Reactor Operation **(8 Hours)**
Batch Operation of a Mixed Reactor, Fed-Batch Operation of a Mixed Reactor, Continuous Operation of a Mixed Reactor, Chemostat Operation, Operation of Plug-Flow reactor

Module 6: Advanced Bioprocessing **(7 Hours)**
Bioprocess Consideration in plant cell cultures, Bioprocess Consideration in animal cell cultures, Bioprocessing in environmental engineering, Industrial Bioprocess

References

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2005.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
3. *Pauline M. Doran,* Bioprocess Engineering Principles, Elsevier Science & Technology Books, 2nd edition, May 1995

<table>
<tr><td rowspan="2">19BT3020</td><td rowspan="2">Advanced Animal Biotechnology and Tissue Culture</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Course Objectives:
1. To Provide insights into Animal Biotechnology
2. To Provide knowledge in Animal Breeding
3. To equip the students with technical knowledge of cell culture and its Applications

Course outcomes:
The students will be able to
1. Describe basic concepts in Animal Biotechnology and its importance in Livestock improvement
2. Understand the role Cryopreservation of embryos and embryo sexing
3. Relate and evaluate the genetic defects in animal embryos through molecular defects.
4. Discuss the significance of transgenesis with respect to animal models
5. Comprehend the fundamental concepts of mammalian cell and generation of cell line and to demonstrate tissue engineering applications for implantable materials.
6. Relate to the social, cultural, economic, legal issues associated and comprehend the need Bioethics and IPR in biotechnological research.

Module 1: Introduction **(8 Hours)**
Introduction to Animal Biotechnology, Cryopreservation of Sperms, Ova of livestock, Artificial Insemination, Super Ovulation, In Vitro fertilization, Culture of embryos, Cryopreservation of Embryos, Embryo transfer, Embryo splitting, Embryo sexing.

Module 2: Transgenic Animals **(7 Hours)**
Transgenic manipulation of animal embryos, different applications of transgenic animal technology, Animal cloning cloning from- embryonic cells and adult cells, cloning for conservation for conservation endangered species, Ethical, social and moral issues related to cloning

Module 3: Germplasm Preservation **(7 Hours)**
In situ and ex situ preservation of germplasm, In utero testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, Gene knock out technology and animal models for human genetic disorders

Module 4: Live Stock Improvement **(8 Hours)**

Genetic characterization of livestock breeds, Marker assisted breeding of livestock, Transgenic animal production and application in expression of therapeutic proteins Detection of meat adulteration using DNA based methods.

Module 5: Cell Culture **(8 Hours)**

Commercial scale production of animal cells, Application of animal cell culture for in vitro testing of drugs, Cytotoxicity and viability assays, Cell line preservation and authentication.

Module 6: Tissue Engineering **(7 Hours)**

Tissue Engineering, 3D Culture with different type of cells, Scaling up of cell culture – Adherence and Suspension type of cells for the production of various products, Different methods and steps involved in cell seeding of implantable materials.

References

1. Ianfreshney B. Culture of Animal cells & Manual of basic technique, fifth edition, Wiley – liss publication, 2006.
2. Dubey R.C. Text book of biotechnology S. Chand & Company Ltd. 2007
3. Sasidhar B. Animal Biotechnology MJP publishers. 2006
4. Portner R. 2007. *Animal Cell Biotechnology*. Humana Press.
5. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare
6. Animal Cell Culture by John R.W. Masters 3rd Edition, Oxford University Press, 2000.

<table>
<tr><td rowspan="2">19BT3021</td><td rowspan="2">Molecular Diagnostics</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Course Objectives:

To improve knowledge on

1. History and Traditional diagnostics in genetic disease.
2. Principles and performance of DNA and RNA isolation, amplification, hybridization, and analysis.
3. Applications in microbiology, diagnosis, cancer, transplantation, and forensic medicine.

Course Outcome:

The students will be able to

1. Understand the basic principles of molecular diagnosis
2. Demonstrate the working mechanism of different traditional and molecular diagnostic methods
3. Categorize genetic diseases and metabolic disorders
4. Apply appropriate diagnostic methods for the diagnosis of genetic and molecular diseases
5. Develop a new diagnostic kits for the emerging diseases
6. Adapt ethical guidelines for molecular test results

Module 1: Introduction to Diagnostics **(7 Hours)**

Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission of infections, Clinical Sample collection- method of collection, transport and processing of samples and Interpretation.

Module 2: Traditional Diagnostic Methods **(9 Hours)**

Diagnosis of infection caused by Bacteria: *Staphylococcus, Streptococcus, Mycobacterium E.coli, Salmonella, Shigella, and Vibrio,* Fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. DNA and RNA viruses- Pox viruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Protozoan diseases: Amoebiosis, Malaria, Leishmaniasis. Helminthic diseases- *Ascaris lumbricoides*, Filariasis- *Wuchereria bancrofti*

Module 3: Major Metabolic and genetic disorders **(7 Hours)**

Traditional methods for the diagnosis of metabolic errors, genetic disorders, identifying human disease genes. Genetics of cancer- oncogenes, tumour suppressor genes. Methods available for the diagnosis of genetic diseases and metabolic disorders. Genetic disorders- Sickle cell anemia, Duchenne muscular Dystrophy, Cystic Fibrosis.

Module 4: Molecular Diagnosis **(7 Hours)**

Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Hot-start, In situ PCR, Long-PCR, PCR-ELISA, Ligase Chain Reaction. Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis

Module 5: Hybridization and Sequencing **(8 Hours)**

Southern, Northern, in situ FISH, microarrays types and applications; Protein extraction and analysis PAGE, Western Blot. Automated DNA sequencing Principles, Methods and Instrumentation Advances in DNA sequencing New Generation sequencing Methods, Pyrosequencing, Microarrays Personalised Medicine- Pharmacogenomics (ADMET)

Module 6: New Trends in Diagnostics **(7 Hours)**

DNA chips in diagnosis of genetic disorders, Diagnosis of neonatal genetic disorders, human genome project, ethical considerations. Good Laboratory Practices. Different Levels of Biosafety and Containment. Forensic Medicine. Ethical and legal issues in genetic counselling.

References

1. Bailey & Scott's Diagnostic Microbiology (2012), Betty A. Forbes , Daniel F. Sahm, Alice S. Weissfeld , Ernest A. Trevino, Published by C.V. Mosby
2. Fundamentals of Molecular Diagnostics (2010). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
3. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws
4. Molecular Diagnostics for the Clinical Laboratorian 2Ed. 2006, W.B. Coleman. Humana Press.

		L	T	P	C
19BT3022	**Drug Design and Discovery**	3	0	0	3

Course Objectives:

1. To explore the process of drug development, from target identification to final drug registration.
2. To provide the knowledge in drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening.
3. To develop skills in specialized areas related to bioavailability, clinical trials, and the essentials of patent law

Course Outcome:

The students will be able to

1. Describe the process of drug discovery and development
2. Discuss the challenges faced in each step of the drug discovery process
3. Classify the computational methods used in drug discovery
4. Organize information into a clear report
5. Demonstrate their ability to work in teams and communicate scientific information effectively
6. Construct, review and evaluate preclinical and clinical pharmaceutical studies.

Module 1: Drug and their Interaction **(8 Hours)**

Introduction to Drugs: Drug nomenclature, Routes of drug administration and dosage forms, Principles of Pharmacokinetics and Pharmacodynamics: ADME, Bioavailability of drugs -Lipinski's rule; How drugs work -Drug targets, drug-target interaction and dose-response relationships.

Module 2: Drug design pipeline **(8 Hours)**

New Drug Discovery & Development: Overview of new drug discovery, development, cost and time lines. Target Identification & Validation. Lead Discovery: Rational and irrational approaches -Drug repurposing, Natural products, High-throughput screening (HTS), Combinatorial chemistry and computer aided drug design (CADD).

Module 3: Fundamental of Drug Actions: (8 Hours)

Inter and intramolecular interactions: Weak interactions in drug molecules; Chirality and drug action; Covalent, ion, ion-dipole, hydrogen bonding, C-H hydrogen bonding, dihydrogen bonding, van der waals interactions and the associated energies. Cation-and-OH interactions. Receptorology : Drug-receptor interactions, receptor theories and drug action; Occupancy theory, rate theory, induced fit theory, macromolecular perturbation theory, activation-aggregation theory. Topological and stereo chemical consideration.

Module 4: Drug toxicity, Assays and testing (7 Hours)

Preclinical Testing of New Drugs: Pharmacology -In vitro/in vivo Pharmacokinetics and Pharmacodynamics testing; Toxicology-Acute, chronic, carcinogenicity and reproductive toxicity testing; Drug formulation testing. Clinical Trial Testing of New Drugs: Phase I, Phase II and Phase III testing; Good clinical practice (GCP) guidelines -Investigators brochures, Clinical trial protocols and trial design; Ethical issues in clinical trials -How are patient rights protected?

Module 5: Drug Regulatory Agencies (8 Hours)

US Food & Drug Administration (US FDA) and Central Drugs Standard Control Organization (CDSCO), India. Regulatory Applications & New Drug Approval: Investigational new drug (IND) application & New drug application (NDA); Regulatory review and approval process. Regulatory Requirements for Drug Manufacturing: Current Good manufacturing practice (cGMP) and GMP manufacturing facility inspection & approval.

Module 6: Intellectual Property Rights (IPR) (8 Hours)

IPR Definition and implications for discovery & development. Forms of IPR Protection-Copyright, Trademark and Patents. International organization and treaties for IPR protection –World Trade Organization (WTO) & Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreements. Controller General of Patents, Designs & Trade Marks, India (CGPDTM), World Intellectual Property organization (WIPO)-Patent Cooperation Treaty (PCT).

References

1. Drugs: From discovery to approval 2nd Ed by Rick NG. Wiley Blackwell (2009)
2. Essentials of Medical Pharmacology, 6the Edition , by Tripathi Kd. Publisher: Jaypee Brothers (2013)
3. Burger’s Medicinal Chemistry and Drug discovery. Volume 2, Wiley-Interscience; Volume 2 edition (January 23, 2003)
4. Intellectual Property Rights In India: General Issues And Implications by Prankrishna Pal. Publisher: Deep & Deep Publications Pvt.Ltd (2008)
5. Stromgaard, Kristian, Povl Krogsgaard-Larsen, and Ulf Madsen. *Textbook of drug design and discovery*. CRC Press, 2009.
6. Katzung, Bertram G., Susan B. Masters, and Anthony J. Trevor. *Basic and Clinical Pharmacology (LANGE Basic Science)*. McGraw-Hill Education, 2012.
7. Spriet, Alain, et al. *Methodology of clinical drug trials*. Basel: Karger, 2004.

		L	T	P	C
19BT3023	**Transport Phenomena**	3	0	0	3

Course Objectives:

2. To give an overview of mass, momentum and energy transport, present the fundamental equations and illustrate how to use them to solve problems.
3. To describe mass, momentum and energy transport at molecular, microscopic and macroscopic level, to determine velocity, temperature and concentration profiles.

4. The study also focuses on how operations related with fluids and how temperature plays a pivotal role in a drug or a chemical plant.

Course Outcome:

The students will be able to

1. Understand the molecular transport of momentum, heat, and mass.
2. Interpret and solve shell momentum, heat, and mass balances for one dimensional steady state problems.
3. Develop dimensional analysis and knowledge of the dimensional numbers that are important in momentum, heat, and mass transfer applications.
4. Analyse inter phase transport problems which involve friction factors, drag coefficients, heat and mass transfer coefficients.
5. Evaluate the problems related with diffusivities and convection.
6. Construct molecule energy related phases in bioengineering.

Module 1: Rheology of Fluids (9 Hours)

Phenomenological Equations and Transport properties, Rheological behaviour of fluids, Balance Equations – Differential and Integral equations.

Module 2: Laminar and Turbulent Behavior of Fluids (7 Hours)

Applications in laminar and turbulent transport in compressible and incompressible fluids. Boundary layer theory.

Module 3: Isothermal and Non Isothermal Systems (7 Hours)

Macroscopic balance for isothermal and nonisothermal systems and their applications in Momentum, Heat and Mass transport problems.

Module 4: Flow Patterns of Fluid Systems (8 Hours)

Friction factor, Fluid –Fluid systems, Flow patterns in vertical and horizontal pipes, Formulation of bubbles and drops and their size distribution, Solid – fluid systems, Forces acting on stagnant and moving solids, Flow through porous medium, capillary tube model and its applications.

Module 5: Convections, Diffusivity (8 Hours)

Heat Transfer coefficient, Forced convection in tubes, around submerged objects, Heat Transfer by free convection, film type and dropwise condensation and equations for heat 19 transfer, Heat transfer in boiling liquids.

Module 6: Design of Heat Transfer Equipment (6 Hours)

Transfer by forced convection in laminar and turbulent flow. Heat exchange equipment's- principles and design.

References

1. Bird R.B., Stewart, W. E. and Lightfoot, E. N., "Transport Phenomena", 2nd Edn.John Wiley and Sons, 2002.
2. Welty, J.R., Wicks, C. E. and Wilson, R. E., "Fundamentals of Momentum, Heat Mass Transfer", 5th Edn., John Wiley and Sons, 2007.
3. Brodkey, R. S. and Hershey, H. C., "Transport Phenomena – A Unified Approach", Brodkey Publishing, 2003.

19BT3024	**Pharmaceutical Biotechnology**	**L**	**T**	**P**	**C**
		3	0	0	3

Course Objectives:

1. To provide the student well versed with recent advances in the field of Pharmaceutical Biotechnology.
2. To make foundation for understanding the various events at molecular level, keeping a balance between health and disease.

3. To enabling the student to gain in-depth knowledge in fundamental and applied aspects of Microbiology and Immunology.

Course Outcome:

The students will be able to

1. Understand and evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market.
2. Aanalyze Screening, isolation, characterization and scale-up of Biological products.
3. Understand the legal steps involved in progressing a new drug to market and their science
4. Develop skills in molecular immunotherapeutics and immunotherapy.
5. Expertise in pharmaceutical drug delivery methods and analysis.
6. Gain knowledge in physicochemical properties, pharmacology and the formulation

Module 1: Introduction to Biopharmaceuticals and Biogenerics. (9 Hours)

Introduction to Biopharmaceuticals and pharmaceutical biotechnology, Biopharmaceuticals: current status and future prospects, generic and branded biopharmaceuticals, overview of life history for development of biopharmaceuticals. Discovery of protein or peptide based therapeutics: In-silico, pharmaco-informatics. Pre-clinical toxicity assessment, Clinical trial phases and design, clinical data management, concept of Pharmacovigilance

Module 2: Impact of omics in Drug Discovery (7 Hours)

Pharmacogenetics, Pharmacogenomics and proteomics, structural, functional and comparative genomics, DNA & oligonucleotides microarrays, genetically engineered animals, Integration of personalized and systems medicines, pharmacogenomics in preclinical and clinical development of drugs

Module 3: Pharmacokinetics and Pharmacodynamics of Biopharmaceuticals (7 Hours)

Definition, rationales, absorption, distribution and metabolism pathway. Factors governing absorption of drug. Pharmacokinetics and Pharmacodynamics of therapeutic peptides. Dose response relationship, interspecies scaling, and heterogeneity of therapeutic proteins.Chemical modification of therapeutic proteins

Module 4: Immunotherapeutic & Immunodiagnostics (7 Hours)

Overview of antibody based therapeutics, biologics for autoimmunity and inflammation, vaccine- adjuvant technology, genetically engineered vaccines.Principles of immunodiagnostic assay based on solid phase system: Malarial & HIV diagnostic kits as case study. Fluorescent ligands and radio-isotope tracers, principles and instrumentation for molecular diagnostics (Time resolved fluorescence immunoassay, light scattering principles), PCR and nucleic acid based diagnostics, imaging techniques.

Module 5: Biopharmaceuticals Based Delivery Systems (7 Hours)

Novel drug delivery systems for biopharmaceuticals (rate controlled and site specific), Nanotechnology based miniaturization of biopharmaceuticals and therapeutics, peptides for intracellular targeting, delivery of nucleic acids and therapeutic peptides, concept of responsive or smart drug delivery system.

Module 6: Formulation of Biopharmaceuticals (7 Hours)

Rational for formulation of bio therapeutics, formulation recipients: solubility enhancers, anti-aggregating agents, buffers, cryoprotectants, antioxidants and preservatives etc significance with relevant examples. Methods to enhance shelf life protein based therapeutics. Packaging techniques and quality analysis of product

References

1. Gary Walsh (2003) Biopharmaceuticals: Biochemistry and Biotechnology, 2nd Edition, John Wiley & Sons, Inc. 2.Daan J A Crommelin (2010),
2. Pharmaceutical Biotechnology, 2nd Edition, Taylor & Francis Group. 3.Rodney J. Y. Ho (2013)
3. Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, 2ndEdition, John Wiley & Sons, Inc, 2013.
4. .Gary Walsh (2007) Pharmaceutical Biotechnology: Concepts and Applications. John Wiley & Sons, Inc.

5. .Oliver Kayser, Heribert Warzecha (2012) Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, 2nd Edition. John Wiley & Sons, Inc.

19BT3025	Bioreactor Engineering	L	T	P	C
		3	0	0	3

Course Objective:

1. This course aims at making the students understand the principles and concepts of Bioreactor engineering.
2. This will help the student understand structured models of growth and product formation
3. To understand the of oxygen transfer and parameters to be monitored and controlled in bioreactors

Course Outcome:

The students will be able to

1. Acquire knowledge on various bioreactors.
2. Classify modern biotechnological process in host vector systems.
3. Devise methods to calculate oxygen and mass transfer coefficients in bioreactors.
4. Assess on-line data analysis for measurement of important physico-chemical and biochemical parameters in bioreactors.
5. Analyze structured models for analysis of various bioprocesses.
6. Design of various instrumentation for monitoring and control of bioreactors.

Module 1: Design and Analysis of Bioreactors (7 Hours)

Design and operation of novel bioreactors-Air-lift loop reactors, Fluidized bed-bioreactors, packed bed reactor, Bubble column reactor, stability analysis of bioreactors

Module 2: Bioreactor Scale-up (7 Hours)

Oxygen mass transfer in bioreactors - microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed

Module 3: Monitoring of Bioprocesses (7 Hours)

On-line data analysis for measurement of important physico-chemical and biochemical parameters; State and parameter estimation techniques for biochemical processes.

Module 4: Modern Biotechnological Processes (8 Hours)

Recombinant cell culture processes, guidelines for choosing host-vector systems, plasmid stability in recombinant cell culture, limits to over expression, Modelling of recombinant bacterial cultures; bioreactor strategies for maximizing product formation; Bioprocess design considerations for plant and animal cell cultures

Module 5: Modelling and Simulation of Bioprocesses (8 Hours)

Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

Module 6: Bioreactor Instrumentation and Control (8 Hours)

Methods of on-line and off-line biomass estimation; microbial calorimetry. Flow injection analysis for measurement of substrates, products and other metabolites. Parameters to be monitored and controlled during fermentation process.

References:

1. Michael Shuler, Fikret Kargi, “Bioprocess Engineering Principles”,Second edition, Prentice Hall, 2008.
2. P.Stanbury, A.Whitaker,SJ Hall “Principles of fermentation technology”, Second edition, Elsvier Pergamon Press,2010.
3. Pauline Doran,”Bioprocess Engineering Principles”, Academic Press, 2010.

4. Elmar Heinzle, Arno P.Biwer, "Development of Sustainable Bioprocess: Modelling and Assessment", Wiley, 2007.
5. Bjorn K.Lyderson, Nancy Ade'lia and Kim Nelson, "Bioprocess engineering *(handcover)",*Wiley Interscience, 2014.

19BT3026	Stem Cell Therapeutics	L	T	P	C
		3	0	0	3

Course Objectives:

To gain awareness about

1. The history and future of the emerging field of Stem Cell Therapy
2. The impact of Stem Cell therapy in health care system.
3. The impact of Stem Cell Therapy in Human civilization.

Course Outcome:

The students will be able to

1. Understand the basic concepts in culturing animal and mammalian cells
2. Understand the aspects of cellular ageing
3. Understand the types of Stem cells, their development and function.
4. Learn the various methods to isolate and culture Stem cells
5. Learn the various therapeutic applications of stem cells
6. Appreciate the bigger picture of Stem Cell Technology and their impact of society and civilization.

Module 1: Introduction (4 Hours)

Introduction to The Syllabus, Overview of Stem Cells, Introduction and history of Stem cells, Stem cells for therapeutics and research.

Module 2: Culturing Cells in the laboratory (5 Hours)

Introduction to Cell Culture, Pros & Cons of Cell culture, Primary and Secondary cultures, Hayflicks limit, telomerase. Aseptic Technique and Cell culture Lab equipments & etiquette

Module 3: Stem cell-Types (6 Hours)

Types of Stems Cells, Embryonic stem cells, Pleuripotent Stem Cells, Adult Stem cells, Induced Pleuripotent Stem Cells, Transit amplifying cells, Symmetry during cell division in Stem cells.

Module 4: Location, Nature & culturing of stem cells (10 Hours)

Stem Cell Niche, Isolation of Stem Cells, & Growth factors, chord cells, Derivation & differentiation of ES Cells, Derivation & differentiation of Pleuripotent Cells

Induced Pluripotent cell-Methods & Genetic & epigenetic reprogramming

Module 5: Applications of Stem cell Technology (10 Hours)

Application of stem cells in disorders of nervous system, Application of Stem cells in Cancer, Stem cells of Gut. Stem cells of the skin- Wound healing & cosmetics, Use of stem cells in tissue engineering & organ generation, Application of stem cells in autoimmune disorders.

Module 6: Ethical Implications of Stem cell therapeutics. (10 Hours)

Benefits, Problems and perspectives of stem cell therapy. Beginning of human life, legal, scientific, ethical, Religio-spiritual explanations. Treating infertility, multiple parents, Somatic Cell Nuclear Transfer & Human cloning, Extinction prevention, Stem cells and meat production, Alternatives to stem cells, Deeper concerns in stem cell technology-Immortality, longevity, ageing.

References

1. Paul Knoepfler, Stem Cells - An Insider's Guide ", 2013
2. Robert Lanza and Anthony Atala, Essentials of Stem Cell Biology", 2013
3. Satish Totey and Kaushik D. Deb, Stem Cell Technologies: Basics and Applications, 2010
4. Warburton David, Stem Cells, Tissue Engineering and Regenerative Medicine, 2015

19BT3027	Nanobiotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know about biology inspired concepts, nanobiometrics, natural nanocomposites, nano analytics and molecular manufacturing
2. To study the properties of fundamental biological units used to create materials for applications in human health care
3. To understand how biology can be used to learn fundamental design principles

Course Outcome:

The students will be able to

1. Define basic terminology and describe concepts in Nanobiotechnology
2. Discuss the principle of various applications in Nanobiotechnology.
3. Interpret the properties of Nanomaterials in Biotechnology.
4. Test the Application of Nanodevices in Biological systems.
5. Design the Application of Molecular recognition elements and transducing.
6. Evaluate New trends in Nanobiotechnology and Defence.

Module 1: History and Concept of Nanobitoechnology (7 Hours)

Various definitions and Concept of Nano-biotechnology & Historical background. Fundamental sciences and broad areas of Nanobiotechnology. Various applications of Nano-biotechnology. Cell – Nanostructure interactions. Functional Principles of Nanobiotechnology- Information-Driven Nanoassembly- Energetic-Chemical Transformation- Regulation- Traffic Across Membranes- Biomolecular Sensing- Self-Replication- Machine-Phase Nanobiotechnology

Module 2: Nanomaterials in Biotechnology (9 Hours)

Drug Nanoparticles- Structure and Preparation, Liposomes, Cubosomes and Hexosomes, Lipid based Nanoparticles-Liquid nanodispersions- Solid Lipid Nanoparticles (SLP)- Biofunctionalsiation of SLP, Charatcterisation- Nanoparticles for crossing biological membranes. Fundamentals- Physicochemical Principles of Nanosized Drug Delivery Systems-Nanotubes, Nanorods, Nanofibers, and Fullerenes for Nanoscale Drug Delivery, Carbon nanotubes biocompatibility and drug delivery. Nanoparticles, quantum dots, nanotubes and nanowires. Microbial Nanoparticle Production : Methods of microbial nano-particle production, Applications of microbial nano-particles, Bacteriorhodopsin and its potential in technical applications – overview, structure, photoelectric applications, photochromic applications and applications in energy conversion.

Module 3: DNA-Protein Nanostructures (9 Hours)

Overview and introduction - Oligonucleotide-Enzyme conjugates, DNA conjugates of binding proteins, Non-covalent DNA-Streptavidin conjugates, DNA-Protein conjugates in microarray technology. Protein-based Nanostructures, Nanobiomachines & Signalling - Overview, chemistry and structure, Genetics & Secondary cell-wall polymers, Self-assembly in suspension, Re-crystallization at solid supports, Formation of regularly arranged Nano-particles, Cell as Nanobiomachine, link between the signaling pathways & molecular movements as well as neuron function, Concepts in nanobiomachines for information processing and communications

Module 4: Nanodevices and Tools used in Nanotechnology (5 Hours)

Biosensors; different classes - molecular recognition elements, transducing elements. Applications of molecular recognition elements in nanosensing of different analytes. Application of various transducing elements as part of nanobiosensors. Tools in Nanotechnology.

Module 5: Biological Nanoparticles (8 Hours)

Production - plants and microbial. Nanobiotechnological applications in health and disease - infectious and chronic. Nanobiotechnological applications in Environment and food - detection and mitigation.

Module 6: New Concepts in Nanobiotechnology (7 Hours)

Cancer treatment and DNA Origami, Green Technology in India, Biological Motors and DNA Origami, Three Concepts – New “Nano” concept, Societal Implications of Nanoscience and Nanotechnology –

Environmental Issues, Nano Ethics, Nanotribolgy and Quantum Computing.

References

1. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications. R.S. Greco, F.B.Prinz and R.L.Smith, Nanoscale Technology in Biological Systems, CRC press, 2005.
2. Sandra J Rosethal, David W Wright, Nanobiotechnology Protocols, Series Methods in Molecular Biology (2005).
3. B. Bhushan , Springer Handbook of Nanotechnology: Volume 1&2, Springer-Verlag. Second ed., (2007)
4. Christof M. Neimeyer, Chad.A.Mirkin (eds.,) Nanobiotechology II : More Concepts, and Applications, Wiley VCH Weinheim (2007).
5. Nanofabrication towards Biomedical Applications, Techniques, Tools, Applications, and Impact. C. S. S. R. Kumar, J. Hormes, C. Leuschner, 2005, WILEY -VCH Verlag GmbH & Co. KGaA, Weinheim, ISBN-13 978-3-527-31115-6.

19BT3028	Advanced Plant Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Plant genetic materials and molecular biology techniques
2. Plant metabolic engineering and its importance
3. Plant transformation techniques and GM crops

Course Outcome:

The students will be able to

1. Understand the plant genome and its molecular mechanisms
2. Interpret additional genomic materials in plant cells
3. Comprehend on metabolic engineering of plant cell metabolites
4. Summarize plant transformation techniques
5. Interpret on mechanisms of plant virus vectors
6. Comprehend on GM crops and its ethical issues

Module 1: Introduction to Plant Molecular Biology (8 Hours)

Genetic material of plant cells, nucleosome structure and its biological significance; transposons,; outline of transcription and translation, alternative and trans splicing, constitutive and differentially expressed genes in plants

Module 2: Chloroplast and Mitochondria (9 Hours)

Structure, function: Light and dark reaction and genetic material; rubisco synthesis and assembly, coordination, regulation and transport of proteins. Mitochondria: Genome, cytoplasmic male sterility and import of proteins, comparison and differences between mitochondrial and chloroplast genome, chloroplast transformation

Module 3: Plant Metabolism and Metabolic Engineering (7 Hours)

Nitrogen fixation, Nitrogenase activity, nod genes, nif genes, bacteroids, plant nodulins, production of secondary metabolites, flavanoid synthesis and metabolic engineering

Module 4: Agrobacterium Mediated Gene Transfer (5 Hours)

Pathogenesis, crown gall disease, genes involved in the pathogenesis, Ti plasmid –TDNA, importance in genetic engineering

Module 5: Plant Viruses (9 Hours)

Plant viruses and different types, Viral Vectors: Gemini virus, cauliflower mosaic virus, viral vectors and its benefits, vectors used for plant transformation, Methods used for transgene identification

Module 6: Applications of Plant Biotechnology **(7 Hours)**
Outline of plant tissue culture, transgenic plants, herbicide and pest resistant plants, molecular pharming, therapeutic products, RNA i, Transgene silencing, ethical issues; case studies on successful transgenics including drought management.

References

1. Slater A et al. Plant Biotechnology : The Genetic Manipulation of Plants, Oxford University Press, (1st and 2nd edition), 2008
2. Athar Ali, Usha Kiran, Malik Zainul Abdin.Plant Biotechnology: Principles and Applications Springer Publications, 2017

19BT3029	Cancer Management Techniques	L	T	P	C
		3	0	0	3

Course Objectives:
To improve knowledge on
1. The pathology, grades and molecular biology of cancer
2. Cancer type specific symptoms and early diagnostic markers
3. Cancer management techniques like detection, treatment, prevention and palliative care

Course Outcome:
The students will be able to
1. Understand the pathology and metabolism of cancers and their reporting systems.
2. Recall the molecular pathways and relate them in cancer development, progression, detection and therapy.
3. Identify the potential molecular and cellular targets for diagnosis and therapy
4. Evaluate the technologies available for early diagnosis-prevention, targeted therapy and for effective management of post therapy – palliative care
5. Analyze the challenges in the present cancer management methods
6. Apply the knowledge and discuss new means of cancer management, prevention strategies and modes of palliative care to prolong the life of cancer cases.

Module 1: Pathology and Types of Cancer **(8 Hours)**
Benign and cancer tumor; Characteristics and hallmarks of cancer; Cancer malignancy – spread, invasion and metastasis; Histopathology of cancer; Cancer staging and grading; Cancer classes and types; Cancer metabolism, Cancer death - obstructions.

Module 2: Molecular Cell Biology of Cancer **(8 Hours)**
Cell growth regulation abnormalities in cancer – Alteration in Growth factors and cell signaling pathways, signal targets; Cell adhesion defects in cancer; Cell migration promoters in cancer-Proteases; Metastatic spread promoters, cancer cells mimicking inflammatory immune cells; Apoptosis regulation defects in cancer; Angiogenesis promoters in cancer.

Module 3: Cancer Symptoms and Markers **(7 Hours)**
Cancer Symptoms – General and specific; Cancer metabolism – Metabolic alterations and role of mitochondria; Cancer Markers – Proteins – Enzymes, Antigens, Antibodies, Hormones; Testing samples - Urine, Blood, Stool, Tumor tissue, other body fluids; Gene expressions – DNA, mRNA and Protein; Scope for early diagnosis.

Module 4: Cancer Detection Methods and Techniques **(8 Hours)**
Cancer Screening and symptoms; Clinical Examination; Radiologic Imaging Techniques – CT, MRI,and PET scans, Ultra sound and Endoscopic Examinations, Mammography and Isotopic Techniques; Laboratory Tests for cancer markers; Immunodetection techniques; Genetic Testing; Confirming cancer by pathologic report - Biopsy and Smear examinations; Early diagnostic methods

Module 5: Cancer Therapeutics (7 Hours)
Combination Therapy; Adjuvant therapy- Chemotherapy and Radiotherapy; Targeted therapy – Targeted drug delivery, targeted therapy drugs; Molecular therapy, Immunotherapy –Antibody, Interferon, Molecular and Gene therapy; Hormone therapy; Treatment fatigue; Clinical trials.

Module 6: Cancer Prevention and Palliative care (7 Hours)
Cancer risk factors; Food and lifestyle in cancer prevention; Post treatment preventive measures-Recurrence prevention, Cancer diagnosis cum therapy; Paliative care; Herbal remedies and plant derived drugs.

References:

1. Stella Pelengaris, Michael Khan, The molecular Biology of Cancer, Blackwell Publishing, 1st edition, 2006.
2. Robert A. Weinberg, The Biology of Cancer, Garland Science, 2nd edition, 2014
3. Macdonald F and Ford CHJ. "Molecular Biology of Cancer", Bios Scientific Publishers, 2002.
4. Richard Pazdur, Kevin A. Camphausen, Lawrence D. Wagman, William J. Hoskins, Cancer Management: A Multidisciplinary Approach**,** 11th illustrated edition, Oncology Publishers, 2003
5. Thomas N. Sayfried, Cancer as a Metabolic Disease: On the Origin, Management, and Prevention of Cancer 1st Edition, Wiley Publications; 2012

		L	T	P	C
19BT3030	**Genomics and Proteomics**	3	0	0	3

Course Objectives:
1. To know the genomics, and proteomics using model organisms representing plants and animals.
2. The course will cover recent developments in genetics, epigenetics, small RNAs, proteomics, gene expression, mutagenesis and mapping genes.
3. Develop skills in experimental design within the context of learning about biology including: signal transduction, regulation of transcription and translation, cancer, aging, drought stress and metabolic pathways

Course Outcomes:
The students will be able to
1. Gain knowledge in genomics and proteomics techniques and analysis.
2. Develop skills in applied bioinformatics, comparative, evolutionary, human genomics and functional genomics.
3. Acquire knowledge on genome sequencing and proteomics and its applications.
4. Apply interdisciplinary knowledge (e.g. chemistry, biophysics) to solve problems in proteomics and genomics
5. Perform database search and analyze genomes, proteins
6. Demonstrate the knowledge during the course would be helpful to those students who want to work in core facilities and commercial biological and medical laboratories

Module 1: Introduction to Genomics (8 Hours)
Introduction to Genomics, Genome Organization of prokaryotes and Eukaryotes, Gene Structure of Bacteria, Archaebacteria and Eukaryotes, Human Genome Project

Module 2: DNA sequence and mapping (8 Hours)
Methodology for DNA sequencing, Contig Assembly, Genetic Mapping- Mendel's Laws of Inheritance, Partial Linkage, DNA Markers and its types, Physical Mapping and its types

Module 3: Functional Genomics and its applications (7 Hours)
Introduction to Functional Genomics, Genome Annotation- traditional routes of gene identification, Detecting Open Reading Frames, Software programs for finding genes, identifying the function of new gene, Gene Ontology

Module 4: Introduction to Proteomics (7 Hours)
Proteomics- Introduction, The proteome, Genomics vs Proteomics, Proteomics and the new biology
Module 5: Analytical Proteomics (8 Hours)
2 Dimensional Polyacrylamide Gel Electrophoresis, Mass Spectrometry for Protein and Peptide Analysis (MALDI-TOF and ESI-Tandem MS), Designing Microarray experiments, Types of Microarrays
Module 6: Applications of Proteomics (7 Hours)
Applications of Proteomics- Mining Proteomes, Protein Expression Profiling, Mapping Post-translational Modification, Peptide Mass Fingerprinting

References

1. Brown T.A., "Genomes ", BIOS Scientific Publishers Ltd, Oxford, 2nd Edition, 2002
2. Daniel C. Liebler, "Introduction to Proteomics: Tools for New Biology", Humana Press, Totowa, New Jersey, 2002
3. HEYER, L. -- CAMPBELL, A. *Discovering Genomics, Proteomics and Bioinformatics*. USA: Cold Spring Harbor Lab. Press, 2006. 352 p. ISBN 0-8053-4722-4.
4. Introduction to Genomics - Arthur M Lesk, Oxford University Press, 2007.
5. Twyman R.M., Principles of Proteomics, BIOS Scientific Publishers, 2004.
6. P.Michael Conn, Handbook of Proteomic Method. Humana Press, Totowa, New Jersay, USA, 2003.
7. Stryer L., Biochemistry, W. H. Freeman and Co., New York, 2007.

19BT3031	Advanced Environmental Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:
1. To analyse environmental problems and find solutions through innovations
2. To develop bioreactors and biotreatment methods of industrial wastewater
3. To learn novel technologies for remediation of environmental pollution

Course Outcome:
The students will be able to
1. Create an awareness of professional responsibility towards protecting the environment.
2. Learn environmental issues involved engineering and resources projects
3. Study the natural and engineered bio-treatment methods to remediate the pollutants
4. Develop treatment methods and create awareness about opportunities in environmental management
5. Future challenges for bioremediation and biodegradation process
6. Investigate the opportunities for incorporating environmental quality into products, processes and projects

Module 1: Introduction (8 Hours)
Current status of biotechnology in environmental protection and its future prospects. Characteristics of wastewater, Classification of pollutants, Impact of pollutants on biotreatment.
Module 2: Environmental pollution (7 Hours)
Types, causes and its effects on environment of Soil pollution, Water pollution, Air pollution**,** Oil pollution, Heavy metal pollution
Module 3: Bioreactors for wastewater treatment (7 Hours)
Design and evaluation of suspended growth reactors, Activated sludge, Biological nutrient removal, Biofiltration, Aerobic digestion, anaerobic processes and lagoons , Design and evaluation of attached growth reactors, Trickling filter, Rotating Biological Contactor, Fluidized bed biological reactors, Upflow anaerobic sludge blanket reactor ,Hybrid reactor, Sequential batch reactor , Techniques for Evaluating Kinetics and Stoichiometric parameters.

Module 4: Biotreatment of industrial wastewater **(8 Hours)**
Wastewater treatment of effluents from dye, tannery, dairy and food industries, Wastewater treatment of effluents from pharmaceutical, distilleries, polymer, electrochemical industries, Wastewater treatment of effluents from explosive, pesticide and petrochemical industries, Treatment of industrial gaseous pollutants and Vocs. Medical waste and solid waste management.

Module 5: Bioremediation and biodegradation **(8 Hours)**
Biostimulation of naturally occurring microbial activities, Bioaugmentation, *In situ, ex situ* and engineered bioremediation, Microbial system for heavy metal accumulation , Biosorption, Bioleaching, Detoxification of chlorinated hydrocarbons, aromatics and DIOXINS, Biodesulphurisation of crude petroleum , Future challenges, fate and effects of xenobiotic organic chemicals

Module 6: Novel Biotechnology methods for pollution control **(7 Hours)**
Application of nanobiotechnology in environment, Vermitechnology, Genomic tools in bioremediation, Development of biodegradable and ecofriendly products, Biosensor, Global environmental problems: Ozone depletion, UV-radiation, Greenhouse gases, acid rain and biotechnological approaches of their management

References

1. Metcalf and Eddy, "Waste water Engineering Treatment, Disposal and Reuse". McGraw Hill, 2013.
2. Jogdand, S.N. "Environmental Biotechnology". Himalaya Publishing House, New Delhi, 2012.
3. Karnely D. Chakrabarty K. Ovnen G.S. "Biotechnology and Biodegradation, Advances in Applied Biotechnology series", Gulf Publications Co. London 2011
4. Prescott, Harley and Klein, "Microbiology", 5th edition, McGraw Hill, 2014.
5. R. C. Dubey A Textbook of Biotechnology, S.Chand publications, 4th edition, 2014
6. Indu Shekhar Thakur, "Environment Biotechnology basic concepts and applications", IK International, 5th edition, 2016
7. Graty. C.P.L., Daigger, G and Lim, H.C, "Biological Wastewater Treatment". 4th Edition, Marcel Dekker, 2011

<table>
<tr><td rowspan="2">19BT3032</td><td rowspan="2">Entrepreneurship and Management</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Course Objectives:
1. To impart various aspects of product design and development
2. To inculculate concept generation and selection
3. To understand technology behind the product of the service

Course Outcome:
The students will be able to
1. Understand the principles of product design, basic management techniques, entrepreneurial skills and funding agencies.
2. Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.
3. Induce entrepreneurial intent as well as innovation, scalability and marketing of the product.
4. Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career.
5. Assess the commercial viability of a new technology based idea to prototype and biosafety.
6. Transform research based ideas into feasibility and business plans and IPR.

Module 1: Introduction **(8 Hours)**
Entrepreneurship and economic development. evolution of entrepreneurship, stages in entrepreneurial process, entrepreneurship in India, Role of SSI in economic development, Government support for SSI. Role of society and family in the growth of an entrepreneur. Challenges faced by women in entrepreneurship.

Module 2: Product design **(7 Hours)**
Product design, importance, objectives, factors influencing product design, Product Development Process, sources of ideas for designing new products, stages in product design. Guidelines of DBT for formulating project and financing.

Module 3: Innovation and prototype **(7 Hours)**
Creativity and innovation, generation of ideas, technical and market feasibility study, opportunity assessment, business plan preparation, execution of business plan, conversion of ideas to prototype, risk taking-concept; types of business risks.

Module 4: IPR and copyright **(8 Hours)**
IPR and copy right, financial opportunity identification; banking sources; non banking institutions and agencies; venture capital and angel investors, meaning and role in entrepreneurship, government schemes for promoting entrepreneurship. GMO and IPR; WTO, GATT and TRIPS agreement; Indian Patent Act; Patenting procedures

Module 5: Biosafety **(8 Hours)**
Plant Breeder's Rights; Biosafety – levels; Biosafety guidelines; Role of Biosafety committee; Definition of GMOs & LMOs; Risk factors; Overview of National Regulations and relevant International Agreements including Cartagena Protocol, Biological material transfer procedure.

Module 6: Start up process **(7 Hours)**
Procedure for getting license and registration, challenges and difficulties in starting an enterprise, host institution support, Funding agencies – BIRAC, NEN, STEP, DST-NIMAT, TSDB; The role of technology/social media in creating new forms of firms, organizations, networks and cooperative clusters. Market- traditional and E-commerce, expanding markets: local to global.

References

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra, Information Solution Pvt. Ltd., 2007.
3. "Entrepreneurship: Theory", Process and Practice, Donald F. Kuratko, 9th Edition, Cengage Learning, 2011.
4. 4. S.S.Kanka Entrepreneurship Development, S.Chand and Co, New Delhi 2007.
5. Anupam Singh and Ashwani Singh. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), NPH, New Delhi (2010)
6. "Entrepreneurial Development", Jayshree Suresh, 5th Edition, Margham Publications, 2008.
7. "Entrepreneurship", Robert D. Hisrich, 6th Edition, Tata McGraw Hill Publications.2009.

19BT3033	Industrial Waste Management	L	T	P	C
		3	0	0	3

Course Objectives:
To improve knowledge on
1. Problems of different kind of hazardous waste from industrial process.
2. Engineering and technical options for site specific waste management
3. Cleaner Industrial process and zero waste sustainable initiatives

Course Outcome:
The students will be able to
1. List out different industrially relevant waste and their challenges in management
2. Infer suitability of available treatment options depending on nature of waste
3. Make use of bio-chemical reactions to develop optimal treatment system
4. Examine energy and eco-efficiency of solid waste and waste-water treatment
5. Recommend advanced treatment technologies with different Industrial Scenarios
6. Formulate cleaner production and waste management technologies

Module 1: Introduction to Industrial waste management system (9 Hours)

Uses of water by industry-Sources and types of industrial wastewater; regulatory requirements for treatment of industrial wastewater-Industrial waste survey Industrial Wastewater generation; Treatment Evaluation for Air Emission and Solid waste; Waste Characterization and classification; Population Equivalent-Toxicity of Industrial effluents and Bioassay tests.

Module 2: Pollution prevention (5 Hours)

Prevention vs. control of Industrial Pollution, Benefits and Barriers-Source reduction techniques, Waste audit; Evaluation of Pollution Prevention options, CO_2 mitigation in industrial environment.

Module 3: Industrial Waste water treatment (10 Hours)

Equalization- Neutralization- Oil separation Flotation-Precipitation-Heavy metal Removal - Refractory organics separation by adsorption. Aerobic and anaerobic biological treatment Sequencing batch reactors-High Rate reactors Chemical; Oxidation –Ozonation. Photo catalysis Wet Air Oxidation-Evaporation Ion Exchange-Membrane Technologies – Nutrient removal.

Module 4: Solid waste treatment and disposal (7 Hours)

Categories and Characterization, Solid waste land fill, Land-fill cover and Cap, Waste stabilization, Management of Organic industrial waste, Incineration strategies and Energy recovery, Composting Industrial waste

Module 5: Case studies with different Industrial Scenarios (7 Hours)

Tanneries-pulp and paper-metal finishing; Petroleum Refining-Pharmaceuticals-Sugar and Distilleries; Food Processing-fertilizers-Thermal Power Plants; and Industrial Estates, Textile and Paper Industries

Module 6: Cleaner production and Newer Management strategies (7 Hours)

Waste management Approach – Volume and strength reduction – Material and process modifications – Recycle, reuse and by-product recovery – Applications, Zero discharge attainment strategies, Naturally Evolving Industrial complexes

References

1. Woodard Frank (2001) *Industrial Waste treatment Handbook*, Butterworth Heinemann
2. Nelson Leonard Nemerow (2010) *Industrial Waste Treatment: Contemporary Practice and Vision for the Future*, Elsevier
3. Wang Lawrence K., Hung Yung-Tse, Lo Howard H., Constantine Yapijakis (2006) *Hazardous Industrial Waste Treatment*, CRC Press
4. John Pichtel, *Waste Management Practices: Municipal, Hazardous, and Industrial*, Second Edition, CRC Press, 2014.
5. Wang Lawrence K., Hung Yung-Tse, Shammas Nazih K. (2009) *Handbook of Advanced Industrial and Hazardous Wastes Treatment*, CRC Press

<table>
<tr><td rowspan="2">19BT3034</td><td rowspan="2">INDUSTRIAL SAFETY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Course Objectives:

1. The course is intended to provide a general concept in the dimensions of disasters caused by nature beyond the human control
2. The disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.
3. To improve knowledge about rescue methods

Course Outcome:

1. Learn the different safety aspects in industrial application and daily life
2. Learn safety procedure followed in industries
3. Learn the different types of rescues
4. Know the procedure for risk analysis

5. Know different type of disaster
6. Know procedure for damage assessment

Module 1: Safety Management **(8 Hours)**

Concept of Safety, Applicable areas, unsafe actions &Conditions. Responsibility of Safety - Society, Govt., Management, Union & employees.

Safety Officer - Appointment, Qualification, Duties of safety officer. Safety Committee - Membership, Functions & Scope of Safety committee. Motivation & Training of employees for safety in Industrial operations.

Module 2: Disaster Management **(8 Hours)**

Introduction on Disaster Different Types of Disaster : Natural Disaster Man-made Disaster Biological Disasters,Accidents (Air, Sea, Rail & Road), Structural failures(Building and Bridge), War & Terrorism etc. Causes, effects and practical examples for all disasters.

Module 3: Risk Analysis **(8 Hours)**

Risk and Vulnerability Analysis ,Risk Reduction , Strategic Development for Vulnerability Reduction,Disaster Preparedness and Response Preparedness- Disaster Preparedness: Concept and Nature,Disaster Preparedness Plan, Prediction, Early Warnings and Safety Measures of Disaster, Role of Information, Education, Communication, and Training, Role of Government, International and NGO Bodies.

Module 4: Responsibility of Engineers **(8 Hours)**

Role of Engineers on Disaster Management. Response- Disaster Response : Introduction, Disaster Response Plan, Communication, Participation, and Activation of Emergency Preparedness Plan, Search, Rescue, Evacuation and Logistic Management, Role of Government, International and NGO Bodies, Psychological Response and Management (Trauma, Stress, Rumor and Panic) , Relief and Recovery, Medical Health Response to Different Disasters

Module 5 Reconstruction and Recovery **(7 Hours)**

Rehabilitation, Reconstruction and Rehabilitation as a Means of Development, Damage Assessment, Post Disaster effects and Remedial Measures, Creation of Long-term Job Opportunities and Livelihood Options, Disaster Resistant House Construction , Sanitation and Hygiene,

Module 6 Safety Awareness **(6 Hours)**

Education and Awareness, Dealing with Victims' Psychology, Long-term Counter Disaster Planning, Role of Educational Institute.

References:

1. Crowl D A, Louvar J F, " Chemical Process Safety Fundamentals with applications", 2nd Prentice Hall, NJ (2002).
2. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services2005
3. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
4. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
5. Cheremisinoff, N. P., Practical Guide to Industrial Safety: Methods for Process Safety Professionals, CRC Press, 2001.

BIOTECHNOLOGY

LIST OF COURSES

Sl.No	Course Code	Name of the Course	Credits [L:T:P:C]
1.	18BT1001	Biology in Everyday Life	3:0:0:3
2.	18BT2001	Cell Biology	3:0:0:3
3.	18BT2002	Basics of Industrial Biotechnology	3:0:0:3
4.	18BT2003	Bioprocess Calculations	3:0:0:3
5.	18BT2004	Bio-analytical Techniques	3:0:0:3
6.	18BT2005	Bio-analytical Techniques Lab	0:0:3:1.5
7.	18BT2006	Biochemistry	3:1:0:4
8.	18BT2007	Biochemistry Lab	0:0:3:1.5
9.	18BT2008	Microbiology	3:0:0:3
10.	18BT2009	Microbiology Lab	0:0:3:1.5
11.	18BT2010	Fluid Mechanics	3:1:0:4
12.	18BT2011	Fluid Mechanics & Heat Transfer Lab	0:0:3:1.5
13.	18BT2012	Bioprocess Principles	3:0:0:3
14.	18BT2013	Bioprocess Lab	0:0:3:1.5
15.	18BT2014	Molecular Biology	3:0:0:3
16.	18BT2015	Genetic Engineering and Bioethics	3:0:0:3
17.	18BT2016	Molecular Biology & Genetic Engineering Lab	0:0:3:1.5
18.	18BT2017	Bioprocess Engineering	3:0:0:3
19.	18BT2018	Enzyme Engineering & Technology	3:0:0:3
20.	18BT2019	Heat & Mass Transfer	3:1:0:4
21.	18BT2020	Downstream Processing	3:0:0:3
22.	18BT2021	Downstream Processing Lab	0:0:3:1.5
23.	18BT2022	Immunology	3:0:0:3
24.	18BT2023	Cellbiology & Immunology Lab	0:0:3:1.5
25.	18BT2024	Chemical Reaction Engineering	3:1:0:4
26.	18BT2025	Mass Transfer & Chemical Reaction Engineering Lab	0:0:3:1.5
27.	18BT2026	Biochemical Thermodynamics	3:1:0:4
28.	18BT2027	Basics of Bioinformatics	2:0:0:2
29.	18BT2028	Bioinformatics Lab	0:0:2:1
30.	18BT2029	Industrial safety & Hazard analysis	3:0:0:3
31.	18BT2030	Environmental Pollution Control Engineering	3:0:0:3
32.	18BT2031	Process Equipment Design & Economics	3:0:0:3
33.	18BT2032	Process Dynamics & Control	3:0:0:3
34.	18BT2033	Mechanical Operation	3:0:0:3
35.	18BT2034	Mechanical Operation Lab	0:0:3:1.5
36.	18BT2035	Biochemical Engineering	3:0:0:3
37.	18BT2036	Biochemical Engineering Lab	0:0:3:1.5
38.	18BT2037	Cancer Biology	3:0:0:3
39.	18BT2038	Clinical Database Management	3:0:0:3
40.	18BT2039	Clinical Database Management Lab	0:0:3:1.5
41.	18BT2040	Plant & Animal Biotechnology	3:0:0:3

42.	18BT2041	Stem Cell Technology	3:0:0:3			
43.	18BT2042	Biopharmaceutical Technology	3:0:0:3			
44.	18BT2043	Agricultural Biotechnology	3:0:0:3			
45.	18BT2044	Metabolic Engineering.	3:0:0:3			
46.	18BT2045	Research Methodology	3:0:0:3			
47.	18BT2046	Molecular Forensics	3:0:0:3			
48.	18BT2047	Protein Engineering	3:0:0:3			
49.	18BT2048	Plant Tissue Culture	3:0:0:3			
50.	18BT2049	Animal Biotechnology and Cell Culture	3:0:0:3			
51.	18BT2050	Plant and Animal Tissue Culture Lab	0:0:3:1.5			
52.	18BT2051	Role of Biotechnology in Environment	3:0:0:3			
53.	18BT2052	Industrial Pollution Control	3:0:0:3			
54.	18BT2053	Biomass& Bioenergy	3:0:0:3			
55.	18BT2054	Environmental Biotechnology	3:0:0:3			
56.	18BT2055	Matlab Programming	3:0:0:3			
57.	18BT2056	Fundamentals of Biochemistry	3:0:0:3			
58.	18BT2057	Pathology and Microbiology	3:0:0:3			
59.	18BT2058	Human Anatomy and Physiology	3:0:0:3			
60.	18BT2059	Entrepreneurship, IPR and Biosafety	3:0:0:3			
61.	18BT3001	Advances in Biopolymer and Applications	3	0	0	3
62.	18BT3002	Genetic Engineering and Recombinant Products	3	0	0	3
63.	18BT3003	Bioprocess Modelling and Simulation	3	0	0	3
64.	18BT3004	Analytical Techniques in Biotechnology Lab	0	0	4	2
65.	18BT3005	Animal and Plant Tissue Culture Lab	0	0	4	2
66.	18BT3006	Advanced Process Equipment Design and Drawing Lab	0	0	4	2
67.	18BT3007	Recombinant DNA Technology Lab	0	0	4	2
68.	18BT3009	Enzyme Technology and Industrial Applications	3	0	0	3
69.	18BT3010	Microbial Biotechnology	3	0	0	3
70.	18BT3011	Agriculture and Food Biotechnology	3	0	0	3
71.	18BT3012	Big Data Analytics	3	0	0	3
72.	18BT3013	Bioethics and Biosafety	3	0	0	3
73.	18BT3014	Chemical Process Technology	3	0	0	3
74.	18BT3015	Immunotechnology	3	0	0	3
75.	18BT3016	Computational Biology	3	0	0	3
76.	18BT3017	Metabolic Regulation and Engineering	3	0	0	3
77.	18BT3018	Clinical trials and Bioethics	3	0	0	3
78.	18BT3019	Sustainable Bioprocess Development	3	0	0	3
79.	18BT3020	Advanced Animal Biotechnology & Tissue Culture	3	0	0	3
80.	18BT3021	Molecular Diagnostics	3	0	0	3
81.	18BT3022	Drug Design and Discovery	3	0	0	3
82.	18BT3023	Transport Phenomena	3	0	0	3
83.	18BT3024	Pharmaceutical Biotechnology	3	0	0	3
84.	18BT3025	Bioreactor Engineering	3	0	0	3
85.	18BT3026	Stem Cell Therapeutics	3	0	0	3
86.	18BT3027	Nanobiotechnology	3	0	0	3

87.	18BT3028	Advanced Plant Biotechnology	3	0	0	3
88.	18BT3029	Cancer Management Techniques	3	0	0	3
89.	18BT3030	Genomics and Proteomics	3	0	0	3
90.	18BT3031	Advanced Environmental Biotechnology	3	0	0	3
91.	18BT3032	Entrepreneurship and Management	3	0	0	3
92.	18BT3033	Industrial Waste Management	3	0	0	3
93.	18BT3034	Industrial Safety	3	0	0	3

18BT1001	BIOLOGY IN EVERYDAY LIFE	L	T	P	C
		3	0	0	3

Course Objective:

1. To comprehend the fundamental principles and concepts of human Health and Well-being.
2. To impart knowledge and implications of Biotechnology in daily Life.
3. To ensure knowledge transfer in applications of biomolecules and trends in biology.

Course Outcome:

1. Classify and Understand Life and Life forms.
2. Acquire knowledge towards Human health and welfare.
3. Assess the Significance of entrepreneurship and industry.
4. Analyze and engineer Molecules that define Life.
5. Rationalize the biological processes and their significance.
6. Understand and Apply Future trends in Biology.

Module I: LIFE AND LIFE-FORMS (9)

Brief Introduction about the Course. Classification of Life forms. Body plan and Design of Life Forms – Evolution. Nutrition in Humans – Macronutrients and Micronutrients. Blueprint of Life. Tree of Life. Case Study – Neanderthals to Homo-Sapiens.

Module II: HEALTH AND WELL-BEING AND STRESS MANAGEMENT (9)

The Human Body during Health and Disease – Example – Two Systems – Digestive and Excretory, their Diseases. Stress - Symptoms, Types, Causes and Treatment. Depression – Symptoms, Types, Causes and Treatment. Alcohol Abuse and Drug Abuse - Symptoms, Types, Causes and Treatment. Case Study – Substance Abuse and Social Responsibility.

Module III: BIOTECHNOLOGY AT HOME AND IN INDUSTRY (9)

Microorganisms – An overview The Good, the Bad and the Ugly Microbes. Bread, Beer and Batter. The Fermentation Industry – Principles, Processes and Products. Antibiotics –Mechanism Immunotherapeutics, Microbes as Fertilizer, Organisms as Pesticides, Biofuels.

Module IV: MOLECULES THAT MAKE US (9)

Biomolecules (Carbohydrates, Proteins, Lipids, and Nucleic Acids) – Types and Properties. Common diseases in Biomolecules. Flow of Genetic information. Genes to Function. Case Study - Crime Scene Investigation (FBI and CBI).

Module V: TRENDS IN BIOLOGY – THE FUTURE (4)

Genetically Modified Organisms (GMO) – Plants, Animals and Microbes (Two Examples Each). Human Cloning. Stem Cells Depot. Drug Resistance.

Module VI: MODERN AND RECENT TRENDS IN MEDICINE (5)

Drug Resistant Pathogens. Biosafety and Ethics. Nobel Prizes in Medicine and Physiology (Current Affairs). Careers in Biosciences – Survey and Interdisciplinary research.

Total Hours:45

Text Books

1. Pelczar MJ, Chan ECS & Krein NR, "Microbiology", Tata McGraw Hill Edition, NewDelhi, India, 2007
2. Prescott LM, Harley JP, Klein DA, "Microbiology", Wm. C. Brown Publishers,3rd edition,2001.
3. Owen J, Punt J, Stanford S, "Kuby Immunology", WH Freeman & Co., 2013.

References Books

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, “Principles of Fermentation Technology”, Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
2. Arthur C Guyton, “A Textbook of Human Physiology”, Elsivier Saunders, International Edition, 11th Edition, 2006.
3. Bruce Alberts, Molecular Biology of the Cell. “Essential of Molecular Biology” by David Frielder, 2010.
4. Peter Raven et al “Biology”, McGraw-Hill Education; 10 edition, January 9, 2013.

18BT2001	CELL BIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To acquaint students with the concepts in Cell Biology.
2. To understand structure and function of the organelles of cells
3. To learn the cell-cell interactions, transport mechanism and signaling pathways of cell

Course Outcome:

1. Acquire knowledge on the structure and function of cellular organelles and components
2. Analyze the behavior of cells in their microenvironment in multicellular organisms (i.e. a cell within its social context) with emphasis on cell-cell interactions, cell-extra cellular matrix interactions
3. Illustrate specific processes and proteins involved in membrane transport.
4. Understand receptor subclasses and their possible uses in cell signaling
5. Determine the Mode of action and regulation of signaling molecules for signal transduction
6. Outline the mechanisms by which different messenger-receptor interactions bring about long or short-term changes in cell state.

Module I: FEATURES OF CELL AND ITS ORGANELLES (9)

Brief history of cytology and cell theory, Prokaryotes and Eukaryotes (plant cell and animal cell), Membranes of the cell: Plasma membrane, Nuclear membranes, Organelle membranes. Brief outline of organelles; Nucleus, nucleolus, ribosome, mitochondria, chloroplast, vacuole, endoplasmic reticulum, golgi apparatus, peroxisome, glyoxisome, lysosome, centriole, cilia and flagella.

Module II: CELL CYCLE AND ITS REGULATION (4)

Cell cycle and molecules that control cell cycle, Regulation of cell cycle.

Module III: CYTOSKELETON AND CELLS IN THEIR SOCIAL CONTEXT (5)

Microtubules, microfilaments, intermediate filaments and their binding proteins. Cell- cell communication: Cell junction, Cell adhesion, Extra Cellular Matrix, Basal Lamina.

Module IV: CELL TRANSPORT AND TRAFFIC (9)

Passive and active transport, permeases, osmosis, pumps and gated channels, co transport: symport, antiport. Vesicular transport: Endocytosis, Exocytosis, Protein glycosylation in eukaryotes and protein sorting. Transport in prokaryotic cells, entry of viruses and toxins into the cell.

Module V: SIGNALING MOLECULES AND THEIR RECEPTORS (9)

Signaling molecules: autocrine, paracrine and endocrine and its mode of action in cell signaling. Cytosolic, nuclear and membrane bound receptors: G-protein coupled receptor, protein tyrosine kinases receptor and cytokine receptors for cell signaling.

Module VI: SIGNAL TRANSDUCTION (9)

Signal amplification, different models of signal amplifications: role of cyclic AMP, cyclic GMP and G proteins in signal transduction, phosphorylation and regulation in signaling: serine – threonine kinases in signaling. Role of Inositol triphosphate (IP_3) in signal transduction, calcium ion flux and its role in cell signaling.

Total Hours:45

Text Books

1. Geoffrey M. Cooper and Robert E. Hausman, The Cell: A Molecular Approach, Fifth Edition, ASM Press and Sinauer Associates, Inc., USA, 2015.
2. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, Molecular Biology of the cell, fifth edition, Taylor and Francis group, 2012.

Reference Books

1. De Robertis & De Robertis, Cell Biology, 4^{th} Edition, 2010.
2. Lodish, H. and D. Baltimore, Cell Biology, W.H. Freeman publishers, 2012.
3. Gerald Karp, Cell and Molecular Biology, John Wiley and sons Inc, 2013.

		L	T	P	C
18BT2002	**BASICS OF INDUSTRIAL BIOTECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objective:

1. To ensure students to have a base on the History of Biotechnology and its source of origin and the analysis on the different kinds of microorganisms this could be deployed for industrial biotechnology.
2. The paper elaborates on the industrial side of biotechnology and being in the engineering side the students will have a strong foundation on the aspects of fermentation and microbial engineering for better bio products.
3. The paper facilitates the need for knowing the various production strategies of bio products employed for better sustainable bioprocess development

Course Outcome:

1. Acquire fundamental knowledge on the history of biotechnology, reactors and microscopes. They will also having a base on modelling and simulation in Bioprocessing.
2. Acquire knowledge on the various types of Reactors and the base of fermentation technology.
3. The students will be aware of all the technical issues related with dealing microorganisms and microbial culture and to select the microorganisms for the kind of bio products they will be able to produce.
4. Help them to analyze industrial-market value of these bio products and relate them with the scope of biotechnology
5. Justify the clinical and biological significance of these bio products for sustainable bioprocess engineering,
6. The paper will enable students to understand the difference in manufacturing commercial bio products and all the ethical issues involved in it. In whole the paper will be very useful for them to scale up their own bio products with respect to entrepreneurial aspects.

Module I: INTRODUCTION TO INDUSTRIAL BIOPROCESS (9)

Introduction on the Historical overview of industrial fermentation processes on that of reactors and microscopes. The Traditional and modern biotechnology and the future perspectives in Industrial Biotechnology. Brief survey of organisms, processes, products related with modern biotechnology.

Module II: PRODUCTION OF PRIMARY METABOLITES (9)

The understanding of process flow sheeting, modelling and simulation in bioprocessing Pictorial representation of the need to know on Hypothesis and pictorial representation on the developmental process concerning upstream and downstream processing. The production of primary metabolites such as organic acids like citric acid, Lysine. Alcohols: Beer and Wine production.

Module III: PRODUCTION OF SECONDARY METABOLITES (9)

The production of secondary metabolites of high commercial value like Antibiotics: Penicillin V, Streptomycin and Ampicillin sodium salt. Production of commercial vitamins like Vitamin B12, Vitamin E, Vitamin B. Production of Bioethanol.

Module IV: PRODUCTION OF INDUSTRIAL ENZYMES AND OTHER PRODUCTS (9)

Introduction on Enzymes and the need for the Michaelis –Menten Kinetics in modelling enzyme reactions. Production of Industrial Enzymes like Amylase, Bromelain. Production of Bio fertilizers, Production of Bio preservatives: Nissin.

Module V: PRODUCTION OF MODERN BIOTECHNOLOGICAL PRODUCTS (5)

Production of Biopolymers like lignocellulose, Xanthan Gum, Poly Hydroxy Butyrate (PHB).

Module VI: PRODUCTION OF TARGET SPECIFIC FINE BIOPRODUCTS: (4)

Single Cell Proteins and fine bio products for pharmaceutical applications like monoclonal antibodies.

Total Hours: 45

Text Books

1. Prescott and Dunn, Industrial Biotechnology, Agro bios (India).
2. P.F. Stanbury and Whitaker, Fermentation Technology, Second Edition.

References Books

1. Elmar Heinzle,Sustainable Bioprocess Development, 2008.
2. Robert H. Perry, Handbook of Chemical Engineering.

18BT2003	BIOPROCESS CALCULATIONS	L 3	T 0	P 0	C 3

Course Objective:

1. To develop skills of students in principles and basic calculations
2. To familiarize in material balance for non-reactive systems and simple reactive systems
3. To conceptualize energy balance for non-reactive systems and simple reactive systems in chemical process engineering.

Course Outcome:

The students will be able to

1. Understand the importance and inter conversion of different units
2. Apply concept of mass balance approach in unit operations
3. Adapt appropriate system boundary to resolve multiunit chemical process
4. Demonstrate vapor-liquid equilibrium calculations for ideal multi component system.
5. Apply concepts of liquid-vapour equilibrium in two phase systems
6. Classify different form of energy and their implication
7. Enable to assess energy expenditure on chemical process system

Module I ModuleS SYSTEMS (9)

Units systems, basic units, derived units, dimension analysis, force, pressure, work, heat, conversion to SI units, Mass and volumetric flux, Avogadro number, molarity, molality and normality, molecular weight, equivalent weight, mass fraction, mole fraction.

Module II MATERIAL BALANCE (9)

Fundamental of material balance, Basics of calculation, approach of solving material balance problems, Mixing, Crystallization, Evaporator, Distillation, Absorption Column, Drier, Liquid - Liquid and Solid - Liquid Extraction

Module III STOICHIOMETRY (9)

Stoichiometry, limiting & excess reactants, fractional conversion, yield, Material balance in sequential multi-unit and recycle Systems, Material Balance of Unsteady State Reaction systems

Module IV GAS LAWS (9)

Ideal Gases, Standard temperature and pressure, partial pressure, Gas laws: Amagat's law and Daltons law, Single component two phase system, vapor pressure, vapor liquid equilibrium, saturation, condensation, relative humidity

Module V ENERGY BALANCE (6)

Elements of energy balance calculations, types of Energy, Internal energy, Enthalpy changes, Heat capacities, Procedure for energy balance calculations.

Module VI SYSTEM BOUNDARIES (3)

Closed/open unsteady state system, closed/open steady state systems.

Total Hours: 45

Text Book

1. David Mautner Himmelblau, James B. Riggs., ‘Basic Principles and Calculations in Chemical Engineering’ Prentice Hall of India, 4th editon. 2004

Reference Books

1. Felder, R.M., Rousseau R.W., “Elementary Principle of Chemical Processes”, John Wiley and Sons Publication 3rd edition, 2000.
2. BI Bhatt & SM Vora “Stoichiometry”, Tata Mcgraw- Hill, 4th edition, 2004.
3. Venkataramani.V and Anantharaman.A., “Process Calculations”, PHI learning Pvt. Ltd, 2003.

18BT2004	BIO-ANALYTICAL TECHNIQUES	L 3	T 0	P 0	C 3

Course Objectives:

1. To provide the students an ability to understand the principles of instrumentation
2. To impart the knowledge of different techniques and methods in biotechnology
3. To improve the understanding of applications of techniques in the field of biotechnology

Course Outcomes:

1. To understand the basic techniques of drug extraction
2. Illustrate the different methods of spectroscopy
3. Classify the various techniques of Chromatography
4. Elaborate the importance of electrophoresis and thermal analysis techniques
5. Analyze the methods of structural elucidation of different drugs
6. Evaluate the importance of detection of radioactive isotopes

Module I EXTRACTION METHODS (9)

Buffers, pH – pH meter and applications, Solvent extraction –introduction and principle; Extraction techniques–batch, stripping or back, continuous and counter-current; Principle of solid extraction (Soxhlet); Types -Temperature assisted, pressurized hot water and supercritical fluids based extraction.

Module II SPECTROSCOPY TECHNIQUES (9)

Basic principle of Spectroscopy -Beer-Lambert’s law, Principle, Instrumentation and applications of Colorimeter, Flame photometry, spectrofluorimetry and Spectrophotometer: types– UV – visible – Raman spectroscopy.

Module III CHROMATOGRAPHY TECHNIQUES (9)

Principle, types and applications of Chromatography- Thin layer, Adsorption, Ion-exchange, Affinity, Gelfiltration, GC and HPLC.

Module IV ELECTROPHORESIS & THERMAL METHOD (9)

Principle, Types and applications of Electrophoresis– agarose gel, polyacrylamidegel (PAGE), SDS-PAGE–principle, instrumentation and applications; isoelectric focusing–principle and applications; Thermo gravimetricanalysis (TGA)-Principle, instrumentation and applications

Module V STRUCTURAL ELUCIDATION TECHNIQUES (5)

Mass spectrometry–principle, instrumentation (electron spray ionization [ESI] & chemical ionization [CI]) and applicationns; nuclear magnetic resonance (NMR) –principle, instrumentation and applications;

Module VI RADIOISOTOPE METHODS (4)

Radioactive isotopes, radioactive decay and their types, radioactive techniques - RIA, GM counter, Scintillation counter, Applications in Medicine & Diagnosis.

Total Hours:45

Text Book

1. Willard and Merrit, Instrumental Methods and Analysis. VI Edition, CBS Publishers & Distributors; 2002.

Reference Books

1. Gurdeep R. Chatwal and Sham K. Anand. Instrumental Methods of Chemical Analysis. 5th Edition. Himalaya Publishing House, India. (2012).

2. B.K.Sharma. Instrumental Methods of Chemical Analysis. 24th revised and enlarged edition. GOEL Publishing House, India. (2014).
3. Keith Wilson and John WalkerPrinciples and Techniques of Practical Biochemistry and Molecular Biology. 7th Edition. Cambridge University Press, U.K. (2010).
4. Douglas A. Skoog, F.James Holler and Stanley R. Crough. Instrumental Analysis. 6th Edition. Brooks Cole Publishing Company. USA, (2007).
5. Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath. Biophysical Chemistry: Principles and Techniques. Himalaya Publsihing House Pvt. Ltd. India, (2014).

18BT2005	BIO ANALYTICAL TECHNIQUES LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To impart technical knowledge about the working principle and applications of different equipments related to biotechnology experiments.
2. To enable the students to understand the principles of instrumentation
3. To impart the knowledge of different techniques and methods in biotechnology

Course Outcome:

1. Understand the basic measurement methods and its applications in biotechnology
2. Describe the instrumentation and applications of different spectroscopic techniques
3. Demonstrate the principles, techniques and applications of chromatography.
4. Explain the determination of pH and their applications in buffer preparations
5. Understand different purification techniques of primary and secondary metabolites
6. Examine the applications of equipments involved in experimental biotechnology

List of Experiments

1. Estimation of Polyphenol by Colorimetric Method
2. Verification of Beers Law and Construction of Beers Law plot
3. Preparation of buffer solution with Henderson-Hasselbach equation and its verification with pH meter
4. Titration curves of Acetic acid and Citric Acid using pH meter
5. Precision and Validity of an experiment
6. Determination of analytical wavelength for given sample
7. Estimation of sugars by ascending paper chromatography
8. Identification of amino acids by ascending paper chromatography
9. Determination of turbidity by nephelometry
10. Conductivity measurement in titration
11. Gas Chromatography
12. High Performance Liquid Chromatography

18BT2006	BIOCHEMISTRY	L	T	P	C
		3	1	0	3

Course Objective:

1. To ensure students will have strong foundation in structure, properties and function of various biomolecules.
2. To introduce them to the basic structure of biomolecules which are involved in metabolic pathways
3. To understand the industrial-market value and significance of these biomolecules and to apply these in the fundamentals of biotechnology

Course Outcome:

1. Acquire knowledge on structure, properties and biological functions of carbohydrates, lipids and proteins which help them to understand the significance of biomolecules in bioprocesses and biotechnology

2. Acquire knowledge on nucleic acids structure, properties and functions of nucleic acids
3. Assess the significance of Vitamins and mineral functions
4. Help them to analyze industrial-market value of these biomolecules and relate them with the scope of biotechnology
5. Justify the clinical and biological significance of these biomolecules
6. Understand the complexes of different biomolecules and their biomedical significance

Module-I CARBOHYDRATES (9)
Classification, structure, properties and functions of carbohydrates: Monosaccharides, Disaccharides, Oligosaccharides-examples; Polysaccharide – classes- homo and hetero polysaccharides,conjugated carbohydtares, glycolysis, gluconeogenesis ,TCA cycle, Pentose Phosphate Pathway,glycogenesis, Glycogen Storage Disease, Respiratory chain and ATP synthesis

Module-II FATTY ACIDS AND LIPIDS (9)
Fatty acids- basic structure, types, properties, functions and essential fatty acids; ketone bodies, Classes, structure, properties and functions of lipids: Simple lipid-fat and wax, Compound lipid-Phospholipid, sphingolipid, ether lipid and glycolipid, Derived lipid – cholesterol biosynthesis, fatty acid biosythesis and degradation, Inborn errors of lipid metabolism.

Module-III AMINO ACIDS, PEPTIDES AND PROTEINS (9)
Amino acids- classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides –examples; Proteins- structure / conformation levels-primary, secondary, tertiary and quaternary, Ramachandran plot, classification, Biosynthesis of aromatic amino acids-tyr,trp,phe, biodegradation of proteins and urea cycle, Review on amino acid metabolic disorders.

Module-IV NUCLEOTIDES AND NUCLEIC ACIDS (9)
Nucleotides- composition, structure, properties and functions; Nucleic acids- types (RNA, DNA), DNA structure-Chargaff's rule on DNA base composition, unusual forms of DNA, RNA types, structure and functions, biosynthesis of purines and pyrimidines and its degradation, Inborn errors of nucleic acid metabolism - Review.

Module-V VITAMINS (4)
Vitamins: classification (A, D, E, K, and B-complex members), basic structure, source, daily requirement, functions and deficiency symptoms,

Module-VI MINERALS – FUNCTIONS AND DISORDERS (5)
Minerals: classification- macro elements and microelements, specific function and deficiency disorders, review on vitamins and mineral supplementations.

Total Hours: 45

Text Books

1. Jain and Jain "Biochemistry", Chand publication, 2008.
2. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.

References Books

1. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.
2. Lubert Stryer, "Biochemistry", WH Freeman & Co., 4^{th} edition, 2000.
3. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2^{nd} Edition, 2013.

18BT2007	BIOCHEMISTRY LAB	L	T	P	C
		0	0	3	1.5

Co-requisite: 14BT2006-Biochemistry

Course Objective:
1. To understand the basic units and measurements of biochemical solutions
2. To develop the skills in identifying the various biomolecules
3. To develop the skills of quantifying the various biomolecules

Course Outcome:

1. Know the basic units, calculations and different measurements tools used in biomolecule evaluations
2. Develop the basic lab skill in preparing different solutions of different concentrations and their measurement tools with representing units
3. Acquire knowledge in estimation of different carbohydrates using suitable method
4. Analyze through tests and identify the different carbohydrate, amino acid and lipid molecules present in the given sample solution.
5. Apply the reaction principle to quantify the proteins, amino acids, cholesterol and nucleic acids using colorimeter
6. Apply basic knowledge on the properties of biomolecules for the extraction of minerals and vitamins from food sources and quantify them.

List of Experiments:

1. Study of biochemical solutions, units and measurements
2. Estimation of total carbohydrate by Anthrone method
3. Qualitative analysis of carbohydrates
4. Estimation of reducing sugars by Di Nitro Salicylic acid method
5. Tests for lipids: - Fats and cholesterol
6. Estimation of cholesterol by Zak's method
7. Estimation of protein by Lowry's method
8. Qualitative analysis of amino acids
9. Estimation of amino acid by Ninhydrin method
10. Estimation of DNA by diphenylamine method
11. Dry ashing of food materials and colorimetric estimation of phosphorus
12. Estimation of ascorbic acid content in foods

18BT2008	MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To highlight the functions and characteristics of microorganisms
2. To study the growth of microorganisms and the impact of environment on their growth
3. To evaluate explicitly, the metabolic pathways, role of microbes in public health; insight into the physical and chemical control of microorganisms

Course Outcome:

1. Acquire basic knowledge on the history and development of microbiology
2. Recognize the fundamental concepts in the structure and functions of microbes
3. Understand the classification and nomenclature of microorganism, microscopic, staining and sterilization techniques
4. Identify the appropriate physical and chemical methods to control the growth of microbes
5. Demonstrate the nutritional requirements for microbial growth and their metabolism
6. Explain the dynamics of commensal, opportunistic and pathological relationships between microbes and humans

Module I: INTRODUCTION TO MICROBIOLOGY (9)

An overview of microbiology including a historical perspective of microbiology-classification, and nomenclature of microorganisms-Basics of Microscopy – light, phase, fluorescent and electron microscopy (SEM and TEM)- principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining, spore staining

Module II: MICROBIAL STRUCTURE AND MULTIPLICATION (9)

Morphology, Structure and Functions of Prokaryotic- and Eukaryotic Cells, Multiplication of bacteria, viruses, algae, protozoa, fungi, yeast with appropriate examples, Life history of actinomycetes and bacteriophage

Module III: MICROBIAL NUTRITON AND METABOLISM (9)
Nutritional requirements of bacteria: Growth curve and Different methods to quantitative bacterial growth, Mathematics of growth generation time and growth rate constant, factors affecting growth. Aerobic and Anaerobic respiration, Microbial metabolism- Entner– Doudoroff and Phosphoketolase pathway
Module IV: CONTROL OF MICROORGANISMS (9)
Physical and chemical control of microorganisms – sterilization: Moist heat, dry heat, radiation and filtration. Disinfection: phenol, alcohol and detergents; Chemotherapy and antibiotics- antibacterial, anti-fungal agents, anti-viral agents
Module V: ENVIRONMENTAL MICROBIOLOGY (4)
Interaction between Microorganisms – Commensalism, Synergism, Mutualism (symbiosis), Lichen symbiosis, Normal flora of human healthy host, importance of nosocomial infections (hospital borne), mode of transmission of airborne pathogens,
Module VI: FOOD AND INDUSTRIAL MICROBIOLOGY (5)
food and water borne infections caused by bacteria and virus, Significance of microbes in food; Industrially important microbial products and processes

Total Hours:45

Text Books
1. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.2007
2. Prasad B.N., "A Text Book of Biotechnology", Budha Academic Enterprises, G.P.O., Box 20195, Kathmandu, Nepal. 2003.

Reference Books
1. Talaron K, Talaron A, Casida, Pelczar and Reid. Foundations in Microbiology, W.C.Brown Publishers, 2001.
2. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 2001.
3. Lim D, "Microbiology", Second Edition, WCB-Mc Graw Hill, 2001.

18BT2009	MICROBIOLOGY LAB	L	T	P	C
		0	0	1.5	1.5

Co-requisite: 18BT2008- Microbiology
Course Objective:
1. To enable the students to understand the basic principles involved in the isolation of different kinds of microorganisms and gain accurate handling of microorganisms
2. Students will be taught about the different parts of microscopes and their functions
3. The students will learn to identify the microorganisms using various staining techniques and biochemical tests

Course Outcome:
1. Acquire basic knowledge on microbiological lab safety guidelines
2. Demonstrate proper handling, identify the parts/functions of microscopes
3. Experiment with transfer of living microbes using aseptic technique
4. Demonstrate proficiency and use of microbial isolation and staining techniques
5. Build skill to prepare media for microbial growth and cultivation techniques of microorganisms
6. Culture, identify, and explain different kinds of microorganisms present in environmental samples

List of Experiments:
1. Lab safety method and Regulations, Principles and methods of sterilization and Study of instruments: Compound microscope, Autoclave, Hot air oven, Laminar Airflow
2. Media preparation- Nutrient broth, Nutrient agar, slants, soft agar
3. Culturing of microorganisms– in broth and plates (pour plate, streak plate)
4. Enumeration of microorganisms from Soil

5. Enumeration of microorganisms from Water
6. Measurement of microbial Size – Micrometry
7. Anaerobic Cultivation – Fluid Thioglycolate broth
8. Staining Techniques -Simple, Gram staining and spore staining
9. Staining of fungus – Lacto phenol cotton blue staining
10. Motility test by Hanging drop method and soft agar inoculation
11. Biochemical Characterization of Bacteria: IMViC test, Catalase, Casein and Starch Hydrolysis
12. Antibiotic sensitivity assay – Disc and Well diffusion method

18BT2010	FLUID MECHANICS	L	T	P	C
		3	1	0	4

Course Objective:

1. To develop skills of students related to the fundamental calculations involved to measure the properties of fluids, measurement of fluid flow
2. To ensure students to have a strong knowledge related to types of fluids, instrument used in fluid flow mechanism
3. To make student understand the fluid flow processes involved in different sections in industrial operations

Course Outcomes

1. On completion of this subject students will be able to know the nature of fluids, kinematics of fluid flow
2. Students will able to know how to do measurement of flow and transportation of fluids in the problems related to the chemical engineering.
3. Students will be having enough basic theoretical knowledge to do an industrial training
4. Students will be having enough theoretical knowledge to work in industry
5. Students will able to face the complex situations during the malfunction of any fluid flow instrument
6. Students learn to deal with the theoretical knowledge on flow around solids

Module I BASICS OF FLUID STATICS AND DYNAMICS (12)

Nature of fluids, properties; Types of fluids, fluid statics: density, pressure-height relationship; pressure measurements-U tube, differential, simple, inverted and inclined manometers, solving problems for pressure measurements, continuity and mechanical energy equations.

Module II FLUID FLOW MEASUREMENT AND CONTROLS (12)

Measurements of fluid flow – orifice meter, venturimeter, pitot tube, rota meter, wires and notchs. Solving problems for venturi meter and orifice meter, Flow controls - gate valve, needle valve, check valve, globe and ball valve. Industrial application of flow measurements and flow controls.

Module III FLUID FLOW THROUGH SOLIDS (12)

Flow around solids and through packed beds; Drag curves for regular and irregular solids. Pressure drop, flooding and loading, friction factor for packed bed, Ergun’s equation. Fluidization: mechanism. Types-fluidized bed. General properties
of fluidized beds.

Module IV MIXING AND AGITATION (12)

Mixing of solids and paste, Agitation and mixing of solids, liquids, mixers for pastes, power requirements, mixer effectiveness, mixer for dry powers, mixing index in blending granular solids. Agitation and mixing of liquids-equipments, flow pattern and power consumption in agitated vessels, blending and mixing scale, agitator design.

Module V TRANSPORTATION OF FLUID (8)

Introduction to fluid transfer, fluids moving machinery performance, Selection and specification, reciprocating pumps, centrifugal pumps, pump characteristics.

Module VI TRANSPORTATION EQUIPMENTS(4)

Concepts of compressors, fans and blowers.

Total Hours:60

Text Books

1. Dr.Bansal.R.K, "A text book of fluid mechanics", Laxmi Publication(P) Ltd, New Delhi, 1st edition, 2008
2. Bernard Massy, John ward and Smith, "Mechanics of fluids", Taylor & Francis Publishers, USA 8th edition, 2006.

Reference Books

1. Mc Cabe W.L and Smith J.C, "Unit operations in chemical engineering", McGraw Hill, 6th edition 2006.
2. Perry R.H., Green D.W. and Maloney J.O. "Perry's Chemical Engineers Handbook", McGraw-Hill, 7th edition 1997.

18BT2011	FLUID MECHANICS & HEAT TRANSFER LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To provide extensive knowledge on various unit operations in bioprocess industries
2. To ensure students to have a strong knowledge on various flow measuring equipments involved in bioprocess industries
3. To make student understand the fluid flow processes involved in different sections in industrial operations

Course Outcome:

The students will be able to

1. Understand the heat transfer concept and its applications.
2. Understand the important of fluid mechanics applications.
3. Analyze various flow meters for wide range of applications in industrial biotechnology
4. Demonstrate the friction factor for wide range of applications in industrial biotechnology
5. Demonstrate the thermal conductivity of materials for wide range of applications in heat exchangers
6. Experiment with annular pipe for wide range of applications in industry.

List of Experiments

1. Calibration of Flow Meter (Venturimeter)
2. Determination of pressure head loss in Annular Pipe
3. Thermal Conductivity for Insulating Medium
4. Determination of friction factor in Helical Coil
5. Determination of Darcy's Friction Factor
6. Determine the overall heat transfer coefficient in Double pipe Heat Exchanger (Parallel and Counter Flow)
7. Determine the coefficient of discharge in Orifice Meter
8. Determine the overall heat transfer coefficient in Shell and Tube Heat Exchanger
9. Determinations of Minor Losses in Pipes (Sudden Expansion and Contraction)
10. Determine the flow rate of Rota meters
11. Pressure Drop in a Fluidized Bed Column
12. Pressure Drop across Packed Column

18BT2012	BIOPROCESS PRINCIPLES	L	T	P	C
		3	0	0	3

Course Objective:

1. To understand the principles of bioprocessing and appreciate its applications in Bioprocess Technology

2. To ensure students to have a strong knowledge on the importance of medium formulations and optimization
3. To provide extensive knowledge on sterilization kinetics

Course Outcome:

The students will be able to

1. Review the fermentation processes and sampling
2. Summarize media formulation and medium optimization for fermentation process
3. Analyze Thermal death kinetics of microbes, sterilization time and filter sterilization of medium and air
4. Demonstrate isolation and storage of industrially important microbes
5. Assess inoculum development for fermentation process
6. Examine stoichiometry of cell growth and product formation

Module – I OVERVIEW OF FERMENTATION PROCESS (6)

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermenter and ancillaries, aseptic condition and containment, Sampling

Module – II MEDIUM FORMULATION AND OPTIMIZATION (9)

Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen,minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization by Plackett burmann method

Module – III STERILIZATION KINETICS (12)

Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of depth filters, design of sterilization equipment - batch and continuous.

Module – IV INOCULUM DEVELOPMENT (8)

Isolation of industrially important microbes, preservation and storage of industrially important microbes, Quality control of preserved stock cultures and development of inoculum for industrial fermentation

Module – V STOICHIOMETRY OF CELL GROWTH AND PRODUCT FORMATION (8)

Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances.

Module –VI YIELD CALCULATIONS (4)

Knowing the Priciples of product yield and calculations of yield coefficients of biomass and product formation.

Total Hours:45

Text Book

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.

Reference Book

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2002

18BT2013	BIOPROCESS LAB	L	T	P	C
		0	0	3	1.5

Co-requisite: 18BT2012- Bioprocess Principles

Course Objective:

1. To learn the culturing of microbes and quantifying biomass production
2. To provide extensive knowledge on enzyme kinetics
3. To learn immobilization techniques

Course Outcome:

The students will be able to

1. Acquire knowledge in the cultivation of microorganisms and estimating its dry weight.

2. Demonstrate enzyme assay qualitatively and quantitatively
3. Examine factors affecting enzyme activity.
4. Devise methods to produce fermented products
5. Utilize solid state fermentation for production of fermented products
6. Assess the effect of substrate concentration on growth of microbes.

List of Experiments:

1. Culturing of Different Types of Microorganism
2. Estimation of Biomass Production
3. Effect of Substrate Concentration on Growth of E-coli
4. Effect of pH on Enzyme Activity
5. Effect of Temperature on Enzyme Activity
6. Immobilization of ∞ - Amylase Enzyme by entrapment method
7. Components of Fermentor
8. Citric acid production by Solid State Fermentation
9. Enzyme Assay- Starch Plate Assay
10. Quantitative Enzyme Assay
11. Production of Wine
12. Production of Amylase from Bacillus subtilis and Assaying for its Activity

18BT2014	MOLECULAR BIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To understand the basics of molecular biology and gene expression.
2. To understand DNA damage and repair systems
3. To get an overview on the regulation of gene expression

Course Outcome:

The students will be able to

1. Understand the fundamental concepts of the organization of genome and central dogma
2. Summarize the fundamental mechanism on the process of replication, transcription and translation in the gene expression
3. Recognize common mutations, their natural repair systems and the natural gene expression regulation systems in prokaryotes and eukaryotes
4. Discuss and distinguish the replication of prokaryotic and eukaryotic DNA
5. Explain the synthesis of RNA and post-transcriptional modifications
6. Comprehend the role of operons and cis/trans elements in gene regulation

Module I CHROMOSOME ORGANIZATION (9)

Chromosome organization in prokaryotes and eukaryotes, Different forms of DNA, Classical experiments : Grifith, Hershey and chase; Avery McLeod & McCarty. Bacterial Recombination: Transformation, Transduction, Sexduction and Conjugation. Lytic and lysogeny.

Module II DNA REPLICATION – PROKARYOTES (4)

DNA replication- Semi conservative replication, Meselson stahl experiment, Enzymes in replication, Replication in prokaryotes, D-loop and rolling circle mode of replication, regulation of replication, replication of linear viral DNA.

Module III DNA REPLICATION – EUKARYOTES AND MUTATIONS (5)

Replication in eukaryotes and telomere replication. Mutation : types, DNA repair - methylation, mismatch, SOS, recombination.

Module IV TRANSCRIPTION (9)

RNA polymerase, features of promoters and enhancers, transcription factors, Prokaryotic and eukaryotic transcription, inhibitors, post-transcriptional modification - RNA splicing and RNA editing. Transcription in virus : RNA replicase, Reverse transcriptase.

Module V TRANSLATION (9)
Elucidation of genetic code-salient features, Process of translation in prokaryotes and eukaryotes, Post-translational modifications, Inhibitors.

Module VI REGULATION OF GENE EXPRESSION (9)
Regulation of gene expression: In prokaryotes - lac and trp operons. Regulation in eukaryotes – cis and trans elements, chromatin in gene regulation.

Total Hours: 45

Text book

1. David Friefelder, "Molecular Biology", Narosa Publ. House. 6th edition 2003.

Reference books

1. David R. Hyde, "Genetic and Molecular Biology", Tata McGraw Publications, New Delhi, 4th edition, 2010.
2. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.
3. Gardner, Simmons and Snustad, "Principles of Genetics", John Wiley, 8th edition, 2000.

18BT2015	GENETIC ENGINEERING AND BIOETHICS	L	T	P	C
		3	0	0	3

Course Objective:

1. Helps the student to understand the tools and steps in Genetic engineering.
2. Trains students on the strategy employed in genetic engineering.
3. Helps the student understand the application in genetic engineering and the social implications and the ethics to be followed.

Course Outcome:

The students will be able to

1. Learn the basics of genetic engineering
2. Understand the basic tools employed in genetic engineering.
3. Understand the use of cloning vectors in genetic engineering.
4. Gain knowledge about polymerase chain reaction and its variations and applications.
5. Learn the strategy of gene cloning.
6. Understand the implications of ethical issues pertaining to genetic engineering.

Module I RESTRICTION ENZYMES (9)
Restriction enzymes- Classification-nomenclature; Ligases- Modifying enzymes; Probe preparation and the methods of labeling them; Southern hybridization-Northern hybridization; Western blotting, Autoradiography; DNA finger printing-RFLP Analysis-chromosome walking.

Module II IDEAL VECTORS PLASMIDS (9)
Properties of ideal vectors Plasmids as vectors- PBR322- pUC vectors--M13-Lambda phage vectors ,Cosmid vectors, Phagemids-Cloning vectors in Gram positive bacteria- streptomycetes, Shuttle vectors, Expression vectors, YAC, BAC, Mammlian cells-SV40 & CMV vectors.

Module III POLYMERASE CHAIN REACTION (9)
Mechanism of Polymerase chain reaction, types of PCR, Inverse PCR, Nested PCR, Molecular beacons, RACE PCR, RAPD, RFLP.

Module IV CONSTRUCTION OF RECOMBINANT DNA (9)
Construction of recombinant DNA: Preparation of competent cell-Transformation (Physical, chemical and biological methods of Transformation), transfection- Recombinant selection and screening of Recombinant DNA, Genomic Library, cDNA library.

Module V BIOETHICS (5)
Definitions, history & views on ethics and bioethics. Ethical issues pertaining to biology and biotechnology. Special procedures for r-DNA based product production.

Module VI BIOSAFETY GUIDELINES (4)
Biosafety regulations, r-DNA guidelines- National and international, levels of containment.

Total Hours: 45

Text Books

1. Desmond S. T. Nicholl, “An Introduction to Genetic Engineering”, 3rd Edition Cambridge University Press; South Asian edition , 2010.
2. Monika Jain “Recombinant DNA Techniques”, Narosa Publishing House, 2012.
3. Barry R. Schaller "Understanding Bioethics and the Law: The Promises and Perils of the Brave New World of Biotechnology" Praeger Publishers Inc, 2007.

Reference Books

1. Sandy B. Primrose, Richard Twyman “Principles of Gene Manipulation and Genomics” Backwell Scientific Publications 2010.
2. Sandhya Mitra, “Genetic Engineering Principles and Practice”, Macmillan Publications, 2008.
3. Dubey R. C, “Text book of Biotechnology”, S. Chand & Co. Publications, 2006.
4. Richard Sherlock, John D. Morrey "Ethical Issues in Biotechnology" Rowman & Littlefield Publishers, 2002.

18BT2016	MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. The objective of the course the student will learn various basic techniques in molecular biology and genetic engineering.
2. The student will learn how to isolate DNA from various sources.
3. The student will learn to manipulate DNA.

Course Outcome:

The students will be able to

1. The student knows how to isolate DNA from Plant source.
2. The student knows how to isolate DNA from Animal source.
3. The student knows how to isolate DNA from bacterial source.
4. The student knows how to carry out qualitative and quantitative measurements on nucleic acids.
5. The student knows how to manipulate DNA using restriction and ligation techniques.
6. The student knows how to transfer DNA into bacteria by the transformation technique.

List of Experiments

1. Isolation of genomic DNA from plant tissue
2. Isolation of genomic DNA from animal liver
3. Isolation of genomic DNA from microorganism (E-coli)
4. Isolation of plasmid DNA from microorganism
5. Quantitative and qualitative analysis of isolated genomic DNA using spectrophotometer
6. Agarose gel electrophoresis of DNA and analysis of their molecular weights by gel documentation
7. Extraction of proteins from plant or animal tissue and confirmation with qualitative tests
8. Separation and identification of proteins by SDS-PAGE using Coomassie Brilliant Blue stain
9. Restriction enzyme digestion of DNA samples confirmation through agarose gel electrophoresis
10. Ligation of DNA fragments and confirmation through agarose gel electrophoresis
11. Competent bacterial cell preparation
12. Transformation of DNA into competent cells

14BT2017	BIOPROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. This course aims at making the students understand the fundamental principles and concepts of Bioreactor engineering.

2. This will help the student understand stoichiometric calculations, models of growth and product formation
3. To understand the basics of oxygen transfer in microbial bioreactors

Course Outcome:

The students will be able to

1. Acquire knowledge on principles of stoichiometry and concepts of bioreactor engineering.
2. Assess elemental balance equations and models of growth and product formation.
3. Classify growth kinetics and product formation kinetics using models
4. Devise methods to calculate volumetric mass transfer coefficient and determination methods.
5. Analyze bioreactors for free cell and immobilized cell reactions
6. Discuss parameters to be monitored and controlled in Fermentation processes

Module I STOICHIOMETRY OF CELL GROWTH AND PRODUCT FORMATION(9)

Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, various yield coefficients of biomass and product formation, oxygen consumption and heat evolution in aerobic cultures

Module II SIMPLE UNSTRUCTURED KINETIC MODELS (9)

Simple unstructured kinetic models for microbial growth, Monod model, Substrate uptake kinetics and maintenance coefficient, growth of filamentous organisms, product formation kinetics - Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Determination of kinetic parameters for monod equation.

Module III OXYGEN TRANSFER IN MICROBIAL BIOREACTORS (9)

Oxygen transfer in microbial bioreactors; oxygen uptake rates and determination of oxygen transfer coefficients (k_La) by correlations and experimental methods; Mass transfer in heterogeneous biochemical reaction system, role of aeration and agitation in oxygen transfer and types of aerators and agitators.

Module IV BIOREACTORS FOR FREE AND IMMOBILIZED CELLS (9)

Bioreactors for free cells – batch, continuous, fed batch, chemostat with recycle and multi stage chemostat systems, air lift and loop reactor, Bioreactors for immobilized cells: packed – bed, fluidized bed and hollow – fibre membrane bioreactors. Basics of solid state fermentation, various scale- up criteria for bioreactors.

Module V PARAMETERS TO BE MONITORED AND CONTROLLED IN FERMENTATION PROCESSES (5)

Basic configuration of fermenter and ancillaries, main parameters to be monitored and controlled in Fermentation processes- Temperature, pressure, flow measurement, rate of stirring, shaft power, weight, Dissolved Oxygen, pH, inlet and exit gas analysis.

Module VI ANALYZING PROCESS PARAMENTERS (4)

Online data analysis of chemical parameter measurements for biochemical processes.

Total Hours: 45

Text Books

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2005.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.

Reference Books

1. Lee, J.M, "Biochemical Engineering", 1st Edition, Prentice Hall, 2001.
2. Blanch, H.W and Clark, D.S, "Biochemical engineering", Marcel Dekker, 1997.

18BT2018	ENZYME ENGINEERING AND TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives

1. To learn the significance of enzyme, classification, application
2. To provide knowledge on kinetics based on different models and theories,

3. To learn on extraction and purification of enzymes, and their immobilization.

Course outcome

Upon successful completion of this course, students will be able to

1. Do the Classification and nomenclature of enzymes.
2. Explain applications in food, pharmaceutical and other industries
3. Evaluate kinetic parameters and understand their usage for research.
4. Explain various enzyme immobilization techniques.
5. Explain the steps involved in the extraction and purification of enzymes.
6. To model different inhibition types.

Module I CLASSIFICATION AND NOMENCLATURE (9)

Brief introduction to enzymes, nomenclature and classification of enzymes, mechanisms of enzyme action, specificity of enzyme action, the structure–functionality relationships, concept and determination of enzyme activity, Effect of physical and chemical factors on enzyme activity, applications in food, pharmaceutical and other industries

Module II ENZYME KINETICS AND INHIBITION (9)

Kinetics of enzyme catalysed reactions. Importance and estimation of kinetic constants, Kinetics of bi substrate enzymes, Enzyme inhibition types and models- Competitive, Noncompetitive and un competitive inhibitions. Inhibition kinetics- substrate, product and toxic compound.

Module III EXTRACTION AND PURIFICATION OF ENZYMES (9)

Extraction and purification of enzymes from plant, animal and microbial sources, Extraction of soluble and membrane bound enzymes. Nature of extraction medium. Purification of enzymes. Criteria of purity. Determination of molecular weight of enzymes.

Module IV IMMOBILIZATION OF ENZYMES (9)

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, Encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages of Different immobilization techniques. Design of immobilized enzyme reactors – Packed bed, Fluidized bed and Membrane bioreactors

Module V ENZYME BIOSENSORS (5)

Applications of enzymes in analysis; Design of enzyme electrodes and their working and experimentation.

Module VI APPLICATIONS (4)

Case studies on their Application as biosensors in industry, healthcare and environment.

Total Hours:45

Text Book

1. T Palmer, "Enzymes", Horwood Publishing Series, 2001. 6th edition, 2006

Reference Books

1. Martin Chaplin and Christopher Bucke, "Text book on Enzyme Technology", Cambridge University Press, 4th edition, 2004.
2. Shuler, M.L. and Kargi,F, " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd., 2nd edition, 2002.

18BT2019	HEAT AND MASS TRANSFER	L	T	P	C
		3	1	0	4

Course Objective:

1. To ensure students to having strong fundamental knowledge about heat transfer operations
2. To introduce them to the heat and mass transfer calculations for bioprocess and biochemical industries
3. To understand the industrial application and significance of these equipment in biotechnology

Course Outcome:

At the end of the course the students could be able to

1. Recognize the basic doctrine of heat transmits

2. Recognize and work out conduction effort
3. Recognize and work out convection effort and analyze heat exchangers
4. Solve the problems related to diffusion, leaching and adsorption
5. Estimate the number of stages for Distillation and absorption
6. Propose and analyze the vertical of evaporators

Module-I – CONDUCTION (12)

Introduction - Modes of heat transfer - Thermal conductance and resistance - Temperature field and temperature gradient - mechanism of heat transfer. Conduction - Heat transfer by conduction - General heat conduction equation - Thermal diffusivity and equivalent thermal conductivity - Linear one-dimensional steady state conduction through plane, cylinders, spheres and composite walls - Heat conduction with internal heat generation - Systems with variable thermal conductivity .

Module-II CONVECTION AND RADIATION (12)

Convection – Types of convection - Individual and overall heat transfer coefficient - Reynolds's analogy - Natural convection – Forced convection , Radiation -Thermal radiation - Spectrum of electromagnetic radiation - Monochromatic Emissive Power of black body - Planck's Distribution Law - Kirchoff's Law - Total Emissive Power, problems on Stefan- Boltzmann's law and Wien's displacement law - Configuration factor determination, typical examples.

Module-III HEAT EXCHANGER AND EVAPORATORS (12)

Heat exchanger-Types of heat exchange equipment and design of heat exchangers-effectiveness of heat exchangers – Logarithmic mean temperature difference –solving problems. Concept of evaporation-types - single effect evaporator -mass and energy balances, capacity, steam economics and effectiveness. Industrial evaporators.

Module –IV DIFFUSION AND INTER PHASE MASS TRANSFER (12)

Diffusion concept – types- mechanism, equimolar and non- equimolar counter diffusion- calculation and measurements, interface theory concept, mass transfer coefficient.

Module-V DISTILLATION AND ABSORPTION (8)

Raoult's law and VLE diagram and methods distillation, methods and types of distillation, calculation of number theoretical plates by McCabe –Thiele methods. Theories of absorption and design.Types of packing and merit and demerits.

Module –VI HEAT TRANSFER APPLICATIONS (4)

Concept of HTU, NTU and total height of column. Industrial application of these equipments.

Total Hours:60

Text Book

1. Holman, J . P., Heat Transfer, 9th Edition, Mc Graw Hill, Singapore, 2002
2. Donald Q. Kern, Process Heat Transfer, Tata McGraw Hill, New Delhi, 1997
3. Heat and mass Transfer solved problems by GK Ray, Tata McGraw Hill, new Delhi.

Reference Book

1. Mccabe, W. L., Smith, J. C., and Harriott, P., Unit Operations of Chemical Engineering, McGraw Hill, New York, 6th Edition,2004
2. Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003

18BT2020	DOWNSTREAM PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study the characteristics of biomolecules and types of cell disruption methods.
2. To study the principles of solid liquid separation processes, isolation of bioproducts
3. To study the principles of purification and polishing of bioproducts.

Course Outcome:

1. Strategies of downstream processing based on characteristics of biomolecules.
2. Various cell disruption techniques for product recovery.
3. Solid liquid separation processes for large scale operations.
4. Techniques of bulk product isolation and purification.
5. To design purification strategy based on product characteristics.
6. To identify finishing operations.

Module I OVERVIEW OF BIOSEPARATIONS (9)

Broad classification of bioproducts, characteristics of fermentation broths and bioproducts. Cell disruption and pretreatment: Analysis of various physical, chemical, enzymatic and mechanical methods for release of intracellular products, Flocculation: electrical double layer concept, mechanisms of charge dependent flocculation.

Module II PRODUCT RECOVERY (9)

Gravity sedimentation: Mechanisms of sedimentation, thickeners, classifiers, applications in downstream processing. Centrifugal bioseparations: Theory of centrifugal settling- basic equations, centrifuge selection-RCF, scale up of centrifuges- sigma analysis, equivalent time.

Filtration: Equipments for conventional filtration- filter media, pretreatment methods, general filtration theory- Darcy's law, compressible and incompressible filter cakes, filtration cycle, scale up and design of filtration.

Module III ISOLATION OF BIOPRODUCT (9)

Adsorption, Extraction, aqueous two phase extraction, Precipitation, Membrane separation processes: reverse osmosis, dialysis, electrodialysis, pervaporation.

Module IV PURIFICATION (9)

Chromatographic separations: Classification of techniques, elution chromatography- retention theory -Gas and liquid chromatography- Ion exchange chromatography, gel permeation chromatography, affinity chromatography

Module V FINISHING OPERATION (5)

Product crystallization: Basic principles- nucleation and crystal growth- supersaturation theory-commercial crystallizers- Recrystallization.

Module VI HEAT AND MASS TRANSFER IN DRYERS (4)

Product drying: Heat and mass transfer in drying- types of commercial dryers- vacuum dryers, freeze dryers, spray dryers. Lyophilization

Total Hours:45

Text Books

1. Paul A Belter, EL Cussler, Wei-shou Hu, Bioseparations: Downstream Processing for Biotechnology - Wiley Interscience, 1988.
2. Sivasankar B, Bioseparations: Principles and Techniques, Prentice-Hall of India Pvt. Ltd., 2008.

Reference Books

1. Roger g. Harrision; paul w. Todd; scott r. Rudge, "bioseparations science and engineering" oxford university press, 2015
2. Don w. Green; nooralabettu krishna prasad "downstream process technology : a new horizon in biotechnology" phi learning private limited, 2010
3. Richardson j.f.;harker j.h.;backhurst j.r. "coulson and richardsons chemical engineering volume 2 : particle technology and separation processes" butterworth-heinemann, 2006
4. Christie john geankoplis "transport processes and separation process principles : includes unit operations" prentice hall of india private limited, 2006

18BT2021	DOWNSTREAM PROCESSING LAB	L 0	T 0	P 3	C 1.5

Course Objectives:

1. To strengthen principles of the unit operations involved in the separation and purification of a biological product
2. To learn on cell disruption techniques, solid liquid separation
3. To learn about product isolation, purification and polishing

Course Outcome

After successful completion of the course, the students would have learnt

1. Strategies of downstream processing based on characteristics of biomolecules.
2. Cell disruption techniques for intracellular product recovery.
3. Separate microbial cells from aqueous suspensions
4. Techniques of bulk product isolation and purification.
5. To design purification strategy based on product characteristics.
6. To identify finishing operations.

List of Experiments

1. Batch Sedimentation
2. Flocculation
3. Cell disruption by homogenizer
4. Isoelectric precipitation
5. Salting out
6. Solvent Extraction
7. Aqueous two phase extraction
8. Leaching
9. Drying
10. Column Chromatography
11. Adsorption
12. Distillation

Text Books

1. Paul A Belter, EL Cussler, Wei-shou Hu, Bioseparations: Downstream Processing for Biotechnology - Wiley Interscience, 1988.
2. Sivasankar B, Bioseparations: Principles and Techniques, Prentice-Hall of India Pvt. Ltd., 2008.

Reference Books

1. Roger g. Harrision; paul w. Todd; scott r. Rudge, “bioseparations science and engineering” oxford university press, 2015
2. Don w. Green; nooralabettu krishna prasad “downstream process technology : a new horizon in biotechnology” phi learning private limited, 2010
3. Richardson j.f.;harker j.h.;backhurst j.r. “coulson and richardsons chemical engineering volume 2 : particle technology and separation processes” butterworth-heinemann, 2006

18BT2022	IMMUNOLOGY	L 3	T 0	P 0	C 3

Course Objective:

1. This course aims to impart basic knowledge in Immunology,
2. To help the students familiarize with the organs and cells of the immune system, the immune response and molecular interactions involved in immune response.
3. To make the students aware of the applications of immunology such as, immunodiagonosis and immunotherapy.

Course Outcome:

1. Student learns the history and development of the field of immunology.

2. Student understands the types of immunity, the basic plan of the immune of the immune system and the organs of the immune system.
3. The students learn about the cells of the immune system and their functions.
4. Students understand the humoral immune system
5. Students understand the physiology and the pathology of the immune system.
6. Students aware of the applications of immunology in diagnosis and treatment of diseases.

Module I IMMUNE SYSTEM (9)

Introduction and an overview of immunology, History of immunology, Types of Immunity - Innate and acquired immunity, Cell mediated and humoral immunity; Organs of the immune system: Lymphoid organs - primary and secondary.

Module II IMMUNE RESPONSE (9)

Granulocytes and Agranulocytes, haematopoiesis, extravasation, phagocytosis. T and B Lymphocytes & NK cells. Major histocompatibility complex; antigen processing and presentation, T-Cell activation and the cellular immune response.

Module III ANTIGEN ANTIBODY REACTIONS (9)

Antigens- chemical and their molecular nature; Haptens; Adjuvants. Antibody – structure, Classes, Genes and Antibody diversity. Antigen Antibody reactions; Neutralization, Opsonization. Complement, Cytokines. Vaccines.

Module IV IMMUNE RESPONSES (4)

Injury and inflammation; immune responses to infections: immunity to bacteria, and virus; Transplantation: laws, consequences and genetics of transplantation,

Module IV CANCER IMMUNOLOGY AND AIDS (5)

Cancer immunology – Tumour Associated Antigens and Tumour Specific Antigens; Autoimmunity; Autoimmune disorders, Allergy and hypersensitivity, Tolerance, Immunosuppression and AIDS.

Module V IMMUNOTECHNOLOGY (9)

Diagnostics; immunodiffusion, Haemagglutination, RIA, ELISA, Western Blotting, Immunofluorescence Assay, Immunohistochemistry. Therapeutics and prophylactics; Abzymes, Monoclonal Antibody production, Chimeric & humanized antibodies. Vaccines.

Total Hours:45

Text Book

1. Roitt I, Male, Brostoff, “Immunology”, Mosby Publishers, 2002.

Reference Books

1. Tizard, “Immunology”, Saunders college publication, 5th Edition. 2004.
2. Kuby J, “Immunology”, WH Freeman & Co., 2000.
3. Ashim K. Chakravarthy, “Immunology”, TataMcGraw-Hill, 2001

18BT2023	CELL BIOLOGY AND IMMUNOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To acquaint the students with basic laboratory techniques involved in cell
2. This course aims to impart basic knowledge in Immunology,
3. To make the students aware of the applications of immunology such as, immunodiagonosis and immunotherapy

Course Outcome:

1. Student understands the types of immunity, the basic plan of the immune of the immune system and the organs of the immune system.
2. The students learn about the cells of the immune system and their functions.
3. Students understand the humoral immune system
4. Students understand the physiology and the pathology of the immune system.
5. Students aware of the applications of immunology in diagnosis and treatment of diseases.

List of Experiments

1. Study of Microscopy
2. Microscopically Identification of Cells in Permanent Fixed Slides
3. Staining for Various Stages of Mitosis in Allium cepa (Onion)
4. Osmosis and Tonicity Studies Using Red Blood Corpuscles
5. Differentiation of Blood Cells Using Giemsa Staining
6. Separation of Peripheral Blood Mononuclear Cells and Trypan Blue Assay for Live Cell
7. Blood Grouping and Rh typing
8. Preparation of Plasma and Serum
9. Single Radial Immunodiffusion
10. Double Immunodiffusion – Ouchterlony Method
11. Immunoelectrophoresis
12. Counter Current Immunoelectrophoresis

18BT2024	CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	1	0	4

Course Objectives

1. To provide knowledge on estimation of kinetic parameter
2. To derive design equations for various reactors.
3. To make the students aware of Non-ideal reactors

Course Outcomes:

The students will be able to

1. Describe the kinetics of reactions
2. Design equations to determine the performance of ideal reactors
3. Create various models for describing non- ideal behavior of reactors
4. Analyze performance of combined reactors
5. Explain adsorption and desorption phenomena in heterogeneous systems.
6. Create design of various fermentor / bioreactors

Module I HOMOGENEOUS REACTIONS (12)

Principles of Homogeneous reactions – and rate equations-estimation of rate constants using constant volume and constant pressure Batch reactor-data for typical reactions – Arrherius equation-Non elementary reaction kinetics-Multiple reactions-yield Concepts.

Module II PERFORMANCE OF BIOREACTORS (12)

Performance equations for single batch reactor, ideal CSTR, ideal PFR-Application to design.

Module III MULTIPLE REACTOR SYSTEMS (12)

Multiple reactor systems – selection of suitable reactor systems for multiple reactions-recycle reactor-Principles in non isothermal reaction and reactors.

Module IV NON IDEAL REACTORS (12)

Non Ideal reactors- Non Ideal Flow-Tracer experiments and application-TIS model, Axial Dispersion model-for tubular reactors. Exchange volume and By Pass and dead volume models for CSTRS.

Module V GAS-LIQUID REACTIONS (8)

Gas-Liquid Reactions-kinetics-G-L reactor design Principles-Principle of Catalysis-types of catalytic reactors.

Module VI CATALYTIC REACTIONS (4)

Concept of effectiveness factor in Catalytic reactions-G-L-S-reactors – slurry reactor.

Total Hours: 60

Text Books

1. Levenspiel, Octave "Chemical Reaction Engineering", 3rd Edition, John – WileySons, 2002.
2. Fogler, H.S. "Elements of Chemical Reaction Engineering", 2nd Edition, Prentice Hall, 2002.

Reference Books

1. Missen, R.W. etal., "Chemical Reaction Engineering and Kinetics", John – Wiley, 1999.

2. Davis, Mark E and Robert J. Davis “Fundamentals of Chemical Reaction Engineering” McGraw – Hill, 2005.
3. Harri ot, Peter “Chemical Reactor Design” Marcel Dekker, 2003.
4. Sila, Harry “Chemical Process Engineering : Design and Economics” Marcel Dekker, 2003
5. Nauman, E. Bruce “Chemical Reactor Design, Optimization, and Scaleup”, McGraw – Hill, 2002.
6. Richardson, J.E. and D.G. Peacock “Coul son & Richardson’ s Chemical Engineering”, Vol.3 (Chemical & Biochemical Reactors & Process control) 3rd Edition, Butterworth Heinemann/ Elsevier, 2006.

18BT2025	MASS TRANSFER AND CHEMICAL REACTION ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objective:
1. To learn chemical engineering principles
2. To provide knowledge on practical applications in the areas of mass transfer
3. To provide knowledge on reaction engineering and particle mechanics.

Course Outcome:
1. Ability to plan experiments and present the experimental data meaningfully
2. Ability to apply theoretical concepts for data analysis and interpretation
3. Capability to visualize and understand chemical engineering unit operations related to fluid and particle mechanics
4. Understand the experimental techniques related to chemical reaction engineering
5. Understand the basic laws of mass transfer.
6. Learn to operate various reactors

List of Experiments
1. Batch reactor
2. Semi batch reactor
3. Continuous stirred tank reactor
4. Plug flow reactor
5. Tank in series
6. Residence time distribution
7. Simple distillation
8. Single effect evaporator
9. Absorption column
10. Extraction

18BT2026	BIOCHEMICAL THERMODYNAMICS	L	T	P	C
		3	1	0	4

Course Objective:
1. To have strong foundation on the thermodynamic laws and concepts relevant to biochemical process.
2. To understand fundamental concepts such as enthalpy, entropy, fugacity, free energy, and chemical potential in biological system
3. To introduce behavior of pure fluid, partial molar properties

Course Outcome:
1. Use fundamentals of biochemical thermodynamics to evaluate real world biological systems.
2. Apply the concept of entropy to assess reversibility or feasibility of biochemical process
3. Demonstrate role biochemical thermodynamics in the reactor designs, vapor-liquid equilibrium and industrial applications

4. Apply fundamentals to assess biochemical reaction equilibrium and its dependency on pressure and temperature
5. Students will be able to analyze energetic problems in biochemical reaction
6. Solve problems dealing with multi-phase biochemical systems.

Module – I: BASIC CONCEPTS & LAWS OF THERMODYNAMICS (12)

System, Surrounding & Processes, Closed and Open systems, State Properties, Intensive & Extensive Properties, State and Path functions, work, enthalpy, internal energy, specific heat, First law for Cyclic Process, Energy Balance for Closed Systems, open systems, Steady flow or non-flow energy equations, Heat reservoir and Heat engines, Heat pump, Carnot cycle, The Reversible Process, General statements of the second law, Concept of entropy, Calculation of entropy changes, Clausius inequality, Entropy and Irreversibility.

Module II: PVT BEHAVIOR AND THERMODYNAMIC EQUILIBRIUM (12)

PVT behavior of pure fluids, equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure constant temperature, adiabatic and polytrophic processes. Equations of state for real gases: Van-der Waals equation, virial equation. Coupled reactions and energy rise compounds, reaction stoichiometry, standard heat of reaction, heat of combustion, Hess's Law of Constant Heat Summation, criteria of biochemical Reaction equilibrium, equilibrium constant and standard free energy change, effect of Temperature, pressure on equilibrium constants.

Module III: THERMODYNAMIC FUNCTIONS (12)

Energy properties, Derived properties, Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy heat capacity relations, Gibbs- Helmholtz equation, Thermodynamic square, Joule-Thomson expansion.

Module IV: THERMODYNAMICS IN BIOCHEMICAL REACTIONS (12)

Thermodynamic energy function to standard state, Molar enthalpy of formation, Entropy change and Gibbs Energy change in chemical reaction. Fugacity: Fugacity, Fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, Fugacity of solids and liquids, Activity: Effect of temperature and pressure on activity. Departure functions and generalized charts, thermodynamic diagrams – types of diagrams and construction of thermodynamic diagrams. Partial molar properties - Partial molar properties of solutions, determination of partial molar properties, chemical potential – effect of temperature and pressure, Gibbs-Duhem equation.

Module V: PHASE EQUILIBRIUM IN SOLUTION (6)

Criteria of phase equilibria, criterion of stability, Duhem's theorem, Vapour-Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions - azeotropes, VLE at low pressures – activity co –efficient equation, bubble point and dew point equilibria, Liquid-Liquid Equilibrium diagrams – binary liquid Equilibrium diagrams.

Module –VI CHEMICAL EQUILIBRIUM REACTIONS(6)

Introduction to Chemical Reaction Equilibrium, Equilibrium criteria for homogeneous chemical reactions; Evaluation of equilibrium constant and effect of pressure and temperature on equilibrium constant; Calculation of equilibrium conversions and yields for single and multiple chemical reactions.

Total Hours: 60

Text Books

1. Introduction to Chemical Engineering thermodynamics - Joseph Mauk Smith, Hendrick C. Van Ness, Michael M. Abbott, McGraw-Hill, 2005
2. Thermodynamics of Biochemical Reactions - Robert A. Alberty, Wiley Inderscience, 2003.

References Books

1. Chemical And Engineering Thermodynamics, Stanley I Sandler, 4th Ed., John Wiley & Sons, Inc. 2006.
2. Chemical Engineering Thermodynamics By Y.V.C. Rao, New Age International.
3. Biological Thermodynamics, Donald T. Haynie, Cambridge University Press.

18BT2027	BASICS OF BIOINFORMATICS	L 2	T 0	P 0	C 2

Course Objective:

1. To learn and understand specific databases and perform effective database searches.
2. To learn and perform various Insilco analysis for gene and protein structure and function identification
3. To learn and perform target identification for drug-designing and to have a platform for interchange and exchange of knowledge with academia and industry.

Course Outcome:

1. Acquire knowledge on structure, properties and biological functions of carbohydrates, lipids and proteins which help them to understand the significance of biomolecules in bioprocesses and biotechnology
2. Apply the knowledge of science and technology to solve the biological problems related to biosciences.
3. Design the solution for biological knowledge based problems and design process the specified needs to solve human problems
4. Help them to analyze biomolecules using appropriate techniques, software resources and modern engineering tools.
5. Understand and exhibit the knowledge vital role for new drug design by various methodologies to save the human health
6. Recognize the need for indeipetend and lifelong learning experience in bimolecular analysis and application

Module I: INTRODUCTION TO BIOINFORMATICS (6)

Definition - Importance and uses of Bioinformatics- Information Technology- Systems Biology, Scope of Bioinformatics. Elementary Commands and Protocols, ftp, telnet, various file formats for biological sequences

Module II: BIOLOGICAL DATABASES (6)

Introduction to Biological databases, organization and management of databases, searching and retrieval of information from World Wide Web. -Primary sequence databases Composite sequence databases- Secondary databases- nucleic acid sequence databases - Protein sequence data bases.

Module III: SEQUENCING ALIGNMENT AND DYNAMIC PROGRAMMING (6)

Alignment-Local, Global alignment, pairwise and multiple sequence alignments. Concept of gap penalty and e-value. Alignment algorithms. Dynamic programming in sequence alignment: Needleman-Wunsch Algorithm and Smith Waterman Algorithm, Aminoacid Substitution matrices (PAM, BLOSUM).Sequence similarity search with database: BLAST and FASTA

Module IV: COMPUTATIONAL GENOMICS AND PROTEOMICS (6)

Large-scale genome sequencing strategies; Comparative genomics; Understanding DNA microarrays and protein arrays, Gene and protein prediction strategies, phylogenetic analysis, primer design, sequence submission, Automated Genome Comparison and its Implication, Automated Gene Prediction, Gene Signaling Pathways and Pathway Regulation

Module V: MOLECULAR MODELING AND DRUG DISCOVERY (3)

Basic concepts of Homology, threading, abinition protein structural modeling, Molecular simulation,

Module VI: DRUG DISCOVERY (3)

Virtual ligands library preparation, target identification and validation, optimization of ligand, docking studies, Industrial application of CADD.

Total Hours: 30

Text Books

1. T K Attwood, D J parry-Smith," Introduction to Bioinformatics", Pearson Education, 1st Edition, 11th Reprint 2005

2. Gusfields G, “Algorithms on strings, trees and sequences- Computer Science and Computational Biology”, Cambridge University Press, 1997.

References Books

1. S.C. Rastogi & others, “Bioinformatics- Concepts, Skills, and Applications”, CBS Publishing, 2003.
2. David W.Mount “Bioinformatics sequence and genome analysis”, Cold spring harbor laboratory press, 2004.
3. Neil C. Jones and Pavel A. Pevzner, “An Introduction to Bioinformatics Algorithms”, MIT Press, First Indian Reprint 2005.

18BT2028	BIOINFORMATICS LAB	L 0	T 0	P 1	C 1

Co-requisite: 14BT2027-Basics of Bioinformatics

Course Objective:

1. To understand the basic methods for sequence retrieving and analysis.
2. To develop the skills in developing knowledge of sequence analysis.
3. To develop the skills of recognition of biomolecule for various application

Course Outcome:

1. Apply the knowledge of internet source to use of biological science
2. Formulate an analytical skill to understand the mathematical principle to solve biological principles.
3. Acquire knowledge in estimation of different biomolecule and their function
4. Characterize the molecular components in biomolecules.
5. Apply the mathematical algorithms to predict function characteristic biomolecule prediction
6. Apply basic knowledge on the properties of biomolecules for important functional modification.

List of experiments:

1. Biological Databases with Reference to Expasy and NCBI
2. Queries based on Biological databases
3. Sequence similarity searching using BLAST
4. Pairwise sequence alignment
5. Multiple Sequence and Phylogenetic Analysis
6. Gene Prediction
7. Protein Familes –SCOP,Pfam and CATH
8. Secondary Structure prediction
9. Tertiary Structure Predicition
10. Analysing the geometry of protein and visuavalize the protein using protein databank and swiss-pdb viewer.
11. Homology Modeling Using Modeller Protein
12. Ligand docking using Glide protocol

18BT2029	INDUSTRIAL SAFETY AND HAZARD ANALYSIS	L 3	T 0	P 0	C 3

Course Objective:

1. Students learn about implementation of safety procedures
2. To understand the risk analysis and assessment
3. To learn and understand hazard identification

Course Outcome:

The students will be able to

1. Demonstrate the awareness of plant safety in selection and layout of chemical plants and the usage of safety codes.

2. Exhibit the skill in classifying chemical, fire, explosion hazards
3. Understand the occupational diseases
4. Analyze the bio medical and engineering response to health hazards
5. Implement the effective process control and instrumentation
6. Create awareness the usage of safety codes

Module I NEED FOR SAFETY (9)

Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling

Module II SAFETY PROCEDURES (9)

Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety

Module III PLANNING AND RISK ASSESSMENT (4)

Over all risk analysis-emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies.

Module IV QUANTITATIVE RISK ASSESSMENT (5)

Quantitative risk assessment - rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

Module IV SAFETY AUDITS (9)

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras-Vizag Bopal analysis

Module V CASE STUDIES (9)

Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system.

Total Hours: 45

Text Books

1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990.
2. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965.

References

1. Handley, W., "Industrial Safety Hand Book ", 2nd Edn., McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., " Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
3. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994.

18BT2030	ENVIRONMENTAL POLLUTION CONTROL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. To give an exposure to various control acts
2. To study the advantages and disadvantages of impact assessment methods
3. To study the methods of reducing the waste and reusing it.

Course Outcome:

The students will be able to

1. Gain basic knowledge on pollution, its types
2. Outline Pollution control acts and regulations.
3. Employ collected raw data on pollution caused by industries.
4. Evaluate audit reports on pollution is finally controlled.
5. Create various approaches for material reuse
6. Integrate various recycling methods

Module I: WATER POLLUTION CONTROL (9)
The water (prevention and control of pollution) act 1974 and rules 1975- CPCB-form XIII,XIV,XV,The air (prevention and control of pollution) act 1981 and rules 1982,CPCB-form I,VI. National ambient air quality standards.
Module II: ENVIRONMENT PROTECTION ACT (9)
The environment (protection) act 1986, rules 1986-definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous, standards of emission or discharge of environmental pollutants. Form V
Module III: ENVIRONMENTAL IMPACT ASSESSMENT (9)
Environmental impact assessment notification, 2006-environmental clearance, list of projects, form I, general structure of EIA documents, content of summary EIA
Module IV: BIOSAFETY (9)
The manufacture, use, import, export and storage of hazardous microorganisms genetically engineered organisms or cells rules, 1989-definitions, competent authorities, animal and human pathogens
Module V: BIOMEDICAL WASTE DISPOSAL (4)
Biomedical waste (management and handling) 1998,-categories of biomedical waste, colour coding and type of container for disposal of biomedical wastes.
Module VI: TRANSFER WASTE EQUIPMENT DISPOSAL (5)
Transport of biomedical waste containers/bags (schedule IV), standards for treatment and disposal of biomedical wastes (schedule V),waste management facilities like incinerator/autoclave/microwave system, form-I,II,III.

Total Hours: 45

Text book:

1. C. S. Rao Environmental Pollution Control Engineering, New Age International, 2007

Reference Books

1. Peter Wathern, “Environmental Impact Assessment theory and practice”, Unwin Hyman Ltd. Routledge, 1990,
2. L. Lee Harrison , “Environmental Health and Safety Auditing Handbook”, 2nd edition, McGraw Hill, Inc., New York, 1995
3. Kirkwood, R. C. and Longley, A. J., “Clean Technology and Environment”, Chapman Hall, 1995.

18BT2031	PROCESS EQUIPMENT DESIGN & ECONOMICS	L	T	P	C
		3	0	0	3

Course Objective:

1. To design safe and dependable processing facilities.
2. This course focus on plant layout and design of piping systems
3. This will provide the basic knowledge to carryout design process cost effectively.

Course Outcome:
The students will be able to

1. Utilize principles of process equipment design, the mechanical aspects of the design
2. Design various unit operation equipments, including safety considerations
3. Develop flow measurement devices
4. Design safe and dependable processing facilities
5. Describe the Scale up criteria of bioreactors
6. Analyze the plant layout.

Module I STANDARD CODES (9)
Design of the equipments as per ASME, ISI codes, drawing according to scale
Module II HEAT EXCHANGERS (9)
Shell and tube heat exchanger , double pipe heat exchanger , Single effect evaporator and vertical tube evaporation

Module III DISTILLATION COLUMNS (9)
Design & Construction details and assembly drawing of distillation column; absorption Towers
Module IV FLOW MEASURING DEVICES (9)
Design of flow measurements -their material of construction.
Module V ECONOMICS (4)
Economics, cost estimation.
Module VI APPLICATIONS (5)
The use of equipments designed for biotechnology industry for different purposes: Reactors, Airlift, Fluidized Bed , Packed bed reactor.

Total Hours: 45

Text Books

1. Joshi, M.V, "Process Equipment Design", MacMillan, 3rd edition, 2004.

Reference Books

1. Brownbell I.E., Young E.H.. "Chemical Plant Design" 1985.
2. Kern D.Q. "Heat Transfer". McGraw Hill, 1985.
3. McCabe, W.L., J.C. Smith and P. Harriott "Unit Operations of Chemical Engineering", 6th edition, McGraw-Hill, 2001.
4. Wnell, L.E, & Young, E.H.: Process Equipment Design, Wiley Eastern, New Delhi, 2000.
5. Ludwig, E.E.: Applied Process Design for Chemical & Petrochemical Plants, Vols. I, II & III, (2nd Ed.), Gulf Publishing Company, Texas, 1977, 1979, 1983.
6. Perry, R.H. & Green, D.W.: Perry's Chemical Engineers' Handbook, (7th Ed.),McGraw Hill (ISE), 2000.

18BT2032	PROCESS DYNAMICS & CONTROL	L	T	P	C
		3	0	0	3

Course Objective

1. To control and measure the processing facilities in a cost effective manner.
2. To focus on plant layout control and piping systems
3. To provide in-depth knowledge on control systems

Course Outcomes:
The students will be able to

1. Analyze open-loop systems
2. Analyze and apply the knowledge of linear closed loop systems
3. Develop working knowledge of control system by frequency response
4. Analyze Frequency response and apply it to advanced control systems
5. Develop working and design knowledge of Digital controllers
6. Compare different control modes for dstillation and heat exchanger.

Module-I OPEN LOOP SYSTEMS (9)
Laplace Transforms - Standard functions, Open loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics
Module –II CLOSED LOOP SYSTEMS (9)
Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element
Module-III FREQUENCY RESPONSE (9)
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram
Module –IV ADVANCED CONTROL SYSTEMS (9)
Introduction to advanced control systems, cascade control, feed forward control, model predictive control, control of distillation Column and heat exchanger

Module –V DIGITAL CONTROLLERS (5)
Introduction to Computer control loops, Digital computer, computer process Interface.
Module –VI DIGITAL CONVERTERS (4)
Digital to analog and analog to digital converters, sampling continuous signal.

Total Hours: 45

Text Books

1. Coughnowr, D. R., Process Systems Analysis and Control, Mc Graw Hill, New York, 2nd Edition,1991.
2. George Stephanopolous, Chemical Process Control, Prentice-Hall of India Pvt-Ltd., New Delhi, 1990.

Reference Books

1. Doeblin Er n e s t , Measurement Systems, Mc Graw Hill, New York , 2005
2. A.Suryanarayanan, "Chemical instrumentation and process control", Khanna Publishers, 2nd edition, New Delhi , 1995
3. George Stephanopolous, Chemical Process Control, Prentice-Hall of India Pvt-Ltd., New Delhi, 1990.

18BT2033	MECHANICAL OPERATIONS	L	T	P	C
		3	0	0	3

Course Objective:

1. To ensure students to having strong fundamental knowledge about various unit operations
2. To introduce them to the Characterize particles and perform size reduction and size analysis of particles
3. To understand the industrial application and significance of these equipment in biotechnology

Course outcome:

At the end of the course the students would be able to

1. Characterize particles and perform size reduction and size analysis of particles
2. Identify conveyors & storage vessels for particular applications
3. Explain the principle, construction and operation of various classification equipments
4. Apply the principles of agitation and mixing
5. Evaluate the parameters of filtration
6. Compare different separation process

Module- I SIZE REDUCTION AND SOLID PARTICLES (13)
Introduction to unit operations and their role in bio chemical Engineering industries - Characteristics of particulate solids - Sampling techniques - Specifications - Screen analysis - Particle size distribution, particle size measurement - Surface area measurements - Relevant equations and problems. Principles of size reduction - Specific properties of solids for size reduction - Energy required for size reduction - Crushing and grinding efficiency - Laws of crushing - Classification of crushing and grinding equipment , Scope and applications - Size enlargement techniques
Module –II TRANSPORTATION AND CONVEYING (9)
Conveying of bulk solids: Classification of conveyors - Selection of conveyors - Storage of solids in bulk protected and unprotected piles - Bins - Silos - Hoppers - Mass flow and funnel flow bins - Flow assisting devices - Feeders - Weighing of bulk solids - Batch and continuous weighing techniques
Module –III CLASSIFICATION OF SOLID PARTICLES (9)
Classification of separation methods for different type of mixtures like solid-solid, solid-gas - solid-liquid - Screening - Classification of screening equipments - Mechanical classification and classifiers - Rare and dense medium separation - Magnetic separation - Electrostatic separation - Floatation and Elutriation - Phase separation - Centrifugal separation - Electrostatic precipitators - Impingement separators - Gas solids separation - Gravity settling - Cyclone separators - Bag filters scrubbers.
Module-IV MIXING BLENDING (5) Mixing of solids, solid- liquid mixing, blending, kneading , impeller -Design of agitator- power of agitation - Correlations for power consumption

Module-V FILTRATION (4)
Filtration - Batch and continuous filtration, compressible and incompressible filter cakes.
Module –VI FILTRATION DEVICES (5)
Calculations for specific cake resistance, filter medium resistance - Industrial filters - Centrifugal filtration

Total Hours: 45

Text Books

1. Mccabe, W. L., Smith, J. C., and Harriott, P., Unit Operations of Chemical Engineering, McGraw Hill, New York, 6th Edition, 2004
2. Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003

Reference Books

1. Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., Coulson and Richardson's Chemical Engineering, Volume I, Butterworth Heinemann, Oxford, 5th Edition, 2002
2. Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., Coulson and Richardson's Chemical Engineering, Volume II, Butterworth Heinemann, Oxford, 5th Edition, 2002

		L	T	P	C
18BT2034	**MECHANICAL OPERATIONS LAB**	**0**	**0**	**3**	**1.5**

Course Objective:

1. To ensure students to having strong fundamental knowledge about various unit operations
2. To introduce them to the Characterize particles and perform size reduction and size analysis of particles
3. To understand the industrial application and significance of these equipment in biotechnology

Course Outcome:
At the end of the course the students would be able to

1. Characterize particles and perform size analysis
2. Evaluate the power consumption for Particle size reduction and size enlargement.
3. Evaluate the constants for crushing
4. Design and operate filtration equipments
5. Analyze Solid liquid separation in industrial equipment based on settling, density and centrifugal force.
6. Evaluation of filtration effect medium and cake resistance.

List of experiments

1. Studies in an agitated vessel
2. Drag studies
3. Particle size distribution
4. Screening Efficiency
5. Determination of specific surface area by air elutriation
6. Determination of area of a thickener by batch sedimentation test
7. Size reduction using Jaw Crusher and Verification of crushing laws
8. Size reduction using Ball Mill and determination of specific surface area
9. Drop weight crushing and verification of crushing laws
10. Determination of specific cake resistance and filter medium resistance for leaf filtration
11. Determination of specific cake resistance and filter medium resistance for rotary vacuum filtration
12. Determination of specific cake resistance and filter medium resistance for filtration in a plate and frame filter press.

Text Books

1. Mccabe, W. L., Smith, J. C., and Harriott, P., Unit Operations of Chemical Engineering, McGraw Hill, New York, 6th Edition, 2004.
2. Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003.

Reference Books

1. Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., Coulson and Richardson's Chemical Engineering, Volume I, Butterworth Heinemann, Oxford, 5th Edition, 2002
2. Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., Coulson and Richardson's Chemical Engineering, Volume II, Butterworth Heinemann, Oxford, 5th Edition, 2002

18BT2035	BIOCHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. To provide the idea to determine the rates of enzyme catalyzed reactions and to provide knowledge on the immobilization of enzymes.
2. To provide knowledge regarding cell growth patterns and design of various bioreactors.
3. To study the enzyme kinetics and inhibition models

Course Outcome:

The students will be able to

1. Classify chemical and biochemical processes
2. Acquire knowledge on growth kinetics and growth inhibitor models
3. Examine various enzyme kinetics and enzyme inhibition models
4. Assess the role of aeration and agitation in fermenter design
5. Design batch and continuous sterilization Process
6. Develop various novel bioreactors

Module I CHEMICAL AND BIOCHEMICAL PROCESSES (6)

Comparison of chemical and biochemical processes, industrially important microbial strains, preservation and storage of industrially important microbes, Quality control of preserved stock cultures

Module II ENZYME KINETICS (9)

Kinetics of single substrate reactions without inhibition- Michelis – Menten parameters, Estimation of MM parameters, Enzyme Inhibition – Substrate, Product and Toxic compound inhibition, types and derivation.

Module III UNSTRUCTURED KINETIC MODELS FOR GROWTH (12)

Simple unstructured kinetic models for microbial growth, Monod model, Substrate uptake kinetics and maintenance coefficient, growth of filamentous organisms, product formation kinetics - Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Determination of kinetic parameters for monod equation

Module IV OXYGEN TRANSFER IN MICROBIAL BIOREACTORS (9)

Oxygen transfer in microbial bioreactors; oxygen uptake rates and determination of oxygen transfer coefficients (k_La) by correlations and experimental methods; Mass transfer in heterogeneous biochemical reaction system, role of aeration and agitation in oxygen transfer and types of aerators and agitators.

Module V BIOREACTORS FOR FREE AND IMMOBILIZED CELLS (5)

Bioreactors for free cells – batch, continuous, fed batch, chemostat with recycle and multi stage chemostat systems, air lift and loop reactor,

Module VI BIOREACTOR EQUIPMENT (4)

Bioreactors for immobilized cells: packed – bed, fluidized bed and hollow – fibre membrane bioreactors.

Total Hours: 45

Text books

1. Shuler M.L and Kargi F, "Bioprocess Engineering Basic Concepts" Prentice Hall of India 4th edition, 2002.

Reference books

1. Lee, J.M, "Biochemical Engineering", Prentice Hall, 2nd Edition, 2001.
2. Blanch, H.W and Clark, D.S, "Biochemical engineering", Marcel Dekker, 1997.

18BT2036	BIOCHEMICAL ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To provide the idea to determine the rates of enzyme catalyzed reactions and to provide knowledge on the immobilization of enzymes.
2. To provide knowledge regarding cell growth pattern and bioreactors.
3. To study the enzyme kinetics and inhibition models

Course Outcome:

The students will be able to

1. Classify chemical and biochemical processes
2. Acquire knowledge on growth kinetics models
3. Examine various enzyme kinetics and enzyme inhibition models
4. Assess the rate constant and Darcy's friction factor for pipeline and helical coil
5. Design batch and continuous sterilization Process
6. Develop various novel bioreactors

List of Experiments:

1. Production of citric acid
2. Comparative study between Free & Immobilized Enzyme
3. Determine the enzyme specificity using α-Amylase
4. Growth kinetics of Baker's Yeast
5. Determination of MM Parameters
6. Batch Reactor –I [Equimolar Concentration]
7. Batch Reactor – II [Non – Equimolar Concentration]
8. Semi batch Reactor
9. Mixed Flow Reactor
10. Determine the rate constant for second order reaction using Batch reactor
11. Darcy's Friction factor for straight pipe line & helical coil.
12. Determine the Thermal conductivity of Composite wall

18BT2037	CANCER BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To educate students the complexity and regulatory networks involved in cancer development process
2. To learn the mechanism involved at cellular and molecular level so as to develop new strategies of therapy.
3. To understand the current strategies of cancer detection, prevention and treatment.

Course Outcome:

Upon completion of the course, the students will be able to

1. Understand the epidemiology of carcinogenesis
2. Know different forms of cancer and the principles of their development

3. Understand the complex pathways and molecular switches involved in the transformation of a normal cell to a cancer cell.
4. Understand the regulatory imbalance between cell growth and programmed death
5. Recognize the molecular mechanism of cancer spread and its clinical implications.
6. Summarize the importance of understanding the biology of cancer, the current strategies of cancer diagnosis, prevention and treatment.

Module I: FUNDAMENTALS OF CANCER BIOLOGY (9)
Epidemiology of cancer: Environmental factors, Viruses, Life style habits - dietary factors, Mutations and DNA repair; Regulation of cell cycle , Modulation of cell cycle in cancer- pRb, p53; Forms and hallmarks of cancers.

Module II: PRINCIPLES OF CARCINOGENESIS (9)
Theory of carcinogenesis- Chemical carcinogenesis, Physical carcinogenesis; X-ray radiation- mechanisms of radiation carcinogenesis; Epigenetics of cancer.

Module III: MOLECULAR CELL BIOLOGY OF CANCER (9)
Cyclin dependent kinases; Tumor suppressor genes, Oncogenes, Virus and cancers- DNA viruses, Retroviruses; Growth factors related to transformation, Telomerases, Apoptosis – p53.

Module IV: PRINCIPLES OF CANCER METASTASIS (9)
Clinical significances of invasion - Three step theory of invasion and metastasis cascade- Role of cell adhesion molecules, Proteinases and tumour cell invasion - Angiogenesis: VEGF signaling

Module V: CANCER DETECTION TECHNIQUES (4)
Cancer screening, clinical interpretation and early detection - Detection using biochemical assays, Tumor markers; Advances in cancer detection,

Module VI: CANCER THERAPY (5)
Different forms of therapy: Chemotherapy, Radiation therapy, Immunotherapy, Molecular therapy, Use of signal targets towards therapy of cancer, Gene therapy, Cancer prevention strategies.

Total Hours: 45

Text Books
1. Stella Pelengaris, Michael Khan, The molecular Biology of Cancer, Blackwell Publishing, 1st edition, 2006.
2. Robert A. Weinberg, The Biology of Cancer, Garland Science, 2nd edition, 2014

References Books
1. Dunmock N.J and Primrose S.B, "Introduction To Modern Virology‘‘, Blackwell Scientific Publications, Oxford, 1988.
2. Franks L. M, Teich N. M, "An Introduction To Cellular and Molecular Biology of Cancer‘‘,Oxford Univ. Press,Oxford Medical Publications, 1992.
3. Macdonald F and Ford CHJ. "Molecular Biology of Cancer", Bios Scientific Publishers, 2002.
4. Robert G, Mckinnell, Ralph E. Parchment, Alan.O. Perantoni, G. Barry Pierce, "The Biological Basis of Cancer", Cambridge University Press, New York. 2003.

18BT2038	CLINICAL DATABASE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objective:
1. To learn and understand clinical data management and its role in clinical research.
2. To impart clear understanding on various essential elements of Clinical Research and Clinical Data Management.
3. To train you on different aspects and activities involved: CRF Designing, Data entry, Data Collection, AE Management, and Report Creation etc.

Course Outcome:
The students will be able to,
1. Acquire knowledge on clinical trials ,data management and preparation

2. Describe analytics and decision support, including the capabilities of dashboards and data capture tools.
3. Utilize enterprise-wide information assets in support of organizational strategies and objectives.
4. Explain concepts of database architecture and design.
5. Differentiate the roles and responsibilities of various providers and disciplines, to support documentation requirements, throughout the continuum of healthcare.
6. Validate the reliability and accuracy of secondary data sources.

Module I: INTRODUCTION OF CLINICAL TRIALS (9)

Basic statistics for clinical trials, Roles & Responsibilities of Key Stakeholders, Preparations & Planning for Clinical Trials, Essential Documentation in Clinical Research & Regulatory Submissions, Clinical Trials Project Planning & Management, Study Start Up Process, Clinical Monitoring Essentials, Compliance, Auditing & Quality Control in Clinical Research

Module II : CLINICAL DATA MANAGEMENT (9)

Introduction to Data Management, Data Definition & Types, Study Set Up, CRF Design Considerations, Data Entry, Remote Data Entry, Identifying and Managing Discrepancies, Medical Coding, Database Closure, Data Management Plan, Electronic Data Capture, Tracking CRF Data, Managing Lab Data, Collecting Adverse Event Data, Creating Reports and Transferring Data, Enterprise Clinical Data Management Tools.

Module III: CLINICAL DATA ANALYSIS AND MANAGEMENT (9)

Study set-up, Introduction to Clinical Database , Documents, guidelines used in CDM, Data Entry, Data Review/Data Validation, Query Management, Data management plan, Project management for the clinical data manager, Vendor selection and management, Data management standards in clinical research, Design and development of data collection, Edit check design principles

Module IV: CLINICAL CASE REPORT FORMS (9)

CRF Completion Guidelines, CRF printing and vendor selection, Data validation, programming and standards, Laboratory data handling, External data transfer, Patient –reported outcomes, CDM presentation at investigator meetings, Metrics for clinical trials, Systems Software Validation Issues Clinical Trials Database Environment

Module V: CLINICAL QUALITY AUDIT (4)

Audit –Definition, types & procedures, Audit standards, Audit trail & its role in authenticity of data, Audit plan, Audit by regulatory authorities,

Module VI: CLINICAL LOGISTICS AND REGULATIONS (5)

GMP, GDP & logistics, Preparing and delivering audit reports, What makes a good audit, New product development & GxP Regulations

Total Hours: 45

Text Book

1. Susanne Prokscha (2011), Practical Guide to Clinical Data Management, Third Edition, CRC Press; 3 edition (18 November 2011), ISBN -13:978-1439848296
2. Richard K Rondel (2000) Clinical Data Management, Second Edition. Wiley Publishing House. ISBN: 978-0-470-85335-1

Reference Book

1. Rondel, R.K., Varley, S.A. and Webb, C.F. eds., Clinical data management. New York: Wiley, 2000
2. Smith, Jonathan A., ed. Qualitative psychology: A practical guide to research methods. Sage, 2015.
3. Machin, D., Day, S. and Green, S. eds., Textbook of clinical trials. John Wiley & Sons, 2007.

18BT2039	CLINICAL DATABASE MANAGEMENT LAB	L 0	T 0	P 1.5	C 1.5

Co-requisite: 18BT2038- Clinical Database Management

Course Objective:

1. To understand the types of clinical data, samples, and software
2. To develop the skills to analyze the clinical trial data management
3. To develop the skills to evaluate clinical data management

Course Outcome:

1. The student shall apply medical terminology, clinical data management learnt to projects to develop databases for health care
2. The student will practice clinical data submission and interpret the clinical results
3. The student will demonstrate skills to analyze clinical data
4. The student will demonstrate skills to validate data
5. The student will develop Case Report Forms to store clinical data
6. The student will gain skillful knowledge of the management of clinical data used in clinical trials

List of experiments:

1. Contribute to the design of protocols, forms, and data collection process Queries based on Biological databases
2. comprehensive database programming
3. Create data validation checks
4. Issue and resolve data queries
5. Create and maintain data management plans
6. Full data integration (eCRF, images, laboratories, other instrumentation)
7. Manage and document study specific change control process
8. EDC and other data management systems
9. SAE reconciliation
10. Medical term coding (i.e. adverse events, medications)
11. Serious adverse Event Management
12. Data Extract and SAS Extract Locking and Freezing

18BT2040	PLANT AND ANIMAL BIOTECHNOLOGY	L 3	T 0	P 0	C 3

Course Objective:

1. To create awareness in Plant and Animal biotechnology.
2. To impart knowledge in micromanipulation techniques in cell culture.
3. To understand the principles of transgenic plants and animals.

Course Outcome:

The students will be able to

1. Acquire knowledge in plant biotechnology and its applications.
2. Gain the knowledge about to increase the production in agriculture products.
3. Prepare them to work in the Agriculture industries.
4. Understand about *In vitro* fertilization and the manipulation of embryo done for genetic screening will provide wider understating among the students and create awareness
5. Study the development of transgenic animals will make the students to know more about breed development and choosing of the breeds for milk production
6. Assess about the scope and applications in this subject

Module I PLANT CELL AND TISSUE CULTURE (4)

Plant cell and Tissue culture: Tissue Culture media, Callus and suspension culture, Somoclonal Variation,

Module II MICROPROPAGATION AND OTHER TECHNIQUES (5) Micropropagation, Organogenesis, Somatic embryogenesis, transfer and establishment of whole plants in soil, green house technology, Artificial seeds, Protoplast fusion and somatic hybridization, cybrids; anther, pollen and ovary culture for production of haploid plants.

Module II PLANT GENETIC TRANSFORMATION (9)

Plant Genetic Transformation Methods: Features of Ti and Ri Plasmids and its use as vectors,

Use of reporter genes and marker genes, gene transfer methods in plants: direct and indirect DNA transfer, Chloroplast transformation and its advantages.

Module III APPLICATION OF PLANT GENETIC TRANSFORMATION (9)

Application of Plant Genetic transformation: Herbicide resistance: Insect resistance, Disease resistance antifungal proteins, PR proteins, nematode resistance.

Module IV INTRODUCTION TO CELL CULTURE (9)

In Vitro fertilization, Embryo transfer- Micromanipulation technology, germ cell manipulation, sperm and embryo sexing

Module V TRANSGENIC ANIMALS (9)

Transgenic Animals and their significance. Ethical issues in Animal Biotechnology

Total Hours: 45

Text Books

1. Introduction. R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.
2. Animal cell culture 3rd ed., by John R.W. Masters A Practical Approach Oxford University press New York 2005
3. H.S. Chawala. Introduction to plant Biotechnology, Oxford and IBH Publishing Co. Pvt. LTD.New Delhi 2002.

Reference Books

1. Bojwani, S.S. “Plant Tissue Culture: Applications and Limitations”, Elsevier science publishers, 1990.
2. Ian Freshney, “Culture of Animal Cells”, Wiley-Liss, 5th edition, 2005
3. Grierson,D. “Plant Biotechnology in Agriculture Prospects for the 21st Century”, Academic press, 2012
4. Doyle, A.R. Hay and B.E. Kirsop, “Living Resources for bio technology”, Cambridge University press, Cambridge, 1990
5. Ed. John R.W. Masters, “Animal Cell Culture - Practical Approach”, Oxford University Press, 3rd edition, 2000.
6. Dunmock N.J and Primrose S.B., “Introduction to Modern Virology”, Blackwell Scientific Publications, 2002

18BT2041	STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. This course will take students on a journey into the stem cell biology and biotech revolution.
2. This course will provide details regarding social implications associated with stem cell technology.
3. The course offers an opportunity to understand the basics of stem cells, embryonic stem cells, adult stem cells and genetic engineering of stem cells and their applications.

Course Outcome:

1. To student gain knowledge in Stem cell basics, growing of ES cells in lab, differentiation of stem cells and application of stem cells.
2. They understand recent advancements in the biotechnological applications using both adult and embryonic stem cells.

Module I: INTRODUCTION (4)

Overview of Stem cell technology; Introduction to Cell Culture; Pros & Cons of Cell culture; Primary and Secondary cultures & Hayflicks limit, telomerase;

Module II: TECHNIQUES (5)
Aseptic Technique and Cell culture Lab equipments & etiquette.
Module III: TYPES OF STEMS CELLS (9)
Totipotency, Pleuripotency, Types of Stems Cells; Embryonic stem cells; Pleuripotent Stem Cells; Adult Stem cells; Induced Pleuripotent Stem Cells
Module IV: ISOLATION OF STEM CELLS (9)
Growth factors; chord cells; Derivation & differentiation of ES Cells; Derivation & differentiation of Pleuripotent Cells; Induced Pluripotent cell-Methods; Genetic & epigenetic reprogramming.
Module V: APPLICATIONS OF STEM CELL TECHNOLOGY (9)
Neurogenesis; Use of stem cells in Vascular biology; Use of stem cells in cardiac disease; Use of stem cells in Cancer; Stem cells of Liver, Gut and pancreas; Use of stem cells in tissue engineering & Gene therapy.
Module VI: ETHICAL CONCERNS OF STEM CELL TECHNOLOGY (9)
Problems and perspectives in stem cell technology; Alternatives to stem cells; Deeper concerns in stem cell technology-Immortality, longevity, ageing.

Total Hours: 45

Text Book
1. Handbook of Stem Cells edited by Anthony Atala, Robert Lanza. (Vol-1) Second edition. Academic press, 2013.

References Books:
1. Stem Cell Biology - edited by Daniel R Marshak, Richard L Gardener, David Gottlieab, Cold Spring Harbor Press.
2. Kursad and Turksen, “Embryonic Stem cells”, Humana Press, 2002.

18BT2042	BIOPHARMACEUTICAL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:
1. To demonstrate the basics of biopharmaceutical technology to the undergraduate students.
2. To motivate the undergraduate students in analyzing the drug metabolism and mode of action.
3. To elaborate basic of formulations of drugs and to apply them in clinical trials.

Course Outcome:
The students will be able to
1. Acquire knowledge on drug development, principles, mechanism of actions of drug.
2. Outline on preparation of biotechnology oriented pharmaceutical products.
3. Demonstrate various testing and quality assurance in drug preparation.
4. Help them to analyze the pharmaceutical products available in the market.
5. Evaluate the recent advances in drug manufacturing.
6. Relate the regulations in clinical trial and management.

Module I DRUGS (9)
Introduction - Development of Drugs and Pharmaceutical Industry. Drug Metabolism and Pharmacokinetics - Drug Metabolism – Physico-Chemical Principles –Pharmacodynamics – Action of drugs in humans.
Module II MANUFACTURING PRINCIPLES (9)
Manufacturing Principles - Compressed tablets – wet granulation, – Dry granulation – Direct compression – Tablet presses formulation – Coating – Pills – Capsules sustained, action dosage forms. Quality control tests for tablets and capsules. Packaging of solid dosage forms.
Module III FORMULATIONS (9)
Manufacturing Principles – Parental, solutions – Oral liquids – injections – Ointments. Quality control tests for semisolid and liquid dosage forms. Packaging of semisolid and liquid dosage forms.

Module IV PHARMACEUTICAL PRODUCTS – VITAMINS AND ANTISEPTICS (4)
Pharmaceutical Products - Vitamins – Cold remedies – Laxatives –Analgesics –External Antiseptics – Antacids.

Module IV ANTIBIOTICS AND rDNA PRODUCTS(5)
Antibiotics – Biologicals – Hormones. Recent advances in the manufacture of drugs using r-DNA technology.

Module V TRIALS & REGULATIONS (9)
Clinical Trials & Regulations - Clinical Trials – Design, double blind studies, placebo effects. FDA regulations (General) and Indian Drug regulations- highlight. Good Laboratory Practice, Good manufacturing practice.

Total Hours: 45

Text Books

1. DM Brahmankar, Sunil B Jaiswal, "Biopharmaceutics and Pharmacokinetics-A Treatise", Vallabh prakashan, 2005.
2. Ansel, H., Allen, L., Popovich, N, "Pharmaceutical Dosage Forms and Drug Delivery Systems", Williams & Wilkins, 1999.

Reference Books

1. Lippin cott, "Remington's Science and Practice of Pharmacy", Williams & Wilkins publishers, 2005.
2. Goodman & Gilman's, "The pharmacological basis of therapeutics" by Joel Griffith Hardman, Lee E. Limbird, Alfred G. Gilman.2005
3. Tripathi KD, "Essential of Medical pharmacology", Jaypee Brothers Medical Publishers 2003.

18BT2043	AGRICULTURAL BIOTECHNOLOGY	L 3	T 0	P 0	C 3

Course Objective:

1. To demonstrate the basics of genes, genomes and breeding principles to the undergraduate students.
2. To motivate the undergraduate students in analyzing the tools and techniques in genetic engineering .
3. To elaborate the understanding of biodiversity and IPR issues in agricultural crops.

Course Outcome:

The students will be able to

1. Acquire knowledge on gene and genome organization.
2. Outline the principles of breeding.
3. Demonstrate various tools involved in genetic engineering.
4. Illustrate the pest management strategies
5. Relate various molecular mapping techniques
6. Help them to analyze the biodiversity and IPR.

Module I GENOMES AND GENES (9)
Chromatin structure, Karyotype analysis, Genome organization – C-Value para, dox, Cot curves & significance, Chromosome behaviour

Module II AGRICULTURE AND PLANT BREEDING (9)
Breeding of crops, Heterosis , Apomixis, Mutations , Polyploidy in crop improvement, Principles of integrated Pest Management

Module III TOOLS AND TECHNIQUES OF GENETIC ENGINEERING (9)
Recombinant DNA technology, Concept of Genetic makers; gene interaction, multiple allelism, pleiotropism and multiple factor inheritance. Genetic, Chromosomal and Molecular map, Techniques in genetic engineering

Module IV BIODIVERSITY (6) Genetic diversity Molecular diversity; Species and Population biodiversity, Collection and conservation of biodiversity, endangered plants, endemism and Red Data Book, Biodiversity and centers of origins of plants; Biodiversity hot spots,

Module V INTELLECTUAL PROPERTY RIGHTS (3)

IPR in relation to Indian Flora- Basmati Rice, Turmeric and Neem

Module VI GENOME ANALYSIS (9)

Genome projects, Genome Annotation, Biological Data Bases, Data base search engines, Sequence Analysis and Molecular Phylogeny

Total Hours: 45

Text Books

1. Principles of Gene Manipulation S. B. Primorose, RM Twyman and R.W. old sixth edition (2001) Blackwell science
2. Induction of Bioinformatics – T.K. Attwood & D.J. Parry-Smith 2002, Pealson Education Singapore Pvt. Ltd Indian, Indian Branch, Delhi. ISBN 817808

Reference Book:

1. Gene Cloning and DNA analysis, an introduction, Fourth edition TA Brown (2001) Blackwell science.
2. From Genes to clones, Introduction to gene Technology. (Erist L innacker (2003) Panima Publishing Corporation.
3. Kothari, A., 1997: "Understanding Biodiversity Life sustainability and Equity Orient".
4. Lewin's Genes XII Hardcover – (2017) by Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick

18BT2044	METABOLIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. To develop skills of the students in the area of metabolic engineering to alter the existing metabolic pathway
2. To introduce novel metabolic pathways in microorganisms using r-DNA technology
3. To learn molecular techniques in order to enhance the product yield

Course Outcome:

1. Ability to integrate modern biology with engineering principles
2. Acquire knowledge on the principles and regulation of metabolic pathways
3. Analyze different methods to obtain improved production strains
4. Categorize the synthesis of primary and secondary metabolites and bioconversion process
5. Practical applications of metabolic engineering in chemical, medical, and environmental fields
6. Develop a good appreciation of the multidisciplinary aspects of biotechnology

Module I: BASICS IN METABOLIC FLUX ANALYSIS (9)

Analysis of metabolic control in glycolysis, metabolic flux analysis and its applications in aminoacid production by glutamic acid bacterium

Module II: REGULATION OF PRIMARY METABOLIC PATHWAYS (9)

Feedback control systems, alteration of feedback regulation for enhanced production of primary metabolites: glutamic acid, Mutants which do not produce feedback inhibitors or repressors- auxotrophs-lysine, isoleucine, arginine, purine nucleotides.

Module III: REGULATION OF SECONDARY METABOLIC PATHWAYS (9)

Producers of secondary metabolites, Precursor effects, trophophase- idiophase relationship, applications of secondary metabolites

Module IV: IMPROVED PRODUCTION OF SECONDARY METABOLITES (9)

Antibiotics, vitamins, Mycotoxins- maintenance of genetic stability; Bioconversions

Module V: APPLICATIONS OF METABOLIC ENGINEERING (5) Product over production examples: amino acids, polyhydroxyalkanoic acids, By-product minimization of acetate in recombinant *E.*

coli, Extension of substrate utilization range for organisms such as *S. cerevisae* and *Z. mobilis* for ethanol production,

Module VI: CELL METABOLIC ENGINEERING (4)

Improvement of cellular properties, Altering transport of nutrients including carbon and nitrogen

Total Hours: 45

Textbooks

1. Gregory N. Stephanopoulos, Aristos A. Aristidou & Jens Nielsen, "Metabolic Engineering: Principles and Methodologies", Academic Press, An Imprint of Elsevier India Pvt.Ltd., 1st edition, 1998.
2. S. Cortassa, M.A.Aon, A.A.Iglesias and D.Llyod, " An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Co. Pte. Ltd, 2002.

Reference Books

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005
2. W.Crueger and A. Crueger, "A Text Book of Industrial Microbiology", Panima Publishing Corporation, 2005
3. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.

18BT2045	RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To intend the students with the knowledge about the basic research methods, applications in conducting research, various data collection and analysis techniques.
2. To gain insights into scientific research.
3. To help in critical review of literature and assessing the research trends, quality and extension potential of research and equip students to undertake research.

Course Outcome:

1. To understand the basic principles of research
2. Illustrate the different methods of sample design
3. Classify the various techniques of data collection and analysis
4. Elaborate the steps involved in thesis and report writing
5. Analyze the importance of biosafety in research
6. Evaluate the importance of ethics in research

Module I: RESEARCH PROBLEMS (5)

Definition and characteristics of research, Basic Concepts- Validity, reliability, Variables- Dependent, Independent and Intervening, Types-Basic and applied- Interdisciplinary - formulation of research problem,

Module II: RESEARCH DESIGN AND EXPERIMENTAL DESIGN (4)

research design -Hypothesis: formulation- Types: Descriptive,relational and explanatory- Methods of Research: descriptive, comparative, experimental- clinical research- controlled clinical trials

Module III: SAMPLE DESIGN, MEASUREMENT AND SCALING TECHNIQUES (9)

Steps in sample design, Criteria for selecting a sample procedure, Characteristics of Good sampling Procedure, Types of Sample Design, Selecting Random Samples, Complex random sampling Design, Measurement Scales, Sources of Errors in measurement, Tests of Second measurement, Technique of developing Measurement Tools, Scaling-Classification and design.

Module IV: COLLECTION, PROCESSING AND ANALYSIS OF DATA (9)

Data collection: methods and types- Processing Operations-Editing, coding, tabulation, Data Analysis, Statistics in Research, Measures of Central Tendency, Dispersion, Asymmetry, relationship. Regression Analysis, Correlation Analysis, Software for statistical analysis- SPSS- features

Module V: MANUSCRIPT/THESIS WRITING (9)
Research report - Types of Research reports, steps of manuscript, thesis and review of literature, Literature citation, Impact factor of journals, Citation index of journals, H-factor, Bibliography and References, Methods of presentation of report, significance of report writing
Module VI: ETHICS AND BIOSAFETY (9)
Introduction- Scientific conduct and misconduct – Authorship issues- basic principles of human and animal research ethics- international regulation- Laboratory safety, biosafety, recombinant material safety, Standard operation protocol

Total Hours: 45

Text Book

1. C.R. Kothari, "Research methodology, Methods and techniques", New Age International (P) Ltd, Publishers, 2nd edition, 2000.

Reference Books

1. Jerrod H. Zar, "Biostatistical analysis", Prentice Hall International, Inc. Press, 1999.
2. Donald H. McBurney, "Research methods", Thomson Asia Pvt. Ltd. 2002
3. Ranjit Kumar, "Research methodology", Sage Publications, London, 2006.
4. Raymond – Alain, "Doing Management research", Sage publications, 2001.

18BT2046	MOLECULAR FORENSICS	L	T	P	C
		3	0	0	3

Course Objective:

1. The molecular forensics provides students with experiences and information that will broaden their understanding of the field of Forensic Science and crime scene investigations.
2. To ensure students in having foundation Forensics and molecular techniques in forensics.
3. A concurrent goal of the subject is to develop observational, organizational and cognitive skills so to be able to integrate their experiences and knowledge so to solve problems.

Course Outcome:

1. The student will understand the history and current state of forensic biological testing and the role of a forensic biologist in a forensic investigation
2. The student will learn the proper methods for the handling of biological evidence.
3. The students understand the application of molecular based techniques in forensics science.
4. The students learn the methods used to identify suspects and parental disputes.
5. The students will gain knowledge in paleo biology and anthropology and its importance in Forensics
6. The student will observe the case studies and will understand the complete details of investigation.

Module I: INTRODUCTION TO FORENSIC SCIENCE (9)
Introduction to Crime Laboratories, Responsibilities of the Forensic Scientist, Securing and Searching the Crime Scene, Recording and Collection of Crime Scene Evidence,Document Examination, Ethics and Integrity
Module II DISCOVERY AND RECOVERY OF HUMAN REMAINS (9)
The Autopsy and Handling of a Dead Body, The Stages and Factors of Decomposition, Determining the Age and Provenance of Remains, Asphyxia, Gunshot Wounds, Bite Marks
Module III PATTERN ANALYSIS (9)
Human Tissues, Body Fluids and Waste Products, Fingerprints, Hair, Teeth, Blood, Detecting the Presence of Blood, Bloodstain Pattern Analysis , Forensic anthropology, Paleontology, Toxicology
Module IV FINGER PRINTING (5)
Mitochondrial, DNA, DNA Finger Printing- RFLP. STR Genotyping issues, VNTRS and STR, mt DNA analysis, Identification of suspects.
Module V RAPD IN FORENSICS (4)
RAPD in Forensics, Study of Kinnship by DNA Profilig.

Module VI FORENSIC CASE STUDIES (9)

Forensic Case studies by molecular identification, PCR directed Y chromosome sequences, PCR Amelogenein Gene, Types of sequencing; forensic significance of polymorphic enzymes, forensics in paternity disputes.

Text Book

1. Lincoln PJ & Thomson J, "Forensic DNA Profiling Protocols", Humana Press. 2011.

References Book

1. Rudin N & Inman K. "An Introduction to Forensic DNA Analysis", 2nd Ed. CRC Press. 2002.

18BT2047	PROTEIN ENGINEERING	L	T	P	C
		3	0	0	3

Course objectives

1. To ensure the strong knowledge in protein architecture through a detailed study of protein structure.
2. To realize the structure-functional relationships of proteins
3. To impart advance knowledge the characteristic properties of proteins and their significance in biological systems

Course Outcome:

1. To analyze the various interactions in protein makeup.
2. To be familiar with different levels of protein structure.
3. To gain knowledge in analyzing the protein structures at various levels
4. To know the role of functional proteins in various field of study.
5. To apply the knowledge in improving the functions of proteins
6. To practice the latest application of protein science in their research.

Module-I BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS (9)

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure. Amino acids (three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

Module II PROTEIN ARCHITECTURE (9)

Primary structure: peptide mapping, peptide sequencing – automated Edman method & mass- spec. High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turnalpha, beta-turn- beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds.

Module III TERTIARY STRUCTURE (9)

Prediction of substrate binding sites, Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures. Quaternary structure: Modular nature, formation of complexes, protein-protein interactions and methods to study it

Module IV STRUCTURE-FUNCTION RELATIONSHIPS (4)

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers, Membrane proteins: General characteristics, Trans-membrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center

Module V IMMUNOGLOBULINS AND ENZYMES (5)

Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications

Module VI PROTEIN ENGINEERING AND PROTEIN DESIGN (9) Protein data base analysis– methods to alter primary structure of proteins –Examples of engineered proteins –Protein design, principles and examples. Methods in Proteins engineering; Immunotoxins; mechanism and its applications; Drug designing; structure based approach, receptor based approach.

Total Hours: 45

Text Books

1. Branden C. and Tooze J., "Introduction to Protein Structure", 2nd Edition, Garlan Publishing, 1999.
2. Creighton T.E. "Proteins: Structures and Molecular properties", 2nd Edition. W.H. Freeman, 1992.

References Books

1. Kristian M. Müller and Katja M. Arndt―Protein Engineering Protocols;, Third Edn. Humana Press, 2007
2. Gregory A. Petsko and Dagmar Ringe―Protein Structure and Function, First Edition, Oxford University Press USA, 2003
3. Moody PCE, and AJ Wilkinson, Protein Engineering, IRL Press, Oxford. 1990

18BT2048	PLANT TISSUE CULTURE	L	T	P	C
		3	0	0	3

Course Objective:

1. To create awareness in plant biotechnology.
2. To impart knowledge in micromanipulation techniques in cell culture.
3. To understand the principles of transgenic plants.

Course Outcome:

The students will be able to

1. Acquire knowledge in cell and tissue culture techniques.
2. Gain the knowledge about to plant genetic engineering tools.
3. Learn the various applications of plant tissue culture.
4. Understand the molecular concepts of disease resistance factors in plants.
5. Study the development of transgenic plants on abiotic and biotic factors
6. Assess about the scope and applications in plant biotechnology

Module I CELL AND TISSUE CULTURE (9)

Definition and need; Types of Methods in plant Biotechnology; Cell and Tissue Culture; Micro propagation; Callus Culture; Somatic Embryogenesis; Hairy Root Culture; Culture Medias.

Module II PLANT GENETIC ENGINEERING TOOLS (9)

Vectors and Genetic Engineering; Agro bacterium mediated gene transfer and cloning; Agro bacterium types; Plant viruses and Genetic Engineered viruses as a tool of deliver foreign DNA; major plant viruses, Camv, TMV, BBTV, Gemim viruses etc.

Module III APPLICATION OF PLANT BIOTECHNOLOGY (9)

Hairy Root Cultures and Secondary Metabolite production; Plant as Bioreactors- edible Vaccines; Germplasm conservation; Gene Banks; Crop improvement; legume symbiosis, N_2 Fixation; Regulation of NIF and NOD Genes.

Module IV MOLECULAR ASPECTS OF DISEASE SUSCEPTIBILITY AND RESISTANCE (9)

Transposable elements, factors influencing disease resistance and susceptibility RFLP

Module V: **TRANSGENICS – ABIOTIC FACTORS (4)**

Stress tolerance-Biotic and abiotic temperature, salinity, drought etc;

Module VI: **TRANSGENICS – BIOTIC FACTORS (5)**

Pests and insects resistance- viral resistance- development of disease resistance plants by introducing *Bacillus thuringiensis* genes.

Total Hours: 45

Text Books

1. Mantal S.H., Mathew J.A.,Mickee R.A., Principles of Plant Biotechnology. An Introduction to Genetic Engineering in Plants, Blackwell Scientific Publication, 1985.

2. Marx J.L., Revolution in Biotechnology, Cambridge University Press, 1989.

Reference Books

1. Dodds J.H., Plant Genetic Engineering, Cambridge University Press, 1985.
2. Grieson, Plant Biotechnology.
3. Glick and Pasternak, Molecular Biotechnology.
4. R.K.Gupta., Introduction to Biotechnology.
5. R.C. Dubay and Maheswari. Introduction to Microbiology, 2002, S.CHAND.
6. Walker and Raplery, Molecular Biology and Biotechnology, Panima.2003.

18BT2049	ANIMAL BIOTECHNOLOGY AND CELL CULTURE	L	T	P	C
		3	0	0	3

Course Objective:

1. To develop skills of the students in the area of animal biotechnology
2. To learn the protocols involved in cell culture techniques
3. To understand the applications in Cell culture and Tissue engineering

Course Outcome:

The students will be able to

1. Acquire knowledge in primary cell culture techniques, maintenance of cell line
2. Understanding the use of scaling up of cell culture and the production of products from cell cultures
3. Gaining knowledge in the latest field of Tissue engineering and to culture cells in 3D methods and its applications
4. Understand about *In vitro* fertilization and the manipulation of embryo done for genetic screening will provide wider understating among the students and create awareness
5. Study the development of transgenic animals will make the students to know more about breed development and choosing of the breeds for milk production
6. Assess about the scope and applications in this subject

Module I INTRODUCTION TO CELL CULTURE (9)

Layout of cell culture laboratory chemically defined and serum free media. Primary cell culture, Establishment of cell line, Maintenance and Preservation of cell line.

Module II SCALING UP OF CELL CULTURES (9)

Suspension cultures, Continuous flow cultures, Immobilized cultures, Cell culture as a source of various products – Vaccine Production

Module III TISSUE ENGINEERING (9)

3D culturing, Different stages of tissue engineering, Protocols for 3D culturing of cells, Different types of cells in matrices for tissue engineering.

Module IV MICROMANIPULATION OF EMBRYOS (9)

Micromanipulation technology, Enrichment of X and Y bearing sperms from semen samples of animals: Artificial insemination and germ cell manipulation, *In Vitro* fertilization and Embryo transfer technology.

Module V: TRANSGENIC ANIMALS (5)

Concepts of Transgenic Animal technology: Stratergies for the production of Transgenic animals and their importance in Biotechnology,

Module VI: STEM CELL TECHNOLOGY AND ETHICS (4)

Stem cell cultures in the production of Transgenic animals, Ethical issues in Animal Biotechnology

Total Hours: 45

Text Books

1. R. *Ian Freshney*. *Introduction to Culture* of Animal *Cells*: A Manual of Basic Technique and Specialized Applications, Sixth Edition. *Publisher*, John Wiley & Sons, 2011.
2. Animal cell culture 3rd ed., by John R.W. Masters A Practical Approach Oxford University press New York 2005

Reference Books

1. Ramadass P, Meera Rani S. “Text Book of Animal Biotechnology”, Akshara Printers, 2000.
2. Ranga M.M. “Animal Biotechnology”, Agrobios India Limited, 2002
3. Methods in Biotechnology, Animal cell Biotechnology. Methods and Protocols. 2nd Ed., Edited by Rolf Portner. Humana Press. 2007.

18BT2050	PLANT AND ANIMAL TISSUE CULTURE LAB	L	T	P	C
		0	0	1.5	1.5

Course Objective:
1. To learn the basic techniques of animal cell culture
2. To impart the technical skills of plant tissue culture
3. To develop the knowledge of preservation and conservation techniques in cell culture

Course Outcome:

The students will be able to
1. Gain knowledge in Animal cell culture technique
2. Understand the sterilization techniques and its importance
3. Analyze and determine the growth of cells in *In vitro* conditions
4. Evaluate the viability cells in animal cell culture
5. Apply the propagation methods for commercially important plants
6. Understand various in vitro techniques in animal and plant cell culture system

List of Experiments
1. Basics of tissue culture laboratory design and maintenance.
2. Packing and Sterilization of glass and plastic wares for cell culture.
3. Preparation of reagents and media for Animal cell culture.
4. Quantification and cell viability test using Tryphan blue.
5. Culturing of Spleenocytes from Spleen.
6. Isolation and culturing of Thymus cells.
7. Introduction to Plant Cell & tissue Culture.
8. Types of Sterilization in Plant Tissue Culture
9. Preparation and sterilization of different culture media.
10. Sterilization and inoculation of explants for micropropagation.
11. Sterilization and inoculation of explants for callus culture.
12. Preparation of synthetic seeds.

18BT2051	ROLE OF BIOTECHNOLOGY IN ENVIRONMENT	L	T	P	C
		3	0	0	3

Course Objective:
1. To learn the importance of biotechnology
2. To learn the importance of environment
3. To understand the significance of conservation

Course Outcome:

The students will be able to
1. Acquire knowledge on the scope of biotechnology
2. Dramatize the health hazards of various pollutants
3. Explain the importance of waste water treatment
4. Understand the significance of waste management
5. Outline the various bioremediation techniques
6. Dramatize the conservation of biodiversity

Module I SCOPE OF ENVIRONMENTAL BIOTECHNOLOGY (9) Environmental Pollution; Types, Causes and Effects of Soil, air, water, oil and heavy metal. Pollution, control measures. Social

Issues- Green House Gases, Global Warming, Acid Rain, Ozone depletion, nuclear accidents and holocaust.

Module II INDUSTRIAL WASTE WATER MANAGEMENT (9)

Purification of waste water; Aerobic and anaerobic treatments; Management of radioactive pollutants in water, VOC, COD BOD and BOD sensors.

Module III BIOMASS, ENERGY AND SOLID WASTE MANAGEMENT (9)

Biomass waste as renewable source of energy; Methods of energy production; Conversion of Solid Waste to Methane; Biogas production; Biofuels, Management of Sludge and Solid waste treatment- Land filling, lagooning, Composting and Vermi Composting.

Module IV BIODIVERSITY TYPES (5)

Definition, Types, Genetic, Species, Ecosystem; Biodiversity at Global Levels; Values of Biodiversity; Hotspots in Biodiversity; Loss of Biodiversity and its causes threats to Biodiversity;

Module V BIODIVERSITY CONSERVATION (4)

Biodiversity and its Conservation- In situ and Ex situ

Module VI BIOREMEDIATION AND BIODEGRADATION (9)

Types- Ex situ and In situ Bioremediation; genetically Engineered Microbes for Bioremediation.

Total Hours: 45

Text Book:

1. Dubey, R.C. “Text Book of Biotechnology”, S. Chand & Co, 2nd edition, 2004.
2. Chatterjee, Introduction to Environmental Biotechnology, PHI Learning pvt ltd,3rd Edition 2011
3. Indu Shekhar Thakur Environmental Biotechnology: Basic Concepts and Applications, IK International Publishing House pvt Ltd, 2011

Reference Books

1. Foster C.F; Johnware D.A, “Environmental Biotechnlogy”, Ellis Harwood Ltd.3rd edition, 1987
2. Gupta P.K. “Elements of Biotechnology”, Rastogi Publications, 2004.

18BT2052	INDUSTRIAL POLLUTION CONTROL	L	T	P	C
		3	0	0	3

Course Objective:

1. To give an exposure to various control acts
2. To study the advantages and disadvantages of impact assessment methods
3. To study the methods of reducing the waste and reusing it.

Course Outcome:

The students will be able to

1. Gain basic knowledge on pollution, its types
2. Summarize Pollution control acts and regulations.
3. Employ preparation EIA report
4. Evaluate audit reports on pollution is finally controlled.
5. Understand the methods of material reuse
6. Understand recycling methods

Module I: PREVENTION AND CONTROL OF WATER POLLUTION (9)

The water (prevention and control of pollution) act 1974 and rules 1975- definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous. Prevention and control of water pollution.

Module II: PREVENTION AND CONTROL OF AIR POLLUTION (9)

The air (prevention and control of pollution) act 1981 and rules 1982,definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous National ambient air quality standards.

Module III: ENVIRONMENT PROTECTION ACT (9) The environment (protection) act 1986,rules 1986-definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous, standards of emission or discharge of environmental pollutants.

Module IV: ENVIRONMENTAL IMPACT ASSESSMENT (4)
Environmental impact assessment notification,2006-environmental clearance, list of projects, form I, general structure of EIA documents, content of summary EIA,
Module V: PLASTIC USAGE RULES (5)
The plastics manufacture, sale and usage rules,1999-definations,restriction on manufacture, sale.
Module VI: RECYLCED PLASTICS (4)
Distribution and use of virgin and recycled plastics carry bag and recycled plastic containers.

Total Hours: 45

Text book:

1. C. S. Rao Environmental Pollution Control Engineering, New Age International, 2007

Reference Books

1. Peter Wathern, "Environmental Impact Assessment theory and practice", Unwin Hyman Ltd. Routledge, 1990.
2. L. Lee Harrison , "Environmental Health and Safety Auditing Handbook", 2nd edition, McGraw Hill, Inc., New York, 1995.
3. Kirkwood, R. C. and Longley, A. J., "Clean Technology and Environment", Chapman & Hall, 1995.

18BT2053	BIOMASS & BIOENERGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To provide a understanding of various renewable feedstocks of importance to undergraduate students
2. To provide a understanding on the concept of biofuel production from biomass and other agri-residues

Course Outcome:
The students will be able to

1. Understand the fundamental principles
2. Know principles underlying the design and operation of waste and biomass to energy
3. Be aware of the techniques and limitations of Biomass preprocessing
4. Be able to compare Biomass conversion processes
5. Be familiar with current research issues in biodiesel production
6. To be familiar with the Environmental impacts of biofueld

Module I ENERGY (9)
Current energy consumption, Energy sources, overview of biofuel/bioenergy, concepts in understanding biofuel/bioenergy production, Renewable feedstocks
Module II BIOMASS (9)
Biomass preprocessing: drying, size reduction, and densification , Various biofuels/bioenergy from biomass
Module III BIOCONVERSION PROCESS (9)
Biomass conversion: gasification, anaerobic digestion, Biochemical conversion to ethanol, enzyme hydrolysis
Module IV BIODIESEL (9)
Carbon capture and sequestration, Biodiesel production from oil seeds, Environmental impacts of biofuel production
Module V WASTE AND ENERGY (5)
Waste composition/arisings: municipal waste, clinical waste, sewage sludge, agricultural waste, Waste & biomass materials handling.
Module VI POLICIES AND LEGISLATION(4)
Pollutants arising from waste/biomass to energy plants, Energy from waste/biomass, policies & legislation

Total Hours: 45

Text Book

1. Robert C. Brown, Biorenewable Resources**:** Engineering New Products from Agriculture.. Wiley-Black well Publishing , 2003.

18BT2054	ENVIRONMENTAL BIOTECHNOLOGY	L 3	T 0	P 0	C 3

Course Objective:

1. To acquire the knowledge of environmental problems and develop technologies
2. To develop skills in bioreactors and biotreatment methods of industrial wastewater
3. To find solution to create green and clean environment

Course Outcome:

1. Learn an awareness of professional responsibility towards protecting the environment.
2. Acquaint oneself with the pertinent legislation and methodology.
3. Study environmental issues involved engineering and resources projects.
4. Acquire the natural and engineered biotreatment methods to remediate the pollutants
5. Investigate the opportunities for incorporating environmental quality into products, processes and projects.
6. Develop novel technologies for bioremediation of environmental pollution

Module I: WATER QUALITY AND WATER TREATMENT (9)

Environmental monitoring – sampling, physical,chemical and biological analysis, Water purification processes in natural and engineered systems – coagulation, flocculation, UV radiation, electrodialysis, Reverse osmosis and capacitance deionizer (CDi). Treatment of groundwater for hardness removal by chemical means and ion exchange. Removal of toxicants from contaminated groundwater by adsorption techniques.

Module II: WASTEWATER TREATMENT (9)

Characteristics of wastewater, Primary treatment by sedimentation, Secondary treatment by suspended growth reactors - Activated sludge process, Aerobic – digestion, Anaerobic processes and Lagoons. Attached growth reactors - Trickling filter, Rotating Biological Contactor, Fluidized bed biological reactors, Upflow anaerobic sludge blanket reactor and Sequential batch reactor. Tertiary treatment: Removal of nitrogen and phosphorus. Polishing operations: Sand filtration, adsorption by activated carbon and chlorination. Treatment of wastewater from dye, food and pharmaceutical industries.

Module III: AIR POLLUTION AND CONTROL TECHNOLOGY (9)

Air Quality: Definitions, Characteristics and Perspectives; Classification of pollutants, Effects of air pollution, Control devices for particulate and gaseous contaminants: Settling chambers, Cyclone separator, Venturi scrubber, Biofiltration, Fabric filters, Electrostatic precipitators, absorption, adsorption, condensation and flaring; Legal and administrative systems for air pollution control.

Module IV: SOLID WASTE TREATMENT AND MANAGEMENT (9)

Types, sources and properties of solid waste, Collection of solid wastes, Transfer and transport, solid waste treatment methods: incineration, composting, land filling ,conversion of solid waste into useful products: Land farming, prepared beds, soil piles, bioventing and biosparging, Reuse, Recycle and Recovering (3Rs), Legal and administrative systems for waste control.

Module V: HAZARDOUS WASTE TREATMENT AND MANAGEMENT (6)

Types of hazardous waste, Xenobiotic compounds, recalcitrance, biodegradation of xenobiotics and oil spills, biological detoxification.

Module VI: BIOWASTE MANAGEMENT (3)

Overview of biodegradable and ecofriendly products.

Total Hours: 45

Text Books

1. Jogdand, S.N. Environmental Biotechnology (2012) Himalaya Publishing House, New Delhi.
2. Prescott, Harley and Klein, “Microbiology”, 5th edition, McGraw Hill, 2014.

Reference Books

1. Karnely D. Chakrabarty K. Ovnen G.S. Biotechnology and Biodegradation, Advances in Applied Biotechnology series, Vol. Gulf Publications Co. London, 2009.
2. Graty. C.P.L., Daigger, G and Lim, H.C, Biological Wastewater Treatment. 3rd Edition, Marcel Dekker, 2008
3. Piasecki, B.W., Fletcher, K. A. and Mendelson, F. J. (2010). Environmental Management and Business Strategy John Wiley & Sons.

18BT2055	MATLAB PROGRAMMING	L 3	T 0	P 0	C 3

Course Objective:

1. To ensure students to having strong foundation in matlab installation, configuration and basic syntax.
2. To introduce them to various string operations, functions and advanced matlab modules for plotting and graphics.
3. To understand the applications of Matlab modules for various biological applications.

Course Outcome:

1. Acquire knowledge on installation, configuration and environmental setup of Matlab and Matlab modules, which help them to understand the customization of any matlab modules.
2. Acquire knowledge on basic syntax and fundamentals of matlab, which help them to understand structure of matlab program and to apply in scripting.
3. Acquire knowledge on data types, operators and control structures, which aids them define data and operate on data.
4. Ability to plot and generate different types of graphs for any given experimental data.
5. Ability to import and export data from matlab to external environments.
6. Proficient in various biological applications such as sequence processing, retrieval, and sequence analysis.

Module-I FUNDAMENTALS (9)

Matlab Local Environment Setup - Set up GNU Octave, Basic Syntax - Commonly used Operators and Special Characters, Variables, Naming Variables, Multiple Assignments - Long Assignments, Creating Vectors - Creating Matrices.

Module-II MATLAB COMMANDS (9)

Commands for Managing a Session - Commands for Working with the System-Input and Output Commands-Vector, Matrix and Array Commands - Plotting Commands, M-Files - Creating and Running Script File.

Module-III DATA TYPES,OPERATORS (4)

Data Types Available in MATLAB - Data Type Conversion - Determination of Data Types, Operators,

Module-IV CONTROL STRUCTURES (5)

Control structures - Decision Making, Loops - Loop Control Statements.

Module-V ADVANCED MATLAB (9)

Strings, Functions - Primary and Sub-Functions, Nested Functions, Private Functions, Global Variables,Data import, Data output, Matlab Plotting, Matlab Graphics.

Module-VI MATLAB FOR BIOLOGICAL APPLICATIONS (9)

Processing biological sequences with MATLAB modules – Sequence acquisition, Operations on nucleotide sequences, Joining sequences, Restriction site detection, Information retrieval from biological databases.

Total Hours: 45

Text Books

1. Amos Gilat “Matlab an introduction with applications ”, Wiley, 2004.
2. Gautam B. Singh “Fundamentals of Bioinformatics and Computaional Biology”, Springer, 2015.

References Books

1. Stephen J. Chapman, “Essentials of MATLAB Programming”, CL Engineering, Second Edition, 2008.
2. William J. Palm III, “Introduction to MATLAB for Engineers”, McGraw-Hill Education, 2010.
3. Rafael E. Banchs, “Text Mining with MATLAB ”, Springer, 2012.

18BT2056	FUNDAMENTALS OF BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Objective:

1. To ensure students to having strong foundation in structure, composition and function of various biomolecules.
2. To introduce them to the basic nature and properties of nucleic acids
3. To understand the significance of these biomolecules

Course Outcome:

The students will be able to

1. Acquire knowledge on structure, properties and biological functions of Primary metabolites which help them to understand the significance of biomolecules
2. Acquire knowledge on nucleic acids structure
3. Assess the significance of vitamins and minerals
4. Relate biomolecules with the biomedical significance
5. Justify the clinical and biological significance of these biomolecules
6. Understand the conjugates of different biomolecules and their importance

Module-I CARBOHYDRATES (9)

Classification, structure, properties and functions of carbohydrates: Monosaccharides –classes, examples, Disaccharides – classes- homo and hetero, examples. Oligosaccharides-examples; Polysaccharide – classes and examples

Module-II FATTY ACIDS (9)

Fatty acids- basic structure, types, isomers, properties, functions and essential fatty acids; Classes, structure, properties and functions of lipids: Simple lipid- examples, Compound lipid- examples, ether lipid, Derived lipid – sterols like cholesterol, clinical significance of fatty acids and lipids –examples.

Module-III AMINO ACIDS (9)

Amino acids- basic structure, isomers, classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides –examples; Proteins- structure / conformation levels, Ramachandran plot, classification, properties and functions of proteins-

Module-IV NUCLEOTIDES (9)

Nucleotides- composition, structure, properties and functions; Nucleic acids- types (RNA, DNA), DNA structure-composition, stabilizing bonds, protein –DNA interactions; RNA types, structure and functions; properties of nucleic acids

Module-V VITAMINS (5)

Vitamins: classification, source, daily requirement, functions and deficiency symptoms, review on nutraceuticals and Vitamin supplementations;

Module-VI MINERALS (4)

Minerals: classification, specific function and deficiency disorders.

Total Hours: 45

Text Books

1. Lehninger, A.L, Nelson D.L and Cox, M.M, “Principles of Biochemistry”, Freeman Publishers, New York, 4^{th} edition, 2005.

Reference Books

1. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 2008.
2. Lubert Stryer, “Biochemistry”, WH Freeman & Co., 4^{th} edition, 2000.

2. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.
3. Jain and Jain "Biochemistry", Chand publication, 4th edition, 2008.

18BT2057	PATHOLOGY AND MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course objectives:

1. Gain knowledge on the structural and functional aspects of living organisms
2. To understand the properties of antigens and antibodies and the concept of antigen-antibody interactions
3. To understand the morphological characteristics and cultivation of bacteria

Course outcome:

1. Acquire the knowledge of concepts of cell injury, neoplasia and changes produced thereby in different tissues and organs
2. Understand in brief, about the hematological diseases and investigations necessary to diagnose them
3. Demonstrate various antigen-antibody interactions and techniques
4. Evaluate the working principle of microscope in diagnosis of infectious and non-infectious diseases
5. Recognize the fundamental concepts in the structure and functioning of a cell
6. Acquire knowledge of common immunological techniques for disease diagnosis

Module I CELL INJURY, INFLAMMATION AND REPAIR (9)

Cell injury: Causes and Mechanism: Ischemic, Toxic. Reversible cell injury: Types, morphology: Swelling, vacuolation, hyaline, fatty change. Irreversible cell injury: Types of Necrosis. Calcification: Dystrophic and Metastatic. Amyloidosis: classification, Pathogenesis, Morphology. Acute inflammation: Inflammatory cells and Mediators, Chronic inflammation: Causes, types, nonspecific and Granulomatous with examples, wound healing by primary and secondary union, healing at specific sites including bone healing

Module II NEOPLASIA AND IMMUNOPATHOLOGY (9)

Atrophy, Hypertrophy, Hyperplasia, Hypoplasia, Metaplasia, Malformation, Agenesis, Dysplasia. Neoplasia: Classification, Histogenesis, Biologic Behaviour: Benign and Malignant; Carcinoma and Sarcoma. Malignant Neoplasia: Grades and Stages, Local and distant spread. Carcinogenesis, Tumor immunology. Laboratory diagnosis: Cytology, Biopsy, Tumor markers Immune system: organisation, cells, antibodies and regulation of immune responses. Hypersensitivity, Antibody and cell mediated tissue injury: Primary immunodeficiency, Secondary Immunodeficiency: Auto-immune disorders like systemic lupus erythematosis.

Module III PRINCIPLES OF MICROBIOLOGY (9)

Commensal and pathogenic microbial flora of human body, host-microbe interactions, routes of transmission of microbes in the body, mode of action of anti microbial agents, antimicrobial susceptibility test, nosocomial infections, post operative infections

Module IV MORPHOLOGY AND STERILIZATION (9)

Morphological features and structural organization of bacteria, growth curve, identification of bacteria – staining techniques, Gram positive and Gram negative cell wall, culture media and its types, culture techniques and observation of culture, control of microorganisms.

Module V INFECTIOUS DISEASES (5)

Mycobacterial Diseases: Tuberculosis and Leprosy. Bacterial diseases: Pyogenic, Typhoid, Diphtheria, Gram negative infection, Bacillary dysentery, Syphilis. Viral: Polio, Herpes, Rabies, Measles; Rickettsial, Chlamydial infection.Fungal diseases and opportunistic infections.

Module VI PARASITIC DISEASES (4)

Parasitic Diseases: Malaria, Filaria, Amebiasis, Kala-azar, Cysticercosis, Hydatid. AIDS: Aetiology, modes of transmission, diagnostic procedures and handling of infected material and health education.

Total Hours: 45

Textbooks:

1. Ramzi S Cotran, Vinay Kumar and Stanley L Robbins, “Pathologic Basis of Diseases”, 7th edition, WB Saunders Co. 2010.
2. Dubey RC and Maheswari DK. “A Text Book of Microbiology” Chand & Company Ltd, 2014.

Reference books:

1. Prescott, Harley and Klein, “Microbiology”, 8th edition, McGraw Hill, 2013.
2. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 5rd edition, 2010.
3. Ananthanarayanan and Panicker, “Microbiology” Orientblackswan, 2015.

18BT2058	HUMAN ANATOMY AND PHYSIOLOGY	L	T	P	C
		3	0	0	3

Course objective:

1. To explain the basics on the structure animal cell and organs
2. To illustrate the different systems of the body and their functioning
3. To demonstrate the fundamentals in human anatomy and physiology

Course Outcome:

The students will be able to

1. To give outline on animal cells, their functions and membrane transportation of cells.
2. To explain the composition of blood and its function on maintaining homeostasis.
3. To demonstrate the components of respiratory and cardiovascular systems.
4. To describe briefly about the anatomical locations, structures and their physiological functions of respiratory and cardiovascular systems.
5. To illustrate the structure and functions of nervous system and parts of brain.
6. To explain about the structure of eye, ear and kidney and their functions.

Module I CELL (9)

structure and organelles, function of each component. Cell membrane, transport across membrane, origin of cell membrane potential (Nernst and Goldman and Katz equations), action potential.

Module II: BLOOD COMPOSITION (9)

Functions of blood, functions of RBC. WBC types and their functions, blood groups, importance of blood groups, identification of blood groups, blood flows factors regulating blood flow such as viscosity, radius, density etc.

Module III COMPONENTS OF RESPIRATORY SYSTEM (3)

Oxygen and carbon di oxide transport and acid base regulation

Module IV HEART AND ITS REGULATION (6)

structure of Heart, properties of cardiac muscle, cardiac muscle and pace maker potential, cardiac cycle, ECG, Heart sound, volume and pressure changes and regulation of heart rate.

Module IV STRUCTURE OF A NEURON (9)

Synaptic conduction. Conduction of action potential in neuron. Parts of brain cortical localization of functions, EEG. Simple reflexes, with drawls reflexes. Autonomous nervous system and its functions

Module V: STRUCTURE OF VISUAL PATHWAYS (9)

Structure of Eye, Ear and auditory and visual pathways. Structure of kidney and nephron, Mechanism of Urine formation and base regulation. Dialysis.

Total Hours: 45

Text Books:

1. Anne Waugh, Allison Grant, “Ross and Wilson: Anatomy and Physiology in health and Illness”, Churchil Livingston Elsvier 2010.

References:

1. Elaine . N. Marieb, “Essentials of Human Anatomy and Phsiology” 8th edition, Pearson education, New Delhi 2007
2. William F Ganang “Review of Medical physiology” 2nd edition McGraw Hill , New Delhi, 2000.

18BT2059	ENTREPRENEURSHIP, IPR AND BIOSAFETY	L 3	T 0	P 0	C 0

Course Objective:

1. To impart various aspects of product design and development
2. To inculcate concept generation and selection
3. To understand technology behind the product of the service

Course Outcome:

1. Understand the principles of product design, basic management techniques, entrepreneurial skills and funding agencies.
2. Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.
3. Induce entrepreneurial intent as well as innovation, scalability and marketing of the product.
4. Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career.
5. Assess the commercial viability of a new technology based idea to prototype and biosafety.
6. Transform research based ideas into feasibility and business plans and IPR.

Module I: CONCEPT OF ENTERPRENEURSHIP (5)

Concept and evolution of entrepreneurship, development of Entrepreneurship, stages in entrepreneurial process, entrepreneurship in India, Role of SSI in economic development, Government support for SSI.

Module II: SOCIETAL ROLE IN ENTERPRENEURSHIP (4)

Role of society and family in the growth of an entrepreneur. Challenges faced by women in entrepreneurship.

Module III: PRODUCT PROCESS AND DESIGN (9)

Identification of business opportunities, project selection, contents, formulation, guidelines by planning commission for project report. Product design, importance, objectives, factors influencing product design, Product Development Process, sources of ideas for designing new products, stages in product design.

Module IV: INNOVATION AND PROTOTYPE (9)

Creativity and innovation, generation of ideas, technical and market feasibility study, opportunity assessment, business plan preparation, execution of business plan, conversion of ideas to prototype, risk taking-concept; types of business risks.

Module V: BIOSAFETY (9)

Procedure for getting license and registration, challenges and difficulties in starting an enterprise, host institution support, The role of technology/social media in creating new forms of firms, organizations, networks and cooperative clusters. Market- traditional and E-commerce, expanding markets: local to global.

Module VI: IPR AND COPYRIGHT (9)

IPR and copy right, financial opportunity identification; banking sources; non banking institutions and agencies; venture capital and angel investors, meaning and role in entrepreneurship, government schemes for promoting entrepreneurship.

Total Hours: 45

Text Books:

1. Jayshree Suresh, “Entrepreneurial Development”, , 5th Edition, Margham Publications, 2008.
2. Robert D. Hisrich, “Entrepreneurship”, 6th Edition, Tata McGraw Hill Publications.2009.

Reference Books:

1. Donald F. Kuratko, “Entrepreneurship: Theory”, Process and Practice 9th Edition, Cengage Learning, 2011.
2. Sateesh MK, Bioethics and Biosafety, IK International, 2012.
3. Anupam Singh and Ashwani Singh. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), NPH, New Delhi, 2010.

18BT3001	Advances in Biopolymers and Applications	L T P C 3 0 0 3

Course Objectives:

To improve knowledge on

1. Application of biopolymers in the field of pharma and food industries.
2. Interaction of biopolymers and their structure – function relationship
3. Recent trends in biomolecules research

Course Outcome:

The students will be able to

1. Understand the significance of the biopolymers and their industrial role.
2. Learn the advances in glycobiology and their application in pharma industry
3. Acquire information on protein engineering and their application in food and nanotechnology
4. Study about the importance of enzymes and lipids in industries
5. Understand the role of hormones, their regulations, nucleic acids and importance of biosensors in diagnosis
6. Apply their knowledge on the emerging biopolymers of industrial significance and to develop possible new drugs for emerging diseases.

Unit-1 Glycobiology (10 hours)

Glycoconjugates – Glycan structure of proteoglycan, glycoproteins, glycolipids and lipopolysaccharides; role of glycans in glycoconjugates - in cell-cell interaction/adhesion, recognition markers; Scope of Glycobiology; Lectins use and interaction with glycoconjugates; Glycans in biotechnology and pharmaceutical industry: as components of vaccines and small molecule drugs, glycosylation engineering, therapeutic glycans. Applications of carbohydrate biopolymers in encapsulation and the synthesis of nanomaterials

Unit-2 Protein Engineering (8 hours)

Structure- function relationship in fibrous and globular proteins, protein motifs; industrially significant peptides; Protein associated diseases and protein marker in disease diagnosis, Protein Engineering Methods - application of amino acids in the synthesis of nanomaterials Applications of proteins: Food industry, Environmental, Medical.

Unit-3 Enzyme Technology and Applications (8 hours)

Enzyme markers in disease diagnosis – hepatobiliary diseases, myocardial disorders, atherosclerosis, renal dysfunction, oxidative stress and cancer; enzyme based biosensors; Enzymes in food, and pharmaceutical industries; Application of enzymes in agriculture and environment protection; enzyme immobilization techniques and its applications.

Unit-4 Hormones and Antibodies (6 hours)

Mechanism of actions of chemically diverse hormones, Regulation of hormone release-by signals; Hormone drugs and their actions; applications of hormones in anti-ageing medicine. Hormone and antibody based biosensors; Antibody engineering, Abzymes

Unit-5 Lipid Technology and Applications (7 hours)

Industrial applications of fatty acids and lipids; liposomes and their novel applications, role of lipids in pharmaceutical industry, Lipid biotransformation, Techniques for the extraction of lipid from natural origin, Structured Lipids for Food and Nutraceutical Applications

Unit-6 Nucleic Acid Biopolymer (6 hours)

Applications of nucleic acid polymer in diagnosis and therapy - nucleic acid probes in clinical laboratory; Application of functional nucleic acids. Review on current status of gene therapy research.

Reference Books

1. Varki A, Cummings R.D, Esko J.D, Freeze H.H, Stanley P, Bertozzi C.R, Hart G.W,Etzler M.E., “ Essentials of Glycobiology”, Second edition; Published by Cold Spring Harbor Laboratory Press, New York, 2009

2. Lehninger A. L, Nelson D. L. and Cox M. M. "Principles of Biochemistry" Fourth Edition (Freeman Publishers), New York, 2005.
3. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.
4. Donald Voet and Judith G. Voet . "Biochemistry" – Volume 1, Biomolecules, Mechanisms of Enzyme Action and Metabolism, John.Willey and sons, 2004.
5. D. D. Lasic is at Liposome Consultations, 7512 Birkdale Drive, Newark, CA 94560, USA.
6. Burcu Turanli-Yildiz, Ceren Alkim and Z. Petek Cakar (2012). Protein Engineering Methods and Applications, Protein Engineering, Prof. Pravin Kaumaya (Ed.), ISBN: 978-953-51-0037-9

18BT3002	Genetic Engineering and Recombinant Products	L	T	P	C
		3	0	0	3

Course Objectives:
To gain knowledge about
1. The history and future of genetic engineering
2. The techniques employed in Genetic Engineering in the field of medicine and the biotech industry.
3. The techniques involved in generating transgenic microbes, plants and animals.

Course Outcome:
The students will be able to
1. Understand the basic concepts in Genetic engineering.
2. Understand the usage of the tools of genetic engineering.
3. Learn the techniques employed in genetic manipulation of microbes.
4. Learn the techniques employed in the genetic manipulation plants for crop improvement
5. Learn the techniques employed in the genetic manipulation animals for commercial purposes.
6. Learn the genetic manipulation techniques employed in the production of therapeutics.

Module I: Introduction & Tools employed in Genetic engineering. (5 Hours)
Impact of r-DNA products in food, drug, agriculture, and industry. Market share of various r-DNA products, the Indian scenario of r-DNA products.

Module II: Vectors (6 Hours)
Properties of ideal vectors, Cloning vectors PBR322- pUC, M13-Lambda phage vectors ,Cosmid vectors, Phagemids Cloning vectors in Gram positive bacteria- Streptomycetes, Shuttle vectors. Expression vectors : pGEX, T7 system, Alternate systems, YAC,BAC, mammalian vectors: SV40 vectors, CMV vectors, Plant vectors, Ti Plasmid vectors, CMV vectors.

Module III: Polymerase Chain Reaction (6 Hours)
Introduction to PCR, Primer design, Mechanism of PCR, Types of PCR, Inverse PCR, Nested PCR, Taqman PCR, Molecular beacons, RACE PCR, RAPD, Reverse Transcriptase PCR, Real Time PCR, Nucleic acid sequenzing methods. PCR/Oligonucleotide directed mutagenesis.

Module IV Construction & Analysis of recombinant DNA (10 Hours)
Construction of Genomic DNA libraries & cDNA libraries, PCR Cloning of DNA for Expression in E.coli, Yeast, Plant & Mammalian cells. Physical, chemical and biological methods of transferring recombinant DNA into target cells: Preparation of competent cell & Transformation into bacteria, Electroporation, Transfection, Biolistics & Gene gun.
Restriction analysis, Colony PCR, Probe preparation-Radioactive & nonradioactive labels-Different labelling methods: End and Body labelling.
Southern hybridization-Northern hybridization; Western blotting, subtractive hybridization, Autoradiography/Chemifluorescence.

Module V: Protein and Nucleic Acid products of rDNA technology (9 Hours)
Production of hormones, enzymes for therapeutics and diagnostics. Recombinant enzymes for industrial applications. Vaccines, Chimeric & humanized antibodies, and immune modulators. DNA vaccines, Gene

therapy. DNA oligonucleotides for Antigene applications, DNAzymes, ribozymes, aptamers, RNA decoys, siRNA, micro RNA and CRISPER-CAS.

Module VI: Genetically Modified Organisms (9 Hours)

Improved crop varieties GMOs: drought resistant, pest resistant, virus resistant salinity tolerant, Terminator technology, Biofortified crops, Phytic Acid GMOs, Plantibodies and Vaccines production in plants. Genetically enhanced animals, hypoallergenic cows, GMO pets, fluorescent aquariums fish.

References

1. Berhard R. Glick, Chery L. Patten, **Molecular Biotechnology: Principles and Applications of Recombinant DNA**, 5th edition
2. W T Godbey, **An Introduction to Biotechnology** ,AP
3. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski, **Recombinant DNA: Genes and Genomes**, W.H. Freeman
4. Kadema Carter, Biomedical Applications of DNA Recombinant Technology, Koros – 2014
5. Lilia Alberghina, **Protein Engineering For Industrial Biotechnology**, Hardwood Academic Press
6. Nigel W. Scott, Mark R. Fowler, Adrian Slater, **Plant Biotechnology**: **The genetic manipulation of plants**,2nd Edition
7. Carl A. Pinkert, **Transgenic Animal Technology**: A Laboratory Handbook.

18BT3003	**Bioprocess Modelling & Simulation**	**L**	**T**	**P**	**C**
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Principles and frameworks of data driven modeling
2. Mathematical models relevant to industrial and environmental bioprocess systems
3. Basics of MATLAB required for formalization of Bioprocess models and its simulation

Course Outcome:

The students will be able to

1. Discretize a given bioprocess system into a set of key mathematical expressions
2. Design required data collection scheme for identification of bioprocess parameters
3. Apply MATLAB for numerical modelling with coupled differential or algebraic equations
4. Perform parameter sensitivity and confidence interval estimation
5. Predict future trend and suggest remedial measures to have sustainable bioprocess
6. Select and Implement appropriate modelling framework depending on bioprocess system

Module I: Introduction to Bioprocess modelling (7 Hours)

Basic modeling principles – Purpose of modelling transient or steady state behaviour – types of mathematical models and modelling approaches. Fundamental laws guiding modelling framework – mass and energy balance, charge balance, equilibrium states and chemical kinetics, continuity equation. Model parameter and complexity

Module II: Mathematical formalization of Bioprocess (7 Hours)

Representation of Bioprocess (with examples) in terms of key mathematical expression, Data availability and designing data collection. Parameter identifiability, estimations and redundancy. Kinetic, stochiometric relations in terms of coupled differential or algebraic equations. Numerical modelling algorithm – initial and boundary value problem.

Module III: Matlab basics for modelling (8 Hours)

Basics of Matlab environments, data import and export, variables, vector-matrices operations, Matlab functions, Numerical integration, Euler and fourth order Runge-Kutta method, Matlab ODE and DAE solvers. Simulating a bioprocess with known process parameters

Module IV: Matlab application in bioprocess modelling (9 Hours)

Solving problems by numerical integration using MATLAB. Modelling simple microbial growth, substrate consumption and product formation kinetics in batch Process. Dynamic simulation of CSTR.

Module V: Parameter Estimation and sensitivity analysis, model fitness (7 Hours)

Parameter estimation from experimental and modelled data, Least square regression techniques -exercise, Embedding numerical bioprocess model into constrained multivariable optimization problem. Sensitivity and confidence interval estimation using boot-strapping

Module VI: Advanced Bioprocess Modelling examples (7 Hours)

Kinetic model for simultaneous saccharification and fermentation, Mathematical modelling of anaerobic digestion, Modelling and Simulation of Citric Acid Production from Corn Starch Hydrolysate, Enzymatic hydrolysis of lignocellulose

References

1. Verma, Ashok Kumar (2014) ***Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering***, CRC Press
2. Dunn, Irving J. (2003) ***Biological reaction engineering : dynamic modelling fundamentals with simulation examples***, Wiley-VCH
3. Nicoletti, Maria Carmo (2009) ***Computational Intelligence Techniques for Bioprocess Modelling, Supervision and Control***. Springer
4. Snape, Jonathan B. Dunn, Irving J., Ingham John, Prenosil Jiri E. (2008) ***Dynamics of Environmental Bioprocesses: Modelling and Simulation***, John Wiley & Sons

18BT3004	Analytical Techniques in Biotechnology Lab	L	T	P	C
		0	0	4	2

Co-requisite: 18BT3001 Advances in Biopolymer and Applications

Course Objectives:

To improve knowledge on

1. Clinical role of biomolecules in biological sample.
2. Importance of biomolecules with the cells and organs of the body
3. Advanced analytical techniques

Course Outcome:

The students will be able to

1. Understand the procedure on assay of antioxidants
2. Know the protocol to isolation of biomolecules from various sources
3. Practice the free radical scavenging and antioxidants assays
4. Study methods of isolation and screening of phytochemicals from plants
5. Learn advanced separation techniques
6. Understand the latest techniques on determination and structure prediction using sophisticated techniques

List of Experiments

1. Assay of acid phosphatase
2. Assay of lipid peroxidation (LPO) in plasma
3. Estimation of glucose by glucose oxidase and peroxidase (GOD – POD) method
4. Estimation of serum hexosamine by Wagner method
5. Determination of peroxide value of an oil
6. Isolation and preparation of lecithin from egg
7. Determination of total antioxidant capacity by phosphomolybdenum method (Prieto *et al.)*
8. Modified hydroxyl radical scavenging assay
9. Phytochemical screening from plants using HPTLC
10. Separation of phytochemicals by HPLC
11. Determination of molecular weight of phytochemicals by Mass spectrometry
12. Biomolecular structure prediction using X-Ray diffraction

18BT3005	Animal and Plant Tissue Culture Lab	L	T	P	C
		0	0	4	2

Course Objectives:

To impart knowledge on

1. Plant tissue culture and transformation techniques
2. Animal tissue culture and assays
3. Sterilization techniques on Plant and Animal Tissue Culture

Course Outcome:

After completing the course the students will be able to

1. Demonstrate media preparation on PTC and ATC
2. Comprehend on sterilization techniques
3. Experiment plant transformation techniques
4. Evaluate the animal cell culture techniques
5. Demonstrate isolation of macrophages from animals
6. Perform MTT assay and analyze the data

List of Experiments

1. Sterilization Techniques – Media and Explants
2. Callus induction from explants
3. Cell Suspension Culture for metabolite production and growth kinetic studies
4. Bacterial transformation and Raising of *in vitro* plantlets
5. Agrobacterium mediated gene transfer in *in vitro* plantlets
6. Preparation of reagents for tissue culture
7. Preparation of growth medium for cell culture
8. Isolation of macrophages from mouse peritoneum
9. Quantification and checking viability of cells (thymocytes or spleenocytes or macrophages) using trypan blue dye exclusion method.
10. Isolation of lymphocytes from thymus
11. Isolation of spleenocytes from mouse spleen
12. MTT Assay

18BT3006	Advanced Process Equipment Design and Drawing Lab	L	T	P	C
		0	0	4	2

CO- request: Process equipment Design

Course Objectives:

1. To design safe and dependable processing facilities.
2. This course focuses on plant layout and selection.
3. This will provide the basic knowledge to carry out process equipment design and cost effect.

Course Outcome :

After completing the course the students will be

1. On completion of this lab subject students should be able to understanding the symbols of process equipments.
2. Understand the procedures for construction of geometric figures
3. Students know very well about plant layout and safety of process equipments
4. Students should be able to understand the mass and energy balance calculations
5. Students will have completed detailed design of unit operations
6. Students should be able to understanding the drawing of process equipments.

List of Equipments:

1. Basics of various unit operation symbols
2. Plant layout

3. Engineering Letters, Lines and numbers.
4. Shell and tube heat exchanger
5. Single effect evaporator
6. Batch reactor
7. Air lift Fermentor
8. Fractional distillation column
9. Rotary drum filter
10. Absorption column
11. Gate Valves
12. Venturi meter

References:

1. Unit operation by McCabe Smith (Mc Cabe Smith)
2. Heat Transfer by Kern (Kern)

18BT3007	Recombinant DNA Technology Lab	L	T	P	C
		0	0	4	2

Co-requisite: Lab in Molecular Biology

Course Objectives:

To impart knowledge on

1. The basic laboratory techniques employed in a genetic engineering Lab
2. The extraction and analysis of nucleic acids and proteins.
3. Genetic manipulation of Nucleic acids for protein production.

Course Outcome:

After completing the course the students will be able to

1. Isolate nucleic acids
2. Perform electrophoresis of nucleic acids and proteins.
3. Manipulate DNA using enzymes.
4. Purify various RNA and perform reverse transcription
5. Amplify nucleic acids using PCR
6. Express, purify and analyze recombinant protein

List of Experiments

1. Isolation of plasmid DNA and restriction digestion to estimate molecular weight by Agarose Gel electrophoresis
2. Isolation of total RNA from E.coli
3. Isolation of total RNA from mammalian cells
4. Isolation of mRNA from mammalian cells using poly T beads.
5. Reverse Transcriptase PCR of target gene & Agarose Gel electrophoresis to estimate molecular weight.
6. RE digestion of the PCR product & cloning the digested PCR product into E.coli Expression vector by ligation
7. Preparation of competent E.coli and transformation of the cloned plasmid and selection of recombinant clones.
8. Induction of expression using IPTG and extraction of expressed protein.
9. Analysis of expressed protein using SDS-PAGE.
10. Midi scale expression of target protein
11. Extraction and purification of target protein using affinity beads/column.
12. Western blotting analysis for confirmation of purity and quality of expressed protein

18BT3009	Enzyme Technology and Industrial Applications	L	T	P	C
		3	0	0	3

Course Objective:

1. To understand the mechanism of biocatalyst
2. To learn the kinetics of enzymatic reaction
3. To learn about applications of enzymes

Course Outcome:

1. The students will understand the concept of immobilization
2. The student will understand extraction and purification of enzymes
3. The student will learn the inhibition kinetics of the enzymatic reactions
4. The student will learn the application of enzymes
5. The student will learn protein engineering of enzymes
6. The student will learn about commercial production of enzyme

Module I: Introduction to enzymes (7 hours)

Classification of enzymes, quantification of enzyme activity and specific activity, Enzyme in action & specificity, Enzyme stability, monomer & oligomeric enzymes. Structure of enzymes-ray crystallography of enzymes, control of Enzyme activity

Module II: Enzyme kinetics & modeling of enzymatic systems:- **(7 hours)**

Kinetics of multisubstrate enzyme catalyzed reaction, relation of kinetic parameters, microenvironmetal effects on enzyme kinetics, Enzyme Inhibition – Substrate, Product and Toxic compound inhibition, types and derivation. Enzyme deactivation kinetics. Allosteric regulation of enzymes, Monod changeux wyman model

Module III: Immobilized enzymes: **(8 hours)**

Introduction, Methods of immobilization, kinetics of immobilized enzymes, Analysis of film and Pore diffusion & application in production of L-amino acids, & other uses, enzyme biosensors (design of E electrodes & application.).

Module IV: Industrial enzymes:- (8 hours)

Few industrial nzymes like glucose-isomerase, cellulases, Pectinases, protease etc. Their importance, source production, optimization of fermentation medium, assay, extraction and purification, Characterization, genetic manipulation etc. Applications of enzymes in analysis; Design of enzyme electrodes

Module V: Protein Engineering of Industrial enzymes: (7 hours)

Introduction, targets by Chemo enzymatic Synthesis, rational design methods, site directed mutagenesis, Chemical modification and unnatural amino acids, Random method like molecular evolution, DNA shuffling, sequence space, method for mutagenesis, for recombination, sequence homology independent recombination,screening and selection

Module VI: Enzyme as tools for stereo specific c- c bond formation in Monosaccharide & analogues (8 hours)

Enzymes like DHAP aldolase, pyruvate aldolase, tyrosine kinase & their uses, Uses of mutagenesis to increase substrate specificity. Producing catalytic antibodies etc.

References:

1. Palmer T, P.L. Bonner, “Enzymes: Biochemistry”, “Biotechnology”, “Clinical chemistry”, 2nd Edn, Harwood Publishing Ltd. 2007.
2. Shuler, M.L. and Kargi,F. “ Bioprocess Engineering - Basic concepts” Prentice Hall of India Pvt. Ltd.,2nd edition, 2002
3. Bailey J.E. and Ollis, D.F. “Biochemical Engineering Fundamentals”, McGraw Hill,2000.
4. Ashok Pande, Colin Webb, Carlos Richard, Cristian Larroche. Enzyme Technology, 2006, Springer
5. Price and Lewis Stevens. Fundamentals of Enzymology, Oxford, United Kingdom, 2000

18BT3010	Microbial Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. To learn bacterial genetics and techniques for genetic engineering.
2. To study the role of microbiology in medicine, agriculture, and the environment.
3. To develop value added microbial products and commercialization

Course Outcome:

The students will be able to

1. Evaluate the role of micro-organisms in specific biotechnological processes
2. Study the complex processes behind the development of genetically manipulated organisms
3. Demonstrate a clear understanding of proteomics relate to biotechnological applications
4. Create an array of products to benefit humans, animals and the environment.
5. Interaction of microbiota with plants, animals, bacteriophages
6. Commercialization of a new microbially-based biotechnology product.

Module I: Introduction (8 Lecture Hours)

Microbial life: Microbial Cell Cultivation Systems, Culture media- types, components and formulations. Sterilization: Batch and continuous sterilization, Types of fermentations- Aerobic and anaerobic fermentation, Submerged and solid state fermentation; Factors affecting submerged and solid state fermentation; Substrates used in SSF and its advantages.

Module II: Microbial Genomics (7 Lecture Hours)

Introduction to Microbial genomes, Genome sequencing of different microbes and their importance, Techniques for genome research (chromosome walking, RFLP etc.), Metagenomics; Application of microbial genomic variability for utilizing in human welfare, Phylogenetic relationships between various genera of microbes, Methods to Compare Genomes, Evolution by Genome Expansion and Reduction, Archaeal Genomics, Microbial Genome Annotation.

Module III: Microbial Proteomics (7 Lecture Hours)

Introduction to microbial proteomics, 2D gel profiling, MALDI – ToF, Protein purification work station of various microbes, Microbial pathogenesis at the proteome level, Structural proteomics and computational analysis Proteomics of Archaea, Proteome research for novel drug targets, High throughput proteomic screening for novel enzymes

Module IV: Microbes in agriculture (8 Lecture Hours)

Microbes as biocontrol agents (Baculoviruses, entomopathogenic fungi, *Bacillus thurinigiensis*, *Bacillus sphaericus*, *Bacillus popilae*, Microbe derived inhibitors, biology of nitrogen fixation, preparation of different types of inoculants (nitrogen fixers, phosphate solubilizers, plant growth promoting rhizobacteria (PGPR), composting, biopesticides.

Module V: Microbial interactions (8 Lecture Hours)

Interactions with microorganisms, plants and animals, Bacteriophages in control of bacteria, The gut microbiota, Cancer and the microbiota, Thermal adaptation of decomposer communities to global warming, Gene manipulation of useful microbes, Recombinant vaccines.

Module VI: Commercial products (7 Lecture Hours)

Organic acids- citric acid, acetic acid, Solvents- ethanol, acetone-butanol , Beverages- beer, wine biopolymers, enzyme, vitamins, antibiotics, biosensors, biosurfactants, bioconversion.

References

1. Ian Humphery-Smith and Michael Hecker, Microbial Proteomics: Functional Biology of Whole Organisms by Publisher: Wiley-Interscience; 1st edition, 2010.
2. Thomas J. Dougherty and Steven J. Projan, Microbial Genomics and Drug Discovery by Publisher: CRC; 1st ed. 2013.

3. Rajhi Gupta, Jagjit Singh, T.N. Lakhanpal, and J.P. Jewari, Advances in Microbial Biotechnology by Publisher: A.P.H. Pub. Corp. 2005.
4. Stanbury, P. F., Whitaker and Hall, A. S. J., Principles of Fermentation Technology. Butterworth-Heinemann, 2009.
5. Shuler, M.L. and Karg, I F., Bioprocess Engineering Basic Concepts, 2010.
6. Crueger W. and Crueger, A., Biotechnology. A Textbook of Industrial Microbiology, Sinauer Associates, 2008.

18BT3011	Agriculture and Food Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

1. To improve knowledge on principles of Agriculture and plant breeding
2. Understand the concept of agricultural microbiology and biotechnology
3. To know Food processing and packaging techniques
4. To elaborate the understanding of biodiversity and IPR issues in agricultural crops.

Course Outcome:

The students will be able to

1. Acquire knowledge on basics of Agriculture and Plant Breeding
2. Outline the principles Agriculture Microbiology
3. Understand the concept of Agriculture Biotechnology
4. Relate Biodiversity and intellectual property rights
5. Evaluate the advances in Food biotechnology
6. Relate Food processing and Packaging techniques

Module I: Basics of Agriculture and Plant Breeding (8 Lecture Hours)

Factors effecting agriculture and agricultural classification of plants, Origin of cultivated plants and plant indication, Methods of breeding self pollinated and vegetatively propagated plants, Breeding of crops pollinated plants

Module II: Agriculture Microbiology (7Lecture Hours)

Microbes of agricultural importance, Microbe based biofertilizers, Soil microbes and plant growth substances, biocontrol agents, Induced systemic resistance(ISR), Plant growth promoting rhizobacteria (PGPR)

Module III: Agriculture Biotechnology (8 Lecture Hours)

Plant derived Biotechnological Products, Plant tissue culture and Genetic engineering, integrated pest and nutrient management, poly house technology, Biotech industries & institutes in India & world, Concepts of Biotech park. Entrepreneurship biotechnology

Module IV: Biodiversity and intellectual property rights (8 Lecture Hours)

Genetic diversity, Molecular diversity; Species and Population biodiversity, Collection and conservation of biodiversity, endangered plants, endemism and Red Data Book, Biodiversity and centers of origins of plants; Biodiversity hot spots, IPR in relation to Indian Flora

Module V: Food biotechnology (7 Lecture Hours)

Food spoilage causes and prevention, Food borne infections and intoxication immobilization of microbial and cultured plant cells. Principles of down stream processing, industrial production of various food products

Module VI: Food processing and Packaging (7 Lecture Hours)

Scope and importance of food processing. National and international perspectives. Principles and methods of food preservation, Storage of food, Packaging operations, shelf life of packaged foodstuff, methods to extend shelf-life, Food packages and containers

References

1. Principles of Gene Manipulation and Genomics (2006) Sandy B. Primrose and Richard Twyman
2. Gene Cloning and DNA Analysis: An Introduction (2010) by T. A. Brown

3. Understanding biodiversity: Life, sustainability, and equity (1997) by Ashish Kothari
4. Plant Breeding: Principles and prospects (1993) by M.D. Hayward and N.O. Bosemark
5. Plant Breeding (2014) by Jack Brown and Peter Caligari
6. Soil Microbiology, Ecology and Biochemistry, Fourth Edition (2014) by Eldor A. Paul
7. Introduction to Soil Microbiology (1999) by Mark Coyne
8. Fundamentals of Food Biotechnology (2015) by Byong H. Lee
9. Food Biotechnology (2012) by Vinod K. Joshi and R. S. Singh
10. Principles of Aseptic Processing and Packaging (2010) by Philip E. Nelson
11. Food Microbiology (2008) by Frazier

18BT3012	Big Data Analytics	L	T	P	C
		3	0	0	3

Course Objectives:
To improve knowledge on
1. Fundamental concepts and methods of Big data analysis.
2. Data exploration, visualization and statistical analysis for given data set.
3. Performing big data analytics for Biological data set.

Course Outcome:
The students will be able to
1. Demonstrate fundamental knowledge of Big data analytics.
2. Explore different types of data from different sources.
3. Write R script to analyse data from data interface.
4. Develop and generate different types of charts and graphs.
5. Perform various statistical analysis using R packages for given data set.
6. Apply knowledge of big data analytics on bioinformatics and health care data set.

Module I: Introduction (8 Lecture Hours)
Big data analytics overview, Data life cycle, Traditional Data mining Life cycle, CRISP, Big Data life cycle methodologies, Machine learning implementation, Recommender system ,
Dashboard, Ad-Hoc analysis**.**

Module II: Data Exploration and Visualization (7Lecture Hours)
Problem Definition, Data Collection, Data Pre-processing, Data Cleaning – Homogenization, Heterogenization, Summarizing data, Data Exploration and Visualization.

Module III: Big Data Methods (9 Lecture Hours)
Introduction to R programming, Data Frames, Atomic vectors, Factors, Data types, Variables, Functions, working with excel files, Data interface.

Module IV: Charts & Graphs (6 Lecture Hours)
Develop pie chart, 3D pie chart, Histograms, Bar chart, Group bar chart, Stacked Bar chart, Line graph, Multiline graph and Box plot.

Module V: Statistical Methods (9 Lecture Hours)
Regression models, Linear Regression, Multiple regression, Logistic regression, Mean, Median, Mode, Chi-Square test, T-Test.

Module VI: Big data analytics for Health care (6 Lecture Hours)
Big data analytics in bioinformatics, Health care, Data mining using RNA seq data, Text mining on complex biomedical literature, Biological sequence motifs and patterns.

References
1. Venkat Ankam, “Big Data analytics”, Packt publishing 2016
2. Parag Kulkarni, Sarang Joshi, ”Big Data analytics“, PHI learning2016
3. Wang, Baoying, Big Data Analytics in Bioinformatics and Healthcare, IGI global edition

18BT3013	Bioethics and Biosafety	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Biosafety regulations and IPR
2. Human genome project and stem cell research
3. ethical issue of organ transplantation and transgenic animals

Course Outcome:

The students will be able to

1. Understand the various biosafety regulations in biotechnology
2. Get familiarized with IPR and patent procedures
3. Comprehend on ethical issues of human genome project and ethical races
4. Gain knowledge on stem cell technology and its application
5. Develop awareness on organ transplantation and its ethics
6. Comprehend on transgenic animals and its ethical issues

Module I: Legal and Socio-economic Impacts of Biotechnology — Biosafety Regulations (7 Lecture Hours)

National and International Level Biosafety Regulations, Trials On-field, Upscaling of Field Trials, Coordination and Capacity Establishment, Screen–A Newsletter on Biosafety, Hazardous Materials Used in Biotechnology—Handling and Disposal, Good Manufacturing Practices, Good Laboratory Practices, Good Laboratory Practice Principles

Module II: Intellectual Property Rights (9 Lecture Hours)

Intellectual Property Rights, World Trade Organisation (WTO), WTO Agreements, General Agreement on Tariffs and Trade (GATT), General Provisions and Basic Principles, Patenting and the Procedures Involved in the Application for Grading of a Patent, Steps to a Patent, Compulsary Licenses, Patent Cooperation Treaty (PCT), Examples of Patents in Biotechnology, Patenting of Living Organisms, Bioethics in Biodiversity

Module III: Human Genome Project (7 Lecture Hours)

Human Genome Project, Ethical Issues of the Human Genome Project, The Human Genome Diversity Project, The Need for a Strategic Framework, Foetal Sex Determination The Indian Law on Abortion, Social Implications of the Act, Ethical Issues in MTP, Ethical Issues Leading to Legal Issues, Genetic Studies on Ethnic Races.

Module IV: Stem Cell Research (9 Lecture Hours)

Introduction**,** Applications of Stem Cells, Ethics Involved in Stem-cell Research, Use of Cell-cultures as Alternatives to Use of Animals, Replacement, Use of Animals for Research and Testing, Animal Cloning, Ethics and Animal Cloning, Human Cloning, Why Cloning Humans is Ethically Unacceptable?, Controlling Someone Else's Genetic Makeup, Instrumentality, Infertility–An Exception to Instrumentality.

Module V: Organs Transplantation in Human Beings (8 Lecture Hours)

Organs Transplantation in Human Beings, Ethics in Xenotransplantation, Bioethical Issues, Transgenesis, Informed Consent, Allocation of Health Care Resources, Patentability and Xenotransplantation, Organ Culture, Ethical Issues.

Module VI: Transgenic Animals (6 Lecture Hours)

CCAC Guidelines on Transgenic Animals (1997), CCAC Guidelines on Animal Welfare, Laboratory Animal Management, The Need for Ethical Review

References

1. Sree Krishna. Bioethics and Biosafety in Biotechnology. New Age International Publishers, New Delhi, 2007

18BT3014	CHEMICAL PROCESS TECHNOLOGY	L	T	P	C
		3	0	0	3

Course objectives

1. This course will give powerful approach in designing new process and product development.
2. This course will be helpful to understand the processes technologies of various organic and inorganic process industries for manufacturing chemicals.
3. This course will be helpful to associated troubleshoot.

Course Outcome

1. Ability to understand the process flow diagram and various process parameters
2. Ability to understand the manufacturing of various inorganic chemicals
3. Ability to understand the manufacturing of various organic chemicals
4. Ability to identify and solve engineering problems during production
5. Ability to understand the process flow diagram and various process parameters
6. Ability to identify and solve engineering problems during production

Module I: Process Flow Diagram (8 Hours)

Basic philosophy of a process flow diagram (PFD). Elements of a PFD. General discussion on Influence of various parameters on deciding process for a product and method of drawing PFD. Nitric acid, sulphuric acid, phosphoric acid and it's important salts

Module II: Industrial Production (8 Hours)

Caustic chlorine industry - mercury, membrane and diaphragm cells. Hydrochloric acid and important chlorine compounds. Soda ash, sodium bicarbonate.Lime, cement and plasters , Glass & ceramic industries

Module III: Oils and Fats (7 Hours)

Methods of extracting vegetable oils (Process Description and Flow sheet). Hydrogenation of oils (Process description & flow sheet), major engineering problems and improved technology.

Module IV: Sugar Derivatives (8 Hours)

Sugar and starch industries: Manufacturing process with flow diagram, Sugar refining, manufacturing process of starch and their different by-products; Glucose, Sorbitol & Polyols.. Pulp and paper Industries, technology and manufacturing methods

Module V: Fermentation Products (7 Hours)

Fermentation industries: Industrial Alcohol, Absolute Alcohol; their production process with flow diagram.

Module VI: Agrochemical Industries (7 Hours)

Elementary ideas on Pesticides, Insecticides, Fungicides, Herbicides, DDT manufacturing process with flow sheet.

References:

1. Dryden, C. E., and Rao, M.G. (Ed.), Outlines of Chemical Technology Affiliated East West Press.2010
2. Austins, G.T., Sherve's Chemical Process Industries, MGH,2012.
3. Venkateswarlu, S. (Ed.) Chemtech (II) Chemical Engineering Development Centre, IIT, Madras.
4. S. K. Ghoshal, S. K. Sanyal and S. Datta, Introduction to Chemical Engineering, Tata McGraw Hill, New Delhi.
5. Kirk & Othmer (Ed.), Encyclopedia of Chemical Technology

18BT3015	IMMUNOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Immune systems and techniques in immunology.

2. Concepts in immunotechnology
3. Advancement in immunology and immunotechnology

Course Outcome:

The students will be able to

1. Understand the basics in functions of immune systems.
2. Learn the types of antibodies and the interaction between antigen and antibodies
3. Know skills and competence in specialized immunological techniques in the diagnosis and management of health related disorders.
4. Acquire knowledge and understanding of research methods employing immunological techniques for application in biomedical and clinical research
5. Apply immunological techniques to manage the immunological diseases
6. Learn about the application of modern technology in diagnosis and treatment of cancer

Module-I – THE IMMUNE SYSTEM (8 Hours)

Introduction - Cells of the Immune system - Innate and Acquired immunity - Primary and secondary lymphoid organs – Nature of antigens - Chemical and molecular basis of antigenecity – Immunogenecity - Haptens-Adjuvants - Primary and Secondary Immune Responses - Theory of Clonal selection. Preparation of antigens for raising antibodies**,**

Module-II – ANTIGEN-ANTIBODY INTERACTION (8 Hours)

In vitro antigen-antibody reactions, Isolation of antibodies, assays for complement, immunoelectrophoresis. ELISA, RIA and immunoblotting, Immunofluorescence, flow cytometry & sorting, T & B cell subset analysis, immuno-electron microscopy.

Module-III – ANTIBODIES (8 Hours)

MAb through hybridoma technology, MAb without hybridoma technology – viral transformation of B cell line, plant as expression systems – plantibodies, applications. Production of abzymes, immunotoxins, chimeric antibodies, bi specific antibodies, single chain Fc, diabodies, tetrabodies, intrabodies; plastibodies; applications. Plaque Forming Cell Assay

Module-IV – CELLULAR IMMUNOLOGY (7 Hours)

PBMC seperation from the blood; identification of lymphocytes based on CD markers; FACS; Lymphoproliferation assay; Mixed lymphocyte reaction; Cr51 release assay; macrophage cultures; cytokine bioassays- IL2, gamma IFN, TNF alpha.; HLA typing.

Module-V - IMMUNITY AND INFECTION MECHANISM: **(7 Hours)**

Tissue injury and Inflammation – Immunosuppression - Immunological Tolerance - Immunity to infectious agents – bacteria, virus, fungi and parasites. Transplantation – Autoimmunity - Tumor Immunology - Vaccines: Conventional Molecular vaccines -Types of vaccines - Recent trends in Immunology of Infectious diseases.

Module-VI – TRANSPLANTATION AND TUMOR IMMUNOLOGY (7 Hours)

Transplantation: genetics of transplantation; laws of transplantation; tumor immunology, Autoimmunity; Autoimmune disorders and diagnosis. Cell Cytotoxicity, mixed lymphocyte reaction, Apoptosis, Cytokine expression; Cell cloning, Reporter Assays, In–situ gene expression techniques;

References

1. David Male Jonathan BrostoffDavid Roth Ivan Roitt, Immunology. 8th Edn., Elsevier, 2012
2. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002
3. Goldsby , R.A., Kindt, T.J., Osbome, B.A. and Kerby J. Kuby Immunology, 6th ed., W.H. Freeman, 2005
4. Weir DM and Stewart, J., Immunology, 10th Edn. Churchill Livingston, New York, 2000.

18BT3016	COMPUTATIONAL BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. To provide foundation in fundamental concepts, tools and resources in Computational Biology.
2. To introduce machine learning and data mining concepts and techniques relevant to biological data along with practical implementation of machine learning techniques.
3. To develop skills in specialized areas related to Computational Biology which will enable high throughput data processing and analysis.

Course Outcome:

The students will be able to

1. Will be familiar with resources, biological data, its analysis and interpretation.
2. Will be able to analyze high throughput biological data and perform statistical analysis / develop mathematical models
3. Will be able to use data mining and apply machine learning techniques like ANN, SVM and HMM for any data classification and prediction problem
4. Will develop skills in molecular modeling and simulation, whole cell modeling, drug discovery, Systems Biology and other emerging areas
5. Will be familiar with the design and implementation of of algorithms which may help them design their own.
6. Will be familiar with the theory and practical aspects of important experimental techniques.

Module I: Introduction (10 Hours)

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications

Module II: Phylogentic analysis (7Lecture Hours)

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.

Module III: Bio molecular structure modelling and simulation (7 Lecture Hours)

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

Module IV: Machine learning methods and analysis (7 Lecture Hours)

Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to Systems Biology and its applications in whole cell modelling, Microarrays and Clustering techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA
Computing.

Module V: Perl for Bioinformatics (7 Lecture Hours)

Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation

Module VI: Systems Biology and protein network analysis (7 Lecture Hours)

Systems Biology Networks- basics of computer networks, Biological uses and Integration. Micro array – definition, Applications of Micro Arrays in systems biology. Self-organizing maps and Connectivity maps - definition and its uses. Networks and Pathways – Types and methods. Metabolic networks.

References

1. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.

2. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
3. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press.
4. Andrew R. Leach, Molecular Modeling Principles And Applications, Second Edition, Prentice Hall
5. Proteomics from protein sequence to function: Edited by S.R.Pennington and M.J.Dunn,Taylor and Francis Group, 2001.
6. Computational systems biology by A.Kriete, R.Eils, Academic Press. 2005
7. Systems Biology and Synthetic Biology by Pengcheng Fu, Sven Panke, Wiley InterScience. 2009

18BT3017	METABOLIC REGULATION AND ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. To develop skills of the students in the area of metabolic regulation and engineering to amend the existing metabolic pathways
2. To enable the students to use molecular techniques to enhance the product yield and also to produce industrially important products in a cost effective manner.
3. To understand the quantitative basis of metabolic networks using enzyme kinetics

Course Outcome:

1. Apprehend the cellular or biochemical changes that conform the basic principles of thermodynamics
2. Acquire knowledge on the regulation of metabolic pathways
3. Analyze different methods to obtain improved and enhanced economically viable products
4. Comprehend the principle role of metabolic engineering practices
5. Demonstrate experiments related to metabolic flux using suitable techniques
6. Appreciate the applications of metabolic engineering in chemical, medical, and environmental fields

Module I: OVER VIEW OF CELLULAR METABOLISM [8 Lecture Hours]

Transport Processes- Altering transport of nutrients including carbon and nitrogen -Fueling reactions-Glycolysis, fermentative pathways- TCA cycle and oxidative phosphorylation, anaplerotic pathways - Catabolism of fats and aminoacids – Metabolomics.

Module II: REGULATION OF METABOLIC PATHWAYS [8 Lecture Hours]

Regulation of enzyme activity – Regulation of enzyme concentration – Regulation of metabolic networks – Regulation at the whole cell level - Mutants which do not produce feedback inhibitors or repressors-auxotrophs-lysine, purine nucleotides

Module III: MANIPULATION AND SYNTHESIS OF METABOLIC PATHWAYS [8 Lecture Hours]

Metabolic pathway manipulations – Enhancement of Product yield and productivity - Extension of substrate range, product spectrum and novel products -Antibiotics, Polyketides and Vitamins,

Module IV: METABOLIC ENGINEERING PRACTICES [7 Lecture Hours]

Fundamentals of Metabolic Control Analysis (MCA), MFA, MPA and their application

Module V: METHODS FOR THE METABOLIC FLUX [7 Lecture Hours]

Methods for the experimental determination of metabolic fluxes by isotope labeling metabolic fluxes using various separation and analytical techniques

Module VI: APPLICATIONS OF METABOLIC ENGINEERING [7 Lecture Hours]

Product over production examples: amino acids, polyhydroxyalkanoic acids, metabolic fluxes in mammalian cell cultures, two successful industrial case studies

References

1. Gregory N. Stephanopoulos, Aristos A. Aristidou & Jens Nielsen, “Metabolic Engineering: Principles and Methodologies”, Academic Press, An Imprint of Elsevier India Pvt.Ltd., 1st edition, 1998.

2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005
3. S. Cortassa, M.A.Aon, A.A.Iglesias and D.Llyod, " An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Co. Pte. Ltd, 2002.
4. Christiana D. Smolke, "The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.
5. W.Crueger and A. Crueger, "A Text Book of Industrial Microbiology", Panima Publishing Corporation, 2005
6. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.

18BT3018	CLINICAL TRIALS AND BIOETHICS	L	T	P	C
		3	0	0	3

Course Objectives:
To improve knowledge on
1. To Explain key concepts in the design of clinical trials
2. To Identify key issues in data management for clinical trials.
3. To describe the roles of Regulatory Affairs in clinical trials.

Course Outcome:
The students will be able to
1. Students are equipped to understand the principles of clinical trials
2. Will be familiar with the theory and practical aspects of important techniques
3. Will develop analytical skills and expertise to formulate and implement a research oriented real time problem.
4. Will be trained in major areas related to clinical research and development
5. The experimental component will help them undertake interdisciplinary work.
6. Will equips them with skills to pursue a career either in academia or industry.

Module I: Introduction to Drug Discovery and Development (9Lecture Hours)
Origin and History of Clinical Research, Introduction to Drug Discovery and drug Development, Clinical Trials in India–The National Perspective, Clinical Trial Phase I, Clinical Trial Phase II, Clinical Trial Phase III, Clinical Trial Phase IV –methods, Principles of sampling -Inclusion and exclusion criteria, Methods of allocation and randomization, Termination of trial.

Module II: Ethical Regulation (8Lecture Hours)
Historical guidelines in Clinical Research -Nuremberg code, Declaration of Helsinki, Belmont report, Research ethics and Bioethics –Principles of research ethics; ethical issues in clinical trials; Use of humans in Scientific Experiments; the informed consent; Introduction to ethical codes and conduct; Introduction to animal ethics; Animal rights and use of animals in the advancement of medical technology

Module III: Regulation in clinical research (7 Lecture Hours)
International Conference on Harmonization (ICH) Brief history of ICH, Structure of ICH, ICH Harmonization Process, Responsibilities of Stakeholders: Sponsors, Investigators, CROs, Monitors, Institutional ethics committee

Module IV: Clinical trial important documentation (7 Lecture Hours)
Essential Documents in Clinical Trials: SOP, Clinical Trial Protocol and 95Protocol Amendment(S), Investigator Brochure, Master Files, Informed Consent Forms, Consort statement, Case Record Form

Module V: Clinical trial data management (8 Lecture Hours)
Project management in clinical trials -principles of project management; Application in clinical trial management; Risk assessment Pharmacovigilance, Project Auditing, Inspection.

Module VI: Clinical data monitoring (7 Lecture Hours)
CRF Review & Source Data Verification, Drug Safety Reporting, Drug Accountability Work, Routine Site Monitoring, Site Close Out Visit

References

1. Lee, Chi -Jen; etal.,"Clinical Trials or Drugs and Biopharmaceuticals." CRC / Taylor &Francis, 2011
2. Matoren, Gary M. "The Clinical Research Process in the Pharmaceutical Industry" Marcel Dekker, 1984.
3. Methodology of Clinical Drug Trials, 2ndEdition.Spriet A., Dupin-Spriet T., Simon P. Publisher: Karger.
4. Design and Analysis of Clinical Trials: Concepts and Methodologies , 3rdEdition.Shein-Chung Chow, Jen-Pei Liu. Publisher: Wiley.
5. Principles and Practice of Pharmaceutical Medicine, 3rdEdition. Lionel D. Edwards, Anthony W. Fox, Peter D. Stonier. Publisher: Wiley-Blackwell.
6. Oxford Handbook of Clinical Medicine, 9 thEdition. Murray Longmore, Ian Wilkinson, Andrew Baldwin, and Elizabeth Wallin.Oxford Medical Handbooks.

18BT3019	Sustainable Bioprocess Development	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Microbial Growth Kinetics
2. Enzyme kinetics
3. Bioreactor operation

Course Outcome:

The students will be able to

1. Develop growth model based on the microbial characteristics
2. Understand Immobilization techniques
3. Understand the mass transfer during Immobilization reaction
4. Design bioreactor based on operational mechanism
5. Understand different configurations of bioreactors
6. Understand the involvement of bioprocess engineering in other related areas

Module I: Introduction (8 Lecture Hours)

Microbial diversity, Cell construction, Major products of biological processing, Component parts of fermentation process, Concept of Upstream, downstream processing and scale up.

Module II: Microbial Growth and Quantifying Growth kinetics (7Lecture Hours)

kinetics of microbial growth, Substrate-limited growth, substrate uptake and product formation- monod model, leudeking-piret models, Models with growth inhibitors , oxygen transfer in microbial bioreactors, volumetric mass transfer coefficient, Measurement of k_La

Module III: Enzyme Engineering (7 Lecture Hours)

Enzyme, How enzyme work, Enzyme kinetics, Enzyme immobilization, Industrial utilization of enzyme, Hheterogeneous Reactions in Bioprocessing, Internal Mass Transfer and Reaction

Module IV: Bioreactor Design (8 Lecture Hours)

Mixing, Mixing Equipment, Flow pattern, Mechanism of Mixing, Power requirement for mixing, Bioreactor Configurations (Different Bioreactors), Membrane bioreactor

Module V: Ideal Reactor Operation (8 Lecture Hours)

Batch Operation of a Mixed Reactor, Batch Operation of a Mixed Reactor, Continuous Operation of a Mixed Reactor, Chemostat Operation, Operation of Plug-Flow reactor

Module VI: Advanced Bioprocessing (7 Lecture Hours)

Bioprocess Consideration in plant cell cultures, Bioprocess Consideration in animal cell cultures, Bioprocessing in environmental engineering, Industrial Bioprocess

References
1. Shuler, M.L. and Kargi,F. “ Bioprocess Engineering - Basic concepts” Prentice Hall of India Pvt. Ltd.,2nd edition, 2005.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, “Principles of Fermentation Technology”, Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
3. *Pauline M. Doran*, Bioprocess Engineering Principles, Elsevier Science & Technology Books, 2nd edition, May 1995

18BT3020	ADVANCED ANIMAL BIOTECHNOLOGY AND TISSUE CULTURE	L	T	P	C
		3	0	0	3

Course Objectives:
1. To Provide insights into animal Animal Biotechnology
2. To Provide knowledge in Animal Breeding
3. To equip the students with technical knowledge of cell culture and its Applications

Course outcomes:
The students will be able to
1. Understand the importance of Animal Biotechnology and its importance in Live stock improvement
2. Gain knowledge in Cryopreservation of embryos, embyo sexing
3. 3.. To identify the genetic defects in animal embryos through molecular defects.
4. To understand the technology used for live stock improvement.
5. Gain knowledge in apllications of cell culture
6. Understand the importance of Tissue engineering.

Module I: Introduction **(8 Lecture Hours)**
Introduction to Animal Biotechnology, Cryopreservation of Sperms, Ova of livestock, Artificial Insemination, Super Ovulation, In Vitro fertilization, Culture of embryos, Cryopreservation of Embryos, Embryo transfer, Embryo splitting, Embryo sexing.

Module II: Transgenic Animals **(7Lecture Hours)**
Transgenic manipulation of animal embryos, different applications of transgenic animal technology, Animal cloning basic concept, cloning from- embryonic cells and adult cells, cloning for conservation for conservation endangered species, Ethical, social and moral issues related to cloning

Module III: Germplasm Preservation **(7 Lecture Hours)**
In situ and ex situ preservation of germplasm, In utero testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, Gene knock out technology and animal models for human genetic disorders

Module IV: Live Stock Improvement **(8 Lecture Hours)**
Genetic characterization of livestock breeds, Marker assisted breeding of livestock, Transgenic animal production and application in expression of therapeutic proteins Detection of meat adulteration using DNA based methods.

Module V: Cell Culture (8 Lecture Hours)
Commercial scale production of animal cells, Application of animal cell culture for in vitro testing of drugs, Testing of toxicity of environmental pollutants in cell culture, Cell proliferation assay, migration assay, adhesion assay

Module VI: Tissue Engineering (7 Lecture Hours)
Tissue Engineering, 3D Culture with different type of cells, Scaling up of cell culture – Adherence and Suspension type of cells for the production of various products, Different methods and steps involved in cell line engineering for the production of various products.

References
1. B. Ianfreshney. Culture of Animal cells & Manual of basic technique, fifth edition, Wiley – liss publication, 2006.

2. Dubey R.C. Text book of biotechnology S. Chand & Company Ltd. 2007
3. B.Sasidhar. Animal Biotechnology MJP publishers. 2006
4. *Portner R. 2007. Animal Cell Biotechnology. Humana Press.*
5. *Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. New Generation Vaccines. 3rd Ed. Informa Healthcare*

18BT3021	Molecular Diagnostics	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. History and Traditional diagnostics in genetic disease.
2. Principles and performance of DNA and RNA isolation, amplification, hybridization, and analysis.
3. Applications in microbiology, diagnosis, cancer, transplantation, and forensic medicine.

Course Outcome:

The students will be able to

1. Define basic terminology and describe concepts in molecular diagnostics that provide the foundation for implementing and adapting new techniques and assays.
2. Explain the principle of traditional diagnosis methods.
3. Explain the major metabolic disorders.
4. Apply molecular diagnostic techniques in the diagnosis of microbiological, hematological, thrombotic, and genetic disorders.
5. Explain and perform electrophoresis and hybridization methods, including Southern and Northern blots
6. Discuss ethical considerations and New trends in Diagnostics

Module I: History of Diagnostics (7 Lecture Hours)

Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, Clinical Sample collection- method of collection, transport and processing of samples and Interpretation.

Module II: Traditional Diagnostic Methods (8 Lecture Hours)

Diagnosis of infection caused by Bacteria: *Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium.*, Fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. DNA and RNA viruses- Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis. Helminthic diseases- *Fasciola hepatica* and *Ascaris lumbricoides*. Filariasis and Schistosomiasis.

Module III: Major Metabolic disorders (7 Lecture Hours)

Traditional methods for the diagnosis of metabolic errors. Disease due to genetic disorders – Identifying human disease genes. Cancer- different types of cancers, genetics of cancer- oncogenes, tumour suppressor genes. Methods available for the diagnosis of genetic diseases and metabolic disorders. Genetic disorders- Sickle cell anemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Sex – linked inherited disorders.

Module IV: Molecular Diagnosis (8 Lecture Hours)

Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, In situ PCR, Long-PCR, PCR-ELISA, Arbitrarily primed PCR, Ligase Chain Reaction. Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis

Module V: Hybridization and Sequencing (8 Lecture Hours)

Southern, Northern, in-situ (including FISH), microarrays – types and applications; Protein extraction and analysis (including PAGE and its variations); Western Blot. Automated DNA sequencing- Principles, Methods and Instrumentation- Advances in DNA sequencing- New Generation sequencing Methods, Pyrosequencing, · Microarrays- Personalised Medicine- Pharmacogenomics (ADMET)

Module VI: New Trends in Diagnostics **(7 Lecture Hours)**

DNA chips, automation, gene therapy; applications in diagnosis of genetic disorders, Diagnosis of neonatal genetic disorders, human genome project, ethical considerations. Good Laboratory Practices. Different Levels of Biosafety and Containment. Gene therapy and other molecular based therapeutic approaches. Forensic Medicine. Ethical and legal issues in genetic counselling.

References

1. Bailey & Scott's Diagnostic Microbiology (2012), Betty A. Forbes , Daniel F. Sahm, Alice S.
2. Weissfeld , Ernest A. Trevino, Published by C.V. Mosby
3. Jawetz, Melnick, & Adelberg's Medical Microbiology (2012), Geo F. Brooks, Stephen A. Morse, Janet S. Butel.
4. Fundamentals of Molecular Diagnostics (2010). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
5. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws
6. Molecular Diagnostics for the Clinical Laboratorian 2Ed. 2006, W.B. Coleman. Humana Press.

<table>
<tr><th rowspan="2">18BT3022</th><th rowspan="2">Drug Design and Discovery</th><th>L</th><th>T</th><th>P</th><th>C</th></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Course Objectives:

To improve knowledge on

1. To explore the process of drug development, from target identification to final drug registration.
2. To provide the knowledge in drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughputscreening.
3. To develop skills in specialized areas related to bioavailability, clinical trials, and the essentials of patent law

Course Outcome:

The students will be able to

1. Will be able to describe the process of drug discovery and development
2. Will be able to discuss the challenges faced in each step of the drug discovery process
3. Will be able to gaine a basic knowledge of computational methods used in drug discovery
4. Will be able to organise information into a clear report
5. be able to demonstrate their ability to work in teams and communicate scientific information effectively
6. Will be familiar with the Construct, review and evaluate preclinical and clinical pharmaceutical studies with a general understanding of aim, choice of procedures, results, conclusions and importance.

Module I: Drug and their Interaction **(8Lecture Hours)**

Introduction to Drugs: Drug nomenclature, Routes of drug administration and dosage forms, Principles of Pharmacokinetics and Pharmacodynamics: ADME, Bioavailability of drugs -Lipinski's rule; How drugs work -Drug targets, drug-target interaction and dose-response
Relationships.

Module II: Drug design pipeline **(8Lecture Hours)**

New Drug Discovery & Development: Overview of new drug discovery, development, cost and time lines. Target Identification & Validation. Lead Discovery: Rational and irrational approaches -Drug repurposing, Natural products, High-throughput screening (HTS), Combinatorial chemistry and computer aided drug design (CADD).

Module III: Fundamental of Drug Actions: **(8 Lecture Hours)** Inter and intramolecular interactions: Weak interactions in drug molecules; Chirality and drug action; Covalent, ion, ion-dipole, hydrogen bonding, C-H hydrogen bonding, dihydrogen bonding, van der waals interactions and the associated energies. Cation-and-OH interactions. Receptorology : Drug-receptor interactions, receptor theories and drug action; Occupancy theory, rate theory, induced fit theory, macromolecular perturbation theory, activation-aggregation theory. Topological and stereo chemical consideration.

Module IV: Drug toxicity, Assays and testing (7 Lecture Hours)

Preclinical Testing of New Drugs: Pharmacology -In vitro/in vivo Pharmacokinetics and Pharmacodynamics testing; Toxicology-Acute, chronic, carcinogenicity and reproductive toxicity testing; Drug formulation testing. Clinical Trial Testing of New Drugs: Phase I, Phase II and Phase III testing; Good clinical practice (GCP) guidelines -Investigators brochures, Clinical trial protocols and trial design; Ethical issues in clinical trials -How are patient rights protected?

Module V: Drug Regulatory Agencies (8 Lecture Hours)

US Food & Drug Administration (US FDA) and Central Drugs Standard Control Organization (CDSCO), India. Regulatory Applications & New Drug Approval: Investigational new drug (IND) application & New drug application (NDA); Regulatory review and approval process. Regulatory Requirements for Drug Manufacturing: Current Good manufacturing practice (cGMP) and GMP manufacturing facility inspection & approval.

Module VI: Intellectual Property Rights (IPR) (8 Lecture Hours)

IPR Definition and implications for discovery & development.Forms of IPR Protection-Copyright, Trademark and Patents. International organization and treaties for IPR protection –World Trade Organization (WTO) & Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreements. Controller General of Patents, Designs & Trade Marks, India (CGPDTM), World Intellectual Property organization (WIPO)-Patent Cooperation Treaty (PCT).

References

1. Drugs: From discovery to approval 2nd Ed by Rick NG. Wiley Blackwell (2009)
2. Essentials of Medical Pharmacology, 6the Edition (Hardcover) by Tripathi Kd. Publisher: Jaypee Brothers (2008)
3. Burger’s Medicinal Chemistry and Drug discovery. Volume 2, Drug Discovery and development.6th Edition. Ed Donald J AbrahamWiley-Interscience.
4. Intellectual Property Rights In India: General Issues And Implications by Prankrishna Pal. Publisher: Deep & Deep Publications Pvt.Ltd (2008)
5. Stromgaard, Kristian, Povl Krogsgaard-Larsen, and Ulf Madsen. *Textbook of drug design and discovery*. CRC Press, 2009.
6. Katzung, Bertram G., Susan B. Masters, and Anthony J. Trevor. *Basic and Clinical Pharmacology (LANGE Basic Science)*. McGraw-Hill Education, 2012.
7. Spriet, Alain, et al. *Methodology of clinical drug trials*. Basel: Karger, 1994.

18BT3023	Transport Phenomena	L	T	P	C
		3	0	0	3

Course Objective:

2. The study of the subject constitutes the chemical engineering aspects and principles in line with temperature differences.
3. It imparts the knowledge of basic principles of science and engineering applied to Industrial Biotechnology and chemical engineering
4. The study also focuses on how operations related with fluids and how temperature plays a pivotal role in a drug or a chemical plant.

Course Outcome:

1. Gaining knowledge on developments in unit operations.
2. Understanding the principles related to laws of thermal conductivity and movement of fluids through energy balances.
3. Analyzing the fluid dynamics in an industrial point of view.

4. Hydrodynamics of a moving fluid will be observed and it paves a way for the Rheology of fluids.
5. Analyzing the Heat and mass transfer operations in an industrial plant.
6. Knowledge on Heat Transfer Equipments and its design.

Module I Introduction (5 Hours)

Introduction to chemical engineering sciences and its role in the design & analysis of chemical processes. Overview of unit operations and processes in the chemical industry. Units and conversion factor. Introduction to Dimensional analysis.

Module II Material and Energy Balances : . (13 Hours)

Overall and component material balances - Material balances without chemical reactions Material balance calculations with chemical reactions – combustion calculations . Energy balances - Entropy - Latent heat - Chemical reactions - combustion

Module III Fluid Mechanics : (9 Hours)

Properties of fluids; Fluid statics – forces at fluid surfaces, Pressure and measurement of pressure differences; Fluid flow concepts and basic equations of fluid flow – continuity equation and Bernoulli's equation; shear stress relationship and viscous effects in fluid flow; non newtonian fluids; significance of dimensionless groups in fluid flow operations.

Module IV Transportation of Fluids : (8 Hours)

Different types of pumps, compressors and valves. Measurement of fluid flow using hydrodynamic methods, direct displacement method. Types of agitators, flow patterns in agitated vessels, calculation of power consumption – applications in bioreactor design

Module V Heat Transfer : **(5 Hours)**

Nature of heat flow - Conduction, convection, radiation. Steady state conduction, Principles of heat flow in fluids.

Module VI Design of Heat Transfer Equiments: (5 Hours)

Transfer by forced convection in laminar and turbulent flow. Heat exchange equipments- principles and design.

References

1. Bhatt B.I., Vora S.M. Stoichiometry.3rd ed., Tata McGraw-Hill, 1977.
2. McCabe W.L., et al., Unit Operations In Chemical Engineering. 6th ed., McGraw-Hill Inc., 2001.
5. Geankoplis C.J. Transport Processes And Unit Operations. 3rd ed., Prentice Hall India,

18BT3024	Pharmaceutical Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. To provide the student well versed with recent advances in the field of Pharmaceutical Biotechnology.
2. To make foundation for understanding the various events at molecular level, keeping a balance between health and disease.
3. To enabling the student to gain in-depth knowledge in fundamental and applied aspects of Microbiology and Immunology.

Course Outcome:

The students will be able to

1. Will be familiar with resources, of DNA based vaccine delivery systems.
2. Will be able to analyze Screening, isolation, characterization and scale-up of microbial products (enzymes, antibiotics and other secondary metabolites) from microorganisms of commercial interest and its pharmacological evaluation.
3. Will be able to Microbial synthesis of nanoparticles: Biosynthesis, isolation and characterization.
4. Will develop skills in molecular signalling pathways in pathogenesis and therapy.

5. Will be familiar in Immunoproliferators: Isolation, characterization and evaluation of cytokine like molecules from microbial source.
6. Will be familiar with the Peptide therapeutics: Design, evaluation and formulation of peptides for therapeutics.

Module I: Biotechnology with reference to Pharmaceutical Sciences. (9Lecture Hours)

introduction to Biotechnology with reference to Pharmaceutical Sciences, Biosensors- Working and applications of biosensors in Pharmaceutical Industries. Brief introduction to Protein Engineering. Use of microbes in industry. Production of Enzymes- General consideration – Amylase, Catalase, Peroxidase, Lipase, Protease, Penicillin's.

Module II: Genetic Engineering (7Lecture Hours)

Basic principles of genetic engineering. Study of cloning vectors, restriction endonucleases and DNA ligase. Recombinant DNA technology. Application of genetic engineering in medicine. Application of r DNA technology and genetic engineering in the products: Interferon b) Vaccines- hepatitis- B c) Hormones- Insulin. Nanodrops, Gene expression analysis.

Module III: Pharmaceutical immunology (7 Lecture Hours)

Structure of Immunoglobulin's, Structure and Function of MHC. Hypersensitivity reactions, Immune stimulation and Immune suppressions. General method of the preparation of bacterial vaccines, toxoids, viral vaccine, antitoxins, serum-immune blood derivatives and other products relative to immunity. Storage conditions and stability of official vaccines. Hybridoma technology- Production, Purification and Applications

Module IV: Immunological techniques and analysis (7 Lecture Hours)

Immunoblotting techniques- ELISA, Western blotting, Southern blotting. Genetic organization of Eukaryotes and Prokaryotes. Microbial genetics including transformation, transduction, conjugation, plasmids and transposons. Introduction to Microbial biotransformation and applications.

Module V:Gene mutation and Fermentation (7Lecture Hours)

Mutation. Types of mutation/mutants. Fermentation methods and general requirements, study of media, equipments, sterilization methods, aeration process, stirring. Large scale production fermenter design and its various controls. Study of the production of – penicillin, citric acid, Vitamin B12, Glutamic acid, Griseofulvin.

Module VI: Microbial Technology (7 Lecture Hours)

Biotransformation for the synthesis of chiral drugs and sterols. Biodegradation of xenobiotics, chemical and industrial wastes. Production of single-cell protein.

References

1. Gene transfer and expression protocols – methods in Molecular Biology, Vol. VII, Edit E.T. Murray.
2. Therapeutic Peptides and Proteins; Formulation, processing and delivery systems: Ajay K Banga.
3. Immobilisation of cells and enzymes: Hosevear kennady Cabral & Bicker staff.
4. Biotechnology of antibiotics and other bioactive microbial metabolites : Gianeario Lancini and Rolando Lorenzetti.
5. Pharmaceutical Biotechnology by Daan J. A. Crommelin, et al
6. Goodman and Gilman's The Pharmacological Basis of Therapeutics Book by J.Hardman, Lee Limbird and A.G. Gilman.
7. "Principles of Pharmacology by D. Golan, A. Tashjian, E. Armstrong, J.Galanter, A.W.Armstrong, R. Arnaout and H.Rose. 2005, Lippincott Williams and Wilkins.

18BT3025	Bioreactor Engineering	L	T	P	C
		3	0	0	3

Course Objective:

1. This course aims at making the students understand the principles and concepts of Bioreactor engineering.

2. This will help the student understand structured models of growth and product formation
3. To understand the of oxygen transfer and parameters to be monitored and controlled in bioreactors

Course Outcome:

The students will be able to

1. Acquire knowledge on design of bioreactors.
2. Devise methods to calculate volumetric mass transfer coefficient and determination methods.
3. Assess on-line data analysis for measurement of important physico-chemical and biochemical parameters.
4. Classify modern biotechnological process in host vector systems.
5. Analyze structured models for analysis of various bioprocess.
6. Discuss on parameters to be monitored and controlled in bioreactors.

Module I: DESIGN AND ANALYSIS OF BIOREACTORS (7 Lecture Hours)

Design and operation of novel bioreactors-Air-lift loop reactors, Fluidized bed-bioreactors, packed bed reactor, Bubble column reactor, stability analysis of bioreactors

Module II: BIOREACTOR SCALE-UP (7 Lecture Hours)

Oxygen mass transfer in bioreactors - microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed

Module III: MONITORING OF BIOPROCESSES (7 Lecture Hours)

On-line data analysis for measurement of important physico-chemical and biochemical parameters; State and parameter estimation techniques for biochemical processes.

Module IV: MODERN BIOTECHNOLOGICAL PROCESSES (8 Lecture Hours)

Recombinant cell culture processes, guidelines for choosing host-vector systems, plasmid stability in recombinant cell culture, limits to over expression, Modelling of recombinant bacterial cultures; bioreactor strategies for maximizing product formation; Bioprocess design considerations for plant and animal cell cultures

Module V: MODELLING AND SIMULATION OF BIOPROCESSES (8 Lecture Hours)

Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

Module VI: BIOREACTOR INSTRUMENTATION AND CONTROL (8 Lecture Hours)

Methods of on-line and off-line biomass estimation; microbial calorimetry. Flow injection analysis for measurement of substrates, products and other metabolites. Parameters to be monitored and controlled during fermentation process.

References:

1. Michael Shuler, Fikret Kargi, "Bioprocess Engineering Principles",Second edition, Prentice Hall,2002
2. P.Stanbury, A.Whitaker,SJ Hall "Principles of fermentation technology", Second edition, Elsvier Pergamon Press,1999.
3. Pauline Doran,"Bioprocess Engineering Principles", Academic Press,1995
4. Elmar Heinzle, Arno P.Biwer, "Development of Sustainable Bioprocess: Modelling and Assessment", Wiley, 2007.
5. Bjorn K.Lyderson, Nancy Ade'lia and Kim Nelson,"Bioprocess engineering *(handcover)",*Wiley Interscience,1994

<table>
<tr><td rowspan="2">18BT3026</td><td rowspan="2">Stem Cell Therapeutics</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Course Objectives:

To gain awareness about

1. The history and future of the emerging field of Stem Cell Therapy

2. The impact of Stem Cell therapy in health care system.
3. The impact of Stem Cell Therapy in Human civilization.

Course Outcome:

The students will be able to

1. Understand the basic concepts in culturing animal and mammalian cells
2. Understand the aspects of cellular ageing
3. Understand the types of Stem cells, their development and function.
4. Learn the various methods to isolate and culture Stem cells
5. Learn the various therapeutic applications of stem cells
6. Appreciate the bigger picture of Stem Cell Technology and their impact of society and civilization.

Module I: Introduction (4 Lecture Hours)

Introduction to The Syllabus, Overview of Stem Cells, Introduction and history of Stem cells, Stem cells for therapeutics and research.

Module II: Culturing Cells in the laboratory (5 Lecture Hours)

Introduction to Cell Culture, Pros & Cons of Cell culture, Primary and Secondary cultures, Hayflicks limit, telomerase.

Aseptic Technique and Cell culture Lab equipments & etiquette

Module III: Stem cell-Types (6 Lecture Hours)

Types of Stems Cells, Embryonic stem cells, Pleuripotent Stem Cells, Adult Stem cells, Induced Pleuripotent Stem Cells, Transit amplifying cells

Symmetry during cell division in Stem cells.

Module IV: Location, Nature & culturing of stem cells (10 Lecture Hours)

Stem Cell Niche, Isolation of Stem Cells, & Growth factors, chord cells, Derivation & differentiation of ES Cells, Derivation & differentiation of Pleuripotent Cells

Induced Pluripotent cell-Methods & Genetic & epigenetic reprogramming

Module V: Applications of Stem cell Technology (10 Lecture Hours)

Application of stem cells in disorders of nervous system, Application of Stem cells in Cancer, Stem cells of Gut. Stem cells of the skin- Wound healing & cosmetics, Use of stem cells in tissue engineering & organ generation, Application of stem cells in autoimmune disorders.

Module VI: Ethical Implications of Stem cell therapeutics. (10 Lecture Hours)

Benefits, Problems and perspectives of stem cell therapy. Beginning of human life, legal, scientific, ethical, Religio-spiritual explanations. Treating infertility, multiple parents, Somatic Cell Nuclear Transfer & Human cloning, Extinction prevention, Stem cells and meat production, Alternatives to stem cells

Deeper concerns in stem cell technology-Immortality, longevity, ageing.

References

1. Paul Knoepfler, Stem Cells - An Insider's Guide ”
2. Robert Lanza and Anthony Atala, Essentials of Stem Cell Biology”
3. Satish Totey and Kaushik D. Deb, Stem Cell Technologies: Basics and Applications
4. Warburton David, Stem Cells, Tissue Engineering and Regenerative Medicine .

18BT3027	Nanobiotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. To know about biology inspired concepts, nanobiometrics, natural nanocomposites, nano analytics and molecular manufacturing
2. To study the properties of fundamental biological units used to create materials for applications in human health care

3. To understand how biology can be used to learn fundamental design principles

Course Outcome:

The students will be able to

1. Define basic terminology and describe concepts in Nanobiotechnology
2. Explain the principle of various applications in Nanobiotechnology.
3. Explain the properties of Nanomaterials in Biotechnology.
4. Understand Application of Nanodevices in Biological systems.
5. Explain the Application of Molecular recognition elements and transducing.
6. Discuss New trends in Nanobiotechnology and Defence.

Module I: History and Concept of Nanobitoechnology (7 Lecture Hours)

Various definitions and Concept of Nano-biotechnology & Historical background. Fundamental sciences and broad areas of Nanobiotechnology. Various applications of Nano-biotechnology. Cell – Nanostructure interactions. Functional Principles of Nanobiotechnology- Information-Driven Nanoassembly- Energetic- Chemical Transformation- Regulation- Traffic Across Membranes- Biomolecular Sensing- Self-Replication- Machine-Phase Nanobiotechnology

Module II: Nanomaterials in Biotechnology (9 Lecture Hours)

Drug Nanoparticles- Structure and Preparation, Liposomes, Cubosomes and Hexosomes, Lipid based Nanoparticles-Liquid nanodispersions- Solid Lipid Nanoparticles (SLP)- Biofunctionalsiation of SLP, Charatcterisation- Nanoparticles for crossing biological membranes. Fundamentals- Physicochemical Principles of Nanosized Drug Delivery Systems-Nanotubes, Nanorods, Nanofibers, and Fullerenes for Nanoscale Drug Delivery, Carbon nanotubes biocompatibility and drug delivery. Nanoparticles, quantum dots, nanotubes and nanowires. Microbial Nanoparticle Production : Methods of microbial nano-particle production, Applications of microbial nano-particles, Bacteriorhodopsin and its potential in technical applications – overview, structure, photoelectric applications, photochromic applications and applications in energy conversion.

Module III: DNA-Protein Nanostructures (9 Lecture Hours)

Overview and introduction - Oligonucleotide-Enzyme conjugates, DNA conjugates of binding proteins, Non-covalent DNA-Streptavidin conjugates, DNA-Protein conjugates in microarray technology. Protein-based Nanostructures, Nanobiomachines & Signalling - Overview, chemistry and structure, Genetics & Secondary cell-wall polymers, Self-assembly in suspension, Re-crystallization at solid supports, Formation of regularly arranged Nano-particles, Cell as Nanobiomachine, link between the signaling pathways & molecular movements as well as neuron function, Concepts in nanobiomachines for information processing and communications

Module IV: Nanodevices and Tools used in Nanotechnology (5 Lecture Hours)

Biosensors; different classes - molecular recognition elements, transducing elements. Applications of molecular recognition elements in nanosensing of different analytes. Application of various transducing elements as part of nanobiosensors. Tools in Nanotechnology.

Module V: Biological Nanoparticles (8 Lecture Hours)

Production - plants and microbial. Nanobiotechnological applications in health and disease - infectious and chronic. Nanobiotechnological applications in Environment and food - detection and mitigation.

Module VI: New Concepts in Nanobiotechnology (7 Lecture Hours)

Cancer treatment and DNA Origami, Green Technology in India, Biological Motors and DNA Origami, Three Concepts – New "Nano" concept, Societal Implications of Nanoscience and Nanotechnology – Environmental Issues, Nano Ethics, Nanotribolgy and Quantum Computing.

References

1. Nanobiotechnology: Concepts,Applications and Perspectives (2004), Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
2. Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.
3. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.

4. R.S. Greco, F.B.Prinz and R.L.Smith, Nanoscale Technology in Biological Systems, CRC press, 2005.
5. Tuan Vo-Dinh, Protein Nanotechnology Protocols, Instrumentation and Application, Series ; Methods in Molecular Biology (2005)
6. Christof M. Neimeyer, Chad.A.Mirkin (eds.,) Nanobiotechology : Concepts, Applications and perspectives, Wiley VCH Weinheim (2004)
7. David. S. Goodsell, Bionanotechnology: concepts, lessons from nature, Wiley-Liss (2004)
8. Sandra J Rosethal, David W Wright, Nanobiotechnology Protocols, Series Methods in Molecular Biology (2005).
9. B. Bhushan , Springer Handbook of Nanotechnology: Volume 1&2, Springer-Verlag. Second ed., (2007)
10. Christof M. Neimeyer, Chad.A.Mirkin (eds.,) Nanobiotechology II : More Concepts, and Applications, Wiley VCH Weinheim (2007)

18BT3028	Advanced Plant Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Plant genetic materials and molecular biology techniques
2. Plant metabolic engineering and its importance
3. Plant transformation techniques and GM crops

Course Outcome:

The students will be able to

1. Understand the plant genome and its molecular mechanisms
2. Get familiarized about additional genomic materials in plant cells
3. Comprehend on metabolic engineering of plant cell metabolites
4. Gain knowledge on Agrobacterium mediated gene transfer techniques
5. Develop knowledge on mechanisms of plant virus vectors
6. Comprehend on GM crops and its ethical issues

Module I: INTRODUCTION TO PLANT MOLECULAR BIOLOGY (8 Lecture Hours)

Genetic material of plant cells, nucleosome structure and its biological significance; transposons,; outline of transcription and translation, alternative and trans splicing, constitutive and differentially expressed genes in plants

Module II: CHLOROPLAST AND MITOCHONDRIA (9 Lecture Hours)

Structure, function: Light and dark reaction and genetic material; rubisco synthesis and assembly, coordination, regulation and transport of proteins. Mitochondria: Genome, cytoplasmic male sterility and import of proteins, comparison and differences between mitochondrial and chloroplast genome, chloroplast transformation

Module III: PLANT METABOLISM AND METABOLIC ENGINEERING (7 Lecture Hours)

Nitrogen fixation, Nitrogenase activity, nod genes, nif genes, bacteroids, plant nodulins, production of secondary metabolites, flavanoid synthesis and metabolic engineering

Module IV: AGROBACTERIUM MEDIATED GENE TRANSFER (5 Lecture Hours)

Pathogenesis, crown gall disease, genes involved in the pathogenesis, Ti plasmid –TDNA, importance in genetic engineering

Module V: PLANT VIRUSES (9 Lecture Hours)

Plant viruses and different types, Viral Vectors: Gemini virus, cauliflower mosaic virus, viral vectors and its benefits, vectors used for plant transformation, Methods used for transgene identification

Module VI: APPLICATIONS OF PLANT BIOTECHNOLOGY (7 Lecture Hours)

Outline of plant tissue culture, transgenic plants, herbicide and pest resistant plants, molecular pharming, therapeutic products, RNA i, Transgene silencing,ethical issues; case studies on successful transgenics including drought management.

TOTAL : 45 PERIODS

References

1. Slater A et al. Plant Biotechnology : The Genetic Manipulation of Plants, Oxford University Press, (1st and 2nd edition), 2008
2. Grierson D. and Covey, S.N. Plant Molecular Biology, 2nd ed., Blackie,1988

18BT3029	Cancer Management Techniques	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. The pathology, grades and molecular biology of cancer
2. Cancer type specific symptoms and early diagnostic markers
3. Cancer management techniques like detection, treatment, prevention and palliative care

Course Outcome:

The students will be able to

1. Understand the pathology of different types of cancer and their reporting systems.
2. Learn the molecular pathways involved in cancer development and progression.
3. Study the molecular targets for diagnosis and therapy
4. Develop new technologies for early diagnosis, targeted therapy and for effective management of post therapy cases with the help of cancer markers
5. Analyze the future challenges in improving the efficacy of current cancer diagnosis and therapy
6. Investigate new means of cancer management, prevention strategies and modes of palliative care to prolong the life of cancer cases.

Module I Pathology and Types of Cancer (8 Lecture Hours)

Benign and cancer tumor; Characteristics and hallmarks of cancer; Cancer malignancy – spread, invasion and metastasis; Histopathology of cancer; Cancer staging and its classifications; Cancer differentiation grades; Cancer classes and types; Cancer death - obstructions.

Module II Molecular Cell Biology of Cancer (8 Lecture Hours)

Cell growth regulation abnormalities in cancer – Alteration in Growth factors and cell signaling pathways, signal targets; Cell adhesion defects in cancer; Cell migration promoters in cancer-Proteases; Metastatic spread promoters, cancer cells mimicking inflammatory immune cells; Apoptosis regulation defects in cancer; Angiogenesis promoters in cancer.

Module III Cancer Symptoms and Markers (7 Lecture Hours)

Cancer Symptom – General and specific; Cancer metabolism – Metabolic alterations and role of mitochondria; Cancer Markers – Proteins – Enzymes, Antigens, Antibodies, Hormones; Testing samples - Urine, Blood, Stool, Tumor tissue, other body fluids; Gene expressions – DNA, mRNA and Protein; scope for early diagnosis.

Module IV Cancer Detection Methods and Techniques (8 Lecture Hours)

Cancer Screening and symptoms; Clinical Examination; Radiologic Imaging Techniques – CT, MRI,and PET scans, Ultra sound and Endoscopic Examinations, Mammography and Isotopic Techniques; Laboratory Tests for cancer markers; Immunodetection techniques; Genetic Testing; Confirming cancer by pathologic report - Biopsy and Smear examinations; Early diagnostic methods

Module V Cancer Therapeutics (7 Lecture Hours)

Combination Therapy; Adjuvant therapy- Chemotherapy and Radiotherapy; Targeted therapy – Targeted drug delivery, targeted therapy drugs; Molecular therapy, Immunotherapy –Antibody, Interferon, Molecular and Gene therapy; Hormone therapy; Treatment fatigue; Clinical trials.

Module VI Cancer Prevention and Palliative care (7 Lecture Hours)

Cancer risk factors; Food and lifestyle in cancer prevention; Post treatment preventive measures- Recurrence prevention, Cancer diagnosis cum therapy; Paliative care; Herbal remedies and plant derived drugs.

References:

1. Stella Pelengaris, Michael Khan, The molecular Biology of Cancer, Blackwell Publishing, 1st edition, 2006.
2. Robert A. Weinberg, The Biology of Cancer, Garland Science, 2nd edition, 2014
3. Macdonald F and Ford CHJ. "Molecular Biology of Cancer", Bios Scientific Publishers, 2002.
4. Richard Pazdur, Kevin A. Camphausen, Lawrence D. Wagman, William J. Hoskins, Cancer Management: A Multidisciplinary Approach**,** 11th illustrated edition, Oncology Publishers, 2003
5. Thomas N. Sayfried, Cancer as a Metabolic Disease**:** On the Origin, Management, and Prevention of Cancer 1st Edition, Wiley Publications; 2012

18BT3030	Genomics and Proteomics	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Genomics, and proteomics using model organisms representing plants and animals.
2. The course will cover recent developments in genetics, epigenetics, small RNAs, proteomics, gene expression, mutagenesis and mapping genes.
3. Develop skills in experimental design within the context of learning about biology including: signal transduction, regulation of transcription and translation, cancer, aging, drought stress and metabolic pathways

Course Outcomes:

The students will be able to

1. Genomics and Proteomics deals with a rapidly evolving scientific area that introduces students into genomes, proteomes and databases that store various data about genes, proteins, genomes and proteomes.
2. Students would learn about genomics, proteomics and bioinformatics 3. Students would gain skills in applied bioinformatics, comparative, evolutionary, human genomics and functional genomics.
3. Students shall have basic knowledge of genome sequencing, major differences between prokaryotic and eukaryotic genomes, basic proteomics and its applications.
4. Apply interdisciplinary knowledge (e.g. chemistry, biophysics) to solve problems in proteomics and genomics
5. Perform database search and analyze genomes, proteins
6. The acquired knowledge during the course would be helpful to those students who want to work in core facilities and commercial biological and medical laboratories

Module I: Introduction to Genomics (8 Lecture Hours)

Introduction to Genomics, Genome Organization of prokaryotes and Eukaryotes, Gene Structure of Bacteria, Archaebacteria and Eukaryotes, Human Genome Project

Module II: DNA sequence and mapping (8 Lecture Hours)

Methodology for DNA sequencing, Contig Assembly, Genetic Mapping- Mendel's Laws of Inheritance, Partial Linkage, DNA Markers and its types, Physical Mapping and its types

Module III: Functional Genomics and its applications (7 Lecture Hours)

Introduction to Functional Genomics, Genome Annotation- traditional routes of gene identification, Detecting Open Reading Frames, Software programs for finding genes, Identifying the function of new gene, Gene Ontology

Module IV: Introduction to Proteomics (7 Lecture Hours)

Proteomics- Introduction, The proteome, Genomics Vs. Proteomics, Proteomics and the New biology

Module V: Analytical Proteomics (8 Lecture Hours)

2 Dimensional Polyacrylamide Gel Electrophoresis, Mass Spectrometry for Protein and Peptide Analysis (MALDI-TOF and ESI-Tandem MS), Designing Microarray experiments, Types of Microarrays

Module VI: Applications of Proteomics **(7 Lecture Hours)**
Applications of Proteomics- Mining Proteomes, Protein Expression Profiling, Mapping Post-translational Modification, Peptide Mass Fingerprinting

References

1. Brown T.A., "Genomes ", BIOS Scientific Publishers Ltd, Oxford, 2nd Edition, 2002
2. Daniel C. Liebler, "Introduction to Proteomics: Tools for New Biology", Humana Press, Totowa, New Jersey, 2002
3. HEYER, L. -- CAMPBELL, A. *Discovering Genomics, Proteomics and Bioinformatics.* USA: Cold Spring Harbor Lab. Press, 2006. 352 p. ISBN 0-8053-4722-4.

18BT3031	Advanced Environmental Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:
To improve knowledge on

1. To analyse environmental problems and find solutions through innovations
2. To develop bioreactors and biotreatment methods of industrial wastewater
3. To learn novel technologies for remediation of environmental pollution

Course Outcome:
The students will be able to

1. Create an awareness of professional responsibility towards protecting the environment.
2. Learn environmental issues involved engineering and resources projects
3. Study the natural and engineered bio-treatment methods to remediate the pollutants
4. Develop treatment methods and create awareness about opportunities in environmental management
5. Future challenges for bioremediation and biodegradation process
6. Investigate the opportunities for incorporating environmental quality into products, processes and projects

Module I: Introduction **(8 Lecture Hours)**
Current status of biotechnology in environmental protection and its future prospects. Characteristics of wastewater, Classification of pollutants, Impact of pollutants on biotreatment.

Module II: Environmental pollution **(7Lecture Hours)**
Types, causes and its effects on environment of Soil pollution, Water pollution, Air pollution**,** Oil pollution, Heavy metal pollution

Module III: Bioreactors for wastewater treatment **(7 Lecture Hours)**
Design and evaluation of suspended growth reactors, Activated sludge, Biological nutrient removal, Biofiltration, Aerobic digestion, anaerobic processes and lagoons , Design and evaluation of attached growth reactors, Trickling filter, Rotating Biological Contactor, Fluidized bed biological reactors, Upflow anaerobic sludge blanket reactor ,Hybrid reactor, Sequential batch reactor , Techniques for Evaluating Kinetics and Stoichiometric parameters.

Module IV: Biotreatment of industrial wastewater **(8 Lecture Hours)**
Wastewater treatment of effluents from dye, tannery, dairy and food industries, Wastewater treatment of effluents from pharmaceutical, distilleries, polymer, electrochemical industries, Wastewater treatment of effluents from explosive, pesticide and petrochemical industries, Treatment of industrial gaseous pollutants and Vocs. Medical waste and solid waste management.

Module V: Bioremediation and biodegradation **(8 Lecture Hours)**
Biostimulation of naturally occurring microbial activities, Bioaugmentation, *In situ, ex situ* and engineered bioremediation, Microbial system for heavy metal accumulation , Biosorption, Bioleaching, Detoxification of chlorinated hydrocarbons, aromatics and DIOXINS, Biodesulphurisation of crude petroleum , Future challenges, fate and effects of xenobiotic organic chemicals

Module VI: Novel Biotechnology methods for pollution control (7 Lecture Hours)
Application of nanobiotechnology in environment, Vermitechnology, Genomic tools in bioremediation Biodegradable and ecofriendly products Global environmental problems: Ozone depletion, UV-radiation, Green house gases, acid rain and biotechnological approaches of their management

References

1. Metcalf and Eddy, "Waste water Engineering Treatment, Disposal and Reuse". McGraw Hill, 2010.
2. Jogdand, S.N. "Environmental Biotechnology". Himalaya Publishing House, New Delhi, 2007.
3. Karnely D. Chakrabarty K. Ovnen G.S. "Biotechnology and Biodegradation, Advances in Applied Biotechnology series", Gulf Publications Co. London 2008
4. Prescott, Harley and Klein, "Microbiology", 5th edition, McGraw Hill, 2014.
5. R. C. Dubey A Textbook of Biotechnology, S.Chand publications, 4th edition, 2009
6. Indu Shekhar Thakur, "Environment Biotechnology basic concepts and applications", IK International, 3rd edition, 2006
7. Graty. C.P.L., Daigger, G and Lim, H.C, "Biological Wastewater Treatment". 3rd Edition, Marcel Dekker, 2008

18BT3032	Entrepreneurship and Management	L	T	P	C
		3	0	0	3

Course Objectives:
To improve knowledge on
1. To impart various aspects of product design and development
2. To inculculate concept generation and selection
3. To understand technology behind the product of the service

Course Outcome:
The students will be able to
1. Understand the principles of product design, basic management techniques, entrepreneurial skills and funding agencies.
2. Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.
3. Induce entrepreneurial intent as well as innovation, scalability and marketing of the product.
4. Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career.
5. Assess the commercial viability of a new technology based idea to prototype and biosafety.
6. Transform research based ideas into feasibility and business plans and IPR.

Module I: Introduction (8 Lecture Hours)
Entrepreneurship and economic development. evolution of entrepreneurship, stages in entrepreneurial process, entrepreneurship in India, Role of SSI in economic development, Government support for SSI. Role of society and family in the growth of an entrepreneur. Challenges faced by women in entrepreneurship.

Module II: Product design (7 Lecture Hours)
Product design, importance, objectives, factors influencing product design, Product Development Process, sources of ideas for designing new products, stages in product design. Guidelines of DBT for formulating project and financing.

Module III: Innovation and prototype (7 Lecture Hours)
Creativity and innovation, generation of ideas, technical and market feasibility study, opportunity assessment, business plan preparation, execution of business plan, conversion of ideas to prototype, risk taking-concept; types of business risks.

Module IV: IPR and copyright (8 Lecture Hours)
IPR and copy right, financial opportunity identification; banking sources; non banking institutions and agencies; venture capital and angel investors, meaning and role in entrepreneurship, government schemes

for promoting entrepreneurship. GMO and IPR; WTO, GATT and TRIPS agreement; Indian Patent Act; Patenting procedures

Module V: Biosafety (8 Lecture Hours)

Plant Breeder's Rights; Biosafety – levels; Biosafety guidelines; Role of Biosafety committee; Definition of GMOs & LMOs; Risk factors; Overview of National Regulations and relevant International Agreements including Cartagena Protocol, Biological material transfer procedure.

Module VI: Start up process (7 Lecture Hours)

Procedure for getting license and registration, challenges and difficulties in starting an enterprise, host institution support, Funding agencies – BIRAC, NEN, STEP, DST-NIMAT, TSDB; The role of technology/social media in creating new forms of firms, organizations, networks and cooperative clusters. Market- traditional and E-commerce, expanding markets: local to global.

References

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra, Information Solution Pvt. Ltd., 2007.
3. "Entrepreneurship: Theory", Process and Practice, Donald F. Kuratko, 9th Edition, Cengage Learning, 2011.
4. 4. S.S.Kanka Entrepreneurship Development, S.Chand and Co, New Delhi 2007.
5. Anupam Singh and Ashwani Singh. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), NPH, New Delhi (2010)
6. "Entrepreneurial Development", Jayshree Suresh, 5th Edition, Margham Publications, 2008.
7. "Entrepreneurship", Robert D. Hisrich, 6th Edition, Tata McGraw Hill Publications.2009.

18BT3033	**Industrial Waste Management**	**L**	**T**	**P**	**C**
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Understanding of problems of different kind of hazardous waste from industrial process.
2. Engineering and technical options for site specific waste management
3. Cleaner Industrial process and zero waste sustainable initiatives

Course Outcome:

The students will be able to

1. Identify the purpose and strategic options for industrial waste management
2. Analysis of hazardous waste constituents understand health and environmental issues
3. Select appropriate waste-water treatment process depending on the scenarios
4. Evaluate challenges and design aspect of land-fill operation for solid-waste management
5. Apply steps in solid waste management-waste reduction at source
6. Design cleaner production strategies and cooperation in industrial complexes

Module 1: Introduction to Industrial waste management system (9 Lecture Hours))

Uses of water by industry-Sources and types of industrial wastewater; regulatory requirements for treatment of industrial wastewater-Industrial waste survey Industrial Wastewater generation; Treatment Evaluation for Air Emission and Solid waste; Waste Characterization and classification; Population equivalent-Toxicity of Industrial effluents and Bioassay tests.

Module II: Pollution prevention (5 Lecture Hours)

Prevention vs. control of Industrial Pollution, Benefits and Barriers-Source reduction techniques, Waste audit; Evaluation of Pollution Prevention options, Co2 mitigation in industrial environment.

Module III: Industrial Waste water treatment (10 Lecture Hours)

Equalization- Neutralization- Oil separation Flotation-Precipitation-Heavy metal Removal - Refractory organics separation by adsorption. Aerobic and anaerobic biological treatment Sequencing batch reactors-

High Rate reactors Chemical; Oxidation –Ozonation. Photo catalysis Wet Air Oxidation-Evaporation Ion Exchange-Membrane Technologies – Nutrient removal.

Module IV: Solid waste treatment and disposal (7 Lecture Hours)

Categories and Characterization, Solid waste land fill, Land-fill cover and Cap, Waste stabilization, Management of Organic industrial waste, Incineration strategies and Energy recovery, Composting Industrial waste

Module V: Case studies with different Industrial Scenarios (7 Lecture Hours)

Tanneries-pulp and paper-metal finishing; Petroleum Refining-Pharmaceuticals-Sugar and Distilleries; Food Processing-fertilizers-Thermal Power Plants; and Industrial Estates, Textile and Paper Industries

Module VI: Cleaner production and Newer Management strategies (**7 Lecture Hours**)

Waste management Approach – Volume and strength reduction – Material and process modifications – Recycle, reuse and by-product recovery – Applications, Zero discharge attainment strategies, Naturally Evolving Industrial complexes

References

1. Woodard Frank (2001) ***Industrial Waste treatment Handbook***, Butterworth Heinemann
2. Nelson Leonard Nemerow (2010) ***Industrial Waste Treatment: Contemporary Practice and Vision for the Future***, Elsevier
3. Wang Lawrence K., Hung Yung-Tse, Lo Howard H., Constantine Yapijakis (2006) ***Hazardous Industrial Waste Treatment***, CRC Press
4. John Pichtel, ***Waste Management Practices: Municipal, Hazardous, and Industrial***, Second Edition, CRC Press
5. Wang Lawrence K., Hung Yung-Tse, Shammas Nazih K. (2009) ***Handbook of Advanced Industrial and Hazardous Wastes Treatment***, CRC Press

		L	T	P	C
18BT3034	**INDUSTRIAL SAFETY**	3	0	0	3

Course Objectives:

1. The course is intended to provide a general concept in the dimensions of disasters caused by nature beyond the human control
2. The disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.
3. To improve knowledge about rescue methods

Course Outcome:

1. To learn the different safety aspects in industrial application and daily life
2. To learn safety procedure followed in industries
3. To learn the different types of rescues
4. To know the procedure for risk analysis
5. To know different type of disaster
6. To know procedure for damage assessment

Module I Safety Management (8 Hours)

- Concept of Safety, Applicable areas, unsafe actions &Conditions. Responsibility of Safety - Society, Govt., Management, Union & employees.

Safety Officer - Appointment, Qualification, Duties of safety officer. Safety Committee - Membership, Functions & Scope of Safety committee. Motivation & Training of employees for safety in Industrial operations.

Module II Disaster Management (8 Hours)

Introduction on Disaster Different Types of Disaster : Natural Disaster Man-made Disaster Biological Disasters,Accidents (Air, Sea, Rail & Road), Structural failures(Building and Bridge), War & Terrorism etc. Causes, effects and practical examples for all disasters.

Module III Risk Analysis (8 Hours)

Risk and Vulnerability Analysis ,Risk Reduction , Strategic Development for Vulnerability Reduction,Disaster Preparedness and Response Preparedness- Disaster Preparedness: Concept and Nature,Disaster Preparedness Plan, Prediction, Early Warnings and Safety Measures of Disaster, Role of Information, Education, Communication, and Training, Role of Government, International and NGO Bodies.

Module IV Responsibility of Engineers (8 Hours)

Role of Engineers on Disaster Management. Response- Disaster Response : Introduction, Disaster Response Plan, Communication, Participation, and Activation of Emergency Preparedness Plan, Search, Rescue, Evacuation and Logistic Management, Role of Government, International and NGO Bodies, Psychological Response and Management (Trauma, Stress, Rumor and Panic) , Relief and Recovery ,Medical Health Response to Different Disasters

Module V Reconstruction and Recovery (7 Hours)

Rehabilitation, Reconstruction and Rehabilitation as a Means of Development, Damage Assessment, Post Disaster effects and Remedial Measures, Creation of Long-term Job Opportunities and Livelihood Options, Disaster Resistant House Construction , Sanitation and Hygiene,

Module VI Safety Awareness (6 Hours)

Education and Awareness, Dealing with Victims' Psychology, Long-term Counter Disaster Planning , Role of Educational Institute.

References:

1. Dr. Mrinalini Pandey, Disaster Management, Wiley India Pvt. Ltd.
2. Tushar Bhattacharya , Disaster Science and Management, McGraw Hill Education (India) Pvt. Ltd.
3. Jagbir Singh, Disaster Management : Future Challenges and Opportunities , K W Publishers Pvt. Ltd.
4. Crowl D A, Louvar J F, " Chemical Process Safety Fundamentals with applications", 2nd Prentice Hall, NJ (2002).
5. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services2005
6. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
7. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
8. Cheremisinoff, N. P., Practical Guide to Industrial Safety: Methods for Process Safety Professionals, CRC Press, 2001.

LIST OF COURSES

Sl.No	Course Code	Name of the Course	Credits
1.	17BT2001	Basics of Biochemistry	3:1:0
2.	17BT2002	Biochemistry Lab	0:0:2
3.	17BT2003	Principles of Chemical Engineering	3:0:0
4.	17BT2004	Cell Biology	3:0:0
5.	17BT2005	Microbiology	3:0:0
6.	17BT2006	Microbiology Lab	0:0:2
7.	17BT2007	Instrumental Methods of Analysis	3:0:0
8.	17BT2008	Instrumental Methods of Analysis Lab	0:0:2
9.	17BT2009	Basic Industrial Biotechnology	3:0:0
10.	17BT2010	Metabolism and Bioenergetics	3:1:0
11.	17BT2011	Bioprocess Principles	3:0:0
12.	17BT2012	Bioprocess Lab	0:0:2
13.	17BT2013	Fluid Mechanics for Biotechnologists	3:1:0
14.	17BT2014	Fluid Mechanics and Heat Transfer Lab	0:0:2
15.	17BT2015	Molecular Biology	3:0:0
16.	17BT2016	Genetic Engineering and Bioethics	3:0:0
17.	17BT2017	Molecular Biology and Genetic Engineering Lab	0:0:2
18.	17BT2018	Bioorganic Principles	3:0:0
19.	17BT2019	Bioreactor Engineering	3:0:0
20.	17BT2020	Enzyme Engineering	3:0:0
21.	17BT2021	Immunology	3:0:0
22.	17BT2022	Cell Biology and Immunology Lab	0:0:2
23.	17BT2023	Chemical Reaction Engineering	3:0:0
24.	17BT2024	Downstream Processing	3:0:0
25.	17BT2025	Downstream Processing Lab	0:0:2
26.	17BT2026	Mechanical Operations	3:0:0
27.	17BT2027	Chemical and Bio-thermodynamics	3:0:0
28.	17BT2028	Heat and Mass Transfer Operations	3:0:0
29.	17BT2029	Plant physiology and Crop Improvement	3:0:0
30.	17BT2030	Plant Genetic Engineering	3:0:0
31.	17BT2031	Agriculture and Biomass Energy	3:0:0
32.	17BT2032	Horticultural Crop Production, Management and Green House Technology	3:0:0
33.	17BT2033	Developmental Biology	3:0:0
34.	17BT2034	Human Genetics and Genomics	3:0:0
35.	17BT2035	Vaccine Biotechnology	3:0:0
36.	17BT2036	Animal Biotechnology and Cell Culture Techniques	3:0:0
37.	17BT2037	Cancer Biology	3:0:0
38.	17BT2038	Biopharmaceutical Technology	3:0:0
39.	17BT2039	Biochemical Engineering	3:0:0
40.	17BT2040	Metabolic Engineering	3:0:0
41.	17BT2041	Process Equipment Design	3:0:0
42.	17BT2042	Pilot plant & Scale Up practice	3:0:0
43.	17BT2043	Industrial Safety & Hazard Analysis	3:0:0
44.	17BT2044	Industrial Effluent Treatment	3:0:0
45.	17BT2045	Pollution Control and Engineering	3:0:0
46.	17BT2046	Mechanical Operation Lab	0:0:2
47.	17BT2047	Plant and Animal Tissue Culture Lab	0:0:2
48.	17BT2048	Bioprocess Control and Instrumentation	3:0:0

49.	17BT2049	Applied Medical Biochemistry	3:0:0
50.	17BT2050	Medical Biochemistry Lab	0:0:1
51.	17BT2051	Human Physiology and Anatomy	3:0:0
52.	17BT2052	Biomaterials and Artificial Organs	3:0:0
53.	17BT2053	Occupational Safety Management	3:0:0
54.	17BT2054	Medical Waste Treatment	3:0:0
55.	17BT2055	Cell Biology and Immunology	3:0:0
56.	17BT2056	Tissue Engineering	3:0:0
57.	17BT2057	Techniques in Pathology and Microbiology	3:0:0
58.	17BT2058	Microbiology and Immunology	3:0:0
59.	17BT2059	Analytical Instrumentation	3:0:0
60.	17BT2060	Biology in Everyday Life	3:0:0
61.	17BT2061	Biotechnology and Environment	3:0:0
62.	17BT2062	Entrepreneurship in Bioengineering	3:0:0
63.	17BT2063	Pollution Control	3:0:0

17BT2001 BASICS OF BIOCHEMISTRY

Credits: 3:1:0

Course Objectives:

- To ensure students to having strong foundation in structure, composition and function of various biomolecules.
- To introduce them to the basic nature and properties of biomolecules which are involved in metabolic pathways and bioprocesses
- To understand the significance of these biomolecules and to apply these fundamentals in biotechnology

Course Outcomes:

The students will be able to

- Acquire knowledge on structure, properties and biological functions of Primary metabolites which help them to understand the significance of biomolecules in bioprocesses and biotechnology
- Acquire knowledge on nucleic acids structure and interactions which help them to understand genetic composition and to apply in genetic engineering
- Assess the significance of vitamins and minerals in the proper functioning of living cells which help them to enrich the biotechnology products
- Relate biomolecules with the scope of biotechnology
- Justify the clinical and biological significance of these biomolecules
- Understand the conjugates of different biomolecules and their importance

Unit-I: Classification, structure, properties and functions of carbohydrates: Monosaccharides –classes, examples, structural and stereo isomers, ring structure and mutarotation; Disaccharides – classes- homo and hetero, examples. Oligosaccharides-examples; Polysaccharide – classes, examples; complex and conjugated carbohydrates- proteoglycan, glycoprotein, glycolipid. Review on industrial significance of carbohydrates-examples, Clinical and biological significance of carbohydrates-examples.

Unit-II: Fatty acids- basic structure, types, isomers, properties, functions and essential fatty acids; ketone bodies, Classes, structure, properties and functions of lipids: Simple lipid- examples, Compound lipid- examples, ether lipid, Derived lipid – sterols like cholesterol; Review on industrial, biological and clinical significance of fatty acids and lipids –examples.

Unit-III: Amino acids- basic structure, isomers, classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides –examples; Proteins- structure / conformation levels, Ramachandran plot, classification, properties and functions of proteins-examples, significance of proteins in biotechnology.

Unit-IV: Nucleotides- composition, structure, properties and functions; Nucleic acids- types (RNA, DNA), DNA structure-composition, stabilizing bonds, protein –DNA interactions; RNA types, structure and functions, nucleoproteins – nucleosome, ribosome; properties of nucleic acids

Unit-V: Vitamins: classification, source, daily requirement, functions and deficiency symptoms, review on nutraceuticals and Vitamin supplementations; Minerals: classification, specific function and deficiency disorders, review on mineral supplementations.

Text Books

1. Lehninger, A.L, Nelson D.L and Cox, M.M, “Principles of Biochemistry”, Freeman Publishers, New York, 4th edition, 2005.

References Books

1. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 2008.
2. Lubert Stryer, “Biochemistry”, WH Freeman & Co., 4th edition, 2000.
2. Voet and Voet, “Biochemistry”, John Wiley & Sons Inc., 2nd Edition, 2013.
3. Jain and Jain “Biochemistry”, Chand publication, 4th edition, 2008.

17BT2002 BIOCHEMISTRY LAB

Credits: 0:0:2
Co-requisite: 17BT2001-Basics of Biochemistry

Course Objectives:

- To understand the basic units and measurements of biochemical solutions
- To develop the skills in identifying the various biomolecules
- To develop the skills of quantifying various biomolecules

Course Outcomes:

The students will be able to

- Know the basic units, calculations and different measurements tools used in biomolecule evaluations
- Develop the basic lab skill in preparing different solutions of different concentrations and their measurement tools with representing units
- Acquire knowledge in estimation of different carbohydrates using suitable method
- Analyze through tests and identify the different carbohydrate, amino acid and lipid molecules present in the given sample solution.
- Apply the reaction principle to quantify the proteins, amino acids, cholesterol and nucleic acids using colorimeter
- Apply basic knowledge on the properties of biomolecules for the extraction of minerals and vitamins from food sources and quantify them.

List of experiments:

1. Study of biochemical solutions, units and measurements
2. Estimation of total carbohydrate by Anthrone method
3. Qualitative analysis of carbohydrates
4. Estimation of reducing sugars by Di Nitro Salicylic acid method
5. Tests for lipids: - Fats and cholesterol
6. Estimation of cholesterol by Zak’s method
7. Estimation of protein by Lowry’s/ Bradford’s method
8. Qualitative analysis of amino acids
9. Estimation of amino acid by Ninhydrin method
10. Estimation of DNA by diphenylamine method
11. Dry ashing of food materials and colorimetric estimation of phosphorus
12. Estimation of ascorbic acid content in foods

17BT2003 PRINCIPLES OF CHEMICAL ENGINEERING

Credits: 3:0:0

Course Objectives:

- To develop skills of students in principles and basic calculations
- To familiarize in material balance for non-reactive systems and simple reactive systems
- To conceptualize energy balance for non-reactive systems and simple reactive systems in chemical process engineering.

Course Outcomes:

The students will be able to

- Understand the importance and interconversion of different units
- Apply concept of mass balance approach in unit operations

- Adapt appropriate system boundary to resolve multiunit chemical process
- Demonstrate vapor-liquid equilibrium calculations for ideal multicomponent system.
- Apply concepts of liquid-vapour equilibrium in two phase systems
- Classify different form of energy and their implication
- Enable to assess energy expenditure on chemical process system

UNIT I - Units systems, basic units, derived units, dimension analysis, force, pressure, work, heat, conversion to SI units, Mass and volumetric flux, Avogadro number, molarity, molality and normality, molecular weight, equivalent weight, mass fraction, mole fraction.
UNIT II - Fundamental of material balance, Basics of calculation, approach of solving material balance problems, Mixing, Crystallization, Evaporator, Distillation, Absorption Column, Drier, Liquid - Liquid and Solid - Liquid Extraction
UNIT III - Stoichiometry, limiting & excess reactants, fractional conversion, yield, Material balance in sequential multi-unit and recycle Systems, Material Balance of Unsteady State Reaction systems
UNIT IV - Ideal Gases, Standard temperature and pressure, partial pressure, Gas laws: Amagat's law and Daltons law, Single component two phase system, vapor pressure, vapor liquid equilibrium, saturation, condensation, relative humidity
UNIT V - Elements of energy balance calculations, types of Energy, Internal energy, Enthalpy changes, Heat capacities, Procedure for energy balance calculations, Closed/open unsteady state system, closed/open steady state systems.

Text Book:
1. David Mautner Himmelblau, James B. Riggs., « Basic Principles and Calculations in Chemical Engineering »Prentice Hall of India, 4th editon. 2004
Reference Books:
1. Felder, R.M., Rousseau R.W., "Elementary Principle of Chemical Processes", John Wiley and Sons Publication 3rd edition, 2000.
2. BI Bhatt & SM Vora "Stoichiometry", Tata Mcgraw- Hill, 4th edition, 2004.
3. Venkataramani.V and Anantharaman.A., "Process Calculations", PHI learning Pvt. Ltd, 2003.

17BT2004 CELL BIOLOGY

Credit: 3:0:0

Course Objectives:
- To acquaint students with the concepts in Cell Biology.
- To understand structure and function of the organelles of cells
- To learn the cell-cell interactions, transport mechanism and signaling pathways of cell

Course Outcomes:
The students will be able to
- Acquire knowledge on the structure and function of cellular organelles and components
- Analyze the behavior of cells in their microenvironment in multicellular organisms (i.e. a cell within its social context) with emphasis on cell-cell interactions, cell-extra cellular matrix interactions
- Illustrate specific processes and proteins involved in membrane transport.
- Understand receptor subclasses and their possible uses in cell signaling
- Determine the Mode of action and regulation of signaling molecules for signal transduction
- Outline the mechanisms by which different messenger-receptor interactions bring about long or short-term changes in cell state.

UNIT I - Brief history of cytology and cell theory, Prokaryotes and Eukaryotes (plant cell and animal cell), Membranes of the cell: Plasma membrane, Nuclear membranes, Organelle membranes. Brief outline of organelles; Nucleus, nucleolus, ribosome, mitochondria, chloroplast, vacuole, endoplasmic reticulum, golgi apparatus, peroxisome, glyoxisome, lysosome, centriole, cilia and flagella. Cell cycle and molecules that control cell cycle, Regulation of cell cycle.
UNIT II - Microtubules, microfilaments, intermediate filaments and their binding proteins. Cell- cell communication: Cell junction, Cell adhesion, Extra Cellular Matrix, Basal Lamina.

UNIT III - Passive and active transport, permeases, osmosis, pumps and gated channels, co transport: symport, antiport. Vesicular transport: Endocytosis, Exocytosis, Protein glycosylation in eukaryotes and protein sorting. Transport in prokaryotic cells, entry of viruses and toxins into the cell.
UNIT IV - Signaling molecules: autocrine, paracrine and endocrine and its mode of action in cell signaling. Cytosolic, nuclear and membrane bound receptors: G-protein coupled receptor, protein tyrosine kinases receptor and cytokine receptors for cell signaling.
UNIT IV - Signal amplification, different models of signal amplifications: role of cyclic AMP, cyclic GMP and G proteins in signal transduction, phosphorylation and regulation in signaling: serine – threonine kinases in signaling. Role of Inositol triphosphate (IP_3) in signal transduction, calcium ion flux and its role in cell signaling.

Text Books:

1. Geoffrey M. Cooper and Robert E. Hausman, The Cell: A Molecular Approach, Fifth Edition, ASM Press and Sinauer Associates, Inc., USA, 2015.
2. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, Molecular Biology of the cell, fifth edition, Taylor and Francis group, 2012.

Reference:

1. De Robertis & De Robertis, Cell Biology, 4^{th} Edition, 2010.

17BT2005 MICROBIOLOGY

Credits: 3:0:0

Course Objectives:

- To highlight the roles and characteristics of microorganisms
- To study in detail the growth of microorganisms and impact of environment on their growth
- To evaluate explicitly, the metabolic pathways, role of microbes in public health; insight into the physical and chemical control of microorganisms

Course Outcomes:

The students will be able to

- Acquire basic knowledge on the history and development of microbiology
- Recognize the fundamental concepts in the structure and functions of microbes
- Understand the classification and nomenclature of microorganism, staining, microscopic and sterilization techniques
- Understand the controlling of microbes using physical and chemical methods
- Demonstrate the microbial nutritional requirements for growth and metabolism
- Explain the dynamics of commensal, opportunistic and pathological relationships between microbes and humans

UNIT I - An overview of microbiology including a historical perspective of microbiology-classification, and nomenclature of microorganisms-Basics of Microscopy – light, phase, fluorescent and electron microscopy- principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining
UNIT II - Morphology, Structure and Functions of Prokaryotic- and Eukaryotic Cells. Multiplication of bacteria, viruses, algae, protozoa and fungi with a special mention of life history of actinomycetes, yeast and bacteriophage
UNIT III - Nutritional requirements of bacteria: Growth curve and Different methods to quantitative bacterial growth. Aerobic and Anaerobic: Mathematics of growth generation time and growth rate constant, factors affecting growth. Microbial metabolism- Entner– Doudoroff and Phosphoketolase pathway.
UNIT IV - Physical and chemical control of microorganisms – sterilization: Moist heat, dry heat, radiation and filtration. Disinfection: phenol, alcohol and detergents; Chemotherapy and antibiotics- antibacterial, anti-fungal agents, anti-viral agents
Unit V: Interaction between Microorganisms – Commensalism, Synergism, Mutualism (symbiosis). Lichen symbiosis. Normal flora of human healthy host, importance of nosocomial infections, mode of transmission of airborne pathogens, food and water borne infections caused by bacteria and virus, Significations of microbes in food; Industrial microbial products and processes

Text Books:

1. Pelczar MJ, Chan ECS And Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.2007

2. Prasad B.N., “A Text Book of Biotechnology”, Budha Academic Enterprises, G.P.O., Box 20195, Kathmandu, Nepal. 2003.

Reference Books:

3. Talaron K, Talaron A, Casida, Pelczar and Reid. Foundations in Microbiology, W.C.Brown Publishers, 2001.
1. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 2001.
2. Lim D, “Microbiology”, Second Edition, WCB-Mc Graw Hill, 2001.

17BT2006 MICROBIOLOGY LAB

Credits: 0:0:2
Co-requisite: 17BT2005- Microbiology

Course Objectives:

- To enable the students to understand the basic concepts involved in the isolation of different kinds of microorganisms and proper handling experience of microorganisms
- Students will be taught the parts of microscopes and the functions
- The students will learn to identify the microorganisms using various staining techniques and biochemical tests

Course Outcomes:

The students will be able to

- Acquire basic knowledge on lab safety guidelines in a microbiology laboratory
- Demonstrate proper usage, identify the parts/functions of microscopes
- Experiment with transfer of living microbes using aseptic technique
- Demonstrate proficiency and use of microbial isolation technique and staining techniques
- Build the skill to prepare media for experiment on media preparation for microbial growth and cultivation techniques of microorganisms
- Culture, identify, and explain microorganisms present in environmental samples

List of Experiments:

1. Lab safety method and Regulations, Principles and methods of sterilization and Study of instruments: Compound microscope, Autoclave, Hot air oven, Laminar Airflow
2. Media preparation- Nutrient broth, Nutrient agar, slants, soft agar
3. Culturing of microorganisms– in broth and in plates (pour plates, streak plates)
4. Enumeration of microorganisms from Soil
5. Enumeration of microorganisms from Water
6. Staining Techniques (Simple, Gram staining, and spore staining)
7. Staining of fungus – Lacto phenol cotton blue staining
8. Measurement of microbial Size – Micrometry
9. Motility test by Hanging drop method and soft agar inoculation
10. Biochemical Characterization of Bacteria-. IMViC test, Catalase, Casein and Starch Hydrolysis
11. Anaerobic Cultivation – Fluid Thioglycolate broth
12. Antibiotic sensitivity assay – Disc and Well diffusion method

17BT2007 INSTRUMENTAL METHODS OF ANALYSIS

Credit: 3:0:0

Course Objectives:

- To enable the students to understand the principles of instrumentation
- To impart the knowledge of different techniques and methods in biotechnology
- To improve the understanding of applications of techniques in the field of biotechnology

Course Outcomes:

The students will be able to

- Understand the basic measurement methods, different extraction methods and its applications in biotechnology
- Describe the instrumentation and applications of different spectroscopic techniques
- Demonstrate the principles, techniques and applications of chromatography.
- Explain the various electrophoretic techniques and their applications in biotechnology
- Understand and interpret various structural elucidation process and radioisotopes methods
- Apply the principle on various techniques and perform research in biotechnology

UNIT I - Classification of instrumental methods; Concepts of accuracy, precision and limits of detection (LOD); Types of errors–random and systematic; Calibration of instrumental methods comparison with standards, Buffers, pH – pH meter and applications, Solvent extraction –introduction and principle; Extraction techniques–batch, stripping or back, continuous and counter-current; Principle of solid extraction (Soxhlet); Types -Temperature assisted, pressurized hot water and supercritical fluids based extraction.
UNIT II - Basic principle of Spectroscopy -Beer-Lambert's law, Principle, Instrumentation and applications of Colorimeter, Flame photometry, nephelometry,spectrofluorimetry and Spectrophotometer: types– UV – visible – IR – Raman spectroscopy.
UNIT III - Principle, types and applications of Chromatography- Thin layer, Adsorption, Ion-exchange, Affinity, Gelfiltration, GC, UPLC and HPLC.
UNIT IV - Principle, Types and applications of Electrophoresis– agarose gel, polyacrylamidegel (PAGE), SDS-PAGE– principle, instrumentation and applications; Immuno, pulse field and capillary electrophoresis, and isoelectric focusing– principle and applications; Thermo gravimetricanalysis (TGA)-Principle, instrumentation and applications
UNIT V - Mass spectrometry–principle, instrumentation (electron spray ionization [ESI] & chemical ionization [CI]) and applications; MALDI-TOF–principle and instrumentation; x-ray diffraction and nuclear magnetic resonance (NMR) – principle, instrumentation and applications; Radioactive isotopes, radioactive decay and their types, radioactive techniques - RIA, GM counter, Scintillation counter, Applications in Medicine & Diagnosis.

Text Books

1. Willard and Merrit, "Instrumental Methods and Analysis" 6th edition, CBS Publishers & Distributors, 2002.

Reference Books

1. Gurdeep R. Chatwal and Sham K. Anand. Instrumental Methods of Chemical Analysis. 5th Edition. Himalaya Publishing House, India. (2012).
2. B.K.Sharma. Instrumental Methods of Chemical Analysis. 24th revised and enlarged edition. GOEL Publishing House, India. (2014).
3. Keith Wilson and John WalkerPrinciples and Techniques of Practical Biochemistry and Molecular Biology. 7th Edition. Cambridge University Press, U.K. (2010).
4. Douglas A. Skoog, F.James Holler and Stanley R. Crough. Instrumental Analysis. 6th Edition. Brooks Cole Publishing Company. USA, (2007).

17BT2008 INSTRUMENTAL METHODS OF ANALYSIS LAB

Credit: 0:0:2

Course Objectives:

- To impart technical knowledge about the working principle and applications of different equipments related to biotechnology experiments.
- To enable the students to understand the principles of instrumentation
- To impart the knowledge of different techniques and methods in biotechnology

Course Outcomes:

- Understand the basic measurement methods and its applications in biotechnology
- Describe the instrumentation and applications of different spectroscopic techniques
- Demonstrate the principles, techniques and applications of chromatography.
- Explain the determination of pH and their applications in buffer preparations
- Understand different purification techniques of primary and secondary metabolites
- Examine the applications of equipments involved in experimental biotechnology

List of Experiments

1. Estimation of Polyphenol by Colorimetric Method
2. Verification of Beers Law and Construction of Beers Law plot
3. Preparation of buffer solution with Henderson-Hasselbach equation and its verification with pH meter
4. Titration curves of Acetic acid and Citric Acid using pH meter
5. Precision and Validity of an experiment
6. Determination of analytical wavelength for given sample
7. Estimation of sugars by ascending paper chromatography
8. Identification of amino acids by ascending paper chromatography

9. Determination of turbidity by nephelometry
10. Conductivity measurement in titration
11. Gas Chromatography
12. High Performance Liquid Chromatography

17BT2009 BASIC INDUSTRIAL BIOTECHNOLOGY

Credits: 3:0:0

Course Objectives:

- The study of the subject constitutes the production of bioproducts .
- It imparts the knowledge of basic principles of science and engineering applied to Industrial Biotechnology.
- The study also focuses on a creative perspective in using microorganisms for the production of various types of bioproducts

Course Outcomes:

The students will be able to

- Gain basic knowledge on the biology of microorganisms and fermentation technology.
- Understand the principles related to aerobic and anaerobic fermentation processes.
- Apply the principles on real time fermentation models using microorganisms.
- Analyze conceptually the need for the production of bioproducts related with food, drug industries.
- Evaluate the media optimization procedures for the better scale up standards in the fermentation industry.
- Create fermentation processes in lab scale and to scale up for large volume production

UNIT I - A historical overview of industrial fermentation process – traditional and modern biotechnology. A brief survey of organisms, processes, products relating to modern biotechnology. Process flow sheeting – block diagrams, pictorial representation.

UNIT II - A brief outline of processes for the production of some commercially important organic acids (e.g. citric acid, acetic acid etc.,); amino acids (glutamic acid, aspartic acid etc.,) and alcohols (ethanol, butanol etc.,)

UNIT III - Study of production processes for various classes of secondary metabolites: antibiotics: beta-lactams (penicillin, cephalosporin etc.), aminoglycosides (streptomycin etc.,)

UNIT IV - Production of industrial enzymes such as proteases, amylases, Production of biofertilisers, biopreservatives (Nisin), cheese, biopolymers(PHB).

UNIT V - Production of vaccines and monoclonal antibodies. Products of plant and animal cell culture.

Text Books

1. Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005. 4th Edition, 2005
2. Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" 2nd Edition Cambridge University Press, 2001.

Reference Books

1. Casida, L.E. "Industrial Microbiology", New Age International (P) Ltd, 1968.

17BT2010 METABOLISM AND BIOENERGETICS

Credits: 3:1:0

Pre-requisite: 14BT2001 Basics of Biochemistry

Course Objectives:

- To learn the metabolic pathways and their regulations
- To learn the importance of bioenergetics
- To understand the inborn errors of metabolism.

Course Outcomes:

The students will be able to

- Acquire knowledge on the metabolic pathways
- Summarize the biosynthesis and degradation pathway of amino acids
- Explain the importance of bioenergetics, energy rich compounds.
- Understand the metabolic reactions of nucleotides
- Learn the various inborn errors of metabolism
- Analyze the anabolic and catabolic reactions of lipids

UNIT I - Glycolysis, TCA cycle Pentose phosphate pathway, Glycogenesis and Glycogenolysis; Glycogen storage diseases.
UNIT II - Transamination and urea cycle. Biodegradation of selected amino acids- Ala, Thr, Leu, Ile, Tyr, Phe, Trp. Biosynthesis of amino acids- tyrosine. phenylalanine and tryptophan and inborn errors of amino acid metabolism
UNIT III - Biosynthesis and oxidation of fatty acids, ketogenesis, energetics of beta oxidation, cholesterol biosynthesis and degradation, inborn errors of lipid metabolism
UNIT IV - Anabolism of purines and pyrimidines, catabolism of purines and pyrimidines, regulatory pathways, inborn errors of purine and pyrimidine metabolism
UNIT V - Definition, redox biochemistry. Energy rich compounds. Respiratory chain and Oxidative phosphorylation.

Text Book:

1. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 4th edition, 2008.

Reference Books

1. Lehninger, David L. Nelson & Michael M. Cox, "Principles of Biochemistry", Freeman Publishers,4th edition, 2005.
2. Lubert Stryer, "Biochemistry", WH Freeman & Co., 4th edition, 2000.
3. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.

17BT2011 BIOPROCESS PRINCIPLES

Credits: 3:0:0

Course Objectives:

- To understand the principles of bioprocessing and appreciate its applications in Bioprocess Technology
- To understand the importance of medium formulations and optimization
- To Understand the sterilization kinetics

Course Outcomes:

The students will be able to

- Review the fermentation processes and sampling
- Summarize media formulation and medium optimization for fermentation process
- Analyze Thermal death kinetics of microbes, sterilization time and filter sterilization of medium and air
- Demonstrate isolation and storage of industrially important microbes
- Assess inoculum development for fermentation process
- Examine stoichiometry of cell growth and product formation

Unit I - Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermenter and ancillaries, aseptic condition and containment, Sampling
Unit II - Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen,minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization by Plackett burmann method
Unit III - Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of depth filters, design of sterilization equipment - batch and continuous.
Unit IV - Isolation of industrially important microbes, preservation and storage of industrially important microbes, Quality control of preserved stock cultures and development of inoculum for industrial fermentation
Unit V - Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation

Text Book

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.

Reference Book

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2002

17BT2012 BIOPROCESS LAB

Credits: 0:0:2
Corequisite: 17BT2011- Bioprocess Principles

Course Objectives:

- To learn the culturing of microbes and quantifying biomass production
- To study enzyme kinetics
- To learn immobilization techniques

Course Outcomes:
The students will be able to

- Acquire knowledge in the cultivation of microorganisms and estimating its dry weight.
- Demonstrate enzyme assay qualitatively and quantitatively
- Examine factors affecting enzyme activity.
- Devise methods to produce fermented products
- Utilize solid state fermentation for production of fermented products
- Assess the effect of substrate concentration on growth of microbes.

List of Experiments

1. Culturing of Different Types of Microorganism
2. Estimation of Biomass Production
3. Effect of Substrate Concentration on Growth of E-coli
4. Effect of pH on Enzyme Activity
5. Effect of Temperature on Enzyme Activity
6. Immobilization of ∞ - Amylase Enzyme by entrapment method
7. Components of Fermentor
8. Citric acid production by Solid State Fermentation
9. Enzyme Assay- Starch Plate Assay
10. Quantitative Enzyme Assay
11. Production of Wine
12. Production of Amylase from Bacillus subtilis and Assaying for its Activity

17BT2013 FLUID MECHANICS FOR BIOTECHNOLOGISTS

Credits: 3:1:0

Course Objectives:
To acquire a sound knowledge on fluid properties and fluid statics

- Dynamic characteristics for through pipes and porous medium,
- Flow measurement and fluid machineries

Course Outcomes:
The students will be able to

- Understand the fundamental properties of fluids and its characteristics under static conditions.
- Develop empirical correlation using dimensionless analysis.
- Analyze flow of fluid through pipe and over the of solid Understand and select flow meter(s),
- Characteristics of pumps used in Chemical Process Industries
- Evaluate the process parameters.
- Create basic equipments from learnt principles.

UNIT I - Methods of analysis and description - fluid as a continuum – Velocity and stress field - Newtonian and non-Newtonian fluids – Classification of fluid motion
UNIT II - Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid - application to manometry – Differential analysis of fluid motion – continuity, equation of motions, Bernoulli equation and Navier- Stokes equation.
UNIT III - The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi-theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies

UNIT IV - Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds.
UNIT V - Flow measurement - Constant and variable head meters; Velocity measurement techniques;Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans.

Text Books

1. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 5th Edition", John Wiley, 2006
2. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", Second Edition, McGrawHill, (1991).

References

1. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999
2. James O Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers' Prentice Hall PTR (International series in Chemical Engineering) (1999)
3. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2005

17BT2014 FLUID MECHANICS & HEAT TRANSFER LAB

Credits : 0:0:2

Course Objectives:

- To provide extensive knowledge on various unit operations and flow measuring equipments involved in bioprocess industries

Course Outcomes:

The students will be able to

- Understand the heat transfer concept and its applications.
- Understand the important of fluid mechanics applications.
- Analyze various flow meters for wide range of applications in industrial biotechnology
- Demonstrate the friction factor for wide range of applications in industrial biotechnology
- Demonstrate the thermal conductivity of materials for wide range of applications in heat exchangers
- Experiment with annular pipe for wide range of applications in industrial.

List of Experiments

1. Calibration of Flow Meter (Venturimeter)
2. Determination of pressure head loss in Annular Pipe
3. Thermal Conductivity for Insulating Medium
4. Determination of friction factor in Helical Coil
5. Determination of Darcy's Friction Factor
6. Determine the overall heat transfer coefficient in Double pipe Heat Exchanger (Parallel and Counter Flow)
7. Determine the coefficient of discharge in Orifice Meter
8. Determine the overall heat transfer coefficient in Shell and Tube Heat Exchanger
9. Determinations of Minor Losses in Pipes (Sudden Expansion And Contraction)
10. Determine the flow rate of Rota meters
11. Pressure Drop in a Fluidized Bed Column
12. Pressure Drop Across Packed Column

17BT2015 MOLECULAR BIOLOGY

Credits: 3:0:0

Course Objectives:

- To understand the basics of molecular biology and gene expression.
- To understand DNA damage and repair systems
- To get an overview on the regulation of gene expression

Course Outcomes:

The students will be able to

- Understand the fundamental concepts of the organization of genome and central dogma
- Summarize the fundamental mechanism on the process of replication, transcription and translation in the gene expression
- Recognize common mutations, their natural repair systems and the natural gene expression regulation systems in prokaryotes and eukaryotes
- Discuss and distinguish the replication of prokaryotic and eukaryotic DNA
- Explain the synthesis of RNA and post-transcriptional modifications
- Comprehend the role of operons and cis/trans elements in gene regulation

UNIT I - Chromosome organization in prokaryotes and eukaryotes, Different forms of DNA, Classical experiments : Grifith, Hershey and chase; Avery McLeod & McCarty. Bacterial Recombination: Transformation, Transduction, Sexduction and Conjugation. Lytic and lysogeny

UNIT II - DNA replication- Semi conservative replication, Meselson stahl experiment, Enzymes in replication, Replication in prokaryotes, D-loop and rolling circle mode of replication, regulation of replication, replication of linear viral DNA. Replication in eukaryotes and telomere replication. Mutation : types, DNA repair - methylation, mismatch, SOS, recombination.

UNIT III - RNA polymerase, features of promoters and enhancers, transcription factors, Prokaryotic and eukaryotic transcription, inhibitors, post-transcriptional modification - RNA splicing and RNA editing. Transcription in virus : RNA replicase, Reverse transcriptase.

UNIT IV - Elucidation of genetic code-salient features, Process of translation in prokaryotes and eukaryotes, Post-translational modifications, Inhibitors..

UNIT V - Regulation of gene expression: In prokaryotes - lac and trp operons. Regulation in eukaryotes – cis and trans elements, chromatin in gene regulation.

Text book

1. David Friefelder, “Molecular Biology”, Narosa Publ. House. 6th edition 2003

Reference books

1. David R. Hyde, “Genetic and Molecular Biology”, Tata McGraw Publications, New Delhi, 4th edition, 2010.
2. Lehninger, A. L, Nelson D. L and Cox, M. M, “Principles of Biochemistry”, Freeman Publishers, New York, fourth edition, 2005
3. Gardner, Simmons and Snustad, “Principles of Genetics”, John Wiley, 8th edition, 2000

17BT2016 GENETIC ENGINEERING AND BIOETHICS

Credits: 3:0:0

Course Objectives:

- Helps the student to understand the tools and steps in Genetic engineering.
- Trains students on the strategy employed in genetic engineering.
- Helps the student understand the power of genetic engineering and the social implications and the ethics to be followed.

Course Outcomes:

The students will be able to

- Students learn the basics of genetic engineering
- Students understand the basic tools employed in genetic engineering.
- Students understand the use of cloning vectors in genetic engineering.
- Students are aware of the polymerase chain reaction and its variations and applications.
- Students learn the strategy of gene cloning.
- Students understand the implications of ethical issues pertaining to genetic engineering.

UNIT I - Restriction enzymes- Classification-nomenclature; Ligases- Modifying enzymes; Probe preparation and the methods of labeling them; Southern hybridization-Northern hybridization; Western blotting, Autoradiography; DNA finger printing-RFLP Analysis-chromosome walking.

UNIT II - Properties of ideal vectors Plasmids as vectors- PBR322- pUC vectors--M13-Lambda phage vectors ,Cosmid vectors, Phagemids-Cloning vectors in Gram positive bacteria- streptomycetes, Shuttle vectors, Expression vectors, YAC, BAC, Mammlian cells-SV40 & CMV vectors.
UNIT III - Mechanism of Polymerase chain reaction, types of PCR, Inverse PCR, Nested PCR, Molecular beacons, RACE PCR, RAPD, RFLP.
UNIT IV - Construction of recombinant DNA: Preparation of competent cell-Transformation (Physical, chemical and biological methods of Transformation), transfection- Recombinant selection and screening of Recombinant DNA, Genomic Library, cDNA library.
UNIT V - Definitions, history & views on ethics and bioethics. Ethical issues pertaining to biology and biotechnology. Special procedures for r-DNA based product production. Biosafety regulations, r-DNA guidelines- National and international, levels of containment.

Text Books

1. Desmond S. T. Nicholl, "An Introduction to Genetic Engineering, 3rd Edition " Cambridge University Press; South Asian edition , 2010
2. Monika Jain "Recombinant DNA Techniques", Narosa Publishing House, 2012.
3. Barry R. Schaller "Understanding Bioethics and the Law: The Promises and Perils of the Brave New World of Biotechnology" Praeger Publishers Inc, 2007

Reference Books

1. Sandy B. Primrose, Richard Twyman "Principles of Gene Manipulation and Genomics "Backwell Scientific Publications 2010.
2. Sandhya Mitra, "Genetic Engineering Principles and Practice", Macmillan Publications, 2008.
3. Dubey R. C, "Text book of Biotechnology", S. Chand & Co. Publications, 2006.
4. Richard Sherlock, John D. Morrey "Ethical Issues in Biotechnology" Rowman & Littlefield Publishers, 2002

17BT2017 MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB

Credits: 0:0:2

Course Objectives:

- The objective of the course the student will learn various basic techniques in molecular biology and genetic engineering.
- The student will learn how to isolate DNA from various sources.
- The student will learn to manipulate DNA.

Course Outcomes:

The students will be able to

- The student knows how to isolate DNA from Plant source.
- The student knows how to isolate DNA from Animal source.
- The student knows how to isolate DNA from bacterial source.
- The student knows how to carry out qualitative and quantitative measurements on Nucelic acids.
- The student knows how to manipulate DNA using restriction and ligation techniques.
- The student knows how to transfer DNA into bacteria by the transformation technique.

List of Experiments

1. Isolation of genomic DNA from plant tissue
2. Isolation of genomic DNA from animal liver
3. Isolation of genomic DNA from microorganism (E.Coli)
4. Isolation of plasmid DNA from microorganism
5. Quantitative and qualitative analysis of isolated genomic DNA using spectrophotometer
6. Agarose gel electrophoresis of DNA and analysis of their molecular weights by gel documentation
7. Extraction of proteins from plant or animal tissue and confirmation with qualitative tests
8. Separation and identification of proteins by SDS-PAGE using Coomassie Brilliant Blue stain
9. Restriction enzyme digestion of DNA samples confirmation through Agarose gel electrophoresis
10. Ligation of DNA fragments and confirmation through Agarose gel electrophoresis
11. Competent bacterial cell preparation
12. Transformation of DNA into competent cells

17BT2018 BIOORGANIC PRINCIPLES

Credits 3:0:0

Course Objectives:

- This course aims at making the students understand the structure and interactions of organic compounds of biological significance.
- This provides knowledge in understanding the reaction processes of biological molecules.
- This will help the student to understand the chemical bases of enzyme catalyzed reactions

Course Outcomes (CO):

The students will be able to

- Acquire the basic knowledge on isomerism and stereochemistry of organic compounds
- Understand the basic reaction mechanism types in organic chemistry
- Apply chemical bonding concepts in the protein structure and its stability
- Learn the mechanism of catalysis and fundamentals of enzymes catalysis
- Analyze the mechanisms of reactions catalyzed by various enzymes
- Evaluate the mechanism of coenzyme involvement in enzymated reactions

UNIT I - Stereochemistry-cis & trans configuration, R, S notation, E, Z Isomerism, D & L system with reference to simple sugars, Optical Isomerism, Polarimeter- principle and instrumentation, Enantiomers,, Diastereomers

UNIT II - Chemical bonds-ionic bonds, Covalent and coordination covalent bonds, Hydrogen bonds, Hdrophobic bonds, van der Waals forces, Chemical bonds involved in protein structure, Homolytic and heterolytic fission, Types of organic reactions, Mechanism of nucleophilic substitution reaction, Mechanism of elimination reaction

Unit III - Acid-base catalysis; Enzyme catalysis Catalytic mechanism of RNase-A, Catalytic mechanism of Lysozyme, Covalent catalysis, Nucleophilic catalysis: Mechanism of action of chymotrypsin, Electrophilic catalysis: Mechanism of action of carboxypeptidase - A, Proteases, Electrostatic catalysis.

UNIT IV - Specificity of enzyme action, Alterations in enzyme specificities, Causes of specificity, HIV-1 protease, Amide bond hydrolysis, Ester bond hydrolysis, Stereochemical course of enzymatic reactions.

UNIT V - Introduction –coenzymes, Nicotinamide nucleotides-ADH, Nicotinamide nucleotides-LDH, Flavin nucleotides-glucose oxidase, Flavin nucleotides-glutathione reductase, Pyruvate dehydrogenase complex, Coenzyme –A , TPP, Tetrohydro folate

Text Books

1. Trevor Palmer, “Enzymes: Biochemistry, Biotechnology, Clinical chemistry”, Affiliated East-West Press Pvt. Ltd, New Delhi, 6th edition 2004.

Reference:

3. Harish K. Chopra, Anupama Parmar and Parmjt S. Panesar, “Bio-Organic chemistry”, Narosa Publishing House, New Delhi, 2013
4. Nelson, D. L. and Cox, M. M, “Lehninger’s Principles of Biochemistry”, Freeman Publishers, New York, 4th edition, 2008.

14BT2019 BIOREACTOR ENGINEERING

Credits: 3:0:0

Course Objectives:

- This course aims at making the students understand the fundamental principles and concepts of Bioreactor engineering.
- This will help the student understand stoichiometric calculations, models of growth and product formation

Course Outcomes:

The students will be able to

- Acquire knowledge on principles of stoichiometry and concepts of bioreactor engineering.
- Assess elemental balance equations and models of growth and product formation.
- Classify growth kinetics and product formation kinetics using models
- Devise methods to calculate volumetric mass transfer coefficient and determination methods.
- Analyze bioreactors for free cell and immobilized cell reactions
- Discuss parameters to be monitored and controlled in Fermentation processes

UNIT I - Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, various yield coefficients of biomass and product formation, oxygen consumption and heat evolution in aerobic cultures,
UNIT II - Simple unstructured kinetic models for microbial growth, Monod model, Substrate uptake kinetics and maintenance coefficient, growth of filamentous organisms, product formation kinetics - Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Determination of kinetic parameters for monod equation
UNIT III - Oxygen transfer in microbial bioreactors; oxygen uptake rates and determination of oxygen transfer coefficients (k_La) by correlations and experimental methods; Mass transfer in heterogeneous biochemical reaction system, role of aeration and agitation in oxygen transfer and types of aerators and agitators.
UNIT IV - Bioreactors for free cells – batch, continuous, fed batch, chemostat with recycle and multi stage chemostat systems, air lift and loop reactor, Bioreactors for immobilized cells: packed – bed, fluidized bed and hollow – fibre membrane bioreactors. Basics of solid state fermentation, various scale- up criteria for bioreactors.
UNIT V - Basic configuration of fermenter and ancillaries, main parameters to be monitored and controlled in Fermentation processes- Temperature, pressure, flow measurement, rate of stirring, shaft power, weight, Dissolved Oxygen, pH, inlet and exit gas analysis. Online data analysis of chemical parameter measurements for biochemical processes.

Text Books

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2005.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.

Reference Books

1. Lee, J.M, "Biochemical Engineering", 1st Edition, Prentice Hall, 2001
2. Blanch, H.W and Clark, D.S, "Biochemical engineering", Marcel Dekker, 1997

17BT2020 ENZYME ENGINEERING

Credits: 3:0:0

Course Objectives:

- To develop skills of the students in the area of Enzyme Engineering
- To study various methods of immobilization

Course Outcomes:

The students will be able to

- Classify enzymes and enzymatic reactions towards various concepts in biotechnology.
- Apply the theoretical and practical aspects of reaction kinetics of enzyme substrate reaction
- Examine various enzyme kinetics and enzyme inhibition models
- Summarize methods of extraction and purification of enzymes
- Formulate the concepts of enzyme immobilization and its applications in food, pharmaceutical and chemical industries
- Design of biosensors and its applications in various industries

UNIT I - Classification of enzymes, quantification of enzyme activity and specific activity. Effect of pH and temperature on enzyme activity, Mechanisms of enzyme action; concept of active site and energetics of enzyme substrate complex formation.
UNIT II - kinetics of single substrate reactions without inhibition- Michelis – Menten parameters, Estimation of MM parameters, Enzyme Inhibition – Substrate, Product and Toxic compound inhibition, types and derivation.
UNIT III - Extraction of commercially important enzymes from natural sources; Commercial applications of enzymes in food, pharmaceutical and other industries; enzymes for diagnostic applications.
UNIT IV - Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, Encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages of Different immobilization techniques
Unit V - Enzyme biosensors, Applications of enzymes in analysis; Design of enzyme electrodes and case studies on their application as biosensors in industry, healthcare and environment.

Text Books

1. T Palmer, “Enzymes”, Horwood Publishing Series, 2001. 6th edition, 2006

Reference Books

1. Martin Chaplin and Christopher Bucke, “Text book on Enzyme Technology”, Cambridge University Press, 4th edition, 2004.
2. Shuler, M.L. and Kargi,F, “ Bioprocess Engineering - Basic concepts” Prentice Hall of India Pvt. Ltd., 2nd edition, 2002.

17BT2021 IMMUNOLOGY

Credits: 3:0:0

Course Objectives:

- This course aims to impart basic knowledge in Immunology,
- To help the students familiarize with the organs and cells of the immune system, the immune response and molecular interactions involved in immune response.
- To make the students aware of the applications of immunology such as, immunodiagonosis and immunotherapy.

Course Outcomes:

The students will be able to

- Student learns the history and development of the field of immunology.
- Student understands the types of immunity, the basic plan of the immune of the immune system and the organs of the immune system.
- The students learn about the cells of the immune system and their functions.
- Students understand the humoral immune system
- Students understand the physiology and the pathology of the immune system.
- Students aware of the applications of immunology in diagnosis and treatment of diseases.

UNIT I - Introduction and an overview of immunology, History of immunology, Types of Immunity - Innate and acquired immunity, Cell mediated and humoral immunity; Organs of the immune system: Lymphoid organs - primary and secondary.

UNIT II - Granulocytes and Agranulocytes, haematopoisis, extravasation, phagocytosis. T and B Lymphocytes & NK cells. Major histocompatibility complex; antigen processing and presentation, T-Cell activation and the cellular immune response.

UNIT III - Antigens- chemical and their molecular nature; Haptens; Adjuvants. Antibody – structure, Classes, Genes and Antibody diversity. Antigen Antibody reactions; Neutralization, Opsonization. Complement, Cytokines.Vaccines.

UNIT IV - Injury and inflammation; immune responses to infections: immunity to bacteria, and virus; Transplantation: laws,, consequences and genetics of transplantation, Cancer immunology – Tumour Associated Antigens and Tumour Specific Antigens; Autoimmunity; Autoimmune disorders, Allergy and hypersensitivity, Tolerance, Immunosuppression and AIDS.

UNIT V - Diagnostics; immunodiffusion, Haemagglutination, RIA, ELISA, Western Blotting, Immunofluorescence Assay, Immunohistochemistry. Therapeutics and prophylactics; Abzymes, Monoclonal Antibody production, Chimeric & humanized antibodies. Vaccines.

Text Book

1. Roitt I, Male, Brostoff, “Immunology”, Mosby Publ., 2002.

Reference Books

1. Tizard, “Immunology”, Saunders college publication, 5th Edition. 2004
2. Kuby J, “Immunology”, WH Freeman & Co., 2000.
3. Ashim K. Chakravarthy, “Immunology”, TataMcGraw-Hill, 2001

17BT2022 CELL BIOLOGY AND IMMUNOLOGY LAB

Credits: 0:0:2

Course Objectives:

- To make the students learn to understand practical concepts in cell biology
- To acquaint the students with basic laboratory techniques involved in cell biology.
- To acquaint the students with basic laboratory techniques involved in immunology.

Course Outcomes:

The students will be able to

- Students learn to stain and differentiate various cells.
- Students learn to handle fish and use it as a model animal for immunology.
- Students learn to prepare antigen and immunize animals.
- Students learn to separate cells of the immune system.
- Students learn to perform techniques in humoral immunity.
- Students learn to perform techniques in cell mediated immunity.

List of Experiments

1 Differentiation of Blood Cells Using Giemsa Staining
2 Osmosis and Tonicity Studies Using Red Blood Corpuscles
3 Staining for Various Stages of Mitosis in *Allium cepa* root tip (Onion)
4 Handling fish (Tilapia) and locating immunological organs in fish.
5 Administration of Antigen and drawing blood from fish.
6 Drawing Blood and Harvesting Anti serum from Fish.
7 Separation of Peripheral Blood Mononuclear Cells.
8 Trypan Blue Assay for to distinguish live versus dead cells .
9 Determination of Antibody titer by passive hemagglutination
10 Demonstration of Delayed Type Hypersensitivity in Fish
11 Graft rejection in Fish
12 Single Radial Immunodiffusion.

17BT2023 CHEMICAL REACTION ENGINEERING

Credit: 3:0:0

Course Objectives

- To estimate kinetic parameter
- To apply design equations.

Course Outcomes:

The students will be able to

- Describe the kinetics of reactions
- Design equations to determine the performance of ideal reactors
- Create various models for describing non- ideal behavior of reactors
- Analyze performance of combined reactors
- Explain adsorption and desorption phenomena in heterogeneous systems.
- Create design of various fermentor / bioreactors

UNIT I - Principles of Homogeneous reactions – and rate equations-estimation of rate constants using constant volume and constant pressure Batch reactor-data for typical reactions – Arrherius equation-Non elementary reaction kinetics-Multiple reactions-yield Concepts.

UNIT II - Performance equations for single batch reactor, ideal CSTR, ideal PFR-Application to design.

UNIT III - Multiple reactor systems – selection of suitable reactor systems for multiple reactions-recycle reactor-Principles in non isothermal reaction and reactors.

UNIT IV - Non Ideal reactors- Non Ideal Flow-Tracer experiments and application-TIS model, Axial Dispersion model-for tubular reactors. Exchange volume and By Pass and dead volume models for CSTRS.

UNIT V - Gas-Liquid Reactions-kinetics-G-L reactor design Principles-Principle of Catalysis-types of catalytic reactors-Concept of effectiveness factor in Catalytic reactions-G-L-S-reactors – slurry reactor.

Text Books

1. Levenspiel, Octave “Chemical Reaction Engineering”, 3rd Edition, John – WileySons, 2002.
2. Fogler, H.S. “Elements of Chemical Reaction Engineering”, 2nd Edition, Prentice Hall, 2002

References

1. Missen, R.W. etal., “Chemical Reaction Engineering and Kinetics”, John – Wiley, 1999.
2. Davis, Mark E and Robert J. Davis “Fundamentals of Chemical Reaction Engineering” McGraw – Hill, 2005.
3. Harri ot, Peter “Chemical Reactor Design” Marcel Dekker, 2003.
4. Sila, Harry “Chemical Process Engineering : Design and Economics” Marcel Dekker, 2003
5. Nauman, E. Bruce “Chemical Reactor Design, Optimization, and Scaleup”, McGraw –
6. Hill, 2002.
7. Richardson, J.E. and D.G. Peacock “Coul son & Richardson’ s Chemical Engineering”,
8. Vol.3 (Chemical & Biochemical Reactors & Process control) 3rd Edition, Butterworth
9. Heinemann/ Elsevier, 2006.

17BT2024 DOWNSTREAM PROCESSING

Credit: 3:0:0

Course Objectives:

- To study the cell disruption methods, solid-liquid separation techniques
- To develop skills of the students in downstream processing with emphasis on purification of products.
- To study the finishing steps in the purification of bio-products

Course Outcomes:

The students will be able to

- Define the fundamentals of downstream processing for product recovery
- Understand the requirements for successful operations of downstream processing
- Identifying product isolation techniques
- Illustrate various purification methods of chromatography
- Assess finishing operations like crystallization, lyophilization and drying for the bio products
- Apply principles of various unit operations used in downstream processing and enhance problem solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion.

UNIT I - Overview of bio separation, Introduction to downstream processing principles, characteristics of bio molecules and bio processes. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pre treatment and stabilization of bio products.

UNIT II - Separation of cells and other insoluble from fermented broth – sedimentation, Filtration (Pretreatment, filtration theory, continuous rotary filters), Microfiltration, Centrifugation (batch, continuous and basket).

UNIT III - Adsorption, Leaching, Liquid-liquid extraction, aqueous two-phase extraction, precipitation of proteins by different methods, Membrane based purification: Ultrafiltration, Microfiltration, Nanofiltration, Electrodialysis, Reverse osmosis, Dialysis, Diafiltration, Pervaporation, Perstraction

UNIT IV - Chromatography – principles, instruments and practice, adsorption, reverse phase, ion exchange, size exclusion, hydrophobic interaction, bio affinity and pseudo affinity.

UNIT V - Case Studies of Downstream Processing - Baker’s yeast, Ethanol, Citric acid, Penicillin, Insulin, crystallization, Introduction to drying, Equilibrium, Different types of moisture contents, Rate of Drying and drying curve, Batch Drying and calculation of time of drying, types of driers, Lyophilization, Formulation.

Text Books

1. Sivasankar.B “Bioseperations: Principles and Techniques”, PHI Learning Pvt. Ltd., 2006

Reference Books

1. Sivasankar.B “Bioseperations: Principles and Techniques”, PHI Learning Pvt. Ltd., 2006
2. Belter P.A, Cussler E.L & Wei-Houhu,“Bioseparations – Downstream Processing For Biotechnology”, Wiley Inter science Publications, 1988.
3. Bio separation science and engineering. Harrison et al. 2006. Oxford Univ. Press
4. Unit operations in chemical engineering. McCabe, Smith and Harriot. McGraw Hill Co.
5. Scopes R.K., “Protein Purification – Principles and Practice”, Narosa Publications, 2004.

6. Trevor G, and Harrison, Roger G, and Rudge, "Bioseparations Science and Engineering", Day Scott R, Publisher, Oxford University Press, USA, 2002

17BT2025 DOWNSTREAM PROCESSING LAB

Credit: 0:0:2
Co-requisite: 17BT2024- Downstream Processing

Course Objectives:
- To develop the skills of students in various downstream process operations
- To understand the extraction of bio-products by various techniques
- To understand the finishing and polishing process of bio-products

Course Outcomes:
The students will be able to
- Predict cell disruption techniques to release intracellular products.
- Acquired knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.
- Examine protocols on various techniques like extraction, precipitation and adsorption for concentrating the biological products.
- Perform basic scale-up calculations for downstream unit operations
- To determine appropriate operating ranges and scale-up parameters for downstream processing steps
- Learned various Drying techniques and Lyophilization for formulating the products for different end uses.

List of experiments:
1. Liquid – Liquid Extraction
2. Studies In Cross Current Leaching
3. Drying Of Solids By Light Source
4. Solids Recovery By Centrifugation
5. Casein Precipitation
6. Flocculation
7. Protein Purification By Salting Out Method
8. Batch Sedimentation
9. Adsorption Techniques
10. Packed Bed Distillation
11. Cell Disruption By Chemical Method
12. Lyophilization (Freeze Drying Of Culture)

17BT2026 MECHANICAL OPERATIONS

Credits: 3:0:0

Course Objectives:
- The study of the subject constitutes the different types of mechanical operations in a chemical industry.
- It imparts the knowledge of basic principles of science and engineering applied to process molecules of varying sizes.
- The study also focuses on a creative perspective in using equipments used for mechanical operations and knowing how it is designed and how it works.

Course Outcomes:
The students will be able to
- Examine the need on how a chemical industry processes the products..
- Describe the principles of each and every downstream equipment used in the industry.
- Experiment on the downstream proceese like sedimentation, filteration which plays a pivotal role.
- Evaluate the volumetric flow rates and output rates of the treatment devices.
- Create basic parameters or equipments for using in the mechanical operation line.

UNIT I - Characterization of solid particles, Screen analysis, Mixing of solids,
Mixer for free flowing solids.
UNIT II - Size reduction equipments, crushers, grinders, Ultra fine grinders, Cutting machines, Screening equipment, Screen Effectiveness

UNIT III - Conditions for Fluidization, Types of fluidization, Conveyers and their types.
UNIT IV - Introduction, Cake filters, Filter press, Shell and leaf filters, Centrifugal filters, Filter media . Filter aids, Principles of cake filtration, Clarifying filters, Batch sedimentation, Rate of sedimentation, , Cyclones, Centrifuges.
Unit V Different types of agitators, Various types of Mixers, Power calculation and impeller tip speeds.

Text Books:

1. McCabe Smith, "Unit Operation in Chemical Engineering", McGraw Hill, 7th edition, 2002.

Reference Books:

1. Foust A. S. & associates, "Principles of Unit Operations", John Wiley and Sons, 3rd editon, 1980.

17BT2027 CHEMICAL AND BIO THERMODYNAMICS

Credit: **3:0:0**

Course Objectives:

- This course aims at making the students understand the fundamental principles and concepts of chemical and bio thermodynamics engineering.
- The students will learn about thermo dynamic laws and and measurement
- The students will study the design equations for various bio process.

Course Outcomes:

The students will be able to

- Apply the laws of thermodynamics to chemical and bio processes
- Calculate differences in thermodynamic properties using equations of state, charts and tables
- Solve problems dealing with multiphase physical and reactive systems
- Explain the molecular basis of thermodynamics
- Interpret thermodynamic data for applications in chemical engineering processes and biotechnology.

UNIT I - Volumetric properties of fluids exhibiting non ideal behavior; residual properties; estimation of thermodynamic properties using equations of state; calculations involving actual property exchanges; Maxwell's relations and applications.
UNIT II - Partial molar properties; concepts of chemical potential and fugacity; ideal and non-ideal solutions; concepts and applications of excess properties of mixtures; activity coefficient;
composition models; Gibbs Duhem equation.
UNIT III - Criteria for phase equilibria; v-l-e calculations for binary and multi component systems; liquid liquid equilibria and solid-solid equilibria.
UNIT IV - Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversion and yields for single and multiple reactions.
UNIT V - Concept of lost work; entropy generation; calculation of real irreversible processes; power cycle; liquefaction.

Text Books

1. Smith J.M., Van Ness H.C., and Abbot M.M. "Introduction to Chemical Engineering
2. Thermodynamics", 6th Edition. Tata McGraw-Hill, 2003.
3. Narayanan K.V. "A Text Book of Chemical Engineering Thermodynamics", PHI, 2003.

Reference

1. Sandler S.I. "Chemical and Engineering Thermodynamics", John Wiley, 3rd edition, 1989
2. Smith J.M.,Van Ness H.C.,Abott M.M"Chemical Engineering Thermodynamics", McGraw-Hill,6th edition, 2001.

17BT2028 HEAT AND MASS TRANSFER OPERATION

Credit: 3:0:0

Course Objectives:

- This course aims at making the students understand the fundamental principles and concepts of Heat and mass transfer operations..
- The students will learn about mass balances and enthalphy balancing .
- The students will study the design equations for various unit operation equipments.

Course Outcomes:
The students will be able to

- Explain the principles of diffusion and mass transfer coefficient.
- Understand the principles of gas liquid operations
- Describe vapour liquid operations in biotech industries
- Learn the concept of liquid – liquid extraction operations
- Understand the solid fluid operations and its equipments with application
- An Understand the mass Transfer principles and its application

Unit I - Modes of heat transfer; Conduction: Fourier's law, Conductivity and heat flux, Conduction through flat slab, Determination of thermal conductivity , cylinder and sphere, Heat transfer through multilayer cylinders, Conduction through materials in composite series, Problems solving the hallo sphere, cylinder and multi layers.
Unit II - Modes of heat transfer; Conduction: Fourier's law, Conductivity, Conduction through flat slab, cylinder and sphere, Heat transfer through multilayer cylinders, Conduction through materials in series and parallel; Insulating materials: General properties and applications; Convection – Dimensional analysis applied to natural convection and forced convection, Heat transfer coefficients; Condensers – filmwise and dropwise condensation
Unit III - Heat Exchangers: Types of flow, LMTD, Fouling, Construction, working and design of Double pipe and shell & tube heat exchange, Fouling factor- cleaning dirt factor, Evaporation- operation, Steam economy, capacity, Evaporation equipments, feeding methods . Overall heat transfer coefficients in evaporators, Calculation methods for single effect evaporator, Overview of Multiple effect evaporator, Evaporation of biological materials
Unit IV - Introduction to mass transfer operations, Molecular and Eddy Diffusion in fluids: Fick's laws Steady state equimolar molecular diffusion and non-equimolar diffusion in fluids , Diffusivity of gases, solids , Interphase Mass Transfer: Concept of overall mass transfer coefficient for liquids and gases, Theories of Mass Transfer – Film, Penetration and Surface renewal theories
Unit V - Vapor-liquid Equilibria, P-x-y and T-x-y diagrams, Ideal solutions, Deviation from ideality, Minimum and maximum boiling azeotropes, Flash and differential distillation, continuous rectification, Determination of number of stages by McCabe-Thiele method.Adsorption Nature of adsorbents, adsorption isotherms – adsorption of single stage operation , problem solved , Adsorption equipments,-fixed bed and moving bed adsorption.

Text Book:

1. K. A. Gavhane,(1992), Heat Transfer, Nirali Prakashan 3rd edition, 1992.
2. Incropera F.P. "Fundamentals Of Heat And Mass Transfer", John Wiley,1998. 2nd Edition, 1998.

References

1. Christie John Geankoplis., (2003), *Transport process and separation process principles*, 4th edition, New Delhi: Prentice-Hall of India Private Limited.
2. Donald, Q.Kern .,(2003). *Process Heat Transfer*,New Delhi:Tata McGraw Hill.
3. Warren L. McCabe, Julian C. Smith, Peter Harriot.,(2005).*Unit Operations of Chemical Engineering*, 7th edition , New Delhi:Tata McGraw Hill.

17BT2029 PLANT PHYSIOLOGY AND STRESS MANAGEMENT

Credits: 3:0:0

Course Objectives:

- To learn the principles of plant physiology.
- To introduce the concepts of plant growth and development.
- To create awareness on basic principles of plant function and cell physiology

Course Outcomes:
The students will be able to

- Understand the organization of plants from the level of cells through tissues, tissue systems, and organs.
- Illustrate the physiological mechanisms involved in the uptake and transport of water and the translocation of food by plants.
- Classify relationship of complementary metabolic pathways such as photosynthesis and respiration in energy acquisition and use during plant development
- Elaborate understanding of plant natural products with respect to their role in plant defense mechanisms
- Analyze the major effects and physiological mechanisms of growth regulators in plants

- Evaluate the stress related response of plants

Unit I - Introduction –Role and significance of water - diffusion, imbibitions, osmosis and its significance, plasmolysis, Definitions - field capacity, water holding capacity of soil and permanent wilting point, Absorption of water - mode of water absorption – active and passive absorption and factors affecting absorption, Translocation of solutes - phloem and xylem transport, Transpiration - types - Steward's theory of mechanism - significance, factors affecting transpiration and guttation - antitranspirants.
Unit II - Mineral nutrition - introduction - criteria of essentiality of elements - macro, secondary and micronutrients - sand and soil less culture- hydroponics, Mechanism of uptake – physiological role of nutrients, Foliar diagnosis - nutritional and physiological disorders - foliar nutrition and fertigation .
Unit III - Photosynthesis - requirements of photosynthesis - light, CO2, pigments and water, Mechanism of photosynthesis - light reaction - cyclic and non cyclic photophosphorilation - Red drop - Emerson Enhancement Effect, Photosynthetic pathways - C3, C4 and CAM, Differences between C3, C4 and CAM pathways - Factors affecting photosynthesis, Photorespiration - photorespiration process and significance of photorespiration, Respiration - Glycolysis, TCA and Pentose Phosphate Pathway, Oxidative phosphorylation – differences between oxidative phosphorylation and photophosphorylation. Respiratory quotient and energy budgeting in respiration.
Unit IV - Growth - growth curve, phases of growth and factors influencing growth, Growth analysis - LAI, LAD, SLW, SLA, LAR, NAR, RGR and CGR in relation to crop productivity,- Source sink relationship - Photoperiodism - Role of phytochrome in flowering and regulation of flowering. Plant growth regulators - growth hormones - definition and classification - physiological role of auxins and GA, Physiological role of Cytokinin, Ethylene and ABA - synthetic growth regulators and their uses in crop productivity,
UNIT V - Environmental stresses - water stress - physiological changes - adaptation to drought and amelioration, Temperature stress - Physiological changes - low and high temperature - chilling injury - tolerance – alleviation, Low light and UV radiation stresses - salt stress - physiological changes and alleviation, Global warming – Carbon Sequestration physiological effects on crop productivity, Seed germination - physiological changes during seed germination,. Abscission – senescence- ripening - types, causes, physiological and biochemical changes and regulation.

Text Book:
1. Salisbury F and C. Ross, "Plant Physiology", Wordsworth Publishing co., Belmont, California, 6th editon, 2005.

References Books
1. H.S. Chawala, "Introduction to Plant Biotechnology", Oxford IBH, 2002
2. Jain, J.K. 2007. Fundamentals of plant physiology, S.Chand & Company Ltd., New Delhi.
3. Pandey, S. N. and B. K.Sinha, 2006.Plant Physiology. Vikas Publishing House Private Limited, New Delhi.
4. Purohit, S.S, 2005. Plant physiology, Student edition, Jodhpur.
5. Ray Noggle, G. and Fritz, G. J., 1991.Introductory Plant Physiology. Prentice Hall of India Pvt. Ltd., New Delhi.
6. Taiz. L. and Zeiger. E., 2006.Plant Physiology. Publishers: Sinauer Associates, Inc., Massachusetts, USA.

17BT2030 PLANT GENETIC ENGINEERING

Credits: 3:0:0

Course Objectives:
- To ensure students in having strong foundation in plant tissue culture
- To create awareness among students about cell culture techniques and its applications in industries.
- To ensure students in developing basic knowledge on secondary metabolites production and its applications.

Course Outcomes:
The students will be able to
- Elaborate basic principles of plant tissue culture
- Illustrate the different methods of plant tissue culture
- Classify the different techniques of plant transformation
- Elaborate the details of various plant transformation vectors
- Analyze the importance of GM crops
- Evaluate the methods of in vitro drug production

UNIT I - History-tissue culture lab - establishing aseptic conditions -types of media and their preparation plant hormones - organogenesis–direct and indirect (meristem/shoot apex culture, callus and suspension culture)

UNIT II - Significance and application of another culture, ovule culture, embryo culture-somatic embryogenesis-protoplast fusion-somaclonal variation-artificial seeds-micropropagation

UNIT III - Biology of Agrobacteriumtumefaciens-plant transformation methods-stable and transient-Agrobacterium-mediated,biolistic,PEG/liposome-mediated,electroporation,chloroplast Transformation, protoplast transformation, site directed integration of transgene (zinc finger)

UNIT IV - Binary and co-integrate vectors-gateway vectors-promoters-selectable and screenable markers-marker free transgenics-significance and applications.

UNIT V - Biotic and abiotic stress tolerant transgenic plants (Btcotton, roundup readysoybean),blue rose, Vitamin A fortified rice,metabolic engineering-oil and secondary metabolite production, Production of edible vaccines and other biotech drugs in transgenic plants

Text Book

1. Razdan.M.K, "Introduction to Plant Tissue Culture"2nd edition, SciencePublishers, 2003.

References

1. Adrian Slater, Nigel W. Scott, Mark R. Fowler,"Plant Biotechnology-TheGenetic Manipulation of Plants"third edition, Oxford University Press, 2008.

17BT2031 AGRICULTURE AND BIOMASS ENERGY

Credits: 3:0:0

Course Objectives:

- To create awareness in the present scenario of agriculture entrepreneur
- To create awareness on renewable energy
- To develop basic knowledge on techniques in biomass energy production

Course Outcomes:

The students will be able to

- Relate the concept of agriculture
- Illustrate the agricultural oprerations
- Compare the Biotech industries and products
- Examine the Biomass and energy production
- Justify the recent conversion technologies
- Estimate the Environmental impacts

UNIT I - Agriculture – importance, agricultural implements, irrigation, fertigation, seeds, crop rotation, agricultural operations, marketing, important agricultural crops, Infrastructural facilities,

UNIT II - Biotechnological Products in India, Quality parameters and quarantine procedures of export, Market integration

UNIT III - Production strategies, harvest, storage, and pretreatment for diverse biomass feedstocks. Biotech industries & institutes in India & world, Concepts of Biotech park

UNIT IV - Biomass – importance and source, techniques and application of energy production. Fundamental theories and applied technologies used in production and conversion of biomass.

UNIT V - Conversion technologies covered include ethanol fermentation, biodiesel catalysis, combustion, pyrolysis, gasification, and anaerobic digestion. Environmental impacts.

Text Books

1. Gry Agnete Alsos, Sara Carter, Elisabet Ljunggren, Friederike Welter. The Handbook of Research on Entrepreneurship in Agriculture and Rural Development, Edward Elgar Pub, 2011

References Books

1. Robert C. Brown, Biorenewable Resources: Engineering New Products from Agriculture, Iowa State Press, Blackwell Publishing. 2003
2. Acharya and Agrawal , Agriculture Marketing in India , Oxford IBH, N. Delhi, 2004.
3. Kotlar and Armstrong , Principles of Marketing by Prentice-Hall, N. Delhi. 2013.
4. Raychaudhuri, S.P. 1964. Agriculture in ancient India. Indian council of Agricultural Research, New Delhi. 4. Razia Akbar (Tr) 2000. Muskha Dar Fauni – Falahat (The art of agriculture). Agri – History Bulletin No. 3. Asian Agri. History foundation, Secundrabad.

17BT2032 HORTICULTURAL CROP PRODUCTION, MANAGEMENT AND GREEN HOUSE TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To provide foundation in horticulture crop production
- To create awareness on Green house technology

Course Outcomes:

The students will be able to

- Asses knowledge on the basic horticulture crop production
- Categorize the various propagation methods involved in horticulture
- Illustrate various practices for cultivation of major Fruit crops
- Discuss the green house technology
- Propose the planning and construction of green house
- Inspect the media requirements in agriculture

UNIT I - Horticulture- Definition, scope, importance, and branches of horticulture. Classification of horticultural crops, Propagation methods, growth habit, training and pruning objectives, methods and season,

UNIT II - Special horticultural practices for horticultural crop production, plant growth regulators and their uses in horticulture.

UNIT III - Package of practices for cultivation of major horticultural crops Fruits, Major pest and diseases of horticultural crops and their control,

UNIT IV - Types of green house, importance, functions and features of green house, Scope and development of green house technology.

UNIT V - Location, Planning of various components of green house, Design criteria, Construction material, covering material and its characteristics, growing media, green house irrigation systems. nutrient management.

Text Book

1. Kumar, P, Management of Hort. Crops Horscience series Vol. 11, New India Publishing Agency, NIPA. 2008.

References Books

1. Manohar, Greenhouse Technology and Management , International Book Distribution Co., Lucknow, 2006.
2. Bose, T.K., S.K.Mitra, A.A. Farooqi and M.K. Sadhu (Eds) 1999. Tropical Horticulture Vol.1. Naya Prokash, Calcutta.
3. Chadha, K.L. 2001. Handbook of Horticulture. ICAR, Delhi
4. Kumar, N. 1997. Introduction to Horticulture. Rajalakshmi Publications,
5. Greenhouse technology and management, Castilla, N, 2013, CABI

17BT2033 DEVELOPMENTAL BIOLOGY

Credits: 3:0:0

Course Objectives:

- To provide with fundamentals and concepts of developmental biology.
- To make students understand about the events involved in the formation of embryo.
- This course serves as a foundation for stem cell research.

Course Outcomes:

The students will be able to

- Describe the molecular changes happening in cell development
- Predict the role of genes and its expression during the process of the development of organs in the embryo and its development
- Understanding the role of proteins in the development of embryo stage by stage
- Gaining knowledge in the formation of organs in the embryo
- To understand about the sex determination during embryonic development
- This paper will provide the compete growth and development of Human embryo

Unit I - Developmental Genetics: An introduction to genetic molecular mechanisms in relation to development of embryo Gene expression for the development of Embryo
Unit II - Internal fertilization in mammals – Getting gametes into oviduct: Translocation and capacitation Hyperactivation, thermotaxix and chemotaxis Recognition at Zona pellucida- Gamete Fusion and Prevention of Polyspermy Fusion of genetic material
Unit III - Early Drosophila development- Fertilization-cleavage-gastrulation, Genes that pattern the Drosophilla Body plan,
Unit IV - Early Mammalian Development- Cleavage – Mammalian Gastrulation- Organogenesis
Unit V - Sex Determination- Chromosomal Sex Determination – Environmental sex determination

Text Books

1. Scott F. Gilbert, "Developmental Biology, 9th edn. Sinauer Associates, Incorporated, 2010..

Reference Book

1. Willium. J. Larsen, Human Embryology 3rd ed. Churchill Livingstone, 1998.

17BT2034 HUMAN GENETICS AND GENOMICS

Credits: 3:0:0

Course Objectives:

- To provide foundation in human genetics.
- To provide basic knowledge in genomics.

Course Outcomes:

The students will be able to

- Acquire knowledge on the basics of human genetics and genomics
- Analyze and identify the meternal effects in inheritance
- Identify and analyze the chromosomal mutations and its impact in humans
- Assess the application of genomics in the field of disease diagnosis,
- Understand the knowledge in mapping of genomes and genetic disease treatments.
- Acquire the importance of gene therapy and its appllications

Unit I - Chromosome structure and function, Location , Interaction of genes, Gene Environment interactions
Unit II - Meternal effects and inheritance, linkage and crossing over, Genetics of sex determination
Unit III - Mutations: Genomic mutation- Variation in chromosomal number , chromosomal mutations- variation in chromosomal structure and gene mutation
Unit IV - rDNA in Genetics: Human genetic diseases, Positional cloning, Chromosomal abnormalities for locating disease genes. RFLP for lineage analysis, DNA finger printing used in courts and identification
Unit V - Gene therapy in Human beings- Cystic fibrosis treatment in Vitro, Human geneome mapping- Human chromosome separation using cell sorting and analyzing - Large scale sequencing of Human HPRT gene

Text Book.

1. Bruce R. Korf , Human genetics and genomics 3rd ed. Blackwell publishing, 2013

Reference Books

2. Recombinant DNA 2nd Ed., James D. Watson, Michael Gilman, Jan Witkowski, Mark Zoller,Scientific American Books, New York 2nd ed. 1992.
3. Genetics by C. B. Powar, 2nd ed., 2000. Mc Grraw hill publishers, New Delhi.

17BT2035 VACCINE BIOTECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To learn the types of vaccine, immunological effects and regulatory guidelines
- To provide the knowledge on conventional to recent technology of vaccine production
- To learn about various vaccine delivery methods

Course Outcomes:

The students will be able to

- Develop the skills to critically assess the different types of vaccines available and their suitability for different diseases
- Develop an understanding of immunization methods and schedules of immunization
- Learn the techniques required for vaccine commercialization
- Demonstrate an understanding of the importance of strict quality control and regulation in the vaccine production process
- Develop ability to critically analyse various delivery methods of vaccine
- Demonstrate an understanding of the importance of vaccines as a public health strategy

UNIT I - Introduction to Vaccines - definition, History of vaccine development, Principles of vaccination, Conventional and Modern vaccines, role and properties of adjuvants, passive and active immunization, immunization programs and role of WHO in immunization programs.
UNIT II - Types of vaccines: Live, Killed, attenuated, Subunit, synthetic, DNA, recombinant and edible vaccines, Chimeric vaccines, polyvalent vaccines, Use of nanoparticles in vaccine application
UNIT III - Techniques in Vaccine Production: Purification, preservation and formulation techniques. Commercial production of DPT, TT, polio, rabies and hepatitis vaccines.
UNIT IV - Delivery methods: Immunomodulators-Innovative methods of delivery of immunogens through liposomes, microsperes, ISCOMS.
Unit V - Regulatory and Biosafety measures: Quality assurance in vaccine production. Regulatory issues - Environmental concerns with the use of recombinant vaccines - Disease security and biosecurity principles and OIE guidelines.

Textbook:

1. Lowrie DB & Whalen R. "New Generation Vaccines", 3rd Edn. Informa Healthcare Humana Press, 2000
2. Barry R Bloom, Paul-Henri Lambert, "The Vaccine Book", Academic Press.2002
3. Robinson A & Cranage MP. "Vaccine Protocols", 2nd Ed. Humana Press, 2003

Reference books:

1. Kindt, T.R. A. Goldsby, B. A. Osborne and J. Kuby, Kuby Immunology, W.H. Freeman & company, 2007.
2. Plotkin, S.A W. A. Orenstein and P. A. Offit, Vaccines, W B Saunders Company, 2012.
3. Cheryl Barton, Advances in Vaccine Technology and Delivery, Espicom Business Intelligence, 2009.
4. Ronald W. Ellis, New Vaccine Technologies, Landes Bioscience, 2001.

17BT2036 ANIMAL BIOTECHNOLOGY AND CELL CULTURE TECHNIQUES

Credits: 3:0:0

Course Objectives:
- To develop skills of the students in the area of animal biotechnology
- To learn about cell culture techniques

Course Outcomes:
The students will be able to
- Acquire knowledge in primary cell culture techniques, maintenance of cell line
- Understanding the use of scaling up of cell culture and the production of products from cell cultures
- Gaining knowledge in the latest field of Tissue engineering and to culture cells in 3D methods and its applications
- *In vitro* fertilization and the manipulation of embryo done for genetic screening will provide wider understating among the students and create awareness
- Studying the development of transgenic animals will make the students to know more about breed development and choosing of the breeds for milk production
- Assess about the scope and applications in this subject

UNIT I - Basics of cell culture, Layout of cell culture laboratory chemically defined and serum free media. Animal cell cultures and their maintenance and preservation.
UNIT II - Scaling up of cell cultures, Suspension cultures, continuous flow cultures, immobilized cultures. cell culture as a source of various products – Vaccine Production
UNIT III - Tissue engineering: 3D culturing, Different stages of tissue engineering, Protocols for culturing,Different types of cells in matrices for tissue engineering.

UNIT IV - Animal Breeding, Invitro fertilization , Embryo transfer- Micromanipulation technology, germ cell manipulation, sperm and embryo sexing
Unit V - Transgenic Animals, Transgenic Animals and their significance. Ethical issues in Animal Biotechnology Ethical issues in Animal Biotechnology

Text Books

1. Introduction. R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.

Reference Books

1. Ranga M.M. "Animal Biotechnology", Agrobios India Limited, 2002
2. Ramadass P, Meera Rani S. "Text Book of Animal Biotechnology", Akshara Printers, 2000.
3. Animal cell culture 3rd ed., by John R.W. Masters A Practical Approach Oxford University press New York 2005

17BT2037 CANCER BIOLOGY

Credits: 3:0:0
Course Objectives:

- To study the factors affecting cancer development, the genetic and cellular basis for cancer development.
- To study the involvement of carcinogens in cancer development.
- To study the characteristic features of cancer invasion, metastasis, their diagnosis and the treatment modalities available.

Course Outcomes:
The students will be able to

- Acquire understanding of the complexity and pathology of cancer, highlighting the need for attention
- Describe the factors, cell cycle de-regulation and mutations leading to cancer
- Attain the knowledge in the fundamentals of carcinogenesis and the complex cause of different cancers
- Understand the molecular and cellular mechanisms that lead to cancer development and progression- oncogene, apoptosis, angiogenesis
- Illustrate the mechanism of cancer invasion - metastasis and analyze different cancer cases –its management methods
- Comprehend the basis of cancer diagnosis, therapy and prevention and summarize advanced methodologies used in cancer research

Unit I - Benign verses cancer tumors, characteristics of cancer cell, tumor grading and staging, histopathology and cytopathology, classification and nomenclature; action of cancer- metabolism, cancer death; factors of carcinogenesis, lifestyle and diet in cancer; regulation of cell cycle, modulation of cell cycle in cancer, mutations that cause changes in signal molecules
Unit II - Carcinogen, theory of carcinogenesis, Types - chemical carcinogenesis, metabolism of carcinogenesis- CYP450 reductase mechanism, physical carcinogenesis - ionizing and non- ionizing radiations, radon; Viral carcinogenesis – Retro viruses - RSV, Papilloma virus; Endogenous carcinogenesis.
Unit III - Cancer associated genes and signal targets, telomerase role in cancer, proto-oncogenes and oncogenes - classification, role in cancer - activation of kinases- Ras pathway, transcription factors-myc, AP-1, bcl-2/bax Growth factors and receptors related to transformation-EGF, FGF, VEGF, PDGF, TGF; identification and detection of oncogenes. Tumor suppressor genes - p53 and Rb; apoptosis-intrinsic and extrinsic pathways; angiogenesis and cancer.
Unit IV - Invasion - three step theory of invasion; Soil and seed hypothesis; Metastatic cascade - basement membrane disruption, role of proteinases and adhesion molecules in metastasis, inflammation and cancer.
Case study – Different solid and blood cancers– etiology, diagnosis and treatment
Unit V - Tumor markers, advances in cancer detection – bioassays and biopsy examinations, molecular tools for early diagnosis of cancer; Different forms of therapy - chemotherapy, radiation therapy, molecular and immunotherapy- use of signal targets towards therapy of cancer; Gene therapy; Role of antioxidants in preventing cancer.

Text Book

1. Robert G, Mckinnell, Ralph E. Parchment, Alan.O. Perantoni, G. Barry Pierce, "The Biological Basis of Cancer", Cambridge University Press, New York. 4th edition, 2003.

Reference Books

1. Macdonald F and Ford CHJ. "Molecular Biology of Cancer", Bios Scientific Publishers, 2002.
2. Ranga M.M. "Animal Biotechnology", Agrobios India Limited, 2002
3. Ramadass P, Meera Rani S. "Text Book of Animal Biotechnology", Akshara Printers, 2000.
4. Dubey, R.C, "Text Book of Biotechnology", S. Chand & Co, 2004.

17BT2038 BIOPHARMACEUTICAL TECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To demonstrate the basics of biopharmaceutical technology to the undergraduate students.
- To motivate the undergraduate students in analyzing the drug metabolism and mode of action.
- To elaborate basic of formulations of drugs and to apply them in clinical trials.

Course Outcomes:

The students will be able to

- Explain about drug development, principles, mechanism of actions of drug.
- Outline on preparation of biotechnology oriented pharmaceutical products.
- Demonstrate various testing and quality assurance of different form of drug preparation.
- Compare the pharmaceutical products available in the market.
- Evaluate the recent advances in drug manufacturing.
- Relate the regulations in clinical trial and management.

UNIT I - Introduction - Development of Drugs and Pharmaceutical Industry. Drug Metabolism and Pharmacokinetics - Drug Metabolism – Physico-Chemical Principles –Pharmacodynamics – Action of drugs in humans.

UNIT II - Manufacturing Principles - Compressed tablets – wet granulation, – Dry granulation – Direct compression – Tablet presses formulation – Coating – Pills – Capsules sustained, action dosage forms. Quality control tests for tablets and capsules. Packaging of solid dosage forms.

UNIT III - Manufacturing Principles – Parental, solutions – Oral liquids – injections – Ointments. Quality control tests for semisolid and liquid dosage forms. Packaging of semisolid and liquid dosage forms

UNIT IV - Pharmaceutical Products - Vitamins – Cold remedies – Laxatives –Analgesics –External Antiseptics – Antacids. Antibiotics – Biologicals – Hormones. Recent advances in the manufacture of drugs using r-DNA technology.

UNIT V - Clinical Trials & Regulations - Clinical Trials – Design, double blind studies, placebo effects. FDA regulations (General) and Indian Drug regulations- highlight. Good Laboratory Practice, Good manufacturing practice.

Text Books

1. 1.DM Brahmankar, Sunil B Jaiswal, "Biopharmaceutics and Pharmacokinetics-A Treatise", Vallabh prakashan, 2005.
2. Ansel, H., Allen, L., Popovich, N, "Pharmaceutical Dosage Forms and Drug Delivery Systems", Williams & Wilkins, 1999.

Reference Books

1. Lippin cott, "Remington's Science and Practice of Pharmacy", Williams & Wilkins publishers, 2005.
2. Goodman & Gilman's, "The pharmacological basis of therapeutics" by Joel Griffith Hardman, Lee E. Limbird, Alfred G. Gilman.2005
3. Tripathi KD, "Essential of Medical pharmacology", Jaypee Brothers Medical Publishers 2003.

17BT2039 BIOCHEMICAL ENGINEERING

Credits: 3:0:0

Course Objectives:

- To provide the idea to determine the rates of enzyme catalyzed reactions and to provide knowledge on the immobilization of enzymes.
- To provide knowledge regarding cell growth patterns and design of various bioreactors.
- To study the enzyme kinetics and inhibition models

Course Outcomes:

The students will be able to

- Classify chemical and biochemical processes

- Acquire knowledge on growth kinetics and growth inhibitor models
- Examine various enzyme kinetics and enzyme inhibition models
- Assess the role of aeration and agitation in fermenter design
- Design batch and continuous sterilization Process
- Develop various novel bioreactors

UNIT I - comparison of chemical and biochemical processes, industrially important microbial strains, preservation and storage of industrially important microbes, Quality control of preserved stock cultures
UNIT II - Kinetics of single substrate reactions without inhibition- Michelis – Menten parameters, Estimation of MM parameters, Enzyme Inhibition – Substrate, Product and Toxic compound inhibition, types and derivation.
UNIT III - Simple unstructured kinetic models for microbial growth, Monod model, Substrate uptake kinetics and maintenance coefficient, growth of filamentous organisms, product formation kinetics - Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Determination of kinetic parameters for monod equation
UNIT IV - Bioreactors for free cells – batch, continuous, fed batch, chemostat with recycle and multi stage chemostat systems, air lift and loop reactor, Bioreactors for immobilized cells: packed – bed, fluidized bed and hollow – fibre membrane bioreactors. Basics of solid state fermentation, various scale- up criteria for bioreactors.
UNIT V - Bioreactors for free cells – batch, continuous, fed batch, chemostat with recycle and multi stage chemostat systems, air lift and loop reactor, Bioreactors for immobilized cells: packed – bed, fluidized bed and hollow – fibre membrane bioreactors.

Text books:

1. Shuler M.L and Kargi F, "Bioprocess Engineering Basic Concepts" Prentice Hall of India 4th edition, 2002.

Reference books:

1. Lee, J.M, "Biochemical Engineering", Prentice Hall, 2nd Edition, 2001
2. Blanch, H.W and Clark, D.S, "Biochemical engineering", Marcel Dekker, 1997

17BT2040 METABOLIC ENGINEERING

Credits: 3:0:0

Course Objectives:

- To develop skills of the students in the area of metabolic engineering to alter the existing metabolic pathway
- To introduce novel metabolic pathways in microorganisms using r-DNA technology
- To learn molecular techniques in order to enhance the product yield

Course Outcomes:

The students will be able to

- Ability to integrate modern biology with engineering principles
- Acquire knowledge on the principles and regulation of metabolic pathways
- Analyze different methods to obtain improved production strains
- Categorize the synthesis of primary and secondary metabolites and bioconversions
- Practical applications of metabolic engineering in chemical, medical, and environmental fields
- Develop a good appreciation of the multidisciplinary aspects of biotechnology

UNIT I - Analysis of metabolic control in glycolysis, metabolic flux analysis and its applications in aminoacid production by glutamic acid bacterium
UNIT II - Feedback control systems, alteration of feedback regulation for enhanced production of primary metabolites: glutamic acid, Mutants which do not produce feedback inhibitors or repressors- auxotrophs-lysine, isoleucine, arginine, purine nucleotides.
UNIT III - Producers of secondary metabolites, Precursor effects, trophophase- idiophase relationship, applications of secondary metabolites,
UNIT IV - Antibiotics, vitamins, Mycotoxins- maintenance of genetic stability; Bioconversions
Unit V - Product over production examples: amino acids, polyhydroxyalkanoic acids, By-product minimization of acetate in recombinant E. coli, Extension of substrate utilization range for organisms such as S. cerevisae and Z. mobilis for ethanol production, Improvement of cellular properties

Textbook

1. Gregory N. Stephanopoulos , Aristos A. Aristidou & Jens Nielsen, "Metabolic Engineering: Principles and Methodologies", Academic Press, An Imprint of Elsevier India Pvt.Ltd.,1st edition, 1998.
2. S. Cortassa, M.A.Aon,A.A.Iglesias and D.Llyod, " An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Co. Pte. Ltd, 2002.
3. Christiana D. Smolke, " The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.

Reference Book

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005
2. W.Crueger and A. Crueger, "A Text Book of Industrial Microbiology", Panima Publishing Corporation, 2005
3. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.

17BT2041 PROCESS EQUIPMENT DESIGN

Credit: 3:0:0

Course Objectives:

- To design safe and dependable processing facilities.
- This course focus on plant layout and design of piping systems
- This will provide the basic knowledge to carryout design process cost effectively.

Course Outcomes:

The students will be able to

- Utilize principles of process equipment design, the mechanical aspects of the design
- Design various unit operation equipments, including safety considerations
- Develop flow measurement devices
- Design safe and dependable processing facilities
- Describe the Scale up criteria of bioreactors
- Analyze the plant layout.

UNIT I - Shell and tube heat exchanger , double pipe heat exchanger , Single effect evaporator and vertical tube evaporation,

UNIT II - Design of the following equipments as per ASME, ISI codes, drawing according to scale; monoblock and multiplayer vessels, combustion details and supporting structure.

UNIT III - Construction details and assembly drawing of distillation column; Plate and Packed absorption Towers; Design of fractional Distillation Towers.

UNIT IV - Design of venturimeter and orifice meter,Design of flow control device - Gate, Globe valves, their material of construction.

UNIT V - Design of airlift fermentor ; parts of fermenter, Ideal batch reactor design, Plant layout For Ethylalcohol and Citric acid .

Text Books.

1. Joshi, M.V, "Process Equipment Design", MacMillan, 3rd edition, 2004.

Reference Books:

1. Brownbell I.E., Young E.H.. "Chemical Plant Design" 1985.
2. Kern D.Q. "Heat Transfer". McGraw Hill, 1985.
3. McCabe, W.L., J.C. Smith and P. Harriott "Unit Operations of Chemical Engineering", 6th edition, McGraw-Hill, 2001.
4. Wnell, L.E, & Young, E.H.: Process Equipment Design, Wiley Eastern, New Delhi, (2000).
5. Ludwig, E.E.: Applied Process Design for Chemical & Petrochemical Plants, Vols. I, II & III, (2nd Ed.), Gulf Publishing Company, Texas, (1977, 1979, 1983).
6. Perry, R.H. & Green, D.W.: Perry's Chemical Engineers' Handbook, (7th Ed.),McGraw Hill (ISE), (2000).

17BT2042 PILOT PLANT AND SCALE UP PRACTICE

Credits: 3:0:0

Course Objectives:

- To provide basic knowledge of scale-up practice
- To teach the details of pilot plant design.
- To study about Pilot plants for reactors and mechanical operations equipments

Course Outcomes:

The students will be able to

- Acquire knowledge in pilot plants for reactors and mechanical operations equipments
- Examine Pilot plant design for several unit operation equipments.
- Assess sampling data and safety factors and dimensional analysis
- Design the bioreactor incorporating scale up concept
- Design bioreactor based on the process requirement

Unit I - Pilot plants, size estimation, sampling data, cost and safety factors, Pilot plants for reactors and mechanical operations equipments

Unit II - Oxygen Pathways in cell cultivations, volumetric oxygen transfer coefficient (K_La), oxygen transfer coefficicnt, oxygen transfer mechanism, resistances to gas liquid interface, Maxing/ Agitation in Biofluids, Measurements of Dissolved Oxygen (DO) and K_La, Assessment of K_La

Unit III - Scale up concerns of microbial, mammalian and plant cell processes, Scale up criteria, Selection of scale up criteria, Dimensional analysis, scale up equations.

Unit IV - Pilot plant design for heat exchangers, mixer equipments, batch and continuous distillation columns. Pilot plants for reactors and mechanical operations equipments

Unit V - Case studies, Economic analysis

Text Book:

1. S.N. Mukhopadhyay, "Process Biotechnology Fundamentals", Viva Books, Second Edition, 2004.

Reference Books:

1. Johnson and Thring, "Pilot plants models and scale up methods in chemical engineering", McGraw Hill Book co. 2nd edition, 1987.
2. Henley and Staffin, "Stage-wise process design", John Wiley, 2nd edition, 1988.
3. Bisio and Kabel, "Scale up of Chemical Process", John Wiley, 2nd edition 1985.

17BT2043 INDUSTRIAL SAFETY AND HAZARD ANALYSIS

Credits: 3:0:0

Course Objectives:

- Students learn about implementation of safety procedures,
- risk analysis and assessment
- hazard identification

Course Outcomes:

The students will be able to

- Demonstrate the awareness of plant safety in selection and layout of chemical plants and the usage of safety codes.
- Exhibit the skill in classifying chemical, fire, explosion hazards
- To understand the occupational diseases
- Analyze the bio medical and engineering response to health hazards
- To implement the effective process control and instrumentation.

UNIT I - Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling

UNIT II - Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety

UNIT III - Over all risk analysis-emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies. Quantitative risk assessment - rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.
UNIT IV - Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras-Vizag Bopal analysis
Unit V - Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system.

Text Books
1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990.
2. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965.

References
1. Handley, W., "Industrial Safety Hand Book ", 2nd Edn., McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., " Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
3. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994

17BT2044 INDUSTRIAL EFFLUENT TREATMENT

Credits: 3:0:0

Course Objectives:
- The study of the subject constitutes the sources, characteristics of waste water Provides various methods for treatment of wastewater.
- It imparts the knowledge of basic principles of science and engineering applied to the problem of water pollution.
- The study also focuses on a creative perspective in using equipments used for effluent treatment and knowing how it is designed and how it works.

Course Outcomes:
The students will be able to
- Gain basic knowledge on waste water treatment.
- Understand the principles to design equipments for waste eater treatment.
- Apply principles on real time environment.
- Analyze conceptually the need for the effluent treatment.
- Evaluate the volumetric flow rates and output rates of the treatment devices.
- Create basic parameters or equipments for using in the effluent treatment processes.

UNIT I - Introduction to industrial effluents and their treatments, Waste water constituents (Physical, Biological and Chemical). Metallic and Non metallic constituents.
UNIT II - Mixing, types of mixers. Screening, types of industrial screening devices. Grit removal, Sedimentation and their processes.
UNIT III - Aeration Systems, Filteration Systems and devices. Coagulation- definition and types of coagulation processes and types of coagulants used (Chemical, Biological)
UNIT IV - Adsorption – Types of natural adsorbants, Chemical Adsorption for phosphorous removal, removal of heavy metals (Cadmium,Lead,Mercury) by adsorption techniques.
UNIT V - Biological treatment and processes involved for effluents- Activated Sludge process, Oxidation ponds, Attached growth and biological trickling filters.

Text Books:
1. Metcalf & Eddy, "Wastewater Engineering (Treatment and Reuse)", 4th Edn, Tata – McGraw Hill, New Delhi, 2003.

Reference Books
1. Mark J. Hammer.: "Water and waste water technology" – 5thEdn", Prentice Hall of India Pvt. Limited, New Delhi, 2007.

17BT2045 POLLUTION CONTROL AND ENGINEERING

Credits: 3:0:0

Course Objectives:

- To give an exposure to various control acts
- To study the advantages and disadvantages of impact assessment methods
- To study the methods of reducing the waste and reusing it.

Course Outcomes:

The students will be able to

- Gain basic knowledge on pollution, its types
- Outline Pollution control acts and regulations.
- Employ collected raw data on pollution caused by industries.
- Evaluate audit reports on pollution is finally controlled.
- Create various approaches for material reuse
- Integrate various recycling methods

UNIT I - The water (prevention and control of pollution) act 1974 and rules 1975- CPCB-formXIII,XIV,XV, The air (prevention and control of pollution) act 1981 and rules 1982,CPCB-form I,VI. National ambient air quality standards.
UNIT II - The environment (protection) act 1986, rules 1986-definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous, standards of emission or discharge of environmental pollutants. Form V
UNIT III - Environmental impact assessment notification, 2006-environmental clearance, list of projects, form I, general structure of EIA documents, content of summary EIA
UNIT IV - The manufacture, use, import, export and storage of hazardous microorganisms genetically engineered organisms or cells rules, 1989-definitions,competent authorities, animal and human pathogens
UNIT V - Biomedical waste (management and handling) 1998,-categories of biomedical waste, colour coding and type of container for disposal of biomedical wastes,label for transport of biomedical waste containers/bags (schedule IV), standards for treatment and disposal of biomedical wastes (schedule V),waste management facilities like incinerator/autoclave/microwave system, form-I,II,III.

Text book:

1. C. S. Rao Environmental Pollution Control Engineering, New Age International, 2007

Reference Books

1. Peter Wathern, "Environmental Impact Assessment theory and practice", Unwin Hyman Ltd. Routledge, 1990,
2. L. Lee Harrison , "Environmental Health and Safety Auditing Handbook", 2nd edition, McGraw Hill, Inc., New York, 1995
3. Kirkwood, R. C. and Longley, A. J., "Clean Technology and Environment", Chapman & Hall, 1995.

17BT2046 MECHANICAL OPERATIONS LAB

Credits: 0:0:2

Course Objectives:

- The experimentation constitutes different processes involved in downstream operations in a biotech and a chemical industry
- It imparts the knowledge of basic principles of science and engineering applied to the mechanical operations on macro and micro molecules.
- The study also focuses on a creative perspective in using equipments used for mechanical operations and knowing how it is designed and how it works.

Course Outcomes:

The students will be able to

- Gain basic knowledge on various mechanical functioning of process equipments.(Mixers, dryers, screens)
- Understand the principles to design equipments for treating macromolecules used in the drug and biotech industries.
- Apply the principles on real time environment.
- Analyze conceptually the need for downstream operation.
- Evaluate analytically problems related with mechanical operating equipments.

- Create basic parameters or equipments for using in the different biotech downstream processing industries.

List of Experiments:

1. Screen Effectiveness
2. Ball Mill
3. Sigma Mixer
4. Ribbon Mixer
5. Dewatering centrifuge
6. Angle of Repose
7. Plate & Frame Filter Press
8. Sparkler Filter Press
9. Cross flow dryer
10. Through flow dryer
11. Extruder
12. Crushing and grinding

17BT2047 PLANT AND ANIMAL TISSUE CULTURE LAB

Credits: 0:0:2

Course Objectives:

- To learn the basic techniques of animal cell culture
- To impart the technical skills of plant tissue culture
- To develop the knowledge of preservation and conservation techniques in cell culture

Course Outcomes:

The students will be able to

- Gain knowledge in Animal cell culture technique
- Understand the sterilization techniques and its importance
- Analyze and determine the growth of cell culture techniques
- Evaluate the efficacy of drugs in animal cell culture
- Apply the propagation methods for commercially important plants
- Understand various in vitro techniques in animal and plant cell culture system

List of Experiments

1. Basics of tissue culture laboratory design and maintenance.
2. Packing and Sterilization of glass and plastic wares for cell culture.
3. Preparation of reagents and media for Animal cell culture.
4. Quantification and cell viability test using Tryphan blue.
5. Culturing of Spleenocytes from Spleen.
6. Isolation and culturing of Thymus cells.
7. Introduction to Plant Cell & tissue Culture.
8. Types of sterilization.
9. Preparation and sterilization of different culture media.
10. Sterilization and inoculation of explants for micropropagation.
11. Sterilization and inoculation of explants for callus culture.
12. Preparation of synthetic seeds.

17BT2048 BIOPROCESS CONTROL AND INSTRUMENTATION

Credits: 3:0:0

Course Objectives

- To control and measure the processing facilities in a cost effective manner.
- To focus on plant layout control and piping systems
- To provide in-depth knowledge on control systems

Course Outcomes:

The students will be able to

- Analyze open-loop systems
- Analyze and apply the knowledge of linear closed loop systems

- Develop working knowledge of control system by frequency response
- Analyze Frequency response and apply it to advanced control systems
- Develop working and design knowledge of Digital controllers
- Compare different control modes for dstillation and heat exchanger.

Unit I - OPEN LOOP SYSTEMS Laplace Transforms - Standard functions, Open loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics

Unit II - CLOSED LOOP SYSTEMS Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transportation lag, transient response of closed-loop control systems, Routh- Hurwitz and Root-locus stability of a control system

Unit III - FREQUENCY RESPONSE Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, Principle of Nyquist diagram, stability criterion, tuning of controller settings

Unit IV - ADVANCED CONTROL SYSTEMS Introduction to advanced control systems, cascade control, feed forward control, model predictive control, control of distillation Column and heat exchanger. Adaptive controller, Supervisory controller and Ratio controller

Unit V - DIGITAL CONTROLLERS Introduction to Computer control loops, Digital computer, computer process Interface, digital to analog and analog to digital converters, sampling continuous signal, Hardware components of a DDC loop, New control Design problems

Text Books

1. Coughnowr, D. R., Process Systems Analysis and Control, Mc Graw Hill, New York, 2nd Edition,1991
2. George Stephanopolous, Chemical Process Control, Prentice-Hall of India Pvt-Ltd., New Delhi,1990

References

1. Doeblin Ernest , Measurement Systems, Mc Graw Hill, New York , 2005
2. C. A. Smith and A. B. Corripio, Principles and Practice of Automatic P r o c e s s Control, John 36
3. A.Suryanarayanan, "Chemical instrumentation and process control", Khanna Publishers 2nd edition, New Delhi, 1995
4. George Stephanopolous, Chemical Process Control, Prentice-Hall of India Pvt-Ltd., New Delhi,1990

17BT2049 APPLIED MEDICAL BIOCHEMISTRY

Credits: 3:0:0

Course Objectives:

- To learn the biochemistry of living cells.
- To provide knowledge on the biochemistry of proteins, lipids and carbohydrates.
- To introduce the different methods of investigation of metabolism and diagnostic tools.

Course Outcomes:

The students will be able to

- State and explain the biochemistry of proteins, lipids and carbohydrates in living cells.
- Employ biochemical reaction and suggest suitable investigation methods.
- Assess the metabolism of biomolecules.
- Summarize the functions of various organs
- Focus on significance of clinical analysis
- Explain the role of vitamins in human health

UNIT I - Biochemistry of living cells, sub cellular fractionation using the differential centrifugation method. Functions of each organelle, redox potential, oxidative phosphorylation, Transport of substances across biological membranes.

UNIT II - Definition, Classification, Structure of monosaccharides, disaccharides, their biomedical importance, diabetes, Blood sugar analysis and glucose tolerance tests.

UNIT III - Lipids, Definition, Classification, Fatty acids, classification and functions, essential fatty acids structure and functions, and cholesterol, Structure and properties, their biomedical importance.

UNIT IV - Proteins, Composition, general properties, classification, biomedical importance, identification of proteins by chromatography and electrophoresis.

Unit V - Vitamins, Classification, functions and deficiency symptoms, hypervitaminosis. Uses of isotopes in biochemistry. Methods of investigation of metabolism, Liver function tests, Renal function tests, Urine analysis and gastric function tests.

Text Book:

1. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.

References:

1. Donald Voet, Judith,G.Voet and Charlotte, W.Pratt."Fundamentals of Biochemistry, Life at the Molecular Level."JohnWiley&sons,Inc.(Asia). 2006.
2. Keith Wilson and JohnWalker. "Principles and Techniques of Biochemistry and Molecular Biology". Sixth Edition. Cambridge University Press.2007.
3. Rodney Boyer, "Modern Experimental Biochemistry," Third edition. Addison Wesley Longman Inc.2000.

17BT2050 MEDICAL BIOCHEMISTRY LABORATORY

Credits: 0:0:1
Co-requisite: 17BT2049 Applied Medical Biochemistry

Course Objectives:

- To learn the biochemistry of living cells.
- To provide knowledge on the biochemistry of proteins, lipids and carbohydrates.
- To introduce the different methods of investigation of metabolism and diagnostic tools.

Course Outcomes:

The students will be able to

- Explain and discuss the biochemistry of proteins, lipids and carbohydrates in living cells.
- Demonstrate biochemical reaction and suggest suitable investigation methods.
- Construct the metabolism of biomolecules.
- Discuss the biochemistry of vitamins
- Demonstrate the estimation methods of macroelements
- Analyze and investigate the metabolic disorders in urine sample

List of Experiments

1. Study of biochemical solutions, units and measurements
2. Estimation of total carbohydrate by Anthrone method
3. Qualitative analysis of carbohydrates
4. Estimation of protein by Lowry's method
5. Estimation of amino acid by Ninhydrin method
6. Estimation of cholesterol by Zak's method
7. Qualitative Analysis of amino acids
8. Qualitative Analysis of Lipids
9. Estimation of ascorbic acid
10. Dry of food materials and estimation of phosphorus

17BT2051 HUMAN PHYIOLOGY AND ANATOMY

Credits: 3:0:0

Course Objectives:

- To explain the basics on the structure animal cell and organs
- To illustrate the different systems of the body and their functioning
- To demonstrate the fundamentals in human anatomy and physiology

Course Outcomes:

The students will be able to

- To give outline on animal cells, their functions and membrane transportation of cells.
- To explain the composition of blood and its function on maintaining homeostasis.
- To demonstrate the components of respiratory and cardiovascular systems.

- To describe briefly about the anatomical locations, structures and their physiological functions of respiratory and cardiovascular systems.
- To illustrate the structure and functions of nervous system and parts of brain.
- To explain about the structure of eye, ear and kidney and their functions.

UNIT I - Cell: structure and organelles, function of each component. Cell membrane, transport across membrane, origin of cell membrane potential (Nernst and Goldman and Katz equations), action potential.
UNIT II - Blood composition, Functions of blood, functions of RBC. WBC types and their functions, blood groups, importance of blood groups, identification of blood groups, blood flows factors regulating blood flow such as viscosity, radius, density etc.
UNIT III - Components of Respiratory system. Oxygen and carbon di oxide transport and acid base regulation, structure of Heart, properties of cardiac muscle, cardiac muscle and pace maker potential, cardiac cycle, ECG, Heart sound, volume and pressure changes and regulation of heart rate.
UNIT IV - Structure of a neuron, Synaptic conduction. Conduction of action potential in neuron. Parts of brain cortical localization of functions, EEG. Simple reflexes, with drawls reflexes. Autonomous nervous system and its functions
Unit V: Structure of Eye, Ear and auditory and visual pathways. Structure of kidney and nephron, Mechanism of Urine formation and base regulation. Dialysis.

Text Books:
1. Anne Waugh, Allison Grant, "Ross and Wilson: Anatomy and Physiology in health and Illness", Churchil Livingston Elsvier 2010.

References:
1. Elaine . N. Marieb, "Essentials of Human Anatomy and Phsiology" 8^{th} edition, Pearson education, New Delhi 2007
2. William F Ganang "Review of Medical physiology" 2^{nd} edition McGraw Hill , New Delhi, 2000

17BT2052 BIOMATERIALS AND ARTIFICIAL ORGANS

Credits: 3:0:0

Course Objectives:
- To learn and understand the Concepts, Classification and Properties, and Structural variations in biomaterials.
- To understand the testing of implants and cell-interfacing materials.
- To know the applications of biomaterials in Artificial Organs and their development.

Course Outcomes:
The students will be able to
- Identify and know the structural variations in biomaterials.
- Determine and classify the various properties of biomaterials.
- Explain the methods for testing implants with different aspects of biomaterials
- Recall the cell-biomaterial interactions for constructing artificial organs.
- Remember the Interfacing materials and ethical implications.
- Apply the biomaterials in the healthcare sectors.

UNIT I - Definition, classification and properties of bio-materials, Surface, bulk, mechanical and biological. Types of biomaterials; Biological response to biomaterials; Crystal structure of metals; Crystal structure of ceramics; Carbon based materials; General structure of polymers; Synthesis of polymers. Bending properties; Time dependent properties – creep properties of polymers; Influence of porosity and the degradation of mechanical properties; Introduction to fatigue.
UNIT II - Wound-healing and blood compatibility. Surface modification of biomaterials – plasma treatment, radiation grafting, self-assembled monolayers (SAMs), Langmuir – Blogett films and covalent biological coatings; Protein properties that affect biomaterial surface interaction; biomaterial surface interaction that affect interactions with proteins; Protein adsorption kinetics; DLVO model for cell adhesion; Assays to determine the effects of cell-material interactions – agar diffusion assay, adhesion assays and migration assays.
UNIT III - Biocompatibility – Toxicology, Biocompatibility, Mechanical and Performance Requirements, Regulation. Biomaterials associated infection. Cytocompatibility evaluation laboratory, Tissue compatibility evaluation laboratory, Hemocompatibility evaluation laboratory, Sterility evaluation laboratory, Histopathology evaluation laboratory, Physiochemcial evaluation laboratory.

UNIT IV - In vitro assays for inflammatory response due to biomaterial implantation; Fibrous encapsulation of healing process; Ideal features of soft tissue implants; Metallic Implant materials, Polymeric Implant materials, Tissue replacement materials-soft, hard and blood interfacing materials.
UNIT V - Heart, heart valves, oxygenators - bubble, film oxygenators and membrane oxygenators. Gas flow rate and area for membrane oxygenators - Anatomy & Physiology of EAR-air conduction, bone conduction, masking, functional diagram of an audiometer. Dialysers - Haemodialysis: flat plate type, coil typeand hollow fiber. Haemodialysis Machine, Portable kidney machine - Brief of lungs gaseous exchange / transport, artificial heart - Lung devices, Dental implants.

Text Book:
1. Joon B.Park Joseph D. Bronzino, "Biomaterials - Principles and Applications" CRC Press, 4th edition, 2003.

Reference Books:
1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons. An Introduction to Materials in Medicine. Academic Press. USA, 2006.
2. Sujata V. Bhatt, "Biomaterials" Second Edition, Narosa Publishing House,2005.
3. Rajendran V. and Marikani A., Materials Science, Tata McGraw Hill Pub. Company Ltd., New Delhi, 2004.

17BT2053 OCCUPATIONAL SAFETY MANAGEMENT

Credit: 3:0:0

Course Objectives:
- To know about the health issues and safety principles
- To apply safety practice through training methods
- To know the occupational safety and health Act and its applications

Course Outcomes:
The students will be able to
- Identify hazards in the home or workplace that pose a danger to their safety or health.
- Control unsafe or unhealthy hazards and propose methods to eliminate the hazard.
- Present a coherent analysis of a potential safety or health hazard.
- Discuss the role of health and safety in the workplace pertaining to the responsibilities of workers, managers, supervisors.
- Indicate a comprehension of the changes created by OSHA in everyday life.
- Identify the decisions required to maintain protection the environment, home and workplace as well as personal health and safety.

UNIT I - - Personal Health and Safety - personal health and safety at home and in the workplace, blood borne virus, hepatitis B, HIV, dermatitis, skin care, Personal Safety - emergency first aid treatment - reaction to accidents, reporting of accidents, pro-active procedures when accidents occur, cleaning the accident site, personal safety wear and protective equipment.
UNIT II - - Accidents & Their Effect on Industry - costs of accidents, work accident costs and rates, time lost - work injuries, parts of the body injured on the job - chemical burn injuries, Carpal Tunnel, Syndrome Injuries, Drugs and Alcohol in the Workplace. Theories of Accidents - Domino Theory of Accident Causation, Human Factors Theory of Accident Causation, Accident/Incident Theory of Accident Causation, Epidemiological Theory of Accident Causation, Systems Theory of Causation, Combination Theory of Accident Causation.
UNIT III - Regulatory matter-Occupational Safety and Health Act (OSHA) of 1971, compliance with established regulations-safe equipment and management supervision, Hazardous Material Information, System - routes of entry into the body of toxic materials, general safety precautions, cleaning chemical spills, MSDS sheets, Falling, Impact, Acceleration and Lifting Hazards - correct lifting techniques, selecting correct lifting procedures in the workplace, safety equipment, safe storage of materials at home and in the workplace, dealing with manual handling, Workers Compensation - injuries and workers compensation, workers' compensation legislation, resolution of workers' compensation disputes. Roles of Health and Safety Personnel - the modern health and safety team, health and safety manager, engineers and safety
UNIT IV - Stress and Safety - workplace stress defined, sources of workplace stress, human reaction to workplace stress, measurement of workplace stress, shift work, stress and safety, improving safety by reducing stress, stress in safety managers, stress and workers compensation. Mechanical Hazards and Safeguarding - common mechanical injuries, safeguarding defined, lockout/tag out systems, taking corrective action, Heat and Temperature Hazards - the body's response to heat, heat stress and its prevention, overview of cold hazards, preventing cold stress, Fire Hazards - sources of

fire hazards, fire dangers to humans, detection of fire hazards, reducing fire hazards, development of Fire Safety Standards, fire safety myths, fire hazards defined, Noise and Vibration Hazards, hazards levels and risks, identifying and assessing hazardous noise conditions, noise control strategies, vibration hazards.

UNIT V - First aid in emergencies - reporting accident, Promoting Safety, safety committees. Health and Safety Training - rationale for health and safety training, Industrial Hygiene - hazards in the workplace, entry points for toxic agents, airborne contaminants, asbestos hazards, hazard recognition, evaluation and control. Importance of Computers, Automation and Robots, Safety and the Environment, Product Safety and Liability and Ergonomics and Safety.

Text Book:

1. Mark A. Friend, James P. Kohn**, "**Fundamentals of Occupational Safety and Health, Bernan Press, 23-Jun-2014.

Reference Books:

1. Geoff Taylor, Kellie Easter, Roy Hegney, "Enhancing Occupational Safety and Health", Elsevier Butterworth-Heinemann, 2004.
2. Occupational safety Manual, BHEL, Trichy, 1988

17BT2054 MEDICAL WASTE TREATMENT

Credits: 3:0:0

Course Objectives:

- To identify the modes of medical waste treatment
- To understand the pollution and health hazards
- To analyze the methods of water treatment

Course Outcomes:

The students will be able to

- Outline about Medical wates and its disposal
- Practice the ways of preventing pollution and personal safety
- Design of instrumentation and control techniques for potable water treatment
- Gains knowledge in computer monitoring system
- Summarize the instruments in waste disposal and its uses
- Develop knowledge for medical waste disposals in hospitals.

UNIT I - Classification of Medical wastes: Sources and classification of medical waste-color code-handling, sterilization, treatment.

UNIT II - Environmental Hazards:-Hazards –personal safety-environmental pollution-health hazards.

UNIT III - Waste Treatment and monitoring system: medical waste treatment system-temperature and level control, toxic gas detector-design of alarm system-central monitoring- pollution monitoring system

UNIT IV - Instuments for monitoring : water pollution-central monitoring system,Proper disposal of wastes , incinerator. Temperature level and flow control for computer applications in central monitoring system

Unit V: Case studies: Hospital Managements , collection , transportation and safe disposal-regulations, ethical issues in waste disposal.

Text Book:

1. P.K. Behera, "Sustainable biomedical waste management", Dominant Publishers And Distributors, 3rd edition, 1993.

References:

1. Dr. Shalini Sharma, SVS Chauhan, "An analysis of medical waste management", Lambert publisher, 2000**.**
2. Etcalf& Eddy, "Wastewater Engineering (Treatment and Reuse)", 4th Edn, Tata – McGraw Hill, New Delhi, 2003.
3. Mark J. Hammer.: "Water and waste water technology" – 5thEdn", Prentice Hall of India Pvt. Limited, New Delhi, 2007.
4. James M. Montgomery.: "Water treatment principles and design" – A Wiley IntersciencePublication, Newyork, 1985.

17BT2055 CELLBIOLOGY AND IMMUNOLOGY

Credits: 3:0:0

Course Objectives:

- This course aims to impart basic knowledge in cell biology & Immunology,
- To help the students familiarize with the organs and cells of the immune system, the immune response and molecular interactions involved in immune response.
- To make the students aware of the applications of immunology such as, immunodiagonosis and immunotherapy

Course Outcomes:

The students will be able to

- Summarize the history and development of the field of cell biology
- Learn various organelles of the cell and their functions.
- Understand the types of immunity, the basic plan of the immune of the immune system and the organs the cells of the immune system and their functions.
- Gains knowledge the humoral immune system
- Outline and understand the physiology
- Aware of the pathology of the immune system.

UNIT I - History of cell biology, inventions, discoveries and the cell theory. Cellular organization, prokaryotes and eukaryotes, Organelles and specialization, Membranes and membrane transport; Plasma membrane & Transport, Cell Wall, ECM, Cell-Cell Interactions.

UNIT II - Modes & Types of Cellular Signals, Receptors: GPCRs, RTKs, Cytokine Receptors & NRTKs, Enzyme linked receptors. Intracellular Signal Transduction Pathways,

Cytoskeleton and cell motility; Structure and Organization of Actin filaments, Microtubules and Intermediate Filaments, Cell Movement, Motor Proteins. Cell Cycle; stages, mitosis, Meiosis.

UNIT III - Introduction and an overview of immunology, History of immunology, Types of Immunity - Innate and acquired immunity, Cell mediated and humoral immunity; Organs of the immune system: Lymphoid organs - primary and secondary.

UNIT IV - Granulocytes and Agranulocytes, haematopoisis, extravasation, phagocytosis. T and B Lymphocytes & NK cells. Major histocompatibility complex; antigen processing and presentation, T-Cell activation and the cellular immune response. Antigens- chemical and their molecular nature; Haptens; Adjuvants. Antibody – structure, Classes Antigen Antibody reactions; Neutralization, Opsonization. Complement, Cytokines

UNIT V - Injury and inflammation; immune responses to infections: immunity to bacteria, and virus; Transplantation: laws,, consequences and genetics of transplantation, Cancer immunology – Tumour Associated Antigens and Tumour Specific Antigens; Autoimmunity; Autoimmune disorders, Allergy and hypersensitivity, Tolerance, Immunosuppression and AIDS.

Text Book

1. Alberts, Molecular Biology of the Cell, Garland Sciences, 4th edition, 2002.
2. Roitt I, Male, Brostoff, “Immunology”, Mosby Publshers, 3rd edition2002.

Reference Books

1. Geoffrey M. Cooper, Robert E. Hausman, The Cell, A Molecular Approach – 6th Edition Sinauer Associates, Inc..
2. Tizard, “Immunology”, Saunders college publication, 5th Edition, 2004.
3. Kuby J, “Immunology”, WH Freeman & Co., 2000.
4. Ashim K. Chakravarthy, “Immunology”, TataMcGraw-Hill, 2001

17BT2056 TISSUE ENGINEERING

Credits: 3:0:0

Course Objectives

1. To introduce the basic concepts of tissue organisation in the human body and the theories related to normal physiology and repair
2. To inculcate knowledge on cell culture, cell signalling and molecular growth factors.
3. To develop tissue implants and transplants and its regulation in tissue engineering

Course Outcomes

The students will be able to

- Outline the fundamental concepts about types of cells and culturing procedures
- Analyze the cellular interaction and molecular aspects of cell differentiation, communication and growth.
- Design scaffolds, tissue implants and its use in tissue engineering
- Gain knowledge in 3D culture mechanism and cell interactions
- Acquire Knowledge in the tissue engineering applications
- Understand about the regulatory issues and therapeutic uses and its recent developments.

UNIT I - Introduction, Basic definition, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, cell culture techniques

UNIT II - Scaffold and transplant, egineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength

UNIT III - Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells in tissue engineering

UNIT IV - 3D cell culturing and protocols involved for the 3D cell culture of different types of cells cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering.

Unit V - Case study of multiple approaches: Ethical, FDA and regulatory issues of tissue engineering, Current scope of development and use in therapeutic and in-vitro testing

Text Book

1. Introduction. R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.
2. Animal cell culture 3rd ed., by John R.W. Masters A Practical Approach Oxford University press New York 2005

Reference Books

1. Robert. P.Lanza, Robert Langer & William L. Chick, Principles of tissue engineering, , Academic press.
2. Joseph D. Bronzino, The Biomedical Engineering –Handbook, CRC press.
3. B. Palsson, J.A. Hubbell, R.Plonsey& J.D. Bronzino,Tissue Engineering, CRC- Taylor & Francis

17BT2057 TECHNIQUES IN PATHOLOGY AND MICROBIOLOGY

Credits: 3:0:0

Course Objectives

- Gain knowledge on the structural and functional aspects of living organisms
- To understand the properties of antigens and antibodies and the concept of antigen-antibody interactions
- To understand the morphological characteristics and cultivation of bacteria

Course Outcomes

The students will be able to

- Acquire the knowledge of concepts of cell injury, neoplasia and changes produced thereby in different tissues and organs
- Understand in brief, about the hematological diseases and investigations necessary to diagnose them
- Demonstrate various antigen-antibody interactions and techniques
- Evaluate the working principle of microscope in diagnosis of infectious and non infectious diseases
- Recognize the fundamental concepts in the structure and functioning of a cell
- Acquire knowledge of common immunological techniques for disease diagnosis

UNIT I - Necrosis, apoptosis**,** cellular adaptations of growth and differentiation, Inflammation and Repair, Neoplasia, tumours, carcinogenesis, autopsy and biopsy, Hemostasis, Edema, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock. Hematological disorders.

UNIT II - Natural and artificial immunity, opsonization, phagocytosis, inflammation, Immune deficiency syndrome, antibodies, antigen and antibody reactions

UNIT III - Light microscope, fluorescence, TEM & SEM. Preparation of samples for electron microscope. Staining methods.

UNIT IV - Morphological features and structural organization of bacteria, growth curve, identification of bacteria , culture media and its types , culture techniques and observation of culture

Unit V: Instrumentation for immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies. Disease caused by bacteria, fungi, protozoal, virus and helminthes.

Textbook:

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB Saunders Co. 2005.

References:

1. Prescott, Harley and Klein, "Microbiology", 5th edition, McGraw Hill, 2002 (Units III,IV& V).
2. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
3. Ananthanarayanan & Panicker, "Microbiology" Orientblackswan, 2005.
4. Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2007

17BT2058 MICROBIOLOGY AND IMMUNOLOGY

Credit 3:0:0

Course Objectives:

- To impart knowledge on classification and structure and function of microbes
- To learn the nutrition and control of microorganisms
- To understand the fundamental principles and concepts of immune system.

Course Outcomes:

The students will be able to

- Understand the historical perspective and scope of microbiology and its advances.
- Simplify and know the structure, functions and nutritional requirements of microbes.
- Understand the concepts of control and growth of microbes and Antimicrobials.
- Outline the general concepts of immune system, cells, organs of the immune system and Antigens and Antibodies.
- Interpret the concept of cell mediated immunity and complement system
- Demonstrate the concept of hypersensitivity and transplantation immunology

UNIT I - An overview of microbiology including a historical perspective of microbiology, Origin of Leeuwenhoek's Animalcules, Germ theory of fermentation and disease, Development of laboratory techniques to study microorganisms, Developments in disease. Classification and Nomenclature of microorganisms; Basics of Microscopy - light and electron microscopy; Principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining and fungal staining.

UNIT II - Morphology, Structure and Functional anatomy of Prokaryotic and Eukaryotic Cells. Multiplication of bacteria, viruses, algae, protozoa and fungi with a special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophage. Nutritional requirements of bacteria and different media used for bacterial culture; Screening and isolation of organisms- Pure culture techniques (spread plate, pour plate, streak plate) Preservation methods.

UNIT III - Microbial growth and factors affecting growth. Growth curve and different methods to quantify bacterial growth, Aerobic and Anaerobic; Introduction to chemosynthesis. Physical and chemical control of microorganisms – sterilization: Moist heat, dry heat, radiation and filtration. Disinfection: phenol, alcohol and detergents. Host-microbe interactions, Chemotherapy and antibiotics- anti-bacterial, anti-fungal agents, anti-viral agents, mode of action and resistance to antibiotics.

UNIT IV - Historical background, general concepts of the immune system. Innate and adaptive immunity. Structure, properties and functions of the immune cells & organs: Hematopoeisis, T and B-lymphocytes, NK cells; Monocytes and macrophages; Neutrophils, eosinophils, and basophils Mast cells and dendritic cells. Thymus and bone marrow; Lymph nodes, spleen, MALT, GALT and CALT. Antigens and haptens; Properties; Adjuvants. B and T cell epitopes. T-dependent and Tindependent antigens. Antibodies: Classification, Structure, function and properties of the antibodies; Antibody as B cell receptor, antigenic determinants on antibodies (isotype, allotype and idiotype).

UNIT V - Major histocompatibility gene complex: Organization of MHC- Types and Functions, Structure and cellular distribution of HLA antigens. Cell mediated immunity: Cell types (CTLs, NK cells, macrophages and TDTH cells), effector mechanisms and effector molecules of cell mediated reactions. Cytokines – interleukins and interferons (outline only).Complement system: Components of the complement activation - classical, alternative and lectin pathways. Biological consequence of complement activation and complement deficiencies. Hypersensitivity: Types and mechanism of hypersensitive reactions Autoimmunity: Mechanisms of induction of organ specific and systemic, autoimmune diseases. Therapeutic approach. Transplantation immunology: Types of grafts, immunologic basis of graft rejection, properties and types of rejection, tissue typing, immunosuppressive therapy. Immunity and tumors: Types of tumors, tumor antigens (TSTA and TATA), immune response to tumors.

Text Books:

1. Kuby, J. H. Immunology, 6th Edn., New York, USA,W. H. Freeman Publication. 2007.
2. Prescott LM, Harley JP, Klein DA, “Microbiology”, Wm. C. Brown Publishers,3rd edition, 2001.

Reference Books:

1. Pelczar MJ, Chan ECS & Krein NR, “Microbiology”, Tata McGraw Hill Edition, NewDelhi, India, 2007
2. Roitt, I., Brostoff, J. and David, M. Immunology, 11th Edn., New York, USA Mosby publishers Ltd. 2008.
3. Tizard, “Immunology”, Saunders college publication, 5th Edition. 2004.

17BT2059 ANALYTICAL INSTRUMENTATION

Credits: 3:0:0

Course Objectives:

- To provide the students an ability to understand the principles of instrumentation
- To impart the knowledge of different techniques and methods in biotechnology
- To improve the understanding of applications of techniques in the field of biotechnology

Course Outcomes:

The students will be able to

- Understand the basic techniques of drug extraction
- Illustrate the different methods of spectroscopy
- Classify the various techniques of Chromatography
- Elaborate the importance of electrophoresis and thermal analysis techniques
- Analyze the methods of structural elucidation of different drugs
- Evaluate the importance of detection of radioactive isotopes

UNIT I - Buffers, pH – pH meter and applications, Solvent extraction –introduction and principle; Extraction techniques– batch, stripping or back, continuous and counter-current; Principle of solid extraction (Soxhlet); Types -Temperature assisted, pressurized hot water and supercritical fluids based extraction.

UNIT II - Basic principle of Spectroscopy -Beer-Lambert’s law, Principle, Instrumentation and applications of Colorimeter, Flame photometry, spectrofluorimetry and Spectrophotometer: types– UV – visible – Raman spectroscopy.

UNIT III - Principle, types and applications of Chromatography- Thin layer, Adsorption, Ion-exchange, Affinity, Gelfiltration, GC and HPLC.

UNIT IV - Principle, Types and applications of Electrophoresis– agarose gel, polyacrylamidegel (PAGE), SDS-PAGE– principle, instrumentation and applications; isoelectric focusing–principle and applications; Thermo gravimetricanalysis (TGA)-Principle, instrumentation and applications

UNIT V - Mass spectrometry–principle, instrumentation (electron spray ionization [ESI] & chemical ionization [CI]) and applications; nuclear magnetic resonance (NMR) –principle, instrumentation and applications; Radioactive isotopes, radioactive decay and their types, radioactive techniques - RIA, GM counter, Scintillation counter, Applications in Medicine & Diagnosis.

Text Books

1. Willard and Merrit, “Instrumental Methods and Analysis” 6th edition, CBS Publishers & Distributors, 2002.

Reference Books

1. Gurdeep R. Chatwal and Sham K. Anand. Instrumental Methods of Chemical Analysis. 5th Edition. Himalaya Publishing House, India. (2012).
2. B.K.Sharma. Instrumental Methods of Chemical Analysis. 24th revised and enlarged edition. GOEL Publishing House, India. (2014).
3. Keith Wilson and John WalkerPrinciples and Techniques of Practical Biochemistry and Molecular Biology. 7th Edition. Cambridge University Press, U.K. (2010).
4. Douglas A. Skoog, F.James Holler and Stanley R. Crough. Instrumental Analysis. 6th Edition. Brooks Cole Publishing Company. USA, (2007).

17BT2060 BIOLOGY IN EVERYDAY LIFE

Credits: 3:0:0

Course Objectives:

- To understand the fundamental principles and concepts of immune system.
- To impart knowledge on recent developments in biology
- To learn the applications of biology in health and human welfare

Course Outcomes:

The students will be able to

- Classify organismal form, function, and diversity.
- Understand Human health and welfare and manage stress.
- Know about the Molecules that define Life and immunotherapeutics.
- Develop a knowledge base for entrepreneurship.
- Appraise the recent trends in biology.
- Demonstrate the ability to undertake careers in biology and be a professional.

UNIT I - Introduction on each application area, Classification of Life forms – Prokaryotes and Eukaryotes, Body plan and Design of Life Forms, Tree of Life and its Fruits. Evolution – Charles Darwin and Carl Linnaeus - Taxonomy, Hierarchy in Classification. Human Nutrition – Macronutrients, Human Nutrition – Micronutrients, Case Study – I (Typhoid Mary).

UNIT II - The Human Body during Health and Disease – Digestive system - Gastroesophageal Reflux Disease (GERD), Jaundice, Dysphagia, Crohn's Disease, Ulcerative Colitis, Celiac disease, Gall Stones, Irritable Bowel Syndrome, Hemorrhoids, and Anal Fissure; Renal System – UTI's, Painful Bladder Syndrome (PBS), Bladder Control Problems, Kidney Stones, Prostatitis, Proteinuria, and Kidney Failure; Circulatory system - High Blood Pressure, Atherosclerosis, Aneurysms, Thrombotic Disorders, Congenital Defects. Stress. Alcohol and Drug Abuse. Depression. Case Study – II (Substance abuse and Social Concern).

UNIT III - Microbes - The Good, the Bad and the Ugly. Bacteria, Fungi, Protozoa, Virus, and Helminthes. Uses in daily life. The Fermentation Industry - Bread making, Beer making and Batter – Idly making– Wine making. Antibiotics – Classification and Mechanism of action in Antibiotics. Immunotherapeutics. Drug Resistance. Microbes as Fertilizer. Organisms as Pesticides. Biofuels and Bioenergy.

UNIT IV - Biomolecules – Types and Properties - Carbohydrates, Fats, Lipids and Nucleic Acids. DNA - Blueprint of Life, Flow of Genetic information, Genes to Function, Forensics - Crime Scene Investigation. Murder mystery and DNA. DNA Fingerprinting. DNA Diagnostics. Population Genetics.

UNIT V - Genetically Modified Plants and Animals, Human Cloning, Stem Cells Depot, Drug Resistant Pathogens, Biosafety and Ethics, Nobel Prizes in Medicine and Physiology, Careers in Biosciences – A Survey.

Text Books:

1. Arthur C Guyton, "A Textbook of Human Physiology", Elsivier Saunders, International Edition, 11th Edition, 2006.
2. Peter Raven et al "Biology", McGraw-Hill Education; 10 edition, January 9, 2013.

Reference Books:

1. Prescott LM, Harley JP, Klein DA, "Microbiology", Wm. C. Brown Publishers,3rd edition,2001.
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
3. Bruce Alberts, Molecular Biology of the Cell. "Essential of Molecular Biology" by David Frielder, 2010.

17BT2061BIOTECHNOLOGY AND ENVIRONMENT

Credits: 3:0:0

Course Objectives:

- To learn the importance of biotechnology
- To learn the importance of environment
- To understand the significance of conservation

Course Outcomes:

The students will be able to

- Acquire knowledge on the scope of biotechnology
- Dramatize the health hazards of various pollutants

- Explain the importance of waste water treatment
- Understand the significance of waste management
- Outline the various bioremediation techniques
- Dramatize the conservation of biodiversity

UNIT I - Definition and Scope of Environmental Biotechnology; Environmental Pollution; Types, Causes and Effects of Soil, air, water, oil and heavy metal. Pollution, control measures. Social Issues- Green House Gases, Global Warming, Acid Rain, Ozone depletion, nuclear accidents and holocaust.
UNIT II - Industrial Waste Water Management, Purification of waste water; Aerobic and anaerobic treatments; Management of radioactive pollutants in water, VOC, COD BOD and BOD sensors.
UNIT III - Biomass, Energy and Solid waste Management, Biomass waste as renewable source of energy; Methods of energy production; Conversion of Solid Waste to Methane; Biogas production; Biofuels, Management of Sludge and Solid waste treatment- Land filling, lagooning, Composting and Vermi Composting.
UNIT IV - Biodiversity and Conservation, Definition, Types, Genetic, Species, Ecosystem; Biodiversity at Global Levels; Values of Biodiversity; Hotspots in Biodiversity; Loss of Biodiversity and its causes threats to Biodiversity; Biodiversity and itsConservation- In situ and Ex situ, IPR and Patenting.
Unit V - Bioremediation and Biodegradation, types- Ex situ and In situ Bioremediation; genetically Engineered Microbes for Bioremediation.

Text Book:

1. Dubey, R.C. "Text Book of Biotechnology", S. Chand & Co, 2nd edition, 2004.

Reference Books

1. 1.Foster C.F; Johnware D.A, "Environmental Biotechnlogy", Ellis Harwood Ltd.3rd edition, 1987
2. Gupta P.K. "Elements of Biotechnology", Rastogi Publications, 2004

17BT2062 ENTREPRENEURSHIP IN BIOENGINEERING

Credits: 3:0:0

Course Objectives:
- To impart various aspects of product design and development
- To inculculate concept generation and selection
- To understand technology behind the product of the service

Course Outcomes:
The students will be able to
- Understand the principles of product design, basic management techniques, entrepreneurial skills and funding agencies.
- Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.
- Induce entrepreneurial intent as well as innovation, scalability and marketing of the product.
- Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career.
- Assess the commercial viability of a new technology based idea to prototype.
- Transform research based ideas into feasibility and business plans.

UNIT I - Concept and evolution of entrepreneurship, development of Entrepreneurship, stages in entrepreneurial process, entrepreneurship in India, Role of SSI in economic development, Government support for SSI. Role of society and family in the growth of an entrepreneur. Challenges faced by women in entrepreneurship.
UNIT II - Identification of business opportunities, project selection, contents, formulation, guidelines by planning commission for project report. Product design, importance, objectives, factors influencing product design, Product Development Process, sources of ideas for designing new products, stages in product design.
UNIT III - Creativity and innovation, generation of ideas, technical and market feasibility study, opportunity assessment, business plan preparation, execution of business plan, conversion of ideas to prototype, risk taking-concept; types of business risks.
UNIT IV - IPR and copy right, financial opportunity identification; banking sources; non banking institutions and agencies; venture capital and angel investors, meaning and role in entrepreneurship, government schemes for promoting entrepreneurship.

UNIT V - Procedure for getting license and registration, challenges and difficulties in starting an enterprise, host institution support, The role of technology/social media in creating new forms of firms, organizations, networks and cooperative clusters. Market- traditional and E-commerce, expanding markets: local to global.

Text Books:

1. "Entrepreneurial Development", Jayshree Suresh, 5th Edition, Margham Publications, 2008.
2. "Entrepreneurship", Robert D. Hisrich, 6th Edition, Tata McGraw Hill Publications.2009.

Reference:

1. 1."Entrepreneurship: Theory", Process and Practice, Donald F. Kuratko, 9th Edition, Cengage Learning, 2011.

17BT2063 POLLUTION CONTROL

Credits: 3:0:0

Course Objectives:

- To give an exposure to various control acts
- To study the advantages and disadvantages of impact assessment methods
- To study the methods of reducing the waste and reusing it.

Course Outcomes:

The students will be able to

- Gain basic knowledge on pollution, its types
- Summarize Pollution control acts and regulations.
- Employ preparation EIA report
- Evaluate audit reports on pollution is finally controlled.
- Understand the methods of material reuse
- Understand recycling methods

UNIT I - The water (prevention and control of pollution) act 1974 and rules 1975- definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous. Prevention and control of water pollution.

UNIT II - The air (prevention and control of pollution) act 1981 and rules 1982,definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous National ambient air quality standards.

UNIT III - The environment (protection) act 1986,rules 1986-definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous, standards of emission or discharge of environmental pollutants.

UNIT IV - Environmental impact assessment notification,2006-environmental clearance, list of projects, form I, general structure of EIA documents, content of summary EIA,

UNIT V - The plastics manufacture, sale and usage rules,1999-definations,restriction on manufacture, sale, distribution and use of virgin and recycled plastics carry bag and recycled plastic containers

Text book:

1. C. S. Rao Environmental Pollution Control Engineering,New Age International, 2007

Reference Books

1. Peter Wathern, "Environmental Impact Assessment theory and practice", Unwin Hyman Ltd. Routledge, 1990,
2. L. Lee Harrison , "Environmental Health and Safety Auditing Handbook", 2nd edition, McGraw Hill, Inc., New York, 1995
3. Kirkwood, R. C. and Longley, A. J., "Clean Technology and Environment", Chapman & Hall, 1995.

LIST OF COURSES

Course Code	Name of the Course	Credits
16BT1001	Biology in Everyday Life	3:0:0
16BT2001	Microbiology and Immunology	3:0:0

REVISED VERSION COURSES

Course Code	Version	Name of the Course	Credits
15BT2001	1.1	Medical Biochemistry	3:0:0
15BT2002	1.1	Medical Biochemistry Lab	0:0:1
15BT2003	1.1	Human Physiology and Anatomy	3:0:0
15BT2004	1.1	Biomaterials and Artificial Organs	3:0:0
15BT2005	1.1	Occupational Safety Management	3:0:0
15BT2006	1.1	Medical Waste Treatment	3:0:0
15BT2007	1.1	Cell Biology and Immunology	3:0:0
15BT2008	1.1	Tissue Engineering	3:0:0
15BT2009	1.1	Techniques in Pathology and Microbiology	3:0:0
14BT2001	1.1	Basics of Biochemistry	3:1:0
14BT2002	1.1	Biochemistry Lab	0:0:2
14BT2003	1.1	Principles of Chemical Engineering	3:0:0
14BT2004	1.1	Cell Biology	3:0:0
14BT2005	1.1	Microbiology	3:0:0
14BT2006	1.1	Microbiology Lab	0:0:2
14BT2007	1.1	Basic Industrial Biotechnology	3:0:0
14BT2008	1.1	Metabolism and Bioenergetics	3:1:0
14BT2009	1.1	Bioprocess Principles	3:0:0
14BT2010	1.1	Bioprocess Lab	0:0:2
14BT2011	1.1	Molecular Biology	3:0:0
14BT2012	1.1	Genetic Engineering and Bioethics	3:0:0
14BT2013	1.1	Molecular Biology and Genetic Engineering Lab	0:0:2
14BT2014	1.1	Bioorganic Principles	3:0:0
14BT2015	1.1	Bioreactor Engineering	3:0:0
14BT2016	1.1	Enzyme Engineering	3:0:0
14BT2017	1.1	Immunology	3:0:0
14BT2018	1.1	Cell Biology and Immunology Lab	0:0:2
14BT2019	1.1	Chemical Reaction Engineering	3:0:0
14BT2020	1.1	Downstream Processing	3:0:0
14BT2021	1.1	Downstream Processing Lab	0:0:2
14BT2022	1.1	Unit Operations	3:0:0
14BT2023	1.1	Animal and Plant Biotechnology	3:0:0
14BT2024	1.1	Plant physiology and Crop Improvement	3:0:0
14BT2025	1.1	Plant Tissue Culture	3:0:0
14BT2026	1.1	Plant Microbe Interactions	3:0:0
14BT2027	1.1	Molecular Plant Pathology and Entomology	3:0:0
14BT2028	1.1	Molecular Plant Breeding	3:0:0
14BT2029	1.1	Biotechnology of Biotic and Abiotic Stress Tolerance	3:0:0
14BT2030	1.1	Entrepreneurial Agriculture and Biomass Energy	3:0:0
14BT2031	1.1	Horticultural Crop Production, Management and Green House Technology	3:0:0
14BT2032	1.1	Food and Nutrition Security of GM Crops	3:0:0

14BT2033	1.1	Post-Harvest Technology	3:0:0
14BT2034	1.1	Mechanization and Post-Harvest Technology Lab	0:0:2
14BT2035	1.1	Gene Manipulation lab	0:0:2
14BT2036	1.1	Plant Breeding and Crop Management Lab	0:0:2
14BT2037	1.1	Developmental Biology	3:0:0
14BT2038	1.1	Human Genetics and Genomics	3:0:0
14BT2039	1.1	Vaccine Biotechnology	3:0:0
14BT2040	1.1	Animal Biotechnology and Cell Culture Techniques	3:0:0
14BT2041	1.1	Molecular Forensics	3:0:0
14BT2042	1.1	Stem Cell Technology	3:0:0
14BT2043	1.1	Human Physiology	3:0:0
14BT2044	1.1	Cancer Biology	3:0:0
14BT2045	1.1	Biopharmaceutical Technology	3:0:0
14BT2046	1.1	Research Methodology	3:0:0
14BT2047	1.1	Biochemical Engineering	3:0:0
14BT2048	1.1	Metabolic Engineering	3:0:0
14BT2049	1.1	Process Equipment Design	3:0:0
14BT2050	1.1	Process Control Engineering	3:0:0
14BT2051	1.1	Pilot plant & Scale Up practice	3:0:0
14BT2052	1.1	Industrial Safety and Hazard Analysis	3:0:0
14BT2053	1.1	Industrial Effluent Treatment	3:0:0
14BT2054	1.1	Bioenergy and Biomaterials	3:0:0
14BT2055	1.1	Pollution Control and Engineering	3:0:0
14BT2056	1.1	Entrepreneurship	3:0:0
14BT2057	1.1	Mechanical Operation Lab	0:0:2
14BT2058	1.1	Process Control Lab	0:0:2
14BT2059	1.1	Cell Biology and Microbiology	3:0:0
14BT2060	1.1	Cell Biology and Microbiology Lab	0:0:2

16BT1001 BIOLOGY IN EVERYDAY LIFE

Credits: 3:0:0

Course Objective:

- To understand the fundamental principles and concepts of immune system.
- To impart knowledge on recent developments in biology
- To learn the applications of biology in health and human welfare

Course Outcome:

- Classify and describe the economic importance of microbes.
- Apply knowledge to demonstrate role of microorganisms in Industry and human welfare.
- Develop skills in recent technologies of bioengineering.

Course Description:

Infectious diseases - cholera, typhoid and influenza. Benefits and ill effects of microbes associated with everyday, microbes in human nutrition, Identification of microbes. Forensic science- investigating a crime by genome analysis. Evolutionary origin of human races - Biomolecules, gene, genome, process of genetic flow and sequencing. Immune system - Immune cells and system, Immune disorder - AIDS, stress related disorders- diabetes, hypertension, cancer, obesity. Narcotic drugs and alcohol abuse. Applications in Medicine - antibiotics, vaccines and monoclonal antibodies. Fermentation in home and industry - Idly, curd, beer and wine, Application in agriculture - Biofertilizers, Integrated pest management. Recent trends in Biology - Biosafety, GM crops - Bt Brinjal, Golden rice, Cloning, Stem cells, Multi drug resistance, Biofuels, Nobel prizes in medicine/ physiology.

Reference Books

1. Pelczar MJ, Chan ECS & Krein NR, "Microbiology", Tata McGraw Hill Edition, NewDelhi, India, 2007
2. Prescott LM, Harley JP, Klein DA, "Microbiology", Wm. C. Brown Publishers,3rd edition,2001.
3. Owen J, Punt J , Stanford S, "Kuby Immunology", WH Freeman & Co., 2013.
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
5. Bruce Alberts, " Molecular Biology of the Cell", Taylor and Francis Publishers, 6th edition 2014.

16BT2001 MICROBIOLOGY AND IMMUNOLOGY

Credits: 3:0:0

Course Objective:

- To impart knowledge on classification and structure of microbes
- To learn the nutrition and control of microorganisms
- To understand the fundamental principles and concepts of immune system.

Course Outcome:

- Classify microorganisms and describe the economic importance of them.
- Apply knowledge to demonstrate multiplication of prokaryotic and eukaryotic microorganisms and the interaction of microorganism with environment and food.
- Develop applications in human health care.

Description: History of microbiology, classification and nomenclature of microorganisms; microbial nutrition, growth curve and control of microorganisms by sterilization methods, multiplication of prokaryotic and eukaryotic microorganisms. Introduction to Immune System**-** Cells of immune system, types, Lymphoid organs, Antigens, Antibodies, Clonal selection, T and B cell development, Antigen-Antibody reaction, MHC, Antigen presentation, Complement, Hypersensitivity, Vaccines, Transplantation, Monoclonal and Polyclonal antibodies and cancer immunology.

Reference Books

1. Pelczar MJ, Chan ECS & Krein NR, "Microbiology", Tata McGraw Hill Edition, NewDelhi, India, 2007
2. Prescott LM, Harley JP, Klein DA, "Microbiology", Wm. C. Brown Publishers,3rd edition,2001.
3. Tizard, "Immunology", Saunders college publication, 5th Edition. 2004.
4. Harwey RA, "Immunology", 2nd Ed. Lippincott Publishers, 2013.
5. Owen J, Punt J , Stanford S, "Kuby Immunology", WH Freeman & Co., 2013.

15BT2001 MEDICAL BIOCHEMISTRY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To learn the biochemistry of living cells.
- To provide knowledge on the biochemistry of proteins, lipids and carbohydrates.

- To introduce the different methods of investigation of metabolism and diagnostic tools.

Course Outcome:

- State and explain the biochemistry of proteins, lipids and carbohydrates in living cells.
- Employ biochemical reaction and suggest suitable investigation methods.
- Assess the metabolism of biomolecules.

Biochemistry of living cells, sub cellular fractionation using the differential centrifugation method. Functions of each organelle, redox potential, oxidative phosphorylation, Transport of substances across biological membranes. Carbohydrates, Definition, Classification, their biomedical importance, diabetes, Blood sugar analysis and glucose tolerance tests. Lipids, Definition, Classification, essential fatty acids and cholesterol, their biomedical importance.
Proteins, Composition, general properties, classification, biomedical importance, identification of proteins by chromatography and electrophoresis. Vitamins, Classification, functions and deficiency symptoms, hypervitaminosis. Uses of isotopes in biochemistry. Methods of investigation of metabolism, Liver function tests, Renal function tests, Urine analysis and gastric function tests.

References:

1. Donald Voet, Judith,G.Voet and Charlotte, W.Pratt."Fundamentals of Biochemistry, Life at the Molecular Level."JohnWiley&sons,Inc.(Asia). 2006.
2. Keith Wilson and JohnWalker. "Principles and Techniques of Biochemistry and Molecular Biology". Sixth Edition. Cambridge University Press.2007.
3. Rodney Boyer, "Modern Experimental Biochemistry," Third edition. Addison Wesley Longman Inc.2000.

15BT2002 MEDICAL BIOCHEMISTRY LABORATORY

Credits: 0:0:1 **(Version 1.1)**
Co-requisite: 15BT2001 Medical Biochemistry

Course Objective:

- To learn the biochemistry of living cells.
- To provide knowledge on the biochemistry of proteins, lipids and carbohydrates.
- To introduce the different methods of investigation of metabolism and diagnostic tools.

Course Outcome:

- Explain and discuss the biochemistry of proteins, lipids and carbohydrates in living cells.
- Demonstrate biochemical reaction and suggest suitable investigation methods.
- Construct the metabolism of biomolecules.

The faculty conducting the laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15BT2003 HUMAN PHYSIOLOGY AND ANATOMY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To provide a basic understanding of the structure and function of human body.
- To provide the students an exposure to the fundamentals in human anatomy and physiology.
- To introduce the different systems of the body and their functioning.

Course Outcome:

- Relate basic human body functions and life processes.

- Demonstrate human body systems and relate their functions.
- Categorize the major components of each system and explain their anatomical locations, structures and their physiological functions.

Cell: Structure and organelles, Functions of each component. Cell membrane, transport across membrane, origin of cell membrane potential (Nernst and Goldman and Katz equations), Action potential. Blood composition, functions of blood, functions of RBC. WBC types and their functions. Blood groups, importance of blood groups, identification of blood groups. Blood flow factors regulating blood flow such as viscosity, radius, density, etc. Structure of Kidney and nephron. Mechanism of Urine formation and acid base regulation. Dialysis. Components in of respiratory system. Oxygen and carbon di oxide transport and acid base regulation. Structure of heart, Properties of Cardiac muscle, Cardiac muscle and pacemaker potential, Cardiac cycle, ECG, Heart sound, volume and pressure changes and regulation of heart rate. Structure of a Neuron. Synaptic conduction. Conduction of action potential in neuron, Parts of brain cortical localization of functions EEG. Simple reflexes, withdrawal reflexes. Autonomic nervous system and its functions, Structure of eye, ear and auditory and visual pathways.

References:

1. Anne Waugh, Allison Grant,"Ross and Wilson: Anatomy and Physiology in Health and Illness", Churchill Livingston, Elsevier 2010.
2. Elaine.N. Marieb, "Essential of human Anatomy and Physiology," Eighth edition. Pearson Education, NewDelhi.2007
3. William F. Ganong, "Review of Medical Physiology" Second Edition. McGrawHill NewDelhi. 2000
4. Prof.A.K.Jain."Textbook of Physiology". Third edition. VolumeI and II, Avichal Publishing company, NewDelhi. 2005
5. Arthur.C.Guyton, John E Hall, "Textbook of Medical Physiology", – W.B. Saunders Company, 2000

15BT2004 BIOMATERIALS AND ARTIFICIAL ORGANS

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To introduce the classifications and characteristics of biomaterials and to understand the properties of bio-compatible materials.
- To learn polymeric materials and combinations that could be used as tissue replacement implants.
- To study artificial organs developed using tissue materials.

Course Outcomes:

- Generalized basic knowledge of biomaterials and their classifications.
- Analyze the bio-compatability of specific materials used as implants.
- Develop combination of materials that could be used as tissue replacement implants.

Description: Structure of Bio-Materials and Bio-Compatibility – Definition, classification and properties of bio-materials. Body response to implants, wound-healing and blood compatibility. Methods of testing implants for biological performance. Metallic Implant materials, Polymeric Implant materials, Tissue replacement materials-soft, hard and blood interfacing materials, Artificial organs-heart, heart valves, oxygenators, Dialysers, Dental implants.

References:
1. Sujata V. Bhatt, “Biomaterials” Second Edition ,Narosa Publishing House,2005.
2. JoonB.Park Joseph D. Bronzino, “Biomaterials - Principles and Applications” CRC Press, 2003
3. Jonathan Black, “Biological Performance of materials”, Marcel Decker, 1981
4. Park J.B., “Biomaterials Science and Engineering”, Plenum Press, 1984.
5. Myer Kutz, “Standard Handbook of Biomedical Engineering & Design”, McGrawHill, 2003
6. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, “Introduction to Biomedical Engineering”, Elsevier, 2005.

15BT2005 OCCUPATIONAL SAFETY MANAGEMENT

Credits: 3:0:0 **(Version 1.1)**

Course objectives:
- To know about the health issues and safety principles
- To apply safety practice through training methods
- To know the occupational safety and health Act and its applications

Course outcomes:
- Outline safety factors in workplace
- Apply training skills for personal safety
- Formulate safe health practices in hazardous environments

Safety and health in work place-issues of chemical, and physical hazards to workplace safety and health-training, compensation, liability coverage, and regulatory matter-Occupational Safety and Health Act (OSHA) of 1971 -compliance with established regulations-safe equipment and management supervision, but also the safety training of workers- technical and human factors consideration in the areas of health and safety - from hazardous substances and radiation, noise and vibration to stress.

References:
1. Louis J. Di Berardinis, “Handbook of occupational safety and health”, John Wiley, 1999.
2. Mark A. Friend, James P. Kohn**, “**Fundamentals of Occupational Safety and Health, Bernan Press, 23-Jun-2014.
3. Geoff Taylor, Kellie Easter, Roy Hegney, “Enhancing Occupational Safety and Health”, Elsevier Butterworth-Heinemann, 2004
4. Occupational safety Manual, BHEL, Trichy, 1988.

15BT2006 MEDICAL WASTE TREATMENT

Credits: 3:0:0 **(Version 1.1)**

Course objectives:
- to identify the modes of medical waste treatment
- to understand the pollution and health hazards
- to analyze the methods of water treatment

Course outcomes:
- Outline the safe methods of medical waste treatment system
- practice the ways of preventing pollution and personal safety
- Design of instrumentation and control techniques for potable water treatment

Sources and classification of medical waste-color code-handling, sterilization, treatment, transportation and safe disposal-regulations-Hazards –personal safety-environmental pollution-health hazards-medical waste treatment system-temperature and level control, toxic gas detector-design of alarm system-central monitoring- pollution monitoring system-waste water treatment system-safety regulations-personal health hazards- Instrumentation for monitoring of water pollution-Case studies-potable water-Instrumentation for water quality monitoring-Boiler, incinerator. Temperature level and flow control for computer applications in central monitoring system.

References:

1. P.K. Behera, "Sustainable biomedical waste management", Dominant Publishers AndDistributors, 1993.
2. Dr. Shalini Sharma, SVS Chauhan, "An analysis of medical waste management", Lambert publisher, 2000**.**
3. Etcalf& Eddy, "Wastewater Engineering (Treatment and Reuse)", 4th Edn, Tata – McGraw Hill, New Delhi, 2003.
4. Mark J. Hammer.: "Water and waste water technology" – 5thEdn", Prentice Hall of India Pvt. Limited, New Delhi, 2007.
5. James M. Montgomery.: "Water treatment principles and design" – A Wiley IntersciencePublication, Newyork, 1985.

15BT2007 CELL BIOLOGY AND IMMUNOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To acquaint the students with the concepts in Cell Biology and Immunology
- To understand the structure and function of the organelles of cells
- To understand the fundamental principles and concepts of immune system and to learn the Immuno techniques

Course Outcome:

- Generalized basic knowledge in the concepts in cell biology.
- Outline fundamentals that will enable them to apply in cell based research.
- Assess and understand the mechanisms by which the human systems interact with pathogenic microbes & eliminates it.

Description: Structure of Prokaryotic and Eukaryotic cells, Cell organelles, cell cycle and regulation, cytoskeleton, Cell- cell communication, active and passive transport, pumps and gated channels, Endocytosis, Exocytosis, protein glycosylation in eukaryotes.

Introduction to Immune System**-** Cells of immune system, types, Lymphoid organs, Antigens, Antibodies, Clonal selection, T and B cell development, Antigen-Antibody reaction, MHC, Antigen presentation, Complement, Hypersensitivity, Vaccines, Monoclonal antibodies, ELISA and Western blotting

Reference Books

1. Geoffrey M. Cooper and Robert E. Hausman, "The Cell: A Molecular Approach", ASM Press and Sinauer Associates, Inc., USA, 5th edition, 2009.
2. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, "Molecular Biology of the cell", Taylor and Francis group, 5th edition, 2007.
3. Kimball T.W., "Cell Biology", Wesley Publishers, 3rd Edition, 2007.
4. Tizard, "Immunology", Saunders college publication, 5th Edition. 2004.
5. Owen J, Punt J , Stanford S, "Kuby Immunology", WH Freeman & Co., 2013.

15BT2008 TISSUE ENGINEERING

Credits: 3:0:0 **(Version 1.1)**

Course Objective

- To introduce the basic concepts of tissue organisation in the human body and the theories related to normal physiology and repair
- To inculcate knowledge on cell culture, cell signalling and molecular growth factors.
- To develop tissue implants and transplants and its regulation in tissue engineering

Course Outcome

- Outline the fundamental concepts and technology in tissue engineering
- Analyze the cellular interaction and molecular aspects of cell differentiation, communication and growth.
- Design scaffolds, tissue implants and explain regulatory issues regarding their application.

Description: Introduction: Basic definition, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing. Scaffold and transplant: Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells: introduction, hepatopoiesis.Case study and regulatory issues: Case study of multiple approaches: cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering.

References:

1. Robert. P.Lanza, Robert Langer & William L. Chick, Principles of tissue engineering, , Academic press.
2. Joseph D. Bronzino, The Biomedical Engineering –Handbook, CRC press.
3. Endarle, Blanchard &Bronzino,Introduction to Biomedical Engg. , Academic press.
4. B. Palsson, J.A. Hubbell, R.Plonsey& J.D. Bronzino,Tissue Engineering, CRC- Taylor & Francis

15BT2009 TECHNIQUES IN PATHOLOGY AND MICROBIOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective

- Gain knowledge on the structural and functional aspects of living organisms.
- Know the etiology and remedy in treating the pathological diseases.
- Empower the importance of public health.

Course Outcome

- Recognize the structural and functional aspects of living organisms.
- Demonstrate the working of microscope
- Summarize methods involved in treating the pathological diseases and public health

Description: Necrosis, apoptosis**,** cellular adaptations of growth and differentiation, Inflammation and Repair, Neoplasia, tumours, carcinogenesis, autopsy and biopsy, Hemostasis, Edema, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock. Hematological disorders. Natural and artificial immunity, opsonization, phagocytosis, inflammation, Immune deficiency syndrome, antibodies, antigen and antibody reactions Light microscope , fluorescence, TEM & SEM. Preparation of samples for electron microscope. Staining methods. Morphological features and structural organization of bacteria, growth curve, identification of bacteria , culture media and its types , culture techniques and observation of culture Instrumentation for immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies. Disease caused by bacteria, fungi, protozoal, virus and helminthes.

References:

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, “Pathologic Basis of Diseases”, 7th edition, WB Saunders Co. 2005 (Units I & II).
2. Prescott, Harley and Klein, “Microbiology”, 5th edition, McGraw Hill, 2002 (Units III,IV& V).
3. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
4. Ananthanarayanan&Panicker, “Microbiology” Orientblackswan, 2005.
5. Dubey RC and Maheswari DK. “A Text Book of Microbiology” Chand & Company Ltd, 2007

14BT2001 BASICS OF BIOCHEMISTRY

Credits: 3:1:0 **(Version 1.1)**

Course Objective:

- To ensure students to having strong foundation in structure, composition and function of various biomolecules.
- To apply these fundamentals in biotechnology

Course Outcome:

- Generalized basic knowledge on structure, properties and biological functions of carbohydrates, lipids and proteins which help to relate them with the industrially significant biomolecules available in the market.
- Identify the biochemical structure and properties of nucleic acids
- Assess the significance of essential vitamins and minerals in the proper functioning of living cells

Description: Biomolecules - structure, properties and functions of carbohydrates: monosaccharides – Glucose, fructose, mannose, Galactose, Isomers, Disaccharides – Sucrose, Lactose, Maltose. Homopolysaccharides – starch, cellulose. Heteropolysaccharides – Hyaluronic acid, chondroitin sulphate, Heparin. Fatty acids and lipids: essential fatty acids, structure, properties and functions of lipids. Amino acids and proteins: structures and classification of aminoacids and classification and functions of proteins, Peptide bond. Nucleotides and nucleic acids, Essential vitamins and minerals: classification and function.

References Books

1. Jain and Jain “Biochemistry”, Chand publication, 2008.
2. Lehninger, A. L, Nelson D. L and Cox, M. M, “Principles of Biochemistry”, Freeman Publishers, New York, fourth edition, 2005
3. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 2008.
4. Lubert Stryer, “Biochemistry”, WH Freeman & Co., 4th edition, 2000.
5. Voet and Voet, “Biochemistry”, John Wiley & Sons Inc., 2nd Edition, 2013

14BT2002 BIOCHEMISTRY LAB

Credits: 0:0:2 **(Version 1.1)**

Co-requisite: 14BT2001-Basics of Biochemistry

Course Objective:

- The lab aims to develop the skills in biochemical analysis
- To develop the skills of the students in Qualitative and Quantitative Analysis of biomolecules.

Course Outcome:

- Generalized knowledge in estimation of biomolecules such as carbohydrates, proteins, amino acids, cholesterol and nucleic acids using colorimeter
- Outline the basic lab skill in preparing different solutions of different concentrations and their measurement tools with representing units
- Recognize basic qualitative tests for the presence of different sugars, amino acids and lipids in a given testing sample.
- Understand the method of extraction of minerals and vitamins from food sources and their estimations.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2003 PRINCIPLES OF CHEMICAL ENGINEERING

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To develop skills of students in principles and basic calculations
- To familiarize in the area of material balance for non-reactive systems and simple reactive systems, energy balance for non-reactive systems and simple reactive systems in chemical process engineering.
- This is a pre-requisite for 14BT2019 on Chemical reaction Engineering.

Course Outcomes:

- Summarize basic knowledge on chemical engineering units
- Practice to solve chemical engineering problems.
- Formulating mass, energy and material balance equations.

Description: Basic units, units systems, derived units, force, pressure, work, heat, Conversion factors to SI units, Molarity, molality and normality, gas laws – Amagat's law and Daltons law , material balance for evaporation, filtration, drying, stoichiometry, limiting & excess reactants, fractional conversion, yield, Elements of energy balance calculations, procedure for energy balance calculations, Hess's law.

Reference Books:

1. Felder, R.M., Rousseau R.W., "Elementary Principle of Chemical Processes", John Wiley and Sons Publication 3rd edition, 2000.
2. BI Bhatt & SM Vora "Stoichiometry", Tata Mcgraw- Hill, 4th edition, 2004.
3. Himmelblue, D. M. "Basic Principles and Calculations in Chemical Engineering", Prentice Hall Publication 4th edition, 2004.
4. Venkataramani.V and Anantharaman.A., "Process Calculations", PHI learning Pvt. Ltd, 2003.

14BT2004 CELL BIOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To acquaint students with the concepts in Cell Biology.
- To understand structure and function of the organelles of cells

Course Outcome:

- Summarize knowledge on the structure and function of cellular organelles and components
- Analyze the behavior of cells in their microenvironment in multicellular organisms with emphasis on cell-cell interactions, cell-extra cellular matrix interactions
- Recognize specific processes and proteins involved in membrane transport.

Description: Structure of Prokaryotic and Eukaryotic cells, Cell organelles, cell cycle and regulation, cytoskeleton, Cell- cell communication, active and passive transport, pumps and gated channels, Endocytosis, Exocytosis, protein glycosylation in eukaryotes, Entry of viruses and toxins into the cell, signaling molecules and their receptors, signal transduction, phosphorylation and regulation in signaling

Reference Books

1. Geoffrey M. Cooper and Robert E. Hausman, "The Cell: A Molecular Approach", ASM Press and Sinauer Associates, Inc., USA, 5^{th} edition, 2009.
2. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, "Molecular Biology of the cell", Taylor and Francis group, 5^{th} edition, 2007.
3. Kimball T.W., "Cell Biology", Wesley Publishers, 3^{rd} Edition, 2007.
4. De Robertis & De Robertis, "Cell Biology", saunders,4^{th} Edition, 2006.
5. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell, "Molecular Biology of the Cell", New York, 5^{th} edition, 2005.

14BT2005 MICROBIOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To impart knowledge on classification and structure of microbes,
- To learn the nutrition and control of microorganisms.

Course Outcome:

- Summarize basic knowledge on the history and development of microbiology
- Understand the classification and nomenclature of microorganism, staining, microscopic and sterilization techniques
- Categorize microorganisms in the field of food, agriculture and environment.

Description: Basics of microbial existence, History of microbiology, classification and nomenclature of microorganisms; Types of microscopes, Principles and types of stains, microbial nutrition, growth curve and control of microorganisms by sterilization methods, Structural organization and multiplication of prokaryotic and eukaryotic microorganisms, food, agricultural and environmental microbiology.

Reference Books

1. Pelczar MJ, Chan ECS & Krein NR, "Microbiology", Tata McGraw Hill Edition, NewDelhi, India, 2007
2. Prescott LM, Harley JP, Klein DA, "Microbiology", Wm. C. Brown Publishers,3^{rd} edition,2001.

14BT2006 MICROBIOLOGY LAB

Credits: 0:0:2 **(Version 1.1)**
Co-requisite: 14BT2005- Microbiology

Course Objective:
- Students will be taught the parts of microscopes and the functions.
- The students will learn to identify the microorganisms using various staining techniques and biochemical tests.
- The students will learn about the enumeration of microorganisms.

Course Outcome:
- Summarize basic knowledge on lab safety guidelines, microscopes and sterilization techniques
- Practice to prepare media for experiment on media preparation for microbial growth and cultivation techniques of microorganisms
- Estimate the microbiological quality of milk, beverages and water.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2007 BASIC INDUSTRIAL BIOTECHNOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:
- To impart the knowledge on historical overview of Biotechnology.
- To learn the production of some commercially important bioproducts, Industrial Enzymes, products of plant
- The students will learn animal cell cultures and production of recombinant proteins.

Course Outcome:
- Summarizing the basic knowledge on how a biotechnological industry is operated.
- Interpreting the importance of the process model for sustainable bioprocess development.
- Summarizing the importance of the production process for various boproducts.

Description: Traditional and modern biotechnology, Process flow sheet, Production of primary metabolites- Citric acid, lysine and ethanol. Production of secondary metabolites- penicillin, streptomycin, production of vitamins- Vit.B12, Production of enzymes- amylases, Production of biopesticides, Biopreservatives, Biopolymers, xanthan gum, PHB and Single cell protein and other bioproducts, modern biotechnology products

Reference Books

1. Casida L.E., “Industrial Microbiology”, New Age International (P) Ltd., 2000.
2. Wulf Cruger and Anneliese Crueger, “Biotechnology: A Textbook of Industrial Microbiology”, Panima Publishing Corporation. 2003.
3. Randolph Norris Shreve and George T. Austin, “Shreves chemical Process Industries”, Mc Graw Hill professional, 2000.
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, “Principles of Fermentation Technology”, Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005

14BT2008 METABOLISM AND BIOENERGETICS

Credits: 3:1:0 **(Version 1.1)**

Pre-requisite: 14BT2001 Basics of Biochemistry

Course Objective:

- To learn the metabolic pathways and their regulations
- To learn the importance of bioenergetics
- To understand the inborn errors of metabolism.

Course Outcome:

- Summarizing knowledge on the metabolic pathways
- Dramatize biosynthesis and degradation pathway of amino acids
- Explain the importance of bioenergetics, energy rich compounds.

Description: Metabolism of carbohydrates- Glycolysis, Pentose phosphate pathway, Glycogenesis and Glycogenolysis; Glycogen storage diseases. Metabolism of amino acids and proteins: transamination and urea cycle. Biodegradation of selected amino acids- Ala, Thr, Leu, Ile, Tyr, Phe, Trp. Biosynthesis of amino acids and inborn errors of amino acid metabolism, Metabolism of lipids- Biosynthesis and oxidation of fatty acids and cholesterol, inborn errors of lipid metabolism, metabolism of nucleotides, inborn errors of nucleotide metabolism, Respiratory chain and Oxidative phosphorylation.

Reference Books

1. Lehninger, David L. Nelson & Michael M. Cox, “Principles of Biochemistry”, Freeman Publishers,4th edition, 2005.
2. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 2008.
3. Lubert Stryer, “Biochemistry”, WH Freeman & Co., 4th edition, 2000.
4. Voet and Voet, “Biochemistry”, John Wiley & Sons Inc., 2nd Edition, 2013.

14BT2009 BIOPROCESS PRINCIPLES

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To understand the principles of bioprocessing and appreciate its applications in Bioprocess Technology
- To understand the importance of medium formulations and optimization

Course Outcome:

- Reviewing the fermentation processes
- Analyze Sterilization time and kinetics of growth and death of microbes
- Assessing media formulation, inoculum development for fermentation process

Description: Overview of fermentation processes, Basic configuration of fermentor, Aseptic condition and containment, Sampling, Raw materials and media design for fermentation process, media optimization – Plackett burmann Method, Sterilization kinetics, Design of sterilization time, design of sterilization equipments, Filter sterilization of air and medium, Development of inoculum for industrial fermentation, Metabolic stoichiometry, Yield coefficients, Elemental balance and Degrees of reduction.

Reference Book

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, “Principles of Fermentation Technology”, Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.

2. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2002

14BT2010 BIOPROCESS LAB

Credits: 0:0:2 **(Version 1.1)**
Co-requisite: 14BT2009- Bioprocess Principles

Course Objective:
- To learn the culturing of microbes and quantifying biomass production
- To study enzyme kinetics
- To learn immobilization techniques

Course Outcome:
- Summarizing the knowledge in the cultivation of microorganisms.
- Examining factors affecting enzyme activity and quantification of enzymes.
- Devising methods to produce fermented products

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD /Director and notify it at the beginning of each semester.

14BT2011 MOLECULAR BIOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:
- To understand the basics of molecular biology and gene expression.
- To study the regulation of gene expression

Course Outcome:
- Outline of basics knowledge in gene expression
- Examine the fundamental mechanism on the process of replication, transcription and translation in the gene expression central dogma
- Recogonize common mutations, their natural repair systems and the natural gene expression regulation systems available in the prokaryotes and eukaryotes

Description: Experiments (Griffith, Avery & McLeod, Herchey Chase), Bacterial recombinations, DNA replication in prokaryotes and eukaryotes, Mutation-types, DNA repair, Prokaryotic and eukaryotic transcription, Post-transcriptional modification, Genetic code, Translation in prokaryotes and eukaryotes, Post-translational modifications, Regulation of gene expression: In prokaryotes - lac and trp operons. Regulation in eukaryotes – *cis* and *trans* elements, chromatin in gene regulation.

Reference books

1. David Friefelder, "Molecular Biology", Narosa Publ. House. 2003
2. David R.Hyde, "Genetic and Molecular Biology", Tata McGraw Publications, New Delhi, 2010.

14BT2012 GENETIC ENGINEERING AND BIOETHICS

Credits: 3:0:0 **(Version 1.1)**

Pre-requisite: 14BT2011 Molecular Biology

Course Objective:

- To provide basic knowledge on the tools used in gene cloning.
- To provide the theoretical background on cloning a gene and to express it in both prokaryotic and eukaryotic systems and the methods to purify the expressed protein
- To impart the importance of ethics in the field of biotechnology.

Course Outcome:

- Outline basic knowledge on the tools used in gene cloning
- Examine the theoretical background on methods of isolation of gene of interest and know different vectors of choice,
- Relate the application of recombinant DNA techniques for generation of knock-out and knock-in transgenic animals, transgenic plants.

Description: Gene cloning- enzymes, vectors, cloning strategy- steps, libraries & screening techniques, Polymerase chain reaction- principle and types, gene expression in prokaryotic and eukaryotic system, techniques to generate fusion proteins to aid in purification, methods of purification of recombinant proteins, Transgenic plants and animals, Knockout mice, bioethics and biosafety.

Reference Books

1. T. A. Brown, "Gene Cloning and DNA Analysis: An Introduction", 6th edition, Wiley-Blackwell, 2010.
2. Old R.W.Primrose SB, "Principles of Gene Manipulation, An Introduction to Genetic Engineering", Backwell Scientific Publications, 2003.
3. Dubey R. C, "Text book of Biotechnology", S. Chand & Co. Publications, 2006.
4. Monika Jain "Recombinant DNA Techniques", Narosa Publishing House, 2012.
5. Doug Erlandson, "Bioethics Basics: A Jargon-Free Guide for Beginners" [Kindle Edition]
6. Roberta M. Berry, "The Ethics of Genetic Engineering", Routledge Reissue edition 2007.

14BT2013 MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB

Credits: 0:0:2 **(Version 1.1)**

Course Objective:

- To learn basic techniques in molecular biology and genetic engineering
- To isolate and analyze DNA qualitatively and quantitatively

Course Outcome:

- Describe various methods used for isolating DNAs from various organisms like plant, animal and microorganisms
- Demonstrate qualitative and quantitative analysis of DNA samples by uv-vis spectrophotometer and Gel electrophoresis.
- Compose transformation techniques

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2014 BIOORGANIC PRINCIPLES

Credits: 3:0:0 **(Version 1.1)**

Pre-requisite: 14BT2001 Basics of Biochemistry

Course Objective:

- The course aims to develop skills of students to integrate biochemistry and organic chemistry.
- Student can be able to study the biological process using chemical methods.
- Develop knowledge in enzyme catalyzed chemical reactions.

Course Outcome:

- Outline of the basic knowledge on isomerism and stereochemistry of organic compounds
- Illustrate the basic reaction mechanism types in organic chemistry
- Categorize the mechanisms of reactions catalyzed by various enzymes

Description: Isomerism in organic chemistry, molecular asymmetry in organic chemistry, reaction mechanisms in organic chemistry - types of organic reactions- nucleophilic substitution and elimination reactions, homolytic and heterolytic fissions, mechanisms in chemical and enzyme catalysis, Stereospecificity of enzyme catalysis, Case studies of enzyme structure and mechanism and enzyme catalysed hydrolysis in chemical synthesis, Co-enzyme dependent reaction mechanisms

Reference Books

1. Trevor Palmer, "Enzymes: Biochemistry, Biotechnology, Clinical chemistry", Affiliated East-West Press Pvt. Ltd, New Delhi, 2004
2. Harish K. Chopra, Anupama Parmar and Parmjt S. Panesar, "Bio-Organic chemistry", Narosa Publishing House, New Delhi, 2013
3. Nelson, D. L. and Cox, M. M, "Lehninger's Principles of Biochemistry", Freeman Publishers, New York, 4th edition, 2008.
4. I. L. Finar, "Organic Chemistry", Pearson Education Publishing, Vol.2, 5th edition, 2007.
5. PL. Soni and HM. Chawla, "Text book of Organic Chemistry" , Sultan Chand & Sons, New Delhi, 2004.

14BT2015 BIOREACTOR ENGINEERING

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- This course aims at making the students understand the fundamental principles and concepts of Bioreactor engineering.
- This will help the student understand stoichiometric calculations, models of growth and product formation

Course Outcome:

- Outline of the basic knowledge on principles of stoichiometry and concepts of bioreactor engineering.
- Calculation of elemental balance equations and models of growth and product formation.
- Devising methods to calculate volumetric mass transfer coefficient and determination methods.

Description: Metabolic stoichiometry, kinetics of microbial growth, substrate uptake and product formation- monod model, leudeking-piret models, oxygen transfer in microbial bioreactors, volumetric mass transfer coefficient, microbial bioreactors - chemostat, air lift loop reactor, packed bed, fluidized bed bioreactors, mode of operation of bioreactors, parameters to be monitored and controlled during fermentation process.

Reference Books

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2005.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
3. Lee, J.M, "Biochemical Engineering", 1st Edition, Prentice Hall, 2001
4. Blanch, H.W and Clark, D.S, "Biochemical engineering", Marcel Dekker, 1997

14BT2016 ENZYME ENGINEERING

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To develop skills of the students in the area of Enzyme Engineering
- To study various methods of immobilization

Course Outcome:

- Classify enzymes and enzymatic reactions towards various concepts in biotechnology.
- Apply the theoretical and practical aspects of reaction kinetics will provide the importance and usage towards research
- Formulate the concepts of enzyme immobilization and its applications in food, pharmaceutical and chemical industries

Description: Classification of enzymes; mechanisms of enzyme action, specificity of enzyme action, kinetics of enzyme action, types of inhibition & models –substrate, product and toxic compound, extraction and purification of crude enzyme extracts from plant, animal and microbial sources, characterization methods, enzyme immobilization- types, biosensors – types and application .

Reference Books

1. T Palmer, "Enzymes", Horwood Publishing Series, 2001.
2. Martin Chaplin and Christopher Bucke, "Text book on Enzyme Technology", Cambridge University Press, 2004.
3. Shuler, M.L. and Kargi,F, " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd., 2nd edition, 2002.

14BT2017 IMMUNOLOGY

Credits: 3:0:0 **(Version 1.1)**

Pre-requisite: 14BT2004 Cell Biology

Course Objective:

- To understand the fundamental principles and concepts of immune system.
- To learn Immunotechniques

Course Outcome:

- Describe various levels of immune system
- Infering various types of immune responses caused by different pathogens
- Relate immunological techniques and their applications.

Description: Introduction to Immune System**-** Cells of immune system, types, Lymphoid organs, Antigens, Antibodies, Clonal selection, T and B cell development, Antigen-Antibody reaction, MHC, Antigen presentation, Complement, Hypersensitivity, Vaccines, Transplantation, Tumor immunology, Auto immune disorders, Monoclonal and Polyclonal antibodies, ELISA, RIA, Western blotting and Immunohistochemistry.

Reference Books

1. Tizard, "Immunology", Saunders college publication, 5th Edition. 2004.
2. Harwey RA, "Immunology", 2nd Ed. Lippincott Publishers, 2013.
3. Owen J, Punt J , Stanford S, "Kuby Immunology", WH Freeman & Co., 2013.
4. Ashim K. Chakravarthy, "Immunology", TataMcGraw-Hill, 2006.

14BT2018 CELL BIOLOGY AND IMMUNOLOGY LAB

Credits: 0:0:2 **(Version 1.1)**
Co-requisite: 14BT2017 Immunology

Course Objective:

- To acquaint the students with basic cell biology and immunology laboratory techniques.
- To study antigen antibody interaction.
- To study cell types and staining techniques.

Course Outcome:

- Summarize various stages of cell division and staining techniques
- Illustrate various antigen-antibody interaction reactions
- Develop immunological techniques.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/ Director and notify it at the beginning of each semester.

14BT2019 CHEMICAL REACTION ENGINEERING

Credits: 3:0:0 **(Version 1.1)**
Pre-requisite: 14BT2003 Principles of Chemical Engineering

Course Objective:

- This course aims at making the students understand the fundamental principles and concepts of chemical reaction engineering.
- The students will learn about RTD and measurement
- The students will study the design equations for various bioreactors

Course Outcome:

- Identifying methods to design and conduct an experimental investigation in order to determine rate equations.
- Analyze and apply principles to solve material and energy balance equations.
- Set up reactor for bio based products to achieve increased performance of a bioreactor.

Description: Classification of chemical reactions, reaction rate, temperature dependency term of a rate equation, performance equations for zeroth order, first order, second order and third order , design equation for steady state batch reactors, CSTR and plug flow reactor, RTD and measurements, Pulse input experiment- C curve, E curve, Step input Experiment-F curve, Tanks-in-series model, Gas solid and gas liquid reactions.

Reference Book

1. Octave Levenspiel, "Chemical Reaction Engineering", John Wiley, 3rd edition, 2006.

2. Shuler, M.L. and Kargi,F, “ Bioprocess Engineering - Basic concepts” Prentice Hall of India Pvt. Ltd., 2nd edition,2002
3. Gavhane K. A “Chemical Reaction Engineering-I”, Nirali Prakashan Publication Ltd.,2008

14BT2020 DOWNSTREAM PROCESSING

Credits: 3:0:0 **(Version 1.1)**
Pre-requisite: 14BT2009 Bioprocess Principles

Course Objective:
- To develop skills of the students in downstream processing with emphasis on purification of products.
- To study the cell disruption methods, solid-liquid separation techniques
- To study the finishing steps in the purification of bio-products

Course Outcome:
- Identifying product isolation techniques
- Illustrate various purification methods of chromatography and electrophoresis
- Assess finishing operations like crystallization and drying for the bioproducts

Description: Bioseperations, cell disruption methods, solid-liquid separation- filtration and Centrifugation, Product isolation by adsorption, Extraction, Membrane, Product purification by chromatography, Finishing operations - Crystallization, Drying and Lyophilization

Reference Books
1. Sivasankar.B “Bioseperations: Principles and Techniques”, PHI Learning Pvt. Ltd., 2006
2. Scopes R.K., “Protein Purification – Principles and Practice”, Narosa Publications, 2004.
3. Trevor G, and Harrison, Roger G, and Rudge, “Bioseparations Science and Engineering”, Day Scott R, Publisher, Oxford University Press, USA, 2002
4. Belter P.A, Cussler E.L & Wei-Houhu ,“Bioseparations – Downstream Processing For Biotechnology”, Wiley Inter science Publications, 1988.

14BT2021 DOWNSTREAM PROCESSING LAB

Credits: 0:0:2 **(Version 1.1)**
Co-requisite: 14BT2020- Downstream Processing

Course Objective:
- To develop the skills of students in various downstream process operations
- To understand the extraction of bioproducts by various techniques
- To understand the finishing and polishing process of bioproducts

Course Outcome:
- Predict cell disruption techniques to release intracellular products.
- Examine protocols on various techniques like extraction, precipitation, adsorption for concentrating biological products.
- Set up purification process like chromatography

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2022 UNIT OPERATIONS

Credits: 3:0:0 **(Version 1.1)**

Pre-requisite: 14BT2003 Principles of Chemical Engineering

Course objectives:

- To provide knowledge on properties of solids, handling and screen analysis.
- To provide the fundamentals of the size reduction techniques and its equipment
- To provide basic knowledge on mixers and agitators required in chemical process industries

Course outcomes:

- Outline various unit operations involved in chemical engineering
- Identify equipments for chemical processes
- Summarize various unit operations in bioprocess

Description: size reduction of solids. Types of crushers Size reduction operation - Power requirements - Laws of comminution, Industrial screening equipments, Screen effectiveness, Mechanical and pneumatic conveying equipments, Storage of solids - Angle of repose & angle of internal friction, Pressures in bins - Janssen equation, Gas cleaning methods Mixing equipments for liquids, pastes, rubber & plastic materials and for dry powders, Power consumption in mixers, Scale up of agitator design. Settling Equipments - Settling chambers, classifiers, jigging and Tabling, Sedimentation, Filtration equipments, Theories of filtration and washing, Industrial filtration practice, Centrifugal filtration.

Reference Books:

1. W. L. Mc Cabe, J. C. Smith, P. Harriott, “Unit Operations of Chemical Engineering”, 7th ed., McGraw-Hill, New York, 2005.
2. Badger, W.L., & Banchero. J.T, “Introduction to Chemical Engineering”, McGraw Hill (ISE), 1993.
3. R. H. Perry and D. W. Green, “Perry's Chemical Engineer's Handbook”, 8th Edn. McGraw-Hill, New York, 2007.
4. C.M. Narayanan & B.C. Bhattacharyya, “Mechanical Operation for Chemical Engineers” (Incorporating Computer Aided Analysis), Khanna Publisher, Third Edition, 2005.

14BT2023 ANIMAL AND PLANT BIOTECHNOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To create awareness in Plant and Animal biotechnology.
- To understand the principles of transgenic plants and animals.

Course Outcome:

- Classify techniques in plant and animal systems.
- Identify transgenic approaches and different therapy for animal diseases.
- Comply the concepts of transgenic in plant and animal for human welfare

Description: Basic techniques of plant and animal tissue culture, recombinant techniques for therapy for animal diseases, transgenic animals and their importance in biotechnology, gene transfer technology in plants, transgenic technology for crop improvement.

Reference Books

1. Bojwani, S.S. “Plant Tissue Culture: Applications and Limitations”, Elsevier science publishers, 1990.
2. Ian Freshney, “Culture of Animal Cells”, Wiley-Liss, 5th edition, 2005
3. Grierson,D. “Plant Biotechnology in Agriculture Prospects for the 21st Century”, Academic press, 2012
4. Doyle, A.R. Hay and B.E. Kirsop, “Living Resources for bio technology”, Cambridge University press, Cambridge, 1990
5. Ed. John R.W. Masters, “Animal Cell Culture - Practical Approach”, Oxford University Press, 3rd edition, 2000.
6. Dunmock N.J and Primrose S.B., “Introduction to Modern Virology”, Blackwell Scientific Publications, 2002

14BT2024 PLANT PHYSIOLOGY AND CROP IMPROVEMENT

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To learn the principles of plant physiology.
- To create awareness among students about the role of genetic engineering in crop improvement.
- To introduce the basic metabolism of plant physiology and its importance

Course Outcome:

- Outline the knowledge of basic principles of plant physiology in plant nutrition.
- Show principles of uptake and metabolism of nutrition.
- Evaluate the applications of transgenic crops

Description: Principles of Plant Physiology with reference to plant nutrition, absorption, translocation and metabolism of nutrients, Soil - water- plant relationship, Role of genetic engineering and biotechnology in crop improvement, genetically modified crop plants.

References Books

1. Salisbury F and C. Ross, “Plant Physiology”, Wordsworth Publishing co., Belmont, California, 2005
2. H.S. Chawala, “Introduction to Plant Biotechnology”, Oxford IBH, 2002

14BT2025 PLANT TISSUE CULTURE

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To ensure students in having strong foundation in plant tissue culture
- To create awareness among students about cell culture techniques and its applications in industries.
- To ensure students in developing basic knowledge on secondary metabolites production and its applications.

Course Outcome:

- Identify and gain knowledge on different techniques of plant tissue culture
- Apply different methods of plant propagation using tissue culture
- Evaluate techniques of *in-vitro* culture such as somatic embryogenesis morphogenesis, Organogenesis, Rhizogenesis

Description: Historical perspective of Plant cell/tissue culture, Scope and importance in crop improvement , totipotency and morphogeneis, Organogenesis, Rhizogeneisis, Embryogenesis, Nutritional requirement of in vitro cultures, Different techniques of in-vitro culture, Factors affecting *in vitro* culture, cryopreservation of germplasm, Secondary metabolites production, extaction of secondary metabolites, hardening techniques of micro-propagated seedlings.

References Books

1. Razdan , "Introduction to Plant Tissue Culture", Oxford IBH, 2007.
2. Dixon, "Plant Cell Culture", Panima publications, New Delhi, 2004.
3. H.S. Chawala, "Introduction to Plant Biotechnology", Oxford IBH, 2002.

14BT2026 PLANT MICROBE INTERACTIONS

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- The course is designed to provide the genetic and molecular principles underlying plant- microbe interactions.
- To create awareness among students about importance of plant microbe interaction for crop improvement practices.

Course Outcome:

- Distinguish basic and recent developments in plant microbe interaction
- Examine complete understanding of beneficial plant microbes at molecular level
- Revise molecular aspects of plant disease susceptibility and resistance to disease.

Description: Plant microbe interaction and recent developments, Beneficial Plant - Microbe interactions (molecular aspects), Parasitism and disease development; Molecular biology of pathogenicity; Molecular genetics of plant disease susceptibility and resistance

Reference Books

1. Agrios G. N, "Plant Pathology", Academic Press, 2005.
2. Dickinson M, "Molecular Plant pathology", BIOS Scientific Press,2003.
3. Jeng-Sheng H. T Kluwer, "Plant Pathogenesis and Resistance: Biochemistry and Physiology of Plant-Microbe Interactions", Academic Publishers, 2001.

14BT2027 MOLECULAR PLANT PATHOLOGY AND ENTOMOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To enable the students to learn concepts of plant pathology and entomology
- To create awareness among students about importance of integrated plant disease management
- To ensure students in developing basic knowledge on techniques to control pests and insects

Course Outcome:

- Summarize basic scope of plant pathology and its historical developments.
- Illustrate characteristics of parasitic and non parasitic disease causing factors.
- Distinguish different approaches and methods of plant disease and pest management practices.

Description: Introduction to the science of phytopathology, its objectives, scope and historical background. Classification of plant diseases, symptoms, signs, and related terminology, Parasitic causes of plant diseases, their characteristics and classification, Nonparasitic causes of plant diseases. Infection process, Survival and dispersal of plant pathogens, Plant disease epidemiology, forecasting and disease assessment, Principles and methods of plant disease management. Integrated plant disease management, Different pest control methods, IPM concept, Insecticide resistance management.

References Books

1. G. N. Agrios, "Plant pathology", 5th edition, Academ. Press, New york , 2004
2. Eugene Nester, Milton P. Gordon, and Allen Kerr, Agrobacterium tumefaciens: From Plant Pathology to Biotechnology, APS press, 2004.
3. B.V. David & T. Kumarswami , Elements of economic entomology, Popular Book Depot, 1988.

14BT2028 MOLECULAR PLANT BREEDING

Credits: 3:0:0 **(Version 1.1)**

Course Objective:
- To enable the students to learn different techniques of plant breeding
- To ensure students in developing basic knowledge on hybridization techniques

Course Outcome:
- Outline knowledge on floral biology and Reproductive systems of plants,
- Illustrate clonal selection and genetic consequences
- Interpret different methods of plant breeding and applicatons

Description: Historical milestones in plant breeding. Various methods of plant breeding in self and cross pollinated crops, acclimatization, selection, pure line theory, Reproductive systems of plants, floral biology, flower parts, Self and cross pollinated crops, genetic consequences and differences between self and cross pollinated crops, clonal selection, population improvement programme. heterosis, genetical and physiological basis. Male sterility Types of male sterility. combining ability-general and specific, its exploitation. Interspecific/ Intergeneric hybridization, Heterosis inbreeding depression, Polyploidy its types, Mutation breeding Gene actions, heritability, genotype and environmental interactions, its importance in plant breeding. Introduction to seed production (Nucleus, breeder, foundation, certified) Maintenance of genetic purity during seed production.

References Books

1. Gardner E.J, M.J Simons and D.P Sanstad , Principles of Genetics, Wiley India Pvt Ltd. 2012
2. Denis Murphy, Plant Breeding and Biotechnology, Cambridge University Press, 2007
3. Lamkey and Lee, Plant Breeding, Panima publishers, N.Delhi, 2002
4. Singh B.D, Principles of Plant Breeding, Kalyani Publishers, New Delhi, 2011.

14BT2029 BIOTECHNOLOGY OF BIOTIC AND ABIOTIC STRESS TOLERANCE

Credits: 3:0:0 **(Version 1.1)**

Course Objective:
- To introduce the prospects and perspectives of stress tolerance
- To create awareness among students about importance of plant defense mechanism
- To develop basic knowledge on molecular advancements in stress management in plants

Course Outcome:

- Identify different prospects of biotic and abiotic stress tolerant plants.
- Illustrate complete understanding of plant and insect pest resistance factors.
- Formulate different molecular approaches to develop tolerance in plants against biotic and abiotic stress.

Description: Prospects & Perspective of Biotic & abiotic stress resistant plants, Genetics of host-pathogen interactions, Mechanism of plant resistance. Insect pest resistance – Structural/morphological changes; Vertical and Horizontal resistance to pathogens, Hypersensitive host response (HRGP) and apoptosis in relation to plant defense. Virulence- Avirulence in host–pathogens interaction. Race specific Resistance Gene Analogues (RGAs), Pathogenesis related proteins – groups with examples. RIP. Biochemical basis of abiotic stresses; stress adaptation, Reactive oxygen species and biotic and abiotic stress, antioxidants, enzymes defense system, Molecular strategies for imparting tolerance against biotic and abiotic stress.

References Books

1. Rout, Gyana Ranjan; Das, Anath Bandhu, Molecular Stress Physiology of Plants, Springer, 2013
2. Ashwani Pareek, Abiotic stress adaptation in plants, Springer, 2010
3. HopkinsWG & Huner NPA. Introduction to Plant Physiology. JohnWiley & Sons, 2004
4. Basra AS, Stress Induced Gene Expression in Plants, Harwood Academic Publ. 1997.
5. Salisbury FB & Ross C. Plant Physiology. 4th Ed. Wadsworth Publ, 1992.

14BT2030 ENTREPRENEURIAL AGRICULTURE AND BIOMASS ENERGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To create awareness in the present scenario of agriculture entrepreneur
- To create awareness on renewable energy
- To develop basic knowledge on techniques in biomass energy production

Course Outcome:

- Outline the prospects of entrepreneurship in agriculture
- Examine policies and prospects under WTO regime
- Evaluate recent techniques in biomass energy and current research achievements

Description: External trade in Agricultural products, Present status, policy and prospects under WTO regime, Export import policy, Regulation of Agricultural marketing system, Infrastructural facilities for exporting efficiency, Biotechnological Products in India, Quality parameters and quarantine procedures of export, Market integration. Biotech industries & institutes in India & world, Concepts of Biotech park/ Biotech Hub. Biomass – importance and source, techniques and application of energy production. Fundamental theories and applied technologies used in production and conversion of biomass. Production strategies focus on sustainable cropping systems, harvest, storage, and pretreatment for diverse biomass feedstocks. Conversion technologies covered include ethanol fermentation, biodiesel catalysis, combustion, pyrolysis, gasification, and anaerobic digestion. System analysis on environmental impacts, policy, and economics.

References Books

1. Gry Agnete Alsos, Sara Carter, Elisabet Ljunggren, Friederike Welter. The Handbook of Research on Entrepreneurship in Agriculture and Rural Development, Edward Elgar Pub, 2011

2. Robert C. Brown, Biorenewable Resources: Engineering New Products from Agriculture, Iowa State Press, Blackwell Publishing. 2003
3. Acharya and Agrawal , Agriculture Marketing in India , Oxford IBH, N. Delhi, 2004.
4. Kotlar and Armstrong , Principles of Marketing by Prentice-Hall, N. Delhi. 2013.

14BT2031 HORTICULTURAL CROP PRODUCTION, MANAGEMENT AND GREEN HOUSE TECHNOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:
- To provide foundation in horticulture crop production
- To create awareness on Green house technology

Course Outcome:
- Outline knowledge on the basic horticulture crop production
- Practice the various propagation methods involved in horticulture
- Design various practices for cultivation of major Fruit crops

Description: Horticulture- Definition, scope, importance, and branches of horticulture. Classification of horticultural crops, Propagation methods, growth habit, training and pruning objectives, methods and season, Special horticultural practices for horticultural crop production, plant growth regulators and their uses in horticulture. Package of practices for cultivation of major horticultural crops Fruits: Major pest and diseases of horticultural crops and their control, Types of green house, importance, functions and features of green house, Scope and development of green house technology. Location, Planning of various components of green house, Design criteria and calculation, Construction material, covering material and its characteristics, growing media, green house irrigation system. nutrient management.

References Books

1. Kumar, P, Management of Hort. Crops Horscience series Vol. 11, New India Publishing Agency, NIPA. 2008.
2. Manohar, Greenhouse Technology and Management , International Book Distribution Co., Lucknow, 2006.

14BT2032 FOOD AND NUTRITION SECURITY OF GM CROPS

Credits: 3:0:0 **(Version 1.1)**

Course Objective:
- To provide foundation in Food safety regulations
- To create awareness on the importance of GM crops
- To develop basic knowledge on techniques in nutrition security of GM crops

Course Outcome:
- Summarize knowledge on the basic Food safety regulations
- Infer food quality Assessment procedures
- Predict impact of Malnutrition and toxicity on human health

Description: International aspects of the quality and safety of Foods derived from modern Biotechnology, Application of ELISA for detection of Toxins in food, Biosensors for food quality Assessment, Malnutrition, consequences, causes, prevention and control. Applied community nutrition. Food safety and food faddism. safety testing for toxicity, allergenicity , anti nutritional effects. Native toxins and toxins produce during storage, health hazards.

References Books

1. Shetty , Food Biotechnology, CRC,NY, 2006
2. Modi H A., Fermented Food Biotechnology, Pointer publishers, 2011
3. Roges, A Food Biotechnology, by. Elsevier Applied Sci. Pub., London, U.K. 1989.
4. Goldberg, I., Chapman and Hall, Functional Foods, New York. 1999.
5. Byong, H. L. Fundamentals of Food Biotechnology, VCH Publishers, New York. 1996.

14BT2033 POST-HARVEST TECHNOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:
- To study the principles of Post-Harvest technology
- To provide knowledge on food processing techniques

Course Outcome:
- List the principles of Post-Harvest technology
- Categorize various food processing techniques
- Evaluate the techniques of value addition and food preservation

Description: Classification, chemical composition and nutritional values of food grains (cereals including millets, legumes and pulses). Anti-nutritional factors- chemistry and methods of their removal, Importance and scope of food preservation and storage. Food spoilages- causes and effects, Principles and methods of food preservation and processing of food crops. Bakery and confectionary- types, ingredients used with their role, other processing techniques- Fermentation, malting, brewing, puffing, flaking, pearling, sprouting, roasting. Enrichments- Methods, need and fortification. Biosol concept, Spheroplast fusion technology. Biocatalysts and worldwide food industry market

References Books

1. R Wills, B McGlasson, D Graham, D Joyce, Postharvest , CABI publishers, 2007.
2. Marwaha & Arora, Food processing: Biotechnological Applications, Asiatech Publishers N.D. 2000.

14BT2034 MECHANIZATION AND POST-HARVEST TECHNOLOGY LAB

Credits: 0:0:2 **(Version 1.1)**

Course Objective:
- To expose the students to the importance of post harvest technology
- To expose the students to food preservation techniques

Course Outcome:
- Explain the importance of post harvest technology
- Examine food preservation techniques
- To develop various food products of commercial attraction

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2035 GENE MANIPULATION LAB

Credits: 0:0:2 **(Version 1.1)**

Course Objective:

- To expose the students to different basic techniques of gene manipulation
- To impart hands on training in transformation and screening techniques

Course Outcome:

- Generalized knowledge on basic and advance techniques of transformation
- Identify different techniques to develop transgenic plants in commercial plants
- Set up training in development of transgenic plants.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2036 PLANT BREEDING AND CROP MANAGEMENT LAB

Credits: 0:0:2 **(Version 1.1)**

Course Objective:

- To expose the students to different techniques of plant breeding
- To impart knowledge on crop management practices
- To expose the students to development of formulations for crop management

Course Outcome:

- List the basic and advance techniques of plant breeding
- Outline different technology in crop management.
- Plan strategies of hybrid plant propagation.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2037 DEVELOPMENTAL BIOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To provide with fundamentals and concepts of developmental biology.
- To make students understand about the events involved in the formation of embryo.
- This course serves as a foundation for stem cell research.

Course Outcome:

- Describe the molecular changes happening in cell development
- Predict the role of genes and its expression during the process of the development of organs in the embryo and its development
- Interpret the regulation of genes in the process of embryo development

Description: An introduction to the genetic, molecular, and cellular mechanisms that direct the development of multicellular organisms. Gametogenesis, fertilization, gastrulation, organogenesis, sex determination, and developmental gene regulation

References Books

1. Scott F. Gilbert, "Developmental Biology, 6th edn. Sinauer Associates, Incorporated, 2000.

2. Willium. J. Larsen, Human Embryology 3rd ed. Churchill Livingstone, 1998.

14BT2038 HUMAN GENETICS AND GENOMICS

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To provide foundation in human genetics.
- To provide basic knowledge in genomics.

Course Outcome:

- Generalized knowledge on the basics of human genetics and genomics
- Analyze mutations, genes implicated in human genetic disease.
- Assess the application of genomics in the field of disease diagnosis, population genetics, mapping of genomes.

Description: Location, transmission, structure and function of genes encoding specific traits. Mutations, genes implicated in human genetic disease, population genetics, mapping of genomes, human genome project, DNA barcoding and recombination.

Reference Books

1. Bruce R. Korf , Human genetics and genomics 3rd ed. Blackwell publishing, 2013

14BT2039 VACCINE BIOTECHNOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To gain knowledge in Vaccine Biotechnology
- To understand to the vaccine development.
- To learn about the importance of immunization.

Course Outcome:

- Outline basics of vaccines and its development
- Interpret types of vaccines and their mechanisms on infectious agents
- Relate the immunization methods and schedules of immunization

Description: Adjuvants, Vaccines – Dead, live attenuated, recombinant, edible, chimeric and DNA vaccines; bacterial vaccines, viral vaccines, combined vaccines and polyvalent vaccines, vaccines to other infectious agents, tumor vaccines, principles of vaccination, passive & active immunization, immunization programs & role of WHO in immunization program.

Reference Books

1. Barry R Bloom, Paul-Henri Lambert, “The Vaccine Book”, Academic Press.2002
2. Lowrie DB & Whalen R. “New Generation Vaccines”, 3rd Edn. Informa Healthcare Humana Press, 2000.
3. Robinson A & Cranage MP. “Vaccine Protocols”, 2nd Ed. Humana Press, 2003

14BT2040 ANIMAL BIOTECHNOLOGY AND CELL CULTURE TECHNIQUES

Credits: 3:0:0 **(Version 1.1)**

Course Objective:
- To develop skills of the students in the area of animal biotechnology
- To learn about cell culture techniques

Course Outcome:
- Outline knowledge on primary cell culture techniques, maintenance of cell line
- Show recent development in Invitro fertilization and the manimulation of embryo done for genetic screening
- Predict the use of gene expression and knock out techniques in the development of transgenic animals

Description: Animal tissue culture – media, sterilization and types of culture – monolayer and suspension culture; production of cell lines; hybridoma technology; Artificial animal breeding – IVF and embryo transfer; Transgenic animals and their significance; ethics of transgenic animal. Knockout mice.

Reference Books:

1. Stella Pelengaris and Michael Khan; The Molecular Biology of Cancer. Blackwell Publishers, 2006.
2. Robert G. McKinnell, Ralph E. Parchment, Alan O. Perantoni, G. Barry Pierce. The Biological Basis of Cancer. Cambridge University Press, New York 2003.
3. Macdonald F and Ford CHJ. Molecular Biology of Cancer. Bios Scientific publishers, 2002.
4. Maly B.W.J, "Virology A Practical Approach", IRLl Press, Oxford, 2001.
5. Dunmock N.J And Primrose S.B., "Introduction to Modern Virology", Blackwell Scientific Publications, Oxford, 2002

14BT2041 MOLECULAR FORENSICS

Credits: 3:0:0 **(Version 1.1)**

Course Objective:
- The molecular forensics provides students with experiences and information that will broaden their understanding of the field of Forensic Science and crime scene investigations.
- To ensure students in having foundation Forensics and molecular techniques in forensics.
- A concurrent goal of the subject is to develop observational, organizational and cognitive skills so to be able to integrate their experiences and knowledge so to solve problems.

Course Outcome:
- List the basic techniques in forensics science.
- Outline knowledge about the paleobiology and anthropology
- Evaluate the methods used in identification of suspects and parental disputes.

Description: Introduction to forensic science, molecular methods in forensic technology, RFLP, RAPD, DNA finger printing, identification of suspects, application in paleontology, astrobiology and anthropology, methods of DNA isolation from various sources, types of amplification methods, types of sequencing; forensic significance of polymorphic enzymes, forensics in paternity disputes.

References Books

1. Lincoln PJ & Thomson J, "Forensic DNA Profiling Protocols", Humana Press. 2011.

2. Rudin N & Inman K. "An Introduction to Forensic DNA Analysis", 2nd Ed. CRC Press. 2002.

14BT2042 STEM CELL TECHNOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- This course will take students on a journey into the stem cell biology and biotech revolution,
- This course will provide details regarding social implications associated with stem cell technology.
- The course offers an opportunity to understand the basics of stem cells, embryonic stem cells, adult stem cells and genetic engineering of stem cells and their applications.

Course Outcome

- Generalized knowledge in Origins and diversity of embryonic stem cell types
- Outline the Principles of embryonic and adult stem cell derivation, culture, differentiation
- Summarize recent advancements in the biotechnological applications using both adult and embryonic stem cells in therapeutic Applications

Description: Stem cells, hematopoietic stem cells, Adult stem cells, embryonic stem cells- isolation and culture, stem cell in drug discovery and tissue engineering, therapeutic application using stem cells, ethical issues related to stem cell technology, Cord blood banks and their significance.

References Books

1. Kursad and Turksen, "Embryonic Stem cells", Humana Press, 2002.
2. National research council, "Stem cell and future of regenerative medicine", National Academic press, 2002.
3. "ICMR guidelines for stem cell Research", 2013 (www.icmr.nic.in)

14BT2043 HUMAN PHYSIOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To ensure students in having strong knowledge in functioning of Human organ systems
- The students will learn the essential theme of maintaining homeostasis.
- This subject helps to understand experimental approach can be applied to studying the various physiological systems of the human body.

Course Outcome:

- Outline knowledge on the fundamental physiology of Human systems.
- Illustrate the physiological relationship of cell interaction, organ development and function.
- Evaluate physiological function in normal and disease states

Description: Introduction to physiology and homeostasis, cell physiology, membranes and tissues, neuronal and hormonal communication, The nervous system – Peripheral Nervous System and Central Nervous System, tissue structure and muscle physiology; circulatory system, digestive system, respiratory system, endocrine system, reproductive system.

References Books

1. Arthur C. Guyton, John E. Hall, "Textbook of Medical Physiology" 11th Edn., Elsevier Saunders, 2006.

2. C.C. Chatterjee, “Human Physiology”, 6th edn., S Chand Publication, 2008.

14BT2044 CANCER BIOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To study the factors affecting cancer development, the genetic and cellular basis for cancer development.
- To study the involvement of carcinogens in cancer development.
- To study the characteristic features of cancer cells, their behavior and the treatment modalities available.

Course Outcome:

- State in depth understanding of the molecular and cellular mechanisms that lead to cancer.
- Relate principles behind personalized medicine and therapeutic cancer management
- Summarize advanced methodologies used in cancer research

Description: Fundamentals of cancer biology, principles of carcinogenesis; cancer and types; carcinogens – physical and chemical; tumour antigens; protooncogenes and oncogenes, tumour suppressor genes, cancer metastasis and tumour angiogenesis, adhesion molecules, role of proteases in metastasis, Role of growth factors in tumour progression; cancer detection, cancer therapy.

Reference Books

1. Macdonald F and Ford CHJ. “Molecular Biology of Cancer”, Bios Scientific Publishers, 2002.
2. Robert G, Mckinnell, Ralph E. Parchment, Alan.O. Perantoni, G. Barry Pierce, “The Biological Basis of Cancer”, Cambridge University Press, New York. 2003.
3. Ranga M.M. “Animal Biotechnology”, Agrobios India Limited, 2002
4. Ramadass P, Meera Rani S. “Text Book of Animal Biotechnology”, Akshara Printers, 2000.
5. Dubey, R.C, “Text Book of Biotechnology”, S. Chand & Co, 2004.

14BT2045 BIOPHARMACEUTICAL TECHNOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To provide an insight to the undergraduate students on the basics of biopharmaceutical technology.
- To equip the students to know the basic of formulations and to apply them in clinical trials.

Course Outcome:

- Classify drug principles, biotechnology oriented pharmaceutical products, pharmacokinetics and pharmacodynamics.
- Demonstrate the preparation of drug dosage forms
- Relate regulations in clinical trial and management.

Description: Basic principles of pharmacokinetics and pharmacodynamics, preparation of solid dosage forms, preparation of semisolid and liquid dosage forms, bio- pharmaceutical products, clinical trials and regulations.

Reference Books

1. DM Brahmankar, Sunil B Jaiswal, "Biopharmaceutics and Pharmacokinetics-A Treatise", Vallabh prakashan, 2005.
2. Ansel, H., Allen, L., Popovich, N, "Pharmaceutical Dosage Forms and Drug Delivery Systems", Williams & Wilkins, 2014.
3. Lippin cott, "Remington's Science and Practice of Pharmacy", Williams & Wilkins publishers, 2012.
4. Goodman & Gilman's, "The pharmacological basis of therapeutics" McGraw-Hill Medical, 2011.
5. Tripathi KD, "Essential of Medical pharmacology", Jaypee Brothers Medical Publishers 2003.

14BT2046 RESEARCH METHODOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To intend the students with the knowledge about the basic research methods, applications in conducting research, various data collection and analysis techniques.
- To gain insights into scientific research.
- To help in critical review of literature and assessing the research trends, quality and extension potential of research and equip students to undertake research.

Course Outcome:

- Discuss the basics concepts of research and its types.
- Analyze of research data using statistical tools in biotechnology.
- To Describe art of technical writing of manuscript and thesis

Description: Objectives of research- types of research - significance of research, criteria for good research, scope and limitations of experimental design- characteristics of good design, methods of research- survey, descriptive, comparative, experimental- clinical research- controlled clinical trials, measurement, scaling techniques and analysis of data, statistics in research, manuscript / thesis writing

Reference Books

1. C.R. Kothari, "Research methodology, Methods and techniques", New Age International (P) Ltd, Publishers, 2nd edition,2000.
2. Jerrod H. Zar, "Biostatistical analysis", Prentice Hall International, Inc. Press, 1999.
3. Donald H. McBurney, "Research methods", Thomson Asia Pvt. Ltd. 2002
4. Ranjit Kumar, "Research methodology", Sage Publications, London, 2006.
5. Raymond – Alain, "Doing Management research", Sage publications, 2001.

14BT2047 BIOCHEMICAL ENGINEERING

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To provide the idea to determine the rates of enzyme catalyzed reactions and to provide knowledge on the immobilization of enzymes.
- To provide knowledge regarding cell growth patterns and design of various bioreactors.
- To study the enzyme kinetics and inhibition models

Course Outcome:

- Acquire knowledge on enzyme kinetics and growth models
- Outline the role of aeration and agitation in fermenter design
- Evaluating various novel bioreactors developed

Description: comparison of chemical and biochemical processes, industrially important microbial strains, Enzyme kinetics: Mechanism of enzymatic reactions; Michaelis-Menten and Briggs Haldane equation; enzymes inhibition. Factors affecting growth; Monod`s equation; modeling of batch and continuous cell growth; Mass transfer coefficients and their role in scale-up of equipments; enhancement of O_2 transfer; sterilization cycles High performance bioreactors

References books:

1. Shuler M.L and Kargi F, "Bioprocess Engineering Basic Concepts" Prentice Hall of India 2002
2. Lee, J.M, "Biochemical Engineering", Prentice Hall, 2nd Edition, 2001
3. Blanch, H.W and Clark, D.S, "Biochemical engineering", Marcel Dekker, 1997

14BT2048 METABOLIC ENGINEERING

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To develop skills of the students in the area of metabolic engineering to alter the existing metabolic pathway
- To introduce novel metabolic pathways in microorganisms using r-DNA technology
- To learn molecular techniques in order to enhance the product yield.

Course Outcome:

- Generalized knowledge on the principles and regulation of metabolic pathways
- Analyze different methods to obtain improved production strains
- Categorize the synthesis of primary and secondary metabolites and bioconversions

Description: Analysis of metabolic control in glycolysis, metabolic flux –Regulations in the production of metabolites: Feedback control systems, alteration of feedback regulation for enhanced production of primary metabolites: glutamic acid, Mutants which do not produce feedback inhibitors or repressors-auxotrophs-lysine, isoleucine, arginine, purine nucleotides. Producers of secondary metabolites, Precursor effects, trophophase- idiophase relationship, applications of secondary metabolites, Metabolic pathways and regulation of production processes- antibiotics, vitamins, Mycotoxins- maintenance of genetic stability; Bioconversions

Reference Book

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005
2. W.Crueger and A. Crueger, "A Text Book of Industrial Microbiology", Panima Publishing Corporation, 2005
3. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.
4. Gregory N. Stephanopoulos , Aristos A. Aristidou & Jens Nielsen, "Metabolic Engineering: Principles and Methodologies", Academic Press, An Imprint of Elsevier India Pvt.Ltd.,1st edition, 1998.

14BT2049 PROCESS EQUIPMENT DESIGN

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To design safe and dependable processing facilities.
- This course focus on plant layout and design of piping systems
- This will provide the basic knowledge to carryout design process cost effectively.

Course Outcome:

- To infer principles of process equipment design, the mechanical aspects of the design
- Illustrate various unit operation equipments, including safety considerations
- To develop flow measurement devices

Description: Process equipment symbols based on IS3232. Plant layout for production of penicillin, citric acid and ethanol. Design of venturimeter, double pipe heat exchanger, Design of gate, design of globe valve, Design of double pipe heat exchanger, design of single effect evaporator. simple distillation column and single ideal batch reactor.

Reference Books

1. Joshi, M.V, "Process Equipment Design", MacMillan, 3rd edition, 2004.
2. Bhattacharya, B.C., "Introduction to Chemical Equipment Design", CBS Publishers and Distributors, New Delhi, 2000.
3. Indian Standard Codes:
   a. IS : 2825 - 1969: Code for Unfired Pressure Vessels.
   b. IS : 4049 - 1979: Specifications for formed ends for Tanks and Pressure vessels.
   c. IS : 4179 - 1967: Sizes of Process Vessels & their Leading Dimensions.
   d. IS: 4864 to 4870 - 1968: Specifications for Shell Flanges for Vessels and Equipment.
   e. IS : 4503 - 1967: Specifications for Shell & Tube Heat Exchangers.
   f. IS : 803 - 1962: Code of practice for Design, Fabrication and Erection of Mild
   g. Steel Cylindrical Welded Oil Storage Tanks.

14BT2050 PROCESS CONTROL ENGINEERING

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To control and measure the processing facilities in a cost effective manner.
- To focus on plant layout control and piping systems
- To provide in-depth knowledge on control systems

Course Outcome:

- Review the principles of process control systems
- Practice laplace transform function
- Compare different control modes for dstillation and heat exchanger.

.

Description: Instrument static and dynamic characteristics, flow and level transmitters. Laplace transform of standard functions, transfer function concept principles and description of Proportional control, Proportional Integral Control, Proportional Derivative control and Proportional Integral and Derivative control modes, control circuit diagram for heat exchanger and distillation column.

Reference Books:

1. George Stephanopoules, “Chemical Process control”, I edition,Prentice-Hall of India, New Delhi, 1998
2. A.Suryanarayanan, “Chemical instrumentation and process control”, Khanna Publishers 2nd edition, New Delhi , 1995
3. D.R.Coughnaour, “Process system analysis & control”, Mc Graw Hill, Singapore II edition, 1991

14BT2051 PILOT PLANT AND SCALE UP PRACTICE

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To provide basic knowledge of scale-up practice
- To teach the details of pilot plant design.
- To study about Pilot plants for reactors and mechanical operations equipments

Course Outcome:

- Outline knowledge in pilot plants for reactors and mechanical operations equipments
- Examine Pilot plant design for several unit operation equipments.
- Assess sampling data and safety factors and dimensional analysis

Description: Pilot plants, size estimation, sampling data, cost and safety factors. Dimensional analysis, scale up equations, analog models. Pilot plant design for heat exchangers and mixer equipments, batch and continuous distillation columns. Pilot plants for reactors and mechanical operations equipments

Reference Books:

1. Johnson and Thring, “Pilot plants models and scale up methods in chemical engineering”, McGraw Hill Book co. New York, 1987.
2. Henley and Staffin, “Stage-wise process design”, John Wiley, New York 1988.
3. Bisio and Kabel, “Scale up of Chemical Process”, John Wiley, Singapore 1985.

14BT2052 INDUSTRIAL SAFETY & HAZARD ANALYSIS

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To provide basic knowledge of occupational health hazards
- Will learn about the necessary safety measure in industrial planning and function.
- To provide basic knowledge about various industrial acts related to labors

Course Outcome:

- Outlining basic concepts related to occupational hazards, first aid practices, PPEs and safety trainings
- Dramatize plant layouts, housekeeping and Ergonomics
- Compare and choose various rules and regulations of factories

Description: Occupational Health Hazards, Safety and Health training, Ergonomics. Plant layout, Safety and good housekeeping, First aid - Rescue and Transport of Casualty, Personal Protective Equipments and devices. Overload and Short circuit protection, Earthing standards, Protection against voltage.Factories Act, 1948, Workman’s Compensation Act, 1943, Employees State Insurance Act, 1948.Child Labour and Women Employee Act, The factories rules and regulations.

Reference Books

1. R. K. Jain and Sunil S. Rao , “Industrial Safet , Health and Environment Management Systems”, Khanna publishers , New Delhi, 2006
2. Grimaldi and Simonds , “Safety Management”, AITBS Publishers , New Delhi , 2001

14BT2053 INDUSTRIAL EFFLUENT TREATMENT

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- The study of the subject constitutes the sources, characteristics of waste water
- Provides various methods for treatment of wastewater.
- It imparts the knowledge of basic principles of science and engineering applied to the problem of water pollution.

Course Outcome:

- Summarize the basic knowledge on the composition of waste water / effluent from the industry.
- Experiment on analysis and removal of toxic wastes and heavy metals by physical, chemical and biological methods
- Assessing various waste water treatment reactors

Description: Waste water constituents, physical characteristics, biological characteristics, non-metallic constituents, metallic constituents, Screening, mixing and flocculation, grit removal, sedimentation, aeration system, filtration, Chemical coagulation, chemical precipitation for phosphorous removal, heavy metals & dissolved inorganic substances , biological treatment: Biological process for wastewater treatment, treatment process – activated sludge process, attached growth and combined biological treatment process - trickling filters.

Reference Books

1. Etcalf & Eddy, “Wastewater Engineering (Treatment and Reuse)”, 4th Edn, Tata – McGraw Hill, New Delhi, 2003.
2. Mark J. Hammer.: “Water and waste water technology” – 5thEdn”, Prentice Hall of India Pvt. Limited, New Delhi, 2007.
3. James M. Montgomery.: “Water treatment principles and design” – A Wiley Interscience publication, Newyork, 1985.

14BT2054 BIOENERGY AND BIOMATERIALS

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To impart knowledge on energy resources,
- To study the basics of energy needs, for environment and society
- To have knowledge about management of energy conservation

Course Outcome:

- Express knowledge on energy resources
- Analyze the various renewable energy sources
- Compose methods of energy conservation

Description: Energy sources: natural gas, coal; energy situation in India. Exploration of combustion energy resources, structural properties of environment; bio-geo-chemical cycles; Biotechnology and its application in environmental protection, Patterns of consumption in developing and advances countries; commercial generation of power requirements and benefit, new energy conservation systems, energy management

Reference Books

1. Jerrold.H.Kertz, "Energy Conservation and Utilization", Allyn and Bacur inc, 1981.
2. Gemand.M.Gramlay, "Energy", Macmillion publishing Co, Newyork, 1975.
3. Krentz, J. H., "Energy Conservation and Utilisation ", Allyn and Bacur Inc., 1976.

14BT2055 POLLUTION CONTROL AND ENGINEERING

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To give an exposure to various control acts
- To study the advantages and disadvantages of impact assessment methods
- To study the methods of reducing the waste and reusing it.

Course Outcome:

- Outline basic knowledge on pollution, its types and control acts and regulations.
- Employ collected raw data on pollution caused by industries.
- Evaluate audit reports on pollution is finally controlled.

Description: Need for impact assessment. Legislation and pollution control acts and Regulations. Methodologies – collection of data and analysis, **a**pplication of Impact assessment methods in specific developmental projects, advantages, disadvantages of different methods, impact assessment report contents for developmental projects-Biochemical and chemical process industries, concepts and contents of environmental management plan. Environmental audits, waste audit, life cycle assessment, industrial symbiosis, clean technology and Clean up technology, materials reuse, waste reduction.

Reference Books

1. Peter Wathern, "Environmental Impact Assessment theory and practice", Unwin Hyman Ltd. Routledge, 1990,
2. L. Lee Harrison , "Environmental Health and Safety Auditing Handbook", 2^{nd} edition, , McGraw Hill, Inc., New York, 1995
3. Kirkwood, R. C. and Longley, A. J., "Clean Technology and Environment", Chapman & Hall, 1995.

14BT2056 ENTREPRENEURSHIP

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To provide basic knowledge of entrepreneurship
- This course will provide necessary details for self-employment in industrial planning and function.
- It provides an insight into various acts related to entrepreneurship.

Course Outcome:

- Reviewing basic ideas and planning of startup entrepreneurs
- Interpreting various policies and incentives of governments and other funding agencies
- Designing plant layouts

Description: Entrepreneurship-employment and self-employment, government policy, incentives. DIC, TIIC, SIDCO, TIDCO, IDBI, SISI, NSIC, banks, IBC, Technology and product life cycle, decision layout methods. Control of inventory, ABC analysis and value engineering, basic provisions of central laws. Factories act, environmental act, payment of wages act, sales tax act, shops and commercial establishment act

Reference Books:

1. C.B Gupta, "Entrepreneurial development in India", Sultan Chand & sons, 1998
2. C.B Gupta & S.S Khanna, "Entrepreneurship and Small business management", Sultan Chand & sons, 1998
3. P. Saravanavel, " Entrepreneurial development", Kitab Mahal, 1991
4. Peter Drucker, " Innovation & Entrepreneurship" , Routledge, 2012

12BT2057 MECHANICAL OPERATIONS LABORATORY

Credits: 0:0:2 **(Version 1.1)**

Course Objectives:

- To provide knowledge on properties of solids
- To learn about various size reduction techniques
- To know the methods to handle solids and to perform screen analysis

Course Outcomes:

- Explain and infer various mechanical operations used in biotechnology industries
- Illustrate mechanical operative procedures in handling solids.
- Formulate downstream processing and equipments used in these processes

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2058 PROCESS CONTROL LAB

Credits: 0:0:2 **(Version 1.1)**

Course Objective:

- This course helps to study the measurement and control of various processes in a cost effective manner.
- This course focuses on plant layout control and piping systems.
- This lab will provide in depth knowledge about the valves used in control systems.

Course Outcome:

- Generalized knowledge in working of basic process control equipments and controllers
- Illustrate various types of controllers used in biotechnology industries
- Summarize applications of various controllers

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2059 CELL BIOLOGY AND MICROBIOLOGY

Credits: 3:0:0 **(Version 1.1)**

Course Objective:

- To acquaint students with the concepts in Cell Biology.
- To educate the students regarding the structure and function of cells
- To impart knowledge on classification and structure of microbes,
- This subject also deals with nutrition and control of microorganisms.

Course Outcome:

- Generalized knowledge on structure and functions of prokaryotes and eukaryotes.
- Analyze transport mechanisms across living cells and cell cycle regulation
- Relate application of microorganisms in the field of food, agriculture and environment.

Description: Biology of cells- structure of prokaryotic and eukaryotic cells, cytoskeletal proteins, transport across cell membranes, regulation of cell cycle- cell division, cell cycle and regulation - cancer-types, basics in microbiology, classification and nomenclature of microorganisms, different staining techniques, physical and chemical control of microorganisms, nutritional requirements of bacteria, types of different media, quantification of bacterial growth.

Reference Books

1. Verma P. S. and Agarwal V. K., "Cell Biology, Genetics and molecular Biology", S. Chand and company, New Delhi, 2000.
2. Pelczer M. J., Chan E.C.S. and Krein N.R., "Microbiology", Tata Mc Graw Hill Publishers, New Delhi, 2000.
3. Lodish H., Bert A., Matsudaria Kaiser C.A., Kriegar M., Scott M.P., Zipursky S.L. and Darnell J., "Molecular cell Biology", WH Freeman and company, New York, 5th edition, 2004.

14BT2060 CELL BIOLOGY AND MICROBIOLOGY LAB

Credits: 0:0:2 **(Version 1.1)**

Co-requisite: 14BT2059- Cell biology and Microbiology

Course Objective:

- Students will be taught practically to learn about cell division, osmosis and tonicity
- The students will learn to identify the microorganisms using various staining techniques
- The students will learn about the enumeration of microorganisms.

Course Outcome:

- Summarize basic concepts in cell division, osmosis and tonicity
- Demonstrate various staining techniques to identify microbial diversity
- Summarize the procedure for enumeration of microorganisms.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

LIST OF SUBJECTS

Code No.	Name of the Subject	Credits
14BT3031	General Microbiology	3:0:0
15BT2001	Medical Biochemistry	3:0:0
15BT2002	Medical Biochemistry Lab	0:0:1
15BT2003	Human Physiology and Anatomy	3:0:0
15BT2004	Biomaterials and Artificial Organs	3:0:0
15BT2005	Occupational Safety Management	3:0:0
15BT2006	Medical Waste Treatment	3:0:0
15BT2007	Cell Biology and Immunology	3:0:0
15BT2008	Tissue Engineering	3:0:0
15BT2009	Techniques in Pathology and Microbiology	3:0:0
15BT3001	Cell Biology and Molecular Signaling	3:0:0
15BT3002	Cell Biology and Immunology Lab	0:0:2
15BT3003	Biotechniques and Instrumentation	3:0:0
15BT3004	Molecular Biology Lab	0:0:2
15BT3005	Microbial Taxonomy and Phylogeny	3:0:0
15BT3006	Molecular Microbiology	3:0:0
15BT3007	Bacteriology, Mycology and Parasitology	3:0:0
15BT3008	Virology	3:0:0
15BT3009	Microbial Physiology and Metabolism	3:0:0
15BT3010	Microbial Genetics	3:0:0
15BT3011	Clinical Microbiology Lab	0:0:2
15BT3012	Biosafety, Bioethics and IPR	3:0:0
15BT3013	Marine Microbiology	3:0:0
15BT3014	Environmental Microbiology	3:0:0
15BT3015	Pharmaceutical Microbiology	3:0:0
15BT3016	Entrepreneurship in Biotechnology	3:0:0
15BT3017	Marine and Environmental Microbiology Lab	0:0:2
15BT3018	Food and Dairy Microbiology	3:0:0
15BT3019	Soil and Agricultural Microbiology	3:0:0
15BT3020	Industrial Microbiology	3:0:0
15BT3021	Biomass, Bioenergy and Biofuels	3:0:0
15BT3022	Food and Agricultural Microbiology Lab	0:0:2
15BT3023	Plant and Animal Tissue Culture	3:0:0
15BT3024	Microbial Nanotechnology	3:0:0
15BT3025	Pharmaceutical and Industrial Microbiology Lab	0:0:2

14BT3031 GENERAL MICROBIOLOGY

Credit 3:0:0

Course Objectives:

- To introduce to the students the diversity of microbes in nature
- To develop in students an ability to culture, identify , and control microorganisms
- To illustrate to students the metabolism and the roles of microbes playing varying roles in the environment

Course Outcomes:

The students will be able

- To distinguish the different types of microorganisms and their characteristics
- To understand the principle behind culture medium preparation and the type of sterilization methods to be applied
- To apply the metabolism concepts to the different microbial activity in nature

Description:

History, Taxonomy and classifications -Microscopy- Light, dark field, phase contrast, Fluorescence and Electron Microscopes. Stains- Simple, Differential and Special stains, Structure and functions of cellular components of bacteria, fungi, algae, parasites and virus.Sterilization and Disinfectants -AntimicrobialChemotherapy- Antibiotics, Source and mode of action -Antimicrobial resistance-Tests for sensitivity to antimicrobial agents -Nutrition-Autotroph, Heterotroph, Chemotroph and Lithotroph- Types of Culture Media. Methods of enumeration of microorganisms-Preservation techniques-Growth Curve-synchronous and asynchronous culture-Factors affecting growth-bacterial metabolism-Respiration, Intermediate metabolism, fermentation and photosynthesis-Role of microbes in nitrogen, phosphorus and sulfur Cycle. Biopesticides&Biofertilisers- Air microbiology –enumeration and control- Sewage Disposal-Leaching of ores by microorganisms-Bioremediation.

Reference Books

1. Pelczar Jr M J, Chan, ECS, and Krieg R, “Microbiology”, McGraw-Hill, New York, 2003.
2. Stanier RY, Ingraham JL, Wheelis ML, Pamler PR, “General Microbiology”, MacMillan Publishers, London, 2003.
3. Prescott LM, Harley JP and Klein DA, “Microbiology”, McGraw Hill, USA, 2005.

15BT2001 MEDICAL BIOCHEMISTRY

Credits: 3:0:0

Course Objective:

- To learn the biochemistry of living cells.
- To provide knowledge on the biochemistry of proteins, lipids and carbohydrates.
- To introduce the different methods of investigation of metabolism and diagnostic tools.

Course Outcome:

- Analyze the biochemistry of proteins, lipids and carbohydrates in living cells.
- Critically analyze any biochemical reaction and suggest suitable investigation methods.
- Analyze the metabolism of biomolecules.

Biochemistry of living cells, sub cellular fractionation using the differential centrifugation method. Functions of each organelle, redox potential, oxidative phosphorylation, Transport of substances across biological membranes. Carbohydrates, Definition, Classification, their biomedical importance, diabetes, Blood sugar analysis and glucose tolerance tests. Lipids, Definition, Classification, essential fatty acids and cholesterol, their biomedical importance.

Proteins, Composition, general properties, classification, biomedical importance, identification of proteins by chromatography and electrophoresis. Vitamins, Classification, functions and deficiency symptoms, hypervitaminosis. Uses of isotopes in biochemistry. Methods of investigation of metabolism, Liver function tests,Renal function tests, Urine analysis and gastric function tests.

References:

1. Donald Voet, Judith,G.Voet and Charlotte, W.Pratt."Fundamentals of Biochemistry, Life at the Molecular Level."JohnWiley&sons,Inc.(Asia). 2006.
2. Keith Wilson and JohnWalker. "Principles and Techniques of Biochemistry and Molecular Biology". Sixth Edition. Cambridge University Press.2007.
3. Rodney Boyer, "Modern Experimental Biochemistry," Third edition. Addison Wesley Longman Inc.2000.

15BT2002 MEDICAL BIOCHEMISTRY LABORATORY

Co-requisite: 15BT2001 Medical Biochemistry

Credits: 0:0:1

Course Objective:

- To learn the biochemistry of living cells.
- To provide knowledge on the biochemistry of proteins, lipids and carbohydrates.
- To introduce the different methods of investigation of metabolism and diagnostic tools.

Course Outcome:

- Analyze the biochemistry of proteins, lipids and carbohydrates in living cells.
- Critically analyze any biochemical reaction and suggest suitable investigation methods.
- Analyze the metabolism of biomolecules.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15BT2003 HUMAN PHYSIOLOGY AND ANATOMY

Credits: 3:0:0

Course Objective:

- To provide a basic understanding of the structure and function of human body.
- To provide the students an exposure to the fundamentals in human anatomy and physiology.
- To introduce the different systems of the body and their functioning.

Course Outcome:

- Relate basic human body functions and life processes.
- Name the major human body systems and relate their functions.
- Name the major components of each system and describe briefly their anatomical locations, structures and their physiological functions.

Cell: Structure and organelles, Functions of each component. Cell membrane, transport across membrane, origin of cell membrane potential (Nernst and Goldman and Katz equations), Action potential. Blood composition, functions of blood, functions of RBC. WBC types and their functions. Blood groups, importance of blood groups, identification of blood groups. Blood flow factors regulating blood flow such as viscosity, radius, density, etc. Structure of Kidney and nephron. Mechanism of Urine formation and acid base regulation. Dialysis. Components in of respiratory system. Oxygen and carbon di oxide transport and acid base regulation. Structure of heart, Properties of Cardiac muscle, Cardiac muscle and pacemaker potential, Cardiac cycle, ECG, Heart sound, volume and pressure changes and regulation of heart rate. Structure of a Neuron. Synaptic conduction. Conduction of action potential in neuron, Parts of brain cortical localization of functions EEG. Simple reflexes, withdrawal reflexes. Autonomic nervous system and its functions, Structure of eye, ear and auditory and visual pathways.

References:

1. Anne Waugh, Allison Grant,"Ross and Wilson: Anatomy and Physiology in Health and Illness", Churchill Livingston, Elsevier 2010.
2. Elaine.N. Marieb, "Essential of human Anatomy and Physiology," Eighth edition. Pearson Education, NewDelhi.2007
3. William F. Ganong, "Review of Medical Physiology" Second Edition. McGrawHill NewDelhi. 2000
4. Prof.A.K.Jain."Textbook of Physiology". Third edition. VolumeI and II, Avichal Publishing company, NewDelhi. 2005
5. Arthur.C.Guyton, John E Hall, "Textbook of Medical Physiology", – W.B. Saunders Company, 2000

15BT2004 BIOMATERIALS AND ARTIFICIAL ORGANS

Credits: 3:0:0

Course Objective:

- To introduce the classifications and characteristics of biomaterials and to understand the properties of bio-compatible materials.
- To learn polymeric materials and combinations that could be used as tissue replacement implants.
- To study artificial organs developed using tissue materials.

Course Outcomes:

- Analyze different types of biomaterials and their classifications.
- Analyze the bio-compatability of specific materials used as implants.
- Perform combination of materials that could be used as tissue replacement implants.

Description: Structure of Bio-Materials and Bio-Compatibility – Definition, classification and properties of bio-materials. Body response to implants, wound-healing and blood compatibility. Methods of testing implants for biological performance. Metallic Implant materials, Polymeric Implant materials, Tissue replacement materials-soft, hard and blood interfacing materials, Artificial organs-heart, heart valves, oxygenators, Dialysers, Dental implants.

References:

1. Sujata V. Bhatt, "Biomaterials" Second Edition ,Narosa Publishing House,2005.
2. JoonB.Park Joseph D. Bronzino, "Biomaterials - Principles and Applications" CRC Press, 2003
3. Jonathan Black, "Biological Performance of materials", Marcel Decker, 1981
4. Park J.B., "Biomaterials Science and Engineering", Plenum Press, 1984.
5. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGrawHill, 2003
6. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, "Introduction to Biomedical Engineering", Elsevier, 2005.

15BT2005 OCCUPATIONAL SAFETY MANAGEMENT

Credits: 3:0:0

Course objectives:

- To know about the health issues and safety principles
- To apply safety practice through training methods
- To know the occupational safety and health Act and its applications

Course outcomes:

- To understand safety factors in workplace
- To apply training skills for personal safety
- to apply safe health practices in hazardous environments

Safety and health in work place-issues of chemical, and physical hazards to workplace safety and health-training, compensation, liability coverage, and regulatory matter-Occupational Safety and Health Act (OSHA) of 1971 - compliance with established regulations-safe equipment and management supervision, but also the safety training of workers- technical and human factors consideration in the areas of health and safety - from hazardous substances and radiation, noise and vibration to stress.

References:

1. Louis J. Di Berardinis, "Handbook of occupational safety and health", John Wiley, 1999.
2. Mark A. Friend, James P. Kohn**, "**Fundamentals of Occupational Safety and Health, Bernan Press, 23-Jun-2014.
3. Geoff Taylor, Kellie Easter, Roy Hegney, "Enhancing Occupational Safety and Health", Elsevier Butterworth-Heinemann, 2004
4. Occupational safety Manual, BHEL, Trichy, 1988.

15BT2006 MEDICAL WASTE TREATMENT

Credits: 3:0:0

Course objectives:

- to identify the modes of medical waste treatment
- to understand the pollution and health hazards
- to analyze the methods of water treatment

Course outcomes:

At the end of this course the student will be able

- to analyse the safe methods of medical waste treatment system
- to learn the ways of preventing pollution and personal safety
- to apply instrumentation and control techniques for potable water treatment

Sources and classification of medical waste-color code-handling, sterilization, treatment, transportation and safe disposal-regulations-Hazards –personal safety-environmental pollution-health hazards-medical waste treatment system-temperature and level control, toxic gas detector-design of alarm system-central monitoring- pollution monitoring system-waste water treatment system-safety regulations-personal health hazards- Instrumentation for monitoring of water pollution-Case studies-potable water-Instrumentation for water quality monitoring-Boiler, incinerator. Temperature level and flow control for computer applications in central monitoring system.

References:

1. P.K. Behera, “Sustainable biomedical waste management”, Dominant Publishers AndDistributors, 1993.
2. Dr. Shalini Sharma, SVS Chauhan, “An analysis of medical waste management”, Lambert publisher, 2000.
3. Etcalf& Eddy, “Wastewater Engineering (Treatment and Reuse)”, 4th Edn, Tata – McGraw Hill, New Delhi, 2003.
4. Mark J. Hammer.: “Water and waste water technology” – 5thEdn”, Prentice Hall of India Pvt. Limited, New Delhi, 2007.
5. James M. Montgomery.: “Water treatment principles and design” – A Wiley IntersciencePublication, Newyork, 1985.

15BT2007 CELL BIOLOGY AND IMMUNOLOGY

Credits: 3:0:0

Course Objective:

- To acquaint the students with the concepts in Cell Biology and Immunology
- To understand the structure and function of the organelles of cells
- To understand the fundamental principles and concepts of immune system and to learn the Immuno techniques

Course Outcome:

- Students will be familiar with the concepts in cell biology.
- Students will acquire fundamentals that will enable them to apply in cell based research.
- At the end of the course the student will learn the mechanisms by which the human systems interact with pathogenic microbes & eliminates it.

Description: Structure of Prokaryotic and Eukaryotic cells, Cell organelles, cell cycle and regulation, cytoskeleton, Cell- cell communication, active and passive transport, pumps and gated channels, Endocytosis, Exocytosis, protein glycosylation in eukaryotes.

Introduction to Immune System- Cells of immune system, types, Lymphoid organs, Antigens, Antibodies, Clonal selection, T and B cell development, Antigen-Antibody reaction, MHC, Antigen presentation, Complement, Hypersensitivity, Vaccines, Monoclonal antibodies, ELISA and Western blotting

Reference Books

1. Geoffrey M. Cooper and Robert E. Hausman, “The Cell: A Molecular Approach”, ASM Press and Sinauer Associates, Inc., USA, 5th edition, 2009.
2. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, “Molecular Biology of the cell”, Taylor and Francis group, 5th edition, 2007.
3. Kimball T.W., “Cell Biology”, Wesley Publishers, 3rd Edition, 2007.
4. Tizard, “Immunology”, Saunders college publication, 5th Edition. 2004.
5. Owen J, Punt J , Stanford S, “Kuby Immunology”, WH Freeman & Co., 2013.

15BT2008 TISSUE ENGINEERING

Credits: 3:0:0

Course Objective

- To introduce the basic concepts of tissue organisation in the human body and the theories related to normal physiology and repair
- To inculcate knowledge on cell culture, cell signalling and molecular growth factors.
- To develop tissue implants and transplants and its regulation in tissue engineering

Course Outcome

- Learn the fundamental concepts and technology in tissue engineering
- Understand the cellular interaction and molecular aspects of cell differentiation, communication and growth.
- Ability to analyze the development of scaffolds, tissue implants and the regulatory issues regarding their application.

Introduction: Basic definition, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing. Scaffold and transplant: Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells: introduction, hepatopoiesis.Case study and regulatory issues: Case study of multiple approaches: cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering.

References:

1. Robert. P.Lanza, Robert Langer & William L. Chick, Principles of tissue engineering, , Academic press.
2. Joseph D. Bronzino, The Biomedical Engineering –Handbook, CRC press.
3. Endarle, Blanchard &Bronzino,Introduction to Biomedical Engg. , Academic press.
4. B. Palsson, J.A. Hubbell, R.Plonsey& J.D. Bronzino,Tissue Engineering, CRC- Taylor & Francis

15BT2009 TECHNIQUES IN PATHOLOGY AND MICROBIOLOGY

Credits: 3:0:0

Course Objective

- Gain knowledge on the structural and functional aspects of living organisms.
- Know the etiology and remedy in treating the pathological diseases.
- Empower the importance of public health.

Course Outcome

- Analyze structural and functional aspects of living organisms.
- Explain the function of microscope
- Describe methods involved in treating the pathological diseases and public health

Necrosis, apoptosis**,** cellular adaptations of growth and differentiation, Inflammation and Repair, Neoplasia, tumours, carcinogenesis, autopsy and biopsy, Hemostasis, Edema, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock. Hematological disorders. Natural and artificial immunity, opsonization, phagocytosis, inflammation, Immune deficiency syndrome, antibodies, antigen and antibody reactions Light microscope , fluorescence, TEM & SEM. Preparation of samples for electron microscope. Staining methods. Morphological features and structural organization of bacteria, growth curve, identification of bacteria , culture media and its types , culture techniques and observation of culture Instrumentation for immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies. Disease caused by bacteria, fungi, protozoal, virus and helminthes.

References:

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB Saunders Co. 2005 (Units I & II).
2. Prescott, Harley and Klein, "Microbiology", 5th edition, McGraw Hill, 2002 (Units III,IV& V).
3. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
4. Ananthanarayanan&Panicker, "Microbiology" Orientblackswan, 2005.
5. Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2007

15BT3001 CELL BIOLOGY AND MOLECULAR SIGNALING

Credits: 3:0:0

Course Objectives:

- The student will acquire basic knowledge on the complexity and harmony of the cell.
- To understand the mechanism of cell- cell communication and molecules that control cell cycle
- To learn the concept of molecular cell signaling and oncogenes.

Course Outcomes:

- At the end of this course, the students will be able to know the molecular mechanisms regulating and controlling the cell cycle
- Students will understand how molecular defects in a cell can lead to its development into a cancer cell

Description: Cell organelles, molecules that control cell cycle and regulation, cytoskeleton, Cell- cell communication, active and passive transport, pumps and gated channels, Endocytosis, Exocytosis, protein glycosylation in eukaryotes, Entry of viruses and toxins into the cell, signaling molecules and their receptors, signal transduction, phosphorylation and regulation in signaling, oncogenes, tumour suppressor genes and molecular approaches to cancer treatment.

Reference Books:

- Geoffrey M. Cooper and Robert E. Hausman, The Cell: “A Molecular Approach”, Fifth Edition, ASM Press and Sinauer Associates, Inc., USA, 2009.
- Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, “Molecular Biology of the cell”, fifth edition, Taylor and Francis group, 2007.
- Kimball T.W., “Cell Biology”, Wesley Publishers, 3rd Edition, 2007.
- De Robertis and De Robertis, “Cell Biology”, Saunders, 4th Edition, 2006.
- Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. “Molecular Biology of the Cell”, New York, 5th edition, 2005.

15BT3002 CELL BIOLOGY AND IMMUNOLOGY LAB

Credits: 0:0:2

Co-requisite:14BT3020 - Immunotechnology

Course Objectives:

- To acquaint the students with basic cell biology and immunology laboratory techniques.
- To study antigen antibody interaction.
- To study cell types and staining techniques.

Course Outcomes:

- The students get familiarized with basic cell biology techniques.
- The students will be familiar with immunological techniques.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15BT3003 BIOTECHNIQUES AND INSTRUMENTATION

Credits: 3:0:0

Course Objectives:

- This course is designed to develop skills of students with various instrumental methods of biological analysis that microbiologists come across during their course and research undertakings.

Course outcomes:

- At the end of the course, the students will have sufficient scientific understanding of the basic concepts in instrumentation used in microbiology.

Description: Chromatographic techniques- Principles and applications of Thin layer chromatography, paper chromatography, size exclusion chromatography, Ion exchange chromatography, Affinity chromatography, HPLC, GLC; Centrifugation, Basic principles, RCF, Sedimentation coefficient, Svedberg's constant. Types of centrifuge: Ultracentrifuge, Preparative centrifugation: Differential and density gradient centrifugation, Applications; Introduction, Principle, theory and applications of Agarose gel Electrophoresis, PAGE, 2 D gel electrophoresis and Isoelectric focusing; Principles and methods used for analysis of biopolymers- X-ray Crystallography, NMR and ESR spectroscopy; Hydrodynamic methods; Atomic absorption and Plasma emission spectroscopy, Isolation of cell organelles, Radio-isotope and tracer techniques

Reference Books:

1. Keith Wilson and John Walker, 2004. Practical Biochemistry - principles and techniques, Cambridge Press, New York.
2. Keith Wilson and Goulding, K.H. 2006, a biologists guide to principles and techniques of practical biochemistry, ELBS, London.
3. Nelson D and Cox MM. 2009. Principles of Biochemistry. W.H. Freeman and Company, New York.
4. Talaro K. P. and Talaro A. 2006. Foundations in Microbiology. McGraw-Hill College Dimensi.

14BT3004 MOLECULAR BIOLOGY LAB

Credits: 0:0:2

Course Objective:

- To train students to isolate, analyze, manipulate and amplify nucleic acids
- To get students familiarize with cDNA synthesis, gene cloning, expression and analysis of cloned genes.

Course Outcome:

- At the end of the lab session, students would have acquired the advanced skill necessary for isolating and analyzing nucleic acids from various sources
- The students would be able to carry out experiments in gene cloning, gene transfer and protein expression

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15BT3005 MICROBIAL TAXONOMY AND PHYLOGENY

Credits: 3:0:0

Course Objectives:

- To understand the ubiquitous nature of microbes and their organizational setup with huge amounts of available information.
- To make predictions and hypothesis based upon this information to classify, characterize and arrange organisms into groups which are essential for the identification of organisms.
- To understand the diversity of the microbial world.

Course Outcomes:

- Upon the completion of the course, students will have advanced knowledge on the microbial world.
- Students will understand the interaction of microorganism, their nutrition and growth in their different habitats.
- Students would understand the structure and physiology of bacteria and fungi.

Description: Introduction to microbiology - History and scope of microbiology, The study of microbial structure: Microscopy and specimen preparation, Prokaryotic and Eukaryotic Cell structure and function, Diversity of the microbial world - Microbial Taxonomy- Introduction to Molecular phylogeny – tree terminology, software programs for making phylogenetic trees – MEGA, Phylib, RAPDistance, The Archaea, Bacteria - Gram Positive and Gram Negative, Fungi, Algae, and Protozoa, Microbial nutrition, Growth and control of microorganisms by Physical and Chemical agents.

Reference Books:

1. Prescott LM, Harley JP, Klein DA, “Microbiology”, Wm. C. Brown Publishers, 3rd edition, 2001.
2. Pelczar MJ, Chan ECS & Krein NR, “Microbiology”, Tata McGraw Hill Edition, New Delhi, India, 2007.
3. Bhatia MS, Principles of Microbiology, Swastik Publishers, India, 2009.
4. Brendan Wren, Nick Dorrell Functional Microbial Genomics (Volume 33) (Methods in Microbiology), Academic Press, UK. 2002

15BT3006 MOLECULAR MICROBIOLOGY

Credits: 3:0:0

Course Objectives:

- To establish an understanding in the principles underlying molecular mechanisms related to medical and environmental microbiology.

Course Outcomes:

- At the end of this course, the students will acquire the knowledge to establish a broad coverage of modern aspects of molecular microbiology
- The students would understand the principles of relevant classical and modern molecular genetics tool.

Description: Introduction to molecular microbiology, Culture based and molecular detection of microbes, Microbial gene regulation, Metagenomics – Identification and characterization of non-cultivable microbes, Microbial advanced techniques – Cloning, Sequencing and Expression of genes, Microbial development – Molecular mechanism

Reference Books:

1. Wen-Tso Liu and Janet K Jansson. Environmental Molecular Microbiology, Publisher: Caister Academic Press, January 2010.
2. Diana Marco. Metagenomics: Theory, Methods and Applications, Publisher: Caister Academic Press, January 2010.
3. David H. Persing and Fred C. Tenover. Molecular Microbiology: Diagnostic Principles and Practice, 2010.

15BT3007 BACTERIOLOGY, MYCOLOGY AND PARASITOLOGY

Credits: 3:0:0

Course Objectives:
- To impart knowledge to the students on basic principles of clinical microbiology
- To develop a knowledge of microbial organisms and their relevance to infectious diseases
- To understand the principles of prevention and treatment of pathogenic microorganism infection in humans

Course Outcomes:
- At the end of this course, the students should be able to state the normal flora and infective microorganisms of the human body and describe the host-parasite relationship
- Students will list the pathogenic microorganisms, their general characteristics, mode of transmission and pathogenesis of the disease.
- Students would understand the principles of the laboratory tests in diagnosis and antimicrobial agents.

Description: Human microbiome: Commensal and pathogenic microbial flora of human body, host-microbe interactions, routes of transmission of microbes in the body, microbial toxins, Mode of action of antimicrobial agents, Nosocomial infections, Specimen collection and processing, Extracellular bacterial pathogens, bacterial enteric pathogens, Fungal classification: Cutaneous mycosis, Subcutaneous mycosis, Superficial mycosis, Systemic mycosis, Opportunistic mycosis, antifungal agents, Parasite classification: Intestinal and Urogenital protozoans, Sporozoa, Blood and Tissue protozoa and Nematodes.

Reference Books

1. Ananthanarayan,R, Jayaram Paniker, C.K., "Text Book of Microbiology", Universities Press (India) Pvt. Ltd. Hyderabad, 8th Edition. 2009.
2. Murray, P.R., K.S. Rosenthal, and M.A. Pfaller. "Medical Microbiology", Elsevier- Mosby, 6th Edition, 2009.
3. Subash Chandra Parija, "Textbook of Medical Parasitology", All India Publishers and Distributors, 2004
4. Jagdish Chander, "Text Book of Medical Mycology", Interprint/Mehta Publishers, 2005.

15BT3008 VIROLOGY

Credits: 3:0:0

Course Objectives:
- To impart knowledge on general properties of viruses, including morphology and classification
- To understand the viral cultural and assay techniques
- To know the pathogenicity of the human, animal and plant pathogenic viruses

Course Outcomes:
- The students will be familiar with the classification of the virus, viral genetics, pathogenicity, diagnosis and the control measures of various human, animal and plant pathogens.
- Students will recognize different group of antiviral drugs used for treatment of viral infections.

Description: Discovery, nomenclature, classification and general characteristics of viruses, Viral genome, their types and structures, Cultivation and purification of viruses, Assay of viruses: Physical and chemical methods, Viral pathogenesis and bacteriophages - human host defenses against viral infection. Organization and life cycle, Viral genetics, Human, animal and plant viral diseases, anti-viral and viral vaccines.

Reference Books:

1. Murray, P.R., K.S. Rosenthal, and M.A. Pfaller.. "Medical Microbiology", Elsevier-Mosby, 6th edition,2009,
2. Saravanan P., "Virology", MJP publishers, Chennai, 2006.
3. Ananthanarayan, R., Jayaram Panikar, C.K., "Text Book of Microbiology", Universities Press (India) Pvt. Ltd. Hyderabad, 8th Edition. 2009.
4. Fields B N, D.M. Knipe, P.M. Howley, R.M. Chanock, J.L. Melnick, T.P. Monath, B.Roizman, and S.E. Straus, "Virology", 3rd Edition. 2005.

15BT3009 MICROBIAL PHYSIOLOGY AND METABOLISM

Credits: 3:0:0

Course Objectives:

- To study the structure, function, energy metabolism, growth and regulatory mechanisms of microorganisms.
- To learn the microorganisms involved for metabolic processes common to all living things
- To emphasize the incredible metabolic diversity exhibited by microorganisms

Course Outcomes:

- Upon successful completion of this course, students will be able to understand the microbial growth and nutritional requirements.
- Studies will lead to develop a concept of integrative rules of biochemistry and genetics governing biological systems leading to the microbial physiology and metabolism.

Description: Nutritional categories of microorganisms based on carbon and energy sources, Metabolite transport, Microbial growth, batch and continuous culture, Physiological adaptations and intercellular signaling, Quorum sensing, Central metabolic pathways and regulation, bacterial photosynthesis and respiration, Nitrogen metabolism, Metabolism of lipids and hydrocarbons, Metabolism of nucleotides.

Reference Books:

1. Zubay G L. Biochemistry, Fourth Edition. Addison-Wesley Educational Publishers Inc., 2008.
2. Byung HK and Geoffrey MG Microbial Physiology and Metabolism. Cambridge University Press, 2008.
3. David White. The Physiology and Biochemistry of Prokaryotes. Second edition, Oxford University Press, 2000.
4. Moat A G., Foster J W., Spector M P. Microbial Physiology. Fourth edition, Wiley India Pvt Ltd., 2009.

15BT3010 MICROBIAL GENETICS

Credits: 3:0:0

Course Objectives:

- To make familiar with the concept of genetics in microbes.
- To learn the principle of genetic transfers and gene expression.

Course Outcomes:

- Upon the completion of the course, student can describe microbe DNA structurally and genetically.
- Student can have an understanding of mutagenesis and gene expression in microbes.

Description: Classical Mendelian genetics and deviation from Mendelian principles, DNA structure and mutagenesis, DNA replication, Types of mutation, DNA methylation and DNA repair mechanisms, Prokaryotic transcription and translation, Organization of transcriptional units and regulation of gene expression, Mechanism of transcription of prokaryotes, Regulation of gene expression in prokaryotes - Operon concept, Phage genetics and Applications of phages in microbial genetics, Fungal genetics: Yeast (*Saccharomyces cerevisiae*, *S. pombe*) and *Neurospora* genomes as model genetic systems.

Reference Books:

1. Stanley Maloy, John Cronan and David Freifelder. Microbial Genetics. Jones and Bartlett Publishers, 2003.
2. Edward A. Birge. Bacterial and Bacteriophage Genetics. Fourth edition, Springer; 2000.
3. Uldis N. Streips, Ronald E. Yasbin Modern Microbial Genetics, John Wiley and Sons, 2004

15BT3011 CLINICAL MICROBIOLOGY LAB

Credits: 0:0:2

Co-requisite: 15BT3007 Bacteriology, Mycology and Parasitology

Course Objectives:

- To demonstrate correctly proper procedures for the collection, safe handling and analysis of biological specimens.
- To utilize correctly the scientific principles, methods for identifying and clinical decision making for the identification of clinically significant microorganisms.

Course Outcomes:

- At the end of the lab session, the student will have knowledge, understanding and be able to evaluate the clinical significance of Microorganisms commonly recovered in Labs.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15BT3012 BIOSAFETY, BIOETHICS AND IPR

Credits: 3:0:0

Course Objective:

- To provides a broad coverage of three areas of patenting-intellectual property rights, biosafety and bioethics.
- To understand the biosafety and bioethical issues prevalent in modern society.

Course Outcomes:

- It creates awareness about the value of IPR in our lives and fosters a better understanding of the rights associated with IPR such as copyright, patent, trademarks, industrial designs, and geographical indications and so on.

Description: Biosafety issues –Biosafety management, Good Microbiological Techniques, safe laboratory techniques, safety issues in GMOs, Bioterrorism safety, responsibilities and rights: assessment of safety and risk - Three Mile Island and Chernobyl case studies. The Cartagena Protocol on Biosafety, Pesticide residues, Collegiality and loyalty - respect for authority - collective bargaining - confidentiality -conflicts of interest - occupational crime - professional rights - employee rights intellectual property rights and patenting: intellectual property rights (IPR) – essential elements of intellectual property rights, patents – requirements – types, copy rights, trademarks, trade secrets, need for protection of IPR and importance of IPR global issues: multinational corporations - environmental ethics - computer ethics – bio-weapons development - code of ethics.

Reference Books:

1. Charles D. Fleddermann, Engineering Ethics, Pearson Education / Prentice Hall, 2004.
2. Diane O. Fleming and Debra L. Hunt, Biological Safety: Principles and Practices, 2006.
3. Biosafety in Microbiological and Biomedical Laboratories (Manual) by Centers for Disease Control and Prevention, Public Health Service, 2010.
4. Deepa Goel and Shomini Parashar, IPR, Biosafety and Bioethics, First edition, Pearson publisher, 2013.

15BT3013 MARINE MICROBIOLOGY

Credits: 3:0:0

Course Objectives:

- To make familiar with the biological organization and the evolution of life in the world's oceans and seas.

Course Outcomes:

- Upon the completion of the course, students can describe different microbes present in the marine environment.
- Students would have an understanding of marine ecosystem and microbes in that niche.

Description: Microbes in the marine environment, Biological organization and the evolution of life, The world's oceans and seas, Chemical and physical factors in the marine environment, Metabolic diversity and the importance of microbial communities, Sampling and experimental approaches, specific staining procedures for Microscopy, study of cellular and sub-cellular organisation using Confocal Laser Scanning Microscopy, Flow Cytometry, Viable But Non Culturable, Rapid Amplified Polymeric DNA and Fluorescent Insitu Hybridization, Carbon cycling in the oceans, Photosynthesis and primary productivity, Eutrophication, Biofouling and bio-deterioration, indicator organisms and pollution control.

Reference Books:

1. Michael Pelczar Microbiology. Fifth edition, McGraw Hill Education (India) Pvt. Ltd, 2001.
2. James Cappuccino and Natalie Sherman. Microbiology- Lab manual, Tenth edition, Benjamin Cummings, 2013.
3. Ralph Mitchell and David L. Krichman. Microbial Ecology of the Oceans. Wiley-Blackwell, 2000.
4. Shinishon Belkin and Rita Colwell. Ocean & Health: Pathogens of the Marine Environment, Springer, 2010
5. Charles Meller and Patricia A. Wheeler. Biological Oceanography, Second edition, Wiley-Blackwell, 2012.

15BT3014 ENVIRONMENTAL MICROBIOLOGY

Credits: 3:0:0

Course Objectives:

- To learn the basic principles of environmental microbiology and be able to apply these principles to understand and solve problems in water quality and bioremediation.
- To become familiar with current research in environmental microbiology.

Course Outcomes:

- Upon completing the course, the student can competently explain various aspects of environmental microbiology.
- Describe how microorganisms impact public health and industry.

Description: Distribution and dispersal of microorganism in fresh water and terrestrial environments, Microbial aspects of air and water pollution; Microbial toxins in the environment, control devices for particulate and gaseous contaminants; pollution indicating microorganisms, Effluent treatment techniques - Microbiology of wastewater and solid waste treatment, Microbial leaching of metal ores, Bioremediation of Xenobiotics - Microbiology of degradation of xenobiotics in the environment-Global environmental problems - Ozone depletion, UV-B, green house effect and acid rain, their impact and biotechnological approaches for management.

Reference Books:

1. Atlas R.M. and R. Bartha, Microbial Ecology- "fundamentals and applications", Dorling Kindersley India Pvt. Ltd. New Delhi, 4th Edition 2007.
2. Das HK," Text book of biotechnology", Wiley India Pvt. Ltd., New Delhi,3rd Edition, 2007.
3. Karnely D. Chakrabarty K. Ovnen G.S. Biotechnology and Biodegradation, "Advances in Applied Biotechnology series", Vol. Gulf Publications Co. London, 2009.
4. Graty. C.P.L., Daigger, G and Lim, H.C, "Biological Wastewater Treatment". Marcel Dekker, 3rd Edition, 2008.
5. Jogdand, S.N. "Environmental Biotechnology", Himalaya Publishing House, New Delhi, 2007.

15BT3015 PHARMACEUTICAL MICROBIOLOGY

Credits: 3:0:0

Course Objectives:

- To develop a comprehensive understanding of the relevance and critical application of pharmaceutical microbiology to the pharmaceutical industry

Course Outcomes:

- The student will understand the mode of action of antimicrobial agents, pathogenicity and resistance to antibiotics

Description: Antibiotics and synthetic antimicrobial agents- antibacterial, antifungal, Mechanism of action of antibiotics- inhibitors of cell wall synthesis, nucleic acid and protein synthesis- Microbial production and spoilage of pharmaceuticals products (sterile injectables, ophthalmic preparations and implements) and their sterilization; Applications in Pharmaceuticals-Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers; Application of microbial enzymes in pharmaceuticals; Quality Assurance and Validation in pharmaceuticals- Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry; Regulatory aspects of quality control; Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification.

Reference Books:

1. Glick, B.R. and Pasternak, J.J. Molecular Biotechnology, ASM Press, 2004.
2. Stanbury, P.F., Whitaker, A. and Hall, S.J. Principles of Fermentation Technology, Second edition, Butterworth-Heinemann, 2006.
3. Hugo W.B. and Russell A.D. Pharmaceutical Microbiology, Sixth edition, Blackwell Scientific Publications, 2004.
4. Vyas S P and Dixit V.K. Pharmaceutical Biotechnology by. CBS Publishers and Distributors, New Delhi 2002.
5. Sydney H.Willig, Murray M.Tuckerman, William S.Hitchings IV, Good Manufacturing Practices for Pharmaceuticals Second Edition, by Mercel Dekker NC New York. 2000

15BT3016 ENTREPRENEURSHIP IN BIOTECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To understand the concept of entrepreneurship and schemes available.
- To know how to develop a business plan and financial plan.
- To learn and understand the market and develop a marketing strategy.

Course Outcomes:

- Upon the completion of the course, students will identify their talents and resources.
- Students will know about various schemes available both in the private and Govt. sectors for finance and capital.
- The course will kindle the business skills towards solving societal issues.

Description: Concept of entrepreneurship, Schemes of Government of India –DST, Nationalized banks, Finance companies – SIDBI, NSIC, NABARD, IDBI, IFCI, ICICI etc., Skills for Entrepreneurs, Business plan – Development, Market need – market research, SWOT analysis, identify your competition, Finance/Funding, Marketing - Distribution, Price, Promotion, and Set marketing goals. Business – Composting, Wastes (domestic, agricultural, industrial) and Vermiculture, SCP production –Plant tissue culture of Agri-horti crops, Mushroom cultivation, Production – Biofertilizers, Biopesticides, Teaching kits, Diagnostic kits and vaccines. Business development, Partnering/Licensing, Case studies – Biocon, Extend biosciences, Cygnet biofuels, Magazine study – The Scientist and Bioenterprenuer, Innovative start-ups, Translational researchers and Academic industry partnerships.

Reference Books:

1. Gianinazzi S, Schüepp H, Barea JM, Haselwandter K Mycorrhiza technology in agriculture : from genes to bioproducts Birkhäuser, Basel, Switzerland 2001
2. Subba Rao, N.S., Soil Microbiology. Oxford and IBH publishers, 2014
3. Totawat, K.L., L.L. Somani, R.A. Sharma and S.R. Maloo. Biofertilizer Technology. Agrotech Publishing Academy, Udaipur, Rajasthan, 2004
4. Martin Grossm, Entrepreneurship in Biotechnology, Physica-Verlag Co., 2003.

15BT3017 MARINE AND ENVIRONMENTAL MICROBIOLOGY LAB

Credits: 0:0:2

Co requisite: 15BT3014 Environmental Microbiology

Course Objective:

- To provide students hands on experience with traditional culture based techniques for enumerating and characterizing the activity of microbes in Marine and Environment.

Course Outcome:

- At the end of the lab session, students would be able to design and conduct sampling for microorganisms in marine and environment.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15BT3018 FOOD AND DAIRY MICROBIOLOGY

Credits: 3:0:0

Course Objectives:

- Knowledge of food safety and its scope in quality control of food, to understand the basic techniques involved in ensuring food quality and to know the quality of milk and milk products.

Course Outcomes:

- At the end of the course, the students will be familiar with the importance of microorganisms in foods, food spoilage and preservation and milk products.

Description: Microorganisms and their importance - Factors affecting growth of microorganisms- Food preservation and spoilage-Food borne infections and intoxications - Food fermentation, spoilage and defects-Laboratory testing procedures- Rapid methods for detection of microorganisms and toxins, Hazard Analysis and Critical Control Point (HACCP), Food Safety and Standards Authority of India (FSSAI), Food and Drug Administration (FDA) and Food and Agriculture Organization (FAO), common microbes in milk and their significance-Microbiological grading of raw milk-Processing techniques of milk-Microbiological quality of dairy products-Importance of biofilm and their role in transmission of pathogens in dairy products and preventive strategies.

Reference Books:

1. Frazier, W. C. and Westhoff, D. C., "Food Microbiology", Tata McGraw Hill Publishing Company Ltd. New Delhi, 4th Edition, 2008.
2. Adams, M. R. and Moss, M. O. "Food Microbiology", New Age International Pvt. Ltd, New Delhi, 2nd Edition, 2007.
3. Dubey.R.C and D.K.Maheswari, "A text book of Microbiology", S.Chand Publishers, New Delhi. Revised Multicolour edition, 2005.
4. Elmer H Marth and Steele, J. L. Applied Dairy Microbiology, 2nd Edition, Marcel Dekker, Inc. 270 Madison Avenue, New York, 2001
5. Rao M. K. Food And Dairy Microbiology, Manglam Publications, India 2007

15BT3019 SOIL AND AGRICULTURAL MICROBIOLOGY

Credits: 3:0:0

Course Objective:

- To understand the microbial association in soil.
- To study about various plant diseases and subsequent control.
- To apply bio-fertilizers and bio-control agents as a means for sustainable agriculture.

Course Outcomes:

- Upon the completion of the course, students would understand that soil also is a carved out niche for microbes.
- Students will know microbe-soil associations and plant disease-microbe interactions.
- Students will understand the use of bio-fertilizers and bio-control agents in agriculture.

Description: Distribution of microorganisms in soil, quantitative and qualitative estimation of microorganisms in soil, Role of microorganisms in soil fertility; influence of soil and environmental factors on microflora, moisture, pH, temperature, organic matter, agronomic practices etc.; Distribution of microorganisms in organic manure and composts; microorganisms in soil processes, Carbon cycle, Organic matter decomposition, Humus formation, Microbial interactions and association in Soil - Symbiosis, Asymbiosis, and Associate symbiosis among bacteria, actinomycetes, and cyanobacteria, R: S ratio Rhizoplane; Spermosphere; Phyllosphere microorganisms, Soil enzymes, Nitrogen fixation, Mycorrhiza – Ecto and Endo, Bio-control agents, Plant pathology – Bacterial, Fungal and Viral diseases, Plant defense/Protection mechanisms – Phytoalexins and Salicyclic acid.

Reference Books:

1. Atlas R.M. and R. Bartha, Microbial Ecology- “fundamentals and applications”, Dorling Kindersley India Pvt. Ltd. New Delhi, 4th Edition 2007.
2. Subba Rao, N.S., Soil Microbiology. Oxford and IBH publishers, 2014
3. Selma A. Waksman, Principles of Soil Microbiology, John Wiley and Sons, Inc.2009.

15BT3020 INDUSTRIAL MICROBIOLOGY

Credits: 3:0:0

Course Objectives:

- To develop skills of the students in the area of strain selection and production of fermented products.

Course Outcomes:

- At the end of the course, the students would have learnt fermentation processes, medium optimization, and production processes of industrially important products.

Description: History and development of fermentation- Screening techniques- detection and assay of fermentation products - strain development - preservation and inoculum preparation - Strain improvement - Media for industrial fermentations - Growth kinetics of microorganisms - Batch fermentation - Fed batch fermentation - Continuous fermentation - Fermentation of Microbial products **-** Enzymes – amylase and protease - Organic acids – citric acid, acetic acid and lactic acid - Vitamins – B12 and riboflavin - Amino acids - glutamic acid and lysine - Alcoholic fermentation – Beer and Wine - Antibiotic fermentation – Penicillin and Streptomycin - Microbial transformation- Single cell proteins

Reference Books:

1. Wulf Crueger and Anneliese Crueger, Biotechnology- “A Text Book of Industrial Microbiology”, Panima Publishing Corporation, New Delhi, 3rd Edition 2005.
2. Stanbury P F, Stephen J. Hall & A. Whitaker, “Principles of Fermentation Technology”, Second Edition, Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2005.
3. Patel A.H, “Industrial Microbiology", Macmillan India Limited, New Delhi, 2007.
4. Shuler, M.L. and Kargi,F. “Bioprocess Engineering “- Basic concepts – Second Edition Prentice Hall of India Pvt. Ltd., 2002.
5. Casida, L.E “Industrial Microbiology”, New age International Private Limited, New Delhi, 2005.

15BT3021 BIOMASS, BIOENERGY AND BIOFUELS

Credits: 3:0:0

Course Objective:

- To provide a thorough understanding of various renewable feedstocks, their availability and attributes for biofuel production
- To provide students with tools and knowledge necessary for biofuel facility operations.
- To teach the students to analyze and design processes for biofuel production.

Course Outcome:

At the end of the course, the student would understand the broad concept of second and third generation biofuel production from biomass and other low-cost agricultural residues and biowastes.

Description: Fundamental concepts in understanding biofuel/bioenergy; renewable feedstocks, their production, availability and attributes for biofuel / bioenergy production; Microbial fuel cells, types of biomass-derived fuels and energy; thermochemical conversion of biomass to heat, power, and fuel; biochemical conversion of biomass to fuel ; biodiesel production; environmental impacts of biofuel production; economics and life-cycle analysis of biofuel; value-added processing of biofuel residues.

Reference Books:

1. Robert C. Brown, Biorenewable Resources: Engineering New Products from Agriculture. Wiley-Black well Publishing, 2003.
2. Samir K. Khanal, Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. Wiley-Blackwell Publishing, 2008.
3. Samir K. Khanal, Rao Y. Surampalli, Tian C. Zhang, Buddhi P. Lamsal, R. D. Tyagi, and C. M. Kao. Bioenergy and Biofuel from Biowastes and Biomass, ASCE publisher, 2010.

15BT3022 FOOD AND AGRICULTURAL MICROBIOLOGY LAB

Credits: 0:0:2

Co requisite: 15BT3019 - Soil and Agricultural Microbiology

Course Objective:

- To correctly use appropriate lab techniques and analyze results for routine microbiological analyses of foods.
- To become familiar with analyses used commonly in the food industry and agriculture.

Course Outcome:

- Correctly predict the types and levels of organisms commonly occurring in different foods and agricultural lands.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15BT3023 PLANT AND ANIMAL TISSUE CULTURE

Credits: 3:0:0

Course Objectives:

- To know techniques in plant cell and tissue culture, *in vitro* conservation, protoplast culture, micropropagation and genetic engineering.
- Know the differences between primary vs continuous culture, normal cells vs transformed cells, monolayer vs suspension culture.

Course Outcomes:

- At the end of the course, the students will be able to understand the advantages of *in vitro* propagation in various areas.
- Know various components of plant tissue culture media, e.g. minerals, growth factors, hormones, and what governs the choice of components, perform some of the more advanced techniques

Description: Plant cell and tissue culture**:** Tissue culture media (composition and preparation), Callus and suspension culture; Somaclonal variation; Micropropagation; Organogenesis; Somatic embryogenesis; transfer and establishment of whole plants in soil; green house technology; Artificial seeds. Protoplast fusion and somatic hybridization; anther, pollen and ovary culture for production of haploid plants; Plant secondary metabolites**-** control mechanisms and manipulation of phenyl proponoid pathway, shikimate pathway; alkaloids; Animal cell culture: Laboratory design, equipments, Aseptic conditions, chemically defined and serum free media, animal cell cultures, their maintenance and preservation; various types of cultures- Primary culture, Secondary culture, cell lines, organ culture, cell cultures as a source of valuable products (TPA, Blood Factor VIII, Erythropoietin); Micromanipulation technology, enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; *in vitro* fertilization and embryo transfer.

Reference Books:

1. Dubay.R.C, "A Text Book of Biotechnology", S.Chand & Company Ltd, 2001,
2. Glick and Pasternak, "Molecular Biotechnology", 2001.
3. Pelengaris and Michael Khan, "The Molecular Biology of Cancer", Blackwell Publishers, 2006.
4. Purohit S.S. Plant tissue culture, Student edition, 2009.
5. Robert G. McKinnell, Ralph E. Parchment, Alan O. Perantoni, G. Barry Pierce, "The Biological Basis of Cancer", Cambridge University Press, New York, 2003.

15BT3024 MICROBIAL NANOTECHNOLOGY

Credits: 3:0:0

Course Objectives:

- To understand the concept of nanoscience.
- To know how to develop applications in biomaterials using nanotechnology.
- To learn and understand the drug development and medical applications.

Course Outcomes:

- Upon the completion of the course, students will know their role in the manufacture of nanomaterials.
- Students will know about various tools used in nanotechnology Research.
- Students will understand the surge of nanotechnology in drug development and green technology with its ethical issues and acceptance of it in the Society.

Description: Evolution of Nano science, Factors affecting the manufacturing process of Nanomaterials – Role of physicists, chemists, medical doctors, engineers, biologists and computer scientists in nanotechnology. Types of nanomaterials - synthesis and characterization of nanoscale materials; Top down and Bottom up approaches; Microbial synthesis of nanomaterials – Silver, Gold, Platinum, CdS, ZnO, Se, Titanium, etc; Characteristics and application of quantum dots, fullernes and CNTs. Important tools used in Nanotechnology - Spectroscopy and Microscopy, Nanospectra biosciences, Nanoprobes for nucleic and hybridization detection, Nucleophillic Carbenes, Drug solubilization and drug delivery, Diagnosis using nanomaterials, Cancer treatment, Green Technology, Nanocarbon ball as deodorizer in fermentation, Nano-Biomotors, Nanoscience in India, Ethics and society.

Reference Books:

1. Richard Brooker and Earl Boysen. Nanotechnology. Wiley Publishing Inc., India.2006.
2. Subbiah Balaji. Nanobiotechnology, MJP Publishers 2010.
3. Niemeyer C M, C. A. Mirkin. Nanobiotechnology: Concepts, Applications and Perspectives, Wiley – VCH. 2004
4. David S. Goodsell. “Bionanotechnology”, John Wiley and Sons, 2004
5. Pradeep T. Nano: The Essentials, McGraw – Hill education, 2008

15BT3025 PHARMACEUTICAL AND INDUSTRIAL MICROBIOLOGY LAB

Credits: 0:0:2

Co- requisite: 15BT3020- Industrial Microbiology

Course Objectives:

- To describe the main steps and processes used to produce biological products in Pharmaceutical industry.
- To understand ethical issues in production microbiology, such as standards of laboratory and in-plant behaviour and etiquette

Course Outcome:

- After the lab the student will be able to perform microbiological investigations, observe and evaluate the data obtained, and report the findings accurately and precisely

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

LIST OF SUBJECTS

Subject Code	Name of the Subject	Credits
14BT2001	Basics of Biochemistry	3:1:0
14BT2002	Biochemistry Lab	0:0:2
14BT2003	Principles of Chemical Engineering	3:0:0
14BT2004	Cell Biology	3:0:0
14BT2005	Microbiology	3:0:0
14BT2006	Microbiology Lab	0:0:2
14BT2007	Basic Industrial Biotechnology	3:0:0
14BT2008	Metabolism and Bioenergetics	3:1:0
14BT2009	Bioprocess Principles	3:0:0
14BT2010	Bioprocess Lab	0:0:2
14BT2011	Molecular Biology	3:0:0
14BT2012	Genetic Engineering and Bioethics	3:0:0
14BT2013	Molecular Biology and Genetic Engineering Lab	0:0:2
14BT2014	Bioorganic Principles	3:0:0
14BT2015	Bioreactor Engineering	3:0:0
14BT2016	Enzyme Engineering	3:0:0
14BT2017	Immunology	3:0:0
14BT2018	Cell Biology and Immunology Lab	0:0:2
14BT2019	Chemical Reaction Engineering	3:0:0
14BT2020	Downstream Processing	3:0:0
14BT2021	Downstream Processing Lab	0:0:2
14BT2022	Unit Operations	3:0:0
14BT2023	Animal and Plant Biotechnology	3:0:0
14BT2024	Plant physiology and Crop Improvement	3:0:0
14BT2025	Plant Tissue Culture	3:0:0
14BT2026	Plant Microbe Interactions	3:0:0
14BT2027	Molecular Plant Pathology and Entomology	3:0:0
14BT2028	Molecular Plant Breeding	3:0:0
14BT2029	Biotechnology of Biotic and Abiotic Stress Tolerance	3:0:0
14BT2030	Entrepreneurial Agriculture and Biomass Energy	3:0:0
14BT2031	Horticultural Crop Production, Management and Green House Technology	3:0:0
14BT2032	Food and Nutrition Security of GM Crops	3:0:0
14BT2033	Post-Harvest Technology	3:0:0
14BT2034	Mechanization and Post-Harvest Technology Lab	0:0:2
14BT2035	Gene Manipulation lab	0:0:2
14BT2036	Plant Breeding and Crop Management Lab	0:0:2
14BT2037	Developmental Biology	3:0:0
14BT2038	Human Genetics and Genomics	3:0:0
14BT2039	Vaccine Biotechnology	3:0:0
14BT2040	Animal Biotechnology and Cell Culture Techniques	3:0:0
14BT2041	Molecular Forensics	3:0:0
14BT2042	Stem Cell Technology	3:0:0
14BT2043	Human Physiology	3:0:0
14BT2044	Cancer Biology	3:0:0
14BT2045	Biopharmaceutical Technology	3:0:0
14BT2046	Research Methodology	3:0:0
14BT2047	Biochemical Engineering	3:0:0
14BT2048	Metabolic Engineering	3:0:0
14BT2049	Process Equipment Design	3:0:0
14BT2050	Process Control Engineering	3:0:0

14BT2051	Pilot plant & Scale Up practice	3:0:0
14BT2052	Industrial Safety and Hazard Analysis	3:0:0
14BT2053	Industrial Effluent Treatment	3:0:0
14BT2054	Bioenergy and Biomaterials	3:0:0
14BT2055	Pollution Control and Engineering	3:0:0
14BT2056	Entrepreneurship	3:0:0
14BT2057	Mechanical Operation Lab	0:0:2
14BT2058	Process Control Lab	0:0:2
14BT2059	Cell Biology and Microbiology	3:0:0
14BT2060	Cell Biology and Microbiology Lab	0:0:2
14BT3001	Applied Biochemistry	3:0:0
14BT3002	Analytical Techniques and Biochemistry Lab	0:0:2
14BT3003	Advanced Bioprocess Engineering	3:0:0
14BT3004	Bioprocess Engineering and Downstream Processing Lab	0:0:2
14BT3005	Computational Biology	3:0:0
14BT3006	Advances in Recombinant DNA Technology	3:0:0
14BT3007	Recombinant DNA Technology Lab	0:0:2
14BT3008	Biopharmaceutical Technology	3:0:0
14BT3009	Advanced Process Equipment Design	2:0:0
14BT3010	Process Equipment Drawing Lab	0:0:2
14BT3011	Sustainable Bioprocess Development	3:0:0
14BT3012	Advanced Environmental Biotechnology	3:0:0
14BT3013	Entrepreneurship, IPR and Biosafety	2:0:0
14BT3014	Research Methodology	2:0:0
14BT3015	Industrial Safety	3:0:0
14BT3016	Enzyme Technology and Industrial Applications	3:0:0
14BT3017	Advanced Bioreactor Engineering	3:0:0
14BT3018	Chemical Process Technology	3:0:0
14BT3019	Chemical and Biochemical Engineering Lab	0:0:4
14BT3020	Immunotechnology	3:0:0
14BT3021	Microbial Pathogenesis	3:0:0
14BT3022	Clinical Trials and Bioethics	3:0:0
14BT3023	Advanced Animal Biotechnology & Tissue culture	3:0:0
14BT3024	Immunotechnology & Clinical Biotechnology Lab	0:0:4
14BT3025	Advanced Plant Biotechnology & Tissue culture	3:0:0
14BT3026	Human Anatomy and Physiology	3:0:0
14BT3027	Biomaterials	3:0:0
14BT3028	Biology for Nanotechnology	3:0:0
14BT3029	Nanobiotechnology	3:0:0
14BT3030	Experimental Techniques for Nanobiotechnology	0:0:2

14BT2001 BASICS OF BIOCHEMISTRY

Credits: 3:1:0

Course Objective:

- To ensure students to having strong foundation in structure, composition and function of various biomolecules.
- To apply these fundamentals in biotechnology

Course Outcome:

- At the end of the semester the students be able to understand the structure and function of biomolecules
- By understanding the biomolecules, they obtain knowledge to continue other advanced courses including metabolism and bioenergetics, Molecular Biology, Enzyme Engineering, Genetic Engineering.

Description: Biomolecules - structure, properties and functions of carbohydrates: monosaccharides –Glucose, fructose, mannose, Galactose, Isomers, Disaccharides – Sucrose, Lactose, Maltose. Homopolysaccharides – starch, cellulose. Heteropolysaccharides – Hyaluronic acid, chondroitin sulphate, Heparin. Fatty acids and lipids: essential fatty acids, structure, properties and functions of lipids. Amino acids and proteins: structures and classification of aminoacids and classification and functions of proteins, Peptide bond. Nucleotides and nucleic acids, Essential vitamins and minerals: classification and function.

References Books

1. Jain and Jain "Biochemistry", Chand publication, 2008.
2. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005
3. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.
4. Lubert Stryer, "Biochemistry", WH Freeman & Co., 4th edition, 2000.
5. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013

14BT2002 BIOCHEMISTRY LAB

Credits: 0:0:2

Co-requisite: 14BT2001-Basics of Biochemistry

Course Objective:

- The lab aims to develop the skills in biochemical analysis
- To develop the skills of the students in Qualitative and Quantitative Analysis of biomolecules.

Course Outcome:

- At the end of lab course, the student be able to quantify the biochemical molecules.
- The students equip themselves with the basic biochemical tools and standard operation procedures.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2003 PRINCIPLES OF CHEMICAL ENGINEERING

Credits: 3:0:0

Course Objective:

- To develop skills of students in principles and basic calculations
- To familiarize in the area of material balance for non-reactive systems and simple reactive systems, energy balance for non-reactive systems and simple reactive systems in chemical process engineering.
- This is a pre-requisite for 14BT2019 on Chemical reaction Engineering.

Course Outcomes:
On completion of this subject students are able to,

- Perform units conversion and basic calculations
- Understand the laws of conservation of mass and energy
- Perform a general mass and energy balances calculations for various unit operations in reactive and non-reactive systems.

Description: Basic units, units systems, derived units, force, pressure, work, heat, Conversion factors to SI units, Molarity, molality and normality, gas laws – Amagat's law and Daltons law , material balance for evaporation, filtration, drying, stoichiometry, limiting & excess reactants, fractional conversion, yield, Elements of energy balance calculations, procedure for energy balance calculations, Hess's law.

Reference Books:

1. Felder, R.M., Rousseau R.W., "Elementary Principle of Chemical Processes", John Wiley and Sons Publication 3rd edition, 2000.
2. BI Bhatt & SM Vora "Stoichiometry", Tata Mcgraw- Hill, 4th edition, 2004.
3. Himmelblue, D. M. "Basic Principles and Calculations in Chemical Engineering", Prentice Hall Publication 4th edition, 2004.
4. Venkataramani.V and Anantharaman.A., "Process Calculations", PHI learning Pvt. Ltd, 2003.

14BT2004 CELL BIOLOGY

Credits: 3:0:0
Course Objective:

- To acquaint students with the concepts in Cell Biology.
- To understand structure and function of the organelles of cells
- This is a pre-requisite for courses 14BT2011- Molecular Biology, 14BT2017- Immunology.

Course Outcome:

- Students be familiar with the concepts in cell biology.
- Students be familiar with the cell signaling pathways.
- Students acquire fundamentals that will enable them apply in cell based research.

Description: Structure of Prokaryotic and Eukaryotic cells, Cell organelles, cell cycle and regulation, cytoskeleton, Cell- cell communication, active and passive transport, pumps and gated channels, Endocytosis, Exocytosis, protein glycosylation in eukaryotes, Entry of viruses and toxins into the cell, signaling molecules and their receptors, signal transduction, phosphorylation and regulation in signaling

Reference Books

1. Geoffrey M. Cooper and Robert E. Hausman, "The Cell: A Molecular Approach", ASM Press and Sinauer Associates, Inc., USA, 5th edition, 2009.
2. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, "Molecular Biology of the cell", Taylor and Francis group, 5th edition, 2007.
3. Kimball T.W., "Cell Biology", Wesley Publishers, 3rd Edition, 2007.
4. De Robertis & De Robertis, "Cell Biology", saunders,4th Edition, 2006.
5. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell, "Molecular Biology of the Cell", New York, 5th edition, 2005.

14BT2005 MICROBIOLOGY

Credits: 3:0:0

Course Objective:

- To impart knowledge on classification and structure of microbes,

- To learn the nutrition and control of microorganisms.
- This is a pre-requisite for courses 14BT2011- Molecular Biology.

Course Outcome:

- At the end of the course, the students are familiar with the classification, economic importance and control of microorganisms.
- The students acquire knowledge on multiplication of prokaryotic and eukaryotic microorganisms
- Students understand the interaction of microorganism with environment and food.

Description: Basics of microbial existence, History of microbiology, classification and nomenclature of microorganisms; Types of microscopes, Principles and types of stains, microbial nutrition, growth curve and control of microorganisms by sterilization methods, Structural organization and multiplication of prokaryotic and eukaryotic microorganisms, food, agricultural and environmental microbiology.

Reference Books

1. Pelczar MJ, Chan ECS & Krein NR, “Microbiology”, Tata McGraw Hill Edition, NewDelhi, India, 2007
2. Prescott LM, Harley JP, Klein DA, “Microbiology”, Wm. C. Brown Publishers,3rd edition,2001.

14BT2006 MICROBIOLOGY LAB

Credits: 0:0:2

Co-requisite: 14BT2005- Microbiology

Course Objective:

- Students will be taught the parts of microscopes and the functions.
- The students will learn to identify the microorganisms using various staining techniques and biochemical tests.
- The students will learn about the enumeration of microorganisms.

Course Outcome:

- At the end of the course, students get equipped with all basic techniques to identify microorganisms,
- The students learn to enumerate the microorganisms and purification of microorganisms.
- The students analyze the microbiological quality of milk and water.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2007 BASIC INDUSTRIAL BIOTECHNOLOGY

Credits: 3:0:0

Pre-requisite: 14BT2005 Microbiology

Course Objective:

- To impart the knowledge on historical overview of Biotechnology.
- To learn the production of some commercially important bioproducts, Industrial Enzymes, products of plant
- The students will learn animal cell cultures and production of recombinant proteins.

Course Outcome:

At the end of the course, the students know,

- The steps involved in the production of primary and secondary metabolites
- The process of production of enzymes, bioproducts, biopesticides
- The steps involved in the production of SCP and some biotechnological products.

Description: Traditional and modern biotechnology, Process flow sheet, Production of primary metabolites- Citric acid, lysine and ethanol. Production of secondary metabolites- penicillin, streptomycin, production of vitamins- Vit.B12, Production of enzymes- amylases, Production of biopesticides, Biopreservatives, Biopolymers, xanthan gum, PHB and Single cell protein and other bioproducts, modern biotechnology products

Reference Books

1. Casida L.E., “Industrial Microbiology”, New Age International (P) Ltd., 2000.
2. Wulf Cruger and Anneliese Crueger, “Biotechnology: A Textbook of Industrial Microbiology”, Panima Publishing Corporation. 2003.
3. Randolph Norris Shreve and George T. Austin, “Shreves chemical Process Industries”, Mc Graw Hill professional, 2000.
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, “Principles of Fermentation Technology”, Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005

14BT2008 METABOLISM AND BIOENERGETICS

Credits: 3:1:0

Pre-requisite: 14BT2001 Basics of Biochemistry

Course Objective:

- To learn the metabolic pathways and their regulations
- To learn the importance of bioenergetics
- To understand the inborn errors of metabolism.

Course Outcome:

- At the end of the course, the students learn various metabolic pathways and regulations.
- The students acquire basic knowledge in bioenergetics.
- Students understand the biodegradation of biomolecules.

Description: Metabolism of carbohydrates- Glycolysis, Pentose phosphate pathway, Glycogenesis and Glycogenolysis; Glycogen storage diseases. Metabolism of amino acids and proteins: transamination and urea cycle. Biodegradation of selected amino acids- Ala, Thr, Leu, Ile, Tyr, Phe, Trp. Biosynthesis of amino acids and inborn errors of amino acid metabolism, Metabolism of lipids- Biosynthesis and oxidation of fatty acids and cholesterol, inborn errors of lipid metabolism, metabolism of nucleotides, inborn errors of nucleotide metabolism, Respiratory chain and Oxidative phosphorylation.

Reference Books

1. Lehninger, David L. Nelson & Michael M. Cox, “Principles of Biochemistry”, Freeman Publishers,4th edition, 2005.
2. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 2008.
3. Lubert Stryer, “Biochemistry”, WH Freeman & Co., 4th edition, 2000.
4. Voet and Voet, “Biochemistry”, John Wiley & Sons Inc., 2nd Edition, 2013.

14BT2009 BIOPROCESS PRINCIPLES

Credits: 3:0:0

Pre-requisite: 14BT2007 Basic Industrial Biotechnology

Course Objective:

- To understand the principles of bioprocessing and appreciate its applications in Bioprocess Technology

- To understand the importance of medium formulations and optimization
- This is a pre-requisite for courses 14BT2015- Bioreactor Engineering, 14BT2020- Downstream processing.

Course Outcome:
At the end of the course, the students learn:
- Fermentation processes, fermenter, medium formulation and optimization, inoculum development etc.
- The methods of designing sterilization time and kinetics of death of microbes
- The Methods of media design and optimization to improve the product yield.

Description: Overview of fermentation processes, Basic configuration of fermentor, Aseptic condition and containment, Sampling, Raw materials and media design for fermentation process, media optimization – Plackett burmann Method, Sterilization kinetics, Design of sterilization time, design of sterilization equipments, Filter sterilization of air and medium, Development of inoculum for industrial fermentation, Metabolic stoichiometry, Yield coefficients, Elemental balance and Degrees of reduction.

Reference Book
1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
2. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2002

14BT2010 BIOPROCESS LAB

Credits: 0:0:2

Co-requisite: 14BT2009- Bioprocess Principles

Course Objective:
- To learn the culturing of microbes and quantifying biomass production
- To study enzyme kinetics
- To learn immobilization techniques

Course Outcome:
- At the end of the course, the students are knowledgeable in the principles involved in bioprocessing.
- The students know the factors affecting enzyme activity and quantification of enzymes.
- The student are able to produce fermented products.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2011 MOLECULAR BIOLOGY

Credits: 3:0:0

Pre-requisite: 14BT2005 Microbiology

Course Objective:
- To understand the basics of molecular biology and gene expression.
- To study the regulation of gene expression
- This is a pre-requisite for courses 14BT2012- Genetic Engineering and 14BT2017-Immunology.

Course Outcome:
- Students understand the fundamental idea on replication, transcription and translation.
- Student understand the process of gene regulation
- Students are familiar with DNA repair mechanisms.

Description: Experiments (Griffith, Avery & McLeod, Herchey Chase), Bacterial recombinations, DNA replication in prokaryotes and eukaryotes, Mutation-types, DNA repair, Prokaryotic and eukaryotic transcription, Post-transcriptional modification, Genetic code, Translation in prokaryotes and eukaryotes, Post-translational modifications, Regulation of gene expression: In prokaryotes - lac and trp operons. Regulation in eukaryotes – *cis* and *trans* elements, chromatin in gene regulation.

Reference books

1. David Friefelder, "Molecular Biology", Narosa Publ. House. 2003
2. David R.Hyde, "Genetic and Molecular Biology", Tata McGraw Publications, New Delhi, 2010.

14BT2012 GENETIC ENGINEERING AND BIOETHICS

Credits: 3:0:0

Pre-requisite: 14BT2011 Molecular Biology

Course Objective:

- To provide basic knowledge on the tools used in gene cloning.
- To provide the theoretical background on cloning a gene and to express it in both prokaryotic and eukaryotic systems and the methods to purify the expressed protein
- To impart the importance of ethics in the field of biotechnology.

Course Outcome:

At the end of the semester the students learn:

- Recombinant DNA technology, generation of genomic library and cDNA library.
- To clone and express genes and purify the resultant protein product.
- The basic concepts of bioethics.

Description: Gene cloning- enzymes, vectors, cloning strategy- steps, libraries & screening techniques, Polymerase chain reaction- principle and types, gene expression in prokaryotic and eukaryotic system, techniques to generate fusion proteins to aid in purification, methods of purification of recombinant proteins, Transgenic plants and animals, Knockout mice, bioethics and biosafety.

Reference Books

1. T. A. Brown, "Gene Cloning and DNA Analysis: An Introduction", 6^{th} edition, Wiley-Blackwell, 2010.
2. Old R.W.Primrose SB, "Principles of Gene Manipulation, An Introduction to Genetic Engineering", Backwell Scientific Publications, 2003.
3. Dubey R. C, "Text book of Biotechnology", S. Chand & Co. Publications, 2006.
4. Monika Jain "Recombinant DNA Techniques", Narosa Publishing House, 2012.
5. Doug Erlandson, "Bioethics Basics: A Jargon-Free Guide for Beginners" [Kindle Edition]
6. Roberta M. Berry, "The Ethics of Genetic Engineering", Routledge Reissue edition 2007.

14BT2013 MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB

Credits: 0:0:2

Course Objective:

- To learn basic techniques in molecular biology and genetic engineering
- To isolate and analyze DNA qualitatively and quantitatively

Course Outcome:

- At the end of the lab session, the student get knowledge in isolation of DNA from various sources

- The student are able to carry out analysis of DNA through restriction, ligation, electrophoresis
- The students are able to perform transformation.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2014 BIOORGANIC PRINCIPLES

Credits: 3:0:0

Pre-requisite: 14BT2001 Basics of Biochemistry

Course Objective:
- The course aims to develop skills of students to integrate biochemistry and organic chemistry.
- Student can be able to study the biological process using chemical methods.
- Develop knowledge in enzyme catalyzed chemical reactions.

Course Outcome:
- At the end of the course, the students are able to understand the chemical transformations that take place in biology.
- Student understand the various mechanism of biochemical reaction.
- Students understand the chemical route of enzyme catalysed reactions.

Description: Isomerism in organic chemistry, molecular asymmetry in organic chemistry, reaction mechanisms in organic chemistry - types of organic reactions- nucleophilic substitution and elimination reactions, homolytic and heterolytic fissions, mechanisms in chemical and enzyme catalysis, Stereospecificity of enzyme catalysis, Case studies of enzyme structure and mechanism and enzyme catalysed hydrolysis in chemical synthesis, Co-enzyme dependent reaction mechanisms

Reference Books

1. Trevor Palmer, "Enzymes: Biochemistry, Biotechnology, Clinical chemistry", Affiliated East-West Press Pvt. Ltd, New Delhi, 2004
2. Harish K. Chopra, Anupama Parmar and Parmjt S. Panesar, "Bio-Organic chemistry", Narosa Publishing House, New Delhi, 2013
3. Nelson, D. L. and Cox, M. M, "Lehninger's Principles of Biochemistry", Freeman Publishers, New York, 4th edition, 2008.
4. I. L. Finar, "Organic Chemistry", Pearson Education Publishing, Vol.2, 5th edition, 2007.
5. PL. Soni and HM. Chawla, "Text book of Organic Chemistry" , Sultan Chand & Sons, New Delhi, 2004.

14BT2015 BIOREACTOR ENGINEERING

Credits: 3:0:0

Pre-requisite: 14BT2009 Bioprocess Principles

Course Objective:
- This course aims at making the students understand the fundamental principles and concepts of Bioreactor engineering.
- This will help the student understand stoichiometric calculations, models of growth and product formation
- This is a pre-requisite for courses 14BT2020- Downstream Processing.

Course Outcome:
At the end of this course, the students learn:
- The principles of stoichiometry, kinetics of microbial growth and product formation
- Transport phenomenon and oxygen transfer in microbial bioreactors.

- Types of microbial bioreactors and parameters monitored during fermentation process

Description: Metabolic stoichiometry, kinetics of microbial growth, substrate uptake and product formation- monod model, leudeking-piret models, oxygen transfer in microbial bioreactors, volumetric mass transfer coefficient, microbial bioreactors - chemostat, air lift loop reactor, packed bed, fluidized bed bioreactors, mode of operation of bioreactors, parameters to be monitored and controlled during fermentation process.

Reference Books

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2005.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
3. Lee, J.M, "Biochemical Engineering", 1st Edition, Prentice Hall, 2001
4. Blanch, H.W and Clark, D.S, "Biochemical engineering", Marcel Dekker, 1997

14BT2016 ENZYME ENGINEERING

Credits: 3:0:0

Pre-requisite: 14BT2009 Bioprocess Principles

Course Objective:

- To develop skills of the students in the area of Enzyme Engineering
- To study various methods of immobilization
- This is a pre-requisite for courses on Molecular Biology offered in the subsequent semesters

Course Outcome:

At the end of the course, the students learn,

- classification of enzymes, enzyme specificity and mechanism of enzyme action
- Immobilization techniques, extraction procedures and purification steps involved in separation of enzymes
- Applications and working of biosensors.

Description: Classification of enzymes; mechanisms of enzyme action, specificity of enzyme action, kinetics of enzyme action, types of inhibition & models –substrate, product and toxic compound, extraction and purification of crude enzyme extracts from plant, animal and microbial sources, characterization methods, enzyme immobilization-types, biosensors – types and application .

Reference Books

1. T Palmer, "Enzymes", Horwood Publishing Series, 2001.
2. Martin Chaplin and Christopher Bucke, "Text book on Enzyme Technology", Cambridge University Press, 2004.
3. Shuler, M.L. and Kargi,F, " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd., 2nd edition, 2002.

14BT2017 IMMUNOLOGY

Credits: 3:0:0

Pre-requisite: 14BT2011 Molecular Biology

Course Objective:

- To understand the fundamental principles and concepts of immune system.
- To learn Immunotechniques

Course Outcome:

- At the end of the course the student learn the mechanisms by which human systems interacts with pathogenic microbes & eliminates it.
- Students learn basics of immunology and techniques associated with immunology.
- Students are familiar with immunopathology and immunotherapy.

Description: Introduction to Immune System- Cells of immune system, types, Lymphoid organs, Antigens, Antibodies, Clonal selection, T and B cell development, Antigen-Antibody reaction, MHC, Antigen presentation, Complement, Hypersensitivity, Vaccines, Transplantation, Tumor immunology, Auto immune disorders, Monoclonal and Polyclonal antibodies, ELISA, RIA, Western blotting and Immunohistochemistry.

Reference Books

1. Tizard, "Immunology", Saunders college publication, 5th Edition. 2004.
2. Harwey RA, "Immunology", 2nd Ed. Lippincott Publishers, 2013.
3. Owen J, Punt J , Stanford S, "Kuby Immunology", WH Freeman & Co., 2013.
4. Ashim K. Chakravarthy, "Immunology", TataMcGraw-Hill, 2006.

14BT2018 CELL BIOLOGY AND IMMUNOLOGY LAB

Credits: 0:0:2

Co-requisite: 14BT2017 Immunology

Course Objective:

- To acquaint the students with basic cell biology and immunology laboratory techniques.
- To study antigen antibody interaction.
- To study cell types and staining techniques.

Course Outcome:

- The students get familiarized with basic cell biology techniques.
- The students learn immunological techniques.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2019 CHEMICAL REACTION ENGINEERING

Credits: 3:0:0

Pre-requisite: 14BT2003 Principles of Chemical Engineering

Course Objective:

- This course aims at making the students understand the fundamental principles and concepts of chemical reaction engineering.
- The students will learn about RTD and measurement
- The students will study the design equations for various bioreactors

Course Outcome:

At the end of this course, the students would learn,

- The principles in chemical reaction kinetics, Ideal reactors, non-ideal flow.
- The concepts of RTD
- About gas solid and gas liquid reactions

Description: Classification of chemical reactions, reaction rate, temperature dependency term of a rate equation, performance equations for zeroth order, first order, second order and third order , design equation for steady state batch reactors, CSTR and plug flow reactor, RTD and measurements, Pulse input experiment- C curve, E curve, Step input Experiment-F curve, Tanks-in-series model, Gas solid and gas liquid reactions.

Reference Book

1. Octave Levenspiel, “Chemical Reaction Engineering”, John Wiley, 3rd edition, 2006.
2. Shuler, M.L. and Kargi,F, “ Bioprocess Engineering - Basic concepts” Prentice Hall of India Pvt. Ltd., 2nd edition,2002
3. Gavhane K. A “Chemical Reaction Engineering-I”, Nirali Prakashan Publication Ltd.,2008

14BT2020 DOWNSTREAM PROCESSING

Credits: 3:0:0

Pre-requisite: 14BT2015 Bioreactor Engineering

Course Objective:

- To develop skills of the students in downstream processing with emphasis on purification of products.
- To study the cell disruption methods, solid-liquid separation techniques
- To study the finishing steps in the purification of bio-products

Course Outcome:

At the end of the course, the students is familiar with,

- Various methods of separation techniques
- Purification by various chromatography and electrophoresis
- Finishing operations by crystallization, drying and lyophilization

Description: Bioseperations, cell disruption methods, solid-liquid separation- filtration and Centrifugation, Product isolation by adsorption, Extraction, Membrane, Product purification by chromatography, Finishing operations - Crystallization, Drying and Lyophilization

Reference Books

1. Sivasankar.B “Bioseperations: Principles and Techniques”, PHI Learning Pvt. Ltd., 2006
2. Scopes R.K., “Protein Purification – Principles and Practice”, Narosa Publications, 2004.
3. Trevor G, and Harrison, Roger G, and Rudge, “Bioseparations Science and Engineering”, Day Scott R, Publisher, Oxford University Press, USA, 2002
4. Belter P.A, Cussler E.L & Wei-Houhu ,“Bioseparations – Downstream Processing For Biotechnology”, Wiley Inter science Publications, 1988.

14BT2021 DOWNSTREAM PROCESSING LAB

Credits: 0:0:2

Co-requisite: 14BT2020- Downstream Processing

Course Objective:

- To develop the skills of students in various downstream process operations
- To understand the extraction of bioproducts by various techniques
- To understand the finishing and polishing process of bioproducts

Course Outcome:

- The student is familiar with various recovery and isolation of bioproducts
- The student perform various concentration and purification techniques.
- The student understands the importance of downstream processing in bioprocess industries.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2022 UNIT OPERATIONS

Credits: 3:0:0

Pre-requisite: 14BT2003 Principles of Chemical Engineering

Course objectives:

- To provide knowledge on properties of solids, handling and screen analysis.
- To provide the fundamentals of the size reduction techniques and its equipment
- To provide basic knowledge on mixers and agitators required in chemical process industries

Course outcomes:

- Understand the properties of solids and working of screening.
- Understand different types of size reduction methods and various types of equipment used for it.
- Understand Theories of filtration and washing

Description: size reduction of solids. Types of crushers Size reduction operation - Power requirements - Laws of comminution, Industrial screening equipments, Screen effectiveness, Mechanical and pneumatic conveying equipments, Storage of solids - Angle of repose & angle of internal friction, Pressures in bins - Janssen equation, Gas cleaning methods Mixing equipments for liquids, pastes, rubber & plastic materials and for dry powders, Power consumption in mixers, Scale up of agitator design. Settling Equipments - Settling chambers, classifiers, jigging and Tabling, Sedimentation, Filtration equipments, Theories of filtration and washing, Industrial filtration practice, Centrifugal filtration.

Reference Books:

1. W. L. Mc Cabe, J. C. Smith, P. Harriott, "Unit Operations of Chemical Engineering", 7th ed., McGraw-Hill, New York, 2005.
2. Badger, W.L., & Banchero. J.T, "Introduction to Chemical Engineering", McGraw Hill (ISE), 1993.
3. R. H. Perry and D. W. Green, "Perry's Chemical Engineer's Handbook", 8th Edn. McGraw-Hill, New York, 2007.
4. C.M. Narayanan & B.C. Bhattacharyya, "Mechanical Operation for Chemical Engineers" (Incorporating Computer Aided Analysis), Khanna Publisher, Third Edition, 2005.

14BT2023 ANIMAL AND PLANT BIOTECHNOLOGY

Credits: 3:0:0

Course Objective:

- To create awareness in Plant and Animal biotechnology.
- To understand the principles of transgenic plants and animals.

Course Outcome:

- The student gets knowledge in plant and animal biotechnology and its applications.

Description: Basic techniques of plant and animal tissue culture, recombinant techniques for therapy for animal diseases, transgenic animals and their importance in biotechnology, gene transfer technology in plants, transgenic technology for crop improvement.

Reference Books

1. Bojwani, S.S. "Plant Tissue Culture: Applications and Limitations", Elsevier science publishers, 1990.
2. Ian Freshney, "Culture of Animal Cells", Wiley-Liss, 5th edition, 2005

3. Grierson,D. “Plant Biotechnology in Agriculture Prospects for the 21st Century”, Academic press, 2012
4. Doyle, A.R. Hay and B.E. Kirsop, “Living Resources for bio technology”, Cambridge University press, Cambridge, 1990
5. Ed. John R.W. Masters, “Animal Cell Culture - Practical Approach”, Oxford University Press, 3rd edition, 2000.
6. Dunmock N.J and Primrose S.B., “Introduction to Modern Virology”, Blackwell Scientific Publications, 2002

14BT2024 PLANT PHYSIOLOGY AND CROP IMPROVEMENT

Credits: 3:0:0

Course Objective:

- To learn the principles of plant physiology.
- To create awareness among students about the role of genetic engineering in crop improvement.
- To introduce the basic metabolism of plant physiology and its importance

Course Outcome:

- The student understands the physiological aspects of plants.
- The student gain knowledge on crop improvement strategies.

Description: Principles of Plant Physiology with reference to plant nutrition, absorption, translocation and metabolism of nutrients, Soil - water- plant relationship, Role of genetic engineering and biotechnology in crop improvement, genetically modified crop plants.

References Books

1. Salisbury F and C. Ross, “Plant Physiology”, Wordsworth Publishing co., Belmont, California, 2005
2. H.S. Chawala, “Introduction to Plant Biotechnology”, Oxford IBH, 2002

14BT2025 PLANT TISSUE CULTURE

Credits: 3:0:0

Course Objective:

- To ensure students in having strong foundation in plant tissue culture
- To create awareness among students about cell culture techniques and its applications in industries.
- To ensure students in developing basic knowledge on secondary metabolites production and its applications.

Course Outcome:

- The student gain knowledge on different techniques of plant tissue culture
- The students acquire knowledge in current research achievements in micro propagation of plants

Description: Historical perspective of Plant cell/tissue culture, Scope and importance in crop improvement , totipotency and morphogeneis, Organogenesis, Rhizogeneisis, Embryogenesis, Nutritional requirement of in vitro cultures, Different techniques of in-vitro culture, Factors affecting *in vitro* culture, cryopreservation of germplasm, Secondary metabolites production, extaction of secondary metabolilites, hardening techniques of micro-propagated seedlings.

References Books

1. Razdan , “Introduction to Plant Tissue Culture”, Oxford IBH, 2007.
2. Dixon, “Plant Cell Culture”, Panima publications, New Delhi, 2004.
3. H.S. Chawala, “Introduction to Plant Biotechnology”, Oxford IBH, 2002.

14BT2026 PLANT MICROBE INTERACTIONS

Credits: 3:0:0

Course Objective:

- The course is designed to provide the genetic and molecular principles underlying plant- microbe interactions.
- To create awareness among students about importance of plant microbe interaction for crop improvement practices.

Course Outcome:

- Students learn plant microbe interaction and its importance
- Students learn genetics of plant diseasesusceptibility.

Description: Plant microbe interaction and recent developments, Beneficial Plant - Microbe interactions (molecular aspects), Parasitism and disease development; Molecular biology of pathogenicity; Molecular genetics of plant disease susceptibility and resistance

Reference Books

1. Agrios G. N, "Plant Pathology", Academic Press, 2005.
2. Dickinson M, "Molecular Plant pathology", BIOS Scientific Press,2003.
3. Jeng-Sheng H. T Kluwer, "Plant Pathogenesis and Resistance: Biochemistry and Physiology of Plant-Microbe Interactions", Academic Publishers, 2001.

14BT2027 MOLECULAR PLANT PATHOLOGY AND ENTOMOLOGY

Credits: 3:0:0

Course Objective:

- To enable the students to learn concepts of plant pathology and entomology
- To create awareness among students about importance of integrated plant disease management
- To ensure students in developing basic knowledge on techniques to control pests and insects

Course Outcome:

- The student will gain knowledge on plant pathogens and different concepts of entomology
- The student get awareness on recent techniques in plant disease management

Description: Introduction to the science of phytopathology, its objectives, scope and historical background. Classification of plant diseases, symptoms, signs, and related terminology, Parasitic causes of plant diseases, their characteristics and classification, Nonparasitic causes of plant diseases. Infection process, Survival and dispersal of plant pathogens, Plant disease epidemiology, forecasting and disease assessment, Principles and methods of plant disease management. Integrated plant disease management, Different pest control methods, IPM concept, Insecticide resistance management.

References Books

1. G. N. Agrios, "Plant pathology", 5th edition, Academ. Press, New york , 2004
2. Eugene Nester, Milton P. Gordon, and Allen Kerr, Agrobacterium tumefaciens: From Plant Pathology to Biotechnology, APS press, 2004.
3. B.V. David & T. Kumarswami , Elements of economic entomology, Popular Book Depot, 1988.

14BT2028 MOLECULAR PLANT BREEDING

Credits: 3:0:0

Course Objective:

- To enable the students to learn different techniques of plant breeding
- To ensure students in developing basic knowledge on hybridization techniques

Course Outcome:

- The student gain knowledge on floral biology
- The student get knowledge on recent techniques in plant breeding

Description: Historical milestones in plant breeding. Various methods of plant breeding in self and cross pollinated crops, acclimatization, selection, pure line theory, Reproductive systems of plants, floral biology, flower parts, Self and cross pollinated crops, genetic consequences and differences between self and cross pollinated crops, clonal selection, population improvement programme. heterosis, genetical and physiological basis. Male sterility Types of male sterility. combining ability-general and specific, its exploitation. Interspecific/ Intergeneric hybridization, Heterosis inbreeding depression, Polyploidy its types, Mutation breeding Gene actions, heritability, genotype and environmental interactions, its importance in plant breeding. Introduction to seed production (Nucleus, breeder, foundation, certified) Maintenance of genetic purity during seed production.

References Books

1. Gardner E.J, M.J Simons and D.P Sanstad , Principles of Genetics, Wiley India Pvt Ltd. 2012
2. Denis Murphy, Plant Breeding and Biotechnology, Cambridge University Press, 2007
3. Lamkey and Lee, Plant Breeding, Panima publishers, N.Delhi, 2002
4. Singh B.D, Principles of Plant Breeding, Kalyani Publishers, New Delhi, 2011.

14BT2029 BIOTECHNOLOGY OF BIOTIC AND ABIOTIC STRESS TOLERANCE

Credits: 3:0:0

Course Objective:

- To introduce the prospects and perspectives of stress tolerance
- To create awareness among students about importance of plant defense mechanism
- To develop basic knowledge on molecular advancements in stress management in plants

Course Outcome:

- The student gets knowledge on mechanism of plant resistance
- Students get awareness on biotic and abiotic stress tolerance

Description: Prospects & Perspective of Biotic & abiotic stress resistant plants, Genetics of host-pathogen interactions, Mechanism of plant resistance. Insect pest resistance – Structural/morphological changes; Vertical and Horizontal resistance to pathogens, Hypersensitive host response (HRGP) and apoptosis in relation to plant defense. Virulence- Avirulence in host–pathogens interaction. Race specific Resistance Gene Analogues (RGAs), Pathogenesis related proteins – groups with examples. RIP. Biochemical basis of abiotic stresses; stress adaptation, Reactive oxygen species and biotic and abiotic stress, antioxidants, enzymes defense system, Molecular strategies for imparting tolerance against biotic and abiotic stress.

References Books

1. Rout, Gyana Ranjan; Das, Anath Bandhu, Molecular Stress Physiology of Plants, Springer, 2013
2. Ashwani Pareek, Abiotic stress adaptation in plants, Springer, 2010
3. HopkinsWG & Huner NPA. Introduction to Plant Physiology. JohnWiley & Sons, 2004
4. Basra AS, Stress Induced Gene Expression in Plants, Harwood Academic Publ. 1997.
5. Salisbury FB & Ross C. Plant Physiology. 4th Ed. Wadsworth Publ, 1992.

14BT2030 ENTREPRENEURIAL AGRICULTURE AND BIOMASS ENERGY

Credits: 3:0:0

Course Objective:

- To create awareness in the present scenario of agriculture entrepreneur
- To create awareness on renewable energy
- To develop basic knowledge on techniques in biomass energy production

Course Outcome:

- The student gain confidence to become an entrepreneur in agriculture
- Get knowledge on recent techniques in biomass energy and current research achievements

Description: External trade in Agricultural products, Present status, policy and prospects under WTO regime, Export import policy, Regulation of Agricultural marketing system, Infrastructural facilities for exporting efficiency, Biotechnological Products in India, Quality parameters and quarantine procedures of export, Market integration. Biotech industries & institutes in India & world, Concepts of Biotech park/ Biotech Hub. Biomass – importance and source, techniques and application of energy production. Fundamental theories and applied technologies used in production and conversion of biomass. Production strategies focus on sustainable cropping systems, harvest, storage, and pretreatment for diverse biomass feedstocks. Conversion technologies covered include ethanol fermentation, biodiesel catalysis, combustion, pyrolysis, gasification, and anaerobic digestion. System analysis on environmental impacts, policy, and economics.

References Books

1. Gry Agnete Alsos, Sara Carter, Elisabet Ljunggren, Friederike Welter. The Handbook of Research on Entrepreneurship in Agriculture and Rural Development, Edward Elgar Pub, 2011
2. Robert C. Brown, Biorenewable Resources: Engineering New Products from Agriculture, Iowa State Press, Blackwell Publishing. 2003
3. Acharya and Agrawal , Agriculture Marketing in India , Oxford IBH, N. Delhi, 2004.
4. Kotlar and Armstrong , Principles of Marketing by Prentice-Hall, N. Delhi. 2013.

14BT2031 HORTICULTURAL CROP PRODUCTION, MANAGEMENT AND GREEN HOUSE TECHNOLOGY

Credits: 3:0:0

Course Objective:

- To provide foundation in horticulture crop production
- To create awareness on Green house technology

Course Outcome:

- The student gain technical knowledge on horticultural crop production
- The students know about green house techniques.

Description: Horticulture- Definition, scope, importance, and branches of horticulture. Classification of horticultural crops, Propagation methods, growth habit, training and pruning objectives, methods and season, Special horticultural practices for horticultural crop production, plant growth regulators and their uses in horticulture. Package of practices for cultivation of major horticultural crops Fruits: Major pest and diseases of horticultural crops and their control, Types of green house, importance, functions and features of green house, Scope and development of green house technology. Location, Planning of various components of green house, Design criteria and calculation, Construction material, covering material and its characteristics, growing media, green house irrigation system. nutrient management.

References Books

1. Kumar, P, Management of Hort. Crops Horscience series Vol. 11, New India Publishing Agency, NIPA. 2008.

2. Manohar, Greenhouse Technology and Management , International Book Distribution Co., Lucknow, 2006.

14BT2032 FOOD AND NUTRITION SECURITY OF GM CROPS

Credits: 3:0:0

Course Objective:

- To provide foundation in Food safety regulations
- To create awareness on the importance of GM crops
- To develop basic knowledge on techniques in nutrition security of GM crops

Course Outcome:

- The student acquire knowledge on International food safety regulations
- The student acquires knowledge in current research achievements in the field of nutritional safety of GM crops

Description: International aspects of the quality and safety of Foods derived from modern Biotechnology, Application of ELISA for detection of Toxins in food, Biosensors for food quality Assessment, Malnutrition, consequences, causes, prevention and control. Applied community nutrition. Food safety and food faddism. safety testing for toxicity, allergenicity , anti nutritional effects. Native toxins and toxins produce during storage, health hazards.

References Books

1. Shetty , Food Biotechnology, CRC,NY, 2006
2. Modi H A., Fermented Food Biotechnology, Pointer publishers, 2011
3. Roges, A Food Biotechnology, by. Elsevier Applied Sci. Pub., London, U.K. 1989.
4. Goldberg, I., Chapman and Hall, Functional Foods, New York. 1999.
5. Byong, H. L. Fundamentals of Food Biotechnology, VCH Publishers, New York. 1996.

14BT2033 POST-HARVEST TECHNOLOGY

Credits: 3:0:0

Course Objective:

- To study the principles of Post-Harvest technology
- To provide knowledge on food processing techniques

Course Outcome:

- The student get knowledge on Post-Harvest techniques of food crops
- The student become aware on research in post harvest crop management

Description: Classification, chemical composition and nutritional values of food grains (cereals including millets, legumes and pulses). Anti-nutritional factors- chemistry and methods of their removal, Importance and scope of food preservation and storage. Food spoilages- causes and effects, Principles and methods of food preservation and processing of food crops. Bakery and confectionary- types, ingredients used with their role, other processing techniques- Fermentation, malting, brewing, puffing, flaking, pearling, sprouting, roasting. Enrichments- Methods, need and fortification. Biosol concept, Spheroplast fusion technology. Biocatalysts and worldwide food industry market

References Books

1. R Wills, B McGlasson, D Graham, D Joyce, Postharvest , CABI publishers, 2007.
2. Marwaha & Arora, Food processing: Biotechnological Applications, Asiatech Publishers N.D. 2000.

14BT2034 MECHANIZATION AND POST-HARVEST TECHNOLOGY LAB

Credits: 0:0:2

Co-requisite: 14BT2031- Horticulture Crop Production, Management and Green House Technology, 14BT2033- Post Harvest Technology

Course Objective:

- To expose the students to the importance of post harvest technology
- To expose the students to food preservation techniques

Course Outcome:

- The student acquire knowledge on Post-Harvest techniques
- The student know about the techniques in food preservation
- The student will be able to develop different kinds of food products

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2035 GENE MANIPULATION LAB

Credits: 0:0:2

Co-requisite: 14BT2025 – Plant Tissue Culture, 14BT2032- Food and Nutrition security of GM crops.

Course Objective:

- To expose the students to different basic techniques of gene manipulation
- To impart hands on training in transformation and screening techniques

Course Outcome:

The student will gain knowledge:

- to perform basic and advance techniques in transformation
- to interpret and analyze the results obtained
- to establish transgenic plants

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2036 PLANT BREEDING AND CROP MANAGEMENT LAB

Credits: 0:0:2

Co-requisite: 14BT2026- Plant Microbe Interactions, 14BT2028- Molecular Plant Breeding.

Course Objective:

- To expose the students to different techniques of plant breeding
- To impart knowledge on crop management practices
- To expose the students to development of formulations for crop management

Course Outcome:

The student will gain complete practical knowledge on,

- Plant breeding techniques
- Equipment handling in plant pathology
- Integrated disease management techniques

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2037 DEVELOPMENTAL BIOLOGY

Credits: 3:0:0

Course Objective:

- To provide with fundamentals and concepts of developmental biology.
- To make students understand about the events involved in the formation of embryo.
- This course serves as a foundation for stem cell research.

Course Outcome:

- At the end of the course, student understand the concepts of development in biology

Description: An introduction to the genetic, molecular, and cellular mechanisms that direct the development of multicellular organisms. Gametogenesis, fertilization, gastrulation, organogenesis, sex determination, and developmental gene regulation

References Books

1. Scott F. Gilbert, "Developmental Biology, 6th edn. Sinauer Associates, Incorporated, 2000.
2. Willium. J. Larsen, Human Embryology 3rd ed. Churchill Livingstone, 1998.

14BT2038 HUMAN GENETICS AND GENOMICS

Credits: 3:0:0

Course Objective:

- To provide foundation in human genetics.
- To provide basic knowledge in genomics.

Course Outcome:

- At the end of the course, the student understand the mechanisms of human heredity
- The students get basic knowledge in genetics and learn genomics.

Description: Location, transmission, structure and function of genes encoding specific traits. Mutations, genes implicated in human genetic disease, population genetics, mapping of genomes, human genome project, DNA barcoding and recombination.

Reference Books

1. Bruce R. Korf , Human genetics and genomics 3rd ed. Blackwell publishing, 2013

14BT2039 VACCINE BIOTECHNOLOGY

Credits: 3:0:0

Course Objective:

- To gain knowledge in Vaccine Biotechnology
- To understand to the vaccine development.
- To learn about the importance of immunization.

Course Outcome:

- At the end of the course the student will gain knowledge in types of vaccines and their production
- The students will get knowledge and understanding of vaccine technology

Description: Adjuvants, Vaccines – Dead, live attenuated, recombinant, edible, chimeric and DNA vaccines; bacterial vaccines, viral vaccines, combined vaccines and polyvalent vaccines, vaccines to other infectious agents, tumor vaccines, principles of vaccination, passive & active immunization, immunization programs & role of WHO in immunization program.

Reference Books

1. Barry R Bloom, Paul-Henri Lambert, "The Vaccine Book", Academic Press.2002
2. Lowrie DB & Whalen R. "New Generation Vaccines", 3rd Edn. Informa Healthcare Humana Press, 2000.
3. Robinson A & Cranage MP. "Vaccine Protocols", 2nd Ed. Humana Press, 2003

14BT2040 ANIMAL BIOTECHNOLOGY AND CELL CULTURE TECHNIQUES

Credits: 3:0:0

Course Objective:

- To develop skills of the students in the area of animal biotechnology
- To learn about cell culture techniques

Course Outcome:

At the end of the course, the students would have learnt.

- Various animal tissue culture methods.
- Aseptic handling of tissues

Description: Animal tissue culture – media, sterilization and types of culture – monolayer and suspension culture; production of cell lines; hybridoma technology; Artificial animal breeding – IVF and embryo transfer; Transgenic animals and their significance; ethics of transgenic animal. Knockout mice.

Reference Books:

1. Stella Pelengaris and Michael Khan; The Molecular Biology of Cancer. Blackwell Publishers, 2006.
2. Robert G. McKinnell, Ralph E. Parchment, Alan O. Perantoni, G. Barry Pierce. The Biological Basis of Cancer. Cambridge University Press, New York 2003.
3. Macdonald F and Ford CHJ. Molecular Biology of Cancer. Bios Scientific publishers, 2002.
4. Maly B.W.J, "Virology A Practical Approach", IRLl Press, Oxford, 2001.
5. Dunmock N.J And Primrose S.B., "Introduction to Modern Virology", Blackwell Scientific Publications, Oxford, 2002

14BT2041 MOLECULAR FORENSICS

Credits: 3:0:0

Course Objective:

- The molecular forensics provides students with experiences and information that will broaden their understanding of the field of Forensic Science and crime scene investigations.
- To ensure students in having foundation Forensics and molecular techniques in forensics.
- A concurrent goal of the subject is to develop observational, organizational and cognitive skills so to be able to integrate their experiences and knowledge so to solve problems.

Course Outcome:

- The students understand the application of molecular based techniques in forensics science.
- The students learn the methods used to identify suspects and parental disputes.
- The students learn methods used in paleobiology and anthropology

Description: Introduction to forensic science, molecular methods in forensic technology, RFLP, RAPD, DNA finger printing, identification of suspects, application in paleontology, astrobiology and anthropology, methods of DNA isolation from various sources, types of amplification methods, types of sequencing; forensic significance of polymorphic enzymes, forensics in paternity disputes.

References Books

1. Lincoln PJ & Thomson J, “Forensic DNA Profiling Protocols”, Humana Press. 2011.
2. Rudin N & Inman K. “An Introduction to Forensic DNA Analysis”, 2nd Ed. CRC Press. 2002.

14BT2042 STEM CELL TECHNOLOGY

Credits: 3:0:0

Course Objective:

- This course will take students on a journey into the stem cell biology and biotech revolution,
- This course will provide details regarding social implications associated with stem cell technology.
- The course offers an opportunity to understand the basics of stem cells, embryonic stem cells, adult stem cells and genetic engineering of stem cells and their applications.

Course Outcome

- To student gain knowledge in Stem cell basics, growing of ES cells in lab, differentiation of stem cells and application of stem cells.
- They understand recent advancements in the biotechnological applications using both adult and embryonic stem cells.

Description: Stem cells, hematopoietic stem cells, Adult stem cells, embryonic stem cells- isolation and culture, stem cell in drug discovery and tissue engineering, therapeutic application using stem cells, ethical issues related to stem cell technology, Cord blood banks and their significance.

References Books

1. Kursad and Turksen, “Embryonic Stem cells”, Humana Press, 2002.
2. National research council, “Stem cell and future of regenerative medicine”, National Academic press, 2002.
3. “ICMR guidelines for stem cell Research”, 2013 (www.icmr.nic.in)

14BT2043 HUMAN PHYSIOLOGY

Credits: 3:0:0

Course Objective:

- To ensure students in having strong knowledge in functioning of Human organ systems
- The students will learn the essential theme of maintaining homeostasis.
- This subject helps to understand experimental approach can be applied to studying the various physiological systems of the human body.

Course Outcome:

- At the end of the semester the students understand the fundamental physiology of Human systems.
- The students understand the physiological relationship of cell interaction, organ development and function.

Description: Introduction to physiology and homeostasis, cell physiology, membranes and tissues, neuronal and hormonal communication, The nervous system – Peripheral Nervous System and Central Nervous System, tissue structure and muscle physiology; circulatory system, digestive system, respiratory system, endocrine system, reproductive system.

References Books

1. Arthur C. Guyton, John E. Hall, “Textbook of Medical Physiology” 11^{th} Edn., Elsevier Saunders, 2006.
2. C.C. Chatterjee, “Human Physiology”, 6th edn., S Chand Publication, 2008.

14BT2044 CANCER BIOLOGY

Credits: 3:0:0

Course Objective:

- To study the factors affecting cancer development, the genetic and cellular basis for cancer development.
- To study the involvement of carcinogens in cancer development.
- To study the characteristic features of cancer cells, their behavior and the treatment modalities available.

Course Outcome:

- The students learn the behavior of cancer cells and the curable measures available.
- The students learn the genes involved in cancer development.
- The students learn the molecular mechanisms involved in cancer progression.

Description: Fundamentals of cancer biology, principles of carcinogenesis; cancer and types; carcinogens – physical and chemical; tumour antigens; protooncogenes and oncogenes, tumour suppressor genes, cancer metastasis and tumour angiogenesis, adhesion molecules, role of proteases in metastasis, Role of growth factors in tumour progression; cancer detection, cancer therapy.

Reference Books

1. Macdonald F and Ford CHJ. “Molecular Biology of Cancer”, Bios Scientific Publishers, 2002.
2. Robert G, Mckinnell, Ralph E. Parchment, Alan.O. Perantoni, G. Barry Pierce, “The Biological Basis of Cancer”, Cambridge University Press, New York. 2003.
3. Ranga M.M. “Animal Biotechnology”, Agrobios India Limited, 2002
4. Ramadass P, Meera Rani S. “Text Book of Animal Biotechnology”, Akshara Printers, 2000.
5. Dubey, R.C, “Text Book of Biotechnology”, S. Chand & Co, 2004.

14BT2045 BIOPHARMACEUTICAL TECHNOLOGY

Credits: 3:0:0

Course Objective:

- To provide an insight to the undergraduate students on the basics of biopharmaceutical technology.
- To equip the students to know the basic of formulations and to apply them in clinical trials.

Course Outcome:

- Students understand drug principles, biotechnology oriented pharmaceutical products: its preparation, testing and quality assurance.
- The students get acquainted to the process of drug formulation.

Description: Basic principles of pharmacokinetics and pharmacodynamics, preparation of solid dosage forms, preparation of semisolid and liquid dosage forms, bio- pharmaceutical products, clinical trials and regulations.

Reference Books

1. DM Brahmankar, Sunil B Jaiswal, “Biopharmaceutics and Pharmacokinetics-A Treatise”, Vallabh prakashan, 2005.
2. Ansel, H., Allen, L., Popovich, N, “Pharmaceutical Dosage Forms and Drug Delivery Systems”, Williams & Wilkins, 2014.
3. Lippin cott, “Remington’s Science and Practice of Pharmacy”, Williams & Wilkins publishers, 2012.
4. Goodman & Gilman's, “The pharmacological basis of therapeutics” McGraw-Hill Medical, 2011.
5. Tripathi KD, “Essential of Medical pharmacology”, Jaypee Brothers Medical Publishers 2003.

14BT2046 RESEARCH METHODOLOGY

Credits: 3:0:0

Course Objective:

- To intend the students with the knowledge about the basic research methods, applications in conducting research, various data collection and analysis techniques.
- To gain insights into scientific research.
- To help in critical review of literature and assessing the research trends, quality and extension potential of research and equip students to undertake research.

Course Outcome:

At the end of the course the students learn to:

- Critically evaluate current research and propose possible alternate directions for further work.
- Develop hypothesis and methodology for research
- Comprehend and deal with complex research issues in order to communicate their scientific results clearly for peer review.

Description: Objectives of research- types of research - significance of research, criteria for good research, scope and limitations of experimental design- characteristics of good design, methods of research- survey, descriptive, comparative, experimental- clinical research- controlled clinical trials, measurement, scaling techniques and analysis of data, statistics in research, manuscript / thesis writing

Reference Books

1. C.R. Kothari, “Research methodology, Methods and techniques”, New Age International (P) Ltd, Publishers, 2nd edition,2000.
2. Jerrod H. Zar, “Biostatistical analysis”, Prentice Hall International, Inc. Press, 1999.
3. Donald H. McBurney, “Research methods”, Thomson Asia Pvt. Ltd. 2002
4. Ranjit Kumar, “Research methodology”, Sage Publications, London, 2006.
5. Raymond – Alain, “Doing Management research”, Sage publications, 2001.

14BT2047 BIOCHEMICAL ENGINEERING

Credits: 3:0:0

Course Objective:

- To provide the idea to determine the rates of enzyme catalyzed reactions and to provide knowledge on the immobilization of enzymes.
- To provide knowledge regarding cell growth patterns and design of various bioreactors.
- To study the enzyme kinetics and inhibition models

Course Outcome:

- At the end of the semester the students apply the basic principles of biology and biochemistry to successfully design and operate a biochemical process.
- Derive the kinetic expression for the rates of enzyme catalyzed reactions.
- Understand the factors effecting cell growth and to design and operate various bioreactors.

Description: comparison of chemical and biochemical processes, industrially important microbial strains, Enzyme kinetics: Mechanism of enzymatic reactions; Michaelis-Menten and Briggs Haldane equation; enzymes inhibition. Factors affecting growth; Monod`s equation; modeling of batch and continuous cell growth; Mass transfer coefficients and their role in scale-up of equipments; enhancement of O_2 transfer; sterilization cycles High performance bioreactors

References books:

1. Shuler M.L and Kargi F, “Bioprocess Engineering Basic Concepts” Prentice Hall of India 2002
2. Lee, J.M, “Biochemical Engineering”, Prentice Hall, 2nd Edition, 2001

3. Blanch, H.W and Clark, D.S, “Biochemical engineering”, Marcel Dekker, 1997

14BT2048 METABOLIC ENGINEERING

Credits: 3:0:0

Course Objective:

- To develop skills of the students in the area of metabolic engineering to alter the existing metabolic pathway
- To introduce novel metabolic pathways in microorganisms using r-DNA technology
- To learn molecular techniques in order to enhance the product yield.

Course Outcome:

At the end of the course, the students learn,

- The principles and regulation of metabolic pathways
- Various methods to synthesis primary and secondary metabolites and bioconversion.
- Methods to improve production strains to meet industrial demands.

Description: Analysis of metabolic control in glycolysis, metabolic flux –Regulations in the production of metabolites: Feedback control systems, alteration of feedback regulation for enhanced production of primary metabolites: glutamic acid, Mutants which do not produce feedback inhibitors or repressors- auxotrophs-lysine, isoleucine, arginine, purine nucleotides. Producers of secondary metabolites, Precursor effects, trophophase-idiophase relationship, applications of secondary metabolites, Metabolic pathways and regulation of production processes- antibiotics, vitamins, Mycotoxins- maintenance of genetic stability; Bioconversions

Reference Book

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, “Principles of Fermentation Technology”, Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005
2. W.Crueger and A. Crueger, “A Text Book of Industrial Microbiology”, Panima Publishing Corporation, 2005
3. Lehninger, A. L, Nelson D. L and Cox, M. M, “Principles of Biochemistry”, Freeman Publishers, New York, fourth edition, 2005.
4. Gregory N. Stephanopoulos , Aristos A. Aristidou & Jens Nielsen, “Metabolic Engineering: Principles and Methodologies”, Academic Press, An Imprint of Elsevier India Pvt.Ltd.,1st edition, 1998.

14BT2049 PROCESS EQUIPMENT DESIGN

Credits: 3:0:0

Course Objective:

- To design safe and dependable processing facilities.
- This course focus on plant layout and design of piping systems
- This will provide the basic knowledge to carryout design process cost effectively.

Course Outcome:

- On completion of this subject students display an understanding of the principles of process equipment design, the mechanical aspects of the design and
- Students understand the operation of process equipment, including safety considerations
- Students know about the designs of several unit operations.

Description: Process equipment symbols based on IS3232. Plant layout for production of penicillin, citric acid and ethanol. Design of venturimeter, double pipe heat exchanger, Design of gate, design of globe valve, Design of double pipe heat exchanger, design of single effect evaporator. simple distillation column and single ideal batch reactor.

Reference Books

1. Joshi, M.V, “Process Equipment Design”, MacMillan, 3rd edition, 2004.
2. Bhattacharya, B.C., “Introduction to Chemical Equipment Design”, CBS Publishers and Distributors, New Delhi, 2000.
3. Indian Standard Codes:
   a. IS : 2825 - 1969: Code for Unfired Pressure Vessels.
   b. IS : 4049 - 1979: Specifications for formed ends for Tanks and Pressure vessels.
   c. IS : 4179 - 1967: Sizes of Process Vessels & their Leading Dimensions.
   d. IS: 4864 to 4870 - 1968: Specifications for Shell Flanges for Vessels and Equipment.
   e. IS : 4503 - 1967: Specifications for Shell & Tube Heat Exchangers.
   f. IS : 803 - 1962: Code of practice for Design, Fabrication and Erection of Mild
   g. Steel Cylindrical Welded Oil Storage Tanks.

14BT2050 PROCESS CONTROL ENGINEERING

Credits: 3:0:0

Course Objective:

- To control and measure the processing facilities in a cost effective manner.
- To focus on plant layout control and piping systems
- To provide in-depth knowledge on control systems

Course Outcome:

- On completion of this subject students display an understanding of the principles of process control systems
- Students know about safety considerations

.

Description: Instrument static and dynamic characteristics, flow and level transmitters. Laplace transform of standard functions, transfer function concept principles and description of Proportional control, Proportional Integral Control, Proportional Derivative control and Proportional Integral and Derivative control modes, control circuit diagram for heat exchanger and distillation column.

Reference Books:

1. George Stephanopoules, “Chemical Process control”, I edition,Prentice-Hall of India, New Delhi, 1998
2. A.Suryanarayanan, “Chemical instrumentation and process control”, Khanna Publishers 2nd edition, New Delhi , 1995
3. D.R.Coughnaour, “Process system analysis & control”, Mc Graw Hill, Singapore II edition, 1991

14BT2051 PILOT PLANT AND SCALE UP PRACTICE

Credits: 3:0:0

Course Objective:

- To provide basic knowledge of scale-up practice
- To teach the details of pilot plant design.
- To study about Pilot plants for reactors and mechanical operations equipments

Course Outcome:

At the end of the semester student acquire knowledge in

- sampling data and safety factors
- Pilot plant design for several unit operations
- Pilot plants for reactors and mechanical operations equipments

Description: Pilot plants, size estimation, sampling data, cost and safety factors. Dimensional analysis, scale up equations, analog models. Pilot plant design for heat exchangers and mixer equipments, batch and continuous distillation columns. Pilot plants for reactors and mechanical operations equipments

Reference Books:

1. Johnson and Thring, "Pilot plants models and scale up methods in chemical engineering", McGraw Hill Book co. New York, 1987.
2. Henley and Staffin, "Stage-wise process design", John Wiley, New York 1988.
3. Bisio and Kabel, "Scale up of Chemical Process", John Wiley, Singapore 1985.

14BT2052 INDUSTRIAL SAFETY & HAZARD ANALYSIS

Credits 3:0:0

Course Objective:

- To provide basic knowledge of occupational health hazards
- Will learn about the necessary safety measure in industrial planning and function.
- To provide basic knowledge about various industrial acts related to labors

Course Outcome:

At the end of the semester student gain inputs on,

- Occupational health and industrial hygiene
- Accidental prevention techniques to the students and risk assessment and management.
- Details of various labor acts.

Description: Occupational Health Hazards, Safety and Health training, Ergonomics. Plant layout, Safety and good housekeeping, First aid - Rescue and Transport of Casualty, Personal Protective Equipments and devices. Overload and Short circuit protection, Earthing standards, Protection against voltage.Factories Act, 1948, Workman's Compensation Act, 1943, Employees State Insurance Act, 1948.Child Labour and Women Employee Act, The factories rules and regulations.

Reference Books

1. R. K. Jain and Sunil S. Rao , "Industrial Safet , Health and Environment Management Systems", Khanna publishers , New Delhi, 2006
2. Grimaldi and Simonds , "Safety Management", AITBS Publishers , New Delhi , 2001

14BT2053 INDUSTRIAL EFFLUENT TREATMENT

Credits:3:0:0

Course Objective:

- The study of the subject constitutes the sources, characteristics of waste water
- Provides various methods for treatment of wastewater.
- It imparts the knowledge of basic principles of science and engineering applied to the problem of water pollution.

Course Outcome:

At the end of the semester the students:

- Understand the ultimate goal of waste water treatment to protect public health and environment.
- Understand various biological processes for waste water treatment
- Understand various chemical treatment methods

Description: Waste water constituents, physical characteristics, biological characteristics, non-metallic constituents, metallic constituents, Screening, mixing and flocculation, grit removal, sedimentation, aeration system, filtration, Chemical coagulation, chemical precipitation for phosphorous removal, heavy metals & dissolved inorganic substances , biological treatment: Biological process for wastewater treatment, treatment process – activated sludge process, attached growth and combined biological treatment process - trickling filters.

Reference Books

1. Etcalf & Eddy, "Wastewater Engineering (Treatment and Reuse)", 4th Edn, Tata – McGraw Hill, New Delhi, 2003.
2. Mark J. Hammer.: "Water and waste water technology" – 5thEdn", Prentice Hall of India Pvt. Limited, New Delhi, 2007.
3. James M. Montgomery.: "Water treatment principles and design" – A Wiley Interscience publication, Newyork, 1985.

14BT2054 BIOENERGY AND BIOMATERIALS

Credits: 3:0:0

Course Objective:

- To impart knowledge on energy resources,
- To study the basics of energy needs, for environment and society
- To have knowledge about management of energy conservation

Course Outcome:

- Students prepare energy audit report
- The student understand energy conservation techniques
- The student understands the importance of renewable energy.

Description: Energy sources: natural gas, coal; energy situation in India. Exploration of combustion energy resources, structural properties of environment; bio-geo-chemical cycles; Biotechnology and its application in environmental protection, Patterns of consumption in developing and advances countries; commercial generation of power requirements and benefit, new energy conservation systems, energy management

Reference Books

1. Jerrold.H.Kertz, "Energy Conservation and Utilization", Allyn and Bacur inc, 1981.
2. Gemand.M.Gramlay, "Energy", Macmillion publishing Co, Newyork, 1975.
3. Krentz, J. H., "Energy Conservation and Utilisation ", Allyn and Bacur Inc., 1976.

14BT2055 POLLUTION CONTROL AND ENGINEERING

Credits: 3:0:0

Course Objective:

- To give an exposure to various control acts
- To study the advantages and disadvantages of impact assessment methods
- To study the methods of reducing the waste and reusing it.

Course Outcome:

At the end of the course the student understands:

- The clean technology.
- The environmental audit method
- pollution control acts and Regulations

Description: Need for impact assessment. Legislation and pollution control acts and Regulations. Methodologies – collection of data and analysis, **a**pplication of Impact assessment methods in specific developmental projects, advantages, disadvantages of different methods, impact assessment report contents for developmental projects-Biochemical and chemical process industries, concepts and contents of environmental management plan. Environmental audits, waste audit, life cycle assessment, industrial symbiosis, clean technology and Clean up technology, materials reuse, waste reduction.

Reference Books

1. Peter Wathern, "Environmental Impact Assessment theory and practice", Unwin Hyman Ltd. Routledge, 1990,
2. L. Lee Harrison , "Environmental Health and Safety Auditing Handbook", 2nd edition, , McGraw Hill, Inc., New York, 1995
3. Kirkwood, R. C. and Longley, A. J., "Clean Technology and Environment", Chapman & Hall, 1995.

14BT2056 ENTREPRENEURSHIP

Credits: 3:0:0

Course Objective:
- To provide basic knowledge of entrepreneurship
- This course will provide necessary details for self-employment in industrial planning and function.
- It provides an insight into various acts related to entrepreneurship.

Course Outcome:

At the end of the semester student understands,
- The role of government agencies, inventory, incentives.
- Different acts such as, wages act, sales tax act and environmental act.

Description: Entrepreneurship-employment and self-employment, government policy, incentives. DIC, TIIC, SIDCO, TIDCO, IDBI, SISI, NSIC, banks, IBC, Technology and product life cycle, decision layout methods. Control of inventory, ABC analysis and value engineering, basic provisions of central laws. Factories act, environmental act, payment of wages act, sales tax act, shops and commercial establishment act

Reference Books:

1. C.B Gupta, "Entrepreneurial development in India", Sultan Chand & sons, 1998
2. C.B Gupta & S.S Khanna, "Entrepreneurship and Small business management", Sultan Chand & sons, 1998
3. P. Saravanavel, " Entrepreneurial development", Kitab Mahal, 1991
4. Peter Drucker, " Innovation & Entrepreneurship" , Routledge, 2012

12BT2057 MECHANICAL OPERATIONS LABORATORY

Credits:0:0:2

Co-requisite: 14BT2022- Unit Operations

Course Objectives:
- To provide knowledge on properties of solids
- To learn about various size reduction techniques
- To know the methods to handle solids and to perform screen analysis

Course Outcomes:
- The student understands the properties of solids and analyses the best screening equipment necessary in chemical industries.

- The student learns different types of size reduction principles and various types of equipment used in it.
- The student gain knowledge in the working principle of filtration equipment.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2058 PROCESS CONTROL LAB

Credits: 0:0:2

Co-requisite: 14BT2050- Process control Engineering

Course Objective:

- This course helps to study the measurement and control of various processes in a cost effective manner.
- This course focuses on plant layout control and piping systems.
- This lab will provide in depth knowledge about the valves used in control systems.

Course Outcome:

- On completion of this subject students, be able to display an understanding of the principles of process control systems, including safety considerations
- The student understands the various types of controllers used in biotechnology industries.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT2059 CELL BIOLOGY AND MICROBIOLOGY

Credits: 3:0:0

Course Objective:

- To acquaint students with the concepts in Cell Biology.
- To educate the students regarding the structure and function of cells
- To impart knowledge on classification and structure of microbes,
- This subject also deals with nutrition and control of microorganisms.

Course Outcome:

At the end of the course,

- The Students acquire fundamentals of cell biology that will enable them apply in cell based research
- The students learn the classification of microorganisms and control of microorganisms.
- Students understand the nutritional requirement and quantification of microorganism.

Description: Biology of cells- structure of prokaryotic and eukaryotic cells, cytoskeletal proteins, transport across cell membranes, regulation of cell cycle- cell division, cell cycle and regulation - cancer- types, basics in microbiology, classification and nomenclature of microorganisms, different staining techniques, physical and chemical control of microorganisms, nutritional requirements of bacteria, types of different media, quantification of bacterial growth.

Reference Books

1. Verma P. S. and Agarwal V. K., “Cell Biology, Genetics and molecular Biology”, S. Chand and company, New Delhi, 2000.
2. Pelczer M. J., Chan E.C.S. and Krein N.R., “Microbiology”, Tata Mc Graw Hill Publishers, New Delhi, 2000.
3. Lodish H., Bert A., Matsudaria Kaiser C.A., Kriegar M., Scott M.P., Zipursky S.L. and Darnell J., “Molecular cell Biology”, WH Freeman and company, New York, 5th edition, 2004.

14BT2060 CELL BIOLOGY AND MICROBIOLOGY LAB

Credits: 0:0:2

Co-requisite: 14BT2059- Cell biology and Microbiology

Course Objective:

- Students will be taught practically to learn about cell division, osmosis and tonicity
- The students will learn to identify the microorganisms using various staining techniques
- The students will learn about the enumeration of microorganisms.

Course Outcome:

- At the end of the course, students get equipped with all basic techniques to identify microorganisms,
- The students learn to enumerate the microorganisms
- The students understand the different stages in cell division.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT3001 APPLIED BIOCHEMISTRY

Credits: 3:0:0

Course Objective:

- To enable the students to understand the importance of glycans in the biomolecules; the structure-function relationship in proteins, the antioxidant system, actions of hormone drugs, and analytical techniques in diagnosis of diseases

Course Outcome:

- The students will be equipped to apply their knowledge on these emerging molecules of industrial significance and to develop possible new drugs for emerging diseases.

Description: Glycobiology: glycoconjugates; role of glycans in glycoconjugates - in cell-cell interaction/adhesion, recognition markers; Scope of Glycobiology; Lectins use and interaction with glycoconjugates; Glycans in biotechnology and pharmaceutical industry: as components of vaccines and small molecule drugs, glycosylation engineering, therapeutic glycans. Proteins: Structure- function relationship in fibrous and globular proteins**;** proteins in diseases and analytical techniques in disease diagnosis: Enzymatic assays, protein marker identification. Antioxidant systems: Free radicals, Membrane lipid peroxidation, role of mitochondria in oxidative stress; Non-enzymatic and enzymatic antioxidants, protective and therapeutic antioxidants. Hormones: Mechanism of actions of chemically diverse hormones, Regulation of hormone release-by signals; Hormone drugs and their actions.

Reference Books

1. Varki A, Cummings R.D, Esko J.D, Freeze H.H, Stanley P, Bertozzi C.R, Hart G.W,Etzler M.E., " Essentials of Glycobiology", Second edition; Published by Cold Spring Harbor Laboratory Press, New York, 2009
2. Lehninger A. L, Nelson D. L. and Cox M. M. "Principles of Biochemistry" Fourth Edition (Freeman Publishers), New York, 2005.
3. Jain and Jain, "Biochemistry", S. Chand publication, 2008.
4. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.
5. Donald Voet and Judith G. Voet . "Biochemistry" – Volume 1, Biomolecules, Mechanisms of Enzyme Action and Metabolism, John.Willey and sons, 2004.

14BT3002 ANALYTICAL TECHNIQUES AND BIOCHEMISTRY LAB

Credits: 0:0:2
Co-requisite: 14BT3001-Applied Biochemistry

Course Objective:

- To equip the students with analytical knowledge on glycobiology, proteins, antioxidants which are useful to engineers

Course outcome:

- The candidates will be familiar with glycan analysis, protein separation and oxidative stress analysis which equip them to develop new drugs using biotechnology tools

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT3003 ADVANCED BIOPROCESS ENGINEERING

Credits: 3:0:0

Course Objective:

- To acquire knowledge about the advances in Bioprocess Engineering

Course Outcome:

- At the end of the course the student will be familiar in fermentation process and metabolic stoichiometry and the way to enhance the product of interest.

Description: Bioprocess considerations in using Plant and animal cell cultures, bioreactor considerations for animal cell culture. different cell culture bioreactors-perfusion bioreactors, hollow fiber bioreactor, products of animal cell. Immobilized plant cell and cell-retention reactors. Cell suspension culture development, hairy root cultures and their cultivation. Guidelines for Choosing Host-Vector Systems. Process Constraints: Genetic Instability. Considerations in Plasmid Design to Avoid Process Problems, commercial tissue culture processes, Major Classes of Interactions in Mixed Cultures. Simple Models describing Mixed-culture Interactions.

Reference Books

1. Shuler and Kargi, “Bioprocess engineering basic Concepts”, Prentice Hall, Second Indian Reprint ,2004.
2. Bailey J.E. and Ollis, D.F. “Biochemical Engineering Fundamentals”, McGraw Hill,2000.

14BT3004 BIOPROCESS ENGINEERING AND DOWNSTREAM PROCESSING LAB

Credits: 0:0:2

Co-requisite: 14BT3003 **A**dvanced Bioprocess Engineering

Course Objective:

- To develop the skills of students in various bioprocess techniques and downstream processing operations.

Course Outcome:

- The student will become familiar with the production and purification of different industrially important products.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT3005 COMPUTATIONAL BIOLOGY

Credit: 3:0:0

Course Objective

- To provide the students with a foundation for applying available computational tools in biology

Course Outcome

- The students will learn the principle and strategies of using computational tools for biological applications

Description: Genome mapping - Genome sequence and assembly, Physical mapping of DNA, building contigs from genome fragments. Sequence alignment methods – Global and Local alignment, Scoring rules, Multiple alignment, similarity search using FASTA, BLAST, scoring matrices for protein sequences. Gene expression analysis – design of microarray experiment, gene expression studies, SAGE, Protein microarrays. Protein interactions - Methods to study protein interactions (Genetic approach, biochemical methods, Yeast di & tri hybrid systems), Protein interaction databases. Comparative genomics – Compositional measures, Transposable elements, Identifying conserved segments, genome evolution, gene content. Gene prediction, Comparative methods, Predicted proteome, assigning gene function.

Reference Books:

1. Richard C.Deonier, Simon Tavareand Waterman Ms, Computational Genome Analysis – An introduction, Springer 2006.
2. Pevzner J, Bioinformatics and functional genomics, 2nd edition, John Wiley and Sons, NJ, USA, 2009
3. Baxevanis AD and Ouellette BFF, Bioinformatics- A practical guide to the analysis of Genes and Proteins, 2nd edition, John Wiley and Sons, NJ, USA, 2001
4. Primrose SB and Twyman RM, Principles of Gene manipulation and genomics, 7th edition, Blackwell Publishings, USA, 2006

14BT3006 ADVANCES IN RECOMBINANT DNA TECHNOLOGY

Credit: 3:0:0

Course Objective:

- The course will provide knowledge of the advanced methods in recombinant DNA technology
- It provides an insight into various advances in recombinant DNA applications.

Course Outcome:

At the end of the semester student understands,

- The advancements of recombinant DNA technology
- The methods employed in rDNA technology.
- The role of rDNA in medicine, agriculture and industry.

Description: Principles and methods in genetic engineering: Isolation and manipulation of Nucleic Acids – Amplification and Analysis of Nucleic acids - Vectors in Gene Cloning and its types, Enzymes used in genetic engineering, principle and methods to express foreign genes in prokaryotes and eukaryotes, principle and methods of gene transfer in prokaryotes and eukaryotes, methods to purify expressed proteins, generation of transgenics (Transgenic plants and animals, gene knock-out and knock-in technologies). Application of genetic engineering in medicine, agriculture and industry- Human genome project, recombinant therapeutics, gene therapy-RNA therapeutics, DNA vaccines, DNA forensics.

Reference Books:

1. Bernard R. Glick, Jack J. Pasternak, , "Molecular Biotechnology: Principles and Applications of Recombinant DNA", ASM Press, 2010
2. Primrose, "Principles of Gene Manipulation & Genomics" 7th Edition, Oxford University Press, 2006.
3. T.A. Brown Wiley-Blackwell, "Gene Cloning and DNA Analysis: An Introduction". 6th edition 2010

4. Richard M. Myers, Amy A. Caudy, James D. Watson and Jan A. Witkowski Cold Spring Harbor Laboratory Press "Recombinant DNA: Genes and Genomes - A Short Course" 3rd edition, 2007

14BT3007 RECOMBINANT DNA TECHNOLOGY LAB

Credits: 0:0:2

Co requisite: 14BT3006 Advances in Recombinant DNA Technology

Course Objective:

- To train students to isolate, analyze, manipulate and amplify nucleic acids
- To get students familiarize with cDNA synthesis, gene cloning, expression and analysis of cloned genes.

Course Outcome:

- At the end of the lab session, students would have acquired the advanced skill necessary for isolating and analyzing nucleic acids from various sources
- The students would be able to carry out experiments in gene cloning, gene transfer and protein expression

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT3008 BIOPHARMACEUTICAL TECHNOLOGY

Credit: 3:0:0

Course Objective:

- To provide an insight to the postgraduate students on the biopharmaceuticals and ADME properties of a drug.
- To equip the students to know the concept of materials and formulations in drugs and gene therapy.

Course Outcome:

- Students understand the metabolism of drugs, its kinetics, origin of various pharmaceutical products, its preparation and safety & efficacy.
- The students get familiar to the process of gene therapy and drug delivery systems.

Description: History of pharmaceutical industry and biopharmaceuticals, Biotechnology production of Secondary Metabolites, ADME properties and Mechanism of Drug Absorption and its Metabolism, Pharmacokinetics, Materials & Formulations, Drug delivery system – controlled and novel, establishing safety & efficacy, Gene Therapy, Monoclonal Antibodies, recombinant subunit vaccines.

Reference Books:

1. Purohit S.S, H.N. Kakrani and A.K. aluja. Jodhpur, Pharmaceutical Biotechnology, Agrobios (India) publisher, 2003.
2. Brahmankar DM, Sunil B Jaiswal, Biopharmaceutics and Pharmacokinetics-A Treatise, Vallabh publications, 2005.
3. Gary Walsh “Pharmaceutical Biotechnology Concepts and Applications” by,2007
4. Ansel, H., Allen, L.,Popovich, N.. Pharmaceutical Dosage Forms and Drug Delivery Systems, Williams & Wilkins. 1999.
5. Michael J. Groves, Pharmaceutical Biotechnology Second Edition,2006.

14BT3009 ADVANCED PROCESS EQUIPMENT DESIGN

Credits: 2:0:0

Course Objective:

- Students should be able to develop process flow sheets and lay outs equipment and pipelines in chemical process plants.

Course Outcome:

- On completion of this subject students should be able to display an understanding of the principles of process equipment design, the mechanical aspects of the design and operation of process equipment, including safety considerations and students will have completed detailed designs of several unit operations.

Description: Introduction to various mechanical properties of materials to be used as material of construction, design of cylindrical storage tank. Design of air lift fermentor and continuous stirred tank reactor, Design of shell and tube heat exchanger and long vertical evaporator. Design of Bollmann extractor and fractionating column. Design of rotary drum dryer and plate and frame filter press.

Reference Books

1. Peters Max.S., Timmerhaus Klaus D.and Ronald E West "Plant Design and Economics for Chemical Engineers", V Edition McGraw Hill.2003.
2. Indian Standard Codes:
   (a) IS : 2825 - 1969: Code for Unfired Pressure Vessels.
   (b) IS : 4049 - 1979: Specifications for formed ends for Tanks and Pressure vessels.
   (c) IS : 4179 - 1967: Sizes of Process Vessels & their Leading Dimensions.
   (d) IS: 4864 to 4870 - 1968: Specifications for Shell Flanges for Vessels and Equipment.
   (e) IS : 4503 - 1967: Specifications for Shell & Tube Heat Exchangers.
   (f) IS : 803 - 1962: Code of practice for Design, Fabrication and Erection of Mild Steel Cylindrical Welded Oil Storage Tanks. (Published by Bureau of Indian Standards, New Delhi).
3. Brownell, L.E, and Young, E.H. " Process Equipment Design", Wiley Eastern, New Delhi, 2000.
4. Ludwig, E.E. " Applied Process Design for Chemical & Petrochemical Plants", Vols. I, II & III, (2nd Ed.), Gulf Publishing Company, Texas, 1977, 1979, 1983.
5. Strigle, R.F.: Random Packings & Packed Towers (Design & Application), Gulf Publishing Company, Texas, 2000.
6. Perry, R.H. & Green, D.W. "Perry's Chemical Engineers' Handbook", (7 th Ed.),McGraw Hill (ISE), 2000.

14BT3010 PROCESS EQUIPMENT DRAWING LAB

Credits: 0:0:2

Co requisite: 14BT3009 Advanced Process Equipment Design

Course Objective:

- To design safe and dependable processing facilities.
- This course focus on plant layout and design of piping systems
- This will provide the basic knowledge to carryout design process cost effectively.

Course Outcome:

- On completion of this lab students understand the principles of process equipment design, the mechanical aspects of the design.
- Students understand the operation of process equipment, including safety considerations
- Students know about the designs of several unit operations.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14BT3011 SUSTAINABLE BIOPROCESS DEVELOPMENT

Credits: 3:0:0

Course Objective:

- To acquire knowledge about methodologies and supporting case studies for the evolution and implementation of sustainable bioprocesses

Course Outcome:

- At the end of the course the student will be familiar with the bioprocess industries, development procedures, bioprocesses and bioproducts, modeling procedures, sustainability assessment methods and some case studies

Description: Modeling and Assessment in Process Development., Types of Bioprocesses and Bioproducts, Elements of Bioprocesses, Problem Structuring, Process Analysis and Process Scheme, Implementation and Simulation- spread sheet model, modeling using a process simulator, Uncertainty Analysis. Economic Assessment- capital cost estimation, operating cost estimation, profitability assessment and Environmental Assessment- structure of method, Impact categories and groups, calculation of environmental factors, calculation of indices, Assessing Social Aspects- indicators for social assessment. Bioprocess development and sustainability analysis of acids, amino acids, vitamins, Antibiotics, Recombinant products, Monoclonal Antibodies and Plasmid DNA.

Reference Books:

1. Elmar Heinzle, Arno P. Biwer, Charles L. Cooney, "Development of Sustainable Bioprocesses: Modeling and Assessment", John Wiley and Sons, Ltd, England, 2008
2. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2002

14BT3012 ADVANCED ENVIRONMENTAL BIOTECHNOLOGY

Credits: 3:0:0

Course Objective:

To develop skills in students with bioreactors and biotreatment methods of industrial wastewater and also learn novel technologies for remediation of environmental pollution

Course Outcome:

At the end of this course, students would have learnt to:

- Create an awareness of professional responsibility towards protecting the environment.
- Study the natural and engineered bio-treatment methods to remediate the pollutants
- Create awareness about opportunities in environmental management
- Investigate the opportunities for incorporating environmental quality into products, processes and projects

Description: Role of biotechnology in environment protection, Types, causes and its effects on soil, water, air, oil and heavy metal pollution in environment, Design and evaluation of bioreactors for wastewater treatment, Wastewater characteristics and bio-treatment of industrial wastewater, Engineered bioremediation and biodegradation of heavy metal, hydrocarbon and xenobiotic compounds, Novel biotechnology methods for pollution control.

Reference Books

5. Metcalf and Eddy, "Waste water Engineering Treatment, Disposal and Reuse". McGraw Hill, 2001.
6. Graty. C.P.L., Daigger, G and Lim, H.C, "Biological Wastewater Treatment". 3rd Edition, Marcel Dekker, 2008
7. Jogdand, S.N. "Environmental Biotechnology". Himalaya Publishing House, New Delhi, 2007.
8. Karnely D. Chakrabarty K. Ovnen G.S. "Biotechnology and Biodegradation, Advances in Applied Biotechnology series", Gulf Publications Co. London 2009.

14BT3013 ENTREPRENEURSHIP, IPR AND BIOSAFETY

Credits: 2:0:0

Course Objective:

The objective of the course is to make students learn about the legal, safety and public policy issues raised due to the rapid progress in Biotechnology and development of new products.

Course Outcome:

At the end of the course,

- It is expected that students have understood the basic issues of Biosafety, Bioethics and IPR.
- It is expected that they will be more confidant to practice and implement all these policies in their future endeavor.

Description: Functions and kinds of entrepreneurs; Entrepreneurship and economic development; project identification, selection and financing; guidelines of DBT for formulating project; Introduction to IPR, Patents; Trademark; Copyright; GMO and IPR; WTO, GATT and TRIPS agreement; Indian Patent Act; Patenting procedures; Plant Breeder's Rights; Biosafety – levels; Biosafety guidelines; Role of Biosafety committee; Definition of GMOs & LMOs; Risk factors; Overview of National Regulations and relevant International Agreements including Cartagena Protocol, Biological material transfer procedure.

Reference Books:

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra, Information Solution Pvt. Ltd., 2007.
3. S.S.Kanka Entrepreneurship Development, S.Chand and Co, New Delhi 1997.

14BT3014 RESEARCH METHODOLOGY

Credits: 2:0:0

Course Objective:

- To equip the students with the knowledge about the basic research methods.
- To create awareness among students about various data collection and applications in conducting research
- To introduce the students to different statistical analysis techniques and its importance

Course Outcome:

- The student would have acquired knowledge on applications of statistics in research.
- The student gain knowledge in experimental design and data collection techniques.
- The student develops the technical art of writing research report and presentations.

Description: Research problems- Types-Basic and applied- Interdisciplinary - formulation of research problem, Methods of Research and experimental design- Types of Sample Design, measurement and scaling techniques- Technique of developing measurement Tools, Scaling-Classification and design, collection, processing and analysis of data- Statistics in Research, Measures of Central Tendency, Dispersion, Asymmetry, Relationship. Regression Analysis, Correlation Analysis, manuscript/thesis writing- Citation index of journals, H-factor, Bibliography and

References, Methods of presentation of report, ethics and biosafety- Laboratory safety, biosafety, recombinant material safety, Standard operation protocol

References Books:

1. Kothari C.R, "Research methodology, Methods and techniques", second edition, New Age International (P) Ltd, Publishers, New Delhi, 2004.
2. Jerrod H. Zar, "Biostatistical analysis", Prentice Hall International, Inc. Press, London 1999.
3. Donald H. McBurney, "Research methods", Thomson Asia Pvt. Ltd. Singapore, 2002
4. Ranjit Kumar, "Research methodology", Sage Publications, London, New Delhi, 2006.
5. Raymond – Alain Thie' tart, "Doing Management research", Sage publications, London, 2001.

14BT3015 INDUSTRIAL SAFETY

Credits: 3:0:0

Course Objective:

- To develop highly qualified professional manpower by systematic quality based coaching and training in advanced science and technologies.

Course Outcome:

- At the end of the course the student will be familiar in safety program in terms of effectiveness to improve safe work practices and good housekeeping, and the effect of mode of administration upon program effectiveness.

Description: Major industrial accidents in India and in other countries, High pressure-high temperature operation-dangerous and toxic chemicals, highly radioactive materials safe handling and operation of materials and machineries. Work environment-noise-effect of noise-unit of sound-noise levels in industries-control of noise-industrial ventilation and exhaust systems. Identification and analysis of causes of injury to men and machineries-accident prevention-accident proneness-vocational guidance, fire prevention and fire protection-personal protective equipments. Occupational, industrial health hazards –health standards and rules-safe working environments. Role of Government, safety organization, management and trade unions in promoting industrial safety- on site and off site safety provisions.

Reference Books

1. R. K. Jain and Sunil S. Rao , "Industrial Safety , Health and Environment Management Systems", Khanna publishers , New Delhi, 2006.
2. Grimaldi and Simonds , "Safety Management", AITBS Publishers , 2001.
3. Krishnan, "Safety Management in Industry" , Jaico Publishers, 2003
4. H.H. Fawcet and W.S. Wood "Safety and Accident Prevention in Chemical Operations", Occupational Safety and Health Management, Anton, McGraw Hill Co., 2000.

14BT3016 ENZYME TECHNOLOGY AND INDUSTRIAL APPLICATIONS

Credits: 3:0:0

Course Objective:

- To understand the mechanism of biocatalyst and the kinetics behind its extraction and purification procedures, immobilization techniques etc.

Course Outcome:

- The students will understand the concept of immobilization extraction and purification and the inhibition kinetics of the enzymatic reactions

Descripion: Classification of enzymes, quantification of enzyme activity and specific activity. Effect of pH and temperature on enzyme activity, Estimation of Michaelis Menten parameters, Enzyme Inhibition – Substrate, Product and Toxic compound inhibition, types and derivation. Enzyme deactivation kinetics. Allosteric regulation of enzymes, Monod changeux wyman model, Extraction of commercially important enzymes from natural sources; Commercial applications of enzymes in industries, Techniques of enzyme immobilization, Analysis of film and Pore diffusion. Applications of enzymes in analysis; Design of enzyme electrodes and case studies on their application as biosensors in industry, healthcare and environment.

Reference Books:

1. Palmer T, P.L. Bonner, "Enzymes: Biochemistry", "Biotechnology", "Clinical chemistry", 2nd Edn, Harwood Publishing Ltd. 2007.
2. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2002
3. Bailey J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals", McGraw Hill,2000.

14BT3017 ADVANCED BIOREACTOR ENGINEERING

Credits: 3:0:0

Course Objective:

- To impart knowledge on the principles and concepts of bioreactor techniques

Course Outcome:

- At the end of the course the students would have learnt the principles of stoichiometry, kinetic of growth and product formation.

Description: Catalytic and non-catalytic heterogeneous reactions, concept of rate controlling / limit step. Contacting pattern for two phase reaction. Alternate approach to evaluate K_{La}, method to find inhibition type from experiment, solved examples. Growth and product kinetics. determination of kinetic parameters for monod equation. Determination of oxygen transfer coefficients by correlations and experimental method. Estimation of power consumption in aerated and non-aerated bioreactors. Various scale up criteria for bioreactors. Monitoring and control in fermentation process. types of control systems.

Reference Books

1. Shuler and Kargi, "Bioprocess engineering basic Concepts", Prentice Hall India pvt. Ltd., 2002.
2. Bailey J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals", McGraw Hill, 2000.

14BT3018 CHEMICAL PROCESS TECHNOLOGY

Credits: 3:0:0

Course Objective:

- To make the students understand the process outline in the production field of organic and inorganic chemical technology.

Course Outcome:

- At the end of the course the student will be familiar in the field of unit operations and unit process like gas industries, fertilizer industries.

Description: Indian Organic and inorganic chemical industries - an overview, Concept of unit operations and unit processes. Refining of edible oil, fats and fatty acids. Production of sugar, starch and starch derivatives. Industrial gases- Carbon dioxide, oxygen, nitrogen, hydrogen and acetylene. Fertilizer industries- biopesticides and biofertilizers

Reference Books:

1. R.N.Shreve and T.Austin. Chemical process industries, McGraw Hill book Company,5th edition Singapore, 1984.
2. Dryden's Outline of chemical technology, 3rd edition, East West Press, New Delhi, 1997.
3. Kirk and Othmer, Encyclopedia of Chemical Technology, Wiley & sons, New York, 4th edition, 1994

14BT3019 CHEMICAL AND BIOCHEMICAL ENGINEERING LAB

Credits: 0:0:4

Co requisite: 14BT3018 Chemical Process Technology

Course Objective:

- The students learn experimental analysis of Michaelis -Menton enzyme kinetics;
- Batch growth of bacteria and Monod growth dynamics;
- Steady state bacterial growth and measurement of oxygen transport parameters.

Course Outcome:

- Students design and analyze experiments to measure the kinetic parameters of an enzyme;
- Analyze microbial growth, substrate consumption, and product formation in batch reactors

14BT3020 IMMUNOTECHNOLOGY

Credits: 3:0:0

Course Objective:

- To provide advanced knowledge in the area of immunology.
- To impart knowledge in immunotechniques

Course Outcome:

At the end of the course the student could

- describe and explain complex immunological processes
- interpret, depict and discuss complex biological observations in terms of immunology.
- describe and explain analytical approaches based on immunological techniques for complex issues within the bio-area evaluate experimental data from an integrated immunochemical and biochemical point of view
- present and interpret experimental data and theoretical considerations in an immunological context

Description: Preparation of antigens for raising antibodies, *In vitro* antigen-antibody reactions, Isolation of antibodies, assays for complement, immunoelectrophoresis, ELISA, RIA and immunoblotting, Immunofluorescence, flow cytometry & sorting, T & B cell subset analysis, immuno-electron microscopy. MAb through hybridoma technology, MAb without hybridoma technology – viral transformation of B cell line, plant as expression systems – plantibodies, applications. Production of abzymes, immunotoxins, chimeric antibodies, bi specific antibodies, single chain Fc, diabodies, tetrabodies, intrabodies; plastibodies; applications. Immunotechniques and technologies involved in the diagnosis and treatment of immunology related diseases – case studies – congenital asplenia, X-linked gammaglobulinemia, hyper IgM immunodeficiency, immunotargetting - super antigen based therapy.

Reference Books

1. Murphy, K. Janeway´s Immunobiology. 8th ed. Garland Science, 2011.
2. Chakravarthy AK. Immunology & Immunotechnology. Oxford University Publishers. 2nd Ed. 2009.
3. Harwey RA, "Immunology", 2nd Ed. Lippincott Publishers, 2013.

14BT3021 MICROBIAL PATHOGENESIS

Credits: 3:0:0

Course Objective:

The objective of the present course is

- To study the fundamental mechanism of disease process
- To give a strong foundation about pathology and the host defense mechanism

Course Outcome:

- At the end of the course, , the student understand the mechanisms of microbial pathogenesis

Description: Microbial agents and molecular mechanism of host response- Infectious agents (bacteria, virus and parasites)- Vector borne diseases – enteric and non enteric pathogens, respiratory pathogens, trafficking intracellular pathogens - microbial adherence, secretory system –general secretory pathways- and microbial toxin mediated diseases , biofilm and bacteriocin – multidrug resistance –quorum sensing– molecular mechanism of virulence-development of vaccine.

Reference Books:

1. Alphonse E. Sirica**,** Cellular and Molecular Pathogenesis, Lippincott Williams & Wilkins; 3rd edition 2010
2. Philip T. Cagle, Timothy Craig Allen, Basic Concepts of Molecular Pathology Springer Publishers, 1st Ed. 2009
3. Ananthanarayan. R. And Paniker C.K. Text Book of Microbiology, 9th Edition, Orient Longman, 2013
4. Murray, P.R., K.S. Rosenthal and M.A. Pfaller "Medical Microbiology" Elsevier – Mosby, 6th Edition, 2009.

14BT3022 CLINICAL TRIALS AND BIOETHICS

Credits: 3:0:0

Course Objective:

The objective of the present course is

- To study the fundamentals of clinical research and bioethics
- To give a strong foundation about different phases of clinical research

Course Outcome:

- At the end of the course the student can understand the steps involved in clinical research
- The student will get an outline about preclinical studies and the ethical aspects associated with clinical research.

Description: Fundamental and clinical trials, Drug development and trial planning - pre-study requirements for clinical trials and toxicological studies; Basic statistics for clinical trials; Regulatory approvals for clinical trials; Requirements of clinical trials protocols; Legislative requirements for investigational medicinal products. Project management in clinical trials - principles of project management; Application in clinical trial management; Ethical issues in clinical trials; Ethics in use of animals and stem cells in clinical studies; Data management – Introduction to trial master files and essential documents; Quality assurance and governance - quality control in clinical trials; Pharmacovigilance; Common pitfalls in clinical trial management.

Reference Books

1. Lee, Chi-Jen; etal., "Clinical Trials or Drugs and Biopharmaceuticals." CRC / Taylor & Francis, 2011.
2. Matoren, Gary M. "The Clinical Research Process in the Pharmaceutical Industry." Marcel Dekker, 1984.
3. Stephen B. Hulley, Steven R. Cummings, Warren S. Browner, Deborah G. Grady, Thomas B. Newman., "Designing Clinical Research." Lippincott Williams & Wilkins; 4th edition, 2013.

14BT3023 ADVANCED ANIMAL BIOTECHNOLOGY & TISSUE CULTURE

Credits: 3:0:0

Course Objective:
The objective of the present course is

- To provide insights into animal tissue culture
- To equip the students with the aspects of animal biotechnology.

Course Outcome:

- At the end of the course, the student understands the methodology for culturing cells, tissues and organs.
- The students can apply this knowledge for producing transgenic animals and molecular pharming.

Description: Introduction to Animal Cell, Tissue and organ culture, IVF technology, Cloning vectors used in transformation; Transgenic animals; Molecular pharming; Baculovirus vector and foreign gene expression; Pest management; transgenic silk production; Biotechnological approach for the production of live feed; Gene therapy; Cryopreservation and transshipment of animal tissue and cell line. Stem cell Technology- Development of pluripotent stem cells using somatic cells.

Reference Books

1. B. Ianfreshney. Culture of Animal cells & Manual of basic technique, fifth edition, Wiley – liss publication, 2006.
2. Dubey R.C. Text book of biotechnology S.Chand & Company Ltd. 2007
3. B. Sasidhar. Animal Biotechnology MJP publishers. 2006

14BT3024 IMMUNOTECHNOLOGY & CLINICAL BIOTECHNOLOGY LAB

Credits: 0:0:4

Co requisite: 14BT3020 Immunotechnology

Course Objective:

- To provide advanced knowledge in the practical aspects of immunotechnology and clinical Biotechnology
- To apply the knowledge to solve problems in the research field and find solutions for health related problems

Course Outcome:
At the end of the course the student could

- Perform experiments in the field independently.
- Interpret and depict the complex biological observations.
- Develop analytical skills, present and interpret experimental data in immunotechnology

14BT3025 ADVANCED PLANT BIOTECHNOLOGY AND TISSUE CULTURE

Credits: 3:0:0

Course Objective:

- To intend the students with the knowledge about plant tissue culture.
- To create awareness among students about different plant transformation techniques
- To introduce the students to different strategies of GM crops and its impact

Course Outcome:

- The student will develop complete knowledge on genetic transformation techniques in plants.
- The course will enhance the student knowledge in plant tissue culture for genetic transformation.
- The student will develop the technical knowledge on development of GM crops.

Description: Plant tissue culture - micro propagation techniques – callus and somatic embryogenesis, Techniques in plant transformation- Agrobacterium mediated gene transfer – Ti plasmid and Ri plasmid- The process of T-DNA transfer and integration – Practical application, Direct Gene transfer methods-Development of Plant Transformation Vectors – Strategies for engineering – Herbicide Tolerance, Pest and disease resistance and stress tolerance development, molecular pharming of carbohydrate, vitamins and protein production, metabolic engineering of lipids.

References Books

1. Adrian Slater, Nigel W. Scott and Mark R. Fowler, "Plant Biotechnology – The genetic Manipulation of Plants", Second Edition Oxford University Press, 2008.
2. H.S. Chawla, "Introduction to Plant Biotechnology",. Oxford and IBH P Publishing Co.Pvt. Ltd. New Delhi, 2002.
3. Monica. A. Hughes. "Plant molecular genetics". Pearson Education limited, England, 1999.
4. J. Sambrook, E.F. Fritsch and T. Maniatis, "Molecular Cloning: a Laboratory Manual"Cold Spring Harbor Laboratory Press, New York, 2001
5. R.C. Dubay. "A Text Book of Biotechnology".. S.Chand & Campany Ltd. 2001.
6. Bernard R. Glick, Jack J. Pasternak and Cheryl L.Patten. "Molecular Biotechnology ASM press, 4th edn., 2010

14BT3026 HUMAN ANATOMY AND PHYSIOLOGY

Credits: 3:0:0

Course Objective:

- To learn about the anatomy and functions various organs of human body.
- To explain the overall structure – functional relationship of physiological systems.
- To apply this basic knowledge to identify the changes in body functions as a result of disease and determine the reason for functional changes.

Course Outcome:

- Appreciate the structural and functional details of human body
- Relate how each body system works in coordination
- Appreciate how homeostasis is achieved in the body

Description: Introduction to cell structure: Function of each component of the cell, Membrane potential , Blood, Blood cells, Composition, Circulatory and respiratory systems: Structure and functioning of lungs, General circulation, Capillary circulation, Venous return, Regulation of breathing-Nervous and sensory systems, Sensory organs, digestive and excretory system, Endocrine system: Pituitary gland, Thyroid and parathyroid glands, Pancreas, Ovary and testis.

Reference Books

1. Arthur.C.Guyton, "Textbook of Medical Physiology" Prism Book (P) Ltd, USA, 2008.
2. Ranganathan, T.S. "Text Book of Human Anatomy", S.Chand&Co. Ltd., New Delhi 2007.
3. Gary A.Thibodeau, Kevin T.Patton, "Anatomy & Physiology,"7th Edition, Mosby Publisher 2009.
4. Gillian Pocock & Christopher D.Richards, "The Human Body", Oxford University Press, 2009.

14BT3027 BIOMATERIALS

Credits: 3:0:0

Course Objective:

- To study the characteristics and classification of Biomaterials.
- To learn about polymeric materials and combinations that could be used as a tissue replacement implants.
- To study the artificial organ developed using these materials.

Course Outcome:

- Analyze properties of the Bio compatible materials.
- Analyze the different types of Biomaterials and its applications.
- Select the appropriate material for implantable materials.

Description: Structure of bio materials and bio compatibility**-** Mechanical properties, Physical characterization, Surface characterization, Thermal characterization, SEM, TEM, X ray diffractometry-Implant materials –smart materials for medical applications- tissue replacement implants-Sutures, Surgical tapes, Adhesive, Percutaneous and skin implants, Maxillofacial augmentation, Joint replacements-Artificial organs- Dental Implants.

References Books

1. Jonathan Black, "Biological Performance of Materials Fundamentals of Biocompatibility", USA, 2004.
2. Joon Bu Park, Roderic S. Lakes, "Biomaterials: An Introduction", New York, 2007.
3. Rater B.D. "Biomaterials Sciences – An Introduction to Materials in Medicine" Academic Press ,China 2004.
4. Joon Bu Park, Joseph D. Bronzino, 'Biomaterials: principles and applications', CRC press, USA, 2003.
5. TeohSweeHin, SweeHinTeoh, 'Engineering materials for biomedical applications' World Scientific Publishing Co, USA, 2004.
6. Sujata V. Bhat, 'Biomaterials', Narosa Publishing House, New Delhi, 2002.

14BT3028 BIOLOGY FOR NANOTECHNOLOGY

Credits: 3:0:0

Objective

- To teach basics about animal and plant cells
- To teach fundamental biological disciplines
- To explain the concepts behind microbial production of nanoparticles

Outcome

- The students will be able to understand basic concepts in various disciplines of biology
- The students will be able to use this knowledge in tandem with Nanotechnology for various healthcare applications.
- The students will learn the technology behind microbial synthesis of nanoparticles

Course Description

Cell Biology & Tissue Culture- Structure and organization of prokaryotic and eukaryotic cell (animal cell & plant cell). Plant Tissue Culture - Structure and organization of prokaryotic and eukaryotic cell (animal cell & plant cell). Plant Tissue Culture- Molecular Biology - Outlines of the Central dogma of molecular biology - Genetic Engineering - Introduction to recombinant DNA technology - Gene cloning – Immunology - Cells and organs of immune system. Innate and acquired immunities - Nanoparticles in Biology - Microbial nanoparticle production, Magnetosomes.

Reference Books

1. James D. Watson , Molecular Biology of the Gene, 5th edition, Pearson Ltd., 2008.
2. Kindt, Goldsby, Osborne, "Kuby Immunology", 6th Edition, WH Freeman and Company.
3. H.F. Gilbert, Basic concepts in biochemistry, McGraw Hill, 2nd Edition, 2002
4. Lehninger, Principles of biochemistry, David L. Nelson, Michael M. Cox, 4th Edition, 2002
5. J.M. Berg, J.L. Tymoczko, L. Stryer, Biochemistry, 5th Edition, W.H. Freeman & Co., 2004
6. Lynne B. Jorde, Biochemistry notes, Kaplan Inc., 2002
7. G. N. Wilson, Biochemistry, McGraw Hill co., 2002

14BT3029 NANOBIOTECHNOLOGY

Credits: 3:0:0

Objective

- To know about biology inspired concepts, nanobiometrics, natural nanocomposites, nano analytics and molecular manufacturing
- To study the properties of fundamental biological units used to create materials for applications in human health care
- To understand how biology can be used to learn fundamental design principles

Outcome:

- Students acquire a good understanding on the basic principles and applications of Nanobiotechnology
- Students will be able to understand the properties of biological building blocks
- Students will be able to appreciate the plethora of methodology that biology has been employing for ages for creating materials for human health care

Description: Biology inspired concepts, Microbial production of nanoparticles, Extracellular matrix, Nanofiber preparation, Bioelectronics, Molecular electronics, Nanobiometrics, Biological computing, DNA computers, Natural nanocomposites, Nanotechnology in agriculture, Nanoanalytics, Quantum dot labeling, AFM and Molecular Pulling Force microscopy, Biofunctionalized nanoparticles for SERS and SPR, Nanosimulation, health and safety implications of nanoparticles, Military applications of nanoparticles

Reference Books

1. R.S. Greco, F.B.Prinz and R.L.Smith, Nanoscale Technology in Biological Systems, CRC press, 2005.
2. Tuan Vo-Dinh, Protein Nanotechnology Protocols, Instrumentation and Application, Series ; Methods in Molecular Biology 2005.
3. Christof M. Neimeyer, Chad.A.Mirkinm, Nanobiotechology : Concepts, Applications and perspectives, Wiley VCH Weinheim 2004.
4. David. S. Goodsell, Bionanotechnology: concepts, lessons from nature, Wiley-Liss, 2004.
5. Sandra J Rosethal, David W Wright, Nanobiotechnology Protocols, Series Methods in Molecular Biology,2005.
6. B. Bhushan , Springer Handbook of Nanotechnology: Volume 1&2, Springer-Verlag. Second edn., 2007.
7. Christof M. Neimeyer, Chad.A.Mirkin, Nanobiotechology II : More Concepts, and Applications, Wiley VCH Weinheim 2007.

14BT3030 EXPERIMENTAL TECHNIQUES FOR NANOBIOTECHNOLOGY

Credits: 0:0:2

Course Objective:

- To strengthen the knowledge in basic techniques in nanobiotechnology
- To understand the concept of various experimental techniques in nanobiotechnology.

Course Outcome:

- The students will be able to understand basic concepts in nanobiotechnology
- The students will be able to use this knowledge for various healthcare applications.

The faculty conducting the laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.