THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

COURSE SCHEME

FOR

M.TECH BIOTECHNOLOGY

2022

Approved in 107th meeting of the Senate held on June 16, 2022

DEPARTMENT OF BIOTECHNOLOGY

M.Tech Biotechnology

Programme Educational Objectives (PEO)

I. The programme focuses on basic and applied understanding in advanced and modern biotechnology with emphasis on industrial applications and product development.

II. The programme is aimed towards the scientific research with focus on applied biotechnology subjects.

III. It also gives emphasis on practical skills in different fields of biotechnology in addition to research training which make students to analyze, design and solve industrial and research associated problems.

IV. The objective of this programme is to make students competitive enough to make successful career in industries and research institutes/universities.

Programme Outcome

After successful completion of this MTech programme in Biotechnology, students will:

I. integrate theoretical and practical skills in basic and applied disciplines of biotechnology.
II. acquire knowledge to develop a research plan in which research question, hypothesis, experimental set-up and data analysis are described in relation to relevant literature.
III. design new biotechnological products or processes by applying knowledge of different disciplines of biotechnology in an integrated manner.
IV. be trained enough for employment in diverse areas of biotechnology as well as for further higher studies.

COURSE SCHEME & SYLLABUS FOR M. TECH (BIOTECHNOLOGY)

SEMESTER – I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY105	RECOMBINANT DNA TECHNOLOGY	3	0	2	4.0
2	PBY106	COMPUTATIONAL & SYSTEMS BIOLOGY	3	1	2	4.5
3	PBY107	TRENDS IN FOOD TECHNOLOGY	3	0	2	4.0
4	PMA102	RESEARCH METHODOLOGY	2	0	2	3.0
5	PBY108	FERMENTATION & BIO-SEPARATION TECHNOLOGY	3	1	2	4.5
6	PBY109	STRUCTURAL BIOLOGY AND PROTEIN ENGINEERING	3	1	2	4.5
7	PBY110	MOOCS COURSE ON START-UP ACTIVITY	0	0	2	2*
TOTAL			**17**	**2**	**14**	**26.0**

SEMESTER – II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY211	PHARMACEUTICAL BIOTECHNOLOGY	3	0	2	4.0
2	PBY212	NANO-BIOTECHNOLOGY	3	1	2	4.5
3	PBY213	BIOREMEDIATION TECHNOLOGY	3	0	0	3.0
4	PBY214	TRANSGENIC TECHNOLOGIES	3	0	2	4.0
5		ELECTIVE I	3	0	0	3.0
6		ELECTIVE II	3	0	2	4.0
TOTAL			**18**	**2**	**8**	**22.5**

ELECTIVE-I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY221	ADVANCED STEM CELL TECHNOLOGY	3	0	0	3.0
2	PBY222	CLINICAL IMMUNOLOGY	3	0	0	3.0
3	PBY223	BIOMATERIALS	3	0	0	3.0

ELECTIVE-II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY231	POST-HARVEST TECHNOLOGY	3	0	2	4.0
2	PBY232	ENZYME TECHNOLOGY	3	0	2	4.0
3	PBY233	OMICS TECHNOLOGY	3	0	2	4.0

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SEMESTER – III

S. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY292	SEMINAR	0	0	0	4.0
2	PBY392	MINOR PROJECT	0	0	0	4.0
3	PBY492	DISSERTATION (STARTS)				
TOTAL						**8.0**

SEMESTER – IV

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY492	DISSERTATION	-	-	-	16.0
TOTAL			**-**	**-**	**-**	**16.0**

TOTAL CREDIT: 72.5

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PBY105: RECOMBINANT DNA TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: This course aims to make students learn about techniques of recombinant DNA technology such as molecular cloning, recombinant protein expression, and gene manipulation. Will also make students learn about applications of rDNA technology in metabolic engineering and other related fields.

Molecular cloning: Restriction enzymes and other DNA modifying enzymes used in cloning and other DNA manipulations, essential and desired properties of cloning vectors, examples of cloning and expression vectors, recombinant protein expression in bacteria, yeast, and higher eukaryotic systems, rDNA technology in the purification of overexpressed recombinant proteins.

Genomic and cDNA Libraries: Molecular techniques for cloning for library construction, different type strategies used in screening libraries, tissue-specific cDNA libraries.

Applications of Genetic Engineering: Principle and applications of PCR, RT PCR, QPCR and their application in molecular diagnostics, Site-directed mutagenesis and its applications, basics of genome editing, reporter gene assay for gene regulation studies, DNA sequencing, next-generation sequencing, hybridization-based detection (Southern blot, northern blot analysis), DNA protein interaction studies (EMSA and DNase I footprinting), protein-protein interaction studies (phage display, yeast two-hybrid analyses), RNA interference, RFLP, RAPD, DNA profiling.

Metabolic Engineering: Principle of engineering metabolic pathways, Directed production of small molecules in microorganisms, Production of novel compounds and diverse chemical structures, Case studies on re-routing metabolic pathways in microbes, plants, or animals.

Self-Learning: Applications of Gene Technology: Therapeutic proteins, Recombinant vaccines, and Monoclonal antibodies.

Laboratory Work:

Competent cell preparation, Bacterial transformation, Isolation of plasmid DNA, Restriction analysis of DNA, Cloning in plasmid vectors, PCR amplification, applications of PCR, Gene expression in a bacterial system, and Reporter gene assay.

Course Learning Outcomes (CLO):

The student will be able to:

1. design and perform cloning of foreign DNA in an appropriate vector.
2. Select the suitable hosts for given vectors and apply them for cloning or expression of recombinant proteins.
3. Amplify DNA with a target sequence using polymerase chain reaction.
4. Demonstrate application of recombinant DNA technology in various research, industrial, diagnostic and therapeutic applications.

Text Books:

1. *Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).*
2. *J. E. Krebs, E. S. Goldstein, S. T. Kilpatrick,Lewin's Genes XI, International Edition, Pearson Education (2014)*

Reference Books :

1. *Alberts, B., Johnson, A., Lewis J., Raff, M., Roberts, K., and Walter, P., Molecular Biology of the Cell, Garland Science Publishing (2007).*

2. *Fritsch, J. and Maniatis, E.F., Molecular Cloning, A Laboratory Manual, Cold Spring Harbor Laboratory (1989).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

PB106: COMPUTATIONAL & SYSTEMS BIOLOGY

L	T	P	Cr
3	1	2	4.5

Course Objective: The objective of this course is to familiarize students with basic concepts of sequences, structural alignment, database searching, and protein structure prediction. To understand the basics of computational science and apply it to solve biological problems. To learn about developing algorithms for solving complex biological problems at a theoretical level.

Detail contents:

Introduction: Introduction to Computational Biology, Biological databases, Evolutionary Basis of sequence alignment, Gap penalties, Scoring matrices, Database similarity search, multiple sequence alignment, and phylogenetic analysis.

Protein structure and function: Protein (secondary and tertiary) structure determination by computational methods. pact of the change of single amino acid (SNP) on the structure and function of the proteins. Protein-protein interactions. Functional insight by molecular docking and dynamic simulations.

Algorithms and Computational tools for biological data analysis: Algorithms, flowchart, Data structures – Array, Stack, Queue, Linked, List concepts, Tools to analyze system biology problems such as high throughput genomics and proteomics data,

Machine Learning and Molecular computational biology: Introduction to Machine learning, Various Machine-learning approaches to classify biological data. to Linux and shell commands and scripts. Gene prediction, sequencing genomes, similarity search, restriction mapping, DNA binding motif finding by sequence alignment.

Laboratory Work*:* DNA and protein sequence searches and complete annotation by using different biological databases and tools. Molecular modeling and dynamics simulations. Shell Scripting to handle complex biological data.

Course Learning Outcomes (CLO):

Students will be able to

1. perform sequence, structure alignment and phylogenetic Analysis
2. Analyze the algorithms of tools to understand the sequence, structure, and function of bio-macromolecules.
3. Classify various types of data and predict biological, and societal issues using Machine learning methods.
4. comprehend various methods involved in data analysis by Biocomputing for commercial applications

Textbooks

1. *Xiong J, Essential Bioinformatics, Cambridge University Press (2012)*
2. *Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2004), 2nd ed*
3. *Ghosh Z, and Mallick B, Bioinformatics – Principles and Applications, Oxford University Press (2010)*
4. *V Susheela Devi and M N Murty, University Press - Pattern Recognition: An Introduction (2011)*

Reference Books

1. *Higgins, D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks – A Practical Approach, Oxford University Press (2000).*

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

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PBY107: TRENDS IN FOOD TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course objective: The objective of this course is to provide knowledge on various processing technologies of food (raw) and food products (processed), preservation techniques, their effects on the nutritional aspects, the composition of foods, and long-term storage.

Course contents:

Basic processing operations: Food raw materials: physical, functional, and other properties. Cleaning: methods and contamination, sorting and grading. Principles of food preservation

Conventional processing operations: Thermal processing, cold processing, evaporation, dehydration, irradiation, fermentation, and addition of chemicals

Novel processing operations: Advantages/disadvantages of conventional processing technologies. Novel thermal processing methods and non-thermal processing operations. Emerging technologies in food processing

Advanced food packaging: Types of packaging, degradability, reusability and regulations, active and intelligent packaging, future packages, labeling guidelines of foods.

Conversion Operations for Food Wastes: Characteristics of food/agro-industry wastes, Current treatment options– Overview, Feasibility of reuse and conversion processes for value-added products.

Laboratory Work: Determination of physical and functional properties of food raw materials, Preservation by Heat, Dehydration of foods, Use of novel processing methods for Preservation, Active packaging of foods, Qualitative Analysis of processed food samples, Microbiological quality analysis, Compositional Analysis of food plant wastes and their reusability, Visit mechanized food-processing Industries.

Course Learning Outcome (CLO):

Students will be able to:

1. *apply pre-processing steps to prepare raw material for further processing*
2. *Comprehend processing techniques and reasons behind the usage and application of unique technology on a particular food.*
3. *Handle packaging and labeling operations after production to increase the shelf life.*
4. *Distinguish between conventional and non-conventional methods of processing with their advantages and disadvantages.*
5. *Carry out the proper conversion of food by-products into value-added products.*

Recommended books

1. *Fellows, P.J., Food Processing Technology: Principles and Practice, Woodhead Publishers Ltd. (2016) 4th ed.*
2. *Manay, N. Shakuntala O. Food: facts and principles. New Age International, 2013.*
3. *Rahman, M. S. Handbook of Food Preservation, CRC Press (2020).*

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Reference books:

1. *Theodoros Varzakas and Constantina Tzia, Handbook of Food Processing: Food Safety, Quality, and Manufacturing Processes, 2016, CRC Press, Taylor and Francis group.*
2. *Sun D.W. Emerging Technologies for Food Processing: Academic press. 2nd Ed. 2014.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

PMA102: RESEARCH METHODOLOGY

L	T	P	Cr
2	0	2	3.0

Course Objective: The primary objective of this course is to develop an understanding of the basic framework of the research process and an understanding of various research designs and techniques. To develop an understanding of the ethical dimensions of conducting applied research.

Introduction: Nature and objectives of the research, Study and formulation of the research problem, Scope and formulation of hypothesis, Preparation, and presentation of research and project proposals, Selection of thrust research.

Introduction to Statistical Analysis: Measures of central tendency and dispersion, mean, median, mode, range, mean deviation, standard deviation.

Random Variables and Probability Distribution: Definition, Distributions, Functions, Mathematical expectation, Binomial, Poisson, geometric, negative binomial, exponential, normal, and log-normal distributions.

Hypothesis Testing: Tests of significance based on average, t, and chi-square distributions, Analysis of variance technique.

Linear Regression and Correlation: Linear regression, least-square principle, and fitted models,Pearson's correlation coefficient, rank correlation, Lines of regression.

Self-Learning: Design of Experiments, Completely randomized design, Random block design, Latin square design, Statistical Analysis and variances of estimates, Analysis of covariance.

Laboratory Work:
Implementation of statistical techniques using statistical packages viz., SPSS, Mathematica, including evaluation of statistical parameters and data interpretation, Regression analysis, Covariance, Hypothesis testing, and Analysis of variance.

Course Learning Outcome (CLO):
Students will be able to:

1. develop testable hypotheses, differentiate research design and/or statistics, evaluate the aptness of research conclusions, and generalize them appropriately.
2. Design and conduct quantitative or qualitative research studies in laboratory or field settings.
3. Apply research data to formulate or evaluate new research questions, using reason and persuasion in a logical argument.

Text Books:

1. *Dowdy S., Wearden, S., and Chilko, D., Statistics for Research, Wiley Series (2004)*
2. *Montgomery DC., Design, and Analysis of experiments (2012), 7th edition*

Reference Books:

1. *Walpole RE, Myers RH, Myers SL, and Ye K, Probability and Statistics for Engineers and Scientists, Pearson Education (2002)*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
	MST	25
	EST	35
	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PBY108: FERMENTATION & BIO-SEPARATION TECHNOLOGY

L	T	P	Cr
3	1	2	4.5

Course Objective: The objective of this course is to enable students to acquire knowledge of reaction engineering systems with an emphasis on the design and construction of fermenters and parameters to be Monitored and controlled the fermentation process, the Kinetics of cell growth, and product formation with separation and purification of desired products.

Introduction to Fermentation Processes: History and development of fermentation industry, the range of fermentation processes, General requirements of fermentation processes; Isolation and improvement of industrially essential strains, Media for industrial fermentations, Media sterilization, Inoculum development for industrial fermentations, Kinetics of microbial growth, Cell death kinetics, Types of fermentation- batch, continuous, fed-batch, surface, and submerged and solid-state fermentation. An overview of aerobic and anaerobic fermentation processes and their application in biotechnology.

Fermenters and Process Control: Design consideration of fermenters; Basic design and construction of fermenters and ancillaries, Measurement and control of bioprocess parameters; temperature, pressure, flow, dissolved oxygen, pH, the Role of computers in fermentation process analysis, Oxygen transfer methodology in Fermenters, Determination of oxygen transfer coefficients (kLa), Factors affecting oxygen transfer rate, Effectiveness factor, and Thiele modulus. Design and operation of various bioreactors, viz CSTF, Fed-batch systems, Plug flow, Packed bed bioreactors, Air-lift bioreactors, Fluidized bed bioreactors, and Scale-up studies.

Recovery and Isolation of Fermentation Products: An overview of bioseparation, Role and importance of bioseparation in biotechnological processes, Separation of cells and other insoluble from fermented broth, Filtration, Centrifugation, Flocculation, Cell disruption methods for intracellular products recovery, Theory, design, and configuration of membrane separation equipment and application, Microfiltration, Ultrafiltration, Reverse osmosis, Dialysis, Diafiltration.

Purification and Polishing of Fermentation Processes: Solvent extraction, co-current, counter-current extractions, Adsorption isotherms, industrial adsorbents, adsorption equipment for batch and continuous operations, adsorption in fixed beds, Precipitation with salts, organic solvents, and polymers, Chromatographic methods (different principles: ion exchange; affinity, gel permeation)- Medium Pressure Liquid Chromatography, HPLC, Drying, Spray drying, Freeze drying, Evaporation, Pervaporation, Crystallization.

Self-learning: Online data analysis of physicochemical parameter measurements for biochemical processes, Concepts of process control viz. PID Controllers-Application of Fuzzy logic and neural networks in bioprocess control, Drying case studies, Case studies for the separation of intracellular and extracellular products.

Laboratory work: Fermenter - design, operation, and control, Microbial production of different products, Whole-cell immobilization, Comparative Study on the rate of product formation using immobilized and suspension culture, Batch sedimentation, Flocculation studies, Conventional filtration, Adsorption process in batch mode, Cell disruption, Batch drying, Chromatography - design, operation, and control, Qualitative and quantitative estimation of compounds using chromatography.

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Course Learning Outcomes (CLO):

Students will be able to:

1. Comprehend various types of fermentation processes
2. Produce bio-products on an industrial scale using fermenters
3. Perform bio-separation operations as applicable in bioprocess industries.
4. Explain different recovery, isolation, purification, and polishing steps of downstream processing.

Text Books:

1. Stanbury PF, Hall SJ, and Whitaker A, Principles of Fermentation Technology, Butterworth – Heinemann (2013).
2. Shuler ML and Kargi F, Bioprocess Engineering, Prentice Hall (2014).
3. Sivasankar B, Bioseparations: Principles and Techniques, PHI Learning Pvt. Ltd. (2016)
4. Belter PA, Cussler E, and Hu WS, Bioseparation – Downstream Processing for Biotechnology, Wiley Interscience (2011)

Reference Books:

1. Doran PM, Bioprocess Engineering Principles, Academic Press (2018)
2. Ahuja S, Handbook of Bioseparations, Academic Press (2012)
3. Harrison RG, Bioseparations: Science and Engineering, Oxford University Press (2010)

Evaluation Scheme:

Sl No.	Evaluation Elements	weightage (%)
1.	MST	25
2.	EST	35
3.	Sessional (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PBY109: STRUCTURAL BIOLOGY & PROTEIN ENGINEERING

L	T	P	Cr
3	1	2	4.5

Course Objective: Aiming to provide basic knowledge of engineering and design of the protein for its application, this course will make students learn structural and functional relationships in proteins and enable students to improvise protein structure and function.

Detail contents:

Elements of protein structure
Introduction to protein engineering; Primary structure: amino acids and their –R groups; Secondary structure: α helix, β strand, β sheet, loops, Ramachandran plot; Supersecondary and tertiary structure: motifs, domain, and fold; Quaternary structure: oligomer assembly; Relationship between structure and function: protein active site, catalytic site, crypto sites, and druggability, cooperativity an allosteric effect.

Experimental and computational tools used in protein structural Biology
Protein structure determination by X-ray diffraction (XRD), NMR, Cryo-electron microscopy (CryoEM), Small-angle scattering (SAC); Prediction of protein structure and conformation from sequence data (Homology Modeling, Threading, and *de novo* prediction.); Computational tools for the prediction of protein active sites; Analysis of protein structure and protein-protein and protein-small molecule interaction by CD spectroscopy, fluorescence spectroscopy, MALDI-TOF; Protein activity and stability measurement (k_{cat}/K_m; T_m) using spectroscopy, thermal-shift assay, Isothermal Titration Calorimetry (ITC), Surface Plasmon Resonance (SPR).

Protein Engineering
Mutagenesis methods: site-directed mutagenesis–insertion, deletion, substitution, modular protein domain, random mutagenesis- directed evolution, gene shuffling (RACHITT, ITCHY, SCRATCHY); Kunkle mutagenesis; Phage display technology; Overview of CRISPR/Cas method (*in vivo*); Insertion of unnatural amino acids in protein using the orthogonal system; Chemical modifications of proteins; Case study – protein engineering in lysozyme.

Application of protein engineering and Design
Concept of protein design and usage; Preliminary considerations of protein structure: structural complementation, long-distance interaction; Special protein structures: protein knot, circularly permuted protein; Designed large oligomer assemblies, scaffolds; Design of peptide and protein mimics, Applications in drug delivery, biosensors, immunotherapy

Laboratory work: Computational prediction of protein function and structure from arbitrary protein sequence; Retrieving protein structure from the database (PDB); Visualization and Analysis of protein structure; Protein precipitation using ammonium sulfate; SDS-PAGE analysis of the protein; Quantification of protein using spectroscopy (Bradford or Lowry); Protein denaturation study using UREA; Protein denaturation study using heat; Chromatography method of protein purification.

Self-Learning: application of protein engineering for stability, producing fusion proteins, engineering therapeutic antibodies and other proteins, engineering molecular probes, enzymes, and biosensor engineering

Course Learning Outcomes (CLO):
Students will be able to
1. Understand the protein structure and function relationship.
2. Know the methods for determining and studying protein structure, function, and stability.
3. Apply the methods involved in protein engineering.

4. Design strategies for protein engineering and design.

Text Books:

1. Primrose SB and Twyman RM: ***Principles of Gene Manipulation and Genomics*** Blackwell Publishing (2006).
2. Cleland JL and Craik CS: ***Protein Engineering: Principles and Practice***, Wiley-Liss. (1996).
3. Zhao H(Editor), Lee SY(Series Editor), Nielson J(Series editor), Stephanopoulos G (Series Editor): ***Protein Engineering: Tools and Applications***, Wiley-VCH (20021).
4. Lutz S and Bornscheuer U T: ***Protein Engineering Handbook***, Wiley-VCH (2009)

Reference Books:

1. Branden CI, Tooze J: ***Introduction to Protein Structure***, Garland Science (1998)
2. Mike Williamson: ***How Proteins Work***, Garland Science (2012)

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

PBY211: PHARMACEUTICAL BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course objective: The overarching aim of this course is to acquaint the student with the process of drug discovery, development of new drugs, and biopharmaceuticals. Further, it emphasizes the regulatory aspects from the laboratory through commercial manufacturing to the end consumer.

Introduction: Modern Drug Discovery and Development: An Overview, Pre-industrial drug discovery (Botanicals), Snapshot of Indian and Global Pharmaceutical Industry; Economics of Drug Discovery and Development, Research trends in the Pharmaceutical Industry.

The rationale of Drug Discovery: Medical Needs, Target Identification and Validation, Drug interaction with targets (GPCRs, Enzymes, Ion Channels, membrane transport proteins)

Small molecule drug discovery: Bioprospecting, Plant natural products, Microbial secondary metabolites, animals and marine natural products, combinatorial chemistry, and combinatorial genomics

Assay Development: General consideration for all screening methods, in vitro assay development (screening systems), Biochemical assays, Cellular assays, Bioassay-guided isolation of leads (antimicrobial, anticancer, antioxidant, and antidiabetic), High throughput Screening systems: Applications and advantages

Medicinal Chemistry: Integrated techniques for lead characterization (TLC, HPLC, I.R., MS, NMR)**,** Structure-activity relationships (SAR), Quantitative Structure-activity relationship (QSAR), including ADME (Absorption, Distribution, Metabolism, and Excretion) profiles of some lead compounds and drugs," Drug like guideline" and Pharmacophore, Bio-isosteres, Lipinksi's Rule, CADD (Computer-aided drug designing)

Pre-clinical studies: *In vitro* ADME screening, Pharmacokinetics- Microbial and animal models (infection and cancer models), *in vitro* and *silico* toxicological models, Bioavailability and Bioequivalence.

Clinical Development: Drug formulations, Delivery methods, the Role of regulatory agencies in clinical development, INDA, Clinical trials (Phase I, II, III, and IV), NDA, Adaptive clinical trial design.

Biologic drug discovery: Concept of Biologic, Biotechnology medicine and Biosimilars, recombinant proteins as therapeutic agents (Insulin, Human growth hormones, erythropoietin, blood factors), recombinant vaccines, hybridoma technology, monoclonal antibodies, cytokines, interferons, recombinant enzymes of therapeutic value, biosimilar development, regulatory guidelines for biologics

Laboratory work: Project-based learning on different aspects of drug discovery.

Course Learning Outcomes (CLO):

The student will be able to:

1. Comprehend the principles and practices of modern drug discovery
2. Apply methods and techniques to isolate drug-like molecules from the biological matrix
3. Recognize the Role and importance of pre-clinical studies in drug development
4. Apply the knowledge in the production of biopharmaceuticals
5. Comprehend the regulatory aspects of drug and biopharmaceutical discovery and development.

Text Books

01. *Benjamin Blass, Basic Principles of Drug Discovery and Development., First Edition, Elsevier (2015), eBook ISBN: 9780124115255*
02. *John P. Griffin, John Posner, Geoffrey R Barker, The Textbook of Pharmaceutical Medicine, Seventh Edition, John Wiley & Sons (2013), Print ISBN:9780470659878 |Online ISBN:9781118532331*
03. *Gary Walsh, Pharmaceutical Biotechnology: Concepts and Applications, John Wiley & Sons (2007), ISBN 978-0-470-01244-4*
04. *Rick NG, Drugs: From Discovery to Approval, Second Edition, Wiley- Blackwell (2009), ISBN 9780470195109*

Reference Books

01. *Binghe Whang, Longqin Hu, Teruna J. Siahaan, Drug Delivery: Principles and Applications, Second Edition, Wiley (2016), ISBN: 978-1-118-83336-0 (Hard Cover)*
02. *Raymond J. Hill, Duncan Richards, Drug Discovery and Development: Technology in Transition, Third Edition, Elsevier (2021), ISBN: 9780702078040*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
01	MST	25
02	EST	40
03	Sessional (May include Assignments/ Projects/ Tutorials/Quizzes/Lab evaluations)	35

PBY212: NANO-BIOTECHNOLOGY

L	T	P	Cr
3	1	2	4.5

Course Objective: The objective of this course is to make students learn about nanotechnology and its applications in biotechnology. The students will also learn about nanotechnology's current and potential contributions to biomolecules and biological systems. The course structure will also sensitize the learner about environmental concerns and the contribution of nanotechnology in solving environmental problems.

Detail contents:

Introduction to Nanoscience: Emergence and challenges of nanoscience and nanotechnology, dimensional, Two dimensional, and Three-dimensional nanostructured materials, Quantum Dots, carbon age-new form of carbon (CNT to Graphene), shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties, the influence of nano- over bulk material, size effects and crystals, large surface to volume ratio, surface effects on the properties.

Nanomaterial synthesis and characterization: Synthesis of bulk nanostructured materials, Sol-Gel Processing, Ball milling–injection molding -extrusion-melt quenching and annealing, Physical and chemical techniques of nanomaterial synthesis, Electrochemical approaches of nanomaterial synthesis, Biogenic synthesis of nanoparticles by microorganisms and plants, Nanomaterial based on DNA, protein and other biopolymers, Characterization of nanomaterials and techniques used in it.

Nanotechnology enabled devices: Nanomaterials and nanostructured films, Nanoscale electronics. Sensor for bio-medical applications, Nanoparticle-biomaterial hybrid systems for sensing applications, Biosensors principles, DNA and nucleotide-based biosensors, Protein-based biosensors, and Nanomaterials in drug delivery.

Nanotechnology and environmental impact: Potential effects of nanomaterials on human health and the environment, Applications of Nanotechnology in wastewater treatment and water purification, Nanotoxicology, Nanoparticles for environmental remediation.

Laboratory work: synthesis of gold or silver nanoparticles, biogenic synthesis of nanoparticles, UV-visible spectroscopy-based Analysis of nanoparticles, simulation of DNA nanostructure synthesis, case studies of nanotoxicity on human health and environment.

Course Learning Outcomes (CLO):

Students will be able to

1. synthesize nanoparticles
2. characterize synthesize nanoparticles
3. demonstrate the importance of biomolecules and their complexes in nanotechnology
4. Apprehend and estimate the potentially harmful effect of nanomaterials on human health and the environment and take appropriate measures.

Textbooks

1. *"Nanostructures and Nanomaterials: Synthesis, Properties, and Applications," G. Cao, Imperial College Press (2004)*
2. *Nanobiotechnology; Concepts, Applications and Perspectives", C. M. Niemeyer, C. A. Mirkin, Wiley-VCH (2004)*

Reference books

Biosensors: A Practical Approach, J. Cooper & C. Tass, Oxford University Press, 2004.

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Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

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PBY213: BIOREMEDIATION TECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: To make the students understand how biological systems can help monitor and remove pollutants and minimize their harmful impacts. To understand what are the various biotechnological approaches to remove contaminants from the environment and their advantages.

Detail contents:

Introduction: Present state of environmental contamination, hazardous and non-hazardous contaminants from the liquid, solid, and gas phase, toxicity and potential hazards, intrinsic and engineered bio-remediation and their advantages and disadvantages.

Biodegradation processes: Aerobic and anaerobic mineralization, co-metabolism and polymerization; factors affecting contaminant biodegradability: toxicity, bioavailability, contaminant structure - steric and electronic effects; biological and environmental factors, effect of halogenations, contaminant mixtures - Rate and extent of contaminant degradation, effect of nutrient ratio, contaminant migration in ground water. Biodegradation of recalcitrant and xenobiotics: natural versus synthetic compounds (e.g. aliphatic, alicyclic, aromatics, dioxins, PCBs, heterocyclic compounds).

Bioremediation processes and technologies: *Ex-situ* and *in-situ* remediation techniques, bio stimulation and bioaugmentation land farming, bio-bed, reactor, bio-slurping, in-situ land farming, bioventing, hydraulic cycles, bio-sparging, groundwater circulation wells, bio-screen and monitored natural attenuation techniques; use of genes, enzymes and GMO's for bioremediation and their limitations; bio/phytoremediation of leachates, soils and sediments, case studies on bioremediation management of plastics, textile dyes and pesticides

Metal Bioremediation: heavy metals and their sources of release, metal solubility, bioavailability and toxicity, physicochemical methods of metal removal, microbial metal resistance and detoxification, adsorption and absorption, metal transformations: oxidation-reduction, methylation; use of plants and microbial approaches in remediation of metal contaminated soils and aquatic systems.

Microbial cleaning of gases: Biofiltration for contaminated gases, design and processes.

Course Learning Outcomes (CLO):

Students will be able to

1. Describe types of pollutant contamination, sources and their toxicity.
2. Understand biodegradation, transformation and detoxification mechanisms of contaminants involved in aerobic and anaerobic processes.
3. Design various *ex-situ* and *in-situ* bioremediation systems for remediation of contaminated sites and environment.
4. Decide application of GMO's in bioremediation and limitations.
5. Understand sources of heavy metals in the environment, their toxicity and removal using microbial systems

TextBooks

1) *Ronald L. Crawford, Don L. Crawford, Bioremediation: Principles and Applications, Cambridge University Press, 2005.*

2) *B.C. Bhattacharya & Ritu Banerjee, Environmental Biotechnology Oxford Press, 2007.*

Reference Books:

1. *Sharma, H. D. and Reddy, K. R. (2004) Geoenvironmental Engineering: Site Remediation, Waste Containment and Emerging Waste Management Technologies, John Wiley and Sons Inc., Hoboken, New Jersey.*
2. *Maiee R. M., Pepper, I. L. and Gerba, C. P. (2009) Environmental Microbiology, Second Ed., Academic Press, California.*
3. *Rittmann, B.E., and McCarty, P.L., Environmental Biotechnology: Principles and Applications, McGraw Hill, 2001.*

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

PBY214: TRANSGENIC TECHNOLOGIES

L	T	P	Cr
3	0	2	4.0

Course Objective: The course will enable the students to acquaint themselves with genetically modified organisms and equip students with technologies for trait-specific modification and molecular farming to produce novel molecules.

Organization of genome, regulation of gene expression and gene silencing in plants and animals and gene cloning, Expression Vectors used in plants and animals. Strategies and methodologies of Screening, Selection, verification, and characterization of transformed tissues of plants and animals.

Gene silencing and genome editing: Different silencing methods such as antisense RNA, RNA interference, and silencing of a eukaryotic gene. Genome editing: Zink finger nucleases, TALENs, and CRISPR-Cas technologies and applications for improvement

Transgenic Animals: Gene transfer methods, Methodology, Embryonic stem cell & Microinjection method, Retroviral method, Detail protocols of creation transgenic animals-Mice, cow, goat, sheep, pigs, zebrafish. Applications of transgenic animals. Biopharmaceuticals are derived from transgenic plants and animals. Animal Pharming: The Industrialization of Transgenic Animals.

Methods of Plant genetic transformation: Transient and stable gene expression in plants. Direct and indirect methods of plant genetic transformation, Details of Agrobacterium and Biolystic gun mediated plant genetic transformation. Analysis of transgenic plants. Protoplast mediated plant transformation and somatic hybridization

Trait specific plant modification – some case studies: Abiotic and biotic stress tolerance, nutritional quality improvement, an extension of shelf life, and reduction of postharvest losses. Molecular farming: Expression of important proteins and metabolic engineering to produce novel compound in plants.

Biosafety aspects of transgenic organisms Regulation and Biosafety of transgenic animals - Value of Transgenic Animals, Biosafety measures in Transgenic Animal Research, Compliance with NIH Guidelines, Policies & Protocols, Disposal of Transgenic Animals, Transfer of Recombinant DNA and Transgenic Materials.

Laboratory Work:
Cloning of eukaryotic gene(s). Making of gene constructs for expression in plants, genetic transformation using agrobacterium and biolistic gun, analysis of transgenic plants through reporter gene and PCR.

Course Learning Outcomes (CLO):
Students will be able to:

1. Familiarize with the various expression vectors used and apprehends the Role of reporter and selection markers
2. Develop strategies for the trait-specific modification of organisms
3. Generate organisms with desirable/novel traits through genetic manipulations
4. Acquire comprehensive knowledge about transgenic animal technologies and their application.

TEXTBOOKS

1. Genetic Engineering - By R. Williamson, Publ: Academic Press
2. Principles of Gene Manipulation - By R.W. Old & S.B. Primrose, Publ: Blackwell
3. Strategies in Transgenic Animal Sciences - By Glenn M.M. and James M. Robl ASMPress 2010.
4. Practical Biotechnology – Methods and Protocols - By S. Janardhan and S. Vincent (Universities Press)
5. Animal Cells as Bioreactors - By Terence Gartoright, Cambridge Univ Press
6. Molecular Biotechnology - By Chinnarayappa (Universities Press)

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S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

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PBY221: ADVANCED STEM CELL TECHNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objective: The course is designed to give a broad view of mammalian stem cells, reviewing where they are found in the body, the different types and how they are cultured. The
topics will cover the basic biology of these stem cells and bioengineering and application of these stem cells to potential treatments of human diseases.

Concept of Stem Cells Introduction to stem cells Definition, properties, proliferation, the culture of stem cells. Adult stem cells, Tumor stem cells, Stem cell plasticity. Methods of characterization of stem cells.

Pluripotency and Reprogramming: Characterizations of pluripotent stem cells (PSCs)**,** Molecular mechanisms underlying pluripotency**,** Induction of pluripotency**,** Potential of induced pluripotent stem cells (iPSCs) in basic and clinical applications, Alternative PSCs**,** Reprogramming using defined factors, Mechanisms of Reprogramming. Methods to engineer pluripotent stem cells to treat genetically impaired conditions/diseases.

Embryonic stem (E.S.) cells: Establishment of embryonic stem cells (ESCs) Isolation of E.S. cells, Salient features and Differentiation of E.S. cells, Human and Mouse embryonic stem cells, Maintenance of E.S. in an undifferentiated state.

Hematopoietic and Mesenchymal Stem Cells: Identification and Characterization of HSCs, Sources of HSC Mouse Assay of HSC, HSC in leukemia and lymphoma, Clinical Use of HSC. Harvesting, Isolation and Characterization, Differentiation studies of MSCs. Clinical application of mesenchymal stem cells

Culture of stem cells: Stem cell culture environment, media, culturing techniques of various types of stem cells.

Bioengineering & Physical engineering of stem cells: Stem cell engineering using cytokines, growth factors, pathway inhibitors, stimulators; transcriptional regulators. Cell-extracellular matrix interactions; Stem cell engineering using scaffolds and cell-cell interaction.

Clinical application of stem Cells: Overview of embryonic and adult stem cells for neurodegenerative therapy diseases; Parkinson's, Alzheimer's Spinal Code Injuries and other brain Syndromes; Tissue system Failures; Diabetes; Cardiomyopathy; Kidney failure; Liver failure; Cancer; Hemophilia, etc. Applications of stem cells in medicine and different disease models, Biosafety and Stem cell research, Regulatory considerations, and FDA requirements for stem cell therapy.

Course Learning Outcome (CLO):

Students will be able to:

1. Comprehend fundamental principles of human stem cells
2. Learn techniques related to culturing of stem cells
3. Learn strategies to engineer stem cells for therapeutic Use
4. Apprehend ethics and applications of stem cell biology

Text Books:

1. *R. Ian Freshney Culture of Animal Cells: A Manual of Basic Technique, (2000).*
2. *Marshak L, Stem Cell Biology, Cold Spring Harbor Publication, (2001).*

Reference Books

1. Tarik Regard, Thomas J. Sayers, Robert C. Rees. Principles of Stem Cell Biology and Cancer: Future Applications and Therapeutics. ISBN: 9781118670620
2. Robert Lanza, Robert Langer, Joseph Vacanti. Principles of Tissue Engineering. ISBN: 978-0-12-398358-9.
3. Robert Lanza and Anthony Atala. Essentials of Stem Cell Biology. ISBN978-0-12-409503-8.
4. Jonathan M. W. Slack. The Science of Stem Cells. ISBN:9781119235156.

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Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

Approved in 107th meeting of the Senate held on June 16, 2022

PBY222: CLINICAL IMMUNOLOGY

L	T	P	Cr
3	0	0	3.0

Course Objectives: Acquire knowledge of different clinical aspects of immunology, including immunological disorders, immunodiagnostics, immunotherapy, and vaccine technology.

Immunological mechanism: Opsonization, Phagocytosis, Inflammatory response, Antigen presentation and processing, T and B cell response, Cell-mediated Cytotoxic Response: Cytotoxic T cell, N.K. Cell and Antibody-mediated effector functions.

Immunological Disorder: Autoimmunity, Hypersensitive reactions, Different types of Hypersensitive reactions, Primary and Secondary Immunodeficiency, Tumor Immunity and Tumor antigens, Transplantation types, Immunological basis of graft rejection

Immunodiagnostics: Agglutination reaction, Coomb's test, Immuno-electrophoresis, Immunochromatographic assays, Radio-immunoassay, ELISA, ELISPOT assay, Western blotting, Immunofluorescence and Flow cytometry, Immunosensors, chemiluminescent detection, Lymphocyte Proliferation assay

Immunotherapy: Immune checkpoint inhibitors, Adoptive cell therapy, Monoclonal antibodies, T-cell engaging bispecific antibody therapy, Anti-inflammatory drugs, Immunosuppressive therapy, Immunostimulation, Cytokines therapy, Oncolytic viruses in immunotherapy, Cancer immunotherapy

Vaccine Technology: Criteria for an effective vaccine, Live and Killed Vaccines, Subunit vaccines, Recombinant Vaccines, DNA vaccines, mRNA vaccines, Peptide vaccines, Reverse vaccinology, Traditional and modern methods of vaccine production, Egg and cell-based vaccine development, Current and future scenario of Vaccines

Course Learning Outcome

Students will be able to

1. demonstrate the association of the immune system with different health ailments
2. adopt the concept of immunological techniques in the design of the immunodiagnostic assay
3. Apply the immunological concept in developing immunotherapy and vaccine

Textbooks

- *Punt J, Stanford S, Jones P, Owen J. Kuby- Immunology W.H. Freeman & Company (2019) VIIIth edition*
- Murphy K., and Weaver C. *Janeway Immunobiology Garland Exclusive (2016) IXth edition*

Reference Books:

- Delves P. J., Martin S. J., Burton D. R., Roitt I. M. Roitt's Essential Immunology Wiley Publisher (2017) XVIIIth Edition
- Karp D. D. Handbook Of Targeted Cancer Therapy And Immunotherapy. Wolters Kluwer (2018) IInd Edition
- Clift I. C. Clinical Immunodiagnostics: Laboratory Principles And Practices Jones and Bartlett Publishers, Inc (2020)

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include Assignments/Seminars/Quizes)	20

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PBY223: Biomaterials

L	T	P	Cr
3	0	0	3.0

Course objective: This course deals with studies on inorganic and organic biocompatible materials used in a medical device intended to interact with biological systems where the materials are expected to perform with an appropriate host response in a specific application. It will help the students to understand the current biomaterials scene, know how these materials are synthesized and fabricated and know the applications in which they are used. The students will also able to design devices for specific scientific, industrial and medical applications using current biomaterials. They will have good exposure pertaining to the field of biomaterials and have broad understanding biomaterials research.

Fundamentals of biomaterials: Definitions, types (metallics, ceramics, polymers, composites), characterization, properties, structures, biocompatibility, enzymatic fabrication of biopolymers

Mechanical and chemical properties: Implant biomaterial characters, cell-biomaterial interactions, Hardness, Elasticity, stress, fatigue, stress cracking, toxicity, corrosion,

Metallic biomaterial in implants: Steel, cobalt, magnesium, titanium alloys, properties

Bioinert ceramics and polymers: Classifications; mechanical properties

Bioactive biomaterials: Overview of surface bioactive and bulk degradable materials, Calcium phosphate and hydroxyapatite, mechanical and chemical properties; bioactive glass

Polymeric biomaterials: Classification of homo and co-polymers; thermoplastics, thermoset elastomers, thermoplastic rubbers, thermoset resins.

Bioresorbable polymers: synthesis and biodegradation; types and characters of polyesters (PLGA, PLA, PCL), polyesters (PHA); elastomeric polyesters (poly(polyol sebacate), polyamide, biocompatibility.

Composite biomaterials: Definition and classifications; general structure-property relationship, natural composite: Bone

Application: Regenerative medicine, use in integumentary system, skeletal system, muscle, muscle, endocrine system, implantable medical device.

CLO:

1. understand common use biomaterials as metals, ceramics and polymers and its chemical structure, properties and morphology.
2. Understand the interaction between biomaterial and tissue for short term and long-term implantations, distinguish between reactions in blood and in tissue.
3. Apply and account for methods to characterize interactions between materials and tissue.
4. explain methods to repair and regenerate injured or lost functional tissue with biomaterials

Texts Books:

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons. Biomaterials Science: An Introduction to Materials in Medicine, Academic Press, 2004, USA

2. J.B. Park and J.D. Bronzino. Biomaterials: Principles and Applications. CRC Press. 2002. ISBN: 0849314917

Reference Books

1. T. M. Wright, and S. B. Goodman. Implant Wear in Total Joint Replacement: Clinical and Biologic Issues, Material and Design Considerations. American Academy of Orthopaedic Surgeons, 2001.

2. L Ambrosio. Biomedical composites, Woodhead Publishing Limited, UK, 2009

3. K.C. Dee, D.A. Puleo and R. Bizios. An Introduction to Tissue-Biomaterial Interactions. Wiley 2002. ISBN: 0-471-25394-4.

4. T.S. Hin (Ed.) Engineering Materials for Biomedical Applications. World Scientific. 2004. ISBN 981-256-061-0
5. B. Rolando (Ed.) Integrated Biomaterials Science. Springer. 2002. ISBN: 0-306-46678-3

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include Assignments/Seminars/Quizes)	20

PBY231: POST HARVEST TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course objective: To acquaint the students with production trends, structure, composition, quality evaluation, and processing technologies for product development and value addition of fruits, vegetables, cereals, pulses, oilseeds, and plantation crops.

Course contents:

Introduction: Production status, losses, need, scope, and importance. Basic postharvest operations are handling drying, storage, size reduction, extraction, and washing; their functions and Use in the postharvest processing.

Fruits and Vegetables: Nutritional importance, postharvest physiology, and biochemistry of fruits and vegetables. Factors causing postharvest losses. Methods of harvesting and handling of fruits and vegetables. Principle of storage of fruits and vegetables. Postharvest treatment to increase shelf life

Cereals, pulses, and oilseeds: Production trends, structure and chemical composition of cereals, pulses, and oilseeds, factors causing postharvest losses of cereals and oilseeds. Handling, milling, and storage of cereals and oilseeds.

Plantation crops and spices: Production trends and chemical composition of tea, coffee, cocoa, and spices, causing postharvest losses. Handling, milling, and storage, processes involved in the manufacture of oleoresins and essential oils

Value addition: Principles and methods of value addition. Value addition of fruits and vegetables, cereals, pulses, and plantation crops.

Laboratory Work: To study the physicochemical properties of food grains. Determination of gluten content in wheat flour. To study the methods of extraction of oil from oilseeds. Determination of maturity indices. Postharvest management practices – pre-cooling, grading, and packaging. Methods for determination of post harvest losses.

Course Learning Outcome (CLO):

Students will be able to:

1. *understand the processes/factors that result in quality deterioration and loss of harvested produce*
2. *comprehend technologies/procedures applied to improve quality and reduce losses of harvested produce.*
3. *Differentiate between the elemental composition and structural parts of different food grains.*
4. *develop value-added products from plantation products and spices*
5. *demonstrate an appropriate technique for the extraction of spice oil and oleoresin with quality standards*

Recommended books

1. Chakravarti A. Post Harvest Technology of Cereals, Pulses, and Oilseeds. Oxford Publishing. Third Ed. 2020

2. Sharma S K. Postharvest Management and Processing of Fruits and Vegetables: Instant Notes. New India Publishers 2010.
3. Shanmugavelu KG, Kumar N, Production Technology of Spices and Plantation Crops, 1st Edition, Peter KV Publisher: Agrobios (India), 2018.

Reference books:

1. *Theodoros Varzakas and Constantina Tzia, Handbook of Food Processing: Food Safety, Quality, and Manufacturing Processes, 2016, CRC Press, Taylor, and Francis group.*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

PBY232: ENZYME TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: The objective of the course is to inform the students about the isolation of novel enzymes, basic principles for optimization, modeling of the industrial Use of the enzymes, etc., in which both free and immobilized enzymes play a role. Students will be able to implement both biochemical and engineering knowledge to design new and improve current enzymatic processes.

Introduction and Scope: Enzymes-historical resume; Nomenclature and Classification; Biological roles, Isozymes; Marker enzymes; Overview of enzyme 3D-structure: active site, catalytic site; Specific activity, Enzyme activity, and Kinetics, K_m, V_{max}, and turn over the number of enzymes and their significance; Modifiers of Enzyme Activity, enzyme Activators, enzyme Inhibitors; Enzyme inhibition kinetics: competitive, non-competitive, and un-competitive; Kinetics of enzyme degradation; Enzyme stability: pH, temperature.

Production of Enzymes: Sources of industrial enzymes (natural & recombinant), Screening for new and improved enzymes, different methods of extraction, isolation and purification of commercially important enzymes, retailoring of enzyme, large-scale industrial enzyme production and downstream processing: Case studies (from literature).

Techniques of Enzyme Immobilization: Immobilization- definition; Immobilization techniques: physical and chemical adsorption, matrix entrapment, encapsulation, crosslinking, covalent binding with examples; Advantages and disadvantages of different immobilization techniques; Overview of applications of immobilized enzyme systems, Enzymes in electrodes.

Kinetics of Immobilized Enzymes: Steady state analysis of mass transfer and biochemical reaction in enzyme reactors; Analysis of mass transfer effects of Kinetics of immobilized enzyme reactions; Packed bed reactors; Analysis of Film and Pore Diffusion Effects on Kinetics of immobilized enzyme reactions; Calculation of effectiveness factors of immobilized enzyme systems.

Application: Industrial uses of enzymes - sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerase, cellulose degrading enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheese production; Clinical enzymology - Enzymes as thrombolytic agents, anti-inflammatory agents, digestive aids; Therapeutic Use of asparginase, streptokinase; Abzymes; Diagnostic enzymes; Biosensors; Bioconversion

Laboratory work: Analysis of protein content and enzyme activity from spent broth of bacteria and fungi using Bradford/Lowry method –standard curve using BSA; purification of amylase enzyme by ammonium sulfate precipitation; SDS-PAGE Analysis of the protein (enzyme); Enzyme crosslinking using glutaraldehyde- SDS PAGE study; Purification of an enzyme by chromatography method; Study of α-amylase activity of starch using DNSA method; pH or temperature-dependent α-amylase activity using DNSA method.

Course Learning Outcomes (CLO):
Students will be able to:
1. Explain the mechanism and function of enzymes and assay enzyme reaction kinetics.
2. Produce, isolate and purify enzymes at a lab/industry scale.
3. Design enzyme immobilization techniques based on the types of enzymes.
4. Comprehend and calculations involved in immobilized enzyme kinetics.
5. Explain the industrial applications of enzymes.

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Text Books:

1. Tripathi G, Enzyme Biotechnology, ABD Publishers (2009)
2. Aehle W, Enzyme in Industry: Production and Applications, Wiley-VCH (2007).

Reference Books:

1. Bisswanger H, Enzyme Kinetics: Principles and Methods, Wiley-VCH (2008).
2. Dixon M and Webb MC, Enzymes, Longmans (1980).

Sl No.	Evaluation Elements	The weightage (%)
1.	MST	25
2.	EST	40
3.	Sessional (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	35

PBY233: OMICS TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: This course aims to familiarize Students with concepts of Omics technologies and understand the steps of high throughput data analysis.

Detail contents:

Introduction: Introduction to Bioinformatics, Computational Biology, Systems Biology, Biological databases, and Omics technologies

Genomes and Genomics: Structure of Gene and genomes of Eukaryotic and prokaryotic, genome databases, Sanger sequencing-principle, methodology and applications, Whole-genome - de novo sequencing or resequencing; exome sequencing

Transcriptomics: RNA sequencing; small RNA sequencing; Next Generation Sequencing (NGS) workflow, Differential expression.

NGS Data Analysis: Next-generation sequence analyses, Data format, Quality control-Phred score; FastQC and FastX tool kits, data analysis tools and pipeline, read length, read depth, sequence coverage, Homology (orthology groups), Genome alignment and Analysis tools- BWA (BurrowsWheeler Aligner), SAMtools, GATK (The Genome Analysis Toolkit), Cuffcompare, Velvet, Oases, Trinity.

Metabolites and Metabolomics: Metabolomics-an overview, basic sample preparation strategies-extraction; Introduction to mass spectrometry and modes of data acquisition, data repositories. Targeted Vs. Untargeted metabolomics; development of targeted assays for small molecules.

Proteomics: Introduction to quantitative proteomics- Differential proteomics, post-translational modifications, Proteogenomics Concepts and principles of genome annotation, genome search specific peptides, alternative translation initiation, small ORFs, Analysis of transcriptomic and proteomic data for genome annotation; Gene prediction algorithms

Laboratory Work*:* NGS (Genome and transcriptome) data analysis and genome annotations. Linux Shell Scripting to handle NGS data.

Course Learning Outcomes (CLO):

Students will be able to

1. perform pre-processing of NGS data
2. analyze the algorithms to handle NGS data
3. perform differential expression analysis from transcriptomic data
4. comprehend various methods involved in data analysis of omics technology for commercial and industrial applications

Textbooks

1. S B Primrose and R Twyman, Principles of gene manipulation and Genomics (2006) 7th Edition

2. Xiong J, Essential Bioinformatics, Cambridge University Press (2006)

3. Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001), 2nd ed

4. Ghosh Z, and Mallick B, Bioinformatics – Principles and Applications, Oxford University Press (2008)

5. V Susheela Devi and M N Murty, University Press - Pattern Recognition: An Introduction (2011)

Reference Books

1. Higgins, D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks – A Practical Approach, Oxford University Press (2000).

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessionals (May include assignments/quizzes)	35

PBY492: DISSERTATION

L	T	P	Cr
0	0	0	16.0

Course objective: The semester project is aimed to impart an in-depth and thorough training on some specific research problems. Exposure to such problems would enable the students to address the various real-time challenges prevalent in different field of biotechnology. The students will grasp knowledge of different experimental skills associated with biochemistry, microbiology, molecular genetics, genetic engineering, immunology and bioinformatics. The students acquire experience and knowledge to work in professional setup.

Scope of Training: The students will get an opportunity to be a part of ongoing research activities in various academic and research institutes. The students will explore and gain experience in different sectors of biotechnology viz agriculture, food, medicine and pharmaceutical. The students will develop understanding of biosafety, bioethic, regulatory and compliances. The students will acquire skill to write, compile and analyze data, and present the detailed technical/scientific report. At the end of successful project semester training, potentially the students become employable in the industries/organizations.

Course Learning Outcomes (CLO):
The students will be able to:

1. work in a team
2. identify a problem in biotechnology based industry.
3. formulate a research problem in research laboratory
4. design experiments to solve the industrial/research problem.
5. compile and/or interpret the industrial data.
6. analyze and interpret the experimental data

Dissertation Evaluation Scheme

Name of the candidate:.....
Name of Father.....Name of Mother.....
Roll No.....Year.....
Date of *Viva Voce*.....

I	**Dissertation (50%)**	MM	Marks Obtained
1	Subject Matter	10	
2	Literature Review	10	
3	Presentation of matter (structuring)	10	
4	Discussion of results and inferences drawn	20	
II	**Presentation and *viva-voce* (40%)**		
1	Subject matter of presentation	10	
2	Presentation structuring	10	
3	Response to questions	10	
4	Usefulness/contribution of the work to the profession	10	
III	**Overall perception which includes communication of paper to a journal (10%)**	10	
	Total	100	

Brief outcome of work:.....
.....

External Examiner
Name and Signature
Affiliation

Internal Examiner/Supervisor (s)
Name and Signature

Expert from Cognate Area P.G. Coordinator

Faculty Member from
Other Deptt/School
Nominated by DOAA

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