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

PROPOSED COURSE SCHEME

FOR

M.Tech. – BIOTECHNOLOGY

2018

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	PBY101	MOLECULAR BIOLOGY AND rDNA TECHNOLOGY	3	0	2	4.0
2	PBY102	BIOPROCESS ENGINEERING	3	1	2	4.5
3	PBY104	APPLIED IMMUNOLOGY AND VACCINE TECHNOLOGY	3	0	2	4.0
4	PMA102	RESEARCH METHODOLOGY	2	0	2	3.0
5	PHU 301	ENTREPRENEURSHIP AND IPR	3	1	0	3.5
6		Elective I	3	0	2	4.0
TOTAL			**17**	**2**	**10**	**23.0**

SEMESTER – II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY201	DOWNSTREAM PROCESSING	3	0	2	4.0
2	PBY202	BIOPHARMACEUTICALS AND PHARMACEUTICAL TECHNOLOGY	3	0	2	4.0
3	PBY205	ADVANCED PLANT BIOTECHNOLOGY	3	0	2	4.0
4	PBY208	BIOINFORMATICS AND SYSTEM BIOLOGY	3	1	2	4.5
5	PBY209	ANIMAL CELL CULTURE AND TRANSGENIC TECHNOLOGY	3	0	2	4.0
6		Elective II	3	0	2	4.0
TOTAL			**18**	**1**	**12**	**24.5**

SEMESTER – III

S. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY291	SEMINAR	0	0	0	4.0
2	PBY392	MINOR PROJECT	0	0	0	4.0
3	PBY401	DISSERTATION (STARTS)				
TOTAL			**0**	**0**	**0**	**8.0**

SEMESTER – IV

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

TOTAL CREDIT: 71.5

ELECTIVE-I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY207	FOOD PROCESSING TECHNOLOGY	3	0	2	4.0
2	PBY303	PROTEIN ENGINEERING	3	0	2	4.0
3	PBY304	BIOPROCESS EQUIPMENT DESIGN	3	0	2	4.0

ELECTIVE-II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY305	DRUG DESIGN AND DEVELOPMENT	3	0	2	4.0
2	PBY	BIOREMEDIATION TECHNOLOGY	3	0	2	4.0
3	PBY204	INDUSTRIAL ENZYME TECHNOLOGY	3	0	2	4.0

PBY101: MOLECULAR BIOLOGY AND rDNA TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: The objective of the course is to enable the students to develop understanding in the salient aspects of molecular biology and rDNA technology. They will gain knowledge on replication, transcription and translation. Moreover, they will learn facile molecular techniques of gene cloning, manipulation and the uses of rDNA techniques.

Molecular Biology: Major molecular events in the cell cycle; architecture of microbial, animal and plant genome; replication and transcription and their control in prokaryotes and eukaryotes, translation and its control, post translational modifications; gene structure and function, regulation of gene expression, silencing of gene function; cellular differentiation, oncogenes and cancer, epigenetic effects, regulatory RNA, programmed cell death.

Recombinant DNA Technology: Relevance and impact of rDNA technology; restriction endonucleases and other enzymes used in manipulation of genes; prokaryotic and eukaryotic hosts, Different cloning vehicles-their relevance and applications; various molecular techniques for exploring genetic resources; isolation and characterization of genes and their regulatory sequences; PCR and their applications; classical and site-directed mutagenesis; expression of cloned genes in prokaryotic and eukaryotic hosts; overproduction of recombinant proteins and their purification, relevance of genome projects; various applications of gene technology: production of pharmaceuticals and other novel compounds; microarrays, other high-throughput systems, and their applications

Laboratory Work:

Small and large-scale isolation of DNA, RNA, cloning vectors & proteins, checking of purity & quality, Operon induction in the prokaryotes, Monitoring constitutive and inducible gene expression, Molecular cloning and characterization of genes, and their regulatory sequences by traditional & PCR approach, *In silico* approaches for DNA sequence analysis, Construction of gene expression cassettes, Recombinant expression of proteins.

Course Learning Outcomes (CLO):

Students will be able to:

1. analyze the overall architecture of eukaryotic and prokaryotic genomes along with structure and function of genes.
2. apply various enzymes, vectors and hosts in molecular cloning experiments
3. perform how to construct and screen of genomic and cDNA libraries
4. generate recombinant DNA molecules for expression of recombinant proteins.
5. apply rDNA techniques for production of novel molecules.

Text Books:

1. *Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P, Molecular Biology of the Cell, Garland Science Publishing (2008).*
2. *Primrose SB and Twyman RM, Principles of Gene Manipulation and Genomics,*

Blackwell Publishing (2006)
3. *JE, Krebs, Goldstein ES and Kilpatrick ST, Lewin's GENES X, Jones and Bertlett Publ. (2011)*

Reference Books:

1. *Balasubramanian D, Bryce CFA, Dharmalingam K, Green J, and Jayaraman, K, Concepts in Biotechnology, Universities Press (2007)*
2. *Fritsch J and ManiatisEF, Molecular CLOning, A laboratory Manual, Cold Spring Harbor Laboratory (1999)*
3. *Molecular diagnosis of diseases, insect control, improved biological detergents, gene therapy, Microarrays & other high throughput systems-their applications, Ethical and safety aspects of gene technology.Krebs*
4. *Becker WM, Kleinsmith LJ and Haldin J the World of the Cell, Pearson Education (2006).*

Evaluation Scheme:

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

PBY102: BIOPROCESS ENGINEERING

L	T	P	Cr
3	1	2	4.5

Course Objective: The objective is to enable students to study a broad base of topics in the fundamentals of engineering focused on the chemical and biological processing of raw materials from sustainable sources.

Material and Energy Balances: Introduction to Engineering calculations and stoichiometry, Degree of reduction, Material balance calculations for substrate utilization and product formation, Material and energy balance calculations with and without chemical reactions.

Microbial Growth and Enzyme Kinetics: Media design for growth, Kinetic models for cell growth, Design equations based on biochemical reactions, Substrate and product inhibited growth models, Factors affecting microbial growth, Enzyme kinetics, M.M kinetics, enzyme deactivation kinetics, Active and passive immobilization,

Transport Phenomena: Mass transfer by diffusion and convection, Theories of mass transfer, Oxygen transfer methodology in Fermenters, Determination of oxygen transfer coefficients (kLa), Role of aeration and agitation in oxygen transfer, Factors affecting oxygen transfer rate, Mass transfer considerations in immobilized cases (Inter and Intra-particle diffusion), Effectiveness factor and Thiele modulus.

Bioreactors and Fermentation: Bioreactor selection criteria and classification, Parameters for control, Design of ideal reactors, Single (Batch, Flow) and multiple reactors, Non-Ideal flow, RTD studies, Modelling of Non-ideal flow reactors, Design and operation of various bioreactors, viz CSTF, fed batch systems, air-lift bioreactors, fluidized bed bioreactors, Scale-up studies.

Sterilization and Process Control: Thermal death kinetics, Design of batch and continuous sterilization, Concept of Del factor, Air sterilization, Log penetration theory for designing the depth filters, Design considerations for fermenter, filter sterilization, Sampling procedures and their design

Laboratory Work: Fermenter - design, operation and control, Microbial production of different products, Whole cell immobilization, Comparative study on rate of product formation using immobilized and suspension culture, kLa determination, Mixing and agitation in fermenters, RTD studies, Fed batch bioreactor.

Self-Learning: Online data analysis of physico chemical parameter measurements for biochemical processes, Concepts of process control viz. PID Controllers-Application of Fuzzy logic and neural networks in bioprocess control.

Course Learning Outcomes (CLO):

Students will be able to:

1. apply the concepts of basic chemical engineering principles in a bioprocess
2. produce bio-products on an industrial scale using fermenters
3. operate and optimize process parameters in a fermenter for producing industrial products.
4. comprehend various types of bioreactors used in industry

Text Books:

1. *Shuler ML and Kargi F, Bioprocess Engineering, Prentice Hall (2004).*
2. *StanburyPF, Hall SJ and Whitaker A, Principles of Fermentation Technology, Butterworth – Heinemann 2005).*
3. *Bailey JE and Ollis DF, Biochemical Engineering Fundamentals, Mc-Graw Hill, Inc. (1986).*

Reference Books:

1. *Atkinson B and Mavituna F Biochemical Engineering and Biotechnology Handbook, McGraw Hill (1993).*
2. *Doran P M, Bioprocess Engineering Principles, Academic Press (1995)*

Evaluation Scheme:

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

PBY104: APPLIED IMMUNOLOGY AND VACCINE TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: The objective of this course is to provide students with detail understanding of different cells, organs and factors of the immune system and their organization, diversity and their specialized functions. The course will provide basic concepts of different immunological techniques and knowledge about role of immune system in the pathogenesis of different diseases.

Basic Concept and Cells of the Immune System: Hematopoietic Stem Cells, Lymphocytes, Granulocytes and Monocytes, Cell participation in Innate and Adaptive Immunity, Antigen and Antibody, Cell mediated Cytotoxic Response: Cytotoxic T cell, NK cell and Antibody dependent cell mediated cytotoxicity, inflammatory response

Immunological Techniques: Immunodiffusion and Agglutination reaction, Coomb's test,Immuno-electrophoresis, RIA, ELISA, ELISPOT assay, Immunofluorescence microscopy, Immunoelectron microscopy, Immunohistochemistry, Immunoprecipitation, Immuno-blotting, Flow cytometry and FACS analysis, Immunomagnetic and Immunodensity method of Cell isolation, Lymphocytes cell proliferation assay

Immunopathology: Tolerance and Autoimmunity, Hypersensitive reactions, Different types of Hypersensitive reactions, Primary and Secondary Immunodeficiency, AIDS, Immune response to Infectious disease, Tumor immunity and Tumor antigens, Transplantation types, Immunological basis of graft rejection

Vaccine Technology: Criteria for effective vaccine, Live and Killed Vaccines, Subunit vaccines, Recombinant Vaccines, DNA vaccines, Peptide vaccines, Edible Vaccines, Reverse vaccinology, Traditional and modern methods of vaccine production, Egg and cell based vaccine development, Current and future scenario of Vaccines, Immuno-informatics approach to identify T and B cell epitopes, Adjuvants, Cell Banking, Bacterial and Viral vaccine

Self-Learning:
Antibody application and Immunotherapy, Production of monoCLOnal antibody, application of monoCLOnal antibody, antibody engineering, Immunosuppressive therapy, Immuno-modulation, Cytokines therapy

Laboratory Work:
Blood film preparation and identification of cells, Immuno-diffusion, Hemagglutination, Agglutination inhibition, Rocket immune-electrophoresis, Western blotting, ELISA, Epitope prediction using Immuno-informatics tool, Isolation of Peripheral blood mononuclear cells, Purification of Immunoglobulin

Course Learning Outcome (CLO):

Students will be able to:

1. comprehend role of immune cells and their mechanism in preventing the body from foreign attack and infectious disease, cancer and other disease development
2. apply the knowledge of immune associated mechanisms in medical biotechnology research.
3. design experiment to know different immune associated mechanism.
4. apply out immunological techniques in industry.
5. apply the concept of vaccine technology in new vaccines development.

Text Books:

1. *Goldsby R. A., Kindt T.J., Osborne B.A, Kuby- Immunology W.H. Freeman & Company (2006).*
2. *Janeway C. A. Travers P., Walport M. Shlomdchik M. J, Immunobiology: the immune system in health and disease, Garland Science Publishing New York(2005).*
3. *Khan F.H. The Elements of Immunology, Pearson Education (2009)*

Reference Books:

1. *Roitt I., Brostoff J., Male D., Immunology, Mosby Elsevier (2004).*
2. *Tizard I. A. Immunology: An introduction, Cengage learning (2009).*

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 understanding of the basic framework of research process and understanding of various research designs and techniques. To develop an understanding of the ethical dimensions of conducting applied research.

Introduction: Nature and objectives of research, Study and formulation of 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 bionomial, exponential, normal and log-normal distributions.

Hypothesis Testing: Tests of significance based on normal, 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 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 (%)
1	MST	25
2	EST	35
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PHU301: ENTREPRENEURSHIP AND IPR

L	T	P	Cr
3	1	0	3.5

Course Objective: Students will be able to demonstrate and develop awareness of personal as well as external resources with a view to successfully launching and subsequently managing their enterprises. They will be able to develop skills in operations, finance, marketing and human resource management and be aware of rights resulting from intellectual property rights and infringement of intellectual property rights.

Entrepreneurship: Entrepreneurship and principles of entrepreneurial development, Qualities of an entrepreneur, Functions and types of entrepreneur.

Project Management: Formulation, Identification and selection based on size, Technological assessment, Project cost and market potential and marketing concepts.

Project Appraisals: Technical reports and feasibility reports with commercial viability, Break-even analysis, Depreciation, Sources of funding.

Financing: Sources of finance, Initial capital, Capital structure, Venture capital and Institutional finance.

Economics: Demand-supply-pricing, Business ethics, Industrial laws, Women entrepreneurs – Role, problems and development.

Industrial Sickness: Symptoms, control and rehabilitation of sick units.

Introduction to Intellectual Property: Intellectual property and IPR, patent, copyrights, geographical indications, trademarks, trade secret, Industrial designs, Patent law, Legislations covering IPR's in India, product planning and development, filing patent, provisional and complete specification, patentable and non-patentable items, Valuation & business concerns.

Course Learning Outcome (CLO):

Students will be able to

1. correlate personal characteristics and interests to that of the "successful" entrepreneur
2. identify and assess sources of support for small businesses
3. evaluate methods of entering an entrepreneurship venture
4. analyze how to start a new venture, business, or becoming a franchisee.

Text Books:

1. *Desai V, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House (2007).*
2. *Singh I. and Kaur B, Patent law and Entrepreneurship, Kalyani Publishers (2006).*

Reference Books:

1. *Sateesh MK, Bioethics and Biosafety, IK International (2008).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

PBY201: DOWNSTREAM PROCESSING

L	T	P	Cr
3	0	2	4.0

Course Objective: The objective of this course is to enable students to acquire knowledge on reaction engineering systems with emphasis on bioreactor design, operation and analysis of kinetics in biochemical engineering reactions along with separation and purification of desired products.

Basic Concepts: An overview of bioseparation, Role and importance of downstream processing in biotechnological processes, Physico-chemical basis of bioseparation processes, Role of economics of downstream processes in industry, Basic methods of separations, Process design for separations of different products.

Primary Separation, Recovery and Purification: Separation of cells and other insolublesfrom fermented broth. Filtration, microfiltration and ultrafiltration, centrifugation (batch, continuous, basket), Sedimentation, Flocculation, Cell disruption methods for intracellular products, physical and biological methods, Liquid- liquid extractions, Liquid chromatographic methods- Medium Pressure Liquid Chromatography, HPLC (different principles: ion exchange; affinity, gel permeation).

Precipitation Methods and Membrane based Purification: Precipitation with salts, organic solvents and polymers, Reverse osmosis, Dialysis, Diafiltration, Pervaporation, Theory, design and configuration of membrane separation equipment and application.

Aqueous two-phase Extraction and Adsorption: Batch extractions, staged extractions-crosscurrent, co-current, counter current extractions. Differential extractions, Adsorption isotherms, industrial adsorbents, adsorption equipments for batch and continuous operations, adsorption in fixed beds.

Self-Learning: Drying and Case studies, Drying curve, Batch and continuous dryers, Case studies for the separation of intracellular and extracellular products, Evaporation and crystallization.

Laboratory Work: Batch sedimentation, Flocculation studies, Conventional filtration, Adsorption process in batch mode, Cell disruption, Ball milling, Batch drying, Qualitative and quantitative estimation of product using GC, Ion-exchange chromatography.

Course Learning Outcome (CLO):
Students will be able to:
1. perform bioreactor operations as applicable in bioprocess industries.
2. scale-up, simulate and model bioprocess operation
3. carry out separation and purification of fermentation products

Text Books:

1. *Sivasankar B, Bioseparations: Principles and Techniques, PHI Learning Pvt. Ltd. (2006)*
2. *Belter PA, Cussler E and Hu WS, Bioseparation – Downstream Processing for Biotechnology, Wiley Interscience (1988)*
3. *Mishra N, Bioseparation Technology, CRC Press (2008)*

Reference Books

1. *Ahuja S, Handbook of Bioseparations, Academic Press (2000)*
2. *Harrison RG, Bioseparations: Science and Engineering, Oxford University Press (2003)*

Evaluation Scheme:

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

PBY202: BIOPHARMACEUTICALS AND PHARMACEUTICAL TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: To acquire knowledge of steps involved in new drug discovery, development and production of biopharmaceuticals, approval process and their quality control in pharmaceutical industry.

Introduction: Development of drugs and pharmaceutical industry – organic therapeutic agents, biopharmaceuticals definitions and biotechnologically derived therapeutics – approved and under development, strategies for new drug discovery, rationale of drug design, drug receptor targeting, high-throughput screening, DNA microarrays.

Biopharmaceuticals: Production of biotechnologically derived therapeutic proteins like humulin, humatrope and hormones, recombinant vaccines, DNA vaccines and monoCLOnal antibodies (hybridoma technology), gene therapy and toxicogenomics; role of proteomics in disease detection and diagnostic kit development, drug registration and regulatory affairs, cGMP guidelines for Biopharmaceuticals.

Pharmaceutical Drug Development: Introduction to drug discovery, lead compound isolation and targeting, combinatorial chemistry, SAR and rational drug design, new drug development, production of pharmaceuticals by genetically engineered cells, microbial transformations for the production of steroids, semi-synthetic antibiotics and therapeutic enzymes like Streptokinase and Staphylokinase.

Pharmaceutical Manufacturing: Drug formulation and their classification - Oral solid dosage forms, Coating of pharmaceutical dosage forms, Parenteral preparations, Novel drug delivery systems, Good laboratory practices and Good manufacturing practices - Issues and packing techniques.

Self-Learning: Pharmaceutical Testing, Analysis and Control: Analysis of medicines using physical, chemical and biological methods, Quality assurance and control, Stability of pharmaceutical products, Bioavailability and bioequivalence testing, Quality control and testing as per Indian/US Pharmacopoeia.

Laboratory Work: Quality control of antibiotic/non-antibiotic formulations using titrimetric, Spectrophotometric, chromatographic and biological methods as per Indian/US Pharmacopoeia, Sterility testing of pharmaceutical products (intra-venous injections, antibiotics and vitamins), Assays for screening antimicrobial/antifungal agents from plants as well as pure drugs.

Course learning outcome (CLO):

Students will be able to:

1. explain the process of new drug discovery.
2. apply the concepts of production of biopharmaceuticals in pharmaceutical industry.
3. apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals.
4. carry out quality control of pharmaceuticals.
5. comprehend the regulatory aspects involved in the development of biopharmaceuticals.

Text Books:

1. *Walsh G, Pharmaceutical Biotechnology: Concepts and Applications, John Wiley and Sons (2007)*
2. *Groves MJ, Pharmaceutical Biotechnology, Second Edition, Taylor & Francis (2006)*
3. *Allen LV, Popovich NJ and Ansel HC, Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincot Williams and Wilkins (2005)*

Reference Books:

1. *Paradkar A and Bakliwal S, Biopharmaceutics and Pharmacokinetics, NiraliPrakshan Pune (2008)*
2. *Beringer P, Der Marderosian A, Felton L, et al., Remington-The Science and Practice of Pharmacy, Lippincott Williams and Wilkins (2005).*

Evaluation Scheme:

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

PBY208: BIOINFORMATICS AND SYSTEM BIOLOGY

L	T	P	Cr
3	1	2	4.5

Course Objective: The objective of this course is to provide students with basic understanding and application of bioinformatics. The course will provide the basic concepts behind the sequence and structural alignments, database searching, protein structure prediction and computer based drug designing.

Introduction: Goals, applications and limitations of Bioinformatics, DNA and protein sequence databases, Structure databases

Pairwise Sequence Alignment and Database Searching: Evolutionary Basis of sequence alignment, Homologous sequence, Global alignment and local alignment, Gap penalties, Dot matrix method, Scoring matrices Dynamic programming methods: Needleman-Wunsch and Smith-Waterman algorithm, Database similarity search, Heuristic methods: FASTA, BLAST

Multiple Sequence Alignment and Phylogenetic: Scoring multiple sequence alignments, Progressive alignment method, Iterative alignment method, Block-based alignment, Molecular evolution and phylogenetics, Phylogenetic trees, Molecular CLOck theory, Maximum Parsimony, Distance based methods: UPGMA, Maximum likelihood method, Bayesian statistical analysis

Structural Bionformatics: Ramachandran plot, protein secondary structure prediction, Chou-Fasman and GOR method, Neural networks, Protein three dimensional structure prediction: Homology modelling and protein Threading, Molecular visualization, Computer aided drug design, Docking and QSAR

System Biology: Objectives and Applications of Systems Biology, Strategies relating to Insilco Modelling of biological processes, Metabolic Networks, Signal Transduction Pathways, Measuring and Quantifying Microarray Variability-Analysis of Differentially Expressed Genes, Markup language (SMBL), E-cell and V- cell Simulations and Applications

Self-Learning: Machine Learning and Bio-programming: Development of Algorithms, Hidden Markov Models, Artificial Neural Networks

Laboratory Work:
DNA and protein sequence and PDB file formats, Local and global sequence alignment of protein and DNA sequences, Needleman Wunsch and Smith-Waterman algorithm, BLAST, Multiple sequence alignment and Sequence logo, Phylogenetic tree construction, Secondary structure prediction, Visualization and editing of three dimensional structure, Homology modelling, Active site prediction, Docking

Course learning outcome (CLO):

Students will be able to:

1. perform alignment of sequences and construct the matrix for alignment based on dynamic programming.
2. construct the phylogenetic of different sequences.
3. analyze sequence and structure of bio-macromolecule data.
4. predict three dimensional structure of protein using structural bioinformatics tools.
5. apply the knowledge of system biology in the biotechnology research and industry.

Text Books:

1. *Xiong J, Essential Bioinformatics, Cambridge University Press (2006)*
2. *Mount D W, Bioinformatics - Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press (2001)*
3. *Ghosh Z, and MallickB, Bioinformatics – Principles and Applications, Oxford University Press (2008)*

Reference Books:

1. *Higgins, D. and Taylor, W., Bioinformatics: Sequence, Structure and Databanks – A Practical Approach, Oxford University Press (2000).*
2. *Systems Biology: Definitions and Perspectives by L. Alberghina H.V. Westerhoff, Springer, 2005*

Evaluation Scheme:

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

PBY205: ADVANCED PLANT BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: To make students learn facile techniques related to micropropagation, development of transgenics, and application of transgenic technology for crop improvement. Course will also provide learning regarding how the plant systems are used for production of industrially and pharmaceutically important molecules.

Plant Tissue Culture and Applications: Technology and applications of plant tissue culture. Haploid production, somatic hybridization, mutation breeding and somaCLOnal variations. Commercial plant propagation, production planning and management of micropropagation unit. Virus elimination and maintenance of disease-free stocks, *in vitro* conservation. Acclimatization, quality control (Virus-free and CLOnal fidelity) of plants.

Plant Transformation Vectors and Methods: Plant transformation vectors: T-DNA and viral vectors, Methods of gene transfer to plants: biological, physical and chemical selection marker and reporter genes; plant transformation by *Agrobacterium* sp., *in planta* transformation and chloroplast transformation; clean gene technology; CRISPR technology, transgene analysis, marker-free and novel selection strategies; gene pyramiding

Applications of Plant Transgenic Technology: Gene silencing: antisense RNA and RNA interference technologies, transgenics for resistance to biotic and abiotic stresses; engineering crops for Agronomic traits such as male sterility, herbicide resistance, flower colour, fruit ripening and senescence; Engineering plants for secondary metabolite production, Biosafety aspects of GM crops for nutritional quality

Molecular Farming: Production of carbohydrates: starch, amylose-free starch, high-amylose starch, cyclodextrins, fructans, trehalose; Production of lipids: medium-chain, saturated & mono-unsaturated fatty acids, improvement of plant oils, Production of rare fatty acids, polyunsaturated fatty acids, biodgradable plastics; Enzymes for industrial and agricultural uses, medically related proteins-antibodies (plantibodies), subunit vaccines, protein antibiotics; The oleosin system: hirudin and insulin production, production of biopharmaceuticals in plants; molecular farming and their future prospects; Economic and regulatory considerations and biosafety.

Laboratory work: Establishment of aseptic culture, Types of culture, micropropagation and acclimatization. Methods of plant genetic transformation, *Agrobacterium*-mediated plant transformation and biolistic approaches. Isolation & characterization of genomic DNA, RNA. cDNA, making genetic constructs, Transient expression studies in plants, Gene expression studies and RT-PCR, studying molecular techniques/protocols related to various case studies: production of carbohydrates, lipids, proteins, antibodies, edible vaccines

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

1. comprehend the role of plant tissue culture in plant improvement and commercial micropropagation

2. apply facile techniques for genetic modification of plants.
3. recognise the role of trait specific modification for plant improvement
4. use plants for the production of industrially important molecules
5. comprehend economic and biosafety aspects of molecular farming

Text Books:

1. *Dodds JH and Roberts LW, Experiments in Plant Tissue Culture, Cambridge University Press (1990).*
2. *George EF, Plant Propagation by Tissue Culture: The Technology, Exegenetics Limited, UK (1993)*
3. *Day JG and Stacey GN, Cryopreservation and Freeze Drying Protocol, Humana Press (2007).*

Reference Books:

1. *Bhojwani SS and Razdan M K, Plant Tissue Culture: Theory and Practice, Elsevier (1996).*
2. *Slater A, Scott N and Fowler M, Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press (2008).*
3. *Primrose SB and Twyman RM, Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).*

Evaluation Scheme:

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

PBY 209: ANIMAL CELL CULTURE AND TRANSGENIC TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: The objective of this course is to enable students to develop proficiency in vertebrate primary cell culture and the maintenance of cell lines. Furthermore to enable students to understand the principles and application of stem cells.

Introduction to Animal Tissue Culture: Background, Advantages, Limitations, Application, Culture environment, Cell adhesion, Cell proliferation, Differentiation.

Media: Role of physicochemical properties of CO_2 and bicarbonates; Buffering; Oxygen; Osmolality; Temperature; Surface tension and foaming, Introduction to the balanced salt solutions and simple growth medium, Complete Media, Role of serum and supplements. Serum free media, Advantages and disadvantages and their applications.

Primary Culture: Isolation of tissue, Steps involved in primary cell culture, Subculture and propagation, Cell lines, Nomenclature, Cell line designations, Routine maintenance, Immortalization of cell lines, Cell transformation. Cell cloning and Cell separation, Cell synchronization, Measurement of viability and cytotoxicity: MTT assays, Trypan Blue, PI, FDA assays, Survival Assays, Applications of cytotoxicity assays

Characterization of Cell Line: Need for characterization, Morphology, Chromosome Analysis, DNA Content, RNA and Protein, Enzyme Activity, Antigenic Markers, Tumorigenicity, Cell counting, Plating Efficiency, Labelling Index, Generation Time.

Contamination and Cryopreservation: Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Need of cryopreservation, Cell banks, Transporting cells.

Transgenic Animals: Gene transfer methods**,** Methodology, Embryonic stem cell & Microinjection method, Retroviral method, Applications of transgenic animals, Transgenic animals as bioreactors, Animal cloning

Concept of Stem Cells: Stem cells: Basic concepts and properties, Totipotency, Pluripotency, Embryonic stem cells, Germinal stem cells, Adult stem cells, Tumor stem cells, Stem cell plasticity.

Embryonic Stem (ES) Cells: Isolation of ES cells, Salient features and application of ES cells, ES cells. Human and Mouse embryonic stem cells, Differentiation of ES cell, Maintenance of ES in undifferentiated state, iPSC technology

Hematopoietic Stem Cells and Mesenchymal Stem Cell: Identification and Characterization of HSCs, Sources of HSC Mouse Assay of HSC, HSC in leukemia and lymphoma, Clinical use of HSC. Embryonic origin of MSC's, Harvesting, Isolation and Characterization, Differentiation studies of MSCs

Epidermal Stem Cells: Liver Stem Cells, Pancreatic Stem Cells, Stem Cells in the Epithelium of the Small Intestine and Colon

Stem Cell Therapy and Future of Stem Cell Research: Potential of stem cell therapy for various diseases, eg. AIDS/HIV, Alzhemier's disease, Anaemia, Anti-ageing, Multiple sclerosis, Parkinson disease, Rheumatoid Arthritis.

Laboratory Work: Laboratory Design & Instrumentation in ATC, Quality Assurance in Animal tissue culture facility, Preparation of animal cell culture media, Isolation and Culturing Peripheral Blood Lymphocytes, Isolation of Chick embryo and establishing primary cultures, Sub-culturing and maintenance of Cell line, Viability assay, Cryopreservation, DNA and RNA isolation from tissues

Course Learning Outcome (CLO):

Students will be able to:

1. comprehend fundamental underlying principles of animal cell culture.
2. Learn techniques for isolation and growth of cells and develop proficiency in establishing and maintaining of cell lines.
3. acquire comprehensive knowledge about transgenic technologies and its application.
4. comprehend the importance of stem cells, different types of stem cells, features, properties and human diseases connected to 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. *Masters, J. R.W., Animal Cell Culture, Oxford (2000).*
2. *Ranga, M.M., Animal Biotechnology, Agrobios (2007).*

Evaluation Scheme:

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

PBY207: FOOD PROCESSING 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, composition of foods and long term storage.

Course contents:

Non-Conversion Operations: Food raw materials: Physical, Functional and other properties, Cleaning of raw materials: Methods and contamination, Sorting, Grading of food materials on the basis of size, Buoyancy, Photometry, Size.

Food Conversion Operations: Size reduction and screening of solids - Equipment, Modes of operation, Disintegration of materials, Mixing and emulsification, Filtration and membrane separation, Centrifugation, Solid-liquid extraction and expression, Heat processing - Modes of heat transfer, Methods of applying heat to food.

Preservation Operations: Microbiological considerations, Methods of heat sterilization in containers, Pasteurization by heat processing, Evaporation - Evaporation principles and equipment, Dehydration, Water in food, Drying, Freezing, Food storage - Storage conditions and packaging, Food products processing primer – Dairy products, Meat products, Juice, Vegetables.

Labelling and Packaging in Foods: Structures of packages, Degradability, Reusability and regulations, Types of packages and future packages, Labeling guidelines of foods.

Non-thermal Processing Operations in Foods: Advantages/disadvantages of thermal technologies, Nutritional and consumer considerations, advanced non-thermal operations, Operational criteria and applications.

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 : Microbial and other quality tests of fluid milk/meat/fish, Preparation of casein and fermented milk; Dehydration of fruits and vegetables, Preparation of tomato products, Determination of thermal process time, Pickling of meat, Use of hurdle concept for preservation of foods, Qualitative analysis of processed food samples, Microbiology of raw produce and processed foods, Microbiology of processing areas, Compositional analysis of food plant wastes and their reusability, Visit to mechanized food-processing Industries.

Course Learning Outcome (CLO):

Students will be able to:

1. prepare raw food materials through different unit operation in food processing
2. comprehend processing techniques and reasons behind the usage and application of individual unit operation on a particular food.
3. handle packaging and labelling 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 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. (2005) 2nd ed.*
2. *Mariott, N.G., Principles of Food sanitation. Kindle Publication (2005) 5th ed.*
3. *Jay, J.M., Modern Food Microbiology, Kindle Publication (2006) 7th ed.*

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	20
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	40

PBY303: PROTEIN ENGINEERING

L	T	P	Cr
3	0	2	4.0

Cold Spring Harbor Laboratory Press.

Course Objective: The objective of the course is to introduce to students the theory and practice of a variety of protein engineering methods. To learn specific examples of engineered proteins and their applications.

Protein Structure: Introduction to protein engineering, structure and properties of amino acids, primary, secondary, tertiary and quaternary structure of proteins, analysis of protein structure by CD spectroscopy, NMR, X ray diffraction crystallography, prediction of protein structure using bio-infomatics approach, protein folding, protein sequence and structure relationship, predicting the conformation of proteins from sequence data

Mutagenesis and Expression of Proteins: Expression of proteins in bacteria, yeast, insect and mammalian cells, mutations and their effects on protein folding, random and site directed mutagenesis, directed evolution

Engineering the Proteins and Their Applications: Effect of amino acids on structure of proteins, prediction of structure function relations of enzymes and other proteins, protein engineering - methodology, application and interpretation, gene shuffling methods such as RACHITT, ITCHY, SCRATCHY

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 Outcome (CLO):
The students will be able to

1. predict protein structure changes after site directed / random mutagenesis.
2. perform site directed mutagenesis.
3. carry out random mutagenesis and screening of proteins with desirable properties.
4. apply protein engineering to stabilize proteins and improve their properties
5. engineer antibodies

Text Books:

1. *Cleland JL and Craik CS, Protein Engineering: Principles and Practice, Wiley-Liss. (1996).*
2. *Lutz S and Bornscheuer U T, Protein Engineering Handbook, Wiley-VCH (2009)*

Reference Books:

1. *Primrose SB and Twyman RM, Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).*

Sambrook J, Fritsch EF, Maniatis T, Molecular CLOning: A Laboratory Manual,

Evaluation Scheme:

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

PBY304: BIOPROCESS EQUIPMENT DESIGN

L	T	P	Cr
3	0	2	4.0

Course Objective: The objective of this course is to enable the students to acquire basic understanding of design parameter, design procedures for commonly used process equipment and their attachments and different types of equipment testing methods.

Introduction: Basic concepts of process flow sheet, Piping and instrumentation, General design information, Design parameters, cGMP guidelines

Scale-up and Scale-down Studies: Bioreactor scale-up based on constant power consumption per volume (P/V), mixing time, shear, mass transfer coefficients. Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply, Scale-up studies of downstream processes: Filtration, Centrifugation, Exacters. Scale down related considerations

Design Considerations: Material selection, Factors affecting the selection and design, Stress considerations due to static and dynamic loads, Design considerations for maintaining sterility of process streams and process equipment, Design wall thickness, Factor of safety, Design pressure, Design temperature, Design stress, Economic considerations, Bioprocess validation; Safety considerations; case studies.

Selection of Bioprocess Equipment: Vessels for biotechnology application, Design of bioreactors, Specifications of bioprocess equipment, Mechanical design of reactors, heat transfer and mass transfer equipment with applications in bioprocess, Piping and instrumentation

Self-Learning: Materials of construction for bioprocess plants.

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

1. Apply the basics of process equipment design and its important parameters.
2. Correlate the equipment design and various process variables.
3. Design reactor vessels for a specific bioprocess/fermentation industry.

Text Books:

1. *Bhattacharyya B C, Introduction to Chemical Equipment Design: Mechanical Aspects, CBS Publishers and Distributors (1998).*
2. *Shuler M and Kargi F Bioprocess Engineering: Basic Concepts, Prentice Hall (2002).*

Reference Books:

1. *Harrison RG, Todd PW, Rudge SR and Petrides D, Bioseparations Science and Engineering, Oxford University Press (2003).*
2. *Joshi MV and V.V. Mahajan VV, Process Equipment Design, Macmillan India Ltd. (2000)*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	40
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	30

PBY305: DRUG DESIGN AND DEVELOPMENT

L	T	P	Cr
3	0	2	4.0

Course Objective: The objective is to enable the students to understand basic modelling techniques to explore biological phenomena at molecular level and modelling drug/receptor interactions by molecular mechanics, molecular dynamics, simulations and homology modelling.

Introduction: Definition of drugs, Overview of drug discovery process, Economics of drug discovery process, Trends in drug discovery process.

Rationale of Drug Discovery: Medical needs, Target identification, Target validation, Receptors and assay development.

Bioresources for Small Molecule Discovery: Bioprospecting, Plant natural products, Microbial secondary metabolites, Marine natural products.

Screening Strategies: High throughput assays for antimicrobial, anticancer, anti-diabetic and anti-hypercholestrolemia, combinatorial chemogenomics, combinatorial chemistry.

Drug Leads: Bioassay guided isolation, Characterization of drug molecules using integratedtechnology (TLC, HPLC, MS, IR, NMR).

Herbal Drugs: Definition, Trade scenario, Pharmacopoeial status of herbal drugs, Phytochemical standardization and fingerprinting, Marker compounds, Polyherbal formulations.

Drug Development and Pre-Clinical Studies: Drug receptor interactions; enzyme inhibition and inactivation, *In-vitro* and *in-vivo* pharmacodynamic models, Therapeutic index, Pharmacokinetics - Microbial and animal models, Lipinski's rule, *In-vitro* and *in-silico* toxicological models, Drug formulations.

Self-Learning: Drug Regulatory Operations, Role of Regulatory Authorities, US Food and Drug Administration, Regulatory applications viz. Investigational new drug (IND), New drug application (NDA), Abbreviated New Drug Application (ANDA).

Laboratory work: Methods of preparation of microbial and plant extracts ,*in-vitro* screening of antimicrobials from plant and microbial extracts, *in-vitro* screening of amylase inhibitors, *in-vitro* antioxidant assay, Herbal formulation and standardization by FIC index, TLC bioautography, Characterization of bioactive compounds of known medicinal plants using standard reference compounds.

Course Learning Outcomes (CLO):

The students will be able to:

1. comprehend the principles and practice of modern drug discovery.
2. apply methods and bioprospecting of drug molecules.
3. comprehend the importance of herbal drugs and Ayurveda in drug development.
4. learn methods of herbal drug standardization.
5. recognise the role of preclinical studies in drug development.

Text Books:

1. *Patwardhan B, Drug Discovery and Development-Traditional Medicine and Ethnopharmacology, New India Publishing (2007).*
2. *Larsen PK, Leljifore T and Medsan U, Text Book of Drug Design and Discovery, CRC Press (2009).*

Reference Books:

1. *Hillisch A and Hilgenfeld R, Modern Methods of Drug Discovery, Birkhauser (2003).*

Evaluation Scheme:

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

PBY 306: BIOREMEDIATION TECHNOLOGY

L	T	P	Cr
3	0	2	4

Course Objective The course will impart a comprehensive knowledge and understanding of technological processes involved in bioremediation and bioremoval of pollutants and application of microorganisms and plants in soil and water remediation.

Detail contents:

Introduction to bioremediation: Global status of environmental pollution and its remediation strategies, various types and mechanisms of bioremediation, factors affecting bioremediation, and its limitations.

Microbes for Bioremediation: Characteristics of Microbes for Bioremediation, Microbial adaptation for adverse conditions, metabolic process involved in bioremediation, Bioremediation of xenobiotics, chlorinated aliphatic compounds and triphenyl methane dyes, Biodegradation plasmids: TOL plasmid, ring cleavage rules, toluene (Tol) degradation pathway, Naphthalene (Nah) degradation pathway, bioremediation of chlorinated phenols, pesticides, PAH. Modelling bioremediation kinetics, aerobic degradation of trichloroethylene, biodegradation of poly-halogenated compounds by genetically engineered bacterium, role of nanoparticles in bioremediation of toxic pollutants

Bioremediation Technologies: application, advantages and disadvantages of specific bioremediation technologies- land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, constructed wet lands, use of bioreactors for bioremediation, restoration of coal mines-case studies, levels of bioremediation: biostimulation, bioaugmentation. *Insitu* & *Exsitu* bioremediation techniques, solid-phase bioremediation**,** phytoremediation of low level nuclear waste

Metagenomics Approach to Bioremediation: applications of metagenomics for industrial bioproducts; *Escherichia coli* host engineering for metagenomic enzyme discovery; Next-generation sequencing approaches to metagenomics; Stable isotope probing and its use in metagenomics; DNA sequencing of uncultured microbes from single cells

Heavy Metal and Oil Spill Bioremediation Heavy metal pollution and sources;

Microbial interactions with heavy metals - resistance and tolerance; Microbial transformation; bioaccumulation and concentration of metals. Biosorption of heavy metals by microbial biomass and secondary metabolites – Biosurfactants. Advantages of biosurfactants over chemical surfactants; Biotechnology and oil spills; Improved oil recovery

Laboratory Work: Isolation and enumeration of biodegrading microbes from soil and water, organic matter decomposition, determination of residual concentration of dyes, pesticides, heavy metals to check levels of bioremediation.

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

Course learning outcomes (CLO):

Students will be able to:

1. acquire complete understanding of principles of bioremediation technology.
2. apply different plant and microbial systems in pollution abatement.
3. apply eco-friendly techniques in remediation of soil and water.

TextBooks

1. *Singh, SN, Tripathi, RD. (2007) Environmental Bioremediation Technologies Springer Publ.*
2. *Fulekar, MH. (2010) Bioremediation Technology: Recent Advances, Springer Publ.*

Reference Books

1. *Peppler H.J and Perlman D (2006), Microbial Technology, Vol I and II, Academic Press, New York.*

Evaluation Scheme:

PBY204: INDUSTRIAL ENZYME TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

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

Introduction and Scope: Enzymes-Historical Resume, Nomenclature and Classification, Biological Roles, Enzyme activity, Specific activity and turn over number, Isozymes, Marker enzymes, Km and Vmax of Enzymes and their significance, 3D- Structure of Enzymes, Active Site, Modifiers of Enzyme Activity, Enzyme Activators, Enzyme Inhibitors.

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, large-scale industrial enzyme production and downstream processing.

Techniques of Enzyme Immobilization: Immobilization- Definition, Immobilization Techniques- Physical and chemical - adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding with examples; Advantages and disadvantages of different immobilization techniques; Overview of applications of immobilized enzyme systems, Design of enzyme electrodes and their application as biosensors in industry, health care, and environment.

Kinetics of Immobilized Enzymes: Analysis of mass transfer effects of kinetics of immobilized enzyme reactions, Analysis of Film and Pore Diffusion Effects on Kinetics of immobilized enzyme reactions, calculation of effectiveness factors of immobilized enzyme systems, Bioconversion studies with immobilized enzyme packed-bed reactors, mass transfer in enzyme reactors, Steady state analysis of mass transfer and biochemical reaction in enzyme reactors.

Self-Learning: Applications of Enzymes, Industrial, Analytical and Diagnostic purposes, commercial applications of enzymes in food, pharmaceutical and other industries, enzymes for diagnostic applications, Case studies on application – chiral conversion, esterification etc.

Laboratory work: Analysis of protein content and enzyme activity from spent broth of bacteria and fungi, purification of amylase enzyme by ammonium sulphate precipitation, determination of protein content and amylolytic activity, purification of enzyme by affinity chromatography/ion exchange chromatography, SDS-PAGE analysis of the protein (enzyme), characterization of the pure enzyme, efficacy of amylase as an additive in detergents

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

1. produce, isolate and purify enzymes at lab/industry scale

2. apply reaction parameters and systems in order to develop an efficient enzymatic process.
3. apply the biochemical knowledge to specific enzymatic process.
4. predict the course of an enzymatic process by kinetic calculation.
5. design new enzymatic processes.

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).*

Evaluation Scheme:

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

PBY: SEMINAR

L	T	P	Cr
0	0	0	4.0

Course objective: The students will choose a topic of their interest and do a literature survey and compile information with latest update and also find gaps or lacunae. The students will acquire skill to write, compile and analyze data and present the detailed technical or scientific report.

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

1. carry out literature survey and compile existing data and information.
2. make a presentation of compiled data and its interpretation to a meaningful conclusion.
3. acquire presentation and oral communication skills of scientific information and data.

PBY392: MINOR PROJECT

L	T	P	Cr
0	0	0	4.0

Course objective: The students will choose a topic of their interest and do a literature survey and compile information with latest update and also find gaps or lacunae to plan for next series of experiments to be conducted to fill the gaps as a major research project. The students will acquire skill to write, compile and analyze data and present the detailed technical or scientific report.

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

1. carry out literature survey and compile existing data and information.
2. formulate a research problem in research laboratory.
3. design experiments to solve research problem.
4. make a presentation of compiled data and its interpretation to a meaningful conclusion.
5. acquire presentation and oral communication skills of scientific information and data.

PBY401: 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

MTech (Biotechnology) Dissertation Evaluation

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:.....
.....
...

Name and Signature of Examiner
Affiliation