COURSES SCHEME

&

SYLLABUS

FOR

M.TECH.

BIO-TECHNOLOGY

2015

COURSES SCHEME & SYLLABUS FOR M.TECH. (BIOTECHNOLOGY)

SEMESTER – I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY101	MOLECULAR BIOLOGY & 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	PHU301	ENTREPRENEURSHIP AND IPR	3	1	0	3.5
TOTAL			**14**	**2**	**8**	**19.0**

SEMESTER – II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY201	DOWNSTREAM PROCESSING	3	0	2	4.0
2	PBY202	BIOPHARMACEUTICAL & PHARMACEUTICAL TECHNOLOGY	3	0	2	4.0
3	PBY208	BIOINFORMATICS AND SYSTEM BIOLOGY	3	1	2	4.5
4	PBY204	INDUSTRIAL ENZYME TECHNOLOGY	3	0	2	4.0
5		ELECTIVE 1	3	0	2	4.0
6	PBY291	SEMINAR	0	0	0	2.0
TOTAL			**15**	**1**	**10**	**22.5**

ELECTIVE-I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY205	ADVANCED PLANT BIOTECHNOLOGY	3	0	2	4.0
2	PBY209	ANIMAL CELL CULTURE AND TRANSGENIC TECHNOLOGY	3	0	2	4.0
3	PBY207	FOOD PROCESSING TECHNOLOGY	3	0	2	4.0

SEMESTER – III

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1		ELECTIVE 2	3	0	0	3.0
2		ELECTIVE 3	3	0	2	4.0
3	PBY307	MINOR PROJECT	0	0	0	4.0
4	PBY491	DISSERTATION (STARTS)				
TOTAL			**6**	**0**	**2**	**11.0**

SEMESTER – IV

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY491	DISSERTATION	-	-	-	12.0
TOTAL			**-**	**-**	**-**	**12.0**

ELECTIVE-II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY301	PLANT MOLECULAR FARMING	3	0	0	3.0
2	PBY302	STEM CELL & TISSUE ENGINEERING	3	0	0	3.0
3	PBY303	PROTEIN ENGINEERING	3	0	0	3.0

ELECTIVE-III

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PBY304	BIOPROCESS EQUIPMENT DESIGN	3	2	0	4.0
2	PBY305	DRUG DESIGN & DEVELOPMENT	3	0	2	4.0
3	PCL101	ADVANCED DATA STRUCTURES	3	0	2	4.0

PBY101: MOLECULAR BIOLOGY & 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 basics of Molecular Biology and rDNA technology. To provide basic knowledge on replication. Transcription and Translation. To provide knowledge on methods of cloning, construction of DNA libraries and applications of rDNA technology.

Molecular Biology: Brief introduction to biomolecules, Interplay of macromolecules in a living cell, Major molecular events in the cell cycle, Architecture of microbial, animal and plant genome, Replication & transcription and their control in prokaryotes and eukaryotes, Features of genetic code, translation and its control, Posttranslational modifications, Gene structure & function, Molecular mechanism of gene expression, silencing of gene function, Extrachromosomal genetic elements, Transposable genetic elements and retroviruses, Molecular basis of cellular differentiation, Oncogenes and cancer, Epigenetic effects, Regulatory RNA, Genetic and metabolic disorders, Programmed cell death, Aging and senescence.

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 & characterization of genes and their regulatory sequences, PCR and their applications, Classical & site-directed mutagenesis, Expression of cloned genes in prokaryotic and eukaryotic hosts, Overproduction of recombinant proteins & their purification, Relevance of genome projects, Various applications of gene technology: production of pharmaceuticals & other novel compounds

Laboratory Work:
Small & large scale isolation of DNA, RNA, cloning vectors & proteins, checking of purity & quality, Operon induction in the prokaryotes, Monitoring constitutive & inducible gene expression, Molecular cloning & characterization of genes & 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 Outcome (CLO):
Students will be able to:
1. apply the knowledge of molecular biology for genetic manipulation of living systems
2. correlate between genotypic and phenotypic attributes of an organism
3. perform genetic manipulations using types of cloning and expression vectors
4. construct the genomic and gene libraries
5. perform site directed mutagenesis

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, Goldstein ES and Kilpatrick ST, Lewin's GENES X, Jones and Bertlett Publishers (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 Maniatis EF, 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 for 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 & 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 fermentors

3. Operate and optimize process parameters in a fermenter for producing industrial products.

Text Books:

1. *Shuler ML and Kargi F, Bioprocess Engineering, Prentice Hall (2004).*
2. *Stanbury PF, 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 and 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 disease like infectious disease, Cancer, autoimmune disease, AIDS etc.

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, Sub unit 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, Immunoinformatics approach to identify T and B cell epitopes, Adjuvants, Cell Banking, Bacterial and Viral vaccine

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

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

Course Learning Outcome (CLO):

Students will be able to:

1. explain 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 see effect of drug molecule on immune response
4. carry out immunological techniques in industry.
5. able to 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, Immuno biology: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. Use 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. Use their 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. 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 and 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 insolubles from 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 & polymers, Reverse osmosis, Dialysis, Diafiltration, Pervaporation, Theory, design & configuration of membrane separation equipment, application.

Aqueous two-phase extraction and Adsorption: Batch extractions, staged extractions-cross current, 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: BIOPHARMACEUTICAL AND PHARMACEUTICAL TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: To acquire knowledge of steps of new drug discovery, development and approval process and drug manufacturing and its quality control in pharmaceutical industry.

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

Biopharmaceuticals: production of biotechnologically derived therapeutic proteins like humulin, humatrop 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 enzyme like Streptokinase and Staphylokinase.

Pharmaceutical Manufacturing: Drug formulation and their classification - Oral solid dosage forms, Coating of pharmaceutical dosage forms, Parenteral preparations, Ophthalmic preparations, Medicated topicals, 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 assurance of antibiotic/non-antibiotic formulations using titrimetric, Spectrophotometric and 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. Apply the concepts of biopharmaceuticals in pharmaceutical industry
2. Apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals
3. Develop the strategies of new drug discovery

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, Nirali Prakshan 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 alignment, 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 Phylogenetics: 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 modeling and protein Threading, Molecular visualization, Computer aided drug design, Docking and QSAR

System Biology: Objectives and Applications of Systems Biology, Strategies relating to in silico 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. Apply key concepts of different bioinformatics tools
2. Analyse sequence and structure bio-macromolecule data
3. Apply the knowledge of bioinformatics in the biotechnology research and industry

4. Use system biology for application in biotechnology

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 Mallick B, 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

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, Advantages & Disadvantages, Types of 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

PBY205: ADVANCED PLANT BIOTECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: The course will enable the students to acquire knowledge about various techniques like micropropagation, single cell culture, suspension culture, protoplast culture, hairy root culture and various techniques of recombinant DNA technology to produce genetically modified organisms with novel characters.

Introduction: Cell plasticity and totipotency, the culture environment, plant growth regulators, various types of plant cell/tissue culture Callus, Applications of micropropagation, Organogenesis, somatic embryogenesis, synthetic seed production, and acclimatization of tissue culture raised plants, commercial micropropagation, assuring plant quality (clonal fidelity and virus indexing)

Applications of Plant Tissue Culture: Haploids: development of haploid and double haploid plants; embryo culture techniques: introduction and their applications and embryo rescue; somaclonal variation: applications of somaclonal variation; mutation breeding; cryopreservation

Plant Transformation Vectors and Methods: Plant transformation vectors: T-DNA and viral vectors, various techniques for direct gene transfer to plants; selectable markers and reporter genes; plant transformation by *Agrobacterium* sp., and *in planta* transformation, molecular mechanism of T-DNA transfer; biolistic approaches-merits and demerits; clean gene technology; transgene analysis, silencing and targeting; marker-free and novel selection strategies; multigene engineering; approaches for post-transcriptional gene silencing

Somatic Hybridization: Protoplast isolation and culture and plant regeneration, methods of protoplast fusion and selection of hybrids; somatic hybrids: symmetric, asymmetric and cytoplasmic hybrids; selection and screening of hybrid lines; applications of somatic hybridization

Applications of Plant Transgenic Technology: Transgenic crops for resistance against biotic and abiotic stresses; engineering crops for male sterility and modification of flower colour, flowering, fruit ripening and senescence; GM crops for nutritional quality and quantity

Self-Learning: Introduction to Biological Safety Cabinets, Primary Containment for Biohazards; Biosafety Levels, Biosafety guidelines; Definition of GMOs & LMOs. GMO applications in food and agriculture, Environmental release of GMOs, Risk management

Laboratory Work:
Media preparation, initiation of aseptic culture and micropropagation, regeneration, another culture, embryo rescue, acclimatization of plantlets. Methods of plant genetic transformation, *Agrobacterium*-mediated plant transformation, biolistic approaches, protoplast mediated DNA uptake, protoplast isolation and culture, somatic hybridization

Course Learning Outcomes (CLO):

Students will be able to:

1. Undertake propagation of plant in culture and plan commercial production of plants through micropropagation
2. Certify tissue culture raised plants
3. Undertake trade specific modification through plant genetic manipulation and somatic hybridization
4. Develop various gene constructs and their expression in plants

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

PBY209: ANIMAL CELL CULTURE & 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. Apply cell and molecular techniques to in vitro situations. The students will have knowledge in areas of cloning, large animal models for disease and development of therapies and treatments.

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

Layout and Equipment: Layout, Essential equipment's, Aseptic technique, Objectives, Elements, Sterile handling, Safety, Risk assessment, General safety, Fire, Radiation, Biohazards.

Media: Role of Physicochemical properties CO2 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, Labeling 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 and Animal Cloning: Methodology, Embryonic stem cell method, Microinjection method, Retroviral method, Applications of transgenic animals, Transgenic animals as bioreactors. Fertilization and Cloning, Conventional methods for animal improvement, Embryo bio-techniques, Embryo splitting, embryo sexing

Self-Learning: Micro manipulation and cloning, Somatic cell cloning, Embryo sexing Artificial insemination, Concept of nuclear transfer in cloning, Creation of Dolly, Polly.

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, *In vitro* anti-cancer assay (MTT Assay), Handling laboratory mice.

Course Learning Outcome (CLO):

Students will be able to:

1. Explain the fundamental scientific principles that underlie cell culture.
2. Exhibit appropriate safety procedures in the cell culture laboratory including personal protective equipment, aseptic technique.
3. Acquire comprehensive knowledge about transgenic technologies and its application.
4. Develop an understanding of current techniques used in biotechnology and their applications to animal and the biomedical field.

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	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	35

PBY207: FOOD PROCESSING TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objective: This course aims to impart a strong basic knowledge on processing criteria of foods (both traditional and emerging technologies) concepts applied in food processing industries, delivery of finished food products. Microbial safety, regulations in practice, traceability methods and state- of- the art analytical techniques used for assessing contamination of food

Introduction: Overview of food processing with special emphasis to fruit and vegetable processing technology, consumer trends in processed foods

Food Handling and Storage: Food refrigeration and cold storage, Food packaging technology, Hygienic handling of food when developing safe and appealing products, Processing, preparation and storage of food.

Analysis: Food products of animal origin, Plantation products and spices technology, Food additives, Aroma and flavour compounds in food

Food Processing: Radiation and thermal preservation and processing of food products, Hurdle concept, Enzymes in food processing, Emerging technologies in food processing, Food dehydration technology, Food process management and control.

Processed Products: Protein chemistry and technology, Food chemistry, engineering properties of foods

Self-Learning: Food Processing Sectors, Dairy technology, Cereals and pulses technology, Sugar and confectionery technology, Milling and bakery technology

Laboratory Work:
Compositional analysis/proximate analysis of foods, Thermal inactivation and processing, minimal processing of fresh cut produces, advanced packaging design, extrusion processes for cereal products and preparation of nutritive snack foods, Determination of taste and flavour components and sensory examination of processed foods, food equipment design, HACCP for implementing safe process design, Enzyme based processing of selected foods.

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

1. acquire an understanding of relevance of food components,
2. acquire an understanding application and detection techniques in food.
3. apply regulatory techniques in real time scenarios
4. acquire an understanding in industrial operations in food, role of microbes

Text Books:

1. *Heldman DR, Food Preservation and Process Design, Academic press (2011).*
2. *Das H, Food Processing Operations Analysis. Asian Books Pvt Ltd (2005).*

Reference Books:

1. *Sun DW. Emerging Technologies for Food Processing: Academic press. (2005).*
2. *Tucker GA and Woods LFJ, Enzymes in Food Processing, Springer. Academic Press (1993).*

Evaluation Scheme:

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

PBY301: PLANT MOLECULAR FARMING

L	T	P	Cr
3	0	0	3.0

Course Objective: The course will enable the students to acquire knowledge about various techniques like micropropagation, single cell culture, suspension culture, protoplast culture, hairy root culture and various techniques of recombinant DNA technology to produce genetically modified organisms with novel characters.

Introduction: Definition and common perception of molecular farming; Transgenic plants as bioreactors-an attractive alternative to current forms of manufacture of various compounds, Relevance & advantages of plant-based molecular farming.

Strategic Details of Various Molecular Farming: Major targets for carbohydrate and lipid molecular farming; Introduction to the crucial metabolic pathways and the involved gene functions in plants & other suitable organisms; Various molecular approaches & strategies relevant to molecular farming; Production of carbohydrates: increased starch amount, 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 having pharmaceutical and nutraceutical values.

Production of Biodegradable Plastics in Plants: Various gene functions involved in the production of polyhydroxy butyrate (PHBs) & polyhydroxyalkanoate co-polymers; Strategies for production of biodegradable plastics in plants.

Genetically engineered plants as protein factories: 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; Chloroplast: a clean high-level expression system for molecular farming based on single or multiple transgenes.

Self-Learning: Critical evaluation on various case studies of molecular farming & their future prospects; Economic and regulatory considerations for molecular farming.

Course Learning Outcome (CLO):
Students well able to:

1. develop strategies for modification of plants for production of important molecules
2. take decision to select the expression system in plants for various proteins and enzymes
3. biotransform the existing bio-molecules

Text Books:

1. *Slater A, Scott NW and Fowler MR, Plant Biotechnology, Oxford University Press (2008).*
2. *Primrose SB and Twyman RM, Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).*
3. *Satyanarayana U, Biotechnology, Books and Allied (P) Ltd. (2005).*

Reference Books:

1. *Barnum SR, Biotechnology-an Introduction, Thompson Brooks/Cole (2007).*
2. *Primrose SB, Molecular Biotechnology, Panima Publishing Corporation (2001).*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	20

PBY302: STEM CELL AND TISSUE ENGINEERING

L	T	P	Cr
3	0	0	3.0

Course Objective: The objective of this course is to enable students to understand the principles of stem cells. To acquire knowledge in the areas of tissue engineering.

Developmental Biology: Principles and applications of Developmental Biology, Early embryonic development, Cleavage: Types and mechanism, Gastrulation.

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, General methods of characterization of stem cells.

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.

Stem Cells and Cloning: Therapeutic and reproductive cloning, Nuclear Transfer method, Application of NT ES cells, Safety of NT ES cells.

Hematopoietic Stem Cells (HSC): Identification and Characterization of HSCs, Sources of HSC Mouse Assay of HSC, HSC in leukemia and lymphoma, Clinical use of HSC.

Mesenchymal and Neural Stem Cell: Embryonic origin of MSC's, Harvesting, Isolation and Characterization, Differentiation studies of MSC's, Neural stem cell and Neural crest stem cell.

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.

Tissue Engineering: Introduction, structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing, Scaffold and transplant –

Self-Learning: Engineering biomaterials, degradable materials, porosity, mechanical strength, 3-D architecture and cell incorporation, Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver.

Course learning outcome (CLO):
The students will be able to:

1. Describe the design, fabrication and biomaterials selection criteria for tissue engineering scaffolds.
2. Discuss the challenges of in vivo implantation of biomaterials and scale-up issues relating to human clinical applications
3. Describe the sources, selection, potential manipulations and challenges of using stem cells for tissue engineering.
4. Explain the ethical and regulatory issues of significance in tissue engineering

Text Books:

1. *Twyman RM, Developmental Biology Viva Books Pvt. Ltd. (2001)*
2. *Marshak L, Stem Cell Biology, Cold Spring Harbor Publication, (2001).*
3. *Lanza RP, Robert Langer R and Chick WL, Principles of Tissue Engineering, Academic Press (1997).*

Reference Books:

1. *Palsson B and Bhatia S. Tissue Engineering, Pearson-Prentice Hall, (2003).*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	20

PBY303: PROTEIN ENGINEERING

L	T	P	Cr
3	0	0	3.0

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 bioinfomatic 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 Application: 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

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).*
2. *Sambrook J, Fritsch EF, Maniatis T, Molecular Cloning: A Laboratory Manual, Cold Spring*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	50
3	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	20

PBY304: BIOPROCESS EQUIPMENT DESIGN

L	T	P	Cr
3	2	0	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 of the course is to enable the students to understand basic modelling techniques to explore biological phenomena at the molecular level. To emphasize Modelling drug/receptor interactions in detail 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 integrated technology (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 *insilico* 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. Implement the principles and practice of modern drug discovery
2. Carry out molecular modelling principles and practice of molecular modelling
3. Use the concepts of rational drug design by understanding the three-dimensional structures and physicochemical properties of drugs and receptors.

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

PCL101: ADVANCED DATA STRUCTURES

L	T	P	Cr
3	0	2	4.0

Course Objective: The objective of the course is to enable the students to be familiar with basic techniques of algorithm analysis and with writing recursive methods. Be familiar with several sub-quadratic sorting algorithms including quicksort, merge sort and heap sort.

Review of Data Structures and Programming concepts: Concepts of structures/classes, functions, Pointers, Dynamic memory allocation and de-allocation, Algorithm complexity, Arrays, linked lists, Stacks, queues, Binary trees, Hashing, Sorting and searching techniques.

Trees: Threaded Trees, Properties of threaded trees, Insertion, Deletion and traversal; AVL Trees: Properties of AVL trees, Rotations, Insertion and deletion; Red-Black Trees: Properties of red-black trees, Rotations, Insertion and Deletion; B-Trees: Definition of B-trees, Basic operations on B-trees, deleting a key from a B-tree, Height of a B-Tree.

Heaps: Properties of Min-max heaps, Building a heap, Basic operations on heaps, Application of min-max heaps. Binomial heaps: Binomial tress and binomial heaps, Operations on binomial heaps.

Data Structures for Disjoint Sets: Disjoint set operations, Linked list representation of disjoint sets, disjoint set forests.

Graph Algorithms: Topological sort, Minimum Spanning tree, Single-source shortest paths, All-pairs shortest paths, Bi-connected components, strongly connected components, Cycles, articulation points, bridges.

Self-Learning: String Matching, Naive string-matching algorithm, Rabin-Karp algorithm, String matching with automata, Knuth-Morris-Pratt algorithm, Boyer-Moore algorithm.

Laboratory Work:
Implementation of various algorithms in C/C++.

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

1. Construct programs of significant length that require modularization in order to be understood.
2. Use and understand basic object oriented programming concepts (e.g., classes, inheritance, interfaces, exception handling and JAVA APIs).
3. Generate source code that is easy to read, well organized, well commented.
4. Employ debugging techniques to assist in problem solving.

Text Books:

1. *Seymour L, Theory and Problems of Data Structures, Tata McGraw Hill (2002)*
2. *Weiss MA, Structures and Algorithm Analysis in C, Pearson Education (2003)*
3. *Alfred VA, Ullman JD and Hopcroft JE, Data Structures and Algorithms, Addison-Wesley (2003).*

Reference Books:

1. *Cormen TH, Leiserson CE, Rivest RL and Stein C, Introduction to Algorithms, Prentice-Hall India (2005)*
2. *Horowitz E and Sahni S, Fundamentals of Data Structures in C++, University Press (2007)*

Evaluation Scheme:

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