Detailed syllabus of

M. Tech in

BIOTECHNOLOGY

Regulation-2019

GIET UNIVERSITY, GUNUPUR-765022

GIET UNIVERSITY, GUNUPUR-765022

M. Tech in Biotechnology

I SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	PC		Biomolecules and Metabolic Regulations	3	0	0	3
2	PC		Bioprocess and Bioseparation Technology	3	0	0	3
3	PC		IPR and Commercialization of Biotechnology	2	0	0	2
4	PE		Plant Biotechnology	3	0	0	3
			Environmental Biotechnology				
			Animal Biotechnology				
5	PE		Advanced Microbiology & Immunology	3	0	0	3
			Genetic Engineering				
			Food Process Biotechnology				
6	AUDIT		Audit course	2	0	0	0
PRACTICAL / SESSIONAL							
7	PC		Laboratory- 1(Biomolecules and Metabolic regulations)	0	0	4	2
8	PC		Laboratory- 2 (Bioprocess and Bioseparation Technology)	0	0	4	2
TOTAL				**16**	**0**	**8**	**18**

GIET UNIVERSITY, GUNUPUR-765022

M. Tech in Biotechnology

II SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	PC		Advanced Biochemical Engineering	3	0	0	3
2	PC		Applied Bioinformatics	3	0	0	3
3	PE		Genomics and Proteomics	3	0	0	3
			Computational Biology				
			Process Control and Instrumentation				
4	PE		Nanobiotechnology	3	0	0	3
			Bioreactor design and optimization				
			Metabolic engineering and metabolomics				
5	AUDIT		Audit Course	2	0	0	0
PRACTICAL / SESSIONAL							
6	PC		Laboratory-3(Advanced Biochemical Engineering)	0	0	4	2
7	PC		Laboratory- 4 (Applied Bioinformatics)	0	0	4	2
8	PC		Mini Project with Seminar	0	0	2	2
TOTAL				**14**	**0**	**10**	**18**

M.Tech In Biotechnology

III SEMESTER [SECOND YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	PE		Molecular modeling and Drug designing	3	0	0	3
2	PE		Pharmaceutical Biotechnology				
3	PE		Protein Engineering				
4	OE		Green Technology	3	0	0	3
			Industrial Safety				
			Research Methodology				
PRACTICAL / SESSIONAL							
5	PC		Dissertation-I/ Industrial Training	0	0	20	10
6							
7							
TOTAL				**6**	**0**	**12**	**16**

. M.Tech In Biotechnology

IV SEMESTER [SECOND YEAR]

Sl. No.	Course Category	CourseCode	Course Title	L	T	P	Credits
THEORY							
1	PC		Dissertation	0	0	32	16
TOTAL							**16**

I Semester

Professional Core

Biomolecules and Metabolic Regulations

Module-I

Macromolecular structure and dynamics: Configurations and conformations of macromolecules; interaction of biological macromolecules with water and non-aqueous environments; non-covalent (weak) forces that stabilize protein and nucleic acid structure; simulation of the structure of biological macromolecules including energy minimization, molecular dynamics and free energy methods.

Module-II

Statistical thermodynamics of biological macromolecules: Partition functions, structural transitions in polypeptides and proteins including coil helix transitions, Structural transitions in polynucleic acids and DNA including melting and annealing of polynucleotide duplexes, helical transitions of double stranded DNA, prediction of helical structures in genomic DNA.

Biophysical techniques for analysis of biomolecules – Chromatography, X-ray crystallography, NMR, Mass spectrophotometry and UV spectrometry.

Module-III

Carbohydrate and lipid metabolism-Glycolysis, Krebs cycle, ETS, Energetics and regulation of these pathways, HMP pathway and its importance, Gluconeogenesis, Mechanism of Oxidative Phosphorylation, Fatty acid oxidation and their metabolic routes of carbon, biosynthesis of lipids (fatty acids and sterols), Glycogen metabolism.

Protein metabolism: Oxidative deamination, decarboxylation,and transamination reactions, Urea cycle, Aminoacid synthesis by microorganisms. Central role of Glutamine. Synthesis of Nucleotides, and salvage pathways.

Module-IV

Integration of metabolism and concept of metabolic regulation: Elucidation of metabolic pathways; Logic and integration of central metabolism; Major pathway and strategies of energy metabolism, entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers. Organ (Brain, Muscle, Liver) specialization, Metabolic adaptation, Metabolic changes associated with plant development and senescence and its regulation.

Text/ Reference Books

1. Biochemistry By U Satyanarayana
2. Biochemistry: Concepts and Connections by R. Appling Dean and J. Anthony-Cahill Spencer
3. Biochemistry by Jeremy M. Berg, Lubert Stryer, et al.
4. David L. Nelson and Michael M. Cox Lehninger Principles of Biochemistry
5. Biochemistry, 4th Edition 4th Edition by Donald Voet , Judith G. Voet

Bioprocess and Bioseparation Technology

Module-I

Concepts of Bioprocess and its parameters: Introduction to bioprocess, Instrumentation and operation of bioreactor; Culture-specific design aspects: Plant/Mammalian cell culture reactors. Biomass clarification and disruption; Membrane-based techniques; Extraction; Adsorption and Chromatography

Module-II

Kinetic models: Stoichiometric analysis; Unstructured Models of growth, substrate utilization and product formation, Transient growth Kinetics, Structured kinetic Models of growth and product formation.

Measurement and control of Bioprocess: On and off-line sensors for a modern bioreactor, Analysis of cell and medium composition,

Module-III

Bioreactor Design, Analysis and Applications: Ideal and Non-Ideal reactors, mixing and residence time distribution studies in a bioreactor. Packed Bed, Bubble columns, fluidized bed and trickle bed bioreactors, Immobilized cell based bioreactor; Bioreactor design for animal cell culture, Bioreactor design for waste treatment.

Bioseparation-I: Theory, Numericals and Applications of Separation of cells and other insolubles from fermented broth. Microfiltration, Ultrafiltration and Nanofiltration, Centrifugation (batch, continuous).

Module-IV

Bioseparation-II: Numericals and Applications of Chromatography: Adsorption chromatography, Ion- exchange, gel-filtration, affinity, high pressure / performance liquid chromatography (HPLC), hydrophobic interaction chromatography. Reverse phase (RP) and thin layer chromatography (TLC). Separation of soluble bio-products: Liquid-liquid extraction, aqueous two-phase extraction, precipitation, adsorption.

Text/ Reference Books

1. Advances in Bioprocess Technology Editors: Ravindra, Pogaku
2.Bioprocess Engineering Principles Book by Pauline M Doran
3.Bioprocess Engineering: Kinetics, Sustainability, and Reactor DesignBook by Shijie Liu

4.Bioseparations Downstream Processing for Biotechnology by Paul A. Belter , E.L. Cussler , Wei-Shou Hu
5. Downstream Process Technology: A New Horizon in Biotechnology by Prasad , Krishna

IPR and Commercialization of Biotechnology

Module: I

Biotechnology and Society: Introduction to science, technology and society, issues of access-Case studies/experiences from developing and developed countries. Ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, biological spots, environmental sustainability, Food and agricultural organization, biotechnology in international relations, globalization and development divide. Public acceptance issues for biotechnology: Biotechnology and hunger: Challenges for the Indian Biotechnological research and industries.

Module: II

Bioethics: Principles of bioethics: Legality, morality and ethics, autonomy, human rights, beneficence, privacy, justice, equity etc. The expanding scope of ethics from biomedical practice to biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues.

Biosafety concepts and issues: Ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards, Biotechnology and biosafety concerns at the level of individuals, institutions, society, region

Module: III

Biosafety in the laboratory : Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution. Experimental protocol approvals, levels of containment.

Regulations: Biosafety assessment procedures in India and abroad. International dimensions in biosafety, HACCP, bioterrorism and convention on biological weapons. Social and ethical implications of biological weapons. Biosafety regulations and national and international guidelines with regard to recombinant DNA technology. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). National and international regulations for food and pharma products.

Module: IV

Ecological & Food Safety: The GM-food debate and biosafety assessment procedures for biotech foods & related products,including transgenic food crops, case studies of relevance. Ecofriendly case studies. Agri & Pharma Sector. Plant breeder's rights. Legal implications, Biodiversity and farmers rights. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in Clinical Trials.

Text/ Reference Books

1.Bioethics and Biosafety Book by M. K. Sateesh
2. IPR, Biosafety and Bioethics Book by Deepa Goel and Shomini Parashar
3. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology by Padma Nambisan
4. Biological Safety: Principles and Practices by Flemming and Hunt
5. Laboratory biosafety manual - World Health Organization

Professional Electives:

Plant Biotechnology

Module-I

Plant Genomics: Introduction Genome mapping; Identification of candidate genes using: genetic information (positional cloning); biochemical and expression analysis (microarray analysis, proteomics, metabolomics); Characterization and functional analysis of candidate genes using: transformation, mutant populations, knockout systems; Heterologous expression systems. Structural and Functional genomics; application of sequence based and structure-based approaches to assignment of gene function.

Module-II

Plant Molecular Mapping : Mole cular marker and its type (RFLP, RAPD, AFLP, SSR, STS, EST, SNP); Constructing molecular maps; Molecular tagging and mapping of genes/traits; Marker assisted selection of qualitative and quantitative traits. Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning; Nucleic acid and Protein arrays: basic principles, instrumentation and applications in plant genomics, Identification of disease genes.

Module-III

The Gene transfer Techniques for the production of Transgenic: Overview of different gene transfer methods , plant vectors for transformation, transgene analysis and expression. Indirect Gene transfer Methods: structural features of Ti plasmid, mechanism of gene transfer to plants Integration of T-DNA into plant genome, Molecular events in *Agrobacterium* mediated gene transfer. Direct gene transfer methods: Particle bombardment mediated transformation, Mechanism, Particle gun design, parameter for effective transformation; silicon carbide fiber

mediated transformation and alternative methods. Reporter genes, Selectable and scorable markers, Binary and Co-integrative vectors, Removal of marker genes, Applications and limitations of *Agrobacterium* gene transfer, Concept of marker free transgenic plants. Plastid engineering: Introduction, importance, scope and technique.

Module-IV

Crop Improvement and Agro-industrial biotechnology: Genetic Engineering for Herbicide resistance; Genetic Engineering for Biotic and Abiotic Stress Resistance/Tolerance; Genetic engineering for Improvement of crop yield and quality: Protein, lipids, carbohydrates, vitamins & mineral nutrients; Applications in Agro-industry: Microbes in agriculture , Production and utilization of essential amino-acids, chemicals from micro-algae. Agro-waste utilization; Mycorrhiza in agriculture and forestry.

Text/ Reference Books

1.Introduction to plant biotechnology : by H. S. Chawla
2. Plant Biotechnology: by S. Umesha
3. Plant Biotechnology, Volume 1: Principles, Techniques, and Applications. 1st Edition. Bishun Deo Prasad, Sangita Sahni, Prasant Kumar, Mohammed Wasim
4. Plant biotechnology : by Adrian Slater
5. Plant Biotechnology and Agriculture: Prospects for the 21st Century by Altman Professor, Arie , Paul Michael Hasegawa

Advanced Microbiology and Immunology

Module-I

Microbial Diversity & Systematics: Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

Module-II

Microbial processes and its optimization: Microbial growth and its kinetics, Models of growth kinetics; Microbial processes-production, optimization, screening, strain improvement, factors affecting down stream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc.

Module-III

Enzyme Technology-production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme and

Cell based biotransformations of steroids, antibiotics, alkaloids, Enzyme based and cell based biosensor.

Module-IV

Advanced Immunology: Fundamental concepts of Immune system; components of innate and acquired immunity; phagocytosis; complement system; MHC – structure, genetic organization; HLA typing; graft versus host reaction; Antigens – immunogens, hapten, adjuvant, carrier. Molecular basis of immune responses: Primary and secondary immune response; kinetics of immune response; Immunoglobulins – class, subclass and structure, Ig superfamily; affinity, avidity, allotype, isotype, idiotype; Antibody genes and antibody diversity. Immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, Immunoflourescence, flow cytometry and immunoelectron microscopy, lymphoprofileration assay, mixed lymphocyte reaction, cell cytotoxicity assays, microarrays, transgenic mice, gene knock outs.

Text/ Reference Books

1. Microbiology: An Introduction by Gerard J. Tortora
2. Prescott's Microbiology by Christopher J. Woolverton, Joanne Willey, and Linda Sherwood
3. Foundations in Microbiology by Kathleen Park Talaro
4. Kuby Immunology: International Edition
5. Janeway's Immunobiology, 7th Edition by Kenneth Murphy, Paul Travers, and Mark Walport

Laboratory- 1(Biomolecules and Metabolic regulations)

LIST OF EXPERIMENTS

1. Determination of protein concentration by various methods: Lowry's, Bradford etc.
2. Extraction of protein by different methods: salt precipitation, solvent precipitation etc.
3. Separation and purification of proteins by gel filtration chromatography.
4. Determination of molecular weight of proteins by SDS-PAGE
5. Assay of enzyme activity such as protease, amylase and lipase.
6. Estimation of alkaline phosphatase activity in blood plasma.
7. Separation of amino acids by TLC.
8. Separation of proteins by 2D gel electrophoresis

Laboratory- 2(Bioprocess and Bioseparation Technology)

LIST OF EXPERIMENTS

1. Microbial growth and product formation kinetics
2. Enzyme kinetics
3. Effects of inhibitor on microbial growth
4. Enzyme immobilization techniques
5. Batch stertilization kinetics
6. Kla Determination by dynamic degassing method
7. Cell disruption by Sonication
8. Precipitaion of protein by salting out method
9. Extraction of protein by aqueous two phase Extraction
10. Chromatographic techniques

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II Semester

Professional Core

Advanced Biochemical Engineering

Module-I

Concept of ideal reactors based on flow characteristics, design of ideal reactors using material and energy balance equations. Single reactors, with ideal flow condition, comparison of volumes of plug flow reactor and chemostat. Searching for mechanism –Arrhenius equation –Batch reactor analysis for kinetics (synchronous growth and its application in product production)

Module-II

Growth Kinetics: Batch growth quantifying cell concentration, growth profiles and kinetics in batch culture, fed batch growth, continuous growth and their growth kinetic quantification, chemostat growth, semi-continuous / exponential feeding strategy.

Module-III

Design principles –Non isothermal reactions and pressure effects; Non-ideal flow in bioreactors-reasons for non-ideality, concept of RTD studies, characterization of non-ideality using RTD studies, various distribution functions, conversions using tracer studies.

Module-IV

Design and analysis of bioreactors-stability and analysis of bioreactors, biomass production and effect of dilution rate. Design and operation of various bioreactors, viz CSTF, fed batch systems, air-lift bioreactors, fluidized bed bioreactors. Scale up of bioreactors. Criteria for selection of bioreactors.

Text Books:

1.Principles of Fermentation Technology, Salisbury, Whitaker and Hall, Aditya Text Pvt. Ltd.

2.Bioprocess Engineering: basic concepts, Michael L. Shuler and Fikret Kargi

References Books:

1.Biochemical Engineering Fundamentals, J.E. Baily and D.F. Oillis, McGraw Hill.
2.Biochemical Engineering S. Aiba, A.E. Humphery and N.F. Millis.

II Semester

Professional Core

Applied Bioinformatics

Module-I

Sequence-alignment methodologies: Sequence databases; Similarity matrices; Pair wise alignment: Features of dynamic Programming, alignment by Bayesian Statistical Methods, multiple sequence alignment: local multiple sequence alignment: MEME, PSSM, HMM (algorithms and applications) Progressive methods for global multiple sequence alignment: CLUSTALW, PILEUP, T-COFFEE;

Module-II

Pattern analysis in sequences and Phylogenetic tree construction methods: Motif representation, Markov models; .Distance Based methods: clustering based methods, optimality based methods: Fitsch -Margoliash and Minimum evolution methods, genetic algorithm and Phylogenetic tree evaluation: Boot strap analysis; dendrogram and applications

Module-III

Structure-Prediction of Biomolecules with applications in Bioinformatics: Structure classification of proteins (SCOP, CATH); Secondary structure prediction of various protein categories (e.g.transmembrane proteins and helical proteins), RNA secondary structure prediction methods.

Module-IV

Patterns, motifs and Profiles in sequences: Derivation and search methods; Derived Databases of patterns, motifs and profiles e.g.Prosite, Blocks, Prints-S, Pfam; Overview of tertiary structure prediction methods; algorithms for modeling protein folding; algorithms for 3D structure prediction with representative examples.

Text books and Reference books:

1. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
2. Structural Bioinformatics. Ed. P.E. Bourne and H. Weissing (2003) Wiley-Liss

II Semester

Professional Electives-I

Genomics and Proteomics

ModuleI

Introduction Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA mitochondrial, chloroplast; DNA sequencing principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

ModuleII

Genome sequencing projects Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, EST's and SNP's.

ModuleIII

Proteomics Protein analysis (includes measurement of concentration, amino acid composition, N terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDITOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

Module IV

Pharmacogenetics High throughput screening in genome for drug discovery identification of gene targets, Pharmacogenetics and drug development. Functional genomics and proteomics Analysis of microarray data; Protein and peptide microarray-based technology; PCR directed protein in situ arrays; Structural proteomics

Texts/References:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006

2. Brown TA, Genomes, 3rd Edition. Garland Science 2006

3. Campbell AM &Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007

4. Primrose S &Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.

5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998

II Semester

Professional Electives-I

Computational Biology

Module-I

Biological Databases: Primary and Secondary Databases; GenBank, EMBL, DDBJ, Swissprot, MIPS, PIR, TIGR, Hovergen, TAIR, PlasmoDB, ECDC, Protein and Nucleic Acid Sequences databases. Search Algorithms: Scoring Matrices and their use; Computational complexities; Analysis of Merits and demerits;

Module-II

Sequence pattern; Pattern databases; PROSITE, PRINTS, Markov chains and Markov models; Viterbi algorithm; Baum-Welch algorithm; FASTAand BLAST Algorithm; Needleman-Wusch& Smith-Waterman algorithms

Module-III

Structure and Analysis: Representation of molecular structures; External and internal co-ordinates; Concept of free energy of molecules; Introduction to various force fields; Molecular energy minimization techniques; Monte Carlo and Molecular Dynamics simulation Molecular structure Determination: Principle of X-ray crystallography and NMR spectroscopy; 2D Protein Data bank and Nucleic Acid Data bank; Storage and Dissemination of molecular structures

Module-IV

Modelling & Drug design: Homology modelling; Threading; Structure prediction; Structure-structure comparison of macromolecules; Simulated docking; Drug design; molecular dynamics simulation, Docking methods, Drug design Process, drug like Property of a molecule, target identification, Drug design process for a known and unknown target. 2D and 3D QSAR; Ligand databases.

Text Books:

1. *Structural Bioinformatics. Ed. P.E. Bourne and H. Weissing (2003) Wiley-Liss*
2. *Computational Biology: Unix/Linux, Data Processing and Programming, Robbe Wunschiers, Springer-Verlag New York, LLC*

Reference Books:

1. *Introduction to Computational Biology: Maps, Sequences and Genomes, Michael S. Waterman, CRC Press*
2. *Introduction to Computational Molecular Biology, Joao Carlos Setubal., Publisher: Brooks/Cole*

II Semester

Professional Electives-I

Process Control and Instrumentation

Module I

Mercury thermometer, step function, impulse function, sinusoidalfunction, step response, impulse response, sinusoidal response, liquid level system, mixing process, RC circuit, Linearization, non-interacting &interacting systems, High order & second order systems.

Module II

Transportations lag. The control system –basics, development of block diagram, control valve, controller, P-control, PI –control, PD –control, PID control.

Module III

Overall transfer function for single loop systems, for change in set point, for change in load. Overall transfer function for multiloop control systems. Concept of stability, stability criterion. Routh test for stability.

Module IV

The Bode stability criterion, Ziegler-Nicholas controller settings, Cascade control, feedforward control. Ratio control, Smith predictor. Internal model control, controller tuning, Ziegler – Nicholas rules, Cohen and Coon rules, process identification, control valve, vlve sizing, valve characteristics, valve positioner.

TEXT BOOKS:

1. 'Process Systems analysis and Control', D.R. Coughanour, McGraw-Hill, 2nd Edition, 1991.

2. 'Process Dynamics and Control', D.E. Seborg, T.F. Edger, and D.A. Millichamp, John Wiley and Sons, 2nd Edition, 2004.

REFERENCES:

1. 'Principle and Practice of Automatic Process Control', C.A. Smith and A.B. Corripio, 3rd ed., John Wiley and Sons, 2005.

2. 'Process Modelling Simulation and Control for Chemical Engineers', W.L .Luyben, McGraw Hill, 2nd Edition, 1990.

3. 'Chemical Process Control –Theory and Practice', Stephanopoulous, Prentice Hall of India Ltd., .1984.

II Semester

Professional Electives-II

Nanobiotechnology

Module I

Introduction and scope of Nano Biotechnology, comparison of Biotechnology to Nano biotechnology. The role of proteins, amino acids, nucleic acids, lipids and polysaccharides in modern biomaterials. Overview of natural Bionanomachines; Thymidylate synthetize, ATP synthetize, Actin and myosin, opsin, Antibodies and collagen.

Module II

Quantum Dot structures and their integration with biological structures. Tools of Analysis: X-Ray crystallography, NMR spectroscopy, Electron microscopy and Atomic force microscopy. Molecular modeling tools: Graphic visualization, structure and functional prediction,

Module III

Structural principles of Nano biotechnology raw materials: Factors governing biomolecular structure and stability, Protein folding; Self-assembly, Self-organization, Molecular recognition and Flexibility of biomaterials. Functional principles of Nano biotechnology: Information driven Nano assembly, Energetics,

Module IV

Fields of Application: Designer proteins, Peptide nucleic acids, Nanomedicine, Drug delivery, DNA computing, Molecular design using biological selection, Harnessing molecular motors, Artificial life, Hybrid materials, Biosensors, Future of Bio nanotechnology.

Text books:

1. David S Goodsell,Bio nanotechnology, John Wiley & Sons, 2004.

2. Greco Ralph S,Nanoscale Technology in Biological Systems, CRC Press, 2005.

II Semester

Professional Electives-II

Bioreactor design and optimization

Module-I

Principles and concepts Recapitulation of the principles of Kinetics for chemical and Bio-chemical Reactions. Fundamentals of homogeneous reactions for batch / semi-batch, plug low reactor (PFR), continuous stirred rank reactors (CSTR), fluidized bed reactor bubble column, air lift fermenter etc., stirred tank/mixed reactors.Adiabaticand programmed reactors. Unconventional bioreactors: Hollow fibrereactor, membranereactor, perfusion reactor for animal andplant cell culture.

Module-II

Bioreactor Analysis Analysis of ideal bioreactors: Fed-Batch reactors, Enzyme catalyzed reactions in CSTRs, CSTR reactors with Recycle and Wall growth, Ideal Plug-Flow Tubular reactor. Analysis of Non-ideal Reactor Analysis: Concept of ideal and non-idealreactor; residence time distribution; models of non-ideal reactors –plug flow reactor for microbial processes; Mass transfer in biochemical processes; Multiphase bioreactors –packed bed with immobilized enzymes or microbial cells; three –phase fluidizedbed trickling bed reactor; Design and analysis of the above reactor systems; Gas liquid reactors, Reactor stability.

Module-III

Bioreactor Design considerations: oxygen transfer, heat transfer, rheology, mixing. Scale up and scale down concepts. Bioprocesscontrol and computer coupled bioreactors; Growth and product formation by recombinant cells. Mechanical fittings in a bioreactor: vessel, agitation system materials, welds, finish, valves, piping and valves for biotechnology, special requirements of utilities and cleaning of production plants.

Module-IV

Instrumentation and control of bioprocesses: Physical and chemical sensors, online sensors for cell properties, off-line analytical methods; Biosensors.Bioreactor design calculations.

Text Books

1. Levenspiel, O., Chemical Reaction Engineering, Wiley Eastern Ltd.

2. Bailey &Olis, Biochemical Engg. Fundamentals, MGH. 1990

3. Atkinson, B., BiologicalReactors, pion Ltd., London, 1974. Coulson, Richardson, Sinnott, An introduction to chemical engineering design, Pergamon Press. Lydersen, D'Elia, Nelson, Bioprocess engineering: Systems and equipment.

II Semester

Professional Electives-II

Metabolic engineering and metabolomics

Module-I

Overview of Molecular biology and cellular metabolism. Metabolic regulations network at enzyme level and whole cell level. Basic concepts of Metabolic Engineering: Identification of metabolic regulation- a key point in metabolic engineering. Overview of cellular metabolism, Different models for cellular reactions, induction – Jacob Monod model and its regulation, Differential regulation by Isozymes, Feed back regulation.

Module-II

Modeling of metabolic networks: Stoichiometry, kinetics, mass balances for the steady state, mass balances for the transient case. Metabolic flux analysis: Linear programming, Cell capability analysis, Genome scale Isotope labeling, Integration of anabolism and catabolism. Experimental determination method of flux distriction. Metabolic flux analysis and its applications, Thermodynamics of cellular processes.

Module-III

Metabolic control analysis: Nonlinear programming, synthesis and design of metabolic networks – inter programming, mixed integer nonlinear programming case studies – ethanol production, amino acid biosynthesis, metabolism in bacteria and yeast. Metabolic engineering with bioinformatics: Metabolic pathway modeling, Analysis of metabolic control and the structure, metabolic networks, Metabolic pathway synthesis algorithms.

Module-IV

Applications of Metabolic Engineering: Application in Pharmaceuticals, Chemical bioprocess, food technology, agriculture, environmental bioremediation and biomass conversion.

Text and References:

1. Metabolic Engineering: Principles and Methodoligies; G. Stephanopoulos, A.A. Aristidou, J.S. Neilson (1998) Academic Press

2. Metabolic Engineering; S.Y. Lee & e.T. Papoutsakis (1999) Marcel Dekker

3. Biochemistry by J.M. Berg, J.L. Tymoczko nd Lubert Stryer (2002) W.H. Freeman, New York

4. Understanding the Control of Metabolism by David Fell (1997) Portland Press, London.

5. Metabolism at a Glance by J.G. Salway (1994) Blackwell Scientific Publications

M.Tech in Biotechnology

III SEMESTER [SECOND YEAR]

Batch: 2019-2021

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	PE	MPEBT3011	Molecular modeling and Drug designing	3	0	0	3
2	PE	MPEBT3012	Pharmaceutical Biotechnology				
3	PE	MPEBT3013	Protein Engineering				
4	OE	MOEBT3021	Green Technology	3	0	0	3
		MOEBT3022	Industrial Safety				
		MOEBT3023	Research Methodology				
PRACTICAL / SESSIONAL							
5	PC	MPCBT3110	Dissertation-I/ Industrial Training	0	0	20	10
6							
7							
TOTAL				**6**	**0**	**12**	**16**

III Semester

Professional Core

Molecular modeling and Drug designing

Module-I

Introduction to Molecular Modelling and its applications Biomolecular modeling problems: protein folding, protein misfolding, nucleic acid/ protein interactions, and RNA folding. Molecular size versus accuracy. Approximate molecular orbital theories. Molecular mechanisms, energy calculations, Bond stretch, Angle bending, torsional terms, Electrostatic interaction- Van der waals interactions.

Module-II:

Introduction to molecular dynamics and simulations; Molecular Dynamics using simple models; Dynamics with continuous potentials, Constant temperature and constant dynamics; Conformation searching and systematic search; Monte-carlo simulation of biomolecules and bio-polymers.

Module-III:

Comparative modeling of protein: by homology- the alignment, construction of frame work, selecting variable regions, side chain placement and refinement, validation of protein models – Ramchandran plot, threading and ab initio modeling.

Module-IV:

Analog based drug designing : Introduction to QSAR. lead module, linear and nonlinear modeled equations, biological activities, physicochemical parameter and molecular descriptors, molecular modelling in drug discovery. Structure based drug designing: 3D pharmacophores, molecular docking, De novo Ligand design, Free energies and solvation, electrostatic and non-electrostatic contribution to free energies.

Text Book:1. A R Leach, Principles and applications of modeling, Prentice Hall.

2. Hans Pieter, Heltje & Gerd Folkens, Molecular Modelling, VCH.

References:1. Jonathan Good man, Chemical Applications of Molecular Modelling, Cambridge Press

III Semester

Professional Core

Pharmaceutical Biotechnology

Module-I:

Introduction History of pharmacy; the pharmaceutical industry & development of drugs; Economics and regulatory aspects; Quality management; GMP. Drug kinetics and biopharmaceutics Mechanism of drug absorption, distribution, metabolism and excretion – factors affecting the ADME process; Bioequivalence; Pharmacokinetics.

Module-II:

Principles of drug manufacture Liquid dosage forms –solutions, suspensions and emulsions; Topical applications –ointments, creams, suppositories; Solid dosage forms –powders, granules, capsules, tablets, coating of tablets; Aerosols; Preservation; Packing techniques. Advances in drug delivery Advanced drug delivery systems –controlled release; Transdermal, Liposomes and drug targeting.

Module-III:

Biopharmaceuticals Understanding principles of pharmacology, pharmacodynamics; Study of a few classes of therapeutics like Recombinant therapeutics, Monoclonal Antibodies, Vaccines, Gene therapy, Antibiotics and Hormones.

Module-IV:

Immunogenicity of biopharmaceuticals: Immunogenicity; Factors contributing to immunogenicity (product related factors, host-related factors), Consequence of immunogenicity to biopharmaceuticals; Measurement of immunogenicity. Case studies: Erythropoietin, Insulin, Somatotropin, Interleukin-2, Interferon Granulocyte macrophage-CSF, DNase, Factor VIIa, Factor IX, Factor VIII, Activated protein C, Tissue plasminogen activator, Monoclonal antibodies.

Text Books:

1. Pharmaceutical Biotechnology Fundamentals and Application by **Dr Chandrakant Kokare**
2. Pharmaceutical Biotechnology by **S.P. Vyas**

Reference books:

1. Textbook of Pharmaceutical Biotechnology by **Kokate**
2. Pharmaceutical Biotechnology by **Richa Manpal**

III Semester

Professional Core

Protein Engineering

Module-I:

Overview of protein structure and its hierarchical architecture; Protein engineering – definition, applications; Properties of engineered proteins, Forces stabilizing proteins – Van der waals, electrostatic, hydrogen bonding and weakly polar interactions, hydrophobic effects; Entropy – enthalpy compensation.

Module-II

Methods of measuring the stability of a protein; Spectroscopic methods to study physicochemical properties of proteins: UV, CD, Fluorescence, ORD; Hydrodynamic properties–viscosity, hydrogen-deuterium exchange; Brief introduction to NMR spectroscopy, Mass spectroscopy and X-ray crystallography and their application in protein engineering.

Module-III

Experimental methods of protein engineering: Rational designing, Directed evolution like site directed mutagenesis, Module shuffling, guided protein recombination, etc.; Computational approaches to protein engineering: sequence and 3D structure analysis,

Module-III

Data mining, Ramachandran map, Mechanism of stabilization of proteins in psychrophiles, thermophiles and mesophiles; Protein and enzyme engineering case studies for its stability, specifity and affinity- Protease, Lipase and Lysozyme.

Text Books:

1. Edited by T E Creighton, Protein structure: A practical approach, 2nd Edition, Oxford press.

2. Edited by T E Creighton, Protein function. A practical approach, 2nd Edition, Oxford university press.

3. Edited by T E Creighton, Protein function. A practical approach. Oxford university press.

Reference Books:

1. Cleland and Craik, Protein Engineering, Principles and Practice, Vol 7, Springer Netherlands.

2. Mueller and Arndt., Protein engineering protocols, 1st Edition, Humana Press.

3. L. Alberghina, Protein Engineering for industrial biotechnology, Harwood Academic Publisher.

III Semester

OE

Research Methodology

Module I:

Meaning, Objective and Motivation in Research: Types of Research, Research Approaches, Research Process, Validity and Reliability in Research. Methods of Data Collection: Primary Data, Questionnaire and Interviews, Collection of Secondary Data, Cases and Schedules.

Module II:

Research Design: Features of Good Design, Types of Research Design, Basic Principles of Experimental Design. Sampling Design: Steps in Sampling Design, Characteristics of a Good Sample Design, Random Samples and Random Sampling Design. Measurement and Scaling Techniques: Errors in Measurement, Tests of sound Measurement, Scaling and scale Construction Techniques, Forecasting Techniques, Time Series Analysis, Interpolation and Extrapolation.

Module III:

Correlation and Regression Analysis, Method of Least Squares, Regression vs. Correlation, Correlation Vs. Determination, Types of Correlation and Their Specific Applications. Statistical Interference: Tests of Hypothesis, Parametric vs. Non-Parametric Tests, Procedure for Testing Hypothesis, Use of Statistical Techniques for Testing Hypothesis, Sampling Distribution, Sampling Theory Chi-Square test, Analysis of Variance and Covariance, Multivariable Analysis.

Module IV:

Interpretation of Data and Report Writing, Layout of a Research Paper, Techniques of Interpretation. Making Scientific Presentation at Conferences and Popular Lecture to Semi Technical Audience, Participating in Public Debates on Scientific Issues. Professional Attitude and Goals, Concept of Excellence, Ethics in Science and Engineering, (Case Studies).

TEXT BOOKS

1. Dane, Francis C, Research methods, Pacific Grove: Brooks /Cole, 1990
2. Devlin, Ann Sloan, Research methods: Planning, Conducting and Presenting Research, Belmont, Calif.: Thomson / Wadsworth, 2006

Reference Books:

1. Patrick F. Dunn, Measurement and Data Analysis for Engineering and Science, 2/e, CRC Press, 2010
2. Ranjit Kumar, Research Methodology: A Step-By-Step Guide for Beginners, Sage Publications, 2010