M. Tech. in Biotechnology (BT)
# M. Tech. Biotechnology Curriculum

## 1st Year 1st Semester:

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<tr>
<th>Sl. No.</th>
<th>Code</th>
<th>Course Title</th>
<th>Contact Hrs/Wk L-T-P</th>
<th>Credit</th>
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<tbody>
<tr>
<td>1</td>
<td>BIOT5101</td>
<td>Advanced Genetic Engineering</td>
<td>3-1-0</td>
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<td>2</td>
<td>BIOT5102</td>
<td>Advanced Enzyme Technology</td>
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<td>3</td>
<td>BIOT5103</td>
<td>Physico-chemical techniques in Biotechnology</td>
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<td>BIOT5104</td>
<td>Engineering Mathematics and Biostatistics</td>
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<td>5</td>
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<td>BIOT5132</td>
<td>Advanced Environmental Biotechnology</td>
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<td><strong>Total Theory</strong></td>
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<td>BIOT5111</td>
<td>Advanced Genetic Engineering Lab</td>
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M. Tech. Biotechnology Curriculum

1st Year 2nd Semester:

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<td>Advanced Cell Biology &amp; Immunotechnology</td>
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M. Tech. Biotechnology Curriculum

2nd Year 1st Semester:

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<td>BIOT6153</td>
<td>Biopharmaceuticals</td>
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B Practical

| 4.     | BIOT6111| Downstream Processing Lab             | 0-0-6                | 2      |
|        |         |                                       |                      |        |
|        |         | Total Practical                       | 0-0-6                | 2      |

C Sessional

| 5.     | BIOT6121| Thesis (Progress) and Seminar         | 0-0-20               | 8      |
|        |         |                                       |                      |        |
|        |         | Total Sessional                       | 0-0-20               | 8      |
|        |         |                                       |                      |        |
|        |         | SEMESTER TOTAL                        | 8-2-26               | 20     |

2nd Year 2nd Semester:

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<td>Semester Total</td>
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Module-I [10L]

**Basic Tools & Techniques of Genetic Engineering**

Tools: Restriction endonuclease, DNA modifying enzymes, Different types of vectors for Cloning, sequencing and Expression of gene and high capacity vectors. Techniques: Restriction analysis (Agrose gel electrophoresis, PFGE), DNA, RNA and protein sequencing methods. DNA, RNA and protein probes (production, labeling by radioactive and non-radioactive method), PCR and different modified PCR, quantitative PCR. Different kinds blotting and hybridization techniques for DNA, RNA and Protein; ELISA and FISH; site Directed Mutagenesis. Chemical synthesis of DNA

Module-II [10L]

**Cloning, Selection and expression of engineered DNA**

Isolation, purification & separation of DNA, RNA and protein from cell or tissue. Different types of cloning and expression techniques in prokaryotic and Eukaryotic model cell system. (restriction cloning, TOPO TA cloning, PCR product cloning, and GATWAY cloning technology and others). Construction and screening of genomic and cDNA library. Selections of positive clone: Direct and indirect methods, Drug resistance, Gene inactivation, DNA hybridization, colony hybridization and in-situ hybridization. Over expression of Protein.

Module-III [10L]

**Manipulation of plants and animals**

Transfer of genes in animal oocyte; cloning of animals, Gene targeting and transposon. Direct and Indirect methods of gene transfer and transgenic animals, techniques of creating transgenic mice, homologous recombination and knockout mice. Direct and Indirect methods of Gene transfer and techniques of creating transgenic plants. Application, Biosafety measures and regulation of genetically engineered plants, animals.

Module-IV [10L]

**Application of Genetic Engineering**

Text Books:
1. Introduction to Genetic Engineering (2009) by Rastogi and Pathak, Oxford University Press.

Reference books:

Subject Name: Advanced Enzyme Technology
Paper Code: Biot5102

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Module-I [10L]
Fundamentals of Enzyme Kinetics & commercial Production of Enzyme
Enzyme nomenclature, Units of Enzyme, Mechanism of Enzyme actions; Enzyme inhibitions, determinations of kinetic constants of enzyme reaction, Kinetics of enzyme inhibitions; Sources of Enzyme and general protocol for processing of Enzyme from different sources.
Unit operations, Solid liquid separation: centrifugation, filtration, aqueous Two-Phase system; Cell breakage: ultrasonic, high pressure homogeniser, bead mills, Freeze-press, lytic enzyme, concentration of enzyme, stabilization of enzyme for commercial preparations.

Module-II [10L]
Purification & immobilization of Enzyme
Purification of enzyme by: Solvent and salt precipitations, heat treatment, Liquid Chromatography methods of protein separation: adsorption, ion exchange, hydrophobic, affinity, gel-exclusion, HPGPLC. Immobilisation of enzyme: Techniques of enzyme immobilization; Immobilised enzyme bioreactor; Kinetics of Immobilized enzyme.
Module-III [10L]

*Large scale use of enzyme*

Enzymes in Detergent industries; Multiple use of enzymes in Leather and wool Industries; Dairy Industry; cheese and lactose free and flavoured milk; Enzymes in Paper Industry – Bioprocessing of wood pulp and biobleaching; Enzymes in cattle feed and in Textile Industry; Enzymes in the production of high fructose syrup, Amino acids, Antibiotics; Immobilised enzyme process for hydrolysis of Lactose, sucrose and raffinose.

Module-IV [10L]

*Future prospects of Enzyme Technology*

Biosensor: Function and types – Biochips - Enzyme in Biosensors development; Enzyme therapy - Pharmaceutical use in different diseases; Enzyme in non aqueous system –media engineering, Enzyme in organic synthesis; Green technology alternative; Artificial Enzyme; Unusual enzyme substrate.

**Text books:**


**Reference books:**


<table>
<thead>
<tr>
<th>Subject Name: Physicochemical Techniques in Biotechnology</th>
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<tbody>
<tr>
<td>Paper Code: BIOT5103</td>
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<tr>
<td>Contact Hours Per Week</td>
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Module-I [10L]

*Introduction to structure and interactions of Biological Macromolecules:*

Biological Macromolecules, configuration and conformation of biological macromolecules; Molecular interactions, overview of thermodynamics; strong and weak interactions in biomolecules; Statistical thermodynamics: Partition function, methods for structural transitions in polypeptides and nucleic acid, prediction of helical structures in genomic DNA.
Module- II [10L]

Techniques based on Absorption Spectroscopy:
Principles, instrumentation and application of absorption spectroscopy Techniques to biological molecules: UV- Visible spectroscopy, IR-Raman spectroscopy, FT-IR, Linear and Circular dichroism (CD) and optical rotatory dispersion (ORD), AAS and NMR

Module-III [10L]

Techniques based on Emission Spectroscopy and light scattering:

Module-IV [10L]

Techniques based on Microscopy:

Text books:
1. Principles of Physical Biochemistry, by K.E. van Holde, W. C. Johnson, and P.S. Ho

Reference books:
1. C.R. Cantor and P.R. Schimmel; Biophysical Chemistry; Freeman.
3. D.M. Freifelder; Physical Biochemistry: Applications to Biochemistry and Molecular Biology (Freeman)
4. J.R. Lakowicz; Principles of Fluorescence Spectroscopy (Springer)
5. Fundamentals of Molecular Spectroscopy - C.N. Banwell, (Tata-McGraw Hill)
8. Lubert Stryer : Biochemistry, 5th edn. (Freeman)
9. Voet and Voet: Biochemistry, 2nd edn. (John Willey & Sons)
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**Module-I [10L]**

Introduction; Linear Algebra: Matrices and Determinants; Eigen values and Eigen vectors; Single and Double differentiation with Applications; Tangent, Normal, Maxima and Minima of a curved line; Partial and Total derivatives; Concept of Function, Limits and Continuity; Single and Multiple integration with Applications; Curve tracing, Area under the curve; Application of calculus: velocity and acceleration; Normal distribution; Differential equations and its application; Numerical solution of ODEs: different methods.

**Module-II [10L]**

Statistics of dispersion: Variability, Range, Mean, mode, Mean deviation, Standard Deviation, Variance, central moments, Coefficient of Quartile deviation, Coefficient of variation, Coefficient of dispersion; Probability Distribution: Probability mass function for discrete random variables and probability density function for continuous random variables; Skewness, Kurtosis, important discrete probability distributions: bernoulli, binomial, geometric, poisson, hypergeometric; important continuous distributions: uniform, exponential, normal. (Exposure to online statistical calculator)

**Module-III [10L]**

Testing Hypothesis: Concepts and importance in experimental research, type of errors; testing means, Significance of difference between means using Z score; Large sample tests based on normal distribution – Test based on t and F distributions, Chi square test for goodness of fit, independence of attribute, homogeneity, and variance of a normal population.

**Module-IV [10L]**

Correlation and Regression: Multiple correlation, Linear, logistic, and multiple regression; Non-parametric and distribution-free statistics: Sign test, Wilcoxon's rank test and Spearman's rank correlation; Analysis of Variance: One way and two way classifications of Anova – Applications in Biological Sciences. (Exposure to online statistical calculators)

**Text books:**
Reference books:

<table>
<thead>
<tr>
<th>Subject Name: Agricultural Biotechnology</th>
<th>Paper Code: BIOT5131</th>
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<td>Module-I [10L]</td>
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**Module-I [10L]**

*Fundamentals of Crop Molecular Biology*

Structural and Functional genomics; application of sequence based and structure-based approaches to assignment of gene function. Quantitative and qualitative traits; MAS for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield; Molecular polymorphism, RFLP, RAPD, STS, AFLP, SNP markers; Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning; Pharmacognostic evaluation and HPTLC Fingerprint Profile.

**Module-II [10L]**

*Biotechnology for quality crop development*

Technological change in agriculture, Green Revolution; traditional and non-traditional methods of crop improvement. Molecular genetics of Photosynthesis, theory and techniques for the development of transgenic plants-conferring resistance to herbicide (Glyphosate and BASTA), Pesticide (Bt-Gene) Technological change in agriculture- for biotic, abiotic stress; Improvement of crop yield and quality; fruit ripening.

**Module-III [10L]**

*Plant as Bioresource:*

Plant biodiversity and bioresources; primary and secondary metabolites (e.g. Neutraceuticals from plant derived products and others) Fermentation and production of industrial enzymes, vitamins and antibiotics and other biomolecules; Production of pharmaceutically important compounds; Bioenergy generation. Importance of Medicinal Plants: Bioactive molecules for lead molecule search.
Module-IV [10L]

Agro-industrial biotechnology
Techniques of some plant tissue culture techniques for bio-resource production: Micropropagation; Somaclonal variation, Artificial seed production; Androgenesis and its applications in genetics and plant breeding; Cell cultures for secondary metabolite production; Germplasm conservation and cryopreservation.

Agro-industry: Microbes in agriculture, Biofertilizer, Microbial enzymes and their applications in agro-chemical industries, Biocatalyst; Agro-waste utilization; Micorrhiza in agriculture and forestry.

Text Book:

Reference books:

Subject Name: Advanced Environmental Biotechnology
Paper Code: BIOT 5132

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Module-I [10L]

Environmental pollution and control strategies: Sources of pollutants in air, water and soil, concept of xenobiotics, persistent organic pollutants and heavy metals, mechanism of toxicity of xenobiotics (in general and with specific examples of poly aromatic hydrocarbons, pesticides, heavy metals)

Module-II [10L]

Conventional techniques for treatment of industrial waste: precipitation, ion-exchange, chelation, membrane separation, end of the pipe treatment – microbial technology, solid waste management

Module-III [10L]

Biodegradation and bioremediation of hazardous wastes: evolution of microbial tolerance towards pollutants, degradation of hydrocarbons (aliphatic and aromatic), organochlorine and aromatic nitrogenous compounds, mechanism of tolerance toward heavy metals (mercury, arsenic, chromium, lead and cadmium), molecular mechanism for spreading of resistance, improvement of tolerant organisms through genetic manipulation, biosorption, techniques of bioremediation, case studies
Module-IV [10L]
Biofuel, bioextraction, biodiversity: Biomass as a source of energy, production of biodiesel, biohydrogen and methane, application of microbial technology in mineral extraction, biodiversity, types of biodiversity, biodiversity indices, calculation of biodiversity, bioprospecting, environmental impact assessment (basic concept)

Text book:

Reference books:

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Experiments:
1. Isolation of plasmid DNA and agarose gel electrophoresis.
2. Restriction enzyme (RE) analysis of plasmid DNA by Agarose gel electrophoresis.
3. Isolation of genomic DNA from bacteria/animal tissue (any one) and RE digestion (to show partial and complete digestion).
4. DNA amplification by PCR and analysis by agarose gel electrophoresis.
5. Isolation of total RNA/polyA mRNA and cDNA amplification by RT-PCR, Ligation, Bacterial transformation, Selection of recombinant colonies.
6. Southern blotting, Northern blotting, Western blotting and ELISA.
7. Site directed mutagenesis using PCR.
8. Over-expression of cloned gene in protein level and analysis by SDS-PAGE.

Subject Name: Physico-chemical Techniques Lab

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Experiments:
3. Intrinsic and extrinsic Fluorescence quenching study using fluorometer.
4. Detections of biomolecules using Fluorescence microscopy.
5. Study of monomer to dimer equilibrium using HPLC (gel filtration chromatography).
6. Characterization of molecules using TEM and SEM.
7. Cell counting study through Flowcytometry.

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**Module I [10L]**

*Sequence-alignment methodologies.*
Sequence databases; Similarity matrices; Pairwise alignment Progressive methods for global multiple sequence alignment: multiple sequence alignment: (CLUSTALW), Approaches of gene identification ; gene prediction of prokaryotic and eukaryotic genomes

**Module II [10L]**

*Pattern analysis in sequences and Phylogenetic tree construction methods*
Motif representation, PSSM, HMM (algorithms and applications); Distance Based methods: clustering based methods, optimality based methods: Fitsch -Margoliash and Minimum evolution methods, Neighbor joining and related neighbor methods Character Based methods: Maximum parsimony methods, Maximum likelihood method. Phylogenetic tree evaluation: Boot strap analysis.

**Module III [10L]**

*Structure-Prediction of Biomolecules with applications in Bioinformatics*
Structure classification of proteins (SCOP, CATH); Secondary structure prediction of various protein categories ;RNA secondary structure prediction methods. 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 and protein 3D structure prediction by comparative modelling approaches (homology modeling and fold recognition) with representative examples; ab initio structure prediction methods.

**Module IV [10L]**

*Molecular Modeling and drug design*
Force fields and their evaluation (e.g. AMBER); Monte Carlo and molecular dynamics simulations (e.g. GROMACS); Energy minimization techniques; Structure comparison using database formalisms (DALI, VAST etc.); Classification of drug targets, characterization of drugs, Target discovery and validation methodologies, Structure based drug design methods including computer-aided drug design (pharmacophore development) and recent technology developments; Target selection, Ligand (lead compound) design ,optimization and analysis; Protein-ligand docking; QSAR; molecular descriptors; ADME parameters and their optimization ; molecular diversity and Combichem; case studies.
Text books:
2. Essential Bioinformatics- Jin Xiong, Oxford University Press.

Reference books:
5. Andrew Leach, Molecular Modelling: Principles and Applications, Pearson Education.

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Module – I [10L]
Intracellular compartments and protein sorting: Compartmentalization of cells, transport of molecules between the nucleus and cytosol, transport of proteins into mitochondria and chloroplasts, peroxisomes, endoplasmic reticulum.
Intracellular Vesicular Traffic: Molecular mechanisms of membrane transport and maintenance of compartmental diversity, transport from ER through the Golgi apparatus, transport from the Golgi network to lysosomes, transport into the cell from the plasma membrane and Golgi network via endocytosis and exocytosis.

Module – II [10L]
Cell Communication: General principles of cell communication, signaling through G-protein linked cell surface receptors, signaling through enzyme linked cell surface receptors, signaling pathways that depend on regulated proteolysis
The Cytoskeleton: The self assembly and dynamic structure of cytoskeletal filaments, how cells regulate their cytoskeletal filaments, molecular motors, the cytoskeleton and cell behaviour.
Module – III [10L]
The Cell Cycle and programmed cell death: An overview of the cell cycle, components of the cell cycle control system, intracellular control of cell cycle events, apoptosis, extracellular control of cell division and cell growth.
Cell Junction, Cell Adhesion and Extracellular Matrix: Cell junction, cell-cell adhesion, the extracellular matrix of animals, integrins, plant cell wall.

Module – IV [10L]
Immunooassays, New generation antibodies; Antibody engineering; phage display; Antibodies as in vivo and in vitro probes; Imaging techniques: Immunofluoresence microscopy, Immunoelectron microscopy, Techniques for live cell imaging and fixed cells.
Vaccine technology: Active and Passive immunization, sub-unit vaccines, recombinant DNA and protein-based vaccines, plant-based vaccines and reverse vaccinology, peptide vaccines, conjugate vaccines, cell-based vaccines.

Text book:

Reference Books:

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<th>Subject Name: Bioprocess Technology</th>
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<tr>
<td>Paper Code: BIOT5203</td>
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Module-I [10L]
Principles of enzyme catalysis: Introduction to enzymes, mechanistic models for simple enzyme kinetics, rate parameters, models for more complex enzyme kinetics, effect of pH and temperature, methods of immobilization, diffusional limitations in immobilized enzyme systems, brief introduction to large scale enzyme production.
Module-II [10L]

Module-III [10L]
Upstream Processing: Media for industrial fermentation, medium formulation, medium optimization, Sterilization, design of batch sterilization process, design of continuous sterilization process. Effect of sterilization on nutrient quality in media.

Module-IV [10L]
Advanced bioprocess engineering concepts: Bioprocess for genetically engineered organisms, Influence of product in process decisions, guidelines for choosing host-vector systems, process constraints in genetic instability, Applications of bioprocess engineering in health care & food industry, mixed culture growth kinetics.

Text books:

Reference Books:

<p>| Subject Name: Advances in Bioreactor design, Development and Scale up |
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| Paper Code: BIOT5204 |</p>
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Module1 [10L]
Introduction to Reaction Engineering
Chemical and biochemical reaction kinetics; Microbial growth and product kinetics; Chemostat, Dimension-less numbers and their importance in reactor operation. Rheological behavior of fluids, Transport Phenomenon in Bioreactor: Oxygen demand, solubility, redox potential, Role of dissolved oxygen concentration in the mass transfer; Determination of mass transfer coefficient ($KLa$); Factors effecting $KLa$ and their relationship.
Module 2 [10L]

**Bioreactor design and scale up**

Reactor operations: Batch, continuous, plug flow, fed-batch, bubble column reactors, loop reactors, residence time distribution (RTD).

Scale-up: Principles and criteria; Different methods of scale-up and the detailed analysis with case studies; Scale up problems; Scale down.

Module 3 [10L]

**Advanced Bioreactors**

Perfusion system, Membrane bioreactors, Raceway ponds, Bioreactor consideration in immobilized cell system. SSF bioreactors, Plant and Animal cell bioreactors: requirements, design and operation.

Module 4 [10L]

**Bioreactor Instrumentation**

Instrumentation of bioprocesses: monitoring and control of dissolved oxygen, pH, temperature and impeller tip speed in stirred tank fermenter.

**Text books:**

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

**Reference books:**


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**Subject Name: Genomics and Proteomics**

**Paper Code: BIOT5241**

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**Genomics:**

**Module-I [10L] Genome anatomy, mapping and assembly**

Overview of genome anatomy: Eukaryotic organelle genomes, anatomy of prokaryotic genomes.

Overview of genome database, Genome mapping and assembly: Genome mapping techniques with special reference to Human Genome Project, Genome sequencing – Clone by clone sequencing, Whole genome shotgun sequencing, Hybrid sequencing, and other modern sequencing methods, Genome sequence assembly and annotation
Module – II [10L]

Functional and Comparative Genomics

Proteomics:

Module-III [10L]

Tools and Techniques for Proteomics

Module-IV [10L]

Structural Proteomics

Text books:

Reference books:
Module-I [10L]
**Food Product Development and Food Ingredient Challenge**
Introduction to food product development, need, importance and objectives of product development in food industry; Factors affecting food product development-extrinsic and intrinsic; methodology involved in food product development; Process control parameters and scale up of developed products; Food Ingredient Challenge: Dietary fiber: source and function, Emulsion and Emulsifier, Biogum, Fat substitute, Alternative sweetener, Antioxidants, Antimicrobial agent.

Module-II [10L]
**Food Safety and Quality Maintenance**
Food toxicity, allergen and detoxification of raw food; Quality control using microbiological criteria; Association of different bacterial and non-bacterial agent with food: Salmonella, Mycobacterium, Brucella, Mycotoxins and relevant detection methods; Quality control using pesticidal criteria; Food safety standards and regulations in India.

Module-III [10L]
**Bioprocessing of various Nutraceuticals and low priced crop**
Nutraceuticals: Definition, Different classes of nutraceuticals; Small molecule nutraceuticals; Lipid-based nutraceuticals, PUFA, Polysaccharides as nutraceuticals, Protein and Nucleotide as nutraceuticals; Low priced food: Toxic component in cereals and tubers; Detoxification techniques for the improvement of low grade food.

Module-IV [10L]
**Functional foods, Natural food additives and recombinant Protein in Food Products**
Phenolic Phytochemicals in food; Genetic modification of edible vegetable oils; Mineral and vitamin fortification of food; Food additives: Flavoring agent, and natural coloring agent, Natural food preservative; Enhancement of antioxidant production in food; Recombinant Proteins: Production and applications in food.
Text books:

Reference books:

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<th>Subject Name: Advanced Bioinformatics Laboratory</th>
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Experiments:
1. Handling of different primary databases and retrieval of primary data of both protein and nucleotide (Expasy, Entrez) of a particular group or type of an enzyme, protein folding classification databases-FSSP, different genomic databases.
2. Different approaches of Prediction of Genes: prokaryotic and eukaryotic genomes and interpretation of results.
3. Sequence alignment: Pair wise and multiple sequence alignment based on different approaches and interpretation of results.
4. Molecular phylogenetic analysis: Distance Based methods and Character Based methods and interpretation of results.
5. Secondary and tertiary structure prediction structure analysis of proteins (especially active sites, binding sites) and comparison, pattern identification.
7. Use of various derived and specialized databases in structure and function assignment, gene expression profiling and in identification of disease genes.
8. Study to find out potential drug targets Using proprietary (Schrodinger: Glide and Prime) and public domain softwares for ligand design, optimization and docking.
Subject Name: Advanced Bioreactor Design & Scale up Lab

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Experiments:
1. Enzyme kinetics.
3. Enzyme immobilization techniques.
5. Bioconversion in batch and continuous bioreactors.
6. Oxygen transfer studies in fermenter.
7. Mixing and agitation in fermenter.
8. RTD studies.

Subject Name: Downstream Processing

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Module-I [10L]

Introduction to Downstream Processing
Basic concepts of separation technology with its importance in biotechnology, Selection strategies of various purification methods based on different properties of biomolecules. Cell disruption by mechanical and non mechanical methods: Chemical lysis, enzymatic lysis, physical methods, Sonication, Homogenization, Centrifugation; Sedimentation; Flocculation.

Module-II [10L]

Isolation of product
Removal of insoluble by filtration, Centrifugation and Ultracentrifugation (Batch, continuous), Extraction (solvent, aqueous two phase, super critical), Precipitation (salt, organic solvent, high molecular weight polymer), Electrophoresis (vertical and horizontal), isoelectric focusing, 2D gel electrophoresis.

Module-III [10L]

Product purification and polishing
Adsorption: Adsorption isotherms and their importance; Chromatography: general theory, partition coefficients, zone spreading, resolution and plate height concept and other chromatographic terms and parameters; chromatographic method selection; adsorption and hydrophobic interaction chromatography (HIC), Gel filtration, molecular imprinting; Ion exchange chromatography, Chromatofocussing; Affinity chromatography, different types: IMAC; Partition chromatography: Normal phase, Reverse phase (RPC), HPLC, Gas chromatography. Polishing of products: Crystallization, Drying and Formulations.
Module-IV [10L]

Membrane Based Separation Process
Membrane based purification: Microfiltration, Ultrafiltration, Reverse Osmosis; Dialysis; Electrodialysis; Diafiltration; Pervaporation; Biotechnological application, Structure and characteristics of membranes. Description of industrial product recovery: Process flow sheet. Case studies: Baker's yeast, Ethanol, Citric acid, Intracellular proteins, Penicillin, Insulin, Interferon, Recombinant proteins

Text and Reference books:

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<tr>
<th>Subject Name: Bioentrepreneurship, IPR &amp; Bioethics</th>
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Module I: 10L

Bioethics
Introduction to ethics and bioethics, the responsible conduct of biotechnological research; research with human subjects; social commitment of a biotechnologist;
Ethical legal social issues (ELSI) in biotechnology: Biotechnology/ biomedicine application – ethical consideration; ethics and the natural world: environmental ethics (protecting public health and environment; genetically modified foods – the ethical and social issue.

Module II: 10L

Intellectual Property Rights (IPR), Patents and protection
IPR: Jurisprudential definition and concept of property rights, duties and their correlations, history and evaluation of IPR – like patent design and copy right. Distinction among the various forms of IPR, requirements of a patentable invention like novelty, inventive step and prior art and state of art procedure; Rights/ protection, infringement or violation, remedies against
infringement, civil and criminal, Indian patent act 1970 (2000) international convention in IPR, major changes in Indian patent system as post TRIPS-GATT-International conventions effects. Contents of patent specification and procedure for patents: a) obtaining patents, b) geographical indication c) WTO. Detailed information on patenting biological products, Biodiversity and farmer rights, Budapest treaty. Case studies on - Patents (basmati rice, turmeric, neem, etc.)

Module-III
Biosafety-Regulatory Framework In India & International Level
Biosafety: The legal and socioeconomic impact of biotechnology, public education of the process of biotechnology involved ingenerating new forms of life for informed decision making, biosafety regulation and national & international guidelines, r-DNA guidelines, experimental protocol approvals, levels of containment, levels of safety. Regulations on ethical principles in biomedical/ biotechnological practice: The Nuremberg code, declaration of Helsinki; the Belmont report, co-operational guidelines – WHO, guidelines of DBT (India), ICMR guidelines, Guidelines for an informed consent.

Module-IV 10L
Entrepreneurship – Objectives and Fundamentals
Entrepreneur & Entrepreneurship concept: role of entrepreneurship in economic development; factors affecting entrepreneurial growth; developing and evaluating opportunities; Growing & sustaining enterprise: Developing start-up strategies, measuring market opportunities. Role of knowledge centres: Knowledge centres like Universities & research Institution, Role of technology & upgradation, managing technology transfer, regulations for transfer of foreign technologies, support mechanism for entrepreneurship in India.

Text books:

Reference Books:
Module-I 10L
*Synthesis of Nanostructure Materials by Physico-Chemical Methods*
Introduction and history of nanotechnology. Concept and development of nanomaterials. Two approaches bottom up and top down synthesis of nanomaterials. Synthetic methodologies: Sol-gel, Micromulsion, CVD, PVD, Molecular beam epitaxy; Vapor (solution)-liquid-solid growth, (VLS or SLS); Spray; Pyrolysis; Lithography. Various kind of Nanostructures: carbon nanotubes (CNT); Metal and metal oxide nanowires; Self assembly of nanostructures; Core-shell nanostructures; Nanoparticle: Nanocomposites. Physical Properties of nanomaterials: Photocatalytic; Dielectric; Magnetic; Optical; Mechanical.

Module-II 10L
*Characterization of Various Nanostructure & Materials*

Module-III 10L
*Nanotechnology in biomedical and Life Sciences:*
Biological nanoparticles production - plants and microbial; Application of Nanotechnology: nanomedicine; nanocapsule; nanorobots; nanopharmacology; Treatment of Infectious Diseases (Viral & Fungal); In Chronic Diseases-I; Cardiovascular Diseases; Hypertension; Nanotechnology Applications In Cancer Diagnosis, Imaging & Therapy; Targeted drug Delivery; Functionalized Gold Nanoparticles for Protein Delivery. Nanobiosensor for detection of small molecules and biomolecules, Biochip. Ethical issus of nanotechnology.

Module-IV 10L
*Nanotechnology in Environmental, Food & Agricultural Biotechnology:*
Nanotechnology In Environment, Environmental Remediation, Applications of Carbon Nanotube in Food Contaminant Detection, Detection Of Pathogens In Food, Opportunities For Nanotechnology In Food Industry, Nanotechnology In Food Preservation, Risk Analysis of the use of Nanotechnology In Food Industry. Nanotechnology in agriculture – Fertilizer and pesticides.

**Text books:**
Reference books:
7. Handbook of nanotechnology by Bhushan
9. Nanoscale Technology in Biological Systems by Cooper, Springer Verlag
11. Surface Science : Foundations of Catalysis and Nanoscience by Kurt W. Kolasinski
12. Self-Assembled Nanostructures by G. Carotenuto

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Module-I 10L

*Approach to Modeling*

Significance of modeling and simulation, kinetic models on different approaches: Deterministic and stochastic, structured and unstructured, segregated and unsegregated; examples of each. Compartmental models (two and four); product formation model; genetically structured models, modeling of extra cellular enzyme production.

Module-II 10L

*Modeling of Bioprocess*

Modeling of: continuous sterilization of medium; activated sludge process, anaerobic digestion. Models for external mass transfer, internal diffusion and reaction within biocatalysts.

Module-III 10L

*Case studies*

Model for penicillin formation, SCP production, therapeutic protein production using genetically engineered cells, numerical problems.
Module -IV 10L

Simulation techniques (Numerical methods)
Programs based on numerical methods like algebraic equations, Newton Raphson method for algebraic convergence, interpolation, arbitrary function generation (FUN1, FUN2 subroutines).
Programs based on solution of differential equations: Euler method for 1st and 2nd order integration, subroutines INT and INTI; Fourth order Runge –Kutta method: stability of numerical integration variable slip size method.

Texts/References:
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Module-I 10L

Drug development and Drug delivery processes
Drug discovery and development: steps of drug discovery; Drug manufacturing and approval processes, biochemical Product formulation processes, statutory regulations in the marketing of biopharmaceuticals.
Pharmacokinetics and Pharmacodynamics: mechanism of drug action, drug receptors, physiological receptors, drug absorption, factors that affect absorption of drugs, distribution of drugs, biotransformation of drugs, bioavailability of drugs.
Delivery of biopharmaceuticals as drugs: Site-directed delivery of biopharmaceuticals, Nanoparticles, liposomes and monoclonal antibodies as drug delivery vehicles, Current status and future development trends of biopharmaceuticals.

Module-II 10L

Cytokine biopharmaceuticals
Types of interferons and function; signal transduction in interferon’s, JAK-STAT pathway in interferon’s and biological effects, eIF-2a protein kinase system, Interferon biotechnology, production and medical uses/applications of IFN-α, IFN-β, Medical a IFN-γ, Additional isolated interferons.
Interleukins: IL-1, IL-2 and other Interleukins; Tumour necrosis factors (TNFs); Growth factors: Insulin-like growth factors (IGFs), Epidermal growth factor (EGF), Platelet-derived growth factor (PDGF), Fibroblast growth factors (FGFs), Transforming growth factors (TGFs), Neurotrophic factors, neurotrophins, Ciliary neurotrophic factor and glial cell line-derived neurotrophic factor, Neurotrophic factors and neurodegenerative diseases.
**Module-III 10L**

*Protein and Nucleic acid Biopharmaceuticals*

Introduction, Therapeutic protein hormones; proteins as thrombolytic agents, Vaccines: for Hepatitis B and tetanus immunoglobulin, Snake and spider antivenins for AIDS and Cancer; Peptide vaccines; monoclonal antibodies and their applications in infectious diseases, oncology and immune disorders; Transplantation and Anti-tumour antibodies; Nucleic acids as therapeutic biopharmaceuticals, Stem cell therapy.

**Module-IV 10L**

*BLOOD factors, Haemopoietic growth factors and Therapeutic enzymes as biopharmaceuticals*

Introduction, Blood and Blood substitutes; Haemostasis: coagulation pathway, Clotting disorders, Production of factor VIII, Factors IX, VIIa and XIII; Anticoagulants, Haemopoietic growth factors: Granulocyte colony stimulating factor (G-CSF), Macrophage colony- stimulating factor (M-CSF) Granulocyte-macrophage colony stimulating factor (GM-CSF), Leukaemia inhibitory factor (LIF), Erythropoietin (EPO), Thrombopoietin; Enzymes of therapeutic value: Asparaginase, DNase, Glucocerebrosidase, α-Galactosidase and urate oxidase, Superoxide dismutase, Lactase.

**Text book:**
1. Pharmaceutical Biotechnology by Sambhamurthy & Kar, NewAge Publishers

**Reference books:**
6. Biopharmaceutics and Pharmacokinetics by V. Venkatesharalu, Pharma Books Syndicate

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**List of experiments:**

1. Cell disruption by various methods: homogenization, sonication, enzymatic lysis
2. Removal of Biomass by Filtration and Centrifugation
3. Fractional precipitation of proteins using ammonium sulphate salt.
4. Extraction of proteins using various organic solvents
5. Studding adsorption kinetics using isotherm model.
6. Chromatographic separation of proteins from a mixture: column preparation, calculating various chromatographic parameters like void volume, plate height, number of theoretical plates, retention time, etc.
7. Membrane based filtration: Dialysis; Ultra filtration.
8. To determine the purity of a protein using SDS-PAGE.