M. Tech. in Biotechnology (BT)

M. Tech. Biotechnology Curriculum

1st Year 1st Semester:

	A	Theory		
Sl. No.	**Code**	**Course Title**	**Contact Hrs/Wk L-T-P**	**Credit**
1.	BIOT5101	Advanced Genetic Engineering	3-1-0	4
2.	BIOT5102	Advanced Enzyme Technology	3-1-0	4
3.	BIOT5103	Physico-chemical techniques in Biotechnology	3-1-0	4
4	BIOT5104	Engineering Mathematics and Biostatistics	3-1-0	4
5.	BIOT5131	Agricultural Biotechnology	3-1-0	4
	BIOT5132	Advanced Environmental Biotechnology		
		Total Theory	**15-5-0**	**20**
	B	**Practical**		
6.	BIOT5111	Advanced Genetic Engineering Lab	0-0-6	2
7.	BIOT5112	Physico-chemical techniques Lab	0-0-6	2
		Total Practical	**0-0-12**	**4**
	C	**Sessional**		
8.	BIOT5121	Seminar-I	0-0-3	1
		Total Sessional	**0-0-3**	**1**
		Semester Total	**15-5-15**	**25**

M. Tech. Biotechnology Curriculum

1st Year 2nd Semester:

	A	Theory		
Sl. No.	**Code**	**Course Title**	**Contact Hrs/Wk L-T-P**	**Credit**
1.	BIOT5201	Advanced Bioinformatics	3-1-0	4
2.	BIOT5202	Advanced Cell Biology & Immunotechnology	3-1-0	4
3.	BIOT5203	Bioprocess Technology	3-1-0	4
4.	BIOT5204	Advances in Biorector Design, Development & Scale up	3-1-0	4
5.	BIOT5241	Genomics and Proteomics	3-1-0	4
	BIOT5242	Advanced Food Biotechnology		
		Total Theory	**15-5-0**	**20**
	B	**Practical**		
6.	BIOT5211	Advanced Bioinformatics Lab	0-0-6	2
7.	BIOT5212	Bioreactor Design & Scale up Lab	0-0-6	2
		Total Practical	**0-0-12**	**4**
	C	**Sessional**		
8.	BIOT5221	Seminar-II	0-0-3	1
		Total Sessional	**0-0-3**	**1**
		Semester Total	**15-5-15**	**25**

M. Tech. Biotechnology Curriculum

2nd Year 1st Semester:

	A	Theory		
Sl. No.	**Code**	**Course Title**	**Contact Hrs/Wk L-T-P**	**Credit**
1.	BIOT6101	Downstream Processing	3-1-0	4
2.	BIOT6151	Nanotechnology	3-1-0	4
	BIOT6152	Modeling and Simulation in Bioprocess		
	BIOT6153	Biopharmaceuticals		
3	BIOT6102	Bioentrepreneurship, IPR and Bioethics	2-0-0	2
		Total Theory	**8-2-0**	**10**
	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:

	A	Sessional		
Sl. No.	**Code**	**Course Title**	**Contact Hrs/Wk L-T-P**	**Credit**
1.	BIOT6221	Thesis (Final)	0-0-30	12
2.	BIOT6222	Thesis viva voce		4
3.	BIOT6223	Grand Viva		4
		Total Sessional	**0-0-35**	**20**
		Semester Total	**0-0-35**	**20**

Subject Name: Advanced Genetic Engineering					
Paper Code: BIOT5101					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

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

Genetically engineered vaccine, Recombinant Enzyme in industry, production of biopharmaceuticals (insulin, interferon, tPA and growth hormones). DNA based diagnosis of genetic diseases and pathogen detection (HIV etc.). Human gene therapy. DNA fingerprinting for parenting and forensics sciences. Strategies for genome sequencing, Human Genome Project. Analysis of gene expression at RNA and protein level, large scale expression (microarray based).

Text Books:

1. Introduction to Genetic Engineering (2009) by Rastogi and Pathak, Oxford University Press.
2. "Molecular Biotecnology: Principles and Applications of Recombinant DNA" (2003) by B. R. Glick and J.J. Pasternak, ASM press.
3. "Principle of Gene Manipulation & Genomics" : by S.M. Primrose , Twyman, and R.W. Old, (2006) Blackwell Science Inc.

Reference books:

1. "Recombinant DNA" by J. D. Watson et al., W.H. Freeman and Company.
2. "DNA cloning: A Practical Approach" by D. M. Glover and B.D. Hames, IRL Press.
3. Molecular cloning: A Laboratory A manual (3rd edition) by J. Sambrook and D. Russell, CHL Press.
4. Ausubel et al. (2002). Short Protocols in Molecular Biology. Wiley.
5. Brown (2006). Gene Cloning and DNA Analysis - An Introduction. Blackwell.
6. Krenzer and Massey (2000). Recombinant DNA and Biotechnology. ASM.
7. Robertson et al. (1997). Manipulation & Expression of Recombinant DNA. AP

Subject Name: Advanced Enzyme Technology					
Paper Code: BIOT5102					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

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 enginnering, Enzyme in organic synthesis; Green technology alternative; Artificial Enzyme; Unusual enzyme substrate.

Text books:

1. "Enzyme Technology" by S. Shanguman & T. Sathiskumar IK International New Delhi (2009)
2. "Enzyme Technology" by Martin Chaplin & Christpher Bucke. Chembridge University Press, 2012.

Reference books:

1. "Enzyme Technology" by A. Pandey, C. R. Socol, and C. Webb, (2006), Springer.
2. "Enzymes in Industry: Procedure and Application" (1990) By W. Aehie, Wiley-WeH Pub.
3. "Enzyme Technology" by Sanjay Grewal & Prasant Muthe. Agrobios (India), 2010.

Subject Name: Physicochemical Techniques in Biotechnology					
Paper Code: BIOT5103					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

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*:**

Principles, instrumentation and application of Emission Spectroscopy and light scattering techniques to biological molecules: Fluorescence (phenomenon), Phosphorescence. Quantum Yield and Stokes shift, Fluorophores, Fluorescence lifetime measurements, fluorescence quenching, fluorescence anisotropy, FRET (resonance energy transfer). Light scattering.

Module-IV [10L]

Techniques based on Microscopy:

Principles, instrumentation and application of Microscopy to biological molecules: Electron Optics, Electron microscopy: TEM, SEM, STM; Atomic Force, Phase contrast and Fluorescence microscopy.

Text books:

1. Principles of Physical Biochemistry, by K.E. van Holde, W. C. Johnson, and P.S. Ho
2. Molecular Biophysics by Igor N. Serdyuk , Nathan R. Zaccai , Joseph Zaccai .
3. Practical Biochemistry and Molecular Biology: 5th edition-By Wilson and Walker (John Wiley &Sons)

Reference books:

1. C.R. Cantor and P.R. Schimmel; Biophysical Chemistry; Freeman.
2. Keith Van Holde, Chien and Ho. Principles of Physical Biochemistry 2nd Edition Pearson
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)
6. Biological Spectroscopy- I.D. Cambell & R.A. Durk, (Benjamin Cummings)
7. Proteins: Structure and Function: David Whitford: John Wiley &Sons.
8. Lubert Stryer : Biochemistry, 5th edn. (Freeman)
9. Voet and Voet: Biochemistry, 2nd edn. (John Willey & Sons)
10. Introduction to Biophysics by Pranab Kumar Banerjee, S Chand and company, 2008.
11. Instrumental methods of chemical analysis by G. R Chatwal and S .K Anand, Himalaya Publishing house, 2008.
12. Biotechnology Procedures and Experiments handbook by S. Harisha, Infinity Science Press LIC, 2008.

Subject Name: Engineering Mathematics and Biostatistics					
Paper Code: BIOT5104					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	

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:

1. Introduction to Biostatistics. Pranab K Banerjee. (2^{nd} edition). S. Chand & Co.
2. P.N. Arora, P.K. Malhan, Biostatistics, Himalaya Publishing House.
3. B.K. Pal and K. Das. Engineering Mathematics. Vol. 1 and 2. U.N. Dhur & Sons Pvt. Ltd.

Reference books:

1. Debajyoti Das and Arati Das. Statistics in Biology and Psychology, Academic Publishers.
2. P. Kandasamy, K. Thilakavthy and K. Gunavathy. Numerical Methods. S. Chand and Co., New Delhi, 1999.
3. B.S. Grewal, J.S. Grewal. Numerical Methods in Engineering and Science. Khanna Publishers, New Delhi, 1999.
4. M.K. Jain, S.R.K. Iyengar and R.K. Jain. Numerical Methods for Engineering and Scientific Computation (3rd Edition). New Age International (P) Ltd., New Delhi, 1995.
5. C.F. Gerald, P.O. Wheatley. Applied Numerical Analysis (5th Edition), Addison – Wesley, Singapore, 1998.
6. S. Narayanan, K. Manickavachakam Pillai and G. Ramanaiah. Advanced Mathematics for Engineering Students-Vol.-III. S. Viswanathan Pvt. Ltd., Chennai, 1993.

Subject Name: Agricultural Biotechnology					
Paper Code: BIOT5131					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

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 (eg 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:

1. Plant Biotechnology and Genetics: Principles, Techniques and Applications C. Neal Stewart, Jr. (Editor) Wiley, 2008.

Reference books:

1. Agricultural biotechnology by . S. Purohit - Second Enlarged Edition, Agrobios, 2007.
2. Agricultural Biotechnology, H. D. Kumar , Daya Publishing House, 2005.
3. Agricultural Biotechnology Challenges and Prospects Edited by Mahesh K. Bhalgat, William P. Ridley, Allan S. Felsot, and James N. Seiber.

Subject Name: Advanced Environmental Biotechnology					
Paper Code: BIOT 5132					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

Module-1 [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), organochrlorine 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:

1. Environmental Biotechnology, Bimal C. Bhattacharyya and Rintu Banerjee, Oxford University Press, 2008.

Reference books:

1. Environmental Biotechnology, Alan Scragg, Oxford University Press, 2nd edition, 2005.
2. Microbial Ecology: Fundamentals and Applications, Ronald M. Atlas & Richard Bartha, Benjamin Cummings, 4th edition, 1997.

Subject Name: Advanced Genetic Engineering Lab					
Paper Code: BIOT5111					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**3**	**3**	**2**

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.
9. Separation of proteins by 2D-Gel Electrophoresis.

Subject Name: Physico-chemical Techniques Lab					
Paper Code: BIOT5112					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**3**	**3**	**3**

Experiments:

1. Study of Beer-Lambert's Law using proteins and other biomolecules.
2. Study of secondary structures of protein by CD Spectroscopy.
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.

Subject Name: Advanced Bioinformatics					
Paper Code: BIOT5201					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

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:

1. N. R. Cohen, Editor, Guidebook on Molecular Modeling in Drug Design. Academic Press.
2. Essential Bioinformatics- Jin Xiong, Oxford University Press.

Reference books:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis, 2nd Edition, CSHL Press, 2004.
2. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss, 2003.
3. P. E. Bourne and H. Weissig. Structural Bioinformatics. Wiley. 2003.
4. C. Branden and J. Tooze, Introduction to Protein Structure, 2nd, Edition, Garland Publishing, 1999.
5. Andrew Leach, Molecular Modelling: Principles and Applications, Pearson Education.
6. Scolnick. J. Drug Discovery and Design, Academic Press, London, 2001.
7. Introduction to Bioinformatics-Arthur W. Lesk-3rd edition, Oxford University Press.
8. Bioinformatics-Principles and Applications-Z.Ghosh and B. Mallick-Oxford University Press.

Subject Name: Advanced Cell Biology & Immunotechnology					
Paper Code: BIOT5202					
Contact	**L**	**T**	**P**	**Total**	**Credit Points**
Hours Per Week	**3**	**1**	**0**	**4**	**4**

Module – I [10L]

Membrane Structure, Transport & Electrical Properties of membranes: Lipid bilayer, membrane proteins Principles of membrane transport, carrier proteins and active membrane transport.

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]
Immunoassays, New generation antibodies; Antibody engineering; phage display; Antibodies as in vivo and in vitro probes; Imaging techniques: Immunoflouresence 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:

1. David E. Sadava. Cell Biology: Organelle Structure & Function. Panima Publishing Corporation (Indian edition) 2004.
2. A.K. Chakrabarty. Immunology and Immunotechnology. Oxford University Press.

Reference Books:

1. Bruce Alberts. Molecular Biology of the Cell. 5th edition. Garland Science. 2007.
2. T.D. Pollard & William C. Earnshaw. Cell Biology. Saunders Elsevier. 2nd edition. 2010.
3. Gerald Karp. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. 7th edition, 2013.
4. Benjamin Lewin, Lynne Cassimeris, V.R. Lingappa, George Plopper. Cells. Jones and Barlett Publishers. 2007.
5. Geoffrey M. Cooper & Robert E. Hausman. The Cell: A Molecular Approach. Sinauer Associates. 6th edition, 2013.

Subject Name: Bioprocess Technology					
Paper Code: BIOT5203					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

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]

Cellular Growth kinetics: Quantifying kinetics in batch culture, Mycelial growth kinetics ,Structured and unstructured growth models, Models for transient behaviour, cybernetic models, Growth in continuous culture, Ideal chemostat and its deviation, growth, non-growth and mixed growth associated product, Product productivity, Stoichiometry of microbial growth and product formation. Operating considerations for bioreactors for suspension and immobilized culture, Oxygen transfer rate, Oxygen uptake rate, Volumetric oxygen transfer rate (k_{La}), Measurement of k_{La}, Power requirement for agitation in gaseous and non gaseous systems, Heat generation and removal of heat from a bioreactor.

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:

1. James M. Lee, Biochemical Engineering, Prentice Hall, 1991.

Reference Books:

1. Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2002.
2. Pauline M. Doran. Bioprocess Engineering Principles. Academic Press. 1995.
3. James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals. Mc-Graw Hill Education. 2nd edition, 1996.
4. Shuichi Aiba, Arthur E. Humphrey & Nancy F. Millis. Biochemical Engineering. Academic Press. 1965.

Subject Name: Advances in Bioreactor design, Development and Scale up					
Paper Code: BIOT5204					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

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.
2. P. F. Stanbury and A. Whitaker, Principles of fermentation technology" Pergamon Press (1984)

Reference books:

1. M. L. Shuler and F. Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, 2001.
2. Pauline M. Doran, Bioprocess Engineering Principles, 1st Edition, Academic Press, 1995.
3. James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals, 2nd Revised Edition, McGraw-Hill, 1986.

Subject Name: Genomics and Proteomics					
Paper Code: BIOT5241					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

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

Sequence based approaches: SAGE, Microarray (Basic principles and technology of cDNA microarrays and their applications, case studies). Molecular Phylogenetics and Comparative Genomics: Gene duplication and phylogeny, Gene order, Lateral and Horizontal gene transfer, Transposable elements, Application of molecular phylogenetics.

Proteomics:

Module-III [10L]

Tools and Techniques for Proteomics

From Genomics to Proteomics, Strategies of Protein Separation and quantitation: 2D gel electrophoresis, Liquid chromatography in Proteomics. Strategies of Protein and identification and peptide sequencing: MALDI-TOF mass spectrometry, ESI-TOF MS and MS-MS methods. Interaction and localization proteomics: phage interaction display, affinity based methods, Y2H and co-immunoprecipitation methods. Protein chips in functional proteomics, Medical proteomics in disease diagnosis.

Module-IV [10L]

Structural Proteomics

Value of protein structure in proteomics**,** Techniques for solving protein structure**:** X-ray Crystallography, Nuclear Magnetic Resonance Spectroscopy (NMR), cryo-EM and additional methods, Comparing protein structure. Protein modification proteomics**:** Phosphoproteomics, Glycoproteomics. Pharmaceutical proteomics in drug discovery.

Text books:

1. "Principles of Proteomics", (2nd Edn) (2013) by Richard Twyman Garland Science,
2. "Principles of Gene Manipulation and Genomics", 7th Edn, (2006) by Primrose S & Twyman R, and Old, Blackwell Pub.

Reference books:

1. "Genomes III" (2006) by T. A. Brown. Garland Science.
2. "Human Molecular Genetics 4" (2010) by T. Strachan and A. P. Read, Garland Science.
3. "Principles of Genome analysis" by S.B. Primrose and R. M. Twyman, Blackwell Pub.
4. "Genomics: Application in Human Biology" by S.B. Primrose and R. M. Twyman. Blackwell Pub.
5. "Functional Genomics: A practicqal Approach" by S. P. Hunt and R. Livesey, Oxford University Press.
6. "DNA Microarry: A practical approach" by M. Schlena, Oxford University Press.
7. "Discovering Genomics, proteomics and Bioinformatics" by A. M. Campbell and L. J. Heyer.
8. Essentials of Genomics and Bioinformatics by C. W. Sensen, John Wiley & Sons Inc.
9. "Proteomics" by T. Palzkil, Kluwer Academic pub.
10. "Protein and Proteomics" by Richard J Simson, I K Publishers.
11. "Introduction to Proteomics: by D. C. Liebler, Tools for the New Biology", Humana Press.

12. "Molecular Biology of the Cell" by B. Alberts, D. Bray, J. Lewis et al, Garland Pub. N.Y 1983.
13. "Genomics" by Cantor & Smith John Wiley & Sons.
14. "Introduction to Proteomics" (2010) By Nawin C. Mishra, John Wiley Sons. Inc.
15. "A Primer of Genome Science" (2nd edn.) (2004) by G. Gibson and S.V. Muse. Sinauer Associates. Inc. Pub.

Subject Name: Advanced Food Biotechnology					
Paper Code: BIOT5242					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

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:

1. Food Biotechnology (2nd Edition). A. Pometto, K shetty, G paliyath & R. Levin. CRC Press (2010).

Reference books:

1. Functional food and Biotechnology (2006) by K. Shelly, CRC Press.
2. Fundamental food and Nutraceuticals (2006) by J. Shi, CRC Press.
3. Biotechnology in Agriculture and food processing: opportunities and challenges. Pramjit Pareasar & Satwindes Marwaha, CRC press (2013).
4. Enzyme in Food Processing. PS Panesar, SS Marwaha, H K Chopra, IK International Publishing House, New Delhi, (2010).

Subject Name: Advanced Bioinformatics Laboratory					
Paper Code: BIOT5211					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**3**	**3**	**2**

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.
6. Approaches for analysis of ligand-protein and protein- protein interactions.
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					
Paper Code: BIOT5212					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**3**	**3**	**2**

Experiments:

1. Enzyme kinetics.
2. Microbial growth and product formation kinetics.
3. Enzyme immobilization techniques.
4. Bioconversion using immobilized enzyme preparation.
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					
Paper Code: BIOT6101					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

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:

1. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley Interscience Publication, 1988.
2. J. E. Bailey and D. F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, Mc-Graw Hill, Inc., 1986.
3. Seperation, Recovery and Purification in Biotechnology, Aenjo J.A. and J.Hong
4. Priniciples of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984)
5. Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2002.

Subject Name: Bioentrepreneurship, IPR & Bioethics					
Paper Code: BIOT6102					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**1**	**0**	**2**	**2**

Module-1 10L

Bioethics

Introduction to ethics and bioethics, the responsible conducts 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.

ELSI in genetic engineering/biomedical science, Eugenics, Use and Misuse of genetic information, Human gene patenting – ethics and policy issues, genetic testing and screening, human gene therapy and genetic modification – ethical and public consideration, legal implication of somatic cell, gene therapy- germ line gene therapy.

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, cooperational 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:

1. IPR, Biosafety and Bioethics. Deepa Goel. Pearson Education. 1st edition, 2013.
2. Intellectual Property Law. P. Narayanan. Eastern Law House. 3rd edition, 2009

Reference Books:

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Sasson A, Biotechnologies and Development, UNESCO Publications.
3. Singh K, Intellectual Property rights on Biotechnology, BCIL, New Delhi
4. Regulatory Framework for GMOs in India (2006) Ministry of Environment and Forest, Government of India, New Delhi.
5. Cartagena Protocol on Biosafety (2006) Ministry of Environment and Forest, Government of India, New Delhi.
6. P.K. Gupta, Biotechnology and Genomics, Rastogi Publications.
7. Patent Strategy For Researches & Research Manegers- Knight, Wiley Publications.
8. Agriculture & Intellectual & Property Rights, V. Santaniello & R E Evenson, University Press.
9. Intellectual Property Protection & Sustainable Development, Phillipe C.

Subject Name: Nanotechnology					
Paper Code: BIOT6151					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

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

Fundamentals of the techniques – experimental approaches and data interpretation – applications/limitations of X-ray characterization: – X-ray sources – wide angle, extended x-ray absorption technique – Electron microscopy: SEM/TEM – high resolution imaging – defects in nanomaterials – Spectroscopy: – electron energy-loss mechanisms – electron filtered imaging – prospects of scanning probe microscopes – optical spectroscopy of metal/semiconductor nanoparticles (FTIR).

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 isssues 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, Nanaotechnology In Food Preservation, Risk Analysis of the use of Nanotechnology In Food Industry. Nanotechnology in agriculture – Fertilizer and pesticides.

Text books:

1. Nanotechnology-principles and applications by S.K. Kulkarni, Capital pub. Com.
2. Nanotechnology: A gentle introduction to the next big by Mark and Daniel Ratner, Pearson low price edition.

Reference books:

1. Nano: The Essentials by T.Pradeep. Tata McGraw Hill, New Delhi (2007)
2. Introduction to Nanotechnology by Charles P Poole Jr and Frank J Ownes, John Wiley Sons, Inc (2003)
3. Nanocomposite Science and Technology by Pulickel m.Ajayan, Linda S.Schadler, Paul V.Braun, Wiley – VCH
4. Nanotechnology: Basic sciences and emerging technologies by Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkar Raguse, Overseas Press (2005).
5. Instrumental Methods of Analysis by Willard, 2000.
6. Instrumental Methods for Chemical Analysis by Ewing. et al 2000.
7. Handbook of nanotechnology by Bhushan
8. Nanostructures & Nano Materials by Ghuzang Cao.
9. Nanoscale Technology in Biological Systems by Cooper, Springer Verlag
10. Nanostructures & Nanomaterials: Synthesis, Properties & Applications by Guozhong Cao
11. Surface Science : Foundations of Catalysis and Nanoscience by Kurt W. Kolasinski
12. Self-Assembled Nanostructures by G. Carotenuto
13. Integrated Chemical Systems: A Chemical Approach to Nanotechnology (Baker Lecture Series) by Allen J. Bard
14. C. M. Niemeyer, C. A. Mirkin, ―Nanobiotechnology: Concepts, Applications and Perspectives, Wiley – VCH, (2004).

Subject Name: Modeling and simulation in bioprocesses					
Paper Code: BIOT6152					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**1**	**0**	**2**	**2**

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 Runga –Kutta method: stability of numerical integration variable slip size method.

Texts/References:

1. Bailey, J.E and D.F Ollis, Biochemical Engineering fundamentals , 2nd ed. McGraw Hill Book Co. , 1988.
2. Blanch, H.W and I.J. Dunn, "Modeling and Simulation in Biochemical Engg" in Advances in Biochemical Engineering.
3.

Subject Name: Biopharmaceuticals					
Paper Code: BIOT6153					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	2	**1**	**0**	**2**	**2**

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, Nano-particles, 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, a-Galactosidase and urate oxidase, Superoxide dismutase, Lactase.

Text book:

1. Pharmaceutical Biotechnology by Sambhamurthy & Kar, NewAge Publishers

Reference books:

2. Biopharmaceuticals Biochemistry and biotechnology" (2nd Edition) by Gary Walsh, Pub: Wiley Reference books.
3. Drug Delivery and Targeting" by A.M. Hillery, A.W. Lloyd and J. Swarbrick, Harwood Academic Publishers.
4. Pharmaceutical Biotechnology" by S. P. Vyas, V. Dixit, CBS Publishers.
5. Monoclonal antibodies: applications in clinical oncology" by Epenetos A.A. (ed), Chapman and Hall Medical, London.
6. Biopharmaceutics and Pharmacokinetics by V.Venkatesharalu, Pharma Books Syndicate

Subject Name: Downstream Processing Lab					
Paper Code: BIOT6111					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**6**	**6**	**2**

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 amonium 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.