BIOTECHNOLOGY

M.TECH. PROGRAMME

With effect from July 2018

M.Tech. Biotechnology Curriculum

1st yr 1st semester

Code	Field	Course Title	Scheme of studies per week			Credits
			L	T	P	
A		**Theory**				
BIOT5101	Prof. Core	Advanced Genetic Engineering	3	0	0	3
BIOT5102	Prof. Core	Physicochemical Techniques in Biotechnology	3	0	0	3
BIOT5103		Research Methodology, Bioethics and IPR	2	0	0	2
BIOT5131	Prof. Elective 1	Advanced Enzyme Technology	3	0	0	3
BIOT5132		Nanotechnology				
BIOT5141	Prof. Elective 2	Agricultural Biotechnology	3	0	0	3
BIOT5142		Advanced Environmental Biotechnology				
DIMA5116	Audit Course-1	Disaster Management	2	0	0	0
INCO5117		Constitution of India				
PDLS5118		Personality Development through Life Enlightenment Skills				
YOGA5119		Stress Management by Yoga				
		Total Theory	**16**	**0**	**0**	**14**
B		**Practical**				
BIOT5151	Prof. Core	Advanced Genetic Engineering Lab	0	0	4	2
BIOT5152	Prof. Core	Physicochemical Techniques Lab	0	0	4	2
		Total Practical	**0**	**0**	**8**	**4**
		SEMESTER TOTAL	**16**	**0**	**8**	**18**

1st yr 2nd semester

Code	Field	Course Title	Scheme of studies per week			Credits
			L	T	P	
A		**Theory**				
BIOT5201	Prof. Core	Advanced Bioinformatics	3	0	0	3
BIOT5202	Prof. Core	Advances in Bioreactor Design, Development and Scale Up	3	0	0	3
BIOT5231	Prof. Elective 3	Advanced Cell biology and Immunotechnology	3	0	0	3
BIOT5232		Genomics and Proteomics				
BIOT5241	Prof. Elective 4	Bioprocess Technology	3	0	0	3
BIOT5242		Advanced Food Biotechnology				
	Audit Course-2	Any one subject from Prof. Elective 3 or Prof. Elective 4 bucket*	3	0	0	0
		Total Theory	**15**	**0**	**0**	**12**
B		**Practical**	**15**	**0**	**0**	**12**
BIOT5251	Prof. Core	Advanced Bioinformatics Lab	0	0	4	2
BIOT5252	Prof. Core	Bioreactor Design and Scale Up Lab	0	0	4	2
		Total Practical	**0**	**0**	**8**	**4**
C		**Sessional**				4
BIOT5293	Seminar	Term Paper and Seminar	0	0	4	2
		Total Sessional	**0**	**0**	**4**	**2**
		SEMESTER TOTAL	**15**	**0**	**12**	**18**

*** Total 3 electives have to be taken with at least one from each bucket; one of them will be treated as the non-credit mandatory course**

2nd yr 1st semester

Course Code	Field	Course Title	Scheme of studies per week			Credits
			L	T	P	
A		**Theory**				
BIOT6131	Prof. Elective 5	Modelling and Simulation in Bioprocess	3	0	0	3
BIOT6132		Biopharmaceuticals				
BIOT6133		Downstream Processing				
BIOT6121	Open Elective*	Engineering Mathematics and Biostatistics	3	0	0	3
AEIE6122		Intelligent Control				
CSEN6121		Business Analytics				
MATH6121		Optimization Techniques				
REEN6122		Safety and Hazards in Energy Industry				
		Total Theory	**6**	**0**	**0**	**6**
B		**Sessional**				
BIOT6195	Project	Dissertation-I /Industrial Project	0	0	20	10
		Total Sessional	**0**	**0**	**20**	**10**
		SEMESTER TOTAL	**0**	**0**	**20**	**16**

*For detailed syllabus please refer to M. Tech. 3rd Sem Open Electives document

2nd yr 2nd semester

Course Code	Field	Course Title	Scheme of studies per week			Credits
			L	T	P	
A		**Sessional**				
BIOT6295	Project	Dissertation II	0	0	28	14
BIOT6297	Viva	Comprehensive viva voce	0	0	0	2
		Total Sessional	**0**	**0**	**28**	**16**
		SEMESTER TOTAL	**0**	**0**	**28**	**16**

1st Year 1st Semester detailed syllabus

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

Course Outcomes:

After completion of this course, the student should be able to:

1. Describe the function and application of the common enzymes used in molecular biology and explain the different DNA sequencing methods and when they would be applied.
2. Explain which biological hosts is the best choice for producing a certain protein and why.
3. Give examples of how to increase or decrease the expression of a given gene using gene regulation mechanisms.
4. Describe methods for performing DNA mutagenesis and how to screen or select for successful mutants.
5. Apply to produce of transgenic plants and animals and explain the principles behind modern gene therapy.
6. Apply the knowledge of genetic engineering in problem solving and in practice

Module-I [9L]

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 [9L]

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 [9L]

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 [9L]

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: Physicochemical Techniques in Biotechnology					
Paper Code: BIOT5102					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:
Upon completion, this course should prepare registered students to:

1. learning and application of molecular thermodynamics towards understanding of molecular mechanics (e.g. strong and weak interactions) and stabilizing interactions (e.g side chain and base stacking interactions) in proteins and nucleic acids
2. learning and application of principles of statistical thermodynamics (including statistical weights and partition function) towards understanding structural transitions in proteins and DNA
3. learning the principles ,instrumentation and methods behind optical absorption spectroscopic (e.g. UV-Vis, FT-IR, CD) and magnetic absorption spectroscopic (NMR,EPR) techniques; applications towards structure elucidation and other applications with respect to biological macromolecules (e.g. UV bioassays, FT-IR of proteins, 2D NMR of proteins and nucleic acids)
4. learning the principles, instrumentation and methods (e.g. quenching, anisotropy)of equilibrium and time resolved fluorescence emission spectroscopy; applications including structure-elucidation and more applied ones (e.g. fluorescence biosensors) ; principles and applications of Rayleigh and Raman scattering to biological macromolecules
5. learning the principles and utility of single molecule techniques in contrast to spectroscopic techniques with examples (e.g folding/unfolding of RNA at single molecule level)
6. learning the principles, instrumentation and applications of Microscopy based techniques to biological macromolecules; techniques and applications specific to atomic force microscopy (AFM), confocal, phase contrast and electron microscopies (SEM,TEM)

Module-I [9L]
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 [9L]
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 [9L]
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 [9L]

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: Research Methodology, Bioethics & IPR					
Paper Code: BIOT5103					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**2**	**0**	**0**	**2**	**2**

Course Outcomes:

After completion of this course, the students should be able to:

1) Describe the different aspects of research, and research processes such as literature survey, hypothesis testing.
2) Describe the important aspects of research problem such as sources of error in measurement, Data collection Methods, Interpretation and report writing.
3) Understand the concept of IPR, and i.e, types of IPR and different types of patents and its laws to protect patents.
4) Understand and explain biosafety and bioethical regulations.

Module-1 [5L]

Research Methodology I

Objectives of research. Different types of research. Research Methods vs Methodology. Research Process: Formulating the research problem; literature survey; formulating hypotheses; research design & sample design; collecting data; execution of the project; data analysis (testing hypothesis, if any) interpretation, preparation of the report, presentation of results and conclusions. Criteria of good research

Module-II [5L]

Research Methodology II

Defining the Research problem: Descriptive or hypothesis-testing research studies. Exploratory or formulative research studies. Concept about variables; experimental and control groups; treatments; experiment. Measurement in research: Sources of error in measurement; tests of validity, reliability and practicality. Data collection Methods: Primary data and secondary data; Survey and Experiment. Processing and analysis of data: Statistical measures. Interpretation and Report writing. Ethics in research.

Module-III [5L]

Intellectual Property Rights (IPR), Patents and Protection

IPR: Definition. Types of IPR: Patent, Copyright, Trademark etc. Basics of Patents: Essential criteria for patentability. Indian Patent Act 1970 with amendments. Implications of WTO and TRIPS. Filing of a patent application: Guidelines; prior art; claims. Role of Patent Office; Patent Cooperation Treaty (PCT); International framework for the protection of IPR. Budapest Treaty. Commercialization of patented innovations; licensing and sale. Patent databases; Searching international databases. IPR of relevance to Biotechnology. Patent infringement. Litigation, case studies and examples.

Module-IV [5L]

Biosafety and Bioethics

Biosafety: Regulations for research and products involving genetically modified organisms (GMO); national and international policy. Biosafety guidelines of Govt of India for GMO research and applications in food, medicine and agriculture. Role of Institutional Biosafety Committee (IBSC). Levels of biosafety lab; containment; biohazards; infectious agents. GRAS organisms.

Bioethics: Ethical aspects of biological research: Impact on society, environment and nature. Bioethics in healthcare & research on human subjects: Informed consent; the Nuremberg code; WHO & ICMR guidelines. Ethical legal social issues in biotechnology and biomedical applications: Genetic testing & screening; human gene therapy using somatic cells & germ-line; human cloning; eugenics. Patenting of human gene. GM food, labeling, public opinion. Protection of environment & Biodiversity.

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: Advanced Enzyme Technology					
Paper Code: BIOT5131					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

After completion of this course, the students should be able to:

1. Students will be able to describe the mechanism of enzyme actions.
2. Students will be able to design general protocol for processing of enzymes from different sources.
3. Students will be able to describe different methods for purification and immobilization of enzymes.
4. Students will be able to apply enzymes in various industries that can benefit human life.
5. Students will be able to develop various enzyme biosensors for therapeutic purposes.
6. Students will be able to interpret future prospects of Enzyme Technology.

Module-I [9L]

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 [9L]

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 [9L]

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 [9L]

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" Shanguman & Sathiskumar. IK International, New Delhi (2009)
2. "Enzyme Technology" M. Chaplin & C. Bucke. Cambridge Univ 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) W. Aehie, Wiley-WeH Pub.
3. "Enzyme Technology" by Sanjay Grewal & Prasant Muthe. Agrobios (India), 2010.

Subject Name: Nanotechnology					
Paper Code: BIOT5132					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

After completion of this course, the students should be able to:

1. explain the inception and development of nanotechnology
2. understand and describe the various methods of nanomaterial synthesis
3. analyze their properties and their characterization by physico-chemical methods.
4. understand the applications of nanoparticles in drug delivery, disease diagnosis and therapeutics.
5. understand various applications of nanotechnology to the biomedical and life sciences and in the areas of environmental, food and agricultural biotechnology.

Module-I [9L]

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 [9L]

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 [9L]

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 [9L]

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: Agricultural Biotechnology					
Paper Code: BIOT5141					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes

At the end of the course the student will be able to:

1. Explain the different techniques of plant tissue culture for bio-resource production.
2. Impart knowledge on all recent biotechnological developments related to the quality improvement of crops.
3. Understand role of plant along with microorganisms in agro-industry.
4. Analyze the role different molecular markers for different characters related to agronomic importance.
5. Understand the role of plants as bioresources by virtue of their secondary metabolites.

Module-I [9L]

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 [9L]

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 [9L]

***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 [9L]

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: BIOT5142					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

After completion of the course the students will be able to:

1) Understand the of the cause and effect of environmental pollution in details
2) Explain the conventional processes of waste treatment
3) Interpret the role of microbes in pollution control
4) Develop biotechnological process for waste treatment
5) Recognize the importance of biodiversity
6) Comprehend the concept of green technology

Module-1 [9L]

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 [9L]

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 [9L]

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 [9L]

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: Disaster Management					
Paper Code: DIMA5116					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**2**	**0**	**0**	**2**	**0**

Course Objectives:

Students will be able to:

1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

	Units	CONTENTS	Hours
Module -I	1	**Introduction on Disaster** Disaster: Definition Types of Disaster • Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc. • Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc. • Differences, Nature and Magnitude • Factors Contributing to Disaster Impact and Severity • Repercussions of various types of Disasters o Economic Damage o Loss of Human and Animal Life o Destruction of Ecosystem o Outbreaks of Disease and Epidemics o War and Conflict Natural Disaster-prone areas in INDIA • Areas prone to o Earthquake o Floods and Droughts, o Landslides and Avalanches; o Cyclonic And Coastal Hazards such as Tsunami; Trends of major Disasters and their Impact on India	3

		• Lessons Learnt from Recent Disasters	
	2	**Introduction to Disaster Management** What is Disaster Management Different Phases of Disasters Disaster Management Cycles Disaster Management Components • Hazard Analysis • Vulnerability Analysis • Prevention and Mitigation • Preparedness • Prediction and Warning • Response • Recovery Disaster Management Act, 2005 National Disaster Management Structure Organizations involved in Disaster Management	3
Module -II	1	**Overview on Hazard Analysis and Vulnerability Analysis** **Disaster Preparedness** • Disaster Risk Assessment, People's Participation in Risk Assessment • Disaster Risk Reduction • Preparedness Plans • Community preparedness: Emergency Exercises/ Trainings/Mock Drills	3
	2	**Disaster Prediction and Warning** • Activities o Tracking of disaster o Warning mechanisms o Organizational response o Public education o Communication o Evacuation planning • Current tools and models used for Prediction and Early Warnings of Disaster o Application of Remote Sensing o Data From Meteorological and other agencies o Smartphone/ Web based Apps for Disaster Preparedness and Early Warning used in different parts of Globe	3

Module -III	1	**Disaster Response**
		• Crisis Management: The Four Emotional Stages of Disaster
		  o Heroic Phase
		  o Honeymoon Phase
		  o Disillusionment Phase
		  o Reconstruction Phase
		• Need for Coordinated Disaster Response
		  o Search, Rescue, Evacuation, Medical Response and Logistic Management
		  o Psychological Response and Management (Trauma, Stress, Rumor and Panic)
		• Role of Government, International and NGO Bodies
			3

	2	**Post-disaster Situation Awareness** • Need for Situation Awareness in Post Disaster scenario • Challenges in communication of situational data from affected areas • Need for community-driven disaster management for reliable situation awareness • Crowd-sourcing of situational data: Issues and challenges **Post-disaster Damage and Need Assessment** • Current Trends and Practices – RAPID Damage and Need Assessment • SPHERE standards in Disaster Response • ICT based techniques for Post-disaster damage and need assessment	3
Module -IV	1	**Rehabilitation, Reconstructions and Recovery** • Reconstruction and Rehabilitation as a Means of Development. • Post Disaster effects and Remedial Measures • Creation of Long-term Job Opportunities and • Livelihood Options • Disaster Resistant House Construction • Sanitation and Hygiene • Education and Awareness • Dealing with Victims' Psychology • Long-term Counter Disaster Planning	3
	2	**Disaster Mitigation** 1. Meaning, Concept and Strategies of Disaster Mitigation 2. Emerging Trends in Mitigation 3. Structural Mitigation and Non-Structural Mitigation 4. Programs of Disaster Mitigation In India	3

SUGGESTED READINGS:

1. R. Nishith, Singh AK, “Disaster Management in India: Perspectives, issues and strategies”, New Royal book Company.
2. Sahni, Pardeep et.al. (Eds.),” Disaster Mitigation Experiences And Reflections”, Prentice Hall of India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies”, Deep & Deep Publication Pvt. Ltd., New Delhi.

Subject Name: Advanced Genetic Engineering Lab					
Paper Code: BIOT5151					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**4**	**4**	**2**

Course Outcomes:

After completing this course, the students should be able to

1. Clone DNA, and analyze and compare different parameters,
2. Compare different isolation techniques, and
3. Evaluate the best method for purifying DNA, RNA and protein from cell.

Experiments (at least 5 experiments to be attempted):

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: Physicochemical Techniques Lab					
Paper Code: BIOT5152					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**4**	**4**	**2**

Course Outcomes:

Upon completion, this practical course should prepare registered students to

1. learn and use a UV-Visible spectrophotometer for an enzyme assay and for studying/monitoring the denaturation profile of a protein or DNA sample.
2. protein purification protocol for an enzyme (e.g. phytoenzymes) using techniques lyophilization, gel filtration chromatography and centrifugation
3. learn and use a phase contrast and inverted microscope for analysis of biological samples
4. learn and use separation methodologies like HPLC for impurity estimation of biological samples
5. learn and use a fluorescence spectrometer for fluorescence quenching/Fluorescence resonance energy transfer experiments using protein samples.

Experiments (at least 5 experiments to be attempted):

1. Study of UV-Visible spectra of macromolecules / small molecules
2. Quantitative analysis of biomolecules by UV-visible spectrophotometry
3. Study of protein / DNA denaturation by UV-visible spectrophotometry
4. Analysis of biological samples using phase contrast/inverted microscope.
5. Analysis of biological samples using fluorescence microscope.
6. Separation of macromolecules / small molecules using HPLC
7. Separation of macromolecules / small molecules using GC
8. Fluorescence spectrophotometry of proteins (e.g. fluorescence quenching, FRET)
9. Characterization of macromolecules using SEM/TEM

1st Year 2nd Semester detailed syllabus

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

Course Outcomes:

Upon completion of this course, registered students should be able to

1. use acquired knowledge about different bioinformatics experiment categories (e.g. sequence, structure analysis) and their applications in new biology (e.g genomics, proteomics)
2. learn organization and characteristics of primary and specialized databases and portals; introduction to new applications of databases/portals towards study of metabolic pathways and systems biology
3. learn and apply sequence alignment methodologies (including comparison of applicable heuristic and dynamic algorithms) for pairwise and multiple sequence alignment and molecular phylogenetics
4. learn and apply bioinformatics based software tools (and the algorithms underlying them) for annotation and structure prediction of prokaryotic and eukaryotic genes, RNA secondary structure prediction and secondary structure prediction of globular, fibrous and membrane proteins (e.g. use of Artificial neural network and Hidden Markov model based algorithms for these purposes)
5. principles and applications of homology, fold recognition and ab initio based algorithms for tertiary structure prediction of proteins; applications of protein tertiary structure prediction towards problems of protein folding and design
6. learn and apply the principles of molecular modeling and energy minimization for small molecule -protein and protein-protein binding ; learn the principles and methodologies of computer aided drug design

Module-I [9L]

***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 [9L]

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 [9L]

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 [9L]

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: Advances in Bioreactor design, Development and Scale up					
Paper Code: BIOT5202					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

After completing this course, students should be able to:

1. Develop basic concept of reaction engineering including microbial growth kinetics.
2. Determine mass transfer coefficient.
3. Cultivate knowledge about different reactor operations and scale up and scale down.
4. Interpret batch reactor data with reference to basic reactor design for a single reaction in an ideal reactor.
5. Develop understanding about different advanced bioreactors.
6. Be familiar with the bioreactor instrumentation for monitoring and control of bioprocesses.

Module-I [9L]

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-II [9L]

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-III [9L]

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-IV [9L]

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: Advanced Cell Biology & Immunotechnology					
Paper Code: BIOT5231					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

After completing this course, students should be able to

1. Understand the mechanisms of cellular transport & trafficking.
2. Analyze the different channels of cell signaling and their interaction with different molecules.
3. Describe the mechanism of cell cycle and its components.
4. Analyze the mechanism of programmed cell death and its applications in human therpaeutics.
5. Apply the knowledge of different bioassays and vaccinology in disease diagnosis and human healthcare.

Module – I [9L]

Cellular transport and membrane trafficking

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 [9L]

Signal transduction and cytoskeleton

Signal transduction: General principles of signal transduction, 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 [9L]

Cell cycle and cell communication

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 [9L]

Immunoassyas and vaccinology

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: Genomics and Proteomics					
Paper Code: BIOT5232					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

After completing this course, students should be able to

1. Describe recent advances in genomics, transcriptomics, metabolomics and proteomics.
2. Explain basic and high throughput techniques in Genomics and their applications.
3. Explain basic and high throughput techniques in Proteomics and their applications.
4. List and discuss the use of genomics and proteomics in human health.
5. Propose appropriate methods for analysis of given sample type with respect to purpose of analysis.
6. Suggest and outline solution to theoretical and experimental problems in Genomics and Proteomics fields.

Genomics:

Module-I [9L]

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 [9L]

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 [9L]

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 [9L]

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 practical 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: Bioprocess Technology					
Paper Code: BIOT5241					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

After completion of the course the students will be able to

1. describe the mechanism of all types of enzyme substrate reactions,
2. calculate various kinetic parameters associated therewith,
3. comprehend various factors affecting the growth of cells and formation of products,
4. solve mathematical problems related to various bioprocesses
5. design mathematically model upstream and fermentation processes, and
6. apply the concepts in real time industrial scenarios in biotechnology.

Module-I [9L]

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 [9L]

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 [9L]

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 [9L]

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

Course Outcomes:

After completing this course, the students will be able to:

1. Apply their knowledge in developing new food processing techniques.
2. Develop new food substances like nutraceuticals and functional food.
3. Improve nutritional quality of food by genetic modification.
4. Apply knowledge about food additives for preservation.
5. Detect different toxic components of food.
6. Have idea about different food safety techniques

Module-I [9L]

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 [9L]

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 [9L]

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 [9L]

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, 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. Paramjit 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 Lab					
Paper Code: BIOT5251					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**4**	**4**	**2**

Course Outcomes:

Upon completion of this practical course, registered students should be able to

- learn about and utilize the widening range of public domain biological portals (e.g. NCBI, PDB and sub-databases therein) and primary and secondary databases for varied data mining applications.
- learn about and utilize derived and specialized databases for specialized applications like protein-protein interaction analysis and study of metabolic pathways respectively.
- learn about and utilize open source/public domain bioinformatics tools for sequence alignment of genes and proteins ; use of multiple sequence alignment for molecular phylogenetics.
- learn and utilize public domain/open source bioinformatics tools for annotation and structure prediction of prokaryotic and eukaryotic genes ; secondary structural element (SSE) prediction/analysis of globular and membrane proteins using public domain/open source resources.
- Use of public domain tools using homology modeling and fold recognition based algorithms for tertiary structure prediction of proteins ; template and residue level analysis of predicted protein structures.
- learn and utilize open source/public domain and proprietary portals/tools for molecular modeling, energy minimization and molecular docking using representative examples.

Experiments (at least 5 experiments to be attempted):

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: Bioreactor Design & Scale up Lab					
Paper Code: BIOT5252					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**4**	**4**	**2**

Course Outcomes:

After completing this course, students should be able to

1. Interpret and compare different hydrolysis processes,
2. Explain different techniques of enzyme immobilization.
3. Students should have basic understanding for the operation of immobilized enzyme reactor (Lab Scale)

Experiments (at least 5 experiments to be attempted):

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.

2nd yr 1st Semester detailed syllabus

Subject Name: Modeling and Simulation in Bioprocess					
Paper Code: BIOT6131					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

After completion of the course the students will be able to

1. Understand the basic concepts of modeling and simulation
2. Differentiate between modeling and simulation
3. Classify mathematical models into deterministic and stochastic, structured and unstructured, segregated and non-segregated models
4. Derive mathematical models for various processes in the biological system
5. Apply different numerical techniques towards simulation of bioprocesses
6. Develop mathematical models for a given bioprocess

Module-I: Approach to Modeling [9L]
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: Modeling of Bioprocess [9L]
Modeling of: continuous sterilization of medium; activated sludge process, anaerobic digestion.Models for external mass transfer, internal diffusion and reaction within biocatalysts.

Module III: Case Studies [9L]
Model of alcohol production process, lactic acid production, therapeutic protein production using genetically engineered cells, numerical problems.

Module IV: Simulation Techniques (Numerical Methods) [9L]
Solution of algebraic equation, Newton-Raphson method for algebric convergence, methods for initial value and boundary value problems, Euler's method, R-K method, related computer programming with any programming language for solution of numerical problems, Regression analysis. Introduction to MATLAB.

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.

Subject Name: Biopharmaceuticals					
Paper Code: BIOT6132					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

After completion of this course, the students should be able to:

1) Understand the concept behind drug discovery and development along with their Pharmacokinetics and Pharmacodynamics knowledge.
2) Analyze the course of actions of various cytokines and their applications in therapeutics.
3) Describe the uses of various types of vaccines
4) Understand and analyze the uses of various kinds of enzymes for their therapeutic values
5) Explain the usage of interleukins and growth factors as biopharmaceuticals.
6) Apply the rationale behind use of peptide vaccines and its application against infectious diseases.

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					
Paper Code: BIOT6133					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

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.