

# BIOTECHNOLOGY

**M.TECH. PROGRAMME**

With effect from July 2018



## M.Tech. Biotechnology Curriculum

**1<sup>st</sup> yr 1<sup>st</sup> semester**

Code	Field	Course Title	Scheme of studies per week			Credits
			L	T	P	
<b>A</b>		<b>Theory</b>				
<b>BIOT5101</b>	Prof. Core	Advanced Genetic Engineering	3	0	0	3
<b>BIOT5102</b>	Prof. Core	Physicochemical Techniques in Biotechnology	3	0	0	3
<b>BIOT5103</b>		Research Methodology, Bioethics and IPR	2	0	0	2
<b>BIOT5131</b>	Prof. Elective 1	Advanced Enzyme Technology	3	0	0	3
<b>BIOT5132</b>		Nanotechnology				
<b>BIOT5141</b>	Prof. Elective 2	Agricultural Biotechnology	3	0	0	3
<b>BIOT5142</b>		Advanced Environmental Biotechnology				
<b>DIMA5116</b>	Audit Course	Disaster Management	2	0	0	0
		<b>Total Theory</b>	<b>16</b>	<b>0</b>	<b>0</b>	<b>14</b>
<b>B</b>		<b>Practical</b>				
<b>BIOT5151</b>	Prof. Core	Advanced Genetic Engineering Lab	0	0	4	2
<b>BIOT5152</b>	Prof. Core	Physicochemical Techniques Lab	0	0	4	2
		<b>Total Practical</b>	<b>0</b>	<b>0</b>	<b>8</b>	<b>4</b>
		<b>SEMESTER TOTAL</b>	<b>16</b>	<b>0</b>	<b>8</b>	<b>18</b>

**1<sup>st</sup> yr 2<sup>nd</sup> semester**

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

**\* 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**

**2<sup>nd</sup> yr 1<sup>st</sup> semester**

Course Code	Field	Course Title	Scheme of studies per week			Credits
			L	T	P	
<b>A</b>		<b>Theory</b>				
<b>BIOT6131</b>	Elective 5	Modelling and Simulation in Bioprocess	3	0	0	3
<b>BIOT6132</b>		Biopharmaceuticals				
<b>BIOT6133</b>		Downstream Processing				
<b>BIOT6121</b>	Open Elective	Engineering Mathematics and Biostatistics	3	0	0	3
<b>AEIE6122</b>		Artificial Intelligence				
		<b>Total Theory</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>
<b>B</b>		<b>Sessional</b>				
<b>BIOT6195</b>	Project	Dissertation-I /Industrial Project	0	0	20	10
		<b>Total Sessional</b>	<b>0</b>	<b>0</b>	<b>20</b>	<b>10</b>
		<b>SEMESTER TOTAL</b>	<b>0</b>	<b>0</b>	<b>20</b>	<b>16</b>

**2<sup>nd</sup> yr 2<sup>nd</sup> semester**

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

## 1st Year 1st Semester

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

### Course Outcomes:

After completing this course,

- students should be able to clone DNA, and
- able to understand the application of genetic engineering in medical, environmental, food and agricultural biotechnology

### 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 Biotechnology: 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

<b>Subject Name: Physicochemical Techniques in Biotechnology</b>					
<b>Paper Code: BIOT5102</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>

### Course Outcomes:

Upon completion, this course should prepare registered students to:

- learn and apply principles of molecular interactions , classical thermodynamics and statistical mechanics to biological macromolecules viz. proteins and nucleic acids.
- learn the principles and instrumentation behind optical absorption techniques (e.g. UV-Vis, FT-IR) and magnetic absorption techniques (e.g. NMR) and their applications in the domain of biological macromolecules( e.g. UV bioassays, NMR of peptides/small proteins)
- learn the principles, instrumentation and applications of various sub-techniques of fluorescence emission spectroscopy (e.g. quenching, anisotropy) and Rayleigh scattering towards basic and applied functions with respect to proteins and nucleic acid (e.g. fluorescence biosensors, size of macromolecules)
- learn the principles, instrumentation and applications of single molecule techniques like confocal, atomic force, phase contrast and electron microscopies (application examples include single particle FRET and motion of RNA polymerase on DNA )

### 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: 5<sup>th</sup> 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.

<b>Subject Name: Research Methodology, Bioethics &amp; IPR</b>					
<b>Paper Code: BIOT5103</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>2</b>

### **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 [10L]**

#### ***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 [10L]**

#### ***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 [10L]**

#### ***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 [10L]**

#### ***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. 1<sup>st</sup> edition, 2013.
2. Intellectual Property Law. P. Narayanan. Eastern Law House. 3<sup>rd</sup> 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.

<b>Subject Name: Advanced Enzyme Technology</b>					
<b>Paper Code: BIOT5131</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>

### **Course Outcomes:**

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

1. describe general protocol for processing of enzymes from different sources
2. compare different methods for purification and immobilization of enzymes
3. apply enzymes in various industries that can benefit human life
4. interpret future prospects of Enzyme Technology

### **Module-I [10L]**

#### ***Fundamentals of Enzyme Kinetics & commercial Production of Enzyme***

Enzyme nomenclature, Units of Enzyme, Mechanism of Enzyme actions; Enzyme inhibitions, determinations of kinetic constants of enzyme reaction, Kinetics of enzyme inhibitions; Sources of Enzyme and general protocol for processing of Enzyme from different sources.

Unit operations, Solid liquid separation: centrifugation, filtration, aqueous Two-Phase system; Cell breakage: ultrasonic, high pressure homogeniser, bead mills, Freeze-press, lytic enzyme, concentration of enzyme, stabilization of enzyme for commercial preparations.

### **Module-II [10L]**

#### ***Purification & immobilization of Enzyme***

Purification of enzyme by: Solvent and salt precipitations, heat treatment, Liquid Chromatography methods of protein separation: adsorption, ion exchange, hydrophobic, affinity, gel-exclusion, HPGPLC. Immobilisation of enzyme: Techniques of enzyme immobilization; Immobilised enzyme bioreactor; Kinetics of Immobilized enzyme.

### **Module-III [10L]**

#### ***Large scale use of enzyme***

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

### **Module-IV [10L]**

#### ***Future prospects of Enzyme Technology***

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

### **Text books:**

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.

<b>Subject Name: Nanotechnology</b>					
<b>Paper Code: BIOT5132</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>

### Course Outcomes:

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

- students will be able to explain the inception and development of nanotechnology which includes various methods of nanomaterial synthesis, their properties and their characterization by physico-chemical methods;
- understand various applications of nanotechnology to the biomedical and life sciences and in the areas of environmental, food and agricultural biotechnology.

### 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 issues 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).

<b>Subject Name: Agricultural Biotechnology</b>					
<b>Paper Code: BIOT5141</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>

### 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

### 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 Nutraceuticals 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.

<b>Subject Name: Advanced Environmental Biotechnology</b>					
<b>Paper Code: BIOT5142</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>

### **Course Outcomes:**

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

- explain the importance of microbial diversity in environmental systems, processes and biotechnological solutions, and
- analyze and address environmental issues including pollution, mineral resource winning, renewable energy and water recycling.

### **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), organochlorine and aromatic nitrogenous compounds, mechanism of tolerance toward heavy metals (mercury, arsenic, chromium, lead and cadmium), molecular mechanism for spreading of resistance, improvement of tolerant organisms through genetic manipulation, biosorption, techniques of bioremediation, case studies

### **Module-IV [10L]**

Biofuel, bioextraction, biodiversity: Biomass as a source of energy, production of biodiesel, biohydrogen and methane, application of microbial technology in mineral extraction, biodiversity, types of biodiversity, biodiversity indices, calculation of biodiversity, bioprospecting, environmental impact assessment (basic concept)

### **Text book:**

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

### **Reference books:**

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

<b>Subject Name: Disaster Management</b>					
<b>Paper Code: DIMA5116</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>0</b>

	<b>Units</b>	<b>CONTENTS</b>	<b>Hours</b>
<b>Module -I</b>	1	<b>Introduction on Disaster</b> Disaster: Definition Types of Disaster <ul style="list-style-type: none"> <li>• Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc.</li> <li>• Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail &amp; Road), Structural failures (Building and Bridge), War &amp; Terrorism etc.</li> <li>• Differences, Nature and Magnitude</li> <li>• Factors Contributing to Disaster Impact and Severity</li> <li>• Repercussions of various types of Disasters <ul style="list-style-type: none"> <li>○ Economic Damage</li> <li>○ Loss of Human and Animal Life</li> <li>○ Destruction of Ecosystem</li> <li>○ Outbreaks of Disease and Epidemics</li> <li>○ War and Conflict</li> </ul> </li> </ul> Natural Disaster-prone areas in INDIA <ul style="list-style-type: none"> <li>• Areas prone to <ul style="list-style-type: none"> <li>○ Earthquake</li> <li>○ Floods and Droughts,</li> <li>○ Landslides and Avalanches;</li> <li>○ Cyclonic And Coastal Hazards such as Tsunami;</li> </ul> </li> </ul> Trends of major Disasters and their Impact on India <ul style="list-style-type: none"> <li>• Lessons Learnt from Recent Disasters</li> </ul>	3
	2	<b>Introduction to Disaster Management</b> What is Disaster Management Different Phases of Disasters Disaster Management Cycles Disaster Management Components <ul style="list-style-type: none"> <li>• Hazard Analysis</li> <li>• Vulnerability Analysis</li> <li>• Prevention and Mitigation</li> </ul>	3

		<ul style="list-style-type: none"> <li>• Preparedness</li> <li>• Prediction and Warning</li> <li>• Response</li> <li>• Recovery</li> </ul> <p>Disaster Management Act, 2005 National Disaster Management Structure Organizations involved in Disaster Management</p>	
<b>Module -II</b>	1	<b>Overview on Hazard Analysis and Vulnerability Analysis</b>  <b>Disaster Preparedness</b> <ul style="list-style-type: none"> <li>• Disaster Risk Assessment, People's Participation in Risk Assessment</li> <li>• Disaster Risk Reduction</li> <li>• Preparedness Plans</li> <li>• Community preparedness: Emergency Exercises/ Trainings/Mock Drills</li> </ul>	3
	2	<b>Disaster Prediction and Warning</b> <ul style="list-style-type: none"> <li>• Activities <ul style="list-style-type: none"> <li>○ Tracking of disaster</li> <li>○ Warning mechanisms</li> <li>○ Organizational response</li> <li>○ Public education</li> <li>○ Communication</li> <li>○ Evacuation planning</li> </ul> </li> <li>• Current tools and models used for Prediction and Early Warnings of Disaster <ul style="list-style-type: none"> <li>○ Application of Remote Sensing</li> <li>○ Data From Meteorological and other agencies</li> <li>○ Smartphone/ Web based Apps for Disaster Preparedness and Early Warning used in different parts of Globe</li> </ul> </li> </ul>	3
<b>Module -III</b>	1	<b>Disaster Response</b> <ul style="list-style-type: none"> <li>• Crisis Management: The Four Emotional Stages of Disaster <ul style="list-style-type: none"> <li>○ Heroic Phase</li> <li>○ Honeymoon Phase</li> <li>○ Disillusionment Phase</li> <li>○ Reconstruction Phase</li> </ul> </li> <li>• Need for Coordinated Disaster Response <ul style="list-style-type: none"> <li>○ Search, Rescue, Evacuation, Medical Response and Logistic Management</li> </ul> </li> </ul>	3

		<ul style="list-style-type: none"> <li>○ Psychological Response and Management (Trauma, Stress, Rumor and Panic)</li> <li>● Role of Government, International and NGO Bodies</li> </ul>	
	2	<b>Post-disaster Situation Awareness</b> <ul style="list-style-type: none"> <li>● Need for Situation Awareness in Post Disaster scenario</li> <li>● Challenges in communication of situational data from affected areas</li> <li>● Need for community-driven disaster management for reliable situation awareness</li> <li>● Crowd-sourcing of situational data: Issues and challenges</li> </ul> <b>Post-disaster Damage and Need Assessment</b> <ul style="list-style-type: none"> <li>● Current Trends and Practices – RAPID Damage and Need Assessment</li> <li>● SPHERE standards in Disaster Response</li> <li>● ICT based techniques for Post-disaster damage and need assessment</li> </ul>	3
<b>Module -IV</b>	1	<b>Rehabilitation, Reconstructions and Recovery</b> <ul style="list-style-type: none"> <li>● Reconstruction and Rehabilitation as a Means of Development.</li> <li>● Post Disaster effects and Remedial Measures</li> <li>● Creation of Long-term Job Opportunities and Livelihood Options</li> <li>● Disaster Resistant House Construction</li> <li>● Sanitation and Hygiene</li> <li>● Education and Awareness</li> <li>● Dealing with Victims' Psychology</li> <li>● Long-term Counter Disaster Planning</li> </ul>	3
	2	<b>Disaster Mitigation</b> <ul style="list-style-type: none"> <li>● Meaning, Concept and Strategies of Disaster Mitigation</li> <li>● Emerging Trends in Mitigation</li> <li>● Structural Mitigation and Non-Structural Mitigation</li> <li>● Programs of Disaster Mitigation In India</li> </ul>	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.

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

#### **Course Outcomes:**

After completing this course, the students should be able to

- Clone DNA, and analyze and compare different parameters,
- Compare different isolation techniques, and
- 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.

<b>Subject Name: Physicochemical Techniques Lab</b>					
<b>Paper Code: BIOT5152</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>0</b>	<b>0</b>	<b>4</b>	<b>4</b>	<b>2</b>

#### **Course Outcomes:**

Upon completion, this practical course should prepare registered students to

- learn and use a UV-Visible spectrophotometer for an enzyme assay and a protein/DNA denaturation experiment.
- learn and use a fluorescence spectrometer for quenching and resonance energy transfer (FRET) studies of a labelled biological macromolecule.
- learn how to use a phase contrast /fluorescence microscope to analyze biological samples ; use of SEM/TEM
- learn and use separation methodologies like GC-MS/HPLC for small and biological macromolecules analysis

#### **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

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

### Course Outcomes:

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

- gain knowledge about bioinformatics experiment categories and their applications to biology; learn characteristics of biological databases and portals and their applications.
- learn and apply sequence alignment methodologies (including analysis of utilized algorithms) for pairwise and multiple sequence alignment, pattern analysis and molecular phylogenetics
- learn and apply bioinformatics software tools and the algorithms underlying them (e.g Neural Networks) for structure prediction of genes (prokaryotic and eukaryotic), globular and membrane proteins(secondary and tertiary) and RNA (secondary).
- learn and apply the principles of molecular modelling to proteins and learn the principles and methodologies of computational drug design

### 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: Fitch -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, 2<sup>nd</sup> 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-3<sup>rd</sup> edition, Oxford University Press.
8. Bioinformatics-Principles and Applications-Z.Ghosh and B. Mallick-Oxford University Press.

<b>Subject Name: Advances in Bioreactor design, Development and Scale up</b>					
<b>Paper Code: BIOT5202</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>

### **Course Outcomes:**

After completing this course, students should be able to:

1. Develop basic concept of reaction engineering including enzyme kinetics.
2. Interpret batch reactor data with reference to basic reactor design for a single reaction in an ideal reactor.

### **Module-I [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-II [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-III [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-IV [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.

<b>Subject Name: Advanced Cell Biology &amp; Immunotechnology</b>					
<b>Paper Code: BIOT5231</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>

### **Course Outcomes:**

After completing this course, students should be able to

- Understand the mechanisms of cellular transport & trafficking
- Analyze the different channels of cell signaling and their interaction with different molecules
- Describe the cell cycle and its components
- Understand the role of different bioassays and vaccinology in human healthcare

### **Module – I [10L]**

#### ***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 [10L]**

#### ***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 [10L]**

#### ***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 [10L]**

#### ***Immunoassays and vaccinology***

Immunoassays, New generation antibodies; Antibody engineering; phage display; Antibodies as in vivo and in vitro probes; Imaging techniques: Immunofluorescence 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. 5<sup>th</sup> edition. Garland Science. 2007.
2. T.D. Pollard & William C. Earnshaw. Cell Biology. Saunders Elsevier. 2<sup>nd</sup> edition. 2010.
3. Gerald Karp. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. 7<sup>th</sup> 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. 6<sup>th</sup> edition, 2013.

<b>Subject Name: Genomics and Proteomics</b>					
<b>Paper Code: BIOT5232</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>

### Course Outcomes:

After completing this course, students should be able to

- understand major differences between prokaryotic and eukaryotic genomes.
- understand the basics of the genomic and proteomic principles.
- understand about the different tools and applications of genomics and proteomics.

### 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", (2<sup>nd</sup> Edn) (2013) by Richard Twyman Garland Science,
2. "Principles of Gene Manipulation and Genomics", 7<sup>th</sup> 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 Microarray: A practical approach" by M. Schlöner, 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. Palzkill, 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" (2<sup>nd</sup> edn.) (2004) by G. Gibson and S.V. Muse. Sinauer Associates. Inc. Pub.

<b>Subject Name: Bioprocess Technology</b>					
<b>Paper Code: BIOT5241</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>

### **Course Outcomes:**

After completion of the course the students will be able to

- describe the mechanism of all types of enzyme substrate reactions,
- calculate various kinetic parameters associated therewith,
- design mathematically model upstream and fermentation processes, and
- apply the concepts in real time industrial scenarios in biotechnology.

### **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. 2<sup>nd</sup> edition, 1996.
4. Shuichi Aiba, Arthur E. Humphrey & Nancy F. Millis. Biochemical Engineering. Academic Press. 1965.

<b>Subject Name: Advanced Food Biotechnology</b>					
<b>Paper Code: BIOT5242</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>

### **Course Outcomes:**

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

1. Gather knowledge on both conventional and unconventional food substances
2. Analyze nutritional content
3. Test the safety and toxicity of different processed food
4. Understand the other importance of food other than nutrition like nutraceuticals.

### **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 (2<sup>nd</sup> 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).

<b>Subject Name: Advanced Bioinformatics Lab</b>					
<b>Paper Code: BIOT5251</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>0</b>	<b>0</b>	<b>4</b>	<b>4</b>	<b>2</b>

### **Course Outcomes:**

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

- learn and utilize the evolving range and applications of public domain biological portals (e.g. NCBI), primary, secondary and specialized databases (including pathway/network databases)
- learn to utilize public domain bioinformatics tools for sequence analysis of genes and proteins and subsequent phylogenetics analysis
- learn to utilize public domain bioinformatics tools for structure prediction of genes and proteins and for interaction analysis (e.g. protein-protein interactions)
- learn and utilize open source/public domain portals/tools using representative examples for molecular modelling and molecular docking.

### **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

<b>Subject Name: Bioreactor Design &amp; Scale up Lab</b>					
<b>Paper Code: BIOT5252</b>					
<b>Contact Hours</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>	<b>Credit Points</b>
<b>Per Week</b>	<b>0</b>	<b>0</b>	<b>4</b>	<b>4</b>	<b>2</b>

**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.