

**Department of Biotechnology**  
**M. Tech. Curriculum**  
**Full Time**  
**FIRST SEMESTER**

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	BT 1001	ADVANCED BIOPROCESS ENGINEERING	3-1-0	4
2	BT 1002	ADVANCED BIO-SEPARATION TECHNOLOGY	3-1-0	4
3	BT 1003	ADVANCED ENVIRONMENTAL BIOTECHNOLOGY	3-1-0	4
4		ELECTIVE I	3-1-0	4
5		ELECTIVE II	3-1-0	4
6	BT 1051	ADVANCED BIOPROCESS ENGINEERING LABORATORY	0-0-4	2
7	BT 1052	MODERN BIOSEPARATION LABORATORY	0-0-4	2
<b>TOTAL</b>			<b>15-5-8</b>	<b>24</b>

**SECOND SEMESTER**

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	BT 2001	ADVANCED FOOD BIOTECHNOLOGY	3-1-0	4
2	BT 2002	GENOMICS, PROTEOMICS AND BIOINFORMATICS	3-1-0	4
3	BT 2003	INDSUTRIAL PRODUCTION OF BIOPHARMACEUTICALS	3-1-0	4
4		ELECTIVE II	3-1-0	4
5		ELECTIVE IV	3-1-0	4
6	BT 2051	ADVANCED FOOD BIOTECHNOLOGY LAB.	0-0-4	2
7	BT 2052	BIOINFORMATICS LABORATORY	0-0-2	1
8	BT 2053	PROJECT I	0-0-2	1
<b>TOTAL</b>			<b>15-5-8</b>	<b>24</b>

**THIRD SEMESTER**

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	BT 3051	PROJECT II		11
2	BT 3052	PROJECT SEMINAR I		2
<b>TOTAL</b>				<b>13</b>

**FOURTH SEMESTER**

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	BT 4051	PROJECT III		11
2	BT 4052	PROJECT SEMINAR II & VIVA VOCE		3
<b>TOTAL</b>				<b>14</b>
<b>TOTAL PROGRAMME CREDIT</b>				<b>75</b>

## SUMMARY OF COURSES

### Sub Discipline: DEPARTMENTAL CORE

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 1001	ADVANCED BIOPROCESS ENGINEERING	3-1-0	4	PROF APURBA DEY, DR SURABHI CHAUDHURI
BT 1002	ADVANCED BIO-SEPARATION TECHNOLOGY	3-1-0	4	DR. KAUSTAV AIKAT
BT 1003	ADVANCED ENVIRONMENTAL BIOTECHNOLOGY	3-1-0	4	PROF APURBA DEY, DR KAZY SUFIA KHANNAM
BT 2001	ADVANCED FOOD BIOTECHNOLOGY	3-1-0	4	DR SURABHI CHAUDHURI, DR. DEBJANI DUTTA
BT 2002	GENOMICS, PROTEOMICS AND BIOINFORMATICS	3-1-0	4	DR. SUBHANKAR ROY BARMAN
BT 2003	INDUSTRIAL PRODUCTION OF BIOPHARMACEUTICALS	3-1-0	4	DR SURABHI CHAUDHURI, DR MONIDIPA GHOSH

### Sub Discipline: DEPARTMENTAL ELECTIVES

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 9011	HUMAN MOLECULAR GENETICS	3-1-0	4	DR. SUDIT SHEKHAR MUKHOPADHYAY
BT 9012	FUNCTIONAL GENOMICS	3-1-0	4	DR. SUBHANKAR ROY BARMAN
BT 9013	IMMUNOTECHNOLOGY	3-1-0	4	DR. DALIA DASGUPTA, DR MONIDIPA GHOSH
BT 9014	CANCER BIOLOGY	3-1-0	4	DR. SUDIT SHEKHAR MUKHOPADHYAY
BT 9015	ADVANCED BIOPHARMACEUTICAL PROCESS DESIGN	3-1-0	4	DR. SURABHI CHAUDHURI
BT 9016	BIOMATERIALS	3-1-0	4	DR KAUSTAV AIKAT
BT 9017	STATISTICS AND INSTRUMENTATION IN BIOTECHNOLOGY	3-1-0	4	DR. DEBJANI DUTTA

BT 9018	STRUCTURAL BIOLOGY	3-1-0	4	DEPARTMENT
BT 9019	COMPUTATIONAL METHODS IN MOLECULAR BIOLOGY	3-1-0	4	EXTERNAL SOURCE
BT 9020	METABOLIC ENGINEERING	3-1-0	4	DR KAUSTAV AIKAT, DR ASHISH BHATTACHARJEE
BT 9021	SYSTEM BIOLOGY	3-1-0	4	DEPARTMENT
BT 9022	NUTRACEUTICALS AND NUTRIGENOMICS	3-1-0	4	DR. DEBJANI DUTTA
BT 9023	BIOMETALLURGY	3-1-0	4	DR KAUSTAV AIKAT
BT 9024	NANOBIOTECHNOLOGY	3-1-0	4	DEPARTMENT
BT 9025	RENEWABLE ENERGY TECHNOLOGY	3-1-0	4	DR. SURABHI CHAUDHURI
BT 9026	MODELING AND SIMULATION IN BIOPROCESSES	3-1-0	4	DEPARTMENT
BT 9027	ADVANCED rDNA TECHNOLOGY AND CELLULAR BIOTECHNOLOGY	3-1-0	4	DR DALIA DASGUPTA
BT 9028	SIGNAL TRANSDUCTION	3-1-0	4	PROF SUDIP CHATTOPADHYAY
BT 9029	MOLECULAR MODELING AND DRUG DESIGN	3-1-0	4	EXTERNAL SOURCE
BT 9030	BIOPROCESS EQUIPMENT DESIGN	3-1-0	4	PROF APURBA DEY
BT 9031	MOLECULAR PLANT PATHOGEN INTERACTION	3-1-0	4	DR. SUBHANKAR ROY BARMAN
BT 9032	ADVANCED CELL SIGNALLING	3-1-0	4	DR ASHISH BHATTACHARJEE

**Sub Discipline: LABORATORY & SESSIONAL COURSES**

BT 1051	ADVANCED BIOPROCESS ENGINEERING LABORATORY	0-0-4	2
BT 1052	MODERN BIOSEPARATION LABORATORY	0-0-4	2
BT 2051	ADVANCED FOOD BIOTECHNOLOGY LABORATORY	0-0-4	2
BT 2052	BIOINFORMATICS LABORATORY	0-0-2	1

**Sub Discipline: PROJECT, SEMINAR etc.**

BT 2053	PROJECT I	0-0-2	1
BT 3051	PROJECT II		11
BT 3052	PROJECT SEMINAR I		2
BT 4051	PROJECT III		11
BT 4052	PROJECT SEMINAR II & VIVA VOCE		3

### Semester-I

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
<b>BT 1001</b>	<b>Advanced Bioprocess Engineering</b>	<b>3-1-0</b>	<b>4</b>	<b>Prof Apurba Dey, Dr. Surabhi Chaudhuri</b>
<p>Recapitulation: Stoichiometry of Growth and Product formation. Heat transfer for biochemical processes. RTD studies, Dispersion model and tanks-in-series model. Kinetics of Growth and Product formation in Batch, Continuous and Fed batch systems. (12)</p> <p>Media Sterilization and Air Sterilization. Design of Stirred Tank Bioreactors. (4)</p> <p>Modeling of growth kinetics –structured and unstructured model. (2)</p> <p>Mass transfer studies in stirred tank reactor and in free and immobilized cell bioreactors. (5)</p> <p>Design of Immobilized biocatalytic reactor, biofilm reactors, membrane reactor, Hollow fiber reactor, airlift reactor. Reactors for solid state fermentation. (3)</p> <p>Large scale mammalian cell culture - non perfused attachment system and perfusion for cell cultivation, suspension culture, microcarrier culture system, microencapsulation, fluidized bed system, aeration, mixing &amp; hydrodynamics in bioreactors, cell culture kinetics, large scale stirred tank and air lift reactors for cultivation of animal cell. (12)</p> <p>Plant cell bioreactors – their design and operation. (3)</p> <p>Large scale propagation of insect cells. (1)</p> <p>Scale up, Instrumentation and Control of Bioreactors. (3)</p>				
<p><b>TEXT BOOKS:</b></p> <ol style="list-style-type: none"><li>1. Large-scale Mammalian Cell Culture Technology, Lubiniecki, CRC</li><li>2. Bioreactors: Analysis &amp; Design, Tapobrata Panda, McGraw Hill</li><li>3. Doran P M, '<i>Bioprocess Engineering Principles</i>', Academic Press</li></ol>				
<p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"><li>1. Bioprocess Engineering: Basic Concepts (2nd Edition), Shuler and Kargi, Prentice Hall International.</li><li>2. International Cell Culture Technology for Pharmaceutical and Cell-Based Therapies, Sadettin Ozturk, Wei-Shou Hu, CRC</li><li>3. Bioprocess Engineering: Kinetics, Biosystems, sustainability and reactor design by Shijie Liu, Elsevier Publisher.</li></ol>				

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
<b>BT 1002</b>	<b>Advanced Bio-Separation Technology</b>	<b>3-1-0</b>	<b>4</b>	<b>Dr. Kaustav Aikat</b>
<p>Adsorption - fixed bed and agitated bed adsorption. (5)</p> <p>Chromatography: Method selection; theoretical concepts of column chromatography, selection of matrix; gel filtration; ion-exchange chromatography; affinity chromatography; hydrophobic interaction chromatography. (5)</p> <p>HPLC, mass spectrometry, coupling of HPLC with mass spectrometry. (4)</p> <p>Sedimentation - sedimentation at low acceleration, centrifugal elutriation, ultracentrifugation. (5)</p> <p>Extraction - countercurrent stage calculations, scale up and design of extractors. (5)</p> <p>Precipitation - protein solubility, precipitate formation phenomena, design of precipitation systems. (5)</p> <p>Membrane filtration. (4)</p> <p>Crystallization - principles, batch crystallizers, process crystallization of proteins, crystallizer scale up and design. (5)</p> <p>Drying – Drying Principles, Drying Equipment basics, Heat and Mass Transfer, Undesirable Effects of Drying. (5)</p> <p>Bioseparation strategies of some typical industrial products. (2)</p>				
<p><b>TEXT BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. Bioseparations Science and Engineering, <u>Roger G. Harrison</u>, <u>Paul W. Todd</u>, <u>Scott R. Rudge</u>, <u>Demetri Petrides</u>, Oxford University press, USA</li> <li>2. Practical Biochemistry Principles and techniques: Editor Wilson and Walker, Cambridge University Press</li> </ol>				
<p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. Bioseparations Engineering: Principles, Practice, and Economics, <u>Michael R. Ladisch</u>, Wiley-Interscience</li> <li>2. Bioseparations – Downstream Processing for Biotechnology, Paul A. Belter, E.L. Cussler, Wei-Shou Hu, Wiley Interscience Coulson &amp; Richardson, Chemical Engineering, Vol- II, Butterworth Heinemann</li> </ol>				

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 1003	Advanced Environmental Biotechnology	3-1-0	4	Prof Apurba Dey, Dr Kazy Sufia Khannam
<p><i>Introduction to Environmental Biotechnology:</i> definition, scope of application; (1)</p> <p><i>Bioremediation:</i>  Introduction, Types of pollutants, sources of pollutants, magnitude of contamination problem, merits and limitations of bioremediation, bioremediation of organic and inorganic pollutants. (2)  Microbial interactions with heavy metals/radionuclides – bioaccumulation, biosorption, biotransformation, bioprecipitation, applications of metal-microbe interactions, engineering microorganisms for metal bioremediation (3)  Biodegradation principles – microbial processes, biotransformation, mineralization, detoxification, activation, cometabolism and growth associated degradation. Requirements for biodegradation, cooperation between different microbial species for enhanced biodegradation, Implications of recalcitrance, acclimation, biotransformation mechanisms – genes, enzymes, reactions, Biodegradation pathways and metabolites, effect of contaminant structure on biodegradability. (10)  Bioremediation strategies – natural attenuation and accelerated bioremediation, aerobic, anaerobic, ex-situ, in-situ, biostimulation, Bioaugmentation (2)  Phytoremediation – phytoextraction, rhizofiltration, phytodegradation, phytovolatilization, rhizoremediation, phytostabilization. (3)</p> <p><i>Waste Water &amp; Sludge treatment:</i>  Characteristics and analysis of waste water, Treatment of waste water of sewage &amp; Industry. Bio-kinetics coefficient and its application in waste water treatment. (4)  Basic design concepts and calculations for waste water treatment of:  i) Preliminary treatment units – screening, grit removal, removal of oil and grease (1)  ii) Primary treatment units- settling tank, flotation. (1)  iii) Biological treatment:  a) Aerobic: Activated sludge process, secondary settling tank, trickling filter, waste stabilization pond. (4)  b) Anaerobic : Anaerobic reactors for treatment of waste water- Anaerobic Digesters, Upflow Anaerobic Sludge Blanket Reactor(UASB), Fluidized Bed Biofilm Reactor(FBBR) (4)  c) Treatment and disposal of sludge (1)  d) Solid waste management (2)  Advanced Waste Water Treatment-Limitations of conventional treatment, pathogen removal, toxic substances removal, phosphorous and nitrogen removal</p> <p><i>Industrial Waste:</i>  Approach to design, process design parameters  Characteristics, analysis and treatment of wastes from different Industry like: dairy industry, fermentation, slaughter house, tanning, dye, pulp and paper, distillery, petroleum, heavy metal pesticides, food and beverage, antibiotics etc. Treatment of biological industry wastes (6)  Treatment &amp; disposal of radioactive waste. (1)</p>				

**TEXT BOOKS:**

- i) Wastewater treatment: Concepts & design approach, G L Karia, R A Christian, PHI
- ii) Waste water Engineering: Treatment, disposal, reuse, by Metcalf & Eddy, Tata Mc Graw Hill

**REFERENCE BOOKS:**

- iii) Environmental Engineering: A design Approach, Sincero, Arcadio. P, Sr. & Greogia; PHI
- iv) Water & wastewater Technology; Hammer, Mark J, Mark J Hammer; PHI

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<b>BT 1051</b>	<b>Advanced Bioprocess Engineering Laboratory</b>	<b>0-0-4</b>	<b>2</b>	
<ol style="list-style-type: none"> <li>1) Growth kinetics studies in shake flask.</li> <li>2) Sterilization of Bioreactor.</li> <li>3) Study of Monod Growth kinetics in a stirred tank bioreactor</li> <li>4) Determination of <math>K_{la}</math> in a bioreactor by ststic/dynamic method</li> <li>5) Mixing time determination in a stirred tank bioreactor</li> <li>6) RTD studies in a bioreactor</li> <li>7) Study of inhibition kinetics in a bioreactor</li> <li>8) Control characteristics in a bioreactor</li> </ol>				

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<b>BT 1052</b>	<b>Modern Bioseparation Laboratory</b>	<b>0-0-4</b>	<b>2</b>	
<ol style="list-style-type: none"> <li>1. Filtration (constant pressure/constant rate filtration)</li> <li>2. Aqueous two phase extraction (binodal diagram)</li> <li>3. Production of protein (such as enzyme) and its bioseparation</li> <li>4. Salt precipitation of protein</li> <li>5. Dialysis</li> <li>6. Separation of proteins by Molecular Sieve /ion-exchange chromatography</li> <li>7. Separation/concentration of proteins by Ultrafiltration.</li> <li>8. Demonstration of lyophilization &amp; Rotary vacuum evaporation</li> <li>9. Preparation of cell-free extract: by sonication and by homogenization</li> </ol>				

## Semester II

<b>SUBJECT CODE</b>	<b>SUBJECT</b>	<b>L-T-P</b>	<b>CREDIT</b>	<b>DEVELOPER</b>
<b>BT 2001</b>	<b>Advanced Food Biotechnoloty</b>	<b>3-1-0</b>	<b>4</b>	Dr Surabhi Chaudhuri, Dr. Debjani Dutta
<p>Introduction to Food Biotechnology – Food Microbiology- Metabolic Engineering of Bacteria for food ingredients, Metabolic engineering of Saccharomyces cerevisiae. [4] Biotechnological Modifications of S. cerevisae and its effect in wine production, genetic Engineering of baker’s yeast, Application of Algae in Food, Recombinant Lactic Acid Bacteria [6] Plant and Animal Food applications and functional food- Introduction to Nutraceutical and Nutigenomics, Probiotics, Bioavailability and delivery of nutraceuticals using nanotechnology Food and food component preventing cancer, Antiobesity effect of Allenic carotenoid, fucoxanthin, Encapsulation of probiotic bacteria, Single Cell Protein [6]</p> <p>Improvement in Food Quality- Enzymes &amp; Recombinant lipooxygenases and oxylipin metabolism for food quality, Molecular design of Soybean Protein for improvement in Food Quality, Biotechnological Approaches to improve Nutritional Quality and Shelf life of Fruits and Vegetables, Genetic Modification of peanut as a solution to peanut Allergy. [5]</p> <p>Food Safety- DNA &amp; Protein microarray for food Safety, Application of DNA Fingerprinting in Food Biotechnology, Application of Biosensors in food processing industry, antibody based diagnostic system. [5]</p> <p>Thermal processing of foods, canning operation. [4] Heat transfer in food, microwave operation [3] Kinetics of chemical reactions in foods [2] Dehydration of foods, Mass transfer in dehydration, Drying rate curve, Psychrometry [4] Physical separation processes in foods – filtration operation, membrane filtration [3] Food quality management, HACCP [2] Design of a food processing plant [2]</p>				
<p><b>TEXT BOOKS:</b></p> <ol style="list-style-type: none"><li>1. Food Biotechnology by Kalidas Shetty</li><li>2. Fundamentals of Food Biotechnology by Lee</li></ol>				
<p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"><li>1. Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals by <u>Jean-Richard Neeser, J. Bruce German</u>, CRC Press</li></ol>				

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 2002	GENOMICS, PROTEOMICS AND BIOINFORMATICS	3-1-0	4	Dr Subhankar Roy Barman

**Genomics:**

Introduction to genomics; Importance of genomics; Sequencing of genomes; Assembly of genome sequences; The human genome project; Locating the genes in the genome; Determination of gene functions; Structural, comparative and functional genomics; Lessons from various prokaryotic and eukaryotic genomes; Comparative genomics in evolution and medicine; Genomic variations. (15)

**Proteomics:**

Introduction to proteomics: Expression proteomics, Functional proteomics, Structural proteomics; Two-dimensional gel electrophoresis (2-DGE); Sample Preparation; Isoelectric focusing (IEF); Equilibration of the IPG strip, the second dimension and detection of proteins on the 2-DGE gel; Introduction to mass spectrometry; Mass spectrometry (MS) - based methods of protein identification: MALDI-MS, ESI-MS; Analysis of phosphoproteins by MS; Glycobiology and proteomics; Protein microarrays; Protein 3D structures; Protein interaction networks; Measuring proteins. (15)

**Bioinformatics:**

Introduction to bioinformatics; Data acquisition; Databases and data retrieval; Searching sequence database; Multiple sequence alignment, phylogenetics and sequence annotation; Structural informatics; Microarray, 2DGE and MS data analysis; Conclusion of bioinformatics. (15)

TEXT BOOKS:

1. S. B. Primrose and R. M. Twyman; *Principles of Genome Analysis*
2. S. B. Primrose and R. M. Twyman; *Genomics: Applications in Human Biology*

REFERENCE BOOKS:

3. A. M. Campbell and L. J. Heyer; *Discovering Genomics, Proteomics & Bioinformatics; Pearson Education; Second Edition.*
4. T. A. Brown; *Genomes; Wiley-Liss; Third Edition.*
5. Mount "Bioinformatics" Cold Spring Harbour  
Arthur Lesk "Introduction to Bioinformatics"
6. Bioinformatics. (A.D.Baxevanis & B.F.F.Ouellette, eds.) Wiley Interscience, 1998.
7. Bioinformatics Sequences and Genome Analysis, 2<sup>nd</sup> edition 2004 by David W. Mount, CBS Publishers and Distributors .

<b>SUBJECT CODE</b>	<b>SUBJECT</b>	<b>L-T-P</b>	<b>CREDIT</b>	<b>DEVELOPER</b>
<b>BT 2003</b>	<b>INDSUTRIAL PRODUCTION OF BIOPHARMACEUTICALS</b>	<b>3-1-0</b>	<b>4</b>	<b>Dr Surabhi Chaudhuri Dr Monidipa Ghosh</b>

Manufacturing process - Drug substance manufacturing, drug product manufacturing, key factors for process evaluation. Manufacturing and storage of cell bank. Comparison of batch and continuous process for fermentation. Difference between suspension fermenters for cell culture and microbial fermentation. (4)

Design and construction of manufacturing facilities for mammalian cell derived pharmaceuticals. (3)

Downstream processing - Harvest of therapeutic proteins from high cell density fermentation broths – centrifugation and filtration. Expanded bed adsorption for separating the biopharmaceutical product from crude solution. Ultrafiltration process design and implementation for biopharmaceutical product recovery. Virus filtration process design for biopharmaceutical product recovery. Product recovery of biopharmaceutical products from transgenic sources – aqueous two phase extraction (10)

Process validation for cell culture derived pharmaceutical proteins. (2)

Role of process development group and manufacturing group in biopharmaceutical process start up. (2)

Making changes to a biopharmaceutical manufacturing process during development and commercial manufacturing – a case study (2)

Legality, morality and ethics, the principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc. in the field of production management of Biosimilars and biotherapeutics. (4)

The expanding scope of ethics from biomedical practice to biotechnology, ethical conflicts in biotechnology. (5)

History and evaluation of IPR – like patent design and copyright in Biopharmaceutical production. Distinction among the various forms of IPR, requirements of a patent able invention like novelty, inventive step and prior art and state of art. (3)

Regulations on ethical principles in biomedical/ biotechnological practice: The Nuremberg code, declaration of Helsinki; the Belmont report, co operational guidelines – WHO, guidelines of DBT (India), Guidelines of an informed consent. (3)

Indian patent act 1970 and TRIPS major changes in Indian patent system, post-TRIPS effects, GATT agreement. (3)

Detailed information on patenting biological products, Biodiversity Quality assurance, GMP and other regulatory issues. (4)

#### TEXT BOOKS:

1. Biopharmaceuticals, an Industrial Perspective, G. Walsh, B. Murphy, Springer
2. Advanced Technologies in Biopharmaceutical Processing, Roshni Dutton, Jenö Schärer, Wiley

#### REFERENCE BOOKS:

1. Process Scale Bioseparations for the Biopharmaceutical Industry, Abhinav A. Shukla, Mark R. Etzel, Shishir Gadgil, CRC
2. Pharmaceutical Production Facilities: Design and Applications, Graham Cole, Informa Healthcare

3. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control from Manufacturer, Sidney Willig, Informa Healthcare
4. Design and start-up of a pharmaceutical pilot plant for the production of bulk API for clinical trials, Robert W Bedle, American Institute of Chemical Engineers  
Biosimilars and non-innovator biotherapeutics in India – an overview of current situation, H Malhotra, Biologicals, 39 (2011) 321-324

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<b>BT 2051</b>	<b>ADVANCED FOOD BIOTECHNOLOGY LABORATORY</b>	<b>0-0-4</b>	<b>2</b>	
<p>Environmental sampling-Variou s food processing environments will be sampled and the samples will be introduced onto a solid culture medium. Variety and quantity of organisms grown on this medium will be examined.</p> <p>Microbial Examination of Solid foods-Total bacterial counts and Yeast and mold counts for solid foods using serial dilution plating technique.</p> <p>Detection of a mycotoxin in a sample-ELISA</p> <p>Identification and Quantification food borne pathogens-<i>Staphylococcus aureus</i> – Using a selective and a differential growth media, <i>Clostridium perfringens</i>- An obligatory anaerobe using anaerobic plate count and MPN methods.Total coliforms, fecal coliforms and presumptive <i>E.coli</i> using the MPN (most probable number) method.</p> <p>Isolation and Identification of a food borne pathogen (<i>Salmonella typhimurium</i>)</p> <p>Classical method involving pre-enrichment, selective enrichment, selective plating growth in differential media and serological confirmation</p> <p>RAPD detection ( DNA fingerprinting)</p> <p>Lactic acid fermentation, Bacteriocin production</p>				
<p><b>TEXT BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. Food Microbiology: A Laboratory Manual, Ahmed E. Yousef, Carolyn Carlstrom, Ahmed Yousef, Wiley-Interscience.</li> <li>2. Food-Borne Pathogens: Methods and Protocols, Catherine Adley, Humana Press</li> </ol>				
<p><b>REFERENCE BOOKS:</b></p> <p>Food Microbiology Protocols, John F. T. Spencer, Alicia L. Ragout de Spencer, Humana Press</p>				

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 2052	BIOINFORMATICS LABORATORY	0-0-2	1	
<p><b>Experiments</b>                      <b>Topic</b></p> <p>Practical No. 1      To retrieve the protein pyruvic dehydrogenase from the protein sequence database, Swiss Prot TREMBL</p> <p>Practical No. 2      To retrieve the nucleotide sequence of chromosome of human.</p> <p>Practical No. 3      To retrieve the structure of the protein from the protein structural database (PDB).</p> <p>Practical No. 4      To find homologous protein sequence for any desired protein using the Basic Local Alignment Search Tool.</p> <p>Practical No. 5      To perform a multiple sequence alignment for any five sequences.</p> <p>Practical No. 6      To predict the secondary structure of protein using proteomic tool. (eg. EXPASY)</p> <p>Practical No. 7      To predict the transmembrane protein using proteomic tool (eg. TMHMM (or) TMPRED (or) TMPRED)</p> <p>Practical No. 8      To retrieve the nucleotide sequence of chromosome 1 of human using genscan.</p> <p>Practical No. 9      To retrieve the nucleotide sequence of chromosome 1 of human using Genmark.</p> <p>Practical No.10      To determine the various information regarding proteins/nucleotides using EMBOSS.</p> <p>Practical No. 11      To visualize, interpret and analyze the 3D structure of any desired protein using the Molecular modeling tool (RasMol).</p>				

### Electives

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 9011	HUMAN MOLECULAR GENETICS	3-1-0	4	Dr Sudit Shekhar Mukhopadhyay
<p>Simple Mendelian traits. (4)</p> <p>Loss-of-function mutations; Gain-of-function mutations; Gene interactions; Dynamic mutations. (5)</p> <p>Genetics of neoplasia. (4)</p> <p>Genomic imprinting and human disease. (5)</p> <p>X-inactivation and DNA methylation. (4)</p> <p>Gene mapping and positional cloning. (4)</p> <p>Genetics of behavioral disorders. (5)</p> <p>Pharmacogenetics and biochemical genetics. (4)</p> <p>Animal models in human genetics. (5)</p> <p>Methods used for diagnosis and detection of gene mutations; Gene Therapy. (5)</p>				
<p>TEXT BOOKS:</p> <p>1. Human Molecular Genetics, Tom Strachan, Andrew Read, Garland Science</p>				

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BT 9012	FUNCTIONAL GENOMICS	3-1-0	4	Dr Subhankar Roy Barman
<p>Introduction; The impact of genomics on biological research; Recent developments in genomics. (3)</p> <p>Molecular markers, various generations including SNPs, molecular markers in understanding and analyzing gene function; map-based cloning in the pre- and post-genomic era, Activation Tagging, Transposon Tagging, T-DNA mediated Tagging in plants. (10)</p> <p>Various methods of sequencing, next-generation sequencing, methods of polymerase chain reaction, methods of analyzing gene functions: gene disruption, gene replacement, over-expression studies, epitope-tagging, gene knock-down approaches; silencing, RNAi – siRNA, miRNA etc. (10)</p> <p>Expression profiling techniques, Differential Display, SAGE, SABRE, microarray, MPSS etc. (12)</p> <p>Protein-protein interaction studies, DNA-protein interaction studies, BiFC, <i>in vitro</i> pull-down assay, co-immunoprecipitation etc. (10)</p>				
<p>TEXT BOOKS:</p> <ol style="list-style-type: none"> <li>1. S. B. Primrose and R. M. Twyman; <i>Principles of Genome Analysis</i></li> <li>2. S. B. Primrose and R. M. Twyman; <i>Genomics: Applications in Human Biology</i></li> </ol>				
<p>REFERENCE BOOKS:</p> <ol style="list-style-type: none"> <li>3. A. M. Campbell and L. J. Heyer; <i>Discovering Genomics, Proteomics &amp; Bioinformatics; Pearson Education; Second Edition.</i></li> <li>4. T. A. Brown; <i>Genomes; Wiley-Liss; Third Edition.</i></li> </ol>				

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 9013	IMMUNOTECHNOLOGY	3-1-0	4	Dr Dalia Dasgupta, Dr Monidipa Ghosh
<p><b><i>Introduction to Immunotechnology</i></b></p> <p>Immunity and infection; Host-microbe interaction, memory. Kinetics of immune response immunity to bacteria, virus, protozoa, Fungi, Tumor. Cancer and the Immune system, Hypersensitivity. (6)</p> <p><b><i>Antibody Related Techniques</i></b></p> <p>Immuno-chemistry of Antigens - immunogenicity, Antigenicity, haptens, Toxins-Toxoids, Haptencarrier system; Genetic bases of immune response – Heterogeneity; Role and properties of adjuvants, Immune modulators; B cell epitopes; Hybridoma Rabbit, human; Antigen – Antibody interaction, affinity, cross reactivity, specificity, epitope mapping; Immuno assays RIA, ELISA,</p>				

Western blotting, ELISPOT assay, immunofluorescence, Surface plasmon resonance, Biosensor assays for assessing ligand –receptor interaction. (7)

### ***New Generation Antibodies***

Multigene organization of immunoglobulin genes, Ab diversity; Antibody engineering; Phage display libraries; Antibodies as in vitro and in vivo probes. (6)

### ***CMI and Imaging techniques***

CD nomenclature, Identification of immune Cells; Principle of Immunofluorescence Microscopy, Fluorochromes; Staining techniques for live cell imaging and fixed cells; Flow cytometry, Instruments, Applications Cell Functional Assays – lymphoproliferation, Cell Cytotoxicity, mixed lymphocyte reaction, Apoptosis, Cytokine expression; (6)

In-situ gene expression techniques; Cell imaging Techniques-In vitro and In vivo; Immuno-electron microscopy; In vivo cell tracking techniques; Microarrays; (4)

### ***Vaccine technology***

Rationale vaccine design based on clinical requirements: Autoimmunity, Transplantation, Tumor immunology, immunodeficiency; Active immunization, live, killed, attenuated, Sub unit vaccines; Recombinant DNA and protein based vaccines; Peptide vaccines, conjugate vaccines; Passive Immunization; Antibody, Transfusion of immuno-competent cells, Stem cell therapy; Cell based vaccines. (10)

**Industrial production of immunological products:** Cellular technologies and animal cell bioreactors for large scale production of monoclonal antibodies, interferons, vaccines. Use of specific cells and cell-lines for therapeutic purposes. (6)

### **TEXT BOOKS:**

1. Kuby J, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4 t h Edition-, Blackwell Publishing, 2002

### **REFERENCE BOOKS:**

1. S. Hockfield, S. Carlson, C. Evans, P. Levitt, J. Pintar, L. Silberstein, Selected Methods for Antibody and Nucleic Acid probes, Volume1, Cold Spring Harbor Laboratory Press,1993.
2. Ed Harlow, David Lane, Antibodies Laboratory Manual, Cold Spring Harbor, Laboratory Press, 1988.
3. The Elements of Immunology. Fahim Halim Khan. Pearson Education.
4. Molecular Biotechnology- Principles of Application of Recombinant DNA. Bernard R. Glick, Jack J Pasternak. ASM Publication.

<b>SUBJECT CODE</b>	<b>SUBJECT</b>	<b>L-T-P</b>	<b>CREDIT</b>	<b>DEVELOPER</b>
<b>BT 9014</b>	<b>CANCER BIOLOGY</b>	<b>3-1-0</b>	<b>4</b>	<b>Dr Sudit Shekhar Mukhopadhyay</b>
Phenotypic characteristics of cancer cells (6) Role of differentiation and apoptosis, Biology of metastasis, Carcinogenesis, Cancer genetics (8) Oncogenes ,Tumor suppressor genes (5) Growth factors and signal transduction (5) Cell cycle regulation and apoptosis (7) Host tumor interactions, Gene rearrangements, detecting oncogene abnormalities in clinical specimens (6) Principles of chemotherapy, Concepts in cancer therapy - Mechanisms of cytotoxic drug action, Cancer Immunotherapy. (8)				
<b>TEXT BOOKS:</b> <ol style="list-style-type: none"> <li>1. Molecular Biology of the Cell, 6<sup>th</sup> ed, Bruce Alberts, Johnson, Lewis etc</li> <li>2. Cells, benjamin Lewin, Jones &amp; Bartlett Learning, 2007</li> </ol>				

<b>SUBJECT CODE</b>	<b>SUBJECT</b>	<b>L-T-P</b>	<b>CREDIT</b>	<b>DEVELOPER</b>
<b>BT 9016</b>	<b>BIOMATERIALS</b>	<b>3-1-0</b>	<b>4</b>	<b>Dr Kaustav Aikat</b>
Definition of biomaterials – biologically derived materials or materials compatible with biology. (2) Common biomaterials: some proteins, many carbohydrates and some specialized polymers. (4) Collagen (protein in bone and connective tissues): Structure production and its use. (3) Fibroin (protein in silk): Production and its use. (2) Production of these proteins by conventional cloning methods. (2) Carbohydrates: Modified carbohydrates acting as lubricants for biomedical applications; Polydextrose; Carbohydrates modified by enzymes; (10) Biopolymers: Synthesis from a simple biological monomer ( eg hyaluronate polymers); Dextrans (used in chromatography columns); Rubberlike materials produced by bacteria and fungi (Polyhydroxybutyrate PHB), Polycaprolactone(PCL); Production of a copolymer of PHB and PHV(polyhydrovaleric acid), sold as Biopol by fermentation by Alcaligenes eutrophus; Biodegradable polymers (12) Industrial biopolymers: Production of polyphenol resins by the enzyme soybean peroxidase; Evaluation of the properties of biopolymers to make good biomaterials; Tensile strength(both elasticity and breaking strength); Hydration, visco – elastic properties; viscosity. (10)				
<b>TEXT BOOKS:</b> <ol style="list-style-type: none"> <li>1. Ratledge C and Kristiansen B, Basic Biotechnology, Cambridge University Press, 2<sup>nd</sup> Edition, 2001</li> <li>2. W. Crueger, Annelise Crueger, Biotechnology: A Textbook of Industrial Microbiology, Sinauer Assoc. Inc</li> </ol>				

REFERENCE BOOKS:

1. Doi Y, Microbial Polyesters, VCH Weinheim, 1990
2. Lehninger, Nelson & Cox, Principles of Biochemistry, CBS Publishers, 1993

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 9017	STATISTICS AND INSTRUMENTATION IN BIOTECHNOLOGY	3-1-0	4	Dr Debjani Dutta

Experimental design: Optimal design, block design – microarray experiments, linear models, Orthogonal polynomials, Randomized block design, Latin square designs, Balanced incomplete block designs, Random block effects, Full factorial designs at 2 levels, Blocking full factorials, Fractional factorial designs, Response Surface Methodology (12)

Biostatistics: Probability, Populations, Means & Variances, Distributions, Type I & Type II errors, Comparing means, Transformations, Sample size & Power analyses, Comparing frequencies, Pseudoreplication and other common design errors. (10)

Applications of spectroscopic and other techniques to the study of biomolecules: UV-Vis spectroscopy, Circular dichroism, Fluorescence, NMR, Mass, IR and Raman spectroscopy, X-Ray diffraction. Cellular Imaging Techniques: Microscopy: Phase contrast Nomarsky, Fluorescence, Atomic Force and confocal. Biophysical techniques to purify and study proteins. Dialysis, salting out and precipitation by organic solvents, Ion exchange, gel filtration, reversed phase, affinity chromatography, ultracentrifugation, gel electrophoresis. (12)

Analysis of Proteins: Electrophoretic separation of proteins (single dimension native and denaturing gels, 2D and digital electrophoretic analysis), detection (staining, blotting and immunodetection) and purification (various chromatography, HPLC, immunoprecipitation) of proteins, and specialized applications (in vitro synthesis of protein, labeling, microsequence analysis, and Mass spectrometry), electron spin resonance spectroscopy, Scanning tunneling microscopy, atomic force microscopy, electron microscopy of biomolecules. (11)

TEXT BOOKS:

1. Glass, D.J. 2006. *Experimental Design for Biologists*. Cold Spring Harbor Laboratory Press, New York, U.S.A.
2. Ford, E.D. 2004. *Scientific Method for Ecological Research*. Cambridge University Press, Cambridge, U.K.
3. Gottelli, N.J. and Ellison, A.M. 2004 *A Primer of Ecological Statistics*. Sinauer, Sunderland, Massachusetts, U.S.A.
4. Quinn, G.P. and Keogh, M.J. 2002. *Experimental Design and Data Analysis for Biologists*. Cambridge University Press, Cambridge, U.K.
5. Zar, J.H. 2007. *Biostatistics*. 5th edition. Prentice-Hall, New Jersey, U.S.A.

REFERENCE BOOKS:

<b>SUBJECT CODE</b>	<b>SUBJECT</b>	<b>L-T-P</b>	<b>CREDIT</b>	<b>DEVELOPER</b>
<b>BT 9018</b>	<b>STRUCTURAL BIOLOGY</b>	<b>3-1-0</b>	<b>4</b>	<b>Department</b>
<p>Basic structural principles - The building blocks, motifs of protein structure, alpha-domain structures, alpha/beta structures, beta structures, folding and flexibility, DNA structures. (10)</p> <p>Structure, function and engineering - DNA recognition in prokaryotes by helix-turn-helix motifs. (4)</p> <p>DNA recognition by eukaryotic transcription factors, specific transcription factors (5)</p> <p>Enzyme catalysis with example of serine proteinases, membrane proteins, signal transduction, fibrous proteins (8)</p> <p>Recognition of foreign molecules by immune system, structure of spherical viruses (8)</p> <p>Prediction, engineering and design of protein structures, determination of protein structures (10)</p>				
<p><b>TEXT BOOKS:</b></p> <p>1. Introduction to Protein Structure: Second Edition by Carl IV Branden, Routledge</p>				
<p><b>REFERENCE BOOKS:</b></p>				

<b>SUBJECT CODE</b>	<b>SUBJECT</b>	<b>L-T-P</b>	<b>CREDIT</b>	<b>DEVELOPER</b>
<b>BT 9019</b>	<b>COMPUTATIONAL METHODS IN MOLECULAR BIOLOGY</b>	<b>3-1-0</b>	<b>4</b>	<b>EXTERNAL SOURCE</b>
<p>Internet resources for molecular biologist. Using genome sequence data to identify and clone ORFs of interest. (8)</p> <p>Comparing genome sequences to identify ORFs encoding proteins with specific functions. Use in identifying missing proteins in metabolic pathways. Defining functions of proteins at different levels of hierarchy. (8)</p> <p>Assigning functions to orphan ORFs -- using sequence data and using 3-D structure data. Functional analysis of polymorphisms -- anatomy of regulatory elements. (10)</p> <p>Gene expression informatics and analysis -- regions of increases gene expression. (7)</p> <p>Proteomic informatics -- interaction networks. assessment and validation of predictions. Exploiting protein networks. High-throughput studies for molecular biologist -- microarrays, 2-D gel electrophoresis. (12)</p>				

**TEXT BOOKS:**

1. Principles of genome analysis and genomics. S B Primrose and R M Twyman (Oxford Blackwell, 2003)
2. Bioinformatics for geneticists. M R Barnes and I C Gray (Wiley, 2003)

**REFERENCE BOOKS:**

1. Biologists guide to analysis of microarray data. S Knudsen (Wiley, 2002)
2. Microarrays and microplates: applications in biomedical sciences / edited by S. Ye and I.N.M. Day. Oxford Bios Scientific publishers,

<b>SUBJECT CODE</b>	<b>SUBJECT</b>	<b>L-T-P</b>	<b>CREDIT</b>	<b>DEVELOPER</b>
<b>BT 9020</b>	<b>METABOLIC ENGINEERING</b>	<b>3-1-0</b>	<b>4</b>	<b>Dr Kaustav Aikat, Dr Ashish Bhattacharjee</b>
	Importance of metabolic engineering		[2],	
	Review of cellular metabolism		[3],	
	Comprehensive models for cellular reactions		[3],	
	Material balances and data consistency		[3],	
	Regulation of metabolic pathways		[3],	
	Examples of pathway manipulations: metabolic engineering in practice – enhancement of product yield and productivity		[3],	
	Extension of substrate range		[2],	
	Extension of product spectrum and novel products (antibiotics, biopolymers, polyketides, vitamins etc)		[4],	
	Improvement of cellular properties		[2],	
	Xenobiotic degradation		[2],	
	Metabolic pathway synthesis		[3],	
	Metabolic flux analysis		[3],	
	Methods for metabolic fluxes determination by isotope labeling		[2],	

Applications of metabolic flux analysis	[2],
Metabolic control analysis	[2],
Analysis of structure of metabolic networks	[2],
Flux analysis of metabolic networks	[2],
Thermodynamics of cellular processes	[2].
<b>TEXT BOOKS:</b>	
<ol style="list-style-type: none"> <li>1. Metabolic Engineering: Principles and Methodologies, Gregory N. Stephanopoulos, Aristos A. Aristidou, Jens Nielsen, Academic Press</li> <li>2. Pathway Analysis and Optimization in Metabolic Engineering, Néstor V. Torres, Eberhard O. Voit, Cambridge University Press</li> </ol>	
<b>REFERENCE BOOKS:</b>	
<ol style="list-style-type: none"> <li>1. An Introduction to Metabolic and Cellular Engineering, S. Cortassa, M. A. Aon , A. A. Iglesias, D. Lloyd, World Scientific Publishing Company</li> <li>2. Bioreaction Engineering Principles, Jens Nielsen, John Villadsen, Gunnar Liden, Springer, 2<sup>nd</sup> Ed.</li> </ol>	

<b>SUBJECT CODE</b>	<b>SUBJECT</b>	<b>L-T-P</b>	<b>CREDIT</b>	<b>DEVELOPER</b>
<b>BT 9021</b>	<b>SYSTEM BIOLOGY</b>	<b>3-1-0</b>	<b>4</b>	<b>DEPARTMENT</b>
<p>Basic concepts, biology in a nutshell, mathematical concepts, experimental techniques. (10)</p> <p>Standard models and approaches in system biology, signal transduction, selected biological processes, modeling of gene expression, analysis of gene expression data, evolution and self organization, data integration, future aspects and applications (20)</p> <p>Computer based information retrieval and examination – databases and tools on the Internet, modeling tools. (15)</p>				
<b>TEXT BOOKS:</b>				
<ol style="list-style-type: none"> <li>1. Systems Biology in Practice: Concepts, Implementation and Application, Edda Klipp, Ralf Herwig, Axel Kowald, Christoph Wierling, Hans Lehrach, Wiley-VCH</li> <li>2. An Introduction to Systems Biology: Design Principles of Biological Circuits, Uri Alon, CRC press</li> </ol>				
<b>REFERENCE BOOKS:</b>				

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 9022	NUTRACEUTICALS AND NUTRIGENOMICS	3-1-0	4	Dr Debjani Dutta
<p>Nutraceuticals: General concepts of cell apoptosis/proliferation and molecular targets of nutraceuticals. [7]</p> <p>Nutraceutical role in host immune response, in cancer, infection and chronic/acute inflammations. Mechanism of action of Nutraceutical-signaling events, proteomics and transcription factors. [10]</p> <p>Nutraceuticals from food and herbs I: Polyphenols, flavonoids and other phenolic compounds. [8]</p> <p>Nutraceuticals from food and herb -II: Saponins, terpenoids and sulphur compounds, Probiotic food with therapeutic applications, Prebiotics, Genomics of Lactic Acid Bacteria [8]</p> <p>Nutrigenomics: An introduction, Nutrient gene interaction- Structure of nuclear receptors with reference to carbohydrate, fat and vitamin A, Type 2 Diabetes Mellitus and nutrigenomics, PPAR-<math>\gamma</math> and Diabetes Mellitus, Bioactive Peptides and its role in Nutrigenomics [12]</p>				
<p>TEXT BOOKS:</p> <ol style="list-style-type: none"> <li>1. Nutritional Genomics: Discovering the Path to Personalized Nutrition by <u>James Kaput, Raymond L. Rodriguez</u>, Wiley</li> <li>2. Functional Food Ingredients and Nutraceuticals by <u>John Shi</u> , CRC Press</li> <li>3. Nutraceuticals by <u>Lisa Rapport, Brian Lockwood</u>, Pharmaceutical press</li> </ol>				
<p>REFERENCE BOOKS:</p> <ol style="list-style-type: none"> <li>1. Nutrigenomics and Proteomics In Health Promotion and Disease Prevention by <u>Mohamed M. Rafi, Fereidoon Shahidi</u>, CRC Press</li> <li>2. Nutraceuticals: The Complete Encyclopedia of Supplements, Herbs, Vitamins, and Healing Foods by <u>Arthur J. Roberts, Genelle Subak-Sharpe, Mary E. O'Brien</u> (Designer) , Perigee Trade</li> <li>3. Regulation of Functional Foods and Nutraceuticals: A Global Perspective by <u>Clare Hasler</u>, Blackwell Publishing Professional</li> </ol>				

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 9023	Biometallurgy	3-1-0	4	Dr Kaustav Aikat
<p>Recapitulation of basics of bioenergetics (ATP as an energy-rich molecule, oxidation-reduction reactions), (3)</p> <p>Biogeochemical cycles – sulphur, iron, and manganese cycles. Nature and characteristics of biogeochemically important micro-organisms. (6)</p> <p>Bioleaching: definition, scope, advantages &amp; disadvantages; Types: direct, indirect, &amp; indirect contact. (3)</p> <p>Types of bioleaching with respect to reaction intermediates (thiosulphate &amp; polysulphide mechanisms). (2)</p> <p>Autotrophs &amp; heterotrophs as candidate microorganisms for bioleaching. (4)</p> <p>Bioleaching by aerobic and anaerobic microorganisms. (4)</p> <p>Bioleaching processes: in situ, heap &amp; dump, &amp; reactor bioleaching. (3)</p> <p>Bioleaching of copper by <i>Acidithiobacillus</i> from chalcopyrites, chalcocite, &amp; covellite. Dump &amp; heap and reactor bioleaching of copper. (5)</p> <p>Uranium bioleaching &amp; biobeneficiation of gold. Environmental pollution control in gold recovery processes. (3)</p> <p>Kinetics of pyrite bioleaching – two-subprocess mechanism- ferric leach kinetics &amp; kinetics of bacterial oxidation of ferrous iron. (3)</p> <p>Modelling of continuous tank bioleaching of pyrite – unsegregated and segregated models. (3)</p> <p>Oxidation of iron by <i>Acidithiobacillus</i> – enzymatic mechanism; role of cytochromes &amp; rusticyanin, elements of electron transport pathways in iron &amp; sulphur oxidation. (3)</p>				
<p>TEXT BOOKS:</p> <ol style="list-style-type: none"> <li>1. Mineral Bioprocessing, edited by Ross W. Smith &amp; Manoranjan Misra TMS publications, 1991</li> <li>2. Environmental Biotechnology by Alan Scragg, Oxford University Press, 2005</li> </ol>				
<p>REFERENCE BOOKS:</p> <ol style="list-style-type: none"> <li>1. Mineral Biotechnology: Microbial Aspects of Mineral Beneficiation, Metal Extraction and Environmental Control, by <a href="#">S.Komar Kawatra</a> (Editor), <a href="#">K.A. Natarajan</a> (Editor), Society for Mining, Metallurgy, and Exploration, 2001</li> <li>2. Microbiology for Minerals, Metals, Materials and the Environment, by Abhilash, B. D. Pandey, K. A. Natarajan, CRC Press, 2015</li> </ol>				

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 9024	NANOBIOTECHNOLOGY	3-1-0	4	DEPARTMENT
<p>Fundamental scientific issues of nanotechnology: Definition, benefits of nanotechnology; Examples of applications of nanotechnology. Investigation tools: experimental methods and probes; Basic principles of scanning force microscopy; Scanning electron microscopy; Transmission electron microscopy. Investigation tools: nanoimprint lithography; Biomolecular recognition. (10)</p> <p>Synthesis, assembly, and processing of nanostructures: basics of intermolecular interactions. Synthesis, assembly, and processing of nanostructures: phenomenon of self-assembly. Synthesis, assembly, and processing of nanostructures: processing of nanostructures. (8)</p> <p>Research and recent development of nanomaterials, Design synthesis and control of material in nanometer dimensions. Biological nanoscopic structures with high complexity and functions of Proteins, enzymes, bio-species and biomaterials. (7)</p> <p>Nanotechnology in new materials in medicine ( intracorporal and extracorporal biomaterials ) , producing energy and material sciences (sensors , microelectronics and catalysis ). Use of biological structures as part of composite materials with conventional materials. Functional matrices for the synthesis of other inorganic nonmetallic phases (biomineralisation), nanostructural materials (metallic, polymeric, ceramic), Development of microcomponent parts and microreactors. (5)</p> <p>Principles and applications of DNA Chip. Applications: Biochips for pathogen detection and identification; Principle and applications of protein chip (5)</p>				
<p>TEXT BOOKS:</p> <ol style="list-style-type: none"> <li>1. Springer Handbook of Nanotechnology, by Bharat Bhushan Springer</li> <li>2. Nanobiotechnology: Concepts, Applications and Perspectives, by Christof M. Niemeyer, Chad A. Mirkin, John wiley</li> <li>3. Introduction to Nanotechnology, by Charles P. Poole, Frank J. Owens, Wiley-Interscience</li> <li>4. Nanofabrication and Biosystems : Integrating Materials Science, Engineering, and Biology, by Harvey C. Hoch, Lynn W. Jelinski, Harold G. Craighead, Cambridge University Press</li> </ol>				
<p>REFERENCE BOOKS:</p>				

<b>SUBJECT CODE</b>	<b>SUBJECT</b>	<b>L-T-P</b>	<b>CREDIT</b>	<b>DEVELOPER</b>
<b>BT 9025</b>	<b>RENEWABLE ENERGY TECHNOLOGY</b>	<b>3-1-0</b>	<b>4</b>	<b>Dr Surabhi Chaudhuri</b>
<p>Energy and fossil fuel use – fossil fuel use, fossil fuel reserves, sustainable fuel sources (4)</p> <p>Consequences of burning fossil fuel – effects of industrial (anthropogenic) activity on greenhouse gases, sources of greenhouse gases (4)</p> <p>Mitigation of global warming – Kyoto protocol, reduction in global greenhouse gases, fuel cells, sequestration of carbon dioxide, alternative energy sources, energy storage. (5)</p> <p>Biological solid fuels – 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> generation biofuels, types of biomass available, energy and fuel generation using biomass. (6)</p> <p>Gaseous biofuels – methane production using anaerobic digestion process, sewage sludge and from landfill sites, use of methane as transport fuel. Hydrogen production from biological material, biological production of hydrogen, photosynthetic hydrogen production, hydrogen storage, use as transport fuel. Diethyl ether production (8)</p> <p>Liquid biofuels to replace petrol – methanol production. Large scale ethanol production from biomass, use of lignocellulosics for ethanol production, ethanol extraction after production, use of ethanol as fuel. Butanol production and use. (7)</p> <p>Liquid biofuel to replace diesel – synthetic diesel (FT synthesis), bio-oil (pyrolysis), microalgal biodiesel, biodiesel from plant oils and animal fats, properties of biodiesel, glycerol utilization. (4)</p> <p>The benefits and deficiencies of biofuels – reduction in fossil fuel use, fuel economy, reduction in carbon dioxide emission from biofuels, improvement in biodiesel quantity and quality, life cycle analysis of biofuels. (5)</p> <p>Jatropha cultivation, National hydrogen energy road map. (2)</p>				
<p><b>TEXT BOOKS:</b></p> <p>1. Biofuels production, application and development. Alan Scragg, CABI.</p>				
<p><b>REFERENCE BOOKS:</b></p>				

<b>SUBJECT CODE</b>	<b>SUBJECT</b>	<b>L-T-P</b>	<b>CREDIT</b>	<b>DEVELOPER</b>
<b>BT 9026</b>	<b>MODELING AND SIMULATION IN BIOPROCESSES</b>	<b>3-1-0</b>	<b>4</b>	<b>DEPARTMENT</b>
<p>Approach to modeling, Unstructured and structured modeling, Deterministic and stochastic models, Segregated and unsegregated models, Shu's segregated models for Lactic acid fermentation. Structured kinetic models: Compartmental models (two and three), Product formation, Unstructured and structured models, Genetically structured models. Stochastic model for thermal sterilization of the medium, Modelling for activated sludge process, Model for anaerobic digestion, Models for lactic acid fermentation and antibiotic production. Process simulation techniques, Equation oriented approach, Equation oriented simulators (SPEED UP, ASCEND, FLOWSIM, QUASILIN, DYN SIM), simulation programs based on Euler's methods, Newton – Raphsen methods, Runga – Kutta methods, Simulation of biochemical system models.</p>				
<p><b>TEXT BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. Development of Sustainable Bioprocesses: Modeling and Assessment, Elmar Heinzle, Arno P. Biber, Charles L. Cooney, Wiley</li> <li>2. J.E. Bailey and D.F. Ollis, Biochemical Engg Fundamentals, 1986, McGraw Hill Book Company</li> </ol>				
<p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"> <li>1) G. Francis, Modelling and Simulation</li> <li>2) A. Haerder and J. A. Roels “ Application of simple structured I Bioengineering, and P55 in Advances In Biochemical engineering Vol21, A. Fiechts (ed) Spring –Verlag , Berlin, 1982.</li> </ol>				

<b>SUBJECT CODE</b>	<b>SUBJECT</b>	<b>L-T-P</b>	<b>CREDIT</b>	<b>DEVELOPER</b>
<b>BT 9027</b>	<b>ADVANCED rDNA TECHNOLOGY AND CELLULAR BIOTECHNOLOGY</b>	<b>3-1-0</b>	<b>4</b>	<b>Dr Dalia Dasgupta</b>
<p><b>Detailed topics</b></p> <p>Introduction on applications of mammalian genetic engineering. Engineered and /or Modified vectors for higher yield of recombinant proteins. Yeast artificial chromosome. (7)</p> <p>Biopharmaceuticals using r DNA technology from microbes, animal and plant cells as bioreactors Transgenic animals and plants, (7)</p> <p>Synthesis of commercial products by recombinant microorganisms.eg: Indigo,,L -ascorbic acid (5)</p> <p>Recent progress in Animal and plant cell Bioreactor development for recombinant protein roduction. (5)</p> <p>Human genetic diseases. Human gene therapy, Gene targeting, Outlines of importance of Human Genome project, Gene amplification (6)</p> <p>Application in genetic diagnosis,DNA fingerprinting, phage display. (5)</p> <p>PCR technology, inverse PCR, multiplex PCR, RT-PCR. Oligonucleotide synthesis, Automated</p>				
<p><b>Classes</b></p>				

DNA sequencing, (5) Current state and Further potential application in different spheres of human activity emphasized by selected articles. (5)
TEXT BOOKS: 1. Molecular Biotechnology: Principles and Applications of Recombinant DNA 2. Textbook by , by Glick, Bernard R, Jack J. Pasternak, and Cheryl L. ASM press
REFERENCE BOOKS: 1. PCR Protocols and Applications (1990) Edited by M. A. Innis, D. H. Gelfand, J. J. Sninsky, T. J. White. 2. Genome Analysis - A Practical Approach (1988) Edited by K.E. Davies.

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 9028	SIGNAL TRANSDUCTION	3-1-0	4	Prof Sudip Chattopadhyay
<b>Detailed topics</b>		<b>Classes</b>		
Two-component regulatory system, Ligands, Receptors, Second messengers and Effectors, Carriers and channels of membrane, G protein-coupled signal transmission Protein tyrosine kinase, Ras/MAP Kinase pathway, JAK-STAT pathway.		(15)		
Transcription factors and regulators, Chromatin remodeling, Ubiquitination and protein degradation, Receptors, MAP Kinase cascade and downstream regulatory.		(10)		
Proteins in ethylene signaling, Light perception and photoreceptors, Overlapping functions of photoreceptors, Signal transducers and master regulators, Photomorphogenesis, Transcriptional networks of seedling development, Light regulated gene expression.		(12)		
Identification of novel signaling molecules, Functional characterization of new components, Cross talks among various signaling pathways		(8)		
TEXT BOOKS: 1. Genes, Benjamin Lewin 2. Biochemistry, Lubert Stryer				
REFERENCE BOOKS:				

<b>SUBJECT CODE</b>	<b>SUBJECT</b>	<b>L-T-P</b>	<b>CREDIT</b>	<b>DEVELOPER</b>
<b>BT 9029</b>	<b>MOLECULAR MODELING AND DRUG DESIGN</b>	<b>3-1-0</b>	<b>4</b>	<b>EXTERNAL SOURCE</b>
<p>Introduction to molecular Simulation Techniques-Monte Carlo Methods-Metropolis Monte Carlo Algorithm, Flow calculations in Metropolis Monte Carlo Algorithm with examples- Ising Lattice, Gibbs Ensemble Monte Carlo Simulations (12)</p> <p>Molecular Dynamics Methods-different methods for the integration of Dynamical Equations, Molecular Dynamics of rigid non linear poly atomic molecules in other ensembles, Structural information from M.D. (8)</p> <p>Molecular mechanics, Energy minimization, intra molecular interactions, physicochemical parameters in drug design-Ionization constants, chelation, solubility and partition Coefficient. Over view of Molecular Descriptors. (8)</p> <p>Rational basis of drug designing, criteria for synthesizing drugs, Drug designing approaches-Pharmacophore based drug design- lead and target tissues, lead finding and lead optimization, action and reaction, Structure based drug design process of Structure based design, Receptor based design-drug designing using known receptor structure, design of energy inhibitors. (8)</p> <p>Overview of computer based tools for drug designing- Ludi, Ludi/CAP, Autodock, GRAMM, CAMD tools, scoring and Docking mode, QSAR principles and Methods in drug designing. (7)</p> <p>Current research in drug designing- a case study. (2)</p>				
<p><b>TEXT BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. ARLeach-Molecular Modelling, .Principles and application 2nd edition–Prentice Hall.</li> <li>2. Krogsgaard,L-Text Book of Drug Design and Discovery-2002 Taylor and Francis, London</li> </ol>				
<p><b>REFERENCE BOOKS:</b></p> <ol style="list-style-type: none"> <li>1. G.Walsh-Biopharmaceuticals-Biochemistry and Biotechnology-2003, Wiley</li> <li>2. Scolnick.J.(2001) Drug Discovery and Design .Academic Press, London</li> <li>3. N. R. Cohen, Editor. Guidebook on Molecular Modeling in Drug Design. Academic Press, San Diego, 1996.</li> </ol>				

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 9030	BIOPROCESS EQUIPMENT DESIGN	3-1-0	4	Prof Apurba Dey
<p><b>Design and Analysis of Bioreactors:</b></p> <p>Components of bioreactors, material of construction, vessel size (3)</p> <p>Residence Time Distribution (RTD) in Bioreactors (1)</p> <p>Aseptic operations in bioreactors (2)</p> <p>Mechanical fittings in bioreactors (3)</p> <p><b>Instrumentation and Control of Bioprocesses:</b></p> <p>Physical and chemical environmental sensors (6)</p> <p>Computer control of bioreactors (2)</p> <p><b>Sterilization of Bioreactors:</b></p> <p>Design of batch and continuous sterilizers (3)</p> <p>Design of Air Filters (2)</p> <p><b>Conventional and unconventional bioreactors and their Design :</b></p> <p>Batch, continuous stirred tank reactors (CSTR), plug flow reactors (3)</p> <p>Enzyme and immobilized bioreactors (2)</p> <p>Fluidized bed bioreactors, bubble column bioreactors, air- lift Bioreactors, hollow- fiber bioreactors, membrane bioreactors (3)</p> <p>Bioreactors for plant and animal cell culture systems (2)</p> <p>Ideal and non ideal reactors (2)</p> <p><b>Modelling and Simulation of Bioprocesses:</b></p> <p>Study of structured and unstructured models for analysis of various processes (2)</p> <p><b>Design of Effluent Treatment Plants:</b></p> <p>Design of aerobic treatment plant (3)</p> <p>Design of anaerobic treatment plant (2)</p> <p><b>Pumps in Bioprocess Engineering (2)</b></p> <p><b>Project Planning in Bioprocess Engineering (2)</b></p>				
<p>TEXT BOOKS:</p> <ol style="list-style-type: none"> <li>Shuler M.L, Kargi F, '<i>Bioprocess Engineering-Basic Concepts</i>', Prentice Hall of India Ltd.</li> <li>Stanbury P F and Whitaker A, '<i>Principles of Fermentation Technology</i>', Pergamon Press</li> </ol>				
<p>REFERENCE BOOKS:</p> <ol style="list-style-type: none"> <li>Doran P M, '<i>Bioprocess Engineering Principles</i>', Academic Press</li> <li>Aiba S, Humphrey A E and Millis N F, '<i>Biochemical Engineering</i>', Academic Press</li> </ol>				

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 9031	MOLECULAR PLANT PATHOGEN INTERACTION	3-1-0	4	Dr Subhankar Roy Barman
<i>Topics to be covered</i> Introduction to molecular plant pathology Plant diseases Plant disease development and environment Effects of pathogen on plant physiology Biochemistry of plant defense reactions Plant-pathogen interactions Genetic regulation of resistance in host plants Genetic regulation of virulence in pathogen Mechanisms of host defense Mechanisms of pathogenesis Biotechnological approach for plant protection; genetically modified plants to protect against pathogens <b>Total number of classes</b>		<i>Number of classes</i> (1) (2) (2) (2) (5) (6) (6) (6) (6) (6) (6) (3) <b>45</b>		
<b>TEXT BOOKS:</b> 1. Plant Pathology; Fifth Edition, Elsevier; By Geroge N. Agrios. 2. Biochemistry and Molecular Biology of Plants; American Society of Plant Biologists; By Bob Buchanan, Wilhelm Gruissem and Russel Jones.				
<b>REFERENCE BOOKS:</b> 3. Plant Immunity; Methods in Molecular Biology, 2011, 712, Springer. 4. Plant-Pathogen Interactions; Methods in Molecular Biology; By Pamela Ronald, 2007, 354, Springer. 5. Plant-Pathogen Interactions; Annual Plant Reviews; By Nick Talbot, 2004, 11, Blackwell Publishing.				

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
BT 9032	ADVANCED CELL SIGNALLING	3-1-0	4	Dr Ashish Bhattacharjee
<p>Introduction of cellular signaling [4]</p> <p>Signaling molecules – Interferons, Interleukins and others [4]</p> <p>Receptor-mediated signaling in cells, Receptor associated and non-receptor tyrosine kinases and their involvement in different signal transduction pathways [5]</p> <p>Role of different transcription factors and kinases (MAP kinases and other ser/thr kinases) [7]</p> <p>Activation of various signalling pathways (Jak-Stat, MAPK, PI3K-Akt, NF-kB etc.) in different cells by extracellular stimuli [10]</p> <p>Involvement of signal transduction pathways in many important cellular processes like Cell migration, cancer, angiogenesis etc. [10]</p>				
<p>TEXT BOOKS:</p> <ol style="list-style-type: none"> <li>1. Molecular Biology of the Cell; By <u>Bruce Alberts</u>, <u>Alexander Johnson</u>, <u>Julian Lewis</u>, <u>Martin Raff</u> , <u>Keith Roberts</u>, <u>Peter Walter</u>; Fifth edition, (2007).</li> <li>2. Molecular Cell Biology; By <u>Harvey Lodish</u>, <u>Arnold Berk</u>, <u>Chris A. Kaiser</u>, <u>Monty Krieger</u>, <u>Anthony Bretscher</u>, <u>Hidde Ploegh</u>, <u>Angelika Amon</u>, <u>Matthew P. Scott</u>; Sixth edition, (2012).</li> </ol>				
<p>REFERENCE BOOKS:</p> <ol style="list-style-type: none"> <li>3. Essential Immunology, Roitt, I.M., 9<sup>th</sup> Ed. (1997), Blackwell Scientific, Oxford, UK</li> <li>4. Immunology, Kuby, J. 3<sup>rd</sup> Ed. (1997), Freeman, W.H,Oxford,UK</li> <li>5. Weir, Immunology, 8<sup>th</sup> ed, W.B. Saunders&amp; Co.</li> <li>6. K.A. Abbas, Immunology, 4<sup>th</sup> ed, W.B. Saunders&amp; Co.</li> <li>7. Relevant publications from many peer-reviewed journals.</li> </ol>				