INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-211** Course Title: **Cell Biology and Microbiology**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To impart the knowledge of the mechanistic features of the cells and microbes to use them as a tool for various applications related to human health and environment.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Eukaryotic and prokaryotic cells, membrane organization, cell organelles, cytoskeletal proteins, cell division.	5
2.	Transport-across cell membranes, **c**ytosolic , nuclear and membrane bound receptors, autocrine, paracrine and endocrine models of actions.	8
3.	Entry of viruses and toxins into cells, cell culture**,** generation of cell lines, apoptosis, carcinogenesis.	8
4.	Basics of microbial existence, classification & nomenclature, isolation and identification of bacteria, fungi, viruses, structural organization and multiplication of microorganisms.	6
5.	Preservation of food, fermentation, food additives and supplements, nutritional requirements and growth curve, aerobic and anaerobic bioenergetics.	7
6.	Production of primary and secondary metabolites, metabolite genes and functions, biogas and bioremediation, leaching of ores by microorganisms, biofertilizers, biopesticides, biosensors.	8
	Total	**42**

Practicals:

1. Laboratory safety and sterilization techniques
2. Microscopic methods in the identification of microorganisms
3. Separation of Peripheral Blood Mononuclear Cells from blood
4. Giemsa Staining
5. Thin layer chromatography
6. Preparation of culture media – nutrient broth and nutrient agar
7. Culturing of microorganisms – in broth and in plates (pour plates, streak plates, isolation and preservation of bacterial cultures)
8. Staining techniques – grams' and differential, antibiotic sensitivity assay, Quantification of microorganisms
9. Isolation and identification of microorganisms from different sources – Soil, water and milk
10. Growth curve – observation and growth characteristics of bacteria and yeast, Effect of different parameters on bacterial growth (pH, temperature & UV irradiation)

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Darnell, J., Lodish, H. and Baltimore, D., "Molecular Cell Biology", W.H.Freeman & Co.	1999
2.	Robertis, D. and Robertis, D., "Cell Biology", Saunders Publication	1999
3.	Watson, J.D., "Molecular Biology of The Cell", Taylor & Francis	2002
4.	Talaron, K., Talaron, A., Pelczar, C. and Reid, A., "Foundations In Microbiology", W.C.Brown Publishers	1993
5.	Pelczar, M.J., Chan, E.C.S. and Krein, N.R., "Microbiology", Tata McGraw Publication	1997
6.	Prescott, L.M., Harley, J.P. and Klein, D.A., "Microbiology", W. C. Brown Publications	1996

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE : **Department of Biotechnology**

1. Subject Code: **BT-213** Course Title: **Biochemistry and Biophysics**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To impart the knowledge of structures of various biomolecules, their interactions, synthesis route and structural relationship.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Molecular basis of life, proteins, classification, structure, function, dynamics, specificity and techniques; Protein configuration, conformation, conformational analysis, Ramachandran's map and energy calculations; Helix to coil transition of proteins.	9
2.	Carbohydrates and lipids, classification, structure and function, membrane fluidity.	4
3.	Nucleic acids, nomenclature, properties and techniques, backbone torsional angle and sugar conformation.	5
4.	Enzymes, introduction, classification, kinetics and Catalysis.	5
5.	Metabolism, basic concepts and design.	3
6.	Metabolism of carbohydrates, glycolysis, citric acid cycle and oxidative phosphorylation, lipid, amino acid and nucleotide metabolism.	7
7.	Integration of metabolism, coordinated control and regulation.	3
8.	Photosynthesis, chloroplast, dark and light reactions.	3
9.	Structural proteins, actin, myosin and muscle contraction.	3
	Total	**42**

Practicals:

1. Preparation of buffer -titration of a weak acid and a weak base.
2. Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars.
3. Quantitative method for amino acid estimation using ninhydrin – distinguishing amino from imino acid.
4. Protein estimation by Biuret and Lowry's methods.
5. Protein estimation by Bradford and spectroscopic methods.
6. Estimation of nucleic acids by absorbance at 260 nm and hyperchromic effect.
7. Enzymatic assay: estimation of glucose by TGO method after hydrolysis of starch with acid and specificity of the enzymatic method.
8. Characterisation of oligo / polynucleotides and amino acids (Tyr, Trp, Phe)/oligopeptides-dependance of absorbance on concentration.
9. Purification of Biomolecules using HPLC systems.
10. Characteristics of secondary and tertiary structures by three dimensional model building.

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Nelson, D.L. and Michael, M. C, "Lehninger's Principles of Biochemistry", Macmillan Worth Publisher.	2000
2.	Stryer, L., "Biochemistry", 4th Ed., WH Freeman & Co.	2000
3.	Voet, D. and Voet, J., "Biochemistry", 2nd Ed., John Wiley & Sons.	1995
4.	Van Holde, K. E., Johnson, W. and Ho, P.S., "Principles of Physical Biochemistry", Prentice Hall Int Inc.	1998
5.	Cantor, C. R. and Schimmel, W.H., "Biophysical Chemistry Part-I and Part-III", Freeman & Co.	1981

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE : **Department of Biotechnology**

1. Subject Code: **BT- 215** Course Title: **Principles of Bioreaction Engineering**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weightage**:** **CWS** **25** **PRS** **0** **MTE** **25** **ETE** **50** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objectives: To introduce the concepts of material and energy balance calculations for biochemical process and its importance in analyzing biological process.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to engineering calculations, material balance fundamentals, conversion, yield, recycle, purge.	5
2.	Energy balance concepts, enthalpy changes, general energy balance equation, simultaneous material and energy balance.	6
3.	Reaction kinetics, laws of mass action, rate equation, elementary and non-elementary chemical and biochemical reaction, chemical and biochemical reaction rate.	4
4.	Analysis of experimental reactor data, evaluation of rate equations.	3
5.	Ideal reactors: batch, stirred tank and tubular flow reactor design, membrane reactor, concept of RTD and bioreactor, conversion and reactor sizing.	7
6.	Multiple reaction, mole balance, maximization of desired product for a reactant, algorithm development, reactor choice.	5
7.	Factors affecting choice of chemical reactor and bioreactor, combination of reactor, size comparison.	5
8.	Heat effects in isothermal bioreactor system, diffusion and bioreaction in porous catalysts and biocatalyst.	7
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", Prentice Hall.	2002
2.	Levenspiel, O., " Chemical Reaction Engineering", John Wiley.	1972
3.	Fogler, H. S. "Elements of Chemical Reaction Engineering", Prentice Hall India.	1994

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-217** Course Title: **Bioinformatics**

2. Contact Hours: **L: 2** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** **2** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**

5. Credits**:** **3** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To understand the functions of each gene and protein that is essential for creating knowledge database and its annotation.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction, database model, raw database and processed database, data mining, data storage and retrieval, querying in database and tools for querying-BLAST, FASTA.	4
2.	Gene finding, Hidden Markov Models (HMM), annotation of protein sequences, prediction of co-regulated genes from sequences and sequence alignment-pairwise, substitution matrices, local, global, multiple sequence alignment, clustering, prediction.	8
3.	Protein-protein interaction, protein chips, searching in databases, binding site prediction, phylogenetic tree analysis, structural database – protein structure database, homology modeling, comparison and superposition of structures.	7
4.	Comparison of distance matrices, searching for patterns and motifs.	3
5.	Evolution of protein structure and sequences by comparing different organisms.	3
6.	Human genome, introduction, tools for analysis, gene finding, probing with EST's exon microarray, database, functional genomics.	3
	Total	**28**

Practicals:

1. Statistics of a blast search – online tutorial.
2. Alignment of whole genomes.
3. Use of FASTA searching – effect of different substitution matrices,change in gap penalties,different ktup values. Comparison of same search with BLAST.
4. Implementation of a selected sequence alignment algorithm.
5. Sequence alignment of two given sequences with FASTA and BLAST. Evaluate the statistical significance of the match with a web program. Effect of presence of low complexity regions in the sequence and filtering.
6. Writing a sequence assembly program.
7. HMM for sequence analysis.
8. To develop a simple "gene finder program" for identifying introns and exons

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Gusfield, D., "Algorithm on Strings, Trees and Sequences: Computer Science and Computational Biology", Cambridge University Press.	1997
2.	Baxevanis, A.D. and Ouellette, B.F.F., "Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins", Wiley-Interscience.	2001
3.	Mount, D.W., "Bioinformatics: Sequence and Genome analysis", Cold Spring Harbor Laboratory Press.	2001
4.	Sensen, C.W., "Essentials of Genomics and Bioinformatics", John Wiley and Sons.	2002
5.	Attwood, T. and Pary-Smith, D., "Introduction to Bioinformatics", Prentice Hall.	1999

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-222** Course Title: **Genetics and Molecular Biology**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: BT-211, BT-213**

9. Objective: To impart fundamental knowledge of genetics and molecular biology in understanding the basis of inheritance, and structure and molecular mechanism of gene function.

10. Details of Course:

S. No.	Content	Contact Hours
1.	Introduction and general background	2
2.	Reproduction as the basis of heredity; Mendelian principles of genetics, applications of Mendelian principles	4
3.	Chromosomal basis of inheritance and linkage; Construction of genetic and physical maps; Linkage and crossing over, genetic mapping in eukaryotes and prokaryotes.	5
4.	Chromosomal changes and gene mutations, types of mutations, consequences of mutations, occurrence and causes of mutations	2
5.	Genetic disorders and genetic counseling: Applications of genetics: Genetic advances in agriculture and medicine, eugenics.	3
6.	DNA Replication in prokaryote and eukaryotes, enzymes and accessory proteins, telomere replication. DNA repair, mutagenesis,	5
7.	Transcription process in prokaryote & eukaryotes, regulation of transcription. RNA processing, nuclear export and stability of mRNA	6
8	Translation in prokaryote and eukaryotes translation, translational control , co and post translational modification of proteins,	4
9.	Gene expression in prokaryote & eukaryote, operon model, genes silencing, transcription factors, antisense and ribozymes	6
10.	Various techniques of molecular biology, DNA cloning, genome sequencing:	5
	Total	**42**

Practicals:

1. Mitotic and meiotic cell divisions;
2. Inheritance and linkage analysis
3. Development of mapping populations
4. Induction and selection of mutants
5. Isolation of bacterial genomic DDNA
6. Restriction enzyme digestion
7. DNA ligation and recombinant DNA preparation
8. Competent cell preparation and transformation
9. DNA probe preparation using random primer methods, Nucleic acid hybridization
10. DNA sequencing

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Snustad, S., "Principles of Genetics", John Wiley & Sons Inc. Hoboken.	2003
2.	Klug, W.S. and Cummings, M.R., "Concepts of Genetics", Pearson Education Inc.	2004
3.	David, F., "Molecular Biology", Narosa Publication House	1999
4.	Watson, J.D., Baker, T.A., Bell, S.P., Gann, A,, Levine, M,, Losick, R, ' Molecular Biology of the gene" 5th Ed., Pearson Education.	2004
5.	Russel, P.J., "Genetics", 6th Ed, Benjamin Cumming Comp. Inc.	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-224** Course Title: **Immunotechnology**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To give an overview of the basic concepts and the principles of immune system and techniques for developing diagnostics.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction, innate and acquired immunity, active, passive and adoptive immunization, clonal selection theory, humoral and cellular Immunity, Regulation of Immune response.	6
2.	Cellular responses, activation and function of T and B cells, general properties and functional categories of cytokines, therapeutic and diagnostic exploitation of cytokines and cytokine receptors, role of Major Histocompatibility Complex (MHC) in the human response.	10
3.	Infection and immunity, host defense against various classes of pathogen, mechanism by which pathogen invade immune responses, active and passive immunization, preparation of human immune serum globulins.	10
4.	Transplantation and tumor immunology, relationship between donor and recipient, role of MHC molecules in Allograft rejection, bone marrow and haematopoietic stem cell transplantation. Tumor antigen, categories of tumor antigen, tumor immunoprophylaxis.	5
5.	Autoimmunity, criteria and causes of autoimmune diseases-Autoimmune hemolytic anemia, myasthenia gravis, systemic lupus erythematosus, multiple sclerosis, rheumatoid arthritis.	3
6.	Applied immunology, antigen and antibody interactions, affinity and avidity, agglutination and precipitation reactions, immunoassays, immunofluorescence, fluorescence activated cell sorting analysis, microarrays to assess gene expression.	8
	Total	**42**

Practicals:

1. Handling of animals, immunization and raising antiserum.
2. Identification of cells in blood smear.
3. Identification of blood group.
4. Immunodiffusion and immunoelectrophoresis.
5. Enzyme Linked Immno Sorbent Assay (ELISA).
6. Isolation of peripheral blood mononuclear cells.
7. Isolation of monocytes from blood.
8. Immunofluorescence.
9. Identification of T cells by T-Cell rossetting using sheep RBC.
10. Haemagglutination reaction test.

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Roitt, I. and Male, B., "Immunology", Mosby Publ	2002
2.	Kuby, J., "Immunology", W.H. Freeman & Co.	2000
3.	Ashim, K. Chakravarthy, "Immunology", TataMcGrew-Hill.	1998
4.	Sites, D.P., Stobo, J.D. and Wells, J.U., "Basic and Clinical Immunology", Prentice Hall.	1999

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-226** Course Title: **Transport Processes**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weightage**:** **CWS** **25** **PRS** **0** **MTE** **25** **ETE** **50** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objectives: To impart basic knowledge related to momentum, heat and mass transport in various unit operations.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Principles of molecular transport of momentum heat and mass, shell balance method, equation of change and velocity profile in circular conduits.	10
2.	Turbulence, creeping flow, potential flow, stream function, boundary layer theory.	8
3.	Diffusion theory, molecular diffusion in liquids, gasses, solids and biological solutions, unsteady state diffusion, convective mass transfer coefficient for various geometries, diffusion and convection in chemical reaction, in porous solids.	12
4.	Steady state heat transfer, mechanism of heat transfer, conduction, forced and natural convection in various geometries, heat exchangers, unsteady state heat transfer, basic equations, unsteady state conduction in various geometries, biological applications.	12
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Geankoplis, C.J., "Transport Processes and Separation Process Principles", 4th Ed., Prentice Hall of India.	2005
2.	Bird, R.B., Stewart, W.E. and Lightfoot, E.N., "Transport Phenomena", John Wiley and Sons.	1994
3	Treybal, R.E., "Mass Transfer Operation", McGraw-Hill International.	1981
4	Kumar, D.S., "Heat and Mass Transfer", S.K. Kataria and Sons.	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-228** Course Title: **Fluid Mechanics**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weightage**:** **CWS** **25** **PRS** **0** **MTE** **25** **ETE** **50** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objectives: The course has been designed to introduce the concepts of fluid mechanics for biochemical processes.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Fluid properties, viscosity, density, elasticity, surface tension, properties of biological fluids	4
2.	Fluid statics, pressure variation, elevation and measurements, buoyancy and stability	4
3.	Mass and energy balance for fluid flow, rate of flow, rotation and vorticity	4
4.	Bernoulli's equation and fluid flow measurements and application, fluid friction in steady one dimensional flow	8
5.	Momentum balance, Navier-Stokes equations, application of Navier-Stokes equation, conversion from rectangular to cylindrical coordinate system	4
6.	Dimensional analysis, boundary layer control, surface resistance, turbulent flow in pipes	8
7.	Flow through porous media, pumps, compressors, turbines, mixing in fluid , scale up of mixing equipments	10
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Noel, de Nevers, "Fluid Mechanics for Chemical Engineers", McGraw Hill International Edition	2005
2.	McCabe, W., Smith, J. and Harriott, P., "Unit Operations of Chemical Engineering", 6th Ed., McGraw Hill International Edition	2004
3.	Wilkes, J.O., "Fluid Mechanics for Chemical Engineers with Microfluidics and CFD", Prentice Hall	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-311** Course Title: **Genetic Engineering**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: BT-222**

9. Objective: To impart knowledge of various aspects of gene cloning, site directed mutagenesis and application of genetic engineering

10. Details of Course:

S. No.	Content	Contact Hours
1.	Introduction and historical background	2
2.	Restriction and modifying enzymes, cloning vectors: Plasmids, phage cosmids, phasmid, YAC, eukaryotic vectors.	8
3.	Isolation, purification and characterization of DNA and RNA, gene cloning, construction of genomic and cDNA libraries, synthesis and labeling of DNA and RNA probes, random primer, nick translation, end labeling, screening of cDNA and Genomic libraries, hybridization probe method, antibody screening..	15
4.	Polymerase chain reaction for DNA amplification, modification of polymerase chain reaction	5
5.	DNA sequencing-Maxmum-Gilbert, Sanger's and Automatic method	2
6.	Site directed mutagenesis, genetic transformation, transgene silencing	6
7.	Genetically modified organisms	2
8.	Risk assessment, biosafety regulations and guidelines	2
	Total	**42**

Practicals:

1. Miniprep isolation of plasmid DNA
2. Large preparation of plant/ animal DNA
3. Restriction digestion of plasmid DNA and electrophoresis
4. Ethidium bromide staining and gel documentation
5. Cloning DNA in a pBlueScript vector
6. Identification and characterization of transformed colonies
7. Restriction of DNA , PAGE and preparation of Southern blot
8. Labeling DNA probe with biotin and Southern hybridization
9. Polymerase chain reaction and resolution of amplicons
10. *Agrobacterium* mediated genetic transformation

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Old, R. W. and Primrose, S. B., "Principles Of Gene Manipulation: An Introduction To Genetic Engineering", Blackwell Science. Publications.	**1993**
2.	Sambrook, J. and Russel, D.W., "Molecular Cloning: A laboratory Manual", Cold Spring Harbor Laboratory Press.	**2001**
3.	Brown, T.A., "Gene Cloning and DNA Analysis", Blackwell Science Ltd.	**2001**
4.	Gupta, P.K., "Biotechnology and Genomics", Rastogi Publications.	**2004**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-313** Course Title: **Microbial Technology**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: BT-211**

9. Objective: To provide the knowledge of scientific and industrial principles for the bioconversion of raw materials into value added products using microorganisms.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Selection of microorganism, screening for metabolites, strain improvement.	5
2.	Fermentation, raw materials for fermentation, submerged, surface and solid-state systems, whole cell and enzyme immobilized systems.	7
3.	Production of organic solvents, organic acids, amino acids.	7
4.	Production of antibiotics, polysaccharides, biosurfactants and applications.	7
5.	Production of enzymes from microbial, plant and animal sources, purification and recovery of enzymes.	5
6.	Genetic engineering, DNA isolation, cloning, expression, regulation and sequencing.	6
7.	Large scale production, fermenters, economics, legislative and safety aspects.	5
	Total	**42**

Practicals:

1. Mutagenesis for strain improvement.
2. Production of organic acid in submerged fermentation.
3. Enzyme Immobilization.
4. Production of enzyme under submerged fermentation.
5. Analysis of critical parameters for metabolite production in fermenter.
6. Study of Production formation kinetics in a fermenter.
7. Protease production in solid state fermentation.

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Rehm, H. J. and Reed, G., " Biotechnology", VCH Publ.	1996
2.	Ratledge, C. and Kristiansen, B., " Basic Biotechnology", Cambridge Univ Press.	2003
3.	Crueger, W. and Crueger, A., "Biotechnology: A Textbook of Industrial Microbiology", R. Oldenbourg Publ.	2000
4.	Rhodes, A. and Fletcher, D.L., "Principals of Industrial Microbiology", Pergamon Press.	1997
5.	Martin, A. M., "Bioconversion of Waste Materials to Industrial Products", Blackie Acad & Profl.	1998

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT. /CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-315** Course Title: **Enzyme Technology**

2. Contact Hours: **L: 2** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **2** **Practical** **0**

4. Relative Weightage**:** **CWS** **25** **PRS** **0** **MTE** **25** **ETE** **50** **PRE** **0**

5. Credits**:** **3** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: BT-213**

9. Objective: To inculcate the knowledge of enzyme catalytic reaction kinetics of free and immobilized enzymes.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction, classification, mechanism of enzyme action, active site determination, identification of binding and catalytic sites, specificity of enzyme action, activation energy and transition state theory, role of entropy in catalysis	6
2.	Kinetics of single substrate enzyme catalyzed reactions, Michaelis-Menten equation, turnover number, enzyme inhibition- competitive, non-competitive, and uncompetitive, allosteric enzymes and metabolic regulation	9
3.	Types of reactors used for enzyme catalysis for free and immobilized enzymes, immobilized enzymes, preparation and properties	5
4.	Immobilized enzyme catalysis; Effects of external mass transfer resistance, analysis of Intra-particle diffusion and reaction. Simultaneous film and intra-particle mass transfer resistances, effects of inhibitors, temperature and pH on immobilized enzyme catalysis and deactivation	8
	Total	**28**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Harvey, W. Blanch, and Douglas, S. Clark, "Biochemical Engineering", Marcel Dekker Inc.	1996
2.	James, M. Lee, "Biochemical Engineering", PHI	1992
3.	Bailey, J.E. and Ollis, D.F., "Biochemical Engineering Fundamentals", McGraw Hill	1986

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE : **Department of Biotechnology**

1. Subject Code: **BT-322** Course Title: **Bioprocess Engineering**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: BT-226, BT-313**

9. Objectives: To impart the knowledge of kinetics of microbial growth, product formation and its role in various modes of bioreactor operation.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Microbial kinetics, Monod's equation, substrate inhibition, double substrate equations.	5
2.	Structured and unstructure substrate & product inhibition and models related to that., cybernetic models, segregated models.	8
3.	Media and air sterilization, sterilization kinetics, batch and continuous sterilization.	4
4.	Agitation and aeration in bioreactor, different types of impellors, power requirements, $k_l a$ determination, mixing, multiphase reaction.	8
5.	Types of bioreactor operation, batch, fed-batch, continuous, cell recycle and cascade mode, calculation of productivity, yield and reactor sizing.	8
6.	Extractive fermentation, high cell density culture, Scale-up and scale down of bioreactor.	9
	Total	**42**

Practicals:

1. Media Sterlization in the Bioreactor
2. Thermal deactivation kinetics
3. Monod Kinetics in batch culture
4. k_{la} determination in the Bioreactor
5. Bioprocess modeling
6. Continuous culture
7. Enzyme kinetic study
8. Enzyme inhibition kinetics

11. Suggested Books:

S. N.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Nielsen, J. and Villadsen, J., "Bioreaction Engineering Principles", Plenum Press	1994
2.	Doran, P.M., "Bioprocess Engineering Principles", Academic Press	1995
3.	James, M. Lee, "Biochemical Engineering", Prentice Hall	1991
4.	Shuler, M.L. and Kargi, F., "Bioprocess Engineering", Prentice Hall	2002
5.	Bailey, J.E. and Ollis, D.F., "Biochemical Engineering Fundamentals", McGarw Hill	1986

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE : **Department of Biotechnology**

1. Subject Code: **BT-324** Course Title: **Environmental Biotechnology**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weightage**:** **CWS** 15 **PRS** 15 **MTE** 30 **ETE** 40 **PRE** 0

5. Credits**:** 4 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To provide the knowledge of biotechnological applications in waste treatment and biodegradation of various xenobiotics using microorganisms.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction, pollution monitoring, biotechnological treatment of wastes.	4
2.	Introduction of water microbiology, waterborne infectious agents and control of pathogenic microbes in water, sewage and sludge.	7
3	Wastewater characteristics, physical, chemical and biological.	4
4	Wastewater treatment, activated sludge processes, biological nutrient removal, wastewater treatment efficiency assessment.	7
5	Biotransformation and biodegradation of pollutants, methods for determining biodegradability and biodegradation of lignocelluloses, PAH, agricultural chemicals.	10
6	Molecular biological techniques in the characterization of environmental populations of microorganisms.	6
7	Emerging Technologies, biosensors and microprobes.	4
	Total	**42**

Practicals:

1. Introduction to environmental biotechnology tools and techniques – use of Microscope, autoclave, spectrophotometer, colony counter.
2. Culture Media preparation, aseptic techniques, sterilization.
3. Isolation and characterization of microbes from water/wastewater samples.
4. Bacterial plate count.
5. MPN test for coliforms.
6. Staining techniques for microbial identification.
7. Bacteriophage isolation and quantification from sewage.
8. Identification and characterization of microbes from soil.
9. Environmental influence and control of microbial growth.
10. BOD, COD tests of given waste sample.

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Hurst, C.J., Crawford, R.L., Knudsen, G.R., MacInerney, M.J. and Stetzenbach, L.D., "Manual of Environmental Microbiology", 2nd Ed., ASM press.	2002
2.	Metcalf and Eddy, "Wastewater Engineering Treatment, Disposal and Reuse", 3rd Ed., Tata MacGraw-Hill publishing company limited.	1995
3.	Pickup, R.W. and Saunders JR., "Molecular Approaches to Environmental Microbiology", 1st Ed., Ellis Horwood Limited.	1996
4.	Scragg A., "Environmental Biotechnology", 1st Ed., Pearson Education Limited.	1999
5.	Evans G.M. and Furlong J.C., "Environmental Biotechnology Theory and Application", John Wiley and Sons, Ltd.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-326** Course Title: **Animal Biotechnology**

2. Contact Hours: **L: 2** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** **2** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**

5. Credits**:** **3** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: BT-222**

9. Objective: To impart the knowledge of the most recent techniques used in animal biotechnology and their application to animal husbandry and biomedical field.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Animal cell culture, basic principles, serum free and serum based media, scaling-up, characterization and preservation of cell lines, cytotoxicity and viability assays.	7
2.	Animal diseases, diagnosis, therapy, variations of diseases, modes of transmission of diseases, control and management of disease spreading	5
3.	Stem cells, micromanipulation of embryos, generation of modified stem cells.	5
4.	Transgenic animals, retroviruses and DNA microinjection method, transgenic mice, cattle, sheep, goat, pig, birds, knock in and knock out animals.	7
5.	Importance of transgenic animals in biotechnology, valuable genes for animal biotechnology.	4
	Total	**28**

Practicals:

1. Trypan blue dye exclusion assay for cell viability.
2. Identification of anatomical organs of mouse/ rat.
3. Surgical procedure for different animal models.
4. Different steps in the development of primary cell culture.
5. Handling of differentiated and cancer cell lines.
6. Transfection of plasmid DNA to cell lines.
7. Cell proliferation assays.
8. Expression of recombinant proteins in cells.
9. Identification of differentiation of cells.
10. Diagnosis of animal based diseases.

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Ranga, M.M., "Animal Biotechnology", Agrobios India Limited.	2006
2.	Ramadass, P. and Meera Rani, S., "Text Book of Animal Biotechnolgy", Akshara Printers.	1997
3.	Pinkart, C.A., "Transgenic Animal Technology", Academic Press Inc.	1998
4.	Sasidhara, R., "Animal Biotechnology", MJP Publishers.	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE**:** **Department of Biotechnology**

1. Subject Code: **BT-328** Course Title: **Plant Biotechnology**

2. Contact Hours: **L: 2** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** **2** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**

5. Credits**:** **3** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: BT-222**

9. Objective: To provide the knowledge of various aspects of plant biotechnology including micropropagation and genetic improvement of plants through wide hybridization, somatic hybridization and genetic transformation.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Historical perspectives, laboratory organization and tissue culture media.	4
2.	Cell, tissue and organ culture, cryopreservation, protoplast culture and applications.	4
3.	Plant regeneration and hardening, micropropagation of disease free plants.	5
4.	Somaclonal variation, production of haploid plants, biotransformation, production of secondary metabolites.	4
5.	Physical methods of transfer of genes to plant, vectorless and vector mediated transformation, transgenic plants and their commercialization, development of insect resistance, herbicide, salt and draught resistance plants.	5
6.	Molecular markers and construction of maps, molecular breeding and DNA fingerprinting and IPRs and biosafety guidelines.	6
	Total	**28**

Practicals:

1. Preparation and sterilization of culture media.
2. Sterilization of explants and transfer to media.
3. Regeneration of plantlets.
4. Rooting and hardening of plantlets.
5. *Agrobacterium* mediated transformation of plants.
6. Selection of transgenic tissues and plants.
7. Use of microsatellite markers for DNA fingerprinting.
8. Embryo culture.

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Old, R.W. and Primrose, S. B., "Principles of Gene Manipulation: An Introduction to Genetic Engineering", Blackwell Science Publications.	1993
2.	Bhojwani, S.S. and Razdan, M.K.,"Plant Tissue Culture: Theory and Practice", Elsevier Publication.	2003
3.	Singh,B.D., "Text Book of Biotechnology", Kalyani Publishers.	1998
4.	Gupta, P.K., "Elements of Biotechnology", Rastogi Publications.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-413** Course Title: **Bioseparation Engineering**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **15** **MTE** **30** **ETE** **40** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: BT-226**

9. Objectives: To provide the knowledge of various separation techniques used in the purification of biological materials from the fermentation broth and complex mixture.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Characteristics of fermentation broth and bioproducts, sedimentation and centrifugation, different type of centrifuges and their theory	7
2.	Theory of filtration, Darcy's law, derivation, filtration of biological fluids and fermentation broth. Relationship between filtration rate and pressure difference, membrane filtration theory, cross flow system, filtration rate.	10
3	Cell disruption, mechanical, chemical and biological methods, precipitation of protein by solvent and ammonium salt, thermodynamic principles, solvent extraction, super critical fluid extraction and aqueous two phase extraction and adsorption	9
4.	Principles of various liquid chromatography: Gel Chromatography, Ion-Exchange, Affinity chromatography, Hydrophobic interaction chromatography, Adsorption, Isotherms of adsorption, scale-up of liquid chromatography	9
5.	Crystallization, drying, mass and heat transfer, rate of drying	7
	Total	**42**

Practicals:

1. Precipitation of protein
2. Concentration of protein in ultra-filtration
3. Gel chromatography
4. Membrane filtration
5. Aqueous two phase extraction of protein

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Belter, P.A., Cussler, E.L. and Wei-Shou Hu., "Bioseparation: Downstream Processing for Biotechnology", Wiely Interscience	1988
2.	Asenjo, J.A. and Merchuk, J.C., "Bioreactor System Design", Marcel Dekker Inc.	1995
3.	Garcia, A.A., "Bioseparation Science", Blackwell Science.	1999

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-415** Course Title: **Biosafety, Bioethics and IPR**

2. Contact Hours: **L: 2** **T: 0** **P: 0**

3. Examination Duration (Hrs.): **Theory** **2** **Practical** **0**

4. Relative Weightage**:** **CWS** **15** **PRS** **0** **MTE** **35** **ETE** **50** **PRE** **0**

5. Credits**:** **2** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: To create awareness regarding safety and ethical issues, about genetic modifications, stem cell research, patents and copyright aspects of the biotechnological products and processes.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction, genetic engineering, safety, social, moral and ethic considerations.	5
2.	Environmental ethics, bioethics and stem cell research.	5
3.	Public acceptance and safety of new biotechnological foods, agro biodiversity and donor policies.	5
4.	Patents, copyrights, trademarks, patent act (1970), patent (amendment)act (2002), salient features and different types of patent and patent specifications.	8
5.	Filling and processing of applications for patents, biopiracy and biocolonialism.	5
	Total	**28**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Subbaram, N. R., " Patents ", Pharma Book Syndicate	2003
2.	Selvin, J., Ninawe, A.S., Sugunan, V.S. and Sukumaran, N., "Biotechnology Emerging Trends ", A.P. Lipton Biotech Books	2003
3.	Ignacimuthu, S., " Basic Biotechnology" , Tata McGraw-Hill,	2003
4.	Lim, H. A., "Genetically Yours ", World Scientific	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPT./CENTRE: **Department of Biotechnology**

1. Subject Code: **BT-422** Course Title: **Bioprocess Control**

2. Contact Hours: **L: 2** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **2** **Practical** **0**

4. Relative Weightage**:** **CWS** **25** **PRS** **0** **MTE** **25** **ETE** **50** **PRE** **0**

5. Credits**:** **3** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: BT-322**

9. Objectives: To impart the knowledge of the control aspects of the process engineering and integrating various process schemes and control loop interactions.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Laplace transformation, transformation of standard function, open loop systems, first order systems, transient response, input functions, linearization, first and second order system and dynamics, transfer functions of bioreactor and dynamics.	7
2.	Closed loop control system, block diagram, servo and regulator problem, Transfer functions for controllers. Transient response, lag, closed loop control and stability.	6
3.	Frequency response closed loop systems, design by frequency, Bode diagram, stability criterion, Nyquist diagram. Tuning.	5
4.	Controller mechanism, introduction to advanced control system, feed forward control, introduction to microprocessor and computer control of bioprocesses, application in bioprocess control.	5
5.	Principles of measurement and classification of process control instruments, a few examples of controlling of parameters, biosensors.	5
	Total	**28**

11. Suggested Books:

S. N.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Luyben, W.L., "Process Modeling, Simulation and Control for Chemical Engineers", 2nd Ed, Mc.Graw-Hill International	1990
2.	Coughanowr D.R., "Process System Analysis and Control", 2nd Ed., McGraw Hill.	1991
3.	George Stephanopolous, "Chemical Process Control", Prentice-Hall of India Pvt. Ltd	1990
4.	Eckman, D.P., "Industrial Instrumentation", Wiley Publications	1978