INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

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 : **Biotechnology Department**

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 : **Biotechnology Department**

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: **Biotechnology Department**

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.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
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: **Biotechnology Department**

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	5

	sequencing:	
	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: **Biotechnology Department**

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,	8

	immunofluorescence, fluorescence activated cell sorting analysis, microarrays to assess gene expression.	
	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: **Biotechnology Department**

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: **Biotechnology Department**

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: **Biotechnology Department**

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	2

	method	
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: **Biotechnology Department**

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,	5

	purification and recovery of enzymes.	
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: **Biotechnology Department**

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	9

	regulation	
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 : **Biotechnology Department**

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_la 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 : **Biotechnology Department**

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	7

	nutrient removal, wastewater treatment efficiency assessment.	
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: **Biotechnology Department**

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	5

	spreading	
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**: Biotechnology Department**

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: **Biotechnology Department**

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: **Biotechnology Department**

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: **Biotechnology Department**

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,	7

	open loop systems, first order systems, transient response, input functions, linearization, first and second order system and dynamics, transfer functions of bioreactor and dynamics.	
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

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-451** Course Title: **Biodiversity, Bioprospecting and Organic-farming**

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**: Both** 7. Subject Area**: DEC**

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

9. Objective: To teach the basis of evolution that causes biodiversity among microbes, plants and animals their survival, domestication and further improvement.

10. Details of Course:

S. No.	Contents	Contact

		Hours
1.	Nomenclature and classification of organisms and major ecosystems of their flora and fauna.	6
2.	Analysis of biodiversity and co-evolution, symbiosis and interaction among organisms.	6
3.	On farm, *ex situ, in situ* and gene bank conservation.	4
4.	Geological and human activities endangering biodiversity.	4
5.	Domestication and utilization of biodiversity and bioprospecting, biodiversity for food, feed, health care and other products.	8
6.	Organic farming and sustainable use of natural and bioresources organic standards and certification of organic produce and products.	8
7.	Ethnobiology, IPRs and patenting and global initiatives on future prospects.	6
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Wrigley, S.K., Hayes M. A., Thomas, R, Chrystal, E .J.T. and Nicholson, L., "Biodiversity: New leads for the Pharmaceutical and Agrochemical Industries", Royal Society of Chemistry.	2000
2.	Tripathi, G. and Tripathi, Y. C. (ed), "Biological and Biotechnological Resources", Campus Books International.	2002
3.	Tiwari, G. S., "Sustainable Development and Conservation of Biodiversity", Anamaya Publishers.	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-452** Course Title: **Biological Spectroscopy**

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**: Both** 7. Subject Area**: DEC**

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

9. Objective: To teach the principles used in each spectroscopic technique and to apply the technique to biological molecules for characterization and structural investigations.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Electromagnetic radiation, Molecular spectra - Electronic transitions, Rotational & vibrational spectra	3
2.	Absorption spectroscopy, Transition probability and transition dipole moment, Spectrophotomer set up, Ultraviolet and visible spectra of amino acids, peptides, proteins, nucleic acid bases, polyribonucleotides, pH, solvent effects, Hypochromism	6
3.	Fluorescence spectroscopy- principle & instrumentation, Competing processes, Fluorescence spectra of amino acids/ peptides/biomolecules, ligand stdies, lifetime measurements,	4
4.	Optical rotary dispersion and Circular dichroism spectroscopy - principle, spectra of alpha helix, beta sheet, beta turn in polypeptides/A, B & Z DNA.	4
5.	Raman, Moss Bauer and pico second spectroscopy.	2
6.	Nuclear Magnetic Resonance (NMR) spectroscopy, classical & quantum mechanics principle, Instrumentation, chemical shift, spin-spin coupling, Relaxation Time T1 & T2, Nuclear Overhauser Enhancement , chemical exchange, decoupling	9
7	Principle of 2D NMR, 2D NMR methods, COSY, NOESY, HSQC, HMBC, TOCSY, etc and structure determination., whole	8

	cell-tissue NMR, Magnetic Resonance Imaging (MRI)	
8	Electron paramagnetic resonance (EPR) spectroscopy.	2
9.	X-ray Diffraction, Diffraction pattern, Compton effect, Bragg's law, phase problem, structure determination.	4
	Total	**42**

11. Suggested Books:

S. No.	Name of Books/Authors/Publisher	Year of Publication
1.	Campbell, I.D. and Dwek, R. A., "Biological Spectroscopy", Benjamin, Cummings Pub. Co. Inc.	1984
2.	Glasel, J. A. and Deutscher, M. B., "Introduction to Biophysical Methods for Protein and Nucleic acid Research", Academic Press.	1995
3.	Cantor, C. R. and Schimmel, P R., "Biophysical Chemistry, Part III", W H Freeman & Co.	1981
4	Biomolecular NMR spectroscopy, Jeremy N S Evans, Oxford	1995
5	NMR in Biological Systems, From Molecules to Man, KVR Chary & G Govil, Springer Netherlands	2008
6.	Gunther, H., "Nuclear Magnetic Resonance Spectroscopy", John Wiley & Sons.	1990

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-453** Course Title: **Gene Regulation**

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**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: BT-222, BT-311**

9. Objective: To provide the knowledge about the various levels of regulation of gene expression in different organisms and some practical application.

10. Details of Course:

S. No.	Content	Contact Hours
1.	Introduction , general and specific methods of study of proteins and mRNAs in tissues	2
2.	Regulation of trascription in bacteria, coordinated gene regulation, operon model , attenuation mode of gene regulation	6
3.	Post-transcriptional regulation in bacteria	4
4.	Regulatory mechanisms in bacteriophages, early and late regulatory gene, gene involved in lysogeny and lytic cycle	4
5.	Gene regulation by loss, amplification and rearrangement of DNA	4
6.	Eukaryotic gene regulation at transcriptional level, DNA methylation, transcription factors, enhance and silencer elements,	8
7.	Eukaryotic gene regulation at post-transcriptional level: RNA processing , snRNA, micro RNA, ribo-switches, etc.	8
8.	Applications of gene regulation , control of various diseases and crop improvement by gene regulation manipulation	6
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Latchman, D. S., "Gene Regulation: An Eukaryotic Perspective", 2nd, Ed., Chapman and Hall.	**2003**
2.	Jun, Ma., "Gene Expression and Regulation", Springer Verlag.	**2005**
3.	Miglani, G.S., "Fundamentals of Genetics", Narosa Publishing House.	**2008**
4.	Jeffery, W., "Post Transcriptional Gene Regulation", Humana Press Inc.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-454** Course Title: **Instrumental Methods of Analysis**

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**: Both** 7. Subject Area**: DEC**

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

9. Objective: To teach principles and parameters used in various instrumentations and enable them to apply these techniques in biotechnology applications.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Ultracentrifugation, viscosity and diffusion, sedimentation equilibrium and velocity method, analytical and preparative ultracentrifuge, density gradient, cell disruption, dialysis, ultra filtration	4
2.	Gel electrophoresis, isoelectric focusing, 2D, immuno, blotting, capillary, pulse field electrophoresis	4
3.	Chromatographic methods, paper chromatography, TLC, adsorption, HPLC, FPLC, gel filtration, ion exchange, affinity chromatography	5
4.	Microscopy, optical, electron, phase contrast, confocal, polarization and fluorescence microscopy	6
5.	Spectroscopic Techniques, absorption fluorescence, ORD, CD, NMR, X-ray, EPR and Mossbauer spectroscopic techniques	6
6.	Diffraction Techniques, X-ray, NMR, Neutron	3
7.	Mass spectrometry, ionisation and fragmentation, ion trap, tandom mass spectrometry, LC/MS and capillary electrophoresis, LC-	4

	NMR-MS.	
8.	Radio analytical techniques, GM and scintillation counter, solid state detectors, IDA, RIA.	4
9.	Polymerase Chain Reaction(PCR), ELISA, immunofluoroscence, immuno histo compatibility, localization of cells in tissues, immuno blotting	6
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Que, L., "Physical methods in Bioinorganic Chemistry, Spectroscopy and Magnetism", University Science Books.	2000
2.	Willard, H.H., Merritt L.L. Dean J.A. and Settle F.A.,"Instrumental Methods of Analysis", 7th Ed., Wadsworth Publishing Co.	1986
3.	Van Holde, K E, Johnson, W. and Ho, P. S., "Principles of Physical Biochemistry", Prentice Hall.	1998
4.	Cantor, C. R. and Schimmel, W.H., "Biophysical Chemistry Part-II", Freeman & Co.	1981
5.	Campbell, I.D. and Dwek, R. A., "Biological Spectroscopy", Benjamin Curmmings Publication Co. Inc.	1984
6.	Glasel, J. and Deutscher, M. B., "Introduction to Biophysical Methods for Protein and Nucleic acid Research", Academic Press.	1995

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-455** Course Title: **Genomics and Proteomics**

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**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: BT-213, BT-222**

9. Objective: To impart in-depth knowledge regarding use of various molecular biology and bioinformatics tools to study the complete genome and proteome of an organism, identification, functional assignment and comparative expression profiles of genes and proteins.

10. Details of Course:

S. No.	Content	Contact Hours
1.	Genome evolution and organization in prokaryotes and eukaryotes	3
2.	Genome sequencing, basics, strategies and methodology, databases and sequence comparisons	7
3.	Comparative genomics, functional genomics, expression sequence tags (ESTs), serial analysis of gene expression (SAGE) and targeting induced local lesions in genome (TILLING)	7
4.	Microarrays technology: Principles and applications, transcriptome analysis and SNPs determination	3
5.	Allele mining and single nucteotide polymorphisms (SNPs)	3
6.	Proteomics: Introduction, proteomics and proteome, protein databases, Tools of proteomics: Analytical protein and peptide separations, high throughput proteome analysis with 2D-IEF, protein digestion techniques, mass spectrometry	9
7.	Peptide sequencing analysis by tandem mass spectrometry data, mass-finger printing, protein–protein interactions	6
8.	Application of genomics and proteomics: mining genome proteomes, protein expression profiles, mapping protein	4

	modifications, new directions	
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Campbell, A. M. and Heyer, L. J., "Discovering Genomics, Proteomics and Bioinformatics", Benjamin Cummings Pub Co. Inc.	**2003**
2.	Pevsner, J., "Bioinformatics and Functional Genomics", John Wiley & Sons.	**2003**
3.	Botwell, D. and Sambrook, J., "DNA Microarrays: Molecular Cloning Manual", Cold Spring Harbor Lab. Press.	**2002**
4.	Hunt, S. P. and Liversey, F. J., "Functional Genomics: A Practical Approach", Oxford University Press.	**2001**
5.	Pennington, S. and Dunn, P. J., "Proteomics: From Protein Sequence to Function", Springer Verlag.	**2001**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-456** Course Title: **Metabolic 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**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: BT-315**

9. Objective: To provide knowledge about metabolic control, metabolic modeling, analysis of metabolic network and system biology.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to metabolism and metabolic Engineering, comprehensive models for cellular reactions, metabolic oscillations	4
2.	Fermentation and cell Cultures, batch kinetics, continuous reactors, transport across cell membrane, stoichiometric analysis.	6
3.	Enzyme Kinetics, inhibition kinetics, regulatory enzyme, analysis of sequences of reactions.	4
4.	Experimental methods for flux analysis, application of metabolic flux analysis, genetic tools for altering gene expression.	6
5.	Metabolic networks, regulation of metabolic networks, bioinformatics for reconstruction of metabolic networks	8
6.	Metabolic control analysis, control coefficient, elasticity, connectivity properties, response coefficients.	6
7.	Functional genomics, microarrays, proteomics, metabolomics, systems biology frameworks for metabolic engineering.	8
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Voit, E.O. "Computational Analysis of Biochemical Systems", Cambridge University Press.	2000
2.	Stephanopoulos, G., Aristidou, A. and Nielsen, J., "Metabolic Engineering Principles and Methodologies", Academic Press.	1998
3.	Heinrich, R. and Schuster, S., "The Regulation of Cellular Systems", Chapman & Hall.	1996
4.	Torres, N.V. and Voit, E.O., "Pathway Analysis and Optimization in Metabolic Engineering", Cambridge University Press.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-457** Course Title: **Protein 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**: Both** 7. Subject Area**: DEC**

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

9. Objective: To impart the knowledge of recent advances in protein folding and function, chemical synthesis of peptides and proteins, site-directed mutagenesis, de novo protein design and protein engineering.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Bonds and energies in protein, covalent, ionic, coordinate, hydrophobic and Vander walls interactions, interaction with electromagnetic radiation and elucidation of protein structure.	6
2.	Amino acids and their characteristics, aminoacids, molecular properties, chemical reactivity, post-translational modification, peptide synthesis.	8
3.	Details of protein structure, alpha helix, parallel and anti parallel beta sheet secondary, super secondary structural motifs, helix-turn-helix, alpha-alpha, beta-alpha-beta structure, domain structures, protein folding and interactions in quaternary structure.	12
4.	Structure-Function relationship, DNA-binding proteins, membrane proteins, immunoglobulins, enzymes.	8
5.	Protein engineering, overview of methods, thermal stability of T4-lysozyme, recombinant insulin, *de novo* protein design.	8
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Voet, D. and Voet, G., "Biochemistry", John Wiley Sons.	2001
2.	Braden, C. and Trooze, J., "Introduction to Protein Structure", Garland Publishing.	1999
3.	Moody, P.C.E. and Wilkison, A.J., " Protein Engineering", IRL. Press	1990

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-458** Course Title: **Biological NMR**

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**: Both** 7. Subject Area**: DEC**

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

9. Objective: To impart the knowledge of introduction to modern NMR experiments and their application to biological problems.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Magnetic moments, Principles of Nuclear Magnetic Resonance (NMR) - classical & quantum Mechanical, Fourier Transform, Instrumentation,	4
2.	Chemical Shift, Spin-spin coupling and Relaxation times (T1 and T2), Nuclear Overhauser Enhancement	4
3.	Principle of 2D NMR,, correlated spectroscopy (COSY), nuclear overhauser effect spectroscopy (NOESY), total correlation spectroscopy (TOCSY), Heteronuclear Correlations (HSQC, HMBC)	6
4.	1D and 2D NMR of peptides, proteins, Strategies of assignment, structure of polysaccharides	6
5.	Protein folding studies and enzyme structure by 1D and 2D NMR	6
6.	Nucleic acids structural analysis, strategies and assignment, sugar conformation, Experimental restraints, Restrained Molecular Dynamics (rMD) based structure, protein-DNA interaction, nature of interactions, binding affinity and specificity	6

7.	Drug DNA interaction, nature, binding affinity and specificity of interactions	6
8.	Membrane structure, its fluidity and Magnetic Resonance Imaging.	4
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1	NMR in Biological Systems, From Molecules to Man, KVR Chary & G Govil, Springer Netherlands	2008
2	Wuthrich, K., "NMR of Proteins and Nucleic acids", John Wiley & Sons.	1986
3	Evans, J. N. S., "Biomolecular NMR spectroscopy", Oxford University Press.	1995
4	Gunther, H., "NMR Spectroscopy", John Wiley & Sons.	1995
5	Derome, A.E., "Modern NMR Techniques for Chemistry Research", Pergamon Press.	1987
6	Glasel, J. A. and Deutscher, M. B., "Introduction to Biophysical Methods for Protein and Nucleic acid Research", Academic Press.	1995

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-459** Course Title: **Diagnostics**

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**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: BT-222, BT-224**

9. Objective: To expose to various technical aspects of diagnostics and power of molecular based analysis.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to medical biotechnology and immunodiagnostic procedures.	7
2.	Monoclonal antibodies and its medical applications and Human Leucosyte Antigens (HLA), HLA typing.	7
3.	DNA diagnostic systems: hybridization probes, Diagnosis of malaria and other diseases, non-isotopic hybridization procedures, in situ hybridization.	6
4	Molecular beacons and oligoriboprobes, ribozymes.	6
5.	Diagnosis of genetic diseases, detection of mutation in DNA, DNA amplification and quantification, PCR/OLA procedures, molecular markers and DNA polymorphism, DNA finger printing.	8
6.	Bioinformatics and molecular diagnostics.	4
7.	Biosensor detection technology.	4

	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Malik, S. and Patel, S., " Molecular Biotechnology: Therapeutic Applications and Strategies", Humana Press.	2002
2.	Birch, J.R. and Lennox, E.S. (editors), "Monoclonal Antibodies: Principles and Applications", Wiley-Leiss.	2001
3.	Watson, J.D., Gilman, M., Witkowski, J.and Zoller, M., "Recombinant DNA", Scientific American Books.	2003
4.	Mullis, K.B., Ferre, F. and Gibbs, R.A., "Polymerase Chain Reaction", Springer-Verlag.	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-460** Course Title: **Biomolecular Modelling**

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**: Both** 7. Subject Area**: DEC**

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

9. Objective: To impart the knowledge of basic concepts of computational biology and advance techniques involved in molecular modeling.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Computational mechanics, molecular orbital calculations and molecular mechanics.	4
2.	Empirical potentials including MM2, CFF, AMBER and CHARMM.	4
3.	Energy minimization and convergence criteria.	2
4.	Computer simulation methods.	2
5.	Molecular dynamics and simulated annealing,	3
6.	Conformational analysis by Distance Geometry (DG) and restrained Molecular Dynamics (rMD),	3
7	Software like MOE, XPLOR and DISCOVER.	4
8	Protein and Nucleic acid modeling, Ligand binding	10
9	Molecular Docking studies, Drug designing, Inhibitor designing.	10
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Andrew, R. Leach , Molecular Modeling –Principles and Applications, Pearson Education Ltd, Prentice Hall.	2001
2.	Glasel, J. A. and Deutscher, M. P. (editors), "Introduction to Biophysical Methods for Protein and Nucleic Acid Research", Academic Press.	1995
3.	Bourne, P.E. and Weissig, H. (editors),"Structural Bioinformatics", Wiley-Liss Publications.	2003
4	H D Holtje, W Sippl, D Rognan, G Folkers, Molecular Modeling – Basic Principles & Applications, Wiley VCH	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-461** Course Title: **Cell and Tissue 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**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: BT-224**

9. Objective: To impart knowledge of tissue engineering with special emphasis on the molecular basis of cellular function and interactions.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to tissue engineering, biomaterials for tissue engineering, biological study of different cell types, tissue structures, tissue modifications	10
2.	Principles and practice gene therapy, musculoskeletal tissue engineering, scaffolds, their various physicochemical properties	8
3.	Modification of tissues ring, tissue structures, tissues as scaffolds, tissue regeneration, tissue processing, tissue scaffolds, classification of scaffolds, manufacture and processing of scaffolds	10
4.	Receptor ligand interaction, receptor, receptor structures, types of receptors, biological functions of receptors.	6
5.	Development of artificial tissues, transplantation biology, immuno-rejection, tissue grafting, tissue typing	8
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Atala, A., and Lanza, R., “Methods of Tissue Engineering”, Academic Press.	2001
2.	Lanza, R.P., Langer, R. and Vacanti, J., “Principles of Tissue Engineering”, Academic Press.	2007
3.	Morgan, J.R. and Yarmush, M.L., “Tissue Engineering Methods and Protocols”, Humana Press.	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-462** Course Title: **Bioreactor Design and Analysis**

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**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: BT-215**

9. Objectives: To impart the concept of various types of bioreactors, analysis, non-ideality and uses in microbial bioprocesses.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Bioreactor models, CSTR, plug flow, physical processes in the reactors, ideal CSTR, Bubble column and air-lift tower loop reactor, description and physical processes.	5
2.	Gas-liquid flow in stirred tank reactor, single phase flow, Transport equations, simulation with experimental observations, multiple impellors, interfacial forces, turbulence model; Non-ideal behavior of bioreactor and its analysis with RTD analysis, basic models for non-ideal reactors.	9
3.	Bioprocess control, disturbances, stability and its analysis, dynamic models, feedback, proportional action, integral action, linear and non-linear control. Heat transfer effects in bioreactors, reactor dynamics, CFD approach for simulation.	8
4.	Bubble column bioreactors, basic equation of motion, fundamental laws of fluid motion, two fluid model, dynamics of the dispersed gas phase, mass transfer and chemical reaction, mixing due to bubble, fluidized bed; trickle bed bioreactor, photobioreactor.	9

5.	Models for kla, interfacial area and bubble behavior, mass transfer correlations, gas-liquid oxygen and other mass transfer, design and operation of aseptic and aerobic fermentation process.	6
6.	Scale-up, of bioreactor, basic requirement and reactor type, CSTR, mixing, power consumption, heat transfer, scale-up related effect on mass transfer, rheology of fermentation broth.	5
	Total	**42**

11. Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	Doran, P.M., "Bioprocess Engineering Principles", Academic Press	1995
2.	Shuler, M.L. and Kargi, F., "Bioprocess Engineering", Prentice Hall	2002
3.	James, E. Bailey and David, F. Ollis, "Biochemical Engineering Fundamentals", McGraw Hill	1986
4.	Schugerl, K. and Bellgart, K.H. (editors), "Bioreaction Engineering: Modeling and Control", Springer-Verlag	2000
5.	Nielsen, J., Villadsen, J. and Liden, G., "Bioreaction Engineering Principles", 2nd Ed., Kluwer Academics/Plenum Publisher	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-463** Course Title: **Genetically Modified Organisms**

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**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: BT-311**

9. Objective: To impart in-depth knowledge about various genetically modified organisms engineered for improvement of resistance against biotic and abiotic stresses, nutritional quality and shelf life, production of pharmaceutical and industrial products.

10. Details of Course:

S. No.	Content	Contact Hours
1.	History of recombinant DNA and guidelines for research	3
2.	Methods of gene cloning and cloned genes, selectable markers and reporter genes	6
3.	Promoters and transformation cassettes, transformation methods	6
4.	Characterization of GMOs, toxicological and allergenicity assessment	6
5.	Regulatory agencies and commercialization	2
6.	GMOs for resistance against abiotic stresses, resistance against biotic stresses, improved nutritional quality and shelf life, engineered enzymes, proteins and pathways, pharmaceutical proteins	15
7.	Gene therapy for congenital and other diseases	2
8.	Risk assessment, IPRs and ethical issues	2
	Total	**42**

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.	Curiel, D. T. and Douglas, J. T., "Adenoviral Vectors for Gene Therapy", Academic Press.	**2002**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-464** Course Title: **Vaccine Biotechnology**

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**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: BT-222, BT-224**

9. Objective: To impart the knowledge of various critical aspects for vaccination and the approaches used for the development of vaccines.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction and history of vaccine, concept of antigen and antibody, immunization, immune response and it's detection.	12
2.	Live, killed, recombinant subunit and peptide vaccines, factors affecting design of vaccines.	9
3.	Vaccine for vaccinia, polio, hepatitis B, influenza and HIV, production of vaccines, biology of various types of vaccines, applications.	10
4.	Pertussis, cholera vaccine, vaccine manufacturing and quality assurance, cost benefit and cost effectiveness, regulation, testing and safety of vaccines.	11
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Manuel, J.T.C., Griffiths, B. and José, L.P. M., "Animal Cell Technology: From Vaccines to Genetic Medicine", Springer.	1996
2.	Spriggs, D.R. and Wayne, C.K., "Topics in Vaccine Adjuvant	1991

	Research", CRC Press.	
3.	"Vaccines: Preventing Disease and Protecting Health", World Health Organization.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-465** Course Title: **Drug Designing**

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**: Both** 7. Subject Area**: DEC**

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

9. Objective: To provide basic understanding of the principles of design and engineering of well-defined molecular structures and architectures.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Drug target classification- DNA, RNA, post-translational processing enzymes, metabolic enzymes involved in nucleic acid synthesis, G-protein coupled receptors, small molecule receptors, transporters	9
2.	Target discovery and validation strategies, genomics, natural products, combinatorial chemistry, general overview modeling methodologies, structure based drug designing, protein structure determination and alternative techniques.	9
3.	Structure based design-'de novo' design methodologies, receptor mapping, 3D-database searching techniques.	8
4.	Design and development of combinatorial libraries for new lead generation, the molecular diversity problem, characterization, chemiometrics in drug design.	8
5.	QSAR, statistical techniques behind QSAR, drug metabolism, toxicity and pharmacokinetics.	8
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Glasel, J.A. and Deutscher, M.P., "Introduction to Biophysical Methods for Protein and Nucleic Acid Research", Academic Press.	1995
2.	Foye, W.O., Lemke, T.L. and Williams, D.A., "Principles of Medicinal Chemistry", Williams and Wilkins.	1995
3.	Pratt, W.B., Ruddon, R.W., Ensminger, W.D. and Maybaum, J., "The Anticancer Drugs", Oxford University Press.	1994
4.	Bourne, P.E. and Weissig, H. (editors),"Structural Bioinformatics", Wiley-Liss Publications.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-466** Course Title: **Bioprocess Economics and Plant Design**

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**: Both** 7. Subject Area**: DEC**

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

9. Objective: To introduce the basic concepts of economics, project design, cost estimation, process optimization and quality control in bioprocess industries.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction of bioprocess economics, importance of various inputs and globalization concept.	5
2.	Status of India in global perspective for bioprocess economics, types of organizations, simple management principles.	7
3.	Project choice, market survey and importance of techno-economic viability studies.	6
4.	Capital investment, concept of time-money, concepts of profitability, capital costs and depreciation.	9
5.	Working capital, project profitability evaluation, performance analysis, process optimization.	8
6.	Basic concepts of quality control, good manufacturing practices, fundamental concept of ISO 9000 quality system.	7
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Peters, M.S. and Klaus, D., "Plant Design and Economics for Chemical Engineers", McGraw-Hill International	1991
2.	Senapathy; R., "Text Book of Principles of Management and Industrial Psychology", Lakshmi Publication	2001
3.	Rudd and Watson, "Strategy for Process Engineering", Wiley Publications	1987

INDIAN INSTITUTE OF TECHNOLGY ROORKEE

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

1. Subject Code: **BT-467** Course Title: **X-Ray Crystallography**

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**: Both** 7. Subject Area**: DEC**

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

9. Objective: To impart an overview of basic concepts and principles of crystallization and X-ray crystallography and also with structure based drug designing.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Overview of X-crystallography method, crystallization methods: vapour diffiusion, hanging and sitting drop method and dialysis method.	7
2.	Crystal symmetry, Laue groups and Bravais lattices.	3
3.	Diffraction theory, scattering of X-rays by atoms and lattices, unit cell, asymmetric unit	7
4.	Instrumentation: X-ray sources, data collection devices. Crystal mounting methods	6
5.	Data collection data indexing, data reduction and space group determination.	7
6.	Data processing, HKL2000 and MOSFLM software packages.	4
7.	Fourier Transforms, phase problem and phase determination.	4
8.	Electron density interpretation using “O” and “COOT” software packages.	4
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Bergfros, T., "Protein Crystallization Strategies, Techniques and Tips, A Laboratory Manual", International University Line.	1999
2.	Drenth, J., "Principles of Protein X-ray Crystallography", 2nd Ed., Springer.	2000
3.	Ducruix, A. and Giege, R., "Crystallization of Nucleic Acids and Proteins, A Practical Approach", 2nd Ed., Oxford University Press.	2000
4.	Hahn, T., "International Tables for Crystallography, Space Group Symmetry, Vol. A", 5th Ed., Springer.	2005
5.	Rhodes, G., "Crystallography Made Crystal Clear", 2nd Ed., Academic Press Inc.	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-468** Course Title: **Nanobiotechnology**

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**: Both** 7. Subject Area**: DEC**

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

9. Objective: To provide an understanding about biological systems as templates in the development of nano-scaled products, and emerging nanotechnologies like nanolabels, nanobiosensors, nanomedicine.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to nanobiotechnology, biological problems	4
2.	Nanocrystals in biological detection	4
3.	Microfluidic meets nano: Potential for nanobiotechnology	6
4.	Protein based nanocyrstals	6
5.	Microbial nanoparticle production	4
6.	DNA based nanostructures and gold nanoparticle conjugates	8
7.	Luminescent quantum dots for biological imaging	6
8.	Emerging nanotechnologies: Nano-labels,biosensors,medicine	4
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Niemeyer, C. M. and Mirkin, C. A., " Nanobiotechnology: Concepts, Applications and Perspectives", Wiley-VCH.	2004
2.	Goodsell, D. S., "Bionanotechnology: Lessons from Nature", John Wiley.	2004
3.	Poole, C. P. and Owens, F. J., "Introduction to Nanotechnology", John Wiley.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-469** Course Title: **Bioprocess Modelling and Simulation**

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**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: BT-215**

9. Objectives: To impart the concepts of mathematical modeling of bioprocesses and thereby parameter estimation, testing and model validation.

10. Details of Course

S. No.	Contents	Contact Hours
1.	Introduction, dimensionless models. General form of linear systems of equations, nonlinear function.	3
2.	State space models for linear and nonlinear models, solution of general state-space form, solving homogeneous, linear ODEs with distinct and repeated Eigenvalues, solving non-homogeneous equation, equation with time varying parameters, Routh stability criterion.	8
3.	Transfer function, lead-lag models, transfer function analysis of higher order systems, pole location, pade approximation for dead time, converting transfer function model to state space form.	7
4.	Block diagrams, system in series, pole-zero cancellation, block in parallel, feedback system, Routh stability criterion	12

	for transfer functions, discrete time models and parameter estimation, phase plane analysis, nonlinear system, nonlinear dynamics, cobweb diagram, bifurcation and orbit diagram, stability, cascade of period doubling.	
5.	Case studies, stirred tank heaters, developing the dynamic model, steady state condition, state space model, dynamic model, steady state analysis, isothermal continuous stirred tank chemical reactors, biochemical reactors: model equations, steady-state function, dynamic behavior, linearization, phase plane analysis, multiple steady state, bifurcation behavior.	12
	Total	**42**

11. Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	Schugerl, K. and Bellgardt, K.H., "Bioreaction Engineering, Modeling and Control", Springer-Verlag	2000
2.	Nielsen, J. and Villadsen, J., "Bioreaction Engineering Principles", 2nd Ed., Kluwer Academic/ Plennum Publishers	2003
3	Luyben, W. L., "Process Modeling, Simulation and Control for Chemical Engineers", 2nd ed., McGraw-Hill International	1990
4	Wayne Bequette, B., "Process Dynamics, Modeling, Analysis and Simulation", Prentice Hall	1998

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-470** Course Title: **Virology**

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**: Both** 7. Subject Area**: DEC**

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

9. Objective: To teach the integrated approach to the understanding of the principles of virology, the characteristics of viruses and their role in disease pathogenesis.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	History, discovery, properties, infections and diseases, virus classification and replication, virus structure.	6
2.	Virus attachment, entry, replication, assembly, exit and maturation.	4
3.	Pathogenesis and control, HIV and AIDS.	3
4.	Methodology, cultivation, detection and genetics.	3
5.	Virus families, DNA, RNA and Retroviruses viruses, life cycle, genome organization, attachment, gene expression, genome replication, assembly and maturation.	9
6.	Viruses, cell transformation and cancer, prevention and control of viral diseases, vaccines, antiviral drugs.	5
7.	Plant virology, virus infection of plants, transmission of plant virus, multipartite plant viruses, pathogenesis of plant virus infection, emerging plant viruses.	6
8.	Virus evolution, emerging viruses (Dengue, West Nile, Hantaan,	3

	Ebola, VEE, SARS etc.), viruses and bioterrorism, hepatitis, Viriods, virusoids, prions and prion diseases.	
9.	Virus vectors and gene therapy.	3
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Flint, S.J., Enquest, L.W., Krug, R. M., Racaniello, V. R., and Skalka, A. M., "Principles of Virology: Molecular Biology, Pathogenesis and Control", ASM Press.	2000
2.	Strauss, E. G. and Strauss, J. H., "Viruses and Human Disease", Academic Press	2002
3.	Cann, A.J., "Principles of Molecular Virology", Academic Press	2005
4.	Howley, F.K., "Fundamental Virology", Raven Press.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-471** Course Title: **Advanced Transfer 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**: Both** 7. Subject Area**: DEC**

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

9. Objective: To provide the knowledge of advanced processes of energy and mass transfer in relation to food preservation, drying, bioreactor modeling and bioprocess modeling.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Equation of change and its application in non conventional systems, turbulence and boundary layer theory.	4
2.	Unsteady state heat transfer, chilling and freezing of food and biological material. Boundary layer flow and turbulence in heat transfer.	3
3.	Mass transfer in suspension, diffusion and convection in chemical and biochemical reactions, numerical analysis.	6
4.	Heat transfer in various geometries in forced convection, heat exchangers, boiling and condensation.	6
5.	Radiation heat transfer, in non Newtonian fluids, numerical analysis.	5
6.	Heat and mass transfer in evaporation, evaporators and condensers, evaporation of biological materials.	5

7.	Drying equipments, drying curves, combined convection, radiation and conduction heat transfer, freeze drying for biological materials	7
8.	Membrane separation processes, gas permeation membranes derivation of equation for counter and co-current flow for gas separation, multicomponent mixtures, cross flow models	6
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Broodkey, R.S. and Hershey, H.C., "Transport Phenomena", McGraw Hill International	1988
2.	Bird, R.B., Stewart, W.E. and Lightfoot, E.W, "Transport Phenomena", John Wiley	1978
3.	Sissom, L.S. and Pitts, D.R., "Elements of Transport Phenomena", McGraw Hill	1983
4.	Wilty, J.R., Wilson, R.W. and Wicks, C.W., "Fundamentals of Momentum Heat and Mass Transfer", 2nd Ed, John Wiley	1973
5.	Geankoplis, C.J., "Transport Processes and Separation Process Principles", 4th Ed., Prentice-Hall of India Pvt. Ltd	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BT-472** Course Title: **Food Biotechnology**

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**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: BT-211, BT-226**

9. Objective: To provide a balanced account of various theoretical and applied aspects of the subject that highlights the environmental factors and potential use of microorganisms in food & food products.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction, factors affecting the growth & survival of microorganisms in food.	5
2.	Microbial spoilage of food- milk, meat, plant products, food borne diseases.	8
3.	Bacterial agents of food borne illness- *Clostridium, Listeria, Salmonella, Shigella,Staphylococcus, Vibrio Yersinia.*	5
4.	Non-bacterial agents of food borne illness- helminthes and protozoa, toxigenic algae, toxigenic fungi, food borne viruses.	3
5.	Fermented and microbial foods- fermented milk, cheese, sauerkraut, fermented meat, beer, vinegar, mould fermentation.	6
6.	Microbiological examination of foods- direct examination, culture techniques, MPN count, and dye reduction assay; Immunological methods, advance techniques.	5

7.	Microbiology of food preservation- physical, chemical and biological based preservation system.	4
8.	Quality control using microbiological criteria- facilities and operation, cleaning and disinfection code for good manufacturing practices,hazard analysis and critical control points, record keeping	6
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Adams, M.R. and Moss-Food, M.O., "Microbiology", Royal Society of Chemistry.	2000
2.	Michael, P. D., Larry, R.B. and Thomas, J., "Montville.Food Microbiology- Fundamentals and Frontiers", ASM press.	2001
3.	James, M. J., "Modern Food Microbiology", Aspen Publications.	2000
4.	Richard, K. R., Carl, A. B. and Patel, P., "Encyclopedia of Food Microbiology", ASM Press.	1999