INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-511** Course Title: **Computer Applications**

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

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

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

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

8. Pre-requisites: **Nil**

9. Objective: To give an over view of basic knowledge in computers and programming.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to computers and system software concept. Binary representation of data.	4
2.	Programming fundamentals of C++, control structures, operators, arrays and strings.	12
3.	Object Oriented Programming: classes, function, overloading, inheritance, containership.	6
4.	Function/ operator overloading and concepts of generic programming	7
5.	Development of large application with streams and files.	7
6.	Elementary word processing, spreadsheets and database concepts.	6
	Total	42

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Robert, L., “Object -Oriented Programming in C++”, Sams	2002
2.	Douglas, C., Schmidt, Stephen, D. and Huston, “C++ Programming”, Cook Book.	2008
3.	Balaguruswamy, “Object -Oriented Programming in C++” Tata McGraw-Hill	2008
4.	Rajaraman, V., “ Fundamentals of Computers”, PHI Learning	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-512** Course Title: **Biochemistry**

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

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

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

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

8. Pre-requisites: **Nil**

9. Objective: To impart knowledge of basic biochemistry for understanding many important problems of biology.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Molecular design of Life; Proteins-classification, levels of structure, function, specificity and dynamics; Overview of techniques of protein purification and characterization; Physiological and structural proteins- ribosomes, hemoglobin, myoglobin, collagen.	9
2.	Enzyme classification, kinetics and catalysis; Enzyme inhibition: Enzyme mechanisms and regulation.	9
3.	Nucleic acids-DNA,RNA, nomenclature, properties, DNA sequencing and chemical synthesis; Carbohydrates-Classification, structure, function; Lipids-Classification, structure, function; Biomembranes and glycoproteins.	10
4.	Metabolism, basic concepts and design; Carbohydtae metabolism-Glycolysis, citric acid cycle, oxidative phosphorylation; Lipid, amino acid and nucleotide metabolism; Coordinated control and regulation of metabolism.	8
5.	Introduction to bioinformatics; Photosynthesis; Biochemistry and physiology of sense organs, and muscle contraction	6
	Total	42

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Stryer, L., "Biochemistry" 4th edition, W. H. Freeman.	2002
2.	Horton, H.R., Moran, L.A., Ochs R.A., Rawn, J. D. and Scrimgeor, R.S., "Principles of Biochemistry" 3rd edition Prentice Hall,.	2001
3.	Voet, D. and Voet, J. G., "Biochemistry" 3rd edition, John Wiley and Sons.	2004
4.	Nelson, D.L. and Cox, M.M.,"Lehninger Principles of Biochemistry", 5th edition, W.H. Freeman.	2009
5.	Wilson, K. and Walker, J., "Principles and Techniques of Practical Biochemistry" 5th edition, Cambridge University Press.	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-513** Course Title: **Biotechnology Laboratory-I**

2. Contact Hours: **L**: 0 **T**: 0 **P**: 8

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

4. Relative Weight: **CWS** -- **PRS** **100** **MTE** -- **ETE** -- **PRE** --

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

8. Pre-requisites: **Nil**

9. Objective: To impart basic practical training in the field of biochemistry and molecular biology.

10. Details of Course:

S. No.	List List of Experiments:
1.	To determine the absorption maxima of two dyes using spectrophotometer. Demonstration of the Beer's law.
2.	To prepare the standard curve for protein estimation and to determine protein concentration by Biuret assay and Bradford method.
3.	Determination of Ascorbic acid concentration in citrus using 2, 6 dichlorophenol Indophenol.
4.	To detect Cholesterol in a given unknown sample by TLC.
5.	Ion-Exchange chromatography, gel filtration chromatography, affinity chromatography.
6.	Study of Enzyme kinetics.
7.	SDS-PAGE for protein separation.
8.	To understand the basic concept of cloning and perform few steps using GFP cloning.
9.	Electrophoretic separation of DNA in agarose gel.
10.	Isolation of RNA from animal tissues.
11.	The estimation of DNA by diphenyl amine.
12.	The estimation of RNA by means of orcinol reaction.
13.	Basic concept of southern blotting

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Joshi R A., and Saraswat M., "A text book of Practical Biochemistry".	2002
2.	Wilson, K. and Walker, J., "Principles and Techniques of Practical Biochemistry" 5th edition, Cambridge University Press.	2000
3.	Holtzhawer, Mertin, "Basic Method for the Biochemical Lab" (Springer lab manual).	2006
4.	Singh S.P., "Practical Manual of Biochemistry" 6 edition, CBS Publisher & Distributer.	2009
5.	Plummer, D. T., "An Introduction to Practical Biochemistry". 3rd Edition, Tata McGraw- Hill.	2006
6.	Sambrook,J., Russel, D.,"Molecular Cloninga Lab Manual" Vol. 3, 3rd Edition, Cold spring harber lab press.	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-514** Course Title: **Applied Microbiology**

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

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

4. Relative Weight**:** **CWS** **25** **PRS** **-** **MTE** **25** **ETE** **50** **PRE** **-**

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

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.	Discovery of microorganisms, morphological and structural organization of microbes,	5
2.	Ultrastructure of Archea, Eubacteria, Unicellular eukaryotes(Yeast) and Viruses (Bacterial, animal and tumour viruses),	5
3.	Microbial growth and nutrition, media formulation, sterilization, effect of physiological parameters.	6
4.	Growth kinetics: Batch, fed batch, continuous kinetics, screening of new metabolites; strain development-mutation and selection of mutants.	6
5.	Microbial interactions and infection, host-pathogen interactions, microbes infecting humans, veterinary animals and plants, pathogenicity islands and their role in bacterial virulence, quorum sensing	8
6.	Preservation of food, fermentation, food additives and supplements, nutritional requirements and growth curve, aerobic and anaerobic bioenergetics.	6
7.	Production of primary and secondary metabolites, metabolite genes and functions, representative examples of ethanol, organic acids and antibiotics	6
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Darnell, J., Lodish, H. and Baltimore, D., "Molecular Cell Biology", W.H.Freeman & Co.	1999
2.	Madigan, M.T. and Martinko, J.M., "Biology of Microorganisms", Person, Prentice Hall	2006
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 DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-515** Course Title: **Genetics and Molecular Biology**

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

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

4. Relative Weight: **CWS 25 PRS -- MTE 25 ETE 50 PRE --**

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

8. Pre-requisites: **Nil**

9. Objective: To expose students to the fundamentals of living processes by integrating cell with molecular biology.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Mendelian principles: Dominance, allele, complementation tests, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, Extra-chromosomal inheritance.	6
2.	Gene mapping methods: Linkage maps, tetrad analysis, mapping genes by interrupted mating, fine structure analysis of genes. Recombination. Mutation: Types, causes and detection, germinal verses somatic mutants, insertional mutagenesis.	6
3.	Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.	4
4.	Developmental Genetics: Genes in early development, maternal effect genes, Pattern formation genes, Homeotic genes. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.	3
5.	Chromosome organization, chromatin structure, complexity of eukaryotic chromosome, cot curve.	2
6.	DNA replication in prokaryote and eukaryotes, enzymes and accessory proteins, telomere replication.	5
7.	Transcription process in prokaryote and eukaryotie, Types of RNAs, transcriptional factors, regulation of transcription; RNA processing and RNPs-spliceosome, splicing of mRNA, tRNA and rRNA,; Nuclear export and stability of mRNA., regulation of gene regulation	10
8.	Translation Process- genetic code, translation mechanism of prokaryote ands eukaryotes, translational control, post translation modification.	6
	Total	42

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Alberts, B , Johnson, A., Laws, J., Raff, M., Robert, K. and Walter, P., " Molecular Biology of the cell" 4th edition, Garaland Publishing.	2002
2.	Watson, J.D., Baker, T. A., Bell, S. P., Gann, A., Levine, N. and Lovisk, R., "Molecular Biology of the gene "5th Edition, Pearson Education.	2004
3.	Lewis, B., "Gene VI" 8th edition. John Wiley and sons	2006
4.	Gardner, Simmons and Snustad; Principles of Genetics, 8th Edition. John Wiley & Sons	2012
5.	Griffith, Wessler, Lewontin and Carroll; Introduction to Genetic analysis; 9th Edition. Freeman, W. H. & Company	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-516** Course Title: **Cell and Developmental Biology**
2. Contact Hours: **L**: 3 **T**: 1 **P**: 0
3. Examination Duration (Hrs.): **Theory** 3 **Practical: --**
4. Relative Weight: **CWS 25 PRS -- MTE 25 ETE 50 PRE --**
5. Credits: **4** 6. Semester: **Autumn** 7. Subject Area: **PCC**
8. Pre-requisites: **Nil**
9. Objective: To expose students to the fundamentals of living processes by integrating functions of cells and the patterns of cellular processes during development of plants and animals.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Structure and function of cells; plasma membrane; molecular organization of cytoskeleton; endoplasmic reticulum- structure, role in glycosylation, lipid biosynthesis, intracellular transport and secretion; Golgi apparatus- organization & role in cell secretion; lysosomes, peroxisomes, glyoxisomes; nucleus-organization of DNA into chromosomes.	7
2.	Chromosome structure and functions; chromosome organization; chromatin structure, complexity of eukaryotic chromosome, cot curve.	7
3.	Cellular fates; signal transduction; malignant growth; cell differentiation; programmed cell death; aging and senescence.	7
4.	Basic concepts of development; potency; commitment; specification; induction; competence; determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells.	7
5.	Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation; cleavage; blastula formation; embryonic fields; gastrulation and formation of germ layers in animals; embryogenesis; establishment of symmetry in plants; seed formation and germination.	7
6.	Cell aggregation and pattern formation in *Drosophila*; amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*; eye lens induction; limb development and regeneration in vertebrates; organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy	7
	Total	42

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Alberts, B , Johnson, A., Laws, J., Raff, M., Robert, K. and Walter, P., " Molecular Biology of the cell" 5th edition, Garaland Publishing.	2007
2.	Watson, J.D., Baker, T. A., Bell, S. P., Gann, A., Levine, N. and Lovisk, R., "Molecular Biology of the gene "5th Edition, Pearson Education.	2004
3.	Gilbert, S. F., "Developmental Biology" 10th Edition, Sinauer Associates, Inc. USA	2013
4.	Wolpert, L., Tickle C., "Principles of Development" 4th Edition, Oxford University Press, UK	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-521** Course Title: **Molecular Biophysics**

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

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

4. Relative Weight: **CWS 25 PRS -- MTE 25 ETE 50 PRE --**

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

8. Pre-requisites: **Nil**

9. Objective: To impart knowledge on conformational analysis of biopolymers based on concepts of thermodynamics.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Properties of amino acids, polarity, discrimination function; Primary structure- cross links, sequence comparison, mutant proteins; Secondary structure,- α helix, β sheet, β turns, poly pro helices; Prediction method, tertiary structure, packing density.	10
2.	Conformational analysis, Φ Ψ angles, Ramachandran plot; Energy terms – vand der waal's, repulsive (non bonded), dipolar (bonded), torsional; Results of energy calculations, experimentally observed values of Φ Ψ angles; Hydrogen bonding, hydrophobic interactions, ionic interactions, disulphide bonds.	10
3.	Structure and physical properties of biomolecules–glycosidic bond rotation, backbone torsional angles and steric hindrance, sugar ring conformations, C3' endo, C2'endo and their energies; Polymorphism in DNA – A, B, Z family of structures, super helical forms; Base pairing – Hoogstein, Waston-Crick, energetics, electronic complementarity; Base stacking – Structure of t-RNA molecule, model of tertiary interactions; Nucleic acid dynamics - protein-nucleic acid interactions, energetic basis of protein structure, stability, dynamics and function, protein-protein and protein-ligand interactions	14
4.	Conformational analysis of carbohydrates, polysaccharides, peptidoglycan in bacteria & animal cell, glycosylation patterns, glycan analysis, energetics of protein-glycan interactions	6
5.	Micelle stability in membrane; Membrane equilibrium – osmotic pressure, Donnan effect. pH across membrane and membrane potential.	2
	Total	42

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Sinden, R.R., "DNA structure and function", Academic Press	1994
2.	Blackburn, G.M. and Giat, M.J., "Nucleic acids in chemistry and biology", IRL press.	2005
3.	Cantor, C.R. and Schimmel P.R., "Biophysical chemistry Part-I and Part-III", WH Freeman.	1986
4.	Govil, G. and Hosur, R.V., "Conformation of biological molecules NMR, Vol. 20", Springer Verlag.	1982
5.	Hoppe, W., Lohmann, W., Merklad, H. and Ziegler, H. "Biophysics", Springer Verlag.	1981
6.	Schulz, G.E.and Schirmer, R.H., "Principles of protein structure", Springer Verlag.	1989
7.	Creighton, T.E., " Protein structure: a practical approach" 2nd edition, Oxford University Press	1997

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-522** Course Title: **Immunology and Immunotechnology**

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

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

4. Relative Weight: **CWS 25 PRS MTE 25 ETE 50 PRE --**

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

8. Pre-requisites: **Nil**

9. Objective: To impart knowledge of basic concepts of immunology and its applications in diagnostics.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	General principles of immune system, cells and tissues of the immune system, blast formation, differentiation into effector and memory cells, phagocytes and lymphoid tissues.	3
2.	Molecular structure of antibodies, antibody diversity; types and functions of antibodies, antigen antibody interaction, B-cell maturation, rearrangement of immunoglobulin genes, expression of different classes of immunoglobulins, class switching.	8
3.	Discovery and structure of MHC, genomic organization and regulation of MHC expression, antigen processing and presentation to T cells, MHC restricted CD4 and CD8 T cells physiological significance, receptors and co-receptors involved in T cell.	8
4.	Cytokines-characteristics, receptors, cytokine related diseases and therapies; immunological tolerance and auto immunity, organ specific and systemic auto immune diseases	7
5.	Transplantation- immunologic basis of graft rejection, clinical manifestations, immunosuppressive therapy; Cancer and immune system-oncogenes and cancer induction, tumor antiges, tumor evasion of immune system, cancer immunotherapy	7
6.	Production and purification of antibodies, hybridomas, isolation and fractionation of lymphocytes, precipitation techniques, immunoelectrophoresis, radiommunoassays, enzyme linked assays, immunocytochemistry, immunohistochemistry and immunodiagnostics.	9
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Hildeman, W.H., "Essentials of immunology", Elsevier Scientific.	2002
2.	Abbas, A.K., Litchman, A.H. and Pobes, J,S,, WB "Cellular and Molecular Immunology", Saunders Co.	2000
3.	Sites, D.P., Stobo, J.D. and Wells, J.U., "Basic and clinical immunology", Prentice Hall.	1982
4.	Kindt, T.J., Goldsby, R.A., and Osborne, B.A., " Kuby Immunology", W.H. Freeman.	2007
5.	Roitt, I.M, Brostoff, J. and Male, D.K., "Immunology " Gower Medical Publishing.	1996

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-523** Course Title: **Biotechnology Laboratory - II**

2. Contact Hours: **L**: 0 **T**: 0 **P** : 8

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

4. Relative Weight: **CWS** -- **PRS 100** **MTE** -- **ETE** -- **PRE** --

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

8. Pre-requisites: **Nil**

9. Objective: The student is expected to develop skills and experience essential for understanding the integrated complexity of the structure and function of living cells and molecules.

10. Details of Course:

S. No.	List of Experiments
1.	Preparation and sterilization of culture media.
2.	Isolation of bacteria from different sources (soil, water, air).
3.	Characterization of the isolated bacteria obtained from different source samples.
4.	Identification of isolated bacterial calories using microscopic & staining techniques.
5.	To plot a growth curve of isolated bacterial strain.
6.	To carry out bacterial transformation conjugation and transduction using gene transfer methods.
7.	To prepare a survival curve for the given bacterial culture using germicidal UV radiation as a mutagen.
8.	To carry out Ame's test for detection of a possible chemical carcinogen**.**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	William, M., O'Leary, "Practical handbook of microbiology", CRC Press.	1989
2.	Albert, B., John H. H., "Practical bacteriology, microbiology and serum therapy (medical and veterinary)", Green.	1913
3.	Roy, D. and Cullimore, "Practical manual of groundwater microbiology:, CRC Press.	2008
4.	Goldman E., Lorrence, H. "Greenpractical handbook of microbiology", CRC Press.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-524** Course Title: **Technical Communication**

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

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

4. Relative Weight: **CWS 100 PRS - MTE -- ETE -- PRE --**

5. Credits: **2** 6. Semester: **Spring** 7. Subject Area: **PCC**

8. Pre-requisites: **Nil**

9. Objective: To develop skills related to delivering writing and discussion of the technical information.

10. Details of Course:

    a. Choosing of a topic from the advancements in biotechnology.
    b. Presentation of the topic following by discussion /question answer session.
    c. Preparing a write up for the selected topic.

11. Suggested Books:

    Recent research papers/reviews from the journals related to the selected topic.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-611** Course Title: **Biophysical Techniques**

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

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

4. Relative Weight: **CWS 25 PRS -- MTE 25 ETE 50 PRE --**

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

8. Pre-requisites: **Nil**

9. Objective: To impart knowledge of advanced analytical techniques in modern biology.

10. Details of Course:

S. No.	Contents	Content Hours
1.	Spectroscopic Techniques- UV-Visible, fluorescence, circular dichroism, nuclear magnetic resonance, isothermal titration calorimetry, atomic spectroscopy.	7
2.	Chromatographic methods- General principles, ion exchange, gel filtration, Affinity, HPLC and gas chromatography techniques.	6
3.	Electrophoresis- General principles, horizontal & vertical gel electrophoresis, isoelectric focusing, 2D, pulse-field and immuno, electrophoresis.	6
4.	Centrifugation techniques- Basic principles, different types of centrifuges, analytical and preparative ultracentrifugation methods,	6
5.	Microscopy- Dark-field, phase contrast, fluorescence, confocal, polarization, scanning and transmission electron microscopy.	6
6.	Radioisotope techniques- Basic concepts, GM and scintillation counter, autoradiography, RIA, applications in biological science	5
7.	Advanced techniques- Basics concepts and applications of mass spectrometry, X-ray crystallography and surface plasmon resonance.	6
	Total	42

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Pungor, E., "A Practical Guid to Instrumental Analysis", CRC Press.	1995
2.	Rickwood, D. and Hames, B.D., "HPLC, Gel Elctrophoresis, Oligonucleotide Synthesis, Soild Phase Peptide Synthesis, The Practical Approach Series", IRL Press.	1994
3.	Glasel, J.A. and Deutscher, M.P., "Introduction to Biophysical Method for Protein and Nucleic Acid Research", Academic press.	1995
4.	Campbell, I.D., and Dwek, R.A., "Biological spectroscopy", Benjamin Cummins.	1984
5.	Wilson, K. and Walker, J., "Principles and Techniques of Practical Biochemistry" 5th edition, Cambridge University Press.	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE: Department of Biotechnology

1. Subject Code: **BTN-612** Course Title: **Genetic Engineering**

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

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

4. Relative Weight: **CWS 25 PRS -- MTE 25 ETE 50 PRE --**

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

8. Pre-requisite: **Nil**

10. Objective: To impart knowledge of various genetic engineering techniques and their applications.

11. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction and historical background	2
2.	Restriction enzymes; Other enzymes used in DNA manipulation; Cohesive and blunt end ligation, Linkers, Adaptors, Homopolymeric tailing; Preparation of DNA and RNA probes; Hybridization techniques: Southern, Northern and colony hybridization; Fluorescence *in situ* hybridization; Chromatin Immunoprecipitation; DNA protein interaction-Electromobility shift assay; DNaseI footprinting; Methyl interference assay	8
3.	Plasmid and bacteriophage vectors: pUC19 and bluescript vectors, lambda vectors, M13mp vectors, insertion and replacement vectors, phagemids; Cosmids; Artificial chromosome vectors: Animal virus-derived vectors: SV40, vaccinia/baculo and retroviral vectors; Expression vectors; Protein purification: His-tag, GST-tag, MBP-tag, etc.; Intein-based vectors; Inclusion bodies: Methodologies to reduce formation of inclusion bodies; Baculovirus and Pichia vector systems; Plant-based vectors: Ti and Ri vectors; Yeast vectors; Shuttle vectors	8
4.	Introduction of foreign DNA into host cells; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning; Yeast two hybrid system; Phage display; Principles in maximizing gene expression	8
5.	Polymerase chain reaction (PCR); Primer design; Thermostable DNA polymerases; Types of PCR: Multiplex, nested, reverse transcriptase, real time, touchdown, hot start, colony PCR, etc.; Cloning of PCR products; T-vectors; Proof reading enzymes; Applications of PCR	8
6.	Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing: Chemical synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction of siRNA; siRNA technology; MicroRNA; Construction of siRNA vectors; Principle and applications of gene silencing; Gene knockouts; Gene therapy; Gene targeting; Transgenics; Possible risks and safety aspects of genetic engineering.	8
	Total	42

12. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Sambrook, J., Fritsch, E.F., and Maniatis, T., "Molecular cloning: A laboratory Manual", Cold Spring Harbor Laboratory.	2001
2.	Brown, T.A., "Gene Cloning and DNA Analysis", Blackwell Science.	2001
3.	Winnacker, E.L., "From Genes to Clones: An Introduction to Gene Technology", VCH.	1989
4.	Old, R.W. and Primrose S.B., "Principles of Gene Manipulation", Blackwell Scientific Publication.	1999
5	Gupta, P.K., "Biotechnology and Genomics", Rastogi Publications.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-614** Course Title: **Biotechnology Laboratory - III**

2. Contact Hours: **L**:0 **T**:0 **P**: 8

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

4. Relative Weight: **CWS -- PRS 100 MTE -- ETE -- PRE --**

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

8. Pre-requisite : **Nil**

9. Objective: This is an advance level practical course, which gives a hand- on experience using some of the most sophisticated equipment that students of biotechnology would use in their career.

10. Details of Course:

S. No.	List of Experiments
1.	To study the expression of cloned gene in E. coli using IPTG inducible promoter and analyze on SDS-PAGE
2.	To perform sandwitch Dot-ELISA for antigen detection.
3.	To perform western blot assay in order to make student understand various steps of western blotting technique.
4.	To perform IEF separation of protein on IPG strips and analysis using PD Quest software.
5.	To perform the southern blotting and hybridization experiment in order to make student understand various steps of southern blotting technique.
6.	DNA fingerprinting experiments and its analysis.
7.	Preparation of competent cells and determination of transformation efficiency using plasmid DNA (PUC19)
8.	Crystallization of Proteins by hanging and sitting drop method
9.	X-ray diffraction studies of macromolecules
10.	Structure determination of macromolecules using molecular replacement method
11.	Structure refinement of macromolecules using crystallography
12.	Ultraviolet spectra of oligo/ poly nucleotides and amino acids/ oligopeptide using Bechman DU6 and Elico spectrophotometer- dependence of absorbance on concentration.
13.	Florescence spectra of aromatic amino acid/ Trip- Tyr containing oligopeptides using Kontron SFM 25 Spectrofluorimeter- dependence of fluorescent intensity on concentration & inner filter effect.
14.	Characteristics of alpha helix, beta sheet and oligonucleotide (DNA/RNA- ApU/d-CpG minihelix)
15.	Separation of some aliphatic/ Aromatic compound/ biomolecules and purification of oligo-nucleotide/ oligo-peptides by reverse phase chromatography (C8/C18 column) by isocratic and gradient method using shimadzu LC 4A and 7A HPLC system.
16.	Assignment of different amino acid residues in an oligopeptide from ID-NMR

11. Suggested Books:

S. No.	Author(s)/Title/Publisher	Year of Publication/Reprint
1.	Sambrook,J., Russel, D.,"Molecular Cloninga Lab Manual" Vol. I, II and III, 3rd Edition, Cold spring harber lab press.	2001
2.	Walker, J.M. and Rapley, R. "Molecular Biology and Bio Technology" 4th Edition, Panima Publishing Corporation.	2002
3.	Messerschmidt, A. " X-ray Crystallography of Biomacromolecules: A Practical Guide". Wiley-VCH Verlag.	2007
4.	Roberts, G.C.K.,"NMR of Macromolecules : A Practical Approach". Oxford University Press.	2002

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-621** Course Title: **Cell and Tissue Culture Technology**

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

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

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

5. Credits: **3** 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisites: **Nil**

9. Objective: To give an overview of plant and animal tissue culture techniques and potential applications.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to basic principles of animal cell culture, laboratory requirements for setting up cell/tissue culture facility, sterility of cell culture facility.	6
2.	Techniques of cell culture – batch, batch fed and continuous cultures, design of media, cytotoxicity and viability assays, cell separation techniques, flow cytometry and fluorescence associated cell sorting, role of enzymes / isozymes in culture.	8
3.	Characterization of cell lines, cryo-preservation and cell banking, primary, secondary cultures and scale up operations.	6
4.	In situ hybridization, hybridoma technology, industrial products of animal cell culture.	5
5.	Elements of plant tissue culture, micropropagation of disease free plants, protoplast isolation, culture and fusion, genetic transformation, transgenic plants.	7
6.	Somoclonal variation and its applications, anther and microspore cultures, chromosome elimination in wild crosses, diploid plants.	5
7.	Tissue cultute techniques for plant inprovement, cryopreservation of germplasm, *in vitro* production of secondary metabolites and biotransformation.	5
	Total	42

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Freshney, R.I., "Animal Cell Culture – A Practical Approach", 4th Edn, Wiley-Liss.	2000
2.	Mukhopadhyay, A., "Animal Cell Technology", 1st Edn, I.K. International Publishing House.	2009
3.	Gupta, P. K., "Plant Biotechnology", Rastogi Publication.	2004
4.	Chawla, H. S., "Introduction to Plant Biotechnology" 2nd Edn, Science Publishers Inc.	2002
5.	Razdan, M.K., "Introduction to Plant Tissue Culture", 2nd End, Science Publishers Inc.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-622** Course Title: **Enzymology and Enzyme technology**

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

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

4. Relative Weight: **CWS 25 PRS -- MTE 25 ETE 50 PRE --**

5. Credits: **3** 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisites: **Nil**

9. Objective: To impart knowledge of fundamental principles of enzyme catalysis and applications of enzyme technology.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction and classification; Structure of enzymes- active site structure determination, identification of binding and catalytic sites, trapping of enzyme substrate complex.	8
2.	Extraction, purification , assay and analysis of enzymes	3
3.	Catalysis and kinetics, factors affecting rates of reaction; Kinetics of single substrate enzyme catalysed reactions, Michaelis- Menton equation, Briggs- Haldane modification, Lineweaver- Burk plot, Kinetics of multisubstrate enzyme catalysed reactions, ping-pong, random order and compulsory order mechanisms; Enzyme inhibition – competitive, uncompetitive and non competitive inhibition, substrate inhibition, allosteric and irreversible inhibition.	12
4.	Investigation of reaction mechanisms- steady and non-steady state methods; Monomeric enzymes- serine proteases, oligomeric enzymes, lactate dehydrogenase and lactose synthase; Mechanism of enzyme catalysis: metals and coenzymes.	7
5.	Binding of ligands to proteins, cooperativity, allosteric enzymes and metabolic regulation, sub-cellular compartmentalization.	5
6.	Clinical aspects of enzymes, plasma enzymes, inborn errors of metabolism, enzymes as reagents, large scale production and purification of enzymes; Immobilized enzymes- preparation and application; Application of enzymes and enzymes technology.	7
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Chaplin, M.F. and Bucke, C., "Enzyme technology," Cambridge University Press.	1992
2.	Palmer, T., "Understanding Enzymes", Prentice Hall.	1985
3.	Boyer, P.D., "The Enzymes V", , Academic Press	1992
4.	Buchholz, K., Kasche, V. and Bornscheuer, U. T., "Biocatalysts and Enzyme Technology", Wiley-VCH.	2005
5.	Shanmugam, S., **"**Enzyme Technology**",** I. K. International.	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-623** Course Title: **Bioprocess Engineering and Technology**

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

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

4. Relative Weight: **CWS 25 PRS -- MTE 25 ETE 50 PRE --**

5. Credits: **3** 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisites: **Nil**

9. Objective: This course is designed for familiarising students with basic idea of Microbial kinetics enzyme kinetics, immobilization kinetics, Bioreactor operation, downstream processing

10. Details of Course:

S.No.	Contents	Contact hours
1	**Basic principle of Biochemical engineering:** Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.	4
2	**Concept of basic mode of fermentation processes:** Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation – Batch, fed batch ad continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design- mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization; Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; scale up and scale down process.	8
3	**Downstream processing:** Bioseparation – filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.	8
4	**Applications of enzymes in food processing:** Mechanism of enzyme function and reaction in process techniques; Enzymic bioconversion e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc. and their downstream processing; banking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.	6

5	**Application of Microbes in food process operations and production:** Fermented foods and beverage; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavour, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and application in food preservation.	8
6.	Enzyme kinetics; Two-substrate kinetics and pre-steady state kinetics; Allosteric enzyme; Enzyme mechanism; Enzyme inhibitors and active site determination Production, recovery and scaling up of enzymes and their role in food and other industries; Immobilization of enzymes and their industrial applications.	8
		42

11. Suggested Books :

S.No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1	Stanbury, P.F., Hall, S. and Whitaker A., "Principles of Fermentation Technology" Second Edition Macmillian	2009
2	Doran, P.M., "Bioprocess engineering Principles" 2nd Edition Academic press	2012
3	Shuler, M.L., and Kargi, F. Bioprocess engineering:Basic concepts 2nd Edition, Prentice Hall	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-624** Course Title: **Molecular Carcinogenesis & Therapy**

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

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

4. Relative Weight: **CWS 25 PRS -- MTE 25 ETE 50 PRE --**

5. Credits: **3** 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisite : **Nil**

9. Objective: To impart knowledge of various factors that induces carcinogenesis and strategies for combating cancer.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to carcinogenesis, origin of cell line, normal and transformed cell lines, growth requirements, cell cycle, mutation in proliferating cells.	8
2.	Growth factors, regulation of cell proliferation PDGF, IGF & EGF receptor interaction, secondary message, erythropoietin, TCGF	6
3.	Characteristic feature of cancer cells, loss of normal cellular affinities, cytoskeletal changes, differential expression of genes, factor affecting carcinogenesis, chemical carcinogens, tumor promoters, viruses, DNA & RNA tumor viruses	8
4.	Role of large T antigen, oncogen carrying retro viruses, molecular features of oncogenes, human cancer genes: H-ras, K-ras and N-ras genes, chromosomal abnormalities in human tumors: abl and myc protooncogene, retinoblastoma gene 1	8
5.	Human cancer viruses- EB virus, Hepatitis B virus, HTLV, Papiloma virus, Cervical carcinoma	4
6.	Primary screening of anti tumor compounds, chemo therapy of Hodgkin's disease, lymphosarcoma & bronchiogenic carcinoma, cancer gene therapy and vaccines, future prospects.	8
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Ross, D.W., " Introduction to Oncogenes and Molecular Cancer Medicine" Springer-Verlag.	1998
2.	Franks, L. M. Teich, N.M., "Introduction to Cellular and Molecular Biology of Cancer", Oxford University Press.	1997
3.	Larionow, L. "Cancer Chemotherapy", Pergamon Press.	2003
4.	Rosenberg, S.A., "Principles and Practice of the Biologic Therapy of Cnacer" Lippincott Williams & Williams	2000

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-625** Course Title: **Vaccine Development & Production**

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

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

4. Relative Weight: **CWS 25 PRS -- MTE 25 ETE 50 PRE --**

5. Credits: **3** 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisite : **Nil**

9. Objective: To provides an in depth view of the various factors and designs used for vaccine production.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction, immune mechanism and effector system antigens, cell surface antigens	4
2.	Rationale for vaccine production, vaccine design in relation with immune response, conventional vaccines, modern vaccine technologies, whole organism and sub unit vaccines, recombinant vaccines, Vaccinia virus as vector for recombinant live vaccines	8
3.	Hepatitis B Virus-structure, antigenic determinants, pathogenesis, recombinant vaccines, vaccine production; Influenza virus-structural features, antigenic drift and antigenic shift, swine flu, bird flu, design and production of vaccine for influenza	8
4.	Polio virus-protomer of virus capsid, polio virus life cycle, pathogenesis, development of inactivated and oral polio vaccines; Herpes simplex virus, Human Immunodeficiency virus-HIV genome, antigenic diversity and modes of infection, designing of AIDS vaccine	8
5.	Bacterial virulence as strategy for developing vaccines, bacterial toxins, non toxic immunogenic analogs of toxins, factors affecting vaccine production, pertussis toxin, approaches for the development of pertussis vaccine. Design of vaccines cholera and streptococcal infection, intracellular bacterial and protozoan parasites and prospects of vaccines	8
6.	Design of peptide vaccines, nucleic acid vaccines, monoclonal antibodies as biotherapeutic agents, combination vaccines, immunological adjuvants	3
7.	Pharmaceutuical aspects- production, formulation and delivery systems, regulatory and clinical aspects	3
	Total	42

10. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Bittle, J.L. and Murphy, E.A., "Vaccine Biotechnology", Academic Press.	2002
2.	Cryps, S.J., "Immunotherapy and Vaccine", VCH Publ.	2003
3.	Walsh, G, " Biopharmaceuticals : Biochemistry and Biotechnology", John Wiley and Sons	2003
4.	Manuel, J.T.C., Griffiths, B. and José, L.P. M., "Animal Cell Technology: From Vaccines to Genetic Medicine", Springer.	1996
5.	"Vaccines: Preventing Disease and Protecting Health", World Health Organization.	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1.Subject Code: **BTN-626** Course Title: **Environmental Biotechnology**

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

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

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

5. Credits**:** 3 6. Semester**: Autumn/Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: Nil**

9. Objective of Course: The course will look at the biotechnological applications in waste treatment and biodegradation of various xenobiotic compounds using microorganisms.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction, parameters of pollution monitoring	2
2.	Waterborne infectious agents, detection and control of pathogenic microbes in water	6
3.	Wastewater treatment methods – Preliminary treatment, clarification, coagulation; aerated laggons; oxidation ponds; trickling filters; rotating biological contractors; wastewater treatment efficiency assessment	8
4.	Metagenomics and culture based approaches for bioremediation; Phyoremediation; waste treatment of dairy, distillery and pharmaceutical industries	8
5.	Biomass as a source of energy; biocomposting; vermiculture; organic farming; bio-mineralization, biofuel.	6
6.	Biodegradation of lignocelluloses, PAH, agricultural chemicals, oil pollution; biosurfactants; microbial leaching,	6
7.	Municipal techniques for prevention and biomedical solid wastes and their treatment, innovative techniques for prevention and control of pollution	6
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Hurst, C.J., Crawford, R.L., Knudsen, G.R., MacInerney, M.J., Stetzenbach, L.D., "Manual of Environmental Microbiology", ASM press, Washington, DC, Second edition.	2002
2.	Metcalf & Eddy, INC, "Wastewater Engineering- Treatment, Disposal and Reuse, 3rd Edition, Tata MacGraw-Hill publishing company Limited, New Delhi.	1995
3.	Pickup R.W and Saunders J.R., "Molecular approaches to environmental microbiology", Ellis Horwood Limited, First Edition, UK.	1996
4.	Scragg, A," Environmental Biotechnology", First Edition, Pearson Education Limited, UK.	1999
5.	Evans, G.M., Furlong, J C.," Environmental Biotechnology- Theory and application", John Wiley & Sons, Ltd, USA.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-627** Course Title: **Molecular diagnostic and Therapeutic Biotechnology**

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

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

4. Relative Weight: **CWS 25** **PRS --** **MTE 25** **ETE 50** **PRE --**

5. Credits: **3** 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisite : **Nil**

9. Objective: To provide knowledge and concepts of modern diagnostics & therapeutics biotechnology.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Immunological diagnostic procedures: enzyme linked immunosorbant assay, radioimmunoassay, dot and slot blot assay, detection of cytoskeleton proteins, immunochemistry of blood and bone marrow, immunosenor technology.	7
2.	Monoclonal antibodies as therapeutic agent: Prevention of rejection of transplant orgons, treatment of bacterial infection and leukemia, HLA typing, transplantation.	5
3.	Genetically engineered immunotherapeutic agents: Fusion protein, production of antibodies in E. coli, purification and application, chemically linked monoclonal antibodies, human monoclonal antibodies, hybrid human-mouse monoclonal antibodies, catalytic antibodies.	7
4.	DNA diagnostic system: Hybridization probes, diagnosis of malaria and other diseases, non isotopic hybridization procedure, detection of mRNA by in situ hybridization, hapten lebeling of nucleic acid probes.	6
5.	Molecular basis of multidrug resistance (MDR): In cancer, leishamania, candida and other diseases, a comparative view.	4
6.	Molecular diagnosis of genetic diseases: PCR application in genetic and diseases diagnosis, PCR/OLA procedure, mulation at different site within one gene, DNA fingerprinting (new genetic tests) application.	6
7.	Ribozymes: Synthesis *in vitro* application *in vivo*, clinical potentials of ribozymes.	3
8.	Genetherapy: Positional cloning, getting closer to diseases causing genes, genes based medicines, genetic immunization, human somatic cell gene therapy, *ex-vivo* and *in-vivo* gene therapy, antisense therapy, germline gene therapy, future and fears, HIV therapy.	4
	Total	42

10. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Buckingham, L. and Maribeth, L.F., " Molecualr Diagnostics: Fundamentals, Methods and Clinical Application", F.A. Davis.	2007
2.	David, B., Edward, A. and Carl. B., "Fundamentals of Molecular Diagnostics", W.B. Saunders.	2007
3.	Gardy, W.W., Nakumura, R.M. and Kieche, F.L., "Molecular Diagnostic: Techniques and Application", Academic Press.	2009
4.	Mausaaum, D., Prasad, G.B.KS., and Bisen, P.S.,"Molecular Diagnostics: Prospect and Possibilities", Springer	2010
5.	Blum, H.E., LU, C.H.,"Molecuar Diagnostics and Gene Therphy" Springer.	2009
6.	Maulik, S. and Patel, P.,"Molecular Biotechnology: Therapeutic and Stratgies", Humana Press.	1996

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-628** Course Title: **Gene Regulation**

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

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

4. Relative Weight: **CWS 25** **PRS --** **MTE 25** **ETE 50** **PRE --**

5. Credits: **3** 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisites: **Nil**

9. Objective: To provide information about the various mechanisms of gene regulation in bacteriphages, bacteria and eukaryotes.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Transcriptional regulation in bacteria; Translational and post-translational regulation in bacteria	8
2.	Gene regulation in bacteriophage lambda life cycle	3
3.	Tissue specific expression of proteins and messenger RNAs; Gene regulation by DNA loss, amplification and rearrangement	7
4.	Gene regulation at transcription in eukaryotes; Post- transcriptional regulation in eukaryotes	8
5.	Transcriptional control –chromatin structure, DNA sequence elements, transcriptional factors.	9
6.	Gene regulation and cancer	3
7.	Applications and future prospects of gene regulation studies	4
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Latchman, D. S., "Gene Regulation: An Eukaryotic Perspective", 2nd, Ed., Chapman and Hall.	2003
2.	Booker, R. J., "Genetics: Analysis and principles", Addison Wesley Longman.	1996
3.	Lewis B., "Genes VI", Oxford University Press.	2010
4.	Jun, M.A., "Gene Expression and Regulation", Springer Verlag.	2005
5.	Jeffery, W., "Post Transcriptional Gene Regulation", Humana Press.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject Code: **BTN-629** Course Title: **Genomics and Proteomics**

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

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

4. Relative Weight: **CWS 25** **PRS --** **MTE 25** **ETE 50** **PRE --**

5. Credits: **3** 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisites: **Nil**

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.

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 modifications, new directions.	4
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Campbell, A. M. and Heyer, L. J., "Discovering Genomics, Proteomics and Bioinformatics", Benjamin Cummings Publication.	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 DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-630** Course Title: **Bioinformatics**

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

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

4. Relative Weight: **CWS 25 PRS -- MTE 25 ETE 50 PRE --**

5. Credits: **3** 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisites: **Nil**

9. Objective: To expose students to the rapidly growing field of Bioinformatics

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to Bioinformatics, NCBI, Protein Data Bank and data retrieval.	6
2.	European Bioinformatics Institute database search; Understanding EXPASY server; European Molecular Biology server.	7
3.	Introduction to Sequence comparison, global and multiple sequence alignment, Multiple sequence alignment using FASTA, Sequence alignment using CLUSTALW, BLAST and advance BLAST.	9
4.	Introduction to 3-dimensional protein structure, superposition of molecules, RMS deviation, classification family of proteins and fold, SCOP, MSD.	10
5.	Introduction of Homology modeling, homology modeling using various tools	10
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Higgins, D. and Taylor, W., "Bioinformatics – Sequence, Structure and Databanks" , Oxford University Press.	2003
2.	Lacroix, Z. and Critchlow, T., "Bioinformatics – Managing Scientific Data", Morgan Kaufmann Publishers.	2003
3.	Bourne, E.,P. and Weissig H., "Structural Bioinformatics"' John Wiley and Sons.	2003
4.	Campbell, A.M., and Heyer, I.J., "Discovering Genomics, Proteomics and Bioinformatics"' Benjamin Cummings.	2003
5.	Mount D.W., "Bioinformatics – Sequence and Genome Analysis" Cold Spring Harbor Lab. Press.	2001
6.	Pevsner, J., "Bioinformatics and Functional Geonomics"' John Wiley & Sons.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-631** Course Title: **Transgenic Animal Technology**

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

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

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

5. Credits: **3** 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisite : **Nil**

9. Objective: To impart knowledge on the technologies involved in generating transgenic animals.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to transgenic animals, reproductive biology of rodents laboratory set up for generating transgenic animals, instrumental set up, various rodent models, breeding procedures, animal house facilities.	6
2.	Basics of transgenic animal production by microinjection method, procedure of super ovulation of animals, egg collection, production of pseudo pregnant female animals, procedure of castration, various methods of microinjections.	7
3.	Applications of knockout animals, principles of making knockout animals, concept of stem cells, culture of stem cells, various methods of gene transfer, blastocyst injection, concept of chimeric animals, making of knockout gene constructs.	8
4.	Viral mediated gene delivery methods, viral vectors, generation of packaging cell lines, testing viral titers.	6
5.	Analysis of integration patterns of transgenes, calculation of copy numbers, concept of founder animals, test cross of transgenic animals.	5
6.	Conditional transgenic animal production technology, applications in biomedical research, marker genes.	5
7.	Basic principles for the production of transgenic fish, poultry breeds, cloning of animals, applications of transgenic animals.	5
	Total	42

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Pinkert, C.A., "Transgenic Animal Technology- A Laboratory Handbook", 2nd Edn, Academic Press.	2002
2.	Nagy, A., Gertsenstein, M., Vintersten, K. and Behringer, R., "Manipulating Mouse Embryo- A Laboratory Manual", 3rd Edn, Cold Spring Harbor Laboratory Press.	2003
3.	Jackson, I.J. and Abbott, C.M., "Mouse Genetics and Transgenics- A Practical Approach" 1st Edn, Oxford University Press.	2001
4.	Tymms, M.J. and Kola I., "Gene Knockout Protocols (Methods in Molecular Biology)", Vol. 158, Humana Press.	2001
5.	Hadley, M.E. and Levine, J.E., "Endocrinology", 6th Edn, Pearson Education Inc.	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-632** Course Title: **Structure Biology**

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

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

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

5. Credits**:** **3** 6. Semester**: Autumn/Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: Nil**

9. Objective:. To impart deep knowledge of biomolecular structural interactions for elucidating structure-function paradigm and structure based drug design.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Overview of structural biology; Primary, secondary, tertiary and quaternary structure of protein; Motifs and domains of protein structures; Structure of RNA and DNA; Conformational analysis	6
2.	Enzymes structure-function relationship and the basis of structure-based drug design	3
3.	Folding and flexibility; helix-coil transition, equilibrium & kinetics studies, duplex to single strand transition, A to B to Z transition, stacking and unstacking equilibrium	7
5.	Symmetry, space group crystal lattices, The Laue equations. Braggs Law. Fourier syntheses, electron density as a Fourier series. structure determination of macromolecules by crystallography technique	12
6.	Nuclear Magnetic Resonance, chemical shift, relaxation dynamics, protein structure determination using multidimensional NMR, molecular mechanisms, thermodynamic concepts and conformational exchange of biomolecules	12
7.	Structures of large molecular machines and virus assembly	2
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Cantor, C. R. and Schimmel, W.H., "Biophysical Chemistry Part-I and Part-III", Freeman & Co.	1981
2.	McPherson, A. **"** Introduction to Macromolecular Crystallography", 2nd edition, Wiley-Blackwell.	2009
3.	Drenth, J., "Principles of Protein X-Ray Crystallography", 3rd edition, Springer.	2007
4	Keeler J. "Understanding NMR Spectroscopy" 2nd edition, Academic Press	2010
5	Wüthrich K "NMR of Proteins and Nucleic Acids" 2nd edition, (Baker Lecture Series)/ John-Wiley.	1986

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-633** Course Title: **Bio- Crystallography**

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

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

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

5. Credits**:** **3** 6. Semester**: Autumn/ Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: Nil**

9. Objective: To give an overview of X-ray crystallography and its application for determining the structure-function relationship of bio-molecules.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Overview of crystallography, X-ray production	2
2.	Crystallization methods and crystal preparation	3
3.	Crystal symmetry, Laue groups, Bravais lattices	5
4.	Diffraction theory, crystal mounting, data collection/instrumentation	4
6.	Data processing: HKL2000 XDS and MOSFLM software packages	4
7.	Space group determination and Wilson plots	3
8.	Phase problem, Patterson maps and structure determination methods	3
9.	Multiple/single isomorphous replacement (MIR/SIR)	3
10.	Multiple/single wavelength anomalous diffraction (MAD/SAD)	3
11.	Molecular replacement (MR)	3
12.	Model refinement: CNS, CCP4 and SHELX software packages	3
13.	Model building, map interpretation and interpreting models	3
14.	Application of X-ray crystallography: Structure and function analysis	3
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Drenth, J, "Principles of Protein X-ray Crystallography", 2nd edition, Springer.	2000
2.	Hahn, T. " International Tables for Crystallography, Volume A: Space-group symmetry", 5th edition, Springer.	2005
3.	McPherson, A. " Introduction to Macromolecular Crystallography", 2nd edition, Wiley-Blackwell.	1999
4.	Rhodes G. "Crystallography made crystal clear", 2nd edition, Academic Press, Inc. USA.	2000
5.	Rossmann, M.G., "International Tables for Crystallography, Volume Crystallography of biological macromolecules", 1st edition, Springer.	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-634** Course Title: **Viruses and Human Diseases**

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

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

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

5. Credits**:** **3** 6. Semester**: Autumn /Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: Nil**

9. Objective: The course emphasizes on the fundamentals of virology and on understanding the mechanisms by which viruses cause infection and human diseases.

10. Details of course:

S. No.	Contents	Contact Hours
1.	Introduction to viruses and virus infection, virus classification, the replication cycle of viruses, virus hosts and effect of infection on the host cell, viral epidemiology	3
2.	Structure of viruses: Enveloped and Non-enveloped viruses, helical and icosahedral symmetry, virus structure determination	3
3.	Viral multiplication and translation strategies: Transcription, assembly, maturation and release of virions.	3
4.	Plus-strand RNA virus: Virus entry, replication, assembly, maturation and pathogenesis, origin and evolution, Polio virus, Chikungunya virus, Dengue virus, JEV, HCV, SARS coronavirus	6
5.	Minus-strand RNA virus: Introduction, virus entry and replication, assembly, virus pathogenesis, Mealses virus, Mumps virus, Rabies virus, Influenza viruses, Ebola virus etc	6
6.	Double stranded RNA virus, reteroviruses and DNA viruses: Virus life cycle, replication and transcription, Rotavirus, HIV and AIDS, HTLV, Small pox virus, Monkey pox virus etc	8
7.	Virus-host interaction: Immune response to viral infection, Innate and acquired immunity, B-cells, T-cells, virus induced immunopathology and immunosuppression	5
8.	Viral pathogenesis: Viral strategy to inhibit eukaryotic translation, cytopathic effect, plaque assay, tropism, virulence, viral replication vs viral disease; Virus vector system and gene therapy	5
9.	Diagnosis, treatment and vaccination: different types of vaccines, antiviral drug targets and antiviral drug discovery, immuno-therapeutics, resistance to antivirals	3
	Total	**42**

11. Suggested Books:

S No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Strauss, E. G. and Strauss, J. H., "Viruses and Human Disease", Academic Press	2007
2.	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
3.	Bernard N. Fields and David Mahan Knipe, "Fundamental Virology", Raven Press	2001
4.	John Carter and Venetia A. Saunders, "Virology: Principles and Applications, 2nd edition, John Wiley & Sons Inc.	2013
5.	Antiviral Drug Discovery for Emerging Diseases and Bioterrorism Threats. Paul F. Torrence (Editor), John Wiley & Sons, Inc.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN- 635** Course Title: **Chemical Genetics and Drug Discovery**

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

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

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

5. Credits**:** **3** 6. Semester**: Autumn/Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: BT-512**

9. Objective: To impart advanced knowledge to Msc final year or fresh Ph.D students in the upcoming area of chemical genetics and drug discovery

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to Classical genetics, Forward genetics, Reverse genetics, Phenotypes,Target identification, biochemical methods.	4
2.	Introduction to Chemical genetics, Forward chemical genetics, Reverse chemical genetics, Comparison and contrast between forward chemical genetics and reverse chemical genetics, small molecules as probes of physiological functions	8
3.	Forward chemical genetics (obtain library, screen, identify target) Chemical libraries: target-oriented synthesis vs diversity oriented synthesis. High throughput screening, high content screening for drug like molecules.Phenotype based screens. Target identification: biochemical approaches; 3-hybrid screens. Chemical approaches (labelling of small molecules, pull-down and cross-linking)	12
4.	Reverse chemical genetics: Relationship to "classical" drug discovery. Lead discovery; fragment based approaches. Diversity oriented synthesis. High throughput screening, high content screening for drug like molecules.	9
5.	Drugs, Antibiotics, Anticancer drugs, mode of action, Discovery of drugs from natural products, drug action and resistance.	9
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Marechal, E., Roy, S., Lafanechere, L., " Chemogenomics and Chemical Genetics", Springer-Verlag Berlin and Heidelberg GmbH & Co. KG., ISBN: 9783642196140	2011
2.	Hisashi, K., "Reverse chemical genetics – methods and protocols", Springer protocols, Humana Press., ISBN 978-1-60761-231-5	2009
3.	Kubinyi, et al., ed., " Chemogenomics in drug discovery: A medicinal chemistry perspective". John Wiley and sons,	2004
4.	Walsh, C., "Antibiotics. Actions, Origins, Resistance". ASM press	2004

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-636** Course Title: **IPR, Good Lab Practices and Bioethics**

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

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

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

5. Credits**:** **3** 6. Semester**: Autumn/Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: BT 524**

9. Objective: To impart advanced knowledge to Msc final year or fresh Ph.D students in the areas of Intellectual Property Rights, good lab practices, biosafety and bioethics

10. Details of Course:

S. No.	Contents	Contact Hours
1.	IPR- Introduction, International laws, creation of IP, IP management, Need for IP: National scenario, TRIPS agreements, Knowledge management databases	8
2.	IPR databases- USPTO, WIPO, patent search, How to carry out patent search, novelty search in various databases, Genetically modified organisms-IPR issues patenting of cell lines , microbes, plant varieties. Patent application and filing. Traditional knowledge: concepts of folklore and traditional knowledge, forms of traditional knowledge.Traditional Knowledge Digital Library (TKDL): its purpose, structure and possible risks	14
3.	Good lab practices:- Introduction, maintenance of lab record notebook, biosafety, level of contamination, safety levels, radiation safety, how to handle chemicals, biochemicals, radioisotopes, toxic chemicals safety measures required.	10
4.	Bioethics- Introduction, international standards, ethical issues in patenting, publishing, how to decide authorship in publications, Issues arising out of Neem, Haldi and basmati cases, conditions and procedure for registration, offences, penalties	10
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Dutfield Graham, "Intellectual Property, Biogenetic Resources and Traditional Knowledge", Earthscan Publications Ltd, illustrated edition	2004
2.	Klemm, Cottier T., "Rights to Plant Genetic Resources and Traditional Knowledge: Basic Issues and Perspectives", Cabi Publishing, 1 ed.	2006
3.	"The Geographical Indications of Goods, (Registration and Protection) Act"	1999
4.	Mgbeoji, Ikechi, "Global Biopiracy: Patents, Plants, And Indigenous Knowledge", Cornell University Press, 1 ed.	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE : Department of Biotechnology

1. Subject Code: **BTN-637** Course Title: **Nanobiotechnology**

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

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

4. Relative Weight: **CWS 25 PRS -- MTE 25 ETE 50 PRE --**

5. Credits: **3** 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisites: **Nil**

9. Objective of Course: This course is intended to impart the knowledge of nanoscale biological molecules, their methods of analysis, integration to macromolecules, and providing an understanding of nanobiotechnological applications in different fields.

10. Details of Course :

S. No.	Contents	Contact Hours
1	**Overview of Nanobiotechnology -** Historical perspective of Integration of biology, chemistry, and material science. Opportunities and Promises of nanobiotechnology.	3
2	**Functional Principles of Nanobiotechnology-** Structure and functional properties of Biomaterials, Bimolecular sensing, Molecular recognition and Flexibility of biomaterials.	4
3	**Protein and DNA based Nanostructures -** Protein based nanostructures building blocks and templates – Proteins as transducers and amplifiers of biomolecular recognition events – Nanobioelectronic devices and polymer nanocontainers – Microbial production of inorganic nanoparticles – Magnetosomes. DNA based nanostructures – Topographic and Electrostatic properties of DNA and proteins – Hybrid conjugates of gold nanoparticles – DNA oligomers	8
4	**Nanomaterials used in Biotechnology -** Nanoparticles, carbon nanotubes, quantum dots and buckyballs interface with biological macromolecules. Biological perspectives of nanomaterials – impact of nanomaterials in biological processes – tolerance by immune systems and toxicity. *Nucleic acid Engineering***-** Modifications of DNA for nano-technological applications. Nanostruture assembly using DNA.	6
5	**Nanotechnology in Biomedical and Pharmaceutical Industry -** Nanoparticles in bone substitutes and dentistry – Implants and Prosthesis - Reconstructive Intervention and Surgery – Nanorobotics in Surgery – Photodynamic Therapy - Nanosensors in Diagnosis– Protein Engineering – Drug delivery – Therapeutic applications	6

6	**Biosensing Applications of nanobiotechnology –** *Nano-Biosensing***-** Biosensors and nanobiosensors – basics. Design and types of nano-biosensors. DNA aptamers for nano-biosensing and drug discovery.	7
7	**Nanotechnology in Agriculture and Food technology -** Insecticides development using nanotechnology and Nanofertilizers. Nanotechnology in food processing, food safety and biosecurity, toxin and contaminant detection, Smart packaging.	8
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact‖, Wiley – VCH.	2005
2.	D.S. Goodsell, Bionanotechnology: Lessons from Nature, Wiley Press	2004
3.	C. M. Niemeyer and C. A. Mirkin- (Editor), Nanobiotechnology: Concepts, Applications and Perspectives, Wiley Press	2004
4	Jennifer Kuzma and Peter VerHage, Nanotechnology in agriculture and food production, Woodrow Wilson International Center	2006
5	Neelina H. Malsch (Ed.),Biomedical Nanotechnology, CRC Press	2005
6	Mark A. Ratner and Daniel Ratner,Nanotechnology: A Gentle Introduction to the Next Big Idea, Pearson	2003
7	S. Klussman, The Aptamer Handbook: Functional Oligonucleotides and their Applications , Wiley- VCH Press	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: Department of Biotechnology

1. Subject Code: **BTN- 638** Course Title: **Microbial Genetics and applications**

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

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

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

5. Credits**:** **3** 6. Semester**: Autumn/Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: BT-524**

9. Objective: To impart advanced knowledge to second year Masters and Pre-PhD students about the developments in the microbial molecular biology and genetics from research point of view.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Overview; organization of microbial genomes, transcription and translation, gene regulatory elements in microbial genomes.	4
2.	Non Coding RNA in microbial Genomes; small RNA – discovery, functions, mode of gene regulation, small RNA in prokaryotes.	8
3.	Ribozymes and Riboswitches mediated gene regulation in Microbes, riboswitches as antimicrobial drug targets.Antisense RNA - Utilization of antisense techniques to understand gene functions in *E.coli* and *Staphylococcus* sp.	8
4.	Cell to cell communication - Quorum sensing in microbes.	3
5.	Molecular Microbial Diversity –Various molecular methods to study microbial diversity; comparison of culture dependent and culture independent approaches. Isolating Functional genes from uncultivable microbes.	7
6.	Advances in Genetic engineering techniques for analysis of microbial genomes and their applications – Interpreting the genomes, genomic library construction from degraded DNA, PCR cloning, Site directed mutagenesis, mutator strains, error prone PCR for protein engineering.	9
7.	Genetic Basis of Multiple drug resistance in emerging pathogenic bacteria - gene flow in microbial communities.	3
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Darnell, J., Lodish, H. and Baltimore, D., "Molecular Cell Biology", W.H.Freeman & Co.	1999
2.	Maloy, S., Cronan ,J.E. Jr., and Freifelder, D., "Microbial Genetics" Jones and Bartlett Publishers.	2006
3.	Watson, J.D., "Molecular Biology of The Cell", Taylor & Francis	2002
4.	Gestland , R.F., Cezh T.R., Atkins, J.F. " The RNA World – 3rd Edition"- Cold Spring Harbor Press.	2006
5.	Snyder, L., Champness, W., "Molecular Genetics of bacteria" ASM press.	2007
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: **BTN-639** Course Title: **Clinical Proteomics**

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

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

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

5. Credits**:** **3** 6. Semester**: Autumn/Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: NIL**

9. Objective: To impart the knowledge of application of proteomics in translational research.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to Proteomics, Sample collection, Storage and Handling to Overcome Pre-analytical Problems/Issues	1
2.	Protein Isolation for Characterization	6
3.	Application of Technologies such as 2DE, High performance Liquid Chromatography and Mass Spectrometry	24
4.	Use of Proteomic Technologies in Diseases in Humans and Animals	10
5.	Future directions	1
	Total	**42**

11. Suggested Books:

S. No.	Authors/ Name of Books/Publisher	Year of Publication/Reprint
1.	Antonia Vlahou "Clinical Proteomics Methods and Protocol" Wiley-VCH	2008
2.	Jennifer E. Van Eyk and Michael J. Dunn. "Clinical Proteomics: From Diagnosis to Therapy. Wiley-VCH	2007
3.	Hubert Rehm. "Protein Biochemistry and Proteomics" Academic Press	2006

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE : Department of Biotechnology

1. Subject Code: **BTN-640** Course Title: **NMR in Biology and Medicine**

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

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

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

5. Credits**:** **3** 6. Semester**: Autumn/ Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: Nil**

9.Objective: To impart the knowledge of nuclear magnetic resonance concepts and its applications in biology and medicine

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Principles of NMR spectroscopy, Understanding NMR spectrometer, data processing, Fourier transformation, Resolution, sensitivity, NMR Probes, NMR Pulses, Gradients, etc	8
2.	Theory of Chemical Shifts, Spin- spin coupling, dipolar coupling, longitudinal, transverse and cross relaxation parameters, Nuclear Overhauser effect (NOE), principles of polarization transfer, homonuclear and heteronuclear Two-dimensional NMR	8
3.	Basic NMR signatures of proteins/peptides, Isotopic labeling strategies, Theory and applications of solution state NMR Triple resonance (3-Dimensional) experiments for protein backbone, side chain assignment. NMR analysis of protein structural determination, dynamics and stabilities	9
4.	Carbohydrates, Nucleic acids and membrane NMR and their resonance assignment strategies, NMR of protein-DNA/carbohydrate/membrane interactions, Characterizing binding surfaces and affinities	9
5.	Solid state NMR: Magic Angle Spinning (MAS), Cross Polarization (CP), CP-MAS, and biological applications.	4
6	Advanced NMR concepts: In-vivo NMR, Magnetic Resonance Imaging, fMRI/MRS and NMR of metabolites	4
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Keeler J. "Understanding NMR Spectroscopy" 2nd edition, Academic Press	2010
2.	Wüthrich K "NMR of Proteins and Nucleic Acids" 2nd edition, (Baker Lecture Series)/ John-Wiley.	1986
3	Cavanagh, J., Fairbrother, W.J., Palmer III, A.J., Skelton, N.J., and Rance M. "Protein NMR Spectroscopy: Principles and Practice" 2nd edition, Academic Press	2005
4	Chary, K.V.R, and Govil, G., "NMR in Biological system", From Molecules to Man, Springer Netherland	2008
5	Glasel, J. A., and Deutscher, M.B., "Introduction to Biophysical Methods for Protein and Nucleic acid Research", Academic Press	1995
6	Evan, J.N.S., "Biomolecular NMR spectroscopy", Oxford University Press	1995

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: Department of Biotechnology

1. Subject Code: **BTN-641** Course Title: **Biophotonics**

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

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

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

5. Credits**:** **3** 6. Semester**: Autumn/Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: Nil**

9. Objective: To impart knowledge about the emerging field of biophotonics and the application of optical based technologies in the field of biosensing, imaging etc.

10. Details of Course:

S. No.	Contents	Contact Hours
1	Basics of structure and function of living materials, Process of light interaction with matter, Light – matter interaction, fundamental nature of light.	5
2	Interaction of light with cells and tissues- Components that interact with light, light absorption in cells, light induced cellular processes, Interaction of light with tissues- absorption, scattering, tissue optical properties, light induced processes in tissue, radiative transport theory	7
3	Optical Spectroscopy: Fluorescence spectroscopy, Raman spectroscopy, CARS, fluorescence detection and quantification of nucleic acids, proteins and cells, Optical activity and circular dichroism.	6
4	Types of light sources, basic principles of lasers, Lasers relevant to biophotonics.	5
5	Optical imaging- Background and need for optical imaging, Different optical imaging techniques, Microscopy –Simple, compound, Fluorescence microscopy, confocal microscopy, Optical tomography, fluorescence resonance energy transfer (FRET), fluorescence life time imaging (FLIM).	8
6.	Optical biosensing- principle, fiber optic biosensors, surface plasmon resonance biosensors, Applications of Bioimaging- endogenous and exogenous fluorophores, tissue imaging, in vivo imaging. Optical diagnostic technique, Light for therapy and treatment, optical tweezer, laser scissor.	9
7.	Bio nanophotonics - major areas of nanophotonics.	2
	Total	**42**

11. Suggested books:

S No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1	Paras N. Prasad, "*Introduction to Biophotonics",* Wiley & Sons	2003
2	Bahaa Saleh and Malvin Teich, "*Fundamentals of Photonics"*, Wiley & Sons	2007
3.	Joseph R Lakowicz , "Principles of fluorescence spectroscopy", Springer	2006
4.	T. Vo-Dinh ed., "Biomedical Photonics Handbook", CRC Press Optics	2002
5.	E. Hecht, "Optics" , Addison-Wesley	2002
6.	Splinter R, and Hooper BA, " An Introduction to Biomedical Optics", CRC Press,Taylor and Francis	2007
7.	Iain D. Campbell, Raymond A. Dwek, "Biological Spectroscopy (Biophysical techniques series)", Benjamin-Cummings Pub Co; 1 edition	1984

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE: Department of Biotechnology

1. Subject Code: **BTN-642** Course Title: **Plant System Physiology**

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

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

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

5. Credits: **3** 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisites: **Nil**

9. Objective: This course will provide a detailed insight into the Plant system physiology to equip students with "state of the art" knowledge in plant system physiology and their modern application in crop improvement.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction**, Plant Metabolism and Nutrient Assimilation:** metabolic processes, natural rhythms, Solute transport and photo assimilate translocation, uptake, transport and translocation of water, ions, solutes, transpiration, mechanisms of Phloem loading and unloading. Recent concept of RNA-mediated solute transport in Plants; Nitrate and ammonium assimilation; amino acid biosynthesis.	6
2.	**Physiology of Photosynthesis**: Light harvesting complexes; mechanisms of electron transport; photo-protective mechanisms; CO2 fixation-C3, C4 and CAM pathways, Photorespiration.	5
3.	**Physiology of Respiration**: Citric acid cycle; plant mitochondrial electron transport, Mitochondrial genome, ATP synthesis; alternate oxidase (AOX); Seed Lipid metabolism.	5
	Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism, vernalization and biological clocks.	6
4.	**Plant Growth regulators**: Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.	4
5	**Plant Development:** Messenger Systems and Cell-Signaling. Morphogenesis and organogenesis in plants. Leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum*	4
6	**Plant Secondary metabolites**: Biosynthesis of terpenes, phenylpropanoids and nitrogenous compounds (Alkaloids) and their ecological roles. Metabolic engineering of plant secondary metabolites in plants. Secondary metabolites as phytomedicines and phytoalexins.	6
7	**Stress physiology:** Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses. Molecular and environmental stress physiology.	6
	Total	42

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/Reprint
1.	Lincoln, Taiz., & Eduardo, Zeiger., " **Plant Physiology"** 5th Edn, Publisher: Sinauer Associates, Inc	2010
2.	Hemantaranjan, A., "**Advances in Plant Physiology Vol. 14**", Scientific Publishers	2013
3.	Jain, V. K., " **Fundamental of Plant Physiology**" Edn – illustrated; Publisher: S. Chand limited	2000
4.	Hari Shankar Srivastava " **Plant Physiology**" Rastogi Publications.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: Department of Biotechnology

1. Subject Code: **BTN-643** Course Title: **Microbial Technology**

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

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

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

5. Credits**:** 3 6. Semester**: Autumn/Spring** 7. Subject Area**: PEC**

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.	Microbial Diversity & Systemics: Domain and kingdom concepts in classification of microorganisms; Criteria for classification; role of rDNA sequencing and database projects	5
2.	Microbial Growth & Physiology: structural organization and multiplication of microorganisms. Physiological adaption and life style of prokaryotes; Extremophiles	8
3.	Large scale cultivation of industrial important microbes; Novel tools used for strain development/improvements; process optimization of selected products.	8
4.	Recombinant protein production in microbes; down stream processing; industrial microbes as cloning hosts.	6
5.	Production of primary and secondary metabolites, Biofuels; bioremediation, leaching of ores by microorganisms; biofertilizers, biopesticides, biosensors.	8
6.	Recovery and purification of fermentation products; Cell immobilization for product enhancement; Fermentation economics	7
	Total	**42**

11. Suggested Books:

S. No.	Author(s)/ Title/ Publisher	Year of Publication/ Reprint
1.	Glazer, Nikaids, "Microbial Biotechology" 2nd Ed., Cambridge University Press	2007
2.	Madigan, M.T. and Martinko, J.M., "Biology of Microorganisms", Person, Prentice Hall	2006
3.	Stanbury, P.F., Whitakar, A., Hall, S.J., "Principles of fermentation technology", Pergamon Press, Oxford.	1995

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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

1. Subject code : **BTN- 644** Course Title: **Research Methods in Bionanotechnology**

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

3. Examination Duration (Hours): Theory : **03** Practical : **--**

4. Relative Weight : CWS : **25** PRS : **--** MTE : **25** ETE : **50**

5. Credits : **03** 6. Semester : **Autumn/Spring** 7. Subject Area : **PEC**

8. Pre-requisite: **Nil**

9. Objective: To impart knowledge on various research methods in bionanotechnology.

10. **Details of Course:**

S.No.	Contents	Contact Hours
1.	**Overview of Bionanotechnology:** DNA nanotechnology; RNA nanotechnology; Protein nanotechnology; Lipid nanotechnology; Carbohydrate nanotechnology.	**6**
2.	**Calculations in Bionanotechnology:** Scientific notations; Calculating dilutions and concentrations; Quantification and analyses of biomolecules; Biostatistical methodologies.	**10**
3.	**Biotechniques:** DNA and RNA purification; Isolation of gene and cloning; PCR- optimization and designing of primers; Electrophoresis; Southern, Northern and Western blotting techniques; Prokaryotic and eukaryotic expression systems.	**10**
4.	**Characterization of therapeutic nanoparticles:** Techniques to determine physical and chemical properties; Assays for detection and quantitation; *in vitro* immunological assays; Pharmacokinetics of therapeutic nanoparticles.	**10**
5.	**Methods in Nanotoxicology:** Cell culture techniques; Cytotoxicity and genotoxicity methods; *in vitro* and *in vivo* nanotoxicology assays.	**6**
	Total	**42**

11. **Suggested Books:**

S.No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Berg, J.M., Tymoczko, J.L. and Stryer, L., "Biochemistry", 6th Ed.-W. H. Freeman and Company.	**2008**
2.	Rosenthal, S.J. and Wright, D.W., "Methods in Molecular Biology-NanoBiotechnology Protocols", Humana Press.	**2005**
3.	McNeil, S.E., "Characterization of Nanoparticles Intended for Drug Delivery", Humana Press.	**2011**
4.	Stephenson, F.H., "Calculations for Molecular Biology and Biotechnology-A Guide to Mathematics in the Laboratory" Academic Press.	**2003**
5.	Gerstein, A.S. "Molecular Biology Problem Solver: A Laboratory Guide", Wiley-Liss, Inc.	**2001**