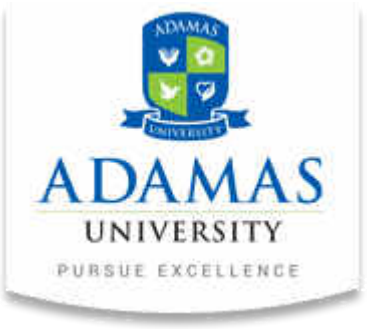

School of Biotechnology

2 Years M.Sc. Biotechnology Course Structure
Total Credits - 100

COURSE STRUCTURE FOR BIOTECHNOLOGY UNDER CBCS BASED CREDIT SYSTEM
(TOTAL CREDIT =22+23+25+30=100)

ADAMAS UNIVERSITY							
FACULTY OF SCIENCE **DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM** SEMESTER - **I** **(Course Code: SBT)**							
Type of the Paper	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
CORE	**SBT51101**	**Theory Biomolecules & Metabolism**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT51103**	**Theory Biophysical chemistry & Bioanalytical Techniques**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT51105**	**Theory Cell & Developmental Biology**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT51107**	**Theory Molecular Genetics**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT51201**	**Practical Analytical Biochemistry & Biophysical Chemistry Lab**	**8**	**0**	**0**	**8**	**4**
CORE	**SBT51203**	**Practical Cell Biology and Genetics Lab**	**8**	**0**	**0**	**8**	**4**
FOUNDATION	**SGY51111**	**Environmental Science and Energy Resources**	**2**	**2**	**0**	**0**	**2**
OTHERS		**English/ Foreign Language**	**2**				**Non Credit**
Total							**22**

ADAMAS UNIVERSITY							
FACULTY OF SCIENCE **DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM** SEMESTER **- II**							
Type of the Paper	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
CORE	**SBT51102**	**Theory Molecular Biology of the Cell**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT51104**	**Theory Recombinant DNA & Genetic Engineering**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT51106**	**Theory Immunology & Medical Biotechnology**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT51108**	**Theory Biostatistics, Bioinformatics & Computer Applications**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT51202**	**Practical Molecular Biology and Recombinant DNA Technology Lab**	**8**	**0**	**0**	**8**	**4**
CORE	**SBT51204**	**Practical Immunology & Medical Biotechnology Lab**	**8**	**0**	**0**	**8**	**4**
Core Elective (Discipline Specific)I	**SBT51110/ 12/14/16**	**Theory SELECT ONE TOPIC**	**3**	**3**	**0**	**0**	**3**
OTHERS		**English/ Foreign Language**	**2**				**Non Credit**
Total							**23**

ADAMAS UNIVERSITY							
FACULTY OF SCIENCE **DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM SEMESTER - III**							
Type of the Paper	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
CORE	**SBT52101**	**Theory Plant & Agricultural Biotechnology**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT52103**	**Theory Genomics, Proteomics & Nano-Biotechnology**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT52105**	**Theory Animal Biotechnology**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT52107**	**Theory Fermentation Technology & Bioprocess Engineering**	**3**	**3**	**0**	**0**	**3**
Core Elective (Discipline Specific)II	**SBT52109/ 11/13/15**	**Theory SELECT ONE TOPIC**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT52201**	**Practical Plant & Animal Biotechnology Lab**	**8**	**0**	**0**	**8**	**4**
CORE	**SBT52203**	**Practical Industrial Biotechnology & Bioprocess Engineering Lab**	**8**	**0**	**0**	**8**	**4**
FOUNDATION	**SBT52601**	**Industry Internship**					**2**
OTHERS		**English/ Foreign Language**					**Non Credit**
Total							**25**

ADAMAS UNIVERSITY							
FACULTY OF SCIENCE **DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM** SEMESTER - **IV**							
Type of the Paper	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
CORE	**SBT52102**	**Theory Bio-Ethics, Intellectual Property Rights & Biological Patent**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT52104**	**Theory Environmental Biotechnology**	**3**	**3**	**0**	**0**	**3**
CORE	**SBT52106**	**Theory Diversity of Life Forms and Ecological Principles**	**3**	**3**	**0**	**0**	**3**
FOUNDATION	**SBT52302**	**Seminar on contemporary research in Biotechnology**	**2**				**2**
CORE	**SBT52502**	**Comprehensive Viva**					**2**
CORE	**SBT52702**	**Dissertation and Viva**					**6**
CORE	**SBT52402**	**Project Work**					**11**
OTHERS		**English/ Foreign Language**					**Non Credit**
Total							**30**

CORE ELECTIVE I (DSE) (choose any one paper in Sem II)*		**CORE ELECTIVE II (DSE) (choose any one paper in Sem III)***	
1	Cancer Biology **(SBT51110)**	1	Systems Biology **(SBT52109)**
2	Human Physiology **(SBT51112)**	2	Population & Evolutionary Genetics **(SBT52111)**
3	Host-Pathogen Interaction **(SBT5114)**	3	Advances in Stem Cell Research **(SBT52113)**
4	Epigenetics **(SBT51116)**	4	Molecular & Cellular Biophysics **(SBT52115)**

* Offering of subjects will vary from year to year, subject to the availability of faculty

ADAMAS UNIVERSITY
FACULTY OF SCIENCE
DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM

SEMESTER I

CORE I SBT51101 THEORY I
BIOMOLECULES & METABOLISM

Unit I: Bio-molecules

1. Bonding and interactions: Structure of atoms, molecules and chemical bonds, Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc.).

2. Carbohydrate: Concepts of stereo-chemistry, monosaccharides and derivatives of sugars, Polysaccharides, glycosaminoglycans, proteoglycans, protein glycosylation and its significance

3. Amino acids and Proteins: Structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, conformation of proteins, Ramchandran Plot, Evolution of protein structure, Structure and functional relationship in model proteins like ribonuclease A, myoglobin, haemoglobin, collagen etc.

4. Dynamics of protein structure: Structural stability of proteins, globular proteins and maintenance of specific confirmation, structural motifs commonly found in various proteins and their functional relevance. Basic concepts of protein folding and its kinetics, chaperones and folding pathways, role of accessory proteins in protein folding.

5. Nucleic acids: Primary, secondary and tertiary structure of RNA and DNA.

6. Lipids: Fatty acids, triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, lipid bilayers.

7. Method of conformational analysis and prediction of conformation: Structure determination using Circular Dichroism Spectroscopy, X-ray diffraction, Nuclear magnetic resonance and Electron Spin Resonance.

Unit II: Metabolism

1. Carbohydrate metabolism: Glycogenolysis, Glycogenesis, Coordinated regulation of Glycogenmetabolism. Glycolysis - Energetics and Regulation, Fermentation reactions (Lactic acid andalcoholic fermentation), Gluconeogenesis, Reciprocal regulation of Glycolysis andGluconeogenesis, Citric acid cycle - Energetics and regulation, Glyoxylate cycle. Pentose phosphate pathway.

2. Protein metabolism: General aspects of amino acid metabolism: Transamination, Deamination, Decarboxylation, basic glutamine and glutamic acid pathways, urea cycle and its regulation.

3. Lipid metabolism: Beta oxidation of Fatty acids-activation, transport to mitochondria, Betaoxidation reactions. Oxidation of unsaturated fatty acids. Alpha and omega oxidation. Biosynthesis of saturated and unsaturated fatty acids and cholesterol.

Suggested Books:

1. Cell (A Molecular approach): Cooper , G. M.
2. Cell and Molecular Biology (1996) Karp, G.
3. Cell Biology (1993) Sadava D. E.
4. Cell and Molecular Biology : deRobertis and deRobertis
5. Principles of Microbiology (1994) Atlas , R. M.
6. Principle of Biochemistry: Leninger , A. L.
7. Biochemistry (1995) Lubert Stryer
8. Text Book of Biochemistry (1997) Devlin , Thomas M.
9. Biochemistry (1993) Geoffery, Zubay
10. Harper's Review of Physiological Chemistry(1993) Murray, R. K., Mayes, P. A. Gramner, D. K. and Rowell V. W.
11. Biochemical Techniques theory and practice : White R

12. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K. H.
13. An Introduction to Practical Biochemistry: Plummer D. T.

CORE II SBT51103 THEORY II
BIOPHYSICAL CHEMISTRY & BIO-ANALYTICAL TECHNIQUES

Unit 1: Thermodynamics
Thermodynamic state, state functions and thermodynamic systems. 1st and 2nd Laws of Thermodynamics, Concepts of enthalpy, entropy and free energy. Gibb's free energy; Chemical Potential, Chemical Equilibrium. Application of thermodynamics in biological systems; Bioenergetics.

Unit 2: Physico-chemical properties of water
Ionic product of water; pH - definition, effect of pH in enzyme catalyzed reaction. Acids, bases and buffers in biological system; Arrhenius, Bronsted-Lowry theories of acid and bases. Polyprotic acids, ampholytes, dissociation of polyprotic acid; titrable and true acidity. Surface tension, viscosity: application to biomolecules.

Unit 3: Reaction Kinetics
Rates and rate equations of chemical reactions. Standard states, steady states. Activation energies, equilibrium constants. Microscopic reversibility. Fast reactions and transient kinetics.

Unit 4: Quantum Chemistry
Waves, particles and quanta; Electromagnetic spectrum and transition energies. Quantum mechanical postulates, eigenfunction, eigenvalue, Schrodinger equation, particle in box problem, central concepts in spectroscopy. Scattering absorption and dispersion.

Unit 5: Spectroscopic Techniques
Concept of electromagnetic radiations - UV, visible, IR. Orbital theory: Bonding and antibonding; Absorption and emission spectroscopy of biomolecules: UV-Visible Spectroscopy, Fluorescence Spectroscopy and Energy transfer.

Unit 6: Centrifugation
Principle of centrifugation and different types of centrifuge. Differential & density gradient centrifugation.

Unit 7: Chromatography Techniques
TLC, HPLC, HPTLC & FPLC, Size-exclusion Chromatography, Affinity chromatography, Ion-exchange Chromatography.

Unit 8: Radioactivity
Radioactive & stable isotopes; Units of radioactivity; Measurement of radioactivity; Measurement of stable isotopes; Falling drop method; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Radioimmunoassay.

Suggested Books:
1. Nuclear Magnetic Resonance: Williams
2. Biochemical Techniques theory and practice : White R
3. Analytical Chemistry: Christion G. D.
4. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H.
5. An Introduction to Practical Biochemistry: Plummer D. T.

CORE III SBT51105 THEORY III
CELL & DEVELOPMENTAL BIOLOGY

Unit I: Cell Theory & Methods of Study

1. Microscope and its modifications: Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc.

2. **Membrane Structure and Function:** Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.

Unit II: Organelles

1. Nucleus: Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; Cell cycle and control mechanisms

2. **Mitochondria:** structure, organization of respiratory chain complexes, ATP synthase, Structure-function relationship; Mitochondrial DNA and male sterility; Origin and evolution

3. Chloroplast: Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution.

Unit III: Endo-membrane System and Cellular Motility

Structure and function of microbodies, Golgi apparatus, Lysosomes and Endoplasmic Reticulum; Organization and role of microtubules and microfilaments; Cell shape and motility; Actin-binding proteins and their significance; Muscle organization and function; Molecular motors; Intermediate filaments; Extracellular matrix in plants and animals.

Unit IV: Cellular Movements and Pattern Formation

Laying of body axis planes; Differentiation of germ layers; Cellular polarity; Model plants like Fucus and Volvox; Maternal gene effects; Zygotic gene effects; Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants; Cell lineages and developmental control genes in Caenorhabditis.

Unit V: Differentiation of Specialized Cells Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Cellular basis of immunity; Differentiation of cancerous cells and role of proto-oncogenes; Phase changes in Salmonella; Mating cell types in yeast; Surface antigen changes in Trypanosomes; Heterocyst differentiation in Anabaena; Sex determination in Drosophila.

Unit VI: Plant Meristem Organization and Differentiation

Organization of Shoot Apical Meristem(SAM); Organization of Root Apical Meristem(RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Self-incompatibility and its genetic control; Embryo and endosperm development; Heterosis and apomixis.

Suggested Books:

1. Cell (A Molecular approach): Cooper, G. M.
2. Cell and Molecular Biology (1996) Karp, G.
3. Cell Biology (1993) Sadava D. E.
4. Cell and Molecular Biology (1995) Kish V. M. and Kleinsmith L. J.
5. Cell and Molecular Biology : deRobertis and deRobertis

CORE IV SBT51107 THEORY IV
MOLECULAR GENETICS

Unit I: Physical basis of Heredity

Cells, chromosomes, cell division, Mendel's laws, gametogenesis, Single gene inheritance, terminology, allelic releationship, single gene crosses,Pedigree analysis; Two or more genes: Independent assortment, dihybrid cross,

Unit II: Genetic interactions:

Two factor interaction, epistatic interaction, non-epistatic interaction, interactions with three or more factors. Linkage and Chromosome mapping: Linkage, cross over, chi square test for linkage, recombination frequency and map construction, tetrad analysis in yeast and recombination mapping with tetrad, mapping with molecular markers. Yeast genetics: isolation and characterization of auxotrophic and temperature sensitive mutants, synthetic lethality, meiotic mapping, multicopy suppression.

Unit III: Hardy- Weinberg equilibrium
Phenotype; Genotype; Gene frequency; Hardy Weinberg law; Factors distinguishing Hardy Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift; Human genetic diversity
Unit IV: Cancer biology
Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, aberrations in signalling pathways, therapeutic interventions of uncontrolled cell growth.
Unit V: DNA damage and repair
Factors affecting DNA bases, identification and molecular characterization of repair enzymes in photoreactivation, excision, recombination, and SOS pathways;
Unit VI: Recombination and transposition
Models for homologous recombination- the Holliday, Meselson Radding and RecBCD pathways and their experimental supports; meiotic recombination mechanism, the double-stranded DNA breaks; site-specific recombination and transposition: lambda phage integration and excision, bacterial use of site-specific recombination, eukaryotic (yeast, maize, fruitfly) and prokaryotic transposons.
Unit VII: Genetic recombination in Bacteria
1. Transformation: Identification and selection of mutants; natural transformation systems, mechanism, gene mapping by transformation; chemical and electrotransformation.
2. Conjugation: discovery, nature of donor strains and compatibility, interrupted mating and temporal mapping, Hfr, F12 heteroduplex analysis, chromosome transfer in other bacteria
3. Transduction: Generalized and specialized transduction; gene mapping by specialized transduction, mechanism of generalized transduction, abortive transduction. Techniques of studying Bacteriophages virulent phage (T4) and Temperate phage(phage lambda). Important aspects of life cycles; phage genome and gene mapping; host parasite relationship, immunity and repression; site specific recombination (lambda and PI), Transposable phage (Phage Mu), genetic organization and transposition , Phase variation in Salmonella and others.

Suggested Books:
1. Text book of Microbiology by Pleczar and Reid (Mc Graw Hill).
2. Microbiology by Tortora, Funk & Case.
3. Microbiology by Prescott.
4. Principles of Genetics by Sinnet et.al (Mc Graw Hill).
5. Principles of Heridity by Robert Tumarin.
6. Genetics by M.W.Strick Berger (Mac Millan).
7. Cell and Molecular Biology by E,D.P. De Roberties (International edition).

CORE PRACTICAL I SBT51201
Lab in Analytical Biochemistry & Biophysical Chemistry

Unit I: Analytical Biochemistry
1. Demonstration of analytical instruments (principles and applications) available in the Department as well as in USIC of VU.
2. Methods of cell breakage.
3. Estimation of total protein, carbohydrate, DNA and RNA of a bacterial cell.
4. Chromatography: Paper, TLC for sugar / lipid / amino acid.
5. Determination of activity of amylase, protease. Effect of pH, temperature on enzyme activity; Enzyme kinetics.
6. Purification of enzyme.
7. Determination of MW of protein by PAGE.
8. Study of enzyme by native gel electrophoresis (zymogram).
9. Demonstration of 2D – gel electrophoresis and Gel documentation system.

Unit II: Biophysical chemistry
Paper chromatography of carbohydrates, use of inhibitors for active site determination,

chromatographic techniques, purification of enzymes, chemical estimation of vitamins, minerals like Ca+2, Fe+2, determination of molecular weight by gel filtration.Techniques for purifying and characterizing Proteins and Enzymes, Idea of all analytical techniques like Electrophoresis, Liquid Chromatography, Column Chromatography for enzyme protein analysis.

Suggested Books:

1. Hawk's physiological chemistry Ed. by Oser (Mc Graw Hill).
2. Biochemical methods By Sadasivam and Manikam (Wiley Eastern limited).
3. An introduction to practical biochemistry by D.T.Plummer (Mc Graw Hill).
4. Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5. Biochemistry - a laboratory courses by J.M.Beckar (Academic Press).

CORE PRACTICAL II SBT51203
Cell Biology and Genetics

1. Microscopy: a) simple, b) compound c) phase contrast microscopes.
2. Cell Division: Mitosis and Meiosis.
3. Permanent Slides: Polytene chromosomes, grass hopper spermatids and chromosomes.
4. Cell motility and flagellar staining, Photography and videotaping (motility, morphometry).
5. Micrometry: Calibration of stage and ocular micrometer and measurement of the given biological sample Haemocytometer: calibration and measurement of biological samples.
6. Electron microscopy : Demonstration and good photographs for interpretation.
7. Blood cells: WBC: types of polymorphs.
8. Demonstration of animal handling for experimental purposes: cervical dislocation, dissection of rat: cardiac puncture, blood sample preparation and its handling, Osmotic fragility of RBC's.
9. Density gradient: sucrose/percoll.
10. Embryo development: permanent mounts.
11. Developmental studies: chick: developmental stages and Gastrulation.
12. Programmed cell death during embryonic development.
13. Cell types of plants - maceration of various tissue explants and identification of xylem vessels, trachieds, stomata, root hair etc.
14. Isolation of chloroplast.
15. Chlorophyll estimation: spectrum and light scatter turbidity correction in chloroplasts.

Suggested Books:

1. Handbook of Microbiological Media by Atlas R.L.
2. Manual of Clinical Microbiology by Lennettee E.H.
3. Manual of Clinical Microbiology by Murray PR.
4. A Laboratory manual of Microbiology: Microbes in action.

SEMESTER II

CORE I SBT51102 Theory I
Molecular Biology of the Cell

Unit I: Genome organization

Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting.

Unit II: DNA Structure; Replication; Repair & Recombination

Structure of DNA - A-,B-, Z- and triplex DNA; Measurement of properties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.

Unit III: Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptional gene silencing

Unit IV: Post Transcriptional Modifications

Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA. Translation & Transport Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation

Unit V: Mutations; Oncogenes and Tumor suppressor genes

Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens; Transposition - Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators.

Suggested Books:

1. Biochemistry by L.Stryer 5 Ed. (Freeman-Toppan)
2. Genes VIII by B.Lewin (Oxford)
3. Cell and Molecular Biology by E,D.P. De Roberties (International edition)
4. Molecular Biology by David Frefielder.
5. DNA Science by Carolin a Publishing Company.
6. Molecular Biology of the Gene by J.D.Watson et. al.,(Benjamin).
7. RNAi-Design and application by Basic (Springer).
8. Small RNAs-Analysis and Regulatory functions by Nellen (Springer).

CORE II SBT51104 THEORY II
Recombinant DNA & Genetic Engineering

Unit I: Basics of DNA cloning

Simple cloning and cloning using linkers and adaptors. Cloning into various kinds of vectors – plasmids, phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs. Selection and screening of clones.

Unit II: Methods of DNA and protein analysis

Agarose, polyacrylamide and pulsed field gel electrophoresis of DNA.

Southern and Northern Blotting. Radiolabelling probes. Isolation and purification of DNA. RFLP analysis. DNA fingerprinting and its application in forensics, in disease diagnosis and in identification

of strains. Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins. Western Blotting analysis.

Unit III: Polymerase Chain Reaction

Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Long PCR, Inverse PRC, Vectorette PCR, RT-PCR, 5' and 3' RACE, qPCR, Real Time PCR using SYBR Green, Scorpion primers and TaqMan probes, MOPAC, Multiplex PCR, Differential Display PCR, RAPD fingerprinting of micro-organisms, Ligation Chain Reaction, Overlap PCR, Rolling Circle Amplification Technology.

Unit IV: Construction of cDNA and genomic DNA libraries

Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries. Screening libraries by colony hybridization and colony PCR. Screening expression libraries. Enriching for clones in cDNA libraries by positive selection and subtractive hybridization. Identifying genes in complex genomes by direct selection of cDNA and exon trapping.

UNIT V: Transcriptional analysis of gene expression and transcriptomics

Gene expression analysis by Northern Blotting, RT-PCR, EST analysis and the use of reporter genes. Enzymatic and bioluminescent reporters. Reporters used in protein localization and trafficking studies. Promoter analysis – deletion analysis and linker scanning analysis coupled to reporter assays, mapping transcriptional start sites by S1 nuclease mapping, primer extension studies or 5' RACE. Transcriptome analysis by DD-PCR and EST analysis, DNA microarrays (cDNA arrays and oligo arrays), Serial Analysis of Gene Expresion (SAGE).

Unit VI: Overexpression of recombinant proteins

Overexpression and tagging of recombinant proteins in *E.coli,* driven by lac, T7 and Tet-regulatable promoters, Expression in *B. subtilis*. Overexpression systems in *S.cerevisiae*, *P.pastoris,S.pombe* and *K.lactis*. Baculovirus overexpression system. Mammalian cell overexpression system.

Analysis of protein-DNA and protein-protein interactions: Gel retardation assay, DNA footprinting by DNase I and chemical methods, yeast one-hybrid assay, ChIP- chips. Yeast two hybrids, three-hybrids, split hybrids and reverse hybrids. Co-immunoprecipitations, pull-downs and Far-Westerns. GFP and FRET. Phage display.

Suggested Books:

1. Recombinant DNA technology by Watson et. al., (Scientific American Books).
2. Genes-VIII by Benjamin Lewin.(Oxford).
3. Principles of Gene Manipulation by Old and Primrose.(Blackwell).
4. DNA Science by Carolin a Publishing Company.
5. From genes to clones by Winneker.
6. From genes to genomes concepts and applications of DNA technology by Jeremy W dale and Malcolm von Scrantz, Weil publications
7. Molecular Biotechnology by Glick.
8. Genetic Engineering by Sandhya Mitra.
9. Genomes by T.A. Brown

CORE III SBT51106 Theory III
Immunology & Medical Biotechnology

Unit I. Immunology- fundamental concepts and anatomy of the immune system

Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses;

Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue.(MALT&CALT); Mucosal Immunity; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing

Unit II. Immune responses generated by B and T lymphocytes

Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants;

Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling;Basis of self –non-self discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system

Unit III. Antigen-antibody interactions

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface plasmon resonance, Biosenor assays for assessing ligand – receptor interaction, CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis, Microarrays, Transgenic mice, Gene knock outs

Unit IV. Clinical Immunology

1. Pathogenic infection: Normal human microflora. Recognition and entry processes of different pathogens like bacteria viruses into animal and plant host cells, Virulance factors and pathogenecity islands, alteration of host cell behavior by pathogens. Immunity to Infection : Bacteria, viral, fungal and parasitic infections (with examples from each group) Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology – Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency-Primary immunodeficiencies, Acquired or secondary immunodeficiencies.

2. Vaccine technology: Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering-chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

Suggested Books:

1. Essentials of Immunology by Roit (ELBS).
2. Immunology by Roit et.al (Harper Row).
3. Text book of Immunology by S.T,Barrot (Mosby).
4. Immunology by Kubay.
5. Principles of Microbiology and Immunology by Davis et.al., (Harper).

CORE IV SBT51108 THEORY IV
Biostatistics, Bioinformatics & Computer Applications

Unit I

Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; equality of means of normal populations(variance known, variance unknown); Chi-square test for independence; P-value of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance; Data transformations.

Unit II

Elements of programming languages - C and PERL; Data base concept; Database management system; Database browsing and Data retrieval; Sequence database and genome database; Data Structures and Databases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR; PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm.

Unit III

Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequence pattern; Regular expression based pattern; Theory of profiles and their use in sequence analysis; Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification;Pattern recognition methods

Unit IV

Goals of a Microarray experiment; Normalization of Miroarray data; Detecting differential gene expression; Principal component analysis; Clustering of microarray data; Structure determination by X-ray crystallography; NMR spectroscopy; PDB (Protein Data Bank) and NDB (Nucleic Acid Data Bank); File formats for storage and dissemination of molecular structure.

Unit V

Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Monte Carlo and molecular dynamics simulation **G**raphical tools in EXCEL for presentation of data. Introduction to SYSTAT package. Searching PubMed , Introduction to NCBI, NCBI data bases, BLAST BLASTn, BLASTp, PSI-BLAST, Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions.

Suggested Books:

1. Bioinformatics – D.Mount
2. Programming in C by Balaguru Swamy.
3. Introduction to Bioinformatics by Arthur M.Lesk, Oxford.
4. Biostatistics – Daniel. (Wiley).
5. Statistics by S.C.Gupta.
6. Statistical Methods by G.W.Snedecor & W.G.Cochran.
7. Fundamentals of Biostatistics – Khan & Khanum.
8. Let us C – Kanetkar.
9. Fundamentals of Biostatistics by U.B.Rastogi (Ame Books Ltd).

CORE PRACTICAL I SBT51202
LAB IN MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

1. a. Preparation of buffers, reagents and media etc.; b. Laboratory equipment handling and safety guidelines
2. a. Isolation and characterization of genomic DNA for E.Coli; b. Unit determination of restriction enzyme activity
3.a.Cutting of DNA and clean up of DNA for ligation; b. Setting up ligation; c. Preparation of culture media, pouring Plates and streaking of E.Coli; d. Evaluation of transformants and preparation of glycerol stocks; e. Demonstration of electorporation
4. a. Induction of Lac operon
5. Demonstration of PCR; a. Setting up PCR reaction; b. Analysis of amplified product
6. a. Minipreparation & digestion of plasmid DNA; b. Southern transfer of plasmid DNA digest & baking of membrane
7. Restriction digestion analysis by agarose gel electrophoresis
8. Restriction digestion analysis by polyacrylamide gel electrophoresis.
9. Demonstration of DNA sequencing; a. Setting up sequencing reactions; b. Casting sequencing gel; c. Gel electrophoresis & autoradiography. d. Reading sequencing from X-ray film

Suggested Books:

1. Biotechnology: A laboratory course by Becker J.M.
2. Molecular Cloning : A laboratory manual Vols. 1-3, Sambrook, J.
3. Lab manual in Biochemistry by J.Jayaraman (Wiley Eastern Limited).
4. Biochemistry – A lab course by J.M.Becker (Academic Press).

CORE PRACTICAL II SBT51204
LAB IN IMMUNOLOGY & MEDICAL BIOTECHNOLOGY

1.To perform immunoelectrophoresis.
2. To perform radial immunodiffusion assay.
3. To perform rocket immunoelectrophoresis.
4. To stain a tissue by immunohistochemical reaction
5. To study quantitative precipitation assay
6. Gel Techniques; ELISA; SDS PAGE/Western blot
7. To perform latex agglutination test
8. To study morphological and staining characteristics of lymphocytes, neutrophils, monocytes, eosinophils, and basophils.

Suggested Books:
1. Hawk's physiological chemistry Ed. by Oser (Mc Graw Hill).
2. Biochemical methods By Sadasivam and Manikam (Wiley Eastern limited).
3. An introduction to practical biochemistry by D.T.Plummer (Mc Graw Hill).
4. Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5. Biochemistry - a laboratory courses by J.M.Beckar (Academic Press).
6. Immunology methods manual - The comprehensive source book by Lefkovits. I.
7. Manual of clinical laboratory immunology by Rose NR.
8. The experimental foundations of modern immunology by Clark W.R.
9. Laboratory Immunology by Bradshaw LJ.

SEMESTER III

CORE I SBT52101 Theory I
Plant & Agricultural Biotechnology

Unit 1
Plant tissue culture: Scope and Importance of plant tissue culture- Media composition and types, hormones and growth regulators, explants for organogenesis, somaclonal variation and cell line selection, production of haploid plants and homozygous cell lines. Micro propagation, somatic embryogenesis, protoplast culture and somatic hybridization. Selection and maintaiinance of cell lines, cryopreservation, germplasm collection and conservation, plant tissue culture certification.
Unit 2
Plant transformation techniques: Mechanism of DNA transfer – *Agro bacterium* mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; design of expression vectors; 35S promoter, genetic markers, reporter genes; viral vectors. Direct gene transfer methods-particle bombardment, electroporation and microinjection. Binary vectors, plasmid vectors-pBluescript IIKs, pBin19, pGreen vectors, Transgene stability and gene silencing.
Unit 3
Metabolic engineering of plants: Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavanoids, alkaloids; mechanism and manipulation of shikimate pathway. Production of Industrial enzymes, biodegradable plastics, therapeutic proteins, edible vaccines and antibiotics using transgenic technology.
Unit 4
Plant Development: Plant growth regulators, auxin, gibberlins, cytokinins, abscicic acid, acetylene. Biological nitrogen fixation, importance and mechanism. Biofertilizers-types, production, VAM, Rhizobium, Azotobacter, Mycorhiza, Actinorhiza Vermicomposting technology. Biopesticides. Phytoremediation.
Unit 5

GM Technology: Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal. Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops. Golden rice and transgenic sweet potato. Stratagies for engineering stress tolerance. transgenic plants; Current status of transgenic plants in India and other countries, Ethical issues associated with GM crops and GM food; labeling of GM plants and products. Importance of integrated pest management and terminator gene technology. Environmental impact of herbicide resistance crops and super weeds

Unit 6

Post-harvest technology: RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalactoronase); delay of softening and ripening of fleshy fruits (tomato, banana, watermelons). Post-harvest protection of cereals, millets and pulses

Suggested Books:

1. Plant Biotechnology by A. Slater, N.W. Scott and M.R. Fowler (Oxford University press).
2. Biotechnology in Agriculture by Swaminathan, M.S (Mc. Milllan India Ltd).
3. Biotechnology and its applications to Agriculture, by Copping LG and P.Rodgers (British Crop Projection).
4. Plant Biotechnology, by Kung, S. and C.J.Arntzen (Butterworths).

CORE II SBT52103 Theory II
Genomics, Proteomics & Nano-Biotechnology

Unit I

Introduction

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD,PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit II

Genome sequencing projects

Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

Unit III

Proteomics

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

Unit IV

Pharmacogenetics

High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

Unit V

Functional genomics and proteomics

Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein *in situ* arrays; Structural proteomics

Suggested Books:

1. Introduction to Proteomics by Daniel. C. Liebler, Humana press, 2002
2. Bionanotechnology by David S.Goodsell, 2004, Wiley Publications.

CORE III SBT52105 Theory III
Animal Biotechnology

1. Genetic Engineering in animals: Animal cell culture and Transformation of animal cells, cloning and methods of creating transgenic animals. Improvements of animal/fish by transgenic approach with specific examples. Genetically engineered animals for pharmacological research. Embryonic stem cell culture and their applications, Embryo technology and transgenic animals; Assisted Reproductive technology, IVF.
2. Baculoviruses in biocontrol and foreign gene expression: Biotechnology of aquaculture. Transgenic animals. -In vitro fertilization and embryo transfer.
3. Animals as bioreactors: production of IFN/TNF in milk/egg white. Cell culture based vaccines Somatic cell genetics.
4. Disease diagnosis & Therapy: robe, PCR, LCR immunological assay. Detection of genetic, Neurogenetic disorders involving Metabolic and Movement disorders. Treatment-products from recombinant and non-recombinant organisms, Interferons, Antisense and RNA interference (RNAi) therapy, cell penetrating peptides, Gene therapy, Types of gene therapy, somatic virus germline gene therapy, mechanism of gene therapy, Immunotherapy, Detection of mutations in neoplastic diseases MCC, SSCP, DGGE, PTTC. Concept of Forensic medicine, Medical transcription, Pharmacogenomics.
5. Principles of Drug Design: Leads and Target Tissues, QSAR and Drug Design, Molecular Basis and Rational Drug Design using computers.
6. Stem cells and Tissue Engineering: Scope, embryonic and adult stem cells, properties, identification, stem cells culture, techniques and their applications in modern clinical sciences. Tissue engineering, biomaterials used in tissue engineering, three dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronal tissues.
8. Ethical issues in animal biotechnology.

Suggested Books:
1. Elements of Biotechnology by PK Gupta (Rastogi & Co).
2. Biotechnology by Kashav. T (Wiley Eastern Ltd).
3.Concepts in Biotechnology by Balasubrahmanian et. al.,(University press).
4.Principles and practices of aquaculture by TVR Pillay.
5.Coastal aquaculture by Santhanam.
6.Fisheries of India by CBL Srivatsava.
7.Molecular Biotechnology by Glick.

CORE IV SBT52107 Theory IV
Fermentation Technology & Bioprocess Engineering

Unit I
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.
Unit II
Concepts of basic mode of fermentation processes
Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation - Batch, fed batch and 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.
Unit III
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.

Unit IV

Applications of enzymes in food processing

Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc. And their downstream processing; baking 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.

Unit V

Applications of Microbes in food process operations and production

Fermented foods and beverages; 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 flavours, 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 applications in food preservation.

Unit VI

Enzyme kinetics; Two-substrate kinetics and pre-steady state kinetics; Allosteric enzymes; 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.

Suggested Books:

1. Biotechnology – Volumes 1 to 5 by Rehem.
2. Industrial Microbiology by LE Casida Jr.
3. Industrial Microbiology by Presscot and Dunn.
4. Immobilized enzymes by Messing.
5. Biochemical engineering fundamentals by Bailey and Ollis.
6. Biotechnology by BD Singh (Kalyani).

CORE ELECTIVE I: Cancer Biology SBT52109

Unit 1: Fundamentals of cancer biology

Regulation of Cell cycle, Mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, Modulation of cell cycle-in cancer, Different forms of cancers, Diet and cancer.

Unit 2: Principles of carcinogenesis

Chemical Carcinogenesis, Metabolism of Carcinogenesis, Natural History of Carcinogenesis, Targets of Chemical Carcinogenesis, Principles of Physical Carcinogenesis, X-Ray radiation – Mechanism of radiation Carcinogenesis.

Unit 3: Principles of molecular cell biology of cancer

Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes, Growth factor and Growth factor receptors that are Oncogenes. Oncogenes / Proto Oncogenes activity. Growth factors related to transformations.

Unit 4: Principles of cancer metastasis

Clinical significances of invasion, heterogeneity of metastatic phenotype, Metastatic cascade, Basement membrane disruption, Three step theory of invasion, Proteinases and tumour cell invasion.

Unit 5: New molecules for cancer therapy

Different forms of therapy, Chemotherapy, Radiation Therapy, Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection.

Suggested Books:

1. King R.J.B., Cancer Biology, Addision Wesley Longmann Ltd, U.K., 1996.
2. Ruddon. R.W., Cancer Biology, Oxford University Press, Oxford, 1995.

CORE ELECTIVE I: Human Physiology SBT52111

Unit 1: Cell

Structure of Cell – Function of each Components of the cell – Membrane Potential – Action Potential – Generation and Conduction – Electrical Stimulation. Blood Cell – Composition – Origin of RBC – Blood Groups – Estimation of RBC, WBC and platelet.

Unit 2: Cardiac and nervous system

Cardiac Cycle – ECG – Blood Pressure – Feedback Control for Blood Pressure – Nervous control of Heart. Cardiac output – Coronary and Peripheral Circulation – Structure and function of Nervous tissue – Reflex action – Velocity of Conduction of Nerve Impulses. Electro Encephalograph – Autonomic Nervous System.

Unit 3: Respiratory system

Physiological aspects of respiration. Exchange of gases – Regulation of Respiration. Disturbance of respirating function. Pulmonary function test.

Unit 4: Digestive and excretory system

Organization of GI system, Digestion and absorption – Movement of GI tract – Structure of Nephron – Mechanism of Urine formation – Urine Reflex – Skin and Sweat Gland – Temperature regulation.

Unit 5: special senses

Optics of Eye – Retina - Photochemistry of Vision – Accommodation Neurophysiology of Vision – EOG. Physiology of Internal Ear - Mechanism of Hearing – Auditory pathway, Hearing Tests.

Suggested Books:

1. Sarada Subramanyam, K.Madhavan Kutty and H.D.Singh – Text book of 'Human Physiology' – S.Chand & Company, 1996.(Unit I –IV).
2. Sujit K.Chaudhuri – Concise Medical Physilogy – New Central Book agency, 1997. (Unit V).

CORE ELECTIVE I: Host-Pathogen Interaction SBT52113

Host-pathogen interaction: Recognition and entry processes of different pathogens like bacteria, viruses and protozoans into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.

Suggested Books:

1. Host-Pathogen Interactions: Methods and Protocols: (Methods in Molecular Biology) by Steffen Rupp (Editor), Kai Sohn (Editor)
2. Host-Pathogen Interactions: Genetics, Immunology and Physiology by Annette W. Barton (Editor)

CORE ELECTIVE I: Epigenetics SBT52115

Fundamentals of regulation of gene expression and chromatin organization. Emerging concepts of how DNA sequence can dictate chromatin organization at the domain level. Regulatory elements such as boundary elements and insulators. Mechanisms underlying the roles of the elements in development, differentiation and complex diseases. Recent developments underlying epigenetic regulation of complex traits such as behavior. Emerging evidence towards transgenerational effects of diet and lifestyle.

Suggested References:

1. Histone variants ancient wrap artists of the epigenome. Talbert P. B. and Henikoff, S. Nat. Rev. Mol. Cell Biol., 2010 doi:10.1038/nrm2861
2. Divide and (epigenetic) rule: Chromatin domains as functional and structural units of genomes. Mishra RK and Galande S. Journal of Indian Academy of Sciences, Platinum Jubilee issue, 2009, pp 211-224.
3. The mammalian epigenome. Berstein et al., Cell 2007, 128: 669-681.
4. Linking DNA methylation and histone modification: patterns and paradigms. Cedar H, Bergman Y. Nat Rev Genet. 2009, 10(5):295-304.
5. Boundaries. Boundaries...Boundaries??? Lunyak VV. Curr Opin Cell Biol. 2008, 20(3):281-7.

6. Transgenerational Epigenetic Inheritance: Myths and Mechanisms. Heard E and Martienssen R, Cell 2014, 157(1):95109.

CORE PRACTICAL I SBT52201 PRACTICAL I
Lab in Plant & Animal Biotechnology

Plant Biotechnology
1. Media composition and Preparation of media
2. Sterilization and contamination
3. Initiation of aseptic cultures from seed, isolated embryos and other explants
4. Callus and suspension culture
5. Study of organogenesis. Hardening and field transfer of tissue culture plants.
6. Study of somatic embryogenesis.
7. Isolation of DNA from plant material, Spectral Analysis, Gel Electrophoresis.
8. Isolation of protein from plant material and qualitative analysis through SDS- PAGE.
9. Genetic Transformation using Agrobacterium

Animal Biotechnology
1. Growth studies. Cell count, protein estimation, mitotic index.
2. Development and maintenance of a cell line.
3. Karyotyping.
4. In vitro assay of drugs, predictive test for anticancer drugs.
6. Staining and screening of cells /sera for mycoplasma, viruses.
7. Cell cloning by single cell dilution method
8. LDH isozyme analysis of the given cell lines.

Suggested Books:
1. Plant cell culture – A practical approach by Dixion RA.
2. Plant tissue culture – theory and practice by Bhojwani, S.S.
3. Biotechnology: A laboratory course by Becker, J.M.
4. Animal cell culture – A practical approach Ed. By John R.W. Masters (IRL Press).
5. Animal cell culture techniques, Ed. Martin clyenes (Springer).

CORE PRACTICAL II SBT52203 Practical II
Lab in Industrial Biotechnology & Bioprocess Engineering

1. Determination of oxygen transfer rate and volumetric oxygen mass transfer coefficient (KLa) under variety of operating conditions in shake flask and bioreactor.
2. Determination of mixing time and fluid flow behaviour in bioreactor under variety of operating conditions.
3. Rheology of microbial cultures and biopolymers and determination of various rheological constants.
4. Production of microbial products in bioreactors.
5. Studying the kinetics of enzymatic reaction by microorganisms.
6. Production and purification of various enzymes from microbes.
7. Comparative studies of Ethanol production using different substrates.
8. Microbial production and downstream processing of an enzyme, e.g. amylase.
9. Various immobilization techniques of cells/enzymes, use of alginate for cell immobilization

Suggested Books:
1. Alba S., Humphrey E and Milli N.R., "Bio Chemical Engineering" Academic Press, 1973.
2. Scragg.A.H "Bioreactors in Biotechnology"- A Practical approach.
3. Bailey and Ollis, "Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.). 1986.
4. Peter F.Stanbury, Allan Whitaker, "Principles of Fermentation Technology".

FOUNDATION IFS5103
Interaction with Industries and National Research Laboratories

Students have to visit Industries / National research laboratories and submit project based on their interactions.

SEMESTER IV

CORE I SBT52102 Theory I
Bio-Ethics, Intellectual Property Rights & Biological Patent

1. Intellectual Property Right (IPR): Concept and provisions of IPR; Patents, Trademarks, Copyright, Conditional information, Breeder's right. Patent; importance, types, scope, criteria, applying for a patent. Protection of Biotechnological inventions. Patent infringement- meaning, scope, litigation, case studies and examples
2. Agreements and Treaties----History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT
3. Safety in Biotechnology--- Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines , Overview of Biotechnology Regulations and relevant International Agreements including Cartegana Protocol.
4. Bioethics: Biotechnology information, communication and public perception, Future prospects of consumers and social acceptance .Case studies
5. Bio-entrepreneurship: Support mechanism for entrepreneurship in India; Leadership skills; Managerial skills; Team building; teamwork;. Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks. Information technology for business administration, E-business setup and management.

Suggested Books:
1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Singh K, Intellectual Property rights on Biotechnology, BCIL, New Delhi.
3. Cartagena Protocol on Biosafety (2006) Ministry of Environment and Forest, Government of India, New Delhi.

CORE II SBT52104 Theory II
Environmental Biotechnology

Unit 1
Environment and monitoring: Introduction, renewable and non-renewable sources of energy; Enviromental pollution- water pollution, soil pollution and air pollution-sources. Xenobiotic compounds and their sources, Biomagnification, Bioindicators. Biomonitoring: Biosensors and biochips.
Unit 2
Water Management and waste water treatment: Water as a scarce natural resource, water management including rain water harvesting. Waste water characteristics, waste water treatment-physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; Anaerobic processes; Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors. Reverse osmosis and ultra filtration. Treatment of industrial effluents.
Unit 3

Bio-mining and Biodiesel: Bioleaching of ores to retrieve scarce metals, Bio-mining; iodiesel production from Jatropa, Pongamia and Castor.

Unit 4

Bioremediation: Concept and principles, Bioremidiation using microbes, *In situ* and *ex situ* bioremediation, biosorption and bioaccumulation of heavy metals; Phytoremediation, bioremediation of xenobiotics (heavy metals, pesticides, oil slicks, plastic). Bioremedidation of soil and water contaminated with hydrocarbons and surfactants, biofilms.

Unit 5

Biowaste treatment: Microorganisms involved in the degradation of plant fibre, cell wall, lignin, fungal de-lignification and pulping of wood. Pitch problems in pulp and paper processes and solving by enzymes or fungi. Hemicellulases in pulp bleaching. Solving slime problem in the pulp and paper industry. Reduction of organochlorine compounds in bleach plant effluents. Solid wastes: Sources and management, waste as a source of energy. Production of oils and fuels from solid waste, composting, vermiculture, Biogas production, methanol production from organic wastes, by products of sugar industries.

Unit 6

Global environmental problems: Global warming, ozone depletion, UV-B, green house effect and acid rain, their impact and management. Biodiversity and its conservation, status of biodiversity, hotspots, Red data book.

Suggested Books:

1. Biotechnology by B.D.Singh (Kalyani).
2. Ecology and Environment by PD Sharma.
3. Fundamentals of Ecology, by Odum, EP (Mc Graw Hill)
4. Environmental Biotechnology by Forster, C.F. and Wase D.A.J. (Ellis Horwood).
5. Biotechnological innovations in environmental management by Leach, CK and Van Dam-Mieras, MCE (Butterworth-Herinemann, Oxford (Biotol Series).
6. Molecular Biology and Biotechnology by Meyers, RA, A comprehensive Desk reference (VCH Publishers).
7. Biotechnology by U. Satyanarayana (Books & Allied (P) Ltd).

CORE ELECTIVE II: Systems Biology SBT52106

System Biology - Concepts and working principles of System Biology - Practical applications of System Biology in Life Sciences - Introduction to System Biology platforms Proprietary system Biology platform. Microarray data analysis - Microarray analysis platforms - Introduction to Concepts and principles of Microarray technology - Application of Microarrays in Life Sciences. Different Markup languages used in systems biology. Introduction to NGS technology.

Suggested Books:

1. System Biology: Computational Systems Biology (Hardcover) by Andres Kriete (Editor), Roland Eils (Editor)
2. Stochastic Modelling for Systems Biology. ISBN-10 1-58488-540-8 and ISBN-13 978-158488-540-5
3. Microarray Data Analysis: Gene Expression Data Analysis. A Beginner's Guide By: Helen Causton (Imperial College), J Quackenbush and AlvisBrazma (The European Bioinformatics Institute)
4. A Practical Approach to Microarray Data Analysis (Hardcover) by Daniel P. Berrar (Editor), Werner Dubitzky (Editor), Martin Granzow (Editor)

CORE ELECTIVE II: Population & Evolutionary Genetics SBT52108

1. Quantitative genotype and phenotype distribution: Determining norms of reactions, Heritability of traits and quantification.
2. Population genetics I: General principles and Mendelian populations: Allele and genetic variations in populations; Mendelian populations. Sources of variations: Hardy-Weinberg

principles and its applications. Population genetics II: Evolutionary agents: Fitness, Selection, Migration, random drift in Small population, Polymorphism, Neutral theory. Population genetics III: Speciation and molecular evolution, Speciation concept, modes of speciation, Pattern of changes in nucleotide and amino acid sequences. Molecular clock and evolution.
3. Molecular phylogenetics: Construction of phylogenetic tree, Phylogenetic inferences: Distance method, Parsimony, maximum - likelihood method, Molecular phylogenetics of Homo sapiens and related issues, Hominid evolution.
4. Human population genetics and evolution: Basic attributes and polymorphic structures in human protein coding genes. Mitochondrial DNA polymorphism. Y-chromosome polymorphism and Single nucleotide polymorphism (SNP), Human society.
5. Genetics in forensic science: Protein comparisons, DNA comparisons, RFLPs, genetic finger-printing, VNTRs, Genetic profiles. Unique correlation, Sociobiology, Alltruism, Kin selection and inclusive fitness, Haplodiploidy, Imprinting phenomena.

Suggested Books:

1. T. A. Brown, 1999. Genomes, John Wiley & Sons (Asia) PTE Ltd.
2. Scott Freeman & Jon C. Herron, 2001. Evolutionary Analysis (2nd Edition), Prentice Hall.
3. Falconer & Mackay, 1996. Introduction to Quantitative Genetics (IV Edition), Longman.
4. David P. Mindell, 1997. Avian Molecular Evolution & Systematics, Academic Press.
5. Derek A. Roff, 1997. Evolutionary Quantitative Genetics, Chapman & Hall.
6. R.S.Singh & C. Krimbas, 2000. Evolutionary Genetics- From Molecules to Morphology, Cambridge University Press.
7. Peter Donnelly & Simon Tavare, 1997. Progress in Population Genetics & Human Evolution (Vol. 87), Springer.
8. William S. Klug & Michael R. Cummings, 2000. Concepts of Genetics (Sixth Edition), Prentice Hall.
9. Monre W. Strickberger, 1985. Genetics (Third Edition), Prentice Hall of India.

CORE ELECTIVE II: Advances in Stem Cell Research SBT52110

Unit I: Introduction – Definition and Criteria for Stem Cells; Pluripotent, Multipotent and Totipotent Stem cells; Primordial Germ Cells, Embryonic Stem Cells; Amniotic Fluid Derived Stem Cells; Cord Blood Stem Cells.
Unit II: Biology and Mechanisms – Molecular Basis of Pluripotency, Mechanisms of Self Renewal, Chromatin signature of pluripotent cells, Cell cycle regulators in Stem Cells; Stem Cell Niches, Change of Phenotype and Differentiation, Senescence of Dividing Somatic Cells, Aging and stem cell renewal, Quiescent Stem Cells.
Unit III: Tissue and Organ Development – Differentiation in Early Development, Potency, Commitment, Polarity and the specification of asymmetric divisions, induction, competence determination and differentiation, morphogenetic gradients, cell fate and cell lineages, Epigenetic silencing and lineage commitment; Cellular differentiation of the Nervous system, Neuronal and Glial Progenitors in Adult Brain, Epithelial Stem Cells; Adult Progenitor Cells, Mesenchymal Stem Cells, Plasticity; De-differentiation, Cancer Stem Cells.
Unit IV: Stem Cell Technology – Characteristics and Characterization of Human Pluripotent Cells; Fluorescence and Magnetic bead Assisted Cell Sorting, Derivation, Characterization and Maintenance of Murine and Human Embryonic Stem Cells, Differentiation of Embryonic Stem Cells; Derivation of Induced Pluripotent Stem Cells; Derivation and Differentiation of Human Embryonic Germ Cells; Genomic Reprogramming, Fate Mapping of Stem Cells.
Unit V: Stem Cells and Regenerative Medicine - Neural Stem Cells in Neurodegenerative Diseases; Hematopoietic Stem Cell Transplantation; Epithelial Stem Cells and Burns; Stem Cells and Heart Disease; Pancreatic Stem Cells and Diabetes; Liver Stem Cells and Cell Therapy for Liver Disease; Embryonic Stem Cells in Tissue Engineering, Stem Cell Banking, Ethical Concerns in Stem Cell Research.

Suggested Books:

1. Essentials of Stem Cell Biology, Third Edition – Edited by Robert Lanza and Anthony Atala. Academic Press, CA, USA (2013)
2. Stem Cell Biology - Edited by Daniel R Marshak, Richard L. Gardner and David Gottlieb. Cold Spring Harbor Press, NY, USA (2001)

CORE ELECTIVE II: Molecular & Cellular Biophysics SBT52112

Biophysics, branches in biophysics, Molecular structure in biological systems: states and forces, hydration, movement, structure formation, self-assembly, mechanical properties, energetics. Membrane transport and diffusion, Famous laws in biophysics, Timing and role in cell biology, Neuronal biophysics – action potential, HH equation, cable theory, ion channels, Biomechanics, Biophysical techniques.

Suggested Books:

1. Daniel Goldfarb, Biophysics demystified, McGraw Hill, 2011.
2. Meyer B. Jackson, Molecular and cellular biophysics, Cambridge University Press, 2006, ISBN: 978-0-521-62470-1.
3. Christof Koch, Biophysics of Computation, Oxford University Press: New York, New York, 1999.

Project Work SBT52402

Every student will be required to undertake a research project based on any of the areas of animal, plant or microbial biotechnology and bioinformatics. The project report will be submitted in the form of dissertation duly certified by the supervisor of School of Biotechnology or at any national institutes and Universities in India. The project work will be presented for evaluation at the end of semester by external expert.

Dissertation/Comprehensive Viva SBT52702

Each student will submit dissertation and deliver seminar on their project work under the supervision of a faculty member. The comprehensive seminar on the project work will be evaluated by external expert.