University of Kalyani
Department of Molecular Biology & Biotechnology
Course Structure (Summary)

SEMESTER - I	
COURSE STRUCTURE	**CREDIT (POINTS)**
Hard Core	**12 (300)**
Course H.1.1:Microbiology	**2 (50)**
Course H.1.2: Laboratory techniques in Microbiology	**2 (50)**
Course No. H.1.3 Biomolecules & Biochemistry	**2 (50)**
H.1.4 Practical on Biomolecules & Biochemistry	**2 (50)**
H. 1.5.Biophysical Chemistry	**2 (50)**
H.1.6 Genetics	**2 (50)**
Soft Core ***Student will select 6 (six) credits from the options below***	**4 (100)**
S.1.1- Advance Microbiology	**1 (25)**
S.1.2- Plant Biochemistry	**1 (25)**
S.1.3- Principles of Microscopy	**1 (25)**
S.1.4.Advance Physico-chemical Technique	**1 (25)**
S.1.5 Population & Human Genetics	**1 (25)**
S.1.6. Genetics (Practical & Problems)	**1 (25)**

SEMESTER - II	
COURSE STRUCTURE	**CREDIT (POINTS)**
Hard Core	**12 (300)**
Course H.2.1. Cell Biology &-Developmental Biology	**2 (50)**
Course H.2.2 Laboratory Techniques on Cell Biology	**2 (50)**
Course H.2.3 Molecular Biology	**2 (50)**
H.2.4 Techniques in Molecular Biology	**2 (50)**
H.2.5 Molecular Genetics & Biostatistics	**2 (50)**
Course H.2.6 Recombinant DNA Technology	**2 (50)**
Soft Core ***Student will select 3 (three) credits from the options below***	**4 (100)**
S.2.1 Advance Cell Biology	**1(25)**
S.2.2 Advance Developmental Biology	**1(25)**
S.2.3. Molecular genetics of Virus	**1(25)**
S.2.4. Review writing on recent technique on molecular biology	**1(25)**
S.2.5. Seminar on one recent development of Recombinant DNA Technology	**1(25)**

SEMESTER - III	
COURSE STRUCTURE	**CREDIT (POINTS)**
Hard Core	**12(300)**
Course H.3.1 Genomics & Proteomics	**2 (50)**
Course H.3.2. Computer Application &Bioinformatics	**2 (50)**
Course H.3.3 Hands on Training on Computer Application & Bioinformatics	**1 (25)**
Course H.3.4 Immunology	**2 (50)**
Course H.3.5 Techniques of Immunology (P)	**1 (25)**
Course H.3.6. Plant Cell, Tissue & Organ Culture	**2 (50)**
Course H.3.7 Hands on Training on PCTOC	**2 (50)**
Soft Core ***Student will select 4 (four) credits from the options below***	**4 (100)**
S.3.1. Electrophysiological techniques	**1 (25)**
S.3.2 plant Bioreactor &Secondary metabolite	**1 (25)**
S.3.3. Ecology	**1 (25)**
S.3.4. Applied ecology	**1 (25)**
S.3.5 Biodiversity& Conservation	**1 (25)**
S.3.6 Techniques of Genomics & Proteomics	**1 (25)**

SEMESTER - IV	
COURSE STRUCTURE	**CREDIT (POINTS)**
Hard Core	**12(300)**
Course H.4.1 Bioprocessing and Fermentation Technology	**2(50)**
Course H.4.2 Microbial Biotechnology	**2(50)**
Course H. 4.3 Animal Cell Culture & Biotechnology	**2 (50)**
Course 4.5 Training on Microbial Technology & Animal Cell Culture	**2 (50)**
Course 4.6. Genetic Engineering of Plants	**2 (50)**
Course H.4.7.Summer Training of 6-weeks from any reputed National/International laboratories or Universities.	**2 (50)**
Soft Core ***Student will select 4 (four) credits from the options below***	**4(100)**
S.4.1 Basic concepts on Environment	**1 (25)**
S.4.2 Biotechnological Approach to save environment	**1 (25)**

S.4.3. Bioethics & IPR	**1 (25)**
S.4.4 Theoretical aspects of Medical Biotechnology	**1 (25)**
S.4.5.Medical Biotechnology (P)	**1 (25)**
Course H. 4.9. Journal Club	**1 (25)**

SEMESTER – I

Students have to complete 12 (Twelve) hard core and 4 (four) soft core credits to qualify the Semester I. The students can also choose any soft core credit from the sister departments of life Science as per availability of the courses.

Hard Core

Course H.1.1: Microbiology- 2-credits (50)

H.1.1.1 –General concept on microbes

1. Classification of microbes and their distinctive characters, Haekel's 3 kingdom concept; Whittaker's 5 kingdom concept, domain concept of Carl Woese. Bacterial systematics- classification and salient features of bacteria according to Bergey's Manual of Determinative Bacteriology.
2. Bacterial cell size & shape and their significances. Bacterial cell envelope – structural components and functional properties
3. General Virology: Discovery of viruses, distinctive properties of viruses; morphology and ultra stucture, capsids and their arrangements. Types of envelops and their composition; Viral genome- type and structure; nomenclature and classification of virus(animal, plant, bacteria). Viruses related agents – viriods, prions

Bacterial cell appendages and cell inclusions

1. Bacterial cellular appendages – their structure and function; bacterial movement with special reference to chemotaxis;
2. Bacterial cell inclusions – Gas vesicles, Carboxysomes, Phycobilisomes, Chlorobium vesicles, Magentosomes. Reserve food materials- Polysaccharides, Polyphosphate granules, oil droplets, cyanophycin granules, sulphur inclusions, PHA.

H.1.1.2 -Nutrition & Metabolism

1. Bacterial nutrition: Nutritional types; Growth conditions – related to oxygen supply, temperature, air pressure and pH.
2. Bacterial metabolism: Photoautotrophy, Chemoautotrophy, mixotrophy& heterotrophy. Methylotrophy, sulphur oxidation and reduction by bacteria, methanogenesis, nitrification; Biological N2 fixation and its regulation.

Reproduction and control

1. Reproduction of bacteria – binary fission, fragmentation and budding. Bacterial cell cycle.
2. Bacterial perennation – cyst, endospore, exospore & other resting forms – their formation, properties and germination.

3. Bacterial Growth – measurement of growth and factors affecting growth; growth curve, generation time, growth kinetics; Culture methods - batch, continuous culture, synchronous growth, diauxic growth.
4. Control of bacteria – Concept of disinfection, sterilization, asepsis and maintenance of axenic conditions, preservation of foods – physical and chemical methods. Use of chemotherapeutants against pathogen.

Course H.1.2: Laboratory techniques in Microbiology 2-credits (50)

1.2.1.- Basic techniques

1. Microscopic study of Bacteria, fungi and microalgae, their morphological study with proper staining procedure. Bacterial staining – Gram staining, capsule and spore staining.
2. Sterilization : principles and techniques – dry heat, wet heat, steam sterilization, filter sterilization; Working principle of axenic environment - Laminar air flow chamber.
3. Preparation of microbial culture media: Complex, minimal, selective and enrichment media. Use of those media for bacterial selection and enumeration. Preparation of fungal media: PDA and Czepeck'sDox agar media.
4. Culture techniques – liquid, slant, stab and plate culture techniques for bacterial multiplication.
5. Methods of inoculation.

H.1.2.2 – Advance techniques

1. Isolation of microorganism for different habitats – dilution technique and using selective medium.
2. Microbial growth measurements – turbidity measurement, total count, MPN count, estimation of dry weight.
3. Antibiotic assay: Cup assay and MIC method.
4. Determination of Phenol co-efficient of commercial disinfectants.
5. Determination of thermal death point.

Course H.1.3 Biomolecules & Biochemistry 2-credits (50)

H.1.3.1- Biomolecule I

1. **Protein** : Amino acids and its chemical and physical properties; peptide bond; sequencing of proteins; hierarchy in protein structure; Ramachandran plot; Motifs; Domains; structure of collagen, keratin and fibroin.
2. **Nucleic Acid:** DNA and RNA; A, B and Z-forms of DNA, DNA denaturation and DNA renaturation, DNA supercoiling; Complex structures of RNA.
3. Transport of oxygen: Structure of myoglobin and hemoglobin; Effect of pH, BPG and CO_2 on oxygen affinity of hemoglobin

Biomolecule II-

1. **Carbohydrates:** Monosaccharides classification, Disaccharides (sucrose, lactose, maltose etc.), Polysaccharides types (glycogen, starch and cellulose), Glycoproteins (Proteoglycans and peptidoglycans), Lectins.
2. **Lipids:** Fatty acids and triglycerides; Glycerophospholipids, sphingolipids and Phosphatidylinositols; Cholesterol, prostaglandin.
3. **Other Biomolecules**: Vitamins & Alkaloids, Steroids, phenolics.

H.1.3.2 – Enzymology, Metabolism & Bioenergetics

1. Enzymes and co-factors, free energy and enzymes, catalytic transition state, Michaelis- Menten Model, co-enzyme; Inhibition of enzymatic activity. Effect of pH and temperature; Nomenclature; enzyme inhibition & its kinetics. Km/kcal ratio, Isozymes, Allosteric regulation, regulation of enzymatic activity by proteolytic cleavage, Catalytic strategies.

Metabolism

1. Glycolysis, TCA cycle, gluconeogenesis, glyoxalate cycle, glycogen metabolisim; metabolism of other hexoses, pentose phosphate pathway, E.D. pathway.
2. Fatty acid biosynthesis & oxidation; Lipid transport.
3. Amino acid metabolism (outline only)
4. Purine and pyrimidine metabolism (outline only).

Bioenergetics

a. Electron-transfer reactions in mitochondria.
b. ATP synthesis: Structure and mechanism of ATP synthase, Chemiosmotic theory.
c. Regulation of oxidative phosphorylation.

Course H.1.4 Practical on Biomolecules & Biochemistry 2-credits (50)

H.1.4.1 -Biomolecule (P)

1. Laboratory rules and safety regulation, first aid.
2. Isolation and quantification of nucleic acid (DNA and RNA) from microorganisms, plant sources etc.by colorimetric methods.
3. pH, pK Henderson-Hasselbach equation , preparation of buffers
4. Isolation and quantification of Protein estimation (Lowry et.al.'s method).
5. DNA denaturation and renaturation.
6. Estimation of total lipid from tissue.
7. Techniques of column chromatography.
8. Gel filtration (Sephadex) for isolation of macromolecules.

H.1.4.2 –Biochemistry (P)

1. Estimation of carbohydrates – anthrone method.
2. Isolation and purification of bacterial alkaline phosphatase, determination of its specific activity and stability.
3. Effects of pH, temperature, inhibitor on BAP activity.
4. Determination of Km and Vmax of alkaline phosphatase

Course H. 1.5. Biophysical Chemistry - 2credits (50)

H.1.5.1 Basic Biophysics

1. **Atoms, Bonds and Molecules**
   Electronics structure of atoms, Molecular orbitals and covalent bonds. Molecular interactions in Biochemistry (Strong and weak interactions), Steriochemistry and chirality, Structure of water, buffer, pH (Biochemical importance).
2. **Thermodynamics**
   Laws of thermodynamics, Entropy, Enthalpy, Free energy, Chemical potential, Oxidation-reduction potential.

3. **Principles of Chromatography**
   Principles and application of different chromatographic techniques (Thin Layer, Paper, Gas, Ion Exchange, Molecular Exclusion and Affinity Chromatography).
4. **Principles of Electrophoresis**
   Principles and applications of different Electrophoretic techniques

H.1.5.2. Spectroscopy

1. UV-vis Absorption Spectrosopy : UV-vis Spectrophotometer, Lambert-Beer Principle, chromophores and different transitions(II ® II. . n ® s*.n ® II.), applications.
2. Fluorescence Spectroscopy : Principle of fluorescence spectroscopy, fluorescence spectropho-tometer, Fluorescence quenching, Polarization, Anisotrophy, Flow cytometry, applications.
3, Principles, Instrumental features and applications of other Spectoscopies.

4. CD-ORD, IR, Raman**,** Atomic absorption and NMR spectroscopy

Course H.1.7 Genetics 2-credits (50)

H.1.7.1 Mendelian Genetics and gene mapping

1. Mendelian principles: A brief history of Premendelian Genetics, monohybrid cross the princilples of Dominance and segregation, dihybrid cross the principle of independent assortment, deviation from Mendelian inheritance.

2. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, the inheritance of continuous characteristics, pleiotropy, genomic imprinting, penetrance and expressivity, linkage and crossing over, mitotic recombination and its example, sex limited and sex influenced characters. Environmental effects on gene expression- phenocopy.

3. Gene mapping methods: The concept of genetic (linkage) map, Gene mapping with three point test cross, interference and coincidence, lod score for linkage testing, tetrad analysis in haploid eukaryotes, mapping of two linked genes using tetrad analysis, mapping with molecular markers, Physical chromosome mapping (A brief concept on- Deletion mapping, somatic cell hybridization, In Situ hybridization, mapping by DNA sequencing) development of mapping population in plants.
   Extra chromosomal inheritance: Maternal inheritance and difference with maternal effect, Inheritance pattern of mitochondrial and chloroplast genes (with example).

H. 1.7.3 Cytogenetics

1. Bacterial and Viral genetics: The bacterial genome, plasmid, Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping of bacterial genes with transformation, interrupted conjugation, gene mapping in phages, transduction: using phages to map bacterial genes fine structure analysis of bacteriophage genes, RNA viruses.
2. Sex determination and sex linked characteristics :Chromosmal, genetic (genic balance theory), environmental sex determination.
3. Organization of genes and chromosomes:, structure of chromatin, centromere, telomere; C-value paradox, unique and repetitive DNA; transposable element, mechanism of transposition, transposable element in bacteia, yeast, maize, drosophila, human, retroposon, genetic and evolutionary significance of transposable element.
5. Structural and numerical alterations of chromosomes and their genetic implications: Deletion, duplication, inversion, translocation, aneuploidy- types, origin, aneuploidy in human being, mosaicism, polyploidy- types, natural and synthetic polyolidy, Role of polyploidy in crop improvement; chromosome mutation and cancer.

Soft Core

Student will select 4 (four) credits from the options below

Each code carry 1credit

Course S.1.1- Virus, Fungi, Algae & Protozoa

1. A brief account of general methods of virology : assay of bacteriophages, animal viruses and plant viruses – basic methods. Cultivation of viruses – egg, live animal/plant, cell culture-primary and secondary cell culture, suspension cell culture, monolayer cell culture.

2. Fungi: Brief account on fungi and their life cycle pattern; Fungi as a microbial resource in human welfare and environment.
3. Algae : General account on algae and their life cycle pattern Alga as a microbial resource in human welfare and environment.
4. Protozoa : General account on protozoa and its interaction with man

Course S.1.2- Plant Biochemistry

1. **Photosynthesis**
   Light harvesting complexes; mechanism of electron transport; photoprotective mechanisms; CO2 fixation-C3, C4, CAM – pathway; & photorespiration.

2. **Plant hormones:**
   Biosynthesis, storage breakdown and transport: physiological effects and mechanism of action.

Course S.1.3- Principles of Microscopy

1. Light Microscopy: Optics, Magnification, Resolution, Different types of light microscopy (Bright field, Dark field, Phase Contrast, Interference, Polarization, Fluorescence).

2. Electron Microscopy: Components of EM, different types of electron microscopy [TEM, SEM, STEM), Specimen preparation, Image reconstruction, Electron diffraction, Cryo-EM.

3. Emerging Trends : Confocal Microscopy, Scanning-Tunneling Microscopy, Atomic Force Microscopy, Interfacial-Force Microscopy.

Course S.1.4. Advance Physico-chemical Techniques

1. Hydration of macromolecules. Role of friction, Diffusion [translational & rotational], Sedimentation, Ultracentrifuge, Viscosity, Osmosis.

2. Radioactivity:Radiation dosimetry, Radioisotopes use in biology, measurement of radioactivity (GM counter, Scintillation Counter), Autoradiography.
3. X-ray Crystallography
   Crystals and symmetries, Point groups and Space groups, Growth of crystals of biological macromolecules, Principles of X-ray diffraction, X-ray Data collection, Structure solution, Refinement of the structure.

Course S.1.5 Population & Human Genetics

1. Human genetics: Pedigree analysis, autosomal recessive and dominant traits, X-linked dominant and recessive traits, Y-linked traits, Genetic disorders-Genetic counseling, Prenatal and post natal genetic testing, the concept of designer baby.

2. Quantitative genetics: The relation between genotype and phenotype, types of quantitative characteristics, Polygenic inheritance, heritability (types, measurements, limitation), QTL mapping and its application.

3. Population genetics – populations, gene pool, gene frequency, allele frequency; Hardy-Weinberg law; forces that change gene frequencies in populations (mutation, migration and random genetic drift); Natural selection, change in gene frequency through natural selection; speciation; allopatricity and sympatricity.

Course S.1.6. Genetics (Practical & Problems)

1. Artificial transformation of E.coli with plasmid.
2. Conjugation and transduction in bacteria
3. Isolation of drug resistant mutant bacteria
4. Isolation of chlorophyll mutant following mutagen treatment
5. Testing goodness of fit.
6. Problems & Solution of Human Pedigree
7. Two point and three point test cross.
8. Problems on Probability.

SEMESTER II

Students have to complete 12 (twelve) hard core and 4 (four) soft core credits to qualify the Semester II. The students can also choose any soft core credit from the sister departments of life Science as per availability of the courses.

Hard Core

Course H.2.1. Cell Biology & Developmental Biology 2credits (50 points)

H.2.1.1: Cell membrane, Cell Wall & Subcellular organelles

1. The origin and evolution of cells; the evolution of metabolism; types of eukaryotic cells, cell specialization; the origin of eukaryotic cell; cells as experimental model organisms.

2. Membrane structure and function: An overview of membrane function; model of membrane Structure; the chemical composition of membranes membrane lipids, membrane carbohydrates; the structure and function and membrane proteins; the movement of substances across cell membranes-diffusion, ion channels, facilitated diffusion, active transport, ion pumps, endocytosis- receptor mediated endocytosis, protein trafficking in endocytosis. Mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.
3. The cell walls, the extra cellular matrix : bacterial cell wall, eukaryotic cell wall, primary cell wall, secondary cell wall in plant; the extra cellular matrix-matrix structural proteins, matrix polysaccharides, matrix adhesion proteins (fibronectin, laminin,entactin); cell matrix interaction (integrin, hemidesmosome etc.); cell -cell interaction, gap junction and plasmodesmata mediated intercellular communication, neurotrans-mission and its regulation.

4. Structure and function of mitochondria (mitochondrial membrane, mitochondrial matrix), protein import and mitochondrial assembly; the structure and function of chloroplasts, import and sorting of chloroplast proteins, photosynthesis, the structure and function of peroxysome; posttranslational uptake of proteins by peroxisomes, mitochondria and chloroplast; nucleus, ultra structure of the nuclear envelop ,nuclear lamina, nuclear matrix, nuclear pore complex, nuclear localization signal, export and import of proteins from the nucleus, chromosomal DNA and its packaging; euchromatin and heterochromatin.

H.2.1.2: Cell cycle, Cell Signaling & Developmental Biology

1. **Cell cycle:** general introduction, control of cell cycle, checkpoints, phases of mitosis, cytokinesis, and meiosis.

2. **Cell signaling &Programmed cell death**: modes of cell cell signaling, steroid hormones and the nuclear receptors, cell surface receptor, G-protein coupled receptors, receptor protein tyrosine kinase, signal transduction pathways, second messengers, regulation of signaling pathways; caspases, bcl2 family,signaling pathway.

3. **Developmental Regulation in Animal:** Gametogenesis, fertilization and early development in animals: the development of germ cells, germ cells differentiation, oogenesis and spermatogenesis in mammals, recognition of egg and sperm, gamete fusion and prevention of polyspermy, the activation of egg metabolism, fusion of genetic material, rearrangement of egg cytoplasm; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals, stem cells.

4. Developmental Regulation in Plants

Gametogenesis, fertilization and early development, morphogenesis and organogenesis in plants: general concept of plant life cycle, microsporogenesis, megasporogenesis, pollination, embryo sac development and double fertilization in plants; embryogenesis, seed formation, dormancy, germination; meristems, root, shoot and leaf development, establishment of symmetry in plants; the vegetative to reproductive transition, genetic control of floral meristem, organ identity genes (homeotic genes)-the ABC model.

Course H.2.2 Laboratory Techniques on Cell Biology 2-credits (50)

H.2.2.1 Technique I

1. Study of mitotic cell division in *Allium cepa*
2. Study of meiotic cell division in *Allium cepa*
3. Karyotype Preparation
4. Cytological study in *Aloe vera*

H.2.2.2 Technique II

1. Cytological study of Mouse chromosome
2. Nucleolus staining of *Allium cepa*
3. Study of Translocation in *Rhoeo*
4. Study of Bar body in squamous tissue
5. Effect of toxic chemicals on chromosomes
6. Effect of Colchicine on chromosome disjunction

Course H.2.3 Molecular Biology 2credits (50)

H.2.3.1 DNA Replication & Transcription

1. DNA replication : Prokaryotic and Eukaryotic DNA replication; mechanics of DNA replication; enzymes & accessory proteins in DNA replication. fidelity of replication, extrachromosomal replicons, Replication of telomere, replication in QX174, M-13, T-odd and even phages; DNA damage and repair mechanisms.

2. Transcription : Prokaryotic and Eukaryotic transcription; RNA polymerases of pro- and eukaryotes; subunits; different sigma factor related to stress, viral infection etc. Transcription of mRNA, rRNA and tRNA; Initiation, elongation and termination (in pro- & eukaryotes); transcription factors; rho dependent and independent termination.Regulatory elements of transcription and mechanisms; Transcription activators and repressors.

3. Post-transcriptional modification of RNA capping, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport. – 5' capping, 3' end processing and polyadenylation, splicing and editing of RNA, exon shuffling; nuclear export of mRNA; mRNA stability, Processing of tRNA, rRNA

H.2.3.2 Translation & Control of Gene expression

1. Prokaryotic and eukaryotic translation machinery, experimental evidences of the mechanisms of prokaryotic and eukaryotic initiation (cap-dependent and IRES mediated), elongation and termination; Wobble hypothesis, Codon bias, Regulation of translation, Co- and post- translational modifications of proteins.

2. Control of gene expression at transcription and translation level: Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing, general discussion or snRNAs (snurps, snorps); Ribozymes, antisense RNA, siRNA, miRNA.

Course H.2.4 Techniques in Molecular Biology 2-credits (50)

H.2.5.1. Technique I

1. beta- galactosidase induction kinetics.
2. Artificial transformation of *E.coli* with plasmid.
3. Isolation of plasmid DNA from E.coli
4. Agarose gel electrophoresis of DNA
5. SDS – PAGE electrophoresis.

H. 2.5.2. Technique II

1. Restriction digestion of DNA and Restriction mapping.
2. PCR amplification of DNA fragment
3. Isolation of RNA
4. Determination of number *E. coli* phage in a given environmental sample

Course H.2.6 Molecular Genetics & Biostatistics 2-credits (50)

H.2.6.1 Molecular Genetics

1. Evolution of concept of gene: Allele, multiple alleles, one gene one enzyme, one gene one polypeptide hypothesis, structural and functional allelism, pseudoallele, complementation tests.

2. Mutation: Categories &Types, phenotypic effects of mutations – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, molecular basis of mutation, insertional mutagenesis, suppressor mutations, causes of mutations, mutator genes, reversion of mutation, detection, adaptive response by *Ada* gene.

3. DNA damage and repair mechanisms: Direct repair, excision repair, mismatch repair, nonhomologous end joining, SOS repairing.

4. Recombination: Homologous recombination at the molecular level (Holliday & DSB repair model); site-specific recombination and transposition of DNA. (4)

3. Mitochondrial & chloroplast DNA: gene structure and organization of mtDNA& cpDNA, replication, transcription and translation of mtDNA&cp DNA, evolution of mtDNA&cpDNA; mitochondrial DNA and aging of human beings.

H. 2.6.2. Molecular Genetics of Cancer & Biostatistics

1. Basic properties of a cancer cell, the causes of cancer-chemical, radiation, virus induced; the genetics of cancer –oncogenes, oncoprotein, tumor suppressor genes, microRNAs,change in chromosome number and structure, genomic instability, DNA repair genes, DNA methylation, telomerase regulation, cancer and the cell cycle, apoptosis; metastasis, diagnosis of cancer- DNA microarrays, new strategies for combating cancer.

2. **Biostatistics**
Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval;errors; levels of significance; regression and correlation; t-test; analysis of variance; X^2 test; basic introduction to Muetrovariate statistics.

Course H.2.7 Recombinant DNA Technology 2-credits (50)

H.2.7.1. Molecular Cloning & Gene Manipulation

1. Restriction modification system, restriction endonucleases- classification, enzymes used in recombinant DNA technology, **Vectors.**

2. Strategies of molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems, Southern blot, PCR; expression of recombinant proteins using bacterial, animal and plant vectors. Strategies for identification and characterization of a Gene

3. Isolation of specific nucleic acid sequences; generation of genomic and cDNA libraries.

4. *In vitro* mutagenesis and deletion techniques, gene- knock out in bacterial and eukaryotic organisms.

H.2.7.3 DNA Sequencing & Protein-Nucleic acid interaction

1. DNA sequencing methods, strategies for genome sequencing; methods for analysis of gene expression at RNA and protein level, Northern Blot, RNase protection assays, SAGE, RT-PCR, q-PCR, Western Blot, .

2. RFLP, RAPD and AFLP techniques, Primer extension, S1 mapping, radiation hybrid mapping, HAPPY mapping

3. Tools for studying DNA-protein interactions, foot-printing analysis, Gel Electrophoretic Mobility Shift Assay, yeast two and three hybrid system, ChIP

SOFT CORE COURSES

Student will select 4 (four) credits from the options below

Each code carry 1credit

Course S.2.1 Advance Cell Biology

1. Cellular transport: the endoplasmic reticulum and protein sorting, targeting protein to the ER, insertion of protein into the ER membrane, protein folding and processing in the ER,quality control in the ER, lipid synthesis and exports of proteins and lipids from ER; organization and protein glycosylation within the Golgi, lipid and polysaccharide metabolism in the Golgi, protein sorting and export from the Golgi apparatus, types and mechanism of vesicular transport, cargo selection, coat protein, vesicle budding and vesicle fusion, sorting proteins at the TGN; lysosome and lysosomal storage, endocytosis, endosome, phagocytosis and autophagy.
2. The Cytoskeleton and Cell movement : structure, organization, assembly of actin filaments, actin, myosin and cell movement, intermediate filaments, structure and organization, assembly of microtubules, microtubule motors and movement, chromosome movement.

Course S.2.2 Advance Developmental Biology

Morphogenesis and organogenesis in animals: differentiation and morphogenesis in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditiselegans; eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development-larval formation, metamorphosis; environmental regulation of normal development.

Course S.2.3. Molecular genetics of Virus

1. Bacteriophages: Structural organization; Life cycle – lytic & lysogenic, DNA replication & regulation, maturation and assembly of virion. Brief outline of life cycle of M13, T_3, T_4, and RNA phage – Q beta and their importance in bacterial genetics and biotechnology.
2. Animal viruses: Life cycle and replication of SV-40, pox, adenovirus, retrovirus.

Course S.2.4. Review writing on recent technique on molecular biology

Course S.2.5. Seminar on one recent development of Recombinant DNA Technology

SEMESTER III

Students have to complete 22 (twenty two) hard core and 2 (two) soft core credits to qualify the Semester III. The students can also choose any soft core credit from the sister departments of life Science as per availability of the courses.

Hard Core

Course H.3.1 Genomics & Proteomics 2-credits (50)

H.3.1.1. Genomics

1. An overview of Prokaryotic, Eukaryotic and Organelle genome structure.

2. Strategies for large scale sequencing projects: Two different strategies for sequencing genomes, Gaps in sequence, Quality of genome sequence data.

3. The human genome: Simple and complex transcription units, Gene family, Multi copy genes, non-protein coding DNA, repeat sequences, LINE, SINE.

4. Comparative genomics: Ortholog and paralogs, comparative genomics of bacteria, organelles and eukaryotes.

5. Epigenetics: Genome imprinting, X chromosome inactivation, Histone code.

H.3.1.2 Techniques in Genomics & Proteomics

1. Mapping genome: Genetic markers for genetic mapping – RFLP, SSLP, STS, SNP; Restriction mapping; Physical mapping, Radiation hybrid mapping, HAPPY mapping, Fluorescent in situ hybridization (FISH).

2. DNA microarray – printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper; genome analysis for global patterns of gene expression using fluorescent labeled cDNA or end labeled RNA probes. Analysis of single nucleotide polymorphism using DNA chips.

3. Exploring genes – Computer analysis of gene function, Assigning gene function by experimental analysis.

4. Proteomics and proteome; Overview of analytical proteomics, analytical protein and peptide separations, protein digestion techniques, mass spectrometers for protein and peptide analysis, by peptide mass fingerprinting, peptide sequence analysis by tandem mass spectrometry, protein identification with tandem mass spectrometry data;

2. Application of proteomics: Mining protein expression profiling, identifying protein-protein interactions and mapping protein modifications.

Course H.3.2. Computer Application &Bioinformatics 2-credits (50)

H.3.2.1. Computer organization & Programming

1. Block diagram of a micro- computer; input, output devices, central processing unit, secondary storage devices, types of digital computers, binary number systems, Gates, Flip-flops; operation system as a resource manager.

2. Operating systems– Windows & DOS, Microsoft Word, Excel, Basics of typing a report or letter; creation of a table with Windows, Microsoft excel – the spreadsheet and presentation software; creating a work book, entering data and formula. Format cell, columns and rows, naming range, different library functions,

statistical functions. Introduction charts-format and re-size charts, print charts, Macros Introduction, Corel draw, power point.

3. overview in C; Constant & variables, data types, operator and expressions. Decision making and branching; Arrays handling of characters, functions. Structure and Union pointer, files.
4. **Computer communication :** Introduction to internet web browsing, E-mail, Search engines, Downloads, HP viruses.

H.3.2.2 Bioinformatics

1. **Introductory concepts:** What is bio-informatics? Its utility and its introduction to some applications and recent advancement in the area.
2. **Pair-wise sequence comparisons & alignments:** Pair-wise alignment, Dynamic programming algorithms, Sequence alignment Heuristics, BLAST (3 approaches), BLAT, FASTA, program comparisons.
3. **Multiple sequence alignment :**Clustal W & X; T- Coffee, PSI-BLAST.
4. **Phylogenetic analysis & evolution:** Clustering & Trees; Distance, Parsimony, ML, Mr. Bayes; Orthologs&Paralogs.
5. Bioinformatics for the analysis of sequence data; approaches for determining gene functions.
6. **Gene Finding:** Hidden Markov Models; gene prediction methods and tools; promoter analysis; SNP's & Genotyping, gene structure or anatomy; mutations & alleles.
7. **Protein sequence & structure:** PDB files; visualizing protein structure – Deep view, Chimera, Matras, HMM's for Protein Structure Prediction; Neural Networks. Introduction to drug design.

Course H.3.3 Hands on Training on Computer Application & Bioinformatics

1credits (25)

1. Programming with different languages, Construction of database, Data analysis, modeling, networking.
2. Graphic presentation of Data, SPS handling and statistical analysis of data.
3. Searching of BLAST / FASTA

Course H.3.4 Immunology 2credits (50)

H.3.4.1. Basic Immunology

1. Innate Immunity

a. Epithelial Barriier. Neutrophil and Macrophage Function.
b. Defense mechanism to Infection (Migration, Inflammation and Phagocytosis).
c. Function of NK cell.
d. Cross-talk with Adaptive Immune system

2. Antigens Presentation

a. Concept of haptens, determinants, conditions of antigenicity, superantigen.
b. Dendritic cell
c. MHC

3. Antigen Recognition

a. Antigen Receptor: T and B cell Receptor
b. Structure of Immunoglobulin and T-cell receptor
c. Antigen Receptor Diversity-Mechanism
d. Antigen Receptor Maturation and selection

4. Cellular Immunity

a. Cell mediated recognition, adhesion and Co-stimulation
b. Clonal Expansion
c. Th 1 and Th 2 Response
d. Cytotoxic T cell response

5. Humoral Immunity

a. Immunoglobulin Type and function
b. Class switching Mechanism
c. B-cell function, maturation and development
d. Complement pathway and disease
e. Polyclonal and Monoclonal Antibody Applications

H. 3.4.2 Advance Immunology & Immunotechniques

1. Asthma and Hypersensitivity

a. Type I
b. TypeII
c. Type III
d. Type IV

2. Tolerance and Autoimmunity

a. Peripheral and Central Tolerance of T and B cell
b. Malfunction and different autoimmune disease.

3. Tumor Immunology

a. Strategies of tumor cell to evade Immune system
b. Anti-tumor Immune response
c. Modern Immunotherapy of Cancer.

4. Transplantation Immunology

a. Basis of Transplatation
b. Acute, Hyperacute and chronic Graft rejection
c. Modern techniques of transplantation (e.gBMT,liver,corneaetc)

5. Immunodeficiencies

a. Congenital Immunodeficiencies
b. Acquired Immunodeficiencies

6. Immunoassays and techniques

a. Antigen-Antibody Reaction Analysis-Agglutination, Diffusion etc.
b. Isolation and culture of Immune cells. Surface marker, MACS, FACS
c. Antigen-Antibody reaction-RIA, ELISA, Western blot
d. Visualization of Immune reaction In vivo and vitro- Immunofluorescence, FISH, GISH, immunohistochemistry etc.

7. Immunization

a. Formulation of vaccines and vaccination schedule.

Course H. 3.5 Techniques of Immunology 1credit (25)

1. Antigen –antibody reaction assessment by (i) immunoddiffusion (ii) immunoblot and (iii) immunoelectrophoresis.
2. Electrophoretic separation of serum protein.
3. Lymphoid organs and their microscopic organization.
4. Immunization, collection of serum
5. Double diffusion and immunoeletrophoresis.
6. Radial immuno diffusion.
7. Separation of mononuclear cells by Ficoll- Hypaque.
8. ELISA (demonstration).

Course H.3.6. Plant Cell, Tissue & Organ Culture 2credits (50)

H.3.6.1 Conventional Plant Breeding & Plant Cell & Tissue Culture

1. Introduction; Objectives; domestication, introduction of germplasms, germplasm preservation; gene pool concepts; hybridization techniques, heterosis & inbreeding depression, back cross method, mutations in crop improvement, polyploidy in crop improvement, distant hybridization, Merits & limitation of conventional plant breeding. Concept of Plant cell and tissue culture, Historical background of PCTOC, introduction of different terminologies used in PCTOC.

2. Plant culture medium

The components, preparation and derivation of Plant culture medium : the development of plant culture medium, composition of plant culture medium, macronutrient salt, micronutrients, vitamins, undefined supplements, organic acids, sugar, gelling agent; plant growth regulators, auxins, cytokinins, gibberellins, ABA, ethylene, polyamines, activated charcoals.

3. Callus and Cell culture : Initiation, maintenance and appearance of callus; isolation of single cells, cell suspension culture, batch culture, continuous culture, chemostat, turbidostat,synchronization, assessment of growth, assessment of viability of cultured cells, techniques of single cell culture, plant cell bioreactor, application of callus and plant cell culture.
4. Protoplast culture and fusion: isolation of protoplast, techniques of protoplast culture, plant regeneration; protoplast fusion, mechanism of fusion,selection of fusion products, somatic hybridization, symmetric and asymmetric hybridization, verification of hybridity, cybridization, application of protoplast culture and fusion.
3. Anther and pollen culture: techniques, androgenesis, gynogenesis, ontogeny of androgenic haploid, diplodization, application.
4. Embryo and endosperm culture.

H.3.6.2 Morphogenesis, variations & Commercial Applications

1. Morphogenesis : cellular totipotency, differentiation, dedifferentiation, redifferentiation, cytodifferentiation, organogenesis (direct and indirect); somatic embryogenesis (direct & indirect),similarity and difference between somatic and

zygotic embryos,cellular origin, stages of embryo development, anatomical features of organogenesis and somatic embryogenesis, molecular aspect of somatic embryogenesis, factors affecting morphogenesis, practical application, synthetic seeds.

2. Somaclonal variation: epigenetic variation, selection of variants, origin, mechanism underlying genetic variation, practical aspects.
3. Micropropagation : methods, stages, advantages and disadvantages, commercial application, production schedules, laboratory designing.
4. Development of virus free plants
5. Role of plant tissue culture in conservation of germplasm

Course H.3.7 Hands on Training on PCTOC 2credits (50)

1. Preparation of stock solution for MS medium
2. General methodology for media preparation
3. Surface sterilization procedure
4. Seed and embryo culture
5. Induction of friable and granular callus
6. Micropropagation through axillary bud culture
7. Organogenesis and meristemoid formation
8. induction of somatic embryos and its study
9. Induction of PLBs and regeneration of plantlets
10. Hardening of micropropagated banana plants.
11. Agrobacterium infection of leaf disc and isolation of transformants.
12. Cell suspension culture and its measurement
13. Isolation of agriculturally useful variants by cell culture methods Salt resistance

Soft Core

Student will select 2 (two) credits from the options below

Each code carry 1credit

Course S.3.1. Electrophysiological techniques

1. Electrophysiological methods**:** Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.
2. A brief concept of nanotechnology and its implication in medical biotechnology.

Course S.3.2 plant Bioreactor &Secondary metabolite

1. Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles, production of secondary metabolites through plant cell

culture, immobilization of cells, hairy root culture, biotransformation, commercial aspect.

2. Plants as Bioreactors: antibodies, edible vaccines, polymer, foreign proteins in seed.
3. Biotechnological approaches for extraction of plant secondary metabolites of commercial and industrial interest (vegetable dye, curcumin, capsiaicin, stevioside).

Course S.3.3. Ecology

1. The Environment: Physical environment; biotic environment; biotic and abiotic interactions.
2. Concept of habitat and niche.
3. Species interactions
4. Community ecology
5. Ecological succession
6. Ecosystem: Structure and function of some Indian ecosystems terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).
7. Biogeochemical cycles & role of microbes in N, S, P cycles

Course S.3.4. Applied ecology

1. **Emergence of evolutionary thoughts:** Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis.
3. **Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; protein and nucleotide sequence analysis; origin of new genes and proteins; gene duplication and divergence.

Course S.3.5 Biodiversity& Conservation

1. **Biodiversity:** Importance of biodiversity as natural resource; and as genetic resource; mega diversity, diversity of micro & macro organisms in India. Biodiversity and ecological balance; speciation & degeneration of diversity. Environmental pollution; global environmental change; biodiversity-status.

2. **Conservation :** Definition & principles; ex-situ & in situ conservation; Ecological management Concept and its progress and sustainability; bio-indicator species for ecological management; Biosphere reserves & national parks sanctuaries of India. Hot spots of India.Wild life management & conservation; Cryopreservation of germplasms/genetic resources – techniques & applications.
3. A brief account of aim, objectives and activities of the following institutes for conservation of flora &fauna : Botanical survey of India (BSI), Zoological Survey of India, Indian Council of Agricultural Research, and National Bureau of Plant Genetic Resources, International Bureau of Plant Genetic Resources.
4. Objective and activities of WWF, Red Data Book, Species survival commission, CITES.

Course S.3.6 Techniques on Genome and Proteome Analysis

1. Isolation of Genomic DNA
2. DNA finger printing
3. RAPD analysis
4. ISSR analysis
5. SDS PAGE
6. 2,D GEL Electrophoresis
7. RT- PCR

SEMESTER IV

Students have to complete 20 (twenty) hard core and 4 (four) soft core credits to qualify the Semester IV. The students can also choose any soft core credit from the sister departments of life Science as per availability of the courses.

Hard core courses

Course H.4.1 Bioprocessing and Fermentation Technology 2credits (50)

H.4.1.1 Introduction to Bioprocess Engineering

1. Bioreactors and Membrane Bioreactors
2. Isolation, selection, improvement, preservation and maintenance of industrial microorganisms
3. Kinetics of microbial growth and death. Media for industrial fermentation, air and media sterilization.
4. Types of fermentation process, analysis of batch, fed-batch and continuous bioreactors
5. Stability of microbial reactors, analysis of mixed microbial population; specialized bioreactors (pulsed, fluidized, photobioreactors). Measurement and control of bioprocess parameters.
6. Downstream processing : Introduction, removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugates, cell disruption, liquid-liquid extraction, chromatography, membrane process, drying and crystallization, effluent treatment, BOD and COD, treatment and disposal of efluents.

H.4.1.2 Industrial production of Chemicals

1. Industrial production of chemicals with reference to raw materials, fermentor type, process of fermentation, downstream process of the following : alcohol (ethanol), acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol), antibiotics (penicillin, streptomycin, tetracycline), amino acids (lysine, glutamic acid).

2. Enzyme and whole cell immobilization and their industrial applications with reference to lipases, proteases, oxygenases, amylase, pectinases, cellulase and streptokinase; enzyme engineering.

Course H.4.2 Microbial Biotechnology 2 credits (50)

H.4.2.1 Production of Pharmaceuticals

1. **Antibiotics :** 1st , 2nd and 3rd generation products (Penicillin model)
2. **Steroids :**Biotransformation of steroids.
3. **Vaccines :** Use of tissue culture (human fibroblast tissue) – Rabies vaccine.
4. **Human proteins using transgenic microbes :** insulin, hepatitis B-vaccine human growth hormone (StH). Interferons, tumor necrosis factors.
5. **Production of vitamins :** Development of overproducing strains, selection of new organisms.
6. **Metal extraction: Biomining of metals:** copper, uranium and gold.
7. **Oil extraction & oil recovery :** Bioleaching of oil shales; tertiary recovery of oil (xanthum).
8. **Production of fine chemicals :**Biosurfactants.
9. **Single cell proteins :** Yeast based, Methylophilus, Spirulina.
10. **Single cell Lipids** : designed unsaturated fatty acids using fungi & bacteria.

H.4.2.2. Food biotechnology & Biofertilizers

1. Processed foods, food products and beverages (bread, dairy products, meat & fish products, fermented vegetables, sauce, fruit juices, silage).
2. Elementary idea of canning & packaging of food and food products; sterilization, Pasteurization of food products
3. Production of neutriceuticals
4. Food color and flavor ; antioxidants; food preservation.
5. Probiotics – application to animal and man.
6. **Biofertilizers :** types, formulation, commercial production with reference to Rhizobium. Azolla, Mycorrhiza; phosphate solubilizing bacteria and fungi;Vermicomposting.

Course H. 4.3 Animal Cell Culture & Biotechnology 2credits (50)

H.4.3.1 General Concept on Cell culture

1. General introduction on Animal cell culture, puripotency, totipotency etc.
2. Primary and secondary cell culture; organ culture, primary explant culture.

3. Application of cell culture: immortalization of cell lines; development of cell line and clones, Diagnostics 4.
Stem cell culture, embryonic cell culture
5. Growth promoter and other products used in cell lines

H.4.3.2 Animal Biotechnology

1. Animal biotechnology in production: Animal genetics and breeding; reproduction in animals and its regulation artificial insemination and embryo transfer technology, IVF in human and farm animals.

2. Gene transfer and transgenic animals transfection methods, Transgenic animals and their advantages; knock out animals. 3.
3. Potential application for bees and apiculture.
4. Potential application for silkworm and sericulture.
5. Biotechnology in aquaculture: Farms of aquaculture and species cultures. Energetics and feeding; formulation of diet, supplementary feed in fish farming, improvement of utilization efficiency of supplementary feed, probiotics in fish feed; biotech of fish spawning and production of hybrid and transgenic fish.

Course 4.4 Training on Microbial Technology & Animal Cell Culture
2credits (50)

1. Isolation of amylase producing microorganisms.
2. Optimization of amylase production using isolated microorganism.
3. Experiments on submerged and static cultures.
4. Experiments on liquid and solid cultures.
5. Mushroom cultivation.
6. Immobilization of microbial cells or enzymes by calcium alginate gel entrapment
7. Culture of adherent and/or suspension cell lines; (e.gHeLa, 293 and Raji).

Course 4.5 Genetic Engineering of Plants 2-credits (50)

4.5.1. Basic techniques of genetic transformation

1. Plant transformation: introduction, Agrobacterium mediated gene transfer, Ti plasmid derived vector system, transformation technique using Ti plasmid; direct nuclear transformation, microprojectile bombardment, micro injection, liposome mediated transformation; use of reporter gene, marker genes, manipulation of gene expression in plants, chloroplast transformation, production of marker free transgenic plants, stability of transgene in transformed plant.
2. Development of pathogen-herbicide resistant plant: insect resistant plant, production of BT cotton, other strategies for protecting plants against insects, genetic engineering of improved bio-control, virus resistant plant, fungus and bacterium resistant plant, herbicide resistant plants.

4.5.2 Applied field of genetic engineering of plants

1. Development of stress and senescence tolerant plants: Stress physiology: Responses of plants to abiotic (oxidative, water, temperature and salt) stresses; mechanisms of resistance to abiotic stress,fruitripening and flower wilting.
2. Genetic manipulation of flower pigmentation .
3. Modification of plant nutritional content: amino acids, vitamins, lipids.
4. Terminator gene technology
5. Modification of food plant taste and appearance : preventing discoloration, sweetness.

Course H.4.6 Summer Training of 6-weeks from any reputed National/International laboratories or Universities. 2 credits (50)

Soft Core (Choose 4 credits)

Student will select 4 (four) credits from the options below

Each code carry 1credit

Course S.4.1 Basic concepts on Environmental Pollution

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2. Environmental pollution- Types of pollution; sources & physicochemical aspects of pollution; methods for measurements of pollution; Bio-monitoring of pollution, biosensors.
3. Air pollution & its control- conventional & biotechnological methods.

4. Water pollution & its control; water - scare natural resource, water management, assessment of water pollution, sources of water pollution; physical, chemical & biological treatment processes.

Course S.4.2 Biotechnological Approach to save environment

1. Climate change: Kyoto protocol and IPCC.
2. Sewage & wastewater management – Aerobic process, activated sludge, oxidation ditches, trickling filter, towers, oxidation ponds; anaerobic process, anaerobic digestion, anaerobic filters.
3. Treatment strategies for wastewater of dairy, distillery, tannery, sugar industries.
4. Xenobiotics in environment – microbial degradation of xenobiotics, bioremediation, phytoremediation, biodegradation of hydrocarbons, oil spill, pesticides, halogenated compounds,.

5. Baculovirus, Bacteria and fungi as the sources of biopesticides.
6. Agrowaste, domestic waste and hospital waste managements.
7. Alternative energy sources from wastes-biogas, microbes-biofuel, bioalcohol and plants- biodiesel.

Course S.4.3. Bioethics & IPR

Intellectual property rights, Trademarks, copyrights, patenting, product and process patenting. Indian Patent Act 1970; WTO & TRIP, patent application principle and procedure, the ethical and social impact of biotechnology, ethical criteria of biotech, Biosafety. Ethical concerns about patenting of living organisms and genetic materials; social acceptance biotech product. Patenting of biological materials; patenting higher plants and animal, patenting transgenic organisms and isolated gene and gene sequences; Plant Breeders Right and farmers Rights.

Course S.4.4 Theoretical aspects of Medical Biotechnology

1. Application of cell cultures for production of immunochemicals, lymphokines, cytokines, interferon DNA and recombinant vaccine.
2. Molecular diagnostic methods for genetic and microbial diseases,
3. Molecular pathology: hemoglobiopathies and hemophilia.
4. Drug design & development: Physico chemical Properties of drug, QSAR – receptor concept, Drug designing, delivery & targeting system
5. Human gene therapy: Retro, lenti, adeno and adeno-associated vectors for gene therapy; advantages and disadvantages of different vectors in gene therapy.
6. Forensic diagnosis.

Course S.4.5.Medical Biotechnology (P)

1. Collection of blood, serum, plasma (human/animal)
2. Blood film and stain, WBC (DC) and TC (RBC/WBC) by haemocytometer count.
3. Quantification of haemoglobin, measurement of ESR.
4. Blood group determination (by commercial kit).

Clinical biochemistry

1. Estimation of serum protein, glucose, cholesterol, triglycerides, urea, creatinine, bilirubin.
2. Estimation of serum enzymes (GOT, GPT)

Course S.4.6 Journal Club- Study and discussion on recent (2010 onwards) published papers from reputed journals on the field of Molecular Biology & Biotechnology. A Seminar based on this study.