UNIT 1: BIOCHEMISTRY

Classification, structure, chemistry and properties of carbohydrate, lipid, amino acids proteins and nucleic acids. Carbohydrate biosynthesis-Lipid biosynthesis- Biosynthesis of amino acids, Nucleotide and related molecules. Principles of Bioenergetics, Glycolysis. Catabolism of hexoses- The citric acid Cycle. Oxidation of fatty acids-Oxidation of amino acids-Oxidative phosphorylation – Photo phosphorylation, Biological membranes and transport. Cytoskeletal organization. Prostaglandins, leukotrienes, thromboxanes – Interferons and interleukins. Antibodies, alkaloids. Plant and Animal pigments. Principle techniques and applications of chromatography, centrifugation and electrophoresis.

UNIT 2: MOLECULAR GENETICS

Identification of DNA as the genetic material, Gene as the unit of mutation and recombination. Mutations: Molecular nature; mutagenesis by nitrous acid, hydroxylamine, alkylating agents, intercalators and UV. Origin of spontaneous mutations and control. Reversion and suppression – suppression of nonsense, missense and frameshift mutations. DNA damage by UV, alkylating agent, cross linkers, Mechanism of repair – photo reactivation, excision repair, recombinational repair, SOS, Adaptive responses and their regulation Heat shock response. DNA damage and repair. Para sexual process in bacteria: Transformation, transduction and conjugal gene transfer: The phenomena mechanisms and applications. Recombination: model, mechanism and control. Gene as the unit of expression. Colinearity of gene and poly – peptide. Elucidation of the genetic code, Wobble hypothesis. Regulation of gene expression. Extra chromosomal heredity: Biology of plasmids discovery, types and structure of F, RTF, Col-Factor and Ti plasmid, replication and partitioning. Incompatibility and copy number control, Natural and artificial plasmid transfer and their applications. Transposable genetic elements – Identification of transposition – IS elements, composite transposons, Tn3, Tn5, Tn9, Tn10 and Mu phage. Mechanism of transposition. Transposable elements in eukaryotes: Maize – Ac & Ds, Spm & dspm, Drosophila – p elements. Retro transposons. Genetics of Eukaryotes: Gene linkage and chromosome mapping. Crossing over–there point cross, tetrad analysis. Organisation of chromosomes, specialized chromosomes, chromosome abnormalities, quantitative inheritance, population genetics. Development of genetics using Drosophila as a model system.Somatic cell genetics. 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, EST's and SNP's.

UNIT 3: MOLECULAR AND DEVELOPMENTAL BIOLOGY

Cell theory, prokaryotic and eukaryotic cell structure and ultra structure and functions of intra cellular organelles. Organisation of cytoskeleton – organization of intermediate filaments, microtubules and actin filaments. Molecular aspects of cell division and cell cycle, mitosis, cytokines – Cell cycle – Cell fusion – Nuclear cytoplasmic interaction. Structure of DNA and

RNA. DNA melting and unwinding. kinetics – cot curve replication of DNA: enzymology, models of replication, kinetics and control. Transcriptions – Enzymology, prokaryotic and eukaryotic transcription, mechanism of transcription, post transcriptional modifications, export of mRNA. Transcription and process of rRNA and tRNA. Translation – Mechanism and regulation, post translational modifications, protein secretion. Regulation of gene expression: Regulation in prokaryotes – Operon concepts, Lac, Trp and Ara. Regulation in eukaryotes – Transcriptional regulation, transcription factors, hormonal regulation, loss, amplification and rearrangement. RNA mediated regulation. Mechanism of signal transduction – G protein, cAMP and calcium ion channel. Cancer – Introduction, types and oncogenesis, mitogens. Oncogenes, suppression of Oncogenes. Functional genomics and proteomics – Analysis of microarray data, Protein and peptide microarray-based technology, PCR-directed protein in situ arrays, Structural proteomics

UNIT 4: IMMUNOLOGY AND IMMUNOTECHNOLOGY

History and scope of immunology.Types of immunity – innate, acquired, passive and active, Physiology of immune response-H1 and CMI specificity and memory. Antigen-Antibody reactions, types of antigens, hapten immuno-globulins, types, structure, distribution and functions. Molecular biology of Ig synthesis. Lymphoid organs, ontogeny and physiology of the immune system, origin and development, differentiation of lymphocytes. Lymphocytes sub-population of mouse and man. Structure and functions of Class I and Class II molecules. HLA in human health and diseases. Transplantation immunity – Organ transplantation and HLA tissue typing, effector mechanism in immunity – Macrophage activation, cellular interaction in immune response, cell mediated cytotoxicity, hypersensitivity reactions, antigen lymphocyte activation, clonal proliferation, differentiation, interleukins and compliment systems. Immunological tolerance, immuno suppression, history and status of tumour immunology, auto immune disorders and immunology of infectious disease. Hybridoma techniques and monoclonal antibody production. Myeloma cell lines. Fusion of myeloma cells with antibody producing B cells and selection of hybrids. Cloning, production and characterization of monoclonal antibody. T-cell cloning and mechanism of antigen, recognition by T & B lymphocytes. Structure, function and synthesis of lymphokines. Antigen presentation and MHC Class-II molecules in T-cell cloning and application of T-cell cloning in vaccine development. Immunity to viruses, bacteria and parasites. Genetic control of Immune response. MHC associated pre-disposition, diseases. Infectious diseases– Leprosy, tuberculosis, malaria, filariasis, amoebiasis, rabies, typhoid, hepatitis and AIDS. Principles and strategy for developing vaccines, immuno diagnosis of infectious diseases.

UNIT 5: MICROBIOLOGY AND MICROBIAL TECHNOLOGY

Ultrastructure and functions of bacteria, fungi, algae, protozoa and viruses. Principles and structure and applications of microscopes. Classification of bacteria, fungi, algae, protozoa and viruses. Molecular taxonomy and current methods of microbial identification for systematic studies. Biology of Echerichia coli, Bacillus substilis, Bacillus thuringiensis, Stretomyces sp., Rhizobium sp., Agrobacterium tumefaciens, Saccharomyces cervisiae, Aspergillusnidulans,

archaeobacteria and bacteriophages. Food and diary microbes, Classification of foods, Contamination, preservation and spoilage of foods, Food borne diseases, Plant microbes interactions–Rhizobium and Mycorrhizae. Human pathogens, nosocomial infections, disinfectants and antibiotics. Biofermentor-upstream and downstream processing. Products of industrial microbiology.

UNIT 6: ENZYMOLOGY AND ENZYME TECHNOLOGY

Enzyme classification and nomenclature, General properties of enzymes like effect of pH, temp, ions etc. Extraction, assay and purification of enzymes. Steady state kinetics. Michaelis–Menten, Lineweaver-Burke, Eadie-hofstee and Hanes-Woolf equations and Km value. Enzyme inhibitors, Pre-steady state kinetics. Fast kinetics to elucidate the intermediates and rate limiting steps (Flow and Relaxation methods). Enzyme specificity. Evidences for enzyme substrate complex. Nucleophilic and electrophilic attack. Role of metal ions in enzyme catalysis. Mechanism of enzyme action eg. Lysozyme, chymotrypsin, DNA polymerases, RNase, Zymogens and enzyme activation. Allosteric interactions and product inhibition; complex kinetics and analyses, Membrane bound enzymes – Extraction, assay lipid protein interaction and effect of fluidity on enzyme activity. Coenzyme; Clinical and Industrial applications of enzymes. Immobilization of enzymes and their application. Ribozymes and their applications. Enzyme engineering.

UNIT 7: PLANT MOLECULAR BIOLOGY AND INTELLECTUAL PROPERTY RIGHTS

Plant genome organization, structural features of a representative plant gene, gene families in plants. Organization of chloroplast genome, nucleus – encoded and chloroplast encoded genes for chloroplast proteins, targeting of proteins to chloroplast. Organization of mitochondrial genome, nuclear and mitochondria – encoded genes for mitochondrial proteins. RNA editing in plant mitochondria, mitochondrial genome and cytoplasmic male sterility. Seed storage proteins. Regulation of gene expression in plant development. Plant hormones and phytochrome. Symbiotic nitrogen fixation in legumes by rhizobia – biochemistry and molecular biology. Agrobacterium and crown gall tumours. Mechanism of T-DNA transfer to plants. Ti plasmid vectors for plant transformation. Agroinfection. Classification and molecular biology of plant viruses. Molecular biology of plant stress response. Genetic engineering in plants, selectable markers, reporter genes and promoters used in plant vectors. Direct transformation of plants by physical methods. Genetic engineering of plants for virus resistance, pest resistance, herbicide tolerance, delay of fruit ripening. Golden rice. Antibody production in plants. Plant genetic engineering for resistance to fungi and bacteria. Production of antibodies, viral antigens and peptide hormones in plants. Gene silencing in transgenic plants, DNA markers in marker-assisted selection and plant breeding. Management aspects of plant genetic engineering. Tagging, mapping and cloning of plant genes. Molecular biology of plant pathogen interactions. Plant tissue culture techniques. Introduction, Principles and importance Intellectual property rights: Patenting.

UNIT 8: ANIMAL CELL BIOTECHNOLOGY

Basic principles of biotechnology applicable to animal science. Artificial insemination. Development and use of transgenic animals – Retroviral vector method, DNA micro injection method and engineered embryonic stem cell method. Transgenic animals sheeps, goats, pigs, birds, fish, Transformation of animal cells – in vitro fertilization and embryo transfer. Cloning vectors – Plasmid vectors, lambda vectors, cosmid vectors, phagemid vectors, BAC, PAC vectors, Plant and animal viruses as vectors. YAC vectors, MAC vectors. Expression vectors - Expression cassettes, baculovirus and expression vectors system for insect cells, virus expression vectors for mammalian cells. Baculovirus as biocontrol agents, Baculo virus for expression of foreign genes. Molecular diagnosis immunological diagnosis – ELISA, use of antibodies as immune therapeutic agents. DNA finger printing and characterization of animal cell. DNA Diagnosis – use of nucleic acid probes in Diagnosis. Gene therapy. Signal transduction and production of recombinant proteins: Acetylcholine, G-protein, visual pigments, growth factor receptors, steroid receptors, AIDS, Oncogenes and anti oncogenes, production of recombinant proteins – vaccines, blood products, hormones, regulatory proteins, phage display technology. Human genome mapping, Restriction fragment length polymorphism (RFLP) and its application, Ethical issues in Animal Biotechnology – CPCSEA and IAEC guidelines, management aspects of biotechnology and genetic engineering. Gene therapy. Application of engineered cell lines -recombinant glycoprotein heterogeneity.

UNIT 9: RECOMBINANT DNA TECHNOLOGY AND BIO-INFORMATICS

Introduction to rDNA technology: DNA modifying enzymes and their uses, Restriction enzymes – Discovery, types, use of type II restriction enzymes. Elucidation of restriction site, Restriction mapping. DNA polymerases – Klenow, DNA polymerase I, Thermostable DNA Polymerase δ used in PCR. T4/T7 DNA polynucleotide kinases and alkaline phosphatases. RNA polymerases, ligases, nucleases – DNAse I, SI Nuclease. Cloning vectors and their applications: vectors for gram positive and gram negative bacteria, Bacteriophage vectors – Lambda and M13 virus based vectors, cosmids, phagmids, yeast vectors, Expression vectors, vector facilitating protein purification, Shuttle vectors. Artificial chromosomes – BAC, YAC, HAC. Inteins (Protein introns) Exteins. DNA cloning – sticky ends, blunt ends, homopolymeric tailing use of adaptors and linkers. PCR based cloning. Preparation of radio labeled/ fluorescent labeled DNA & RNA probes. Chemical synthesis of oligo nucleotides. Blotting & hybridization techniques. Screening of recombinants, alpha complementation and Blue White selection. DNA sequencing – Maxam and Gilbert, Sanger methods, short gun sequencing Automated DNA sequencing. PCR technology – concept, types primer design, analysis of products and applications. DNA finger printing. Chromosome jumping, chromosome walking. Site – directed mutagenesis. Strategies for the production of recombinant proteins – insulin, human growth hormone, industrially important proteins. Construction of genomic DNA library and cDNA library. Bioinformatics Introduction to bioinformatics – Definitions and basic concepts – Genome projects. Biological data complexity – The role of bioinformatics. Biological database – Sequence databases - Sequence assembly – Submission of sequences – Sequence formats – Conversion between formats – Database browsers and Search engines. Sequence Alignment – Pair wise comparison – Sequence comparison scoring systems – Sequence similarity searching

algorithms (BLAST & FASTA family of programs) – Similarity searching scores and their statistical interpretation. Sequence Analysis – Nucleic acid sequence analysis – Reading frames; Codon Usage analysis; Translational and transcriptional signals – Protein sequence analysis – Compositional analysis; Hydrophobicity profiles; Amphiphilicity detection; Introduction to secondary structure prediction methods. Multiple Sequence alignment – Methods available – Iterative alignment, Progressive alignment – Clustal W, T-Coffee – Profile Methods – Clustering and Phylogeny–Methods for Phylogeny analysis: Distance and Character based methods.

UNIT 10: ENVIRONMENTAL BIOTECHNOLOGY

Biotools for environmental monitoring. Role of biotechnology in environmental protection. Waste water treatment. microbial system in waste water stabilization. biofilms. immobilization technology. oil degradation. Biodecolourization. reed bed technology. Rhizosphere engineering-biofiltration and bioindicators. Biodegradation of agrochemicals and other organic compounds. Biotransformation of xenobiotic compound - Role of GEMS in degradation of xenobiotics, bioscrubbers-Biomining of metals- Biopulping. Biodegradable plastics-biotechnology of microbial composting. Biofertilizers, Biopesticides. Bioindicators-biomarkers, biosensors, biofilms, biofouling, biomonitoring–polluted environment–short term and long term monitoring remediated sites.