

Semester I

(Paper 1) SCRM 1.1.1 Biochemistry (60 hrs)

Unit I. Amino acids, Proteins and Nucleic acids (15 hrs)

Amino acid: Classification, structure and properties, amphoteric nature, isoelectric point, peptide bond formation. Protein: Classification, properties and biological functions; Protein Structure: primary, secondary, tertiary and quaternary, structure and function of myoglobin, hemoglobin, collagen, Ribonuclease A, chymotrypsin; Protein folding, Chaperones. Structure of nucleoside, nucleotide. De novo and salvage pathways of nucleotide synthesis. Secondary structure of DNA, Watson and Crick model of DNA. A, B and Z forms of DNA, T_m and its relation to GC content. Chemical and enzymatic degradation of nucleic acids. RNA-structure and types.

Unit II. Enzymes (15 hrs)

Enzymes: classification, Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, K_m , V_{max} , L.B Plot, Turnover number, K_{cat} . Kinetics of Enzyme Inhibition. Kinetics of Allosteric enzymes. Immobilization of enzymes, Role of Vitamins and Cofactors in enzyme activity.

Unit III. Carbohydrates (15 hrs)

Carbohydrates: Classification, properties and biological functions of, Monosaccharides: Classification, properties, functions, isomerism, D & L forms, Disaccharides: Glycosidic bond, classification, composition and biological importance. Polysaccharides: Classification, properties and functions; Photosynthesis; aerobic and anaerobic respiration.

Unit IV. Lipids (15 hrs)

Lipids: Classification, properties and functions; fatty acids: composition, classification, characteristics and functions; Simple lipids, Triglycerides Conjugated lipids, phospholipids and its functions, glycolipids lipoproteins, Cholesterol-structure, properties and functions, Liposomes, lipids, lipoproteins and apolipoproteins.

Suggested Readings:

1. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto - Biochemistry, 8th edition (2015), WH Freeman publications.
2. Biochemistry by Voet Donald, Voet, Judith G. (2004) 3rd edition (J Wiley and Sons)

3. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
4. Biochemistry by Lubert Stryer, 4th Edition.
5. Pharmaceutical Biotechnology (Kindle Edition) by S. P. Vyas, V. K. Dixit, CBS Publishers and distributors.
6. Meeting Educational Needs with "Course" Remodelled Biotech Curricula May, 2017 Copyright © Deptt. of Biotechnology Ministry of Science & Technology Government of India Compiled and Coordinated Ms. Shreya Malik, DM, BCIL Edited Dr. Suman Govil, Adviser, DBT Dr. Purnima Sharma, MD, BCIL.

(Paper 2) SCRM.1.1.2 Cell Biology and Developmental Biology (60 hrs)

Unit 1. Work of Cells (15 hrs)

Plasma membrane and cell organelle. Structure-function of peroxisome; mitochondrial genome; Golgi apparatus, lysosomes and endoplasmic reticulum; Protein processing, sorting; vesicle transport, secretion; Nucleus: structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; Cell cycle and control mechanisms; Mitochondria: structure, origin and evolution, organization of respiratory chain complexes, Overview of cellular cytoskeleton, Organization and role of microtubules and microfilaments; Intermediate filaments; Muscle organization and function; Cellular motility; Molecular motors; Extracellular matrix in plants and animals; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo and Exocytosis; Cell-Cell and Cell-Matrix junctions and adhesions; Mechanism of cellular recognition and communication.

Unit 2 Cell Signaling (15 hrs)

Overview of various cellular signaling cascades Types of cell signalling pathways include checkpoint signalling, lipid signalling, growth signalling, nutrient signalling, insulin signalling, stress signalling, morphogen signalling, Hippo signalling, TOR signalling and integrin signaling *etc.*

Unit 3. Overview of development and developmental processes (15 hrs)

Types of development in organisms, Quantitative and qualitative development, Progressive and regressive development, Single-phase and multiphase development, Structural and functional development, Normal and abnormal development, Development of single-celled organisms
Open and closed systems of development: Blastogenesis versus embryogenesis, Constituent processes of development: Growth, Morphogenesis, Morphogenesis by differential growth, Morphogenetic fields, Morphogenesis by the self-assembly of units, Control And Integration Of Development: Phenomenological and Analytical aspects, Development And Evolution: Length and timing of the reproductive phase, Recapitulation of ancestral stages, Adaptability and the canalization of development. Genetic assimilation

Unit 4 Developmental anomalies and role of stem cells in development (15 hrs)

Stem cell functional division during development, stem cell control and recognition by morphological differences. The role of genetic and epigenetic factors in development, Developmental defects and disorders; Hypotheses exploring the relationship between genotype and phenotype

References:

1. Lodish, H. F. (2000). *Molecular Cell Biology*. New York: W.H. Freeman.
2. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). *Becker's World of the Cell*. Boston: Benjamin Cummings.
3. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). *Molecular Biology of the Cell*. New York: Garland Science.
4. Watson JD, Baker TA, Bell SP, Gann A, Levine M & Losick R (2014) *Molecular Biology of the Gene*, 7th Edition, Cold Spring Harbor Laboratory Press, New York
5. Cooper, G. M., & Hausman, R. E. (2009). *The Cell: a Molecular Approach*. Washington: ASM ; Sunderland.
6. Gilbert SF., Barresi MJF. (2010) *Developmental Biology*; (9th Ed).; Sinauer Associates Inc
7. Wolper L., Tickle C; (2001); *Principles of Development*; Oxford University Press, UK

(Paper 3) SCRM 1.1.3 Genetics and Molecular Biology

(60 hrs)

Unit I. Principles of Genetics

(15 hrs)

Classical genetics: Mendelian laws of Inheritance, Chromosomal basis of inheritance, principles, Gene interaction, Genetic linkage and gene mapping, Yeast genetics and Tetrad analysis, Sex chromosomes and sex determination. General features of chromosomes. General features of Genetic code, Cytogenetics: Human karyotype, Chromosome banding, ploidy, chromosome aberrations and position effect. Population genetics: Calculation of allelic frequencies, Hardy-Weinberg law. Contributions of Thomas Hunt Morgan.

Unit II. Nucleic Acids and Replication

(15 hrs)

Molecular structure of DNA and RNA. Identification of DNA as a genetic material. Hershey and Chase experiments on T₂ phage. Chargaff's experiments. Central Dogma of molecular biology. DNA Replication. A structural Overview. Three different models on DNA replication. Semi-conservative model. Bacterial DNA replication. *In vitro* DNA replication. Eukaryotic DNA replication, Steps and enzymes involved.

Unit III. Gene transcription and Translation

(15 hrs)

Transcription in prokaryotes and eukaryotes. RNA modification. Types of RNA. Transcriptional regulation in prokaryotes and eukaryotes. Translation of mRNA. The genetic basis of protein synthesis. The structure and function of t RNA. Ribosome structure and assembly. Translation in prokaryotes and eukaryotes. Gene regulation in prokaryotes and eukaryotes. Chromatin remodeling. Histone modification. DNA methylation. Regulation of RNA processing, Gene silencing, siRNA, micro RNA, Gene editing Crispr-Cas system.

Unit IV. Gene mutations and human genetic disorders

(15 hrs)

Consequences of mutation. Causes and occurrences of mutations. Repair of DNA: various mechanisms. Genetic recombination: Homologous recombination. Site specific recombination, Transposons, Discovery and molecular identification of transposons in various life forms. Introduction to Human Genetic Diseases: Cystic Fibrosis, Duchene muscular dystrophy, Thalassemia, sickle cell anaemia, SCID, Downs syndrome.

References:

1. Robert J Brooker , Genetics : Analysis and Principles. Mc Graw Hill Publications .New York, USA. International student's edition. 2012.
2. Jocelyn E.Krebs, Elliot S.Goldstein and Stephen T.Kilpatrick . Lewin s: Genes XI .Jones & Bartlett student edition. 2014
3. Mathew R.Walker with Ralph Rapley: Route Maps in Gene Technology. Blackwell Science.Mass.USA.1997.
4. Robert F.Weaver : Molecular Biology Fifth edition. McGRAW Hill International Edition. 2008
5. Brown TA: Gene Cloning and DNA Analysis. Willey Blackwell.2010.West Sussex.UK
6. Meeting Educational Needs with "Course" Remodelled Biotech Curricula
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Government of IndiaCompiled and Coordinated Ms. Shreya Malik, DM, BCIL
Edited Dr. Suman Govil, Adviser, DBT Dr. Purnima Sharma, MD, BCIL

(Paper 4) SCRM.1.1.4 Immunology and Virology (60 hrs)

Unit I. Introduction to immune system

(15 hrs)

Innate and adaptive immunity; Hematopoiesis; Organs and cells of the immune system; Primary and secondary immune responses; Haptens, Antigens; Super antigens; Structure and function of immunoglobulins, Hybridoma /monoclonal antibodies, Antigen-antibody interactions. B-cell and T-cell receptors and co-receptors, Organization of Ig gene loci; Molecular mechanisms of generation of antibody diversity; Class switching; Expression of Ig genes; Regulation of Ig gene transcription; Antibody engineering; Organization of TCR gene loci; Allelic exclusion, Generation of TCR diversity; HLA complex: Organization of HLA complex; Structure of class I and II HLA molecules; Expression of HLA genes; HLA polymorphism, MHC-restriction.

Unit II Generation and regulation of immune responses

(15 hrs)

Antigen processing and presentation; Cytokines and signaling; T Cell Maturation, its activation and differentiation; B Cell Generation, its activation and differentiation; Clonal selection and immunological memory; Complement system; Leukocyte activation and migration; Chemotaxis; Cell mediated cytotoxic responses; ADCC, Regulation of immune responses; Immunological tolerance. T-cell immunodeficiencies; B-cell immunodeficiencies; Combined T and B-cell deficiencies, Defects in antigen presenting cells, Deficiencies of complement and neutrophildefects, Secondary immunodeficiencies; Autoimmune disorders; Hypersensitive reactions (Type I to Type IV) with suitable examples; Cytokine related diseases.

Unit III. Transplantation Immunology

(15 hrs)

Immunologic basis of graft rejection, clinical manifestation of graft rejection, immunosuppressive therapy; applications of monoclonal antibodies, single chain and humanised antibodies.

Unit 4 Virology (15 hrs)

Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles – viroids and prions. Immune response to infectious diseases (Tuberculosis, Typhoid fever, HIV/AIDS, Schistosomiasis, Kala Azar, Swine Flu, Chikungunya, Dengue, SARS CoV2) and malignancy (breast cancer, Lung cancer, Leukemia); Concept of immunotherapy; Vaccines (Recombinant,

DNA, live and attenuated, subunit); Herd immunity; Success stories in vaccinology e.g. small pox, polio, Hepatitis, DPT

References:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne, (2002), *Immunology*, 6th Edition, Freeman
2. Brostoff J, Seaddin JK, Male D, Roitt IM., (2002), *Clinical Immunology*, 6th Edition, Gower Medical Publishing
3. Janeway *et al.*, *Immunobiology*, (1999), 4th Edition, Current Biology publications
4. Peakman, M and Vergani D, (2009), *Basic and Clinical Immunology*, 2nd Edition.
5. Maclachlan, NJ and Dubovi, EJ. (2011). *Fenner's Veterinary Virology*, 4th edition. Elsevier Inc.
6. Murphy, FA (2015). *The Foundations of Medical and Veterinary Virology: Discoverers and Discoveries, Inventors and Inventions, Developers and Technologies*.
7. Mahy BWJ & Kangaro HO. (1996). *Virology Methods Manual*. Academic Press.
8. Reference: Meeting Educational Needs with “Course” Remodelled Biotech Curricula May, 2017 Copyright © Deptt. of Biotechnology Ministry of Science & Technology Government of India Compiled and Coordinated Ms. Shreya Malik, DM, BCIL Edited Dr. Suman Govil, Adviser, DBT Dr. Purnima Sharma, MD, BCIL

Practicals

(Practical 1) SCRM.1.1.P.1 Practical Biochemistry (15 hrs)

1. Separation of amino acids by paper chromatography.
2. Separation of amino acids by Thin layer chromatography.
3. Colorimetric estimation of glucose.
4. Colorimetric estimation of proteins.
5. Isolation of amylase producing organism from soil.
6. Determination of isoelectric pH of Proteins.
7. Colorimetric estimation of DNA
8. Colorimetric estimation of RNA
9. Separation of phospholipids by TLC technique.
10. Estimation of Cholesterol.

(Practical 2) SCRM.1.1.P.2 Cell Biology & Developmental Biology (15 hrs)

1. Principles of microscopy and optics, Compound microscopy, Bright field. microscopy, phase contrast microscopy, Fluorescence and confocal microscopy, Electron microscopy.
2. Cell size determination by the use of an ocular and stage micrometer, Hanging drop technique for demonstrating motility of bacteria.
3. Simple, Gram staining and Endospore staining of microorganisms.
4. Observation of Mitosis and the Cell Cycle in Onion Root-Tip Cells.
5. Histology – Hand-sectioning of stem and leaf, saffranin and fast green staining.
6. Microtomy - fixing of tissues, dehydration, wax-embedding, sectioning and staining.

(Practical 3) SCRM.1.1.P.3 Genetics and Molecular Biology (15 hrs)

1. Isolation of total DNA from bacteria.
2. PCR amplification of given gene and analysis by agarose gel electrophoresis
3. Preparation of plasmid from *E. coli* and gel analysis.
4. Restriction digestion of given vector by various restriction enzymes.
5. Plasmid isolation restriction digestion, ligation, and transformation in *E. coli*. confirming recombinant by PCR and RE digestion.
6. Transformation of *E. coli* with recombinant plasmid.
7. SDS-PAGE analysis of given protein.
8. Purification of protein by Column chromatography.
9. Random Prime labelling.
10. Southern blot and hybridization.

(Practical 4) SCRM.1.1.P.4 Immunology and Virology (15 hrs)

1. Antibody titre by ELISA method.
2. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
3. Complement fixation test.
4. Isolation and purification of IgG from serum/IgY from chicken egg.
5. SDS-PAGE, Immunoblotting, Dot blot assays.
6. Blood smear identification of leucocytes by Giemsa stain.
7. Separation of leucocytes by dextran method.
8. Demonstration of Phagocytosis of latex beads and their cryopreservation.
9. Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation.
Demonstration of ELISPOT.
10. RT-PCR analysis for viral disease diagnosis.

(Practical 5) SCRM.1.1.P.5 Industry visit and report