

Syllabus for MSc. in Molecular Biology and Biotechnology (MBBT)

SEMESTER I
PAPER CODE: MBB701C
CELL AND MOLECULAR BIOLOGY
CREDITS: 3+1+0

Unit 1: Internal organization of the cell

The chemical components of a cell, intracellular compartments and protein sorting, mitochondria and chloroplasts, cytoskeleton and cell motility; major functions of cytoskeleton.

5 Hours

Unit 2: Nucleic acid metabolism

Structure of DNA and its physico-chemical properties; DNA replication in prokaryote and eukaryote; structure and properties of RNA polymerases in prokaryote and eukaryote; mechanism of transcription; eukaryotic promoters and enhancers; general transcription factors, TATA binding proteins (TBP) and TBP associated factors (TAF); activators and repressors; Post transcriptional modifications of RNA.

7 Hours

Unit 3: Regulation of gene expression

Prokaryotic gene expression with reference to inducible and repressible operons, concept of eukaryotic gene regulation, genetic basis of pattern formation in *Drosophila*, antisense RNA and RNA interference, post transcriptional controls.

5 Hours

Unit 4: Translation and 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.

5 Hours

Unit 5: Cell signaling

General principle of cell signalling: signalling molecules and their receptors, G-protein coupled receptors, second messengers, intracellular messengers, signal transduction: protein tyrosine phosphorylation. Receptor mediated signalling related to EGFR, WNT, SMAD.

10 Hours

Unit 6: Cell cycle

An overview of gene control, checkpoint pathways induced in response to DNA damage, the role of tumor suppressor genes and oncogenes, signal transduction pathways of apoptosis, defective apoptotic/cell proliferation pathways leading to cancer etc, role of ROS in signalling.

6 Hours

Unit 6: Basic concepts of development

Stages of development, cell fate and commitment – potency- concept of embryonic stem cells, differential gene expression, terminal differentiation, lineages of three germ layers, fate map, mechanisms of differentiation, pattern formation- axis specification, positional identification (regional specification), morphogenetic movements. Early development in invertebrate/vertebrate models -*Drosophila*, *C. elegans*, *Xenopus*, Mouse/ human: Cleavage, gastrulation, Axis specification (Dorsoventral, anterior posterior), and body plan patterning, left right asymmetry in vertebrates. Late Development in invertebrate /vertebrate models: Organogenesis- development of ectodermal organs, mesodermal organs, endodermal organs.

10 Hours

Suggested Readings

1. Lewin. B. Gene IX. 9th Ed, Jones and Barlett Publishers, 2007.
2. Alberts. B., Johnson. A., Lewis. J., Morgan. D., Roberts. K. and Walter. P. Molecular Biology of the Cell, Garland Science, 6th Ed, 2014.
3. Lehninger. A. L., Nelson. D. L., Cox. M. M., Principles of Biochemistry. CBS Publications, 2001.
4. Karp. G. Cell and Molecular Biology. 6th Ed, John Wiley and Sons, Inc, 2010.
5. Brown. T. A. Gene Cloning and DNA Analysis. 5th Ed, Wiley Blackwell, 2007.
6. Cooper. G. M. and Hausman. R. E. The Cell: A Molecular Approach. 6th Ed, Sinauer Associates, Inc, 2013.
7. Slack. J. Essential Developmental Biology. 3rd Ed, Willey Blackwell, 2013.
8. Gilbert S.F. Developmental Biology. 6th Ed, Sinauer Associates, 2000.

SEMESTER I
PAPER CODE: MBB702C
BIOCHEMISTRY
CREDITS: 3+1+0

Unit 1: Chemical Foundation of Biology and Concepts of energy

Acids, Bases and buffers, Henderson- Hasselbach equation, biological buffer solution, pH, pK, Concept of free energy: Principles of thermodynamics, kinetics, dissociation and association constant, energy rich bonds, weak interactions, coupled reactions and oxidative phosphorylation, group transfer.

9 Hours

Unit 2: Biochemistry of Macromolecules

Sugars: Classification, occurrence, isolation, purification, properties and biological reaction, Glycoproteins and Proteoglycans

Proteins: Amino acids and Peptides – classification, Physio- chemical properties, peptide bond, Primary, Secondary and tertiary structure of protein, Conformation of protein and polypeptide

Lipids: Structure and function, Triglycerides, Phospholipids, steroids and terpenes, Role of lipids in biomembranes.

9 Hours

Unit 3:Enzymology and Nucleotide metabolism

Nomenclature, Enzyme kinetics, Regulation of enzymatic activity, Enzyme catalysis. Active sites: Enzymes and coenzymes: coenzymes interactions: activators and inhibitors, kinetics of enzyme inhibitors, isoenzymes, allosteric enzymes, ribozymes. Abzyme. Biosynthesis and degradation of nucleotide.

8 Hours

Unit 4:Bioenergetics

Glycolytic pathway; Gluconeogenesis; Pentose Phosphate pathway; Kreb's cycle; Fatty acid catabolism; Amino acid oxidation; Biosynthesis of carbohydrates, lipids; amino acid biosynthesis and oxidation; Oxidative phosphorylation; Photosynthesis; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers.

14 Hours

Unit 5:Vitamins, Minerals and Hormones:

Sources, biological and biochemical functions, Steroids and isoprenoid derivations from vitamins. Minerals: requirements, macro and minor minerals- source and function. Hormones: Classification of hormones, function of hormones and their regulation, mechanism of hormone action, site of biosynthesis and physiological function.

8 Hours

Suggested Readings

1. Berg. J. M, Tymoczko. JL and Stryer. L. Biochemistry. 5th Ed, WH Freeman, New York, 2002.
2. Voet. D and.Voet. JG, Biochemistry. 3rd Ed, John Wiley, New York, 2004.
3. Nelson. D. L and Cox. MM, Lehninger Principles of Biochemistry. 5th Ed, W.H Freeman and Company, 2008.
4. Zubay. G. L, Biochemistry. 4th Ed, Wm C Brown publishers, 1998.
5. Sadasivam. SK and Manikam. A, Biochemical methods. 2nd Revised Ed, New Age International, 2005.
6. Palmer.Tand Bonner.P, Enzymes-Biochemistry, Biotechnology, Clinical Chemistry. 2nd Edition, Woodhead Publishing Limited, 2007.

SEMESTER I
PAPER CODE: MBB703C
MICROBIOLOGY
CREDITS: 3+1+0

Unit 1: Microbial characteristics

Cell division and growth curve, Bacterial culture methods, Bacterial metabolism, bacterial genetics.
9 Hours

Unit 2: Microbial diversity

Classical and modern methods and concepts, domain and kingdom concepts in classification of microorganisms, Criteria for classification; Classification of Bacteria according to Bergey's manual; Bacteria: Purple and Photosynthetic, green bacteria, cyanobacteria, Archaea, Eukarya: Algae, Fungi.

11 Hours

Unit 3: Control of microorganisms

Microbial diseases, detection and Control of microorganisms: Physical and chemical control of microorganisms, antibiotics, antifungal drugs, mode of action, antimicrobial drug resistant.

9 Hours

Unit 4: Virology

Virus and bacteriophages, General properties of Viruses, Viral structure, Taxonomy of virus, Purification and Isolation, cultivation and identification of viruses, viral replication. Control of virus, Subviral particles – viroids and prions.

9 Hours

Unit 5: Host-microbe interaction

Host-pathogen interaction, Symbiosis, Microbes infecting humans, veterinary animals and plants; Microbial communication system; Microbial fuel cells; Prebiotics and Probiotics.

10 Hours

Suggested Readings

1. Pelczar. M. J Jr, Chan. E.C.S. and Kreig. NR., Microbiology. 5thEd, Tata McGraw Hill New Delhi, 2004.
2. Madigan. M.T., Martinko. J. M., Stahl. D.A., and Clark. D. P. Brock's Biology of Microorganisms. 13th Ed. Benjamin Cummings, San Francisco, CA, 2012.
3. Maloy. S. R., Cronan, J. E. Jr. and Freifelder, D.J. Microbial Genetics, 2nd Ed, Bartlett Publishers.1994.
4. Cappuccino. J.G. and Sherman. N, Microbiology-a Laboratory Manual. 4th Ed, Addison Wesley, Longman, USA, 1999.
5. Atlas. R.M, Principles of Microbiology. 2nd Ed. WM.T.Brown Publishers, 1997.

6. Willey. JM, Sherwood. LM, and Woolverton. CJ. Prescott, Harley and Klein's Microbiology. 7th Ed, McGraw Hill Higher Education, 2008.
7. Brooks. GF, Carroll. KC, Butel. JS and Morse. SA. Jawetz, Melnick and Adelberg's Medical Microbiology. 24th Ed, McGraw Hill Publication. 2007.
8. Aneja. KR, Experiments in Microbiology Plant pathology, Tissue culture and Mushroom Cultivation. 2nd Ed, New Age International, 2003.
9. Tortora.G.J, Funke B.R., and Case C.L. Microbiology: An introduction. Pearson Publication, 2013.

SEMESTER I
PAPER CODE: MBB704C
GENETICS
CREDITS: 3+1+0

Unit 1: Patterns of inheritance

Mendel's law of inheritance, multiple allelic systems, Co-dominance, sex determining mechanisms, sex-linked, sex-influenced and sex-limited inheritance, Epistasis, Pleiotropy. Cytoplasmic inheritance. Linkage and chromosome mapping: linkage, crossing over, genetic recombination, genetic mapping.

10 Hours

Unit 2: Mutagenesis

Mutagenic agents, mechanisms of mutagenesis-chemical and radiation; Expression of mutations – gene mutation; point mutations and frameshift mutations, isolation of auxotroph, conditional, lethal Assay of mutagenic agents (Ames test).

8 Hours

Unit 3:Cytogenetics

Cell division and errors in cell division; non disjunction; structural and numerical chromosomal abnormalities – deletion, duplication, translocation; Disorders of sex chromosomes and autosomes. Molecular cytogenetics – Fluorescence *In Situ* Hybridization (FISH), Comparative Genomic Hybridization (CGH).

8 Hours

Unit 4: Microbial genetics

Conjugation, transduction and transformation in bacteria, lambda phage – genetic map, lysogenic and lytic cycles; Transposable genetic elements.

8 Hours

Unit 5:Human genetics

The human chromosome, types of genetic diseases, genetic screening; biochemical markers, pre-natal diagnosis, ethical issues, concept of epigenetics.

6 Hours

Unit 6: Population genetics and evolution

Phenotype, Genotype, Gene frequency; Hardy-Weinberg law; Factors distinguishing HardyWeinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift.

8 Hours

Suggested Readings

1. Gardner EJ and Sunstad DP, Principles of Genetics, John Wiley and Sons, 2000.
2. Strickburger MW, Genetics, Macmillan Pub. Co.,1994.
3. Strachan T and Read AP, Human Molecular Genetics, Garland Science, 2004.
4. Peter J. Russell, Genetics, Benjamin-Cummings Publishing Company, 1998.
5. Lewis, R. Human Genetics: Concepts and Application.McGraw-Hill Education; 5th Ed, 2002.

6. Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, A, Scott. Molecular cell Biology, W. H. Freeman; 7th Ed, 2013.
7. Klug, W.S Cummings. Concepts of Genetics, 7th Ed, Pearson Education, 2003.

SEMESTER I
PAPER CODE: MBB705L
LAB COURSE-1
CREDITS: 0+0+4

List of practical

1. Washing, sterilization techniques, basic safety measures and laboratory record keeping.
2. Handling and safe operation of instruments, housekeeping for sophisticated instrumentation and personal protective equipment.
3. Preparation of blood smear, staining and observation under microscope.
4. Isolation of auxotroph mutants in bacteria.
5. Protein estimation by Bradford method.
6. Estimation of Vitamin - C.
7. DNA extraction from plant and animal tissues.
8. Extraction of RNA and cDNA synthesis.
9. Amplification of DNA using Polymerase Chain Reaction.
10. RAPD analysis to study the genetic diversity.
11. Demonstration of Western Blotting technique for detection of protein.
12. Isolation and maintenance of bacteria and fungi
13. Study of bacterial growth kinetics.
14. Antibiotic sensitivity assay.