

# **COURSE STRUCTURE & SYLLABUS**

(w.e.f. 2020)

## **M.Sc. Biosciences (CBCS Pattern)**

Department of Biosciences  
Jamia Millia Islamia

<b>SEMESTER - I</b>		<b>Credits</b>
<b>BSM-101 Biochemistry</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-102 Cell Biology</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-103 Genetics</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-104 Bioinformatics &amp; Biostatistics (CBCS)</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-105 Lab Course-I</b>	12 periods/wk Marks : 75*+75**=150	<b>6</b>

<b>SEMESTER - II</b>		<b>Credits</b>
<b>BSM-201 Animal Physiology</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-202 Microbiology</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-203 Genome Biology</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-204 Biophysics (CBCS)</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-205 Recombinant DNA Technology (SEC)</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-206 Lab Course-II</b>	12 periods/wk Marks : 75*+75**=150	<b>6</b>

<b>SEMESTER -III</b>		<b>Credits</b>
<b>BSM-301 Immunology</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-302 Plant Physiology</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-303 Molecular Biology</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-304 Technical Writing &amp; Seminar (AECC)</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-305 Environmental Biology (CBCS)</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-306 Lab Course-III</b>	12 periods/wk Marks : 75*+75**=150	<b>6</b>

<b>SEMESTER -IV</b>		<b>Credits</b>
<b>BSM-401 Physical Chemistry of Macromolecules</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-402 Toxicology (CBCS)</b>	4 periods/wk Marks : 60*+40**=100	<b>4</b>
<b>BSM-403 Lab Course-IV</b>	4 periods/wk Marks : 25*+25**=50	<b>2</b>
<b>BSM-404 Project and Dissertation</b>	16 periods/wk Marks : 100*+100**=200	<b>8</b>

**Total Credits = 92**

**\*Semester End Examination**

**\*\*Internal Assessment**

# **BSM -101**

## **BIOCHEMISTRY**

### **Unit I- Carbohydrate and Lipid Metabolism**

Glycolysis, HMP pathway, Glycogenolysis, PDH reaction, Tricarboxylic Acid Cycle: Kreb's discovery, isotopic tests, amphibolic nature, energetics and regulation. Gluconeogenesis, Synthesis of Glycogen and important disaccharides, hormonal regulation of Carbohydrate metabolism. Oxidation of lipids: beta-oxidation, oxidation of unsaturated and odd chain fatty acids, regulation of Fatty acid oxidation, Formation and oxidation of Ketone bodies. Biosynthesis of saturated fatty acids: carbon sources, acetyl CoA carboxylase and reaction of Fatty acid synthase. Synthesis of odd chain and unsaturated fatty acids. Biosynthesis of Triacylglycerol and phosphoglycerides. Biosynthesis of cholesterol and its regulation.

### **Unit II- Amino Acid Metabolism Amino acid oxidation**

flow sheet, deamination and transamination reactions, alpha- ketoglutarate, succinate, fumarate and oxaloacetate pathways of amino acid oxidation. Metabolic fates of amino groups, role of glutamate and glutamine. Urea Cycle: reaction and regulation, Biosynthesis of standard essential and non-essential amino acids. Regulation of amino acid biosynthesis. Genetic defects in amino acid metabolism.

### **Unit III- Nucleotide and Heme Metabolism**

Degradation of purine & pyrimidine ribonucleotides and its regulation. Biosynthesis of purine & pyrimidine 4 ribonucleotides: de-novo pathways and salvage. Reactions and regulation of ribonucleotide reductase and thymidylate synthase, purine nucleotide cycle. Genetic defects, in nucleotide metabolism. Enzymes of Nucleotide metabolism as chemotherapeutic targets. Heme biosynthesis and degradation

### **Unit IV- Enzymology**

Enzyme catalysis: Acid-Base, metal ion, covalent and electrostatic catalysis, Reaction coordinates. Transition state stabilization and entropy reduction by enzymes. Enzyme kinetics: Substrate velocity curve, MichaelisMenten mechanism for single substrate reactions, Meaning and significance of  $K_m$ ,  $K_s$ ,  $K_{cat}$  and specificity constant. Lineweaver-Burk and Eadie-Hofstee plots, kinetics of bisubstrate reactions. Enzyme Inhibition: Mechanism and kinetics of competitive, uncompetitive, mixed and noncompetitive inhibitions.

### **Recommended Books:**

1. Nelson, David L., Albert L. Lehninger, and Michael M. Cox. Lehninger principles of biochemistry. Macmillan, 2008. Berg, Jeremy M., John L. Tymoczko, and Lubert Stryer. "Biochemistry 5th ed." (2002).
2. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. Fundamentals of Biochemistry 2002 Update. John Wiley & Sons, 2002.

## **BSM -102**

### **CELL BIOLOGY**

#### **Unit I- Cytoskeletal Network Intramembrane System**

Cytoskeletal network, alpha and beta tubulins, actin-myosin system intermediary filaments and Dynein activator complex. Structure and Function of Endoplasmic Reticulum, Golgi body and Lysosome.

#### **Unit II- Nucleus, Cell cycle and Molecular Structure of Gene**

The nuclear envelop and traffic between nucleus and cytoplasm, internal organization of the nucleus, the nucleolus, nucleus during mitosis. The eukaryotic cell cycle, regulation of cell cycle progression. Nuclear compartment chromosomal organization of genes, functional rearrangement in chromosomal DNA, Morphology and functional elements of eukaryotic chromosome, mitochondrial DNA.

#### **Unit III- Cell to Cell Signaling**

Overview of extracellular signaling, Arachadanic acid Nitricoxide based signaling, G-protein coupled receptors and their effectors, Receptor tyrosine kinase and RAS, MAP kinase pathways. Program cell death.

#### **Unit IV- Molecular basis of Cancer**

Tumor cells and onset of cancer, Protooncogene and tumor suppressor gene, oncogenic mutations affecting cell proliferation, mutation causing loss of cell cycle control, mutation affecting genome stability.

#### **Recommended Books**

1. The Cell, A Molecular Approach – 6th Edition – Geoffrey M. Cooper/Robert E. Hausman- Sinauer Associates, Inc.
2. Molecular Biology of the Cell - 5th Edition - Bruce Alberts et al - Garland Science
3. Molecular Cell Biology - 7th Edition - Harvey Lodish, Arnold Berk & Chris A. Kaiser - W.H. Freeman
4. Lewin's Cells – 2nd Edition – Cassimeris/Lingappa/Plopper – Johns & Bartlett Publishers
5. Cell Biology, A Short Course – 3rd Edition – Stephen R. Bolsover et al – John Wiley& Sons
6. Microbial Physiology: Moat, Foster and Spector
7. Cell and molecular biology: Gerald Karp.
8. Cell and molecular biology: DeRobertis and DeRobertis

## **BSM -103 GENETICS**

### **Unit I**

Chromatin structure, Nucleosome, Chromosome structure-centromere and telomere. Tandomly repeated non-coding DNA Interspersed repeated non-coding DNA Expression and processing of heterogeneous nuclear RNA, r RNA, t RNA. Alternate transcription and processing on individual genes. Mitochondrial genome and diseases.

### **Unit II**

General homologous recombination. Non-homologous end joining. Site specific recombination, Transposable elements, Mechanism of Transposition. The Lac -operon positive, negative and repression. Arabinose operon. Tryptophan operon. The lambda phase: a complex of operon.

### **Unit III**

Molecular basis of gene mutation. Gain of function mutation. Loss of function mutation and their consequences. Chemical mutagenesis in higher organism. Repair of DNA damage. Photoreactivation. SOS repair mechanism. Base excision repair. Nucleotide excision repair. Stability of the genome.

### **Unit IV**

Population and gene pool. Calculating allele frequencies. The Hardy-Weinberg law. Extension of Hardy -Weinberg law, Natural selection, Mutation, Migration, Genetic drift, Non-random mating. Adaptive radiation and modification, Isolating mechanism, Speciation- Allopatric and Sympatric, Convergent evolution, Sexual selection, Co-evolution.

### **Recommended Books:**

1. Introduction to Genetic Analysis. 9<sup>th</sup> Edition by Griffiths et al. 2008.
2. Concept of Genetics. 9<sup>th</sup> Edition, by Klug et al. 2009.
3. Principles of Genetics by Snustad et al. 2004.
4. Genes IX Lewin 2008.
5. Molecular Biology of the Gene Watson et al. 6th Edition 2009.
6. Molecular Cell Biology by Lodish et al. 2008
7. Molecular Biology of the Cell Alberts et al. 5<sup>th</sup> Edition. 2007.

## **BSM -104**

### **BIOINFORMATICS & BIOSTATISTICS (CBCS)**

#### **Unit I**

What is Bioinformatics, Biosciences, Emerging areas in Bioinformatics, Future prospects of Bioinformatics, Introduction to Genomics, Introduction to Proteomics, Human Genome Project, Public Database, Gene Bank, Using Public Database? Computer Basics: Computer and its components, Characteristics of computer, Classification of Computers, Hardware: Processor/CPU, Input/Output devices, motherboard slots/cards, bus parallel and serial ports, various storage devices/media, Client-Server concepts, Memory. Software basics: Data vs. information, Software: types of software's, Firmware, Operating system, Programming Languages, Compilers, Interpreters, Ideas of portability and platform dependence, MS-DOS, Windows, UNIX, Linux.

#### **Unit II**

DNA and Protein sequence analysis, tools, BLAST, FASTA, Protein Visualization tools, Ras Mol. VMDL, Chime, ORF finder, Gene finder, Gene Scan. Biological databases: Medline EMBL Gene bank, Pub Med, PDB, Entry and retrieval of Data from public databases. Database: Database basics, RDBMS, MS Access, My SQL, ER- Diagram, Relationship. Internet: Computer networking: LAN & WAN, Internet and its application, Major features, WWW and its attributes, web browsers & web server, websites/ address/ pages, Client Server Principles, Protocols and search engines/tools, Bioinformatics resources on internet.

#### **Unit III**

Measures of central tendency- average, mean, median, mode, measures of location-percentile, graphic method, Arithmetical method, application and uses of percentiles, Types, biological, real, experimental, measures of variability, range, semi-inter quartile range (Q), mean deviation, standard deviation (SD), and coefficient of variation (CV), Probability: Addition law of probability, multiplication law, binomial probability distribution, Poisson distribution, probability chance from shape of normal distribution or normal curve. Basic introduction to Multivariate statistics.

#### **Unit IV**

Idea of parametric and non parametric statistics, Hypothesis testing (Large and small samples test), types of errors and level of significance, confidence interval, test of significance (F-test & T-test), chi-square test, Significance of difference in proportions of large samples, Correlation and regression, Design and methodology of an experiment or a study: Step and methodology, format for presentation of any research work.

#### **Recommended Books:**

1. Fundamental Concepts of Bioinformatics Dan E. Krane, Wright State University Michael L. Raymer, Wright State University
2. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins By Andreas Baxevanis and Francis Ouellette'
3. Bioinformatics: A Biologist's Guide to Biocomputing and the Internet By Stuart Brown
4. All of Statistics: A Concise Course in Statistical Inference by Larry Wasserman
5. Biostatistics: The Bare Essentials Geoffrey R. Norman PhD, David L. Streiner PhD
6. Principles and Practice of Biostatistics B Antonisamy, Prasanna S. Premkumar

# **BSM -201**

## **ANIMAL PHYSIOLOGY**

### **Unit I- Cardiovascular System and Respiratory System**

Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG-its principle and significance, cardiac cycle, blood pressure, regulation of blood pressure.

Comparison of respiration in different species, transport of gases (oxygen transport, oxygen-haemoglobin dissociation curve, carbon dioxide transport), exchange of gases, waste elimination, regulation of respiration.

### **Unit II- Digestive System and Excretory System**

Physiological anatomy of Gastro-Intestinal Tract (GIT), Digestion and absorption of food (carbohydrates, proteins and fats) in the GIT, Energy balance, BMR.

Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, acid-base balance, homeostasis, Renin-Angiotensin System.

### **Unit III- Nervous System**

Neurons, action potential, gross neuroanatomy of the brain and spinal chord, central and peripheral nervous system. Vision, Hearing and Tactile response.

### **Unit IV- Endocrine system and Reproductive System**

Endocrine glands (Hypothalamus, pituitary gland, pineal gland, thyroid gland, parathyroid gland, thymus, adrenal gland, pancreas, testis, ovary), basic mechanism of hormone action, hormones and diseases. Male reproductive system, female reproductive system, reproductive processes (spermatogenesis, oogenesis), Neuroendocrine regulation.

### **Recommended Books**

1. Barret Kim E., Boitano Scott, Barman Susan M., Brooks Heddwen L. Ganong's Review of Medical Physiology. 25th ed. New York: McGraw Hill Medical, 2015.
2. Hall John E. Guyton and Hall Textbook of Medical Physiology. 13th ed. Philadelphia, PA: Saunders Elsevier, 2015.

## **BSM -202**

### **MICROBIOLOGY**

#### **Unit I**

Bacterial taxonomy: Characteristics used in classification of microorganisms, Bergey's Manual Trust, A brief account of Bergey's Manual of Determinative Bacteriology and Bergey's Manual of Systematic Bacteriology, Structure and functions of bacterial cell wall: Gram positive bacteria, Gram Negative bacteria, Archaeobacteria. Bacterial Endospore: Structure, formation and germination.

#### **Unit II**

Electron Microscopy: Transmission Electron Microscope, Scanning Electron Microscope. Cultivation of bacteria: Bacteriological media, Physical conditions required for growth, Batch culture, Continuous cultures, Chemostat, Turbidostat. Measurement of growth. Control of microorganisms: Definitions and fundamentals of control, mode of action of antimicrobial agents, Conditions influencing antimicrobial action.

#### **Unit III**

Human microbe interaction: Normal microbiota of Skin, Eye, Respiratory tract, Intestinal tract, and Genitourinary tract. Gnotobiotic animals. Determinants of infectious diseases: Transmission, Attachment, Colonization, Entry, Growth and multiplication, Exotoxins, Endotoxins, Leucocidins and Hemolysins. Antibacterial drugs. Drug Resistance: Mechanism of drug resistance, Origin and transmission.

#### **Unit IV**

Morphology and Ultrastructure of Viruses: Icosahedral, Helical and complex symmetry. Viral genome, Capsid and capsomers, Envelope and enzymes. Replication of Viruses: Replication of animal viruses (HIV and Poliovirus), Transmission and Replication of plant viruses with special reference to TMV. Bacteriophage (T4 Phage): Adsorption, Penetration, Synthesis of nucleic acid and protein, Assembly and release.

#### **Recommended Books**

1. Prescott, Harley & Klein, Microbiology (WCB)
2. Ronald M. Atlas, Microbiology, Fundamentals and Application (McGraw Hill)
3. Tortora, Funke & Case, Microbiology, An Introduction (Addison Wesley and Longman Inc.)
4. Volk, Beniganin, Kodner & Parsons. Essentials of Medical Microbiology.
5. Alcamo's, Fundamentals of Microbiology, Addison Wesley Long Inc.
6. R.E.F. Mathews, Plant Virology (Academic Press)



## **BSM -203**

### **GENOME BIOLOGY**

#### **Unit I- Genome Organization & Transgenesis**

Elements of eukaryotic genome organization; Human genome and organization of genes; Epigenome and regulation of genes through epigenetic mechanism, genomic imprinting; Uni Parenta Disomy(UPD).Principle, methods and types of gene transfer in animal oocytes and embryonic stem cells. Production of transgenic/gene knock out animal (Mice), applications of transgenic animal; animal cloning and its broad spectrum applications, advantages, disadvantages and ethical concern.

#### **Unit II- Molecular Pathology**

Understanding chromosomal and molecular basis of genetic diseases in man. Molecular pathology of single gene multifactorial and sex linked diseases with special reference to Marfan Syndrome, Prader Willi Syndrome, Fragile 'X' Syndrome, sickle cell anemia, and DMD. Cancer and characteristics of cancer cells, involvement of tumor suppressor genes and oncogenes in cancer.

#### **Unit III- Molecular Diagnosis**

Prenatal diagnosis, Chorionic Villi Sampling Amniocentesis, Cordocentesis. Application of molecular, Cytogenetic and immunohistochemical techniques in diagnosis of various chromosomal and molecular pathogenesis.

#### **Unit IV- Molecular Therapeutics**

Types and models of gene therapy; gene delivery system, viruses in delivery system. Application of gene therapy in correction of different genetic diseases. Ethics associated with somatic and germ cell gene therapy. Interferon and other cytokines in therapeutics. Therapeutical application and ethical implication of cloned animals.

#### **Recommended Books**

1. Human Genetics: Proceedings of the 7th International Congress Berlin 1986 Paperback – Import, 17 Nov 2011
2. Vogel and Motulsky's Human Genetics: Problems and Approaches Hardcover – Import, 1 Feb 1982
3. Genetics of Sex Determination (Advances in Genome Biology Book 4) Kindle Edition by R. S. Verma (Editor)
4. Genomes 4 Paperback – 21 Jun 2017 by T. A. Brown (Author)
5. Genome Refactoring (Synthesis Lectures on Synthetic Biology) Paperback – Import, 1 Jun 2009
6. Lewin's GENES XII Hardcover – 1 Feb 2017 by Jocelyn E. Krebs (Author), Elliott S. Goldstein (Author), Stephen T. Kilpatrick (Author)

## **BSM -204**

### **BIOPHYSICS (CBCS)**

#### **Unit I- Bioenergetics**

Free energy changes, Gibbs energy, Flow of energy in the biological system, concepts of chemical energy, Redox Potential, Nernst Equation, Ion electrochemical potential, Proton electrochemical potential, Membrane potential, equilibrium across a semi-permeable membrane, Donnan potential, respiratory chains, mitochondrial respiratory chains, respiratory control and oxidative phosphorylation, photosynthetic generators of proton motive force.

#### **Unit II- Membrane Biophysics**

Structure and organization of cell membrane, membrane models and drug delivery system. Energy transducing membranes, measurement of driving forces, metabolite and ion transport, active and passive transport, influx and efflux mechanisms, proton circuit and electrochemical gradient, Ionophores, Uniport, antiport and symport mechanisms, Shuttle systems. ATP synthase, Transport ATPases, Na<sup>+</sup>/K<sup>+</sup>ATPase and H<sup>+</sup>/K<sup>+</sup>ATPase, Molecular mechanisms of calcium transport, use of Na<sup>+</sup> as an alternative to H<sup>+</sup> in energy transduction.

#### **Unit III- Radiation Biophysics**

Electromagnetic spectrum, properties of non-ionizing and ionizing radiation, radiation units, principles of detection and measurement, Interaction of radiation with matter, free radicals, ions pair and dosimetry, dose effect graphs and target theory, direct and indirect radiation action, radiation effects on proteins, nucleic acids, carbohydrates, cell and whole organism, genetic effects of radiation, repair of radiation induced damages, radiation in diagnosis and therapeutics.

#### **Unit IV- Biophysical Techniques**

**Spectroscopy:** Principle instrumentation and applications of UV-visible Fluorescence, Infra Red, Raman and CD spectroscopies. Basic concept of NMR and X-ray crystallography. Dynamic Light Scattering, Surface Plasmon Resonance, Differential scanning and Isothermal Calorimetry. Mass Spectrometry; MALDI-TOF, ESI/MS. **Microscopy:** Optical, Phase Contrast, Fluorescence Microscopy, Scanning Electron, Transmission Electron.

#### **Recommended Books**

1. Keith Wilson and John Walker. Practical Biochemistry Principles and Techniques. Cambridge University Press.,1997
2. Creighton TE. Proteins Structures and Molecular Properties. W.H. freeman & Company, New York.,2006
3. David Freifelder. Physical Biochemistry: applications to Biochemistry and Molecular Biology. W.H. freeman and Company.,2006
4. New Era of Bioenergetics, by YasuoMukohata, Publisher Academic Press, 2012, ISBN 0323140297, 9780323140294.
5. Principles of Bioenergetics: Authors, Vladimir P. Skulachev, Alexander V. Bogachev, Felix.

6. Fundamentals of Molecular Spectroscopy, 5th Edn, McGraw Hill, ISBN-10 1259062597, ISBN-13 9781259062599, 2013 May.
7. Chadwick K.H. & Leenbouts H.P. Molecular Theory of Radiation Biology, Springer Verlag.
8. Atlik F.H. Introduction to Radiological Physics and Radiation Dosimetry, John Wiley

**BSM -205**  
**RECOMBINANT DNA TECHNOLOGY (SEC)**

**Unit I**

History of recombinant technology, restriction modification system in bacteria, DNA modifying enzymes and their mechanisms of action, functions of adapters, linkers and homopolymer linking in molecular cloning, purification of DNA from living cells, construction of genomic and cDNA libraries, screening of libraries, substrative hybridization for tissue specific DNA libraries

**Unit II**

Expression of foreign genes in *E. coli*, production of recombinant protein by prokaryotic expression vectors, eukaryotic expression vectors, mammalian expression vectors; fusion tags, role in purification of recombinant proteins, detection of expressed proteins

**Unit III**

Chemical synthesis of DNA, changing gene: Random and site-directed mutagenesis, strategies for gene transfer to animal cells, genetic manipulation of mammals, genetic transformation of plant cells - biolistics and *Agrobacterium* mediated, next generation and advanced sequencing, pyrosequencing, recent advances in protein engineering and metabolic engineering

**Unit IV**

Nucleic acid sequences as diagnostic tools, new drugs and new therapies for genetic diseases, gene therapy for genetic diseases, production of recombinant pharmaceuticals, hormones, recombinant vaccines, antisense therapy, gene knockout

**Recommended Books**

1. Singh BD (2010) Biotechnology 4 th Edition, Kalyani Publications
2. Nair AJ (2008) Introduction to Genetic Engineering and Biotechnology. Infinity Science Press
3. Brown T (2010) Gene cloning and DNA analysis: an introduction. John Willey & Sons

# **BSM -301**

## **IMMUNOLOGY**

### **Unit I**

Introduction and Overview of the Immune System. Origin of Immunology and its evolution. Infection and immunity. Types of immunity- Innate and acquired, active and passive, humoral and cell mediated. Clonal selection theory. Organs and cells of the immune system: structure and function. Hematopoiesis. Lymphocyte traffic. Antigens and immunogens. Adjuvants. Requirements for immunogenicity.

### **Unit II**

Structure and function of immunoglobulins. Antibody variants- isotypes, allotypes and idiotypes. Monoclonal antibodies. Hybridoma technology. Organization of immunoglobulin genes. Theories and genetic basis of antibody diversity. Antibody –antigen binding: affinity, avidity, cross reactivity. Antigen-antibody interactions; agglutination, hemagglutination. Precipitation reactions in solution and in gels. Immunoassays: Radioimmunoassay, ELISA, ELISPOT, immunofluorescent assays. Fluorescence activated cell sorting. Western blotting.

### **Unit III**

Major histocompatibility complex. MHC genes and Histocompatibility antigens. Role of MHC in T cell selection. Cytokines and their role in immune regulation. Complement system. Mechanism of its fixation; complement activation and its biological activities. Classical, alternative and lectin pathways; Regulation of complement.

### **Unit IV**

Immunological tolerance to self and to antigens; its induction and features. Immunosuppression-specific and non-specific. Allergy and hypersensitivity. Effector mechanisms and examples of each type of hypersensitivity. Transplantation immunology. Tumor immunology. Immunodeficiencies; primary and secondary. Autoimmunity: factors contributing to autoimmunity; examples and diagnosis. Immunization and Vaccines.

### **Recommended Books**

1. Basic Immunology by Abul Abbas Andrew H. Lichtman and Shiv Pillai, Elsevier
2. Basic immunology by Jacqueline Sharon, Williams & Wilkins
3. Kuby Immunology. W. H. Freeman & Co.
4. Immunology by Ivan Roitt, Jonathan Brostoff, and David Male, Elsevier
5. How the Immune System Works, by Lauren M. Sompayrac, Wiley
6. The Elements of Immunology by Fahim Halim Khan Pearson Education India, 2009
7. Kuby Immunology, Sixth Edition 6th Edition by Thomas J. Kindt (Author), Barbara A. Osborne (Author), Richard A. Goldsby (Author)

## **BSM -302**

### **PLANT PHYSIOLOGY**

#### **Unit I**

Plant water relations, mechanism of water transport through xylem, transpiration, stomatal physiology, factors affecting transpiration, guttation. Photosynthesis: Historical background, photosynthetic pigments and light harvesting complex, photosystems I & II, mechanism of quantum capture and energy transfer system, Calvin cycle, C4 cycle and CAM pathway, translocation of solutes. Carbon allocation. Mechanism of loading and unloading of photoassimilates.

#### **Unit II**

Hydrolytic and phosphorolytic degradation of starch and sucrose. Respiration: respiratory quotient, ATP generation, factors influencing the rate of respiration (light, temperature, oxygen availability). Electron Transport system in mitochondria, oxidative phosphorylation.

#### **Unit III**

Nitrogen metabolism, biological nitrogen fixation and ammonia assimilation, nitrate reduction and its incorporation into amino acids. Study of various plant stress, resistant strategies, plant defense mechanism against biotic and abiotic stress.

#### **Unit IV**

Tissue cultures, general tissue culture techniques, totipotency, roles of tissue culture techniques in haploid and triploid production. Biosynthesis, Physiological role and mechanism of action of various plant growth regulators like auxin, gibberellins, cytokinin, abscisic acid and ethylene etc.

#### **Recommended Books**

1. Introduction to Plant Physiology 16 December 2008 by William G. Hopkins and Norman P. A. Hüner
2. Fundamentals of Plant Physiology 2017 by V. K. Jain
3. Principles of Plant Physiology 6 July 2017 by B.P. Nautiyal
4. Plant Physiology and Biochemistry 1 December 2005 | Import by H. S. Srivastava and N. Shankar

# **BSM -303**

## **MOLECULAR BIOLOGY**

### **Unit I**

Enzymes used in Molecular Cloning: Restriction enzymes, DNA polymerases, ligase, kinase, phosphatase, nuclease; molecular cloning of DNA or RNA; Cloning Vectors: Lambda phage, plasmid, M13 phage, cosmid, shuttle vectors, yeast and viral vectors, construction of genomic and DNA library. DNA Sequencing and Amplification of DNA: DNA Sequencing and Amplification of DNA by polymerase chain reaction, types of PCR: RT-PCR, inverse PCR, asymmetric PCR.

### **Unit II**

RNA Synthesis: Types of RNA polymerases, mechanism of transcription, RNA processing, capping, polyadenylation, splicing; micro RNA. Protein Synthesis: Ribosome, formation of initiation complex, initiation, elongation and termination of protein synthesis.

### **Unit III**

Replication of DNA: DNA polymerase and other enzymes involved, replication origin, replication fork, semi conservative replication of double stranded DNA, mechanism of replication.

### **Unit IV**

Gene Expression and Regulation: Prokaryotic and eukaryotic gene expression; gene silencing: transcriptional, post transcriptional, antisense RNA, oligonucleotide technology. Methods of Gene Transfer: Analysis of gene expression, micro arrays, restriction fragment length polymorphism, DNA finger printing, production of GMO.

### **Recommended Books**

1. Principles of Gene Manipulations & Genomics, S.B. Primrose, M. Twyman, John & Willey Publishers
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Bernard R.Glick and Jack J.Pasternack, Panima Publishing Corporation.
3. Gene Cloning – An Introduction. Blackwell Publishing, Brown, T. A. , 2016, (7<sup>th</sup> edition).
4. Krebs E, J., Goldstein S, E. and Kilpatrick, T. S. (2013). Lewins Gene XI. Jones and Bartlett publishers, Inc.
5. Molecular Cell Biology, Lodish, H., Berk, A., Zipursky, S., Matsudaira, P., Baltimore, D. and Darnell, J. (2016), W. H. Freeman and Company, 8<sup>th</sup> Ed.
6. Molecular Biology, David P. Clark & Nanette J. Pazdernik, Elsevier Academic Press, UK, (2013), 2<sup>nd</sup> Ed.

**BSM -304**  
**TECHNICAL WRITING & SEMINAR (AECC)**

In Presence of the Supervisor



**BSM -305**  
**ENVIRONMENTAL BIOLOGY (CBCS)**

**Unit I**

Ecosystem Degradation by Deforestation, Overgrazing , Agriculture, Mining, Urbanisation, Shifting Cultivation, Development Projects, Fuel and Industrial Raw Material Requirements, Threat to Wild Life Through Hunting, Habitat Destruction, Selective Destruction, Domestication, Introduction of New Species, Pesticide Use, Pets Trade, Medical Research Experimentations and Captivity in Zoos , Extinct Species Categories - Threatened Species, Endangered Species, Rare Species, Depleted Species and Intermediate Species, Endemic Species, Habitat Conservation, Providing Critical Resources, Captive Breeding, Development of Biological Reserves, National Parks, Forest Reserves, Wild Life Refuges and Biosphere Reserves, Controlling Introduction of Alien Species, Pollution Reduction, Research and Development, Legal Actions, Public Participation and Awareness, Traditional and Modern Approaches Used In India for Conservation, Project Tiger, Chipko Movement, Appiko Movement, Indian Biosphere Reserve Programme.

**Unit II**

Municipal water Treatment, Waste water treatment - Pre treatment, Primary Treatment, Secondary or Biological and Tertiary Treatments\_ Trickling Filters, Rotating Biological Contractors, Activated Sludge Process, Oxidation Ponds. Infectious and Medical Waste Pollution and Management, Solid waste pollution and management

**Unit III**

Microbial degradation of xenobiotics, Genetic engineering of biodegradative pathways – manipulation by plasmid transfer and gene alterations, Biomass utilization (Starch, Sugar, Cellulose) for commercial production of fructose, alcohol and biofuel (biodiesel & bioethanol).

**Unit IV**

Microbial insecticides (*Bacillus thuringiensis* & *Baculo virus*) mode of action, toxin gene isolation and genetic engineering; Biofertilizers – Bacterial and Cyanobacterial nitrogen fixers, bacterial, cyanobacterial and mycorrhizal phosphate solubilizers nitrogen fixing gene and their manipulations, composting, green manuring.

**Recommended Books**

1. Climate Change Biology by Lee Hannah, Academic Press Elsevier 2011
2. Environmental Based Management edited by Ramchandra, CRC Press Teller & Francis Group
3. Molecular Biotechnology; Principles & Applications of Recombinant DNA by Bernard R Glick & Jack J Pasternak, ASM Press 2010
4. Biodegradation & Bioremediation by Martin Alexander, Academic Press 1999
5. Microbial Biotechnology; Fundamentals of Applied Microbiology by Alexander N Glazer & Hiroshi Ni Raido, Cambridge University Press 2007

**BSM -401**  
**PHYSICAL CHEMISTRY OF MACROMOLECULES**

**Unit I- Macromolecules Proteins**

Amino acids their physical & chemical properties, Peptides and polypeptides. Peptide group, charges on peptides (pH dependence), Handersen-Haselbalch equation, buffers. Primary structure of proteins, separation of amino acids, end group analysis, reduction, modification and location of disulfide bonds, sequencing of polypeptide.

Nucleic acids: Primary, secondary and tertiary structures of Nucleic acids, polymorphism of DNA (A, B, Z forms), denaturation and renaturation of DNA, supercoiled DNA, superhelix topology, measurements of supercoiling.

**Unit II- Structure and function of Protein**

Different levels in protein structure, Ramachandran plot, Secondary structure ( $\alpha$ -helix,  $\beta$ -strand,  $\beta$ -sheet, turns and loops), Super secondary structures, tertiary structure, quaternary structure, globular and fibrous proteins.

Functions of different protein, Hemoglobin function, oxygen binding, hill equation, Bohr effect, binding of BPG.

**Unit III- Protein folding**

Forces stabilizing the native state of proteins (electrostatic, hydrophobic and hydrogen bonding). The denatured state, modes of denaturation. Protein folding. Landmark experiments in protein renaturation, folding pathways, techniques to monitor protein folding, landscape theory of protein folding. Accessory proteins in folding: protein disulfide isomerase, Rotamases and molecular chaperones.

**Unit IV- Biophysical Techniques Chromatography**

Paper, TLC, adsorption, partition, ion exchange, gel filtration, affinity, GLC, HPLC.

Electrophoresis: paper electrophoresis, gel electrophoresis SDS-PAGE, isoelectric focussing, gel electrophoresis of nucleic acids.

Viscosity and Sedimentation: Viscosity of macromolecules, measurement of viscosity, velocity and equilibrium sedimentation of macromolecules, diffusion of macromolecules, centrifugation techniques and their applications, ultracentrifugation (analytical and preparative), boundary and band sedimentation, estimation of molecular weight.

**Recommended Books**

1. Principles and Techniques of Biochemistry and Molecular Biology by Wilson and Walker 2005
2. Nelson, David L., Albert L. Lehninger, and Michael M. Cox. Lehninger principles of biochemistry. Macmillan, 2008. Berg, Jeremy M., John L. Tymoczko, and Lubert Stryer. "Biochemistry 5th ed." (2002).
3. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. Fundamentals of Biochemistry 2002 Update. John Wiley & Sons, 2002.

## **BSM-402**

### **TOXICOLOGY (CBCS)**

#### **Unit I**

History, general principles and scope of toxicology. Dose response relationships. LD<sub>50</sub>, ED<sub>50</sub>, LC<sub>50</sub>, EC<sub>50</sub>. General mechanisms of toxicity. Disposition of toxicants – adsorption, distribution, and elimination of toxicants. Biotransformation of Xenobiotics – basic properties, categories and distribution of xenobiotic biotransforming enzymes.

#### **Unit II**

Toxic agents – Toxic effects of pesticides & metals with special reference to DDT, lindane, cyclodienes, lead, arsenic, mercury, cadmium, aluminum. Health effects of radiation and radioactive materials. Important radiation episodes.

#### **Unit III**

Environmental Toxicology – air pollution & health effects, pollutants of the outdoor ambient air with special reference to sulfur dioxide, sulfuric acid, particulate matter, smog, ozone, nitrogen dioxides and carbon monoxides.

#### **Unit IV**

Applications of Toxicology : *Food Toxicology* – Safety standards for foods, food ingredients & contaminants; *Forensic Toxicology* – analytic role, toxicological investigation of a poison death, criminal poisoning of the living; *Clinical Toxicology* – strategy for treatment of the poisoned patient; *Cosmetic Toxicology* , *Occupational Toxicology* – Occupational diseases, worker health surveillance, exposure monitoring

#### **Recommended Books**

1. A Textbook of Modern Toxicology by Ernest Hodgson & Patricia E Levi, III Ed. Appleton & Lange 1997
2. A Textbook of Modern Toxicology IV Edition, edited by Ernest Hodgson Wiley, 2010
3. Principles of Biochemical Toxicology by John Timbrell, IV Edition
4. Principles of Toxicology, III Edition 2015 by Karen E Sine & Thomas M Brown, CRC Press Teller & Francis Group
5. Environmental Toxicology; Current Developments Edition J. Rose 1998, CRC Press Teller & Francis Group

**BSM -404**  
**PROJECT & DISSERTATION**

In Presence of the Supervisor