JAMIA HAMDARD

(Deemed to be University)

www.jamiahamdard.edu

M.Sc. Biochemistry Syllabus

(Approved by the Board of Studies and Academic Council

Effective September 2021

DEPARTMENT OF BIOCHEMISTRY
SCHOOL OF CHEMICAL AND LIFE SCIENCES

Department of Biochemistry

The Department of Biochemistry established in the year 1994, is one of the six Departments of School of Chemical and Life Sciences of Jamia Hamdard. The department is recognized for its excellence in higher education and research in India and abroad. The Department of Biochemistry conducts Integrated BSc-MSc, MSc and PhD programmes. The faculty is highly accomplished and is involved in cutting edge research in the field of biological sciences. Apart from grants from various prestigious funding agencies such as CSIR, ICMR, CCRUM, DST, DBT the department is also a recipient of UGC Special Assistance Program (UGC-SAP) and has recently been upgraded to DRS II. The department has access to a dedicated animal house for research programs which maintains small animals such as mice, rats, rabbits, and guinea pigs. The university has smart classrooms for studies along with dedicated and well-equipped labs for PG and UG students within the department. The school also has a central instrumentation facility (CIF) for its 6 departments including the department of biochemistry. The CIF has the state-of-the-art equipment such as HPLC, RT-PCR, FTIR, Confocal Microscope, Ultracentrifuge etc. In addition, the department has its own CIF as well. The syllabus is periodically revised in consultation, and with approval from the Board of Studies of the department to keep the students abreast with current trends in Biochemistry. The syllabus is also well aligned with the key national level scholarship programs like CSIR, DBT, ICMR etc. The hands-on training is imparted to students in most of the contemporary areas, which prepares them to undertake research in cutting-edge fields for their PhD within the university or outside. There is a fine balance in class room teaching as well as hands on experimental training.

Thrust Areas of Research

- Innate immunity, Chronic diseases, Tissue injury, Regeneration and repair.
- Cancer Etiology, DNA damage and repair, Nutrigenomics, Proteomics.
- Molecular Immunology, Development of FRET Based Biosensors.
- Host-pathogen interactions; Computational biology.
- Alternative splicing and disease.
- Toxicant mediated metabolic syndrome.
- Role of novel kinase pathways in virus mediated oncogenesis.

Courses Offered

1. B.Sc MSc Dual Degree Programme (Biochemistry)
Duration: Five years (Six semesters)

Eligibility: A candidate seeking admission to the BSc-MSc Dual Degree must have passed Senior Secondary (12th/Intermediate) examination with Biology/Mathematics from CBSE or any other Board recognized by JH as equivalent thereto, securing at least 50% marks or equivalent CGPA in aggregate.

Selection procedure: Selection will be made purely based on the marks obtained in qualifying examination.The Candidate will be awarded B.Sc. (Honours) degree in Biochemistry.

2. M.Sc. Biochemistry
Duration: Two years (Four semesters)

Eligibility: Passed B.Sc. in Biochemistry or equivalent examination in Biological Sciences with Biochemistry or Chemistry as one of the subjects securing at least 50% marks in aggregate.

Selection procedure: Selection for PG programs will be based on the merit in the qualifying examination. Qualifying exam will mean average of three years marks of B.Sc. programme. In case where final year exam result is not out, the average of last two years marks will be counted for provisional selection of candidates.

3. Ph.D. Biochemistry
Ph.D. programme shall be for minimum duration of three years, including course work and ideally 5 years subject to maximum of six years as per the Jamia Hamdard PhD byelaws.

Eligibility and selection procedure: Candidates shall have a Master's Degree or a professional degree declared equivalent to Master's degree by the corresponding statutory body, with at least 55% marks in aggregate or its equivalent Grade 'B' in the UGC 7-point scale. NET-JRF/Individual Fellowship holders/Project Fellows will be preferred for admissions in Ph.D. programs.

Since the inception of Department around 20 batches comprising of >350 students have passed the PG program in Biochemistry. Over the years, the department has developed facilities for high precision analytical work, and has acquired advance equipment and tools for cellular and molecular research including the facility to work on cell lines. Our M.Sc. pass out students are working as scientists and academicians besides taking up jobs in private sectors as well as abroad. In last five years the Department has awarded 39 PhD and published >75 research articles in SCI journals.

Faculty

Dr. Shakir Ali	Ph.D.	Professor
Dr. Rana Zaidi	M.Phil., Ph.D.	Professor and Head
Dr. Farah Khan	Ph.D.	Associate Professor
Dr. Vikas Sood	Ph.D.	UGC FRP Assistant Professor
Dr. Sayeed ur Rehman	Ph.D.	Assistant Professor
Dr. Mohan Kamthan	Ph.D.	Assistant Professor
Dr. Saurabh Pandey	Ph.D.	Assistant Professor

Contact:

Mr. Shahrukh Khan
Junior Assistant

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M. Sc. Biochemistry
Choice Based Credit System (CBCS)
Jamia Hamdard

COURSE CONTENT

Semester I

Course I	Core Course	MBC 101: Biomolecules	4	100
Course II	Core Course	MBC 102: Cell Biology	4	100
Course III	Core Course	MBC 103: Enzymes	4	100
Course IV	Core Course	MBC 104: Lab Course-I	8	200
Course V	Core Course	MBC 105: Biochemical and Biophysical Techniques	4	100
Course VI	Core Course	MBC 106: Molecular Biology-I	2	50
Course VII	Core Course	MBC 107: Fundamentals of Biochemistry and Biophysics	2	50
			28	**700**

Semester II

Course VIII	Core Course	MBC 201: Molecular Biology-II	4	100
Course IX	Core Course	MBC 202: Protein and Proteomics	4	100
Course X	Core Course	MBC 203: Metabolism-I: Bioenergetics, Carbohydrate and Intermediary Metabolism	4	100
Course XI	Core Course	MBC 204: Immunology	4	100
Course XII	Core Course	MBC 205: Lab Course-II	8	200
Course XIII	Generic Elective	MBC 206/207/208: GE-I*	2	50
Course XIV	Discipline Centric Elective	MBC 209/210/211: DCE-I**	2	50
			28	**700**

Semester III

Course XV	Core Course	MBC 301: Analysis and Visualization of Genomic Data	4	100
Course XVI	Core Course	MBC 302: Genetic Engineering	4	100
Course XVII	Core Course	MBC 303: Metabolism-II: Lipid, Amino Acid and Xenobiotic Metabolism	4	100
Course XVIII	Core Course	MBC 304: Clinical and Nutritional Biochemistry	4	100
Course XIX	Core Course	MBC 305: Lab Course-III	8	200
Course XX	Generic Elective	MBC 306/307/308: GE-II[#]	2	50
Course XXI	Discipline Centric Elective	MBC 309/310/311: DCE-II[##]	2	50
			28	**700**

Semester IV

Course XXII	Core Course	MBC 401: Dissertation		
		Thesis	20	500
		Presentation	4	100
			24	**600**

Total credits/marks in four semesters: 108/2700

Each 4-credit theory paper will be taught in 50 lectures and 2 credit paper will be taught in 25 lectures, each of one-hour duration. Core courses are compulsory and integral part of the subject.

Electives:

**** GE-I (any ONE)***	***** DCE-I (any ONE)***
1. MBC 206: Laboratory Animal Sciences 2. MBC 207: Mathematics in Biology 3. MBC 208: Biostatistics	1. MBC 209: Microbiology and Virology 2. MBC 210: IPR 3. MBC 211: Introduction to Manuscript Writing
# GE-II (any ONE)	***## DCE-II (any ONE)***
1. MBC 306: Bioinformatics 2. MBC 307: Concepts in Translational Biology 3. MBC 308: Concepts in Next Generation Sequencing	1. MBC 309: Genetics 2. MBC 310: Biotechnology 3. MBC 311: Poster Presentation

SEMESTER-I

Course I
Paper code: MBC 101

Core Course

BIOMOLECULES

CREDITS: 4, LECTURES: 50, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM)

Objective of this course is to introduce the structure and function of biomolecules, and understand the chemical principles in life processes. Classification, disorders related to overproduction and underproduction of hormones are also emphasized in this paper.

Unit I: Carbohydrates

Occurrence, classification, characteristics, structure and functions of monosaccharides, disaccharides, trisaccharide and polysaccharides; Structure and conformation of sugars; Stereoisomerism and optical isomerism; Selected chemical reactions of the functional groups; Sugar derivatives; Mucopolysaccharides; Glycosaminoglycans; Proteoglycans; Glycoproteins.

Unit II: Lipids

Classification and types of lipids; Structure, nomenclature and properties of fatty acids; Glycosides; Soaps; Micelles; Structure, classification, properties and functions of phospholipids and sphingolipids; Glycolipids; Composition and biological role of lipoproteins; Structure and functions of steroids and prostaglandins; Eicosanoids; ω3 and ω6 fatty acids.

Unit III: Amino acids, nucleotides and water

Structure, nomenclature, classification, acid-base behavior and chemical reactions of amino acids; Stereoisomerism and optical properties of amino acids; Modified amino acids; Nucleotides; Water and its physicochemical properties, Ionization of water, pH scale, Henderson-Hasselbalch equation.

Unit IV: Hormones/Signaling molecules

General characteristics of hormones and other signaling molecules; Classification, functions, mechanism of action and abnormalities of the hormones of thyroid, pancreas, hypothalamus, pituitary and gonads; Hormone replacement therapy; Plant hormones with specific reference to Auxins; Pheromones: types and functions.

Course II
Paper Code: MBC 102

Core Course

CELL BIOLOGY

CREDITS: 4, LECTURES: 50, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM)

The paper is aimed at to provide an insight into the molecular organization, structure and functions of the cell, as well as the Regulatory mechanisms governing the Cell function. After studying this paper, student is expected understand the fundamentals of the biology and biochemistry of the Cell and explore the reactions and processes in living organisms for the benefit of mankind.

Unit I: An overview of the cell and cell structure

The Cell – An introduction to chemical composition, molecular organization, origin and evolution; Prokaryotic and eukaryotic cells; Cell theory and modern cell biology; Cell organelles: Structure of the Endoplasmic Reticulum, Golgi body, Lysosome, Peroxisome, Plant vacuole, Ribosome, Mitochondria, Chloroplast, Nucleus, Cytoskeleton, Plant cell wall; Subcellular fractionation by differential centrifugation; Protoplasm, cytoplasm and cytosol; Methods to study the cell: Principles of microscopy, Cell culture, flow cytometry.

Unit II: Membrane biology

Biological membranes - Chemical composition and structural plan; Models of membrane structure; Membrane as a two dimensional fluid; Factors affecting the fluidity and permeability of the membrane; Phase transition; Membrane proteins: types and isolation; Movements of small molecules and ions across the membrane; Movements of macromolecules across membrane; Osmosis; Diffusion; Active and passive transport; Types of ATPases; Endocytosis; Receptor mediated endocytosis; Phagocytosis; Membrane fusion; Artificial membranes.

Unit III: Major cell functions

The cytoplasmic membrane/endomembrane system; Synthesis and transport of proteins to membrane and various organelles; Secretory proteins - transport mechanism; Signal hypothesis; Protein targeting to the peroxisome; Major functions of various cell organelles; Packaging of eukaryotic DNA into chromosome; Nucleosome and higher levels of structural organization of eukaryotic chromosome; Nuclear pore complex and its function; Trafficking across the nucleus; Nucleolus and the synthesis of ribosome; Electric properties of membrane; Patch clamp and voltage clamp techniques.

Unit IV: Regulation of cell functions

Signal transduction; Receptors and ligands; Proteins and other molecules involved in the transduction of signal into the cell and eliciting a response; G proteins and G protein coupled receptors; Growth factors and receptor tyrosine kinase; Second messengers; Cell cycle and its regulation; Cancer; Characteristics of a tumor cell; Mechanism of transformation/Carcinogenesis; Tumor suppressor genes; Cell signaling in development and differentiation; Stem cell; Regeneration; Cell death mechanisms - Apoptosis, necrosis and autophagy.

Course III
Paper Code: MBC 103

Core Course

ENZYMES

CREDITS: 4, LECTURES: 50, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM)

This course is meant to give student an in-depth knowledge of enzyme, their classification, catalysis and kinetics, as well as to give an account of the catalytic mechanisms and immobilized enzymes.

Unit I: Enzymes – Introduction and classification

Enzymes as biological catalysts: characteristics, nomenclature and classification; Enzyme assay and enzyme activity; Enzyme units; Coenzymes: structure and function; Factors affecting initial velocity of enzyme catalyzed reactions; Multifunctional enzymes and multienzyme complexes; Isoenzymes and their analysis; Ribozyme; Catalytic antibodies.

Unit II: Enzyme kinetics and enzyme inhibition

Kinetics of enzyme catalyzed reactions; Steady-state hypothesis and derivation of Michaelis-Menten equation; Significance of Km and Vmax and their determination using different plots; Double reciprocal plot; Enzyme inhibition: competitive, noncompetitive, and uncompetitive inhibition; Excess substrate inhibition; Enzyme kinetics in the presence of inhibitors; Determination of Ki; Enzyme catalyzed reactions involving two substrates.

Unit III: Catalytic mechanisms

Catalytic efficiency and factors associated with catalytic efficiency: proximity, orientation, distortion and strain; Catalytic mechanisms: acid-base, covalent, metal ion and electrostatic catalysis; Active site mapping of enzymes; Experimental approaches to the determination of enzyme mechanisms; Mechanism of action of lysozyme and serine proteases.

Unit IV: Regulation of enzyme activity and immobilized enzymes

Mechanisms to control the enzyme activity; Allosteric enzymes and their kinetics; Hill and Scatchard plots; Models of allosteric regulation; Enzyme immobilization: methods, kinetics and applications; Enzyme turnover and its significance; Convergent and divergent evolution of enzymes; Non-enzymatic biochemical reactions.

Course IV
Paper Code: MBC 104

Core Course

LAB COURSE - I
(Analytical and Separation Techniques)

CREDITS: 8, HOURS: 200, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM)

Lab course 1 is intended to provide hands-on training to newly inducted students of biochemistry a basic understanding of common analytical and separation techniques and introduce simple methods for studying a biomolecule. The principle, theory and instrumentation of the technique will be explained before taking up the exercise

Lab Exercises

1. Qualitative analysis of lipids, carbohydrates, proteins and amino acids
2. Estimation (spectrophotometric) of cholesterol, glucose, nucleic acid and protein
3. Chromatographic separation of sugars, fatty acids and amino acids by paper and thin layer chromatography - and an Introduction to various Chromatographic techniques
4. Isolation of starch or glycogen from a biological source
5. Isolation of casein from milk, its digestion and determination of phosphorous content in the digest
6. Extraction of oil/lipid from plant material and determination of its saponification value and iodine number
7. Subcellular fractionation by differential centrifugation - Isolation of nuclear and mitochondrial fractions and determination of the protein content
8. Immobilization of cell: RBC/yeast
9. Determination of the acid dissociation constant, pKa, of an amino acid

Course V
Paper Code: MBC 105

Core Course

BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES

CREDITS: 4, LECTURES: 50, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM)

This course has been designed to introduce the student to various classical and modern techniques used in biochemical research. The course encompasses the principles, significance, applications, and limitations of these techniques. The basic instrumentation is also included.

Unit I: Spectroscopy

Principle, instrumentation, and applications of Colorimetry, UV-Visible Spectroscopy, Fluorescent and Emission Spectroscopy, IR Spectroscopy, Atomic Absorption Spectrometry, NMR, ESR, CD, ORD, Raman, Atomic force microscopy, and X-Ray Crystallography; Difference spectra.

Unit II: Chromatography

Partitioning and Counter Current distribution; Principle, instrumentation, and applications of Paper chromatography, Thin layer chromatography (TLC), Gel permeation (size exclusion) chromatography, Ion exchange chromatography, Affinity chromatography, Immobilized metal ion affinity chromatography (IMAC), Hydrophobic interaction chromatography, Gas chromatography, HPLC, HPTLC, RP-HPLC, and FPLC.

Unit III: Centrifugation and Electrophoresis

RCF; Types of rotors; Principle, instrumentation and applications of Centrifugation, Ultracentrifugation, CsCl and sucrose density gradient Ultracentrifugation; Principle, instrumentation and applications of Native PAGE, SDS-PAGE, Agarose, Starch, and Cellulose acetate electrophoresis; Electrophoresis in determining M_r and conformation; Moving boundary & zonal electrophoresis; Pulse field gel electrophoresis, Blotting techniques; Zymography.

Unit IV: Radioisotopic/Tracer Techniques

Radioisotopes; Units of radioactivity; Detection and measurement of radioactivity by gas ionization and scintillation counting; GM Counter; Gamma counter; Autoradiography; Fluorography; Phosphor imaging; Isotope dilution method-pulse chase; RIA; Alternative to radioactivity: Luxometry and chemiluminescence.

Course VI
Paper Code: MBC 106

Core Course

MOLECULAR BIOLOGY-I

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (13 INTERNAL ASSESSMENT + 37 SEMESTER EXAM)

This course deals with a detailed insight into the historical events that lead to the conclusion of DNA as genetic material. Structure of DNA and RNA, Genome analysis and complexity, DNA replication, Transcription and post transcriptional processing.

Unit I: DNA and Replication

DNA as genetic material and classical experiments; Levels of structures of DNA; Forms of DNA; Properties of DNA in solution; COT curves; Central dogma of molecular biology. Replication of DNA; Enzymes involved in replication; Mechanisms of replication; Modes of DNA replication in prokaryotes and eukaryotes; Role of chromatin structure in gene expression; Comparison of replication in prokaryotes and eukaryotes, Replication of viral RNA. Chromosome segregation: random versus biased segregation. DNA supercoiling and topoisomerases in eukaryotes and prokaryotes. Mechanisms of actions of topoisomerases. Topological problems during replication.

Unit II: RNA, Transcription and Post-transcriptional processing

RNA: Structure function and types of RNAs; unusual bases in RNA. Structure of promoters in prokaryotes and eukaryotes, Transcription in prokaryotes and eukaryotes: three stages of RNA synthesis, initiation, elongation and termination, Regulatory region and transcriptional unit of gene; Inhibitors of transcription; Reverse transcription. Post-transcriptional processing of RNA: splicing, cap addition and polyadenylation; Polynucleotide phosphorylase. Processing of rRNA, tRNA precursors.

Course VII
Paper Code: MBC 107

Core Course

FUNDAMENTALS OF BIOCHEMISTRY AND BIOPHYSICS

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (13 INTERNAL ASSESSMENT + 37 SEMESTER EXAM)

This course deals with a detailed insight into the basic concepts in biochemistry such as, concentration, solutions, spectroscopy and biochemical equations. The course also provides basic concepts of Bioenergetics, standard states, equilibrium, redox reactions and activation energy.

UNIT I: Basic Biochemistry

Safety measures in laboratories. Mole concept: Concepts of molarity, molality and normality, solutions (polar and non-polar), concentration, stock and working solutions, serial dilutions. Quantitative transfer of liquids. Bioenergetics – energy rich compounds, source, conservation and utilization of energy in cell. Concept of small and macromolecules, rate of reaction, order of reaction, molecularity of reaction, polymers, theory of polymerization and copolymerization, absorption and emission spectroscopy of biomolecules, solving biochemical problems.

UNIT II: Principles of Biophysical Chemistry

Principles of biophysical chemistry: Laws of mass action, Reaction Quotient, Chemical equilibrium constant, Relation of Kp and Kc, pH, buffer, buffer index, buffer capacity, Arrhenius equation, and colligative properties. Standard states, steady states, activation energies, equilibrium constants. Oxidation and reduction phenomenon in biological systems, redox potential, redox indicators (stains and dyes), formal potential and its determination, thermodynamics: free energy, entropy, enthalpy, significance of free energy of biomacromolecules in determination of stability constants.

SEMESTER-II

Course VIII
Paper Code: MBC 201

Core Course

MOLECULAR BIOLOGY-II

CREDITS: 4, LECTURES: 50, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM)

This course deals with a detailed insight into DNA mutations, types of DNA damage, DNA repair, recombination, gene conversion. Translation, control of Translation, Test of mutagenicity and genotoxicity. The course also provides detailed concepts in regulation of gene expression and epigenetics

Unit I: Mutation, DNA Repair and Recombination

Mutations: Replication errors in DNA, chemical mutagens, spontaneous versus induced mutation. Types of DNA damages; Transposition, transposable elements, importance of transposable elements, Repair mechanism in prokaryotes and eukaryotes: direct repair system, excision repair (NER and BER), Mismatch repair (MMR), double stranded DNA break repair (DSB): non-homologous end joining and homologous recombination. Biochemistry of Recombination; types of homologous recombination: Gene conversion and mating type switching, Site-specific recombination, VD-J recombination, applications of homologous recombination. CRISPR-Cas system.

Unit II: Translation

General features of the genetic code, Ribosome as the site of protein synthesis, Activation of amino acids, Initiation, elongation and termination of protein synthesis in prokaryotes and eukaryotes, Fidelity of protein synthesis, GTPase timer, Bioenergetics of protein synthesis, Control of translation: Role of guanine nucleotides, Ribosome skipping/ jumping during translation, inhibitors of protein biosynthesis. Test of mutagenicity and genotoxicity: Ames test, Comet assay, Micronucleus assay, Mouse lymphoma TK assay, Mammalian cell HPRT assay.

Unit III: Regulation of gene expression

Regulation of gene expression in prokaryotes: Negative and positive control, Concept of operon, Transcriptional termination control via mRNA alternative conformations, Regulation of gene expression in eukaryotes, Britten-Davidson model, Control by steroid hormones, Cytoplasmic regulation of gene expression, Regulation of RNA synthesis in lambda phage, Riboswitches. DNA binding motifs in prokaryotes and eukaryotes: Helix turn helix, zinc fingers, leucine zippers/ b zip, helix loop helix motifs. Detecting DNA-binding sites.

UNIT IV: Epigenetics

Chromatin remodelling; Histone Modifications; Histone variants; Silencing mechanisms; RNA-based silencing; DNA Methylation/imprinting; CpG Islands, Epigenetic regulation of transcription. Role of epigenetic mechanisms in normal development and oncogenesis; Molecular techniques used in the studies of epigenetic phenomena (ChIP, Chip-Seq, MNase mapping, FAIRE).

Course IX
Paper Code MBC 202

Core Course

PROTEIN AND PROTEOMICS

CREDITS: 4, LECTURES: 50, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM)

The main aim of this course is to understand proteins, their structure, conformation and dynamics, protein folding, protein ligand interactions, and mechanisms. The paper emphasizes on various aspects of proteomics, understanding and exploring applications of mass spectrometry in protein structure determination.

Unit I: Primary structure

An overview of protein structure; Globular and fibrous proteins; Hierarchy of protein structure; Determination of N and C-terminal residues; Dihedral angles; Ramachandran plot; Determination of amino acid composition of protein and determination of sulfhydryl groups; Location of disulfide bonds; Fingerprinting; Chemical synthesis of peptides.

Unit II: Secondary and tertiary structure

Secondary structure of proteins: alpha helix and beta structure; Dinucleotide fold; Collagen helix and other types of helical structures; Supersecondary structures; Amino acid sequence and three-dimensional structure; Domains; Forces stabilizing the secondary and tertiary structure; Protein purification; Criteria of purity, and fold purification.

Unit III: Sequencing, protein folding and denaturation

Protein sequencing; Sequenators; Hydropathy plot; Quaternary structure of proteins; Structure and function of hemoglobin and comparison with myoglobin; Characteristics of molten globule state; Proteins involved in folding; *in vivo* folding; Models of protein folding; Chaperones; Protein conformation and misfold diseases.

Unit IV: Proteomics

Overview, tools and applications; Two-dimensional polyacrylamide gel electrophoresis; Protein spot detection; Mass spectrometry: matrix assisted laser desorption ionization MS, electrospray ionization MS, and tandem MS for protein identification; Identification of protein-protein interactions; Protein complexes; Prediction of tertiary structure (introduction).

Course X
Paper Code MBC 203

Core Course

METABOLISM- I: Bioenergetics, Carbohydrate and Intermediary Metabolism

CREDITS: 4, LECTURES: 50, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM

This course deals with the introduction to the laws of thermodynamics and their significance in biological systems, the concept of metabolism, characteristics of metabolic pathways and strategies used to study these pathways. This is followed by a detailed overview of various pathways involved in carbohydrate metabolism with their significance and regulation. The course also focuses on some important plant-specific metabolic pathways with relevant details.

Unit I: Bioenergetics and Introduction to Metabolism

Bioenergetics: Laws of thermodynamics; Concept of free energy, and standard free energy change; Determination of free energy change for a reaction; Equilibrium constant and standard free energy change; Biological oxidation-reduction reactions; Standard reduction potential and its relationship with free energy change. Metabolic pathways: Characteristics of metabolic pathways; Strategies used to study metabolic pathways. High energy compounds: ATP as universal energy currency in biological systems; Processes that generate and utilize ATP in the cell; Other high-energy compounds; Role of NADH and NADPH in metabolism.

Unit II: Carbohydrate Metabolism

Digestion and absorption of carbohydrates; Glycolysis; Entry of other monosaccharaides in glycolytic pathway; Gluconeogenesis; Citric acid cycle; Pentose phosphate pathway; Glucuronate pathway; Biosynthesis of lactose; Biosynthesis of oligosaccharides and glycoproteins; Glycogen metabolism and its regulation; Glycogen storage diseases and other genetic defects in carbohydrate metabolism; Regulation of carbohydrate metabolism; Metabolic adaptation in starvation and diabetes mellitus.

Unit III: Mitochondrial ATP Synthesis

Mitochondrial electron transport chain: Properties of inner mitochondrial membrane; Electron carriers and their organization; Sequence of respiratory complexes; Protein and no-protein components of respiratory complexes; Transport of equivalents of NADH produced in cytoplasm; $FADH_2$ oxidation. Oxidative phosphorylation: Sites of phosphorylation; P/O ratio; ATP synthase and mechanism of ATP synthesis; Inhibitors and uncouplers; Energetics and regulation of oxidative phosphorylation.

Unit IV: Plant-Specific Metabolic Pathways

General pathways: Glyoxylate pathway; Photosynthesis and carbon fixation; Cyclic and noncyclic electron transport; C3, C4, and CAM pathways; Photorespiration; Biosynthesis of Sucrose, starch and cellulose; Role of vacuole in plant metabolism. Plant secondary metabolism: Significance of secondary metabolites; Major classes of secondary metabolites and their properties; Common metabolic precursors; Outline of biosynthesis pathways of Alkaloids, Phenolics, Glycosides, and Terpenoids.

Course XI
Paper Code: MBC 204

Core Course

IMMUNOLOGY

CREDITS: 4, LECTURES: 50, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM)

The course on immunology is intended to make the student aware of the types of immunity, and biochemical mechanisms involved in immune responses and immune-mediated diseases. An introduction to immunotechnology, and other emerging areas in this field, is also included.

Unit I: Types of immunity

Innate Immunity and Adaptive Immunity; Cells and organs of immunity: Primary and secondary lymphoid organs; T cells, B cells, macrophages and effecter cells; Macrophage plasticity; Humoral and cellular immunity; Antigens and immunogens; Immunoglobulins: types and structure; CDRs; Immunoglobulin fold; Isotypes, allotypes and idiotypes; Valency, affinity and avidity; Primary and secondary immune response; Immunological memory; Clonal selection theory.

Unit II: Immune responses: T & B cell interaction

The immunoglobulin genes: organization and assembly; Generation of immunological diversity; Major histocompatibility complex (MHC): structure and organization of MHC class I and class II molecules; Antigen processing and presentation; T-cell receptor: αβ and γδ TCR; T cell maturation, activation and differentiation; Types of B cells; B cell generation, activation and differentiation; T-dependent and T-independent antigens.

Unit III: Immune effector mechanisms

B cell mediated effector responses; Cell mediated effector responses; Cytokines: properties and functions of lymphokines, monokines, interleukins and chemokines; Complement and mechanism of complement fixation; Hypersensitivity; Types of hypersensitivity reactions. Transplantation immunology- graft rejection, graft versus host reaction.

Unit IV: Immune-mediated diseases & Immunotechnology

Tolerance and autoimmunity; Immune response to infectious diseases; Viral, bacterial and protozoal infections; Cancer immunotherapy; Mucosal immunity; Adjuvants; Immunotherapy; Plant defense mechanisms; Immunoprecipitation; Agglutination; Immunoelectrophoresis; Immunofluorescence; Cytotoxicity assay; ELISPOT; ELISA; Western blotting; Flow cytometry; Immunization protocol; Hybridoma technology.

Course XII
Paper Code MBC 205

Core Course

LAB COURSE - II (Enzyme Analysis and Microbiology Techniques)

CREDITS: 8, HOURS: 200, MAXIMUM MARKS: 200 (50 INTERNAL ASSESSMENT + 150 SEMESTER EXAM)

This course is aimed at to make the student understand the procedures involved in experiments on enzymes, train them on methods of preparation of buffer including Henderson-Hasselbalch method, pH &pK determination, and methods for the isolation of enzymes, measuring their activity, kinetics, assays, immobilization, and studies on denaturation. The course also includes exercises on the Western blotting, SDS-PAGE, and UPLC-MS. Faculty supervising the course will be explaining the principle, theory and instrumentation of the technique to be used before starting the practical exercise.

Lab Exercises

1. Preparation of buffers and determination of pH.
2. Isolation and assay of an enzyme and determination of its kinetic properties.
3. Immobilization of enzyme and measurement of its activity.
4. Effect of pH, time and temperature on enzyme activity.
5. Analysis of lactate dehydrogenase isoenzymes.
6. Experiments on protein denaturation.
7. Assay of clinically important enzymes.
8. Sterilization techniques.
9. Preparation of culture media.
10. Bacterial culture: establishing a pure culture; identification of bacteria; staining techniques; antibiotic sensitivity of bacteria.
11. Isolation of plasmid DNA, and its digestion by restriction endonuclease and separation of restriction fragments by agarose gel electrophoresis.
12. Isolation of RNA and separation on agarose gel.
13. Quantitative estimation of DNA and RNA.
14. Polymerase chain reaction.

Course XIII
Paper Code MBC 206

Generic Elective Course (GE-I)

LABORATORY ANIMAL SCIENCES

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (13 INTERNAL ASSESSMENT + 37 SEMESTER EXAM)

Laboratory animals are one of the most important tools in modern biology and should be used with utmost importance. Therefore, its critical to learn their handling as well as ethical rights. This paper will give a brief introduction to animal handling, their ethical rights as well as describe various techniques to handle them.

UNIT I: Human-Animal interaction, Ethical guidelines

Animal welfare and Animal Welfare Act Experimentation on laboratory animals - national and international guidelines (CPCSEA, AAALAC, CCAC) CPCSEA (Committee for the Purpose of Control and Supervision of Experiments on Animals)- Mandate, composition and functions IAEC (Institutional Animal Ethics Committee) - Role, Composition Duties and responsibilities

UNIT II: Laboratory animals: use and maintenance

Small and large animals- good husbandry, health and genetic monitoring, handling, maintenance and enrichment, normal animal behavior, signs of discomfort, pain, suffering and distress in animals, especially in small animals (rodents) Rational use of animals for experimentation- Concept of 3Rs, 4Rs, 5Rs and humane endpoints. Methods of anesthesia, analgesia, pain relief, injections, sampling, euthanasia, necropsy and organ collection in rodents. Blood collection methods. Alternatives of animal use in experimentation - In vitro toxicity testing, Bioinformatics, Drosophila, C. elegans, Maintenance of laboratory animals and record keeping, Factor influencing animal experimentations.

Course XIII
Paper Code MBC 207

Generic Elective Course (GE-I)

MATHEMATICS FOR BIOLOGISTS

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (13 INTERNAL ASSESSMENT + 37 SEMESTER EXAM)

The aim of this course is to teach the fundamental mathematical concepts to biologists. The course details the basics of algebra, calculus, and coordinate geometry and their biological applications. It will help students to develop the quantitative aptitude.

UNIT I: Basics of Algebra, coordinate geometry and calculus

Number System, Elements of Coordinate Geometry and Algebra; Equations and graphs of Line, circle and conic sections, Function shifting graphs, trigonometric functions. Relations, Functions, including Periodic Functions, Inverse Functions, Limits and Continuity, Rates of change and limits, rules for finding limits, extension of the limit concept, continuity, Topics from Differential Calculus such as max/min of functions of one variable differentials and approximations. Partial derivatives, Antiderivatives, Indefinite and definite integrals, Differential Equations and their applications in biology

UNIT II: Logarithmic, exponential functions, Sequence and series, Probability Theory

Logarithms and Exponential Functions, Applications of Logarithms and Exponential Functions, Arithmetic series, Geometric series, Harmonic series, binomial theorem, System of equations and inequalities, Concepts of probability theory, Permutation, combinations.

Course XIII
Paper Code MBC 208

Generic Elective Course (GE-I)

BIOSTATISTICS

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (13 INTERNAL ASSESSMENT + 37 SEMESTER EXAM)

This Course provides an insight into the fundamentals of statistics and its application in biochemistry.

Unit I: Fundamentals of statistics

Arithmetic mean, median, mode: theory and simple numerical problem; Measures of variation: standard deviation, variance, coefficient of variation; Correlation, types and methods: simple, multiple, linear and nonlinear correlation, spearman's correlation, rank correlation; Regression: linear and curvilinear regression (for two variable X and Y only), Regression lines by least square method; regression equations of X on Y and Y on X only; Sample size; Power of study.

Unit II: Tests of significance

Null hypothesis; Standard error; Level of significance; Degrees of freedom; Significance of mean for large samples; Significance in means for small samples (students t-test); Significance in ratio of two samples; F test (for difference between variance of two samples); Chi square test; Analysis of variance test (ANOVA) for one and two-way classification; Signed rank test; Dunnet's test; Applications of various online tools: SPSS, Minitab, XLSTAT.

Course XIV
Paper Code MBC 209

Discipline Centric Elective Course (DCE-I)

MICROBIOLOGY & VIROLOGY

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (13 INTERNAL ASSESSMENT + 37 SEMESTER EXAM)

The objective of this paper is to familiarize the student with concepts in microbiology.

Unit I: Microorganisms

Prokaryotic and eukaryotic microorganisms - Bacteria, Archaebacteria, Algae, Fungi and Protozoa - General characteristics. Bacterial taxonomy - Criteria used in classification, Phenetic and phylogenetic classification, Numerical taxonomy. General nutritional and growth requirements of bacteria, culture media, measurement of bacterial growth. Common staining methods. Control of microbial growth. Gene transfer mechanisms in bacteria. Common microbial diseases in humans. Mechanisms of antimicrobials drugs. Antibiotic resistance.

Unit II: Acellular infectious particles

Viruses, Virusoids, Viroids and Prions - General characteristics and types. Baltimore scheme of classification. Stages in viral replication. One-step growth curve. Isolation, cultivation and assay methods. Lysogeny and lytic cycle. Satellite and defective viruses. Viral interference. Common viral infections and antiviral drugs.

Course XIV
Paper Code MBC 210

Discipline Centric Elective Course (DCE-I)

INTELLECTUAL PROPERTY RIGHTS

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (13 INTERNAL ASSESSMENT + 37 SEMESTER EXAM)

The objective of this paper is to familiarize the student with concepts in Intellectual Property Rights.

UNIT I: Introduction to Intellectual Property Rights

Basics of Intellectual Property, History and Evolution of Intellectual Property, Treaty and Convention on IP, World Intellectual Property Organization and International Cooperation, Types of IPR, Economic importance of IPR

UNIT II: Intellectual Property laws and its role in development

Patents, Trademarks, Copyright, Designs, Geographical Indications, Other related rights, Prosecution of IPR, Infringement and Enforcement of IPRs, Effect of Intellectual Property Protection in Development, Ideal industrial and institutional setup for Intellectual Property Outcomes, Role of Licensing and commercialization, IP Cells and Technology Transfer Offices, Future scope and career in Intellectual Property Field

Course XIV
Paper Code MBC 211

Discipline Centric Elective Course (DCE-I)

INTRODUCTION TO MANUSCRIPT WRITING

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (13 INTERNAL ASSESSMENT + 37 SEMESTER EXAM)

This course is aimed to provide a platform to the post graduate students to develop skills in manuscript writing.

Unit I: Research Paper forms

Research paper forms: communication and exploration; Resources: online and print; Review of latest literature (peer reviewed); Concept of a Modern academic library; Library cataloguing, JSTOR, library of congress catalogue; Understanding Plagiari2sm: definition, unintentional plagiarism and consequences; Collaborative work; Copyright infringement; Additional published sources: reviews, abstracts, pamphlets, reports, books, journal and magazine articles; Unpublished sources: monographs, microform editions, CD-ROMs or DVD-ROMs.

Unit II: Noting and Drafting

Notes and Drafts; Sources: primary, secondary and tertiary; Format of the research paper; Journal type and style; Recording essential publication information (books, journal articles, internet source); Topic selection: working hypothesis, focus appropriation; Authorship concerns; Title subtitles and Keywords; Writing of abstract, introduction, conclusion and acknowledgement; Presenting evidence in tables and figures.

SEMESTER-III

Course XV
Paper Code MBC 301

Core Course

ANALYSIS AND VISUALIZATION OF GENOMIC DATA

CREDITS: 4, LECTURES: 50, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM)

The course provides basic concepts in genomic data analysis. The course provides introduction to PYTHON for big data analysis. The course also introduces Pandas and Matplotlib.

Unit I:
Introduction to python programming language, Various data types in python including Numbers, Strings, Lists, Dictionaries, Tuples, Booleans, Introduction to indexing, slicing, variable assignment and comparison operators.

Unit II:
Printing and Manipulating text, Reading and Writing files, Conditional statements including If, If-Else, If-Elif-Else statements, Loops in python including For loop, While loop and Until loop.

Unit III:
Functions in python. Writing customized functions, using python script for downloading and manipulating DNA sequencing data, finding reverse complement, finding GC content, finding restriction sites in DNA sequences, trimming adaptor sequences, extraction of exonic and intronic sequences.

Unit IV:
Introduction Pandas and Matplotlib: Advantages of using Pandas, Reading a file (excel or csv) by pandas, Concept of delimiter while reading a file in pandas, visualising selected rows of data frame, selecting specific column from the data frame, Addition and subtraction of new columns, Concept of axis in pandas, Sorting the data frame, Selection of rows using iloc from the data frame, Selection of rows on the basis of some criteria, grouping in data frame, Saving the data frame into excel or csv file. Introduction to Matplotlib, Advantages of Matplotlib, Introduction to various plots such as Scatter plot, Bar graph, Histogram, Pie Chart, Bubble Chart, Heatmap, Volcano plot. Concept of legend, Title, Spines in Matplotlib graphs.

Course XVI
Paper Code MBC 302

Core Course

GENETIC ENGINEERING

CREDITS: 4, LECTURES: 50, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM)

This course will give a professional approach to the field of genetic engineering. After the delivery of the course, student will have an understanding of the concepts and major issues concerning gene cloning, analysis of genes and genome by DNA sequence analysis, and critical description of existing methods in gene technology.

Unit I: Gene cloning and construction of gene library

Gene cloning strategies; Isolation and purification of nucleic acid and its quantification and analysis; Molecular tools and their applications; Polymerase chain reaction: principles, process, design and optimization; Taq DNA polymerase; Restriction endonucleases; DNA modification enzymes; Site directed mutagenesis; Cloning vectors; Ligation of DNA fragments: Linkers, adapters and homopolymeric tailing; Synthesis of cDNA; Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors. mRNA enrichment; Reverse transcription and library construction; DNA sequencing methods, strategies for genome sequencing.

Unit II: Expression systems

Expression vectors; Choice of expression system; Expression in bacterial, yeast, insect mammalian and plant cells; Baculovirus expression systems; Expression of heterologous genes; Factors affecting the expression of cloned genes; Codon bias; Vector engineering and codon optimization; Host engineering.

Unit III: Recombinant proteins and transgenics

Processing of recombinant proteins: purification and refolding; Characterization of recombinant proteins; Stabilization of recombinant proteins; Transgenic and gene knockout technologies; Transgenic methodology; Transgenic animals and plants; Targeted gene replacement and introduction to CRISPR/Cas system Chromosome engineering; Value addition through genetic engineering; Protein engineering.

Unit IV: PCR and DNA fingerprinting

Types of PCR: allele specific, inverse, asymmetric, and real-time PCR; Application of PCR in diagnostics, forensic science, gene manipulation Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques and evolutionary biology; Ligase chain reaction; SNP and application in molecular diagnostics; DNA fingerprinting: applications and prospects; restriction fragment length polymorphism (RFLP) and its uses; FISH; Prenatal diagnosis.

Course XVII
Paper Code MBC 303

Core Course

METABOLISM-II: Lipid, Amino Acid and Xenobiotic Metabolism

CREDITS: 4, LECTURES: 50, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM)

The paper is in continuation to the paper on metabolism in the previous semester where the metabolism of carbohydrates was discussed with significant detail. The paper gives an idea to the student about how biomolecules other than carbohydrates are metabolized. Lipids, amino acids and nucleotides have been individually addressed. The last unit deals with some unique pathways identified in prokaryotes only.

Unit I: Lipid Metabolism

Major dietary lipids; Digestion and absorption of dietary lipids; Pathways for the transport of endogenous and exogenous lipids; Major serum lipoproteins and their metabolism; Main and alternative pathways of fatty acid oxidation; Oxidation of odd carbon number and unsaturated fatty acids; Significance and metabolism of ketone bodies; Biosynthesis of saturated and unsaturated fatty acids; Metabolism of triacylglycerols, glycerolipids, sphingolipids and cholesterol; Role of leptin in the regulation of lipid metabolism.

Unit II: Amino Acid and Porphyrin Metabolism

Amino acid metabolism: Digestion of dietary proteins; Absorption of amino acids; General reactions in the degradation of amino acids; Deamination and transamination reactions; Urea cycle; Glucogenic and ketogenic amino acids; Fate of the carbon skeleton of individual amino acids; Essential and nonessential amino acids; Biosynthesis of individual amino acids; Inborn errors of amino acid metabolism; Amino acids as biosynthetic precursors. Porphyrin metabolism: Biosynthesis and degradation of Heme; Genetic defects in heme metabolism.

Unit III: Nucleotide and Xenobiotic Metabolism

Nucleotide metabolism: Degradation of nucleic acids: deoxyribonucleases and ribonucleases; Biosynthesis and degradation of purine and pyrimidine nucleotides; Regulation of purine and pyrimidine nucleotide metabolism; Formation of NDPs and NTPs; Biosynthesis of deoxy-ribonucleotides and its regulation; Inborn errors of nucleotide metabolism; Nucleotide coenzymes. Xenobiotic metabolism: Significance; Phases of xenobiotic metabolism; Types of reactions involved.

Unit IV: Unique Metabolic Pathways of Prokaryotes

Nitrogen fixation and properties of nitrogenase; Entner-Doudoroff pathway; Heterolactic,;propionic, butyric and mixed acid fermentations; Anaerobic respiration; Methanogenesis and reverse methanogenesis; Chemoautotrophic fixation of carbon dioxide via Reductive acetyl-CoA pathway, Reductive TCA cycle, 3-Hydroxypropionate cycle and 4-Hydroxy- butyrate cycle Anoxygenic photosynthesis; Light-driven non-photosynthetic photophosphorylation.

Course XVIII
Paper Code MBC 304

Core Course

CLINICAL AND NUTRITIONAL BIOCHEMISTRY

CREDITS: 4, LECTURES: 50, MAXIMUM MARKS: 100 (25 INTERNAL ASSESSMENT + 75 SEMESTER EXAM)

The clinical biochemistry section emphasizes on the concepts of quality assurance in clinical biochemistry and an understanding of major organ functions in health and disease. Nutritional Biochemistry aims at understanding the food groups, formulation of balanced diets, vitamin types, human nutrition, and the disorders that arise due to nutritional imbalances and its impact on overall health, and gives an introduction to nutrigenomics.

Unit I: Clinical biochemistry and quality assurance

Clinical chemistry/biochemistry - concept, definition and scope; Biological samples - types, collection, processing, stability and storage; Phlebotomy; Serum and serum separator devices; Chemical composition of biological fluids - blood, urine and cerebrospinal fluid; Reference range; Quality assurance; Accuracy and precision; Factors influencing the accuracy of results; Levy-Jennings's chart; Reliability of a laboratory method; Interferents; Responsibilities of a clinical biochemist.

Unit II: Biochemical tests in clinical practice

Biochemical tests in clinical practice – characteristics and uses of a biochemical test; Criteria for selecting a method for biochemical analysis; Enzymes as diagnostic tool; Advantages and disadvantages of enzyme assays; Isozymes and their diagnostic importance; Methods for the detection of isoenzymes; Organ function tests - Clinical presentation and diagnosis of the diseases of the liver and kidney; Bilirubin metabolism; Acid base disorders.

Unit III: Nutritional requirements

Basic concepts, scope and methodology; Principal food components; Vitamins: classification, deficiency disorders and functions; Food nutrients: recommended allowances and their modifications under stress conditions; Deficiency and excess of principal nutritional components; Formula diets and crash diets; Formulation of balanced diets; Dietary standards: EAR, RDA, ADI, DRV, DRI, TUL; Water as an essential nutrient; Food preservatives; Additives and anti- nutrients; Toxic effects of food: sources, active agents and effects.

Unit IV: Nutrition in health and diseases

Protein energy malnutrition; Energy balance and requirements: basal metabolic rate (BMR); Factors affecting BMR and its measurement; Resting metabolic rate; Specific dynamic action of food; Dietary fat and heart disease and cancer; Atherosclerosis: risk factors and protective measures; Nutritional management of diabetes and obesity; Weight management; Anthropometric measurements; Nutrition and infection; Basics of nutrigenomics.

Course XIX
Paper Code MBC 305

Core Course

LAB COURSE III
(Molecular Biology and Immunological Techniques)

CREDITS: 8, HOURS: 200, MAXIMUM MARKS: 200 (50 INTERNAL ASSESSMENT + 150 SEMESTER EXAM)

This course has been designed to provide hands-on experience on the tools and techniques used in protein chemistry and immunology. The experiments have been designed in such a way that the student will have the opportunity to isolate a specific protein from a natural source, purify it and determine its molecular weight. The protein will then be administered to animal to raise antibody, which will be isolated and used to demonstrate the antigen-antibody reaction. Besides, students will get an opportunity to learn isoelectric focusing and two-dimensional electrophoresis.

Lab Exercises

1. Isolation of protein from its source.
2. Salt fractionation for partial purification.
3. Dialysis.
4. Spectroscopic analysis of protein and determination of absorption spectrum and quantitative estimation.
5. Gel filtration, and Ion-exchange chromatography for further purification.
6. Polyacrylamide gel electrophoresis of the protein in the absence or presence of SDS to check purity of the preparation.
7. Determination of molecular weight by gel filtration.
8. Determination of molecular weight by SDS-PAGE.
9. Immunization of experimental animals with the purified protein.
10. Detection of antibodies in antiserum by Double immunodiffusion.
11. Isolation of IgG from the antiserum.
12. Western blotting (Demonstration only).
13. DNA/RNA blotting techniques.
14. Green fluorescence protein (GFP) and bacterial transformation experiments.
15. Demonstration of radioactive counters and its principles; safety aspects.
16. Animal tissue culture (demonstration only).

Course XX
Paper Code MBC 306

Generic Elective Course (GE-II)

BIOINFORMATICS

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (13 INTERNAL ASSESSMENT + 37 SEMESTER EXAM)

This course is meant to familiarize the student with the use of computer software in understanding life processes and to retrieve information, and use of tools for data analysis.

Unit I: Concepts of Bioinformatics

Bioinformatics: introduction and future prospects; Applications in genomics and proteomics; Public databases; Gene bank; Database searches: sequence retrieval systems; Similarity searching: BLAST, FASTA; Multiple sequence alignment: CLUSTALW; Detecting functional sites in DNA; Motif and domain prediction and analysis; Identification of open reading frames (ORF); Gene annotation technology.

Unit II: Applications of Bioinformatics

Computational methods for sequence analysis: Dot blot and dynamic programming methods; Phylogenetic analysis (UPGMA); Virtual and electronic cell; Internet tools for DNA sequence translation; Restriction enzyme mapping; Prediction of secondary structure of proteins; Application tools: primer designing, molecular mapping and computer aided drug designing; QSAR; In silico methods for identification of vaccine/drug target.

Course XX
Paper Code MBC 307

Generic Elective Course (GE-II)

CONCEPTS IN TRANSLATIONAL BIOLOGY

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (13 INTERNAL ASSESSMENT + 37 SEMESTER EXAM)

Translational research is a bidirectional process that involves multidisciplinary integration among basic, clinical, practice, population, and policy-based research. The goal of this course is to provide concepts in translational research devised to speed up various industrial processes and community benefits.

UNIT I: Applied Biology

Microbial fermentation and production of small and macro molecules. Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for plants and animals. Transgenic animals and plants, molecular approaches to diagnosis and strain identification.

UNIT II: Genomics and its application

Genomics and its application to health and agriculture, including gene therapy, Bioresource and uses of biodiversity, Breeding in plants and animals, including marker – assisted selection, Bioremediation and phytoremediation, Biosensors

Course XX
Paper Code MBC 308

Generic Elective Course (GE-II)

CONCEPTS IN NEXT GENERATION SEQUENCING

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (13 INTERNAL ASSESSMENT + 37 SEMESTER EXAM)

This paper gives a brief introduction to Next Generation Sequencing Data generation and its analysis. Unit 1 will provide brief overview of various techniques used for DNA sequencing. Furthermore, this unit will also cover the basics of Linux and Python, two most powerful languages that are extensively utilised for analysis of NGS data. Unit II will provide brief overview of DNA sequencing data analysis using command line tools.

Unit I: Introduction to Genomics, Linux and Python

Genomics

Introduction to genomics and transcriptomics, basic understanding various methods used for DNA Sequencing including Maxam Gilbert sequencing, chain termination sequencing, shotgun sequencing, Massively parallel sequencing, Solexa sequencing, Solid Sequencing, DNA Nanopore sequencing, ion torrent sequencing,

Linux:

Introduction to unix shell organization, Introduction to command line and file system, essential unix commands like *cal, banner, touch, file, wc, sort, cut, grep, dd, write, wall*, introduction to piping, loops, regular expressions, decision commands including various forms of *if* commands, logical operators and loop control structures

Python

Introduction and environment, Printing and manipulating text, Reading and writing files, introduction to lists and loops, functions, writing customised functions, conditional tests, regular expressions, Dictionaries and complex data structures

Unit II: Analysis of DNA sequencing data

Introduction to DNA sequencing data analysis, Manipulating DNA strings, downloading and parsing genome, sequencing reads in FASTA format, working and analysing sequencing reads, introduction to alignment, Boyar Moore basics and its use in DNA sequencing, indexing reads, implementation and variations of k mer indexing, Introduction to genome assembly, its laws and shortest common superstring

Course XXI
Paper Code MBC 309

Discipline Centric Elective Course (DCE-II)

GENETICS

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (15 INTERNAL ASSESSMENT + 35 SEMESTER EXAM)

This course is meant to give student an in-depth knowledge of concepts in Genetics. The course will provide comprehensive knowledge of chromosomal basis of inheritance and recombination. Through this course students would also study the role of environment in Genetic.

UNIT I: Chromosomal basis of Inheritance and Recombination

Mendelian Genetics and analysis: Extension of Mendelian analysis, Chromosomal basis of Inheritance, Chromosome characteristics: Chromosome structure, Euchromatin and heterochromatin, Coding and Non-coding sequences, transposons. Genetic Recombination in Eukaryotes: Linkage and Crossing Over, Chromosome mapping, Tetrad analysis and Gene Conversion, Mutations and mutagenesis: Detection, Molecular basis and Applications, Chromosomal Changes: Number variation – Euploidy (auto and allopolyploidy), aneuploidy, Structural variations – Deficiencies, duplications, Inversions, translocations

UNIT II: Genetics and Environment

Interaction of Genotype and Environment: Twin studies, genetic environment, non-genetic environment, phenocopies, penetrance and expressivity, Gene expression regulation during differentiation and growth: Heterochromatization in human beings and other mammals, dosage compensation, mechanism, sex chromatin, position effect, Quantitative inheritance: Continuous traits – multigenic variability, dominance. Non-Mendelian Inheritance: Plastid mutations – nature and mode of transmission; Mitochondrial traits – nature and mode of transmission.

Course XXI
Paper Code MBC 310

Discipline Centric Elective Course (DCE-II)

BIOTECHNOLOGY

CREDITS: 2, LECTURES: 25, MAXIMUM MARKS: 50 (15 INTERNAL ASSESSMENT + 35 SEMESTER EXAM)

Understanding the biochemical processes in living organisms provide an opportunity to use these reactions and processes for the benefit of mankind. This course provides an understanding of how biochemical processes find application and improved our life. The course introduces the concept and application of plant tissue culture, transgenic technology, fermentation technology, genome analysis and gene therapy.

Unit I: Plant tissue culture and microbial biotechnology

Plant tissue culture: concept, methods and applications; Somaclonal variation; vector independent transformation; transgenic technology; transformation vectors; Plastome engineering; Bioreactors; Fermenting microorganisms; Batch and continuous culture techniques; Application of fermentation biotechnology; Production of penicillin; Single cell proteins; Value addition through genetic engineering; Synthetic seeds.

Unit II: Applications of gene technology

Sequencing genome; EST sequencing and sequence skimming; Genome mapping; Genetic polymorphism; Fingerprinting and fluorescent in situ hybridization; Determination of function of genes; Computer analysis of gene function; Assigning gene function by experimental analysis; Gene therapy: vector engineering strategies of gene delivery; Gene replacement/augmentation; Gene correction; Synthesis of DNA chips; DNA microarray.

Course XXI
Paper Code MBC 311

Discipline Centric Elective Course (DCE-II)

POSTER PRESENTATION: RECENT ADVANCES IN BIOCHEMISTRY

CREDITS: 2, MAXIMUM MARKS: 50

This course will help students in learning the basics of poster presentation. Selection of topics, poster designing and presentation skills will be the key points to be considered by examiners.

SEMESTER-IV

Course XXII
Paper Code MBC 401

Core Course

M.Sc. DISSERTATION

CREDITS: 24, MAXIMUM MARKS: 600 (20 credits-Thesis+ 4 credits-Presentation)

For this course the students will be sent to different laboratories within the department or outside to undertake small research projects culminating in a short dissertation.

SUGGESTED READINGS

Fundamentals of Biochemistry and Biophysics

1. Lehninger Principles of Biochemistry by David L Nelson and Michael M Cox
2. Physical Chemistry by P.W. Atkins
3. Biophysical Chemistry by C.R. Cantor and P. R.Schimmel

Biomolecules

1. Principles of Biochemistry, A.L. Lehninger, D.L. Nelson and M.M. Cox (2008), 5thed.. W.H. Freeman & Co.
2. Study Guide to Organic Chemistry, R.T. Morrison and R.N. Boyd (2002), 6thed.. Prentice Hall of India.
3. Hormones: From Molecules to Disease, editors: E.E. Baulieu and P.A. Kelly (1990). Chapman and Hall, New York and London Hermann Publishers in Arts and Science.
4. Human Physiology (1990), The Mechanisms of Body Function, A.J. Vander, J.H. Sherman and D.S. Luciano, 5th ed.. Mc Graw Hill, New York.
5. Endocrinology, Mac E. Hadley (2000), 5thEd., Prentice Hall International Inc.

Cell Biology

1. Molecular Biology of the Cell, Bruce Alberts, Alexander Johnson, JuliasLevis, Martin Raff, Keith Roberts and Peter Walter (2008), 6thed.. Garland Science, Taylor & Francis Group.
2. The Cell: A Molecular Approach, Geoffrey M. Cooper (2007), 4thed., ASM Press.
3. The World of the Cell, W.M. Becker, L.J. Kleinsmith, J.Hardin (2006), Pearson Education.
4. Molecular Cell Biology, H.F. Lodish, A. Berk, C.A. Kaiser, M. Krieger, M.P. Scott (2007), 6thed., W.H. Freeman & Co.

Enzymes

1. Comprehensive Enzyme Kinetics, V. Leskovac (2003), Kluwer Academic Publisher, N.Y.
2. Enzyme Assays, R. Eisenthal and M.J. Danson (2002), Oxford University Press.
3. Enzymes Biochemistry, Biotechnology and Clinical Chemistry, T. Palmer (2001), Ellis Harwood Publishing Ltd., New York.
4. Fundamentals of Enzymology: The Cell Molecular Biology of Catalytic Proteins, N.C. Price and L. Stevens (2000). Oxford University Press, Oxford.
5. Enzymes, M. Dixon and E.C. Webb (1979), Longman, London.

Molecular Biology

- Lewin's Genes XII (2017) by Krebs, Goldstein and Kilpatric. Oxford University Press, London.
- Molecular Biology of the Gene (2017) by Watson, Hopkin, Roberts, Stertz, Weiner, Freeman Pub., San Francisco.
- Molecular Cell Biology (2016) by Lodish, Berk, Kaiser, Krieger, Bretscher. Eighth edition. W.H. Freeman & Co Ltd.

- Molecular Biology of the Cell (2014) by Bruce Alberts. Sixth Edition.
- Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth Edition, WH Freman and Co.

Protein and Proteomics

1. Principles of Biochemistry, D.L. Nelson & M.M. Cox (2008), 5th ed., W.H. Freeman & Co.
2. Biochemistry, Jeremy M. Berg, John L. Tymockzo, LubertStryer (2007), 6th ed., W.H. Freeman and Co.,NY.
3. Protein Structure, Stability and Interactions, John M. Shriver (2009), Humana Press.
4. Introduction to Protein Structure, Carl Branden and John Tooze (1999), 2nd ed.. Garland Publishing Inc.
5. Proteins: Structure and Molecular Properties, T.E. Creighton (1993), 2nd ed.. W.H. Freeman & Co. 30 4. Molecular Cell Biology, A. Berk , S.L. Zipursky, P. Matsudaira, D. Baltimore, J. Darnell, (2004), 5th ed.. W.H. Freeman & Co.

Metabolism-I: Bioenergetics, Carbohydrate and Intermediary Metabolism

1. Principles of Biochemistry, D.L. Nelson and M.M. Cox (2008), 5th ed., W.H. Freeman & Co.
2. Biochemistry, D. Voet and J.G. Voet (2004), 3rd ed.. John Wiley and Sons Inc.
3. Biochemistry, J.M. Berg, J.L. Tymoczko and L. Stryer (2007), 7th ed., W.H. Freeman & Co.
4. Essentials of Glycobiology, E. Etzler et.al. (2009), Cold Spring Harbor Laboratory Press.
5. Plant Physiology, L. Taiz and E. Zeiger (2006), 4th ed., Sinauer Associates Inc.

Biochemical and Biophysical Techniques

1. Principles of Physical Biochemistry, Kensal E. Van Holde, W.C. Johsnon, P. Shing O (2006), 2nd ed., Pearson Education International.
2. Physical Biochemistry: Principles and Application, David Sheehan (2000), John Wiley and Sons.
3. Principles and Techniques of Biochemistry and Molecular Biology, K. Wilson and J. Walker (2010) 7th ed., Cambridge University Press.
4. Physical Biochemistry, David Freifelder (1982), 2nd ed., W.H. Freeman & Co.
5. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, Irwin H. Segel (1976), 2nd Ed., John Wiley & Sons.

Immunology

1. Essential Immunology by P.J. Delves, S.J.Martin, D.R. Burton, I.M. Roitt. 12th ed., Wiley Publishing House.
2. Immunology, W.E. Paul (2008), 5th ed., Wolters Kluwer.

3. The Elements of Immunology, Fahim H. Khan (2009), Pearson Education.
4. Immunology, J. Kuby (2007), 6th ed.. W.H. Freeman and Co., New York.
5. Essentials of Clinical Immunology, H. Chape, M. Haeney, S. Misbah, N. Snowder (2006), 5th ed., Blackwell Publishing Ltd.

Genetic Engineering

1. From Genes to Genomes: Concepts and Applications of DNA Technology, Jeremy W. Dale and Malcolm Von Schantz (2003), John Wiley & Sons Ltd.
2. Gene Cloning: Mechanics of DNA Manipulation, D.M. Glover (1986), 2nd ed.. Chapman & Hall.
3. Genetic Engineering, R. Williamson (1981-89), volumes 1-7, Academic Press London.
4. ICRF Handbook of Genome Analysis, Nigel K. Spurr, Bryan D. Young, Stephen P. Bryant (1998), volume 1 and 2, Blackwell Science.
5. Genomes 3, T.A. Brown (2007), volume 3, Garland Science.

Metabolism-II: Lipid, Amino Acid and Xenobiotic Metabolism

1. Biochemistry by D.E .Metzler, 2nd ed. (2003). Academic Press, USA.
2. Biochemistry, D. Voet and J.G. Voet (2004), 3rd ed.. John Wiley and Sons Inc.
3. Biochemistry, J.M. Berg, J.L. Tymoczko and L. Stryer (2007), 5th ed., W.H. Freeman & Co.
4. Bacterial Metabolism, Gottschalk, Gerhard (1986), 2nd ed., Springer Series in Microbiology.
5. Microbiology, Bernard D. Davis, Renato Dulbecco, Herman N. Eisen, and Harold S. Ginsberg (1990) 4th ed., Illustrated. Philadelphia, J.B. Lippincott.

Clinical and Nutritional Biochemistry

1. Good Clinical, Laboratory and Manufacturing Practices, P.A. Carson and N. Dent (2009), RSC (The Royal Society of Chemistry) Publishing.
2. Clinical Biochemistry, Geoffrey Beckett, Simon Walker, Peter Rae, Peter Ashby (2006), 7th ed., Blackwell Publication.
3. Lecture Notes Clinical Biochemistry, Geoffrey Becket, Simon Walker, Peter Race, Peter Ash (2006), 7th ed.. Blackwell Publishing.
4. Tietz Textbook of Clinical Biochemistry, Carl A. Burtis and Edward R. Ashwood (1998), 3rd ed.. Harcourt Brace & company Asia PTE LTD. W.B. Sauners Company.
5. Krause' Food Nutrition and Diet Therapy, L.K. Mahan, S.E. Stumph (2004), 11th ed., Saunders Publications.
6. Nutrition Science and Application, Lori A. Smolin, Mary A. Grosvenor (2000), 3rd ed., .
7. Human Nutrition and Dietetics, J.S. Garrow and W.P.T. James (1993), Publications.
8. Harper's Illustrated Biochemistry (LANGE Basic Science), Murray, R.K.,Granner, D.K., Mayes, P.A., Rodwell, V.W. (2003), McGraw-Hill Medical Publication.

Biotechnology

1. Biotechnology, Clark (2009), Academic Press.
2. Biotechnology Theory and Techniques, Jack G. Chirijian (1995), Jones and Bartlett Publishers, Boston, London.
3. Enzyme Biotechnology, M. Prakash (2007). Discovery Publishing House.
4. Environmental Biotechnology, Alan Scragg (2005), Oxford.

Microbiology

1. Prescott, Harley and Klein's Microbiology, J.M. Willey, L.M. Sherwood and C.J. Woolverdon (2008), 7^{th}ed., McGraw Hill Publishers.
2. Microbiology: Principles &Explorations, J.G. Black (2002), 5th ed.. John Wiley & Sons Inc.
3. Zinsser Microbiology, Wolfgang K. Joklik, Hilda P. Willett, D. Bernard Amos, Catherine M. Wilfert (1988), 9^{th} ed., Prentice Hall International Inc.
4. Microbiology; An introduction, Tortura, G.J., Funke, B.R., Case, C.L. (2009), 9^{th}ed., Pearson Education Intnl.

Biostatistics and Bioinformatics

1. Introduction to Biostatistics, Le and Chap (2009), Wilay and Sons.
2. Fundamentals of Biostatistics, B. Rosner (2005), Duxbury Press.
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