MSc Biochemistry Syllabus

(Approved by the BoS/Academic Council)

Effective from July 2009

COURSE CONTENTS

		Credit	Marks
SEMESTER – I			
Course I	MFC 001: Foundation Course*	6	200
Course II	MBC 101: Cell Biology	4	100
Course III	MBC 102: Biomolecules	4	100
Course IV	MBC 103: Bioenergetics and Intermediary Metabolism	4	100
Course V	MBC 104: Molecular Biology	4	100
Course VI	MBC 105: Lab Course – 1	4	100
		26	700
SEMESTER – II			
Course VII	MBC 201: Enzymes	4	100
Course VIII	MBC 202: Metabolism	4	100
Course IX	MBC 203: Gene expression	4	100
Course X	MBC 204: Protein and Proteomics	4	100
Course XI	MBC 205: Seminar (Assignment based)	4	100
Course XII	MBC 206: Lab Course – 2	4	100
		24	600
SEMESTER – III			
Course XIII	MBC 301: Genetic Engineering	4	100
Course XIV	MBC 302: Nutrition and Clinical Biochemistry	4	100
Course XV	MBC 303: Microbiology	4	100
Course XVI	MBC 304: Immunology	4	100
Course XVII	MBC 305: Dissertation-1 (Based on Microbial and Molecular Biology Techniques)	8	200
		24	600
SEMESTER – IV			
Course XVIII	MBC 401: Biotechnology and Nanotechnology	4	100
Course XIX	MBC 402: Computational Biochemistry and Bioinformatics	4	100
Course XX	MBC 403: Biochemical Techniques and Biostatistics	4	100
Course XXI	MBC 404: Industrial Biochemistry	4	100
Course XXII	MBC 405: Dissertation-2 (Based on Protein isolation/Purification and Immunological Techniques)	8	200
		24	600

Total credits: 98
Total marks: 2500

Each paper will be taught in 50 lectures, each of one-hour duration, except for Foundation Course where the number of lecturers is 100. This course will be coordinated by the Dean of the Faculty of Science.
**The syllabus for MFC001 (Foundation Course) is appended as Annexure-1*

Semester I

Course II

Cell Biology

Paper code: MBC 101

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

Unit I: An overview of the cell and cell structure

Introduction to the cell, its chemical composition, molecular organization, origin and evolution; prokaryotic and eukaryotic cells; cell theory and modern cell biology; cell organelles; structure and function of endoplasmic reticulum, Golgi body, endosome, lysosome, vacuole, peroxisome, ribosome, mitochondria, chrloroplast, nucleus, cytoskeleton, cell wall, and glycocalyx; subcellular fractionation, cytoplasm, cytosol; basics of microscopy, centrifugation, tissue culture and flow cytometry.

Unit II: Membrane Biochemistry and function

Chemical composition of the plasma membrane; membrane models; membrane as a two dimensional fluid; factors affecting the membrane fluidity; phase transition; membrane proteins; movement of small and large molecules across the plasma membrane; osmosis, diffusion, phagocytosis and endocytosis; receptor mediated endocytosis; clathrin; artificial membranes.

Unit III: Major cell function

Cytoplasmic membrane system, protein secretion and transport to various cell compartments; signal hypothesis; targeting the proteins to the peroxisomes; packaging of DNA into the eukaryotic chromosome; levels of organization; nuclear pore complex and molecular trafficking; nucleolus, and the synthesis of the ribosome; electric properties of membranes; patch clamp and voltage clamp techniques.

Unit IV: Signal transduction, cell cycle, stem cell, cancer and cell death

Receptor and ligand binding; G protein coupled receptors and signal transduction; growth factors and receptor tyrosine kinase; second messengers; cell cycle and its regulation; cyclin; cell signaling in development and differentiation; regulatory genes in the development of *Drosophila*; cell proliferation and stem cell; cancer biology: oncogenes; tumour suppressor genes; mechanism of neoplastic transformation and characteristics of tumour cells; cell death.

Semester I

Course III

Biomolecules

Paper code: MBC 102

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

Unit I: Carbohydrates

Occurrence, classification, characteristics, structure and functions of monosaccharides, disaccharides and polysaccharides; structure and conformation of sugars; monosaccharides: stereoisomerism and optical isomerism; chemical reactions of the functional groups; sugar derivatives; mucoploysaccharides; glycosaminoglycans; proteoglycans and glycoproteins; glycobiology.

Unit II: Lipids

Lipids: classification and types; fatty acids: structure, nomenclature and properties; glycosides: soaps and detergents; phospholipids and sphingolipids: structure, classification, properties and functions; glycolipids; lipoproteins: composition and biological role; steroids and prostaglandins: structure and functions; eicosanoids; vegetable and fish oils.

Unit III: Amino acids, nucleotides and water

Amino acids: structure, nomenclature, classification, acid-base bahaviour and chemical reactions; stereoisomerism and optical properties of amino acids; non-standard amino acids; nucleotides and alarmones: structure and functions; physicochemical properties of water.

Unit IV: Hormones

General characteristics, classification, chemistry, function, mechanisms and abnormalities of: thyroid, parathyroid, adrenal, pancreatic, gastric and reproductive hormones; hypothalamus and pituitary; NO and CO; detection of hormones; hormone replacement therapy; radioisotope studies; plant hormones; pheromones.

Semester I

Course IV

Bioenergetics and Intermediary Metabolism

Paper code: MBC 103

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

Unit I: Bioenergetics

Bioenergetics: concepts, laws of thermodynamics, free energy, standard free energy; determination of ΔG for a reaction; equilibrium constant and standard free energy change; biological oxidation-reduction reactions; redox potential; relation between standard reduction potentials and free energy change; high energy phosphate compounds, and ATP as universal energy currency in biological systems; other high-energy compounds in biological systems.

Unit II: Carbohydrates metabolism

Carbohydrates: digestion and absorption; glycolysis, citric acid cycle, pentose phosphate pathway, gluconeogenesis, glucuronate pathway and their regulation; metabolism of disaccharides; biosynthesis of oligo-saccharides and glycoproteins; glycogen metabolism and its regulation; glycogen storage diseases; regulation of carbohydrate metabolism; metabolic adaptation in starvation and diabetes mellitus.

Unit III: Phosphorylation

Electron transport chain; electron carriers and their organization; respiratory complexes; oxidative phosphorylation; sites of phosphorylation; P/O ratio; energetics of oxidative phosphorylation; inhibitors and uncouplers of oxidative phosphorylation; microsomal electron transport chain; reactions that generate and utilize ATP in the cell; substrate level phosphorylation.

Unit IV: Plant Biochemistry

Plant-specific metabolic pathways; photosynthesis and carbon fixation; cyclic and noncyclic electron transport; C_3, C_4, and CAM pathways; photorespiration; fixation of atmospheric nitrogen and properties of nitrogenase complex; secondary metabolites and their significance; metabolism of isoprenoids; glyoxylate cycle; role of vacuole in plant metabolism.

Semester I

Course V

Molecular Biology

Paper code: MBC 104

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

Unit I: DNA and RNA

DNA as genetic material; primary, secondary and three dimensional structure of DNA; supercoiling; forms of DNA; polytene and lampbrush chromosomes; properties of DNA in solution; denaturation and renaturation; reassociation reactions: COT curves; types of RNAs and their primary and secondary structure; role of RNA; unusual bases in RNA.

Unit II: Replication

Replication of DNA and synthesis of RNA; central dogma of molecular biology; DNA and RNA polymerases and other enzymes involved in replication; mechanisms of replication; inhibitors of transcription; proof reading function and fidelity of DNA replication; possible modes of DNA replication; theta model and rolling circle model of DNA replication; replication of DNA in eukaryotes; role of methylation; replication of viral RNA; reverse transcriptase.

Unit III: Gene and mutations

Prokaryotic and eukaryotic gene structure; transposable elements in bacteria; mobile elements in eukaryotes; regulatory region and transcriptional unit of gene: post-transcriptional processing of RNA: splicing, cap addition and polyadenylation; polynucleotide phosphorylase; classification and molecular basis of mutation; Ames test and other testing systems; repair mechanism in prokaryotes and eukaryotes; site directed mutagenesis.

Unit IV: Molecular evolution

Molecular Evolution: separation, natural selection, and evolution of proteins and nucleotide sequences; allelic frequency; calculation of allelic frequency; molecular clocks; evolution by gene duplication and exon shuffling; deleterious genes; eugenics; gene frequencies and conservation of gene frequencies; convergent evolution.

Semester I

Course VI

Lab Course -1

Paper code: MBC 105

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lab hours: 100

Basic biochemical experiments

1. Qualitative analysis of biomolecules: carbohydrates, lipids, amino acids and proteins.
2. Colorimetric and spectrophotometric methods for the quantitative estimation of biomolecules glucose, cholesterol and protein
3. Chromatographic methods: separation of sugars, fatty acids and amino acids by paper chromatography and thin layer chromatography; HPLC (demonstration only)
4. Determination of accurate concentration of hygroscopic substances in liquids using refractometer.
5. Isolation of polysaccharide (starch or glycogen) from the biological material.
6. Isolation of casein from milk.
7. Digestion of casein and determination of phosphate in the digest.
8. Centrifugation technique: subcellular fractionation and isolation of nuclei and mitochondria from the animal tissue.
9. Extraction of lipids from the plant source.
10. Determination of saponification value of fats/oils.
11. Determination of iodine number of fats/oils.
12. Food analysis.
13. Immobilization of cell: RBC/yeast.
14. Preparation of nanoparticles such as silver nanoparticles and targeting

***Note**: Before starting the actual practical exercise, the principle, theory and instrumentation of the technique(s) to be used would be explained in detail.*

Semester II

Course VII

Enzymes

Paper code: MBC 201

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

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 K_m and V_{max} and their determination using different plots; double reciprocal plot; enzyme inhibition: competitive inhibition, noncompetitive inhibition, and uncompetitive inhibition; excess substrate inhibition; enzyme kinetics in presence of inhibitors; determination of K_i: 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 kinetics and therapeutic uses; enzyme turnover and its significance; convergent and divergent evolution of enzymes.

Semester II

Course VIII

Metabolism

Paper code: MBC 202

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

Unit I: Lipid metabolism

Dietary lipids: digestion, absorption and metabolism; main and alternative pathways of fatty acid oxidation; oxidation of odd carbon number and unsaturated fatty acids; biosynthesis of saturated and unsaturated fatty acids; metabolism of triacylglycerols, phospholipids, glycolipids, sphingolipids and cholesterol; formation of ketone bodies and their oxidation; leptons; fatty acid biosynthesis in plants; lipoprotein metabolism.

Unit II: Metabolism of proteins and amino acids

Digestion of proteins and absorption of amino acids; general reactions in the degradation of amino acids; deamination and transamination reactions; urea cycle; fate of the carbon skeleton of amino acids; essential and nonessential amino acids; biosynthesis of individual amino acids; regulation of amino acid biosynthesis; inborn errors of amino acid metabolism.

Unit III: Metabolism of nucleic acids

Degradation of nucleic acids; deoxyribonucleases and ribonucleases; biosynthesis and degradation of purine and pyrimidine nucleotides; regulation of purine and pyrimidine nucleotide metabolism; biosynthesis of deoxyribonucleotides; interconversion of nucleotides; inborn errors of nucleotide metabolism; biosynthesis of nucleotide coenzymes; metabolism of porphyrins.

Unit IV: Environmental biochemistry and toxicology

Environment and pollution; pollutants and cellular metabolism; biotransformation; drug metabolizing enzymes; eutrophication; biomagnifications; biochemical effects of As, Cd, Pb, Hg, Co, NO_x, SO_x, O_3, cyanide, hydrocarbons, particulate matter, pesticides and other common pollutants; toxicity testing systems; green house effect; global warming and consequences on plant and animal metabolism; xenobiotic metabolism; nonenzymatic reactions in the body.

Semester II

Course IX

Gene Expression

Paper code: MBC 203

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

Unit I: Gene expression and its regulation

Gene expression in prokaryotes; enzyme induction and repression; negative and positive control; concept of operon; catabolic repression; transcriptional termination control via mRNA alternative conformations; regulation of gene expression in eukaryotes; promoters, enhancers and response elements; regulation at transcriptional level: Britten Davidson model; control by steroid hormones; role of chromatin structure in gene expression; cytoplasmic regulation of gene expression; organelle genome; epigenetics.

Unit II: Protein synthesis and its control

Translation; adapter role of RNA in protein synthesis; size of the code; methods of deciphering the genetic code; code word dictionary; general features of the genetic code; identification of anticodons; wobble hypothesis; ribosome as the site of protein synthesis; polysomes; activation of amino acids; initiation, elongation and termination of protein synthesis in prokaryotes and eukaryotes.

Unit III: Control of translation and post translational modifications

Control of translation: role of guanine nucleotides; post-translational processing of the polypeptide chains: acylation, methylation, phosphorylation by protein kinases, sulfation, glycosylation, vitamin C-dependent modifications, and vitamin K-dependent carboxylation.

Unit IV: Proteolytic processing and targeting

Proteolytic processing and protein degradation; inhibitors of protein biosynthesis; eukaryotic protein sorting and translocation; protein biosynthesis in mitochondria and chloroplast; protein targeting-vesicles; clathrin coated vesicles; targeting of vesicles to various cell compartments.

Semester II

Course X

Proteins and Proteomics

Paper code: MBC 204

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

Unit I: Primary structure of protein

An overview of protein structure; globular and fibrous proteins; hierarchy of protein structure; dihedral angles; Ramachandran plot; determination of N and C-terminal residues; determination of amino acid composition of protein and determination of sulfhydryl groups; location of disulfide bonds; fingerprinting; chemical synthesis of peptides; structure and function of some biologically important polypeptides.

Unit II: Secondary and tertiary structure of proteins

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; determination of molecular weight of proteins; protein purification; criteria of purity, and fold purification.

Unit III: Sequencing, protein folding, and denaturation

Protein sequencing; sequenators; hydropathy index; quaternary structure of proteins; structure and function of hemoglobin and cytochrome c; characteristics of molten globule state; proteins involved in folding; in vivo folding; models of protein folding; chaperones; protein conformation and diseases: Alzheimer's disease.

Unit IV: Proteomics

Overview and tools; 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; transmembrane domains; functional proteomics; application of proteome analysis.

Semester II

Course XI

Seminar (Assignment based)

Paper code: MBC 205

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

This paper is aimed at to inculcate in students the habit of thinking, planning, developing ideas, literature search, and retrieve information; preparation of scientific report on specific topic/review article; order of paragraph writing, proper use of nouns, pronouns and articles, tenses and spelling; presentation of seminar: clarity of objective, design, parameters, data interpretation, summary.

Seminar will be delivered using power point, and the contents of the lecture will be submitted to the department in the form of a paper/report, and will be evaluated y a committee constituted by the Head of the Department. At the end of the semester, the student will be required to submit the assignment/technical report, which will be evaluated by an external examiner who will be called for the viva.

Semester II

Course XII

Lab Course-2

Paper code: MBC 206

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lab hours: 100

Enzymatic methods

1. **Preparation of buffers and determination of pH.**
2. **Determination of pK values of amino acids.**
3. **Isolation and assay of an enzyme and determination of its kinetic properties.**
4. **Immobilization of enzyme and measurement of its activity.**
5. **Effect of pH and temperature on enzyme activity.**
6. **Enzyme inhibition studies.**
7. **Analysis of lactate dehydrogenase isoenzymes.**
8. **Experiments on protein denaturation.**
9. **Assay of clinically important enzymes.**
10. **Western blotting**
11. **UPLC MS (Visit to the facility followed by a lecture on applications)**

Note: *Before starting the actual practical exercise, the principle, theory and instrumentation of the technique(s) to be used would be explained in detail.*

Semester III

Course XIII

Genetic Engineering

Paper code: MBC 301

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

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; restriction endonucleases; DNA modification enzymes; cloning vectors; ligation of DNA fragments: linkers, adapters and homopolymeric tailing; synthesis of cDNA; construction of genomic library; mRNA enrichment; reverse transcription and library construction; DNA Sequencing.

Unit II: Expression systems

Expression vectors; choice of expression system; expression in bacterial, yeast, insect and mammalian 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; chromosome engineering; value addition through genetic engineering; protein engineering.

Unit IV: PCR and DNA fingerprinting

Polymerase chain reaction: principles, process, design and optimization; Taq DNA polymerase; types of PCR: allele specific, inverse, asymmetric, and real-time PCR; application of PCR in diagnostics, forensic science, gene manipulation expression studies and evolutionary biology; ligase chain reaction; SNP and the application in molecular diagnostics; DNA fingerprinting: applications and prospects; restriction fragment length polymorphism (RFLP) and its uses; FISH; prenatal diagnosis.

Semester III

Course XIV

Nutrition and Clinical Biochemistry

Paper code: MBC 302

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

UnitI: Human nutrition

Basic concepts; scope and methodology; principal food components; vitamins: structure and function; food nutrients: classification and distribution; recommended allowances and their modifications under stress conditions; deficiency and excess of principal nutritional components; formula diets and crash diets; balanced diets; dietary standards: EAR, RDA, AL, DRI, TUL; water as an essential nutrient; food preservatives; additives and anti-nutrients; toxic effects of food: sources, active agents and effects.

Unit II: Nutrition and diseases

Protein energy malnutrition; energy requirements: basal metabolic rate (BMR); factors affecting BMR and its measurement; resting metabolic rate; specific dynamic action of food; dietary fat, heart disease and cancer; atherosclerosis: risk factors and protective measures; diabetes, obesity and their nutritional management; weight management; anthropometric measurements; nutrition and infection; basics of nutrigenomics.

Unit III: Quality assurance in clinical biochemistry

Biological samples: types, collection, processing, stability and storage: phlebotomy tubes; serum separator devices; chemical composition of biological fluids: blood, urine and cerebrospinal fluid; reference range; quality control and quality assurance; accuracy and precision; factors influencing the accuracy of results; Levy-Jennings's chart; reliability of laboratory methods; interferents; clinical research.

Unit IV: Biochemical tests and disease diagnosis

Biochemical tests in clinical medicine: basic concepts, and scope; criteria for selecting a method for biochemical analysis; enzymes as diagnostic tools; advantages and disadvantages of enzyme assays; isoenzymes and their diagnostic importance; methods for the detection of isoenzymes; organ function tests: clinical presentation and diagnosis of the diseases of liver and kidney; bilirubin metabolism and hyperbilirubinaemia; acid base disorders.

Semester III

Course XV

Microbiology

Paper code: MBC 303

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

Unit II: Microorganisms and acellular infectious agents

Prokaryotic and eukaryotic microorganisms; general characteristics of bacteria, algae, fungi and protozoa; criteria used in microbial classification; salient features of major divisions; animal and plant diseases caused by microorganisms; normal human microbiota; general characteristics of virions; viruses of eukaryotes: isolation and cultivation; bacteriophages; one step growth curve; replication of DNA and RNA viruses; viral infections and antiviral chemotherapy; viral interference; virusoids, viroids and prions.

Unit I: Eubacteria and Archaebacteria

Characteristics and the criterial used in the classification of bacteria; bacterial taxonomy; numerical taxonomy; staining procedures; selective and differential staining; Gram staining and acid-fast staining; general characteristics of major groups of prokaryotes; evolutionary relationships between eubacteria and archaebacteria.

Unit III: Microbial growth and genetics

Microbial nutrition; culture media; growth curve and measurement of bacterial growth; identification and isolation of bacterial mutants; control of microorganism by physical and chemical agents; antibiotics and other antimicrobial agents: structure and mechanisms; antiviral agents; bacterial and phage genetics; gene transfer in bacteria: conjugation, transformation and transduction; molecular mechanism of recombination; mapping the structure of bacterial chromosome; lysogeny and lytic cycle in bacteriophages.

Unit IV: Environmental microbiology

Microbial communities; interaction of microorganisms with environment; microorganisms as primary producers in presence and absence of sunlight; biogeochemical cycles of important nutrients; biomarkers of environmental exposure; bio-pollutants; animal-microbe and plant-microbe interactions; biological treatment of solid and liquid wastes and pollutants; microorganisms and bioleaching; recovery of metals and oil.

Semester III

Course XVI

Immunology

Paper code: MBC 304

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

Unit I: Types of immunity

Humoral and cellular immunity; clonal selection theory; cells and organs of immunity; primary and secondary lymphoid organs; T and B lymphocytes; macrophages and effecter cells; primary and secondary immune response; Immunological memory; antigens; haptens and immunogens; antigen antibody interactions; immunoglobulins: types and structure; CDRs; immunoglobulin fold; isotypes, allotypes and idiotypes; valency, affinity and avidity.

Unit II: Immunogenetics

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; T-cell receptor; antigen processing, antigen presentation; products and factors produced by T-cell activation; dendritic cells; cytokines and co-stimulatory molecules; B cell activatory factors; B-cell and helper T-cell subset interactions; cytotoxic T-cell mediated killing.

Unit III: Immune responses and immunization

Immune response to tumors; immunodeficiency and autoimmunity; immunoregulation; immune response to infectious diseases; viral, bacterial and protozoal infections; H1N1; cancer and immune system; cancer immunotherapy; mucosal immunity; adjuvants and vaccines; active immunization (immunoprophylaxis); passive immunization (immunotherapy); complement and mechanism of complement fixation; immunological tolerance.

Unit IV: Antigen-antibody interactions and hybridoma technology

Measurement of antigen-antibody interactions; immunoprecipitation; agglutination; immunoelectrophoresis; rocket immunoelectrophoresis; radioactivity based detection methods and principles: RIA; immunofluorescence; cytotoxicity assay; plaque assay and ELISPOT; ELISA; Western blotting; hybridomas and their production; immunization protocol; production of human monoclonal antibodies.

Semester III

Course XVII

Dissertation-1

(Based on Microbial and Molecular Biology Techniques)

Paper code: MBC 305

Credits: 8; Maximum marks: 200 (Internal assessment: 50, Semester examination: 150); Time: 200 hour

This dissertation has been designed to provide the students an understanding and hands-on experience on the following microbial and molecular biology techniques:

1. **Sterilization techniques.**
2. **Preparation of culture media.**
3. **Culture of bacteria; establishing a pure culture; identification of bacteria; staining techniques; antibiotic sensitivity of bacteria.**
4. **Isolation of plasmid DNA; digestion by restriction endonuclease and separation of the restriction fragments by agarose gel electrophoresis.**
5. **Isolation of RNA and separation on agarose gel.**
6. **Quantitative estimation of DNA and RNA.**
7. **DNA/RNA blotting techniques.**
8. **Polymerase chain reaction.**
9. **Green fluorescence protein (GFP) and bacterial transformation experiments.**
10. **Demonstration of radioactive counters and its principles; safety aspects.**
11. **Animal tissue culture (demonstration only)**

In addition to the day-to-day assessment by the concerned supervisor, the internal assessment will be done by a committee constituted by the Head of the Department. Copy of the dissertation will then be submitted and evaluated by the external examiner at the time of viva at the end of the semester.

Semester IV

Course XVIII

Biotechnology and Bio-nanotechnology

Paper code: MBC 401

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

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 of through genetic engineering; synthetic seeds

Unit II: Applications of gene technology

Sequencing genome; EST sequencing and sequence skimming; mapping genome; 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 microarrayas.

Unit III: Environmental Biotechnology

Definition and applications; bioindicators; environmental monitoring; biopesticides; biocontrol; food chains and biomagnification; biological mining; bioremediation; biofuel; biological waste management; landfills and vermin composting; environment and transgenics; biofertilizers; production of technology for major biofertilizers; ethical, social and biosafety aspects of biotechnology; biological containment.

Unit IV: Nanotechnology

Nanotechnology and its applications in biosciences: basics only; Biosystems at the nanoscale; interaction of nanoparticles with macromolecules and biomolecules; dendrimers; quantum dots; nanotubes; nanoshells; biocompatible matrices; interaction of biological and synthetic material; biomaterial; nanofabrication methods and cell behavior; high throughput screening; nanomedicine; nano-enabled biodefense; nanobiosensors.

Semester IV

Course XIX

Computational Biochemistry and Bioinformatics

Paper code: MBC 402

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

Unit I: Computer science

Computer: introduction, capabilities and applications; hardware and software; memory/storage devices; operating systems (OS): multiprogramming OS, time-sharing OS; MS-DOS; UNIX; windows; programming language; machine language; assembly language and higher-level language; computer network; transfer of network data; data handling, data acquisition, data achieving and data mining; Internet; privacy and security issues.

Unit II: Computational biochemistry

Computational fundamentals and data design; analysis of biochemical data with spreadsheet application; biochemical data management with database program; internet resources and biochemical interest; computer graphics and representation of molecular structure; search and analysis of enzyme data; receptor biochemistry and signal transduction; systems biology: interlinking of pathways; molecular modeling and simulation.

Unit III: Bioinformatics

Bioinformatics: introduction and basics; emerging areas in bioinformatics 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; restriction enzyme mapping; identification of open reading frames (ORF); gene annotation technology.

Unit IV: Applications of bioinformatics

Computational methods for sequence analysis; phylogenetic analysis; comparative genomics; identification of bacteria and viruses through software; virtual and electronic cell; internet tools for DNA sequence translation; protease digestion mapping; prediction of signal peptide; secondary structure and phosphorylation sites; application tools: primer designing; tools for molecular mapping.

Semester IV

Course XX

Biochemical Techniques and Biostatistics

Paper code: MBC 403

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

Unit I: Methods for biochemical fractionation

Chromatography: general principles, types and techniques; partition, size exclusion, ion exchange, affinity chromatography, IMAC, GLC; electrophoresis and isoelectric focusing; centrifugation: preparative and analytical; types of rotors.

Unit II: Spectroscopic techniques

Spectroscopic techniques: principles and applications in the study of biomolecules; spectrofluorometry; infrared spectrophotometry; atomic absorption spectroscopy; NMR spectrometry; ORD, CD and X-ray diffraction technique; mass spectrometry; ESR spectroscopy; Raman spectroscopy.

Unit III: Fundamentals of statistics

Arithmetic mean, median and mode (theory and simple numerical problem); measures of variation: Standard Deviation, Variance, Coefficient of Variation, properties; Correlation: Types of correlation, methods of correlation, simple, multiple and linear and non linear correlation, spearman's correlation, rank correlation; Regresion: Linear regression, curvilinear regression (for two variable X and Y only), regression lines by last square methods, regression equations of X on Y and Y on X only

Unit IV: 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 (student 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.

Semester IV

Course XXI

Industrial Biochemistry

Paper code: MBC 404

Credits: 4; Maximum marks: 100 (Internal assessment: 25, Semester examination: 75); Lectures: 50 hrs

Unit I: Chemical engineering, bioprocess design and scale up

Basics of chemical engineering: mass transfer processes; transport through membranes; heat, energy and thermodynamics; heat generation and removal; fluid mechanics; viscosity, hydraulic conductivity and capillary flow; control and applications of industrial processes; chemostat and its applications; process evaluation and development; over production of metabolites and methods; strain selection/development and enhancement; design of fermenters and mode of their operation; anaerobic fermenters; downstream processing; gene dosage and its applications in industrial processes.

Unit II: Pharmaceutical technology and hybridoma technology

Drug design; formulations; pharmacokinetics and pharmacodynamics; theories of the mechanism of drug action; factors affecting drug efficacy; drug resistance; traditional medicines; biotransformation; hybridoma technology; hybridomas and their production; monoclonal antibodies; large scale production of monoclonal antibodies; production of human monoclonal antibodies; diagnostics; biosensors.

Unit III: Food biochemistry

Introduction to different categories of food; principles and applications of physical and chemical methods for determining constituents of food; introduction to food processing; food spoilage; intrinsic and extrinsic factors affecting the quality and life of food material; quality assurance; food storage and preservation techniques; food poisoning and intoxications; by-product utilization and scale up.

Unit IV: Industrial uses of enzymes and other biomolecules, IPR and GATT

Industrial production of enzymes from traditional sources and genetically engineered organisms; proteases; carbohydrases; lipases and their applications; immobilized enzymes and methods of immobilization; applications of enzyme immobilization; enzymes for analytical applications; industrial uses of seed oils; production of proteins by rDNA technology: isolation and purification; downstream processing and scale up; patenting; intellectual property rights (IPR); general agreement on trade and tariff (GATT)

Semester IV

Course XXII

Dissertation-2

(Based on Protein Isolation/Purification and Immunological Techniques)

Paper code: MBC 405

Credits: 6; Maximum marks: 200 (Internal assessment: 50, Semester examination: 150); Time: 200 hour

This dissertation has been designed to give an understanding and hands-on experience to the students on the following techniques:

1. **Purification of protein such as egg albumin from hen egg white**
2. **Salt fractionation; dialysis; gel filtration and ion-exchange chromatography.**
3. **Spectroscopic analysis of ovalbumin and determination of absorption spectrum and quantitative estimation.**
4. **Polyacrylamide gel electrophoresis of the purified ovalbumin in absence and presence of SDS to check purity of the preparation.**
5. **Determination of molecular weight of the ovalbumin by gel filtration and SDS-PAGE.**
6. **Immunization of experimental animals with the purified ovalbumin and detection of antibodies in the antisera; immunodiffusion; ELISA.**
7. **Isolation of IgG from the antiserum.**

In addition to the day-to-day assessment by the concerned supervisor, the internal assessment will be done by a committee constituted by the Head of the Department. Copy of the dissertation will then be submitted and evaluated by the external examiner at the time of viva at the end of the semester.

ANNEXURE-1

Semester I

Foundation Course*

Foundation Course

Paper code: MFC 001

Credits: 6; Maximum marks: 200 (Internal assessment: 50, Semester examination: 150); Lectures: 100 h

***This is a Basic Course Common to All MSc Semester I Students Admitted to the Faculty of Science**

UNIT - I

Chemical Equilibrium - Laws of mass action, Le-chatelier's principle, Reaction Quotient, Chemical equilibrium constant, Relation of Kp & Kc, pH, Buffer, Buffer index, Buffer capacity, Common ion effect. Hendessen Equation, Solubility product & Ionic product, Acid base titrations and theory of indicators; **Solutions -** Methods of expressing the concentration (Molality, Molarity, Normality etc.), Colligative properties, Molecular mass determination using colligative properties. **4**

Thermodynamics and Kinetics - Thermodynamic work & heat change, extensive & intensive properties. Enthalpy, Internal Energy, Gibbs free energy, work function, First, second & third law of thermodynamics. Entropy change & concept of spontaneity, Rate of reaction, Order of reaction, Molecularity of reaction, Methods to determine order of reaction, Arrhenius equation of rate of reaction. Nanotechnology **4**

General organic chemistry – Aliphatic and Aromatic Compounds - Sructure and reactivity of alkanes, alkenes, akynes, benzene and its derivatives, Concepts of resonance and aromaticity. **2**

Natural Products – Primary and secondary metabolism, Structure, classification, general properties, tests, extraction methods of steroids, saponins, terpenoids, flavonoids, anthraquinones and alkaloids. **3**

Analytical Chemistry – Chromatographic techniques: Applications of paper chromatography, size exclusion chromatography, ion - exchange chromatography, GC, HPTLC, Elisa, Elctrophoresis, AAS & ICP; **Spectroscopic techniques:** Absorption of electromagnetic radiation, Principle, theory instrumentation and applications of UV-VIS, IR, NMR spectroscopy and Mass spectrometry; **Radioactivity:** Radioactive decay, Half- life, Radioactive detection. **7**

UNIT - II

Basic Metabolism: Intracellular components, metabolism of carbohydrates, proteins, lipids and fats, vitamins and minerals; glycolysis citric acid and oxidative phosphorylation; ATP and high-energy phosphate compounds, enzymes nucleoproteins, regulation of acid-base balance. **6**

Immunology: Humoral and cell mediated immunity; primary and secondary lymphoid organs; T and B lymphocytes, mactrophages and effecter cells; immunological memory; antigens, haptens and immunogenes; antigen antibody intractions; immunoglobulins **6**

Microbes: Pro and eukayotes, viruses, prions, disease causing microorganisms, ecto- and endotoxins, food microbiology, fermentation, probiotic **8**

UNIT - III

Plant groups: Basics of Classification **2**

Biological diversity: Concept and levels, Conservation of biodiversity, International efforts and India initiatives, Endemism, biodiversity hotspots, Environmental pollution, Global Warming, Green house effect, Bioremediation. **4**

Climate change: Consequences (CO_2 fertilization, global warming, sea level rise, UV radiation) Bioremediation, Bioindicators, Green house gases (trend and role), ozone layer and ozone hole. **4**

Ecosystem: Producers, consumers and decomposers of food chain **2**

Natural Resources: Ethnobotany, Renewable and non-renewable resources of energy **2**

Special crops: Toxic and poisonous plants, Petrocrops and energy plantation, plant drugs and their constituents used in allopathic system of medicine. **6**

UNIT - IV

Genetics of inheritance: Laws of inheritance, recombination, segregation of traits and, segregation ratio, interaction between traits and quantitative inheritance. **3**

Molecular Biology: The genetic material, 'C' value, RNA as genetic material, fidelity of DNA replication, transcription, translation, gene regulation, promoters, enhancers, silencers and other regulatory elements, exons and introns, nuclear splicing, role of SnRNPs, ribozyme, reverse transcriptase, Mutation and mutagenesis, Ames test, role of methylation, SOS response, Transposons. **8**

Genetic Engineering: Essentials of gene manipulation, vectors, gene cloning, genomics, proteomics **3**

Applications: Stem cell research, disease tolerant plants, insecticide and herbicide tolerant plants, increasing the shelf life of vegetables and fruits, improvement in quality (golden rice) and quantity of produce. **3**

Biotech and society: Apprehensions, effect on ecosystem, development of tolerance, loss of genetic base, loss of diversity, IPR concerns, adaptation, judicious implementation. **3**

UNIT - V

Introduction to Toxicology: Various types of toxicity (Acute, subacute, subchronic and chronic), Chemical interactions (Additive effect, potentiation, synergism and antagonism), Dose response relationship, ED_{50}, LD_{50} EC_{50}, LC_{50} Routes of exposure, absorption, distribution, elimination. In vitro and in vivo models in toxicological studies **8**

Metabolic pathways of Toxicants: Biotransformation, Phase I and Phase II reactions (various types of hydrolysis, Oxidation, Reduction and Conjugation reactions with appropriate examples), Cytochrome P-450: its nomenclature, various forms and involvement in toxicity and carcinogenicity of environmental chemicals. **4**

Common reactions of drug overdose toxicity and management **4**

Concept and requirement of Good Laboratories Practices (GLP) **2**

GMP, GCP **2**

UNIT - VI

Development of communication skills, language improvement, use of correct pronunciation, use of correct words, singular and plural etc., Science literature – literature search, learning resources, books-author and subject index, CDs etc, computer applications and data management-data handling data acquisition, data archiving, data mining. **20**