M.Sc., Biochemistry Semester System

Credit System

SCHEME OF INSTRUCTION AND EXAMINATION

Paper No.Title of the Paper	Periods/ Week	No of Credits	Duration of Exam (hrs)	Max Marks
I Semester:				
Theory				
BC 1.1 Chemistry of Biomolecules	4	4	3	85
BC 1.2 Biochemical Techniques	4	4	3	85
BC 1.3 Physiology and Bioenergetics	4	4	3	85
BC 1.4 Enzymology	4	4	3	85
***Practicals:**				
BC 1.5 Biochemical Techniques	12	2	6	85
BC 1.6 Enzymology	12	2	6	85
BC 1.7: Viva – Voce	--	1		25

Total marks for I Semester				535 + 90* = 625
II Semester:				
BC 2.1 Microbiology	4	4	3	85
BC 2.2 Cell Biology and Genetics	4	4	3	85
BC 2.3 Intermediary Metabolism	4	4	3	85
BC 2.4 Molecular Biology	4	4	3	85
Practicals:				
BC 2.5 Microbiology and Genetics	12	2	6	85
BC 2.6 Quantitative Analysis and Molecular Biology	12	2	6	85
BC 2.7 Viva-Voce	--	1		25

Total marks for II Semester				535 + 90* = 625
III Semester:				
BC 3.1 Plant Biochemistry and Human Nutrition	4	4	3	85
BC 3.2 Immunology	4	4	3	85
BC 3.3 Regulation of Gene Expression and Genetic Engineering	4	4	3	85
BC 3.4 Industrial Biotechnology	4	4	3	85
***Practicals:**				
BC 3.5 Immunology and Food Analysis	12	2	6	85
BC 3.6 Biotechnology and Genetic Engineering	12	2	6	85
BC 3.7 Viva – Voce	--	1		25

Total marks for III Semester				535 + 90* = 625
IV Semester:				
BC 4.1 Clinical Biochemistry and Endocrinology	4	4	3	85
BC 4.2 Genomics, Proteomics and Bioinformatics	4	4	3	85
BC 4.3 Applied Biochemistry	4	4	3	85
Practicals:				
BC 4.4 Clinical Biochemistry and Bioinformatics	12	2	6	85
BC 4.5 Viva - Voce	--	1	--	25
BC 4.7 Project Work	--	4	--	200

Total marks for IV Semester				565 + 60* = 625
Grand Total for 4 Semesters				2170 + 330 = 2500

*****Internal assessment component carries 15 marks for each theory and practical papers.

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M.Sc., BIOCHEMISTRY SEMESTER SYSTEM

CREDIT SYSTEM

SCHEME OF INSTRUCTION AND EXAMINATION

Paper No.Title of the Paper	Periods/ Week	No of Credits	Duration of Exam (hrs)	Max Marks
III Semester:				
BC 3.1 Plant Biochemistry and Human Nutrition	4	4	3	85
BC 3.2 Immunology	4	4	3	85
BC 3.3 Regulation of Gene Expression and Genetic Engineering	4	4	3	85
BC 3.4 Industrial Biotechnology	4	4	3	85
***Practicals:**				
BC 3.5 Immunology and Food Analysis	12	2	6	85
BC 3.6 Biotechnology and Genetic Engineering	12	2	6	85
BC 3.7 Viva – Voce	--	1		25
Total marks for III Semester				535 + 90* = 625

*****Internal assessment component carries 15 marks for each theory and practical papers.

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I SEMESTER
BC: 1.1: Chemistry of Biomolecules

Unit – 1

Amino acids – classification, structure and physiochemical properties, chemical synthesis of peptides – solid phase peptide synthesis. Proteins – classification, purification, and criteria of homogeneneity. Structural organization, sequence determination and characterization of proteins. Conformation of proteins – Ramachandran plots. Denaturation of proteins.

Unit – 2

Classification, chemical properties of carbohydrates, Chemistry and biological roles of homo and heteropolysaccharides, peptidoglycan, glycosaminoglycans, glycoconjugates, glycoproteins, Structural elucidation of polysaccharides; Oligosaccharides – lectin interaction in biochemical processes.

Unit – 3

Classification of Lipids, Fatty acids and their physiochemical properties. Structure and properties of Prostaglandins. Fats and waces, physicochemical properties and characterization of fats and oil. Structure, properties and biological roles of phospholipids and Sphingolipids. Chemistry and properties of Sterols and Steroids. Salient features of bacterial and plant lipids.

Unit – 4

Nucleic acids – bases, nucleosides, nucleotides, physicochemical properties of nucleic acids, cleavage of nucleic acids by enzymatic methods, non – enzymatic transformation of nucleotides and nucleic acids, methylation, Sequencing, chemical synthesis of DNA. Three dimensional structure of DNA. Different froms of DNA – circular DNA and Supercoiling. Types of RNA. Strucure of t-RNA. Nucleotids as regulatory molecules, enzyme fofactors and mediatros of chemical energy in cells. Pporphyrins – Structure and properties of porphyrins – heme , Chlorophyll and Cytochromes.

BC 1.2: Biochemical Techniques

Unit – 1:

Separation Techniques: Principles, methods and applications of chromatography – Paper, thin layer, ion exchange, ge filtration and affinity chromatography, GLC, HPLC and chromatofocussing.

Unit – 2:

Tissue homogenization. Disruption of tissues and cells, Centrifuges – Principle, applications and types. Differential and density gradient centrifugation. Preparative and analytical ultracentrifuge. Principles and applications of manometry and oxygen electrode, Principle and applications of microscopy, types of microscopes, phase contrast, fluorescent and electron microscopes.

Unit – 3:

Basic Principles of spectroscopy, basic laws of light absorption; instrumentation and applications of UV_visible, IR,ESR,NMR, aatomic absorption and Mass spectroscopy, flourimetry, flame photometry, bephelometry, ORD, CD, X-ray diffraction.

Unit – 4:

Nuclear techniques – nature of radioactivity, detection and measurements of radioactivity, Radio isotopic techniques, Biochemical uses of isotopes. Radiation hazards and methods of radioactive disposal. Principles, methods and applications of electrophoresis, moving boundary electrophoresis, zone electrophoresis, paper, starch, agarose, PAGE, High voltage and Capillary electrophoresis, Isoelectric focusing, two-dimensional electrophoresis, PFGE.

BC 1.3: Physiology and Bioenergetics

Unit – 1:

Composition of blood, erythrocytes, leucocytes, thrombocytes, Coagulation of blood and fibrinolysis. Respiratory organs and mechanism of respiration. Hemoglobin and transport of gases, Physiology of heart, Digestion and absorption of foods. Structure of kidney and nephron. Physiology of kidney. Regulation of electrolyte, water and acid base balance in the body.

Unit – 2:

Structure and organization of muscle cell, types of muscles. Molecular organization of contractile systems nd molecular mechanisms of contraction and relaxation of muscle. Biochemical changes associated with muscle contraction and relaxation. Structure of nerve cell, origin of membrane potential, mechanism of propagation of nerve impulse in unmyelinated and myelinated nerve fibers. Synapse – types of synapses, transmission at adrenergic and cholinergic nerve endings. Blood brain barrier, Neurotransmitters. Physiology of vision.

Unit – 3:

Composition and structure of cell membranes, Molecular constituents of membranes, asymmetric organization of lipids and proteins, fluidity of membranes, different membrane models,. Membrane channels and pups, ligand gated ion channels, Ionic channels. Molecular models of transport mechanism, Membrane biogenesis, cell- cell interactions, ionophores, gap junctions, artificial membranes and liposomes.

Unit – 4:

Principles of thermodynamics, free energy, enthalpy and entropy, Free energy changes in biological transformations in living systems. Redox potential, phosphate group transfer potential and ATP, High-energy compounds, oxidation and reduction reactions.Oxidation and reduction enzymes, utilization of exygen aby oxygenases, superoxide dismutase and catalase. Mitochondrial electron transport system – organization of components and importance. Substrate level phosphorylation, oxidative phosphorylation, respiratory control, Mechanism and theories of exidative phosphorylation. Respiratory chain inhibitors and unvouplers of exidative phosphorylation. Mivrosomal electron transport system. Bioluminisence.

BC 1.4: Enzymology

Unit: 1

Classification of enzymes, Remarkable properties of enzymes – catalytic power, specificity. Transformation of different froms of energy. Enzyme localization and assay of enzymes, Units of enzyme activity , Active site – Fisher and Koshland models,

formation of enzyme – substrate complex and experimental evidences. Nature of active site, mapping of enzyme active site through chemical procedures and site directed mutagenesis, Factors affecting enzyme activity, Modern concepts of evolution of catalysis, ribozymes, abzyme and synzymes.

Unit – 2:

Kinetics of single substrate enzyme catalyzed reactions, Michaelis – Menten equation, Lineweaver - Burk, Eadie – Hofstee and Hanes plots. Significance of Vmax, Km, Kcat, specificity constant (Kcat/Km)

Kinetics of multisubstate reaction – Classification with examp0les. Rate expression for non-sequential (ping-pong) and sequential (ordered and random) mechanisms.

Use of initial velocity, Inhibition and exchange studies to differentiate between multi substrate reaction mechanisms. Flexibility and conformational mobility of enzymes.

Ebztne ubguvutuib – reversible inhibition – competitive, non-competitive , un-competitive inhibition; irreversible inhibition, Determination of Ki values

Unit – 3;

Types of reaction catalysis – General acid – base, electrostatic, covalent, intermolecular, metal – ion catalysis, Proximity and orientation.

Mechanism of reaction catalyzed by serine proteases – trypsin and chymotrypsin, carboxypeptidase, lysozyme, triose phosphate isomerise, ribonuclease

Rotational catalysis – ATPase.

Mechanism of catalysis with coenzymes – pyridoxal phosphate, flavin nucleotides, thiamine lpyrophosphate, biotin, tetrahydrofolate, lipoic acid.

Unit – 4:

Enzyme regtuation – general mechanisms of enzyme regulation. Allosteric enzymes (ATCase). Cooperativity phenomenon. Hill and Scatchard plots. Sigmodal kinetics and their physiological significance, Symmetric and sequential models of action of allosteric enzymes and their significance. Feedback inhibnition and feed forward stimulation., Control of enzymatic activity by products and substrates. Reversible and irreversible activation Isoenzymes, Multifunctional enzymes, Multi – enzyme systems – properties, mechanism of action and regulation of Pyruvate dehydrogenase and Fatty acid synthase complex

PRACTICAL – I
BC 1.5: Biochemical Techniques

Paper chromatography – ascending and descending – separation of amino acids, sugars, purines and pyrimidines. Qualitative tests for their identification.

Thin – layer chromatography of amino acids and lipids.

Coumn chromatographic separation of plant pigments.

Separation of amino acids by paper electrophoresisl.

Polyacraylamide Gel Electrophoresis of serum proteins.

Ion Exchange chromatography of amino acids.

Absorption spectrum of chlorophyll extracted from green leaves.

Absorption spectrum of aromatic amino acids, purines, pyramidines and heme.

Determination of Molar absorption coefficient of tyrosine.

Optical rotation of glucose and fructose using polarimeter.

Sub – cellular fraction of organelles of liver cells and identification by the marker enzymes.
Affinity Chromatography.
N and C terminal analysis of proteins. (End group analysis of proteins).
Peptide mapping.
Molecular weight of protein by SDS-PAGE
Estimation of proteins by Spectrophotometric method
Density gradiant centrifugation – Isolation of rat liver mitochondria.
2- Dimensional electrophoresis of lproteins
Isoelectric focusing

PRACTICAL – II
BC 1.6: Enzymology

Assay of Amylase from saliva
Assay of Acid phosphatise from potato
Assay of Trypsin
Assay of urease from Horse – gram
Assay of Succinate dehydrogenase from the liver
Isoenzymes of LDH – electrophoretic separation and specific staining technique
Time course of enzyme activity
Effect of PH on enzyme activity and determination of optimum PH
Effect of temperature on enzyme activity and calculation of energy of activation.
Effect of substrate concentration on enzyme activity and determination of Michealis constant.
Enzyme inhibition – irreversible inhibition of Papain Or Serine proteases by appropriate inhibitors
Effect of substate and regulators on allosteric enzyme – Phosphorylase Or ATCase
Enzyme purification by 3 or 4 steps

a) Acetone precipitation
b) Ammonium sulphate fractionation
c) Ion – exchanging chromatography
d) Gel filtration
e) Electrophoresis

Effect of metal ions on enzyme ions on enzyme – Alcohol dehydrogenase

II SEMESTER

B.C. 2.1: MICROBIOLOGY

Unit1:1

Morphology and classification of bacteria – phenotype, numerical and phylogenetic tree - rRNA, DNA and Proteins, Microbial diversity, Major characteristics used in taxonomy – morphological, physiological and metabolic, ecological, genetic analysis and molecular characterizations- (protein, nucleic acid composition), Isolation and cultivation of bacteria, bacterial growth curves. Culture media and methods, staining techniques, differences between Gram-positive and Gram-negative bacteria. Methods of sterilization and Pasteurization.

Unit-2:

Molds – characteristics, classification and reproduction. Yeasts – morphology, characteristics and reproduction. General characteristics of Actinomycetes, Rickettsiae, Spirochaetes and mycoplasma. Economical and industrial uses of algae. Microbial interactions – mutualism, protocooperation, commensalism, predation, parasitism, amensalism, competition, symbiosis in complex system. Role of microorganisms in domestic and industrial sewage. Microbiology of fermented foods, food spoilage and its control (Preservation). Food borne diseases – Botulism, Salmonellosis, E.coli diaorrhea, Shigellosis, Staphylococcal food poisoning

Unit-3:

Microbial diseases-Pathogenesis of bacterial diseases – maintenance, transport, invasion and multiplication and regulation. Airborne diseases – Diphtheria, Meningitis, Pneumonia, Tuberculosis and Streptococcal diseases. Arthropod borne – Lyme, Plague. Direct contact – Anthrax, Gonerreah, Conjunctivitis, Gastritis, Syphilis, Tetanus, Leprosy, Staphylococcal diseases. Sepsis, Mycoses, Malaria, Ameobiosis, Candidiases.

Unit-4:

Viruses- classification, structure and replication. Methods of assay and cultivation-chicken embryo, animal inoculation and tissue culture, quantification and propagation. Maintenance of animal and plant viruses. Tumor viruses. Viral diseases – Dengue, Hepatitis, HIV, Polio, Rabies, SARS. Inactivation of viruses – photodynamic inactivation. Antiviral agents- chemical and biological agents**.**

B.C: 2.2: CELL BIOLOGY AND GENETICS

Unit-1

Structure of a typical cell, Differences between prokaryotic and eukaryotic cells, animal and plant cells. Cytoskeleton – microtubules, microfilaments, Epithelial tissue, Basement membrane, Extracellular matrix – collagen, elastin, fibrillin, fibronectin, laminin, proteoglycans, integrins.
Autocrine, paracrine, exocrine and endocrine systems, , Molecular mechanism of signal transduction (Biosignalling), G proteins, Second messenger system – c AMP, cGMP, Calcium, IP_3, DA G, nitric oxide, Mechanism of their generation and action. Role of different protein kinases.

Unit-2

Cell receptors - nature and types of receptors, ligand and receptor interaction, up and down regulation of receptors.
Chromatin organization – euchromatin and heterocromatin, telomere, centromere, Cell division by mitosis and meiosis, Cell cycle and its regulation, Apoptosis, Biochemistry of cancer – carcinogenesis, characteristics of cancer cell, Agents promoting carcinogenesis.

Unit-3

Mendel's experiments as an example of good scientific technique,
Genotype and phenotype; Genotype-environment interaction; Norm of reaction, Developmental Noise; Concept of Dominance; Penetrance and expressivity; Concept of alleles- Multiple alleles, Test for allelism, types of alleles, Benzer's rII alleles; Concept of cistron, recon, and muton; Interaction between genes - Modified dihybrid ratios;
Sex determination with special reference to genetic basis of sex determination in humans-*sry* gene; Sex linked inheritance.

Unit-4

Linkage and crossing over- 2 point test cross, 3 point test cross, recombination as a basis for variation; Quantitative inheritance; Extra chromosomal inheritance; Concept on origin of mutations taking bacteria as an example-Classical experiments of Luria and Delbruck, Newcombe and Lederberg – Fluctuation test, Plate spreading, Replica plating and Sib selection; Mutations – Types of mutations, Mutagens and their mechanism of action, Molecular mechanism of mutations; Modern concept of the gene-Split gene; Overlapping genes, Assembled genes, Repeated genes, Polyprotein genes, Nested genes.

BC 2.3: INTERMEDIARY METABOLISM

Unit-1:

Approaches for studying intermediary metabolism. Glucose as fuel, glucose transporters, Glycolysis and its regulation. Substrate cycling, TCA cycle – function and regulation, Glyoxylate cycle, Gluconeogenesis and its regulation, HMP shunt and its significance, Uronic acid pathway, Glycogen metabolism and its regulation with special reference to phosphorylase and glycogen synthase, Metabolism of fructose, galactose and lactose, Biogenesis of amino sugars, peptidoglycans, glycosyl aminoglycans and glycoproteins. In born errors of carbohydrate metabolism.

Unit-2:

Proteins turn over – Role of ubiquitin. General metabolic reactions of amino acids. Metabolic breakdown of individual amino acids. Ketogenic and glycogenic amino acids. Formation of creatinine, ammonia and urea. Regulation of urea cycle. Essential and non-essential amino acids. Biosynthesis and regulation of branched chain amino acids, aromatic amino acids, histidine and methionine. In born errors of amino acid metabolism.

Unit-3:

Fats as energy stores, Oxidation of fatty acids, Formation and utilization of ketone bodies. Biosynthesis of fatty acids and regulation. Metabolism of arachidonic acid – formation of prostaglandins, thromboxanes, leucotrienes. Biosynthesis of triglycerides. Metabolism of phospholipids, sphingolipids. Biosynthesis of cholesterol and its regulation, Formation of bile acids. Role of liver and adipose tissue in lipid metabolism. In born errors of lipid metabolism

Unit-4:

Biosynthesis and degradation of purines and pyrimidines and their regulation. Structure and regulation of ribonucleotide reductase. Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides. Inhibitors of nucleic acid biosynthesis. Biosynthesis and degradation of heme. In born errors of nucleic acid and porphyrin metabolism.

BC: 2.4: MOLECULAR BIOLOGY

Unit-1:

Models of DNA Replication, Origin and direction of replication, Semidiscontinuous replication, DNA polymerases of prokaryotes and their mechanism of action; Primase, Ligase, Single strand DNA binding protein, Helicase, Topoisomerases
Replication strategies for replicating circular DNA: ϕ mode replication,σ mode or rolling circle replication and D-loop replication.
Eucaryotic DNA polymerases, Reverse transcriptase, Strategies for replicating linear DNA, Fidelity and processivity of replication, Inhibitors of replication.

Unit-2:

DNA Repair mechanisms, Photoreactivation, Excision repair mechanism, Post replication repair mechanisms - recombination repair, mismatch repair system, SOS response, transcription-repair coupling.
Recombination - models of general recombination; Hollyday model, asymmetric strand transfer model, double strand break repair model, site-specific recombination. Transposition of DNA; Transposable elements, Prokaryotic transposons, Eukaryotic transposons, Retroposons.

Unit-3:

Principles of transcription, Prokaryotic RNA polymerase, Conserved sequences of prokaryotic promoters, Initiation of transcription, Chain elongation, Chain termination, Eukaryotic RNA polymerases, Conserved sequences of eukaryotic promoters, Transcriptional factors and basal eukaryotic transcription complex, Enhancers, Transcriptional termination in eukaryotes
Post transcriptional processing of pre-mRNA - addition of Cap to the 5' end, Polyadenylation to the 3' end, mechanism of intron removal and exon splicing,
Procesing of r-RNA, Self-splicing of group-1 and group-11 introns, Processing of tRNA, RNA editing changes.

Unit-4:

General features of genetic code, Structural components of prokaryotic and eukaryotic ribosomes, Mechanism of protein synthesis in prokaryotes and eukaryotes - aminoacylation of tRNA, protein synthesis - initiation, elongation and chain termination, Protein synthesis inhibitors, Translational control in eukaryotes, Protein targetting and processing; Singal sequences, signal recognition particle, signal hypothesis, molecular chaperons.

PRACTICAL – I

BC: 2.5: MICROBIOLOGY AND GENETICS

Sterilization Techniques-Autoclaving, hot-air oven sterilization, Sieve filtration, membrane filtration.
Preparation of culture media – Nutrient Broth, Nutrient Agar, Blood agar MacConkey's agar, Potato dextrose agar.
Isolation of bacteria – Streak plate and pour plate methods.
Motility of Bacteria – "Hanging drop" technique
Bacteriological examination of water and milk
Bacterial growth curve
Identification of bacteria by staining techniques – simple, differential, Gram staining and acid-fast staining.
Identification of bacteria – Morphological, cultural and biochemical characteristics
Microbiological assay of a vitamin/amino acid
Analysis of domestic and industrial effluents - MPN, BOD, COD and DO
Isolation of phage and plaque formation units (PFU)
Mitosis in onion root tip cell
Meiosis in onion flower buds
Karyotyping
Problems on monohybrid ratio, dihybrid ratio, gene interaction, linkage and crossing over – 2 point test cross.

PRACTICAL – II

BC: 2.6: QUANTITATIVE ANALYSIS AND MOLECULAR BIOLOGY

Determination of P^{ka} and P^{I} values of an amino acid by titrimetric method
Estimation of proteins by Lowry, Bradford methods
Determination of carbohydrates by Anthrone method
Determination of RM value and polensky number of oils
Estimation of pyruvate by 2,4 Dinitrophenyl hydrazine method
Estimation of Ca^{++}/Zn^{++} by EDTA titrimetric method
Determination of melting temperature (T_{m}) of DNA
Isolation of DNA from bacterial, plant and animal cells.
Estimation of DNA by Diphenylamine method.
Isolation of RNA from yeast cells.
Estimation of RNA by Orcinol method.
Estimation of DNA and RNA by UV absorption method and determination of purity of nucleic acids.

Determination of sugar and phosphate ratios in DNA and RNA samples.
Conjugation: Use of broad host range plasmid RP in demonstrating conjugation transfer of plasmid bacteria.
Catabolite repression: Evidence of *B*-Galactosidase induction in presence of lactose in *E.coli lac* strains.
Mutations: UV damage and repair mechanism in *Escherichia coli* Or *Seratia marcesens*
Strain improvement of *Aspergillus niger* using chemical mutagen – Ethidium bromide

III SEMESTER

BC 3.1: PLANT BIOCHEMISTRY AND HUMAN NUTRITION

Unit-1

Photosynthesis – Light and Dark reactions. Hill reaction. Cyclic and Non-cyclic photophosphorylation, mechanisms. Light receptors – photo systems I and II – their location, mechanism of quantum capture and energy transfer between photo systems. Proton gradient and ATP synthesis. CO_2 fixation in C-3, C-4 and CAM plants. Quantum efficiency and regulation of photosynthesis. Mechanism of photorespiration and its significance.

Unit-2:

Nitrogen cycle. Symbiotic N_2fixation, nitrate reduction and assimilation in plants. Seed germination and dormancy. Factors effecting seed germination and biochemical changes during seed germination. Secondary metabolites in plants – Nature, distribution, biosynthesis and function of plant phenolics, alkaloids, lignins, terpenoid and lectins.
Structure, physiological function and mechanism of action of phytohormones – auxins, gibberellins, cytokinins, ethylene and abscisic acid.

Unit-3:

Animal and vegetative foods – chemical composition. Nutrients – Essential Nutrients and their classification. Digestibility, absorption and biochemical functions of macro nutrients, Carbohydrates – dietary requirements. Proteins – Nitrogen balance studies, Determination of Biological values of proteins, Specific Dynamic Action, improvement of protein quality by supplementation and fortification. Lipids – Dietary needs of lipids, essential fatty acids. Calorific values of foods, Basal metabolic rate and its determination, factors influencing BMR. Clinical nutrition – role of diet and nutrition in prevention of atherosclerosis and obesity, role of leptin in regulation of body mass. Starvation – Protein sparing treatment during fasting, Protein calorie malnutrition – Kwashiorkar and Marasmus, Nutritional requirements for pregnant and lactating women and aged people.

Unit-4:

Biological effects of non nutrients, dietary fibre, physiological actions. Antinutrients – Protease inhibitors, hemeagglutinins, hepatotoxin, goitrogens, cyanogenic glucosides, methyl xanthines, oxalates. Toxins from mushrooms. Biological effects of food contaminants – Hexachlorobenzene, arsenic, DDT, cadmium, mercury, lead, aflatoxins, food additives - saccharin and sodium nitrite. Animal foods and seafoods. Food allergy – role of allergens, diagnosis and management of food allergy. Food processing and loss of nutrients during processing and cooking.

Vitamins: sources, physiological role and deficiency disorders of vitamins A, D, E, K, Vitamin C and B complex vitamins–Thiamine, riboflavin, niacin, pantothenic acid, lipoic acid, pyridoxine, biotin, folic acid and Vitamin $B_{12.}$ Functions and deficiency disorders of minerals.

BC 3.2: IMMUNOLOGY

Unit- I

Types of immunity – Innate and adaptive. Antigens, Super antigens, Adjuvants. Cells and organs of the immune system -Thymus, bone-marrow, spleen, lymph node. T and B lymphocytes – Origin, activation, differentiation, characteristics and functions. Nature of T and B cell surface receptors. Major Histocompatibility Complex- H-2, HLA, Polymorphism of MHC molecules. Congenic and inbred strains of mice. MHC restriction and its role in immune response, Antigen presenting cells, Processing and presentation of antigens.

Unit-2

Structure of immunoglobulins, Immunoglobulin classes and biological activities. Isotypes, Allotypes, Idiotypes. Immunoglobulin genes and antibody diversity, Class switching, Humoral and cell-mediated immune responses, Cytokines, Interleukins, Interferons, The Complement components and biological consequences of complement activation.

Unit-3

Antigen-antibody interactions: Antibody affinity and avidity, Precipitation reactions – Immunodiffusion, Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis, Rocket immunoelectrophoresis, Agglutination reactions- Hemeagglutination and complement fixation, Immunoflourescence, FACS, RIA, ELISA, Immunoblotting, Hybridoma technology - production of monoclonal antibodies and their applications, humanized antibodies.

Unit-4

Immune effector mechanisms – Hypersensitivity: immediate (type I, type II, type III) and delayed hypersensitivity reactions, Immunodeficiencies - SCID and AIDS. Autoimmunity - organ specific (Hashimoto's thyroiditis) and systemic (Rheumatoid arthritis) diseases. Tissue transplantation - auto, allo, iso and xenograft, tissue matching, transplantation rejection, mechanism and control, immunosuppressive agents. Cancer immunology – Tumor associated antigens, Immunological surveillance of cancer.

BC 3.3: REGULATION OF GENE EXPRESSION AND GENETIC ENGINEERING

Unit-1:

Structure and function of *lac* operon, Induction of *lac* operon – a negative control system, Catabolite repression – a positive control system, Function and regulation of *trp* operon, Atenuation of *trp* operon, *ara* operon: dual functions of the repressor,
Diversity of sigma factor - Bacterial sporulation and Phage infection in *Bacillus subtilis,* Heat-shock response in *E.coli,* Regulation of phage variation in *Salmonella.*
Regulation of lytic phase and lysogenic phase of Bacteriophage λ.

Unit-2:

Structural changes in the eukaryotic active chromatin - hypersensitive sites, chromatin remodeling, Levels of eukaryote gene control - Control at the level of transcription, processing of RNA, mRNA stabilization in the cytoplasm and translation of mRNA.
Eukaryote promoter and enhancer sequence organization. Interaction of eukaryote transcriptional factors with DNA - helix-turn-helix motif, zinc-finger motif, leucine zipper, helix-loop-helix motif. Regulation of galactose metabolism in yeast.
Steroid hormone induced gene expression. Regulation of gene expression by anti-sense RNA.

Unit-3:

Restriction endonucleases, Restriction maps, isolation of gene fragments using restriction endonucleases and mechanical shearing. Cloning vectors - Isolation and properties of plasmids, bacteriophage cosmids, Ti plasmid (binary vector), expression vectors, viral vectors, YAC, BAC, phagemids and vectors used for cloning in mammalian cells, other enzymes related to molecular cloning. Hosts - Prokaryotic : *E.coli, B.subtilis,* Eukaryotic: Yeast and mammalian cell lines. Ligation of fragments - Cohesive and blunt ends,

Homopolymer tailing. Gene transfer techniques. Biological and artificial delivery system, knockout mice.

Unit-4:

Cloning strategies, shot gun experiments, isolation of poly mRNA, synthesis of cDNA, cDNA cloning in bacteria. Genomic and cDNA libraries. Identification of recombinants - structural and functional analysis of recombinants. Design and preparation of DNA and RNA probes for hybridization. Southern blotting, Northern blotting, South-Western blotting, PCR, Expression of cloned genes in bacteria, yeast, animal and plant cells. Biological, Medical and Industrial applications of recombinant DNA technology. Transgenics: Making Golden rice and Dolly.

BC 3.4: INDUSTRIAL BIOTECHNOLOGY

Unit-1:

Fermentation technology – Principles of fermentation, surface, submerged and solid state fermentations. Batch, fed batch, semi-continuous and continuous culture techniques. Design and operation of fermentors, Agitation and aeration, Types of fermentors-continuous stirred tank fermentor (CSTF), air-lift fermentor, Types of reactions in fermentations, Selection and characteristics of industrial microorganisms, Primary and secondary metabolites, Strategies for strain improvement and maintenance of the industrial strains, Raw materials, different types of fermentation media, Recovery of products, steps in downstream processing, Bioreactors.

Unit-2:

Production of ethyl alcohol and beer by yeast, Fermentative production of Antibiotics - pencillin, streptomycin, tetracycline, Organic acids - citric acid, lactic acid, acetic acid, Enzymes - amylase, proteases, streptokinase, Amino acids - glutamic acid, lysine and Vitamins - $B_{12,}$ $B_{2,}$ and vitamin C. Production of biogas from agricultural wastes.

Unit-3:

Immobilization of enzymes and cells – methods of immobilization, effect of partition on kinetic properties of enzymes, immobilization of multienzyme systems, enzyme reactors, packed bed reactors, fluidized bed reactors, problems in using immobilized biocatalysts,

Industrial and medical applications of immobilized enzymes and cells. Principle and applications of Protein engineering. Principle, types and applications of Biosensors.

Unit: 4:

Single cell protein- Production and applications, Microbial transformations (bioconversions)-: Types and applications, steroidal transformations. Bioleaching, biosorption, biodegradation, bioremediation. Biofertilizers – Blue-green algal fertilizers (*Azolla*, *Aneabena*), seaweed fertilizers, *Mycorrhiza*, Biocontrol agents- Siderophores, biopesticides – Insecticidal toxin of *Bacillus thuringiensis*, mode of action and control, Bacculoviruses.

PRACTICAL-I

BC 3.5: IMMUNOLOGY AND FOOD ANALYSIS

Determination of A, B, O and Rh blood groups in human beings
Dissection and Identification of thymus, spleen and lymph nodes
Techniques of Immunization and Bleeding
Ouchterlony immunodiffusion for detection of Antigens
Radial Immunodiffusion
Immunoprecitation and precipitin curve
Immunoelectrophoresis
Rocket immunoelectrophoresis
Purification of bovine serum IgG by ammonium sulphate precipitation
Enzyme Linked Immuno Sorbent Assay (ELISA)
Western blotting
Diagnostic test for typhoid fever
VDRL Test
Pregnancy Test
Isolation of Glycogen from Sheep Liver
Preparation of Carotenes from Carrots
Preparation of Haemoglobin from Blood
Preparation of Chloroplasts from green leaves
Isolation of Glutamic acid from Gluten of Wheat
Extraction and estimation of total lipids from oil seeds (solvent extraction)
Quantitative analysis of foods for -

a) Moisture

b) Ash

c) Iron

d) Calcium

e) Copper

PRACTICAL-II

BC 3.6: BIOTECHNOLOGY AND GENETIC ENGINEERING

Fermentative production and quantification of:
Antibiotics - penicillin/ streptomycin/ tetracycline
Organic acid: citric acid/ lactic acid/ acetic acid
Enzymes: amylase/ protease/urease
Amino acid: glutamic acid/ lysine

Vitamins: B_{12}/ B_2/vitamin C
Ethyl alcohol/ fruit wine and calculation of fermentation efficiency
Methods of immobilization of protein/enzyme and microbial cells
Isolation of plasmids and estimation of plasmid DNA by UV method
Restriction digestion of λ DNA, Ligation of RE fragments
Agarose and Polyacrylamide gel electrophoresis of nucleic acids
Recovery of DNA/RNA fragments from agarose gels
Preparation of competitive *E.coli* cells and transformation
Expression of cloned gene (GFP)
DNA finger printing (RFLP or RAPD)
PCR
Southern blotting

M.Sc., BIOCHEMISTRY SEMESTER SYSTEM

CREDIT SYSTEM

SCHEME OF INSTRUCTION AND EXAMINATION

Paper No.Title of the Paper	Periods/ Week	No of Credits	Duration of Exam (hrs)	Max Marks

III Semester:

BC 3.1: Plant Biochemistry and Human Nutrition	4	4	3	85
BC 3.2: Immunology	4	4	3	85
BC 3.3: Regulation of Gene Expression and Genetic Engineering	4	4	3	85
BC 3.4: Industrial Biotechnology	4	4	3	85
***Practicals:**				
BC 3.5: Immunology and Food Analysis	12	2	6	85
BC 3.6: Biotechnology and Genetic Engineering	12	2	6	85
BC 3.7: Viva – Voce	--	1		25

Total marks for III Semester				535 + 90* = 625

*****Internal assessment component carries 15 marks for each theory and practical papers.

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IV SEMESTER

BC 4.1: CLINICAL BIOCHEMISTRY AND ENDOCRINOLOGY

Unit 1:

Gastrointestinal hormones - Gastrin, secretin and cholecystokinin. Disorders of gastric function, methods of evaluation. Pancreatic exocrine secretions, pancreatic diseases, steatorrhoea. Malabsorption syndrome – tests for their evaluation and significance.

Plasma proteins – Properties , functions and their variations in diseases, Plasma lipids and lipoproteins, Interrelationship of lipids, lipoproteins and apolipoproteins. Erythropoiesis, abnormalities in blood formation. Anemias. Heamoglobinopathies. Cerebrospinal fluid – composition in health and diseases.

Unit 2:

Liver function tests, their significance, Liver diseases – Jaundice, hepatitis, gall stones, cirrhosis and fatty liver. Free radical mechanism and role of reactive oxygen species in diseases. Role of liver in metabolic regulation and drug metabolism. Clinical chemistry of new born.

Clinical enzymology - Plasma enzymes in diagnosis and prognosis, Isoenzymes in health and diseases (Liver, cardiac and skeletal muscle enzymes)

Kidney – Renal hormones –Renin, erythropoietin and angiotensin. Investigations of renal functions, biochemical investigation of renal disorders. Nephritis, nephrotic syndrome and urolithiasis. Compensatory mechanism for acidosis and alkalosis.

Unit 3:

Pancreatic hormones – Biosynthesis of insulin, regulation of secretion of insulin and glucagon, their role in carbohydrate ,lipid and protein metabolism. Endocrine disorders of pancreas – Diabetes mellitus, melliturias, hypoglycemia. Glucose tolerance test.

Thyroidal hormones – Chemistry, function and metabolism. Hypo and hyper thyroidism, tests for thyroid function. Parathyroid hormones – Parathormone and calcitonin, their role in calcium and phosphate metabolism, abnormalities of parathyroid functions and methods of evaluation.

Adrenals - Chemistry and biosynthesis of adrenal medullary and adrenal cortical hormones . Disorders of adrenal cortex and adrenal medulla, tests for the evaluation of adrenal functions. Biochemical effects of tumours.

Unit 4:

Synthesis, secretion, transport and biological actions of hypothalamic, adenohypophysial and neurohypophysial hormones. Hypothalamic disorders. Pituitary - Clinical syndromes and their evaluation. Penial hormones – Melatonin and serotonin.

Chemistry, biosynthesis and role of androgens , estrogens and progesterone. Hormonal regulation of menstrual cycle, Hormonal contraception. Placental hormones. Biochemistry of reproductive disorders, pregnancy toxemia, pregnancy tests.

BC 4.2: GENOMICS, PROTEOMICS AND BIOINFORMATICS

Unit: 1

Significance of statistical methods in biological investigation, Sampling techniques and evaluation of residues, Probability theory, Binomial distribution, SD & MD, "t" test. Analysis of variance and its significance (ANOVA). Coefficient of correlation (r). Chi – square test and simple regression of equation and regression lines.

Organisation of computers, External and internal storage devices, Basics of operating systems – DOS,Windows, Unix, Linux. WWW, HTML, HTTP, Intra net and Internet concepts.

Origin of Bioinformatics, Branches of bioinformatics, Scope of Bioinformatics

Unit: 2

High throughput DNA sequencing, Whole genome sequencing, shot gun sequencing, sequencing editing, contig assembly

Genome projects: Human genome projects, features of yeast, Arabidopsis genomes.

Introduction to Data Bases, types of Data Bases.

INSD-International Nucleotide Sequence Database, Gen Bank, EMBL, DDBJ, special focus on NCBI, Protein sequence Data base- Swissprot , Tr- EMBL, PIR, Uniprot and Pfam, Structural Data bases-PDB, CATH, SCOP, MMDB

Unit: 3

Structural genomics- Genome annotation, Gene finding. Functional Genomics – Interpro. Comparative genomics - Orthologs, paralogs, and homologs.

Concepts of sequence alignments and its importance. Pairwise and multiple sequence alignment.

Molecular phylogeny concept. Tree types, Tree constructions – UPGMA, Neighbor joining, Maximum parsimony, Minimum evolution, Boot strapping, Blast search tool.

Unit: 4

Proteomics: Significance and applications of proteomics in Biology.

Introduction to principle and techniques – 2D gel electrophoresis, DIGE electrophoresis, MALDI- TOF/TOF, Q –TOF.

Molecular Modeling – Structure of protein at Primary, secondary, tertiary and quaternary level. Understanding Molegro Molecular viewer for protein 3D visualization – RASMOL. Protein secondary structure prediction – Chou Fasman method.

Homology modeling and docking studies (Using Molegro Virtual Docker)

Molecule Import and preparation from PDB. Docking, Analysis, Constrains, Data analyser, sidechain flexibility and templet docking.

Drug discovery – target identification, target validation, lead identification, lead optimization, Phase I,II and III clinical trials, pharmacodynamics.

BC 4.3: APPLIED BIOCHEMISTRY

Unit: 1

Methods for measuring nucleic acid and protein interactions – foot printing, CAT assay, gel shift analysis. DNA markers in genetic analysis – RFLP, Minisatellites, Microsatellites, PCR based RAPD markers, Chromosomal Walking, Chromosomal jumping.

DNA fingerprinting, SNPS, Mapping Genes – Somatic cell hybridization mapping, FISH, Transposon tagging. RNA silencing – siRNAs and anti- sense RNAs- their design and applications; shRNA, epigenetic gene silencing.

Unit: 2

Plant tissue culture: Culture media – Composition and preparation, Totipotency, Organogenesis and plant regeneration, Somatic embryogenesis, Artificial seeds, Micropropagation. Isolation and culture of protoplasts, Somatic hybridization. Plant cell cultures, Plating efficiency, Production of secondary metabolites through in vitro culture.

Unit: 3

Animal tissue culture: Composition and preparation of culture media, Primary cultures, established/continuous cell lines. Tissue and organ culture. Stem cells – Sources - embryonic stem cells, adult stem cells, cord blood stem cells. Generation of stem cells by cloning, stem cell differentiation, stem cell plasticity, preservation of stem cells. Organogenesis through stem cells for transplantation. Applications of stem cell therapy- Parkinson's disease and Alzheimer's disease.

Unit: 4

Vaccines: Principles of vaccination, Design of vaccines. Conventional vaccines – Whole organism, live and attenuated, purified macromolecules. New generation vaccines- Recombinant antigen vaccines, recombinant vector antigens, DNA vaccines, synthetic vaccines, edible vaccines.Vaccine delivery systems – Liposomes, micelles, ISCOMS. Strategies for developing vaccines for malaria, HIV and Salmonellosis. Gene therapy –Types and use of rDNA constructs for gene therapy. Microarrays and biochips. Principle and applications of Metabolic engineering. Principle and applications of Nanotechnology.

PRACTICAL – 1
BC 4.4 CLINICAL BIOCHEMISTRY AND BIOINFORMATICS

Analysis of Blood for:

- Hemoglobin and derivatives – Spectroscopy
- Glucose by chemical and enzymatic methods
- Glycosylated hemoglobin

Analysis of serum for:

- Creatine and creatinine
- Uric acid by chemical and enzymatic methods
- Bilirubin
- Chlorides

- Calcium
- HDL Cholesterol and LDL cholesterol
- Total proteins, Albumins and globulins
- Thymol turbidity and zinc sulphate turbidity tests
- GOT and GPT
- LDH, Gamma glutamyl transferase
- Acid and Alkaline Phosphatase
- Creatine Kinase

Analysis of Plasma for:

- Fibrinogen

Analysis of Urine for:

- Qualitative tests and microscopic examination
- Urea by micro diffusion method
- 17 Oxo and 17 – Oxogenic steroids

Search of databases:

- Using DNA sequence, identifying the protein through database
- Using amino acid sequence of a protein, identifying the gene through database
- Alignment of DNA and protein sequence using BLAST, FASTA
- Multiple sequence alignment (MSA) of proteins and nucleic acids
- Phylogenetic tree construction using CLUSTAL tools

Demonstration of 2D electrophoresis