M. Sc. DEGREE PROGRAMME IN BIOCHEMISTRY

w.e.f. 2017 Admission

M. Sc. BIOCHEMISTRY

SCHEME & SYLLABUS

Semester	Paper No	Title of the Paper	Instructional Hours/Weeks			Max. Marks		
			L	T	P	CA	ESA	Total
Semester I	BC 211	Techniques in Biochemistry	5	1	0	25	75	100
	BC 212	Cell Biology & Genetics	5	1	0	25	75	100
	BC 213	Plant & Microbial Biochemistry	5	1	0	25	75	100
	BC 214	Practical I - Biochemical & Microbial techniques	0	0	10	25	75	100
Semester II	BC 221	Enzymes	5	1	0	25	75	100
	BC 222	Metabolism	5	1	0	25	75	100
	BC 223	Clinical &Nutritional Biochemistry	5	1	0	25	75	100
	BC 224	Practical II - Enzymology & Clinical Biochemistry	0	0	10	25	75	100
Semester III	BC 231	Molecular Biology	4	1	0	25	75	100
	BC 232	Immunology	4	1	0	25	75	100
	BC 233	Pharmacology & Toxicology	4	1	0	25	75	100
	BC 234	Methods in Research	3	1	0	25	75	100
	BC235	Practical III - Immunotechniques & Phytochemical Analysis	0	0	10	25	75	100
Semester IV	BC 241	Molecular Endocrinology	5	1	0	25	75	100
	BC 242	Biotechnology &Genetic Engineering	5	1	0	25	75	100
	BC 243	Practical IV - Techniques in molecular Biology	0	0	10	25	75	100
	BC 244	Dissertation	0	0	5	0	100	100
		Comprehensive Viva-Voce					100	100

Distribution of hours per semester

3 Theory papers 90 x 3	=	270 hrs
Practical	=	180 hrs
Test Papers, seminars	=	30 hrs

Distribution of marks

Theory 100 x 12	=	1200
Practical 100x 4	=	400
Dissertation	=	100 (80 + 20)
Viva –voce	=	100 (80 +20)
Total		1800

Dissertation

Aim: (a) Application of knowledge to real life situation (b) to introduce research methodology. Topic of dissertation may be chosen from any area of biochemistry and may be laboratory based, field based or both or computational, with emphasis on originality of approach. It may be started during 2nd / 3rd semester and shall be completed by the end of the 4th semester. The dissertation to be submitted should include (a) background information in the form of introduction (b) objectives of the study (c) materials and methods employed for the study (d) results and discussion (e) summary and conclusions and (f) bibliography. Apart from these sections, importance of the results, originality and general presentation also may be taken into consideration for evaluation. These data's may be presented using power point at the time of dissertation viva.

Pattern of Question papers: Theory

Each question must have five units drawing questions from the respective unit of the syllabus. Each unit must have two questions of which one must be attempted. Each question must have subunits a, b and c, each carrying 2, 5 and 8 marks respectively. The minimum marks of each paper shall be 75.

Scheme of practical

Semester I	BC 214	Biochemical techniques & Microbial techniques	100 marks
Semester II	BC 224	Enzymology & Blood analysis	100 marks
Semester III	BC 235	Immunotechniques & Phytochemical analysis	100 marks
Semester IV	BC 243	Techniques in molecular Biology	100 marks

The practical examinations are conducted at the end of semester II & IV. At the end of semester II, examination for practicals BC 214 and BC 224 and at end of semester IV, examination for practicals BC 235 and BC 243 will be conducted.

Distribution of marks for practical examination

			Duration	ESA	CA	Total marks
Semester I	BC214	Practical I	6 hrs			
		Spot test/practical based short questions		10		
		Biochemical techniques		30		100
		Microbial techniques		35	25	
Semester II	BC224	Practical II	6 hrs			
		Spot test/practical based short questions		10		
		Enzymology		35		
		Blood analysis		30	25	100
Semester III	BC235	Practical III	6 hrs			
		Spot test/practical based short questions		10		
		Immunotechniques		25		
		Phytochemical analysis		40	25	100
Semester IV	BC243	Practical IV	6 hrs			
		Spot test/practical based short questions		10		
		Nucleic acids		35		
		Electrophoresis		30	25	100

PAPER I - BC 211

TECHNIQUES IN BIOCHEMISTRY

Unit I : Biochemical and Cytochemical techniques.

General scheme for purification of biocomponents. Methods of studying cells and organelles, sub cellular fractionation and marker enzymes. Methods for lysis of plant, animal and microbial cells. Ultra filtration, sonication, freeze drying and fractional precipitation. Ultra centrifugation – velocity and buoyant density determination, density gradient centrifugation, molecular weight determination. Cell architecture, sorting of cells- flow cytometry, fixation and staining, growth of the cells in culture - primary culture – cell lines applications.

Unit II : Chromatography

Basic principles, instrumentation, working and applications of partition chromatography (Paper), adsorption chromatography (TLC, HPTLC, column), affinity chromatography, ion exchange chromatography, gel filtration chromatography, Gas-Liquid Chromatography (GLC), High Pressure Liquid Chromatography (HPLC).

Unit III : Electrophoresis and Blotting

Electrophoretic techniques - slab, capillary, 2-D, pulse field, polyacrylamide/agrose gel electrophoresis. Blotting techniques: Western, Southern and Northern blotting- principle and methodology.

Unit IV: Photometry & Spectroscopy

Outline and fundamental principles of flourescene & phosphorescence, absorption, transmission of light, Beer – Lamberts law, Colorimeter, flame photometry. Principle, instrumentation, working and application of – UV, visible and IR spectroscopy, spectrofluorimetry, atomic absorption spectrometry, Nuclear Magnetic Resonance (NMR), Electron Spin Resonance (ESR), Mass spectroscopy - GC-MS, HPLC-MS and LC-MS/MS, Matrix-assisted laser desorption/ionization- Time- of- Flight Mass spectroscopy (MALDI-TOF MS). X-ray crystallography.

Unit V: Microscopy and Radiobiology

Basic principles, instrumentation and applications of microscopy. Bright field, phase-contrast, fluorescence and confocal microscopy. Electron microscope – scanning and

transmission electron microscopy. Nature of radioactivity, decay and types of radiation. Radiation hazards and precautions taken while handling radioisotopes. Radiation detection and measurements: Geiger Muller counter, scintillation counter and pulse height analyzer. Application of radioisotopes in biological science- autoradiography.

Reference Books

1. Practical Biochemistry - Keith Wilson
2. Principles of Biochemistry - Lehninger, Coz (Pub)
3. Introduction to Practical Biochemistry - Sawhan
4. Biochemistry - Zubay
5. Harpers review of Biochemistry -
6. Text Book of Biochemistry - Devlin, Wiley Lis Pub
7. Protein purification - Robert Scopess (Springer Velay Publication)
8. Tools in Biochemistry - David Cooper
9. Centrifugation - D. Rickwood
10. The Cell - Kooper

PAPER II - BC 212

CELL BIOLOGY AND GENETICS

Unit 1 : Plasma membrane and Transport

Structure and function of plasma membrane, different models, membrane proteins, membrane lipids and membrane fluidity. Transport across cell membrane, passive transport, active transport – primary (P-type, F-type, V-type ATPases, ABC transporters) and secondary, co-transport-symport and antiport. Ion channels, Aquaporins, Regulation of cell volume, Internalization of macromolecules - Endocytosis, pinocytosis, phagocytosis and exocytosis. Receptor mediated endocytosis, coated pits & clathrins.

Unit II : Cell Cycle and Protein Trafficking

Cell division- mitosis and meiosis, Phases of eukaryotic cell cycle, check points – cyclins, maturation promoting factor (MPF), Cyclin dependent kinases, growth factors, inhibition of cell cycle progression. Protein Sorting and Targeting **-** Overall pathway of synthesis of nuclear, secretory, lysosomal and membrane proteins. Import across

endoplasmic reticulum (ER) – Signal hypothesis, post translational modifications of secretory/membrane proteins in ER, sorting of lysosomal proteins, mannose - 6 - phosphate receptors, synthesis, trafficking and localization of mitochondrial proteins. Protein traffic into and out of nucleus.

Unit III : Extracellular Matrix & Cell signalling

Overview of Extracellular Matrix components – Glycoproteins, Proteoglycans, Fibronectin, Laminin. Cytoskeleton – Microtubules – Microfilaments and Intermediary filaments. Signaling molecules, receptors and their functions – G protein coupled receptors- Cyclic AMP, Cyclic GMP, IP3, Calcium. Receptor protein tyrosine kinases- Ras and Raf, MAP kinase pathway, JAK/STAT Pathway, Non Receptor protein tyrosine kinases, Growth factors, Toll like receptors, NF kB, Wnt signaling, Notch pathway. Intracellular receptors (NO, nuclear receptor). Apoptosis.

Unit IV : Classical Genetics

Introduction to Mendelian Genetics - Mendal's Laws of inheritance. Gene interaction- incomplete dominance, co-dominace, epistasis - different types. Multiple alleles, linkage, chromosome mapping, crossing over, three point cross, pleotropism, tetrad and pedigree analysis.

Unit V : Human Genetics

Gene complementation, organizations of chromosomes, specialized chromosome, chromosomes abnormalities, sex linked inheritance, quantitative inheritance. Population genetics - gene pool, gene frequency, Hardy-Weinberg law, non-random mating, factors influencing, heritability, polymorphism.

Reference Books

1. Molecular Genetics - D Friefelder
2. Molecular Cell Biology - Lodish
3. Cell and Molecular Biology - G.Karp
4. The Cell, a molecular approach - G.M. Cooper & R.E. Hausman
5. Essentials of Cell Biology - Alberts et al, Garland Press Science
6. Gens VIII - Lewin
7. Genetics - Gardner
8. Genetics - Suzuki
9. Molecular Genetics - Klug & Cummings
10. The Science of Genetic - Atnerly, Mc Donald
11. Genetics - L. Hart

PAPER III - BC 213

PLANT & MICROBIAL BIOCHEMISTRY

Unit 1 : Photosynthesis & Nitrogen Cycle

Plant cell, uptake and transport of nutrients. Structure & biosynthesis of chlorophyll (a and b). Cyclic and non-cyclic photophosphorylation- photosystem I and photosystem II, Calvin cycle and its regulation, Hill's equation, photorespiration, C_4 pathway of CO_2 fixation. Nitrogen cycle, nitrogen fixation, assimilation of nitrate, ammonium ions and sulphate. Plant-microbe interaction-fungal, bacterial and viral.

Unit II : Plant Hormones

Structure and functions of plant hormones - ethylene, cytokininins, auxins(indole acetic acid), absicic acid, florigin and gibberellins. Photochemical and hormonal control in plants. Structure, properties and mechanism of action of phytochromes. Calcium and calmodulm mediated Pfr responses, senescence – various levels of senescence, Mechanism of different biochemical changes during senescence.

Unit III : Secondary Metabolites and Plant Resistance

Introduction to secondary metabolites, classification, biosynthetic pathways (overview). Isoprenoids - classification, biosynthesis, structure of menthol, myrcene, linalool, abietic acid, sitosterol, biological functions; Alkaloids - classification, biological functions, structucture of nicotine, morphine, quinine; cyanogenic glycosides; Phenolics - classification, structure of gallic acid, protocatechuic acid, geraniol, quercetin, catechin; lignin - structure of coniferyl alcohol; flavonoids - classification, structure of flavones, flavonols, isoflavonones, anthocyanin, functions of flavonoids; tannins- classification, structure of digallic acid, functions. Mechanism of plant resistance, phytoallexins, elicitors and pathogen related proteins

Unit IV: Introduction to Microbiology

A brief introduction to major groups of microorganisms - bacteria, viruses, fungi, mycoplasma, protozoa and algae (classification not expected). Bacteria- Ultra structure of bacteria, chemical composition of bacterial cell wall. Staining techniques- simple, differential and special staining techniques. Cultivation and growth of bacteria,

nutritional types of bacteria, bacteriological media, physical conditions required for growth, bacterial growth curve. Sterilization and disinfection.

Unit V: Nutrient Cycles and Bacterial Genetics

Microbes as components of the environment – nutrient cycles carbon, nitrogen, sulpur and phosphorus cycles. Symbiotic and non-symbiotic nitrogen fixation. Degradation of industrial wastes, petroleum hydrocarbons, pestcidies, biofouling and corrosion. Fermentation - alcohol, propionic acid, butyric acid fermentation. Para sexual process in bacteria and its significance: Transformation, transfection, transduction and conjugation.

Reference Books

1. Plant Biochemistry - James Bonner and J.R. Varner
2. Introduction to Plant Biochemistry - Goodwin
3. Plant Physiology - Salisbery
4. Plant Biochemistry & Molecular Biology - P.J. Lea & R.G. Heagood
5. Plant biochemistry - P.M. Dey and J.B. Harborne
6. Fundamental Principles of Bacteriology - A.J. Salle
7. Molecular biology and Biotechnology - J.M. Walker & Ginold E.B.
8. Industrial Microbiology - Presscott & Dunn
9. Microbial Physiology - Albert G. Moat
10. Industrial Microbiology - Miller & Litsky
11. Microbiology - M.J. Pelchar

PAPER IV - BC 221

ENZYMES

Unit I : Introduction to enzymes

General features of enzymes. Energy of activation and its significance. Transition state theory, rate enhancement through transition state stabilization and chemical mechanisms for transition state stabilization. Enzyme Commission system of classification and nomenclature of enzymes (Class and subclass with one example). Measurement and expression of enzyme activity - Definition of Unit, international unit (IU), katal.

Unit II : Coenzymes and mechanism of enzyme action

. Coenzymes and Co factors. Classification of coenzymes. Structure and coenzyme function of CoA, TPP, PLP, NAD/NADP, FAD, FMN, Biotin, folic acid, Vitamin B12 coenzymes. Concept of ES complex. Features of active site and mapping of active site.

Mechanism of enzyme action – acid-base catalysis, covalent catalysis, proximity and orientation effect. Structure and mechanism of action of representative enzyme – Trypsin, Chymotrypsin, Ribonuclease and Lysozyme.

Unit III : Enzyme kinetics

Order of reaction, progress curve for enzyme catalyzed reactions. Study of the factors affecting the velocity of enzyme catalyzed reaction - enzyme concentration, temperature, pH, inhibitors and activators (explanation with graphical representation), Michaelis Menten equation; Km and Vmax values and their significance, Lineweaver-Burk plot and its physiological significance, Eadie - Hofstee plot. Bi- substrate reactions, mechanism of bi substrate reactions - random, ordered and ping pong mechanisms.

Unit IV : Enzyme inhibition and regulation

Enzyme inhibition – competitive, non-competitive, uncompetitive and mixed. Allosteric and feedback inhibition with examples, suicide inhibition. Dose- response curves of enzyme inhibition, Enzyme regulation – cooperativity and allostery in proteins, models of allosteric behaviour. Covalently modulated enzymes - reversible and irreversible covalent modifications. Zymogen form of enzymes and zymogen activation. Multienzyme system –mechanism of action of pyruvate dehydrogenase and fatty acid synthase complexes. Isoenzymes- lactate dehydrogenase and creatine phosphokinase.

Unit V : Enzyme Technology

Isolation and purification of enzymes and criteria of purity. Industrial uses of enzymes- production of glucose from starch, cellulose and dextrans, use of lactase in diary industry, production of glucose fructose syrup from sucrose, use of proteases in food, leather and detergent industry. Immobilized enzymes. Enzyme engineering - modifying enzymes to make them stable and heat resistant. Designer enzymes- Abzymes, Ribozymes. Serum enzymes in health and disease - diagnostic and therapeutic applications.

Reference Books

1. Enzymes - Dixon & Web
2. Biological Chemistry - Mahler & Cordes
3. Principles of Biochemistry - Lehninger
4. Methods in Enzymology - Relevant volumes
5. Enzymes - Boyer

PAPER V – BC 222

METABOLISM

Unit I : Metabolism of Carbohydrates

Overview of glycolysis, gluconeogenesis, citric acid cycle, galactose and fructose metabolism. Detailed study of regulatory mechanism and energetics. Importance of pyruvate dehydrogenase. Significance of Cori and glyoxylate cycle. Pentose phosphate pathway- significance and regulation machinery. Biosynthesis and degradation of glycogen, starch and sucrose-role of UDP sugars in carbohydrate metabolism. Detailed study of hormonal regulation and role of secondary messengers in glycogen metabolism. Biosynthesis and biochemistry of mucopolysaccharides- hyaluronic acid, chondroitin sulfate, dermatan sulfate, heparin and keratin.

Unit II : Metabolism of Lipids

Biological regulation and significance of fatty acid metabolism. Metabolism of ketone bodies - Formation, utilization, excretion and clinical significance. Metabolism of triglycerides, phospholipids and sphingolipids. Fatty acid derivatives: eicosanoids, their function and metabolism. Lipoprotein metabolism and its regulation. Lipid peroxidation. Cholesterol – Biosynthesis, regulation, transport and excretion. HMG CoA reductase regulation. Biosynthesis of cholesterol derivatives; overview- bile acids, vitamin D and steroid hormones.

Unit III : Metabolism of Amino acids

Overview of biosynthesis of nonessential amino acids. Catabolism of amino acid nitrogen - transamination, deamination, ammonia formation and the urea cycle. Catabolism of amino acid carbon skeleton. Common enzymatic reactions of amino acid degradation – degradation of individual amino acids - regulation of amino acid metabolism.

Unit IV : Metabolism of Nucleic acids

Nucleotide biosynthesis - de novo and salvage pathways for biosynthesis of purine and pyrimidine. Mechanism of feedback regulation. Biosynthesis of dNTPs. Mechanism of purine and pyrimidine catabolism, uric acid, xanthine oxidase inhibitors.

Unit V : Bioenergetics

Principles of energy, energy transduction, membrane energy interconversions, high energy compounds, standard free energy of hydrolysis of ATP, transfer potential of phosphate groups, mitochondria - unltrastructure, electron transport chain, components and different complexes in detail. Mobile electron carriers. Proton transport during electron flow, inhibitors of electron transport chain. Mitochondrial electron transporters and shuttle systems. microsomal electron transport chain. Functions of ATP, substrate level phosphorylation, oxidative phosphorylation - mechanisms - energy coupling, chemical and chemiosmotic, conformational coupling, inhibitors and uncouplers, control of oxidative phosphorylation.

Note : Disorders of metabolism not included.

Reference Books

1. Principles of Biochemistry : Lehninger
2. Biochemistry : Stryer. L
3. Biochemistry : Garret & Grisham
4. Principles of Biochemistry : White, Handler & Smith

PAPER VI – BC 223

CLINICAL AND NUTRITIONAL BIOCHEMISTRY

Unit I : Energy metabolism

Energy metabolism- energy value of foods, Determination of Energy value using Bomb calorimeter – Respiratory quotient, Basal Metabolic Rate (BMR) – factors affecting BMR, Determination of energy metabolism during work, Energy expenditure for various types of activities, Recommended Daily Allowance (RDA), Specific Dynamic Action (SDA) of foods. Food additives and leavening agents, Browning reactions in foods, Flavor components in food, spices, condiments etc. Food preservation and food adulteration, Effect of cooking and heat processing on the nutritive value and digestibility of foods.

Unit II : Nutritional aspects of Food

Nutritional aspects of carbohydrates, lipids, proteins and fiber - sources, requirement, absorption and functions. Vitamins - classification, chemistry, physiological and biochemical functions, requirement, food sources, absorption, antagonists, deficiency, hyper vitaminosis. Minerals - major and minor minerals - sources, absorption, requirement, physiological and biochemical functions and deficiency. Free radicals and Antioxidants.

Unit III : . Biochemical aspects of Diet and Diet related Diseases

Balanced diet formulation, Determination of nutritive value of proteins, Biological value of proteins (BV), Protein efficiency ratio (PER), Digestibility coefficient, Net protein utilization, Net Protein Ratio (NPR), Chemical score, Protein energy malnutrition – Kwashiorkor, Marasmus. Life Style diseases – Atherosclerosis, Diabetes, Cancer, Inflammatory arthritis, Obesity – Risk factors, Molecular pathogenesis, Biochemical and clinical features, diagnosis, treatment.

Unit IV : Diseases related to digestion and absorption of foods

Gastritis and gastric atrophy (hyperacidity), Achlorhydria (hypochlorhydria), Ulcers - Peptic ulcer, Zollinger –Ellison syndrome, Meckel's diverticulum. Pancreatitis, Lactose intolerance, Monosaccharide malabsorption, Disaccharidase deficiency, Steatorrhea, Chyluria, Cholelithiasis, Sprue. Liver Diseases- Porphyrias, Jaundice, Hepatitis.

Unit V : Inborn Errors of Metabolism

Glycogen storage diseases, galactosemia, Hereditary fructose intolerance and Fructosuria, Diabetes insipidus, hypercholesterolemia, Hypo and Hyper lipoproteinemia, Mucopolysaccharidosis, Spingolipidosis, Phenylketonuria, Tyrosinosis, Albinism, Alkaptonuria, Maple syrup urine disease, Hartnup disease, homocystinuria, Disorders of urea cycle, Hypo and Hyperuricemia, Gout, Orotic aciduria, Abnormal hemoglobin - Hemoglobinopathies, Thalassemias and Anemias. Hereditory methemoglobinemia.

Reference Books

1. Applied nutrition - Dr. R. Rajalekshmi
2. Food science, Chemistry and experimental Foods - Dr. M. Swaminathan
3. Principles of Biochemistry - Lehninger
4. Biochemical basis of Inherited diseases - Fredrickson et.al
5. Clinical biochemistry:Metabolic concepts and clinical Aspects by W.J. Marshall and S. K. Bangrit
6. Text Book of Medical Physiology - Aurther C. Guyton
7. Harrisons Text book of medicine
8. Harper's Biochemistry - Murray et al
9. Genetic Biochemical Disorders - Benson and Fenson
10. Tietz fundamentals of clinical Chemistry - Carl A Burits, Edward R Ashwood

PAPER VII - BC 231

MOLECULAR BIOLOGY

Unit I : **Overview of genetic material- DNA Replication and Repair**

Genetic material DNA, RNA, viroid, prions -Concept and definition of the gene, complexity of the eukaryotic gene. Coding and non coding regions, C paradox, pseudogenes, and gene clusters, spacers, repetitive sequences, satellites, LINEs and SINES . Single and multiple copy genes in eukaryotes. Detailed mechanism of replication - eukaryotic, nuclear and mitochondrial DNA replication, details of events, enzymes and protein factors, cellular control of replication. Telomerase in replication. Mutation and mutagenic agents, replication repair, SOS response, recombination repair, nucleotide excision repair (mammalian and E.Coli)..

Unit II : Transcription

Transcription - eukaryotes, RNA polymerase, transcription factors. Differences between prokaryotic and eukaryotic transcription, inhibitors, post transcriptional modification of mRNA, tRNA, rRNA, RNA splicing, spliceosome machinery, Group I and Group II introns, alternative splicing, trans splicing, exon shuffling, RNA editing.

Unit III : Translation

Genetic Code, triplet code, triplet binding assay, general features, incorporation of novel amino acids. Translation in eukaryotes – initiation, elongation, termination

of protein synthesis, components required at each stage ,sequence of reaction, inhibitors of protein synthesis, Posttranslational processing of protein (protein folding, signal cleavage, disulphide bond formation, O and N-glycosylation, folding of nascent protein, role of chaperons, attachment of glycosyl anchor, and other modifications processing by chemical modification)

Unit IV : Regulation of gene expression

Regulation of Transcription and Translation – Positive and negative control, Repressor & inducer, concept of operon, lac, ara, trp operons, attenuation, catabolite repression, regulatory RNA gene silencing, RNAi, microRNAs, regulation of gene expression in bacterial virus (bacteriophage) lytic cycle of bacteriophage; stringent response of rRNA synthesis. Hormonal control, transcription factors, steroid receptors. DNA binding motifs in pro- and eukaryotes – Helix turn helix, zinc fingers, leucine zippers, helix loop helix motifs, acetylation and deacetylation, epigenetic effects.

Unit V : Introduction to Developmental Biology

Classification of eggs based on different criteria, cleavage; types of cleavage, blastulation-introduction, different types of blastula, blastocyst, gastrulation: introduction, brief account of morphogenetic movement- epiboly and emboly, concept of germ layers, cell differenciation: totipotency, pleuripotency and unipotency of embryonic cells. Gene action, Drosophila as a model organism.

Reference Books

1. Fundamentals of Biochemistry - Donald Voet et.al
2. Cell and Molecular Biology - Gerald Karp
3. Principles of Biochemistry - Geoffrey L. Zubay
4. Genes VI & VII - Benjamin Lewin
5. Essentials of Molecular Biology . - David Friedfelder
6. Biochemistry & Molecular Biology - Elliot & Elliot
7. Principles of Genetics . - Gardner et.al
8. Molecular Biology of the Gene - Watson,Baker, Gann, Levine & Losick.
9. Developmental Biology - Scott F Gilbert.
10. Introduction to embryology - B. I. Balinsky

PAPER VIII – BC 232

IMMUNOLOGY

Unit I : Innate immunity

Immunity- Types and general features, Hematopoiesis, Cells and Organs of immune system- structural features and functions. Innate immunity- Barriers of innate immunity (anatomic, physiologic, phagocytic and inflammatory barriers – Lipid mediators, Cytokines, Complement system-classical, alternative and lectin pathway, acute phase proteins, Kinin system.). Antigens, epitopes and haptens.

Unit II : Humoral Immunity

Antibody - structure, properties, different classes and biological functions, allotypes, isotypes,and idiotypes. Humoral immunity - B cell receptor, B cell development, Activation, Differentiation - generation of plasma cells and memory B cells. Clonal selection hypothesis. Antigen- antibody interaction, Genetic basis of antibody diversity.

Unit III : Cell mediated Immunity

Major histocompatibility gene complex(MHC) - organization, structure and cellular distribution of HLA antigens, Antigen processing and presentation – endogeneous and exogeneous pathways. Cell-mediated immunity :T cell development, structural organization of T cell-receptors, T-cell maturation, Activation, Differentiation, Proliferation , B cell – T cell interaction, The germinal centre reactions, Class switch recombination, generation of CD4+and CD8+ cell responses, secondary immune responses, regulation of the adaptive immune response.

Unit IV : Immunological techniques

Affinity, avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, Radioimmunoassay (RIA), ELISA (indirect, direct, sandwich, chemiluminescence, ELISPOT assay), HLA typing, leukocyte migration inhibition technique, delayed hypersensitivity techniques, cytotoxicity assay, immunoflurescence and immunoelectron microscopy.

Unit V : Clinical Immunology

Hypersensitivity - types and mechanism of hypersensitive reaction. Autoimmunity- mechanism of induction of organ specific (Hashimato'thyroiditis, autoimmune anemias,

Good Pasteur syndrome, IDDM) and systemic (SLE, mutiple sclerosis, rheumatoid arthritis) autoimmune diseases. Transplantation immunology-types of graft, immunological basis of graft rejection, tissue typing, bone marrow and kidney transplantation. Immunodeficiency diseases-specific impaired function in lymphoid lineage (SCID, Waldanstorm, agammaglobulinemia, Di George syndrome, common variable immunodeficiency) myeloid lineage (CGD, congenital neutropenia, Chediac-Higashi syndrome and leucocyte adhesion deficiency, AIDS). Vaccination and immunization.

Reference Books

1. Essential Immunology by Roit, I. Blackwell Science, Oxford
2. Immunology by Kuby, J. W.H. Freeman and Company, New York
3. Immunology by Roit, brostoff and Male. Mosby Edinburgh
4. Text Book of Immunology by Barrett. The C.V. Masby Company, St. Louis
5. Immunology by Tizard. Saunders College Publishing, Philadelphia
6. The Experimental Foundations of Modern Immunology by W. Clark. John wiley and Sons, New York
7. Cellular and Molecular Immunology by Abbas, Lichtman and Pober, W.B. Saunders Company, Philadelphia

PAPER IX – BC 233

PHARMACOLOGY AND TOXICOLOGY

Unit I : General Pharmacology

Introduction to pharmacology, sources of drugs, Classification of drugs based on sources, dosage forms, route of administration, site of action of drugs.Mechanism of action, concept of receptors, combined effect of drugs, factors modifying drug action. Dose response curve- ED50 and LD50.

Unit II : Pharmacokinetics

Absorption and distribution of drugs, importance of drug – protein interaction. Drug metabolism: chemical pathway of drug metabolism, phase I and phase II reactions, role of cytochrome P450, non- microsomal reactions of drug metabolism, drug metabolizing enzymes. Drug elimination of liver and kidney.

Unit III : Therapeutics

Biochemical mode of action of antibiotics- penicillin and chloramphenicol, actions of alkaloids, antiviral and antimalarial substances. Biochemical mechanism of drug resistance- sulphonamides. Drug potency and drug efficacy. General principles of chemotherapy: chemotherapy of parasitic infections, fungal infections, viral diseases. Introduction to immunomodulators and chemotherapy of cancer.

Unit IV : Screening for pharmacological activity

Analgesic, anti-inflammatory and antipyretic agents, gastrointestinal drugs, antiulcer and laxatives, antioxidants, anticancer and anti-fertility agents. Drugs for metabolic disorders like antidiabetic, anti-hyperlipidemic, anti-obesity and hepatoprotective agents.

Unit V : Clinical Toxicology

Definition, classification of toxicity – occupational, environmental and pharmaceutical. Types of toxins and their mechanism of action. Factors affecting toxicity- Drug tolerance, intolerance, addiction, allergy, hypersensitivity, antagonism and synergism. Methods of detection. Drug abuses and their biological effects. Rational prescription of drugs. Toxicity of anticancer drugs. Clinical symptoms of toxicity and marker parameters.

Reference Books

1. F S K Barar, Essentials of Pharmacotherapeutics, S. Chand Limited, 2000.
2. J. Lippincot co,pharmaceutical chemistry, Philadelphia.
3. Bertram Katzung, Anthony Trevor, Basic and Clinical Pharmacology, McGraw Hill Professional, 2014.
4. Golan, David E., Armen H. Tashjian, and Ehrin J. Armstrong, eds. Principles of pharmacology: the pathophysiologic basis of drug therapy. Lippincott Williams & Wilkins, 2011.
5. Klaassen, Curtis D., ed. Casarett and Doull's toxicology: the basic science of poisons. McGraw-Hill, 2013.
6. Screening methods in pharmacology. Robert A Turner, academic press, Newyork.
7. Goodman & Gilman. The pharmacological basis of therapeutics,Pentagon press.

PAPER X - BC 234

METHODS IN RESEARCH

Unit I : Introduction to Intellectual Property

IPR policy of Government of India, Indian & International Patent laws, Types of patents. Indian Patent Act 1970; Recent Amendments; Protection of New GMOs; Financial assistance for patenting-introduction to existing schemes. Procedure for patent application, International harmonization of patent laws, Patenting of life forms - plant, animals, microbes, gene, process and products,

Unit II : Research methodology and Scientific Writing :

Goals of research – Types of research – Important and need for research ethics and scientific research. Formulation of hypothesis. Characteristic designing a research work - experimental design. Characteristic logical format for writing thesis and papers- Essential features of abstract, Introduction, Review of literature, Materials and methods, results and discussion, Effective illustration, Tables and figures, reference style- Harward and Vancavour system. When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Citation and Acknowledgement, ISBN & ISSN. Peer review. Impact factor and H- index of journals. Presentation tools : oral and poster, Microsoft Power Point and PDF slides.

Unit III : Biostatistics

Introduction to Biostatistics. Concept of sampling and sampling methods. Classification and tabulation of data. Diagrammatic and graphical representation of data. Measure of central tendencies- Mean, median, mode, geometric mean and harmonic mean. Variance- Coefficient of variation. Statistics of Dispersion- range, quartile deviation, mean deviation, standard deviation and standard error. Concepts of moments, skewness and kurtosis; Simple correlation and regression; Correlation analysis-scatter diagram, Karl Peason's coefficient of correlation and Spearman's rank correlation. Software packages for statistical analysis - MS-Excel. Probability and law of probability; Probability distributions (binomial, poisson and normal); Tests of statistical significance (t –Test, chi-square test); Analysis of variance- one way and two way ANOVA (Notice:- The

students are expected to understand the concepts and solve relevant problems. No derivations and proofs are expected).

Unit IV : Bioinformatics

Introduction to bioinformatics. Application of bioinformatics, Bioinformatics resources. Biological databases : overview of biological databases, nucleotide databases (Gen Bank, DDBJ, ENA) Protein structure databases (PDB, SCOP, CATH), Organism specific databases, Bibliographic databases. Sequence analysis : pair wise alignment, multiple sequences alignment, Scoring matrices, Phylogenetic trees. Sequence similarity search, Blast, FASTA, CLUSTAL.

Unit V : Genomics and Proteomics

Genomics: Introduction to genomics, comparative genomic databases, objective of genome comparisons, Genome alignments. Proteomics : Overview of proteomics, Experimental techniques, Protein – Protein interaction, databases and software. Molecular visualization softwares, Structure based drug design, Molecular docking software, Protein structure prediction – comparative modeling, threading.

Reference Books

1. Research methodolody - R. Paneerselvam
2. Research methodolody - C. R. Kothari
3. How to write a scientific paper - R. A. Day
4. Guide to Scientific and technical writing - Cooray P. G.
5. Biostatistics - Herrold H. Zar (4^{th} edition)
6. Statistical Methods - S. P. Gupta
7. Fundamentals of IT - Alexis Leon & Mathews Leon
8. Programming in ANSI C - E.Balaguruswamy
9. Information Technology : The Basics - Barbara Wilson
10. Developing Bioinformatics Computer Skills - Wibas C, Jenbeck P
11. P. Narayanan, Intellectual Property Laws, Eastern Law House : 2001.
12. Meenu Paul, Intellectual Property Laws, Allahabad Law Agency ;2009 .
13. Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.

PAPER XI - BC 241

MOLECULAR ENDOCRINOLOGY

Unit I : Introduction to endocrinology

Chemical classification of hormones, feedback regulations, hormone receptors- general features, structure regulations, types - plasma membrane receptors, Role of Plasma membrane receptors- G protein coupled receptors, Receptor protein tyrosine kinases, Non Receptor protein tyrosine kinases, Steroid hormone receptors and thyroid receptors. Mechanism of hormone action and signal transduction- Group I and Group II hormones.

Unit II : Hypothalamo - Hypophysial – Hormones

Bio-chemistry and mechanism of action, regulation, synthesis and secretion Hypo and hyperactivity of pituitary hormones - Hypothalamic releasing factors, Anterior Pituitary hormones, Vasopressin, Oxytocin. Regulation of synthesis. Lactogenic hormones. Glycoprotein hormones of the POMC family, endorphins, Gigantism , Dwarfism, Acromegaly, diabetics insipidus, syndromes of inappropriate ADH secretion. Mechanism of action and functions of melatonin

Unit III : Thyroid and para thyroid hormones

Synthesis, secretion, transport and mechanism of action. Metabolic fate and biological action, thyroid diseases, thyrotoxicosis, goiter, hypothyroidism, grave's disease, Hashimoto's disease, thyroid function tests, calcium and phosphorus metabolism, calcitriol, pathophysiology.

Unit IV : Adrenal hormones

Adrenal cortex, glucocorticoids and mineralocorticoids, Synthesis, secretion, transport and mechanism of action. Metabolic fate and biological actions, Hormones of Adrenal Medulla - Catecholamines - Biosynthesis, storage, metabolism, regulation of synthesis. abnormal secretion of adrenal hormones, Addison's disease, Cushing's syndrome, congenital adrenal, hyper plasia, phaeocromocytoma. Gonadal hormones, Androgen, estrogen, synthesis, secretion, transport and mechanism of action. Metabolic fate and biological action, Ovarian cycle. Pregnancy, Biochemical changes in pregnancy.

Unit V : Pancreatic Hormones

Islets of langerhans and hormone secretions, biosynthesis, secretion and mechanism of action, receptor signaling, pathway of insulin and glucagon, somatostatin, pancreatic poly peptide and insulin- like growth factors, gastro intestinal hormones- synthesis, structure, secretion and function. GIP, VIP, gastric, CCK and other peptides.

Reference Books

1. Endocrinology : Mac Hadley
2. William text book of Endocrinology : Larcen Et Al
3. Memalian Biochemistry : White Handler Smith
4. Harper's Biochemistry : Murray Etal
5. Principles of Biochemistry : Nelson Cox
6. Biochemistry : Voet and Voet
7. Introduction to Endocrinology : Chandra S.Negi

PAPER XII – BC 242

BIOTECHNOLOGY AND GENETIC ENGINEERING

Unit I : Recombinant DNA technology

Principles, procedures and applications of recombinant DNA technology. Construction of genomic and c-DNA library. Enzymes in cloning. Restriction analysis of DNA, Chromosome walking, jumping, Reporter genes, Vectors for molecular cloning- phages, plasmids and cosmids, YACs and BACs - properties and applications. Screening of recombinants - Marker inactivation, nucleic acid hybridization and immunological screening for expressed genes. Prokaryotic expression systems and eukaryotic expression systems (outline)

Unit II : Advanced molecular techniques

Sequencing of DNA-chemical and enzymatic methods, Pyrrosequencing, Next gen sequencing. Genetic polymorphism, DNA markers -VNTR, STR, microsatellite, SNP. RFLP, RAPD and PCR- Principles, procedures and applications, variations of PCR. DNA Finger printing, site directed mutagenesis. DNA microarrays, human genome mapping, human genome project.

Unit III : Medical Biotechnology

Hybridoma technology and monoclonal antibodies in diagnosis and therapy, liposomes, drug targeting, interferones, vaccines, diagnostic kits and diagnostic probes, immobilised enzymes as diagnostic reagents, biosensors and their applications. Genetic counselling, possible approaches for tackling genetic disorders, diagnosis of genetic defects, eugenics, anti natal diagnosis, fetus sexing, Gene therapy

Unit IV : Plant Biotechnology

Principles and applications of plant tissue culture-techniques and prospects. Recombination by protoplast fusion. Genetic engineering of plants- transfer and expression of genes in plants-transgenic plants, manipulating plants for non-food carbohydrates and lipids, production of vaccines and molecular farming. Terminator genes, BT gene, production of artificial genes. Plant breeding techniques, methods of crop and live stock improvement.

Unit V : Environmental and Industrial Biotechnology

Definition and application - bio indicators, biopesticides, biological mining, bioremediation, biofuel, Environmental monitoring; land fills and vermi compositing; biofertilizers; technology for production of major biofertilizers; ethical, social and biosafety aspects of biotechnology; biological containment. Bioreactors: Introduction to bioreactors - Aerobic and anaerobic fermentation; solid state and submerged fermentation; Types of Bioreactors: Batch, continuous and fed-batch (variants), Production, harvest, recovery of enzymes, antibiotics (penicillins, tetracycline, streptomycin). Production of human insulin.

Reference Books

1. Comprehensive Biotechnology - Moo and Young(eds.) Vol 2, 3 and 4
2. Biotechnology - B. D. Singh
3. Microbial Biotechnology - Peppler J.H. & Perlman, D.(Eds), Vol I & II
4. Molecular Cloning - Fritch, E.F. and Sambrook J. Cold Spring Harbour Lab: A laboratory manual.
5. Gene Cloning - Glower, Vol I to IV
6. Principles of gene manipulations - Primose S.B., R.W.Blackwell scientific Edition.
7. Recombinant DNA - Watson, Tose & Kurtz, New York.
8. Biotechnology - J. E. Smith

9. Principles of fermentation technology - P. F. Stanbury and A.Whitaker, Pergamon press. Second edition.
10. Fermentation microbiology and Biotechnology - Second edition, edited by El-.Mansi, C.F.A. Bryce, A.L. Demain, A.R. Allman. Taylor and Francis, 2007.

PRACTICAL I - BC 214

BIOCHEMICAL & MICROBIAL TECHNIQUES

I BIOCHEMICAL TECHNIQUES:

A. **Dialysis**

1. Separation of macromolecules from small molecules

2. Concentration of protein solution.

B. **Paper chromatography**

1. Separation of sugars by ascending or descending chromatography

2. Separation of aminoacids by two-dimensional chromatography

C. **Thin layer chromatography**

1. Separation of sugars on thin layer of silica gel

2. Separation of lipids on silica gel

D. **Electrophoresis**

1. Separation of proteins by polyacrylamide gel electrophoresis

II MICROBIAL TECHNIQUES:

Sterilization techniques - Principles, methods - moist heat, dry heat, filter types.

Preparation of media - liquid, solid; Agar- plate, slant, tube.

Staining techniques - simple, differential and special staining.

Pure culture techniques - streak plate, pour plate.

Detection of enzyme activity- Catalase, oxidase, amylase, caseinase,

Phosphatase test for the quality of milk.

Total viable count determination - streak plate, pour plate.

Enumeration of microorganisms from water; standard plate count, MPN test

Practical examination Scheme

BIOCHEMICAL & MICROBIAL TECHNIQUES- 75 marks

I . BIOCHEMICAL TECHNIQUES: 30 marks

Thin layer/Paper chromatography/PAGE : Procedure – 5 marks; Instrument Setting - 5 marks; Chromatogram development/ running the gel- 5 marks; Final result- 15 marks.

II MICROBIAL TECHNIQUES: 35 marks

A. Staining techniques- 20 marks : Procedure- 5 marks ; Preparation of smear and staining-5 marks; Final result- 10 marks.

B. Detection of enzyme activity- Catalase/ oxidase/ amylase/ caseinase- 15 marks : Procedure- 5 marks ; Steps- 5 marks ; Observation- 5 marks.

III. Spot test/ practical based short answer type questions (10 numbers) - 10 marks
(Answer in a word or sentence)

PRACTICAL II – BC 224

ENZYMOLOGY AND CLINICAL BIOCHEMISTRY

1. **Determination of enzymatic activity in biological tissues- serum/plasma, liver, plant extracts, etc (Any five)**

   β hexosaminidase, Amylase , Trypsin, Urease

2. **Enzyme kinetics (amylase, trypsin, urease, yeast fructfuranosidase) – any one**

   Progress curve of enzyme action

   Effect of substrate concentration on enzymatic activity

   Effect of pH on enzymatic activity

   Effect of enzyme concentration on enzymatic activity

   Effect of temperature on velocity of enzyme catalysed reaction

   Effect of activators/electrolytes on velocity of enzyme catalysed reaction

3. **Preparation and purification of any of the following enzymes**

. LDH from rabbit muscle, Urease from red gram, β-amylase from sweet potato

4. **Blood analysis -**

   1. **Liver Function Tests :**
      Acid and alkaline phosphatase, ALT, AST, Bilirubin, protein, albumin, A/G ratio
   2. **Kidney Function Tests :** Urea, uric acid, creatinine
   3. **Cardiac Markers :**

      Lipid profile (Cholesterol, Triglyceride, HDL-C, LDL-C), LDH, CRP, CPK

   4. **Biochemical markers of Diabetes Mellitus**

      Blood glucose (RBS, FBS, PPBS), Glycosylated Hb, Glucose tolerance test.

Practical examination Scheme

ENZYMOLOGY AND CLINICAL BIOCHEMISTRY : 75 MARKS

1. **ENZYMOLOGY- 35marks**
   Determination of enzymatic activity/ Enzyme kinetics - 35 marks :
   (Principle & Procedure- 5 marks ; Isolation of enzymes - 10 marks ; Tabulation- 5 marks ; Graph- 5 marks ; Final value- 10 marks)

11. Blood analysis- 30 marks : Blood/Liver/ kidney function tests

(Principle & procedure- 5 marks ; Tabulation- 5 marks ; Graph- 5 marks ; Calculation- 5 marks ; Final value- 10 marks)

III. Spot test/ practical based short answer type questions (10 numbers) - 10 marks
(Answer in a word or sentence)

PRACTICAL III - BC 235

IMMUNOTECHNIQUES AND PHYTOCHEMICAL ANALYSIS

I . IMMUNOTECHNIQUES

1. **Blood film preparation and identification of cells**

2. **Demonstration of immune reaction**

   1. Blood group
   2. Widal test
   3. Pregnancy test
   4. Coombs test
   5. ELISA

3. **Antigen antibody reaction**
   1. Ouchterlony double diffusion
   2. Immunoelectrophoresis
   3. Immunoblotting
   4. Immunostaining
   5. Immunofluorescent

4. **Production of antibodies**
   1. Purification of immunoglobulins

II. PHYTOCHEMICAL ANALYSIS

1. Preparation of extracts of crude drugs/herbs by successive solvent extraction method to record the percentage yield and for subjecting them to phytochemical screening
2. Preliminary phytochemical screening
   a. Cold and hot extraction methods

b. Qualitative chemical examination.- Detection of phytoconstituents by test tube methods – Alkaloids ,phenolcs, flavonoids, glycosides,steroids, triterpenoids, saponins, tannins.

3. Identification of alkaloids in a mixture by TLC
4. Quantitative analysis of phytoconstituents by various methods-
   a. Determination of total phenolic content
   b. Determination of total flavonoid content
   c. Determination of total antioxidant activity
5. Screening of herbal extracts/products for free radical scavenging and antioxidant activities.
6. Isolation of natural products by column chromatography

Practical examination Scheme

IMMUNOTECHNIQUES AND PHYTOCHEMICAL ANALYSIS : 75 MARKS

I. IMMUNOTECHNIQUES- 25 marks : Principle and procedure- 5 marks ; Demonstration of immune reaction (steps and result)- 10 marks ; Antigen- antibody reaction(steps and result) - 10 marks.

II. PHYTOCHEMICAL ANALYSIS- 40 marks

1. Qualitative analysis (positive and negative reactions & confirmatory test) - 10 marks.
2. Quantitative determination of phytoconstituents- total phenolics/ flavonoids/antioxidant activity- 30 marks : Principle and procedure - 5 marks ; Tabulation- 5 marks ; Graph – 5 ; Calculation- 5 marks ; Final value- 10 marks)
3. Spot test/ practical based short answer type questions (10 numbers) - 10 marks (Answer in a word or sentence)

PRACTICAL IV – BC 243

TECHNIQUES IN MOLECULAR BIOLOGY

I. Nucleic acids

1. Isolation of RNA from yeast/ E.coli
2. Isolation of DNA from coconut endosperm/Plants/banana
3. UV absorption of nucleic acids
4. Estimation of DNA by diphenylamine reaction
5. Estimation of RNA by orcinol method

II. Electrophoresis

1. Agarose gel electrophoresis of DNA

III. Amplification of DNA by PCR

IV. Culture of E. coil cells and isolation of plasmid

Practical examination Scheme

TECHNIQUES IN MOLECULAR BIOLOGY : 75 MARKS

I. Nucleic acids – 35 marks : Procedure- 10 marks ; Isolation of DNA- 25 marks.

II. Electrophoresis- 30 marks : Instrument setting 10 marks, Separation of DNA- 20 marks.

III. Spot test/ practical based short answer type questions (10 numbers) - 10 marks
(Answer in a word or sentence).