

SYLLABUS SCREENING TEST BIOCHEMIST

FUNDAMENTALS OF BIOCHEMISTRY

Structure of monosaccharides, oligosaccharides and polysaccharides, glycoproteins, glycolipids, proteoglycans, mutarotation, anomers, epimerization, stability of polysaccharides. Glycolytic pathway; regulation of the hexokinase, phosphofructokinases, Krebs' cycle; amphibolic nature of TCA cycle, glyoxylate cycle, glycogen breakdown, glycogen synthesis, regulation of glycogen metabolism, gluconeogenesis and its regulation, pentose phosphate pathways, metabolism of Fructose and Galactose.

Structure and properties of fatty acids, storage and membrane lipids, phospholipids and cholesterol, Composition and synthesis of lipoproteins and their transport in the body, oxidation of fatty acids (beta & alpha), oxidation of long chain fatty acids, Synthesis of lipids, elongation of fatty acids, desaturation of fatty acids, regulation of fatty acid synthesis, cholesterol metabolism, regulation of cholesterol metabolism. Structure, composition and properties of nucleic acids, De-Novo synthesis of purine and pyrimidine nucleotides and its regulation. Synthesis of nucleoside di- and triphosphates, deoxynucleotides and TMP and degradation of purine and pyrimidine nucleotides, salvage pathways of nucleotides synthesis.

Structure and properties of amino acids, Structure of protein (Primary, Secondary, Tertiary and Quaternary), essential and non-essential amino acids, general reactions of amino acid metabolism, urea cycle, synthesis of various molecules via amino acid metabolism intermediates, non-standard Amino Acids. Structure and properties of vitamins, co-enzymes, biochemical action of vitamins and water-soluble vitamins, Biosynthesis of vitamins, role of vitamins in the metabolism.

Practicals

Preparation of Acetate and phosphate buffer system and validate the Henderson Hasselbach equation.

To determine concentration of an unknown protein by UV-Vis Spectrophotometer.

Determination of Molar extinction coefficient of protein.

Protein purification by gel filtration, ion-exchange chromatography.

Determine pKa and pI of amino acids

Protein separation by SDS-PAGE

Qualitative and Quantitative Analysis of Carbohydrates, Amino acids and proteins, lipid and nucleic acid.

Separation of amino acids and sugars by TLC

Extraction of proteins, RNA and DNA from cultured cells.

CELL BIOLOGY

Cellular organization: Membrane models, chemical composition of membrane, membrane proteins, movement of small and large molecules across the cell membrane, osmosis, diffusion, endocytosis, phagocytosis, artificial liposomes and its application. Sub-cellular organelles: Structure and functions of intracellular organelles such as nucleus, mitochondria, endoplasmic reticulum, golgi apparatus, lysosomes, plastids, peroxisomes. Cytoskeleton: Structure, organization and function of microtubules and microfilaments, role of myosin, kinesin and dynein, cell movements.

Extracellular matrix and cell adhesion molecules: Function and composition of extracellular matrix molecules, types of cell adhesion molecules, integrin, cadherin and immunoglobulin superfamily proteins. Protein targeting: Protein synthesis on free and bound ribosomes, modification and quality control of protein in ER, secretion and transport of protein to various cell compartments, post translational modification.

Signal Transduction: Receptors and ligands, cellular communication, signalling through membrane receptors like GPCR, receptor tyrosine kinase, receptor serine/threonine kinase, PI3K/Akt, MAPkinase, cytokine signalling like JAK-STAT, TCR mediated signalling.

Cell cycle and cell death: cell cycle, role of cyclins, cyclin dependent kinase in cell cycle progression. Apoptosis; pro-apoptotic and anti-apoptotic regulators, mechanism of necrosis and autophagy. Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth, embryonic signature in cancer cells.

MICROBIOLOGY

Introduction of Microbiology: Origin and evolution of microbial world; Pathway of discovery in Microbiology; Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese, Classification and bacterial and archaea systematics: conventional and modern methods of bacterial taxonomy. Classification of bacteria according to Bergey's manual, bacterial identification, general characteristics of archaea, eubacteria, acellular life forms
Microbes Growth: Definition of growth, mathematical expression of growth, growth curve, diauxic & synchronous growth, continuous culture. Effect of environmental on bacterial growth

Prokaryotic and Eukaryotic Microbiology: General characteristics of various groups of prokaryotes: bacteria including, Rickettsiae, Chlamydiae, Spirochaetes and Actinobacteria, Cyanobacteria and Mycoplasmas. Eubacteria: cell structure, nutrition, isolation and cultivation. Diversity, nutrition, ecology, significance of gram-positive (Firmicutes, Actinobacteria) and gram-negative [Proteobacteria (cyanobacteria, Rhizobia), Deinococcus-Thermus, Spirochaetes, Bacteroidetes].

Mycology and phycology: General characters of fungi and algae, cultivation, cultural characteristics, microscopic morphology, importance of fungi and algae in industry and food production. Yeasts: General characteristic, structure, classification, life cycles (important forms), sexual and asexual reproduction of yeast (*Saccharomyces cerevisiae*)

Virology- Structure of animal viruses and plant viruses; satellite viruses; viroids; prions; diseases caused by animal viruses and plant viruses, genome organization of animal viruses; genome organization of DNA and RNA plant viruses, bacteriophages, lytic and lysogenic cycles, cultivation of viruses, diagnosis viruses
Protozoa: Classification, morphology, reproduction, modes of nutrition, modes of transmission, life cycle, cultivation of protozoa. Structure and significance: Entamoeba, Plasmodium. Applied Microbiology- Overview of applications of microorganisms in Agriculture, Environment, Food, Industry and Medical Sciences.

Microbiology Practical

Sterilization, disinfection, safety in microbiological laboratory

Preparation of media (plates, broth and slants) for growth of various microorganisms.

Identification and culturing of various microorganisms. Spreading and streaking plating techniques.

Staining of bacteria – Simple staining, differential staining, staining of spores and capsules

Enumeration of microorganisms from water by viable plate counting

Determination of growth curve of bacteria and calculation of bacterial population by turbidometry

Effect of pH, temperature and UV irradiation in bacterial growth

Determination of Minimal Inhibitory concentrations (MIC) for kanamycin and ampicillin against Bacteria.

HUMAN PHYSIOLOGY

Digestive System: Anatomy and functions of alimentary canal and digestive glands, digestive processes, food intake and regulation, enzymes secretions and their function in the oral cavity, stomach and intestine, Nutritional value of micronutrients, BMR and nutritional disorders. Cardiovascular System: Components of blood, plasma, blood groups, Rh factor, structure and function of heart and blood vessels; cardiac cycle; origin, conduction and regulation of heart beat, cardiac disorders, ECG, lymphatic system. Respiratory System: Exchange of gases, transport of O₂ and CO₂ in blood, O₂ and CO₂, dissociation curves, control and regulation of respiration, disorders associated with respiration system.

Nervous System: Organization of nervous system-CNS, PNS. PNS, somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron and glial cells, Synapse, nerve impulse transmission, function of voltage-dependent and neurotransmitter-gated ion channels; the role of these ion channels in synaptic transmission, synaptic modification, and neuromodulation; molecular and cellular properties of ion channels in neurons and sensory cells and their relationship to brain and sensory systems, neurotransmitters, sense organs- gustatory, olfactory, vision, hearing, touch receptors. Musculo-skeletal System: Components of skeletal system; skeletal organization; bone structure and function, development and growth, mechanism of bone remodelling and osteoporosis, types of muscles- smooth, cardiac, skeleton muscles, muscle contraction and theory of muscle contraction.

Uro-Genital System: structure and function of kidney and nephron, mechanism and regulation of urine formation, haemodialysis and homeostatic imbalances in excretion, reproductive cycles, reproduction, fertilization, embryogenesis and fetus development, fate maps and amniocentesis, embryonic membrane and placentation, in-vitro fertilization, regulation of fertility
Histology and functions of endocrine glands- Pituitary, Thyroid, Adrenal, Parathyroid, Pancreas; nature of hormones, regulation of hormone secretion, effects of abnormal secretions of hormones and placental hormones, peptide hormones and steroid hormones, biochemistry of hormone action.

INFECTION BIOLOGY

Viral infection: Development of HIV virus, HIV infection to humans, Structure of HIV virus, mechanism of HIV infection, role of T cells in infection development, development of therapy against HIV, anti-retroviral therapy, HAART, economic loss by HIV at national & international Revised M.Sc. Biochemistry from 2019 17 level. Hepatitis virus, types of hepatitis infection, viral outbreaks such as Ebola, H1N1, and Zika virus.

Bacterial infection: Development of tuberculosis infection, diagnosis of tuberculosis, epidemiology and geography of tuberculosis, treatment of tuberculosis, identification of drug targets, vaccine development for tuberculosis, mechanism of antituberculosis drug action, development of resistant, multidrug resistant, economic loss by tuberculosis at national and international level, HIV-tuberculosis co-infection.

Parasite infection: Parasitic infectious diseases, leishmaniasis, epidemiology and geography of leishmaniasis, vector and transmission of leishmaniasis, host-pathogen interaction, diagnosis and treatment for leishmaniasis, genetics of leishmaniasis, mechanism of drug resistance and drug susceptibility for promastigotes and amastigotes, history of malaria, life cycle of plasmodium, factors affecting transmission of parasite, vectors and epidemics, parasite metabolisms, secondary endosymbiosis, drug resistant parasites, identification of drug targets, amoebiasis.

CLINICAL BIOCHEMISTRY

Quality control, accuracy, precision, specificity, sensitivity and limitation of errors allowable in the laboratory; Chemistry, composition & functions of lymph, CSF, and synovial fluid; Urine formation, excretion and urine analysis; collection of bloods, anti-coagulants, preservatives of blood; Composition, chemistry & functions of specialized tissues like i.e. bone, brain, adipose tissue, etc. Clinical investigation of sugar levels in blood and urine; factors influencing blood glucose level; carbohydrate tolerance tests, glycogen storage diseases; Biosynthesis of bile acids, bile pigments and steroid hormones, plasma lipoproteins, Disorders associated with lipid metabolism and its therapeutic intervention, ketone bodies and ketosis;

Hemoglobin, Met-Hb, embryonic-Hb, heme metabolism associated diseases, sickle cell anemia, thalasemia, malnutrition, measurement of fuel values of foods, measurement and calculation of BMR, Metabolic disorders of amino acid metabolism and urea cycle, phenylketonuria, alkaptonuria, albinism, Lesch-Nyhan syndrome, disorders of nucleic acids metabolism Biochemical mechanism of blood clotting and hemorrhagic disorders, disseminated intravascular coagulation, acquired prothrombin complex disorders. Biochemistry of vitamins and micronutrients, biochemical basis of diseases with their deficiency;

Electrolytes, reabsorption of electrolytes, acid-base balance, regulation of electrolyte content of body fluids and maintenance of pH, regulation of sodium and water balance, renin-angiotensin system, clinical investigation of sodium, potassium, chloride; Pathophysiology of different diseases like diabetes, Jaundice, Fatty liver, atherosclerosis, and osteoporosis; Functional test of liver, kidney, thyroid, gastrointestinal and pancreas, biochemical diagnosis of diseases by enzymatic assays; Clinical tissue analysis, biopsy, liquid biopsy, circulating RNA and DNA as molecular diagnosis of different diseases.

Practical

Estimation using semi & fully automated analyzers :

Glucose

Components of LFT, RFT, lipid profile, diabetic profile etc.

Enzymes of diagnostic importance – amylase, lipase, CPK, CPK-MB, Troponin I, LDH etc.

Estimation of hormones, vitamins, tumour markers and other biomarkers by ELISA, RIA, CLIA etc.

Biochemical analysis of fluids: CSF, ascitic & pleural fluids etc.

Analysis of arterial blood gases & electrolytes

Fractionation & identification of

Amino acids

Sugars

Proteins

Lipoproteins by –

Thin layer & Paper chromatography

Various diagnoses using HPLC

Gel electrophoresis & paper electrophoresis

Capillary electrophoresis of plasma proteins

Calculation of coefficient of variation, coefficient of correlation, plotting LJ charts

Total quality management of laboratory:

Specimen collection, handling & storage of sample

Methods of standardization & calibration

Methods of quality control & assessment

Interpretation and correlation of various biochemical parameters with different clinical conditions

Blood cell counts

Determination of blood uric acid, albumin, creatinine.

Determination of blood SGPT, SGOT.

Determination of blood SOD, Catalase, Glutathione peroxidase activity

Determination of blood alkaline phosphatase, myeloperoxidase activity

Determination of blood Ca²⁺, Na⁺ and K⁺ .

BIOSTATISTICS AND RESEARCH METHODOLOGY

Research Basics: definition, purpose and types; Process of Research and Dimensions of research, research problem, research questions, Research design, tools of research; methods of research, systematic review of literature, preparation of research proposal/ synopsis, Research Ethics (Issues relating to referencing and documentation, copyrights, plagiarism), Impact Factor, HIndex, Citation Index, references/bibliography, structuring the thesis, use of software in thesis writing.

Data collection, processing and presentation, Measures of central tendency, Regression and Correlation, ANOVA; Errors; Levels of significance; probability distributions; Analysis of χ variance Hypothesis; Probabilities; chi-square test, t-test, p-value and Fisher's exact test; non-parametric tests of significance, statistical aspects of diagnostic tests, multivariate analysis of variance and multiple range tests, use of software in statistical analysis;

Preparation of manuscript and its submission, writing of innovative project proposal and its submission.

Total quality management of laboratories; internal quality control, EQAS, Lab accreditation etc.

NUTRITION

Digestion and absorption from gastrointestinal tract.

Energy metabolism – Calorimetry, BMR – its determination & factors affecting it, SDA of food

Macro & Micro – elements and their role in health & disease, water metabolism and its regulation.

Vitamins – Chemistry, biological importance, deficiency manifestations & recommended daily allowance.

Principles of nutrition – Balanced diet and its planning, nutritive importance of various food sources, calorific value of food, toxins and additives, obesity, protein energy malnutrition.

Metabolic changes during starvation.

Diet management of chronic disease viz. Diabetes mellitus, coronary artery disease, renal disorders, cancer, hypertension, anemia, rickets and osteomalacia.

Importance of pollution free and ecofriendly environment, exposure to cold stress, exposure to heat, air pollution, water pollution and food pollution.

MOLECULAR BIOLOGY

Replication, transcription, protein biosynthesis and gene regulation, genetic code, mutations and mutants, DNA repair, purines and pyrimidines – biosynthesis and degradation, signal transduction, receptor – structure and regulation, cloning, construction of genomic libraries, strategies for screening DNA libraries, genes and chromosomes, gene mapping, chromosome walking etc. Gene expression and gene amplification and gene regulation. Genetic engineering; Recombinant DNA technology and its applications. Restriction endonucleases, plasmids, cosmids, gene cloning, gene libraries, oncogenes, biochemistry of cancer and tumour markers.

IMMUNOLOGY

Structure functions, classifications and synthesis of immunoglobulins, antigen – antibody reaction, mechanisms and regulation of immune responses. Complement system, hypersensitivity, immune tolerance, immunity to infection, autoimmunity and autoimmune diseases, tumour immunity, genetics of immune response, major histocompatibility complex, transplantation, vaccination and immunization strategies, hybridoma technology. Apoptosis, telomeres and telomerase, cytokine network, immunodiagnostics, biochemistry of AIDS

Books recommended

Voet D., Voet J.G, Biochemistry 4th Edition., John Wiley and Sons, 2011.

Nelson, D. C. and Cox, M.M., Lehninger Principles of Biochemistry, 5th Edition, W. H. Freeman, 2010.

Berg J.M., Tymoczko J.L. and Stryer L., Biochemistry. 7th edition, W.H. Freeman and Co. New York, 2011.

G.M. Cooper. 2013. The Cell - A Molecular Approach, Sunderland (MA), Sinauer Associates, Inc. USA.

Gerald K., Cell and Molecular Biology, Concept and Experiment, 5th Edition, Wiley, 2007.

Lodish, H., Berk A., Kaiser C. A., Krieger M., Bretscher A., Ploegh H., and Scott M.P. Molecular Cell Biology, 7th Edition, Freeman, W. H. and Co., 2013.

Alberts B., Walter P., Johnson A., Lewis J., Morgan D., and Raff. M., RobertsK., Walter P. Molecular Biology of the Cell, 6th Edition, Garland Publishing Inc., 2014.

Michael J Pelczar, Microbiology, Tata McGraw, India.

Microbiology by Stuart Walker, W B Saunders

Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. S. J. Flint, V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka.

A text book of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia.

Introduction to Physiology by Davidson H and Segal M. B. Academic Press.

Review of Medical Physiology-William F.Ganong

Physiological basis of Medical Practice, John.B.West.

Vander's Human Physiology-The mechanism of Body function, Widmaier, Raff, strang.

Irwin W. Sherman, Malaria Parasite Biology, Pathogenesis, and Protection, American Society for Microbiology. 1998. WHO technical series-949; Control of the leishmaniasis (ISBN 978 92 4 120949 6)

Virology: Principles and Applications John Carter, Venetia Saunders.

Harpers Illustrated Biochemistry 30th Edition, McGraw-Hill Education, 2015

Clinical Biochemistry and Metabolic Medicine Eighth Edition by Martin Andrew Crook, CRC Press, 2012

Textbook of Biochemistry for Medical Students, 7th edition, by D M Vasudevan, Sreekumari S, KannanVaidyanathan, 2010, Jaypee.

Clinical chemistry: Techniques, Principles, Correlations , 6th Edition, by Bishop, Fody and Schoeff, 2012, Lippincott Williams & Wilkins

John W. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Edition SAGE

Sharan B. Merriam & Elizabeth J. Tisdell, Qualitative Research: A Guide to Design and Implementation, 4th Edition, John Wiley & Sons