

**JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE
(AUTONOMOUS)
OOTY ROAD, MYSORE – 25.**



DEPARTMENT OF BIOCHEMISTRY

**SCHEMATIC SYLLABUS UNDER CHOICE BASED CREDIT SYSTEM
(CBCS)**

2018

SEMESTER – I

CORE: FUNDAMENTALS OF CHEMISTRY AND MOLECULES OF LIFE (THEORY)

Unit : 1	THE FOUNDATIONS OF BIOCHEMISTRY : Cellular and chemical foundations of life	2 Hrs
Unit : 2	WATER: Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.	4 Hrs
Unit : 3	CONCENTRATION UNITS: Mole, Mole fraction, Molality, Molarity and Normality (problems to be worked out).	1 Hr
Unit : 4	STEREOCHEMISTRY: Stereoisomerism, types. Geometrical Isomerism- Cis Trans & E/Z nomenclature. Optical Isomerism- asymmetric carbon atom, Optical activity, plane polarized light, Chirality, Specific molecular rotation, Projection formula- Fischer & Newman projection formulae, optical isomerism in Glyceraldehyde, Lactic acid, Tartaric acid. Nomenclature of enantiomers - D and L system, Racemisation and resolution (biochemical method)	4 Hrs
Unit: 5	REACTION MECHANISM: Concept of inductive, mesomeric and resonance effect. Concept of the reaction intermediates- carbanions, carbocations, free radicals, carbenes. Nucleophiles and Electrophiles.	3 Hrs
Unit : 6	CARBOHYDRATES & GLYCOBIOLOGY: Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and nonreducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates	12 Hrs
Unit : 7	LIPIDS: Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes- glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Saponification value, Iodine value, Peroxide value, Acid value and their significance. Eicosinoids: Definition, types, Prostaglandins: Definition, biological functions, structure of	12 Hrs

	PGE1 & E2 and PGF1&F2. Thromboxans and leukotrienes- Biological roles. Plant steroids. Lipids as signals, cofactors and pigments	
Unit : 8	AMINO ACIDS & PROTEINS: Structure and classification, physical, chemical and optical properties of amino acids Peptide bond - Formation and structure. Structure and biological importance of Glutathione, Oxytosine, Vasopressine, Endorphine. Synthetic peptides – importance of polyglutamic acid, polylysine. Classification of proteins based on structure with examples. Primary structure of proteins – Determination of amino acid composition, determination of N- and C- terminal amino acids, sequencing by Edman’s degradation method. Secondary structure: - a Helix, b- sheet, b barrel and b turn. Tertiary structure – Fibrous proteins (collagen) and Globular proteins (Myoglobin). Quaternary Structure – hemoglobin, Denaturation and renaturation of proteins by Anfinsen’s experiment.	8 Hrs
Unit : 9	NUCLEIC ACIDS: Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.	8 Hrs
Unit : 10	VITAMINS : Structure and active forms of water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis	6 Hrs

PRACTICALS

1	Safety measures in laboratories.
2	Preparation of normal and molar solutions.
3	Preparation of buffers.
4	Determination of pKa of acetic acid and glycine.
5	Qualitative tests for carbohydrates.
6	Qualitative tests for lipids.
7	Qualitative tests for amino acids, proteins.
8	Qualitative tests for nucleic acids.
9	Separation of amino acids/ sugars/ bases by thin layer chromatography.
10	Estimation of vitamin C by iodometric method
11	Preparation of ZnSO ₄ standard solution, standardization of approximately N/10 EDTA solution and estimation of total hardness of water using Erichrome black – T indicator.
12	Preparation of standard sodium carbonate solution. Standardization of approximately N/10 NaOH and estimation of HCl in the given solution.

13	Determination of density the given protein solution or liquid using specific gravity bottle and viscosity by using ostwald's viscometer.
14	Conductometric titration of Amino acid against astrong base.

SUGGESTED BOOKS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., JohnWiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

SEMESTER – II

CORE: PHYSIOLOGY (THEORY)

Unit : 1	HOMEOSTASIS & THE ORGANIZATION OF BODY FLUID COMPARTMENTS: Intracellular, extracellular and interstitial fluid. Homeostasis, control system and their components. Plasma as an extracellular fluid, RBC, molecular mechanism of blood coagulation, role of vitamin K in coagulation, anticoagulant and fibrinolytic systems. Anemias, polycythemia, haemophilia and thrombosis	8 Hr
Unit: 2	CARDIOVASCULAR PHYSIOLOGY : Anatomy of heart. Physiology of the cardiac muscle, Pressure, flow and resistance. Ventricular volumes and the ECG, control of cardiac function and output. The arterial system, venous system, the microcirculation and mechanics of capillary fluid exchange. Control of blood flow to the tissues. Portal circulations. Hypertension, congestive heart disease, atherosclerosis and myocardial infarction.	8 Hr
Unit: 3	RESPIRATION: Mechanism of respiration. Principles of gas exchange and transport. Regulation of respiration. Pulmonary oedema and regulation of pleural fluid. Hypoxia, hypercapnea, pulmonary distress, emphesema, ARDS.	6Hr
Unit: 4	RENAL PHYSIOLOGY: Anatomy of the kidney and the nephron. Regulation of renal blood flow. Cell biology of the Bowmans' capsule. Physiology of glomerular filtration and GFR. Tubular processing of the glomerular filtrate. Blood buffer systems, renal and pulmonary control of blood pH, renal clearance. Assessment of kidney function. Acidosis and alkalosis. Glomerular nephritis, renal failure, dialysis and diuretics.	7Hr
Unit: 5	GASTROINTESTINAL & HEPATIC PHYSIOLOGY: Propulsion and motility of food and digested material.digestion and absorption of macro and micronutrients. Peptic ulcer, Sprue, celiac disease, IBD, regurgitation, diarrhoea and constipation. Anatomy of the hepatic lobule and blood flow into the liver. Formation and secretion of bile. enterohepatic cycle, reticuloendothelial system, metabolic importance of liver. Liver function tests. Jaundice, liver cirrhosis and fatty liver.	6Hr
Unit :6	MUSCULOSKETETAL SYSTEM: Bone structure and formation. Physiology of muscle contraction in striated and non-striated muscle.	4Hr
Unit: 7	REPRODUCTIVE PHYSIOLOGY: Sex determination and differentiation. Development of female and male genital tracts. Spermatogenesis, capacitation and transport of sperm, blood testis barrier. Ovarian function and its control. Uterine changes, fertilization and implantation. Placenta as a feto- maternal unit, gestation and parturition.	7Hr
Unit :8	NEUROCHEMISTRY & NEUROPHYSIOLOGY: Central Nervous	6Hr

	system. Peripheral Nervous system. Blood brain barrier and CSF. Membrane potentials. Synaptic transmission. Neurotransmitters. Sensory receptors and neural pathways. Somatic sensation, EEG, sleep, coma, learning and memory.	
Unit :9	PLANT RESPIRATION: Overview of glycolysis, Alternative reactions of glycolysis, Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration.	8Hr

PRACTICALS

1	Hematology.
2	a. RBC and WBC counting
3	b. Differential leucocyte count.
4	c. Clotting time.
5	Estimation of haemoglobin.
6	Separation of plasma proteins.
7	Determination of total iron binding capacity.
8	Pulmonary function tests, spirometry and measurement of blood pressure.
9	Separation of isoenzymes of LDH by electrophoresis.
10	Histology of connective tissue, liver and/ brain permanent slides.
11	Case studies (Renal clearance, GFR, ECG).
12	Estimation of serum phospholipids
13	Demonstration of ELISA
14	Identification of PMN leucocytes from human peripheral blood sample by staining

SUGGESTED BOOKS

1. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T., McGraw Hill International Publications (New York), ISBN: 978-0-07-128366-3.
2. Harper's Biochemistry (2012) 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN:978-0-07-176-576-3.
3. Textbook of Medical Physiology (2011) 10th ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1-4160-4574-8.
4. Fundamental of Anatomy and Physiology (2009), 8th ed., Martini, F.H. and Nath, J.L., Pearson Publications (San Francisco), ISBN: 10:0-321-53910-9 / ISBN: 13: 978-0321-53910-6

SEMESTER – III

CORE: METABOLISM (THEORY)

Unit : 1	INTRODUCTION TO METABOLISM: Anabolism and catabolism, compartmentalization of metabolic pathways.	2 Hr
Unit : 2	METABOLISM OF CARBOHYDRATES: Glycolysis - reactions, regulation and energetics. Entry of other carbohydrates (Fructose, Galactose and Mannose) into glycolytic pathway. Fates of pyruvate – Under aerobic and anaerobic conditions (conversion of pyruvate to lactate, alcohol and acetyl coA	10Hr
Unit: 3	CITRIC ACID CYCLE: Reactions, regulation and energetics. Amphibolic and integrating roles of TCA cycle. Anaplerosis. Pentose Phosphate pathway and its significance. Cori cycle - its significance. Rapoport and Luebering cycle, Gluconeogenesis pathway & their significance.	10Hr
Unit: 4	Uronic acid pathway – Reactions and its significance. glyoxalate pathway – Reactions and its significance. Glycogen metabolism – glycogenolysis and glycogen synthesis and its regulation	06Hr
Unit: 5	METABOLISM OF LIPID: Oxidation of fatty acid - α , β and ω - oxidation of saturated fatty acids, Energetics of β - oxidation. Biosynthesis of even number saturated fatty acids, ketone bodies- formation and its significance.	8Hr
Unit: 6	Bio synthesis of triglycerides, glycolipids, phospholipids and sphingolipids Cholesterol - Outline of biosynthesis and its degradation	8Hr
Unit :7	METABOLISM OF AMINO ACIDS: General reaction of amino acid degradation – Transamination, deamination and decarboxylation (oxidative and non oxidative). Ketogenic and glucogenic amino acids. Urea cycle and its significance. Biosynthesis of amino acids (Phenyl alanine and Glutamic acid) and their degradation.	8Hr
Unit: 8	NUCLEIC ACID METABOLISM: Degradation of Nucleic acids by DNase I & II, pancreatic RNase and phosphodiesterases. Biosynthesis and degradation of purine and pyrimidine nucleotides, salvage pathways, regulation of purine and pyrimidine synthesis.	8Hr

PRACTICALS

1	Glucose by DNS method.
2	Amino acid by Ninhydrine method.
3	Protein by Lowry's method.

4	Urea by DAMO or nitroprusside method.
5	Creatinine by Jaffe's method.
6	Phosphorous by Fiske and Subbarow's method.
7	Iron by Wong's method.
8	Ketoacids by DNPH method
9	Glycogen by anthrone method
10	Cholesterol by Zak's method
11	Isolation of lecithin, identification by TLC, and its estimation.
12	Isolation of cholesterol from egg yolk and its estimation.
13	Assay of serum transaminases – SGOT and SGPT.

SUGGESTED BOOKS

- 1.** Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
- 2.** Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., JohnWiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4 / BRV ISBN: 978-0-470-60152-5.

SEMESTER – IV

CORE: ENZYMOLOGY & BIOENERGETICS (THEORY)

Unit : 1	INTRODUCTION TO ENZYMES: Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme. IUBMB classification of enzymes.	2 Hr
Unit : 2	FEATURES OF ENZYME CATALYSIS: Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.	6Hr
Unit : 3	ENZYME KINETICS : Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant - monosubstrate reactions. Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. Km and Vmax, Kcat and turnover number. Effect of pH, temperature and metal ions on the activity of enzyme.	7Hr
Unit : 4	ENZYME INHIBITION : Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and substrate). Mechanism based inhibitors - antibiotics as inhibitors	6Hr
Unit : 5	MECHANISM OF ACTION OF ENZYMES : General features - proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme).	5Hr
Unit : 6	REGULATION OF ENZYME ACTIVITY: Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbamoylase). Occurrence and isolation, phylogenetic distribution and properties (pyruvate dehydrogenase, fatty acyl synthase) Isoenzymes - properties and physiological significance (lactate dehydrogenase).	6Hr
Unit : 7	INVOLVEMENT OF COENZYMES IN ENZYME CATALYSED REACTIONS: TPP, FAD, NAD, Pyridoxal Phosphate, Biotin, Coenzyme A, Tetrahydrofolate, Lipoic Acid.	6Hr
Unit: 8	APPLICATIONS OF ENZYMES: Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO), enzyme therapy (Streptokinase). Immobilized enzymes.	6 Hr
Unit : 9	INTRODUCTION TO BIOENERGETICS: Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters.	8Hr

	Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.	
Unit: 10	OXIDATIVE PHOSPHORYLATION: Mitochondria. Electron transport chain - its organization and function. Inhibitors of ETC and uncouplers. Peter Mitchell's chemiosmotic hypothesis. Proton motive force. Fo F1ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis. Alternative respiratory pathways in plants.	8Hr
PRACTICALS		
1	Partial purification of acid phosphatase from germinating mung bean.	
2	Assay of enzyme activity and specific activity, e.g. acid phosphatase.	
3	Effect of pH on enzyme activity	
4	Determination of Km and Vmax using Lineweaver-Burk graph.	
5	Enzyme inhibition - calculation of Ki for competitive inhibition.	
6	Continuous assay of lactate dehydrogenase.	
7	Coupled assay of glucose-6-phosphate dehydrogenase	
8	Determination of specific activity of Salivary amylase by DNS (2 practicals)	
9	Determination of pH optimum of Salivary amylase.	
10	Determination of Km and Vmax of Salivary amylase	
11	Determination of initial velocity (time Kinetics) of Salivary amylase.	
12	Determination of optimum temperature and energy of activation of Salivary amylase.	
13	Separation of photosynthetic pigments by TLC	

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- 1.** Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.
- 2.** Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt.Ltd. (New Jersey), ISBN:978-1180-25024.
- 3.** Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.

SEMESTER – V

DSE -1: NUTRITIONAL BIOCHEMISTRY (THEORY)

Unit : 1	INTRODUCTION TO NUTRITION & ENERGY METABOLISM Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. Measurement of energy content of food, Physiological energy value of foods, SDA. Measurement of energy expenditure. Direct and Indirect Calorimetry, factors affecting thermogenesis, energy utilization by cells, energy output – Basal and Resting metabolism, physical activity, factors affecting energy input - hunger, appetite, energy balance Energy expenditure in man. Estimating energy requirements, BMR factors Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.	8Hr
Unit: 2	DIETARY CARBOHYDRATES & HEALTH: Review functions of carbohydrates. Digestion, absorption, utilization and storage, hormonal regulation of blood glucose. Dietary requirements and source of carbohydrates, Dietary fiber, role of fibre in lipid metabolism, colon function, blood glucose level and GI tract functions.	8Hr
Unit :3	DIETARY LIPID & HEALTH: Review of classification, sources, functions, digestion, absorption, utilization and storage. Essential Fatty Acids; Functions of EFA, RDA, – excess and deficiency of EFA. Lipotropic factors, role of saturated fat, cholesterol, lipoprotein and triglycerides. Importance of the following: a) Omega – fatty acids. Omega 3/ omega 6 ratio b) Phospholipids c) Cholesterol in the body d) Mono, Polyunsaturated and Saturated Fatty Acids. Dietary implications of fats and oils, Combination ratios of n6 and n3, MUFA, PUFA and SFA.	8Hr
Unit: 4	DIETARY PROTEINS & HEALTH: Review of functions of proteins in the body, Digestion and absorption. Essential and Nonessential amino acids. Amino Acid Availability Antagonism, Toxicity and Imbalance, Amino acid Supplementation. Effects of deficiency. Food source and Recommended Dietary Allowances for different age group. Amino acid pool. NPU, Biological Value, Nitrogen balance. PEM and Kwashiorkor.	8Hr
Unit :5	FAT & WATER SOLUBLE VITAMINS: Vitamin A, C, E, K and D Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion(ADME), Deficiency. Role of Vitamin A as an antioxidant, in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Role of Vitamin E as an antioxidant. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis. Vitamin C role as cofactor in amino acid	8Hr

	modifications. Niacin- Metabolic interrelation between tryptophan, Niacin and NAD/ NADP. Vitamin B6-Dietary source, RDA, conversion to Pyridoxal Phosphate. Role in metabolism, Biochemical basis for deficiency symptoms. Vitamin B12 and folate; Dietary source, RDA, absorption, metabolic role Biochemical basis for deficiency symptoms.	
Unit: 6	MINERALS: Calcium, Phosphorus and Iron - Distribution in the body digestion, Absorption, Utilization, Transport, Excretion, Balance, Deficiency, Toxicity, Sources, RDA. Calcium: Phosphorus ratio, Role of iron in prevention of anemia. Iodine and iodine cycle. Iodine, Fluoride, Mg, Cu, Zn, Se, Manganese, Chromium, Molybdenum Distribution in the human body, Physiology, Function, deficiency, Toxicity and Sources.	12Hr
Unit: 7	ASSESSMENT OF NUTRITIONAL STATUS: Anthropometric measurements; Z scores, BMI, skinfold, circumference ratios. Biochemical assessment; Basal metabolic panel, Comprehensive metabolic panel, CBC, Urine Analysis, Assessment of Anemia, ROS assessment, GTT and glycosylated Hb, Differential diagnosis of B12 and folate.	4Hr
Unit: 8	FOOD & DRUG INTERACTIONS & NUTRICEUTICALS: Nutrient interactions affecting ADME of drugs, Alcohol and nutrient deficiency, Antidepressants, psychoactive drugs and nutrient interactions, Appetite changes with drug intakes and malnutrition. Food as medicine.	4Hr

PRACTICALS

1	Bioassay for vitamin B12/B1.
2	Homocystiene estimation.
3	Serum/ urine MMA estimation.
4	Anthropometric identifications for Kwashiorkor, Marasmus and Obesity.
5	Determination of oxidative stress: TBARS, antioxidant enzymes in hemolysate.
6	Vitamin A/E estimation in serum.
7	Bone densitometry /bone ultrasound test demonstration (visit to a nearby clinic)
8	Proximate analysis of food samples- Moisture, fibre, protein fat and carbohydrate (by difference) (3 practicals)
9	Detection of adulterants in food.
10	Estimation of Calcium in ragi.
11	Estimation of Vitamin – C in lemon or gooseberries by DPPH method
12	Estimation of Lactose in milk by Benedict's method
13	Estimation of Vitamin – E by alpha- alpha bipyridyl method in a given sample (Cod liver oil)

SUGGESTED BOOKS

- 1.** Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
- 2.** Nutrition for health, fitness and sport (2013) ; Williams.M.H,Anderson,D.E, Rawson,E.S. McGraw Hill international edition. ISBN-978-0-07-131816-7.
- 3.** Krause's Food and Nutrition Care process.(2012); Mahan, L.K Strings,S.E, Raymond,J. Elsevier's Publications. ISBN- 978-1-4377-2233-8.
- 4.** The vitamins, Fundamental aspects in Nutrition and Health (2008); G.F. Coombs Jr.Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.
- 5.** Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford University Press.

SEMESTER – V

DSE -2: MOLECULAR BASIS OF INFECTIOUS DISEASES

Unit : 1	CLASSIFICATION OF INFECTIOUS AGENTS: Bacteria, Viruses, protozoa and fungi. Past and present emerging and re-emerging infectious diseases and pathogens. Source, reservoir and transmission of pathogens, Antigenic shift and antigenic drift. Host parasite relationship, types of infections associated with parasitic organisms. Overview of viral and bacterial pathogenesis. Infection and evasion	12Hr
Unit: 2	OVERVIEW OF DISEASES CAUSED BY BACTERIA: Detailed study of tuberculosis: History, causative agent, molecular basis of host specificity, infection and pathogenicity, Diagnostics, Therapeutics, inhibitors and vaccines. Drug resistance and implications on public health. Other bacterial diseases including Typhoid, Diphtheria, Pertussis, Tetanus, Typhoid and Pneumonia.	18Hr
Unit: 3	OVERVIEW OF DISEASES CAUSED BY VIRUSES: Detailed study of AIDS, history, causative agent, pathogenesis, Diagnostics, Drugs and inhibitors. Other viral diseases including hepatitis, influenza, rabies, chikungunya and polio.	12Hr
Unit: 4	OVERVIEW OF DISEASES CAUSED BY PARASITES: Detailed study of Malaria, history, causative agents, Vectors, life cycle, Host parasite interactions, Diagnostics, Drugs and Inhibitors, Resistance, Vaccine development. Other diseases including leishmaniasis, amoebiasis.	8Hr
Unit :5	OVERVIEW OF DISEASES CAUSED BY OTHER ORGANISMS: Fungal diseases, General characteristics. Medical importance of major groups, pathogenesis, treatment.	10Hr

PRACTICALS

1	WIDAL test
2	Gram staining
3	Acid fast staining
4	PCR based diagnosis
5	Amino acid by Ninhydrine method.
6	Protein by Lowry's method.
7	Urea by DAMO or nitroprusside method.
8	Creatinine by Jaffe's method.
9	Phosphorous by Fiske and Subbarow's method.
10	Iron by Wong's method.
11	Ketoacids by DNPH method
12	Ammonia by nitroprusside method
13	Glycogen by anthrone method
14	Cholesterol by Zak's method

SUGGESTED BOOKS

1. Prescott, Harley, Klein's Microbiology (2008) 7th Ed., Willey, J.M., Sherwood, L.M., Woolverton, C.J. Mc Graw Hill International Edition (New York) ISBN: 978-007-126727.
2. Mandell, Douglas and Bennett.S, Principles and practices of Infectious diseases, 7th edition, Volume, 2. Churchill Livingstone Elsevier.
3. Sherris Medical Microbiology: An Introduction to Infectious Diseases by Kenneth J.Ryan, C. George Ray, Publisher: McGraw-Hill
4. Medical Microbiology by Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, Elsevier Health Sciences

SEMESTER – V

SEC-1: TOOLS AND TECHNIQUES IN BIOCHEMISTRY

TOTAL HOURS: 30

CREDITS : 2

Unit : 1	BIOCHEMICAL REAGENTS & SOLUTIONS: Safety practices in the laboratory. Preparation and storage of solutions. Concepts of solution concentration and storing solutions. Quantitative transfer of liquids. Concept of a buffer, Henderson-Hasselbach equation, working of a pH meter. Exercise <ul style="list-style-type: none">• Preparation of a buffer of given pH and molarity.	7Hr
Unit : 2	Chromatography- Definition, types, Principles of Adsorption and Partition chromatography. Techniques of circular, 2D chromatography, Thin Layer Chromatography- and its advantages Column chromatography – Principle and applications of Gel Filtration chromatography, HPLC and GLC	6 Hrs
Unit : 3	Electrophoresis : Principle and applications of electrophoresis technique- PAGE, SDS - PAGE	3 Hrs
Unit : 4	Centrifugation : Principle of differential and density gradient centrifugation. Ultra centrifuge – construction and applications	3 Hrs
Unit: 5	SPECTROPHOTOMETRIC TECHNIQUES: Principle and instrumentation of UV-visible and fluorescence spectroscopy. Exercises <ul style="list-style-type: none">• Determination of the absorption maxima and molar extinction coefficient (of a relevant organic molecule).• Measurement of fluorescence spectrum.• Determination of concentration of a protein solution by Lowry/BCA method.	5Hr
Unit :6	Introduction and importance of virtual labs in biochemistry	6Hr

SUGGESTED BOOKS

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-
2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
3. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

SEMESTER – V

SEC-2: CLINICAL BIOCHEMISTRY

TOTAL HOURS : 30

CREDITS : 2

Unit : 1	INTRODUCTION: Organization of clinical laboratory, Introduction to instrumentation and automation in clinical biochemistry laboratories safety regulations and first aid. General comments on specimen collection, types of specimen for biochemical analysis. Precision, accuracy, quality control, precautions and limitations. Exercises <ul style="list-style-type: none">• Collection of blood and storage.• Separation and storage of serum.	4Hr
Unit :2	EVALUATION OF BIOCHEMICAL CHANGES IN DISEASES: Basic hepatic, renal and cardiovascular physiology. Biochemical symptoms associated with disease and their evaluation. Diagnostic biochemical profile.	4Hr
Unit: 3	ASSESSMENT OF GLUCOSE METABOLISM IN BLOOD: Clinical significance of variations in blood glucose. Diabetes mellitus. Exercises <ul style="list-style-type: none">• Estimation of blood glucose by glucose oxidase peroxidase method.	4Hr
Unit :4	LIPID PROFILE: Composition and functions of lipoproteins. Clinical significance of elevated lipoprotein. Exercises <ul style="list-style-type: none">• Estimation of triglycerides.	4Hr
Unit :5	LIVER FUNCTION TESTS Exercises <ul style="list-style-type: none">• Estimation of bilirubin (direct and indirect).	4Hr
Unit: 6	RENAL FUNCTION TESTS & URINE ANALYSIS: Use of urine strip / dipstick method for urine analysis. Exercises <ul style="list-style-type: none">• Quantitative determination of serum creatinine and urea.	6Hr
Unit: 7	TESTS FOR CARDIOVASCULAR DISEASES: Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin. Exercises <ul style="list-style-type: none">• Estimation of creatine kinase MB.	4Hr

SUGGESTED BOOKS

- 1. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol.I (2010), Mukherjee, K.L., Tata Mc Graw–Hill Publishing Company Limited (New Delhi). ISBN: 9780070076594 / ISBN: 9780070076631**
- 2. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. II (2010), Mukherjee, K.L., Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi), ISBN: 9780070076648.**
- 3. Medical Biochemistry (2005) 2nd ed., Baynes, J.W. and Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia), ISBN:0-7234-3341-0.**
- 4. Experimental Biochemistry: A Student Companion (2005) Rao, B.S. and Deshpande, V., IK International Pvt. Ltd. (New Delhi), ISBN: 81-88237-41-8.**

SEMESTER – VI

DSE-1: ADVANCED CELL BIOLOGY AND ENDOCRINOLOGY (THEORY)

Unit : 1	PLASMA MEMBRANE & NUCLEAR TRANSPORT: Properties and Composition of Cell Membrane; Structure of Nuclear Envelope; Nuclear Pore Complex; Transport Across Nuclear Envelope; Regulation of Nuclear Protein Import and Export.	8Hr
Unit: 2	CELL-CELL INTERACTION: Cell-Cell Interactions and Cell-Matrix Interactions; Components of Extracellular Matrix: Collagen and Non-Collagen Components; Tight Junctions; Gap Junctions; Desmosomes; Hemidesmosomes; Focal Adhesions And Plasmodesmata; Cell Wall; Role Of Cell Interaction In Development.	10Hr
Unit :3	CELL CYCLE & PROGRAMMED CELL DEATH: Overview of The Cell Cycle; Eukaryotic Cell Cycle; Events Of Mitotic Phase; Cytokinesis; Events Of Meiosis And Fertilization; Regulation Of Cell Division And Cell Growth; Apoptosis And Necrosis, Stem Cells And Maintenance of Adult Tissues, Hematopoiesis, Embryonic Stem Cells and Therapeutic Cloning.	12Hr
Unit :4	CANCER BIOLOGY: Development and causes Of Cancer; Genetic Basis of Cancer; Oncogenes, Tumor Viruses; Molecular Approach to Cancer Treatment.	10Hr
Unit: 5	ADVANCED METHODS IN CELL BIOLOGY: Ultracentrifugation, Fluorescence Microscopy- FACS, Confocal Microscopy, Electron Microscopy, Plant and Animal Cell Culture, Immunohistochemistry.	10Hr
Unit: 6	ENDOCRINE SYSTEM: Endocrine organs, hormones-classification, Hierarchy, interplay, dynamic balance and regulation of their secretions. Functions of the hormones of Hypothalamus, Pituitary, Adrenal, Thyroid, pancreas and Gonads. Concept of receptors- Membrane and cytosolic. Mechanism of hormone action - Steroid hormone and Peptide hormone (second messengers hypothesis. Eg: cAMP, DAG, IP3).	10Hrs

PRACTICALS

1	Isolation of organelles by sub-cellular fractionation.
2	Study of cell viability /death assay by use of trypan blue and MTT assay.
3	Study of apoptosis through analysis of DNA fragmentation patterns in mitochondria.
4	Identification and study of cancerous cells using permanent slides and photomicrographs.
5	Isolation of organelles by sub-cellular fractionation.

6	Cell counting methods: counting using Haemocytometer.
7	Calibration of ocular micrometer and Measurement of average cell size using Stage micrometer
8	Separation of cell organelles by differential centrifugation and assay of marker enzymes. (2 Practicals)
9	Study of different types of cells.
10	Isolation of chloroplast by differential centrifugation & its identification.
11	Buccal smear- barr bodies
12	Identification of normal & abnormal karyotype

SUGGESTED BOOKS

1. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
2. Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6 edition. JohnWiley & Sons. Inc.
3. Alberts, B., Johnson,A., Lewis, J., and Enlarge, M. 2008 Molecular Biology of the Cell.5th ed., Garland Science (Princeton),
4. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J. 2012. Molecular Cell Biology. 7th ed., W.H. Freeman & Company (New York),
5. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

SEMESTER – VI

DSE-2: PLANT BIOCHEMISTRY (THEORY)

Unit : 1	INTRODUCTION TO PLANT CELL STRUCTURE: Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes.	5Hr
Unit :2	PHOTOSYNTHESIS & CARBON ASSIMILATION: Structure of PSI and PSII complexes, Light reaction, Cyclic and non cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration.	14Hr
Unit :3	NITROGEN METABOLISM: Biological Nitrogen fixation by free living and in symbiotic association, structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by Glutamine synthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals.	14Hr
Unit :4	REGULATION OF PLANT GROWTH: Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light.	7Hr
Unit :5	SECONDARY METABOLITES: Representatives alkaloid group and their amino acid precursors, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, Coumarins, Benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids.	12Hr
Unit :6	PLANT TISSUE CULTURE: Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation.	8Hr
Unit: 7		
PRACTICALS		
1	Induction of hydrolytic enzymes proteinases /amylases/lipase during germination	
2	Extraction and assay of Urease from Jack bean	
3	Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables	
4	Separation of photosynthetic pigments by TLC	
5	Culture of plant plants (explants).	

SUGGESTED BOOKS

1. Plant Biochemistry (2008), Caroline Bowsher, Martin steer, Alyson Tobin, Garland science ISBN 978-0-8153-4121-5

- 2. Biochemistry and molecular Biology of plant-Buchanan. (2005) 1 edition. Publisher: IK International. ISBN-10: 8188237116, ISBN-13: 978-8188237111.**
- 3. Plant Biochemistry by P.M Dey and J.B. Harborne (Editors) (1997) Publisher: Academic Press ISBN-10:0122146743, ISBN-13:978-0122146749.**