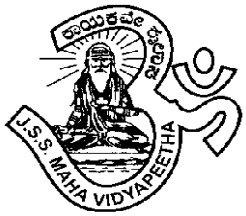

JSS Mahavidyapeetha

JSS COLLEGE FOR WOMEN, SARASWATHIPURAM, MYSORE-570 009

(AUTONOMOUS INSTITUTION)

(AFFILIATED TO UNIVERSITY OF MYSORE & REACCREDITED BY NAAC WITH'A^+ 'GRADE)

DEPARTMENT OF BIOCHEMISTRY

GRADUATE COURSE – CBCS SCHEME

2018 -2020

BIOCHEMISTRY SYLLABUS

SCHEME OF INSTRUCTION / EXAMINATION

OBJECTIVES

- **To create skilled human resource with knowledge in the field of Biochemistry.**
- **To inculcate research aptitude while learning.**

Outcome of B.Sc. course with Biochemistry as one of the optional subject.

- **Deals with the study of chemical process in living organisms.**
- **It includes study of Bioorganic, Biophysical, Human physiology, Nutrition, Enzymology, Metabolism and basics of Immunology, Biostatistics and Bioinformatics.**
- **They also study the structure and functions of chemical components of the cell involved in biological process.**
- **This provides an excellent preparation for higher studies and research in the field of Biochemistry, Molecular science and profession in the area leading to health sciences.**
- **It also meets the requirement of those who are interested in perceiving their education in medical, dental, paraclinical subjects and Food Technology.**
- **Biochemistry knowledge can be used to develop products and monitor the production in pharmaceutical, food processing and beverage industries.**
- **They can also perceive carriers in marketing, technical sale, and regulatory affairs in pharmaceutical industries & Food processing industries.**

SEMESTER – I

DSC -1: PRINCIPLES OF CHEMISTRY & BIOMOLECULES-I (THEORY)

Total Hours: 64 **Credits: 04**

PART A: PRINCIPLES OF CHEMISTRY		
Unit: 1	**Introduction to Biochemistry:** Cellular basis and chemical foundations of life**.** **Water:** Unique properties, weak interactions in aqueous systems, ionization of water, water as a reactant and fitness of the aqueous environment. **Buffers:** Henderson- Hasselbalch equation. Buffer capacity.	**04 Hrs**
Unit: 2	**Concentration units:** Mole, Mole fraction, Molality, Molarity and Normality (Problems to be worked out). **Photochemistry:** Laws of photochemistry, quantum efficiency, Beer's-Lambert's law, Spectrophotometer and Colorimeter - Constructions and their working principle. Fluorescence, Phosphorescence, Chemiluminescence – Explanation with an example for each. Bioluminescence- Explanation with one example. **Radio Chemistry:** Natural and Artificial radioactivity, units of radioactivity, half-life, disintegration constant. Principle of GM counters.	**06 Hrs**
Unit: 3	**Biochemical Toxicology:** Sources and Toxicity of Lead, Aluminum, Fluoride, Mercury, Cadmium, Chromium, Molybdenum and Arsenic. LD_{50}. **Alkaloids:** Definition and Classification based on their structure with examples. Structures & physiological action of LSD, Caffeine, Piperazine, Reserpine, Theobromine, Cocaine, Morphine, Nicotine & Atropine.	**04 Hrs**
Unit: 4	**Terpenes:** Isoprene rule, classification, structure, occurrence and biological importance of the following: Monoterpene – Limonene and Menthol. Sesquiterpenes –Juvenile hormone – I and Absicin- I. Diterpenes – Phytol. Triterpenes – Lanosterol Tetraterpenes – Lycopene Polyterpenes – Dolichol **Phytochemicals:** Definition with examples. Source and importance of Curcumin, Quercitin, Capsaicin & Epigenin.	**06 Hrs**

Unit: 5	**Stereochemistry:** Stereoisomerism & types. Geometrical Isomerism- Cis -Trans & E/Z nomenclature. Optical Isomerism- Optical activity, asymmetric carbon atom, plane polarized light, Chirality and Specific molecular rotation. Nomenclature of enantiomers - D and L system. Projection formula- Fischer & Newman projection formulae. optical isomerism in Glyceraldehyde, Lactic acid, and Tartaric acid., Racemisation and resolution (biochemical method) **Reaction Mechanism:** Concept of inductive, mesomeric and resonance effect. Concept of the reaction intermediates- carbanions, carbocations, free radicals, and carbenes. Nucleophiles and Electrophiles, Mechanism of addition, elimination, substitution and rearrangement reactions with one suitable example for each.	**08 Hrs**
PART B: **BIOMOLECULES-I**		
Unit: 6	**Carbohydrates:** Classification with examples (Haworth & cyclic structures). Biological importance. **Stereochemistry** – Concept of + & -, D & L, epimers, anomers, enantiomers, diastereomers and mutarotation. **Monosaccharides** – Configurational and Ring structures of aldoses and ketoses (Biologically important pentoses & hexoses only). Derived monosaccharides- Structure & biological importance of amino sugars (Glucosamine & Galactosamine), Deoxy sugars (2'-deoxy-β-D-ribose), sugar acids (Glucuronic acids, Neuraminic acid & Muramic acid). **Disaccharides**- Determination of nature of Glycosidic linkage, Structure & biological importance of reducing and non- reducing disaccharides – Lactose, Maltose, Isomaltose, Cellobiose & Trehalose. **Polysaccharides:** **Homopolysaccharides**- Occurrence, Partial Structure & biological importance of storage & structural polysaccharides - Starch, Glycogen, Cellulose, Chitin, Pectin and Inulin. **Heteropolysaccharides**- Occurrence, structure of repeating units and biological importance of Hyaluronic acid, Chondroitin sulfate, and Heparin. **Bacterial cell wall polysaccharides:** Peptidoglycan & Teichoic acid- Partial structure & importance. **Proteoglycans** -Structure and their role. **Glycoproteins** – Structure and their function.	**16 Hrs**
	Amino acids, peptides & Proteins: **Amino acids:** Classification of amino acids based on polarity with examples, Zwitter ions - structure and their properties. pKa values. Optical isomerism. Reactions of amino acids with HNO_2, $LiAlH_4$, Ninhydrin, Phenyl isothiocyanate, Dansyl chloride and FDNB. Reactions of Carboxyl group with hydrazine.	**12 Hrs**

Unit: 7	**Peptides:** Peptide bond – Formation & structure. **Naturally occurring peptides** – Structure & biological importance of Valinomycin, Enkephalin and Endorphin. **Synthetic peptides** – Structure & importance of polyglutamic acid and polylysine. **Proteins:** Classification of proteins based on composition, structure & functions with examples. **Structural organization of proteins:** **Primary structure** - Determination of N & C terminal amino acids, Amino acid composition and Sequencing by Edman's degradation method. **Secondary structure** – α- helix, β-sheet, β-turn. **Tertiary structure**- Globular protein - Myoglobin and Fibrous protein - Collagen. **Quaternary structure** -Hemoglobin. **Denaturation & renaturation of proteins** -Anfinsen's experiment.	
Unit: 8	**Nucleic acids:** **Components of Nucleic acids –** Heterocyclic bases **–** Purines & Pyrimidines, Pentose sugars –Ribose & 2'-deoxyribose & Phosphoric acid. **Nucleosides & Nucleotides –** Structure & Nomenclature. **Other functions of nucleotides -** Source of energy, component of coenzymes & second messengers. **DNA:** Primary & secondary structure (Watson crick model) and polymorphism. Hypo & Hyperchromic effect. Melting point (Tm). Biological functions. **RNA:** Structural features of mRNA, tRNA (Clover-leaf model) and rRNA and their functions**.** **Nucleic acid chemistry -** Effect of acid and alkali on DNA & RNA.	**08 Hrs**

Practical

Total Hours: 32 **Credits: 02**

Sl. No.	Experiments
1.	Safety measures in laboratories.
2.	Verification of Beer's law and determination of λ max.
3.	Preparation of normal, molar, % by weight & % by volume solutions.
4.	Preparation of acidic & basic buffers.
5.	Qualitative analysis of carbohydrates (02 practicals).
6.	Qualitative analysis of amino acids & proteins.
7.	Qualitative tests for lipids & nucleic acids.
8.	Estimation of amino acid by Ninhydrin method.
9.	Estimation of protein by Biuret method.
10.	Preparation of standard $ZnSO_4$ solution, standardization of EDTA solution and estimation of total hardness of water using Eriochrome black-T indicator.
11.	Estimation of amino acid by formal titration.

REFFERENCE 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.

Objectives / Outcome of the course DSC -1

Learn and understand

- Cellular basis and chemical foundations of life.
- Unique properties of water & concentration units,
- Biophysical chemistry - Photochemistry, radioactivity, its units and measurement & buffers
- Biooganic chemistry – Classification, structure and importance of Alkaloids, Terpenes & pytochemicals
- Stereochemistry – Types, nomenclature with examples
- Reaction mechanism – Concept of reaction intermediates and mechanism with examples
- Biomlecules – Classification,structure and biological functions of Carbohydrates,amino acids , proteins and nucleic acds

They also practice and acquire practical knowledge in

- Qualitative analysis of Biomolecules .
- Quantitative analysis of Biomlecules by titrimetry and colourimetry
- Working principle of colorimeter

SEMESTER – II

DSC -2: BIOMOLECULES-II & ENZYMOLOGY (THEORY)

Total Hours: 64 **Credits: 04**

PART – A LIPIDS		
Unit: 1	**Lipids:** Classification based on composition with examples. General biological role of lipids. **Fatty acids-** Saturated (C_4 to C_{24}) & Unsaturated (C_{16} to C_{20}) – Structure & nomenclature. Essential fatty acids, omega-3 and omega-6 fatty acids. **Storage lipids -** Triacyl glycerol and waxes – Structure, Physical and chemical properties - Hydrolysis, Hydrogenation and Rancidity. Chemical constants- Saponification number, Acid number, Iodine number and RM number and their significance. **Phosphoglycerides** - Structure & Biological importance of Lecithin & Cephalins. **Phosphoinositol** - Structure & Biological importance of Phosphatidylinositols, Plasmalogens & Cardiolipin **Sphingolipids**-Structure and biological importance of Sphingomyelin. **Glycolipids :** **Glycosphingolipids** - Structure and biological importance of Gangliosides-GM_1, GM_2, and GM_3. Cerebrosides- Galactocerebrosides, Glucocerebrosides. **Sulpholipids**- Structure and biological role. **Steroids:** **Animal steroids-** Cholesterol- Structure and Biological role. **Plant steroids –** Stigma sterol-structure and Biological role. **Fungal steroids-** Ergosterol-structure and Biological role. **Eicosanoids** – Definition & types. **Prostaglandins** – Definition, Structure and Biological functions of $PGE_1\alpha$, PGE_2 & $PGF1\alpha$ and PGF_2. **Thromboxanes-** Definition, Structure and Biological functions of TXA_2 **Leukotrienes –** Definition, Structure & Biological role of LTB_4 and LTC_4. **Lipoproteins –** Definition, types and their role. **Lipids as signals, cofactors and pigments (With one example for each).**	**16 Hrs**

Unit: 2	**Biomembranes:** **Introduction -** Composition and structure of biomembranes. Monolayer, planar bilayer, micelleles and liposomes as model membrane systems. Fluid-mosaic model. Lipid rafts, tight junction, RBC membrane architecture. **Membrane transport:** Simple and facilitated diffusion, passive transport – glucose transporter and types, anion transporter with one example and porins. Primary active transporters- P-type ATPase, V-type ATPases. Secondary active transporters-lactose permease, Na^+ - glucose symporter. **Ion channels:** **Na^+- K^+- gated channel, ligand-gated ion channels -** Definition, types and examples. Acetylcholine receptors. Ionophores – Valinomycin.	**16 Hrs**

PART – B **ENZYMOLOGY**		
Unit: 1	**Enzymes:** Introduction & General characteristics. Ribozymes and Abzymes. Classification, nomenclature and numbering based on IUB with examples. Units of enzyme activity, Specific activity and Turnover number. **Concept of Active site** - Salient features. **Features of enzyme catalysis** – Collision theory, transition state theory, reaction rates and thermodynamics of reaction & Catalytic power. **Specificity of enzymes** – Group, Optical, substrate and reaction specificity. **Mechanism of interaction-** Lock and Key theory and Induced fit model. **Coenzymes & Cofactors:** Definition, Apoenzyme & holoenzyme. Structure and functions of TPP, NAD^+, $NADP^+$, FAD, FMN, Coenzyme – A & Metal ions as cofactors.	**10 Hrs**
Unit: 2	**Enzyme Kinetics:** **Factors affecting enzyme activity-** Substrate concentration - Michaelis-Menton equation (No derivation), Lineweaver-Burk plot-determination of Km & Vmax and their significance. pH, temperature, activators and inhibitors. **Enzyme Inhibition- Reversible inhibition**-Competitive, non-competitive and un-competitive inhibition with one example for each. Effect of K_m & Vmax using LB plot. Irreversible inhibition and Suicide inhibition with one example for each. **Mechanism of enzyme action** – General features – Proximity and orientation. Acid-base and Covalent catalysis with chymotrypsin and lysozyme as examples.	**10 Hrs**

	Regulation of enzymes- End product inhibition (Examples), reversible covalent modification - phosphorylation (glycogen phosphorylase). Proteolytic cleavage- Zymogen (Examples).	
Unit: 3	**Allosteric enzymes**: Definition, positive and negative modulators, Feedback inhibition - Mechanism using KNF and MWC model with Aspartate transcarbamoylase (ATCase) as an example. **Isoenzymes**: Definition, characteristics and explanation with Lactate dehydrogenase (LDH) as example and its physiological significance. **Multienzyme complex:** Definition, characteristics and explanation with Pyruvate dehydrogenase as an example and its role as regulatory enzyme. **Multifunctional enzyme:** Definition, characteristics and explanation with DNA polymerase as an example. **Applications of enzymes:** Immobilized enzymes-examples, enzymes in diagnosis (SGPT, SGOT, Creatine kinase, alkaline and acid phosphatases enzyme, immunoassay (HPRO), enzyme therapy (Streptokinase). **Industrial applications:** Production of glucose, Use of lactase in dairy industry, use of proteases in food and detergent industries.	**12 Hrs**

Practical

Total Hours: 32 **Credits: 02**

Sl. No.	Experiments
1.	Determination of specific activity of Salivary amylase. (02 practicals)
2.	Determination of time kinetics (initial velocity) of Salivary amylase.
3.	Determination of optimum pH of Salivary amylase.
4.	Determination of optimum temperature and energy of activation of Salivary amylase.
5.	Determination of Km and Vmax of Salivary amylase.
6.	Ammonium sulphate fractionation of crude homogenate using Mung bean.
7.	Extraction of oil from oil seeds.
8.	Determination of Saponification value of an oil or fat.
9.	Determination of Iodine value of an oil or fat.
10.	Determination of Acid value of an oil or fat.

REFFERENCE 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. 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.
4. 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-
5. 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.
6. 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.

Objectives /Outcome of the course DSC -2

Learn and understand

- The classification , structure & biological importance of lipids.
- The classification, characteristic properties and importance in different fields of enzymes.

They also practice and acquire practical knowledge in

- How the activity and characteristics of enzymes can be determined.

SEMESTER – III

DSC -3: PHYSIOLOGY
(THEORY)

Total Hours: 64 **Credits: 04**

Unit: 1	**Homeostasis and the organization of body fluid compartments -** Intracellular, extracellular and interstitial fluid. Homeostasis, control system and their components. Plasma as an extracellular fluid, Blood buffer system, blood volume and long term blood pressure. Renal and pulmonary control of blood pH. RBC, molecular mechanism of blood coagulation, role of vitamin K in coagulation, anticoagulant and fibrinolytic systems. Anemias, polycythemia, haemophilia and thrombosis.	**10 Hrs**
Unit: 2	**Neurochemistry and neurophysiology:** Central Nervous system. Peripheral Nervous system. Blood brain barrier and CSF. Types of neurons, generalized structure of multipolar neuron, resting and action potential, propagation of nerve impulse along an axon. Excitatory & inhibitory neurotransmitters, synaptic transmission (electrical and chemical theory). Structure of neuro-muscular junction and mechanism of neuromuscular transmission.	**10 Hrs**
Unit: 3	**Muscle:** Types and their structure. Ultra structure of skeletal muscle fiber. Mechanism of muscle contraction (Physical and chemical) – sliding filament model. **Cardiovascular physiology** - Physiology of the cardiac muscle, atomicity of the cardiac muscle contraction, excitation contraction coupling, relationship between cardiac cycle, heart sound, ventricular volumes and the ECG. Control of cardiac function and output. **Bone:** Composition and structure of a long bone, growth & remodeling of long bone. Factors affecting the growth.	**12 Hrs**
Unit: 4	**Renal Physiology:** Structure of Nephron. Formation of urine- Physiology of glomerular filtration and GFR, Tubular processing of the glomerular filtrate. **Respiration:** Transport of oxygen and CO_2, factors influencing gas exchange.	**08 Hrs**
Unit: 5	**Gastrointestinal and Hepatic Physiology:** **Digestion**: Composition and functions of salivary, gastric, bile, pancreatic and intestinal juices. GIT hormones, Appetite. Propulsion and motility of food and digested material. Digestion, absorption and transport of carbohydrates, proteins and fats. Abnormalities of digestion of carbohydrate & protein. Abnormalities in the absorption of amino acids. Abnormalities in the digestion & absorption of lipids. Concept of peptic ulcers & pancreatitis.	**10 Hrs**

	Obesity: Factors responsible, assessment, complications, prevention & treatment. **Liver:** Structure of the liver lobule. Functions – Metabolic, storage & detoxification (Conjugation and oxidation). Formation and secretion of bile.	
Unit:6	**Physiology of vision:** Structure of rods & cones. Visual cycle and color adaptation.	**04 Hrs**
Unit:7	**Endocrine system-I:** Classification of hormones, hierarchy, interplay and dynamic balance & regulation of hormone secretions. **Endocrine system-II:** Mechanism of action of hormones –Peptide hormones (water soluble)-second messenger concept (cAMP, cGMP, IP_3, DAG and Ca^{2+}). Steroid hormones- Gene regulation. Hypo and hyper secretions of hormones-hypothalamus, pituitary, thyroid, parathyroid, adrenal, pancreatic and their functions. **Gonadal hormones:** Structure and functions of Testosterone, Progesterone and Estrogen. Menstrual cycle.	**10 Hrs**

Practical

Total Hours: 32 **Credits: 02**

Sl. No.	Experiments
1.	Estimation of Haemoglobin.
2.	Haematology: WBC counting: TC and DC.
3.	Histology of connective tissue-liver and brain using permanent slide.
4.	Determination of serum lipid profile.
5.	Separation of plasma proteins by electrophoresis. (02 practicals).
6.	Demonstration of glucose tolerance test (GTT).
7.	Determination of titrable acidity and ammonia in urine.
8.	Determination of blood groups and Rh factor.
9.	Assay of enzyme activity of serum - alkaline phosphatase and Acid phosphatase.

REFFERENCE 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.
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. 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

Objectives /**Outcome of the course DSC -3**

Learn and understand

- Physiology of muscular system, Nervous system, Cardiovascular system, Excretory system & Gastrointestinal, Endocrine system & hepatic system

They also practice and acquire practical knowledge in

- Determination hemoglobin, Lipid profile ,Hematology urine analysis for constituents.

SEMESTER – IV

DSC -4: METABOLISM AND BIOENERGITICS (THEORY)

Total Hours: 64 **Credits: 04**

Unit: 1	**Introduction to metabolism:** Metabolism – catabolism & anabolism. Overview of metabolic pathways & compartmentalization of metabolic pathways.	**2 Hrs**
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. **Citric acid cycle –** Reactions, regulation and energetics, Amphibolic and integrating role. Anaplerosis. Energetics of complete oxidation of Glucose. **Gluconeogenesis** – Reactions & significance, reciprocal regulation of glycolysis and gluconeogenesis. **Pentose Phosphate Pathway (HMP shunt) –** Reactions & significance**.** **Glucuronic acid cycle & Glyoxylate cycle (Embden- Meyeroff Paranus Pathway)** – Reactions and their importance. **Rapoport-lubering cycle** – Reactions and its significance. Cori cycle and its significance. **Glycogen metabolism –** Glycogenesis and its regulation. Glycogenolysis – pathway and its significance. **Synthesis of carbohydrates:** . Regulated synthesis of starch and sucrose. Photorespiration.C_4-pathway & its significance. **Disorders of Carbohydrate metabolism –** Glycogen storage diseases and Diabetes Mellitus.	**18 Hrs**
Unit: 3	**Metabolism of lipid: I -** Oxidation of fatty acids – Types - α, β & Ω Oxidation. Carnitine cycle, β – oxidation of Palmitic acid and its energetic. Ketone bodies – Formation and its significance. Biosynthesis of palmitate and oleate. Biosynthesis of triglycerides and phospholipids. **Cholesterol -** Outline of biosynthesis, regulation and its degradation**.** Lipoprotein Metabolism. Disorders of lipid metabolism **–** Tay-Sach`s disease, Niemann-Pick disease.	**10 Hrs**
Unit: 4	**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.	**10 Hrs**

	Disorders of amino acid metabolism: Phenyl ketonuria, Alkaptonuria, Maple syrup urine disease, Homocysteinuria and Hartnup's disease. Biosynthesis of creatine, polyamines (spermidine), catecholamines (Dopamine) and neurotransmitters (Serotonin, GABA).	
Unit: 5	**Nucleic acid metabolism:** Degradation of Nucleic acids by DNase I & II, pancreatic RNase and phosphodiesterases. **Degradation of Purine and Pyrimidine nucleotides**: Degradation of Purine and Pyrimidine nucleotides. **Biosynthesis of purine and pyrimidine nucleotides:** *De novo* synthesis of Purine and Pyrimidine nucleotides & their regulation. Salvage pathways. Conversion into triphosphates and coenzymes. **Deoxyribonucleotides -** Biosynthesis of deoxyribonucleotides and its regulation**.** **Disorders of purine and pyrimidine metabolism:** Gout, Lesch-Nyhan syndrome, SCID, Adenosine deaminase deficiency. Integration of Carbohydrate, Lipid and Amino acid metabolic pathways.	**10 Hrs**
Unit: 6	**Bioenergetics:** Laws of thermodynamics. Concept of enthalpy, entropy and free energy. Coupled reactions. ATP cycle, phosphorylation potential, phosphoryl group transfers. High energy compounds, chemical basis of high standard energy of hydrolysis, Other phosphorylated compounds and Thioesters. Redox reactions, standard redox potentials and Nernst equation. **Oxidative phosphorylation:** Mitochondria – structure. ETC- organization and reactions. Inhibitors & Uncouplers of ETC, Peter-Mitchell Chemi-Osmotic hypothesis – proton motive force, Fo-F1 ATP synthase - structure and mechanism of ATP synthesis. Regulation. **Photophosphorylation:** Structure of chloroplast, molecular architecture and PS-I and PS-II. Cyclic & Non- cyclic photophosphorylation and their significance. Z –Scheme of light reaction, Calvin cycle & its regulation	**12 Hrs**

Practical

Total Hours: 32 **Credits: 02**

Sl. No.	Experiments
1.	UV-absorption spectrum of protein and nucleic acid using spectrophotometer.
2.	Estimation of protein by Bradford method.
3.	Estimation of urea by DAMO Method.
4.	Estimation of creatinine by Jaffe's Method.
5.	Estimation of inorganic phosphate by Fiske and Subbarow's Method.
6.	Estimation of keto acid by DNPH method.
7.	Estimation of glucose by anthrone method.
8.	Estimation of uric acid by Phosphotungstic acid method.
9.	Determination of antioxidant activity in selected plant source by DPPH method / Estimation of beta-carotene by bleaching method. (Demonstration).
10	Isolation of phospholipids from egg yolk and identification by TLC.
11.	Isolation of lecithin and its estimation. (02 practical).

REFERENCE 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.

Objectives /Outcome of the course DSC -4

Learn and understand

- Metabolism of Carbohydrates, amino acids, lipids & nucleic acids
- Oxidative phosphorylation & Phtophosphorylation.

They also practice and acquire practical knowledge in

- Estimation of metabolites such as Glucose,Protein , urea, Creatinin,keto acids & Uric acid & phosphate.
- Isolation and identification of phospho

SEMESTER – V

DSE 1- : NUTRITIONAL BIOCHEMISTRY (THEORY)

Total Hours: 64 **Credits: 04**

Unit: 1	**Introduction:** Concept of nutrition, Calorific value of foods and its determination using Bomb Calorimeter. Different components of energy expenditure, measurement of energy expenditure by direct and indirect calorimetric method (Principle only). Respiratory quotient. Basal metabolic rate (BMR)-Definition, determination by indirect calorimetric method (Benedict & Roth method) & factors affecting it. Specific dynamic action of foods. Energy expenditure at rest and work. RDA. & Assessment for different age groups.	**12 Hrs**
Unit: 2	**Carbohydrates:** Dietary sources, dietary fibers and protein sparing action. Glycemic index and its importance, Lactose intolerance. **Proteins:** Dietary sources, nutritional classification, nutritional values - PER, NPU and Biological value (BV). Essential amino acids. Nitrogen balance. Mutual Supplementation of proteins. Malnutrition-Kwashiorkar and Marasmus - Causes, clinical signs with symptoms & treatment. Balanced diet, Dietary requirements for infants, pregnant, lactating women and in old age. Proximate analysis of foods with an example. **Fats:** Dietary sources, visible and invisible fats. Effects of fried foods. Role of DHA and PHA. **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.	**18 Hrs**
Unit: 3	**Vitamins:** Dietary sources, requirement, deficiency disorder with symptoms and biological role of water soluble vitamins-Thiamine, Riboflavin, Niacin, Pantothenic acid, Pyridoxine, Biotin, Folic acid, Vitamin-B_{12} and Vitamin-C. Fat soluble vitamins-A, D, E and K. Hypervitaminosis. 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. Role of Vitamin D and its effect on bone physiology.	**14 Hrs**
Unit: 4	**Minerals – Macro and micronutrients:** Calcium, Phosphorus and Iron – Sources, distribution in the body, digestion, Absorption, Utilization, Transport, Balance and Excretion, Deficiency disorders. Calcium: Phosphorus ratio, Role of iron in prevention of anemia. Sodium, Potassium, Chlorine, Iodine, Mg, Cu, Zn, Se, Manganese, Chromium -	**14 Hrs**

	Distribution in the human body, Physiology, Function, deficiency.	
Unit: 5	**Assessment of Nutritional status** - Anthropometric measurements; Z scores, BMI, skin fold, circumference ratios. Biochemical assessment: Basal metabolic panel.	**03 Hrs**
Unit: 6	**Nutraceuticals:** **Functional foods:** Definition and example. Prebiotics and probiotics.	**03 Hrs**

Practical

Total Hours: 32 **Credits: 02**

Sl. No.	Experiments
1.	Determination of moisture content of foods and detection of adulterants in food.
2.	Estimation of calcium in ragi.
3.	Estimation of iron in drum sticks.
4.	Estimation of vitamin-C in lemon or goose berries by DNPH method.
5.	Isolation and estimation of beta carotene.
6.	Isolation and quantification of Betaline from beet root or Lycopene from tomato.
7.	Extraction of casein from milk and starch from potato.
8.	Extraction of caffeine from tea powder.
9.	Estimation of viamin-E by alpha-piperidine method.
10.	Determination of acidity of milk.
11.	Estimation of lactose in milk by Benedict's method.
12.	Estimation of reducing sugar in food supply (Jams, Jellies etc.,).

REFERENCE 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.

Objectives /**Outcome of the course DSE -1**

Learn and understand

- Concept of Nutrition
- Dietary sources, requirement, Biological functions & deficiency disorders of macro & micro nutrients .
- Energy requirement for BMR & different physical activities and their determination
- Assessment of nutritious status
- Nutraceuticals

They also practice and acquire practical knowledge in

- Estimation of various nutrients in food samples including milk.

DSE -2: MOLECULAR BASIS OF NON-INFECTIOUS DISEASES (THEORY)

Total Hours: 64 **Credits: 04**

Unit :1	**Nutritional disorders:** Overview of major and minor nutrient components in the diet. Nutrient deficiencies; Kwashiorkor and Marasmus, Scurvy, beri beri, pellagra and B12 deficiency, Xerophthalmia and Night blindness, Vitamin D deficiency, Vitamin K deficiency. Discuss with relation to biochemical basis for symptoms.	**12 Hrs**
Unit:2	**Metabolic and Lifestyle disorders:** Obesity and eating disorders like Anorexia nervosa and Bullemia. Diabetes mellitus A metabolic syndrome and the relationship with hypertension, obesity, hypothyroidism and stress. Cardio vascular disorders and Atherosclerosis-defining the broad spectrum of ailments that fall in this category, understanding the factors that contribute to the syndrome, stages of disorder and the management of the condition. Irritable bowel syndrome- biochemistry behind the disorder and the influence of diet, stress and environment on the condition.	**12 Hrs**
Unit:3	**Multifactorial complex disorders and Cancer:** Understanding the definition of multifactorial diseases. Polygenic diseases and the relationship of environmental factors and genetic makeup in the onset of diseases. Cancer: characteristics of a transformed cell, causes and stages of Cancer, molecular basis for neoplastic growth and metastasis, Proto-oncogenes and tumor suppressor genes; Cancer causing mutations; Tumor viruses; Biochemical analysis of cancer; Molecular approaches to cancer treatment. Disorders of mood: Schizophrenia, dementia and anxiety disorders. Polycystic ovarian syndrome, Parkinson's disease, ALS.	**20 Hrs**
Unit:4	**Diseases due to misfolded proteins:** Introduction to protein folding and proteosome removal of misfolded proteins; etiology and molecular basis for Alzheimer's, Prion diseases, Huntington's Chorea, sickle cell anemia, Thalassemia.	**8 Hrs**
Unit:5	**Monogenic diseases: Inborn errors in metabolism:** PKU, Alkaptonuria, Maple syrup urine disease; Receptor and transport defects: Cystic fibrosis, Long QT syndrome, familial hypercholesterolemia, Achondroplasia. Hemoglobinopathies and clotting disorders.	**12Hrs**

Practical

Total Hours: 32 **Credits: 02**

Sl. No.	Experiments
1	Anthropometric measurements for normal and high risk individuals.
2	Anthropometric identifications for Kwashiorkor, Marasmus and Obesity.
3	Estimation of homocysteine levels in serum.
4	Estimation of glycosylated hemoglobin.
5	Permanent slides for different types of cancer.
6	Diagnostic profile for assessment of CVS and Diabetes mellitus using case studies.
7	Bone densitometry test demonstration (visit to a nearby clinic).
8	Bioassay for vitamin B_{12}/B_1.
9	**Determination of oxidative stress:** TBARS, antioxidant enzymes in hemolysate
10	Serum/ urine MMA estimation.
11	Serum/ urine MMA estimation estimation in serum.

REFERENCE 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. Introduction to Human Physiology (2013) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning.
3. The World of the cell, 7th edition (2009)
4. Genetics (2012) Snustad and Simmons,
5. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Objectives /Outcome of the course DSE -2

Learn and understand molecular basis of

- Nutritional disorders such as Kwashiorkor and Marasmus, Scurvy, beri beri, pellagra, Xerophthalmia and Night blindness with relation to biochemical basis for symptoms.
- Metabolic and Lifestyle disorders such as Obesity, diabetes Miletus & cardiovascular disorders
- Mulifactorial disorders & cancer
- Inborn errors of Metabolism & Diseases due to misfolded proteins:

They also practice and acquire practical knowledge in

- Anthropometric measurements for normal and high risk individuals
- Estimation of homocysteine levels in & glycosylated hemoglobin. Serum/ urine MMA & Serum/ urine MMA
- Determination of oxidative stress:

SEC-1: TOOLS AND TECHNIQUES IN BIOCHEMISTRY (THEORY)

Total Hours: 32 **Credits: 02**

Unit:1	**Biochemical techniques**: Dialysis, Ultra filtration, precipitation by salting in and salting out, organic solvent and pH precipitation. **Chromatography**: Definition, types - Principles of adsorption and partition chromatography. **Paper chromatography** – Techniques of circular, ascending, descending and 2D chromatography with suitable examples and their applications. **Thin layer chromatography**- Technique with suitable example (Separation of phospholipids), advantages over paper chromatography & its applications. **Exercise:** **1.** Identification of amino acid by circular chromatography. **2.** Demonstration of amino acid identification by ascending and 2D paper chromatography.	**12 Hrs**
Unit:2	**Column chromatography**- Adsorption chromatography - Principle & applications of gel filtration, Ion exchange & affinity chromatography. **HPLC & GLC –**principle & applications**.** **Electrophoresis**- Principle, SDS-PAGE technique & applications Principle and applications of 2D electrophoresis and Iso-electric focusing **Exercise:** **1.** Demonstration of Separation and identification of plant pigments by column chromatography using silica gel-G (Demo). **2.** Demonstration of SDS-PAGE.	**10 Hrs**
Unit:3	**Centrifugation:** Principle, Sedimentation co-efficient, Svedberg constant. Principles of differential and density gradient centrifugation. **Ultracentrifugation:** Construction and applications. **Spectroscopy:** Principles and applications of UV - visible, Fluorescent emission, IR & NMR spectroscopy. **Exercise:** 1. Separation of cell organelles by differential centrifugation and identification of a bmarker enzyme.	**10 Hrs**

SEC-2: PROTEIN PURIFICATION TECHNIQUES

Total Hours: 32 **Credits: 02**

Unit-1	Purpose , Preliminary steps, Extraction, Precipitation and differential solubilization and Ultracentrifugation. **Exercise –** Isolation of protein from plant source.	**08 Hrs**
Unit-2	Purification strategies, Size exclusion chromatography, Separation based on charge or hydrophobicity, Hydrophobic interaction chromatography, Ion exchange chromatography and Free-flow-electrophoresis. **Exercise –** Purification of proteins using salting in, salting out and dialysis.	**12 Hrs**
Unit-3	Affinity chromatography, Metal binding, Immunoaffinity chromatography, Purification of a tagged protein and HPLC. **Exercise** – Purification of proteins using column chromatography.	**08 Hrs**
Unit-4	Concentration of the purified protein, Lyophilization, Ultra filtration and Evaluating purification yield. **Exercise** – Separation of proteins by Electrophoresis- SDS-PAGE.	**04Hrs**

REFERENCE BOOKS

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.

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.

Objectives /Outcome of the course SEC -1

They learn the principle and practice

- Biochemical techniques such as Chromatographic, Electrophoresis, Spectroscopy & centrifugation techniques

Objectives /Outcome of the course SEC -1

They learn principle and practice

- protein isolation , purification & characterization techniques

VI - SEMESTER

DSE 3- : MOLECULAR BIOLOGY AND IMMUNOLOGY (THEORY)

Total Hours: 64 **Credits: 04**

PART: A MOLECULAR BIOLOGY		
Unit:1	**Structure of genes & chromosomes –**Chromosomal organization of genes in prokaryote and eukaryotes. Generalized structure of prokaryotic and eukaryotic genes. **DNA as genetic material: -** Griffith, O.T.Avery and his co-workers and Hershey and Chase experiment.	**04 Hrs**
Unit:2	**DNA replication in prokaryotes**- Types, experimental proof for semi conservative replication. **Mechanism** - Initiation, elongation and termination. Fidelity of replication. Inhibitors of replication and their importance.	**06 Hrs**
Unit:3	**Prokaryotic transcription**: RNA polymerase structure & transcription cycle in bacteria. **Mechanism of transcription** -Initiation, elongation and termination. Inhibitors of transcription and their applications as anti-microbial drugs. **Eukaryotic transcription:** Post transcriptional modification of mRNA and splicing of tRNA. **Reverse transcription**: Mechanism & its importance.	**06 Hrs**
Unit:4	**Genetic code:** A brief outline of deciphering of genetic code, General features and Wobble hypothesis **Prokaryotic translation**: Structure of Ribosome. Mechanism- Attachment of amino acids to tRNA, Initiation, elongation and termination. Regulation of translation. **Eukaryotic translation** Post-translational modifications. Use of antibiotics in understanding protein synthesis and applications in medicine.	**05 Hrs**
Unit:5	**Gene expression and regulation in prokaryotes:** Concept of Operon. Lac operon - control by positive and negative regulatory proteins. Trp operon – Control by attenuation.	**03Hrs**
Unit:6	**Gene mutations:** Concept of mutation: Mutagens – Definition and types with example. **Mechanism of action of chemical mutagens** – HNO_2, Alkylating and Intercalating agents. **Physical mutagens** - UV-radiation (Thymine dimer formation) with one suitable example. Ame's test.	**06 Hrs**

	Concept of point mutation – Types with one example for each (Missense, Non-sense, Silent and Frame shift). **DNA repair**: Excision repair, Mismatch repair, Photo activation and SOS repair.	

PART: B **IMMUNOLOGY**		
Unit:1	Historical development of immunology. Innate and acquired immunity. Primary and secondary lymphoid organs. Structure and functions of leucocytes-neutrophils, eosinophils, basophils. Antibody mediated and cell mediated immunity.	**08 Hrs**
Unit:2	**Formation & functions:** T lymphocytes- Helper T cells, Killer T cells, Cytotoxic T cells and Natural killer cells. B lymphocytes and macrophages. Complement activation. **Antigen:** Properties - Specificity and Cross reactivity, antigenicity, immunogenicity, antigen determinants & haptens. Adjuvants & MHC-outlines. **Antibodies:** Properties, classes, general structure (IgG), Monoclonal and polyclonal antibody - Hybridoma technology. **Cytokines:** Properties and functions.	**08 Hrs**
Unit:3	**Antigen-antibody interaction**: Precipitation and agglutination – Haemagglutination & Widal test. **Immunodiffusion**: Radial and double. Immunoelectrophoresis. Principle and applications: RIA, ELISA, Western blotting, Fluorescent antibody technique.	**08 Hrs**
Unit:4	**Allergy and Hypersensitivity**: Type I, II, III and IV with one example for each. **Vaccination:** Passive and active immunization (definition, characteristic, functions and examples). Attenuated and inactivated (viral or bacterial) vaccines, Recombinant vaccines and DNA vaccines - preparation with one example for each. Immune response – primary and secondary. Benefits and adverse effects.	**08 Hrs**

Practical

Total Hours: 32 **Credits: 02**

Sl. No.	Experiments
01	Extraction and quantification of DNA (2 practical).
02	Isolation of RNA from spinach leaf / yeast cell (2 practical).
03	Estimation of DNA by DPA method.
04	Estimation of RNA by orcinol method.
05	Visiualization of DNA by agarose gel electrophoresis.
06	Demonstration of Western blotting technique. (2 practical)
07	Demonstration of DOT ELISA.
08	Immuno diffusion technique –ODD.
09	Photographic identification of IgGs, RIA and ELISA.

REFERENCE BOOKS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (NewYork), ISBN:13: 978-1-4641-0962-1 / ISBN:10-14641-0962- 1.

2. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3 / ISBN: 10:0-7617- 8590-0.

3. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.

Objectives /Outcome of the course DSE -3

Learn and understand

- Structure of prokaryotic & eukaryotic genes Replication of DNA,Transcription
- translation & mutation under Molecular biology
- Different types of immunity
- Structure & charecterstics of of Antibodies & Antigens
- Antigen antibody interaction
- Hypersensitivity reactions
- Vacination

They also practice and acquire practical knowledge in

- Isolation of DNA & RNA from different sources & quantification using spec
- Estimation of DNA & RNA
- Immuotechniques – ODD,ELISA & Western blotting

DSE 4: PLANT BIOCHEMISTRY
(THEORY)

Total Hours: 32 **Credits: 02**

Unit: 1	**Introduction to Plant cell structure:** Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes.	**04 Hrs**
Unit: 2	**Photosynthesis and Carbon assimilation:** Structure of PSI and PSII complexes, Light reaction, Cyclic and non cyclic photophosphorylation, Calvin cycle and its regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration.	**14 Hrs**
Unit: 3	**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.	**12 Hrs**
Unit: 4	**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.	**12 Hrs**
Unit: 5	**Regulation of plant growth:** Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light. Unit 6 Secondary metabolites No. of Hours : 8 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.	**12 Hrs**
Unit: 6	**Regulation of plant growth:** 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.	**10 Hrs**

Practical

Total Hours: 32 **Credits: 02**

Sl. No	Experiments
1	Induction of hydrolytic enzymes proteases / 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 (explants).

REFERENCE 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: I K 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

Objectives /**Outcome of the course DSE -**4

Learn and understand under plant Biochemistry

- Plant cell structure.
- Photosynthesis and Carbon assimilation.
- Nitrogen metabolism.
- Regulation of plant growth.
- &Plant tissue culture.

They also practice and acquire practical knowledge in

- Induction of hydrolytic enzymes proteases / amylases / lipase during germination
- Separation of photosynthetic pigments by TLC.
- Culture of plant (explants)

SEC 3: CLINICAL BIOCHEMISTRY

Total Hours: 32 **Credits: 02**

Unit: 1	**Introduction:** Definition, scope, units, collection & preservation of biological fluids-Blood, urine, CSF and gastric fluid. **Urine:** Normal composition– volume, pH, color, specific gravity. Normal constituents & clinical significance of their variations – Urea, Uric acid, Creatinine & Bile pigments. Abnormal constituents and their clinical significance – Glucose, Albumin & Ketone bodies. **Blood:** Anticoagulants. Serum and plasma. Normal constituents of blood & their variation in abnormal conditions – Urea, Uric acid, Creatinine, Glucose, Bilirubin, Total protein and Albumin / Globulin ratio. **Exercise:** 1. Collection, separation and storage of serum. 2. Determination of serum phospholipids.	**08 Hrs**
Unit: 2	**Disorders of Carbohydrate metabolism**: Normal range of FBS, PPBS and RBS and their determination.GTT. Glycosylated haemoglobin. Renal threshold and regulation of blood glucose concentration. **Diabetes mellitus**- Types, clinical pathology and diagnosis. **Haematology**- Hb%, RBC count, WBC -TC and DC, ESR, platelet counting. Blood grouping. **Exercise:** 1. Estimation of glucose in blood serum by glucose oxidase / Folin-Wu method.	**08 Hrs**
Unit: 3	**Gastric function**: Tests for gastric function - Fractional test meal & Insulin stimulation test. **Pancreatic Function:** Pancreatic function tests - Serum amylase and lipase tests. **Kidney function test**: Creatinine and Urea clearance tests. **Liver function tests**: Estimation of conjugated and total bilirubin in serum (Diazo method) and Vandenberg reaction. Detection of bilirubin and bile salts in urine - Fouchet's test and Hay's Sulphur test. **Exercise:** 1. Estimation of bilirubin by direct bilirubin method. 2. Creatinine / Urea clearance test.	**08 Hrs**

Unit: 4	**Liver diseases** – Hepatitis – A, B and C. Fatty liver, Cirrhosis and Jaundice. **Serum enzymes in liver disease** – Normal range of SGPT, SGOT, LDH, alkaline phosphatase and clinical significance of their variation. **Cardiac injury profile** – Normal range of CKMB, LDH and clinical significance of their variation. **Exercise:** 1. Estimation of SGOT / SGPT in blood.	**08 Hrs**

REFERENCE 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 VoI. 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.

SEC-4: BIOSTATISTICS AND BIOINFORMATICS

Total Hours: 32 **Credits: 02**

BIOSTATISTICS		
Unit: 1	Mean, median, mode, weighted mean. Sample and sampling - random sampling. Use of random number table. Collection and sorting of data, diagrammatic representation of data- histogram, line graph, scatter diagram, pie chart. Hypothesis testing using student's t-test - Comparing sample mean with population mean. Comparing means of two samples, paired sample. X^2 test and goodness of fit.	**12 Hrs**

BIOINFORMATICS		
Unit: 1	**Introduction to bioinformatics:** Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - genomics, proteomics, and computer aided drug design (structure based and ligand based approaches) and Systems Biology. Applications of bioinformatics.	**06 Hrs**
Unit: 2	**Biological databases and data retrieval:** Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Structure viewers (Ras Mol, J mol), file formats.	**08 Hrs**
Unit: 3	**Sequence alignment:** Similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTALW.	**06 Hrs**

REFERENCE BOOKS

1.Bioinformatics: Sequence and Genome Analysis (2001), 1st ed., Mount, D.W. Cold Spring Harbor Laborator Press (New York), ISBN: 0-87969-608-7.
2. Bioinformatics and Functional Genomics (2003), 1st ed., Pevsner, J., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47121004-8.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (2005), 3rd ed., Baxevanis, A.D. and Ouellette, B.F., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47147878-4.
4. Bioinformatics – Principles and Applications (2008), 1st ed. Ghosh, Z. and Mallick, B., Oxford University Press (India), ISBN: 9780195692303.

Objectives /Outcome of the course SEC -3

They learn principle and practice

- Analysis of Urine & blood for various constituents & their clinical significance.
- Disorders of Carbohydrate metabolism.
- Gastric function, Pancreatic Function, Kidney function & Liver function tests
- Serum enzymes in liver disease
- Cardiac injury profile

Objectives /Outcome of the course SEC -4

They learn principle and practice

- Basics in Biostatistics
- Bioinformatics - *Biological databases and data retrieval &- Sequence alignment*

SCHEME OF EXAMINATION – THEORY

(QUESTION PAPER PATTERN)

Biochemistry

DSC (I to IV semester) & DSE (V & VI Sem)

Duration: 3 Hours. **Max. Marks**: 70

Instructions: Answer all questions in part-A and any four from part-B and any three questions from part-C.

PART-A

(Compulsory)

I. Answer all the questions: **2 x 10 = 20**

1. ----------
2. ----------
3. ----------
4. ----------
5. ----------
6. ----------
7. ----------
8. ----------
9. ----------
10. ----------

PART-B

II. Answer any four questions: **5 x 4 = 20**

11. ----------
12. ----------
13. ----------
14. ----------
15. ----------

PART-C

III. Answer any four questions: **10 x 4 = 30**

16. ----------
17. ----------
18. ----------
19. ----------
20 ----------

(Note: Questions carrying 10 marks can be divided into 3+3+4 or 6+4).

Biochemistry

SEC: (V and VI semester)

Duration: 3 Hours. **Max. Marks**: 50

Instructions: Answer all questions in part-A and any three questions from part-B.

PART-A

(Compulsory)

I. Answer all the questions: **2 x 5 = 10**

1. ----------
2. ----------
3. ----------
4. ----------
5. ----------

PART-B

II. Answer any three questions: **10 x 4 = 40**

6. ----------
7. ----------
8. ----------
9. ----------
10. ----------

(Note: Questions carrying 10 marks can be divided into 3+3+4 or 5+5 or 6+4).

SCHEME OF EXAMINATION AND VALUATION – PRACTICAL

SCHEME OF EXAMINATION

I- SEMESTER
PRACTICAL – I
DSC -1: PRINCIPLES OF CHEMISTRY & BIOMOLECULES-I

Duration: 3 Hours. **Maximum Marks: 40**

NOTE: - Candidates are required to submit the records duly signed by the teacher-in charge and certified by the Head of the Department.

1. Principle and procedure writing---------- 05 Marks
2. Experiment – estimation/determination ---------- 25 Marks
3. Viva---------- 05 Marks
4. Record ---------- 05Marks

PART- A

PRINCIPLE OR PROCEDURE WRITING 05 Marks

I. Any one of the following experiments may be given:

1. Verification of Beer's law and determination of λ max.
2. Preparation of normal solution.
3. Preparation of molar solution.
4. Preparation of acidic buffer.
5. Preparation of basic buffers.

PART- B

ESTIMATION/DETERMINATION:

II. Any one of the following may be given: 25 Marks

1. Estimation of amino acid by Formal titration.
2. Determination of acid value of given oil/fat.
3. Determination of Hardness of water.
4. Qualitative analysis of Biomolecules.

PART-C

QUALITATIVE ANALYSIS OF BIOMOLECULES

Identify the given Biomolecules: 25 Marks

1. **Carbohydrate –** Glucose, Fructose, Lactose, Maltose, Sucrose and Starch**.**

2. **Amino acids –** Arginine, Tryptophan, Tyrosine, Cystein, Histidine, phenyl alanine

3. **Proteins** - Albumin and Casein.

Note: Simple amino acids-glycine, alanine, Aromatic amino acids- tyrosine Sulphur containing amino acids- cysteine may be given.

SCHEME OF VALUATION

ASSESSMENT OF EXPERIMENTAL RESULTS

PART-A

PRINCIPLE AND PROCEDURE WRITING ---------- (2+3) = **05 Marks**

PART-B

Estimation:

1. **Determination of Acid value / Formal titration / Hardness of water: 25 Marks**
   i.) Preparation of standard solution and calculation of normality --------**05 Marks**

   ii) Standardization & estimation/determination:

Discrepancy in titer values	Standardization	Estimation
± 0.2 ml	08 Marks	08 Marks
± 0.3 ml	06 Marks	06 Marks
± 0.4 ml	04 Marks	04 Marks
Any other value	02 Marks	02 Marks
Calculation	02 Marks	02 Marks

II QUALITATIVE ANALYSIS OF BIOMOLECULES **25 Marks**

1. **If carbohydrate is given,**
   i. Molisch test 05 Marks

   ii. Test for reducing test (any two test) 05 Marks

   iii. Distinguishing test (mono/disac) 05 Marks

   iv. Distinguishing test (aldose/ketose) 05 Marks

   v. Preparation of osazone and identification & report 05 Marks

2. **If amino acid is given,**

i. Molisch test	04 Marks
ii. Ninhydrin test	04 Marks
iii. Biuret test	04 Marks
iv. Xanthoproteic test	04 Marks
v. Millon's test / Nitroprusside / lead acetate test	04 Marks
vi. Hopkins's test	04 Marks
vii. Report	01 Marks

3. If protein is given,

i. Molisch test	04 Marks
ii. Ninhydrin test	04 Marks
iii. Biuret test	04 Marks
iv. Lowry's test	04 Marks
v. Any two precipitation test	08 Mark
vi. Report	01 Mark

SCHEME OF EXAMINATION

B Sc II - SEMESTER PRACTICAL EXAMINATION
BIOCHEMISTRY PRACTICAL-II
DSC-2: ENZYMOLOGY

Duration: 3 Hours. **Max. Marks: 40**

NOTE: Candidates are required to submit the record duly signed by the teacher-in-charge and certified by the Head of the Department.

1. Procedure writing	----------	05 Marks
2. Experiment	----------	25 Marks
3. Viva	----------	05 Marks
4. Record	----------	05 Marks

PART A

PRINCIPLE AND PROCEDURE WRITING: **05 Marks**

I. Any one of the following experiments may be given:

1. Extraction of oil from oil seeds.
2. Determination of Saponification of oil or a fat.
3. Determination of Iodine value of oil or a fat.
4. Determination of acid value of oil or a fat.
5. Estimation of Amino acid by formal titration.

PART – B

Experiment:

I. Any one of the experiment may be given: **25 Marks**

<u>Salivary amylase :</u>

1. Determination of specific activity Salivary amylase by DNS method.
2. Determination of optimum pH of Salivary amylase by DNS Method.
3. Determination of initial velocity (time kinetics) of Salivary amylase by DNS Method.
4. Determination of Km and Vmax of Salivary amylase by DNS Method.

NOTE:

a. **Specific activity:**
    i. Working standard solution of sugar may be given by the examiner.
    ii. Concentration of the enzyme protein must be given to the students.
b. **Optimum pH:** Buffers of 5 different values may be given.
c. **Optimum time:** Different time intervals may be given by the examiner.
d. **Determination of Km & Vmax:** Different substrate concentration may be given by the examiner.

SCHEME OF VALUATION
ASSESSMENT OF EXPERIMENTAL RESULTS

PART-A

PRINCIPLE AND PROCEDURE WRITING ---------- 05 Marks

PART-B

Experiment:

Enzymology: **25Marks**

1. Tabular column ---------- 03Marks
2. Graph ---------- 05 Marks
3. For conducting experiments ---------- 10 Marks
4. Calculation ---------- 05 Marks
5. Report with unit ---------- 02 Marks

SCHEME OF EXAMINATION

B Sc III - SEMESTER PRACTICAL EXAMINATION

BIOCHEMISTRY PRACTICAL-III

DSC-3: PHYSIOLOGY

Duration: 3 Hours. **Max. Marks: 40**

NOTE: Candidates are required to submit the record duly signed by the teacher-in-charge and certified by the Head of the Department.

1. Procedure writing ---------- 05 Marks
2. Experiment ---------- 25 Marks
3. Viva ---------- 05 Marks
4. Record ---------- 05 Marks

PART- A

PRINCIPLE AND PROCEDURE WRITING: **05 Marks**

I. Any one of the following experiments may be given:

1. Separation of plasma proteins by electrophoresis.
2. Glucose tolerance test.
3. Determination of Serum Alkaline phosphatase activity / Acid phosphatase activity.

PART – B

Major experiment:

I. Any one of the following experiment may be given: **25 Marks**

1. Estimation of hemoglobin.
2. Determination of titrable acidity and ammonia of urine.
3. Determination of blood group and Total and differential counting of WBCs

SCHEME OF VALUATION

ASSESSMENT OF EXPERIMENTAL RESULTS

PART-A

PRINCIPLE AND PROCEDURE WRITING ---------- 05 Marks

PART – B

Experiment:

1. **Estimation of hemoglobin.**

1. Tabular column ---------- 02 Marks
2. Graph ---------- 05Marks
3. For conducting experiments ---------- 10 Marks
4. Calculation ---------- 03 Marks
5. Report with unit ---------- 02 Marks

2. **Determination of titrable acidity and ammonia of urine:**

i)Preparation of standard solution and calculation of normality ---------05 Marks

ii) Standardization & estimation/determination:

Discrepancy in titer values	Standardization	Estimation
$\pm$ 0.2 ml	08 Marks	08 Marks
$\pm$ 0.3 ml	06 Marks	06 Marks
$\pm$ 0.4 ml	04 Marks	04 Marks
Any other value	02 Marks	02 Marks
Calculation	02 Marks	02 Marks

A. Blood grouping

1. Performance of the experiment ---------- 07 Marks
2. Accurate identification of blood group---------- 02 Marks

B. WBC counting:

1. Performance of the experiment---------- 12 Marks
2. Accurate counting---------- 04Marks

SCHEME OF EXAMINATION
B Sc, IV- SEMESTER PRACTICAL EXAMINATION
BIOCHEMISTRY PRACTICAL-IV

DSC-4: METABOLISM AND BIOENERGETICS

Duration: 3 Hours. **Max. Marks: 40**

NOTE: Candidates are required to submit the record duly signed by the teacher-in-charge and certified by the Head of the Department (No evaluation of the record).

1. Procedure writing	----------	05 Marks
2. Experiment	----------	25 Marks
3. Viva	----------	05 Marks
4. Record	----------	05 Marks

PART- A

PRINCIPLE AND PROCEDURE WRITING: **05 Marks**

Any one of the experiment may be given:

1. Estimation of inorganic phosphate by Fiske and Subbarow's Method.
2. Estimation of uric acid by Phosphotungstic acid method.
3. Isolation of phospholipids from egg yolk.
4. Determination of antioxidant activity.

PART-B

Experiment: Colorimetric estimation:

Any one of the experiment may be given: **25 Marks**

1. Estimation of protein by Bradford method.
2. Estimation of urea by DAMO Method.
3. Estimation of creatinine by Jaffe's Method.
4. Estimation of keto acid by DNPH method.
5. Estimation of glucose by anthrone method.

SCHEME OF VALUATION

ASSESSMENT OF EXPERIMENTAL RESULTS

PART-A

PRINCIPLE AND PROCEDURE WRITING ---------- 05 Marks

PART – B

Experiment:

Colorimetric estimation:

i. Preparation of stock and working standard solution---------- 05Marks
ii. Reaction---------- 01Marks
iii. Tabular column---------- 03Marks
iv. Graph---------- 05Marks

Result:

Discrepancy in %	**Marks**
± 10%	10
± 15%	08
± 20%	06
Any other value	04

Report with units ---------- 01 Mark

SCHEME OF EXAMINATION
B Sc, V- SEMESTER PRACTICAL EXAMINATION
BIOCHEMISTRY PRACTICAL-V

DSE-1: NUTRITIONAL BIOCHEMISTRY

Duration: 3 Hours. **Max. Marks: 40**

NOTE: Candidates are required to submit the record duly signed by the teacher-in-charge and certified by the Head of the Department (No evaluation of the record).

1. Procedure writing	----------	05 Marks
2. Experiment	----------	25 Marks
3. Viva	----------	05 Marks
4. Record	----------	05 Marks

PART A

PRINCIPLE AND PROCEDURE WRITING: **05 Marks**

Any one of the experiment may be given:

1. Determination of moisture content of foods.

2. Isolation and estimation of beta carotene.

3. Isolation and quantification of Betaline from beet root / Lycopene from tomato.

4. Extraction of caffeine from tea powder.

5. Estimation of viamin-E by alpha-piperidine method.

PART- B

Experiment: Any one of the experiment may be given: **25 Marks**

A. Colorimetric estimation:

1. Estimation of reducing sugar in food supply (Jam's, Jellies etc.,).
2. Estimation if iron in drum sticks.
3. Estimation of vitamin-C in lemon or goose berries by DNPH method.

B. Titrimetric estimation:

1. Determination of acidity of milk.
2. Estimation of lactose in milk by Benedict's method.

SCHEME OF VALUATION

ASSESSMENT OF EXPERIMENTAL RESULTS

PART-A

PRINCIPLE AND PROCEDURE WRITING ---------- 05 Marks

PART – B

Experiment:

A. Colorimetric estimation:

i. Preparation of stock and working standard solution ----------05Marks
ii. Reaction ---------- 01Marks
iii. Tabular column ---------- 03Marks
iv. Graph ---------- 05Marks
v. Result:

Discrepancy in %	**Marks**
± 10%	10
± 15%	08
± 20%	06
Any other value	04

Report with unit ---------- 01 Mark

B. Titrimetric estimation:

Preparation of standard solution and calculation of normality ……. **05 Marks**

ii) Standardization & estimation:

Discrepancy in titer values	Standardization	Estimation
+ 0.2 ml	08 Marks	08 Marks
+ 0.3 ml	06 Marks	06 Marks
+ 0.4 ml	04 Marks	04 Marks
Any other value	02 Marks	02 Marks
Calculation	02 Marks	02 Marks

SCHEME OF EXAMINATION

B Sc, V- SEMESTER PRACTICAL EXAMINATION

BIOCHEMISTRY PRACTICAL-V

DSE-2: MOLECULAR BASIS OF NON-INFECTIOUS DISEASES

Duration: 3 Hours. **Max. Marks: 40**

NOTE: Candidates are required to submit the record duly signed by the teacher-in-charge and certified by the Head of the Department (No evaluation of the record).

1. Procedure writing	----------	05 Marks
2. Experiment	----------	25 Marks
3. Viva-voce	----------	05 Marks
4. Record	----------	05Marks

PART A

PRINCIPLE AND PROCEDURE WRITING: **05 Marks**

Any one of the experiment may be given:

1. Anthropometric measurements for normal and high risk individuals.
2. Anthropometric identifications for Kwashiorkor, Marasmus and Obesity.
3. Determination of oxidative stress: TBARS / antioxidant enzymes in hemolysate.
4. Bioassay of Vitamin-B_1 / B_{12}.

PART – B

Experiment: **25 Marks**

Any one of the experiment may be given:

1. Estimation of homocysteine levels in serum.
2. Estimation of glycosylated hemoglobin.
3. Estimation of Vitamin-A in serum.
4. Estimation of MMA in urine / serum.

SCHEME OF VALUATION

ASSESSMENT OF EXPERIMENTAL RESULTS

PART-A

PRINCIPLE AND PROCEDURE WRITING ---------- 05 Marks

PART – B

Experiment:

A. Colorimetric estimation:

i. Preparation of stock and working standard solution ----------05Marks
ii. Reaction ---------- 02Marks
iii. Tabular column ---------- 04 Marks
iv. Graph ---------- 03Marks
v. Result:

Discrepancy in %	**Marks**
± 10%	10
± 15%	08
± 20%	06
Any other value	04

Report ----------01 Mark

SCHEME OF EXAMINATION

B Sc, VI- SEMESTER PRACTICAL EXAMINATION

BIOCHEMISTRY PRACTICAL-VI

DSE-2: MOLECULAR BIOLOGY AND IMMUNOLOGY

Duration: 3 Hours. **Max. Marks: 40**

NOTE: Candidates are required to submit the record duly signed by the teacher-in-charge and certified by the Head of the Department (No evaluation of the record).

1. Procedure writing	----------	05 Marks
2. Experiment	----------	25 Marks
4. Viva-voce	----------	05Marks
5. Record	----------	05 Marks

PART A

PRINCIPLE AND PROCEDURE WRITING: **05 Marks**

Any one of the experiment may be given:

1. Visualization of DNA by Agarose gel electrophoresis.
2. Isolation of RNA from spinach leaf / yeast cell.
3. Western blotting technique.
4. Identification of antigen and antibody reaction by ODD.

PART-B

Experiment:

Any one of the experiment may be given: **25Marks**

1. Extraction and quantification of DNA from plant source.
2. Estimation of DNA by DPA method.
3. Estimation of RNA by Orcinol method.

SCHEME OF VALUATION

ASSESSMENT OF EXPERIMENTAL RESULTS

PART-A

PRINCIPLE AND PROCEDURE WRITING ---------- 05Marks

PART – B

Experiment:

1. **For estimation of DNA / RNA: 25 Marks**

i. Preparation of stock and working standard solution ----------05 Marks
ii. Reaction ---------- 02 Marks
iii. Tabular column ---------- 04Marks
iv. Graph ---------- 03Marks
v. Result:

Discrepancy in %	**Marks**
± 10%	10
± 15%	08
± 20%	06
Any other value	04

Report ---------- 01 Mark

2. For Extraction and quantification of DNA: 25 Marks

Principle	05 Marks
Extraction	15 Marks
Calculation	03 Marks
Result	02 Marks

SCHEME OF EXAMINATION

B Sc, VI - SEMESTER PRACTICAL EXAMINATION
BIOCHEMISTRY PRACTICAL-VI

DSE-3: PLANT BIOCHEMISTRY

Duration: 3 Hours. **Max. Marks: 40**

NOTE: Candidates are required to submit the record duly signed by the teacher-in-charge and certified by the Head of the Department (No evaluation of the record).

1. Procedure writing	----------	05 Marks
2. Experiment	----------	25 Marks
3. Viva-voce	----------	05 Marks
4. Record	----------	05 Marks

PART A

PRINCIPLE AND PROCEDURE WRITING: **05 Marks**

Any one of the experiment may be given:

1. Culture of plant (explants).

2. Separation of photosynthetic pigments by TLC.

PART – B

Experiment: **25 Marks**

Any one of the experiment may be given:

1. Estimation of carotene / ascorbic acid in fruits and vegetables.

2. Assay of Urease enzyme activity from Jack bean.

(**Note:** Urease enzyme extract from Jack bean has to be provided).

SCHEME OF VALUATION

ASSESSMENT OF EXPERIMENTAL RESULTS

PART-A

PRINCIPLE AND PROCEDURE WRITING ---------- 05 Marks

PART – B

Experiment: 25 Marks

1. Assessment of experimental results for estimation of DNA / RNA: 25 Marks

i. Preparation of stock and working standard solution ----------05 Marks
ii. Reaction ----------02 Marks
iii. Tabular column ----------04 Marks
iv. Graph ----------03 Marks
v. Result:

Discrepancy in %	**Marks**
± 10%	10
± 15%	08
± 20%	06
Any other value	04

Report ---------- 01 Mark