JYOTI NIVAS COLLEGE AUTONOMOUS
SYLLABUS FOR 2018 BATCH AND THEREAFTER

Programme: B.Sc. **Semester: VI**

CHEMISTRY PAPER VIII
BIOCHEMISTRY

Course Code:18VICH8 **No. of Hours: 45**

COURSE OBJECTIVES:

By the end of the course students should be able to understand and explain

- The structure and function of the major classes of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids.
- The importance of enzyme substrate interactions and on enzyme inhibitions.
- Energy transfers in biological systems and to understand redox reactions which are utilized to produce ATP energy.
- The fundamental metabolic pathways of carbohydrate, fatty acids, proteins and to familiarize with their metabolic disorders.
- The classification and importance of vitamins and hormones in human beings.
- To analyze carbohydrates and amino acids qualitatively. (laboratory component)
- Use of a spectrophotometer for quantitative analysis of sugars, creatinine, inorganic
- phosphate (laboratory component)
- Determination of saponification number of lipids and the importance of separation
- Techniques like chromatography. (Laboratory component).

LEARNING OUTCOMES:

On completion of the course, the student should be able to

- Write the structures of biomolecules and to know their importance.
- Explain enzyme catalysed reactions and to know the significance of allosteric enzymes in regulation of metabolic pathways.
- Calculate energy yield from biological redox reactions and able to understand energy coupling in biological reactions.
- Understand the integration of carbohydrate, lipid and amino acid metabolism and familiarize with the consequences of metabolic disorders like Diabetes mellitus, Alkaptonuria, Phenylketonuria and Albinism.
- To carry out colorimetric estimations of important biomolecules.
- To carry out chromatographic separation of amino acids.

UNIT I

Chapter 1.1 INTRODUCTION TO BIOCHEMISTRY 02 HRS

Contributions of Lavoisier, Wohler, Fischer, Pasteur, Embden, Meyerhof, Parnas, Kreb, Michaelis and Menten, Watson and Crick, Chargaff, H.G. Khorana, Knoop, Pauling, Hopkins and Miescher. Development of biochemistry as a discipline. Elemental and biochemical composition of living organisms. Role of water in biochemical systems (mention the properties of water which makes water a solvent of life).

Chapter 1.2 CARBOHYDRATES **05 HRS**

Disaccharides: Glycosidic bond. Structures of maltose, isomaltose, cellobiose, lactose, trehalose and sucrose. Haworth structures.

Derivatives of carbohydrates: Amino sugars : β-D-glucosamine - biosynthesis from glucose and biological importance, N-acetylglucosamine- structure and importance, N-acetylmuramic acid (NAMA) – structure, role in bacterial cell wall. β-D-galactosamine - structure and importance, N-acetylgalactosamine - importance; N-acetylneuraminic acid (NANA) - open chain and pyranose forms. Role in G_{M1} ganglioside.

Sugar acids: Structure and biological importance of D-gluconic acid, D-glucuronic acid, and D-glucaric acid. Partial structure and importance of hyaluronic acid, heparin, keratin sulphates, chondroitin sulphate

Polysaccharides- source, comparative account of partial structure and biological function of starch, glycogen, cellulose, chitin and inulin.

Chapter 1.3 LIPIDS **05 HRS**

Introduction, Classification of lipids.

Fatty acids - definition, classification - essential and non-essential ,saturated and unsaturated with examples and structure (lauric, myristic, palmitic, stearic, palmitoleic, oleic). Essential fatty acids/poly unsaturated fatty acids –definition, properties, examples (linoleic, linolenic and arachidonic acids)

Triglycerides- Structure of simple and mixed glycerides and their functions. Properties of triglycerides- acid and alkali hydrolysis, saponification number and its significance, iodine number and its significance, rancidity (oxidative and hydrolytic).

Phosphoglycerides – general structure of 3-Sn-phosphatidic acid, structure and biological importance of lecithin, dipalmitoyl lecithin, cephalin, phosphatidylserine, phosphatidylinositol. Amphipathic lipids – definition, lipid aggregates and their applications - lipid bilayer (as in cell membrane), micelles, liposomes, lipoproteins – basic structure and its types (Chylomicrons, HDL, LDL and VLDL).

Sphingolipids-structure and biological significance of ceramide and sphingomyelin.

UNIT II

Chapter 2.1 PROTEINS **05 HRS**

L-α–Amino acids – Introduction, structure, classification on the basis of polarity of R groups, essential and non-essential amino acids. Non-standard amino acids (hydroxyproline, hyroxylysine). Ionic properties and reactions of amino acids with alcohol, nitrous acid, ninhydrin, Sanger's and Edman's reagents. Amphoteric nature of amino acids- titration curve of leucine. Peptide bond and its polarity. N- and C- terminals of peptide chains, naming of peptide chains (Glutathione). Classification of proteins based on structure, composition and biological functions (enzymes, hormones, transport agents, antibodies).

Levels of organizations of proteins: Primary structure, secondary structure (α-helix, triple helix example Collagen and *β*-pleated sheet), tertiary structure (myoglobin) and forces stabilizing it, quaternary structure (haemoglobin).

Denaturation and renaturation of proteins – agents of denaturation, characteristics of denaturation. Anfinsen's experiment on protein folding (ribonuclease).

Chapter 2.2 NUCLEIC ACIDS 03 HRS

Types - components of nucleic acids, bases, nucleosides and nucleotides with structures. Partial structure of polynucleotide.

Structure of DNA (Watson – Crick model) and RNA. Biological roles of DNA and RNAs. Protein – nucleic acid interaction: chromatin, viral nuclear capsid and histones.

UNIT III

Chapter 3.1 ENZYMES 05 HRS

Introduction, Classification of enzymes, IUB classification (EC code number not required). Holo enzyme (apoenzyme and coenzyme). Active site, specificity and its types. Enzyme substrate interaction- Fischer and Koshland models.

Enzyme kinetics – Michaelis-Menten equation (derivation not required) and mechanism, significance of K_M, k_{cat}, V_{max}. Lineweaver-Burk plot. Factors affecting rate of enzymatic reactions- enzyme concentration, pH and temperature.

Allosteric regulation of enzymes – definition, examples and significance.

Enzyme inhibitions - Reversible inhibition: Competitive, non-competitive and uncompetitive inhibition with one example for each. Irreversible inhibition (inhibition of cytochrome oxidase by cyanide)

Chapter 3.2 BIOLOGICAL OXIDATION 06 HRS

Bioenergetics – Introduction - stages of energy transformation. Exergonic and endergonic reactions. Relationship between ΔG and K_{eq}.

High energy phosphates-definition, examples, structural features of ATP that makes it a high energy molecule (electrostatic repulsion, opposing resonance, solvation of ATP). Examples of high energy phosphates other than ATP. Energy coupling in biological reactions with examples.

Biological oxidation-comparison of oxidation with combustion using glucose as an example. Redox potentials of some biological important half-cell reactions. Calculation of energy yield from biological redox reaction (oxidation of NADH by oxygen, reduction of acetaldehyde by NADH). Mitochondrial electron transport chain - components, schematic representation indicating sides of energy conservation, ATP synthesis, oxidative phosphorylation – chemi-osmotic theory.

Chapter 3.3 METABOLISM **07 HRS**

Introduction - Catabolism and anabolism. Stages in catabolism. Carbohydrate metabolism: reactions of glycolysis, fate of pyruvate. TCA cycle. Energetics of glucose metabolism and TCA cycle. Outline of gluconeogenesis.

Fatty acid metabolism – fatty acid activation, transport of acyl CoA into mitochondria, β oxidation pathway of palmitic acid and its energetics.

Protein metabolism – general aspects of amino acid degradation – deamination (oxidative and non-oxidative), transamination and decarboxylation. Synthesis and degradation of tyrosine. Urea cycle.

Chapter 3.4 METABOLIC DISORDERS **04 HRS**

Regulation of blood glucose – Homeostasis. Role of insulin and glucagon. Supply and removal of glucose – hyperglycemia and hypoglycemia. Diabetes mellitus (IDDM & NIDDM).

Disorders of urea cycle, inherited disorders of amino acid metabolism; alkaptonuria (AKU), phenylketonuria (PKU), albinism. (Discussion with help of case studies).

UNIT IV

Chapter 4 VITAMINS AND HORMONES **03 HRS**

Vitamins – Definition. Classification and deficiency manifestations of water soluble and fat soluble vitamins. Coenzyme functions of B - complex vitamins.

Hormones - Definition. Classification: a) amino acid derivatives b) peptide and polypeptide hormones c) steroid hormones with important examples and functions. Mechanism of action of steroid hormone and insulin.

REFERENCES:

1. Fundamentals of Biochemistry: Life at the molecular level, Voet. D & Voet J.G, 5th edition. February 2016, Wiley Publication.
2. Nelson D & Cox M, Lehninger's Principles of Biochemistry,7th Ed., 2017, W.H Freeman and Co.
3. Rodwell W.V, Bender D.A., Botham K.M., Kennely P.J. &Weil P.A., Harper's Illustrated Biochemistry, 31st Ed., 2018, Lange International Publishers.
4. Berg J.M., Tymoczko J.L., Gatto G.J. Jr. & Stryer L, Biochemistry, 9th Ed., 2019, W.H Freeman and Co.
5. Das D., Biochemistry, 14th Ed., 2012, Academic Publishers.
6. Sathyanarayana U. & Chakrapani U., Biochemistry, 5th Ed., 2019, Elsevier Books and Allied publishers Jain J.L., Jain S. & Jain N, Fundamentals of Biochemistry, 7th Ed., 2016, S. Chand Publications.

CHEMISTRY PRACTICAL

VI SEMESTER - PAPER VIII (BIOCHEMISTRY

DURATION: 3 HRS / WEEK **NO. OF UNITS: 15**

1. Estimation of reducing sugar by Hagedorn – Jensen's method

2 Estimation of reducing sugar by Somogy's method

3. Qualitative analysis of carbohydrates.

4. Qualitative analysis of amino acids

5. Estimation of reducing sugar by dinitrosalicylate (DNS) method

6. Estimation of inorganic phosphate by modified Fiske –Subbarow method

7. Estimation of creatinine by Jaffe's method

8. Estimation of fructose by Seliwanoff's method.
9. Determination of saponification number in coconut oil.
10.Separation of amino acids by paper chromatography.

12. Detection of adulterants in food

Test, repetition and demonstration experiments

REFERENCES:

1. J Jayaraman, Laboratory Manual in Biochemistry. New Age International Publishers.2011.

2. Sadashivan and Manickan, Biochemical Methods , New age international, 2016.

3. S K Gupta, Veena Singh Geehlaut and Anju Jain, Manual of Practical Biochemistry for MBBS. Arya Publishing Company 2005

4. Williams and Wilson, Principals and Techniques of Practical Biochemistry,Edward Arnold 1981