Name of the Programme: M.Sc. Part-I (Biochemistry)

Course Code: CHB-500 **Title of the Course:** Biomolecules and Bioenergetics

Number of Credits: 4

Effective from AY: 2022-23

Pre-requisites for the Course:	Students should have graduate level knowledge either in chemical or life sciences or should have qualified change of discipline test.	
Course Objectives:	1. To develop concepts about structures and functions of different biomolecules. 2. To understand the reactivity of biomolecules and their role in metabolic pathways. 3. To understand the metabolism of biomolecules and their regulation in living cells.	
Content:		**No of hours**
	1. Introduction to Biomolecules a. Origin, aim and scope of Biochemistry. b. Introduction to various classes of major biomolecules.	1
	2. Structure and properties of water a. Structure and physico-chemical properties of water, Ionic product of water. b. Importance of water in biological systems.	2
	3. Chemical bonding, Stereochemistry and Reactions a. Properties of covalent bond, non-covalent bonds and their importance in biological systems. b. Brief revision of configurational nomenclature: R & S; D & L; E & Z; cis & trans and syn & anti nomenclature with respect to biomolecules. c. Types of biochemical reactions: oxidation-reduction, condensation, rearrangement, addition, elimination, group-transfer, resonance bond, electrophilic and nucleophilic substitution reactions.	7
	4. Structure and Biological functions of biomolecules **a. Amino acids, Peptides and Proteins** i. Amino acids: Structure, Classification, physico-chemical properties of amino acids and role of non-protein amino acids. ii. Peptides: peptides of physiological significance, peptide bond. iii. Proteins: primary (importance of primary structure), secondary (alpha-helix, β – structure, β-helix, super secondary structure), tertiary (stabilizing forces, unfolding/refolding) and quaternary structures (e.g.; Haemoglobin). **b. Nucleotides and Nucleic acids** i. Structure and properties of nucleotides, nucleosides, purine (Adenine, Guanine) and pyrimidine (Cytosine, Thymine, Uracil) bases.	20

	ii. Structural features of nucleic acids (DNA & RNA) and their biological functions. **c. Carbohydrates** i. Structure, stereochemistry, reactions and functions of monosaccharides, disaccharides, polysaccharides. ii. Complex carbohydrates; amino sugars, proteoglycans and glycoproteins. **d. Lipids** Classification, structure and function of major lipid subclasses - Triacylglycerols, Phospholipids, Sphingolipids, glycolipids, Lipoproteins, chylomicrons, LDL, HDL and VLDL, steroids, prostaglandins and bile acids, rancidity.	
	5. **Bioenergetics and Oxidative Phosphorylation** a. Thermodynamics: laws of thermodynamics, mechanism of exergonic and endergonic reactions, redox potential, high energy compounds, ATP structure and significance. b. Aerobic electron transport and oxidative phosphorylation, redox enzymes of ETC, ATP synthase and mechanism.	6
	6. Metabolism of Biomolecules: **a. Carbohydrate metabolism** Regulatory mechanisms, bioenergetics and significance of central pathways of carbohydrate metabolism: Glycolysis, TCA, Pentose phosphate pathway, Entner-Doudoroff pathway, glycolate cycle, Gluconeogenesis, gluconeogenesis from TCA intermediates/ amino acids / acetyl-CoA, glucuronic acid pathway, Utilization of sugars such as lactose, galactose, maltose and of polysaccharides such as starch, glycogen. Biosynthesis of polysaccharides and sugar interconversions. **b. Lipid metabolism** Oxidation of fatty acids and its energetics: oxidation of saturated and unsaturated (mono and polyunsaturated fatty acids (PUFA), Peroxisomal oxidation of fatty acids (Phytanic acid), Refsum's disease, ketone body formation and their clinical significance, diabetic ketoacidosis, Biosynthesis of fatty acids and regulation, Biosynthesis of triglycerides, cholesterol and phospholipids. **c. Amino acid metabolism** General reactions of amino acid metabolism - Transamination, decarboxylation, oxidative and non-oxidative deamination of amino acids. Special metabolism of methionine, histidine, phenylalanine, tyrosine, tryptophan, lysine, valine, leucine, isoleucine and polyamines. Urea cycle and its regulation. Overview of biosynthetic pathways of amino acids and their regulation; Assimilation of ammonia, biosynthesis of essential	24

	and non-essential amino acids, regulation of glutamine synthetase and aspartate family of amino acids. **d. Nucleotides and nucleic acids metabolism** Purine and pyrimidine nucleotides: biosynthesis and its regulation. Deoxyribonucleotides: biosynthesis and regulation. Biosynthesis of nucleotide coenzymes. Catabolism of purine and pyrimidine nucleotides.	
Pedagogy:	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References/ Readings:	1. D. L. Nelson, M. M.Cox , Lehninger Principles of Biochemistry, W.H. Freeman; , 7th Edition,2017. 2. D. Voet, J. G. Voet, C. W.Pratt, Fundamentals of Biochemistry, John Wiley & Sons Inc. 5th Edition,2016. 3. J. MBerg, L Stryer, J. L Tymoczko,G. J Gatto, Biochemistry, W.H Freeman, 9th Edition. 2019. 4. P. Kuchel, S. Easterbrook-Smith, V. Gysbers, J.M. Guss, D.Hancock, J. Johnston, A. Jones, J. Matthews,Schaum's Outline of Biochemistry, McGraw-Hill Book Co,3rd Edition,2009.	
Course Outcomes:	1. Students will be able to classify different biomolecules based on their structure and explain their 3-dimensional arrangement and biological functions. 2. Students will be able to write the metabolic pathways for major macromolecules and recognize the chemical changes occurring at each step based on the functional groups involved. 3. Students will be able to compute the energetics involved in metabolic pathways in terms of number of ATPs and describe the different regulatory mechanisms. 4. Students will be able to relate certain common diseases to the malfunctioning of respective metabolic pathways.	