MICROB-DSC103
BIOCHEMISTRY OF CARBOHYDRATES AND LIPIDS

Marks: 100 (Theory = 75 marks
Practicals = 25 marks)

Duration: Theory = 45 hours (3 credits)
Practicals = 30 hours (1 credit)

Course Objectives:

The major objective of this course is to enable the students to develop a clear understanding of the structures and properties of biomolecules: proteins, lipids, carbohydrates and nucleic acids, and lays the foundation for a basic understanding of cellular processes. The students will gain an understanding of the principles of thermodynamics and bioenergetics, and will be introduced to the basic concepts of enzymes and enzyme kinetics. This course will empower the students with essential knowledge to support learning in subsequent courses offered in the program.

Pre-requisite: Student should have studied Biology/ Biotechnology/ Biochemistry in 12th standard

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

CO1: Explain the principles of thermodynamics as applied to biological systems and will be able to comment on the rate constants and feasibility of biochemical reactions by calculating free energy changes.

CO2: Describe the structures and properties of various types of carbohydrates and will be able to relate the structures of simple and complex carbohydrates to their wide range of functions. Will gain knowledge of the role of sugars and their derivatives in formation of macromolecules /supramolecular complexes.

CO3: Converse on the building block of lipids: fatty acids and their properties. Will acquire a clear understanding of the structures, properties and functions of storage and membrane lipids. Will learn of different types of lipid aggregates and their applications.

CO4: Prepare buffers and solutions of different molarity and normality and will be adept in the use of fine weighing balances and pH meter.

CO5: Analyze foodstuff for their microchemical composition, and will be able to detect the presence of carbohydrates and fats in samples by performing qualitative tests. Will become familiar with the use of spectrophotometer.

Contents:

Theory **45 hours**

Unit 1: Bioenergetics and thermodynamics: Laws of thermodynamics. Gibbs free energy: exergonic and endergonic reactions. Enthalpy: exothermic and endothermic reactions. Entropy, standard free energy change and actual free energy change, equilibrium constant and spontaneous reactions. Coupled reactions and additive nature of standard free energy change. Energy rich compounds: ATP, BPGA, Acetyl

CoA. **9**

Unit 2: Carbohydrates: Introduction to mono-, di- and poly-saccharides. Monosaccharides: aldoses and ketoses. Stereoisomers: enantiomers, epimers, diastereoisomers, mutarotation and anomers. Fischer and Haworth formulae of sugars. Sugar derivative: O-,N-glycosides. Disaccharides: Structures and properties of maltose, lactose, and sucrose reducing and non- reducing sugars. Polysaccharides: storage polysaccharides (starch and glycogen), structural polysaccharides (cellulose, chitin, peptidoglycan, pectin). **15**

Unit 3: Storage Lipids: Introduction to storage and structural lipids. Storage lipids: triacylglycerols, building blocks, fatty acids structure and properties, essential fatty acids, saponification.

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Unit 4: Structural Lipids: Membrane lipids: phosphoglycerides (building blocks, structure of phosphatidylethanolamine and phosphatidylcholine). Sphingolipids: building blocks, structure of sphingosine, ceramide, general structure and functions of sphingomyelin, cerebroside and ganglioside. Lipid functions. Lipid aggregates: micelles, monolayers, bilayers and liposomes.

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Practicals: 30 hours

Unit 1: Preparation of buffers and solutions: Concepts of molarity versus normality. Preparation of simple stock solutions of different molarities: sodium chloride, potassium permanganate, magnesium chloride solutions. Concept of pH. Role of buffers in biochemical reactions. Buffers of different pH ranges. Commonly used buffers in biochemical assays. Principle, calibration and use of pH meter. Preparation of two commonly used buffers: phosphate buffer, citrate buffer. Preparation of complex buffered stock solutions. Preparation of working solutions. **14**

Unit 2: Qualitative biochemical analyses: The use of pipettes and micropipettes. Cleaning and calibration of micropipettes. Principles and performance of qualitative tests for the detection of reducing and non-reducing sugars: Benedict's Test, Fehling's Test, Molisch Test; and starch: Iodine Test. Detection of lipids using Solubility Test, Osmic acid Test, Acrolein Test, Sudan III Test.

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Suggested readings:

***Theory*:**

1. Lehninger Principles of Biochemistry by D.L. Nelson and M.M. Cox. 8th edition. W.H. Freeman and Company, UK. 2021.
2. Biochemistry by J.M. Berg, J.L.Tymoczko, G.J. Gatto, and L. Stryer. 9th edition. W.H. Freeman and Company, UK. 2019.
3. Biochemistry by T.A. Brown and S.N. Mukhopadhyay. 1st edition. Viva Books, India. 2018.

4. Fundamentals of Biochemistry by D. Voet, J.G. Voet and C.W. Pratt. 5th edition. John Wiley and Sons, UK. 2016.

Practicals:

1. Practical Biochemistry by R.C. Gupta and S. Bhargava. 5th edition. CBS Publishers and Distributors, India. 2018.

2. An Introduction to Practical Biochemistry by D. Plummer. 3rd edition. McGraw Hill Education, India. 2017.

3. Introduction to Practical Biochemistry (ebook) by G. Hegyi, J. Kardos, M. Kovacs, A. Malnasi-Csizmadia, L. Nyitray, G. Pal, L. Radnai, A. Remenyi and I. Venekei. Eotvos Lorand University. 2013.

4. Modern Experimental Biochemistry by Rodney Boyer. 3rd edition. Pearson, India. 2002.

Facilitating the achievement of Course Learning Outcomes:

S. No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks*
1.	Explain the principles of thermodynamics as applied to biological systems and will be able to comment on the rate constants and feasibility of biochemical reactions by calculating free energy changes	Classroom lectures on laws of thermodynamics, bioenergetics, numericals on standard free energy changes of coupled reactions	Problems on free energy change and standard free energy change and determination of equilibrium constant from data provided.
2.	Describe the structures and properties of various types of carbohydrates and will be able to relate the structures of simple and complex carbohydrates to their wide range of functions. Will gain knowledge of the role of sugars and their derivatives in formation of macromolecules /supramolecular complexes	Pictorial presentations of carbohydrates, mono, di-, and polysaccharides, including starch, glycogen, cellulose, and peptidoglycan. Use of flow charts for teaching structures and reactions.	Drawing the structures of carbohydrates. Multiple choice questions-type quiz on identification of anomers, epimers, enantiomers of sugars.

3.	Converse on the building block of lipids: fatty acids and their properties. Will acquire a clear understanding of the structures, properties and functions of storage and membrane lipids. Will learn of different types of lipid aggregates and their applications.	Lecture on lipids' structure, characteristic features and different types of "formations". Discussion on essential fatty acids and their significance in human nutrition.	Pictorial quiz on identification of biomolecules forming different types of lipids. Practice sessions for writing biochemical structures of different examples from lipid classes.
4.	Prepare buffers and solutions of different molarity and normality and will be adept in the use of fine weighing balances and pH meter.	Calibration and use of pH meter. Students in groups will prepare citrate buffers , phosphate buffer and acid of given molarities. Preparation of the stock solution of a given substance in group and its dilutions individually.	Students are required to write a report for all the exercises in a record book They will submit the practical's record on a specified date and will be assessed for it.
5.	Analyze foodstuff for their microchemical composition, and will be able to detect the presence of carbohydrates and fats in samples by performing qualitative tests. Will become familiar with the use of spectrophotometer.	Use of micropipettes and testing their accuracy Qualitative tests for the presence of reducing and non-reducing sugars, proteins, and lipids and resolving the composition of unknown samples.	May be given lab sheets with a write up leaving sections like observations and error analysis, for the students to complete. Students will perform and record in their lab books and assessed on the basis of their reporting. Students will be observed while performing lab work and will be assessed for their technical performance. They are encouraged to

			keep their lab books up to date which will be sampled a number of times during the semester.

***Assessment tasks are indicative and may vary.**