

## BIOCHEMISTRY

Program	BSc in Chemistry					
Module Name	Applied Chemistry					
Module Number	11					
Module code	Chem-M3111					
Course Title	Biochemistry					
Course Code	Chem3116					
Prerequisite	Chem3091					
Module coordinator's name and address	TBA					
Instructor(s) name and address	TBA					
Lecture days, Hours & room	TBA					
Cr. Hrs/ EtCTS	3/5					
Work load (per week)	Lecture	Tutorial	Lab.	Home study	Assessment	Total
	48	16	-----	66	5	135
Target group	3 <sup>rd</sup> year chemistry students					
Mode of delivery	Semester based					
Semester	Semester II					
Status of the course	Core Compulsory					

### Course Description

Unique properties of Water as applied to Life, Structure and chemistry of biomolecules (proteins, carbohydrates, lipids, nucleic acids, Minerals and Hormones); enzymology; intermediary metabolism and generation and storage of metabolic energy; oxidative-reductive processes; selected metabolic pathways of carbohydrates and fats; integration of metabolism, Structure and chemistry of biomolecules (proteins, carbohydrates, lipids, nucleic acids); enzymology; Hormones and their roles in metabolic regulations; intermediary metabolism and generation and storage of metabolic energy; oxidative-reductive processes; selected metabolic pathways of carbohydrates and fats; integration of metabolism.

### Learning Outcomes

By the end of this course students should be able to:

- Write the structures and chemistry of biological molecules namely: proteins, carbohydrates, lipids and nucleic acids;
- Discuss about the different metabolic reactions that take place in our body;
- Describe enzymology and enzymatic reactions
- Describe the applications of chemistry in life and write the different metabolic reactions and pathways in different kinds of living things.

## Course Outline and Schedule

Week	Contents	Methodology	Activities	Readings
1 & 2	<b>1. Introduction to biochemistry</b> <ul style="list-style-type: none"> <li>• Definition and scope of biochemistry</li> <li>• Chemical and biochemical reactions</li> <li>• Chemistry of organelles (hierarchical organization of organelles in living cells, composition, properties, and function of organelles)</li> </ul> <b>2. Water, pH, and buffer</b> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Unusual properties of water to be used as a biological solvent</li> <li>• Role of water in biological system</li> <li>• Intermolecular forces</li> <li>• Colligative properties</li> <li>• Hydronium ion and pH</li> <li>• Physiological Buffers and buffering agent</li> <li>• Buffers used by cells</li> <li>• Some common Buffers used in biochemical reactions</li> </ul>	<ul style="list-style-type: none"> <li>✓ Lecture</li> <li>✓ Group discussion</li> <li>✓ Oral questions</li> <li>✓ Asking questions</li> </ul>	<ul style="list-style-type: none"> <li>➤ Listen</li> <li>➤ Question &amp; answering</li> <li>➤ Home/class works</li> <li>➤ Taking short note</li> </ul>	<ul style="list-style-type: none"> <li>➤ A.L. Lehninger Principles of Biochemistry, 4<sup>th</sup> edition, 2005: <b>pp 1-28; 47-74</b></li> </ul>
	<b>Assignment 1 (10 %)</b>			

3 & 4	<b>3. Protein Structure and Function</b> <ul style="list-style-type: none"> <li>Structure and function of Amino Acids <ul style="list-style-type: none"> <li>➤ Introduction to Amino acids (essential and non-essential amino acids)</li> <li>➤ Structure of Amino Acids</li> <li>➤ Amino Acids as Buffers</li> <li>➤ Peptide Bond Formation (Peptide linkage)</li> </ul> </li> <li>Structure and function of Proteins <ul style="list-style-type: none"> <li>➤ Primary Structure of Proteins</li> <li>➤ Secondary Structure of Proteins</li> <li>➤ Tertiary Structure of Proteins</li> <li>➤ Quaternary Structure of Proteins</li> <li>➤ Denaturation of Proteins</li> <li>➤ Uses of proteins</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>✓ Lecture</li> <li>✓ Group discussion</li> <li>✓ Oral questions</li> <li>✓ Asking questions</li> </ul>	<ul style="list-style-type: none"> <li>➤ Listen</li> <li>➤ Question &amp; answering</li> <li>➤ Home/class works</li> <li>➤ Taking short note</li> </ul>	<ul style="list-style-type: none"> <li>➤ A.L. Lehninger Principles of Biochemistry, 4<sup>th</sup> edition, 2005: <b>pp 75-156</b></li> <li>Garret and Grisham Biochemistry: <b>PP 120-126</b></li> </ul>
	<b>Quiz 1 (5 %)</b>			
5 & 6	<b>4. Enzymes</b> <ul style="list-style-type: none"> <li>Definition of Enzymes</li> <li>Properties of Enzymes</li> <li>Major Classes of Enzymes</li> <li>Enzyme Kinetics</li> <li>Enzyme Mechanism (mechanism of catalysis)</li> <li>Regulation of Enzyme activity (Activation/Inhibition)</li> </ul>	<ul style="list-style-type: none"> <li>✓ Lecture</li> <li>✓ Group discussion</li> <li>✓ Oral questions</li> <li>✓ Asking questions</li> </ul>	<ul style="list-style-type: none"> <li>➤ Listen</li> <li>➤ Question &amp; answering</li> <li>➤ Home/class works</li> <li>➤ Taking short note</li> </ul>	A.L. Lehninger Principles of Biochemistry, 4 <sup>th</sup> edition, 2005: <b>pp 190-237</b>
	<b>Test 1 (10 %)</b>			

7 & 8	<b>5. Lipids</b> <ul style="list-style-type: none"> <li>• Definition of lipids</li> <li>• Discussion on different classes of lipids (Free fatty acids, Triacylglycerols, waxes, , phospholipids, sphingolipids, eicasanoids, isoprenoids, Steroids and other lipids</li> <li>• Biological membranes</li> <li>• Membrane transports</li> </ul>	<ul style="list-style-type: none"> <li>✓ Gapped Lecture</li> <li>✓ Group discussion</li> <li>✓ Oral questions</li> <li>✓ Asking questions</li> <li>✓ Reading assignme nt</li> </ul>	<ul style="list-style-type: none"> <li>➤ Listening</li> <li>➤ Question &amp; answering</li> <li>➤ Home/class works</li> <li>➤ Taking short note</li> </ul>	A.L. Lehninger Principles of Biochemistry, 4 <sup>th</sup> edition, 2005: <b>pp 343-368</b>
	<b>Presentation (10 %)</b>			
9	<b>6. Carbohydrates</b> <ul style="list-style-type: none"> <li>• Definition and Classification,</li> <li>• Monosaccharides</li> <li>• Disaccharides</li> <li>• Polysaccharides</li> </ul>	<ul style="list-style-type: none"> <li>✓ Gapped Lecture</li> <li>✓ Group discussion</li> <li>✓ Oral questions</li> <li>✓ Asking questions</li> <li>✓ Reading assignme nt</li> </ul>	<ul style="list-style-type: none"> <li>➤ Listening</li> <li>➤ Question &amp; answering</li> <li>➤ Home/class works</li> <li>➤ Taking short note</li> </ul>	<ul style="list-style-type: none"> <li>➤ A.L. Lehninger Principles of Biochemistry, 4<sup>th</sup> edition, 2005: <b>pp 238-246</b></li> <li>➤ John McMurry, Organic Chemistry, 7<sup>th</sup> edition, 2007: <b>Pp 973-997</b></li> <li>➤ A.L. Lehninger Principles of Biochemistry, 4<sup>th</sup> edition, 2005: <b>pp 247-255</b></li> <li>➤ John McMurry, Organic Chemistry, 7<sup>th</sup> edition, 2007: <b>Pp 977-1005</b></li> </ul>

9 & 10	<p><b>7. Introduction to Metabolism</b></p> <ul style="list-style-type: none"> <li>• Metabolic Pathways</li> <li>• Bioenergetics</li> <li>• Regulations</li> </ul> <p><b>8. Carbohydrate Metabolism</b></p> <ul style="list-style-type: none"> <li>• Structure of Carbohydrate <ul style="list-style-type: none"> <li>➤ Overview</li> <li>➤ Digestion of Carbohydrate</li> </ul> </li> <li>• Glycogen Metabolism/Starch <ul style="list-style-type: none"> <li>➤ Overview</li> <li>➤ Degradation of Glycogen</li> </ul> </li> <li>• Metabolism of Monosaccharides and Disaccharides (Overview)</li> <li>• Glycolysis <ul style="list-style-type: none"> <li>➤ Fates of Pyruvate</li> <li>➤ Energy yield of Glycolysis</li> </ul> </li> <li>• Citric Acid Cycle</li> <li>• Electron Transport Chain and Oxidative Phosphorylation</li> <li>• Hexose Monophosphate Pathway (Pentose Phosphate pathway) <ul style="list-style-type: none"> <li>➤ Overview</li> <li>➤ NADPH/Pentose</li> </ul> </li> <li>• Gluconeogenesis <ul style="list-style-type: none"> <li>➤ Overview</li> <li>➤ Reactions Unique to Gluconeogenesis</li> <li>➤ Substrates for Gluconeogenesis</li> <li>➤ Regulations of Gluconeogenesis</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>✓ Gapped Lecture</li> <li>✓ Group discussion</li> <li>✓ Oral questions</li> <li>✓ Asking questions</li> </ul>	<ul style="list-style-type: none"> <li>➤ Listening</li> <li>➤ Question &amp; answering</li> <li>➤ Home/class works</li> <li>➤ Taking short note</li> </ul>	<p>A.L. Lehninger Principles of Biochemistry, 4<sup>th</sup> edition, 2005: pp 489-520; 521-630</p>
Presentation (5 %)				

<b>11<sup>th</sup> &amp; 12<sup>th</sup></b>	<b>9. Lipid Metabolism</b> <ul style="list-style-type: none"> <li>• Introduction <ul style="list-style-type: none"> <li>➤ Metabolism of Dietary Lipids <ul style="list-style-type: none"> <li>▪ Overview</li> <li>▪ Digestion, Absorption, Secretion, and Use of Dietary Lipids</li> </ul> </li> <li>➤ Fatty Acid and Triacylglycerol Metabolism</li> <li>➤ Mobilization of Stored Fats and Oxidation of Fatty Acids</li> </ul> </li> <li>• Phospholipid Metabolism</li> </ul>	<ul style="list-style-type: none"> <li>✓ Gapped Lecture</li> <li>✓ Group discussion</li> <li>✓ Oral questions</li> <li>✓ Asking questions</li> <li>✓ Reading assignment</li> </ul>	<ul style="list-style-type: none"> <li>➤ Listen</li> <li>➤ Question &amp; answering</li> <li>➤ Home/class works</li> <li>➤ Taking short note</li> </ul>	<ul style="list-style-type: none"> <li>➤ A.L. Lehninger Principles of Biochemistry, 4<sup>th</sup> edition, 2005: <b>pp 631-655</b></li> </ul>
<b>Test 2 (10 %)</b>				

13 & 14	<p><b>10. Amino Acids/Nitrogen Metabolism</b></p> <ul style="list-style-type: none"> <li>• Nitrogen Fixation and Synthesis of Amino Acids <ul style="list-style-type: none"> <li>▪ Digestion of Dietary Proteins</li> <li>▪ Removal of Nitrogen from Amino Acids</li> <li>▪ Urea Cycle: The Major Pathway of Disposal of Nitrogen</li> </ul> </li> <li>➤ Amino Acids: Metabolism of Carbon Atoms <ul style="list-style-type: none"> <li>▪ Catabolism of the Carbon Skeletons of Amino Acids</li> <li>▪ Biosynthesis of Nonessential Amino Acids</li> </ul> </li> <li>➤ Conversion of Amino Acids to Specialized Products: An overview</li> </ul> <p><b>11. Integration of Metabolism</b></p> <ul style="list-style-type: none"> <li>• Metabolic Effects of Insulin and Glucagon <ul style="list-style-type: none"> <li>▪ Overview</li> <li>▪ Insulin</li> <li>▪ Glucagon</li> </ul> </li> <li>➤ Starvation and fasting; similarity and differences</li> <li>➤ Nutrition</li> <li>➤ Vitamins</li> </ul>	<ul style="list-style-type: none"> <li>✓ Gapped Lecture</li> <li>✓ Group discussion</li> <li>✓ Oral questions</li> <li>✓ Asking questions</li> <li>✓ Reading assignment</li> </ul>	<ul style="list-style-type: none"> <li>➤ Listen</li> <li>➤ Question &amp; answering</li> <li>➤ Home/class works</li> <li>➤ Taking short note</li> </ul>	<ul style="list-style-type: none"> <li>➤ A.L. Lehninger Principles of Biochemistry, 4<sup>th</sup> edition, 2005: <b>pp 671-750; 881-920</b></li> <li>➤ Garret and Grisham Biochemistry: <b>PP 584-607</b></li> <li>➤ Harpers Illustrated Biochemistry, 26<sup>th</sup> edition, 2003: <b>Pp 231-236</b></li> </ul>
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15	<b>12. Nucleic Acid Structure and Function</b> <ul style="list-style-type: none"> <li>• Structure of DNA and RNA</li> <li>• DNA Synthesis (Overview) (Replication)</li> <li>• RNA Synthesis <ul style="list-style-type: none"> <li>➤ Overview</li> <li>➤ Transcription</li> </ul> </li> <li>• Protein Synthesis <ul style="list-style-type: none"> <li>➤ The Genetic Code</li> <li>➤ Translation</li> </ul> </li> </ul>	✓ Gapped Lecture ✓ Group discussion ✓ Oral questions ✓ Asking questions ✓ Reading assignment	➤ Listen ➤ Question & answering ➤ Home/class works ➤ Taking short note	➤ A.L. Lehninger Principles of Biochemistry, 4 <sup>th</sup> edition, 2005: pp <b>921-1080</b>
16	<b>Final written exam (50 %)</b>			

### Mode of Assessment

Assessment Breakdown	%
continuous assessment (not more than 10% for each)	<b>50</b>
End of Semester Examination	<b>50</b>

### Course Policy

Beside the university's policy on course delivery and evaluation, students are expected to actively participate in learning process by obeying the following course policies:

- Coming class on time (punctuality)
- Attend all class sessions
- Be prepared to learn and actively participate during class discussion
- Do all assignments, group works, project works, and presentations on time
- All students are expected to complete their own work to the best of their ability and cheating is strictly forbidden
- Do not miss quizzes, assignments, and exams unless you are forced due to health and other reasonable problems
- Cite all sources consulted to any extent (including material from the internet), whether or not assigned and whether or not quoted directly. It is strictly forbidden to take others work and present as own.
- Make-up class shall be conducted if classes are missed due to national holidays and/or when unpredicted conditions result in class dismissal



## References

1. D.L. Nelson and M.M. Cox, A.L. Lehninger Biochemistry, Worth Publishers, Inc. New York. 2005
2. E.E Cohn and P.K Stumpf. Outlines of Biochemistry John will & sons, Inc.
3. Elliott, WH & Elliott, DC 2001. Biochemistry and Molecular Biology, 2<sup>nd</sup> edn, Oxford University Press, Oxford.
4. J.M. Berg, J.L. Tymoczko and L. Stryer, Biochemistry, 5<sup>th</sup> Ed., 2005: and Student's Companion to Stryer's Book.
5. L. Smith, et al, Principles of Biochemistry, General aspects, McGraw-hill Book Co, 1982.
6. Mathews, CK, Van Holde, KE & Ahern, K.G, Biochemistry, 3rd edn, Benjamin/Cummings Publishing Company, 2000 (Pearson Educ)
7. P.C. Champe; R.A. Harvey, Biochemistry, 4th Ed., Lippincott's Illustrated Reviews, 2007.
8. Voet, D, Voet, J G & Pratt, C. W Fundamentals of Biochemistry, John Wiley & Sons, New York. 1998.
9. Zubay, Parson and Vance, Principles of Biochemistry, 1995.