



Department of Physical Sciences and Mathematics  
College of Arts and Sciences  
University of the Philippines Manila  
Second Semester AY 2020 to 2021



**CHEMISTRY 40: ELEMENTARY BIOCHEMISTRY**

**Course Description**

This is a three-unit lecture course that focuses on the structure and function of biomolecular compounds: proteins, nucleic acids, carbohydrates, and lipids and their roles in energy transduction and metabolism.

**Course Learning Outcomes**

After completing the course, you should be able to:

1. Demonstrate knowledge of the fundamental concepts in biochemistry.
2. Discuss the reaction pathways involving biomolecules such as proteins, nucleic acids, carbohydrates and lipids.
3. Apply biochemical reaction pathways in the analysis of problems and situations accompanied by erroneous metabolism.
4. Solve common qualitative and quantitative problems in biochemistry

**Course Requirements**

**Pre-Final Standing**

- Four (4) Departmental Exams
- Class quizzes and problem sets
- Other class activities

**Final Exam**

**2/3 of grade**

60%  
20%  
20%

**1/3 of grade**

**Grading System**

%	Eq.
[90, 100]	1.00
[85, 90)	1.25
[80, 85)	1.50
[75, 80)	1.75
[70, 75)	2.00
[65, 70)	2.25
[60, 65)	2.50
[55, 60)	2.75
[50, 55)	3.00
[40, 50)	4.00
[0, 40)	5.00

**Class Policies**

1. Submit and comply with all course requirements.
2. Actively participate in group work and discussions through the given LMS platform or through synchronous sessions.
3. Politely and respectfully interact with instructors and classmates in all remote platforms.
4. Must take ALL exams (including final exam if required).
5. Criterion for finals exemption: MUST PASS all departmental exam (at least 50%).
6. All forms of cheating will NOT BE TOLERATED and will merit a grade of 5.0. (Students will not be allowed to drop the course if found guilty.)

Please remember that the goal of all requirements (e.g. quizzes and exams) is to facilitate learning. PLEASE PRACTICE ACADEMIC INTEGRITY AT ALL TIMES.

### Course Content and Schedule

Week No.	Topic	Topic Outcome	Time Frame (hr)	Learning Activities	Learning Resources
1	<b>Orientation</b>		1.0	Synchronous through Zoom or other online meeting platform	- Online Videos/ References
	<b>Introduction to Biochemistry</b>	- Relate biochemistry to the life sciences, particularly of biology and medicine	0.5	Watch video/ Read module	- Lectures - Modules - Textbooks
	<b>Buffers</b> - Definition of acid, bases, pH, pKa - Henderson-Hasselbalch equation - Titration curves	- Explain how buffers work in biological systems  - Solve problems on buffers		Problem solving exercises	
	<b>Amino Acids and pI</b>	- Explain the physiological and chemical properties of amino acids especially their function as biological buffers - Classify the amino acids according to their structures and properties	1.5	Watch video/ read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
2	<b>Proteins: Structure and Function</b> - Peptide bond - Levels of protein organization (collagen, hemoglobin) - Functions (catalytic, immunological, structural, etc.)	- Explain how the nature of amino acids affect protein structure - Discuss the different functions of proteins in relation to their structures	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
	<b>Proteins: Isolation and Characterization Techniques</b>	- Differentiate techniques in isolating and purifying proteins and their applications	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
3	<b>Proteins: Enzymes</b> - Classification - Kinetics (Michaelis-Menten, Lineweaver-Burk)	- Discuss the concepts of enzyme catalysis - Differentiate types of inhibitors on enzyme catalysis	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks

Week No.	Topic	Topic Outcome	Time Frame (hr)	Learning Activities	Learning Resources
	- Inhibition (irreversible, competitive, noncompetitive, uncompetitive)	- Solve problems involving enzyme kinetics			
	- Factors affecting kinetics - Minerals, coenzymes, cofactors - Multienzyme complexes (pingpong, ordered, random, sequential)	- Differentiate enzyme and multi-enzyme complexes	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
	<b>FIRST EXAM</b>				
4	<b>Nucleic Acids: Structure, Properties and Function</b> - Central dogma - RNA vs. DNA - Levels of structural organization	- Identify the components of nucleic acids - Explain the structural differences between DNA and RNA - Describe DNA structure and how it is packed in the cell	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
	<b>Nucleic Acids: Replication of Eukaryotes and Prokaryotes</b>	- Describe how a new copy of DNA is synthesized	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
5	<b>Nucleic Acids: Transcription and Post-transcriptional modification</b>	- Describe how RNA is synthesized from DNA - Differentiate transcription in prokaryotes and in eukaryotes - Discuss post-transcriptional modifications in eukaryotes	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
	<b>Nucleic Acids: Translation in Eukaryotes and Prokaryotes</b>	- Describe how protein is synthesized from mRNA - Differentiate the mechanisms of translation in eukaryotes and prokaryotes	1.0	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
	<b>Exceptions to the central dogma</b>	- Explain how retroviruses utilize their genetic material	0.5		

Week No.	Topic	Topic Outcome	Time Frame (hr)	Learning Activities	Learning Resources
	- Retroviruses and reverse transcription - Epigenetics	- Differentiate epigenetic and genetic effects on gene expression			
6	<b>Nucleic Acids: Mutations and Repair</b> - Types of mutations - Effects of physical, chemical, and viral agents - Protective and repair mechanisms	- Assess the different mechanisms of mutation and how various agents of mutation exhibit their effects on the structure and function of nucleic acids - Explain the various protective mechanisms and repair systems in cells	1.5	Watch video/ Read module  Solve problems and exercises  Look into: <a href="#">Chem 41\BRCA-1scenario.pdf</a>	- Online Videos/ References - Lectures - Modules - Textbooks
	<b>Nucleic Acids: Isolation, characterization and manipulation methods</b> - Basic recombinant DNA techniques - Current approaches to DNA manipulation and analysis	- Explain the techniques used in recombinant DNA technology - Discuss current approaches to DNA manipulation and analysis	1.5	Watch video/ Read module  Answer discussion questions	- Online Videos/ References - Lectures - Modules - Textbooks
<b>SECOND EXAM</b>					
7	<b>Carbohydrates: Structure and Function</b>	- Relate the structures, properties, and reactivities to the functions of carbohydrates - Draw carbohydrate structures	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
	<b>Carbohydrates: Functions of polysaccharides</b>	- Differentiate the structure and function of polysaccharides	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
8	<b>Lipids: Structure and Function</b>	- Relate the structures and properties to the functions of lipids - Draw lipid structures	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks

Week No.	Topic	Topic Outcome	Time Frame (hr)	Learning Activities	Learning Resources
	<b>Biological Membranes and Membrane Transport</b>	<ul style="list-style-type: none"> <li>- Relate membrane structure to its functions</li> <li>- Discuss transport mechanisms in membranes</li> </ul>	1.5	Watch video/ Read module Solve problems and exercises	<ul style="list-style-type: none"> <li>- Online Videos/ References</li> <li>- Lectures</li> <li>- Modules</li> <li>- Textbooks</li> </ul>
9	<b>Bioenergetics</b> <ul style="list-style-type: none"> <li>- Introduction to metabolism, stages, and regulation</li> <li>- Free energy, high energy compounds, and coupled reactions</li> <li>- Substrate level phosphorylation</li> <li>- Oxidative phosphorylation</li> <li>- Electron transport chain</li> <li>- Inhibitors of ATP chain</li> <li>- Other energy transducing reactions</li> </ul>	<ul style="list-style-type: none"> <li>- Present an overview of metabolism</li> <li>- Apply the laws of thermodynamics in the maintenance of cellular functions</li> <li>- Discuss the methods of ATP synthesis and processes that affect it</li> <li>- Enumerate important biological reactions that use and produce energy</li> </ul>	1.5	Watch video/ Read module Solve problems and exercises	<ul style="list-style-type: none"> <li>- Online Videos/ References</li> <li>- Lectures</li> <li>- Modules</li> <li>- Textbooks</li> </ul>
	<b>Carbohydrate Catabolism</b> <ul style="list-style-type: none"> <li>- Glycolysis</li> <li>- Krebs's cycle</li> <li>- Glycogenolysis</li> <li>- Anaerobic respiration (ethanol fermentation, lactic acid fermentation)</li> </ul>	<ul style="list-style-type: none"> <li>- Discuss cellular respiration as the major catabolic and energy-producing pathway of all cells</li> <li>- Illustrate various catabolic pathways for carbohydrates</li> </ul>	1.5	Watch video/ Read module Solve problems and exercises	<ul style="list-style-type: none"> <li>- Online Videos/ References</li> <li>- Lectures</li> <li>- Modules</li> <li>- Textbooks</li> </ul>
10	<b>Continuing on Carbohydrate Catabolism</b>		1.5	Watch video/ Read module Solve problems and exercises	<ul style="list-style-type: none"> <li>- Online Videos/ References</li> <li>- Lectures</li> <li>- Modules</li> <li>- Textbooks</li> <li>-</li> </ul>
	<b>Lipid Catabolism</b> <ul style="list-style-type: none"> <li>- Lipolysis</li> <li>- <math>\beta</math>-oxidation</li> </ul>	<ul style="list-style-type: none"> <li>- Discuss the role of lipids as alternative sources of energy and the different reactions in the</li> </ul>	1.0	Watch video/ Read module Solve problems and exercises	<ul style="list-style-type: none"> <li>- Online Videos/ References</li> <li>- Lectures</li> <li>- Modules</li> <li>- Textbooks</li> </ul>

Week No.	Topic	Topic Outcome	Time Frame (hr)	Learning Activities	Learning Resources
11	<b>Amino Acid Catabolism</b> - Transamination, oxidative deamination, direct deamination - Amino acid catabolism - Nitrogenous base catabolism - Urea cycle  <b>Nucleic Acid Catabolism</b> - Purine and Pyrimidine Catabolism	- Discuss the role of amino acids as primary or alternative sources of energy - Trace the fates of the amino group and carbon skeleton of amino acids - Calculate and compare the ATP generated from various sources  - Explain nucleic acid catabolism	2.0	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
	<b>THIRD EXAM</b>				
	<b>Carbohydrate Anabolism</b> - Gluconeogenesis - Glycogenesis and regulatory enzymes - Pentose phosphate pathway	- Discuss the pathways leading to the synthesis of glucans and glucose	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
12	<b>Lipid Anabolism</b> - Biosynthesis of fatty acids - Lipogenesis - Ketogenesis - Biosynthesis of cholesterol and eicosanoids - Lipid transport: HDL, LDL, VLDL, chylomicrons	- Present the pathways that cells undergo in order to synthesize fatty acids - Discuss the pathways that liver cells undergo to compensate for the decrease in dietary sources of energy - Explain the reactions leading to cholesterol synthesis and how these processes are regulated	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
	<b>Nitrogen Anabolism</b> - Biosynthesis of amino acids - De novo and salvage pathways of nitrogenous bases	- Summarize the precursors and pathways leading to the synthesis of amino acids and nucleotides	1.5	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules - Textbooks
13	<b>Integration</b> - Digestion and Absorption of Foodstuffs	- Correlate the various metabolic pathways	3.0	Watch video/ Read module  Solve problems and exercises	- Online Videos/ References - Lectures - Modules

Week No.	Topic	Topic Outcome	Time Frame (hr)	Learning Activities	Learning Resources
	<ul style="list-style-type: none"> <li>- Metabolic Patterns in Animals (e.g. plasma levels of glucose, fatty acids and ketone bodies)</li> <li>- Integration and Regulation of Metabolic Pathways</li> </ul>	<ul style="list-style-type: none"> <li>- Compare the levels of metabolites during the different stages of metabolism</li> <li>- Differentiate metabolic needs of various organ systems</li> <li>- Discuss how various metabolic pathways are regulated</li> </ul>			<ul style="list-style-type: none"> <li>- Textbooks</li> </ul>
	<b>FOURTH EXAM</b>				
<b>14</b>	<b>FINAL EXAM</b>				

**Main Textbook References:**

Ahern, K., Rajagopal, I. (2015). *Biochemistry: Free and Easy*. Available at: <https://biochem.oregonstate.edu/files/biochem/ahern/BiochemistryFreeandEasy3.pdf>.  
 Ahern, K., Rajagopal, I., Tan, T. (2018). *Biochemistry: Free For All*. Available at: <https://open.umn.edu/opentextbooks/textbooks/biochemistry-free-for-all-ahern>.  
 Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P., (2015). *Molecular Biology of the Cell*, 6<sup>th</sup> Ed. New York: Garland Science.  
 Berg, J., Tymoczko, J., Stryer, L., Gatto, G. (2012). *Biochemistry*, 7<sup>th</sup> Ed. New York: W.H. Freeman and Company.  
 Campbell, M., Farrell, S., & McDougal, O. (2017). *Biochemistry*. Pacific Grove, CA: Brooks Cole.  
 Nelson, D., Cox, M. (2008). *Lehninger Principles of Biochemistry*, 5<sup>th</sup> Ed. New York: W.H. Freeman and Company.  
 Voet, D., Voet, J. (2011). *Biochemistry*, 4<sup>th</sup> Ed. New Jersey: John Wiley & Sons, Inc.