

The University of Jordan

Faculty: Medicine

Semester: Summer

Course Name: Introductory

Biochemistry and molecular biology (for medical students)

Department: Physiology and Biochemistry

Academic Year: 2022-2023

Course Number: 0501118

Credit hours	3	Level	1	Prerequisite	None
Coordinator/ Lecturer	Prof. Mamoun Ahram Prof. Nafez Abu Tarboush Dr. Diala Abu Hassan	Office number		Office phone	
Course website		E-mail		Place	

Office hours					
Day/Time	Sunday	Monday	Tuesday	Wednesday	Thursday
	TBD	TBD	TBD	TBD	TBD

Introduction

Biochemistry as the name implies is the chemistry of life. It is the alphabet and language of biology. The study of biochemistry is essential to understanding the structure and functioning of cells at the molecular level. Biochemistry is perhaps the most rapidly developing subject in medicine. No wonder the major share of Nobel prizes in medicine has gone to research workers engaged in biochemistry and molecular biology.

Course Description

This three-credit-hour course is mandatory for first-year medical students. The course is designed to introduce medical students to biochemistry and molecular biology by covering the basic concepts of structures and functions of macromolecules. A large portion of the course will also cover detailed information on enzymes, their mechanisms of action, their regulation, and their uses in biology and medicine with an emphasis on molecular biology, cofactors critical for enzyme function and mechanism of actions, clinical enzymology, and isoenzymes. Basic and advanced biochemical and molecular techniques used in research will be discussed.

Learning Objectives

- Understand strong and weak acids and bases
- Metabolic sources of acids and bases
- The concept of pH and pKa
- Regulatory mechanism against changes in pH
- Main physiological buffers and their actions

- Describe the chemical structures of carbohydrates, lipids, amino acids and proteins, enzymes, co-enzymes, and vitamins
- Explain the chemical structures in relation to the function of the macromolecules
- Appreciate the specificities and catalytic power of enzymes, understand the mechanisms of their actions and identify factors that affect their activity
- Know the principles and applications of different biochemical techniques used in biological research

Intended Learning Outcomes (ILOs):

Successful completion of the course should lead to the following outcomes:

A. Knowledge and Understanding: The student is expected to

- A1- Differentiate the types and characteristics of non-covalent interactions
- A2- pH and buffers: Recall the concepts of acids, bases, amphoteric molecules, and ionization of water and weak acids
- A3- Apply the molecular expressions: molarity, normality, equivalence, pH, and pKa.
- A4- Know the chemical concept of different types of buffers, buffering capacity, midpoint, and titration.
- A5- Apply the Henderson-Hasselbalch equation and mechanisms of buffer actions.
- A6- List of physiological buffers and translate knowledge into normal and abnormal conditions.
- A7- Review of basic organic chemistry and functional groups in biomolecules.
- A8- Definition of Carbohydrates
- A9- Chemistry of Carbohydrates
- A10- Importance of Carbohydrates
- A11- Classification of Carbohydrates (e.g. mono and disaccharides)
- A12- Important disaccharides and polysaccharides
- A13- Differentiate proteoglycans and glycoproteins and carbohydrates linked to blood groups.
- A14- Define lipids and the importance of lipids.
- A15- Identify the classifications, drawing, structure, and function of lipids (fatty acids, triglycerides, waxes, phospholipids, glycolipids, and steroids.
- A16- Differentiate the basic mechanism of lipid transport in blood
- A17- Recall the complex structure of cell membranes
- A18- Define proteins
- A19- List amino acids
- A20- Differentiate the structure, isomerism, and classes of amino acids
- A21- Identify the ionization states of amino acids
- A22- Know the concept of isoelectric point
- A23- List modified and specialized amino acids
- A24- Recall of features of peptide bond
- A25- Apply the concept isoelectric point of amino acids to polypeptides
- A26- Recall the four levels of protein structure
- A27- Differentiate the different secondary structures of proteins and their structural significance

- A28- Understand the formation of tertiary structure of proteins
- A29- Define quaternary structure
- A30- Know the concept of complex protein structures (glycoproteins, lipoproteins, phosphoproteins)
- A31- Apply the concepts of denaturation and renaturation to protein structure and function
- A32- Apply the previous information to pathological defects in protein formation
- A33- Recognize the different classes of proteins (fibrous, globular)
- A34- Discuss different proteins from each class I (mainly collagen, myoglobin, hemoglobin, and immunoglobulins) in connection to their function in light of previous knowledge
- A35- Define enzymes
- A36- Recall the general properties and functions of enzymes, ribozymes.
- A37- List the classes of enzymes and differentiate the reactions they catalyze
- A38- Recall the major features of active sites
- A39- Recall the concept of free energy and activation energy, transition state, abzymes.
- A40- Differentiate between holoproteins and apoproteins
- A41- Differentiate classes of cofactors
- A42- Define and list vitamins and understand their contribution in enzymatic reaction (coenzymes)
- A43- Identify the role of metals in enzyme activity of metal-activate enzymes
- A44- Define enzyme kinetics
- A45- Apply the concept of V_o , V_{max} , and K_M , and their biological significance
- A46- Apply the above terms to the Michaelis-Menten equation
- A47- Apply the enzyme units to understand the following terms: (rate of reaction (V_o), V_{max} , specific activity, turnover number).
- A48- Link the mechanisms of action of the different classes of inhibitors in relation to the Lineweaver-Burk or double-reciprocal plot
- A49- Describe how enzyme activity can be regulated by physiological and pharmacological inhibitors
- A50- Recall the concept of allosteric regulation
- A51- Identify the role of small and large enzyme regulatory molecules
- A52- Irreversible inhibition and suicide inhibition.
- A53- Define the various modes of enzyme regulation.
- A54- Discuss the effect of nonspecific inhibitors (temperature, pH) on protein structure and function
- A55- Define isoenzymes and know their biological and clinical significance (Clinical enzymology).
- A56- Principles and applications of dialysis.
- A57- Various types of chromatography techniques: gel filtration chromatography ion exchange chromatography, and affinity chromatography.
- A58- Vertical protein electrophoresis and isoelectric focusing.
- A59- Immunological techniques (ELISA, immunoblotting, immunoprecipitation, proteomics – mass spectrometry, protein arrays, cell fractionation).
- A60- Advanced molecular techniques (restriction endonucleases for DNA cloning and recombinant DNA technology and DNA cloning, immunoprecipitation, yeast two-hybrid system, the luciferase reporter assay, PCR, DNA sequencing, DNA microarrays, RNA-seq, CRISPR-Cas9)

- B. Intellectual Analytical and Cognitive Skills:** Student is expected to
- B1-Calculate pH and changes in pH according to different variables
 - B2-Predict changes in blood pH according to equilibrium of bicarbonate buffering system
 - B3-Differentiate between the various sugar molecules, lipids, and amino acids
 - B4-Calculate isoelectric point of small polypeptides
 - B5-Predict changes in enzyme kinetics according to inhibitor type
 - B6-Calculate enzyme units
 - B7-Determine enzyme class according to catalyzed reaction and involved cofactor
 - B8-Turnover number and specific activity.
 - B9-Interpretation of technical results.

Teaching/Learning Methods

Teaching Method	ILO/s
Lectures and Discussions:	X
Homework and Assignments:	
Projects:	
Presentation	

Course Contents

Topic	No. of lectures	Week	Reference	ILOs
Introduction	1	1	Chapter 4, 5	A1
Acids, bases, pH, and buffers	4	1, 2	Chapter 4	A2-6
Carbohydrates	2	2	Chapter 5	A7-13
Lipids	2	2	Chapter 5	A14-17
Amino acids	1	3	Chapter 5, 6	A18-23
Polypeptides and protein structure	3	3	Chapter 6, 7	A24-30
Protein structure-function relationship (part I: fibrous proteins)	1	4	Chapter 7, 47	A31-34
Protein structure-function relationship (part II: globular proteins)	1	4	Chapter 7	A31-34
Protein structure-function relationship (part III: immunoglobulins)	1	4	Chapter 7	A31-34
Enzymes (introduction)	1	5	Chapter 8	A35-40
Enzymes (cofactors)	1	5	Chapter 8	A41-43
Enzymes (kinetics)	1	5	Chapter 9	A44-48
Enzymes (mechanism and regulation)	2	5, 6	Chapter 9	A49-55
Biochemical techniques	33	6, 7	https://themedicalbiochemistrypage.org/protein-structure-and-analysis/	A56-59
Molecular techniques	6	Online	Cooper, Ch. 4	A60

Learning Methodology

Lectures and homework

Projects and Assignments

None

Evaluation

Evaluation	Point %	Date
Midterm Exam	40%	
Project	0%	
Assignments	0%	
Quizzes	0%	
Final Exam	60%	

Main References:

1. Marks' Basic Medical Biochemistry by M. Lieberman A. Marks and Alisa Peet, Lippincott, Williams and Wilkins, 2017. 5th edition.
2. The Cell: A Molecular Approach, Geoffrey M. Cooper and Robert E. Hausmann, 8th edition, Sinauer Associates, 2019.

Additional references:

- NCBI Bookshelf:
(<http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=Books>)
- The Medical Biochemistry Page: (<https://themedicalbiochemistrypage.org/>)

Intended Grading Scale

Notes:

- Concerns or complaints should be expressed in the first instance to the module lecturer; if no resolution is forthcoming, then the issue should be brought to the attention of the module coordinator (for multiple sections) who will take the concerns to the module representative meeting. Thereafter, problems are dealt with by the Department Chair and if still unresolved the Dean and then ultimately the Vice President. For final complaints, there will be a committee to review grading the final exam.
- For more details on University regulations please visit:
<http://www.ju.edu.jo/rules/index.htm>