

The University of Jordan

Faculty: Pharmacy

Department: Biopharmaceutics and Clinical Pharmacy

Program: Pharmacy

Academic Year/ Fall Semester: 2013/14

Biochemistry 1 (1203251)

Credit hours	2	Level	2 nd year	Pre-requisite	Biology I (0303231)
Coordinator/ Lecturer	Prof. Yasser Bustanji Dr. Violet Kasabri	Office number		Office phone	
Course website		E-mail		Place	

Office hours	
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Course Description

Provides principle information concerning the chemical and physical properties of biomolecules (carbohydrates, lipids, amino acids and fibrous and globular proteins) and their interrelated functioning in a biological system. Biological membranes and transport will be further discussed. Bioenergetics and oxidative phosphorylations will be covered. Additionally basic concepts of metabolisms and biosignalling will be illustrated. The topics of enzymes and amino acids titration curves are also taught.

Learning Objectives

This course is the first course in a two-semester sequence in biochemistry. The students are expected to:

1. Demonstrate a good awareness and understanding of biochemical principles
2. Understand the main concepts regarding the chemical and physical properties of key organic molecules used by living systems (fibrous and globular proteins, amino acids and peptides, carbohydrates, fatty acids and lipids)
3. Know the basic concepts and kinetics of enzymes, protein structure and function, regulatory strategies in enzymes and hemoglobin, lipids' classes and cell membranes channels and pumps, signal transduction pathways, transducing and storing energy.
4. Understand the main concepts of bioenergetics and oxidative phosphorylation, its dependence on a proton gradient and electron transfer.
5. Basic concepts of metabolism, metabolic regulation, biosignalling, enzymes, protein function as well as biological membranes and transport in addition to hemoglobinopathies will be delivered.

Intended Learning Outcomes (ILOs):

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

A. Knowledge and Understanding: Student is expected to develop Intellectual skills (cognitive and analytical) via learning:

A1. Introduction

- Key organic molecules are used by living systems

- Weak Interactions in Aqueous Systems
- Ionization of Water, Weak Acids, and Weak Bases
- Buffering against pH Changes in Biological Systems
- Water as a Reactant

A2. Transducing and Storing Energy

- Metabolism: Basic Concepts and Design
- Changes in free energy alone can predict reaction or process spontaneity
- Movement of substrate down its electrochemical gradient is exergonic so is ATP hydrolysis
- Changes in free energy of consecutive reactions are additive
- The coupling of favorable and unfavorable reactions takes place via common intermediates
- Substrate level phosphorylation generates ATP
- Relief of charge repulsion justifies the high phosphate transfer potential of ATP

A3. Oxidative Phosphorylation

- The Oxidation of Carbon Fuels Is an Important Source of Cellular Energy
- Catabolic pathways of fuel molecules converge to acetylCoA generation
- Oxidative Phosphorylation in Eukaryotes Takes Place in Mitochondria
- Oxidative Phosphorylation Depends on Electron Transfer
- The Respiratory Chain Consists of Four Complexes: Three Proton Pumps and a Physical Link to the Citric Acid Cycle
- A Proton Gradient Powers the Synthesis of ATP
- Problems

A4. Signal-Transduction Pathways: An Introduction to Information Metabolism

- Metabolism Is Composed of Many Coupled, Interconnecting Reactions
- Metabolic Pathways Can intersect
- Neural transmission across synapses recruits a diversity of ion channels and ion pumps
- Transmembrane- Receptors Change Conformation in Response to Ligand Binding and Activate receptor catalytic domains
- Activation of membrane-coupled G Proteins can be actively involved in biosignalling and signal amplification via enzyme cascades and Cross-phosphorylation
- The Hydrolysis of Phosphatidyl Inositol Bisphosphate by Phospholipase C Generates Two Messengers
- Calcium Ion Is a Ubiquitous Cytosolic Messenger
- Some Receptors Dimerize in Response to Ligand Binding

A5. Carbohydrates

- Monosaccharides Are Aldehydes or Ketones with Multiple Hydroxyl Groups
- Complex Carbohydrates Are Formed by Linkage of Monosaccharides
- Carbohydrates Attached to Proteins Form Glycoproteins
- Glycosaminoglycans represent gigantic heteropolysaccharides in chain
- Blood groups are Specific membrane protein-binding and lipid-binding carbohydrates

A6. Lipids and Cell Membranes

- Triacylglycerols Are Highly Concentrated Energy Stores
- Fatty Acids Are Key Constituents of Lipids
- Phospholipids and Sterols are most popular polar lipids
- Glycolipids are glycosylated ceramide derivatives
- Important Derivatives of Cholesterol Include Bile Salts and Steroid Hormones
- Lipids can function as signals, cofactors and pigments
- Many Common Features Underlie the Diversity of Biological Membranes
- There Are Three Common Types of Membrane Lipids

- Phospholipids and Glycolipids Readily Form Bimolecular Sheets in Aqueous Media
- Proteins Carry Out Most Membrane Processes
- Lipids and Many Membrane Proteins Diffuse Rapidly in the Plane of the Membrane
- Eukaryotic Cells Contain Compartments Bounded by Internal Membranes
- Membrane Channels and Pumps
 - The Transport of Molecules Across a Membrane May Be Active or Passive
 - A Family of Membrane Proteins Uses ATP Hydrolysis to Pump Ions Across Membranes
 - Secondary Transporters Use One Concentration Gradient to Power the Formation of Another
 - Specific Channels Can Rapidly Transport Ions Across Membranes
 - Ionophores are antimicrobial agents meant to dissipate metabolism-related ion gradient

A7. Amino acids and Protein Structure and Function

- Proteins Are Built from a Repertoire of 20 Amino Acids
- Different classes of amino acids and their Titration curves work via acid-base concepts; pKa and pI Values of Amino Acids
- Problems
- Primary Structure: Amino Acids Are Linked by Peptide Bonds to Form Polypeptide Chains
- The Amino Acid Sequence of a Protein Determines Its Three-Dimensional Structure
- Secondary Structure: Polypeptide Chains Can Fold Into Regular Structures Such as the Alpha Helix, the Beta Sheet, and Turns and Loops
- Tertiary Structure: Water-Soluble Proteins Fold Into Compact Structures with Nonpolar Cores
- Quaternary Structure: Polypeptide Chains Can Assemble Into Multisubunit Structures associated via non covalent linkages
- Keratins, collagens and elastin comprise main Fibrous proteins

A8. Enzymes: Basic Concepts and Kinetics

- Enzymes Are Powerful and Highly Specific Catalysts
- Free Energy Is a Useful Thermodynamic Function for Understanding Enzymes
- Enzymes Accelerate Reactions by Facilitating the Formation of the Transition State
- The Michaelis-Menten Model Accounts for the Kinetic Properties of Many Enzymes
- Enzymes Can Be Inhibited by Specific Molecules
- Enzyme inhibitors of different modes can be successful drug candidates
- Vitamins Are Often Precursors to Coenzymes
- V_{\max} and K_M Can Be Determined by Double-Reciprocal Plots
- Problems on competitive and non competitive enzyme inhibitors

A9. Regulatory Strategies: Enzymes

- An Enzyme can be Allosterically Inhibited by the End Product of Its Pathway
- Isozymes are different enzymes that catalyze the same reaction
- Substrate concentration, reaction pH and temperature can enzyme catalyzed reaction velocity
- Feed forward activation is another means of allosteric regulation in metabolic pathways
- Isozymes Provide a Means of Regulation Specific to Distinct Tissues and Developmental Stages where Many Enzymes Are Activated by Specific Proteolytic Cleavage
- Covalent Modification Is a Means of Regulating Enzyme Activity
- Kinases and phosphatases are directly involved in reversible phosphorylation of enzymes
- Induction or repression of enzyme synthesis mainly regulates binding sites populations intracellularly.

A10. Regulatory Strategies of Hemoglobin

- Hemoglobin Transports Oxygen Efficiently by Binding Oxygen cooperatively though non-covalently.
- Oxygen binding at the Iron sites in Hemoglobin induces substantial changes in quaternary structure of Hemoglobin; Transition from T to R state upon oxygenation
- Tuning the oxygen affinity of Hemoglobin: The effect of 2,3-Bisphosphoglycerate
- Fetal Red blood cells have a higher oxygen affinity than that of maternal red blood cells.
- The Bohr Effect: Hydrogen ions and carbon dioxide promote the release of oxygen
- There are different fetal and adult hemoglobins
- Hemoglobinopathies are mostly related to structural or subunit quantitative defects.

B. Subject specific skills

C. Transferable Skills: Student is expected to

D1. Develop of problem solving and critical thinking skills.

D2. Use oral communication to effectively transmit ideas and conclusions to a scientific audience.

ILOs: Learning and Evaluation Methods

ILO/s	Learning Methods	Evaluation Methods
A. Knowledge and Understanding B. Intellectual skills (cognitive and analytical) C. Transferable Skills:	Lectures and Discussions, Video simulations in addition to class problems	Exam, Quiz, Self study Quiz

Course Contents

Content	Reference	Week	ILO/s
Introduction		1 st	
Biomolecules.	2	Self study	A & B & C
Water and pH.	2	Self study	A & B & C
Bioenergetics and oxidative Phosphorylation	1 & 2	1 st & 2 nd	A & B & C
Basic concepts of metabolism	1 & 2	3 rd	A
Biochemistry of Carbohydrates.	1 & 2	4 th and 5 th	A & B & C
Glycoproteins and Glycosaminoglycans.	1 & 2	6 th	A & B & C
Biochemistry of Lipids	1 & 2	7 th and 8 th	A & B & C
Biological Membranes.	1	9 th	A & B & C
Biochemistry of Amino Acids and Peptides.	2	10 th & 11 th	A & B & C
Portrait of Allosteric Protein	2	12 th and 13 th	A & B & C
Enzymes.	1 & 2	14 th and 15 th	A & B & C
Final exam		16 th	

Learning Methodology

Lectures and Discussions,
Video simulations

Evaluation

Evaluation	Point %	Date
Midterm Exam	40	8 th week
Quiz 2	10	11 th week
Final Exam	50	16 th week

References:

ISBN	Title	Author	Year
716712261	BIOCHEMISTRY 4TH EDITION	STRYER, LUBERT	1995C
781769604	BIOCHEMISTRY LIPPINCOTT'S ILLUSTRATED REVIEWS, 4TH EDITTION	CHAMPE, PAMELA; HARVEY, RICHARD; FERRIER, DENISE; COOPER, MICHAEL	2008C
7167743396	LEHNINGER PRINCIPLES OF BIOCHEMISTRY	LEHNINGER, ALBERT	2005C
9780071765763	HARPER'S ILLUSTRATED BIOCHEMISTRY-27ED.	MURRAY, ROBERT K. (ROBERT KINCAID)	2012
0272797138	ESSENTIALS OF HUMAN BIOCHEMISTRY	PATERSON, COLIN RALSTON	1983