BIOCHEMISTRY 2 [1203253]

The University of Jordan
Faculty: Pharmacy
Department: Biopharmaceutics and Clinical Pharmacy
Program: Pharmacy
Academic Year/ Fall Semester: 2014/15

Credit hours	3	Level	2nd year	Pre-requisite	-
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Course website	-	E-mail		Place	Pharmacy

Course Objectives:
This course is the second course in a two-semester sequence in biochemistry. The students are expected to:
1- Use the knowledge gained in Biochemistry I to understand the basic concepts of metabolism
2-Understand the metabolic pathways of the major biomolecules; carbohydrate, lipids, proteins and nucleotides.
3-Understand the main issues regarding the storage and expression of genetic information

Learning Outcomes:
A. Knowledge and Understanding of:

A1. DNA, RNA, AND THE FLOW OF GENETIC INFORMATION

A1.1 Nucleotide Biosynthesis

- Purine Bases Can Be Synthesized de Novo or Recycled by Salvage Pathways
- Deoxyribonucleotides Synthesized by the Reduction of Ribonucleotides Through a Radical Mechanism
- Key Steps in Nucleotide Biosynthesis Are Regulated by Feedback Inhibition
- In de Novo Synthesis, the Pyrimidine Ring Is Assembled from Bicarbonate, Aspartate, and Glutamine
- Nucleoside Monophosphate Kinases: Catalyzing Phosphoryl Group Exchange between Nucleotides Without Promoting Hydrolysis
- Disruptions in Nucleotide Metabolism Can Cause Pathological Conditions

A1.2 DNA Structure, Replication, Recombination, and Repair

- A Nucleic Acid Consists of Four Kinds of Bases Linked to a Sugar-Phosphate Backbone
- A Pair of Nucleic Acid Chains with Complementary Sequences Can Form a Double-Helical Structure
- DNA Is Replicated by Polymerases that Take Instructions from Templates
- DNA Can Assume a Variety of Structural Forms
- DNA Polymerases Require a Template and a Primer
- Double-Stranded DNA Can Wrap Around Itself to Form Supercoiled Structures
- DNA Replication of Both Strands Proceeds Rapidly from Specific Start Sites
- Double-Stranded DNA Molecules with Similar Sequences Sometimes Recombine

A1.3 RNA Synthesis and Splicing

- Transcription Is Catalyzed by RNA Polymerase
- Eukaryotic Transcription and Translation Are Separated in Space and Time
- The Transcription Products of All Three Eukaryotic Polymerases Are further subjected to downstream processing
- Most Eukaryotic Genes Are Mosaics of Introns and Exons

A1.4 Protein Synthesis

- Gene Expression Is the Transformation of DNA Information Into Functional Molecules
- Amino Acids Are Encoded by Groups of Three Bases Starting from a Fixed Point
- Protein Synthesis Requires the Translation of Nucleotide Sequences Into Amino Acid Sequences
- Mutations Involve Changes in the Base Sequence of DNA
- Aminoacyl-Transfer RNA Synthetases Read the Genetic Code
- A Ribosome Is a Ribonucleoprotein Particle (70S) Made of a Small (30S) and a Large (50S) Subunit
- Protein Factors Play Key Roles in Protein Synthesis
- Eukaryotic Protein Synthesis Differs from Prokaryotic Protein Synthesis Primarily in Translation Initiation and subsequent coupling reactions.

A1.5 The Gene Expression Regulation

- Prokaryotic DNA-Binding Proteins Bind Specifically to Regulatory Sites in Operons
- The Greater Complexity of Eukaryotic Genomes Requires Elaborate Mechanisms for Gene Regulation
- Transcriptional Activation and Repression Are Mediated by Protein-Protein Interactions
- Some Receptors Dimerize in Response to Ligand Binding and Signal by Cross-phosphorylation
- Gene Expression Can Be Controlled at Posttranscriptional Levels

A1.6 Molecular basis of inherited diseases

- Restriction Enzymes: Performing Highly Specific DNA-Cleavage Reactions
- DNA recombinations are helpful in establishing genomic as well as cDNA libraries
- Antibiotic resistance genes can select for the transfected cloning vector.
- The utility of Sanger dideoxy method is basically for purified DNA sequencing.
- Restriction Fragment Length Polymorphism analysis is a direct diagnostic tool of sickle cell disease.
- Polymerase chain reaction is highly advantageous in detecting/tracing low abundance nucleic acid sequences
- Microarray technique is quite a handy Analytical means of determinations of the gene expression products.
- ELISA and Western blots can be Important Techniques to investigate specific proteins.

A2. TRANSDUCING & STORING OF ENERGY
INTERMEDIARY METABOLISM

A2. 1 Glycolysis and Gluconeogenesis

- Metabolism Is Composed of Many Coupled, Interconnecting Reactions
- The Oxidation of Carbon Fuels Is an Important Source of Cellular Energy
- Glycolysis Is an Energy-Conversion Pathway in Many Organisms
- The Glycolytic Pathway Is Tightly Controlled
- Glucose Can Be Synthesized from Noncarbohydrate Precursors
- Gluconeogenesis and Glycolysis Are Reciprocally Regulated

A2. 2 Citric Acid Cycle

- The Citric Acid Cycle Oxidizes Two-Carbon Units
- Entry to the Citric Acid Cycle and Metabolism Through It Are Controlled

- The Citric Acid Cycle Is a Source of Biosynthetic Precursors. Amino Acids Are Made from Intermediates of the Citric Acid Cycle and Other Major Pathways

A2. 3 The Pentose Phosphate Pathway

- the Pentose Phosphate Pathway Generates NADPH and Synthesizes Five-Carbon Sugars
- The Metabolism of Glucose 6-Phosphate by the Pentose Phosphate Pathway Is Coordinated with Glycolysis
- Glucose 6-Phosphate Dehydrogenase Plays a Key Role in Protection Against Reactive Oxygen Species

A2. 4 Glycogen, hexoses and disaccharides Metabolism

- Glycogen Breakdown Requires the Interplay of Several Enzymes
- Phosphorylase Is Regulated by Allosteric Interactions and Reversible Phosphorylation
- Epinephrine and Glucagon Signal the Need for Glycogen Breakdown
- Glycogen Is Synthesized and Degraded by Different Pathways
- Glycogen Breakdown and Synthesis Are Reciprocally Regulated
- All hexoses are to be phosphorylated before they are any further metabolized
- Hexose epimerase can substitute for lacking dietary sources of galactose
- Lactose synthesis is mainly mediated by galactosyltransferases

A3. LIPID METABOLISM

A3. 1 Fatty Acid Metabolism

- Triacylglycerols Are Highly Concentrated Energy Stores
- The Utilization of Fatty Acids as Fuel Requires Three Stages of Processing
- Certain Fatty Acids Require Additional Steps for Degradation
- Fatty Acids Are Synthesized and Degraded by Different Pathways
- Acetyl Coenzyme A Carboxylase Plays a Key Role in Controlling Fatty Acid Metabolism via Carnitinr shuttle modulation
- Elongation and Unsaturation of Fatty Acids Are Accomplished by Accessory
- Ketogenesis is strictly hepatic and ketone bodies can be consumed by brain as well as muscle cells

A3. 2 The Biosynthesis of Membrane Lipids and Steroids

- Phosphatidic acid Is a Common Intermediate in the Synthesis of Phospholipids and Triacylglycerols
- Cholesterol Is Synthesized from Acetyl Coenzyme A in Three Stages
- The Complex Regulation of Cholesterol Biosynthesis Takes Place at Several Levels
- Important Derivatives of Cholesterol Include Bile Salts and Steroid Hormones

A4. PROTEIN TURNOVER AND AMINO ACID CATABOLISM

- Proteins Are Degraded to Amino Acids
- Protein Turnover Is Tightly Regulated
- Many Enzymes Are Activated by Specific Proteolytic Cleavage
- The First Step in Amino Acid Degradation Is the Removal of Nitrogen
- Ammonium Ion Is Converted Into Urea in Most Terrestrial Vertebrates
- Carbon Atoms of Degraded Amino Acids Emerge as Major Metabolic Intermediates
- Inborn Errors of Metabolism Can Disrupt Amino Acid Degradation
- Amino Acids Are Precursors of Many Biomolecules

A5. THE INTEGRATION OF METABOLISM

- Metabolic Pathways Contain Many Recurring Motifs
- Metabolism Consist of Highly Interconnected Pathway
- Each Organ Has a Unique Metabolic Profile

- Food Intake and Starvation Induce Metabolic Changes
- Ethanol Alters Energy Metabolism in the Liver
- Peptide hormones, namely insulin and glucagon, are actively involved in reciprocal regulation of metabolism during absorptive and postabsorptive phases

B. Intellectual skills (cognitive and analytical):
   - Integrate metabolic pathways, and analyze the complete integrated metabolic map.
   - Interpret metabolic abnormalities and relate them to possible causes and mechanisms.
   - Relate the biochemical events at the cellular level to the physiological processes occurring in the whole animal.
   - Follow up the flow of genetic information; DNA→RNA→Protein

C. Subject specific skills

D. Transferable Skills
   - The development of problem solving and critical thinking skills.
   - Use oral communication to effectively transmit ideas and conclusions to a scientific audience.

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

Lecture notes are available on
http://blackboard.ju.edu.jo
User name: pharm_std
Password: pharm_std

Course Contents and Schedule

Subject	No. of lectures
Introduction	1
Storage and expression of genetic information.	
• Nucleotide metabolism.	3
• DNA structure and replication	3
• RNA structure and synthesis	2
• Protein Synthesis	3
• Regulation of gene expression	3
• Molecular basis of inherited disease	5
Intermediary metabolism.	
• Glycolysis.	2
• Gluconeogenesis.	2
• Hexose Monophosphate pathway	2
• Citric acid cycle.	2
MIDTERM	
Carbohydrate metabolism	
• Glycogen metabolism.	2
• Metabolism of monosaccharides and disaccharides	
Lipid metabolism.	
• Metabolism of dietary lipids.	2
• Fatty acid and triacylglycerol metabolism.	2
• Phospholipid metabolism	1
• Cholesterol and steroid metabolism.	3
Nitrogen metabolism.	
• Disposal of Nitrogen.	2
• Metabolism of carbon skeleton.	1
• Conversion of amino acids to specialized products	1
Integration of metabolism.	
• Metabolic effects of insulin and glucagon.	1
• Metabolism in the well-fed state.	1
• Metabolism in starvation and diabetes mellitus	1
FINAL EXAM	