COURSE PLAN

FIRST: BASIC INFORMATION

College	
College	: Medicine
Department	:Medicine
Course	
Course Title	:Medical Biochemistry
Course Code	**31501221**
Credit Hours	: 3
Prerequisite	: None
Instructor	
Name	: Dr. Nabil Amer
Office No.	: 2
Tel (Ext)	: 3574
E-mail	: namer@bau.edu.jo
Office Hours	: Sunday, Tuesday, Thursday: 10-1.00

Class Times

Buiding	Day	Start Time	End Time	Room No.
	S, T, Th.	8.00	9.00	Auditorium 1

Recommended Text Book

1. Biochemistry by Mary Campbell & Shawn Farrell, Eight Ed. 2016 ,Thomas Books/Cole ISBN 0-534-39499-X
2. Lippincott's illustrated reviews in Biochemistry by Ferrier. 6th Edition

SECOND: PROFESSIONAL INFORMATION

COURSE DESCRIPTION

This course is designed to explore biochemical and molecular basis of life. Course content reflects subjects such as the following: behavior of proteins; the structure and function of hemoglobin and enzymes, and the metabolism of macromolecules, metabolic pathways of small molecules, and the integration of metabolism within and between tissues, cell communication strategies such as hormonal communication and signal transduction and nutrition. Case studies will be routinely applied to integrate biochemical, and cellular contributions to enhance our understanding of systemic pathology.. Nutrition will be discussed in the context of biochemistry and metabolic pathways.

COURSE OBJECTIVES

1. Describe the process by which various Biomolecules are synthesized and how they function.
2. Describe the manner in which biological energy is stored, recovered and generated
3. Integrate overlapping pathways of metabolism within a variety of tissues.

COURSE LEARNING OUTCOMES

The intention of the course is for students to:

1 Acquire the technical language used to communicate biochemistry information and use that language to describe proteins, molecules, signaling pathways, catalysis, and metabolism accurately
2 Recall key elements of basic biochemistry principles, including metabolic pathways, molecule names, molecular structures (as noted), enzyme/cellular control mechanisms, catalysis, and signaling pathways
3 Perform analyses relevant to the material presented
4 Communicate (through writing and speaking) key concepts relevant to biochemistry
5 Understand and apply general concepts of biochemistry to relevant, specific problems.
6 Predict the directions of metabolic pathways from an understanding of the control mechanisms and energy considerations of biochemical reactions.
7. Integrate metabolic pathways and energy source for each organ
8. Metabolism in different situations like post fed state, fasting and starvation.
9. Nutrition including the role of water soluble vitamins

COURSE SYLLABUS

Week	Course Topic	Notes
Week 1	The Behavior of Proteins: Hemoglobin	Myoglobin structure Heme group **Oxygen Binding** • Oxygen binding and iron movement - deoxy versus oxygenated state • Iron-oxygen binding • Quaternary structure of deoxyhemoglobin • Oxygen binding of myoglobin • Oxygen binding of hemoglobin **Cooperativity** • Cooperativity in hemoglobin's oxygen binding • Response to exercise • Quaternary changes on oxygen binding by hemoglobin

		• Concerted model • T to R transition • Sequential model of binding • 2,3 BPG • The effect of 2,3 BPG • Binding of 2,3BPG to hemoglobin • Oxygen binding and fetal hemoglobin **The Bohr Effect** • Effect of pH on oxygen affinity of hemoglobin • Chemical basis of Bohr effect • Carbon dioxide and pH • Carbon dioxide effects • Carbamate formation • Transport of CO_2 to lungs **Hemoblobin Genetic Considerations** • Sickled blood cells and hemoglobin fibers • Sickle cell traits and malaria
Week 2	The Behavior of Proteins: Enzymes I Enzymes II Enzymes III	Enzymes - Basic Concepts and Kinetics Enzymes as Catalysts • Enzyme rate enhancement / Enzyme specificity • Enzyme cofactors Free Energy • ΔG determines the direction a reaction proceeds • $\Delta G^{0'}$ o $\Delta G^{0'}$ is related to ΔG. It is the same as ΔG under standard conditions • Calculations o $\Delta G = \Delta G^{0'} + RT \ln[Products]/[Reactants]$, w R is the gas constant and T is the temperature in Kelvin o Relation between $\Delta G^{0'}$ and K'eq at 25°C Mechanisms • Enzymes speed reactions • Reaction velocity versus substrate concentration • Residues at active site / Hydrogen bonds with substrate • Fischer lock & key model of catalysis / Koshland induced fit model Michaelis-Menten Model • Initial velocity determination • K_M determination • LineWeaver-Burk plot • K_M values of some enzymes / Turnover numbers • Substrate preferences of chymotrypsin

		• Diffusion-controlled enzymes Multiple Substrate Reactions Double displacement Allosteric enzyme kinetics Enzyme Inhibition • Uninhibited vs. Competitive vs. Uncompetitive vs. Non-Competitive • Methotrexate and Tetrahydrofolate • Kinetics of a competitive inhibitor (V vs. [S]) and (Lineweaver-Burk) Kinetics of a non-competitive inhibitor (V vs. [S]) and (Lineweaver-Burk) • Serine modification by DIPF • Suicide inhibition o Triose phosphate isomerase by bromoacetal phosphate o Glycopeptide transpeptidase by penicillin
Week 3	Catalytic Strategies I Catalytic Strategies II	Catalytic Strategies Outline Proteases • Hydrolysis reaction • Specificity of chymotrypsin cleavage • Chymotrypsin's unusually reactive serine • Chromogenic substrate • Kinetics of action • Covalent intermediate • Catalytic triad • Catalytic mechanism - Steps • Oxyanion hole / Hydrophobic pocket • Trypsin-chymotrypsin similarity • S1 pockets of chymotrypsin, trypsin, and elastase . • Effects of site-directed mutagenesis of subtilisin • Active sites of three classes of proteases • Activation strategies
Week 4	Allostery and Regulation I Allostery and Regulation II	Regulatory Strategies - Enzymes and Hemoglobin Allosterism and ATCase ATCase overview and CTP inhibition Sigmoidal kinetics Cysteine modification ATCase in the centrifuge ATCase structure • PALA (an inhibitor) • PALA & T-R States

		• R-T state equilibrium
		• CTP and the T-State / CTP Kinetic Effect
		• ATP Kinetic Effect
		• MWC (concerted) model quantitation
		• Sequential model
		Protein kinase A
		• cAMP
		• Regulation
		Covalent Modification of Enzymes
		• Covalent modifiers of protein activity
		• Acetylated lysine
		• Phosphorylation
		  ○ Protein kinase action
		  ○ Serine/threonine kinases
		• Dephosphorylation
		  ○ Protein phosphatase
		  ○ Energy considerations
		• Zymogens
		  ○ Secretion from pancreas
		  ○ Examples
		  ○ Chymotrypsinogen
		  ▪ Activation
		  ▪ Conformations

Week 5	Metabolic Energy I Metabolic Energy II	Interconnected Pathways - Glucose Metabolism / Metabolic Roadmap Thermodynamics and Reaction Direction - Delta G, Keq ATP as Energy Currency • Coupled Reactions • Shift of Equilibrium by ATP Hydrolysis The free energy of a process is the energy available to do useful work " Gibbs Free Energy". Structure and Phosphate Energy • Glycerol-3-Phosphate • Orthophosphate Resonance Forms • High Hydrolysis Energies Exercise and Energy - Reaction = Creatine + ATP <=> Creatine Phosphate + ADP / $\triangle G^{0'}$ = +12 kJ/mol Energy Generation/Expenditure Oxidation Energy Cellular Energy Sources • Glycolytic Oxidation/ATP Synthesis . • Proton Gradients Metabolic Catabolism Oxidation / Reduction Metabolic Carrier Molecules

		Metabolic Reaction Types • Oxidation-Reduction Reactions • Ligation Reactions • Isomerization Reactions • Group Transfer Reactions • Hydrolytic Reactions • Lyases
Week 6	Glycolysis I Glycolysis II/ Gluconeogenesis	Glycolysis & Gluconeogenesis Outline Introduction . Glycolysis Breakdown (Overview) Stage I - Energy Investment - Stage II - Energy Generation - Overall Summary Redox Balancing and Pyruvate Fates / Ethanol Formation / Lactate Formation Pathogenic obligate anaerobes Fermentation options Regulation Phosphofructokinase . Activation by F2,6BP Structure of F2,6BP Regulation in muscle and Pyruvate kinase regulation **Other Considerations** Glucose Transport Proteins Glycolysis and Hypoxia/Cancer and Glucose Synthesis From glycerol Gluconeogenesis (Overview) Pyruvate Carboxylase Biotin binding Carboxybiotin PEP Carboxykinase (PEPCK) Glucose-6-phosphatase Glycolysis / Gluconeogenesis Regulation Reciprocal Regulation of Glycolysis and Gluconeogenesis Phosphofructokinase 2 Fructose 2,6 Bisphosphate Synthesis & Degradation Cori Cycle Schematic

Week 7	Sugar Metabolism
	Regulation
	PPP/ Glycogen
		• Entry of Other Sugars
		  ○ Fructose Metabolism
		  ○ Galactose Metabolism and / Cataract

	Metabolism I	Consideration Lactose Metabolism/Intolerance pentose phosphate pathway (PPP) It is important to cells as a an important source of NADPH, & as an important source of ribose-5-phosphate for nucleotide synthesis; also as an interchange; and a way to mix and match sugars according to the needs of cells. Glycogen structure and Glycogen Breakdown Glycogen granules in liver cytoplasm / fates / phosphorylysis reaction Debranching enzyme activities Phosphoglucomutase reaction Glycogen phosphorylase structure Phosphorylase kinase activation Hormonal control and Epinephrine / Glucagon Glycogen Synthesis UDP-glucose / formation Addition of a glucose to glycogen Branching enzyme Glycogen metabolism regulation PP1 reciprocal effects / Control of PP1 Insulin action Glucose and regulation of glycogen metabolism. Glycogen storage diseases
Week 8	**Block Week**	**Midterm Exam 50 % of Total Grades**
Week 9	CAC	1. What Role Does the Citric Acid Cycle Play in Metabolism? 2. What Is the Overall Pathway of the Citric Acid Cycle? 3. How Is Pyruvate Converted to Acetyl-CoA? 4. What Are the Individual Reactions of the Citric Acid Cycle? 5. What Are the Energetics of the Citric Acid Cycle, and How Is It Controlled? 6. What Is the Glyoxylate Cycle? 7. What Role Does the Citric Acid Cycle Play in Catabolism? 8. What Role Does the Citric Acid Cycle Play in Anabolism?
	ETC & Oxidative phosphorylation I,II	1. What Role Does Electron Transport Play in Met.? 2. What Are the Reduction Potentials for the Electron Transport Chain? 3. How Are the Electron Transport Complexes

		Organized? 4. What Is the Connection between Electron Transport and Phosphorylation? 5. What Is the Mechanism of Coupling in Oxidative Phosphorylation? 6. How Are Respiratory Inhibitors Used to Study Electron Transport? 7. What Are Shuttle Mechanisms?
Week 10	Lipid Metabolism I , II & III	1. How Are Lipids Involved in the Generation and Storage of Energy? 2. How Are Lipids Catabolized? 3. What Is the Energy Yield from the Oxidation of Fatty Acids? 4. How Are Unsaturated Fatty Acids and Odd-Carbon Fatty Acids Catabolized? 5. What Are Ketone Bodies? 6. How Are Fatty Acids Produced? 7. How Are Acylglycerols and Compound Lipids Produced? 8. How Is Cholesterol Produced? 9. Lipoprotein Metabolism
Week 11	Nitrogen Metabolism I & II	1. What Processes Constitute Nitrogen Metabolism? 2. How Is Nitrogen Incorporated into Biologically Useful Compounds? 3. What Role Does Feedback Inhibition Play in Nitrogen Metabolism? 4 .How Are Amino Acids Synthesized? 5 .What Are the Essential Amino Acids? 6 .How Are Amino Acids Catabolized?
Week 12	Purine & Pyrimidines Metabolism	1. How Are Purines Synthesized? 2. How Are Purines Catabolized? 3. How Are Pyrimidines Synthesized and Catabolized? 4. How Are Ribonucleotides Converted to Deoxyribonucleotides? 5. How Is dUTP Converted to dTTP?
Week 13	Integration of Metabolism	1. How Are the Metabolic Pathways Connected? 2. How Can Biochemistry Help Us Understand Nutrition?
Week 14	Obesity , Nutrition &	1. What Are Hormones and Second Messengers?

	diabetes	2. How Are Hormones Involved in the Control of Metabolism? 3. What Are the Many Effects of Insulin?
Week 15	**FINAL EXAM**	**50 % of Total**

COURSE LEARNING RESOURCES

Lectures
Data show
Handouts including highlights

ONLINE RESOURCES

The medical Biochemistry web page

ASSESSMANT TOOLS

(Write assessment tools that will be used to test students ability to understand the course material and gain the skills and competencies stated in learning outcomes

ASSESSMENT TOOLS	**%**
Mid Exam	50
Final Exam	50
TOTAL MARKS	100

THIRD: COURSE RULES

ATTENDANCE RULES

Attendance and participation are extremely important, and the usual University rules will apply. Attendance will be recorded for each class. Absence of 10% will result in a first written warning. Absence of 15% of the course will result in a second warning. Absence of 20% or more will result in forfeiting the course and the student will not be permitted to attend the final examination. Should a student encounter any special circumstances (i.e. medical or personal), he/she is encouraged to discuss this with the instructor and written proof will be required to delete any absences from his/her attendance records.

GRADING SYSTEM Example: REMARKS

COURSE COORDINATOR		
Course Coordinator:	Dr. Nabil Amer	Department Head: Dr. Nabil Amer
Signature:		Signature:
Date:		Date: