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**Department of Biology**

**College of Education/Shaqlawa**

**University of Salahaddin**

**Subject: Biochemistry**

**Course Book: Second class**

**Lecturer's name: Hassan Mahdi Salieh**

**Academic Year: 2022/2023**

**Course Book**

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| **1. Course name** | **Biochemistry** |
| **2. Lecturer in charge** | **Dr. Noor Ali Gheni** |
| **3. Department/ College** | **Biology/ Education/Shaqlqwa** |
| **4. Contact** | **e-mail: noor.gheni@su.edu.krd** |
| **5. Time (in hours) per week** | **Theory:    2**  **Practical: 6** |
| **6. Office hours** | **6** |
| **7. Course code** |  |
| **8. Teacher's academic profile** | **B.Sc.acheaved : 2007/ 2008**  **M.Sc. acheaved : 2008/2011**  **Employed year: 2013**  **PhD. acheaved: 2020** |
| **9. Keywords** |  |
| **10.  Course overview:**  Biochemistry is the study of chemical processes in living organisms. Biochemistry governs all living organisms and living processes. By controlling information flow through biochemical signaling and the flow of chemical energy through metabolism, biochemical processes give rise to the incredible complexity of life. It is a laboratory based science that brings together biology and chemistry. By using chemical knowledge and techniques, biochemists can understand and solve biological problems. ... Because of its breadth, biochemistry is very important and advances in this field of science over the past 100 years have been staggering.  This course will afford an outline of the main features of biochemistry by relating molecular interactions and their effects to humans’ body. Energy/thermodynamics, macromolecules, bioenergetics and integrative biochemistry notions will be addressed through the study of structures, functions and interactions of macromolecules that manage the essential biological procedures. The course is planned to serve as a pre-requisite for students seeking careers in the health professions field.  Also, it surveys the structure, function, and metabolism of amino acids, proteins, carbohydrates, lipids, and nucleic acids. It introduces the concepts in cell structure, replication and growth, and metabolic regulation. By focusing on metabolic pathways, cycles, and control mechanisms. In addition, it will cover bioenergetics and metabolism of carbohydrates, lipids, amino acids and nucleotides. Designed for biochemistry majors and others desiring part two of a two semester comprehensive biochemistry series. | |
| **11. Course objective:**  This course meets the following programmatic goals for the B.S. Biology degree program:   * The specific learning goal for biochemistry are to provide students with a working knowledge of fundamental principles in biochemistry that will provide a foundation for their later advanced course work in more specific biological subjects. * Understand the structure of carbohydrate, lipids, protein, enzymes and nucleic acides * Anumber of metabolic pathways will be studied and how the energy are produce. | |
| **12.  Student's obligation**  In this course the lecturer shall write the role of students and their obligations throughout the academic year, for example the attendance and completion of all tests, exams, assignments, reports , essays…etc  all the exams, assignments and reports are obligatory required from the students during the academic year 2022/2023. Since they help to evaluate the students’ achievements during the course and show the area of weakness of individual that need to be developed throughout the course. | |
| **13. Forms of teaching**  The lectures showed through power point slides by data show and the explanations discussed on the white board and at the same time the students will have a copies of the lecture. | |
| **14. Assessment scheme**  Average per semester: 50%  Final exam 50%  **Marking System**  The grades for each piece of assessed work are as follows:   * 90-100 %  is excellent * 80-89%  is very good * 70-79%  is good * 60-69%  is a moderate pass * 50-59%  is a pass   ‌ | |
| **15. Student learning outcome:**  Students after this course will be able to:   1. Define the biochemical key processes that illustrate living organisms. 2. The structure and composition of biomolecules 3. the major property of carbohydrate, lipid, protein, nucleic acid and enzyme 4. Explain catabolism and anabolism and describe the overall chemical reactions associated with these processes. 5. Have a good knowledge about biochemistry and how it is related to cell biology | |
| **16. Course Reading List and References‌:**  ▪  **Key references**:   1. Nelson, David L, Cox, Michael M, Lehninger’s Principles of Biochemistry, 6th edition, WH Freeman and Company, 2013. 2. ALEXANDER J., DAVID P. BALLOU,. *Fundamental Laboratory Approaches for Biochemistry and Biotechnology. 2nd ed.* Hoboken NJ: John Wiley & Sons, 2010. ISBN 978-0-470-08766-4.   3-, JOHN B. *Laboratory Manual — Biology 301: Biochemistry.* Annandale-on-Hudson NY: Bard College, 2012.  4-David L.Nelson, Michael M.Cox**,** Priciple of Biochemistry, third edition: 2010..  ▪  **Useful references**: **Text: Lehninger Principles of Biochemistry***,*  **5th edition,** by David L. Nelson and Michael M. Cox***.*** New York**:** W.H. Freeman and Company, 2008. Textbooks can be purchased at the Health Center Bookstore,  **The useful links:** | |
| **17. The Topics:** | **Lecturer's name** |
| **Unit 1:Introduction to Biochemistry and Carbohydrates**  It deals with the structure of monosaccharides, sterioisomerism and optical isomerism of sugars, reactions of aldehydes and ketone groups, ring structure and anomeric forms, mutarotation. Chemical reactions of sugars,  important derivatives of monosaccharides, di- and tri-saccarides Structure, occurrence and biological importance of monosaccharides, oligosaccharides and polysaccharides, e.g. glycogen, Starch, cellulose, blood group  polysaccharides, inulin, chitin, glycosaminoglycans.  **Unit 2: Lipids**  It deals with the definition and classification of Lipids. Fatty acids: introduction, classification, nomenclature, structure and properties of saturated and unsaturated fatty acids. Essential fatty acids. Triacylglycerols: nomenclature, physical properties, chemical properties and characterization of fats - hydrolysis, saponification value, acid value, rancidity  of fats, Reichert-Meissel number and reaction of glycerol. Biological significance of fats. Glycerophospholipids (lecithins, lysolecithins, cephalins. phosphatidyl serine, phosphatidyl inositol, plasmalogens), sphingomyelins, glycolipids -cerebrosides, gangliosides.  **Unite 3: Proteins**  It deals with a quick review of amino acids, physico-chemical properties of amino acids (Solubility, Boiling & melting points, Reactions like Edman’s, Sanger’s, Dansyl chloride, Ninhydrin& Formaldehyde). Unusual aminoacids.  In addition, it shows the determination of primary structure of proteins and Peptide, peptide mapping, Merrifield-Gutt synthesis.  **Unit 4: Proteins**  a) Secondary structure of proteins:  b) Tertiary structure of proteins: Forces that stabilize the structure, Concept of domains, Protein denaturation.  c) Quaternary structure of proteins: Subunit interaction  d) Structure and biological functions of Collagen.  **unite 5:Nucleic acids**  a) Chemical structure & base composition of nucleic acids, Chargaff’s rules.  b) Double helical structures, Watson - Crick Model (B-DNA), Deviations from Watson - Crick Model, Other  DNA helices (A- & Z- DNA).  c) Forces stabilizing nucleic acid structures, Denaturation &renaturation, Sugar phosphate chain conformation,  Base pairing, Base stacking, Hydrophobic and ionic interactions.  **Unit6:Nucleic acids: -**  a) Tm & buoyant density and their relationship with G-C content in DNA, Satellite DNA.  b) DNA sequencing: Maxam-Gilbert & Sanger’s dideoxynucleotide sequencing.  c) Structure of m-RNA, r-RNA & t-RNA.  **Unit 7: ENZYMOLOGY**  History & Terminology  b) Classification & nomenclature of enzymes, Specificity of enzyme action (Lock & key model & Induced fit  model).  c) Enzyme catalysis: Proximity & Orientation effect, covalent catalysis, acid-base catalysis, metal ion catalysis.  d) Regulatory enzymes: - Allosteric (ATCase) & covalently modulated (Glycogen phosphorylase) enzymes.  **Unit 8: Enzyme kinetics**   Importance of measuring initial velocities, Derivation of Michaelis-Menten equation, Single &double reciprocal plots, Graphical representation of various inhibitors (Competitive, Noncompetitive &  Uncompetitive) on Lineweaver-Burke plots. Importance of Kcat / Km .Bisubstrate reactions – brief introduction to sequential and ping-pong mechanisms with examples.  a) Effect of pH, General pH profile diagram with exceptions.  b) Concept of enzyme assay & its importance, Enzyme activity units (Katal& Specific activity)  c) Enzyme isolation and purification:- Enzyme solubilization, Brief idea of various fractionation procedures,  Criteria for enzyme purity and homogeneity.  **Unit 9: Bioenergetics:**  a) Concept of free energy, Entropy, Enthalpy & Redox Potential. Determination of ΔG0’ for a reaction.  b) High energy phosphate compounds (Ex. ATP, Phosphoenol pyruvate, Creatine phosphate etc.) – phosphate potential, Free energy of hydrolysis of ATP along with reasons for high ΔG0,. Other high energy compounds.  c) ATP-ADP Cycle, Energy charge (Phosphate potential) & its relation to metabolic regulation.  **Unit 10: Carbohydrate metabolism**  a) Detailed account of glycolysis with energy considerations & regulation, Entry of fructose, mannose &galactose in glycolysis, Cori cycle, Futile or substrate cycles in carbohydrate metabolism.  b) Glycogenolysis& Glycogenesis – Detailed account & hormonal control. Glycogen storage diseases.  c) Formation of acetyl CoA & detailed account of TCA Cycle, Isotopic tests of TCA cycle (Concept of Prochirality), Regulation, Amphibolic and anaplerotic nature of TCA cycle.  **Unit 11: Carbohydrate metabolism**  a) Glyoxylate cycle and its role in conversion of fats into carbohydrates.  b) Gluconeogenesis– Detailed account of bypass reactions, Regulation, Malate &glycerophosphate shuttlesystem.  c) Electron Transport chain-Structure of mitochondria, oxidative and substrate level phosphorylation, Electron carriers of ETC, Incomplete reduction of oxygen (Cell injury – superoxide radicle), ATP Synthase (F1 F0 ATPase), Chemiosmotic hypothesis, Sites of ATP synthesis, Specific inhibitors and uncouplers of oxidative phosphorylation.  **Unit 12: Lipid metabolism**  a) Hydrolysis of triacylglycerols, transport of fatty acids into mitochondria (Carnitine), Detailed account of β-oxidation of fatty acids (β-oxidation in mitochondria and peroxisomes), Oxidation of unsaturated fatty acids  & odd carbon fatty acids. β-Oxidation- Brief idea. ATP yield from fatty acid oxidation. Regulation.  b) Detailed account of HMP Shunt & its significance in general, its connection to lipid metabolism.  **Unit 13**:**Lipid metabolism**  a) Ketogenesis, Ketosis & ketoacidosis in physiology & pathology.  b) Biosynthesis of fatty acids, Fatty acid synthase complex, Regulation, Microsomal & Mitochondrial system of chain elongation & synthesis of unsaturated fatty acids.  c) Biosynthesis of triglycerides & phospholipids (Phosphatidyl-ethanolamine, choline, inositol), sphingolipids.\\  **Unit 14:Protein metabolism**  a) Transamination.  b) Oxidative & Non-oxidative deamination.  c) Transport of ammonia (Carrier of ammonia – Glutamine, Alanine).  d) Urea cycle – Detailed account, Linkage of urea & TCA cycle, Compartmentation of urea cycle, Regulation,  Metabolic disorders of Urea cycle, Treatment of disorder of urea cycle.  e) Transmethylation& Decarboxylation.  f) Metabolism of phenylalanine. Glycogenic and ketogenic amino acids. | Hassan Mahdi Salieh      (2 hrs)    (2 hrs)      (2 hrs)    (2 hrs)       (2 hrs) |
| **18. Practical Topics (If there is any)** |  |
| 1- Libratory Roles and safety  2- Qualitative tests for carbohydrates  A.Molisch’s Test  B.Benedict’s test  C.Barfoed’s Test  D.Seliwanoffs Test  E.Bial’s Test  F.Iodine test  3- Qualitative tests for lipids  A- Solubility of lipids.  B- Acrolein Test.  4. Determination of Saponification Value of Fats and Oils.  5.Detection of cholesterol in samples (food, serum,…)  6-Lieberman test.  7-Salkowaski test.  8-Copper acetate Test  9- Unsaturation test  10-Determination of Acid Value of Fats and Oils  11- Determination of Peroxide Value of Fats and Oils:  12- Rancid lipid test | Dr. Noor Ali Gheni |
| **19. Examinations:**  ***1.  Compositional:***  **Q/ What are the Carbohydrate?**  The Carbohydrates, together with lipids, proteins and nucleic acids, are one of the four major classes of biologically essential organic molecules found in all living organisms. Carbohydrates are organic substances contain Carbon, Hydrogen and Oxygen. A major source of energy from our diet, also called saccharides, which means (sugars). They are defined as polyhydroxy aldehyde or polyhydroxy ketones. The general formula for a carbohydrate is Cn(H2O)n.  **Q/**  ***2.True or false type of exams:***  **Q/** Enzymes are protein in nature.   The answer is (T)  ***3. Multiple choices: choose the best answer***  Q/  the following is not a polyunsaturated fatty acid  a. palmitoleic acid  b. linoleic acid.  c. arachidonic acid  The answer is a. | |
| **20. Extra notes:** | |
| **21. Peer review** | |