Biochemistry M123;
Course Description and Objectives:
This course deals with structure and properties of biomolecules, such as amino acids, proteins, carbohydrates, lipids, and nucleic acids. The focus of this course will be on the relationship between protein structure and its biological function, generation and storage of metabolic energy, main metabolic pathways and their key steps. In addition, the role of phospholipids in determining the properties of biological membranes and their function will be discussed. The principal objective of the course is for students to acquire knowledge and understanding of current concepts in the subject of the course and to develop critical thinking skills.

Textbook:

Course Outline:
1. Water: The Solvent for Biochemical reactions (Chapter 2)
   a. What makes water a polar molecule?
   b. What is a hydrogen bond?
   c. What are acids and bases?
   d. What is pH, and what does it have to do with the properties of water?
   e. What are titration curves?
   f. What are buffers, and why are they important?

2. Amino Acids and Peptides (Chapter 3)
   a. What are amino acids, and what is their three-dimensional structure?
   b. What are the structures and properties of the individual amino acids?
   c. Do amino acids have specific acid-base properties?
   d. What is the peptide bond?
   e. Are small peptides physiologically active?

3. The Three-Dimensional Structure of Proteins (Chapter 4)
   a. How does the structure of proteins determine their function?
   b. What is the primary structure of proteins?
   c. What is the secondary structure of proteins?
   d. What can we say about the thermodynamics of protein folding?
   e. What is the tertiary structure of proteins? (Denaturation and refolding)
   f. Can we predict protein folding from sequence?
   g. What is the quaternary structure of proteins?
4. The Behavior of Proteins: Enzymes (Chapter 6)
   a. What makes enzymes such effective biological catalysts?
   b. What is the difference between the kinetic and the thermodynamic aspects of reactions?
   c. How can we describe enzyme kinetics in mathematical terms?
   d. How do substrates bind to enzymes?
   e. What are some examples of enzyme catalyzed reactions?
   f. What is the Michaelis-Menten approach to enzyme kinetics?
   g. How do enzymatic reactions respond to inhibitors?

5. The Behavior of Proteins: Enzymes, Mechanisms, and Control (Chapter 7)
   a. Does the Michaelis-Menten model describe the behavior of allosteric enzymes?
   b. What are the models for the behavior of allosteric enzymes? (Concerted Model)
   c. How does phosphorylation of specific residues regulate enzyme activity?
   d. What are zymogens, and how do they control enzyme activity?
   e. How do active-site events of an enzyme affect the reaction mechanism? (The Mechanism of Chymotrypsin Action)
   f. What types of chemical reactions are involved in enzyme mechanisms?
   g. What are coenzymes?

6. Lipids and Proteins are Associated in Biological Membranes (Chapter 8)
   a. What is the definition of a lipid?
   b. What are the chemical natures of the lipid types?
   c. What is the nature of biological membranes?
   d. What are some common types of membrane proteins?
   e. What is the Fluid-Mosaic model of membrane structure?
   f. What are some of the functions of membranes?
   g. What are the lipid-soluble vitamins, and what are their functions?
   h. What are prostaglandins and leukotrienes, and what do they have to do with lipids?

7. The Importance of Energy Changes and Electron Transfer in Metabolism (Chapter 15)
   a. What are standard states for free-energy changes?
   b. What is a modified standard state for biochemical applications?
   c. What is metabolism?
   d. How are oxidation and reduction involved in metabolism
   e. How are coenzymes used in biologically important oxidation-reduction reactions?
   f. How are production and use of energy coupled?
   g. How is coenzyme A involved in activation of metabolic pathway?

8. Carbohydrates (Chapter 16)
   a. What are the structures and the stereochemistry of monosaccharides?
   b. How do monosaccharides react? (The formation of glycosides)
   c. What are some important oligosaccharides?
   d. What are the structures and functions of polysaccharides?
   e. What are glycoproteins?

9. Glycolysis (Chapter 17)
   a. What is the overall pathway in glycolysis?
   b. How is the 6-carbon glucose converted to the 3-carbon glyceraldehydes-3-phosphate?
   c. How is glyceraldehydes-3-phosphate converted to pyruvate?
   d. How is pyruvate metabolized anaerobically?
   e. How much energy can be produced by glycolysis?
10. Storage Mechanisms and Control in Carbohydrate Metabolism (Chapter 18)
   a. How is glycogen produced and degraded?
   b. How does gluconeogenesis produce glucose from pyruvate?
   c. How is carbohydrate metabolism controlled?
   d. Why is glucose sometimes diverted through the pentose phosphate pathway?

11. The Citric Acid Cycle (Chapter 19)
   a. What role does the citric acid cycle play in metabolism?
   b. What is the overall pathway of the citric acid cycle?
   c. How is pyruvate converted to acetyl-CoA?
   d. What are the individual reactions of the citric acid cycle?
   e. What are the energetics of the citric acid cycle, and how is it controlled?
   f. What is the glyoxylate cycle?

12. Electron Transport and Oxidative Phosphorylation (Chapter 20)
   a. What role does electron transport play in metabolism?
   b. What are the reduction potentials for the electron transport chain?
   c. How are the electron transport complexes organized?
   d. What is the connection between electron transport and phosphorylation?
   e. What is the mechanism of coupling in oxidative phosphorylation? (Chemiosmotic Coupling)
   f. How are respiratory inhibitors used to study electron transport?
   g. What is the ATP yield from complete oxidation of glucose?

13. Lipid Metabolism (Chapter 21)
   a. How are lipids involved in the generation and storage of energy?
   b. How are lipids catabolized?
   c. What is the energy yield from the oxidation of fatty acids?
   d. How are unsaturated fatty acids and odd-carbon fatty acids catabolized?
   e. What are ketone bodies?
   f. How are fatty acids produced? (Brief pathway)
   g. How is cholesterol produced?

14. The Metabolism of Nitrogen (Chapter 23)
   a. What processes constitute nitrogen metabolism?
   b. How is nitrogen incorporated into biologically useful compounds?
   c. How are amino acids synthesized?
   d. What are the essential amino acids?
   e. How are amino acid catabolized?

15. Nucleic Acids: How Structure Conveys Information (Chapter 9)
   a. What are the levels of structure in nucleic acids?
   b. What is the covalent structure of polynucleotides?
   c. What is the structure of DNA?

16. Integration of Metabolism: Cellular signaling (Chapter 24)
   a. What are hormones and second messengers?
   b. How are hormones involved in the control of metabolism?
   c. What are the many effects of insulin?

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