CHEM 372

Bioorganic Chemistry

Goals:

Biochemistry is the study of the variety of ***chemical structures and chemical reactions*** that occur in living organisms. In order to truly understand the detailed mechanisms of these diverse reactions, one must assimilate aspects of organic chemistry, inorganic chemistry, and physical chemistry and apply these chemical principles to the complex structural environment presented by natural proteins, nucleotides, and membranes.

The goal of this course is to learn about general aspects of biochemical pathways from the perspective of the chemical principles and chemical reactions. We will cover:

1. **Biochemical structures.** We will study detailed aspects of the three-dimensional structure of proteins, and how this translates into differences in the function of these proteins. We will also cover the synthesis of biopolymers – peptide synthesis from protected amino acids and DNA synthesis from nucleoside phosphoramidites.

2. **Energy metabolism.** Biological systems use sugars and fatty acids to store energy. We will learn how this chemical energy is carefully harvested through stepwise oxidation, electron capture, proton and ion gradients, and conversion to mechanical energy. In particular, we will explore the thermodynamics of electron transport, proton pumping, and ATP biosynthesis.

3. **Molecular biosynthesis.** Most organisms can biosynthesize amino acids, lipids, vitamins, and cofactors using a host of complex enzymes that demonstrate fundamental chemical principles. By contrasting specific enzymes that use organic and inorganic catalytic cofactors, we can illustrate these catalytic principles while learning important pathways.

4. **Frontiers in biochemistry.** Current research in biochemistry focuses on understanding complex biochemical environments, such as the human brain (neurochemistry) or the control of gene expression in eukaryotic cells (genomics and proteomics). The growth of microorganisms in extreme environments using complex metalloenzymes will also be examined.

This course is intended to provide a solid background in the fundamental chemistry of biological systems in preparation for a career in biochemical research or for future graduate study in chemistry or biochemistry. This course is <u>not</u> intended to prepare students for the health professions or for professional school admissions exams (MCAT, PCAT, DAT, etc.); although it may suffice for that purpose, there is no attempt to cover the full range of topics that will be found on those exams.

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Lectures
Tues – Thurs
12 – 1:15 pm
Bilger 335

Office Hours
Wed
12 – 1 pm
(or stop by anytime)

Text: **The Organic Chemistry of Biological Pathways**,
Authors: John E. McMurry and Tadhg P. Begley
Publisher: Roberts and Company Publishers, Englewood, CO

Some initial lectures on proteins and enzymes will be taken from a Biochemistry text. Handouts will be provided.

In addition, handouts and review articles will be provided in class for topics not covered in the text.

Lectures:
- Two lectures per week will cover the basic material from the text and highlight the important enzymes and pathways.
- One lecture per section will focus on a specific chemical reaction or concept, in order to illustrate the importance of chemical principles in arriving at a detailed understanding of each topic.

Homework:
- Reading assignments will be given prior to each lecture.
- You are responsible for everything in the reading, even if it is not covered in lecture.
- No homework, although memorizing structures and working through mechanisms on your own will be necessary.

Grading:
- Three short exams worth 20 % of the final grade (60 % total) (each will be 40 min)
- Final exam worth 40 % of the grade.

Student Learning Outcomes:

1. Students can describe the basic elements of amino acid, peptide, and protein structure.
2. Students can explain the common features of enzyme catalysts, and the basic methods used in studying enzyme function.
3. Students can outline the basic metabolic pathways for glucose metabolism, amino acid biosynthesis and breakdown, fatty acid/lipid production and breakdown.
4. Students can describe fundamental chemical mechanisms for each of the major types of chemical reactions observed in biochemistry, including at least one specific example for each.
5. Students can use research databases, journal articles, and reviews to learn more about a modern topics in bioorganic chemistry.

Syllabus:

Week	Topic	Book Chapter
	Biochemical Structure and Function	
Week 1	Amino acids and the primary structure of peptides and proteins.	
Week 2	Three-Dimensional Structure of Proteins, Protein Folding.	
Week 3	Enzymes and Enzyme Mechanisms	
	Exam 1	
	Bioorganic Chemistry and Metabolism	
Week 4	Common Chemical Mechanisms in Biological Chemistry	Chapter 1
Week 5	Biomolecules	Chapter 2
Week 6	Lipid Metabolism	Chapter 3
Week 7	Lipid Metabolism (continued)	Chapter 3
Week 8	Carbohydrate Metabolism	Chapter 4
Week 9	Carbohydrate Metabolism (continued)	Chapter 4
	Exam 2	
	Biosynthesis of Biomolecules	
Week 10	Amino Acid Metabolism	Chapter 5
Week 11	Nucleotide Metabolism	Chapter 6
Week 12	Natural Product Biosynthesis	Chapter 7
	Exam 3	
UNIT 4	**Frontiers of Biochemistry**	
Week 13	Biophysical Methods in Biochemistry	
Week 14	Metals in Biology and Bioinorganic Chemistry	
Week 15	Chemical Biology, Genomics, and Proteomics	
	Final Exam	