The Catholic University of America

Department of Chemistry
Washington, D.C. 20064
202-319-5385

Chemistry 571
General Biochemistry

Instructor: Dr. Ildiko M. Kovach  Time: 5:10-6:30 P, T,Th, 1.10 P, F in 400 Gowan Hall
Office: 204 Maloney Hall  Place: 212 Maloney Hall
Phone: 202-319-6550  Period: 8/25/08-12/17/08
E-mail: Kovach@cua.edu  Credits: 4 hrs

Please READ THIS SYLLABUS carefully and remember its contents including dates of exams without any further reminder or notice. Please MARK YOUR CALENDAR. Ask your questions about the policy as soon as you read it.


3. More recent readings from Scientific American (a Journal aimed at the educated non-expert reader) and Science, both available in the Biology & Nursing Library.

Course Description: Lectures on the chemistry of biological systems, including discussion of important metabolic pathways. Prerequisites: 204, 214.

Mechanics: The material will be discussed in two lectures per week 1.5 hrs each. An hour discussion per week will be used for examinations, problem solving, discussion, question and answers. Additional material will be covered through reading assignments, problem sets, occasional handouts and Web assignments.

Course Objectives:

Please note that the material covered in this course (as in the book) is a general requirement for the subject as specified by the American Chemical Society (ACS) advised by the American Society for Biochemistry and Molecular Biology (ASBMB).
1. Introduction: Macromolecules and fundamentals to Biochemistry (Ch. 1)
   a. Key organic molecules in living systems
   b. DNA, proteins, carbohydrates and lipids
   c. DNA provides the relation between form and function
   d. Unity on the molecular level underlies biological diversity
   e. Review of chemical bonds especially noncovalent interaction critical to biochemistry
   f. Thermodynamics. Energy transformations to support living systems
   g. Genomic evolution in biochemistry and medicine

2. Amino Acids (Ch. 2)
   a. Structure; side chains
   b. Acid-base properties and titration curves; pKₐ's - pI
   c. Stereochemistry
   d. Chromatography/ion exchange/electrophoresis

3. Peptides and Proteins (Ch. 3)
   a. Levels of protein structure/conformation/function
   b. Amino acid sequence determines 3D structure of a protein/peptide
   c. Purification based on size and pI
   d. Sequencing; end group analysis, chemical and enzymic degradation
   e. Peptide synthesis
   f. NMR and X-ray for the determination of protein structure

4. Nucleotides and Nucleosides (Ch. 4)
   a. Pyridine and purine bases
   b. Nucleic acid stereochemistry and structure
   c. Secondary structure and conformational analysis

5. Genes (Ch. 5)
   a. Sequencing
   b. Gene expression and transcription
   c. Genetic code
   d. Protein synthesis
   e. Cloning
   f. Restriction enzymes
   g. Manipulation of eukaryotic genes.

6. Evolution and bioinformatics (Ch. 6)
   a. Homologs, paralogs
   b. Statistical analysis of sequence alignments to detect homology
   c. The key importance of 3D structure for understanding evolutionary relationships
   d. Evolutionary trees can be constructed from sequence information
   e. Modern techniques in experimental studies of evolution

7. Hemoglobin: Portrait of a protein in action (Ch. 7)
   a. Oxygen binding in myoglobin and hemoglobin
   b. Cooperative binding of oxygen in hemoglobin
   c. The Bohr effect; how H ions and CO₂ promote oxygen release
d. Mutagenic diseases related to hemoglobin structure

8. Enzyme Kinetics (Ch. 8)
a. Energetics  
b. Michaelis-Menten kinetics and Lineweaver-Burk Plots  
c. Allosteric enzymes  
d. Enzyme inhibition  
e. Vitamins are precursors to coenzymes

9. Mechanism of Enzyme Action (Ch. 9)
a. Proteases, serine hydrolases  
b. Carbonic anhydrase  
c. Restriction enzymes  
d. Kinases

10. Control of enzyme activity, regulatory strategies (Ch. 10)
a. Allostery: ACT and hemoglobin  
b. Isoenzymes  
c. Covalent modifications  
d. Enzyme activation, zymogens

11. Carbohydrates (Ch. 11)
a. Monosacharides, stereochemistry  
b. Complex carbohydrates  
c. Glycoproteins  
d. Lectins

12. Lipids and Cell Membranes (Ch. 12)
a. Fatty acids and triglycerides  
b. Three types of membranes,  
c. Phospholipids and glycolipids  
d. Peripheral and integral proteins in membranes  
e. Lipid dynamics and protein mobility in membranes

If time allows:

13. Membrane Channels and Pumps (Ch. 13)
a. Active and passive transport across membranes  
b. ATP hydrolysis is the driving force for pumping ions  
c. Membrane binding proteins with ATP-binding cassette domains  
d. Secondary transporters  
e. Ion channel and gap junctions

Goals for Student Learning

First level of understanding is the guiding principles and basic concepts of biochemistry. These allow the student to understand and work with specific examples. These are found in the Chapter Summary in the book and emphasized in lecture. Students will have to know the structure of the four nucleic base, the twenty
essential amino acids, glucose, fructose, ribose, ribulose, NAD+, NADH, FAD, FADH₂, pyridoxal phosphate, glycerol, fatty acids C₁₂ to C₂₀, essential fatty acids and other basic biochemicals to follow discussions of biochemistry. Students will be expected to convert linear carbohydrate structures to cyclic structures and be ready to do similar conversions with other molecular structures. Students will also need to know the one and three letter codes of amino acids. Several of the basic metabolic mechanisms are considered essential and students are expected to master writing the mechanisms of these metabolic reactions at the molecular level.

Second level of performance in class includes knowing the classical experiments and their history. Be glib with working out specific examples and quantitative kinetic and bioanalytical problems. An A in class will be earned by mastering material at all levels.

Important: Get the big picture first and then complement it with details instead of doing the opposite.

Professional Standards addressed

This material is covered in National tests (ACS subject test MCAT, GRE). A good understanding of the subject on the molecular level will enable you to obtain a score in the 50 percentile or above on these tests based on previous experiences. (Scores of former CUA students on ACS tests 10-90%). The ACS subject test for biochemistry will be administered at the end of the second semester.

Course Policies and Expectations

Attendance at all classes is required. This requirement is for the protection of the student. A missed lecture often requires up to three times the lecture time to make up on one's own. It will help in understanding the material covered in each lecture if the student quickly skims the material in the text before the lecture.

Homework: Although the textbook will be followed quite closely, success will depend on all three; attention to lectures, study from lecture notes and the book, and practice solving problems and drawing structures. Students are required to read each chapter in the text possibly prior to lecture and after class, and work examples in the body of the chapter as we cover the material. Additional exercise problems (at the end of the chapter) will be assigned during the lecture. If you have difficulty in doing these exercises, do not wait until the day before a test to seek help. Many of these concepts build on each other and if a student falls behind early in the course, it may not be possible to catch up. Homework, in general, will not be graded but ALL homework assignments are required to be completed.

Preparation for exams: Chapter summaries and chapter integration problems are provided for this purpose. Web-site quizzes provided to monitor student progress will be used.

Quizzes and exams. All quizzes and tests will be closed book. There is no assigned seating but each student should be certain that there is an empty row of seats in front and in back of him/her and an empty seat to each side. This allows you to ask questions without disturbing those around you and reduces potential misunderstandings.

Answers will be posted on the bulletin board near Maloney 204. Errors in grading must be reported within one week of the return of tests or quizzes in order to be corrected.

Grades: will be based on the results of three hour-exams 100pts (15%) each, ten quizzes (5 min) 100pts in total (20%) and a final exam 200pts (35%). The following grading scale will be used: A >90%; A- 87-89%, B+ 85-
86%, B 78-84%, B- 76-77%, C+ 74-75%, C 68-74%, C- 66-67%.

EXAMS: On Fridays 9/24; 10/22; 11/19 and on final exam week, T, 12/14 6-8 pm

QUIZZES: every F, at least 10

**Key to success:** being glib and prompt in using the structures of amino acids, nucleic acids, basic carbohydrates, vitamins, cofactors, glycolysis, citric acid cycle, redox reactions of respiration and photorespiration. The material is vast and cumulative; it requires attention daily and frequent reviews.

**Ethics:** Cheating in any form will not be tolerated. Any assignment for which credit is given must be the work of the individual student. This includes all quizzes, tests and exams.

**Academic honesty:** Academic honesty is expected of all CUA students. Faculty are required to initiate the imposition of sanctions when they find violations of academic honesty, such as plagiarism, improper use of a student’s own work, cheating, and fabrication.

The following sanctions are presented in the University procedures related to Student Academic Dishonesty (from [http://policies.cua.edu/academicundergrad/integrityprocedures.cfm](http://policies.cua.edu/academicundergrad/integrityprocedures.cfm)): “The presumed sanction for undergraduate students for academic dishonesty will be failure for the course. There may be circumstances, however, where, perhaps because of an undergraduate student’s past record, a more serious sanction, such as suspension or expulsion, would be appropriate. In the context of graduate studies, the expectations for academic honesty are greater, and therefore the presumed sanction for dishonesty is likely to be more severe, e.g., expulsion. In the more unusual case, mitigating circumstances may exist that would warrant a lesser sanction than the presumed sanction.”

Please review the complete texts of the University policy and procedures regarding Student Academic Dishonesty, including requirements for appeals, at [http://policies.cua.edu/academicundergrad/integrity.cfm](http://policies.cua.edu/academicundergrad/integrity.cfm) and [http://policies.cua.edu/academicundergrad/integrity.cfm](http://policies.cua.edu/academicundergrad/integrity.cfm).