Biological Chemistry I: Macromolecules

Chemistry 321

T. Glen Lawson

Textbook: *Biochemistry*
by Miesfeld and McEvoy
Laboratory Manual: *Practical Biochemistry in the Laboratory*, 13th ed. by T. G. Lawson, Beth Whalon, and Amy McDonough

office hours:
(in ARC, Ladd Library)
Tu, 11:00 AM – 12:30 PM
W, 4:30 – 6:00 PM
F, 3:00 – 4:00 PM

Laboratory Instructors: T. Glen Lawson and Colleen O'Loughlin
Laboratory Assistant in Instruction: Amy McDonough

A web page for this course can be found at: http://abacus.bates.edu/~tlawson/Classes.htm

Objectives: In this course we will examine the structures, functions, and chemical and physical behavior of the major classes of biological macromolecules, including proteins, carbohydrates, lipids, and nucleic acids. Special attention will be paid to the kinetics and mechanisms of enzyme-catalyzed reactions. The laboratory component will provide hands-on training in the use of some fundamentally important practical biochemistry techniques and education in professional scientific writing.

Learning Outcome Goals: With the completion of this course you should be able to explain, both orally and in writing, the structures adopted by biological macromolecules in solution, the inter- and intra-molecular forces involved in the formation of these structures, and the connections between these structures and the biochemical processes they support. You should be able to use thermodynamic principles to explain the spontaneity and directionality of reactions in living systems. You should be able to derive rate law equations that describe the kinetics of enzyme-catalyzed reactions and explain both the significance of the rate constants in these equations and the catalytic reaction mechanisms that coincide with them. You should be able to differentiate between the major types of membrane transport systems used by all living organisms. You should be able to describe strategies, using current technology, for isolating and structurally characterizing protein and nucleic acid molecules. Finally, and perhaps most importantly, you should be able to apply what you learn in this course to data analysis, solving new biochemical problems, and designing experimental strategies appropriate for seeking the answers to at least some novel biochemical questions, and you should be able to describe your strategies, data interpretation, and experimentally-derived findings with succinct clarity in written forms consistent with those accepted by the professional molecular life science community.

Lecture/Discussion Topics

I. Introduction (Sept. 4 & 6)
history, biological molecules, water and pH
(textbook chapters 1.1 – 1.2; 2.2)

II. Amino Acids and Proteins (Sept. 9 – Sept. 27)
amino acids, peptide bonds, primary structures and protein folding, higher order structures, allosterism, purification of proteins*, analysis of protein structure
(textbook chapters 4.1 – 4.3; 5.1 – 5.4; 6.1 & 6.2)

Quiz† (background biology, pH and amino acids) - Monday, Sept. 16
Exam I† - Wednesday, Oct. 2

III. Enzyme Kinetics and Mechanisms (Sept. 30 – Oct. 30)
kinetics and kinetic analysis of enzyme-catalyzed reactions, enzyme inhibitors and inhibition kinetics, chemistry and mechanisms of enzyme action, and control of enzyme activity
(textbook chapters 7.1 – 7.5; problem-based learning modules)

Exam II† - Monday, Nov. 4

IV. Carbohydrates (Nov. 1 & Nov. 6)
simple carbohydrates, complex carbohydrates, glycoproteins
(textbook chapter 13.1 – 13.3)

V. Lipids and Membranes (Nov. 8 - 15)
fatty acids and lipids, membranes, membrane transport
(textbook chapter 15.1 – 15.3; 2.3; 6.3)

VI. Nucleic Acids (Nov. 18 - Dec. 6)
chemistry of nucleosides and nucleotides, structure and chemistry of DNA and RNA, purification of polynucleotides*, analysis of nucleic acid structure
(textbook chapter 3.1, 3.3)

Exam III/Final† - Tuesday, December 10 (1:15 PM)

†This is a chemistry course. Mathematical calculations are part of the course and the assessment tools. Bring a calculator to class and to all quizzes and exams.

*Topics covered in the laboratory manual, not in class.

Problem Solving

Understanding and mastery of the course material requires that you put concepts into practice. Your performance on exams will certainly depend upon the extent to which you engage in problem-solving exercises. This is something for which you must take personal responsibility because problem solving will not be subjected to formal evaluation. You will be assigned review questions and problems from the textbook, which you should work on your own as we move through each set of concepts. The answers are available in the textbook. In addition, some class time will be used for in-class problem solving, in a group format. The group compositions will be changed for each in-class problem-solving exercise. To fully participate in and obtain full benefit from these exercises, it is important that you review the relevant material before coming to class.

Laboratory

The laboratory component of this course will nominally be held on Tuesdays or Wednesdays at 1:10 – 3:55 PM in Dana 312, although additional time in the laboratory will be necessary and expected. Teams of three individuals will work together on the exercise and projects. The description of each project should be thoroughly read and understood before the laboratory work is initiated. A short quiz will be administered at the beginning of four of the lab periods to evaluate your pre-laboratory preparation. Journal-style laboratory reports should be prepared according to the formats described in the laboratory manual. The laboratory instructors may provide additional instruction on report preparation; the instructors, for the purpose of providing constructive criticism, may collect drafts of report sections. The anticipated schedule and final report due dates for the laboratory are provided below. Group notebooks will be subjected to spot

checks throughout the semester by the course A.I., and the A.I. will formally evaluate the notebooks at the end of the semester. Questions relating to the laboratory may appear on exams.

Exercise: *pH and UV Spectroscopy*
- laboratory work: Tues., Sept. 10 or Wed., Sept. 11
- final project paper due: Tues., Sept. 17 or Wed., Sept. 18

Project 1: *Purification of Egg White Lysozyme*
- laboratory work: Tues., Sept. 17 - Tues., Oct. 8 or Wed., Sept 18 - Wed., Oct. 9
- final project paper due: Tues., Oct. 8 or Wed., Oct. 9

Project 2: *Kinetic Analysis of Alkaline Phosphatase*
- laboratory work: Tues., Oct. 8 - Tues., Oct. 29 or Wed., Oct. 9 - Wed., Oct. 30
- final project paper due: Tues., Nov. 5 or Wed., Nov. 6

Project 3: *Detection of Gene Expression at the Transcriptional Level in Saccharomyces cerevisiae*
- laboratory work: Tues., Nov. 5 - Tues., Nov. 19 or Wed., Nov. 6 - Wed., Nov. 20; optional data analysis meetings will be held on Tues., Dec. 3 and Wed., Dec. 5.
- final project paper due for both sections: Fri., Dec. 6 (4:00 PM)

Classroom Environment

All class participants are to be treated with respect and dignity, and discussions are to be carried out in a civil manner. To maintain an environment that respects others and supports learning, please arrive for class and lab meetings on time and refrain from leaving during class meetings except for emergencies. (In other words, eliminate your personal biological waste products before coming to class.) Chronic tardiness and absences will negatively impact your final effort score. Mobile communication devices and laptops, etc. brought to class must be turned off and stored out of sight. Only students with certain documented learning differences may use electronic devices during class meetings. You may bring food and non-alcoholic beverages to class, but out of respect for others, please do not consume large, messy, or odiferous items during class meetings.

Other Course Policies

Due Dates and Exam Dates: The exam dates and due dates for assignments are firm and will not be changed for any reason except for situations of documented illness or family tragedy. Exceptions may be made for situations that affect the entire class.

Learning Difference Issues: Students with documented learning difference/disability issues who wish to exercise extended time options for exams must see that the instructor is provided by the Dean of Students Office (DOS) with evidence of said documentation by no later than two weeks after the first day of the semester. Students with this documentation will have the option of taking exams/quizzes under extended time conditions in the DOS office. The exams must be taken on the date of the scheduled exam/quiz, as close to the scheduled class meeting time as possible. ***It is the student's responsibility to make the arrangements with the DOS and to inform the instructor of the arrangements at least two class days***

before the day of <u>each</u> scheduled exam. Please note that the extended time arrangement and instructor notification for one exam does not automatically extend to subsequent exams.

Graphing Software Policy: Excel *may not* be used to graph laboratory data or solve problems. Prism or SigmaPlot are highly recommended alternatives.

Academic Dishonesty: No academic dishonesty of any type will be tolerated. This includes all forms of plagiarism. The first incidence of academic dishonesty will result in zero points for the assignment and a referral to the Dean of Students Office. The second incident will result in an automatic F for the course.

Grading

Grades will be assigned based upon points accumulated throughout the semester. A maximum of 400 points is possible, broken down as follows:

Quiz and Exams (230 pts.):

quiz	-	20 pts.
exam I	-	60 pts.
exam II	-	60 pts.
exam III/Final (60/30 pts.)	-	90 pts.

Laboratory (140 pts.):

pre-lab quizzes	-	20 pts.
lab exercise	-	12 pts.
lab project paper 1	-	30 pts.
lab project paper 2	-	30 pts.
lab project paper 3	-	30 pts.
group notebook	-	18 pts.

(The project paper score includes a subjective evaluation of laboratory work quality.)

Instructor's subjective estimation of effort and class/laboratory participation - 30 pts.

It is anticipated that grades will be assigned according to the following percentages, with the *final* class mean adjusted to at least 75%, if necessary:

A+	97 - 100%	C+	70 - 73%
A	93 - 96%	C	66 - 69%
A-	89 - 92%	C-	62 - 65%
B+	84 - 88%	D+	58 - 61%
B	79 - 83%	D	54 - 57%
B-	74 - 78%	D-	50 - 53%