
Instructor: Jeff Dahlseid, Ph.D.

Class: MTWF 11:30-12:20

Office: Nobel 221C, Phone: x6129

Classroom: Nobel 222

E-mail: dahlseid@gustavus.edu

Laboratory: Nobel 207

Class URL: www.gustavus.edu/~dahlseid/CHE255/

Office hours: M 2:30, W 9:00, F 1:30

Texts: Chemistry 255 - Biochemistry Lab Manual

Lehninger Principles of Biochemistry, Nelson & Cox, 4th Ed., 2005, Freeman, NY, NY

Description and Course Outline:

Biochemists study the molecular basis for the functioning of living systems, including the structures, chemical properties, physical interactions, and biological functions of biochemicals. Yet **biochemistry** is more than that. Authors of our textbook write that biochemistry's "ultimate concern is with the wonder of life itself." (pp. 3) Biochemistry is surely an exciting and integrative field of study. The four types of macromolecules central to biochemistry are called proteins, nucleic acids, lipids, and carbohydrates. This semester you will discover these and a host of other biomolecules, be exposed to techniques and principles for biochemical investigation, and gain insight into the significance of biochemistry as part of our effort to understand the living world.

In this course, we will study proteins, their building blocks, structure, and folding. We will learn about nucleic acids, their structure, building blocks, and how these molecules store genetic information. A case study of the proteins involved in oxygen binding and transport, including their physiological context, will serve to illustrate the relationship between protein structure and function. We will extend these ideas by considering enzymatic catalysis and kinetics of biochemical reactions. We will study lipids and the associations that give rise to membranes, the principal biological barrier. Consideration of biosignaling processes will help us appreciate the control of the metabolic processes we will study. An introduction to bioenergetics and carbohydrates will precede a study of energy metabolism including glycolysis, the citric acid cycle, and oxidative phosphorylation. Examples of the mechanisms of protein catalysis and of the mechanisms regulating protein function will be integrated into the material.

Course Objectives:

This course aims to integrate class and laboratory learning of biochemistry. Although a course in biochemistry necessarily involves learning new facts and laboratory techniques, my goal for this course is that you will come to appreciate the *breadth* of biochemistry and develop a solid background its *fundamental* principles and practices. Specifically, my objectives regarding content are that you:

- develop a knowledge of biochemical building blocks and how their structures and assembly mediate their biological functions
- appreciate nucleic acid structure and its informational role in genetics
- understand and apply principles of enzyme kinetics to biochemical problems
- appreciate the structures of lipids and the interactions that contribute to the formation and maintenance of membranes
- develop a knowledge of the events and principles of signal transduction
- comprehend the principles of bioenergetics and how the reactions and events of catabolism, the citric acid cycle, and oxidative phosphorylation produce energy
- appreciate the relationship between the structure and function of biomolecules
- illustrate mechanisms of protein catalysis and regulation

Course Objectives (cont.)

Laboratory is an integral part of this course. Our hands-on learning about biochemical investigations will focus upon protein enzymes and their activities, properties, and kinetics. Laboratory will also have an emphasis on scientific writing. For laboratory, my objectives are that you:

- understand and use many of the techniques and tools of biochemistry
- comprehend fundamental principles of biochemical experimentation and research
- communicate research results accurately and effectively in written form

Teaching approach:

We will primarily use class time to engage in learning course material, and it is my hope that together we can cultivate an environment of active learning (including real discussion). Because of this approach and the challenging nature of the subject, you should expect effective learning to come from reading the text material for each class meeting **ahead** of time and preparing questions, points for clarification, or ideas for discussion in class. You are **required** to attend class, both physically and mentally, to give yourself every opportunity to learn the material. Repeated unexcused absences will be sufficient basis for a lower course grade. If you anticipate a valid excuse for being absent, please see me about being excused. In the event that you miss a class, you are responsible for *understanding* the material from class, including handouts, etc.

We will use scheduled laboratory time to engage in hands-on learning about biochemical techniques and principles as well as to focus upon scientific writing. Coming prepared, as for class, is highly recommended. I believe this is so important that we will hold pre-laboratory meetings *before* each scheduled exercise. You are **required** to attend laboratory, both physically and mentally. Failure to do so will result in failure of this portion of the course. If your attendance is challenged by a crisis or emergency, please contact me as soon as possible. Arrangements will be made for valid circumstances.

I welcome and encourage your participation in classroom and laboratory learning. Biochemistry is a rigorous topic and I expect everyone to work hard, but if you are having problems with the course please let me know. I am here to help you learn.

Academic honesty:

It is my expectation and policy that you will participate in this class in an honest and honorable way; I will not tolerate academic dishonesty. While I encourage you to work together to learn biochemistry, the work you submit on behalf of an assignment or exam must be your own. Dishonesty includes plagiarism, which is presenting someone else's ideas or words as your own. It is your responsibility in all written work to credit sources from which you draw ideas and language (quotes are rare here) with proper referencing. Dishonesty also includes cheating on exams. Gustavus has an Honor Code and, by virtue of being a student here (as well as your signed agreement from course registration), you have agreed to uphold the Honor Code. In this course, you are required to sign the following statement for papers and exams (though it applies to all of your work): "On my honor, I pledge that I have not given, received, nor tolerated others' use of unauthorized aid in completing this work." Central to the code is non-tolerance for violations. Though you are not expected to police others' actions, under the code (and in this class), failure to report a violation of which you are aware also constitutes an honor code violation. Documented violations will result in a zero for the assignment in question, will be reported to the Dean's office, and may result in failure of the course. If you have questions concerning particulars of academic honesty, please see me.

Course Activities and Requirements:

- **Research Article Summaries:** Throughout the semester, you must use the search tools Medline or SciFinder Scholar and the Library (and ILL) to identify and obtain a copy of a research article on a biochemical topic (NOT a review) of interest to you. You will be required to read the article and write a two-page summary addressing a series of provided questions. Due dates are below. See course web page for details.
- **Protein Explorer (PE) Exercises:** This assignment will require you to do three things: 1) learn how to use a tool for the graphic display of molecular structures called Protein Explorer, 2) use Protein Explorer to explore the structures of biomacromolecules (proteins mostly) and capture a graphical image of your molecule, 3) record your observations from your exploration of molecular structure. Due dates are below. See course web page for details.
- **Exams:** During the semester you will be required to take four mid-term exams and a final exam. The mid-term exams will cover new material and concepts covered in class, laboratory material, and assigned readings through the test date. The final exam will be comprehensive, so it will be important to integrate your learning of material from throughout the course. All exams will assess your cumulative learning of biochemical principles, problem solving skills, and critical thinking skills. They will require some level of synthesis and include questions requiring recall (facts, names and structures) and short answers.

The mid-term exams and comprehensive final exam will be given at the times indicated on the schedule. **Exam attendance is mandatory**, and exams cannot be made up except for a *crisis* or *emergency*. For a crisis, you must talk with me personally in advance to arrange for a make-up exam. In an emergency, contact me by phone, voice-mail or e-mail, or, if you are unable to reach me, Nadine Zuhlsdorf (x7320) in the Chemistry office or the Dean's office (x7526). IF I am properly notified AND your emergency is valid, a make-up exam will be arranged. All students must take the final exam as scheduled.

- **Laboratory reports:** For laboratory, you will write two short reports and a initial and final draft of a full report as part of an integrated series of activities intended to promote good scientific writing. Both report types will be formal. The short format allows an early focus on the writing of methods and results. The full report is designed to provide significant feedback on a complete report. See the lab manual for scheduled due dates and assignment details. Note that the Writing Center (x6027 for appointments) is available to you for help with your writing.
- **Peer evaluations of laboratory reports:** You will evaluate the initial draft formal report of one of your peers. Additional detail will be available as the time nears.
- **Data analysis and questions (DAQs):** You will complete and hand in your data analysis and answers to provided questions for three laboratory exercises. These assignments are aimed at assessing your ability to perform technically in laboratory, to acquire good data, and to meaningfully analyze and present it.
- **Experimental investigation:** This multi-week experience will proposing, planning and implementing an original biochemical investigation. Stay tuned for details.

- **Laboratory notebooks:** Keeping a careful record of your work is a *most important* component of laboratory investigations. You **must** keep a laboratory notebook for biochemistry laboratory. The notebooks will be collected twice during the semester for evaluation (see schedule). Note that although notebooks receive their own point score (see below), I will make substantial penalty point reductions for laboratory reports that are inadequately supported by a laboratory notebook record.

Grading breakdown: Article summaries (3 @ 30 pts)	90
PE exercises (2 @ 20 pts)	40
Midterm Exams (4 @ 100 pts)	400
Comprehensive final exam	100
Laboratory reports	
Short reports (2 @ 20 pts)	40
First draft full report	25
Final draft full report	75
Peer evaluation	30
Experimental investigation	70
DAQs (3 @ 10 pts)	30
<u>Laboratory Notebooks (2 @ 20 pts)</u>	<u>40</u>
Total	940

Final grades will be assigned according to a straight percentage scale. The following percentage scale will serve as a **guideline** for letter grade assignment:

90-100% = A
80 - 89% = B
70 - 79% = C
60 - 69% = D

Class e-mail policy: I use e-mail to help manage the course and field questions about the material, so I require that you use your **Gustavus** e-mail account. The advantages to this system include speed, avoided trips to Nobel Hall for simple questions, and a generally smoother running course. Here's the protocol.

When you have questions, e-mail them to me. If your question is very specific, I will reply directly. If the question seems potentially interesting to the entire class, I will forward the question (anonymously) and my reply to the class. I will assume you do not object to sharing your question unless you specifically state so. I also encourage you to use the **f-che-255** class alias to ask each other questions. As I may refer to e-mail questions in class and I use e-mail for general class announcements, **I encourage you to check your e-mail before class.** Campus rules for alias use apply and abuse will not be tolerated.

Feedback: I am very enthusiastic about being and becoming an outstanding educator, both for you and future students. I welcome constructive suggestions about how to improve class, my teaching, and the course. I expect to learn from you this semester how I might teach better. I invite you to discuss your suggestions with me in my office at any time.

Students with disabilities: Appropriate accommodations will be made for students with specific, documented disabilities of a physical, psychiatric or learning nature. Related information will be kept strictly confidential. Please contact either me or Laurie Bickett (x7027) in Academic Advising if this applies to you.

Note this syllabus and schedule are subject to change at the instructor's discretion.

9/7	Introduction, themes of biochemistry	Ch. 1
9/9	Cells, Biomolecules	Ch. 1
9/12	Biomolecules, Properties of water	Ch. 1,2
9/13	<i>Prelaboratory Expt. 1</i>	
9/14	Properties of water	Ch. 2
9/16	Protein Structure - amino acids	Ch. 3
9/19	Protein Structure - peptides	Ch. 3
9/20	<i>Prelaboratory Expt. 2, Intro to protein methods</i>	Ch. 3
9/21	Protein Structure - methods	Ch. 3
9/23	Protein Structure - 3-D structure	Ch. 4
9/26	Protein Structure - 3-D structure	Ch. 4
9/27	<i>Prelaboratory on buffers</i>	
9/27	Nobel Conference - The Legacy of Einstein	
9/28	Protein Structure - folding	Ch. 4
9/28	Nobel Conference - The Legacy of Einstein	
9/30	Protein Structure - folding	Ch. 4
	Paper summary due (on protein crystallography)	
10/3	Midterm Exam 1 - Ch. 1-4	
10/4	<i>Prelaboratory Expt. 3</i>	
10/5	Protein Function - oxygen transport	Ch. 5
10/7	Protein Function - oxygen transport	Ch. 5
	ProteinExplorer exercise due	
10/10	Protein Function - oxygen transport	Ch. 5
10/11	<i>Prelaboratory Expt. 3 continued, oxygen transport</i>	Ch. 5
10/12	Protein Function - oxygen transport	Ch. 5
10/14	Protein Function - introduction to enzymes	Ch. 6
	ProteinExplorer exercise due	
10/17	Protein Function - enzyme kinetics	Ch. 6
10/18	<i>Prelaboratory Expt. 3 continued, enzyme kinetics</i>	Ch. 6
10/19	Protein Function - enzyme kinetics	Ch. 6
10/21	Midterm Exam 2 - Ch. 5-6	
10/24-25	<i>Reading Break</i>	
10/26	Nucleotides	Ch. 8
10/28	Nucleic Acids	Ch. 8
10/31	Nucleic Acids	Ch. 8
11/1	<i>Prelaboratory Expt. 4, peer evaluation</i>	
11/2	Lipids	Ch. 10
11/4	Lipids	Ch. 10
11/7	Membranes	Ch. 11
	Paper summary due	
11/8	<i>Prelaboratory on Experimental Design</i>	
11/9	Transport	Ch. 11
11/11	Biosignaling	Ch. 12
11/14	Biosignaling	Ch. 12
11/15	Carbohydrates	Ch. 7

11/16	Bioenergetics	Ch. 13
11/18	Bioenergetics	Ch. 13
11/21	Midterm Exam 3 - Ch. 8, 10-12	
11/22	Glycolysis	Ch. 14
11/23	Glycolysis	Ch. 14
11/24-11/27	Thanksgiving Break	
11/28	Glycolysis	Ch. 14
11/29	Citric Acid Cycle	Ch. 16
11/30	Citric Acid Cycle	Ch. 16
12/2	Citric Acid Cycle	Ch. 16
12/5	Oxidative Phosphorylation	Ch. 19
12/6	<i>Prelaboratory Expt. 5</i>	
12/8	Midterm Exam 4 - Ch. 7, 13, 14, & 16	
12/9	Oxidative Phosphorylation	Ch. 19
12/12	Oxidative Phosphorylation	Ch. 19
	Paper summary due	
12/13	Oxidative Phosphorylation	Ch. 19
12/14	Review, course evaluations	
12/20	Comprehensive Final Exam 8:00-10:00 a.m.	

Biochemistry Laboratory Schedule

<u>Week of:</u>	<u>Topic</u>
9/12	Expt 1: Introduction to Basic Techniques
9/19	Expt 2: pH-Dependence of Fumarase Short report for Expt 1 due
9/26	Writing discussion and workshop; Buffer preparation Literature reading, questions for discussion, buffer problems due
10/3	Expt 3: Purification of Yeast Fumarase Short report for Expt 2 due
10/10	Expt 3: (cont'd) Anion exchange separation data analysis & questions (DAQ) due
10/17	Expt 3: (cont'd) Midterm lab notebooks due 10/21
10/26	Writing help available for formal reports Expt 3 formal report initial draft due by 5 pm on 10/28
10/31	Expt 4: Kinetic Analysis of Fumarase Expt 4 DAQ due Peer review of formal report due 11/4
11/7	Scheduled writing consultations/Fumarase Experiment Design Fumarase experimental design idea proposal draft due
11/14	Fumarase Experimental Design & Preparation Fumarase Experimental Design experimental plan due Final draft of Expt 3 formal report due at beginning of lab
11/21	Fumarase Experimental Execution
11/28	Fumarase Experimental Execution
12/5	Expt 5: Stereospecificity of the Fumarase Reaction Expt 5 DAQ due Final lab notebooks due 12/9
12/12	Presentation of Experimental Investigation during lab