

**CHEM 115 PO-02: Biochemistry**

**Instructor**

Prof. Jane M. Liu (SN 216)  
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**Office Hours**

M 2-4 pm; W 8:30-10:30 am; or by appointment

**Class**

Tuesday, Thursday 8:10 am – 9:25 am, SC 103

**PRE-REQUISITE: CHEM 110A**

**Review Session**

R 11:30 am – 1 pm

**COURSE GOALS**

This upper-level course, for those students with a background in both general chemistry and organic chemistry, will address the following questions:

- **How does the shape, structure and functional groups of macromolecules and metabolites relate to their biological reactivity and function?**
- **How do we isolate, manipulate and study a specific protein of interest from a cell?**
- **How do we study an enzyme's activity?**
- **How do molecules functionally interact in a cell?**

The study of biochemistry investigates the interplay between biological macromolecules such as proteins and nucleic acids, and low molecular weight molecules (such as the products of glucose metabolism). In this course, you will apply your knowledge of intermolecular forces, thermodynamics (when a reaction occurs), chemical kinetics (how fast a reaction occurs), and chemical structure and functionality to understand how biological molecules (and life) work.

**After successfully completing this course, students will be able to:**

- Apply the properties of water, chemical equilibria, and thermodynamics to understand biology at the molecular level
- Describe/identify the forces that direct/stabilize different macromolecular structures
- Predict how changes in amino acid (or nucleotide) sequence can affect macromolecular structure and function
- Explain why catalysis is central to life and how enzymes and cofactors are able to affect reaction rate enhancement; in particular, the importance and mechanisms of "coupling" in the harnessing of favorable reactions to do biochemical "work"
- Articulate and apply what the enzyme parameters of  $K_M$ ,  $V_{max}$ ,  $k_{cat}$  and  $k_{cat}/K_M$  tell us about an enzyme
- Explain inhibition processes and different methods for regulating biological processes and/or flux through a pathway
- Describe the interactions of biomolecules both quantitatively and qualitatively (in many cases, including mechanistic details and the molecular basis of selectivity)
- Recognize the flow of metabolic intermediates through a pathway and communicate information about metabolic pathways using diagrams, especially in the context of human/medical biochemistry
- Describe multiple experimental methods used in biochemistry, interpret data from these methods to form conclusions, and develop a testable hypothesis to answer a question
- Summarize and analyze primary literature and data, and apply gathered information to new situations

### Engagement with this course will allow students to:

- Increase problem solving skills such as: critical thinking, data analysis, graphical analysis
- Increase process skills such as: communication of scientific concepts and experimental results; group dynamics and teamwork; management and self-assessment
- Develop an engaged community of active learners who are intentional about their educational choices

### OUTCOMES

For each topic, a list of learning outcomes will be provided to you, so that you can gauge your mastery of the materials and skills covered in CHEM 115.

### COURSE MATERIALS

- Voet, Voet and Pratt. *Fundamentals of Biochemistry, 5<sup>th</sup> Edition*.
- Key Questions, Videos, Worksheets, Problem Sets and additional Papers will be posted on Sakai
- Calculator and an active email account. Prof. Liu emails the class frequently. You are expected to check your school email account for these emails and to read them.

### COURSE OVERVIEW

#### Your Tasks

**Before class:** You will frequently be given initial assignments to work on as an individual before class. The Key Questions (on Sakai) are meant to guide you through the reading and help you focus on the major points that Prof. Liu considers important for the course. These assignments must be ready at the start of class – your preparation will form part of your weekly participation grade.

**In class:** During our class meeting time, you will frequently function as a member of a Learning Team, developing and examining chemistry concepts as a unit. Your team effort and participation is part of your weekly participation grade. The team responses to a few key questions on each in-class activity will be evaluated for strength of concept and effective communication of the concept. The team will also strategize on ways to improve teamwork and team products. These responses will also form part of your weekly participation grade.

**After class:** Application exercises will be assigned for each activity. Together with problems from the text, they will form your **problem sets** that will be collected and graded for each individual. **Actively** working these homework problems is essential for your understanding of the material, as they bring your concept development full circle.

**Problem Sets** (5 pts/question): Due on specified **Fridays (or Wed)** at noon (office OR email)

**Recorder Sheets** (3 pts/ea): Due by 11:50 pm, day activity is finished (office OR email)

**Strategist Sheets** (2 pts/ea): Due on Fridays at noon (office OR email)

**Performance Evaluations** (3 pts/ea): Due on specified Fridays at noon (office OR email)

**Office Hours:** These are guaranteed times when Prof. Liu can be found in her office, ready and waiting for you to come by. You can come by with specific questions. Lots of students do this: they've organized their class notes, homework, etc. and they bring those documents with them, along with the textbook and ask Prof. Liu specific questions. Some students bring their computer, so they can type while they and Prof. Liu chat; other students just write a bunch of stuff on paper. Some example of specific questions you might ask Prof. Liu:

*I didn't understand XX when we talked about it in class. Can you help me understand?*

*I don't understand how to start this problem on the problem set – can you help me get started?*

*I don't understand what this paragraph in the textbook means – can you help me?*

*I keep getting the wrong answer for this back-of-the-chapter problem. Where am I going wrong?*

If you do not have a specific question, you can still go to office hours! It may help if you have at least a starting point for the conversation (bring some class notes, parts of the book, etc to refer to). Some things you might say are:

*So.... Thermodynamics. Yeah. Tell me about that.*

*Organic chemistry was really hard for me. So I'm scared. What can I do?*

*I want to do well in this class. What should I do?*

If you do not have a specific question and you do not have a starting point for the conversation, that is OK too! By just chatting about the course, questions will surely evolve.

**Review session:** This is another time to ask Prof. Liu specific questions. You could ask her to go over a specific question or two from an activity; you could ask her to go over a specific question or two from a problem set; you could ask her to go over a specific question or two from the book. The review sessions are run Q&A style. However, if you just want to say: *So.... Thermodynamics. Yeah. Tell me about that.*, Prof. Liu will work with it!

### Assessments

#### Final Grade Calculation

#### Grading Scale

Mid-term exams:	30%	A	93-100	C	73-76
Final exam:	20%	A-	90-92	C-	70-72
Team participation:	10%	B+	87-89	D+	67-69
Problem Sets/Other:	15%	B	83-86	D	63-66
Laboratory:	25%	B-	80-82	D-	60-62
		C+	77-79	F	≤59

*There is no curve for this course – you need only worry about your own performance. Please note that an “A” grade represents excellent mastery and intelligent discussion of concepts covered in this course.*

**Problem Sets:** The PSs in this class will provide opportunities to practice applying concepts covered in class, and they will also be used to cover material that is an extension of concepts covered in class or assigned reading. Questions from the PSs (including those that were not assigned) are fair game for the exams. Each question is worth **5 points**. You will receive: **5 points** for the complete and correct answer that *includes sound biochemical reasoning* that is clearly and effectively communicated; **3 points** for correctly approaching the problem, but getting the wrong answer or making a minor mistake in setting up the calculation or drawing a structure; **1 point** for attempting the problem but making little progress or making serious errors. **Your answers must be typed up and in your own words (see academic integrity statement below).**

**Exams:** The exams will be comprised of short answer and short essay questions. The questions will be drawn from lectures, in-class activities, problem sets and discussions, as well as relevant primary literature that you may not have been previously assigned. No make-up exams will be given. If you know in advance that you will miss an exam, please notify Prof. Liu at least one week ahead of time so that alternative arrangements can be made. If you miss an exam due to a documented health or family-related emergency, your other two exams will each count 25% of your total grade. **The final exam will be cumulative.**

**Grading Policy:** Any query regarding scores on graded assignments or exams should be presented within three days of return of the assignment/exam. It is the student's responsibility to meet with the professor to make any adjustments. Please note that Prof. Liu reserves the right to regrade the entire submission, and as a result, she may raise or lower your entire score. After three days, all scores become final and unalterable.

**Attendance:** Attendance in class is mandatory in an active learning environment. In addition to mastering the material yourself, you are responsible for assisting the other members of your team in their understanding of the material. You must not miss class. Please be respectful of Prof. Liu and your fellow classmates and show up to class on time. You can expect your grade to drop substantially with 3 or more absences. Valid reasons for missing class are serious illness, religious observations or family emergencies. **You are responsible for handing in all assignments on time and obtaining all activities, regardless of missed classes.**

**Late policy:** For all assignments (except exams), **late work will be accepted**. However, for every 24 hours that the assignment is tardy, a 10% deduction will be applied to your grade on that assignment.

**Laboratory:** The purpose of *doing* biochemistry is to gain experience in experimental methods that you'll be reading about throughout the semester. Attendance on your scheduled lab day is expected. In order to receive a passing grade in CHEM 115, you must receive a 70% or higher in CHEM 115L.

**Special circumstances:** If there are special circumstances, such as illness or other form of emergency, which should be taken into account with regard to any of the stated class policies, please inform Prof. Liu as soon as possible so that alternative arrangements can be made.

**Disability Accommodations:** Pomona College is committed to providing equal opportunity for participation in all programs, services and activities. Prof. Liu asks students who may need accommodations to assure their success to see the appropriate staff member in the Dean of Students Office and then come see her during office hours *before* the third week of class.

**Academic ethics and integrity policy:** You are expected to abide by the Pomona College Standards of Academic Honesty. For the official policy go to:

[http://catalog.pomona.edu/content.php?catoid=28&navoid=5638&hl=%22academic+integrity%22&returnto=search#academic\\_honesty](http://catalog.pomona.edu/content.php?catoid=28&navoid=5638&hl=%22academic+integrity%22&returnto=search#academic_honesty). Plagiarism, whether deliberate or unintentional, and cheating on examinations is not acceptable.

#### Schedule (Subject to Change):

Wk	(Lecture) Date	Topic	Assignments Due
1	(1) 9/3	<b>Get to Know the Players!</b> Introduction to Biochem; NCI, Thermodynamics	
	(2) 9/5	Water, Acids and Bases, Buffers	
2	(3) 9/10	Amino Acids and Peptide Bonds	
	(4) 9/12	Protein Folding	<b>PS 1 (9/13 - noon)</b>
3	(5) 9/17	Working with Proteins	
	(6) 9/19	Working with Proteins	

4	(7) 9/24 (8) 9/26	Hemoglobin Molecular Recognition	<b>PS 2</b> (9/27 - noon)
5	(9) 10/1 (10) 10/3	Enzyme Catalysis Enzyme Mechanisms; <b>Exam 1 OUT</b>	
6	(11) 10/8 (12) 10/10	Enzyme Inhibition I Enzyme Inhibition II	<b>Exam 1</b> (10/8 – 8:10 am)
7	(13) 10/15 (14) 10/17	Lipids and Membranes Membrane Transport	<b>PS 3</b> (10/18 - noon)
8	(15) 10/24	<i>Fall Recess</i> Model Protocell	
9	(16) 10/29 (17) 10/31	Model Protocell, Intro to Signal Transduction <b>See Them in Action!</b> Signal Transduction (GPCRs)	
10	(18) 11/5 (19) 11/7	Signal Transduction, Biosynthesis of Catecholamines Metabolism Overview	<b>PS 4</b> (11/8 - noon)
11	(20) 11/12 (21) 11/14	Glycolysis Regulation of Glycolysis and Gluconeogenesis <b>Exam 2 OUT</b>	
12	(22) 11/19 (23) 11/21	PDH / Citric Acid Cycle TCA for All?	<b>Exam 2</b> (11/19 – 8:10 am)
13	(24) 11/26	TCA for All? <i>Thanksgiving</i>	
14	(25) 12/3 (26) 12/5	Oxidative Phosphorylation <b>Applications to Modern Biochemistry</b> Drug Discovery	<b>PS 5</b> (12/4 – noon)
15	(27) 12/10	Quorum Sensing; <b>Final OUT</b>	<b>Final Due 12/18, 10 pm – Prof. Liu's Office</b>