

CHEM 181: Chemical Biology

Instructor

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

T 3:30-5 pm, W 1:00-2:30 pm; [or by appointment](#)

Class

MW 11:00 am – 12:15 pm

Prerequisite: CHEM115 PO (Biochemistry)

All times are PST/PDT unless otherwise stated.

A Message from Prof. Liu:

Welcome! [The Chemistry Department is committed to diversity and inclusion.](#) I want our classroom to be inclusive, equitable, and full of participation. As your instructor, I am committed to creating a classroom environment that welcomes and supports all students, regardless of race, gender, religious beliefs, etc. Regardless of where you're starting out, I am committed to helping you succeed in this class. I expect that your unique background will enrich our learning environment and I am excited to have you in this class. We all have implicit biases, and I will try to continually examine my judgments, words, and actions to keep my biases in check and treat everyone fairly. I hope that you will do the same and that you will let me know if there is anything I can do to make sure everyone is successful in this class. If there are any aspects of the instruction or design of the course that result in barriers to your learning, please let me know as soon as possible. If you do not feel comfortable approaching me directly, please feel free to reach out to one of the [Chemistry Department Liaisons](#).

It is common that college students experience a great deal of stress. In a class of this size, there will likely be a number of individuals who are going through hard times and who are experiencing psychological difficulties. If you are feeling miserable, or you think you are experiencing psychological problems, please do seek help! If you think you may benefit from psychological help, please reach out to Monsour Counseling and Psychological Services (MCAPS), 909-621-8202. For students living outside California, Monsour staff will provide a one-time consultation or crisis appointment. They will then work with out-of-state students to find a local clinician to provide regular care. Also note that Campus Health via the TimelyMD app will continue to be available for to all students. This service provides free and unlimited medical and mental health services. To register and access this service, please go to the [CAMPUS.HEALTH website](#) and use customized password/code POMONA2020.

Technological Needs and Considerations for An Online Course:

We will use Zoom extensively in this class. All materials for this course will be posted in [Sakai](#) in the form of Word documents, PDFs, PowerPoint files and websites. Live polling will require a web browser or a smart phone.

The primary means that Prof. Liu will communicate with the class is via email. You should expect several emails from her each week. Emailing Prof. Liu is a great way to communicate with her!

If you have any concerns about your ability to engage in this course, please do speak with Prof. Liu. She has ideas and alternatives in mind!! Pomona's ITS is available to help you! If you are having ANY issues getting a response from ITS, please let Prof. Liu know. She will advocate for your needs to be met.

To request a computer or WiFi hotspot: <https://www.pomona.edu/administration/its/sta>

Tips to resolve slow internet speed: <https://bit.ly/3jshiE4>

Support from ITS with various remote learning issues: <https://bit.ly/2OJEYpb>

ASPC's comprehensive guide to campus: <http://tinyurl.com/springresources>

Access software, files and journal articles on Pomona's network: <https://tinyurl.com/yxb4hslv>

Online student's manual for success: <https://bit.ly/3hgcYps>

COURSE OVERVIEW

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

- What is chemical biology?
- How can chemistry be used to advance the study of biological systems?
- How can chemists understand and control biological systems?
- What can chemical biology do to ethically and justly advance science and human health?

Some historians suggest that the roots of chemical biology lie in research conducted in the 19th century, which set the foundation for the fields of biology and chemistry. In addition, some scientists may also consider the deciphering of metabolic pathways, throughout the 20th century, representative of chemical biology. The journal *Nature Chemical Biology* defines chemical biology as a field that combines the scientific ideas and approaches of chemistry, biology and allied disciplines to understand and manipulate biological systems with molecular precision. In this course, we will consider this definition and explore examples of each of these views of chemical biology.

Engagement in this course will contribute to your ability to:

- Communicate effectively with others
- Problem solve
- Apply chemical knowledge to solve problems related to human health
- Work effectively with others
- Be an autonomous learner
- Process information and interpret data
- Think critically

INTENDED LEARNING OUTCOMES

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

- Articulate their personal responsibility – and those of their STEM colleagues – for eliminating injustice and creating more equitable outcomes in chemistry and biology
- Recognize, draw and analyze chemical structures of biomolecules
- Compare and contrast how biomolecules are synthesized by living cells and by scientists in the lab

- Explain, with examples, how chemistry can be used to advance molecular understanding of biological systems
- Explain, with examples, how chemists can manipulate or mimic biological systems to do chemistry
- Identify gaps in scientific knowledge by reading chemistry and biology primary literature

COURSE MATERIALS

All course materials will be posted onto the course Sakai site. It is your responsibility to make sure that you have the correct materials. Prof. Liu frequently communicates information regarding the course via email. You are expected to read these emails.

GRADES

<u>Final Grade Calculation</u>		<u>Grading Scale</u>			
Exams, 2 highest scores:	30%	A	93-100	C	73-76
Exam, lowest score:	10%	A-	90-92	C-	70-72
Participation:	10%	B+	87-89	D+	67-69
Figure Facts:	10%	B	83-86	D	63-66
Journal Clubs:	15%	B-	80-82	D-	60-62
Proposal:	25%	C+	77-79	F	≤59

Grading Policy: For most assignments, you will be provided rubrics beforehand that clearly lay out the expectations for the assignment and how you will be graded. 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 reach out to 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.

Exams: There will be three exams comprised of short answer and short essay questions. The questions will be drawn from lectures, in-class activities, journal club discussions, as well as relevant primary literature that you may not have been previously assigned. Your lowest exam grade will count as 10% of your final grade, and the other two exams will each count 15%. All three exams will be open notes, cumulative and take home. Exam due dates/times will be clearly communicated. 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 20% of your total grade.

Attendance: Attendance in class is important in an active learning environment. In addition to mastering the material yourself, you are responsible for assisting the other members of the class in their understanding of the material. Unless you have developed an alternative agreement with Prof. Liu, you should try to not miss class. Please be courteous to 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 include illness, religious observations or family emergencies. **You are responsible for handing in all assignments on time and obtaining all activities, regardless of missed classes.**

This course will make extensive use of primary literature. Different types of assignments are assigned to help you develop different skills related to primary literature.

Figure Facts: These assignments will allow you to focus on data-interpretation and the “take home points” of primary research articles. Each Figure Fact will be graded on a scale of 1-5, with the grading based on whether your answers contain sufficient detail and are written in your own words. Your lowest Figure Fact score of the semester will be dropped.

Journal Clubs: These assignments will allow you to practice summarizing the important points of a primary research article and critically evaluate a paper’s quality. You will engage with your classmates in discussions of the paper (both before and during class). In addition, you will be asked to write a short (**2-2.5 pages**) review describing the main findings of the paper and the implications of the research. Instructions for these reviews will be posted on Sakai. During the in-class sessions, small groups will be asked to present figures from the paper.

Grant Proposal Project: This assignment will allow you to engage, independently, with scientific literature and contribute to the field by proposing the next experimental step along a trajectory of scientific discovery. Throughout this course, you will be exposed to many innovative experimental approaches being developed and used by chemical biologists to address questions in biology and chemistry. Based on your experience with this material, each student will develop a novel research proposal that uses chemical biology to address a problem concerning human health in a developing country/region of the world (i.e. not the U.S. or Western Europe). Students will generate a single, testable question (or hypothesis) and write an **8-page** grant proposal to the National Institutes of Health (NIH). In addition to Prof. Liu’s evaluation of the proposal, all proposals will be reviewed during an in-class study section. **Rubrics will be provided.**

What is the human health problem you want to address? Week 3 (10 points)

Annotated bibliography of problem. Week 4 (15)

Meeting with Prof. Liu to discuss question / hypothesis. Week 6 (10)

Spring Break. Week 7

Annotated bibliography of question/hypothesis. Week 8 (25)

Specific Aims page. Week 9 (20)

Outline of paper. Week 10 (20)

Full draft. Week 13 (20)

Study Section. Week 14 (30)

Final Paper. Finals Week (100)

Due date extension policy: In general, Prof. Liu expects work to be turned in by the communicated due date, which were all decided with careful consideration of all of the assignments throughout the semester, along with assignments and exams in other courses that students are commonly cross-enrolled in. Learning to manage due dates and multiple responsibilities will also be helpful for future jobs and internships. However, Prof. Liu recognizes that the lives of students are *busy* and in life the only thing that one can really expect is the unexpected. The current state of the world and the realities of our far-from-normal learning environment are also likely to place you under increased pressures and disruptions. Thus, in this class, you each will have **three "Flex Tokens"**. Application of the Flex Token allows you to receive a no-questions-asked deadline extension. By the original due date, you should communicate your use of the Flex Token to Prof. Liu and together you can determine an alternate due date.

When Flex Tokens are not used, **late work will be accepted** for all assignments (except exams). However, for every 24 hours that the assignment is tardy, a 10% deduction will be applied to your grade on that assignment.

Special circumstances: If there are special circumstances, such as illness of 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: Your experience in this class is important to Prof. Liu. Pomona College is committed to making all courses accessible for everyone and **Prof. Liu is committed to making this particular course accessible to you**. If you need academic accommodations, please contact the Accessibility Resources and Services (ARS) in the Dean of Students office and visit the Accommodation Services page for more information about how the accommodation process.

Prof. Liu encourages you to come talk to her about your accommodations. As a Pomona faculty member, she is dedicated to supporting all students in her courses. Together you will develop strategies to meet both your needs and the requirements of the course.

If you have any questions about accommodations, please reach out to Accessibility Resources and Services (ARS) at disability@pomona.edu or 909-621-8017.

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](#). Plagiarism, whether deliberate or unintentional, and cheating on examinations is not acceptable.

You are encouraged to collaborate with other students on individual assignments in this course. However, each student must each turn in their own assignment. If you work on an assignment with others, write up your answer in your own words and acknowledge the assistance you received from others in your write up. It is important that you develop the ability to work independently as well as the ability to problem-solve with others. The goal is for you to learn how to collaborate with others and at the same time develop your own deep understanding of the course material.

The use of previously posted solutions in the preparation of your assignments is strictly prohibited. This includes referring to solutions associated with homework or exams turned in by a student in a previous version of the course or answers you find online.

COURSE TOPICS

In many ways, traditional enzymology and drug discovery fit the definition of chemical biology in that these fields use small molecules to modulate protein function. More recently, technological advances have allowed chemical biologist to employ both large libraries of small molecules and robust screens for biological activity to decipher complex biological systems. This approach benefits from both a firm grasp of synthetic chemistry and an understanding of molecular biology, representing a true intersection of the two fields.

Chemical biologists may also apply their knowledge of chemistry to design tools that advance the study of biology. Chemists have synthesized or engineered dyes, fluorescent proteins, and chemical probes in order to address an increasing desire to understand biology at a molecular level. In addition, chemists have applied fundamental principles of biology, such as evolution and self-replication, to achieve new chemistry. These are all purported examples of chemical biology that will be explored in this course, along with their implications to science and health, at large.

Schedule (*Subject to Change*):

Wk	(Lecture) Date	Topic	Proposal Assignments Due 12 pm (noon)
1	(1) 1/25 (2) 1/27	Structure, Chemistry and the Synthesis of Life Central Dogma; What is Chemical Biology? Bias, STEM and society; Proteins and protein folding	

2	(3) 2/1 (4) 2/3	Peptide sequencing Peptide identification	
3	(5) 2/8 (6) 2/10	Peptide synthesis Protein synthesis	2/12: Problem
4	(7) 2/15 (8) 2/17	Wrap up proteins; Natural product synthesis Natural product synthesis (NRPS)	2/19: Annot Biblio 1
5	(9) 2/22 (10) 2/24	Natural product synthesis (NRPS) Natural product synthesis (PKS); Exam 1 Handed Out	
Exam 1 Due – Feb 28, 5 pm			
6	(11) 3/1 (12) 3/3	Nucleic acids and DNA synthesis Journal Club 1	3/4 or 3/5: Meet with Prof. Liu
7	3/8-3/12	<i>Spring Break</i>	
The Molecular Biology Toolkit			
8	(13) 3/15 (14) 3/17	Grant Writing; DNA replication and cloning Overexpressing genes in <i>E. coli</i>	3/19: Annot Biblio 2
9	(15) 3/22 (16) 3/24	CRISPR CRISPR	3/26: Specific Aims
10	(17) 3/29 (18) 3/31	Reporter genes and small molecule screens Small molecule target ID	4/2: Outline
Solving Molecular Problems by Mimicking Biology			
11	(19) 4/5 (20) 4/7	Selections and screens Molecular evolution; Exam 2 Handed Out	
Exam 2 Due – Apr 11, 5 pm			
12	(21) 4/12 (22) 4/14	Molecular evolution Journal Club 2	
What Chemists Can Do for Biology			
13	(23) 4/19 (24) 4/21	Chemical Genetics Orthogonal chemistry	4/23: Full Draft for Study Section
14	(25) 4/26 (26) 4/28	Non-natural amino acids Study Section	
15	(27) 5/3 (28) 5/5	Journal Club Last Class; Exam 3 Handed Out, Due TBA	Final Paper Due: May 14