CHEMICAL BIOLOGY SYLLABUS

Course Offered: Spring 2020, T/Th 8:00-9:20 am
Enrollment Limit: 16
Instructors: John Hanson (Chemistry) & Bryan Thines (Biology)
PreReqs: CHEM 251 & BIOL 212 or 213 and permission of instructor

This course explores how modern chemical and biochemical strategies are used to interrogate and manipulate biological systems. The course will focus on selected, recent developments in the field as described in review articles and the primary literature. Themes include modifying and expanding the genetic code, screening and selection of chemical and biological libraries, directed evolution and rational design in the production of new protein activities, molecular imaging and probes for spatial and temporal localization of biological activity, modification of biological systems to produce new products or new activities, and design and use of novel molecular effectors of biological systems. In addition to examining the science of chemical biology, the course will also explore the commercialization of chemical biology and the background and influence of key individuals involved in developing this hybrid discipline. The course will emphasize process, with students directly engaging with primary sources, collaboratively analyzing and discussing information obtained from those sources, selecting and investigating topics in chemical biology that interest them, presenting the results of their investigations to their peers, and reflecting upon the scientific, commercial, and social impacts of modern chemical biology.

STUDENT LEARNING OUTCOMES

1) Understand the biological molecules, chemical systems, reaction mechanisms, and core cellular processes commonly utilized and manipulated by chemical biologists

2) Understand common methods and approaches that chemical biologists use to solve scientific problems and generate new knowledge

3) Critically read and assess primary literature in the field of chemical biology

4) Develop skills related to the communication and understanding of scientific knowledge and data across disciplines

5) Recognize the role that individuals and their diverse backgrounds play in influencing the development of the field of chemical biology

6) Appreciate how the field of chemical biology is uniquely positioned in lending itself to innovation in the biotech sector, and understand how a scientific discovery leads to product development in the biotech industry
OUTLINE OF CONTENT AND SCHEDULE OF WORK

Part I (Weeks 1 & 2): Review and Introduction to Foundational Concepts
Instructors and students will present short lectures that review important foundational chemical biology concepts essential to the understanding of literature they will be reading in the course.

- Structures and roles of biological molecules
- Relevant principles and examples of chemical and biochemical reactions
- Noncovalent interactions and binding
- Central dogma of molecular biology and core cellular processes
- Anatomy and physiology of cells
- Analytical techniques in chemical biology

Part II (Weeks 3-8): Faculty-Selected Topics in Chemical Biology
This part of the course will be defined by cycles of two class meetings. During the first meeting, students will be introduced to a particular topic through background and review reading prior to class followed by in-class discussion; in the second meeting students will discuss a paper from the primary research literature related to that same topic. During this part of the course students will also learn some of the intellectual and personal histories of key researchers in the field.

Week 3: Expanding the Genetic Code
  Key scientists: Peter Schultz & Steve Benner

Week 4: Bioluminescence, Molecular Imaging, and Biosensors
  Key scientists: Roger Tsien, Martin Chalfie, and Osamu Shimomura (2008 Nobel Prize winners), and Douglas Prasher

Week 5: Glycobiology and Bioorthogonal Chemistry: Carbohydrates, Click Chemistry, and Cancer
  Key scientists: Carolyn Bertozzi, Laura Kiesling

Week 6: Screening: Metagenomics and Small Molecule Discovery
  Key scientist: Steve Withers
Week 7: Directed Evolution vs. Enzyme Design  
**Key scientists:** Francis Arnold, George Smith, Gregory Winter (2018 Nobel Prize winners)  

Week 8: Altering targeted protein degradation in eukaryotic cells: PROTACs  
**Key scientist:** Craig Crews  

Part III (Weeks 9 & 10): The Business of Chemical Biology  
In this part of the course we will focus on examples of the commercialization of chemical biology by looking at a variety of chemical biology-based companies.

**How a Drug Company is Founded and Evolves**  
Vertex Pharmaceuticals (www.vrtx.com) - After reading excerpts from the two books by Barry Werth, students will participate in a discussion of issues involved in converting a scientific idea into a product.  

**Biotech Company Case Study Day**  
Students, working in pairs, will identify and research a startup company that is commercializing a chemical biology technique or chemical biology-based treatment. The pair will then present a 10 minute overview of the company briefly describing how it was founded, the science behind the company, and its commercial potential.

**Conversation with a Biotech Leader**  
Gary Ashley, Founder and Chief Scientific Officer of Prolynx (www.prolynxllc.com) will lecture to the class and answer questions about his experiences in chemical biology-based businesses.  

**Onsite Tour of a Biotech Company**  
Gilead Sciences, Inc., Seattle, WA (www.gilead.com)

Part IV (Weeks 11-14): Student-Selected Chemical Biology Articles  
In this part of the course (Weeks 11-14), pairs of students will select a chemical biology topic of interest to them, do background research on their topic, and select a recent journal article to serve as the basis for student-led class discussion.
ASSIGNMENTS AND ASSESSMENT

Weekly guided questions and reflective writing

Half of the overall graded workload in this course will be learning from and responding to assigned readings through relatively short written responses to pre-class guide questions and writing prompts assigned on a weekly basis during Parts II - IV. This written work will lead to a deeper understanding of the reading and prepare students to make contributions to in-class discussion. These regular pre-class guide questions and writing prompts will be designed to:

1) Help students identify and understand essential background concepts

2) Introduce students to research methodologies and promote critical thought surrounding experimental outcomes and data interpretation

3) Help students identify specific aspects of the readings that rely on interdisciplinary thinking and approaches

4) Encourage students to apply learned concepts to new situations

5) Promote student reflection on meta level issues, such as the intent and goals of the author(s)

6) Help students track their efforts, reflect, and identify areas for improving how they approach reading, writing, and thinking critically about the primary research literature

Assessment of this written and reflective work will be through a labor-based grading contract. In brief, students will start with a “B” grade for reasonably written responses to a minimum number of writing prompts; late and missed work will decrease this grade, while additional work will increase this grade. Students will have ample opportunity on a weekly basis to increase their grade by responding to additional writing prompts and/or by responding through writing to instructor comments on their previous work.

Assessment of this written and reflective work will be through a labor-based grading contract. In brief, students will start with a “B” grade for reasonably written responses to a minimum number of writing prompts; late and missed work will decrease this grade, while additional work will increase this grade. Students will have ample opportunity on a weekly basis to increase their grade by responding to additional writing prompts and/or by responding through writing to instructor comments on their previous work.


Company case study day

During Part III of the course, students, working in pairs, will identify and research a startup company that is commercializing a chemical biology technique or chemical biology-based treatment. The pair will then present a 10 minute overview of the company briefly describing how it was founded, the science behind the company, and its commercial potential.
Student led discussion

During Part IV of the course (Weeks 11-14), pairs of students will select a chemical biology topic of interest to them, do background research on this topic, and select a recent journal article to serve as the basis for class discussion. The students will present a short (~15 minute) presentation at the end of class on the day prior to the discussion to provide students with background information necessary to engage the research article, along with specific questions that students should explore in their reading of the article. Then they will lead an approximately 50 minute discussion on the paper.

Final proposal

As a final project, students will build on their work and experiences during the semester to write a short proposal in the field of chemical biology that will either: 1) identify a novel application of a chemical tool to a biological system, or 2) identify a new method or chemical tool that could potentially be developed based on preliminary published work. This short, single-spaced two-page (not including figures and references) proposal will contain essential background information, a clear description of methods, and a succinct discussion of predicted outcomes and their impact. This proposal will be written in stages during the second half of the semester and will rely on regular feedback from the instructors and structured peer-editing exercises with other students.

GRADING STRUCTURE

- 5% Initial review presentations
- 50% Weekly responses to guide questions and reflective writing
- 5% Company case study
- 15% Student led discussion of a research paper
- 15% Final proposal
- 10% Class participation

ACADEMIC INTEGRITY

Academic integrity is a core value in this course. Students in this course must abide by norms of academic honesty, which include avoiding plagiarism or otherwise appropriating others’ ideas or work without proper acknowledgement. Collaboration with peers is an important part of this course; academic integrity in this context means that you are an active and engaged participant who shares in the workload of the group and is reasonably available for meetings outside of class. In addition, you are expected to be attentive to and supportive of others during discussions and presentations, and to have done pre-class work so that you can contribute to those discussions.
CLASSROOM EMERGENCY RESPONSE GUIDANCE
Please review university emergency preparedness and response procedures posted at www.pugetsound.edu/emergency/. There is a link on the university home page. Familiarize yourself with hall exit doors and the designated gathering area for your class and laboratory buildings.

If building evacuation becomes necessary (e.g. earthquake), meet your instructor at the designated gathering area so she/he can account for your presence. Then wait for further instructions. Do not return to the building or classroom until advised by a university emergency response representative.

If confronted by an act of violence, be prepared to make quick decisions to protect your safety. Flee the area by running away from the source of danger if you can safely do so. If this is not possible, shelter in place by securing classroom or lab doors and windows, closing blinds, and turning off room lights. Lie on the floor out of sight and away from windows and doors. Place cell phones or pagers on vibrate so that you can receive messages quietly. Wait for further instructions.

OFFICE OF ACCESSIBILITY AND ACCOMMODATIONS
If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Peggy Perno, Director of the Office of Accessibility and Accommodations, 105 Howarth, 253.879.3395. She will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

STUDENT BEREAVEMENT
Upon approval from the Dean of Students' Office, students who experience a death in the family, including parent, grandparent, sibling, or persons living in the same household, are allowed three consecutive weekdays of excused absences, as negotiated with the Dean of Students’. For more information, please see the Academic Handbook.

COPYRIGHT AND FAIR USE
Course materials are subject to the copyright law of the United States (Title 17 U.S. Code). They are for educational purposes only and limited to students enrolled in the course. Further reproduction or distribution is prohibited.