Chem302: Chemical Biology (upper level elective)

Emily E. Weinert
Assistant Professor
Department of Chemistry
Emory University

The course is designed to introduce upper level students to an array of chemical biology techniques and teach them how to read and interpret scientific primary literature and develop hypotheses. Therefore, to adapt the class to focus on sustainability, I've chosen to incorporate examples from the primary literature that utilize each of the techniques that we cover but are broadly related to sustainability issues. As many of the students who take the class anticipate attending medical school and/or are are interested in biomedical research, I've chosen to use as many research articles as possible that involve aspects of both sustainability and human health. For instance, when discussing metabolic engineering, we will discuss a series of papers from the Keasling lab outlining the synthesis of an artemisinin precursor in yeast. Artemisin is an anti-malarial drug and was originally isolated from a medicinal herb, which is related to sustainability because of the need to alter land use requirements for plant growth an/or develop less resource-intensive ways to generate important drugs. Similarly, the topic of evolving enzymes will focus on developing new catalysts for biomass degradation, which is important for developing alternative carbon-neutral fuels and links to the health/societal issues related to climate change and habitat loss. Topics such as chemical genomics and small molecule target ID/validation will cover papers related to identifying the proteins and pathways targeted by man-made compounds released into the environment that have detrimental effects on human and environmental health. Throughout the class, I plan to include discussions related to the reasons driving the research in that we're discussing to introduce the students to the broader sustainability issues underpinning the broader research areas. The papers listed in the syllabus either directly relate to sustainability issues or provide information on a method that will allow for discussion of how the techniques can be applied to issues of sustainability.

Chemistry 302: Chemical Biology

Instructor: Emily Weinert
Email: emily.weinert@emory.edu
Office: 403 Emerson Hall
Office Hours: T/F 10-11am, by appt.

Prerequisites: Undergraduate biology and organic chemistry required, biochemistry recommended.

Course Description

This course builds on principles developed in Chem 301 and will discuss advanced topics in chemical biology. Subject matter will be approached using case studies highlighting techniques that allow us to gain a chemical understanding of biological processes. Examples include identification of drug binding sites, probing protein-protein interactions, targeting protein degradation, and modulating transcription. Important advances in our understanding of biological systems brought about by these techniques will also be discussed. Discussion of primary literature readings will include benefits/drawbacks of the various techniques, complementarity of methods, and the applicability of various aspects of chemical biology to dissect new problems. In addition, we will discuss the broader aspects of the advances, including the implications for human health and the environment. The links between chemical biology and all aspects of sustainability will be an overarching theme in the course, with discussions about the benefits of cutting edge research and technique development to improving sustainability and helping the environment, as well as potential environmental issues.

Course Materials

The required textbook is:

- *Chemical Biology: Learning through Case Studies* by Herbert Waldmann and Petra Janning (Wiley-VCH).

In addition, you will be assigned papers from the primary literature to expand on the various topics. A basic biochemistry textbook may also be helpful as a reference. You are expected to read the assigned chapter and other papers before class so that we can discuss the topic. Reading assignments will be provided for 2-3 weeks in advance and will be updated on Blackboard throughout the semester.

Course Assignments & Assessments

Assignments and other course materials (classroom PowerPoints, supplemental materials, etc) will be posted regularly to Blackboard. Please use this site to exchange interesting papers or comments.

Homework: Problem sets will be given out regularly and will cement some of the concepts you learn in class and help you prepare for the exam. They will be due one week after they are assigned.

In class exercises, literature discussions, and participation: In class exercises will be assigned throughout the semester. Participation in these exercises and in class discussions of assigned literature articles is required.

Proposal & presentation: You will be asked to prepare a short proposal and a presentation describing your proposal.

Examinations: There will be one exam. The dates for the exams have been tentatively scheduled (see below). If the date changes, you will be notified one week in advance. The material covered will depend on what we have studied in class.

Course Policies

Course Grade: Your grade in this course will be based on the following components:

Homework	15%

In class exercises & participation	15%
Proposal *(Written component and oral component)*	35%
Midterm (3/2) and Final (4/28-5/8) Exams	35%

Attendance: Attendance during regular class time is expected. It is to your advantage to attend our scheduled class meetings since material that you might have difficulty with may be clarified. Keep in mind that there is a class participation/contribution component to the final grade you will receive in the course. In addition, please note that at times you will be assigned work to be completed in class. If you have an unexcused absence you will receive a grade of zero for that day's assignment(s).

Late work: Assignments not submitted by the date and time indicated will be considered late unless arrangements are made in advance. There will be a penalty for late work.

Examination policies: Exams are administered under the guidelines of the Emory College Honor Code. During exams, all electronic devices should be completely powered down so that there is no possibility of receiving assistance from outside, including text messages and email.

Makeup examinations are not given after missed examinations. If you must be absent from class during an examination period for an approved Emory University activity or religious holiday, please notify Professor Weinert at least one week in advance. It may be possible to take an exam earlier than the regularly scheduled time; under no circumstances will you be allowed to take an exam after the scheduled time. If you miss the midterm exam due to a valid, documented excuse (hospitalization, etc.), the midterm will not factor into your final grade determination (i.e. your final grade will be determined as a percentage of 800 pts instead of 1000 pts).

An excused absence from the final examination requires the prior approval of the Emory College Dean before a grade of incomplete can be awarded. In this case, the final exam will be taken at a mutually agreeable time, but preferably at the earliest possible opportunity.

If you are registered with the Office of Disability Services (ODS), please submit the documentation letter to Professor Weinert during the first week of the semester, so that appropriate accommodations can be made.

Regrade policy: To request a regrade, submit the exam and a written request to Professor Weinert no later than the end of the class period following the period that the exams were returned (i.e., if the exam is returned on a Tuesday, a regrade must be submitted by the end of class on Thursday of that week). Under no circumstances should you write on your exam after it is returned if you intend on submitting a regrade request.

If you submit an exam for a regrade, I will review the exam in its entirety. There is a potential that other grading errors discovered during my review may cause you to gain or lose points.

Please note: Exams will be photocopied randomly prior to grading and any alterations made to answers will be sent to the Emory University Honor Council immediately.

Extra credit policy: Extra credit questions may appear on exams occasionally. However, under no circumstances will extra credit assignments be given on request (i.e., to improve an individual student's grade).

Honor Code: You are expected to conduct yourselves as per the terms of the Emory University Code of Academic Ethics. Any cheating (including plagiarism) will be punished as severely as allowed under University guidelines. Please review the college's Honor Code at www.college.emory.edu/current/standards/honor_code.html

Topics and Schedule: We will cover the following topics over the course of the semester. Detailed weekly reading and assignment lists will be distributed to the class.

Topic

1. Reengineering Native Systems
    a. Directed Evolution
    b. Metabolic Engineering
2. Controlling Protein Activity
    a. Optogenetics
    b. Modulating Protein-Protein Interactions
    c. Targeted Protein Degradation
3. Identifying Novel Proteins and Pathways
    a. Chemical Genomics
    b. Analog Sensitive Proteins
    c. Photoaffinity labeling
    d. Activity-Based Protein Profiling
4. Elucidating/Controlling Molecular Interactions
    a. Microarray-Based Strategies to Identify Protein Interactions
    b. Small Molecule Target Identification and Validation
    c. Introduction of Chemical Reporter Groups

Representative Sustainability-Related Chemical Biology Articles

1. Pardon, *et al.* High-level semi-synthetic production of the potent anti-malarial artemisin. *Nature* **2013**, *496*, 528-32.
2. Badran, *et al.* Continuous Evolution of the *B. thuringiensis* Toxins Overcomes Bt Resistance in Insects. *Nature* **2016**, *533*, 58-63.
3. Larue, *et al.* Directed evolution of a fungal β-glucosidase in *Saccharomyces cerevisiae. Biotech. Biofuels* **2016**, *9,* 52.
4. Ryan, *et al*. Cell-cell signal-dependent dynamic interactions between HD-GYP and GGDEF domain proteins mediate virulence in *Xanthomonas campestris. Proc. Natl. Acad. Sci. U.S.A.* **2010**, *107*, 5989-5994.
5. Ha, *et al.* Positive regulatory role of strigolactone in plant responses to drought and salt stress. *Proc. Natl. Acad. Sci. U.S.A.* **2014**, *111*, 851-856.
6. Park, *et al.* Abscisic acid inhibits type 2C protein phosphatases via the PYR/PYL family of START proteins. *Science* **2009**, *324*, 1068-1071.
7. Salomon, *et al*. A chemical-genetic approach for functional analysis of plant protein kinases. *Plant Sig. Behav.* **2009**, *4*, 645-647.