Course Outline: Chem 556 Synthetic Biochemistry

Course Description: Compares and contrasts cell-based and cell-free approaches to making and engineering commodity small molecules and genetically-encoded biopolymers using naturally-existing or biologically-inspired enzymes. Both templated and non-templated synthetic systems will be explored. Includes biofuels production, drug discovery, protein engineering, and structural biophysics.Prerequisites: CHEM 341 or 351, CHEM 201 (or equivalent), and CHEM 401 or equivalent.

Students will be responsible for delivering presentations on topics selected from the literature and generating novel research proposal ideas. The proposals will be evaluated for creativity, feasibility, and impact. Recent discoveries and applications from both the scientific literature and industry will be featured throughout the course.

Course Learning Outcomes

- Describe the major pathways by which biological systems make and evolve small molecules and biopolymers.
- Examine how scientists have begun to harness and adapt these natural biosynthetic pathways for the production of designer molecules *in vivo* (e.g. synthetic or chemical biology).
- Examine how scientists have begun to harness and adapt these natural biosynthetic pathways for the production of designer molecules *in vitro*.
- Describe the advantages, limitations, and complementary nature of the *in vitro* and *in vivo* approaches mentioned above.
- Describe the different applications for which templated (i.e. genetically-encoded) and non-templated synthetic biochemistry tools are most well suited.
- Recognize the challenges involved in efforts aimed at designing artificial minimalistic cells and organisms.

Text: A collection of research articles and excerpts from selected texts will be made available in the form of a course reader. The following textbooks will also be made available to the class by the instructor:

- Introduction to Bioorganic Chemistry and Chemical Biology, by David Van Vranken and Gregory A. Weiss, *Garland Science*, 2012

Attendance: This course is discussion-based and relies heavily on the use of class notes for quizzes rather than texts. For these reasons, attendance is essential to do well in the class.

Examination: An open notes essay- and problem-based final exam will be given.

Quizzes: Eight quizzes are anticipated for the semester. The 15-minutes quizzes will be based on readings and class notes since the last quiz. Goals in this course include the ability to discuss important aspects of study in natural products biosynthesis and to have a good set of notes to take with you.

Grading: The course will be graded based on the following criteria

Presentation & Discussion	200 points	
Quizzes	120	(8 quizzes x 15 points each)
Participation	40	
Final Exam	100	
Total Possible Points	460	

Topics:

Week 1-3	Using aptamers to control transcription and translation; Chemical synthesis of proteins; Incorporating unnatural amino acids into proteins *in vitro* and *in vivo*; Directed evolution of enzymes;
Week 4-5	The combinatorial nature of DNA and RNA
Week 6-8	Biosynthesis of Natural Products; Combinatorial and diversity-oriented synthesis; Chemical genetics; Small molecule/ drug discovery; Small-molecule target identification; Drug mechanism; Drug design
Week 9-10	Chemical control of signal transduction in various applications
Week 11	Glycobiology
Week 12-14	Student Presentations
Week 15	Review

Presentation

Part 1: Oral. Students will choose from a list of topics to study in more detail and present to the class. Students will choose one paper that would be a good introduction to the topic for classmates. Paper will be submitted to instructor at least 3 class sessions before scheduled oral presentation. The paper will be distributed to the class one week before the discussion. Students will prepare 3-5 thought-provoking questions for the class to incorporate into the presentation.

Part 2: Written. A 5-6 page paper (1.5 – double spaced, 12 pt. font, ¾" – 1" margins) is due within two weeks of oral presentation. Five points per day will be deducted for late papers. The paper should be written as a review of your topics, complete with abstract.