CSE 488 Laboratory Methods in Synthetic Biology

Credits
4.0 (1 hr lecture, 3 hr lab)

Lead Instructor
Georg Seelig

Textbook
Nelson and Cox, Principles of Biochemistry, 4th Edition, Freeman, 2004.
Micklos, Freyer and Crothy, DNA Science Cold Spring Harbor Laboratory Press, 2003.

Course Description
Designs and builds transgenic bacterial using promoters and genes taken from a variety of organisms. Uses construction techniques including recombination, gene synthesis, and gene extraction. Evaluates designs using sequencing, fluorescence assays, enzyme activity assays, and single cell studies using time-lapse microscopy.

Prerequisites
either BIOEN 401, BIOEN 423,E E 423, or CSE 486

CE Major Status
Selected Elective

Course Objectives

At the end of this course students will be able to:

1. Culture bacteria.
2. Manipulate DNA with restriction, ligation, PCR and gel electrophoresis.
3. Transform bacteria with recombinant DNA and screen for successful transformants.
4. Design genetic regulatory networks at the level of the DNA sequence.
5. Extract DNA from cells and prepare it for sequencing.
6. Perform fluorescence and growth assays with a fluorescence plate reader.
7. Use a fluorescence microscope to capture single cell behavior in time.
8. Analyze experimental data and fit it to mathematical models.
9. Understand the risks and ethical considerations of synthetic biology.

ABET Outcomes

(a) An ability to apply knowledge of mathematics, science, and engineering to the design of biochemical networks for specific applications.
(b) An ability to design and conduct experiments, as well as to analyze and interpret data
(c) An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
(d) An ability to function on multi-disciplinary teams.
(f) An understanding of professional and ethical responsibilities related to introducing new genetic material into the ecosystem.
(h) The broad education necessary to understand the impact of engineering biological solutions in a global, economic, environmental and societal context.
(j) Knowledge of contemporary issues in genetic engineering, gene therapy, biofuels and energy, medicine and disease.
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Course Topics

1. The applications, risks and ethics of synthetic biology
2. Lab safety
3. Basic lab techniques including pipetting and sterile technique
4. Bacterial cultures and growth curves
5. Design of experiments and controls
6. Extraction of plasmid DNA from E. coli
7. Recombinant DNA techniques include restriction digests, gel purification, ligation, and PCR based methods
8. Sequencing for the purposes of debugging constructs
9. Fluorescence reporters and methods for measuring cell activity using fluorescence
10. Time lapse fluorescence microscopy
11. The application of differential equations and stochastic processes to predicting the behavior of synthetic biochemical networks
12. Parameter estimation and system identification