Genetic Circuits (SSB-811) CHR (3-0)

Educational Objectives:

For synthetic biologists to engineer cells that can make complex chemicals or perform complex functions, they must be able to tell the cell which genes to turn on and at what time. To do this they will be taught to build genetic circuits composed of a series of gates that respond to a specific input with a specific output. In addition, they will develop software that lets users arrange the gates to form a circuit of their choice. These software provides DNA sequence encoding the genetic circuits, and the DNA can be synthesized and inserted into a cell.

Course Outcomes:

This course provides clear and direct methods to implement Design-Build-Test-Learn (DBTL) into synthetic biology research. Students will be able to:

- Model and simulate biological systems, redesign biological systems, set up an automated biolaboratory, step-by-step guide on how to perform computer aided design, RNA sequencing, microfluidics -using bacterial cell free extracts, live mammalian cells, computational and experimental procedures, metabolic burden, computational techniques to predict such burden from models, and how DNA parts can be engineered in mammalian cells to sense, and respond to, and intracellular signals in general.

Course Contents:

- Oscillators
- Repressilator
- Mammalian tunable synthetic oscillator
- Bacterial tunable synthetic oscillator
- Coupled bacterial oscillator
- Globally coupled bacterial oscillator
- Bistable switches
- Toggle-switch
- **Logical operators**
- **Analog tuners**
- **Controllers of gene expression heterogeneity**

- **Other engineered systems**
- Pulse-controlled gene cascade
- Application of logic elements enables genetic "programming" of cells
- Circuit Design

Recommended Books:

- Engineering Genetic Circuits (Chapman & Hall/CRC Computational Biology Series) 1st Edition
- Synthetic Gene Circuits: Methods and Protocols (Springer US)
- Journals and other published material.