Bioengineering 499: Systems and Synthetic Biology
Spring Quarter 2007, University of Washington, Syllabus
Draft 1.1

Objective

An introduction to systems and synthetic biology, including computational and experimental approaches.

Instructor

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Prerequisites and Recommended Background

Matlab programming or other programming experience, basic mathematics (differential equations and matrix algebra) and cell and molecular biology. BIOEN 485 (Computational Bioengineering) provides a good foundation for this class.

Class Schedule and Meeting Times

First Class: March 27th
Last Class: May 31st

Class Schedule: Tuesdays and Thursdays, 11am to 12.20 pm
Class Room: Computer Room N140 in Bioengineering

Office Hours:

Topics

Building differential equation and stochastic models
Network motifs and their properties (feedback and feed-forward loops)
Building oscillators, switches and other devices
Engineering new networks in vivo
Applications, technologies and ethics of synthetic biology
Perturbation analysis and stoichiometry
Literature survey

Course Material Web Site

Web Site:

`http://www.sys-bio.org/sbwWiki/doku.php?id=uw:bioeng_synthetic_biology_class`

Workload and Grading

Weekly Assignments (no more than three hours per week)	20 %
Practicals (Part of weekly assignments)	20 %
Student Talks	35 %
Term Paper	25 %

Goal

An introduction to an exciting new research and application area in bioengineering.

Course Details

Week 1 (Introductory Material)

a) Introduction to systems and synthetic biology,
relevance to pure and applied research, case studies, iGEM
b) ODE based reaction models and solving for steady and transient states
c) Stochastic models (PRACTICAL)

Week 2 (Rate Processes)

a) Raw laws, recap mass-action and aggregate rate laws
b) Complex Rate laws - deriving gene expression rate laws.
c) Elasticities and Lin-Log Approximations

Week 3 (Stoichiometric Properties)

a) Stoichiometry
b) Conservation laws
c) Flux Laws

Week 4 (Control of Pathways)

a) Control of pathways (Basic Properties)
b) Control of pathways (Theorems)
c) Control of pathways (Frequency Response)

Week 5 (Synthetic Networks)

a) Building synthetic networks
b) Monitoring outputs (GFP, FACS, FlAsH, ReAsH and Riboswitches)
c) Single cell and population studies (PRACTICAL))

Week 6 (Synthetic Networks and Motifs)

a) Simulating synthetic networks (PRACTICAL), its a noisy world
b) Introduction to complex networks, the concept of network motifs
c) Cooperativity and covalent modification cycles.

Week 7 (Motifs)

a) Feedforward and feedback regulation
b) Control properties of regulated systems
c) Bistable and oscillating systems, theory and experiment

Week 8 (Motifs)

a) Bistable and oscillating systems, theory and experiment
b) Bistable and oscillating systems (PRACTICAL)
c) Signal Filters, homeostasis, amplifiers and computational circuits.

Week 9 and 10: Student contributions, reviewing research papers on applications, research, technologies and ethics.