BCB 715 – Modeling signaling and regulatory networks

Instructor: Timothy Elston
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Class Location/Time: 3074 Bondurant Hall/TTH 11:00 - 12:15 (March 26-April 25)
Office Hours: 1:00-2:30 Friday (or by appointment)

The course will use the Sakai system as the primary mode of communication: https://sakai.unc.edu/portal

TA: Kyla Lutz
Email: lutzka@email.unc.edu
Email homework to Kyla.

Target Audience

This course is targeted toward first year students in Biological and Biomedical Sciences Program who plan to participate in the Curriculum in Bioinformatics and Computational Biology and/or the Graduate Training Program in Molecular and Cellular Biophysics.

Course Prerequisites

There are no formal prerequisites for the class. However, students are expected to have taken calculus as an undergraduate and be comfortable with computer programming.

Description and Course Goals

The course will provide an introduction to the basic mathematical techniques used to develop and analyze models of signaling pathways and regulatory networks. Both deterministic and stochastic models will be discussed. The numerical techniques covered in the class will include methods for solving ordinary differential equations and Monte Carlo methods. If time permits, the diffusion equation also will be considered. Homework assignments will be completed using MATLAB. No experience using MATLAB is assumed. Particular emphasis will be placed on feedback and feed-forward control mechanism used to regulate biochemical pathways. The course will be self-contained, with all the necessary biology and mathematics covered in class. Upon completion of the course, students will have a working knowledge of MATLAB and be able to construct and simulate mathematical models of signaling pathways and regulatory networks.

Tentative Course Schedule:

- Introduction to MATLAB and the logistic map (March 26, 28)
- Simple regulatory motifs and ordinary differential equations (March 28, April 2)

- Chemical kinetic equations with applications to Michaelis-Menten kinetics and cooperativity (April 4, 9)
- Feedback control mechanisms, signal-response curves, and oscillations (April 9, 11, 16)
- Introduction to stochastic processes and diffusion
- Stochastic Modeling with applications to gene regulation (April 16,18, 23)
- Diffusion and spatial models (April 25)

Due Dates for Homework

- Homework 1 – Due Tuesday, April 2
- Homework 2 – Due Tuesday, April 9
- Homework 3 – Due Tuesday, April 16
- Homework 4 – Due Tuesday, April 23
- Homework 5 – Due Tuesday, April 30

Method of Evaluation

Grades will be based on students' performance on weekly homework assignments. All homework assignments involve programming in MatLab. Completed homework assignments will be emailed to the TA for class who will verify programming tasks have been successfully completed. If the assignment is not successfully completed, the student is expected to meet with the TA or myself to understand where mistakes were made and revise and resubmit the homework. To receive a passing grade, students must satisfactorily complete all the homework assignments. Participation in class room discussions is always encouraged, but not required.

Course Policies

Students are expected to attend all classes and complete homework assignments on time. Students are permitted to discuss the homework problems, but all programming must be done individually.

Suggested Texts

1. *Mastering MATLAB7*. D Hanselman and B. Littlefield, Prentice Hall (2004)
2. *Computational Cell Biology*. Editors C. Fall, E. Marland, J. Wagner, and J.Tyson, Springer Verlag (2002)
3. *Nonlinear Dynamics and Chaos*. S. Strogatz, Wesview Press (1994).
4. *An Introduction to Systems Biology: Design Principles of Biological Circuits.* Uri Alon, Chapman and Hall/CRC (2006).

The instructor reserves the right to make changes to class schedule and due dates for homework assignments.