BCB 715 – Modeling signaling pathways and gene regulatory networks

Instructor: Timothy Elston
Office: 11010B Mary Ellen Jones
Phone: 843-7670
Email: telston@med.unc.edu
Class Location: 6004 Marsico Hall
Class Time: Tuesday-Thursday, 11:00-12:15 (September 28 – October 31)
Office Hours: 2:00-3:00 Friday or by appointment.

The course will use the Canvas system as the primary mode of communication: https://edtech.unc.edu/service/canvas/

TA: Matthew Sutcliffe
Email: matthew_sutcliffe@med.unc.edu

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, spatial models 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:

- Overview and introduction to MATLAB (September 28)
- Difference equations and the logistic map (October 3)
- Simple regulatory motifs and ordinary differential equations (October 5 and 10)

- Chemical kinetic equations with applications to Michaelis-Menten kinetics and cooperativity (October 12)
- Feedback control mechanisms, signal-response curves, and oscillations (October 17 and 24)
- Stochastic Modeling with applications to gene regulation (October 27)
- TBD (October 31)

Due Dates for Homework

- Homework 1 – Due Tuesday, October 10
- Homework 2 – Due Tuesday, October 17
- Homework 3 – Due Tuesday, October 24
- Homework 4 – Due Tuesday, October 31
- Homework 5 – Due Tuesday, November 7

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 submitted to the TA for the 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 instructor 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.

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 MATLAB.* D Hanselman and B. Littlefield, Prentice Hall (2011)
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.