Biological Modeling

Biology 610 – Winter 2016

Instructor: Dr. Patrick Phillips, Pacific 316, 346-0916, pphil@uoregon.edu
Office Hours - Wed 1:00-2:00 or by appointment

Schedule: MW 10:00-11:20, Columbia 142

Textbook: Otto & Day, *A Biologists Guide to Mathematical Modeling.* Princeton Univ. Press
Book Website: http://www.zoology.ubc.ca/biomath/index.htm

Software: *Mathematica* v. 10.3.1.0 (Wolfram Industries)
Download: https://it.uoregon.edu/software/mathematica

Description: This course addresses the fundamental approaches used to create and analyze theoretical models of biological processes. This includes the logical structure of constructing useful models and understanding model dynamics and stability. The primary course goal is to empower students to be able to read and understand the basic approach and results of any theoretical paper within the biological sciences. Real examples draw heavily from ecology, evolution, and genetics.

Expected learning outcomes: Students will use advanced equation processing software (*Mathematica*) to construct and analyze models. Students will learn how to use this software to analyze models, including producing graphs of model outcomes. Students will receive a refresher on essential mathematical techniques (especially calculus) and build upon this knowledge so that they can fully analyze difference and differential equations describing dynamical biological systems. Students will also gain an understanding of probability distributions, estimation and stochastic models.

Expected student workload: In addition to class attendance, students will spend a significant time outside of class reading background material, learning how to use the analysis software and completing weekly homework assignments.

Homework: There will be weekly homework assignments that are central to learning the material of the course. Students are encouraged to work together in solving these problems, but every student must turn in their own work. Students must turn in all assignments to pass the course.

Final project: The final project, due March 16, is to fully review and analyze a paper or set of papers that examine a relevant biological topic using a theoretical/modeling approach. The intent will be to rederive the results of the paper, fully analyze the equations presented, and to interpret (or re-interpret the results). The final report will be in the form of a five or so page written discussion of your findings. It is obviously essential that you choose an interesting/appropriate paper for this assignment, so you should check with Patrick before proceeding.

Grading: The course grade will be determined by performance on the homework assignments (65%), the final project (25%), and class participation (10%).

Lecture Schedule

Week 1: Recursion and differential equations (Chapters 1 & 2)
Week 2: Basic models from population biology and population genetics (Chapter 3)
Week 3: Taylor series and solving differential equations (Chapters 3 & 4, Appendix 2)
Week 4: Stability and equilibria (Chapters 4 & 5)
Week 5: Probability distributions (Primer 3)
Week 6: Estimation: Maximum likelihood and Baysian analysis (Primer 3)
Week 7: Matrix operations: Functions of multiple variables (Primer 2)
Week 8: Matrix structure (Chapter 7)
Week 9: Systems of linear equations (Chapter 7)
Week 10: Stochastic processes (Chapters 13 & 14)