UBC Mathematics 361, Fall 2016
Introduction to Mathematical Biology

Course Website

http://www.math.ubc.ca/∼yxli/m361/m361_16.html

Text

Strogatz, Steven H. *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering*, Westview Press, 1994.

Brief introduction

Mathematical Biology has become a vast area of research that includes numerous subareas and disciplines. The present course is aimed at introducing some fundamental concepts in understanding the formation of some biological patterns ubiquitously observed in nature. To make such an understanding possible, an introductory level of mathematical and computational skills that are necessary in the analysis of pattern formation in linear and nonlinear dynamical systems will be covered. Examples introduced range from molecular biology, cell biology, physiology to ecology and evolutionary biology.

Prerequisites

Differential and Integral Calculus (Math 100 and 101 or equivalents). Elementary ordinary differential equations (One of Math 215, 255, 256, 265, or BIOL 301 or equivalents).

Course schedule (preliminary and subject to changes as the course proceeds):

1 Introduction to mathematical biology and pattern formation

- Brief overview of mathematical biology and modelling
- Mathematics of biological pattern formation
- Some examples of temporal, spatial, and spatio-temporal patterns in biology
- Mechanisms governing spontaneous pattern formation.

2 Simple models in discrete time

- Linear systems: Exponential growth/decay of a single species.
- Evolution without selection: Hardy-Weinberg Model
- Evolution with selection.
- Nonlinear systems: Logistic map. Fixed points and cobwebing. Linear stability.
- Demography described in age-structured models.

3 Simple models in continuous time

- Linear systems. Exponential growth/decay of a single species.
- A model of a simple molecular switch.
- Nonlinear systems. Logistic model of a single species.
- Phase space: a geometric way of thinking. Fixed points and linear stability.
- Bifurcations in one-dimensional nonlinear differential equations.
- Introduction to XPP and numerical solutions to differential equations.
- A nonlinear model of spruce budworm population.

4 Models involving two interacting components

- Michaelis-Menten model of enzyme-catalyzed biochemical reactions. Multiple times scales.
- A model for two competing species. Steady states and stability. Phase-plane analysis.
- A model for predator-prey systems. More about XPP.
- A model for enzyme-catalyzed oscillations observed in glycolysis.
- A model for neuronal excitability. More about XPP and AUTO.

(Total time $\approx$ 36 hrs.) (Yue-Xian Li, September 2016)