UBC Mathematics 361, Fall 2014
Introduction to Mathematical Biology

Course Website

http://www.math.ubc.ca/~yxli/m361_14.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 intensive research that includes numerous subareas and disciplines. Such a course can be taught in so many different possible ways that one often finds it hard to recognize that they can be given under the same course name. 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 nonlinear dynamical systems is also covered.

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 may be changed without notice):

1 Introduction to Mathematical Biology and Pattern Formation

- What makes life and artifacts different from other natural objects?
- Spontaneous self-construction, reproductive invariance, and teleonomy.
- Life based on known first principles.
- Mechanisms governing spontaneous pattern formation.
- Some examples of temporal, spatial, and spatio-temporal biological patterns.

2 Models in one-dimensional differential equations

- Linear equations. Exponential growth/decay of the population of a single species. A model of a simple molecular switch.
- Nonlinear equations. 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.

3 Models in discrete-time maps/difference equations

- Logistic map. Fixed points and cobwebs. Linear stability.
- Age-structured models and two-dimensional maps.

4 Models in two-dimensional differential equations

- Michaelis-Menten kinetics of enzyme-catalized biochemical reactions. Multiple times scales.
- A model for two competing species. Steady states and stability. Phaseplane analysis.
- A model for predator-prey systems. More about XPP.
- A model for enzyme-catalized glycolitic oscillations.
- A model for neuronal excitability. More about XPP and AUTO.

5 * An introduction to LaTeX - a scientific type-writing software

May or may not be taught depending on the schedule.

(Total time $\approx$ 36 hrs.) (Yue-Xian Li, September 2014)