Computers in Medicine and Biology, Spring 2018
MATH-UA 256-001, BIOL-UA 256-001
SYLLABUS

A case study approach will be followed to cover a variety of topics in infectious diseases, cell growth, dynamics of neuronal systems, hormone regulation and metabolism, … Classroom sessions will involve mixed lecture and interactive model development/computer simulation format. There is typically one recitation section per week with a Teaching Assistant. There will be homework assignments (generally involving computer simulations) and a term project. For computer simulations students will learn and use Matlab.

Instructor: John Rinzel, rinzeljm@gmail.com, CNS – Rm 755, Courant – Rm 919
Classroom lecture: Tuesday & Thursday, 2:00-3:15pm, CIWW Rm 705 (not Rm 230).
Recitation section: Thursday, 8 - 9:15 AM, Rm 705.


1. Population dynamics. Discrete time, discrete age/stage classes (weeks: 1-2)
   a. Malthusian growth
   b. Age/class structure – Leslie matrix
   c. Logistic growth
   d. Introduction to continuous time (ODE) models: Malthusian & logistic

2. Infectious diseases. (weeks: 3-5)
   a. One time epidemic, SIR model
   b. Endemic disease, SIS model
   c. SIR model, with birth/death; cyclic recurrence.
   d. * Sexually transmitted diseases
      i. Gonorrhea and the “core group”
      ii. HIV, immune system dynamics

3. Dynamics of neuronal systems. (weeks: 6-9)
   a. Background – neurophysiology
   b. The Hodgkin-Huxley model for action potential
   c. Reduced “HH-like” model; excitability in the phase plane
   d. Idealized network models: neuronal interactions, synchronization and rhythms
   e. Network models for perceptual bistability (eg, the Necker cube)

4. Hormonal regulation and metabolism. (weeks: 10-12)
   a. Overview – glucose regulation, pulsatile insulin secretion
   b. Calcium oscillations in secretory cells
   c. Tissue/organ glucose-insulin oscillations
   d. * Energy balance and metabolism
   e. Simple model for a weight control strategy

5. Cellular dynamics. (weeks: 13-…)
   a. Cell division and growth
   b. Gene regulatory networks: switches and clocks
   c. The cell cycle, molecular dynamics
   d. * Circadian rhythms

* Will be covered, if time permits.

Grading:
~ 50% Homeworks. 5-6 HWs: equally weighted
~ 40% Project
~ 10% Quizzes & Class participation