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.

Text: Ellner SP, Guckenheimer J: Dynamic Models in Biology. Princeton University Press, 2006

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