

## Math/Bio 497A Modelling in Medicine and Biology

**When and Where:** Monday, Wednesday, Friday, 4:40-5:30 pm, 312 Boucke. We may occasionally move lecture to a different room if we need particular computing resources.

**Instructor:** Timothy Reluga

**Office:** 424 McAllister Hall (but I'll soon be moving to 210 McAllister)

**Email:** treluga@psu.edu

**Prerequisite:** Calculus (Math 141) and sophomore-level biology.

**Textbook:** *Dynamic Models in Biology* by Stephen Ellner and John Guckenheimer. I will also make use of *Mathematical Physiology*, volumes 1 and 2, by James Keener and James Sneyd.

**Course web page:** <http://www.math.psu.edu/treluga/497A>

**Office Hours:** 4 - 5pm Tuesday, and by appointment.

**Modelling Software:** We will make use of a modelling program called COPASI in this course. COPASI is open-source, and freely available for all major OS's at <http://www.copasi.org/> We may also make use of python, netlogo, matlab, or other programming environments as need arises.

**Homework:** Homework will be assigned weekly, and collected 7 days later.

**Projects:** Each student will be expected to complete a research-and-modelling project. Project topics should involve the modelling of a biological system, along with a review of recent scientific research concerning this system. Project work will consist of an oral presentations, and a peer reviewed written paper. The oral presentations will be the week of March 25 - 29. On March 29th, a paper on your project will be due. The papers will be peer-reviewed by April 12th. The final version of the papers, responding to peer review, must be handed in by April 26th.

**Final Exam:** There will be a final exam for the course, administered during final-exam week at a time and date to be announced.

**Grading Policy:** There will be a total of 100 points in this courses allocated among Homework (28 points), Class Participation (10 points), Oral Presentations (8 points each), Peer Review of Project Papers (10 points), Term Paper (14 points), and the Final Exam (16 points). Course grades will be assigned out of 100 points as follows:

A 100-95 A- 95-90 B+ 90-87 B 87-83

B- 83-80 C+ 80-77 C 77-70 D 70-60 F 0-60

**Academic Integrity:** All Penn State and Eberly College of Science policies regarding academic integrity apply to this course. See

<http://science.psu.edu/current-students/Integrity/Policy.html>.

**First assignment:**

- Please read Chapter 1 of Ellner.

**Course Description:** This course is a study of computational, mathematical, and statistical models used in biological sciences and medicine. The course emphasis will be on critical thinking, and analysis of scientific questions of causation using quantitative methods. Mathematics will be used frequently in lectures to the extent needed to illuminate biology questions. The course material covers the building and using of mathematical (and computational) models to help us understand human systems.

- Reaction models and differential equations
- Linear compartment models
- Markov models and stochastic processes
- Physics-based models
- Boolean Networks
- Spatially structured PDE models

We usually include computer labs for

- Implementing models
- Fitting models to data

Applications of these methods are made to

- Pharmacokinetics
- Enzyme kinetics
- Oncology and Cell growth
- Immunology and viral dynamics
- Epidemiology
- Circulation
- Neurophysiology

Other topics of interest to the class may be added.