Catalog description: Modeling and mathematical analysis of biological processes using first principles at scales ranging from the molecular to the population level. Deterministic models are studied in both discrete and continuous time and analyzed using linearization principles, linear and nonlinear stability techniques, phase plane methods, and methods from partial differential equations. Results obtained from mathematical analysis will be qualitatively interpreted and applied to the biological process under investigation. All courses used to satisfy MTH prerequisites must be completed with a C- or better.

Credits: 3

Terms offered: Fall.

Meets: Three weekly lectures.

Enforced Prerequisites: MTH 256, MTH 341

Course Content: The goal of this course is to make students comfortable with the mathematical modeling of various biological processes. Different models are often appropriate to understand distinct features, and choosing an appropriate model is an integral part in the modeling procedure. Various mathematical tools can be applied to analyze these models with tools being model-dependent. For instance, discrete models require an understanding of the dynamics of iterated maps, whereas continuous models require an understanding of the qualitative behavior of solutions of differential equations. It is expected that different instructors will emphasize different applications of the mathematical models covered. The particular model applications in biology that will be covered this term are the following.

- Population models and ecology: single species growth, multi-species interactions such as competition, mutualism, foodwebs such as predator-prey systems.

- Mathematical immunology: models of the interaction of an infective agent and the immune system.


- Mathematical epidemiology: models for the spread of an epidemic; basic reproduction number, control via immunization.

- Movement models: diffusion, advection and taxis; traveling waves, pattern formation.

Learning Resources: A course in mathematical biology, Quantitative modeling with mathematical and computational tools by G. de Vries, T. Hillen, M. Lewis, J. Muller, B. Schonfisch; SIAM, 2006 will be used as a text for the course. In addition several handouts and article reprints will be provided.

Course Learning Outcomes
A student who has successfully completed MTH 427 will be able to:

1. Convert verbal descriptions of biological systems into appropriate mathematical models amenable to quantitative and qualitative analysis.
2. Perform elementary mathematical analysis of models introduced and interpret conditions obtained from the analysis - usually taking the form of relationships between model parameters - that correspond to specific model behavior, and express the ramifications for the biological process being considered.

3. Be prepared to discuss specific biological systems with life scientists, and in particular communicate efficiently how values of model parameters can impact the qualitative behavior of the system.

Since the background of the students of this class is expected to be quite diverse, interdisciplinary training through exposure to other areas will be tangible outcomes of this course.

A student who has successfully completed MTH 527 will be able to:

1. Achieve all of the outcomes of students having successfully completed MTH 427 as outlined above in addition to the following.

2. Read, situate, and understand research papers in the area of mathematical biology.

3. Be equipped to think independently about current research problems in mathematical biology.

**Grading:** Students in MTH 427 are expected to complete 3 homework assignments (50% of grade) and 2 exams (50% of grade). Learning Outcome 1 will be tested for instance via homework problems, in which students will be provided with a verbal description of a biological system and asked to write down differential equation models or difference equations for these systems. Learning Outcome 2 will be tested via homework problems and exams. Learning Outcome 3 will be tested by students’ class participation.

Students in MTH 527 are expected to complete 3 homework assignments (50% of grade) and 1 class presentation, as well as a written review report of a research paper (50% of grade). Learning Outcome 2 for MTH 527 will be measured by the quality of the written review paper and the class presentation.

**Students with Disabilities:** Accommodations are collaborative efforts between students, faculty and Disability Access Services (DAS). Students with accommodations approved through DAS are responsible for contacting the faculty member in charge of the course prior to or during the first week of the term to discuss accommodations. Students who believe they are eligible for accommodations but who have not yet obtained approval through DAS should contact DAS immediately at 737-4098.

**Student Conduct:** All students are expected to obey to OSU’s Student Conduct Code; see http://studentlife.oregonstate.edu/studentconduct/offenses-0.