# Math 19
# Mathematical Modeling
# Project Description

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## The Project Description

Your assignment is to either critique one of the articles listed below or formulate and analyze a mathematical model for the situation described in one of the articles. If you decide to formulate a model for the situation described by the article, you may wish to look at how the article, "The Case of the Missing Meat Eaters," was analyzed in Chapter 12 or how the article, "Left Snails and Right Minds," was analyzed in Chapter 5. If you decide to critique an article such as "Malaria: Focus on Mosquito Genes," you must do so from a mathematical standpoint and not simply from the viewpoint of whether the biology will or will not work.

### Articles

1. "HIV-1 Dynamics in Vivo: Virion Clearance Rate, Infected Cell Life Span, and Viral Generation Time," pp. 15–22.
2. "Wolves Moose, and Tree Rings on Isle Royale," pp. 96–102.
3. "Malaria: Focus on Mosquito Genes," pp. 198–202
4. "Counting Polymers Moving Through a Single Ion Channel," pp. 219–224.
5. "Diffisional Mobility of Golgi Proteins in Membranes of Living Cells," pp. 230–237.

6. "Direct and Continuous Assessment by Cells by Their Position in a Morphogen Gradient; Activin Signalling and Response to Morphogen Gradient," pp. 296–300.

7. "Disparate Rates of Molecular Evolution in Cospeciating Hosts and Parasites," pp. 401–410.

8. "Thresholds in Development," pp. 421–428.

You may substitute a different article for one of the above articles with my approval.

### Some Models to Consider

You will want to consider one or more of the mathematical models that we have studied or will study in this course.

- Exponential growth model:

$$\frac{dP}{dt} = \alpha P.$$

- Logistic growth model:

$$\frac{dP}{dt} = \alpha P - \beta P^2.$$

- Epidemic model:

$$\begin{aligned} \frac{dx}{dt} &= -\lambda xy + \alpha x, \\ \frac{dy}{dt} &= \lambda xy + \beta y. \end{aligned}$$

- Predator-prey model:

$$\begin{aligned} \frac{dx}{dt} &= \alpha x - \beta x^2 - \gamma xy, \\ \frac{dy}{dt} &= -\sigma y + \lambda xy. \end{aligned}$$

- Competing species model:

$$\begin{aligned} \frac{dx}{dt} &= \alpha x - \beta x^2 - \gamma xy, \\ \frac{dy}{dt} &= \delta y - \lambda y^2 - \sigma xy. \end{aligned}$$

- Advection model:
$$\frac{\partial u}{\partial t} = -c\frac{\partial u}{\partial x} + f(u).$$
- Diffusion model:
$$\frac{\partial u}{\partial t} = \mu\frac{\partial^2 u}{\partial x^2} + f(u).$$

## General Rules

You may consult me or other students for help, but your work and your report must be your own.

## The Final Report

The project is due on Friday, January 16, 2003. The report must be typed in 12 point type, double spaced with 1.25 inch margins, and the page numbers on each page in the upper righthand corner. Typing mathematical symbols and formulas is a sophisticated skill. Please write mathematical expressions by hand unless you know how to write expressions *correctly* with a word processor. Take care to write your report in proper English. A significant part of your grade will be based on exposition.

- A title page containing:
  - Title of the report
  - Course name and number
  - Author's name
  - Date completed
- The report. The body of your report may not exceed 10 pages.
- References.
- Appendix. The appendix may contain information such as graphs, calculations, etc.