BIOS 419: Computer Simulation in Biology Winter 2008
(Call Number 07446)

Class meets MF 2-4 in Irvine 163, W 2-4 in Irvine 159.
Lecture/discussion M 2-3, W 2-4. Computer lab F 2-4. Open computer lab M 3-4.

Instructor: W. Holmes

Required Texts:
An Invitation to Biomathematics, RS Robeva et al. 2008, Academic Press
Laboratory Manual of Biomathematics, RS Robeva et al. 2008, Academic Press

Course Content: The purpose of this course is to introduce students to computer modeling and simulation in biology and to illustrate the power and limitations of these techniques. Biological research involves the formulation and testing of conceptual models. One important means of testing conceptual models is to convert them to mathematical models that can be simulated on the computer. By comparing simulation data with real experimental data, one can identify flaws in the conceptual models and gain insights into the biological mechanisms being studied.

Outcomes: By the end of the course students should be able to form mathematical models for biological problems, solve them with appropriate software, and interpret the results. Students should also be able to fit models to data and explore the consequences of parameter variations.

Computer Simulation: Mathematical models will be solved with Berkeley Madonna software. This software is available free from http://www.berkeleymadonna.com. However, the free version does not allow you to save files or print graphs. The full version is available on certain computers in the computer lab (Irvine 163) and you are welcome to save files and print graphs from these computers any time the room is free. It may be possible for you to obtain a temporary license good for the quarter. I will discuss specifics in class. One computer lab will use either gepasi or copasi (for fitting models to data) and both are freely available (www.gepasi.org, www.copasi.org)

Office Hours: Office hours are MF 11-12 or by appointment or just stop in.
Office location is 011 Wilson West basement (under the dorm, south side)
Office phone is 593-0075
E-mail is holmes@ohio.edu

Attendance Policy: Attendance is expected. Please notify the instructor if you must miss a class

Academic Conduct: Much of your grade is earned from exercises that are submitted for credit. Do not to copy the work of any other student. Do not allow others to copy your work. Plagiarism is a serious offense in this course. Any student found to be involved in either giving or receiving exercise answers from someone else will be penalized. Penalties will range from losing two or three letter grades to failing the course and possibly being expelled from the University. To keep from getting involved in illegitimate activities of this sort, observe the following advice:

1. **Do not get behind in your work.** If you avoid getting into a panic, you will not be tempted to do something stupid.
2. If you need help, ask for it from the instructor. I will be happy to answer any reasonable questions about model development, Madonna programming and machine operations.
3. Turn in **all** your work associated with a given exercise.
4. If anyone asks to see your program, tell them to ask the instructor for help.

5. If you see anyone copying your material, report it to the instructor so that you will not be held responsible for exchanging material.

GRADING BASIS FOR BIOS 419: Grades will be calculated from:

Homework exercises assigned from the text or handed out in class (30%),
Computer lab write-ups (35%)
A mid-term exam (20%),
A final project (15%).

Homework Exercises. A number of exercises are described in each chapter in the textbook, and answers are provided either at the back of the book or on the book web site. Answers to assigned exercises from the text should demonstrate an understanding of what is asked and not just a repetition of the given answers. In addition, homework exercises will be handed out in class. For these exercises, please provide the computer code, plots, and data as required by the problem and answer all questions. Homework is due weekly, usually on Wednesdays.

Computer lab write-ups. Seven of the computer labs come from the laboratory manual. For these labs, do all of the exercises (unless I tell you otherwise) and provide computer code, graphs and tables when asked to do so. Answer all questions.

Test. There will be one test given in week 5. If you keep up with the exercises you should do well on this test.

Final project. You should select a paper from the biological literature that contains a model. The paper must be approved by the instructor by the end of week 8, preferably earlier. First, you should repeat a major simulation described in the paper. Examine the effect of varying values of the rate constants and discuss the implication of these results for the model. Is the model particularly sensitive to one or more parameter values? Propose a new simulation not done in the paper that you think would be interesting. Explain why you think this would be an interesting simulation to do, perform the simulation and discuss the results. Prepare a 15 minute presentation of your work and give your presentation during the final exam period. Submit a paper that describes what you have done (also due at the final exam period).

BIOS 419: COURSE SCHEDULE **Winter 2008**

Date		Tentative Topic	Reading
Jan	7	Modeling, course mechanics, lab schedule	Handouts
		LAB—Computer & Madonna introduction	
	9	Forming models, Analytical Models, Mathematics review	pp 1-22
	11	LAB—No class. Please start on LAB 1 on your own.	pp. 44-50
Jan	14	Steady-state and stability	
		LAB—Introduction to Madonna	Laboratory 1
	16	Population Models—Logistic equation , chaos	pp. 22-36
	18	LAB—Logistic populations	Laboratory 2
Jan	21	No class—Martin Luther King holiday	
	23	Numerical Integration, curve fitting	pp. 233-242
		Dose schedules, compartment models of physiology	pp. 36-44
	25	LAB—Dose schedules	Laboratory 3
Jan	28	Epidemics—SIR models, reproductive rates	pp. 53-70
	30	Epidemics (cont). AIDS model	pp. 70-81
Feb	1	LAB—Epidemics	Laboratory 4
Feb	4	Genetics, selection, mutation	pp. 99-127
	6	TEST	
	8	LAB—Genetics	Laboratory 6
Feb	11	Lotka-Volterra and fish catch	pp. 81-94
	13	Insect pesticide application, null clines	
		Species competition	
	15	LAB—Predator Prey models	Laboratory 5
Feb	18	Zinc homeostasis	pp. 211-217
	20	Model fitting with gepasi or copasi	pp. 252-262
		Calcium oscillations	handout
	22	LAB—Fitting models to data	handout
Feb	25	Endocrinology	pp. 267-275
	27	Growth Hormone model	pp. 301-338
	29	LAB—Modeling the growth hormone network	Laboratory 11
Mar	3	Physiological models, bilirubin metabolism	handout
	5	Kinase switches, Biochemical cascades	
	7	LAB—Kinase switches or bilirubin model	notes
Mar	10	Monte Carlo models	handouts
	12	Random Walks in Biology	
	14	LAB—Open lab for projects	
Mar	**18**	**Tuesday, Final exam period 12:20 pm , projects due.**	