MTH 370
Mathematical Biology
Section 1, Fall 2009

When:	MWF 12:40-1:30pm
Where:	MW in C207 Wells Hall, F in B100C Wells Hall
Instructor:	Berton Earnshaw
Office:	A308 Wells Hall
Office hours:	M 9:30am-12:30pm or by appointment
Email:	earnshaw@math.msu.edu
Telephone:	353-0693
Web:	www.math.msu.edu/∼earnshaw
Class webpage:	www.math.msu.edu/∼earnshaw/teaching/mth370-01-09fall/
Texts:	*Mathematical Models in Biology*, SIAM (2005) by L. Edelstein-Keshet
	A Course in Mathematical Biology, SIAM (2006) by G. de Vries, et al.
	Mathematical Models in Biology, Cambridge (2004) by E. Allman and J. Rhodes

Description: From the course catalog… "First-order linear ordinary differential equations and systems. Qualitative theory of nonlinear continuous dynamical systems. Reaction-diffusion equations. Numerical analysis and computer simulation of solutions to nonlinear systems of differential equations. Numerical linear algebra. Applications to biological sciences."

We are also going to learn some linear algebra and MATLAB. We are going to learn how to think about the dynamics of biological systems by 1) mathematically modeling them, 2) quantitatively and qualitatively analyzing the solutions of the models, and 3) numerical simulating the solutions of the models.

Prerequisites: (MTH 132 or LB 118) and (MTH 133 or LB 119) and (BS 110 or BS 111 or BS 148H or BS 149H or LB 144 or LB 145 or LB 148H or LB 149H)

Homework: Yes, lots of it. You can only learn math by doing it. Homework problems will be assigned most Mondays, and will be due at the **beginning of class** the following Monday (see Tentative Schedule). Each assignment will be drawn from the material covered during the week in which it is assigned, and each will be posted on our class webpage. You may work with other classmates on the problems; however, each student must turn in his or her own assignment. Late homework will **only be accepted** if I have given my prior approval.

Exams: There will be one midterm exam and final exam. The midterm is scheduled for October 14 during our regular class time and will be administered in our classroom (C207 Wells Hall). The final is scheduled for December 14, 12:45-2:45pm, and will be administered in our classroom (C207 Wells Hall).

Grading: The homework assignments are meant to help you learn and not meant to penalize your grade, so please do every problem. Each homework assignment is worth 2 points and scored as follows:

Not turned in	0 points
Turned in with minimal effort and/or poor presentation	1 point
Turned in with substantial effort and excellent presentation	2 points

Your final grade is calculated as follows:

Homework assignments:	50% = 12 assignments, drop lowest 2, rest 5% each
Midterm exam:	20%
Final exam:	30%

ADA statement: The American with Disabilities Act requires that reasonable accomodations be provided for students with physical, sensory, cognitive, systemic, learning, and/or psychiatric disabilities. Please contact me at the beginning of the semester to discuss any such accommodations you may require for the course.

Tentative Schedule

Difference Equations and Linear Algebra		
Sep 2,4: 1D linear difference eqs	Introduction to course and MATLAB Modeling and simulating cell division	Keshet 6-8 Allman 1-5
Sep 9,11: 1D nonlinear difference eqs	Single-species population models Cobwebbing, fixed points, stability Allee effect, tragedy of the commons	Keshet 39-55 Vries 9-18 Allman 11-24
Sep 14,16,18: 1D nonlinear difference eqs	Discrete logistic equation (HW1 due Sep 14) Periodic solutions Period-doubling route to chaos	Keshet 44-49 Vries 18-25 Allman 24-28
Sep 21,23,25: 2D linear difference eqs	Age-structured population models (HW2 due Sep 21) Linear algebra: matrices, vectors, determinants, traces, eigenvalues, eigenvectors, generalized eigenvectors	Keshet 13-29 Allman 41-83
Sep 28,30, Oct 2: 2D linear difference eqs	Linear algebra continued (HW3 due Sep 28) Perron-Frobenius theorem Age-structured population models continued	Keshet 13-29 Allman 41-83
Oct 5,7,9: 2D nonlinear difference eqs	Host-parasitoid systems (HW4 due Oct 5) Taylor expansion of vector-valued functions, Jacobian matrix	Keshet 55-71 Vries 36-47 Allman 85-101
Oct 12,14: **Midterm**	Review for midterm on Oct 12 (HW5 due Oct 12) Midterm on Oct 14 Class canceled on Oct 16	
Ordinary Differential Equations		
Oct 19,21,23: 1D linear and nonlinear ODEs	Single-species population models Separation of variables, integrating factors Equilibria, stability, phase-line analysis	Keshet 164-171, 210-218 Vries 55-60
Oct 26,28,30: 2D linear ODEs	Solving systems of linear ODEs (HW6 due Oct 26) Phase-plane analysis of the origin Classification of equilibria: node, saddle, focus, center	Keshet 171-193 Vries 66-74
Nov 2,4,6: 2D nonlinear ODEs	Predator-prey systems (HW7 due Nov 2) Equilibria, stability, phase-plane analysis Lotka-Volterra equations	Keshet 171-193, 218-231 Vries 66-79
Nov 9,11,13: 2D nonlinear ODEs	Chemical reactions (HW8 due Nov 9) Law of mass action Michaelis-Menten reactions	Keshet 271-280 Vries 60-66
Nov 16,18,20: 2D nonlinear ODEs	Chemical reactions continued (HW9 due Nov 16) Nondimensionalization, quasi-steady-state approximation Cooperative/inhibitive reactions	Keshet 271-299 Vries 60-66
Nov 23,25: 2D ODEs	Bifurcations, existence of limit cycles (HW10 due Nov 23) Poincaré-Bendixon theorem, Hopf bifurcation theorem	Keshet 327-330, 341-346 Vries 83-88
Nov 30, Dec 2,4 2D ODEs	Neural models (HW11 due Nov 30) Hodgkin-Huxley equations, FitzHugh-Nagumo equations	Keshet 311-341
Dec 7,9,11: 2D ODEs	Oscillations in chemical reactions (HW12 due Dec 7) Review for final	Keshet 352-360
Final Exam		
Dec 14	Final exam, 12:45-2:45pm, C207 Wells Hall	