University of California Merced
Biology 180 – Fall 2012
Mathematical Modeling for Biology

Lecture Meeting Time: MWF 1:30-2:20 pm **Place**: SSM 104
Credit: 4 units **Section**: 01
Prerequisites: MATH 018 Minimum Grade: B-
Or MATH 032 Minimum Grade: B-
And BIO 100 Minimum Grade: C-
Or BIS 100 Minimum Grade: C-
Or BIO 101 Minimum Grade: C-
Or BIS 101 Minimum Grade: C-
Or BIO 002 Minimum Grade: C-
And MATH 012 Minimum Grade: B-
Or MATH 022 Minimum Grade: B-
Or MATH 030 Minimum Grade: B-

Instructors: Dean of Natural Sciences: Juan Meza, PhD
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Required Texts

1) *Modern Statistics for the Life Sciences*, Grafen and Hails Oxford (2002)
2) *Mathematical Models in Biology,* E.S. Allman & J.A. Rhodes, Cambridge Univ. Press (2004)
3) Assigned Readings on UCMCROPS (to be announced)

Description of the Course and Course Objectives

The analysis of quantitative data is at the heart modern biology. This course will provide basic statistical analysis and mathematical modeling skills for 21st century life scientists. The course will focus on the practical application of modern statistical tools for complex, real-world data sets, and the elements of using difference equations to predict the growth of animal and cell populations, the mutualistic or competitive interactions between species, demographic change, and the spread and control of epidemics. The course will use the "R" statistical language, a very powerful and freely available software tool.

Student Learning Outcomes

By the end of the course, the student should be able to:

I. Use the General Linear Model statistics framework to analyze datasets that include multiple continuous or categorical explanatory variables.
II. Design experiments according to optimal statistical design criteria.
III. Build and analyze population-based models of many different biological phenomena.
IV. Use the freely available R statistical modeling language to graph data sets and build statistical models.
V. Write basic population modeling programs in the R statistical modeling language.
VI. Understand and apply the principles of modeling human epidemics and disease spread.

Discussion

This class has both a lecture and a discussion component. During discussion, worksheets and quizzes will be assigned to build the student's knowledge of theory and to gain practical experience in statistical analysis. The schedule for the discussion sections can be found, below:

Section	Day	Time	Location	Instructor
BIO-001-02 D	F	12:30-1:20 PM	COB 281	Swift
BIO-001-03 D	F	2:30-3:20 PM	COB 281	Swift

UCMCROPS and Email

To be successful in this course, students should be UCMCROPS savvy. The syllabus, assignments, grades, PowerPoints, and other course information will be posted on UCMCROPS. Check UCMCROPS frequently for changes and new information.

The class may be contacted via email on occasion about changes to the class. Thus, students should check their email daily to avoid missing important emails. Failure to do so will not exempt students from the information contained in those emails.

Attendance

Attendance is necessary in order to be successful in this class. Paying attention and taking notes will expose the student to the information that will be on the exams. It is highly advised to miss class sparingly as the PowerPoints alone will not provide necessary explanations of the concepts.

Class Conduct

Students are expected to be courteous to the instructional faculty and to other students. Please turn off all cell phones and keep talking to a minimum. Those students who violate these expectations will be requested to leave the classroom. Laptops are allowed for taking notes, only. Any disruptive behavior (including, but not limited to tardiness) is considered reason for the instructor to request the disruptive student to leave. Further, lectures may not be recorded without prior permission (which may or may not be granted).

Presentation Techniques

The lecture may incorporate charts and illustrations of biostatistics concepts, PowerPoint slides, animations, and other in-class techniques. It will be up to the student to take notes on the information they feel is important. It is beneficial to print out the PowerPoint documents (in .PDF format) and make notes pertinent to each slide in the margin, or on the slide itself. If paper is a concern, having the document available to annotate on a laptop is another great option.

Grading

Exams: There are three (3) exams in this course administered during lecture. Each student must complete all three. There will be two (2) in-class exams and a cumulative three-hour final exam. These exams will be comprised of both a theoretical and applied practical component. Studying for these exams should include any and all material made available to the students in the course.

Quizzes: In discussion, on days where a worksheet is due, a quiz will be administered at the beginning of class. The quizzes will be based primarily off of lecture material, but may incorporate ideas from the prior week's worksheet. There will be a total of ten (10) quizzes. The eight (8) highest quiz scores will be factored into final grades.

Worksheets: These ten (10) worksheets will guide students through the practical component of the course. They will be based on the lecture material for the week. These are subject to the late policy found later in the syllabus.

Homeworks: Seven (7) homeworks will be assigned over the course of the semester. These homeworks are an extended version of the worksheets. The R-coding needed to complete these homeworks will be provided during lecture or in prior worksheets. The homeworks will synthesize the practical component of the worksheets with the interpretive foundation developed by lecture. The homeworks are subject to the late policy found later in the syllabus.

Exams

Punctuality is necessary on exam days. If students arrive late, they will not be granted additional time to complete the exam. The doors will close half an hour after the exam is scheduled to begin. If a student arrives after this time, they will not be allowed to take the exam.

Make Up Exam Policy

Only **one** missed exam may be made up for the class. **Quizzes cannot be made up**. In order to qualify for a make-up, the student must 1) have had a documentable emergency (which is limited to situations of death of an immediate family member, hospitalization, and other events of a similar magnitude), and 2) contacted the instructional faculty as soon as they know they are going to miss an exam. Moreover, the deadline for contacting the instructors for a makeup is the day of the exam, itself. Exceptions to the temporal component of the policy will only be granted if documentation is provided that demonstrates the student was unable to contact the professor (e.g. a doctor's note stating the student was hospitalized). In addition, the make-up exam will be scheduled around the availability of the discussion instructor. Thus, the make-up time may conflict with a student's work and school availability. Failure to follow these guidelines will prevent the student from taking a make-up and the final.

Grade Calculation/Policy

The gradebook will be maintained on UCMCROPS. Even though every effort will be made to ensure it is accurate, the calculations provided by UCMCROPS cannot be relied upon and may show an inflated grade (dropping two quiz grades at the end of the semester will cause this). Thus, it is the student's responsibility to manually calculate their individual grades if they want to know their progress in the course. The grading scale for this course can be found, below:

Item	Number	Point Value	Total Points	% of Total Points
Exams	2	200	400	40%
Final Exam	1	250	250	25%
Quizzes	8	10	80	8%
Worksheets	10	10	100	10%
Homeworks	7	25	175	17%
Total			1005	100%

The letter grade that corresponds to the overall percentage earned in the class can be found in the table, below:

Grade	% of total points achieved
A (A-, A, or A+)	Over 87%
B (B-, B, or B+)	Over 77%
C (C-, C, or C+)	Over 67%
D (D-, D, or D+)	Over 57%

Grades cannot be negotiated under any circumstances. If a student feels there is a grade error, they must submit in writing a formal request for a grade review with documentation of the error.

Homeworks, quizzes, worksheets, and the exams can all be submitted for re-grading if the student believes there is an error. These requests must be submitted within a week of the work being returned. The entire document will be re-graded, which means the new grade may either be higher or lower than the original grade. The instructors will randomly photocopy exams after the initial grading. If the re-grade submission does not match the photocopy, the incident will be reported to the Office of Judicial Affairs.

Late Policy

Turning in assignments late slows the grading process for the entire course. Thus, late work is subject to the following policy: 25% will be deducted per week it is late, with a maximum of 2 weeks. After two weeks, late work will no longer be accepted.

The clock for UCMCROPS will not necessarily match the student's clock. Thus, it is good practice to submit class work at least 10 minutes before the due date and time. UCMCROPS will mark submissions late if submitted within 5 minutes of the due date and time.

Students with Special Needs

Students with special needs (as documented by the Disability Services Center) should identify themselves to instructional faculty during the first week of class (due to testing accommodations). The School of Natural Sciences is dedicated to providing these students with necessary academic adjustments and auxiliary aids to facilitate their participation and performance in the classroom. Moreover, the University of California Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. Students are encouraged to register with Disability Services Center immediately to verify their eligibility for appropriate accommodations.

Academic Integrity

The instructors will not tolerate any form of cheating or violations of the honesty policy. If a student is guilty of any violations, a penalty of a zero for the assignment in question will be assigned and instructional faculty may pursue failure of the course and further academic discipline. Each student in this course is expected to abide by the University of California, Merced's Academic Honesty Policy. The detailed policy can be found at:

http://studentlife.ucmerced.edu/what-we-do/student-judicial-affairs/uc-conduct-standards. **Any work submitted by a student in this course for credit will be the student's own work.** Plagiarism and collaboration on any work in this class will not be tolerated.

Class Schedule

Lectures may not follow schedule exactly and are subject to change. Exam dates will not change without PRIOR notice.

Week	Session	Date	Concepts	Readings	Learning Outcomes
	Lecture	8/24/12	Descriptive Statistics	GH Revision Section	I
1	*Discussion 1*	8/24/12	Worksheet 1: *Descriptive Statistics and Variability*		I
	Lecture	8/27/12	Descriptive Statistics; Measures of variability in data	GH Revision Section	I
	Lecture	8/29/12	Measures of variability in data	GH Revision Section	I
	Lecture	8/31/12	Analysis of Variance	GH § 1	I
2	*Discussion 2*	8/31/12	Worksheet 2: *Analysis of Variance*		I
		9/3/12	**Holiday! Labor Day**		
	Lecture	9/5/12	Analysis of Variance; Regression	GH § 1, 2	I
	Lecture	9/7/12	Regression	GH § 2	I
3	*Discussion 3*	9/7/12	Worksheet 3: *Linear Regression*		I
	Lecture	9/10/12	Putting It All Together: General Linear Models	GH § 3	I
	Homework 1	**9/10/12**	*Descriptive Statistics and ANOVA*		I
	Lecture	9/12/12	General Linear Models; Multiple explanatory variables	GH § 3, 4	I, II
	Lecture	9/14/12	Multiple explanatory variables	GH § 4	I, II
4	*Discussion 4*	9/14/12	Worksheet 4: *Sums of Squares and General Linear Models*		I, II
	Lecture	9/17/12	Designing experiments	GH § 5	I
	Homework 2	**9/17/12**	*Regression Analysis and General Linear Models I: Hypotheses and Interpreting Parameters*		I, II
	Lecture	9/19/12	Designing experiments; Mixing categorical and continuous variables	GH § 5, 6	I
	Lecture	9/21/12	Mixing categorical and continuous variables	GH § 6	I
5	*Discussion 5*	9/21/12	*Exam 1 Review*		
	Exam 1	**9/24/12**	***Exam 1***		
	Lecture	9/26/12	Factorial Experiments	GH § 7	I, II
	Lecture	9/28/12	Testing for independence	GH § 8	I
6	*Discussion 6*	9/28/12	*Exam 1 Recap*		
7	Lecture	10/1/12	Testing for independence, homogeneity, additivity, and normality	GH § 8, 9	I
	Lecture	10/3/12	Testing for homogeneity, additivity, and normality	GH § 9	I

	Lecture	10/5/12	Model selection	GH § 10	I
	Discussion 7	10/5/12	Worksheet 5: *Multiple Linear Regression and Interactions*		I
	Lecture	10/8/12	Model selection	GH § 10, 11	I
	Lecture	10/10/12	Model selection	GH § 10, 11	I
	Homework 3	**10/10/12**	*Regression Analysis and General Linear Models II: Interactions*		I
	Lecture	10/12/12	Random effects and nested data	GH § 12	I, II
8	*Discussion 8*	10/12/12	Worksheet 6: *Testing Model Assumptions and Transforming Variables*		I
	Lecture	10/15/12	Random effects and nested data; Intro to biological population modeling	GH § 12, AR § 1	I, II, III
	Lecture	10/17/12	Intro to biological population modeling	AR § 1	III
	Homework 4	**10/17/12**	*Regression Analysis and General Linear Models III: Mixed Data and Model Selection*		I
	Lecture	10/19/12	Programming in R		III, IV, V
9	*Discussion 9*		Worksheet 7: *Introduction to R Programming*		III, IV, V
	Lecture	10/22/12	Difference and differential equations	AR § 1	III
	Lecture	10/24/12	Difference and differential equations	AR § 1	III
	Lecture	10/26/12	Linear models	AR § 2	III
10	*Discussion 10*	10/26/12	*Exam 2 Review*		
	Exam 2	**10/29/12**	***Exam 2***		
	Lecture	10/31/12	Linear models	AR § 2	III
	Lecture	11/2/12	Linear models	AR § 2	III
11	*Discussion 11*	11/2/12	*Exam 2 Recap*		
	Lecture	11/5/12	Non-linear models of interactions	AR § 3	III
	Lecture	11/7/12	Non-linear models of interactions	AR § 3	III
	Homework 5	**11/7/12**	*Population Modeling I: Equilibrium Points, Malthusian and Logistic Models*		III
	Lecture	11/9/12	Non-linear models of interactions	AR § 3	III
12	*Discussion 12*	11/9/12	Worksheet 8: *Modeling Age-Structured Populations*		III
		11/12/12	**Holiday! Veterans Day**		
	Lecture	11/12/12	An introduction to epidemic modeling	AR § 7	III, VI
	Homework 6	**11/14/12**	*Population Modeling II: Linear Models, Matrix Algebra, Projection Matrices, Eigenvalues and Eigenvectors*		III
	Lecture	11/16/12	Epidemic Modeling - S.I.R models	AR § 7	III, VI
13	*Discussion 13*	11/16/12	Worksheet 9: *Non-Linear Models of Interacting Populations*		III
	Lecture	11/19/12	Epidemic Modeling - S.I.R , S.I., and S.I.S. models	AR § 7	III, VI
	Lecture	11/21/12	Epidemic Modeling - S.I., and S.I.S. models	AR § 7	III, VI
14		11/23/12	**No Discussion or Lecture: Holiday! Thanksgiving**		
15	Lecture	11/26/12	Epidemic Modeling - Advanced Models	AR § 7	III, VI

	Lecture	11/28/12	Epidemic Modeling - Advanced Models; Themes and strategies in population modeling	AR § 1-3, 7	III, VI
	Lecture	11/30/12	Themes and strategies in population modeling; Review	AR § 1-3, 7	III, VI
	Discussion 14	11/30/12	Worksheet 10: *Modeling Epidemics*		III, VI
	Lecture	12/3/12	Advanced Topics: Bayes Theorem	Available on UCMCROPS	II
	Lecture	12/5/12	Advanced Topics: Bayes Theorem & t-Tests	Available on UCMCROPS	II
	Homework 7	**12/5/12**	*Modeling Epidemics*		III, VI
	Lecture	12/7/12	Advanced Topics: T-Tests & Chi-Square	Available on UCMCROPS	II
16	*Discussion 15*	12/7/12	***Final Exam Review***		
17	***Final Exam***	**12/8/12**	***Final: 11:30 am - 2:30 pm***		