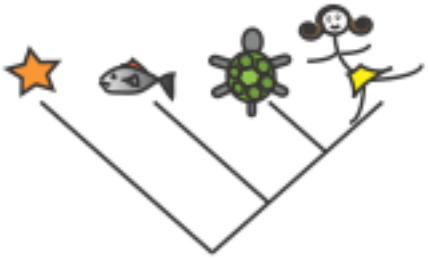
BIOL 170
Biodiversity and Evolution



MWF 10:50-11:50
OlinRice 250

Instructors: Mary Montgomery (M^2), associate professor
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http://www.macalester.edu/~montgomery/
OlinRice 218, x6425
Office hours: By appointment

Lab Instructors: M^2 and Mike Anderson, Ordway Naturalist (andersonm@macalester.edu)
Lab meets in OlinRice 273 on Thursdays

Textbook: Sadava *et al.* *Life: The Science of Biology, 8th edition* (W.H. Freeman & Company)
(NOTE: This course will also be supplemented with additional reading assignments from the primary literature and other sources. All assigned text readings will be listed on moodle. Additional readings, such as scientific papers, will be posted on the moodle course website as .pdf files.)

Course website: http://moodle.macalester.edu Enter this website by logging in with your email username and password.

COURSE DESCRIPTION: "From so simple a beginning, endless forms most beautiful and most wonderful have been, and are being, evolved." Darwin's final words in the Origin of Species are an apt characterization of this course, which focuses on the diversity of life forms (morphology, physiology, genetics) and their respective evolutionary origins and relationships (phylogeny). Using recent findings from such diverse fields as molecular genetics, developmental biology, and paleontology, this course will take a comparative approach as it reviews the evolution and diversity of some of life's major taxa. No prerequisites. Every semester. (4 credits)

COURSE OBJECTIVES: Upon successful completion of this course, students should be able to demonstrate the following competencies:

(1) knowledge of basic concepts in evolutionary theory and an introductory level understanding of phylogenetic methodologies;
(2) familiarity with the general patterns of how organisms are grouped (systematics) and knowledge of the history and mechanisms by which diversity among organisms has been generated;
(3) an understanding of how organisms are adapted to their environments, including specific examples of organisms characteristic of freshwater, marine, and terrestrial habitats;
(4) an understanding that science is a continual process of investigation and interpretation, and that scientific knowledge progresses via the support and rejection of competing hypotheses, collective decisions that are based on empirical evidence and logical interpretation using inductive and deductive reasoning;
(5) improved research skills and the ability to critically assess the content value of different types of information;
(6) improved presentation skills, including the ability to present scientific information in an accessible manner to both specialized and broader (non-specialist) audiences

COURSE SCHEDULE (subject to revision)

DATE	TOPIC
	<u>UNIT ONE: EVOLUTION and PHYLOGENETIC SYSTEMATICS</u>
Jan 28	Introduction: evolution and phylogeny
30	Historical perspective on evolutionary biology
Feb 1	Homology, convergent evolution, and building phylogenies
Feb 4	Sources of genetic diversity: genes, alleles, meiosis, independent assortment
6	Population genetics and the Hardy-Weinberg hypothesis
8	Natural selection, genetic drift, and gene flow
Feb 11	Natural selection and adaptation
13	Species concept and taxonomy
15	Mechanisms of speciation ***Problem Set DUE***
Feb 18	Biogeography and adaptive radiation
20	***Journal club 1: adaptive radiation***
22	TBA
Feb 25	The fossil record
27	The modern synthesis: evo-devo
29	***Journal club 2: evo-devo***
Mar 3	Review session for exam one
5	***EXAM ONE***

	UNIT TWO: ORGANISMAL DIVERSITY, PART ONE
Mar 7	The "Tree of Life"
Mar 10	Prokaryotes: physiological diversity
Mar 12	***Journal Club 3: Prokaryotes, evolution of community, and quorum sensing***
Mar 14	The serial endosymbiosis theory and the origin of eukaryotes
Mar 17-21	SPRING BREAK
Mar 24	Evolution of multicellularity
26	Major plant groups
28	The origin of land plants
Mar 31	Case study: coevolution of plants and insects
Apr 2	Fungi
4	Origin of the animals: multicellularity evolves again (choanoflagellates, sponges)
Apr 7	***Journal Club 4: Cnidarian-algal symbioses***
9	Review session for exam two
Apr 11	***EXAM TWO***
	UNIT THREE: ORGANISMAL DIVERSITY, PART TWO
Apr 14	Emergence of the Bilateria: The Cambrian Explosion
16	Lophotrochozoa & Ecydosozoa: a new view of animal evolution
18	Arthropoda: rulers of land and air
Apr 21	Deuterostomes: vertebrates and stranger beasts
23	Vertebrates: water-to-land transition and the emergence of the tetrapods
25	Comparative physiology: adaptations in freshwater vs marine habitats
Apr 28	Comparative physiology: adaptations to life on land
30	Amniotes and the evolution of flight
May 2	Evolution of *Homo sapiens*
May 5	***Journal Club 5: Tracing histories using mtDNA and the Y chromosome***
May 10	***FINAL EXAM (Unit 3 plus a cumulative section) (10:30 to 12:30)***

Expectations and Evaluation

Student learning will be assessed using multiple formats, including informal ongoing and in-classroom assessment, and formal methods, such as exams, writing assignments, problem sets, and lab projects (see Grading below).

GRADING

	% of Final Grade
Lecture-based Component	**70%**
Exams 1 & 2	25%
Final Exam	15%
Problem set	5%
Journal Club assignments	12%
Primary Literature Writing Assignment	5%
Other in-class assignments	8%
Laboratory/Field Component	**30%**
Cladistics Lab	4%
Microbial Phylogeny Project & Poster	12%
Lab Notebook	4%
Como Zoo Project	10%

Exams, including the final exam, will be composed of both short answer (matching, multiple choice, etc.) and long answer (paragraph length) questions. The exams will test your knowledge of material covered in the lecture component of the course. The final exam will test your knowledge of material specifically covered in Unit Three as well as contain a cumulative section wherein you will be asked to illustrate larger concepts that apply to material covered throughout the semester.

You will be assigned one take-home **problem set**. You will be able to work on these problems with other students in the course (ideally other members of your study group), although each student must turn in his/her own set of answers.

This course will be supplemented by readings from the primary literature and other sources, in addition to assigned readings from your textbook. Typically a **short writing assignment** will accompany the supplemental readings listed under ***Journal Club*.** In addition you will be asked to research a topic related to the course and report on 2-3 papers from the **primary literature**. Plagiarism will be handled according to the Macalester policy on academic integrity in the student handbook, with which you need to be familiar (**www.macalester.edu/~dstudent/handbook/academic_policies.html**) Finally, to promote an active learning environment, I will ask you to participate in various group activities, one of which will involve a 15-minute group oral presentation.

Regular attendance and participation in class is expected. You are allowed three unexcused absences, after which your final grade will be negatively affected. For example, an additional 2-3 unexcused absences may result in dropping your final grade as much as one-third a grade (e.g. B to B-). Although no formal points are given for participating in class discussions, I will naturally get to know better those students who speak up in class, which greatly aids me in writing good strong letters of recommendation. ☺

The **final 30% of your final grade** will be based on your performance in the **laboratory/field portion** of the course.

LABORATORY SCHEDULE

Phylogenies Based on Morphological Data

Jan 31	Introduction to Biology 170 Laboratory Cladistics Lab: Evolution of the Caminalcules, Formulating Hypotheses
Feb 7	Cladistics Lab: Evolution of the Caminalcules, Morphological Data & Analysis
Feb 14	Cladistics Lab: Evolution of the Caminalcules, Discussion of Results Morphology in Living Animals

Phylogenies Based on Molecular Data: Identification of Bacteria in the Environment

Feb 21	Bacterial DNA Lab: Introduction to the Microbial World; Collection of source material, community culturing/streaking plates; the following TUESDAY pick individual colonies and streak new plates (sign up for slot)
Feb 28	Bacterial DNA Lab: DNA isolation & PCR; Gram staining & morphological observations of bacterial colonies
Mar 6	Bacterial DNA Lab: Gel electrophoresis, PCR product cleanup, DNA quantification, Set up of sequencing reactions
Mar 13	Bacterial DNA Lab: Sequence/data analysis & work on posters (M^2 gone)
Mar 20	SPRING BREAK – NO LAB
Mar 27	Bacterial DNA Lab: Sequence/data analysis & work on posters
Apr 3	Bacterial DNA Lab: Poster Presentation

Communicating Science to the Public

Apr 10	Biodiversity Project & Plant Lab: Trip to Como Zoo and Conservatory
Apr 17	Biodiversity Project: Gathering and organizing information on organism of choice; Fact-checking Zoo displays
Apr 24	Biodiversity Project: Continuation of research
May 1	Biodiversity Project: Final project due

Some Dry (but Important) Legalese: The only acceptable excuses for missing an exam are severe personal illness, a death in the family, or other emergency of similar nature. You will need to show me some form of documentation should such a situation arise and you return to class to make up an exam. If you cannot take an exam on the assigned day because of participation in a sporting event or other official Macalester activity, you must notify me ahead of time (i.e., BEFORE the day of the exam) so that we can schedule an appropriate time for you to take the exam.

Assignments handed in late will suffer a 20% penalty or "late fee" for each 24 –hour period turned in after the due date/time.

How to Succeed in this Course:

(1) Attend all class meetings. Pay attention, take notes, ask questions.

(2) Use the lecture outlines to organize your notes, but *not* as a substitute for taking your own notes.

(3) Read the assigned texts *before* coming to class.

(4) Test your understanding of some of the material using online problem sets and tutorials, such as those found at The Biology Project: http://www.biology.arizona.edu/default.html; Make flashcards for yourself to help with learning the enormous volume of new vocabulary.

(6) Turn in assignments on time. Similar to credit card company late fees, assignments turned in after the due date will be penalized 20% for each day late.

(7) Show up on time for exams to give yourself all the allotted time to work on the exam. Because many students have a class directly after this one, I will not be able to provide extra time to work on exams after the class period has ended. However, if you have a diagnosed learning disability or English is not your first language, please speak with me about making alternative arrangements for test-taking.*

(8) Process the information you are learning in as many different ways as possible: by reading, writing, listening, speaking. Typically you will hear or read a concept or idea first in a passive setting (reading, listening). You then need to *actively* engage the material by doing problem sets, or writing a short paper, or explaining the material to someone else (e.g., your classmates). Understanding what you've just read or heard is *not* the same as knowing something well enough to explain it to others or being able to solve problems on your own. Only when you can do the latter will you be ready for the exams-- and only then will you have really learned what this course has to offer.

(9) Spend on average 2-3 hours studying outside class for each hour in class. Manage your time well. Set aside a block of time several times per week to do the readings and practice problems, and to go over your notes. For each lecture you might consider writing a summary of what you've learned and what questions remain unclear. Bring your questions to the next class meeting or email them to me or stop by my office during office hours.

(9) Form a study group. Get together with 2 or 3 of your classmates and meet on a regular basis (e.g., 1-2 hours per week). A useful way to run a study group session is for each member to have completed a problem set on his/her own and then get together with the group to go over the answers. If members are coming up with different answers for the same problem, often much learning can take place by discussing the problem and each person's approach to solving it.

(10) Come talk with me during my office hours. I will do my best to identify problem areas during class time; but, "the squeaky wheel gets greased" and you will get the best help when you ask for it. Don't wait until you are feeling overwhelmed or do poorly on an exam—come talk to me the minute you are feeling confused or uncomfortable in class. And come talk to me when things are going well! I'd love to hear for example when you've made a connection between what you are learning in the classroom and life outside it, or when you find a particular topic intellectually engaging. Those are the moments we professors especially enjoy.

*If you need special accommodation for note-taking or test-taking, e.g. due to ESL or a learning disability, please feel free to discuss your situation with me. I will do my best to accommodate your needs and help you achieve your full potential in my course.