BIOL 100: First-Year Research Seminar. Fall, 2005
SYLLABUS

I. GENERAL INFORMATION

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Office Hours: By appointment
Class meetings: Tuesday/Friday, 1:25-4:25*, Room 121 Lasry
*additional time may be required outside of regular classes for fieldwork or laboratory follow-up.
Text: *Biology, Seventh edition*, by Campbell and Reece. Published by Benjamin Cummings; ISBN: 0-8053-6624-5 (if you purchase a used text, be sure to get the seventh edition). This is the same text used in Introductory Biology (BIOL 101-102).

Overview: BIOL 100 is for first-year students only. This course will be organized around a semester-long team-driven research project in fungal molecular ecology. BIOL 100 is intended as an alternative to first semester Introductory Biology (BIOL 101), which is a lecture/laboratory style course. We will study the fungal partners of "indian pipes" (*Monotropa uniflora*), which are non-photosynthetic plants that obtain their nutrition by parasitizing fungi and trees. We will collect plants in the field, bring them back to the lab, and extract plant and fungal DNA from the roots. We will then amplify and sequence ribosomal genes of the fungi and use bioinformatics tools to identify the fungi that are partnered with the indian pipes. Each student will prepare a term paper based on her/his individual results. In addition, we will pool the entire class's data, analyze the data, and make a group presentation about our research at the end of the semester (see below).

BIOL 100 will include a mixture of lectures (to provide background information), laboratory research, field trips, and discussions. There will also be sessions treating scientific writing, graphics, and presentation skills. The topics covered in lectures will include basic genetics, molecular biology, and evolutionary biology. These topics overlap with those treated in BIOL 101, but some topics covered in BIOL 101 are not treated in our course (e.g., developmental genetics, endocrinology). BIOL 100 will satisfy the BIOL 101 requirement for upper-level courses, and it will enable you to move into BIOL 102 in the spring semester.

II. GRADING PROCEDURES AND COURSE ORGANIZATION

Grades will be based on 1) quizzes, 2) individual research papers, 3) group project and presentation, 4) lab notebooks, and, 5) participation.

Quizzes: There will be five quizzes throughout the semester. The goal of the quizzes is to test comprehension of background material presented in lectures (and other course-related information). Quizzes will include multiple-choice and short-answer questions.

Research projects, term paper, and group presentation: BIOL 100 will combine individual and group projects. During the bulk of the semester, each student will work independently to collect and analyze data obtained from a small number of personal samples of plants and fungi. The goal of these analyses will be to identify the fungal symbionts associated with individual indian pipes plants. The results of this work will be written up as individual research papers that will be submitted by Nov. 22. I will prepare a set of written comments for each paper. Each student will revise and resubmit her/his paper, along with a description of changes in the text in response to the comments (we will talk more about the structure of the papers and the revision process as the due date approaches). The first submission and the revision will both be graded.

After the individual analyses have been completed, we will pool all the data obtained in the class, and perform analyses on the pooled data. The goals of these analyses will be to characterize the "population" of indian pipes symbionts, and to contrast the symbionts of indian pipes from different localities. This group project will not be written up as a paper, but the class will collectively present the results of the analyses in an open presentation at the end of the semester. The presentation should include an introduction to the monotrope symbiosis and the techniques used in molecular ecology, as well as an evaluation of the results of the class project. *Everyone must participate in the presentation.* I will require that the class submit: 1) the PowerPoint file used in the presentation; 2) an outline of the presentation; 3) a description of the role that each member of the class played in analyzing the data and preparing the presentation. I will assign a grade for the project and presentation for the entire class (i.e., everyone gets the same grade). However, note that work on the group project will count toward grades assigned for "participation" (see below).

Lab notebook: Students will keep a lab notebook (sewn binding—purchase at the Clark bookstore or elsewhere). This should be initialed by DH or ZW after each lab, and then submitted for grading on the last day of class. Points will be awarded based on clarity and accuracy. The lab notebook should include a record of the exercises that you performed in lab, including fungus ID, molecular biology, and bioinformatics. It is not for lecture notes. You may paste in photos, print-outs, and protocols. The purpose of a lab notebook is to allow you or another scientist to repeat your experiments.

Participation: Points will be awardedfor participation, as measured by: attendance, participation in group discussions, lab etiquette, *contribution to development of the group presentation,* etc.

Points distribution: 500 points are available, distributed as indicated below. It is anticipated that a traditional grading scale will be used (A=90-100%, B=80-89%, etc), but final grades may not adhere to this scale exactly.

Item	**Points available**
Quiz 1	50
Quiz 2	50
Quiz 3	50
Quiz 4	50
Quiz 5	50
Lab notebook	50
Paper—first submission	50
Paper—revision and responses to comments	50
Group presentation (same grade for all class members)	50
Participation	50
Total	**500**

III. TENTATIVE CLASS SCHEDULE

Caveat emptor:
The following schedule is subject to change!
The list of reading assignments is incomplete—additional readings will be assigned during the semester.

Date	**Lecture/readings**	**Lab**
Aug. 26 F	Course overview Classes of biomolecules/organic compounds Overview of the carbon cycle—roles of carbon fixation vs. respiration Autotrophs vs. heterotrophs: fungi/plants/animals Mycorrhizal symbiosis and monotropes *Questions/Hypotheses to address in this course* **Readings:** **53**: 1163-1164 (parasitism vs. mutualism), 1166-1167 (trophic structure) **54**: 1184-1186 (chemical cycling and energy flow), 1191-1193 (energy transfer between trophic levels), 1195-1196 (carbon cycle), 1203-1205 (atmospheric CO_2) **31**: 618-620 (basidiomycetes) **37**: 768 (indian pipes) **Background reading** (chemistry and biomolecules): **2, 4, 5**	
30 T	**Field trip**: Boynton Park, Worcester MA Collect/record fungi and monotropes **In lab:** Set up spore prints Photograph collections Store mushrooms and monotropes in refrigerator	
Sept. 2 F	Overview of basidiomycete life cycle—parts of a fungus Anatomical feature of mushrooms Mushroom identification How to use a dichotomous key Use of microscopes, stains, etc Methods for sample preparation for permanent collections and DNA isolation **Readings: 31:** 608-612, 618-620 (Intro to Fungi, Basidiomycetes)	Identify mushrooms using keys, microscopic characters Make permanent collections of mushrooms and monotropes (prep labels, place on dryer) Prepare samples of monotrope roots and mushrooms for later DNA isolation
6 T	**Field trip**: Moose Hill Wildlife Management Area, Paxton MA Collect/record fungi and monotropes **In lab:** Set up spore prints Photograph collections Store mushrooms and monotropes in refrigerator	
9 F	**Quiz 1** Identify mushrooms using keys, microscopic characters Make permanent collections of mushrooms and monotropes (prep labels, place on dryer) Prepare samples of monotrope roots and mushrooms for later DNA isolation	
13 T	DNA structure, replication, and repair Causes of mutations **Readings**: **16**: 293-305	Begin isolations of DNA from mushrooms and monotropes
16 F	Intro. to molecular techniques Cloning The polymerase chain reaction	Complete DNA isolations

	Readings: 20: 384-392, 396-399	
20 T	Molecular techniques, comtinued Gel electrophoresis Sanger DNA sequencing **Readings: 20:** 392-394, 396-399	Run/check DNAs on agarose gel Set up dilutions of DNA for use as PCR templates Set up and run PCR reactions
23 F	Gene to protein: transcription The genetic code **Readings**: **17**: 309-326, 328-329	Check PCR products on agarose gel Clean PCR products Start 2nd set of DNA isolations
27 T	**Quiz 2** Gene to protein: translation Function of the ribosome, structure of ribosomal genes **Readings**: **17**: 320-327 **18**: 340-342 (retroviruses) **19**: 377-378 (multigene families, rDNA)	Check cleaned PCR products Continue 2nd set of DNA isolations
30 F	Mutation Evolution 1: Historical perspectives Descent with modification **Readings**: **17**: 328-331; **22:** 438-444; **24**:486-488	↓
Oct. 4 T	*No lecture*	Complete 2nd set of DNA isolations Set up new PCRs, including repeats of first set
7 F	Evolution 3: Natural selection and genetic drift **Readings**: **22:** 444-448; **23:** 460-462	Check and clean PCR products (prepare sequencing templates)
11 T	*Mid-term break—no class*	
14 F	**Quiz 3** Evolution 4: Population genetics perspectives and a "reductionist" definition of evolution. Evolution of DNA sequences; effects of natural selection on rates of molecular evolution **Readings**: **23**: 454-470	Check cleaned PCRs Set up sequencing reactions [Send out reactions for sequencing—this will be done for you]
18 T	Phylogenetics 1: Reconstructing the tree of life using molecular and morphological characters "Homology" **Readings: 25:** 491-504	Introduction to techniques of molecular ecology: Using DNA databases to identify environmental sequences with BLAST and UNITE (we will practice with "dummy" sequences provided by the instructors)
21 F	Phylogenetics 2: Parsimony and maximum likelihood analysis **Readings: 25:** 491-504	Collect sequencing results (we hope!) Begin editing sequences using Sequencher (may need to be completed outside of class)
25 T	Estimating confidence in phylogenetic trees: The "bootstrap". Species and speciation: How the tree of life grows Isolating mechanisms and the biological species concept **Readings**: **24**: 472-486	Estimate sequence identities using BLAST and UNITE Assemble dataset and align with Clustal. Refine alignment in MacClade
28 F	Scientific writing 1: the anatomy of a typical primary research paper, functions of paper sections	Individual sequence analysis using PAUP* (parsimony heuristic and bootstrap searches)

	including graphics, tables, appendices	
Nov. 1 T	**Quiz 4** **Discussion of :** Bidartondo, M., and T. D. Bruns. 2001. Extreme specificity in epiparasitic Monotropoidea (Ericaceae): widespread phylogenetic and geographic structure. *Molecular Ecology* 10: 2285-2295 (on reserve in Science Library).	
4 F	Brief, informal presentations of results of individual sequence analyses (lab meeting format). Compare and discuss individual results. Exchange individual data and begin alignment and phylogenetic analyses of pooled data.	
8 T	Scientifc writing 2: categories of scientific writing, publishing your work, the review process.	Continue analyses of pooled data
11 F	Overview of the basidiomycete life cycle contrasted with plant and animal life cycles: Timing of meiosis and mitosis, roles of sexual vs. asexual reproduction **Readings: TBA**	Introduction to graphics and presentation software (PowerPoint) Effective use of graphics in presentations vs. publications
15 T	Cell division: mitosis **Readings**: **12**: 218-228	Public speaking workshop—techniques for successful presentations
18 F	Meiosis and sexual life cycles **Readings**: **13**: 238-249	
22 T	**Paper deadline** (based on analyses of individual data and analyses). Mendelian genetics 1 **Readings**: **14**: 251-270	Plan/organize group presentation based on analyses of pooled class data
25 F	*Thanksgiving break—no class*	
29 T	**Quiz 5** Mendelian genetics 2 **Readings**: **14**: 251-270	Continue work on group presentation
Dec. 2 F	Practice group presentation	
6 T	**Group presentation on analyses of pooled class data** Submit powerpoint file, outline of presentation, and description of each student's contribution to the group project **Submit lab notebooks** **Comments on individual papers returned**	
Dec. 15 (finals week)	**Revised paper (with responses to comments) deadline**	