*Fall 2006*

**BIOL 4590A**
**RESEARCH PROJECT LAB**

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***Course summary:*** Experience in designing, implementing, and communicating a biology research project, and practical training in modern approaches for biological research. This section will have a scientific theme of "Impacts of Biodiversity". Students will design and run projects to test the impacts of genetic, species, or habitat diversity on ecological processes or the impacts of various environmental and ecological factors on biodiversity.

BIOL 4590 is a 3-credit lab-based course. BIOL 4450 (Senior Seminar) is a co-requisite for BIOL 4590, since students will present their research from BIOL 4590 in Senior Seminar. Students enrolled in BIOL 4590A can sign up for either BIOL 4450A (Kubanek) or BIOL 4450B (Cairney).

BIOL 4590A meets on Mondays from 4:05 to 4:55 pm in Cherry Emerson room 204 to discuss and plan research activities, and on Wednesdays from 12:05 to 5:55 pm in Cherry Emerson room A105 to conduct experiments. In addition, there will be one weekend field trip (Sept 29-Oct 1) to Sapelo Island, Georgia, for which attendance is mandatory. There is no textbook for this course. Readings will be made available on WEBCT (webct.gatech.edu), and students are encouraged to use library databases and the scientific literature to pursue topics in more detail. Since there is no textbook and this is a lab-based course, attendance and active participation are required. Should you miss a lab, you must convince the instructor that the absence was excusable. Examples of excusable absences include documented illness, death in the family, accident. If you know that you are going to be absent from a lab, you must let the instructor know ahead of time. Each unexcused lab absence will lower the final grade by 10%. Unexcused absences from Monday class sessions will lower the course participation grade.

**Office hours:** By appointment. Please email or consult with instructor during class to set up a time. Students are also welcome to visit the instructor to talk about issues other than course material (e.g., career plans, research interests).

**Teaching assistant**: Wendy Morrison (PhD student in Biology) email: wm127@mail.gatech.edu

**Lab essentials:** You will need to wear safety glasses and closed-toe shoes whenever we're in the lab, and you'll need a new lab notebook (*not a spiral notebook or 3-ring binder*). There is no textbook.

**Evaluation:**

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|---|---|
| **Quizzes and periodic lab notebook checks** | **10%** |
| **Written reports on planned experiments #1-2** | **15%** |
| **Short project at Sapelo Island** | **15%** |
| **Independent research project:** | |
| **Proposal** | **10%** |
| **Preliminary manuscript** | **10%** |
| **Final manuscript** | **20%** |
| **Course participation** | **20%** |

**Quizzes** will serve solely as a means of ensuring that students read the assignment. Each quiz will be one or two questions, resulting in a grade of 0, 50, or 100%.

**Lab notebooks** should be handwritten (not typed) in pen and should include original notes you take during the experiment, as well as any preparatory notes you wish to include. Notebooks are graded individually (each student is required to present his/her own notebook). Every page should be numbered (by you if the book doesn't come with numbers). Your notebooks should contain description of the procedures you have performed, and

actual/original data. You have to outline experimental steps so that an experienced person (including yourself) should be able to trace your experiments without frequent references to the original detailed procedures or cited references. In addition, it is required that you include all the changes made from the planned procedure, as well as all calculations, measurements/observations, etc.

**Written reports on planned experiments** should each be no more than 2 pages of text (single-spaced, 12-point font) plus additional page(s) for figures and references. They should be written in manuscript-style (see recent articles in the journal "Ecology" and instructions for authors for this journal http://esapubs.esapubs.org/html/ecol_author_instructions.html for appropriate style). Each student writes their own report, even if they worked in teams for gathering data.

**Short project at Sapelo Island** will be conducted in teams and designed and executed while on the field trip. There will be no write-up or formal presentation of this project, but students will report verbally on their project to the instructor and other students towards the end of the field trip.

**Independent research projects** will run from weeks 7-15, in pairs. Pairs of students will choose their own project, in consultation with the instructor and TA. Recommended readings and the class discussion in week 3 are designed to help students come up with an original, manageable project. Although the research will be conducted in pairs, each student will write their own proposal and manuscript, although it is expected that pairs to work together in analyzing and interpreting their data.

**Proposals** will be one-page (single-spaced, 12-point font) plans of the project that will be conducted. The proposal should include background and justification (why would anyone want to do this project and why should anyone want to hear about it), a description of hypotheses to be tested (these can be in the form of questions or falsifiable statements), how the hypotheses will be tested (i.e., what experiments will be conducted), and how data will be interpreted. It is also a good idea to include a statement of expected results, and how the results relate to the goals of the project. The proposal can include a few citations, not included in the page limit.

**Preliminary manuscripts** will consist of the introduction section of the manuscript related to the research of the independent project, written in the style of the journal "Ecology". The introduction should be no more than 5 pages (double-spaced, 12-point font) and should include the background to the research project, why the project is being undertaken (why anyone should care…), and the overall goals of the project. However, it should NOT be written in the future tense as the proposal is written; instead, the introduction should be written as if the project has already been undertaken. Citations should be included at the end of the preliminary manuscript and are not included in the 5-page limit. Feedback from the instructor and TA on this preliminary manuscript can then be used to improve the introduction for re-submission as part of the final manuscript.

**Final manuscripts** will be in the style of the journal "Ecology" and will be no more than 15 pages (double-spaced, 12-point font), plus figures, tables, and citations. The final manuscript must include an abstract, introduction (based upon the preliminary manuscript, with any changes the student wants to make), materials & methods, results, discussion (results & discussion can be combined into one section if desired). Data should be provided in tables and/or figures as appropriate and appropriate legends for tables and figures should be used. There is no limit on the number of citations used; however, students should NOT cite papers that they have not read.

**Course participation** will be judged by the extent to which each student participates in class discussions (by asking questions, answering questions, offering ideas, opinions, and critiques of readings) and in lab activities (by being proactive with conducting your own experiments, by being prepared and ready to conduct experiments, by being considerate and helpful of other students in the lab when working alone or in a team).

*Please see www.honor.gatech.edu for Georgia Tech's Academic Honor Code, which you are required to uphold.*

***Class calendar:***

| Week | Date | Topic | Reading assignment |
|---|---|---|---|
| 1 | Aug 21 | Introduction to course and assignment of readings | |
| | Aug 23 | Group discussion of readings on how science differs from other ways of thinking | Chamberlin<br>Platt (there will be a quiz) |
| 2 | Aug 28 | Discussion to prepare for Aug 30 experiment | |
| | Aug 30 | Planned experiment #1 (day 1): Soil diversity, and Group discussion on experimental design | Hurlburt (quiz) |
| 3 | Sept 4 | No class (Labor Day) | |
| | Sept 6 | Planned experiment #1 (day 2): Soil diversity, and Group discussion on recent developments in biodiversity research | One biodiversity research article (not a review) to present to class |
| 4 | Sept 11 | Discussion to prepare for Sept 13 experiment | |
| | Sept 13 | Planned experiment #2 (day 1): Predator effects on prey species diversity<br>***written report for planned experiment #1 due*** | |
| 5 | Sept 18 | Discussion to prepare to Sept 20 experiment<br>Overview of what's expected for independent projects | |
| | Sept 20 | Planned experiment #2 (day 2): Predator effects on prey species diversity | |
| 6 | Sept 25 | Discussion to prepare for field trip<br>***proposals due*** | |
| | Sept 27 | No class<br>***written report for planned experiment #2 due*** | |
| | Sept 29-Oct 1 | Field trip to Sapelo Island, GA (leave Friday 11:00am, return Sunday 10:00pm) | |
| 7 | Oct 2 | Discussion to prepare to start independent projects | |
| | Oct 4 | Independent projects | |
| 8 | Oct 9 | Discussion of issues related to independent projects | |
| | Oct 11 | Independent projects | |
| 9 | Oct 16 | No class (Fall break) | |
| | Oct 17 | Independent projects | |
| 10 | Oct 23 | Discussion of issues related to independent projects | |
| | Oct 25 | Independent projects | |
| 11 | Oct 30 | Discussion of issues related to independent projects | |
| | Nov 1 | Independent projects<br>***preliminary manuscripts due*** | |
| 12 | Nov 6 | Discussion of issues related to independent projects | |
| | Nov 8 | Independent projects | |
| 13 | Nov 13 | Discussion of issues related to independent projects | |
| | Nov 15 | Independent projects | |
| 14 | Nov 20 | Discussion of issues related to independent projects | |
| | Nov 22 | No class | |
| 15 | Nov 27 | Discussion of issues for finishing independent projects | |
| | Nov 29 | Independent projects – last day in the lab | |
| 16 | Dec 4 | Course wrap-up | |
| | Dec 6 | Clean up lab<br>***final manuscripts due*** | |

**Partial reading list – these articles are available on WEBCT**

**General readings:**

Chamberlin TC (1965) The method of multiple working hypotheses. Science 148:754-759 [reprinted from 1890]

Hurlburt SH (1984) Pseudoreplication and the design of ecological field experiments. Ecological Monographs 54:187-211

Platt JR (1964) Strong inference. Science 146:347-353

**Biodiversity reviews and classic papers:**

Chapin FS, Walker BH, Hobbs RJ, Hooper DU, Lawton JH, Sala OE, Tilman D (1997) Biotic control over the functioning of ecosystems. Science 277:500-504

Connell JH (1978) Diversity in tropical rain forests and coral reefs. Science 199:1302-1310

Connell JH, Orias (1964) The ecological regulation of species diversitiy. Am Nat 98:399-414

Duffy JE (2002) Biodiversity and ecosystem function: the consumer connection. OIKOS 99:201-219

Hooper DU, Chapin FS, et al. (2005) Effects of biodiversity on ecosystem functioning: A consensus of current knowledge. Ecol. Monog. 75:3-35

Huston M (1979) A general hypothesis of species diversity. Am Nat 113:81-101

Hutchinson GE (1961) The paradox of the plankton. Am. Nat. 95:137-145

Janzen D (1970) Herbivores and the number of tree species in tropical forests. Am Nat 104:501-528

Loreau M, Naeem S, et al. (2001) Biodiversity and ecosystem functioning: current knowledge and future challenges. Science 294:804-808

Lubchenco J (1978) Plant species diversity in a marine intertidal community: importance of herbivore food preference and algal competitive ability. Am. Nat. 112:23-39

Mittelbach GG, Steiner CF, et al. (2001) What is the observed relationship between species richness and productivity? Ecology 82:2381-2396

Paine RT (1966) Food web complexity and species diversity. Am. Nat. 100:65-75

Rainey PB, Buckling A, Kassen R, Travisano M (2000) The emergence and maintenance of diversity: insights from experimental bacterial populations. TREE 15:243-247

Sala OE, Chapin FS, et al. (2000) Global biodiversity scenarios for the year 2010. Science 287:1770-1774

Sousa WP (1979) Experimental investigations of disturbance and ecological succession in a rocky intertidal algal community. Ecol. Monog. 49:227-254

**Recent and not-so recent biodiversity research articles – a sampling:**

Borghans JAM, Beltman JB, DeBoer RJ (2004) MHC polymorphism under host-pathogen coevolution. Immunogenetics 55:732-739

Carrington M, Nelson GW, Martin MP et al (1999) HLA and HIV-1: Heterozygote advantage and B*35-Cw*04 disadvantage. Science 283:1748-1752

Chase JM, Leibold MA (2002) Spatial scale dictates the productivity-biodiversity relationship. Nature 416:427-430

Downing AL, Leibold MA (2002) Ecosystem consequences of species richness and composition in pond food webs. Nature 416:837-841

France KE, Duffy JE (2006) Diversity and dispersal interactively affect predictability of ecosystem function. Nature 441:1139-1143

Hay ME (1986) Associational plant defenses and the maintenance of species diversity: turning competitors into accomplices. Am. Nat. 128:617-641

Hughes AR, Stachowicz JJ (2004) Genetic diversity enhances the resistance of a seagrass ecosystem to disturbance. Proc. Nat. Acad. Sci. USA 101:8998-2002

Jiang L, Morin PJ (2005) Predator diet breadth influences the relative importance of bottom-up and top-down control of prey biomass and diversity. Am Nat 165:350-363

Kerr B, Riley MA, Feldman MW, Bohannan BJM (2002) Local dispersal promotes biodiversity in a real-life game of rock-paper-scissors. Nature 418:171-174

Knops JMH, Tilman D, et al. (1999) Effects of plant species richness on invasion dynamics, disease outbreaks, insect abundances and diversity. Ecol. Lett. 2:286-293

Olendorf R, Rodd FH, Punzalan D, Houde AE, Hurt C, Reznick DN, Hughes KA (2006) Frequency-dependent survival in natural guppy populations. Nature 441:633-636

Smith VH, Foster BL et al. (2005) Phytoplankton species richeness scales consistently from laboratory microcosms to the world's oceans. Proc. Natl. Acad. Sci 102:4393-4396

Sommer U (1995) An experimental test of the intermediate disturbance hypothesis using cultures of marine phytoplankton. Limnol. Oceanog. 40:1271-1277

Stachowicz JJ, Whitlach, RB, Osman RW (1999) Species diversity and invasion resistance in a marine ecosystem. Science 286:1577-1579

Tilman D, Reich PB, Knops JMH (2006) Biodiversity and ecosystem stability in a decade-long grassland experiment. Nature 441:629-632

Yachi S, Loreau M (1999) Biodiversity and ecosystem productivity in a fluctuating environment: the insurance hypothesis. Proc. Nat. Acad. Sci. USA 96:1463-1468