Plant Physiological Ecology

Integrative Biology 151 - lecture (4 credits) (CCN 42532) – limited to 55
Integrative Biology 151L - laboratory (2 credits) (CCN 42541) – limited to 25

Instructor: ***Todd Dawson*** (VLSB 4006, 642-6090, tdawson@berkeley.edu)
Lab Website: http://ib.berkeley.edu/labs/dawson/
Course Website: http://ib.berkeley.edu/courses/ib151/

Graduate Student Instructors: ***Cameron Williams*** (cameron_williams@berkeley.edu), ***Andrew Weitz*** (apweitz@berkeley.edu), ***Gabriel Damasco*** (gdamasco@berkeley.edu)

Lecture Course Objective: A survey of physiological approaches to understanding plant-environment interactions from the functional perspective. Lectures cover physiological adaptation; limiting factors; resources acquisition/allocation; photosynthesis, carbon, energy balance; water use and relations; nutrient relations; linking physiology, stable isotope applications ecophysiology; stress physiology; life history, physiology; evolution of physiological performance; physiology population, community, ecosystem levels.
Laboratory Course Objectives: The laboratory is focused on instructing you on observational and experimental approaches and methods used in plant physiological ecology. Students are introduced to a wide range of techniques and will make measurements on different plant species growing in the field or greenhouse (weeks 1-7). A group research project is required (weeks 9-12).

Lectures (IB 151)	T, TH	9:30 – 11:00 am	141 Giannini
Sections (required):	Thursdays	8-9 am	141 Giannini (cc 42535)
		3-4 pm	2066 VLSB (cc42538)
Laboratory (IB 151L)*	T	2:00 – 5:00 pm	3059 VLSB

*This is a separate enrollment (= second course) and anyone who enrolls in 151L **MUST** also be enrolled in the lecture (IB151).

Grading:
Lecture & Discussion (1000 points total) - IB 151

200 pts.	Exam I (take home questions); Handed out February 19th - Due in one week
250 pts.	Exam II (take home questions); Handed out March 31st - Due in one week
300 pts.	Exam III (take home research problem); Handed out April 30th, Due in one week
100 pts.	Discussion assignments (3 @ ~33 pts. Each)
150 pts.	Discussion participation, attendance, and a 15-minute quiz every other week

Laboratory (500 points total) - IB 151L

100 pts.	Attendance and in-class assignments
150 pts.	Research Proposal
250 pts.	Final Project Report & Oral Presentation

Grades are not curved but instead a percentage scale is used. The table below shows the minimum grade you will receive based on your cumulative numeric score across all required assignments and exams. At our discretion, we may lower the numeric breakpoints (i.e. you could get a higher grade than indicated here), but we will not raise them.

Number grade	Minimum letter grade
> 93.5	A
≥ 90.1 - 93.4	A-
≥ 87.1 - 90	B+
≥ 83.5 - 87	B
≥ 80.1 - 83.4	B-
≥ 77.1 - 80	C+
≥ 73.5 - 77	C
≥ 70.1 - 73.4	C-
≥ 65.1 - 70	D+
≥ 60.1 - 65	D
< 60	F

LECTURE COURSE REQUIREMENTS:

Lectures. Although handouts are provided for the lecture topics, there is a great deal that is discussed that is not in the handout and often the examples used foster detailed elaborations of key points that you may see again on exams. Therefore, if you miss lectures, you may find the exams difficult and most importantly, you will miss class discussions of the topics that often provide context for the course material and exam answers – so please attend. Handouts will outline what is to be covered including the appropriate tables and figures. There is a great deal of information presented in the class - these handouts have been designed to allow you to listen and respond to the lecture materials without the burden of having to write down every detail.

Examinations. Three take-home examinations will be given. They consist of a combination of (i) questions meant to be answered with a short essay, (ii) problem solving questions based on alternate outcomes, and (iii) questions that will ask you to evaluate experimental data. They will be based primarily on the lectures and reading assignments. You will have one week to answer 2 to 5 questions.

Discussion sections. Weekly discussions are intended to provide you with additional opportunities to discuss and build upon the primary lecture topics through (1) question and answer reviews of each weeks materials, (2) additional reading (peer-reviewed scientific publications), (3) in-class problem solving assignments (e.g. evaluating data, running a computer program that demonstrates a key principle, etc.), (4) weekly quizzes focused on a concept or problem presented in lecture, and (4) mini-debates of "current topics" that small teams of three students organize together and formulate a 'group position' on that topic.

The student community at UC Berkeley has adopted the following Honor Code:

"As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others." The hope and expectation is that you will adhere to this code.

Collaboration and Independence: Reviewing lecture and reading materials and studying for exams can be enjoyable and enriching things to do with fellow students. This is recommended. However, unless otherwise instructed, homework assignments are to be completed independently and materials submitted as homework should be the result of one's own independent work.

Cheating: A good lifetime strategy is always to act in such a way that no one would ever imagine that you would even consider cheating. Anyone caught cheating on a quiz or exam in this course will receive a failing grade in the course and will also be reported to the University Center for Student Conduct. In order to guarantee that you are not suspected of cheating, please do your own work (in your own words) and create you own materials for the answers to quizzes or exams.

Plagiarism: To copy text or ideas from another source without appropriate reference is plagiarism and will result in a failing grade for your assignment and usually further disciplinary action. For additional information on plagiarism and how to avoid it, see, for example:
http://www.lib.berkeley.edu/instruct/guides/citations.html#Plagiarism
http://gsi.berkeley.edu/teachingguide/misconduct/prevent-plag.html

Academic Integrity and Ethics: Cheating on exams and plagiarism are two common examples of dishonest, unethical behavior. Honesty and integrity are of great importance in all facets of life. They help to build a sense of self-confidence, and are key to building trust within relationships, whether personal or professional. There is no tolerance for dishonesty in the academic world, for it undermines what we are dedicated to doing – furthering knowledge for the benefit of humanity.

Your experience as a student at UC Berkeley is hopefully fueled by passion for learning and replete with fulfilling activities. And we also appreciate that being a student can be stressful. There may be times when there is temptation to engage in some kind of cheating in order to improve a grade or otherwise advance your career. This could be as blatant as having someone else sit for you in an exam, or submitting a written assignment that has been copied from another source. And it could be as subtle as glancing at a fellow student's exam when you are unsure of an answer to a question and are looking for some confirmation. One might do any of these things and potentially not get caught. However, if you cheat, no matter how much you may have learned in this class, you have failed to learn perhaps the most important lesson of all.

For more information: http://asuc.org/honorcode/resources.php

Lecture Schedule

I. Introduction
- What is the field of Physiological Plant Ecology?
- Resources, tradeoffs, limitations, acclimation, adaptation, change

II. Characterization of the Physical Environment in the Changing World
- Climate & Vegetation
- The Principle of Limiting Factors
- Plants and Microclimates

III. Resource Acquisition Aboveground
- Radiation Balance and Leaf Energy Budgets
- Limitations to Photosynthesis: an overview
- Photosynthetic Adaptation to Light and Temperature
- Stomatal and Biochemical Control of Leaf Gas Exchange
- Stable Isotopes, Water-use Efficiency, and Photosynthetic Performance
- Variation in Photosynthetic Pathways
- Canopy Architecture and Productivity

IV. Below Ground Processes and Plant Response
- Water in Plants, in Soils and in the Atmosphere
- Root Systems and Water Capture
- Water Use and Tissue Water Relations
- Plant Architecture and Hydraulic Conductivity
- Adaptation to Water Stress - Drought - Salinity - Flooding
- Nitrogen Availability, Requirements, Symbiosis, Use-efficiencies
- Response to Limited Nutrient Availability
- Soil Factors & Edaphic Adaptations

V. Resource Balance in Plants
- Carbon Allocation - Construction Costs, Storage, Turnover
- Carbon Allocation - Patterns and Phenology
- The Ecophysiology of Defense Against Herbivory

VI. Ecophysiology Above the Individual Level
- Ecophysiology in Plant Populations
- Ecophysiological Aspects of Competition
- Life History Variation and Physiology
- Reproductive Ecophysiology
- The Ecophysiology of Succession
- Ecosystem Physiology – Measurements, Models, Scales & Scaling

VII. Physiology and Evolution
- The Evolution of Physiological Performance
- Evolution, Phylogeny, and Physiological Adaptation
- ** UCB Plant Physiological Ecology Symposium **

** Those students enrolled in the laboratory course (IB 151L) will be asked to give an informal presentation of their project results at the bi-annual, UCB Plant Physiological Ecology Symposium the week following the end of classes (second week of May). Everyone in the class is welcome to attend.

<u>Critical dates to remember:</u>
- March spring recess; early April – optional overnight field trip to Blue Oak Ranch Reserve

Reading

There is no perfect textbook for this course because the course is designed to span an array of topics drawn from the areas of plant physiology and biochemistry as well as ecology and evolutionary biology. There is one required text for the lecture that does provide good background reading. The textbook for the lab has been out-of-print for many years, but copies can be made available in lab and permission to photocopy the text is being sought from the publisher.

The **required text** for the lecture is the second edition of **Plant Physiological Ecology** (2008) by H. Lambers, F.S. Chapin III and T.J. Pons. We recommend that you use the lecture handouts to guide your reading in the book. For this reason we have not assigned specific pages or sections; what is best for you to do is find the relevant pages in the text AFTER each lecture is given and use this reading to supplement and expand upon the examples given and to clarify points or concepts that we address. At times, the lecture and book may provide slightly different perspectives – this is useful. If, however, particular facts or concepts between lecture and the book seem at odds, bring this to our attention!

Some topics, such as Ecophysiological Aspects of Competition, Herbivory and Ecophysiology, Reproductive Ecophysiology, The Ecophysiology of Succession, Scales and Ecosystems in Plant Ecophysiology, and Evolutionary Ecophysiology will have special readings that are not covered in the books.

In addition to the readings outlined above, specific papers taken from the primary literature will be assigned during the semester when they are central to a particular topic being covered. In addition, several other texts are available in the library that provides good coverage of some topics. These texts are all part of either the Academic Press Ecophysiology or Springer-Verlag Ecological Studies series. I will point out the relevant texts as we come to specific topics.

- Two **optional texts** that can be very helpful for adding to your background in the area of plant ecology and plant physiology are: (1) ***Plant Ecology,*** edited by M. Crawley and (2) ***Plants and Microclimate***, by H.G. Jones, respectively. Relevant readings in Crawley, by week are: Week 3, chap. 11; week 6, chap. 12; week 10, chaps., 2 & 9; week 11, chaps., 4, 5 & 8; week 12, chap. 6. Relevant readings in Jones, by subject are: Radiation, pp. 8-44, 106-116, 124-130; Stomata, pp. 131-162; Light, pp. 223-226; Temperature, pp. 231-245, 251-263; Photosynthesis, pp. 163-171, 176-179; 185-214; Water Relations, pp. 264-293.

- The **text** entitled **Physiological Plant Ecology: field methods and instrumentation**, edited by R.W. Pearcy, J.R. Ehleringer, H.A. Mooney, and P.W. Rundel is now ***out of print***, but copies will be made available for students enrolled in 151L. **Readings in PEARCY et al. are:**
week 1, chap. 1; week 2, chap. 6, 14; week 3, chap. 4; week 4, chaps. 6, 12, 13; week 5, chaps. 3, 8; week 6, chaps. 5, 9, 10; week 7, chaps. 11, 12; week 8, chaps. 8, 16; week 9, chap. 15.

LABORATORY COURSE REQUIREMENTS (151L)

Laboratory. The lab serves two purposes: (1) to instruct you in the methods and the use of key equipment used in plant ecophysiological research, and (2) to prepare you to conduct your course project (see p. 5 for full details). Some labs may be held at the U.C. Botanical Garden.

Research Proposals / Final Project Reports. During weeks 2 and 4 we will talk about your class projects. At week 5, we will ask you to hand in the specific questions you'd like to address for your project and the methods you intend to employ to address these questions. These will be reviewed and handed back to you with comments. At week 8, a detailed proposal for your project will be turned in. Details about this proposal and the project reports can be found below. The Final Project Reports are worth 200 points and due on April 30th.

Laboratory Schedule

The purpose of the laboratory is to allow you to become familiar with the approaches and methodology used in plant physiological ecology. To do this we will learn a number of techniques and make measurements on different plant species growing in the field or greenhouse. The first several weeks will focus on learning a number of techniques, becoming more familiar with computers for data management, and writing-up your findings. In addition, you will identify and set-up your class research projects. The last four weeks of the semester will be spent working specifically on your projects; i.e. collecting and analyzing the data (we will be following your progress and can offer assistance and guidance if needed), as well as project write-up. Periodically during this time, one of the instructors will meet individually with you to go over the experimental procedures and data evaluation for your project. On the day of the final exam, each group will present a brief talk (15 minutes) on the results of your research. Handouts for each week's lab will be passed out in class on the previous Thursday. It is expected that you will take the time to become familiar with the handout before each week's lab.

Week 1	Introduction to Lab course objectives and requirements
Week 2	Discussion of what you'll learn and how to apply this to your Class Project
Week 3	Principles and Measurements Leaf & Canopy Energy Balance
Week 4	Set-up of Class Projects Foci, Timelines & Budgets
Week 5	Principles and Measurements of Photosynthesis (+ Project questions due)
Week 6	Principles and Measurements of Plant Water Use & Status - I
Week 7	Principles and Measurements of Plant Water Use & Status - II
Week 8	Class projects discussion and organizations for measurement schedule (+ Project proposals due)
Week 9	Principles and Measurements of Stable Isotopes
Week 10	SPRING BREAK
Weeks 11-14)	Conduct Individual Research Projects
Week 15	Final Project Reports Due (April 30th)
Final exam week	Oral Presentations (~15 min.); May 13th from 11:30-2:30. *food & drinks will be provided*

Grading for Lab:
1. Attendance and in-class assignments (100 pts.)
2. Research Proposal (150 pts.)
3. Final Project Report (250 pts.; note: your oral presentation will factor into this grade)

About Your Projects

Your GSIs and I will prepare a list of potential project themes and plants that you might want to use for your course projects. Some projects are fairly narrowly defined while others allow you the freedom to ask a range of questions about plant ecophysiology. They are all designed to give you exposure to asking questions about ecophysiology and to the methods that are commonly used in this field. You will carry out these projects in groups of 3 or 4 students who share some common interests.

During our second lab, we will ask you to choose a project topic that is most interesting to you. In the third week of lab, we will set up those experiments together so that you will be ready to make your measurements on established plants later in the semester. By week 5, you will need to turn in refined questions for your project. Three weeks later (week 8), you will turn in a research proposal (100 points) that outlines the research you plan on carrying out for your project. The proposal must include five parts:

(1) a statement of the research objective(s) and goal(s)
(2) a description of the methods to be used including: what you will measure, how you will measure it, what your experimental design is, the equipment you will need to carry out your project
(3) a short discussion of the predicted results for your experiment
(4) a list of references (5-15) on the research topic that clearly indicate you are aware of the relevant literature
(5) a list of references in which the authors employ the methods you plan to use.

After your proposal has been approved, there will be a sign-up sheet for equipment that you MUST put your name on if you hope to have access to any of it.

You will begin your research during the 9th week of the semester and will be able to collect data for approximately four weeks. This should allow sufficient time to collect enough data so that you can draw some firm conclusions. We will be available for consultation throughout the semester.

After you complete your project, you will have TWO things to accomplish: A written report to be handed in the end of April and a 15 minute oral powerpoint presentation of your study, its results, and implications that you should be prepared to give at the bi-annual, **UCB Plant Physiological Ecology Symposium** (at the end of classes; the second week of May).

If you are not thoroughly aware of how to use the library for tracking down references, following up specific reference citations, and on how to use the various abstracts, please see one of the instructors - we have handouts to help you.

If you are not thoroughly familiar with how to write a scientific paper, expected for the research project, please see one of the instructors - we have handouts to help you.