

Plant Physiological Ecology

Integrative Biology 151 - lecture (3 credits)
Integrative Biology 151L - laboratory (2 credits)

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Lab Website: <http://ib.berkeley.edu/labs/dawson/>
Course Website: <http://ib.berkeley.edu/courses/ib151/>

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Lectures:	T, Th	9:30 – 11:00 am	(IB 151)	3030 VLSB
Laboratory:	T	1:00 - 5:00 pm	(IB151L)	3059 VLSB

Grading:

Lecture (600 points total) - IB 151

175 pts.	Exam I (take home questions); Handed out 2/16, Due 2/23
200 pts.	Exam II (take home questions); Handed out 3/23, Due 3/30
225 pts.	Exam III (take home research problem); Handed out 5/4, Due 5/10

Laboratory (400 points total) - IB 151L

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

Grading will be approximately:	90-100%	= A
	80-89%	= B
	70-79%	= C
	60-69%	= D
	<60%	= E

Anyone enrolled in the laboratory course (IB 151L) must also be enrolled in the lecture.

LECTURE COURSE REQUIREMENTS

Lectures. Attendance is essential; although detailed handouts are provided for each lecture topic, there is a great deal that is discussed that is not in the handout or is a detailed elaboration of points contained in it. If you miss lectures, you may find the exams more difficult and most importantly, you will miss class discussions of the topics – 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. There will be three take-home examinations. They consist of a combination of (i) questions meant to be answered with a short essay, (ii) problem solving questions, and (iii) questions which ask you to evaluate experimental data. They will be based primarily on the lectures and reading assignments. You will have several days (Thursday until Tuesday) to answer up to 6 questions.

Lecture Schedule

I. Introduction

Introduction and a Brief History of Physiological Plant Ecology
 Acclimation, Adaptation, and Natural Selection
 Climate and Life Forms

II. Characterization of the Physical Environment

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
 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
 Ecophysiology in Ecosystems - Models and Scales

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 after the final week of classes (~May 12th). We hope everyone in the class will attend.

DATES to remember:

Holiday; March 21-25, spring break; March 30 no lecture; April 9th or 16th – optional field trip.

Readings

There is no perfect textbook for this course because the course is designed to span a broad array of topics and explore their physiological, ecological and evolutionary meaning. There is one required text for the lecture that does provide good background reading. The textbook for the lab is out-of-print, but three copies will be made available in lab and permission to photocopy the text is being sought from the publisher.

The **required text** for the lecture is: **Plant Physiological Ecology**, 1998 by H. Lambers, F.S. Chapin and T. Pons. We recommend that you use the lecture handouts to guide your reading. This means reading the relevant pages **AFTER** each lecture and relating them to what was covered.

Readings in Lambers et al. are:

TOPIC 1	pp. 1-9
TOPICS 2/3	pp. 210-216 (sections 1-2.4); pp. 218-223 (up to section 2.2.2)
TOPICS 4/5	pp. 10-17; 20-21; 24-30; Box 3 (pp. 31-33); 33-36; 40-50
TOPICS 6/7/8	pp. 50-89; Box 2 (pp. 21-24)
TOPIC 9	pp. 15-25 (beginning @ section 2.2.1); pp. 52-58
TOPIC 10	pp. 62-85 (C ₄ and CAM) ending w/section 11.7; pp. 122-134
TOPIC 11	pp. 230-238
TOPIC 12	pp. 154-160
TOPIC 13	pp. 160-171

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 provide 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 and *Plant Ecology*, edited by M. Crawley and *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** for the lab is: *Physiological Plant Ecology: field methods and instrumentation*, edited by R.W. Pearcy, J.Ehleringer, H.A. Mooney, and P.W. Rundel. This book is now **out of print**, but copies will be made for each of you enrolled in 151L and you can get them in lab during week 1.

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 equipment use and techniques used in plant ecophysiological research, and (2) to prepare you to conduct your course project (see p. 7 for full details). Some labs may be held at the U.C. Botanical Garden.

Research Proposals / Final Project Reports. During the first two weeks 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 Tuesday May 6th.

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). 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 project reports, each of you will turn in your project report and 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 and Discussion about Class Projects
Week 2	Set-up of Class Projects
Week 3	Principles and Measurements Leaf/Canopy Energy Budgets
Week 4	Principles and Measurements of Photosynthesis I
Week 5	Principles and Measurements of Photosynthesis II (+ Project questions due)
Week 6	Principles and Measurements of Plant Water Status
Week 7	Principles and Measurements of Plant Water Use
Week 8	Class projects update and discussion (+ Project proposals due)
Week 9	Principles and Measurements of Stable Isotopes
Week 10-14	Conduct Individual Research Projects
Week 11	SPRING BREAK
Week 15	Final Project Reports Due (May 6 th) Oral Presentations (~15 min.) on May 12 th 9:30-12am; food & drinks provided

Grading for Lab:

1. Attendance and in-class assignments (100 pts.)
2. Research Proposal (100 pts.)
3. Final Project Report (200 pts.; note: your oral presentation will factor into this grade)

About Projects

Your GSIs have prepared a list of potential projects for this course. Some projects are fairly narrowly defined while others allow you the freedom to ask a broad 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 2-4 students.

During our first lab, we will ask you to choose a project topic that is most interesting to you. In the second 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 6, you will need to turn in refined questions for your project. Two weeks later (week 8), you will turn in a research proposal (100 points) that outlines the research your 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 or 10th 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 on May 6th and a 15 minute oral presentation of your study, its results, and implications that you should be prepared to give at the bi-annual, **UCB Plant Physiological Ecology Symposium on May 12th**.

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.