

## Botany 3204 - Plant Physiology - Spring 2008

**Prerequisites:** Botany SI2104, Chem PS/SI1050 or Chem SI1120 or Chem 2310, and Math QL1050 or Math QL1080

**Lecture:** 9:00-9:50, TuTh, SL421    **Lab:** 11:30-2:20, TuTh; SL422

**Instructor:** Dr. S. Harley    **Office:** SL409M, 626-7434;    **Office hours:** MWF 9:00-9:50, TuTh 8:00-8:50, or by appointment;    **e-mail:** sharley@weber.edu

**Course URL:** <http://faculty.weber.edu/sharley/3204/3204.htm>

### Catalog description:

A study of the physiological processes of plants, including carbon metabolism, mineral assimilation, water relations, and plant hormones. Two hours of lecture and two 3 hour lab periods per week.

Plant Physiology meets twice a week for lecture. The lectures cover water relations, photosynthesis, respiration, intermediary metabolism, mineral uptake and assimilation, nitrogen metabolism, plant hormones, and photomorphogenesis. Approximately half of a student's grade is based on mastery of the lecture material.

The field of plant physiology has developed due the laboratory work of many investigators. With two lab periods per week, the experimental nature of this field can be emphasized. The lab exercises are designed to be investigational. Besides introducing students to many of the techniques used in plant physiology, lab also provides an opportunity to develop good lab discipline through the keeping of a laboratory notebook. In addition, students get practice in the formalized writing used to present experimental results and conclusions through the writing of laboratory reports. Approximately half of a student's grade is based on the lab reports and notebook.

### Required texts and materials:

Textbook: L Taiz and E Zeiger. *Plant Physiology*, 4th ed, 2006. Sinauer Associates, Sunderland, MA.  
Textbook website: <http://www.plantphys.net>.

Lab Manual: Will be provided as a collection of PDF files on CD at the first class meeting.

You will also need a bound, quad-ruled laboratory notebook, a calculator capable of doing standard deviation and linear regression analysis, and safety glasses.

*Writing Papers in the Biological Sciences*, 3rd ed, by V. E. McMillan, is recommended. (This text is required for Botany 2121.)

### Students With Disabilities

Any student requiring accommodations or services due to a disability must contact Services for Students with Disabilities (SSD) in room 181 of the Student Services Center. SSD can arrange to provide course materials in alternative formats, if necessary.

## Student Behavior

This class meets in a laboratory room. Therefore, food and drink are prohibited. Feet must be in enclosed shoes. Your clothing must cover your lap when you are seated. Safety glasses are required. Additional safety information will be covered in the first lab period. You are expected to comply with the Botany Department Statement of Expectations of Students.

## Botany Student Portfolio

Botany majors must turn in a copy of the Botany Essay that is in their respective portfolios at the start of the semester. At the end of the semester, the entire portfolio must be turned in, including an essay revised in light of the material covered in Plant Physiology. Be sure that the revisions stand out from the rest of the essay by using a different font and providing a cover sheet that lists where the revised sections are located.

## Calculation of Final Grade:

*Exam 1	130 points
*Exam 2	130 points
*Exam 3	130 points
Laboratory reports, 8 @ 20 points each	160 points
*Laboratory notebook (includes lab participation)	175 points
Autobiography summary	15 points
*Plant hormone lecture	60 points
*Portfolio (Botany majors only)	0 points
TOTAL	800 points

You need at least 480 points (60% of the total points available) to pass (D-) the class. Also in order to pass, you need a minimum of 195 points (50%) from the three exams. If you neglect to do one or more of the items marked with an asterisk (\*), you will get a UW.

## NO MAKE-UP EXAMS. NO MAKE-UP ACTIVITIES.

**Extra Credit:** There is no extra credit in this class. (1) If you do not have time to master the content material and complete the assignments listed above, you certainly do not have time to do extra work. (2) It is not fair to your classmates for you to have different criteria for your grade.

## Point totals to achieve a specific grade are as follows:

A = 744-800 (93%)	B = 664-695 (83%)	C = 584-615 (73%)	D = 405-535 (63%)
A- = 720-743 (90%)	B- = 640-664 (80%)	C- = 560-583 (70%)	D- = 480-503(60%)
B+ = 696-719 (87%)	C+ = 616-639 (77%)	D+ = 536-559 (67%)	E = 0-479

## Lecture Outline (subject to change)

- I. Introduction -- chapter 1 (review Botany 2104 notes on biomolecules, cell structure, plant cells and tissues)
- II. Water relations -- chapters 3, 4 (review Botany 2104 notes on membranes)
- III. Photosynthesis -- chapters 7, 8, 9 (review Botany 2104 notes on photosynthesis)
  - A. The nature of light
  - B. The light reactions
    - I. The Z-scheme
    - ii. Photolysis
    - iii. Photophosphorylation
  - C. Calvin cycle
  - D. Photorespiration
  - E. C4 photosynthesis
  - F. Crassulacean acid metabolism (CAM)

End of material to be covered on the first exam on February 21.

- IV. Respiration and related metabolism -- chapter 11 (review Botany 2104 notes on respiration)
  - A. Glycolysis
  - B. Krebs cycle
  - C. Electron transport chain
  - D. Oxidative phosphorylation
  - E. Alternate pathway
  - F. Pentose phosphate shunt
  - G.  $\beta$ -Oxidation
  - H. Gluconeogenesis
- V. Mineral nutrition -- chapters 5, 12, CD (review Botany 2104 notes on mineral nutrition)
  - A. Mineral uptake mechanisms and kinetics
  - B. Mineral assimilation, excluding nitrogen

## C. Nitrogen assimilation and metabolism

End of material to be covered on the second exam on March 25.  
Note: Material for the second exam is dependent on material from the first exam. You will be responsible for comparing and contrasting photosynthesis and respiration on the second exam.

## VI. Plant growth and development -- chapters 16-25

- A. Plant hormones
  - I. auxin
  - ii. gibberellin
  - iii. cytokinin
  - iv. abscisic acid
  - v. ethylene
  - vi. brassinosteroids
  - vii. jasmonates, salicylates, and peptide hormones
  - viii. florigen
- B. Phytochrome
- C. Blue light responses

## VII. Tools in plant physiology – ch 14 (online), CD

- A. Antibodies
- B. Recombinant DNA
- C. Model organisms

End of material to be covered on the third exam on April 29.  
The third exam is not formally cumulative, but there is an assumption that you remember material from earlier in the semester.

## 2008 Plant Physiology Laboratory Schedule (subject to change)

<b>Date</b>	<b>Unit</b>	<b>Readings</b>	<b>Report Due</b>
Jan 8	Lab check-in Lab safety orientation Lab Notebook Guidelines Writing a Lab Report	McMillan	
Jan 10	Unit 1. Introduction to Spectrophotometry and Beer's Law	Fig 7.4 (p 127) Web Topic 7.1	
Jan 15	Unit 2. Anthocyanins vs. Betacyanins	pp 326-327	Jan 22
Jan 17	Unit 7. Cell Membranes		
Jan 18 (Friday)	Unit 3. Leaf Senescence I: The Effect of Kinetin on Chlorophyll Levels During Leaf Senescence. Set up leaf segments.	410-412 (PCD) Web Topics 21.3, 23.3 (bioassay) 559 (cytokinin)	
Jan 22	Unit 3. Start chlorophyll extraction  Unit 6. Enzyme Kinetics: $\beta$ -Galactosidase	Ch. 2 (online)	Jan 29
Jan 24	Unit 3. Chlorophyll measurements  Unit 4. Leaf Senescence II: Student-designed Experiments with Leaf Senescence Students design their experiments		Feb 14
Jan 29	Unit 8. Induction of Nitrate Reductase I: Dependence of induction on nitrate concentration	pp 292-294	
Jan 31	Unit 5. Developmental Change in $\beta$ -Galactosidase Activity	Ch. 2 (online)	Feb 7
Feb 5	Unit 4. Leaf Senescence II: Student-designed Experiments with Leaf Senescence Start chlorophyll extractions  Unit 9. Induction of Nitrate Reductase II: Student-designed experiments Students design their experiments		Feb 14  Feb 26
Feb 7	Unit 4. Chlorophyll measurements  Tissue Culture		Feb 14

Feb 12	Unit 10. Ribonucleases I: Changes in Ribonucleases During Seed Germination		
Feb 14	Plant Hormone Lecture - Library Visit  Unit 11. Ribonucleases II: Student-designed experiments Students plan experiments		
Feb 19	Unit 9. Induction of Nitrate Reductase II: Student-designed experiments		Feb 26
Feb 21	Exam 1		
Feb 26	Unit 12. Effect of Ethylene on Peroxidase Distribution in Pea Stems	pp 326-327	Mar 4
Feb 28	Unit 11. Ribonucleases II: Student-designed experiments		Mar 6
Mar 4, 6	Tools of Plant Physiology (lectures)	Ch. 14 (online) online notes	
March 10-14: Spring Break			
Mar 18	Unit 13. Affinity Purification of Pea or Lentil Lectin, Lab 1		Apr 3
Mar 20	Unit 13. Affinity chromatography, Lab 2		Apr 3
Mar 25	Exam 2		
Mar 27	Unit 13. Affinity chromatography, Lab 3		Apr 3
Apr 1, 3, 8, 10	Unit 14. SDS/PAGE, Immunoblotting, and ELISA (Enzyme-linked Immunosorbent Assay)	Web Topic 17.3	
Apr 15	Plant Hormones: lecture		
Apr 17, 22	Student lectures on plant hormones		
Apr 24	Odds-n-ends; turn in Portfolios		
April 29	Exam 3, 12:00-2:00 pm		

## Lab Notebooks and Reports

Lab notebooks are due at the start of the exams on February 21, March 25, and April 29 for scoring. Lab notebooks are due at the beginning of lecture for pre-lab checks.

Reports are due at the **beginning** of lecture on the due date unless otherwise noted. Late assignments will be docked 4 points for each *calendar* day they are late. Reports are to be typed, double spaced with one inch margins and 12 point font. The **required** report format is in your lab manual.

**In addition to the basic information required in your lab notebook (see the lab manual) and IMRAD format for all reports (see the lab manual), the following elements for each lab exercise are specifically required for notebooks (NB) and reports (R):**

1. Beer's Law. NB: absorption spectrum (graph)  
NB: [methyl red] from the standard curve (graph and linear regression calculation)
2. antho/beta. NB: HCl responses; NaOH responses; TLC plate; R<sub>f</sub> values; graphs of absorption spectra with wavelength range for 95-100% max A indicated.  
NB, R: Summary table of results  
NB, R: Draw **supported** conclusions about the identities of the unknowns.
3. Leaf Sen I. NB: std curve for [kinetin]; calculation of [kinetin equivalent] in unknown
4. Leaf Sen II: NB, R: rationale  
NB: calculation of [chl], normalized to g fr wt of leaf if applicable  
NB, R: graph or table of final results (depending on experiment done); interpretation of results based on the rationale
5. β-gal dev: NB: calculations of β-gal activity  
NB, R: graphs of β-gal activity vs. age  
NB, R: graphs of fresh and dry weights vs. age
6. β-gal kinetics. NB, R: graphs for pH optimum, inhibitors/activators (indicate best ↑ and ↓), and K<sub>m</sub> (Hanes plot)
7. Cell Membranes. NB: graphs for sections I, II, and III  
NB: answers to I #10, II # 5, and III # 6
8. NR I. NB: data printouts, graph of NR activity vs. [nitrite]
9. NR II: NB: data printouts and calculations  
NB, R: graph or table of final results (depending on experiment done); interpretation of results based on the rationale
10. RNase I. NB: gel; interpretation of the gel; answers to #11
11. RNase II. NB, R: rationale  
NB: gel; interpretation of the gel  
R: scan or photo of gel; interpretation of the gel
12. ethylene. NB: sketch of section; tissue prints (protein stain, peroxidase stain)

R: sketch, scan, or photo of tissue prints

13. lectin purification: NB, R: column elution profile, purification table  
NB: gel; interpretation of the gel  
R: scan or photo of gel; interpretation of the gel
14. SDS/PAGE, etc. NB: gel, western blot, ELISA data and standard curve, calculation of [lectin]  
R: photos or scans of gel and blot; [lectin]

### **Autobiography Summary**

Every year, the *Annual Review of Plant Biology* (*Annual Review of Plant Physiology and Plant Molecular Biology* from 1988 to 2001 and *Annual Review of Plant Physiology* prior to that) includes a short autobiography by a plant physiologist who has made career-long and significant contributions to the field. You are to select one of these autobiographies, summarize it, and give your reaction, including an explanation of why you selected that particular autobiography. The autobiographies vary widely in style and approach, so you might want to read several before choosing one to summarize.

Summary due: Jan 31. Be sure to include a citation for the autobiography you choose. Your summary cannot be longer than two (2) pages.

### **Plant Hormone Lecture**

Each student is to prepare and deliver a 40-60 minute lecture on one of the following plant hormones: auxins, gibberellins, cytokinins, abscisic acid, ethylene, or brassinosteroids.

Your lecture must include the following elements:

History of discovery of the plant hormone

Was the plant hormone discovered because it was specifically looked for? Was the plant hormone discovered because of a particular phenomenon that it triggered? What sort of objections (if any) needed to be overcome for the molecule to be accepted as a plant hormone?

Structure and biosynthesis of the hormone

What is the structure of the endogenous compound(s)? Are there any synthetic analogues that are active? Is there a clear structure/activity relationship? Are any of the analogues that are competitive inhibitors? Can the plant hormone or any of the analogues be synthesized readily?

Which organisms make the substance? Biosynthetic pathway - is there only one? Does the rate of biosynthesis change developmentally or environmentally? Are there ways of reducing its biosynthesis? Mutants? Chemicals? What are the common model systems for studying biosynthesis?

Analysis

What methods are used to quantify the hormone: bioassay, GC, GC/MS, ELISA, HPLC? Is there an analysis method that seems to be a standard?

Mode of action

Does it have only one mode of action? Which are the common model systems for studying the mode of action? Which cells are target cells? Does its action require protein or mRNA synthesis? Does its action involve the movement of ions across membranes? Are there any mutants or recombinants that are insensitive or hypersensitive?

Physiological role

Are there roles for which there is overwhelming evidence that it is an endogenous regulator?

Are there roles for which there is some evidence that it is an endogenous regulator? Are there roles for which it has been suggested that it is a regulator but with inadequate evidence?

Application and uses

Is the plant hormone, an analogue, or an anti-hormone used commercially? If so, describe the

application(s).

Summary of a recent (no older than Jan 2005) research paper (primary literature)

Introduce the paper, setting the problem under study in the context of the background information you have just given on the plant hormone. Describe each experiment completely (methods, results, conclusion) before moving onto the next experiment. Give a final summary of all of the conclusions, being sure that you set the conclusions of the paper in the context of the problem posed in the introduction of the paper and the known action/physiology of the plant hormone.

Due dates for progress reports: Feb 12, Mar 20

Failure to turn in a progress report on the due date will result in the loss of 10 points. I will be keeping the progress reports.

Due Apr 15: bibliography, outline, and copy of the primary research paper

### **Bibliography**

You must use a minimum of three references for your plant hormone lecture. One of the references must be a scientific paper from the primary literature. No more than one reference can be a textbook. No more than one reference (excluding online journals) can be a web site.

### **Format for citations:**

#### **Journal articles**

Author AB, Author BB. Year. Title of article. *Title of Journal* vol: pages.

#### **example:**

Bouquin T, Meier C, Foster R, Nielsen ME, Mundy J. 2001. Control of specific gene expression by gibberellin and brassinosteroid. *Plant Physiology* 127: 450-458.

#### **Book articles**

Author AB, Author BB. Year. Title of article. In Editor A, Editor B, eds, *Title of Book*, Ed., Vol. Publisher, City, pages.

#### **example:**

Beevers H, Stiller ML, Butt VS. 1966. Metabolism of the organic acids. In Stewart FC, ed, *Plant Physiology, a Treatise*, Vol. IVB, Academic Press, New York, pp 119-262.

#### **Books**

Author AB, Author BB. Year. *Title of Book*, Ed., Vol. Publisher, City.

#### **example:**

Uno G, Storey R, Moore R. 2001. *Principles of Botany*. McGraw-Hill, Boston.

#### **Web sites**

Author AB (if known). Date (if known). Title. *If part of a larger work or site, its title in italics*. <URL in angle brackets>. (date of visit)

#### **example:**

Anonymous. Helpful Links. *Weber State University Writing Center*. <<http://weber.edu/writingcenter/Links.htm>> (29 Aug 2002).

### **Outline**

You must turn in a fully developed outline of your report. Your second progress report should include a fairly complete version of what will be your final outline. Please be aware that this outline is **not** the outline printout that Presentations or PowerPoint is happy to make for you.

**Important Dates:**

Jan 21	Martin Luther King, Jr. Day - no classes
Jan 22	Unit 2 lab report due
Jan 29	Unit 6 lab report due
Jan 31	Autobiography Summary due
Feb 7	Unit 5 lab report due
Feb 12	First progress report for hormone lecture due
Feb 14	Unit 4 lab report due
Feb 18	Presidents' Day - no classes
Feb 21	Exam 1; lab notebooks due for scoring
Feb 26	Unit 9 lab report due
Mar 4	Unit 12 lab report due
Mar 6	Unit 11 lab report due
Mar 10-14	Spring Break - no classes
Mar 20	Second progress report for hormone lecture due
Mar 25	Exam 2; lab notebooks due for scoring
Apr 3	Unit 13 lab report due
Apr 15	bibliography, outline, and copy of the primary research paper for hormone lecture due
Apr 17, 22	Student lectures on plant hormone
Apr 18	Annual Botany Department Field Trip to Antelope Island State Park <a href="http://faculty.weber.edu/sharley/AIFT/home.htm">http://faculty.weber.edu/sharley/AIFT/home.htm</a>
Apr 24	Botany Student Portfolios due
April 29	Exam 3; lab notebooks due for scoring

For additional information and support materials, visit the Botany 3204 Home Page:

<http://faculty.weber.edu/sharley/3204/3204.htm>