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BIOO 434.01: Plant Physiology Laboratory

Anna Sala
University of Montana - Missoula, sala@mso.umt.edu

BIOO 434 - PLANT PHYSIOLOGY LABORATORY - SYLLABUS

Instructor: Anna Sala NS 117a; email: sala@mso.umt.edu
Teaching Assistant:

Meeting Day/Times: Tuesdays 1:10 - 3:00 PM
Laboratory Room: Natural Sciences 207

Text: A. Sala. Plant Physiology Lab Manual

Course Description:

This course consists of a series of laboratory exercises intended to familiarize students with core concepts and techniques in plant physiology. It complements the lecture course (BIOO 433), which is an absolutely **necessary** pre-requisite. This laboratory course entails substantial scientific writing and it is a "Partial Writing Course", where grades are based on writing assignments with at least one of the assignments revised based on instructor feedback.

Main Laboratory Objectives/Outcomes:

- Learn some common research techniques used in plant physiology
- Increase your appreciation for plants and their complex, integrated nature
- Increase your understanding of how plants grow, develop and sense their environment
- Ability to write scientific papers (identify conceptual framework and main goals or hypotheses; summarize methods or approach; explain main results and interpretation).
- Ability to write a solid research proposal (develop clear rationale based on current understanding; identify and justify specific questions or hypotheses addressed; develop a detailed approach to address the questions or hypotheses).
- Learn to communicate scientific ideas in oral presentations.
- At the end of this course, students will have written five scientific, two-page reports and one eight page research proposal. Students will receive feedback to improve their subsequent report and during the development of the proposal.

Course Structure:

The course consists of a **two hour laboratory** every week. The labs are intended to help students visualize main basic concepts and common techniques in plant physiology (see Laboratory Schedule). Students will learn basic data analysis techniques and how to interpret results from simple experiments. After each laboratory, students either answer questions in a worksheet or write a short scientific report following the guidelines below. Worksheets and reports and are due at the beginning of the following lab. Although students work in pairs in the classroom and are encouraged to discuss the results in groups, each student is required to write her/his own reports or worksheets independently. Therefore, different wording and writing structure is expected. Failure to comply with this rule constitutes academic dishonesty and is grounds for failure of the course for all students involved.

Students are also required to write a research proposal during the semester. Undergraduate students will work on the proposal in groups of two while graduate students will work individually. Guidelines on how to write proposals are included in the lab manual. In addition, we will distribute examples and discuss the most important elements of successful proposals in class. The construction of the proposal will be an iterative process, with students receiving oral and written feedback on drafts along the way. Students might elect to pursue their proposed research during the semester for extra credit in the course, or as an independent study. At the end of the course, students will present their proposal to the rest of the class.

The instructors will be happy to help you any time. **You are encouraged to approach either the teaching assistant or the course instructor for guidance on this and all other aspects of the course.**

Grading: Late work will lose 10% of the assigned points per day.

4 Laboratory worksheets (15 each):	60	90-100% = A
5 Laboratory short reports (20 each):	100	80-89% = B
Proposal	40	70-79% = C
Proposal Presentation	20	60-69% = D
Total:	**220**	<60% = F

Unfortunately, due to the nature of the course, **laboratories cannot be made up**. If you have an extenuating circumstance that forces you to miss a lab, please talk to the instructors **in advance** to see if you can switch sections or make other arrangements at the discretion of the teaching assistant or course instructor. Any student that misses **3 or more** laboratory sessions will automatically receive a zero for the lab. Failure to appear in class **or** to turn in homework for a lab session counts as a missed session.

Adds, drops and changes of grade: This course follows university policies on drops, adds, changes of grade option, or changes to audit status. Please check the Registrar's Office Calendar for important deadlines and dates after which course changes are not automatically approved. Requests to drop a course or change the grade basis to benefit a student's grade point average will not be approved. A grade of C or higher will be considered passing for the P/NP option.

Special circumstances:
Only students registered with Disability Student Services (see: http://life.umt.edu/dss/) will be considered for disability accommodation as needed. Please contact the teaching assistant or the main instructor at least **one week before** the accommodation is required.

PLANT PHYSIOLOGY LABORATORY (BIOO 434) SCHEDULE 2014

Note: Reading means reading *in advance*, from the lab manual. Generally, assignments are due the following week. Late reports will receive a grade reduction of 10% per day.

Week	Date	Topics	Reading	Homework	Due that Week
1	Jan. 28	**No Lab**			
2	Feb. 4	**LAB 1: Basics of Plant Anatomy**		WORKSHEET	
3	Feb. 11	**LAB 2: Data Analysis and Graphs**	16-18	REPORT	Lab 1 Worksheet
4	Feb. 18	**LAB 3: Tissue Water Potential**	35-40 42-43	WORKSHEET	Lab 2 Report
5	Feb. 25	**LAB 4: Mineral Nutrition: Setup**	44-47	none	Lab 3 Worksheet & **PROPOSAL TITLE & OUTLINE**
6	Mar. 4	**LAB 5: Stomatal Conduct-uctance & Transpiration**	56-61	REPORT	
7	Mar. 11	**LAB 6: Xylem Water Potential**	65-69	REPORT	Lab 5 Report
8	Mar. 18	**LAB 7: Hill Reaction**	70-72	REPORT	Lab 6 Report
9	Mar. 25	**LAB 4: Mineral Nutrition: Harvest**		REPORT	Lab 7 Report & **PROPOSAL DRAFT**
10	Apr. 1	**SPRING BREAK**			
11	Apr. 8	**LAB 8: Measurement of Photosynthesis**	75-77	WORKSHEET	Lab 4 Report
12	Apr. 15	**LAB 9: Plant Hormones**	80-84		Lab 8 Worksheet
13	Apr. 22	**LAB 9: Hormones Cont. & How to Make Presentations**	89-98	WORKSHEET	
14	Apr. 29	**Proposal Presentations**			Lab 9 Wksheet & **PROPOSAL DUE**
15	May 6	**Proposal Presentations**			

Writing guidelines for lab reports

Reports must be **2 pages** long (excluding figures and tables), double spaced and **typed**. Use 11 or 12 font size and 1 inch margins.

All reports are due at the beginning of the next laboratory meeting. Exact due dates are listed in the syllabus.

Late reports will lose **10% of the POSSIBLE grade per day.** So a report that is given 17.5 points by the instructor will only earn 15.5 points if turned in a day late.

Your report must have the following sections:

- Title
- Introduction
- Materials and Methods
- Results
- Discussion

Bibliographic references are not required for lab reports. However, you are welcome to use references and include a References section at the end of the report. This section, however, will not count towards the two pages of the report. For citation of references in the text and formatting the References section follow the format in the Journal *Plant, Cell and Environment.*

Title:
The title should be short and informative. Avoid titles like: "Measurement of the water potential in plant tissues", as they are very devoid of information. Whenever possible write a statement-type title (e.g. "Tissue water potential is sensitive to desiccation") which is much more informative. If results are not clear enough to allow a statement-type title, an acceptable alternative title would be: "Effect of tissue desiccation on tissue water potential." Note that this title is much more informative than the first.

Introduction:
The introduction should provide a brief sentence about the ***conceptual background*** behind the experiment. For example: "Plant cells need to be under turgor pressure to remain functional'. Follow with a general description of the general problem or topic being studied. Then narrow down to identify the specific ***objectives*** of the experiment. When appropriate, outline the specific ***hypotheses*** the experiment is designed to test (a proposed explanation of the phenomenon under investigation). Hypotheses should never come as a surprise after a proper introduction. Rather, they are a natural progression from the background provided. Hypotheses should be followed by specific ***predictions***. A prediction is a specific statement forecasting what will happen under *certain* conditions, typically expressed in the form *If X …, then B ....* For instance: Hypothesis: The size of tomatoes produced by a tomato plant is positively related to light availability. Prediction: tomato plants grown under low light will produce smaller tomatoes than plants grown under high light.

Materials and Methods:
The materials and methods section of a scientific paper usually describes the methods in enough detail to allow someone else to duplicate the experiment. In this case, provide a brief explanation of the methods that outlines the basic idea. Use your ***own words*** rather than copying the lab manual. If appropriate, include any modifications you made during the procedures (both deliberate and accidental). In this section, as well as in '*Results*' and '*Discussion*' use ***past tense***.

Results:
The '*Results*' section should contain a brief, objective (as opposed to subjective) description of your main analyzed findings (e.g. only averages of several replicate measurements). ***Do not describe raw data in the results***. Rather, refer to tables and/or figures to describe main results. For example: 'Nitrogen deficiency reduced growth in all species tested (Table 1)'. Tables and figures are attached at the end of the paper. If more than one table or figure are necessary, number them sequentially (e.g. Table 1, Table 2 etc., or Figure 1, Figure 2, etc.).
Each Table or figure should be accompanied by a ***legend*** that clearly describes what is contained in a table or shown in a figure. For example: 'Figure 1. Percent plasmolyzed cells as a function of osmotic potential', or 'Table 1. Osmotic potential at different sucrose concentrations'. The table legend usually appears above a table and the figure legend appears below.
Unless unit less, all results need to be reported according to the ***SI units*** (see appendix).
Do not interpret your results in this section. Just describe what they are.

Discussion:
The discussion section should include an ***interpretation or explanation*** of your main results. Are your results consistent with your hypotheses and predictions? If the experiment did not work or produced unclear or questionable results, try do discuss what might have gone wrong and how could have affected the results. What conclusions can you draw with regard to the objectives described in the Introduction? You may also discuss future improvements of the experiment or additional experiments to test alternative hypotheses.

Grading Criteria for lab reports:
Title: 2 points
Introduction: 5 points
Methods: 2 points
Results (including Figures and Tables): 6 points
Discussion: 5 points

Guidelines Research Proposals

The purpose of a research proposal is to present an idea for a research project and to convince your target audience (i.e., a funding agency, a thesis committee, or yourself) that the project is doable, relevant, and worth time and money.

The format for a research proposal varies depending on who is funding it. Major funding agencies include the US Department of Agriculture (USDA), US Forest Service, National Institute of Health (NIH) and the National Science Foundation (NSF). Private organizations are another common source of scientific funding. The format for a proposal typically includes a title, an introduction, a section on preliminary results that support your proposed research, research methods, data analysis, scientific and social significance of the proposed research, references and budget.

You will be writing a research proposal for BIOO 434, with a length of no less than **8 double-spaced pages** and no more than 10.

Students taking the course for undergraduate credit will work with a partner on the proposal, and graduate students will work individually.

The topic of the research proposal should be related to **plant development** or **stress physiology**. You will probably find out that the selection of the specific topic will require more time than you anticipated. So plan ahead.

Proposal Format

The proposal should have the following sections clearly identified:

- Title
- Introduction
- Objectives
- Hypotheses or Questions
- Methods
- Significance
- References (see below for specific guidelines on proposal development and format).

Each section serves a separate important function, but a good proposal presents a cohesive message with a sense of continuity between sections.

A very important element of strong proposal writing is to **be brief and clear**. A good proposal is very compact and **easily digestible** to readers. Reviewers often have to review dozens of proposals in only a few days. These binge reviewing sessions are exhausting. You want reviewers to take notice of your proposal, to remember it favorably after reading dozens of other proposals, and to be able to glance at the title or front page and immediately remember your research objectives. You also want it to be as easy as possible for reviewers to see how your proposal matches the funding objectives.

Thus, clarity is fundamental. Avoid information not directly relevant to your proposed research. Even for people with outstanding organizational skills it is necessary to write an outline.

Title

The title should state the subject of the research. It should be short and as informative as possible. The title is very important to capture the interest of the reader. Avoid vague phrases like "Studies of" or "Investigation of". Although it is best to avoid jargon in the body of your proposal, sometimes it can help to sell your title. Again, you want your title to remind reviewers of your objectives at a glance.

Introduction

The introduction should consist of several paragraphs (perhaps 20-25% of the length of the entire proposal).

The introduction is a fundamental part of your proposal. An excellent introduction starts with a paragraph where you lay out the *broad* **conceptual** and/or **practical** significance of the *general* research area pursued. This should be a few sentences followed by a summary and justification of important outstanding issues or questions in this area. This, in turn, leads to the general goal of your research. Excellent proposals usually state the *general* goals right away (in the first paragraph). It is **very important** to begin with a statement of significance. Whether you emphasize the conceptual or practical significance is up to you.

In the following paragraph you go back to the general topic of your research. Here you use your references to help you hone in on your specific research topic, by first identifying and justifying areas in need of further research, and then gradually moving to your specific research questions. You will elaborate on what is known and what is not known on the topic of interest and bring into focus the *specific* issue or issues that need further investigation. You should clearly identify these issues and why is it important to conduct additional research. In your introduction it should be clear that you have carefully read core research papers and that you understand the key concepts involved in the research discussed. In this way you will demonstrate to readers your knowledge of the field.

When you have finished setting the stage for your research question, you should state clearly and concisely the "what," "when," and "how" of your proposed research. Be brief and avoid unnecessary elaboration. You will cover more detail elsewhere in the proposal. You may want to wrap everything up by returning to the significance of the project.

You will have written a good introduction if your reader can predict what you are going to propose and why. Your goal is not to leave surprises for your readers, but to confidently and clearly explain the significance, conceptual background, and goals of your proposed project.

Objectives

Here, you will provide a clear statement of the *overall* objectives or goals of the proposed project. The goal of this section is to distill your objectives into a single, "sound bite" statement for your reviewers. This will clear any lingering confusion about your goals, and will allow readers to easily pick up your proposal and remind themselves of your objective.

Although this is only a proposal, pretend that you will have reasonable facilities (reasonably well equipped laboratory, growth chambers and greenhouse space) and that you have two semesters at the most to complete your project. (Hint: **keep it simple** and remain focused!).

The point of this section is to be brief, so one or two sentences may suffice.

Hypotheses

A hypothesis is a proposed explanation for a phenomenon (e.g. "warm temperature enables growth of tomatoes"). In science we test hypotheses by evaluating whether they make correct predictions. When we enumerate the hypotheses of a project, usually what we are actually doing is enumerating the **predictions** (e.g. "the size of tomato plants will increase with warmer temperatures").

When making predictions it is very important to consider all possible alternative hypotheses. Also, it may be that multiple hypotheses make the same prediction.

In this section you will explicitly state your specific predictions. By far the best way to do this is to use a numerated list. This will make it easy for your readers to identify the hypotheses at a glance. There is no need to contextualize your hypotheses here: readers should already understand this from the introduction. See below for examples of how to enumerate the hypotheses.

Methods

In a proposal, the roles of the methods section are: 1) to demonstrate to readers that you have carefully thought through your research design, and 2) to demonstrate that your proposed project is feasible.

The methods section should have enough detail (or provide sufficient bibliographic references) to allow the reader to conduct your study by themselves, under guidance of common sense.

In your methods begin with a summary of your ***approach and experimental design***. Then move to explain your particular study system. Usually it is important to have some natural history information of your study species or relevant information about your study system. Defend your choice of systems as well. Careful choice and justification of study systems distinguishes good research.

Your proposal may consist of several experiments, each designed to address a specific hypothesis. Make sure to identify which hypotheses apply to each experiment.

For each experiment, describe:

- Your experimental treatments (what variable you are modifying and how).
- Your number of replicates per treatment.
- Growth conditions (e.g. type of pot and soil, location of experiment, etc.).
- What response variables to measure and how.
- Your statistical approach. This is VERY important in professional proposals, although you may consider this optional here.

Finally, make sure your experimental design is sufficiently robust to distinguish between main and alternative hypothesis, and describe how you will do this.

Significance

You should already have made the significance clear in the introduction, but this is your chance to lay it out clearly and simply for reviewers. If a reviewer wants to remind him or herself of the significance of your project, that reviewer will open your proposal to this section.

Here you should elaborate on how your results will help answer the presented questions/hypotheses as well as the potential broader implications of your research beyond the justification specified in the introduction.

The best research has both conceptual and social significance. Reveal both of these aspects of the significance of your research here and elsewhere.

Again, the goal of this section is to convey information quickly. It is OK to be brief, but do not skimp on selling the significance of your project.

References

List all the references cited in the text at the end of your proposal. To cite and list the references follow the format in Plant, Cell and Environment.

Proper formatting of references is critical. This is considered a basic courtesy, and improper formatting of references is interpreted as a lack of interest in and commitment to the proposal. Both proposals and research papers will be summarily dismissed if the references are formatted haphazardly or in a different style than demanded by the funding source.
Examples:

Journal article:
Nonami H, Schulze ED, Ziegler H. 1990. Mechanisms of stomatal movement in response to air humidity, irradiance, and xylem water potential. Planta 183: 57–64.

Book:
Nobel PS. 1991. *Physicochemical and Environmental Plant Physiology*. London, UK: Academic Press.

Book chapter:
Steudle E. 1994. The regulation of plant water at the cell, tissue, and organ level: role of active processes and compartmentation. In: Schulze E-D, ed. *The Regulation of Plant Water at the Cell, Tissue, and Organ Level: Role of Active Processes and Compartmentation*. San Diego, CA, USA: Academic Press, 237–299.

Due dates (see laboratory Syllabus for specific dates)

End of the 4th week of the semester (3rd lab session) by 5 PM: Title and general outline of your research proposal topic, including your hypotheses or question and proposed research approach. It should be no less than 1 page). The outline should be detailed enough to give the instructor a good idea of what you plan to do, so she/he can give you feedback.

Tuesday of 9th week of the semester (8rd lab session) by 5 PM: Draft proposal due (3-5 double-spaced pages). All work cited should be referenced (e.g. Sala 1998, Beerling and Kelly 1996), with a complete list of references at the end. This draft is extremely important so we can provide you feedback on your objectives, methods and writing. Your draft will be graded and returned to you with corrections and comments. You will need to revise this draft.

Tuesday 14th week of the semester (2nd to last lab session) by 5 PM: Your final revised proposal is due. Use **Times New Roman size 12 font**. Proposals should be 6-10 typed, double-spaced pages long, following the format described above. There is no penalty for having a short proposal as long as it is well written and meets the goals of this project. You will be asked to give a brief (10 minute) presentation of the research you propose, and to answer questions from a scrutinizing audience (the class!). The two last lab meetings will be devoted to oral presentations.

Grading Criteria for Research Proposals

Title and outline
Did you make a concerted effort in advance to identify a feasible research project?
Is the topic narrow enough and doable?
Is the topic creative?
Does the title summarize concisely what the project is about?
Are the tentative hypotheses and research approach reasonable?

Proposal (revised version)
Have you clearly identified the conceptual/practical significance of your general research area and justified why it is significant?
Have you identified which specific areas require further research and justified why?
Have you narrowed down to your specific research area following a logical flow?
Have you stated your overall goals in the first paragraph or so?

Do you provide a literature background leading to your specific questions/hypotheses?
Have you included at least 5 recent original research articles (excluding reviews)?
Are articles properly referenced?
Are articles relevant to your research topic?
Is there evidence that you have critically read the articles?
Does the background logically lead to the specific questions?
Are the specific questions or hypotheses explicitly stated?
Are they testable? Are they realistic? (i.e. could you implement the research at the University of Montana in no more than one year?)
Did you consider alternative hypotheses?
Is the study design appropriate to unequivocally answer your questions?
Do methods clearly explain how each hypothesis will be addressed?
Are the methods appropriate?