

PLANT ECOPHYSIOLOGY

BIO 366-01 & Lab

FALL 2023

MACALESTER COLLEGE



COURSE INFORMATION

- Instructor: Prof. Mary Heskel (she/hers); mheskel@macalester.edu
- Class: MWF 10:50-11:50 AM (OIRi 284); Lab: Thursday 1:20-4:30 (OIRi 275, 285 varies)
- Meeting time/Office Hours: Monday 1:15-3:15 PM in Olin Rice 220 or Smail Gallery
- Texts: *Plants in Action* (free online, thanks to the Australian Society for Plant Biology). All readings will be available through Moodle or as a hard copy pdf.
- Prerequisite: BIO/ENVI 170

Plants are the world's 'dominant life-form' - they account for 80% of global biomass (Bar-On *et al.*, 2018). Plant physiological processes and how they interact with the environment have a large role in regulating local, regional, and global climate and controlling ecosystem functions. Climate change is altering these processes across diverse ecosystems. We will learn about plant physiological processes, including converting light to energy, carbon cycling and storage, water transport, nutrient acquisition, growth, and the responses of these processes to an increasingly variable and potentially stressful world. Plant Ecophysiology is notoriously 'gadget' intensive; we will learn about current techniques available to measure physiological processes from leaf to globe, and analyze new data and publicly available datasets in R.

We will also focus on the broader process of science: how do we turn ideas into questions, questions into data, and data into compelling stories about the natural world? How can science be practiced inclusively and equitably?

WHAT QUESTIONS DRIVE PLANT ECOPHYSIOLOGY (and our class)?

We will spend the semester together reading, observing, critiquing, measuring, brainstorming, analyzing, and developing new ideas, with the goal of digging into the following questions as well as others:

- What will terrestrial ecosystems look like in the future?
- How will the functions and roles of plants change under current and future climate change?
- Can we use experiments to reliably predict plant function now, and under future conditions?
- How can we apply tools and models to understand plant function? What are their limits?
- What roles do technology and individual/team creativity play in experiments/science?
- Where are the intersections of Plant Ecophysiology and Environmental Justice?
- How can we work effectively as individuals and in small and large groups?

OUR LEARNING GOALS

Being an effective scientist requires an open, collaborative mindset that adapts to new information. In Plant Ecophysiology, we will discuss both the technical details of plant processes, how they are measured, and their function in diverse landscapes. We will discuss literature weekly, present on our ideas frequently, and analyze data in R/RStudio. Labs will emphasize concepts through collection and analysis of novel and publically available datasets. We will also work individually and collectively to foster a welcoming, safe, and supportive environment grounded in mutual respect.

- Discuss plant physiological concepts and experimental techniques, citing classic and current literature.
- Compare and contrast drivers and controls of plant function under different climates, environments, and biological categories
- Analyze original data and available open datasets with R/RStudio
- Communicate ideas effectively to experts and non-experts through writing, speaking, and visual presentations.
- Identify, describe, and contextualize multiple ecophysiological 'tools'.
- Read a scientific paper without anxiety and evaluate its strengths and weaknesses and areas to expand on.
- Work independently or as a small team on a larger examination of an original topic (ie - data investigation, experimental analysis, research proposal, GRFP example, etc)
- Connect plant physiological processes to broader environmental justice contexts.
- Build a community of learning where challenges are met with thoughtful, open discussion and collaboration

Plant Ecophysiology is my professional discipline – I love it and look forward to sharing it with you. I envision this class as a place to grow and experiment with new approaches and ideas. For everyone to do that successfully, the class needs to be a welcoming, supportive, and respectful environment grounded in mutual respect of the individuals that comprise the class and their ideas.

If you at any point feel there is something about the class that is keeping you from success, I encourage you to reach me by email, in person, or through a designated student 'ombudsman'/advocate.

*What is an ombudsman? A student representative to serve as an advocate for a particular issue or problem that you may not feel comfortable saying to the professor directly. You will nominate our class ombudsman the first day of class.

I also encourage you to take care of yourselves through the semester and prioritize your physical and mental health - eat well, sleep well, and take breaks as needed. If you are feeling overwhelmed, need academic or mental health support, prioritize those needs. Tend to your needs as you would tend to those of a plant – if you are not thriving, reflect and see how to adjust the environment!

Academic support for writing: Works in Progress peer-support or MAX Center
Disability Services: disabilityservices@macalester.edu
Hamre Wellness Center same-day therapy appointments: 651-696-6275
Student Support: Office of Student Affairs studentaffairs@macalester.edu

| GRADING POLICIES | COMMUNICATION |
|--|---|
| <ul style="list-style-type: none"> ● Attendance Expectations: You are expected to attend all lectures and labs. You are responsible for all readings and material covered in class. If certain circumstances prevent you from attending class, please email me so we can discuss options. ● Excused absences include: travel for athletic or academic competition, emergencies, health/illness days, and religious observances. ● Missing quizzes, exams, and labs: MQs, exams, and labs will be offered at the scheduled time in person. Please arrange with me and the MAX Center if accommodations are needed to take exams outside of the class. ● Late work: Everyone is granted <u>one</u> "no questions asked" (NQA) 3-day extension on an assignment. To use this, email Mary within 24 before the deadline that you are applying your NQA extension for 3 extra days. <i>This does not apply to the final report, in-class presentations, or group presentations.</i> ● Grade Scale: A = 100-94%; A- = 90-93.9%; B+ = 87-89.9%; B = 83-86.9%; B- = 80-82.9%; C+ = 77-79.9%; C = 73-76.9%; C- = 70-72.9%; and so on. My goal is to make your grade status in this course transparent through the semester. ● Pass/Fail and Incompletes: You can declare your grading option before Dec 13. November 10th is also the last day to withdraw. | <p>How to address me: I go by Mary, Prof. Heskell, or Dr. Heskell – and am comfortable with any of those. I use she/her pronouns.</p> <p>Do you have a question/concern?</p> <ul style="list-style-type: none"> ● Ask in class, directly after class, during student hours, by appointment, or if my office door is open. ● I aim to respond to email in 24 hours. I try not to respond to emails in the evenings or on the weekends. ● Office hours/student meetings can be about anything - but try to make an appointment first! You can come with friends/as a group. <p>Discussions and Peer Review: Developing your own ideas about science can be personal, and the ultimate goal is understanding and learning from each other. This best occurs when there are shared values, expectations and norms of behavior. We will set norms together and define what works for our group.</p> <p>Developing your voice and being a team member: Science requires a balance of confidence and humility. We will need confidence to pursue and develop new ideas and approaches, to thoughtfully critique ideas, and to follow your curiosity. Science also requires humility and patience - with yourself, others, and the material. Individually, in groups, and as a class, we will identify our limitations, ask for help and guidance, listen to thoughtful, appropriate criticism from others, and reflect on our improvement and setbacks. As you develop your thoughts and opinions in this class, be mindful that we are also collectively creating an open, accepting community of learning and growth.</p> |

AI/ChatGPT thoughts & Policy: Yikes! "*O brave new world, with such [AI] in it!*" In a word, ChatGPT makes me uneasy. It looks like an incredibly helpful tool, but also one that might not attribute or cite the work it draws from, and one that could diminish the role of your individual approaches to questions and writing. Here's the thing about science and most academic disciplines - you aren't often defined by your 'rightness' but by your creativity and originality. So maybe let's practice being original as much as we can, while we still can? What else do we offer, if not our new ideas about the world? Resist becoming replaceable and producing ideas that can be generated in seconds by algorithms.

That said, if you choose to use AI, all uses of AI must be cited and explained why and how it was used. **This must include: the prompt put into AI, the original output, how you changed the output, how you fact-checked all information, and your reasoning as to why you used this. This will be attached as an AI Statement for all assignments where it is used.**

Macalester has updated its Academic Integrity policy to include AI offenses: Using AI under unauthorized, unacknowledged use can now count as cheating and plagiarism, which are grounds for interventions with the Academic Programs Director, Ann Minnick and myself.

Flexibility & Accommodations: I am happy to work together with students and the Disability Services office to make sure all accommodations are met. If you have accommodations for this class, please set up a meeting with me the first two weeks of the semester to discuss how they can be met.

If you do not have accommodations, but have in the past had needs for flexibility in attendance and deadlines, I suggest meeting with the Disability Services office. Similarly, please make a meeting with me early in the semester to talk about meeting the goals of the class.

Missing Labs:

Labs will not be made up after the fact. If you miss a lab for unexcused reasons (see section above for what makes an excused absence), you must get information and data from the lab from classmates, and can only receive a maximum grade of 75% for that lab assignment.

Missing Classes:

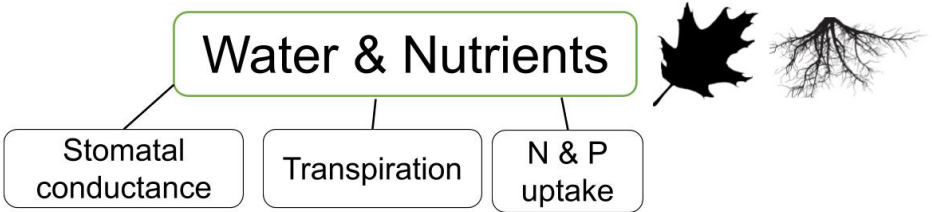
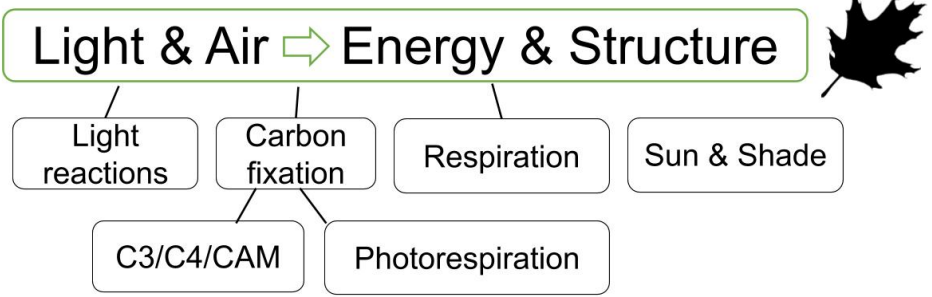
To promote communication, and minimize unexcused absences, there will be deductions in what is the maximum grade achievable for students. If you have 0 unexcused absences, your maximum grade is an A; if you miss 3 unexcused absences, your maximum grade is a B+, if you miss greater than 6 unexcused absences, your maximum grade is a B-. This maximum grade is assuming all other assignments and expectations have been met.

COURSE ASSESSMENTS / GRADING*

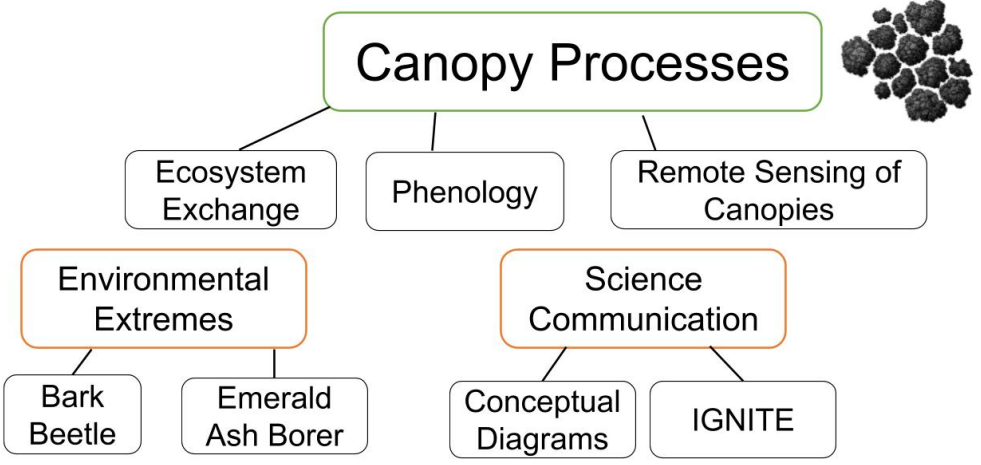
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| Mini-quizzes (MQ) | Mini-quizzes (1-3 questions, ~10 minutes) will be given in class every week. MQs review recently covered content and <u>will not be assigned a grade (just credit/no credit)</u> . After completion, questions will be reviewed and discussed in class. Select questions will reappear on exams - so hold on to them to study! | 5% |
| Participation & Engagement | Being an engaged participant will benefit your understanding of material, as well as your peers'. Examples of engagement: maintaining your journal, asking questions, acting as scribe/moderator for discussions, providing helpful criticism or dialogue about peers' work, student hours, attendance, showing up ready to participate in class | 10% |
| Reading & Discussion Responses | We will read and discuss primary literature regularly. Reading and discussion responses will occur in class and on Moodle/Perusall. Reading responses are meant to help you engage more as a critical reader of papers and provide starting points for discussions. | 10% |
| Lab assignments | Lab activities complement what we learn in class. We will collect new data, analyze datasets, and learn ecophysiological methods and analysis techniques. Lab assignments will vary based on focus. *Descriptions of specific assignments will be posted on Moodle* | 15% |
| Fascination of Plants Reports & Presentations | You will select materials about plants to briefly report on (750 words) and present in class to your peers. This can be drawn from current events, arts, history, books, documentaries, podcasts and the like. Your report will be an evaluation that ties into themes of the class, with the goal of extending your learning to new media, and then presenting your connections to the group, using references to support your writing. This will occur twice during the semester. Presentations will be 5 minutes total (IGNITE optional). (Report = 5%, Presentation = 2.5%) | 10% |
| Game Design | In groups of 3-4, you will develop original games - either card or table-top games, based on plant ecophysiology & ecology. Games will be presented and evaluated based on: fun, scientific accuracy, creativity, and engagement by peers. We will have a game day mid/late semester. | 10% |
| Midterm Exams | There will be two midterm exams that comprise a mix of short and longer answer questions and take place during class period. 10% each | 20% |
| The Big Project | <p>You will develop an original project on an ecophysiological question of your choice based on major themes covered in the course. You can work individually or as a pair. <i>Ideas include: GRFP style proposal, boardgame, open-data project, original data project, literature review, creative project (poetry, podcast, art, etc)</i></p> <ul style="list-style-type: none"> ● Individual idea meeting w/ professor (C/NC) ● Abstract, conceptual diagram, & class critique (C/NC) ● Methods & background, Broader Impact statement & Land Acknowledgement sections draft (5%) ● IGNITE Presentation (last week of class) (5%) ● Final project due (15%) | 20% |

WEEK

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- 14



Growth & Allocation



"Nothing in biology makes sense except in the light of evolution" – Dobzhansky

We will use a similar mentality towards studying plant ecophysiology: examining plant processes within the context of global climate change and its effects: elevated temperatures, increasing drought occurrence and severity, elevated CO₂, sea level rise, altered nutrient cycles.

All readings, assignment descriptions, lab quizzes, and other information about the course will be on Moodle. I will update Moodle frequently, so please check there. If something seems to be missing – please let me know!

| Week: Topic | Monday: Concepts | Wednesday: Eco application | Thursday: Lab | Friday: Primary Lit / Seminars / Fun |
|----------------------------|--|--|--|--|
| 1: Welcome to Ecophys! | | 9/6 Welcome! | 9/7 Biodiversity Exploration on campus; Setting up Grow House / Planting Corn, Soy, Sun flower | 9/8 Plant Narratives - What is your plant story? |
| 2: Eating the Sun | 9/11 Leaf structure & Light Reactions | 9/13 Light Reactions II MQ | 9/14 Field Trip to Cedar Creek! | 9/15 Leaf trait survey of the Prairie on Campus |
| 3: Sun + Shade Leaves | 9/18 Sun & Shade Phys & Sun/Shady Card Game! | 9/20: Sun & Shade – Building leaves MQ | 9/21: Ordway Field Trip : Light Response Curves, leaf angle, leaf traits, perimeter, petiole length, fluorescence (sun/shade) | 9/22: Daphne Bloom (PhD Student), UPenn - Visiting Seminar |
| 4: Eating the Air | 9/25 Yom Kippur -No Class | 9/27 Carbon fixation; Calvin-Benson cycle MQ | 9/28 Ordway Field Trip CO2 response curves, PAR estimates Leaf trait lab due (TBD) | 9/29 (Mary might be out) Photorespiration / Paper discussion |
| 5: Forms of Photosynthesis | 10/2 C3 / C4 / CAM 1 Month Eval | 10/4 FACE/ Global Change Experiments MQ | 10/5 C3, C4 CO2 responses and stomata density (at Mac) | 10/6 Sam Sharpe (PhD student), Kansas State Visiting Seminar |
| 6: Respiration | 10/9 Respiration MQ | 10/11 MIDTERM 1 | 10/12 Light response curve Analysis in R | 10/13 Response of A + R to Temperature Network Game! |
| 7: Water transport | 10/16 Stomata, Water Use and Transport | 10/18 Cavitation, Embolism and C starvation MQ | 10/19 Brainstorm Big Projects - Plant if needed! Work on Games in small groups! Response Curve Lab Due | 10/20 Dr. Jeannie Wilkerson & Xiating Chen (UMN) visit - Urban Plant Hydrology from cells to space! |

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| 8: Nutrients | 10/23 Nutrient Acquisition Mycorrhizae & Hyphal networks | 10/25 Mother Tree Debate! Schedule Project meetings | 10/26 Lab meets on Tuesday this week / Tree Coring at Ordway | 10/27 No Class - Fall Break! |
| 9: Growth & Allocation | 10/30 Sources + Sinks Project meetings this week | 11/1 Prof. Paul Overvoorde visit - plant hormones! | 11/2 Calculating Biomass and Incremental Growth / Work on Big Projects & Games | 11/3 Fascination of Plants Presentations |
| 10: Canopy fluxes | 11/6 Ecosystem Exchange & Flux Networks | 11/8 Ameriflux Data | 11/9 Visit to flux towers in Vermillion Highlands | 11/10 MIDTERM 2 |
| 11: Phenology | 11/13 Phenology of canopies Conceptual Diagram work time | 11/15 *Mary's talk at UMN today! *maybe no class? | 11/16 Observing Seasons: PhenoCams *Bring in laptop* Work on Big Projects & Games Biomass lab due | 11/17 Discuss Zohner et al. |
| 12: | 11/20 RP abstract & conceptual model peer review in class | Thanksgiving Break - No class | | |
| 13: Sensing a Canopy | 11/27 Remote Sensing of canopies MQ | 11/29 Satellites for Good! RP Methods & Background & BI/LA draft due | 11/30 Canopies from Space *Bring in laptop* / Work on Big Projects Phenocam Lab due | 12/1 Visit from Dr. Vini Marcilio-Silva (UMN) on urban tree diversity and phenology |
| 14: Project Work Time! | 12/4 Project Time | 12/6 Project Time | 12/7 Field trip to Conservatory | 12/8 Game Play! |
| 15: Future of EcoPhys | 12/11 IGNITE Presentations | 12/13 Future of EcoPhys (Last Class) | | Final RP due 12/15! No Final Exam |