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BOT 4503: Plant Physiology

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Class Meetings: Tuesday and Thursday 11:00-12:15

Office Hours (on Zoom): Tuesdays 1:00-3:00 or by appointment

Introduction

I first became fascinated by ecology at the end of high school when I first went to a desert and saw how diverse plants are—depending on the habitat in which they live. At the same time, I have found botany challenging to study because there is seemingly endless vocabulary associated with plants. In this course, we will focus less on the memorization of vocabulary and more on understanding how plants are built, how they work, and how their diversity of form and function can help us understand other biological and synthetic systems. In particular, we will focus on extracting fundamental 'rules' and general principles that apply not only to plants but also across all of life and even to social systems.

This is a Discipline-specific Global Learning (GL) course that counts towards your graduation requirement. This GL designation means that in addition to understanding *how* plants work, we will also understand the role plants play in local, regional, and global contexts: how their physiology influences and responds to climate across spatial scales, how they have been and are used by human societies and economies, and how their biogeographic history influences how they function and are used now.

Course Prerequisites: BSC 2010 and BSC 2011 (General Biology I & II)
CHEM 1045 and CHEM 1046 (General Chemistry I and II)

Course Objectives

1. To comprehend the fundamental concepts of plant physiology
2. To describe the physiological mechanisms regulating growth, function, and development
3. To understand and describe how plants respond to their environment over short- and long-term scales
4. To recognize the common functions shared by plants and other taxa

Global Learning Outcomes

Global Awareness: Students will demonstrate an understanding of the interrelatedness of specific plants' socioeconomic and/or ethnobotanical relevance across different local and global contexts.

Students completing the lecture course will gain familiarity with the diversity of plant structures and functions around the world, from deserts to tropical forests. Students will discover how plant form and function respond to and influence local, regional, and global climate processes. Additionally, students will gain an understanding of how aspects of plant structure and function have influenced their socioeconomic and/or ethnobotanical relevance across different local and global contexts. By

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gaining this awareness, students will gain a deeper understanding of the role of plants in their own communities and lifestyles and in communities and lifestyles of other people around the world.

***Global Perspective:* Students will conduct a multi-perspective analysis of an ecosystem challenged by different stakeholder interests, which impact local, regional, and global ecological and socioeconomic dynamics.**

Students will gain an understanding of how plants are at the center of many social conflicts, and how multiple stakeholder perspectives often conflict to influence environmental outcomes. Students will learn how to represent and defend viewpoints other than their own and demonstrate how to engage constructively with differing viewpoints in order to negotiate and (ideally) come to a consensus.

***Global Engagement:* Students will demonstrate a willingness to engage in solving challenges ecosystems face from different local, regional, and global stakeholders.**

In addition to gaining insight into the diversity of stakeholder perspectives based on different levels of appreciation of plants and plant function, students will be asked to reflect on how well they have engaged with formulating their own perspectives and with other opposing perspectives. Students will reflect on how to improve their own abilities to engage with global, diverse perspectives. They will demonstrate evidentiary basis for their own viewpoints and reflect on how their own and others' views are either not always based on evidence or they rely on different value weighting. Students will reflect on how different functions and uses for plants influence how different stakeholders value plants.

Plant Physiology Lab

Students participating in the lab section of this course will be conducting group research projects. They will gain experience in experimental design, hypothesis testing, data collection, data analysis, figure creation, and report writing. These skills are useful not only for biological research but for any type of project management or oversight involving quantitative data. In addition, students participating in the lab section will present their lab projects to the lecture section in order to gain skills presenting scientific information.

Course Structure

The course structure starts small—with cells—and moves progressively larger up to tissues, organisms, and ecosystems. At the same time, we will explore various themes related to resource acquisition and movement that influence plant growth and performance. We will identify the essential functions and challenges of being a plant, and then identify all the different solutions to these challenges that together result in the incredible diversity of plants that have existed over the last 500 million years. While this is a course in physiology, we cannot fully understand physiology without understanding evolution, and so throughout the course we will discuss how natural selection acts on plant structure and function. In so doing, what we discuss will complement other botany courses at FIU, such as Tropical Botany and General Ecology. Physiology addresses not just the 'what' but primarily the 'how' of plant biology. Furthermore, we will show how plants are model systems for understanding

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myriad other biological, synthetic, and social systems. To do this, we will draw on a diversity of other disciplines, including physics, engineering, urban planning, and architecture.

Date	Topic
23-Aug	Intro; supply chains; what is plant physiology?
25-Aug	Plant Cell Structure, cell walls
30-Aug	Energy and Work
1-Sep	Physics of Water
6-Sep	Fick's Law of Diffusion; Water Potential I
8-Sep	Water Potential II
13-Sep	Liquid Flux: Xylem structure, function, evolution
15-Sep	EXAM 1
20-Sep	EXAM 1 REVISIONS
22-Sep	Photosynthesis: Light+Carbon Reaction
27-Sep	Photosynthesis: Light Responses
29-Sep	Energy Balance
4-Oct	Transpiration: Vapor Flux
6-Oct	Photosynthesis: CO ₂ response
11-Oct	Carbon-Concentrating Mechanisms: C4
13-Oct	Carbon-Concentrating Mechanisms: CAM; Water-Use Efficiency
18-Oct	Review: gas exchange
20-Oct	Soil-Plant-Atmosphere Continuum (SPAC): water vapor, climate
25-Oct	EXAM 2
27-Oct	EXAM 2 REVISIONS
1-Nov	Xylem Embolism, and failure of vascular systems
3-Nov	Climate Change, ecological physiology
8-Nov	Reproductive Physiology
10-Nov	Organismal Design
15-Nov	Wrap-Up, Review
17-Nov	Stakeholder Debates I
22-Nov	Stakeholder Debates II
24-Nov	NO CLASS: THANKSGIVING

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29-Nov	Lab Project Presentations I
1-Dec	Lab Project Presentations II

Evaluation and Grades

In every course I have taken, my grade starts at 100% but it never stays there because I miss points on each assignment. In this model, grades can only decline throughout the semester. Rather than *losing* points throughout the semester, in this course you will *gain* points throughout the semester. This is a 'positivist' approach to grading. This style of grading has a few features:

1. Your final grade will be the total of all the points you have gained throughout the semester; below I have outlined how the final number of points maps to letter grades.
2. Within some bounds, assignments are optional. That's right: optional! You must fulfill a specific number of assignments in these 'buckets':

Assignment	Replicates (required)	Points per individual assignment	Total possible points per assignment type	Points	Letter grade
Quizzes	4 (2)	30	120	76 - above	A
Homework	2 (0)	50	150	600-675	A-
Midterm Exams	2 (1)	150	300	525-599	B+
Final Exam	1 (1)	150	150	450-524	B
Plant Profile	1 (1)	100	100	400-449	B-
Position Paper/Debate	1 (1)	150	150	350-399	C+
Debate Reflection	1 (1)	100	100	300-349	C
Total			1070	250-299	C-

- a. take at least one midterm exam
 - b. take at least two quizzes (and these will be scheduled in advance—it's important to attend class)
- This model has built-in extra credit! Essentially, *any assignment* (beyond the bucket minima) is extra credit.

Exams

There will be two midterms. We will discuss more details about administration of the exams. In the class after you turn in the exam, you will work in groups to revise your exam and earn up to 50% of the points back. The goal is not to highlight what you don't know, but rather for you to consider the

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problem and form an opinion before discussing with other people—the exam should be a first draft of your thoughts. (This is essentially how all research projects work.)

Quizzes

During four as yet unspecified classes, I will have a quiz for you to take in class. You must take at least two of these quizzes throughout the semester.

Homeworks

I will give you two homework assignments during the course. These will be written similar to how exam questions will be written, so they will be good practice for the exam.

Late Policy and the Bucket Minima

Because every assignment is optional, I have a strict late policy. Homeworks cannot be made up—if you don't turn them in by the deadline, then you won't get the points. Quizzes and exams are fewer in number and have a required minimum number that you must take (two quizzes and one midterm exam). *Without an approved excuse*, you cannot make up the Quizzes or Exams. Papers have deadlines and are fewer in number, but you must complete them. For each day (24 hours) they are late you will lose 7% of the points. I encourage you to plan ahead and earn points early in the semester. Students who wait too long to begin completing assignments struggle to earn a grade they are happy with.

The one punitive grading policy is that you will lose 30 points for each bucket whose minimum number of assignments is not met. For example, if you take only one quiz, then you will lose 30 points from your total grade. Or, if you do not take either of the midterm exams, then you will lose 30 points from your final grade. The minimum number of assignments you must complete is low, so meeting the bucket requirement should be easy. However, this also requires some planning on your part to ensure if you skip one assignment in a bucket that there remain options to fill that bucket later.

Course Materials

There is no required textbook for this course. I will be providing background and recommended readings as necessary throughout the course. This means that lecture attendance is crucial for your success. However, if you want textbook recommendations for reference, I suggest *Plant Physiological Ecology* (any version), most recently by Lambers and Oliveira (previous versions were by Lambers, Pons, Chapin) (full disclosure: Rafael Oliveira is a friend and collaborator of mine.) Also, *Plant Physiology* by Taiz and Zeiger is another excellent textbook.

Some of the course readings that present multiple and diverse perspectives:

Plant Vision, Sentience, Bioethics:

Gianoli E and Carrasco-Urra F. 2014. Leaf mimicry in a climbing plant protects against herbivory. *Current Biology* 24:984-987.

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Baluška F and Mancuso S. 2016. Vision in plants via plant-specific ocelli? *Trends in Plant Science* 21:727-730.

Gianoli E. Eyes in the chameleon vine? *Trends in Plant Science* 22:4-5.

Singer P. 18 February 2022. Even if plants experience consciousness, that doesn't mean we should stop eating them. *The Globe and Mail* <<https://www.theglobeandmail.com/opinion/article-even-if-plants-experience-consciousness-that-doesnt-mean-we-should/>>

Tropical Deforestation and Meat Consumption:

Malhi Y et al. Climate change, deforestation, and the fate of the Amazon. *Science* 319:169-172.

Williams NE et al. Resource users as land-sea links in coastal and marine socioecological systems. *Conservation Biology* 36:e13784.

Boyce CK and Lee J-E. 2010. An exceptional role for flowering plant physiology in the expansion of tropical rainforests and biodiversity. *Proceedings of the Royal Society B* 277:3437-3443.

Moran B. 2018. Farmers & Forests. *The Brink*. <<https://www.bu.edu/articles/2018/deforestation-in-brazil/>>

My advice for success in this class: do the assignments on time and earn points early. Asking questions during class, engaging in class discussions, attending office hours will all improve your understanding. You'll find that my homework and exam questions ask you to apply your understanding to new situations, so memorizing lecture content will not get you far. For many people taking notes during the class helps with focus and engagement. *I encourage you to take notes with pen and paper and not on your computer.* Substantial research shows that physically writing better commits ideas to memory because you must process the material. I will make my slides available each week in Canvas, but you will find that having the slides alone without notes will probably not suffice for reviewing and studying the material. I have also found that studying in groups helps me to better understand material, and I encourage you to do the same.

Class Meetings

Attendance is expected in this class, but I will not be grading you on attendance. Because there will be four pop quizzes and because there is little required reading, it is in your interest to attend class.

I expect active and thoughtful course engagement and attendance. This entails showing up on Tuesdays/Thursday 11-12:15 and sharing your ideas either through in-class conversation. The more engagement we bring to the classes, the more valuable our time together will be.

Studying and Communicating during a Pandemic

The pandemic has brought with it a great deal of uncertainty. Since we can't predict how the situation will change, it is important that we remain flexible and adaptable as circumstances evolve. I will keep everyone informed if/when changes to the course are needed. Similarly, if you encounter challenges due to the pandemic, do not hesitate to contact me and reach out to support services at

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FIU. I will be following CDC guidance and wearing a mask during lecture, unless we are outside. I encourage you to follow the advice of public health officials for all of our safety.

Daily and before arriving to campus, complete the P3 app. If you are not given the green check mark to enter campus, then return home, and contact me by email.

If you do not feel well, have tested positive for COVID, or have been in contact with a person with COVID while not yet being fully vaccinated, **please do not come to class, immediately complete the P3 app to notify the COVID Response Team or call them at 305-348-1919, and contact me by email as soon as you can. To excuse absences for P3 failure/COVID, please contact the COVID Response Team at 305-348-1919.** If you are directed to quarantine because of COVID-19, your absences will be considered excused. We will discuss the assignments and any make-up options. However, because many of the assignments in this course are optional, there will be few make-up options for assignments.

Per recent CDC guidelines, a vaccinated, asymptomatic individual exposed to a COVID-19 positive person does not need to isolate or quarantine. Nevertheless, it is strongly encouraged to continue to wear a mask. Furthermore, it is recommended to get tested 3-5 days after your own exposure. However, if at any time you become symptomatic, you need to test immediately. If the test returns positive, you will need to follow the COVID-19 positive protocol at that time.

- Asymptomatic” means (of a condition or person) producing or showing no symptoms.
- Symptomatic” means exhibiting or involving symptoms.
- People with COVID-19 have had a wide range of symptoms reported – ranging from mild symptoms to severe illness. Symptoms may appear 2-14 days after exposure to the virus. Anyone can have mild to severe symptoms. People with these symptoms may have COVID-19:
 - Fever or chills
 - Cough
 - Shortness of breath or difficulty breathing
 - Fatigue
 - Muscle or body aches
 - Headache
 - New loss of taste or smell
 - Sore throat
 - Congestion or runny nose
 - Nausea or vomiting
 - Diarrhea

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Please take every precaution to keep yourself and others healthy. Per CDC guidelines, you are encouraged to get vaccinated and strongly advised to wear a mask indoors and in public including all FIU facilities. For me to assist you in achieving your goals, it is important for you to contact me as soon as you experience any events that might disrupt your course participation. For up-to-date information about COVID, please see the repopulation.fiu.edu FAQs.

Please be advised that class content may be subject to streaming or course capture for future access by students in this course. Your attendance/participation in this course constitutes consent to such recording.

I value frequent, open, honest communication with students. I will communicate with all of you primarily through Canvas and announcements during class meetings. You can also email me directly at <aroddy@fiu.edu>. Please put the course name or number in the subject line. I will try to respond within 24 hours, but please be patient with me, as I will be with you.

Mental Health and Wellbeing

The global pandemic has changed our daily lives in unprecedented ways. It's understandable for us to experience fear and concern when facing immense change and uncertainty. To look for ways to cultivate calm and a clear perspective amidst the chaos, check out the https://greatergood.berkeley.edu/article/item/greater_good_guide_to_well_being_during_coronavirus Guide to Well-Being During Coronavirus from the University of California Berkeley's Greater Good Science Center.

If you are interested in seeking support from a mental health professional, please call FIU's Counseling & Psychological Services at 305-348-2277 (MMC) or 305-919-5305 (BBC).

Don't forget to take breaks while reading assignments and studying. Taking a break while going over the course material is important because it gives your brain time to rest and recover, which leads to boosts in everything from your productivity to your wellbeing.

Nobody signed up for this! Know that we are all in this together, so let's prioritize supporting each other as humans, finding simple solutions that make sense, and sharing resources and communicating clearly.

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