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BIOB 524.01: Physiological Plant Ecology

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BIOB 524 - PHYSIOLOGICAL PLANT ECOLOGY - FALL 2014

Instructor: Dr. Anna Sala; BOT 117-A; 243-6009; sala@mso.umt.edu
Days and Time: Tuesdays and Thursdays 2:10- 3:30 p.m.
Meeting Room: NAC 202
Office Hours: By appointment

Reference Texts: We will not follow a textbook. Instead, we will read papers from the literature. I will provide a list of general reference textbooks.

Reading Materials: Digital copies of selected papers will be distributed via email (you can also get them on your own)

Course Format: This is a combination of lectures/discussions course. It is not meant to be a comprehensive, content-filled 'walk' through the entire field of Plant Physiological Ecology. Instead, we will cover several broad topics centered on one or a few questions. For each topic I will provide some background and/or students will be assigned to read review papers ahead of time. Students will also read assigned ideas, synthesis or original research papers ahead of time, which will then be discussed in class. Most likely, we will not be able to cover all topics outlined. This is fine as long as you are aware of the issues not covered, and the relevance they may have on your work. Alternatively, we may modify topics depending on students' interest. This means that this syllabus is only tentative and we may change it as we go. I will try to give updates of changes via email, but if you miss class it is ultimately your responsibility to make sure what has been covered and whether we made changes.

Pre-requisites: Plant Physiology is fundamental. If you are rusty, you should review the basics of water relations, photosynthesis, mineral nutrition and growth and development. Please, let me know if you need help to catch up with a particular topic.

What to expect: This is a graduate course that requires a graduate student attitude: you are here because you are interested and/or the topic is relevant to your graduate work, not because you are asked to. Therefore, I expect you to do your best. Undergraduate students taking this course should be aware that you are no longer in the passive, listener end. What you learn from this course ultimately depends on what you want to learn. Student participation and motivation is fundamental. Inquisitive and involved students result in interactive, fun and productive classes. Therefore, class success depends as much on your contribution as on mine. Read, read, read, and ask, ask, ask, particularly, if you do not know or you do not understand something. I benefit immensely from your feedback. I particularly welcome additional/different suggested readings, topics and questions, alternative interpretations or views, intellectual challenge (I benefit from your challenge as much as I will try to challenge you)

Grade Basis: Grades will be tentatively determined based on: 1) class preparation and participation, 2) synthesis/ outline/critique of selected papers, 3) performance on a take home final, and 4) proposal.

Tentative grading criteria: **320 points total**

Synthesis/critique of discussion papers (10 papers @ 20 points each)	200	
Take home final		60
Proposal	60	

Synthesis/critique of selected papers: You are asked to write a short synthesis/critique of 10 of the papers discussed in class. Note that there are more papers discussed than written synthesis required. However, *it is critical that you read each paper prior to class discussion regardless of whether you write a synthesis or not*. I will not take more than one synthesis/critique per week (i.e. it comes to about one paper per week). Synthesis/critiques should be turned in **prior** to the discussion in class. Late papers **will not** be accepted. You are welcome to submit more than 10 syntheses, in which case I will use only the best 10 for grading purposes.

Each synthesis/critique should be typed, 12 font, adequate margins (no less than 1 inch), and no more than two pages long (1.5 line spacing is much preferred over single spaced but I will take both). I encourage you to follow a bulleted format as in the abstracts of many journals (e.g. *New Phytologist; Functional Ecology*, etc.). I tend to grade generously the first syntheses/critiques submitted, but I will tighten the grading gradually. The idea is for students to practice writing well, clearly, with a logical flow, and as succinctly as possible while not missing main points.

For original research papers, the first bullet should identify the broad conceptual/theoretical framework of the paper. Subsequent bullets should identify the specific topic of the paper, the questions/hypothesis pursued, the overall approach followed, main results and conclusions. A final bullet(s) should be your own critical evaluation of the paper (is the conceptual framework well defined?; are the hypotheses/main questions well justified and reasonable?; are the experiments and/or measurements appropriate to test the hypothesis/questions formulated?; are the methods and statistical analysis appropriate?; are the results clear and well presented?; are the results sufficient to test the hypothesis and draw the conclusions?; is the discussion sound?; what is the potential impact of the paper to the scientific community? etc.). If you think the research is well done and has no major flaws, you might not need to raise all of these points and your own creative comments and interpretation of the results will be just as valuable (or more!) for the discussion in class.

For review papers: Summarize in your own words the conceptual framework and the main ideas. I suggest writing a bulleted outline (as if you were preparing a talk about the material in the review) where each bullet conveys a clear message (e.g. broad conceptual background; purpose of the review; main approach; main findings; proposed directions, etc). You may want to highlight what you think are particularly relevant or innovative ideas. It may also be that you find the review problematic for whatever reason (e.g. certain topics not covered or not current enough, narrow focus, etc.). If so, add some bullets on why the review is problematic.

Take Home Final. It generally consists of evaluation/interpretation of real empirical data. I may also include some short essay-type questions, in which case I will specify whether you can consult your notes or not.

Proposals. The proposal should have a physiological component. Proposals are due on Tuesday of finals week. They should be typed, no more than 8 pages double-spaced (excluding literature and figures). See separate guidelines for proposal preparation. I will send examples of successful proposals or pre-proposals. Because the hardest part of a proposal is the Introduction (which is very important), we'll go through a couple of rounds of Introduction drafts (the first due in October) before you submit your final proposal at the end of the semester.

TENTATIVE **CLASS SCHEDULE (See questions and readings below)**
At the end of the semester, I need at least 10 critiques selected from papers followed by '(critique)

WEEK	DATE	TOPIC
Week 1	26- 28 Aug.	Introduction and current directions. Plant Groupings. **Paper 1 (critique).**
Week 2	2-4 Sept.	Photosynthesis: responses to the environment. **Paper 2 (read)** **Papers 3 (critique)**
Week 3	9-11 Sept.	Photosynthetic pathways. **Paper 4 (read)** **Paper 5 (critique)**
Week 4	16-18 Sept.	Carbon Isotope Ratios. **Paper 6 (read)** Photosynthesis and climate. **Paper 7 (critique)**
Week 5	23-25 Sept.	Respiration **Paper 8 (critique)**
Week 6	30 Sept.-2 Oct.	Above- and below-ground carbon interactions **Paper 9 (read)** **Paper 10 (critique)**
Week 7	7-9 Oct.	Carbon and growth **Papers 11-12 (read), 13 (critique)** **First Proposal Introduction draft due**
Week 8	14 Oct. **16 Oct.**	Phloem. **Paper 14 (critique)** **No CLASS (Anna's Travel) Work on proposal**
Week 9	21-23 Oct.	**No CLASS (Anna's Travel)**
Week 10	28-30 Oct.	Water relations: cell, tissues. **Paper 15 (critique)**
Week 11	**4 Nov.** 6 Nov.	**Election day. Make up class?** Water relations: Hydraulics. **Paper 16 (critique)** **2nd draft Proposal Introduction**
Week 12	11 Nov. 13 Nov.	**Veteran's day. Make up class?** Water relations: plant survival **Papers 17 (critique) and 18 (read)**
Week 13	18-20 Nov.	Mineral nutrition. **Paper 19 (read)** **Papers 20 (critique) and 21 (critique)**
Week 14	25 Nov. 27 Nov.	Plant Reproduction. **Paper 22 (critique).** **NO CLASS. Thanksgiving**
Week 15	2-4 Dec.	Plant Defenses. **Paper 23 (read)** **Paper 24 (critique).**
Week 16	11-13 Dec.	**Full Proposal due. Take Home Final**

MAIN TOPICS AND *TENTATIVE* READINGS

Plant Groupings

- Why grouping?
- On what basis? Functional groups or Trait-based grouping? Why?

Reading:

1. Poorter L, Wright SJ, Paz H, et al. 2008. Are functional traits good predictors of demographic rates? Evidence from five Neotropical forests. Ecology 89: 1908-1920.

Photosynthesis: responses to the environment

- How sensitive is photosynthesis to changes in light, water, temperature and CO_2?

Readings:

2. Leakey ADB., Ainsworth, EA, Bernacchi CJ, et al. 2009. Elevated CO_2 effects on plant carbon, nitrogen, and water relations: six important lessons from FACE. Journal of Experimental Botany 60: 2859-2876.
3. Givnish, TJ; Montgomery, RA; Goldstein, G. 2004. Adaptive radiation of photosynthetic physiology in the Hawaiian lobeliads: Light regimes, static light responses, and whole-plant compensation points. American Journal of Botany 91: 228-246

Photosynthetic pathways

- What were the drivers for the evolution of alternative photosynthetic pathways?
- Do we expect shifts between C3 and C4 species with climate change?

Readings:

4. Ehleringer JH and Monson RK (1993) Evolutionary and ecological aspects of photosynthetic pathway variation. Annu. Rev. Ecol. Syst. 24:411-439.

5. Osborne CP, Beerling DJ. 2006. Nature's green revolution: the remarkable evolutionary rise of C-4 plants. Philosophical Transactions of the Royal Society B-Biological Sciences 361: 173-194.

Carbon Isotope Ratios

- What explains variation?

Reading:

6. Cernusak LA, Ubierna N, Winter K, et al. 2013. Environmental and physiological determinants of carbon isotope discrimination in terrestrial plants. New Phytologist 200: 950-965

Photosynthetic pathways and climate change

- Do we expect shifts between C3 and C4 species with climate change?

Reading:

7. Wittmer MIHO, Auerswald K, Bai Y, Schäufele R, Schnyder H. 2010. Changes in the abundance of C3/C4 species of Inner Mongolia grassland: evidence from isotopic composition of soil and vegetation. Global Change Biology 16: 605–616.

Respiration

- How sensitive is respiration to light, temperature and moisture?
- Does respiration acclimate to changing temperature regimes?

Reading:

8. Atkin, O. K., Bruhn, D., Hurry, V. M. & Tjoelker, M. G. 2005 The hot and the cold: unravelling the variable response of plant respiration to temperature. Funct. Plant Biol. 32, 87–105.

Above and below ground carbon interactions

- Does photosynthetic activity influence below ground processes?
- Measuring soil respiration: what in the world are we really measuring?

Readings:

9. Högberg P, Read DJ. 2006. Towards a more plant physiological perspective on soil ecology. Trends in Ecology & Evolution 21: 548–554.

10. Aubrey DP, Teskey RO. 2009. Root-derived CO_2 efflux via xylem stream rivals soil CO_2 efflux. *New Phytologist* **184**: 35–40

Carbon and growth

- Does carbon availability control growth?

Readings:

11. Körner C. 2003. Carbon limitation in trees. Journal of Ecology 91: 4–17.

12. Sala A, Woodruff DW, Meinzer FR. 2012. Carbon dynamics in trees: feast or famine? Tree Physiology 32: 764-775.

13. O'Brien MJ, Leuzinger S, Philipson CD, Tay J, Hector A. 2014. Drought survival of tropical tree seedlings enhanced by non-structural carbohydrate levels. Nature Climate Change 4: 710–714.

Phloem

- How much do we know and why should we care?

Readings:

14. Fu QS, Cheng LL, Guo YD, Turgeon R. 2011. Phloem Loading Strategies and Water Relations in Trees and Herbaceous Plants. Plant Physiology 157: 1518-1527.

Water Relations

- Why does plant growth cease when water is limiting?
- Do plants face water transport efficiency vs. safety tradeoffs?
- What are the ecological implications of different drought resistance strategies?
- How does drought kill trees?

Readings:

15. Arndt SK, Livesley SJ, Merchant A, Bleby TM, Grierson PF. 2008. Quercitol and osmotic adaptation of field-grown *Eucalyptus* under seasonal drought stress. Plant, Cell & Environment 31: 915–924.

16. Maherali H, Pockman WT, Jackson RB. 2004. Adaptive variation in the vulnerability of woody plants to xylem cavitation. Ecology 85: 2184-2199

17. Tyree, M. T., Engelbrecht, B. M. J., Vargas, G. & Kursar, T. A. 2003. Desiccation tolerance of five tropical seedlings in Panama: Relationship to a field assessment of drought performance. Plant Physiol. 132, 1439–1447.

18. McDowell N, Pockman WT, Allen CD, Breshears DD, Cobb N, Kolb T, Plaut J, Sperry J, West A, Williams DG et al. 2008. Mechanisms of plant survival and mortality during drought: why do some plants survive while others succumb to drought? New Phytologist 178: 719–739.

Mineral nutrition

- What are the costs and benefits of different nutrient acquisition/conservation strategies in plants?
- What are potential effects of climate change on plant mineral nutrition?

Readings:

19. Lambers H, Raven JA, Shaver GR, Smith SE. 2008. Plant nutrient-acquisition strategies change with soil age. Trends in Ecology and Evolution 23:95-103.

20. Averill C, Finzi A. 2011. Increasing plant use of organic nitrogen with elevation is reflected in nitrogen uptake rates and ecosystem delta N-15. Ecology 92: 883-891.

21. Orians GH, Milewski AV. 2007. Ecology of Australia: the effects of nutrient-poor soils and intense fires. Biol. Rev. 82: 393–423.

Plant Reproduction

- How costly is plant reproduction?

Reading:

22. Sala A. Hopping K, McIntire EJB, Delzon S, Crone EE. 2012. Masting in whitebark pine (*Pinus albicaulis*) depletes stored nutrients. New Phytologist *In Press.*

Plant Secondary Compounds:

- How costly is plant defense?
- Do plants integrate defense responses?

Readings:

23. Herms DA, Mattson WJ. 1992. The dilemma of plants: to grow or defend. Quarterly Review of Biology: 283-335.
24. Moreira X, Zas R, Sampedro L. 2011. Genetic variation and phenotypic plasticity of nutrient re-allocation and increased fine root production as putative tolerance mechanisms inducible by methyl jasmonate in pine trees. Journal of Ecology 100: 810–820.