Botany 330 Take-Home Midterm Exam 2016

I. Introduction. These essay questions are designed to foster integrative thinking, comprehend the peer-reviewed literature, and express findings in a clear way to a peer audience. The essays are meant to model the kinds of short reports that you might write in a future professional situation. In almost any biology-related field, you are likely to be expected to summarize important information for the rest of your work group in a concise, yet readable way, and to do so by mandated deadlines.

In these essays, you are writing for a reader who is a professional and has earned at least an undergraduate degree in biological science, in other words, a peer. ESSAYS SHOULD NOT BE WRITTEN FOR THE GENERAL PUBLIC. Please use technical language and high-level concepts that you have learned in your previous biology courses!

It is important to have your drafts edited by the instructor before you produce the final product. You will be told exactly what changes are needed to achieve an excellent grade. If you comply with specified deadlines and editorial recommendations, you should be able to earn all or most of the available points for essay exams!

It is not advisable to wait until close to deadlines to start writing! You can benefit your work in this and other courses by starting to work on Botany 330 essays right away and continuing to work steadily toward the midterm due dates.

II. Essential components. Each of your answers is expected to combine relevant material from the textbook with content from a particular, very recent peer-reviewed article, in approximately equal amounts. The textbook reflects compendia of information that you might rely upon in a future professional situation and the peer-reviewed articles display the latest thinking, techniques, and results in a field. Obtaining information from more than one reliable source is a good way to cross-check information and detect information that has become outdated.

Don’t use any other sources of information to write your essays, because such sources are unlikely to be as accurate and current.

So, don’t forget to include both sources of material (text & article) in your essays. It is common for people to become so focused on the articles that they forget to incorporate essential background information from the text. Text information is likely to come from >1 chapter; use search terms to find all relevant material.

When discussing articles, it is very important to include at least an overview of methods used in the study, because without that information, it would be difficult for a peer reader to evaluate the accuracy of the results.
III. Getting started. So that we can get everyone on the right track, everyone must turn in a draft answer to the first question by 5 pm on Wed. Sept. 21, 2016. Your drafts must incorporate/integrate: 1) textbook chapters 2 (biogeochemistry), 3 (biotic interactions), and 6 (cyanobacteria); and 2) the Sandrini et al. 2016 article “Rapid adaptation of harmful cyanobacteria to rising CO₂,” published in *PNAS*.

The article title explains why this is an important topic for biologists and society.

*This first draft essay is so important that 10 points will be deducted from the total for the midterm exam if this draft is late.*

Note: Q1 provides abundant prompts to focus your attention on essentials, but other questions will not include these prompts because the process of writing a draft of essay 1, receiving edits, and revision will acquaint you with what is needed.

All drafts and final essays must be at least 2 and maximally 4 double-spaced pages long, with 12-point easy-to-read typeface such as Times New Roman. Upload drafts to the Botany 330 Learn@UW Dropbox into the file marked “midterm exam drafts”. Draft essay 1 will be edited and returned via Botany 100’s Learn@UW dropbox by Sept. 30. Don’t wait for this edit before proceeding with other questions though.

In addition to Q 1, undergraduates must also answer 4 of the questions posed below; graduate students must write about any additional 5. It is a graduate school requirement that in mixed courses, graduate students must perform work not required of undergraduates.

IV. Additional Deadlines. Drafts of the other 4-5 essays are due on or before 5 pm, October 7. Ten points will be deducted from the potential 100 points if all 5-6 drafts have not been turned in by 5 pm on this date.

*Please link all 5-6 of your draft essay files together and incorporate your surname in the filename to reduce odds of misplacing files.* (It is common for people to upload essays one at a time or to name them cryptically, in which case grading is delayed by the amount of time needed to gather and rename files.) Edits will be returned via Learn@UW by Oct. 14, in time to incorporate suggested modifications into drafts of all essays. Most edits will be completed well before Oct. 14, so check Learn@UW to see if your edits are there earlier, then go right ahead with revisions.

**The final version of all midterm essays is due by 5 pm on October 19.** Ten points will be deducted if any portion of the final version of the midterm exam is late.

(The purpose of the deadlines and deduction of points if deadlines are missed is to foreshadow processes that occur in workplaces. There are always deadlines in workplaces and consequences for missing them, so by imposing deadlines we are not being mean, but rather trying to foster work habits that will benefit you later.)
Please link all 5-6 of your final essay files together and incorporate your surname in the filename to reduce odds of misplacing files.

V. Resources. The articles you will write about were chosen for currency and relevancy to issues of wide concern. The journals represent the highest-rated & most demanding publication sources. In the future, these are among the sources you can trust to provide authoritative and carefully peer-reviewed information.

Before starting to write your essays, please read through the document “Editorial Issues” located on the Botany 100 course website. This action may help you to avoid making common errors in English usage. Because this is a Comm B course, essays will be graded on English expression as well as content. We recommend printing out the editorial issues document and posting it at your workspace for easy reference.

VI. Ethics and scholarly responsibilities. You must cite the article author(s) appropriately within your essays in this form: (Sandrini et al. 2015). See “Editorial Issues” to understand why “et” is never followed by a period, but “al.” always has a period. This might seem picky, but it is core biological literacy.

Notice where literature citations occur in scientific articles: immediately following material that has been addressed in the citation. Do not credit article authors for knowledge generated by previous workers, such as information provided in article introduction sections. Only cite article authors for the work they actually did. If an entire paragraph is related to such work, only cite authors at the end of the paragraph (not in every sentence).

At the end of each essay provide article author names, date, article title, journal name, volume, & pages. For simplicity, it is not necessary for you to cite the textbook.

For this exam, do not use any sources of information other than your own copy of the 3.1 edition of the digital textbook Algae, or the assigned articles. The reason for this is that these sources are the most current and reliable.

Collaboration with your peers in the composition of these essays is specifically prohibited, though it is perfectly fine to discuss articles amongst yourselves or with instructors.

It is also prohibited for you to have your essays edited or “polished” in any way by anyone other than current Botany 330 course instructors. Don’t ask friends to help or use professional editing services. The reason for this is to ensure than you will receive the maximum practice in writing and revising, to benefit your future success.
You are not expected to necessarily agree with the conclusions of authors; a skeptical view or alternative opinion might be justified. Essay content should be professionally unemotional. Personal opinion is fine, but only if it can be justified by peer-reviewed literature. Personal attacks on authors (known as *ad hominem* attacks) are not acceptable.

1. **Overarching question:** How is environmental change likely to influence the abundance of toxin-producing cyanobacteria?

   **Sub-components of answer in an appropriate order:**
   1) Explain why cyanobacteria, and particularly *Microcystis*, are important to society (Ch. 3 and 6). This discussion must include toxins, particularly microcystins.
   2) Explain the concept of nutrient limitation and discuss how cyanobacteria cope with limiting modern levels of CO$_2$ (Ch. 2). Discuss the role of cyanobacteria in reducing ancient Earth's higher atmospheric CO$_2$ content to today's lower levels (Ch. 6).
   3) What question did the article authors set out to answer and how did they approach the question? Provide at least a paragraph about methods that your peer reader will need to know. This material can be found in Sandrini et al. (2016) *Rapid adaptation of harmful cyanobacteria to rising CO$_2$*. *Proc. Natl. Acad. Sci. USA* 113:9315-9320.
   4) What were the major results described by the article and what do they mean for human society?

   Notice that sub-components 1 & 2 require background material from the textbook. In this case and for other essays, the articles provide updates and specific information related to the overall question, but articles should NOT be the main focus of any of your essays. Sometimes students try to cut corners by reading and writing about only the article and maybe just the article abstract. Avoid that temptation and include textbook information that provides essential context.

2. **How does fundamental knowledge of algal photosynthesis aid technological application?** Begin with an introduction to algal photosynthesis from textbook Chapter 1; include discussion of mechanisms that protect photosystems from damage by excess light. Segue to a brief list of ways in which algal photosynthesis yields materials useful to humans (Ch. 4); end that discussion with food supplements and valuable astaxanthin. Then explain why and how Chekanov et al. (2016) performed their related research (*Modulation of photosynthetic activity and photoprotection in Haematococcus pluvialis* cells during their conversion into haematocysts and back, published in 2015 in *Plant Physiology* 169:2444-2461). Finish by explaining how the results of that research contribute to astaxanthin production.

3. **How can genetic manipulations be used to improve production of renewable biofuels from algae?** Begin by explaining three major ways in which algae are used to generate renewable biofuels (Ch. 4), and then discuss genetic manipulation techniques (Ch. 4 section 5). With this background, explain why and how Fan et al.

4. How are cyanobacteria environmentally significant?
Start by summarizing the diverse environmental roles of cyanobacteria past and present (Chapter 6). End this discussion with a description of calcification by cyanobacteria (stromatolites and thrombolites), which will allow you to segue to a discussion of how cyanobacteria can bore through carbonate rocks. Finally, explain how and why Guida and Garcia-Pichel (2016) did the work described in their article “Extreme cellular adaptation and cell differentiation required by a cyanobacterium for carbonate excavation.” What surprising capacity did they find?

5. What is the past and modern importance of endosymbioses involving algae?
Begin by defining endosymbiosis and explaining how this mechanism gave rise to mitochondria and chloroplasts in the past. Then describe some modern examples of endosymbiotic algae (Chapter 7). End these examples with endosymbiotic cyanobacteria that occur in some diatoms, and the environmental importance of this association (Chapters 6 & 12). This background provides context for discussion of cyanobacterial associations with other phytoplankton such as haptophytes, described in the article by Cornejo-Castillo et al. 2016, “Cyanobacterial symbionts diverged in the late Cretaceous towards lineage-specific nitrogen-fixation factories in single-celled phytoplankton,” *Nature Communications* DOI: 10.1038/ncomms11071.

6. How might global environmental change influence algae? Chapter 1 ending provides an introductory example of warming influences on algae, and Chapter 2 includes a discussion of ocean acidification effects on carbonates produced by algal calcification. Segue to Chapter 10 material on coccolithophorids, and explain the composition and development of holococcoliths. This background will support a discussion of the Gibbs et al. 2016 article “Ocean warming, not acidification, controlled coccolithophore response during past greenhouse climate change,” *Geology* 44:59-62. What does the past suggest about our future?

7. To what other algal group(s) are haptophytes most closely related?
Chapter 7 introduces supergroups such as SAR and controversies that surround the supergroup placement of some algal groups (e.g. cryptomonads and haptophytes). After explaining why these issues matter, use material in Chapter 5 to explain how biologists try to assess phylogenetic relationships, and also the significance of horizontal gene transfer in algal evolution. This background provides context for discussing Miller and Delwiche (2015) “Phylogenomic analysis of *Emiliania huxleyi* provides evidence for haptophyte-stramenopile association and a chimeric haptophyte nuclear genome,” *Marine Genomics* 21: 31-42.

8. How does the structure of diatom frustules contribute to diatom survival?
Chapter 12 contains basic information about diatom frustules that you will need to forge the background to a discussion of the Aitken et al. (2016) article,
“Microstructure provides insights into evolutionary design and resilience of

9. What is the state of our knowledge regarding global marine diatom distribution and diversity? Use Ch. 12 to explain why diatoms are considered to be globally significant, and why their diversity matters. Use Chapter 5 to explain modern methods for assessing diversity by using molecular markers (e.g. the 18S rRNA gene for eukaryotes). Explain why and how the Malviya et al. (2016) team did the work described in the article “Insights into global diatom distribution and diversity in the world’s ocean,” Proc. Natl. Acad. Sci. USA www.pnas.org/cgi/doi/10.1073/pnas.1509523113. What do their results indicate about distribution patterns and unrecognized diversity?

10. How do diatoms cope with low irradiance? Begin by discussing the environmental and industrial importance of diatoms, primarily in Chapter 12. Then discuss photosynthetic responses to high light, including photoprotection pigments (see Chapter 1). Segue to low light responses, of importance in deeper waters and for optimizing industrial diatom growth for renewable energy production (low light environments would save on energy costs) (Chapter 4). Then discuss the Fisher & Halsey (2016) article “Mechanisms that increase the growth efficiency of diatoms in low light,” Photosynthesis Research 129:183-197.