

Bio101 Review Paper – Spring Semester 2019
Instructions for Students, and Scientific Writing Background

I. OVERVIEW

I sympathize with your perspective. It goes something like this: You love biology, you have a natural aptitude for math and science (or you are willing to learn...and you CAN!), you work tenaciously (often into the wee hours of the morning), you spend at least some of your free time thinking, reading, and talking with friends about biology, and you might even have a career goal identified. When it comes to being a professional scientist, you assume that these attributes will make you a certain success. Welcome to an industry secret: one of the most important skills in science is reading and writing. (It is apt to consider reading and writing as “one” skill, because the two are inseparable).

Reading and writing efficiently as a scientist is critical so that one can assimilate large volumes of new information, meet deadlines, communicate with fellow scientists, win competitive grant proposals, generate technical reports, and publish work in scientific journals. Reading and writing scientific literature is difficult because the topics are complex, the vocabulary is technical, and the writing style is unlike most forms of literature. In this course, we will expand your relationship with this style of writing.

Most articles in scientific journals belong to one of two categories: 1) original research articles, and; 2) review articles. Original research articles use data to test specific and well-defined hypotheses. In contrast, review articles provide a summary of all the pertinent research articles in a given field, and thereby provide a *review* of the scientific community’s current understanding of a topic. Both types are “peer-reviewed”, meaning that they are accepted for publication only after a rigorous process of review and approval by other expert scientists.

In this course, you will be required to write a scientific review article. In doing so, you will read and cite at least 10 original research articles. The ability to find relevant articles in libraries and databases is an important skill. We will begin honing this skill in the second week of the semester, at which time we’ll spend a lab period with the reference librarian in SBCC’s Luria Library.

DUE DATES:

- **Week 6, in lab, or Weds lecture, 5 points extra credit:** Turn in a 1-2 page overview of your review paper, including: Topic overview (1 paragraph), a brief overview of each of the 3-5 subsections of your paper, and three recent (published since 2013) peer-review original research article references, properly formatted (see *Literature Cited* format, below).
- **March 22 (Friday), via *turnitin.com*:** final review article is due (100 pts.)
- **March 22 (Friday), in Bio Office EBS212:** submit paper copy of paper

II. READING/WRITING SCIENTIFIC ARTICLES

II-A. Structure of original peer-review research articles, and advice for reading them:

Original research articles usually are formatted into the following sections (in order):

Abstract: A very brief (typically 200-300 words) overview of the hypothesis/research question being tested, a few essential results, and a statement regarding the study’s importance.

Introduction: Provides an overview of the research question(s), a brief summary of previous research and what is known about the topic, a description of how the hypothesis/research question being tested advances current understanding of a topic (and why this matters to the field and/or society in general), and (hopefully) a very brief statement about how the authors test their research question.

Materials and Methods: Detailed and technical description of the experiments, observations, and/or analyses used to address the research question/hypothesis.

Results: Reporting of the data collected, almost always including figures and the results of statistical analyses.

Discussion: Highly variable, but typically an interpretation of the results in the context of what is known and reported from previous literature. The discussion should provide an “answer” to, and broader conceptual exploration of, the research question posed in the introduction. Often, authors will identify future research or new research questions posed by the discoveries reported in a paper.

Literature Cited: This is a list of all sources cited in the paper. They are usually other peer-reviewed articles, but may include books, websites, government reports, etc.

The sectional organization of research articles allows readers to quickly prioritize their scrutiny of a paper. I suggest the following approach, taken in the following order:

1. Procure and read the paper in a physical format that you are comfortable annotating. You will use your notes not only to comprehend the article, but also to synthesize your own thoughts and organize your writing. This is possible with PDF files (the most common digital format for articles) as long as you have access to a newer version of Adobe Acrobat. Paper copies are very convenient to annotate and scan for content, but they can be cumbersome to store and access compared to digital files.
2. Be an “active reader”. See the above suggestion: your reading should be littered with notes, underlines, highlighted text, etc.
3. Read the title and abstract twice before proceeding to the *Introduction* section.
4. Read the *Introduction* section as many times as necessary to understand the background information and research question at hand (this might require multiple readings).
5. Skim or skip the *Materials and Methods* (your time is precious, and you can read this material later if you work in the field and/or need clarification. Most readers skip or very lightly skim this section).
6. Study the figures and figure captions of the *Results* section. Make sure you understand the axes and units!
7. Skim the *Results* section and re-read the figures and figure captions. Don’t get bogged down in the details of statistical analyses presented in the text, try to stay on point with regard to the content. (You might find yourself lightly skimming entire paragraphs that explain content that is obvious in the figures.)
8. Finally, read the *Discussion* section. While doing so, do not hesitate to refer to earlier portions of the paper.
9. Understand that some peer-review papers are going to be “over your head”. This is true for every scientist, especially when one is reading outside of one’s own field of expertise. If you are completely “stumped” by a paper for this project, take from it what you can and move on to another article. Or, come talk to me and let’s read through it together. Needless to say, simply discarding every challenge in your life is not a recipe for success. Try your best but know your limitations. Work efficiently - I can help.

II-B. Tips for writing your review article:

1. Read published review articles to get a feel for how they are organized. Organization of review articles is not the same as for original research articles. (Review articles are usually divided into multiple sections that address specific subtopics within the review. The subtopic sections have very short titles of approximately 2-10 words.)

The following reference* is for a recent review paper that is well-written, logically structured, and serves as a great example for your paper:

Céccoli, G., Ramos, J., Pilatti, V., Dellaferrera, I., Tivano, J.C., Taleisnik, E., & Vegetti, A.C. 2015. Salt glands in the Poaceae family and their relationship to salinity tolerance. *Bot. Rev.* 81: 162-178.

*The Botanical Review (abbreviated here as Bot. Rev.) is a peer-review journal that publishes review articles in botany (as the title suggests), and it is available through SBCC's Luria Library as an *ejournal*. I urge you to browse a few issues, and to emulate the style of scientific writing and structure of review articles that it contains.

2. Break your review paper into subtopic sections based upon content, and give those sections distinct titles. This will help focus your writing, and assist the reader in navigating your review.
3. Gather and read all of your source material in advance. Attack your search of databases early in the process. Some materials will require time to arrive via interlibrary loan. Do not procrastinate!
4. Read (and cite?) more sources than the 10-paper minimum for this project. Doing so will strengthen your understanding of the topic and increase the number of factual statements that you can include while writing your review paper. These two factors will work in your favor and accelerate the writing process. (One tip: once you find two or three highly relevant articles, you should be able to "mine" each paper's *Literature Cited* section for additional articles, and in turn "mine" the *Literature Cited* section(s) of those papers until you find a critical mass of references for your own paper. Needless to say, previous review articles for a topic are a great place to start...if they exist.)
5. Statements of common knowledge, and widely accepted scientific concepts, do not need to be supported with a reference. For example, the following statement does not need a citation: "Photosynthesis is a fundamentally important process by which plants convert light energy into chemical energy...". References are appropriate to support facts/ideas that are not well known or can be attributed to a single (or very few) original research article. Citations are meant to help a reader verify and research information with which he/she is not familiar, and to give credit where it is due for novel ideas and discoveries.
6. Outline your paper in advance – know what you want to say, and where to say it in the paper, before you start writing.
7. Write the abstract and title LAST. Consider writing the introduction after writing your subtopic sections. If you do write the introduction first (i.e., before the subtopic sections), do not be afraid to re-tool the introduction to better reflect the content of what you've written in the subtopic sections.
8. Follow rules for correct grammar, spelling, and punctuation. Scientific authors do NOT get a free pass for these requirements.
9. "Keep it simple". Avoid "flowery" language and write concisely. Use as few words as possible to make your point, do not attempt to impress your reader with complex language. The words you string together are a tool for conveying concepts, do not allow the language to detract from the point you want to make.
10. Write many drafts. All writing is inferior on the first try, but improves with each draft.
11. Have your drafts read and edited by multiple colleagues.
12. Allow a few days to pass between editing your own writing so that you see it with "fresh eyes". Needless to say, this requires that you not procrastinate on this project.
13. Be patient, and embrace the following adage: "writing is easy, editing is difficult".
14. USE THE TUTORS TO ASSIST WITH ALL ASPECTS OF THIS ASSIGNMENT!!!

III. WRITING ASSIGNMENT FOR THIS CLASS

III-A. Your assignment: a detailed description

1. Select and research a topic in botany (see suggested topics, below).
2. Write a review article of **at least 1500 words** (not including the abstract).
3. Please use Calibri, Arial, or Times New Roman font (11 or 12 pt), 1.5 line spacing, and format the page width in a reasonable manner (i.e., I will not check your margins with a ruler...but I will count the words...). Number pages middle bottom.
4. Turn in review article by **March 22, 2019 at 4:00 PM**, via turnitin.com
5. This assignment is worth 100 pts (equal to a midterm).
6. Your review must contain at least 10 citations from peer-reviewed scientific journals.
7. Your review must contain the following sections:
 - 7.1. Title. The title should be no longer than 12-15 words, Catchy but not colloquial, and centered at the top of the first page (i.e., do not include a separate title page).
 - 7.2. Author information. This includes name, institution, contact email, LAB SECTION (day and time), and should appear directly underneath the title, centered on the page as one or two lines. Using smaller font (e.g., 10 pt) is a nice touch...but is not required.
 - 7.3. Abstract. This is a BRIEF summary of the research question, important findings of the current study, relevance to science and/or importance to society, and future research needs. 300 words MAX! The abstract does NOT count towards your 1500 word minimum.
 - 7.4. Introduction. Introduce the review article by providing a brief history of the topic (which includes research milestones and key discoveries), stating why it is important to science/society, and perhaps a “punchline” regarding the current understating of the topic (you will explore this in more detail in your paper). Effective introductions are typically 2-4 paragraphs, and for this project 1-3 paragraphs should be adequate.
 - 7.5. Subtopic sections that break the body of your review into 2-4 (or more) conceptual “subsections”. Be sure to provide a title for each subtopic section.
 - 7.6. Literature Cited: You must use the format followed by the peer-reviewed journal *The Botanical Review*. (*The Botanical Review* is available through SBCC’s Luria Library as an *ejournal*.) I encourage use of non peer-reviewed sources (books, websites, magazine articles), but they do not qualify for inclusion among the 10 required peer-review citations.
 - 7.7. Grading rubric for the assignment, stapled to the paper copy (not needed on e copy).
8. Figures: you must include at least three figures in your paper. Of the three, your paper must include one map or photograph and two data figures (graphs that report quantitative data). All figures should be embedded in the text in appropriate locations. Data figures criteria:
 - 8.1. Figures may be synthesized/reproduced (by you) from one or more studies, or you can simply “copy and paste” figures from papers you site.
 - 8.2. You may create your own map, photograph, or dataset (using data from the literature) and build your own original figure(s) if you wish.
 - 8.3. Figures should be sequentially labelled (Figure 1, Figure 2, etc...) and referenced in the text of your review article.
 - 8.4. Be sure to clearly reference the paper from which you extract/reproduce a figure (or use data if you create your own original data figure). For example, do this in the following manner: “Salt glands in the Poaceae are structurally diverse (Figure 1; reprinted from Ceccoli et al. 2015).”
 - 8.5. Figure captions must be included – this is easily accomplished using a text box in Microsoft Word. Figure captions should be very brief, please read samples in *The Botanical Review*.
9. Save your review paper as a PDF prior to submitting it. Word documents (.doc files) are highly unstable.

III-B. Your assignment - grading

The 100 points possible for this assignment will be awarded in the following manner:

40 pts: Scientific merit

- Does the paper address a well-defined topic in botany?
- Does the paper adequately survey the scientific literature to provide a current and accurate summary of what is known? (It is OK to report that there is not a strong consensus among the published papers that were surveyed).
- Is the paper based upon well-referenced scientific information?
- Does the author avoid editorializing (i.e., statement of opinion)?
- Does the author identify and synthesize trends in research articles he/she references, such that he/she can make valid generalizations about the current state of knowledge in a topic (i.e., does the author avoid mindlessly listing the results of many studies)? (Again, it is often useful to report that there is not a strong consensus among the published papers in a topic. This simply means that more research is needed in certain areas).
- Does the author identify voids in the current understanding of the topic, and propose future research to fill these voids? For this, the identification of specific research questions is very compelling for the reader (and your instructor!).

20 pts: Research

- Does the paper include 10 peer-reviewed original scientific articles?
- Are the articles used appropriately in the text to support statements made by the author?
- Is the research current? Literature cites must include at least three peer-review original research articles published in the past five years.
- Does the research extend far back into history of the topic to adequately capture this history?

20 pts: Clarity of writing and grammar

Is the review generally well written, such that ideas are presented in a coherent manner? As I grade, I'll pay particular attention to the following questions:

- Are sentences properly constructed (i.e., not "run-on", contain a verb, subject, and object, do not end in a prepositional phrase, have commas in proper location if necessary, etc.)?
- Are paragraphs structured as discrete units of information that address a particular idea?
- Do paragraphs begin with a topic sentence that introduces the main idea, and are paragraphs typically comprised of 3-5 sentences?
- Is the writing overly bombastic or colloquial (avoid!), or is the writing concise and free of superfluous verbiage (aspire to this!)?
- Is the paper free of spelling mistakes and grammatical errors?

10 pts: Structural organization of paper

- Review article contains the required sections: title, author information, abstract, introduction, subtopic sections (each with a title), and literature cited. These section headings appear in bold font (no section headings for the title or author information). You do not need a separate title page.
- Body of article (i.e., introduction and subtopic sections) is appropriate length to adequately address topic (**≥1500 words...remember that the abstract does not count towards the 1500 word minimum!**).

- Subtopic sections are “meaningful” divisions within paper and do not appear to be superficially applied after text was written.
- Abstract is no more than 300 words.
- Article is printed in Calibri, Arial, or Times New Roman font (11 or 12 pt.), 1.5 line spacing, pages are numbered middle bottom of every page.
- Article contains three figures (one map/photo, two data figures), each of which is properly captioned, labeled, referenced in the text, and embedded in an appropriate location within the body of the paper.

10 pts: Literature Cited section

- All references in the *Literature Cited* section are properly formatted per *The Botanical Review*, are free of typos and stray punctuation etc., and are in alphabetical order.
- Note that references for peer-review articles, books, and websites are formatted differently.
- References within the text are appropriately formatted (for example: Smith, 2015) and actually refer to papers in the literature cited.
- References with more than three authors are cited in the text as “Lead author et al., date” (e.g., Smith et al., 2015).
- See the example of a properly formatted reference on page 3 of this document.

IV. RESEARCH TOPICS (you may choose you own...)

You may select any topic in botany and provide a review article as long as: 1) the work is original and you are not plagiarizing or paraphrasing somebody else’s work, 2) you cite ten at least ten (10) peer-reviewed original research articles as the basis for your review. Reading (and citing) more than ten articles will expand your understanding of your topic, and it will accelerate your synthesis and writing processes. (Trust me: in the long run, the difficulty of writing this review paper will be inversely proportional to the number of articles you read.)

Some of the following topics (see *Sample Topics*, below) are widely reported in popular press media outlets. They are often controversial, highly political, and described at an unsophisticated level of scientific detail. I provide this list of suggested topics because students are often curious about them, and they enter into our “every-day” lives. I welcome students to select one of the following topics for this review article assignment. I especially encourage this because one of your duties as a scientist is to serve the general public (i.e., non-scientists) by digesting complex issues and providing accurate and unbiased syntheses of what is known (in a sense, you will thereby provide a semi-technical review for lay audiences).

Following each topic listed below is a series of 2-4 questions. I list these questions as sample subtopics around which you might construct subtopic subsections within your review. Feel free to use these subsections, which I listed in a very “off the cuff” manner, but please also think of your own. I highly encourage you to select your own topic of interest!

Sample Topics

Human health impacts of GMO crops: 1) What types of genes are commonly inserted into target plants? Provide concrete examples of genes that serve specific purposes (e.g., deter herbivory, resist disease, etc.). 2) How (i.e., using what technology) are foreign genes inserted into the genome of target organisms? 3) What is the source for DNA inserted into target organisms (from what organisms is the DNA isolated). 4) Is there a link to human disease? 5) Do GMO’s contribute to feeding the world? If not,

what are the practical limitations of overcoming food insecurity that are not solved with crop science? 6) Are there social justice issues associated with GMOs.

Environmental Impacts of GMO crops: 1) What types of genes are commonly inserted into target plants? Provide concrete examples of genes that serve specific purposes (e.g., deter herbivory, resist disease, etc.). 2) How (i.e., using what technology) are foreign genes inserted into the genome of target organisms? 3) What is the source for DNA inserted into target organisms (from what organisms is the DNA isolated). 4) Do GMOs lead to more, or less, pesticide use and thus agricultural pollution? 5) Compared to non-GMO crops, do GMOs contribute to global warming? 6) Do GMOs cause population declines in non-target organisms?

Climate Change I: 1) Is it happening? 2) What gasses are causing it and where do they come from. 3) what is the link to forestry practices? 4) What is the evidence that it is human-caused? 5) What are the latest predictions for global/regional change. (If you select this topic – at least 5 of your references must be from the past three years).

Climate Change II: 1) What possible impacts for plant communities and species? Have any of these been documented? (Impacts to individual plant communities are a logical basis for subtopic subsections).

“Probiotic” foods: 1) What are probiotic foods (i.e., specifically what organisms do they contain and what are some examples)? 2) how are they manufactured, that is to say, what are the detailed chemical processes involved or that are carried out by probiotic organisms. 3) What is the role of human bacterial flora for good health. 4) what is the scientific evidence, if any, for human health benefits?

Pesticide use in agriculture: 1) what are the biochemical mechanisms of various types of pesticides (i.e., how do they kill the target pests)? 2) what are links of pesticide use to human health. 3) what are specific environmental impacts of pesticides? 4) compare resource use (i.e., water, fossil fuels, labor costs) in organic fruits/vegetables vs. “conventionally grown” foods - is there a link between agriculture and global warming, and if so is there a difference in organic vs. conventional production?

Plant communication: 1) Define “communication” as the term will be used in this review, 2) the evidence for airborne communication – what is the evidence, and are there alternative explanations?; 3) communication through mycorrhizal fungal networks – evidence and interpretations?; and; 4) given the modern understanding of how natural selection functions (i.e., individuals with superior adaptive traits survive and reproduce at a higher rate compared to less well-adapted individuals, and thus pass on genes at a higher rate), how can communication among plants be considered adaptive? (That is to say, explain how “plant A” communicating to “plant B” leads to greater fitness of “plant A”). In this context, does plant communication make sense in all reported instances? In which does it make evolutionary sense (i.e., do some peer-reviewed articles make claims about communication that can be explained by an alternative hypothesis)?

Angiosperm evolution: 1) When do the first angiosperms appear in the fossil record? 2) Describe the history of fossil discoveries over the past 50 years and how this has changed our understanding of the most likely angiosperm ancestor(s). 3) Compare and contrast the woody magnoliid vs. paleoherb hypotheses for angiosperm evolution. Provide a photo or drawing of the likely appearance of ancestral angiosperms under the paleoherb and woody magnoliid hypotheses.

Mitochondria function in plants vs animals: 1) Explore the function of mitochondria in plants vs animals. 2) What are some important similarities and differences? 3) What is the current state of research into

biochemical pathways in plant mitochondria function (i.e., how is the biochemistry of plants different from animals).

Chloroplast evolution: 1) What is the origin of chloroplasts in photoautotrophic eukaryotes? 2) Provide a phylogeny of all eukaryotic organisms and provide the supporting evidence – in which groups are chloroplasts thought to have arisen independently? 3) Compare/contrast proton flow in eukaryote chloroplasts vs photosynthetic prokaryotes such as cyanobacteria during light reactions of photosynthesis. 4) What is the origin of the two membranes in eukaryotic chloroplasts?

Thermoregulation in plants: 1) Which groups of plants do it (i.e., how widespread is this in the plant kingdom?). 2) Why do they do it (i.e., how is this adaptive)? 3) How do they do it (i.e., how biochemically is it achieved?). Go!!

Any aspect of plant evolution...

Any aspect of plant structure and function that is worthy of a review paper (see the example review paper provided as part of this assignment: *Salt glands in the Poaceae family...*)

Any aspect of plant conservation worthy of a review...

Wildfire in California...

Conservation threats to California flora and plant communities...

The options are seemingly infinite!!

*A note about scientific discussion of socially relevant and complex issues:

As an objective scientist, you should avoid editorializing and providing simplistic opinions. In fact, in many cases you might find that there are no clear answers, or that there are not adequate scientific data to draw a reliable conclusion. Your job for this assignment is to digest the available science and write a review paper based upon credible peer-reviewed journal articles. This will be a HUGE responsibility of yours in your future role as a professional biologist. Society is counting on you to think critically and save humanity from the often biased, overly-simplistic, and poorly researched sound bites that spill from the pens and microphones of popular media.