**Peer-Reviewed Literature and Scientific Writing**

**Ecology Lab PCB 3043L**

Some of you may recall the discovery of a “new kind of life” in 2010. Scientists working at a national laboratory in Berkeley, California discovered bacteria that thrived in the absence of phosphorous and the presence of arsenic. Before this research was peer-reviewed, they conducted press releases describing their findings and received much attention. Shortly thereafter, many scientists working in similar fields questioned the original methods and results, and expressed distress at the lack of peer-review before the results were shared with the public. 18 months later these critics were vindicated, as attempts to replicate these findings showed many flaws in the original research and eventually disproved the results. If the Berkeley scientists had gone through the peer-review process and published their results in the primary literature instead of communicating their science through press release, the entire ordeal and a lot of embarrassment could have been avoided.

Here is a recent article describing the debacle: <http://www.nature.com/news/arsenic-loving-bacterium-needs-phosphorus-after-all-1.10971>

Peer-reviewed literature is the first and most important kind of scientific writing. New discoveries are (almost) always sent to peer-reviewed journals first, and scientific progress is conducted on the backs of already published peer-reviewed articles. Knowing how to write in the style of peer-reviewed literature, and knowing what to expect from well-written articles when performing your own literature reviews, is necessary to being able to understand and conduct scientific research.

The purpose of this lesson is to improve both your reading and writing abilities. Being a critical, active reader will teach you to recognize clear and concise writing, and to incorporate it into your own work. Noting which parts of certain papers you find difficult to read will help you avoid making the same mistakes. Similarly, being a skilled scientific writer will allow you to more easily navigate journal articles, and to better understand the research of other scientists. These two skills are inextricably linked.

**Scientific Writing**

* Peer-reviewed literature almost always follows a format. You will encounter each of these sections in order, but do not necessarily need to read them in order. For example, many people prefer to skip straight to the discussion section, because they feel it helps give them more context for the rest of the paper. As you practice going through the literature, you will develop habits that allow you to grasp the research most efficiently.
  + **Title**
    - The title is read by more individuals than any other part of the manuscript. It must be short, informative, and clear.
      * The title is written to reflect the study objective, it describes what the study is about.
      * The title is the most demanding in terms of precision and accuracy. Each word must be essential, and each word must be the right word. A good rule of thumb is that the title should be written in 12 words or less.
  + **Abstract**
    - The abstract is your paper in miniature, and serves to summarize it for readers. In practice, it lets readers know whether your paper is relevant to their interests. There is a strong emphasis on conciseness, with many journals imposing a word limit on abstracts. A good rule of thumb is to keep abstracts under 300 words.
    - Why did you do your study (Introduction)?
      * This is the first sentence, and places the study in a broader context. This helps the reader understand why they should care about your research.
    - How did you do your study (Methods)?
      * This is next couple sentences, and is very challenging. You must integrate your methods section into a short “sound bite” to describe your overall approach.
    - What did you find (Results)?
      * This forms the main body of your abstract. You can often copy the topic sentences from key paragraphs to fill it in. Devote one sentence to each major finding.
    - What do your findings mean (Discussion)?
      * This is the last sentence of your abstract. It should contain your single most important conclusion.
  + **Introduction**
    - The introduction justifies your research project, starting as broadly as possible. The question you should be answering for the reader is “Why should I care?”
      * The title of the journal offers a guide as to how broadly you need to justify your research. Some journals are for very specific audiences, and it is assumed that the reader cares about very specific topics. Other journals address very broad topics, and you need to justify your research in a much broader context. For example, Ecology needs a broader justification than The North American Journal of Fisheries Management.
      * You get more specific as you progress, ending with the last paragraph having your research objective(s) as a topic sentence. This paragraph also often includes your hypotheses.
    - Your research objective describes the purpose of your study.
    - State your objective in terms of what you want to learn, not what you did.
  + **Methods**
    - The purpose of a methods section is to describe exactly how you conducted your study. It is important to describe your study so well that a reader could replicate it exactly without ever having to talk to you. The methods section typically follows a format of its own.
      * Study area
        + Clearly describe all physical, chemical, and biological attributes of your study area.
        + Readers probably do not know your study area well enough to interpret how what you found relates to their own work. You need to give your findings context for researchers working in other ecosystems.
      * Study design
        + Clearly describe the sampling units and their distribution in space and time.
        + What was measured, how often measurements were taken, and how much variation in routine occurred are all part of your study design.
      * Sampling
        + Describe your sampling methods in a logical, usually chronological, order.
        + This subsection can vary depending on the nature of your study. It will be different for field studies compared to lab studies, but the basics are the same. Describe the sampling gear used, how samples were prepared, and what attributes were measured.
      * Data analysis
        + Describe all of the data analysis you used completely and unambiguously.

What statistical test or procedure was applied to each question (you can use your objectives as a checklist to ensure that you don’t miss any).

What are the dependent and independent variables for each model? It’s important to think about what causes what, and to not blindly apply statistics.

* + - * + Ensure that each statistical result mentioned in the Results section is described in the Methods section
  + **Results**
    - Of all the parts of a paper, the purpose of the Results section is the simplest: you are telling your readers what you found.
    - Organize the Results sections around your findings.
      * Begin by looking at the results of your analysis, whether tables or figures, and writing one paragraph for each. Compose these paragraphs in topic sentence format, telling your readers what you see in the figure or table.
      * Never “discuss” a finding in the Results section! You are describing what you found, not what you think it means.
    - Describe your results in biological, not statistical, terms!
      * Statistical tools are means to an end, but are not important in and of themselves.
      * Focus the description of each result on why the test was used, and what it tells you about the biological variables being measured.
  + **Discussion**
    - The purpose of the Discussion section is to interpret your findings for your readers, and to relate your findings to previous research.
    - Organize your Discussion around each of your major findings.
      * Devote one paragraph to each finding in the same order that they appeared in the Results.
      * Begin each paragraph with a general statement of how your finding compares to other studies, and narrow down each paragraph with sentences that compare the details.
    - Integrate each of your findings with other related studies.
      * Never repeat statements from the Results section. Instead, compare or contrast your findings to those of related studies.
    - Limit the Discussion to the scope of your study and your findings.
      * Every study is limited, and admitting it does not negate your findings. Do not “discuss” topics you didn’t investigate, instead be thorough about your treatment of your findings and your review of previous research.
  + **References**
    - Ensure that all in-text citations match a reference. Re-checking your References section after every major edit will help you avoid mismatched references.
    - Carefully format references to conform to the target journal’s style guidelines. MLA format is great for high school, but every journal has their own format and none of them will appreciate manuscript submissions with a Reference section in the wrong style.
    - Review a recent issue of the target journal to see how the references are formatted. Also, many journals publish a “Guide for Authors” on their website that will instruct you in their format.
* **Scientific Reading Tips**
  + Always be an active, critical reader. You should constantly be asking what the article is about and what the author is actually saying.
  + Read the objective multiple times, and try to determine how you would go about achieving it before reading further. Badly stated objectives are rampant, and can cripple a study. If there is no way to achieve the stated objective, then the study was poorly designed.
  + Pair up the Introduction with the Methods, and see if the author is actually designing a study that can answer the questions he is asking. It is common to see objectives that cannot be achieved using the methods stated.
  + Pair up the Results with the Discussion, and see if the Discussion is staying within the scope of the study. It is common to see conclusions drawn from results that do not support them.
* **Scientific Writing Tips**
  + Create an outline before you start writing.
    - List each section of the paper.
    - Note the important items that must be brought up in each section and where they would best fit.
    - Note which parts of the paper seem under-developed, and which seem cluttered.
  + Always have a colleague review and edit your writing before submitting it.
  + When reviewing your work, focus on whether each sentence would be clear to someone with no prior knowledge of your topic.
  + Check all writing for grammar and spelling. While writing style is crucial, bad grammar or spelling can cripple otherwise good writing.

**Assignment**

* You have been assigned a scientific article with the abstract covered
  + Read it critically
  + Write an abstract for the paper
  + You don’t need to understand the statistics in the paper to write an abstract
* Limited to 300 words
* Double-spaced
* No citations in an abstract! Limit your writing to what you find in the assigned paper

I WILL be looking for plagiarism of the published abstract.