

Guide to Critical Reading in Quantitative Biology

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This reading course is quite different from typical journal clubs. For those of you who are new to biology, you may take this as an opportunity to learn how to read biology papers critically. This will be very important to your ability to do research in biology down the road; it can also help you to communicate better with biologists and set a standard for your own work. For those of you from biology, you will see new challenges brought up by pursuing quantitative studies. The approach of the class is explained below; hopefully it will be clear after a few trials.

Research in biology is very much like detective work. Typical biology papers are like prosecution documents in legal proceedings. The goal of the prosecution team (the authors) is to lay down all relevant facts towards the establishment of a verdict BEYOND REASONABLE DOUBT. [The concept "beyond reasonable doubt" is important, since very rarely can a single experiment establish a claim unequivocally; most often, a collection of facts are used to support a claim, such that the chance that all of the facts are red herrings become very small.] Each paper will tell the readers what verdict it wants to establish, and proceed to lay down the facts, followed by logical arguments. Sometimes, it is a slam-dunk case; other times, the prosecution may not have their facts all together and hence cannot quite establish the verdict (even though the conclusion may be true). Yet other times, the prosecution may be selling the jury something that cannot be true. It is up to you, the alert readers (judges or jurors), to decide where each paper belongs. If you are a naive physicist/engineer just getting into biology, you should definitely not take any claim you read for granted. (Nor is the brand name of the journal a good indicator of what to trust!) As a start, it may be reasonable to assume that 50% of the claims made to have possible problems. You should position yourself at least as a neutral juror while reading a paper; better yet, you may want to play the role of a defense lawyer some time, i.e., actively challenging the prosecution. Remember that the prosecution needs to do the work to prove its case.

With the above general setting in mind, you are suggested to go through the following:

- start reading early; you need time to reflect on the entire case as well as judge the validity/relevance of specific "facts" presented.
- What is the major claim of the paper? Is it something that can be established in principle? What is the strategy used by the authors to establish this?
- What are the major FACTS used to support the claim? Be very specific, e.g., "compare columns 2 and 3 of Table 1". (An experienced experimenter would know here how trustworthy different pieces of facts are; if you don't know, you can raise the question during the reading club.)
- What INTERPRETATION did the authors give to each piece of FACT? Did they discuss alternative interpretations and try to shoot down (or at least pretend to shoot down) their own interpretations? (These are called "control experiments".) Can you think of alternative interpretations?
- What arguments did the authors use to integrate different pieces of interpretation-of-fact together to reach their conclusion? Are their logical gaps and inconsistencies in these

arguments?

- What results from other studies did the authors invoke in their arguments? If these results are critical to the authors' central claims, then you should look at them as well to decide how trustworthy they are. (The latter part should not be automatic once you accept that published works may not be problem-free.)

A detailed worksheet is provided below to help you address the above questions. While you do not need to turn it in, it is highly recommended that you have the worksheet next to you when reading the paper, so that you can jog down your questions and comments as you go through the paper. **During the session on small-group discussion, you should try to work through this form as much as possible.**

During the quarter, we will select 3-4 papers to work on. For each paper, we will have 3 meetings to work on it. First, a faculty member who selected the paper will provide an introduction to both the scientific background and relevant technical details on the paper chosen. You will then read the paper on your own and discuss in assigned small groups the following week. If important questions emerge during your own reading or during small group discussions, email them to the faculty who introduced the work with cc to the instructor. One member of your small group will write up a "referee report", due 2 days before the 3rd meeting, when we will evaluate the paper together in class.

The content of the referee report should include a concise summary of the work described in the study, the significance of the work if claims are true, validity of the findings, suggestion of additional work (if needed), and your overall assessment [accept as is, minor revision, major revision, reject without possibility of revision.]

During the evaluation meeting (after handing in the report), you will assess the paper together with the instructor: *Every student should be prepared to describe the content of each figure/table and comment on its quality, significance, etc. according to the list of questions in the worksheet.*

Good luck and have fun with reading!