

## **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 Discussion, you should try to work through this form as much as possible.**

Each quarter, we will select 3 papers to work on, by 3 faculty members. For each paper, you will have 3 meetings (one per week). First week, a faculty member will come to introduce their research and provide an introduction or background to the paper chosen. You will then read the paper on your own and discuss in assigned small groups the second 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 3<sup>rd</sup> week's 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 in week 3 (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!

## QBIO Critical Reading Worksheet – Fall 2017

Name: \_\_\_\_\_

Date: \_\_\_\_\_

**Paper title / Journal:**

### **I. Basic information**

Key authors:

Any comments on the authors' background?

Key claim(s) of this study? It is useful to differentiate between major and minor claims.

Broader significance of the work if the claims are true?

### **II. Factual information**

Brief description of what was done (rather than what was said) experimentally and/or computationally

Brief description of the key factual findings presented; these are usually in terms of figures, and tables; often the crucial information is contained in "Supplementary Materials".

Brief description of prior knowledge in the literature central to the study (if applicable)

Is anything unclear about methodology used? about the context of the work?

### **III. Critique of the factual part of the study**

Do you see any potential pitfalls in what was done in the experiments and/or data analysis (e.g., in terms of procedure, instrumentation, measurements)?

Do you see any problems in links made to existing literature (e.g., invoking literature result outside of its regime of applicability)?

Do you see any possible problem with the findings themselves regardless of how they were obtained (e.g., parameters outside of the common range, inconsistency among the results)?

In studies involving computational modeling, how were the parameters obtained? In what ways do the findings depend on the parameters?

### **IV. Interpretation of the factual findings**

How did the authors interpret each major finding? What assumptions are made in each case? Did they discuss/rule out alternative interpretations?

For which major findings can you provide additional alternative interpretation? what would you do to distinguish between the different interpretations.

## **V. From findings/interpretations to claims**

What overall strategy or argument did the authors use to relate the factual findings / interpretations to their claims?

Can you detect any logical flaws in the strategy or argument?

If you find a major flaw, what alternative strategy would you use? If not, then identify the one or two pieces of findings that the strategy rely the most on. Go back to look at those pieces of findings again, together with the interpretation. Are you satisfied with the authors handling / presentation of those central findings?

What additional measurements/calculations would you want to get to make the interpretations and arguments more credible?

## **VI. Overall Assessment**

Overall, are you convinced of the validity of the findings?

How significant do you feel the main findings are?

Did the authors' writing style facilitate or hinder the understanding of the key components of the paper? If it hindered, how might the writing be improved?