UC Berkeley, Department of Molecular and Cell Biology
Guidelines for writing the Undergraduate Honors Thesis

Congratulations! You have excelled in the challenging MCB major at UC Berkeley and are about to graduate with honors. Your thesis is a synthesis of at least two semesters of independent research and represents one of the most important documents you will write at UC Berkeley. It is critical that you turn in your very best work.

Traditionally, the thesis is written in the format of a research paper with Abstract, Introduction, Materials and Methods, Results (including tables and figures), Discussion, and References. Your research advisor may have additional requirements for your thesis, which you should discuss with him/her well ahead of the due date. For example, if you have generated a significant number of plasmids, used a large number of oligonucleotide primers or antibodies, or developed protocols for a side project only peripherally related to your thesis work, your research advisor may ask that you list/describe these in an appendix at the end of your thesis. We are often asked “How long should my thesis be?” It should be long enough to fully develop your ideas, clearly present your data, and carefully discuss the results and the implications of the work. MCB faculty have all seen 80 page theses that would have been much improved in shorter format, as well as 10 page theses that were under-developed.

A thesis usually describes hypothesis-based research. A hypothesis is a suggested explanation for a phenomenon – it is experimentally testable and allows one to predict outcomes of experiments. When experimental results are consistent with the hypothesis, they increase the probability that the hypothesis is valid. Hypothesis-driven research often appeals to a much broader audience than a more descriptive paper because (a) the emphasis on the biological question (“big picture”) addressed by the hypothesis helps readers understand the motivation for the work, (b) possible experimental outcomes are predicted and interpreted in the context of the hypothesis, and (c) the reader becomes engaged in the logic of your arguments and thus the justification for your experiments. Sometimes, a student engages in research to develop new methods or to optimize protocols; although this work is not usually hypothesis-driven, the student can and should provide a clear explanation to justify why s/he undertook the project.

> *Example: You have been working hard to crystallize a protein and near the end of your thesis, you get amazing crystals that refract to 2.0 angstrom resolution. What is your hypothesis? Would you state “I hypothesize that I can crystallize protein X under anaerobic conditions and high salt concentration”? Of course not. You need to step back and think about <u>WHY</u> you are crystallizing this protein. Why are you compelled to crystallize Protein X? What is the big picture? For example, you might propose that there are specific structural changes in Protein X upon phosphorylation that make it a target for anti-cancer drugs – this is a much more appealing motivation for experiments. In this scenario, solving the structure of Protein X is only one step towards addressing the question, but much more interesting because the reader understands and appreciates the big picture. You can always include a Future Directions section that would state for the reader the experiments you would propose next!*

Your thesis should include significant background and references so that any professor, postdoctoral fellow, graduate student, or advanced undergraduate from any MCB division, can understand the motivation for and significance of your work. References must be included when discussing the work of others. Plagiarism (copying text or figures from any source, printed or online, without attribution) is unacceptable and will result in an automatic failure.

Practical advice: *(These are only suggestions – in talking with your research advisor and lab members, you may come up with a different approach! This approach assumes that your hypothesis is already well developed and has guided your experiments.)*

(1) Start with the data and figures. Figures should be of professional quality and have descriptive legends, comparable to figures published in scientific journals. Every figure should be referred to, in order, in the narrative, in a way that readers understand the motivation for the experiment, the proposed outcomes, and the actual observations.

(2) Once you lay out the big picture and the data, talk through your figures to envision the text transitions between each figure. You may see obvious gaps when more information/data is needed for a particular transition, or you may decide that you need to present the work in a different order. Science is rarely linear. To support your conclusions, the presentation of your results should be in a LOGICAL order, not in the chronoLOGICAL order in which you did the experiments.

(3) After deciding on a logical order for your figures, you will be able to write the Results section.

(4) After writing the Results section, it will be much easier to see how to discuss your results. Whereas the Results describe the data, the Discussion is the place to highlight the importance of your findings and put them in the context of the field. Writing the Discussion after the Results are completed will also help you see what background you need to cover in the Introduction to ensure the reader has the appropriate context to understand the question addressed by your hypothesis and to follow the experimental logic.

(5) In the Results section, some data interpretation may be necessary to transition from one experiment to the next (e.g. to motivate the next question/experiment); however, remember that a full discussion of the implications of the results should be reserved for the Discussion.

(6) Write the abstract LAST. An abstract is typically 200-400 words and outlines the hypothesis and the key conclusions of the work. Your main points will be obvious and much easier to state after completing the Results and Discussion.

(7) If you get writer's block, you can always start with the Materials and Methods. This section is usually written in narrative form, without bullet points or numbering.

(8) If you are having difficulty, get help from your research advisor or others in the lab early on. If you need additional advice, check with your faculty advisor.

Hallmarks of an "Excellent" Piece of Scientific writing *(adapted from UC Davis "Writing across Curriculum" Program)*:

(1) Ideas: A well-written thesis will provide a thoughtful answer to a question worth asking. The hypothesis and central ideas of the work are clearly stated. The thesis clearly addresses any nuances and complexity, but stays on track, without straying unnecessarily from the main point.

(2) Support: The data presented convincingly support the main conclusion(s). It should be clear that the author has critically and thoroughly analyzed the data, as well as the work of others.

(3) Organization and Coherence: The document is well organized and logically structured and follows a standard scientific format that is familiar to the reader. Transitions are well crafted and lead the reader easily from one experiment and/or observation and/or idea to the next. Paragraphs make clear points in support of the question/hypothesis and represent logical transitions from one idea to the next.

(4) Style: The document demonstrates that the author has a clear command of the English language. The sentence style is appropriate for the scientific audience and varied enough to keep their interest. Words are chosen carefully and for their precise meaning.

(5) Mechanics: The document contains very few, if any, spelling, punctuation, or grammatical errors. Abbreviations are defined the first time they appear in the text. References follow standard, accepted format.