

## Biology Honors Thesis Guidelines

**Purpose:** to prepare Biology Honors students to write up their research project in the form of a scholarly Senior Honors Thesis.

This document provides guidelines for what is often the most intimidating part of the research project: writing up the Honors Thesis. After completing your Honors Thesis proposal and collecting and analyzing your data, you will present your work in oral and written formats. Good work takes time, so starting the writing process early and allowing sufficient time to revise are key to writing a high quality thesis (and lowering your stress). The good news is that you already have started this process. In writing your Thesis Proposal, you explored your topic in the primary literature, and rationalized your study. Since then, you have, no doubt, collected and read additional research articles and become more knowledgeable about your topic. Still, the Thesis Proposal is a good starting point for beginning to write your Thesis and you may wish to simply add information to the Thesis Proposal while writing your Honors Thesis.

**General Format:** Your Honors Thesis will follow the conventional format for a scientific research paper, including the following sections: Abstract, Introduction, Materials and Methods, Results, Discussion, and Literature Cited. The Honors Thesis should be written according to conventions of scientific writing using clear, concise sentence structure, well-developed paragraphs with strong topic sentences, and a logical progression of ideas. For in-depth details on writing in Biology, it may be useful to refer to the materials used in your Writing Intensive Biology class (e.g., BIO306W or BIO311W), including “A Student Handbook for Writing in Biology” by Karin Knisely (2013). While there are not specific page limits for the Honors Thesis, it is likely that at least 20 pages (12-point font, double-spaced, not counting figures or works cited) will be needed to provide sufficient background information and to document, analyze, and contextualize experimental results.

**Timeline:** Good writing takes time and multiple drafts. Waiting to write up your thesis until the end of the semester is likely to result in an unacceptably poor-quality product. Before starting to write the Honors Thesis, it is a good idea to formulate a plan and timetable. During this planning process, make sure to leave enough time for multiple revisions (allowing your research mentor about two weeks to comment on each draft). Drafts that are not up to standards may be rejected by the Biology Honors Advisor, and even drafts that are well done are likely to require at least one additional round of revisions based on comments from the Honors Advisor. Following the timeline below will improve the quality of your writing.

Year	Date	
1-2		Meet with BIO Honors Advisor, begin to explore research opportunities
2		Identify a research advisor; begin discussing potential projects
3	Sept-Nov	Meet with BIO Honors advisor to discuss Thesis Proposal, prepare Thesis Proposal, submit Thesis Proposal to research advisor, revise
3	January 31	Thesis Proposal due to BIO Honors advisor
3-4		Conduct experiments and collect data
4	January	Undergraduate Symposium Abstract due
4	January	Complete data analysis
4	Jan-March	Prepare draft of Honors Thesis and Undergraduate Symposium presentation
4	Early March	Submit draft of Honors Thesis to research advisor, revise
4	Late March	Undergraduate Symposium (oral or poster presentation)
4	April 1	Honors Thesis due to BIO Honors Advisor
4	Mid-Late April	Revise Honors Thesis based on comments from BIO Honors Advisor
4	Late April	After approval by BIO Honors Advisor, submit final revised Honors Thesis to Honors College

## Guidelines and Tips:

- **Title.** The title should specify the experimental system used as well as key variables analyzed and/or significant discoveries. It should be specific, informative, and brief.
- **Abstract.** The abstract is a one-paragraph condensation of the entire work. The abstract should be a self-contained unit capable of being understood without the benefit of the text. It should contain five elements, in this order: 1) an introductory sentence highlighting the importance of the topic; 2) the purpose of the study and the hypotheses tested; 3) a brief statement of the general approach taken to test the hypotheses (the methods used); 4) a statement of what was found (the results); 5) a brief statement of conclusion. The major portion of your abstract should be presentation of results. Limit the abstract to 250 words.
- **Introduction.** This section is designed to draw the reader in and to contextualize and rationalize the study. The Introduction provides context by explaining why a topic is important or relevant and by describing what is known and what gaps remain in our knowledge of the topic. You should structure the Introduction as a funnel consisting of the following three elements (each of which may require multiple paragraphs):
  - An explanation of the general biological issue and its significance
  - A review the state of current knowledge relating to your topic (including significant unanswered questions or gaps in understanding)
  - A description of the specific research question your study addresses

To make your case, you will need to reference the primary literature. It is often useful to cite review articles relating to your topic in the opening paragraphs (and reading review articles will help you get a handle on the current state of the field). In the final paragraph of your Introduction, include the goal/purpose of the study, the hypothesis and predictions, and the general approach used to test the hypothesis. Be sure to include a biological mechanism (the explanation why) within the hypothesis. The use of one or more figures/models within the Introduction is recommended to illustrate important concepts relating to your hypothesis and/or experimental design and logic. The use of topical subheadings within the Introduction is recommended as a way to improve organizational clarity of this section of the Honors Thesis.

- **Materials and Methods.** This section can often provides a great starting point for writing a Thesis or research paper. The Materials and Methods section should describe your research approach, including specific references for experimental design, laboratory techniques, specific reagent formulations, analyses or processing, and statistical analyses, as appropriate. While the information in this section of the Thesis should not be the same as a detailed protocol, the descriptions should provide sufficient detail to enable an individual “familiar with the art” to repeat your experiments. The use of citations to related studies employing similar techniques lends credibility to your approach, though you may also include novel approaches. If there are several parts to your study, the use of subheadings corresponding to each portion is recommended. If your project is a field study, the first sub-section should describe the study site. If you are working on a particular organism, you might begin with a sub-section related to its natural history or its use as a model organism. Consider using visual aids to illustrate experimental design or procedures. In order to learn about field-specific conventions for describing particular analyses (or other aspects related to the Materials and Methods), seeking examples from published works in the field is recommended.
- **Results.** The functions of this section are to (1) summarize general trends in the data *without comment, bias, or interpretation*, and (2) report the results of statistical analyses testing your hypotheses. Conclusions about whether your results support or refute your hypotheses should be

saved for the Discussion. Like in the Methods section, you should organize the Results section with sub-headings, and these sub-headings should mirror the order in which they were described in the Methods section. Describe your results in words, referring to tables and figures parenthetically to support your statements. It is important to remember that tables and figures do not substitute for a written summary of the findings. In short, the text should be able to be understood by someone who has not seen your figures and tables, while facilitating interpretation of the figures and tables.

- **Results – use of figures and tables.** Experimental data should be presented using figures or tables, as appropriate. Figures (graphs, maps, and diagrams) and tables are independent units of information. They each possess descriptive headings that will allow them to be understood by someone who has not yet read the paper. These captions appear BELOW figures and ABOVE tables. Graphs, maps, and diagrams are labeled as "figures" (Fig. 1, Fig. 2, etc.), and tables are labeled as "tables" (Table 1, Table 2, etc.). Data should be displayed in only one format; i.e., you should choose whether a figure or a table is the best way to present the data. In general, a visual figure is preferred, but in cases where a figure becomes too complicated for easy interpretation, there is too much data, and/or no trend is apparent, a table may be better.
- **Tips for writing the Results section:**
  - Choose data presentations (e.g., figures, tables, gel images, etc.) that are best suited to display and summarize the data and illustrate any specific trends (if present). Be sure to carefully and unambiguously describe all data presentations in the caption to facilitate their interpretation.
  - Statements about results should be backed up with statistical tests, whenever possible. For example, "Seed set of plants grown in the presence of pollinators was two times greater than the seed set of plants from enclosure plots ( $t=3.8$ ,  $df=20$ ,  $p<0.05$ )."
  - When using statistical tests, emphasize the biological result, not the statistical result.
    - Not effective: "The student's t-test with 20 degrees of freedom showed a statistically significant difference between..."
    - Hint: Use the dependent variable (what you measured or calculated) as the subject of the sentence.
  - State how much of an effect the independent variable had on the dependent variable (= **effect size**), in addition to mentioning there was a significant difference.
  - Be sure to present the general trends, not the exact data values in the text of the Results section. These values are provided in your table or figure.
  - Be sure to include text description(s) of control trial(s), and compare/contrast results of these with trials involving experimental variables. Control results also should be included in figures, tables, etc.
- **Discussion.** The functions of this section are to (1) evaluate the meaning of your results in terms of your original hypothesis, (2) offer interpretation and explanations for your results (whether they support your hypothesis or not), and (3) compare and contrast your results to those from related studies. Use relevant literature to help come up with explanations. It is often useful to organize the Discussion section as a "reverse funnel," starting with your study and moving to the bigger biological issue that your study addresses. As in the Introduction, the use of sub-headings in the Discussion section is recommended improve clarity and organization. Within each section, topic sentences should be used to structure the flow of the Discussion section. The Discussion section should integrate your data with the relevant literature to provide a detailed interpretation of the research data and research question(s).

Begin the Discussion with a paragraph that highlights the results of your experiments and whether your results support or refute your hypothesis, and offers a biological explanation for your results (if you have more than one hypothesis, you might do this for each hypothesis - in the order they were

presented in your Introduction). You can also compare your results to those from other studies (do they agree? disagree? and offer possible explanations why or why not). Remember that your job is to analyze your own results. You should not dedicate whole paragraphs to describing other researcher's studies; their findings should be integrated with yours in order to formulate causal explanations of your results.

The Discussion section also can address any problems that arose and where your study leads us, however, you want to take a positive approach to discussing "problems." One way to do this is to frame a problem as a limitation of your study and then propose what should be done to address this limitation. When proposing future studies, describe specifically what types of additional studies might be useful and what such studies would tell us. Speculation is valuable for stimulating further thought.

Be sure to end your Discussion with a short Conclusion paragraph that summarizes your major findings and fits them into a larger biological context. What are the most important take-home messages from your study for the reader?

- **Literature cited.** Choose a premier journal in your field and consistently apply the bibliographic formatting of that Journal within your Honors Thesis. You should aim for at least 20 references, including several review articles. The Zotero bibliographic management tool (<http://www.zotero.org>) should be used to format the in-text citations and bibliography according to the conventions of the journal you select.