

## **GUIDELINES FOR BIOLOGY MAJORS WHO PLAN TO WRITE AN HONORS THESIS.**

*These guidelines are intended to provide an outline to help students organize, write, and submit a thesis. Students always should consult with their faculty mentor in making specific decisions as early as possible in the process of preparing an honors thesis. The Biology Honors Committee may make exceptions to any of these guidelines on a case-by-case basis.*

**Motivation.** Prospective candidates should explore their motivation to do an honors thesis prior to their senior year. For most thesis projects, research is begun in the junior or sophomore year, and in many cases students work on the project over one or more summers. Many but not all theses include data that will become part of a paper in a scientific journal. Collection of quality data and preparation of a thesis are time consuming processes that may interfere with your ability to commit the necessary time to academics. Keep in the mind that the thesis is due just after spring break of the senior year, at the very time that many students are engaged in interviews and diverse applications. The Honors Committee encourages you to evaluate where your time is best spent in senior year to achieve your academic and post baccalaureate goals.

**Overview.** The thesis should represent original research done by the student. The research must be carried out under the direct supervision of a faculty member on Cornell's Ithaca campus. If a student plans to do research off campus, it must first be approved by the Honors Committee, and a faculty member on the Ithaca campus must be a co-mentor who is actively engaged in the research. Surrogate mentors, i.e. Cornell Ithaca campus faculty who are mentors in name only and are not directly involved in a student's research, are not allowed.

Applications for the honors thesis program are due in the spring semester of the junior year (see <https://biology.cornell.edu/research/honors>). The program will accommodate January graduates. January graduates should make an appointment with the Director of Undergraduate Research in their junior year to discuss the fall, final semester timeline.

Early in the fall semester of the senior year each student is assigned to one of the honors groups, led by a faculty member expert in that area. The Director of Undergraduate Research makes this assignment, with input from faculty on the Honors Committee (see <https://biology.cornell.edu/research/honors>). Note that the honors group to which a student is assigned is based loosely on the subject matter, and may not match the student's concentration in the biology major. Criteria for this assignment may include more uniform distribution of theses among the groups. Each honors group leader will meet with his/her students in the fall semester of the senior year, either as a group or individually, to go over the thesis requirements and to answer questions.

Ideally, one goal of an honors thesis is to present results that are publishable in a scientific journal, not necessarily independently but integrated with other work to flesh out the story. However, given the time limits inherent in undergraduate research, this goal in many cases is not achievable. If the results are not publishable, to be acceptable

a thesis should describe the design and implementation of the experiments undertaken, the analysis of the data that were obtained, and any future modifications of the design that in principle might lead to publishable results. The initial decision on what comprises a suitable project for an honors thesis is made by the research mentor, together with the student. If there is some disagreement or uncertainty in this decision, the mentor and student (together or separately) should consult with the leader of the appropriate honors group. The Honors Committee, comprising all of the honors group leaders, has the final say in whether the thesis is acceptable. The committee relies heavily on the reviews by other faculty to make this decision. The most important factors considered in evaluating the thesis are the quality and rigor of the scientific work, feedback from the thesis mentor, and the thesis presentation itself.

*“Latin honors”* as recorded on the diploma (*cum laude*, *magna cum laude*, or *summa cum laude*) is assigned differently for students in the College of Agriculture and Life Sciences (CALs) and students in the College of Arts and Sciences (AS). In CALs, the level of Latin honors is determined exclusively by the student’s final grade point average (GPA). If the student has written an acceptable honors thesis, the further words *“with distinction in research”* are added after (for example) *“cum laude”*. In AS, for all majors Latin honors requires a student to write a thesis. In the Biological Sciences major, the honors committee is responsible for assigning the level of Latin Honors, and the committee may use both GPA and the thesis evaluation as inputs for this decision. In AS, *“Distinction in all subjects”* is awarded to the graduates who achieve a GPA in the upper 30 percent of their class at the end of the seventh semester or next to last semester for transfers.

A student contemplating writing an honors thesis should look at past theses from the same lab and/or other labs, to use as models. Past biology theses also can be accessed through the library at [<https://ecommons.cornell.edu/handle/1813/2936>] if the author and thesis mentor signed a release to publish the manuscript. Typical theses are about 20 to 30 pages double-spaced, not counting figures.

*Thesis deadlines for students.* Students are expected to keep to the deadlines announced by the OUB for honors theses (see calendar on Blackboard and the [OUB Honors web page](#)). The first spring deadline for submission to the mentor is flexible, if the mentor is OK with that. **The deadline for formal submission of the thesis to the honors group leader is not flexible. This version of the thesis is the one that will be judged by the honors committee, and hence should be regarded as the “final version”,** even though small changes may be made later to address comments by the reviewers. The honors group leader and the honors committee are not obligated to accept any thesis that is submitted past the deadline. Students must plan ahead! Good communication with their mentor and honors group leader is essential. If the student has questions about deadlines, he/she should consult the following in this order: *first*, mentor; *second*, leader of honors group; *third*, OUB Director of Undergraduate Research.

*Public presentation of thesis research.* The candidates are required to publicly present their thesis research in an Honors symposium hosted by the Office of

Undergraduate Biology and biology departments. The symposia are in the format of PowerPoint talks or poster sessions, and are scheduled in the last week of the semester and during study days. January graduates are encouraged to present in the CURB Fall Forum, formally in lab meeting, or department lunchtime brown bag seminars.

*Plagiarism.* The student is required to upload his/her final version of the thesis on the Honors program Blackboard site, where it will be evaluated for plagiarism with [Turnitin](#). No part of the thesis (including sections on Introduction and Materials and Methods, for example) may be copied from other sources, or trivially rephrased from other sources. Evidence of plagiarism will lead the honors committee to reject the thesis.

### **THESIS FORMAT.**

The Honors program encourages candidates to format their thesis following a journal in their field. Most journal websites will have Instructions for Authors that provide detailed formatting guidelines. This practice is especially useful if the results will be part of a future publication. The thesis must include the following sections with separate headings. **Except for the title page, all the text should be double spaced, with a font size of 12.**

*Title page.* The title page should use the template provided by the Honors program and specified by the candidate's college. It should show the title, the student author, and the mentor's name and departmental affiliation.

*Abstract.* On a separate page should be an abstract (summary), as in a typical scientific journal of the type in which this work might appear. The abstract should summarize the results and say something about the significance. The word limit for honors thesis abstracts is 250. In the abstract, as well as elsewhere in the thesis, the author should use the first person singular ("I") -- not the first person plural ("we"), except for those experiments or results that were truly obtained in collaboration with someone else. You may switch to passive voice (e.g. "xxx was measured..." as opposed to "I measured...") only if the authorship has been clearly established in an earlier sentence, usually in the same paragraph by use of "I". Note that the suggested use of the first person singular is in contrast to modern scientific publications, which almost invariably have multiple authors and thus use the first person plural "we".

*Introduction.* This section should comprise perhaps three to six pages (~750 - 1500 words). The introduction should give enough background for a reader who is knowledgeable in modern biology, but not expert in this particular field, to understand the thesis research and the results. The introduction should explain any field-specific concepts, methodologies, or assumptions necessary to understand why the study was undertaken, and what the objective(s) of the study were (or what hypotheses were being tested). Writing a good introduction usually requires citing perhaps two dozen published papers, or in some cases more. In many journals it is conventional that the last short paragraph of the Introduction restates the results and conclusions of the paper in very brief form, even more brief than the abstract. This is a device to tie the

Introduction easily to the Results section. Some faculty suggest that the Introduction be written last, after the Results and Discussion, to allow the writer a better perspective on how the goal of the project and the results are most clearly introduced.

*Materials and Methods.* This section should explain in detail the source of the starting materials and the experimental design, i.e. how the experiments were done, how the data were collected, and how the results were analyzed. Also included in the Materials and Methods should be a paragraph explaining what statistical tests were used to analyze the data and to gauge their statistical significance. The M&M section, which can be placed either after the Introduction and before the Results, or at the end after the Discussion, should be detailed enough so that someone in a different lab but with the same equipment and reagents could repeat the results. In lieu of a detailed description of some experimental approach, papers that fully describe the methods that you used may be cited. However, it is almost always appropriate also to summarize in a couple of sentences the most important methods. For example: *“Proteins were purified after expression in E. coli as described in ref X. Briefly, after induction of protein expression, lysates were fractionated by ultracentrifugation to remove ribosomes and debris, and then submitted to ion exchange chromatography, with XX assay used to identify the purified protein.”*

*Results.* This section is the meat of the thesis. It should be organized with separate headings for the different experiments or measurements that were carried out, perhaps with one or a few paragraphs each. As in a regular scientific paper, often the Results section starts with a short paragraph, or even just a couple of sentences, describing the motivation or the experimental logic for the research. For example: *“While the pathway for cholesterol biosynthesis is well understood, the mechanism by which cholesterol regulates membrane properties is unclear. This thesis describes my experiments to investigate how cholesterol stiffens the membrane...”* or *“Mutations in and near the myc oncogene are involved in many human and mouse cancers (reviewed in REF), but how the Myc protein functions to promote transcription of specific genes is controversial (REFs). I sought to address this question using an in vitro system in which ...”* Every paragraph should have an easily understandable topic sentence (usually the first sentence) telling the reader what the paragraph is about. Paragraphs should not be longer than about one page (double spaced). Ideally, each paragraph that describes an experimental result should end with one or two sentences that summarize the conclusions or implications of the data presented in that paragraph. For example: *“In summary, these data imply that...”*, or *“I interpret these results to mean that...”* The Results section of the thesis typically might be 1000-1500 words, but this number varies widely, and in some cases is considerably longer.

*Discussion.* This section may be combined with the Results section (*“Results and Discussion”*) if this type of presentation makes the data and interpretations easier to follow. The Discussion often is the most challenging to write. Frequently in scientific papers the first short paragraph of this section briefly again summarizes what the Results have shown, but this is not required. The Discussion should not repeat what has already appeared in the text of the Results, but instead should take up the bigger issues

raised by the data that are presented. For example: *How firm are the interpretations, or what are their limitations? Are other interpretations possible, and if so, what experiments might address this in the future? How do the data and the conclusions fit with other published work? If the results contradict something that was published earlier, how could the contradictions be resolved?* At the end of the Discussion, it is often suitable to write a paragraph describing how this work could be continued profitably by others. It will strengthen the thesis if the candidate spends time discussing results with lab members in advance of writing, and/or presents the results in a lab meeting and asks for feedback on the validity of conclusions.

*Figures and/or Tables.* These present the data collected. As the results are described, the text should refer to each figure or table. Every figure and table must be referred to at least once some place in the text, usually in the Results but perhaps also in the Materials and Methods or Discussion. The order in which the figures are mentioned in the text determines the numbering of the figure. For example, as in journal articles, one cannot refer to “*Figure 4*” before one has described “*Figure 3*”. Typically the number of figures or tables should be similar to what would appear in a scientific journal in the same field, perhaps 6 – 12 figures, but some of which might have multiple panels. Graphs should have error bars or some other way of indicating statistical significance. Each Figure should have a legend that describes what is in the figure. The legend should include a short sentence about statistics. For example: “*Error bars indicate standard deviation from the mean, N = 6*”. In some cases, e.g. pictures such as fluorescence images of a cell, it will be necessary to say that this picture is a representative example of N such pictures that were taken. The pixel size of pictures should be reduced so that they are not unnecessarily large, to keep the megabytes of the thesis to a reasonable value. The figures or tables, with their legends, may be integrated with (interdigitated with) the text, or they may be placed after the text at the end of the thesis.

*Acknowledgements.* This short paragraph after the Discussion should give credit to those who helped in the research, including financial support, technical support, and intellectual support.

*Citations (Bibliography or Reference List).* Any of a variety of styles can be used for references, but the list should include all of the authors of every paper (not only the first one or two authors followed by “*et al*”), the date published, the full title, and of course the journal name, volume and page number. Generally it is best to use a referencing style that is common in journals in which this kind of research would be published. Whatever citation style is used, it should be the same throughout the thesis. It will be highly advantageous to use a reference manager application like EndNote or one of the similar open access applications (Mendeley or Zotero). See [\[http://guides.library.cornell.edu/c.php?g=412004&p=2807644\]](http://guides.library.cornell.edu/c.php?g=412004&p=2807644) or the [Mann workshops calendar](#) for training sessions. Most theses have approximately two dozen or more citations, although the number may vary a lot depending on the scientific field. One common style for the reference list is that the papers appear alphabetically by first author (e.g. starting with “1. Adamson, ..., and then “2. Bailey...”, etc.) Then the text refers to the paper by its number (e.g. “*Cells were grown in DMEM medium as*

*described in [3]*". Another common style is to number the references by the order in which they appear in the text. Still another common style is not to use numbers at all, e.g. "Cells were grown in DMEM medium as described in [Smith et al 2006]." Once you pick the style, the Citation Manager application will do all the formatting for you.

*Submission of the thesis.* The thesis should be submitted electronically to the honors group leader, both as a Word document and as a PDF. Please use the following convention for naming the files: "LASTNAMEfirstname thesis", for example: "SMITHjudy thesis". Using this convention facilitates any manual sorting of the theses. If the file size is too large for Cornell email, please use Cornell DropBox.

*Contribution of others to the thesis.* Theses authored by more than one student are not acceptable. The thesis may include some figures or tables or diagrams from other people's work (either published or unpublished), if the purpose is clarity of presentation of the student's own results. But in each such case it is critically important to write an attribution in the legend, i.e. who is the author of the data and where was this published, e.g. "This figure is reproduced from Figure 2 [or perhaps 'modified from Figure 2'] in reference 6"; or "This diagram was modified from one drawn by Nancy Smith"; or "This experiment was done by Paul Jones"; or "These data were obtained with help from Paul Jones".

## HELPFUL RESOURCES

[Research in the Biological and Life Sciences](#): A Guide for Undergraduates-this guide is newly designed for Biology by Mann Library Life Sciences Librarians for Research.

[Mann Library Training Workshops](#)-Topics include Citation Management Software (Mendeley, Endnote, Zotero), Excel, Data Management, Advanced Searching in PubMed and Web of Science, Poster-making.

Statistical Resources-<http://mannlib.cornell.edu/equipment-software/software/statistical-resources>. Individual consultations available to address your data analysis needs.

[Mann Library Individual Research Consultations](#).

[Plagiarism and Copyright](#), Mann Library Guide (referenced above).

[Recognizing and Avoiding Plagiarism](#), Cornell College of Arts & Sciences.

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