

Writing and Defending an Honors Thesis in IPHY: Student Guide

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1. Thesis Content & Formatting

1. General Guidelines

An Honors thesis should follow the general format of a peer-reviewed publication in your research area, but should contain a more extensive background and discussion section, as well as include justification for the formation of your hypotheses and predictions. This means that you should use (1) headers for sections and sub-headers for subsections, include an (2) abstract, (3) an introduction that ends with a clear hypothesis or question, (4) a materials and methods section, (5) a results section with figures, tables, and/or schemes, (6) a discussion section, (7) a brief conclusion section (optional), and (8) a reference list. In addition, you must include a (9) title page (see a page 9 of this document). For more detailed descriptions of these sections, see below.

(1) *Headers and Subheaders:* These include the names of sections (i.e., Abstract, Introduction, etc.), as well as natural subsections within those sections (e.g., Data Collection, Data Analysis, etc.)

(2) *Abstract:* This is a brief summary of your research that includes 1-2 sentences of introduction, 1-3 sentences of methods, 1-3 sentences of results and conclusions, and 1-2 sentences for how the research impacts the field at large. This should not exceed one page (-200 words).

Introduction: Introduce the field that you are studying and clearly demonstrate a need for your research (i.e., an open gap or question), and tie this to a rationale for choosing your topic. The Introduction should be broader than it is in typical peer-reviewed empirical publications, and must be accessible to people who are not actively conducting research in this field, like your non-IPHY committee member and the members of the CU Honors council. You should introduce all concepts and define all technical terms and abbreviations for non-expert readers. The purpose of this section is to lead into your hypotheses and predictions, so that readers understand why you are asking certain questions, and why you are predicting certain results. Be sure to clearly state your research question including hypotheses and predictions, giving justification for why you think what you do. If you have a large amount of background information (i.e., more than 2-3 pages), provide a short general introduction ending with your hypotheses, and follow up with a Background section after this brief introduction.

(4) *Materials and Methods:* This section is a detailed description of how you performed your study and how you analyzed your results. Using past tense, include everything necessary to completely replicate your experiment, from the statistical program you used to analyze your results, to the equipment used. For equipment and reagents provide the name of the company from which they were purchased and the location of the company's headquarters.

(5) *Results:* Using past tense, succinctly report your results using text, figures, tables and schemes. Be sure to provide supporting statistics for the results you present. Do not discuss or analyze results further in this section! If you include figures, do not report results in legends of figures or tables or simply restate numbers and data points. Figure captions should include a first sentence that clearly indicates what results are shown in the context of your research question, followed by a brief statement of any context for results (e.g., the treatment applied or the relationship displayed, etc.), the subjects (and sample size) studied in the experiment, a key to any abbreviations used, and statistical test annotations. Look at figures in peer-reviewed publications in your research area for examples to work from." Refer to all tables and figures in

the text (e.g., see Table X), and also indicate the main “take home point” about the figures/tables in the text.

(6) *Discussion*: In this section, summarize and interpret results, discuss potential strengths and weakness of the results in a constructive manner, talk about other studies that either contradict or corroborate your results, and present possible future research. Do not list your results in any detail again; you may refer to figures/tables to selected cases. Be sure to highlight how your data provides some novel insight. It is important to have a structure to your discussion; it often works well to discuss your overall findings first, and then individual findings in the same order as in the Results section.

(7) *Conclusions*: This is a brief, concise statement of the most important findings of your research and how they are immediately interesting to the audience. This section is optional, because you may be able to cover this in your discussion.

(8) *Reference List*. List all previous literature/studies that you read, used and cited in your paper. Do not wait to compile your reference list until the last draft! For every draft you submit, your reviewers will want to see the list of research and documents you are relying on. The purpose of the reference list is to demonstrate to your readers that you have read enough to be a credible researcher and lend credence to your study and findings. Follow the format of citations in a sample peer-reviewed publication in your research area, and keep it consistent. Be sure to spell out the journal names. See example below:

Dalton TD, Shertzer HG and Puga A (1999) Regulation of gene expression by reactive oxygen.
Annual Review of Pharmacology and Toxicology 39, 67-101.

(9) *Title Page*: See the template later in this document (page 9).

In your thesis, you should communicate information in a succinct professional writing style, like in a peer-reviewed publication, and should not use colloquial or “lab” jargon. Be sure to check your grammar and punctuation! The thesis should flow from one section to another – your introduction should set up the need for your project, your methods should clearly demonstrate how you will fill that gap, your results should show how the gap was addressed and/or filled, and your discussion should expound on the results and show how your study leaves room for other studies and creates more gaps - questions - to be filled and answered. Every section should begin with “hints” that keep the reader informed about what is coming and why. There should typically be no direct quotes from previous research; paraphrase ideas and give citations for all thoughts, ideas or results reported. Whenever you make a statement of fact, you must support this claim using previous research. Use in-text citations at the end of every sentence that references another scientist’s work following the format of a peer-reviewed publication in your research area; e.g., (Møller *et al.* 2009). *Et al.* (for *et alii*) means “and others” and should be used for research that has more than two authors.

2. *Final Thesis (Defense Copy)*

This copy should include any and all revisions you have made, as this is the copy that will determine your level of Honors. You will submit a hard copy of this document to the College of Arts and Sciences Honors Program, and offer a copy (electronic or paper) to each member of your committee to read thoroughly prior to your defense. Be sure to check the Honors Program deadlines for when this copy is due.

3. *Archival Copy*

This copy will be submitted *after* your defense (and includes any changes requested by your defense committee) but remember that your Honors designation is decided by your Honors defense committee based on your defense copy of thesis. Upload the final copy of thesis to the Undergraduate Honors Theses repository on CU Scholar by 3:00 pm on the published date.

II. Getting Started

1. *Developing a Research Question*

Great research questions address gaps in the current literature, but are able to build on previous research. It is perfectly okay to follow the suggestion for a suitable research question/project from the advisor you choose, and later increasingly take “ownership” of the project as you conduct your research. In other cases, it may be appropriate for you to develop a research question more independently before starting the research. In that case, you should seek the feedback of your advisor on the feasibility of successfully pursuing your idea as an Honors project with its limited time frame. In either scenario, you should conduct several thorough literature searches (see the section below for more details), and pay attention to aspects of phenomena that you notice as needing further investigation. This process will help you ascertain where the gaps are in the current literature, which makes for a more interesting thesis topic! It usually takes quite a bit of reading to understand the “dialogue” that has been taking place in any sub-discipline of science, but it may help to begin your search by looking in topics that interest you and pertain to your advisor’s work. Reading recently published papers (including reviews!) will show you how phenomena are currently investigated, but be sure to expand your reading frame to include classic papers in your field, to understand how the scientific investigation has developed through the years. You may find a topic and read extensively about it, and find that there are a number of questions that have not been addressed. Alternatively, you may consider a phenomenon and number of questions that haven’t yet been explored yet. The key to a good research question is that it attempts to describe and address a gap in the literature, but builds on previous research in a logical and creative way.

2. *Literature Searches*

Your literature searches may be one of the most important steps to crafting an interesting and novel study that will garner attention from your committee and the research community! After discussing possible projects with your advisor, utilize multiple online journal searches through databases (such as Web of Science, Google Scholar) to find relevant papers. It is especially helpful to find related reviews of the current literature to get a better handle on how research is being done, then focus in on relevant studies discussed in the review. Additionally, in the Web of Science, you can perform “forward” and “backward” searches for studies that are cited by, or cite, any given research article, which often helps to further direct your searches. Be sure to continually comb the literature for related papers to add to your understanding of the topic, even after you have started your work. Use the auto-update feature in the search engine to be informed about recent publications in the field. In your written thesis, you must cite an appropriate number of references for your field, and references that bolster your credibility as a researcher. Use both classic and newer studies to illustrate and authenticate your own research. All this will allow you to better understand your research area, grasp the meaning and importance of your own results, and compare your results with those of other authors.

3. *Writing*

Start early! We highly recommend you take IPHY 3700, Scientific Writing in Integrative Physiology, the semester before you defend your thesis. See Tables 2 and 3 for suggested timelines. Writing the thesis may seem daunting at first, because you are indeed starting a long process, but do not fear! The thesis should not be written in one sitting, but should be worked on over a longer period of time. You should begin by keeping “notes” and outlines of each section, especially of your methods, so that as you gain more information, you can then fill in your outlines with more detail. If you begin by building a logical structure of your study, with clear research questions and hypotheses, you will be able to identify those portions that “don’t fit” or where further thought to fill gaps is needed. Be sure to note all assumptions or premises of your arguments, as these are of particular interest of your committee: everything you do should have a well thought out reason! The thesis is not just a summary of what you have seen previously, but a novel piece of your own work and ideas - these will be developed through your drafts.

It is also important to note that your thesis is typically not written about what you originally set out to find, but to describe the results you actually obtained (rather than what you might have hoped to find!). In your introduction, formulate the question you actually answered. Every section should prepare the reader to understand and appreciate the results and conclusions you discovered. If you find a non-significant result where you had expected something significant, prepare your readers in the introduction (and throughout the thesis) for the possibility that there is another phenomenon acting on the system. **Every section should contribute to a single, unified presentation of the actual findings from your study as an answer to your research question.**

You may find that making one (or a series of) outline(s) helps you develop your ideas, a logical flow of those ideas, and thus a convincing argument. The thesis should tell one logical story, and everything in your thesis should support that story. Develop an outline of ideas that allows you to show this (that is, your outline should clearly show how one idea connects logically to the next one, and so on). Once you have your final outline, fill in sections as best suits you! For example, it may be best to write your Methods section as you carry out the research, such that no important details are left out! You will likely be surprised about how much time is devoted to describing how you conducted your experiment. Additionally, before writing the Results section, remember that the goal of the thesis is to demonstrate one logical flow of information, and thus be sure to take time to carefully order all of your graphs and tables before you start writing this section.

4. *Tips on Meeting Deadlines*

Spend time making an initial in-depth schedule when you begin the thesis writing process, including the official deadlines from the Honors Program. Schedule personal deadlines with goals early in the semester to allow a time buffer in case problems or “hitches” are encountered, which occurs almost invariably. Try to meet with your advisor once a week, as well as consider meeting the other defense committee members, or the Writing Center in Norlin Library to garner further feedback. The more feedback you are able to get, the better your product will be. Write all your deadlines in a day planner at the beginning of the semester so you know what’s due and when. You can revise these as needed as you go along. See Tables 2 and 3 for suggested timelines.

III. Honors Thesis Defense Committee

1. *Working with your advisor*

Your advisor should make himself/herself available for regular meetings with you, to answer questions and give you guidance about the proceedings of the scientific content of your thesis. Your advisor should play a key role in the revisions of your thesis and give suggestions of studies you should read to expand and broaden your understanding of the research topic. Since one of the biggest problems for Honors students is insufficient time allocated for the back-and-forth of thesis drafts between you and your advisor, be sure to check the sample time schedule found in Tables 1 and 2 (for Spring and Fall graduations, respectively).

2. *Choosing your committee members*

You should choose your committee and have their acceptances by early November for Spring graduation. You need to have decided on your primary advisor at that time - but it is much easier on you and your advisor if you have made this decision earlier! You need no less than three defense committee members: One Honors council member, your faculty advisor, and one outside (non-IPHY) member. The outside member cannot be cross-listed as IPHY faculty. You may find someone with whom you've taken a class you enjoyed, or you may explore faculty members with related research interests to find someone who would find your research interesting. Your advisor may have some good suggestions, too! Keep in mind that your outside committee member will most likely not be familiar with your research area, and that you'll need to accommodate them in your oral defense and thesis writing by being transparent and defining all technical terms you use. You may choose to invite more than three committee members, but the more people you have on your committee the more difficult scheduling is, and the more random/"unwanted" questions you may get.

3. *Communication with your committee*

Be respectful and punctual through email correspondence with your committee. Be sure to set up a time for your defense early in the semester, so that finding a time that works for your all your committee members is relatively easy. Give a range of dates (e.g. the last two weeks of March) and ask your committee what general time of day or days of the week that would fit in their schedules. You may want to send out a Doodle poll to come up with the defense time. As the thesis defense gets closer, remind your committee of when and where your defense will be in the week of the presentation. Remember to send your final defense copy to the whole committee 1-2 weeks prior to the defense. Offer several different versions of your thesis (.doc, .docx, PDF, printed hard copy) and remember to request comments from your committee; the additional critique will likely help your thesis be even better!

IV. Defense Presentation

1. *Purpose*

The oral defense of your written thesis allows you to demonstrate familiarity with specific and broader aspects of your research area, and the ability to think critically and communicate effectively. This is not simply an "overview" of your thesis, but an opportunity to show the "bigger picture" into which your work fits, to engage in conversation about where your research could go, and reflect on research that has been done previously.

2. *Guidelines and Formatting*

You should begin with a 15-20 minute synopsis of your thesis (typically using PPT). Introduce your study by giving a rationale of your work: why it matters, why you spent time researching this, what the bigger picture is. You should then give a brief summary of the methods, results and the conclusions of the study. Your methods should be described such that the audience can easily understand how you are answering your research question. Discuss any pitfall and limitations of your study, constructively - don't sell your research short, but be realistic. It is an excellent idea to practice your defense as much as possible. As you "talk it out", it is easier to identify holes in logic, reconstruct weak arguments, and doing this gives you more confidence when presenting the "real thing." You might even consider videotaping yourself to confirm that you are confident and composed while presenting; be familiar enough with your presentation that you do not rely on slides or notes to give you the information.

3. *Defense Agenda*

You will set up your presentation, and greet committee members as they arrive. You will then give your 15-20 min presentation, and subsequently engage in a period of questions and conversation about your presentation (expect conversation about tangentially related subjects, as well!). This may take another 20 to 45 minutes. You will then be asked to leave once again, while the committee discusses, and after their discussion, you may return and pack up your laptop and belongings!

Be prepared to answers questions about the following items: (1) any and all aspects of your research, especially what is mentioned in your **presentation**, written on your **PowerPoint slides** and in your written thesis, (2) background knowledge of the main issues (found in the body of literature and sometimes textbooks), (3) relevant literature (e.g., what was known by the research community when you started, how do your results fit into the "big picture"), (4) things you may do differently if you could perform your experiment/project over again, and (5) future plans with your career! Previous students suggested writing a list of specific possible questions that you can prepare to answer for your committee, so that no question takes you by complete surprise.

4. *Scheduling the defense*

You are responsible for scheduling the defense with your committee members (as mentioned above), and booking a room early in the semester. Contact Rachel in the IPHY main office to schedule a room; book it for two hours to give yourself and the committee ample time. Previous Honors students recommend that you complete your defense before Spring Break (for Spring graduation), although you are free to schedule it any time before the Honors Program deadline.

V. Honors Designations

1. *How the decision is made*

Your cumulative **GPA** suggests a specific Honors designation (see table below), but the thesis must earn this designation independently; written thesis, defense performance and **GPA** are all taken into consideration for the final designation. For *Magna* and *Summa*, both the defense and written thesis must demonstrate a clear command of the "big picture", and the research should be conducted somewhat independently (especially for a *Summa*). For a *Summa*, the thesis and defense must be "impeccable." To be considered for higher Honors than your cumulative **GPA** suggests, you must produce a thesis and defense that is **two levels higher** than your **GPA** (e.g. *Magna* level thesis is

required for Honors if you have a **GPA** below 3.300, graduate-level work is required for *Summa* if you have a **GPA** of 3.500 - 3.799). Your committee will write a letter to the Honors Council recommending a particular level of honors, but the Honors Council has the final say on the level of honors awarded. If the recommendation is for two levels higher than the GPA, two letters must be submitted to the Honors council. Also is there is a split vote among your committee members, two letters should be submitted as well.

Table 2. Honors designations and corresponding cumulative GPAs.		
Honors Level	Latin Honors	GPA
Honors	<i>Cum laude</i>	3.300-3.499
High Honors	<i>Magna cum laude</i>	3.500-3.799
Highest Honors	<i>Summa cum laude</i>	3.800-4.000

2. *Honors Council*

The Honors council is a group of faculty members representing all Arts & Sciences departments (50+, with many non-science disciplines). They make the final decision on your Honors designation. Their role is crucial when the defense committee's recommendation is not unanimous, or when the recommended designation is higher or lower than what the GPA suggests. In the latter cases, the archival copy of your thesis is circulated and leafed through by the Honors council members.

Title of Thesis (Capitalized)

By
(Student name)
(Department), University of Colorado at Boulder

Defense Date (Month Day, Year)

Thesis Advisor (Advisor Name), Department or Program

Defense Committee (Advisor Name or 1st Committee member), Department or Program (2nd Committee Member), Department or Program (3rd Committee member), Department or Program

Table 2 Honors deadlines for Spring Graduation

Early October (check Honors website for actual date)	Submit 2-page (hard copy) application to A&S Honors program (Room M400M in Norlin) with <i>all required signatures!</i> www.colorado.edu/honors/graduation
6 weeks before your defense*	Submit a working copy of your thesis to your advisor; by this time, you should have at least an outline of your thesis prepared
4 weeks before your defense*	Submit a first full draft of your thesis to your advisor, and expect there to be 2-4 renditions after this draft before your final defense copy can be submitted to the committee
At least 1 week before your defense (not including Spring Break)	Submit the final defense copy of your thesis to your whole committee.
April 11, 2017 at 3:00 p.m. (this date may change from year to year)	Last day to defend thesis. Defense Copy of thesis due to Honors Program Office in Norlin (M400M) by 3:00 p.m.
April 14, 2017 at 3:00 pm (this date may change from year to year).	Upload the final copy of thesis to the Undergraduate Honors Theses repository on CU Scholar by 3:00 pm.
* recommended deadlines	

Table 3 Honors deadlines for Fall Graduation

Early May (check Honors website for actual date)	Submit 2-page (hard copy) application to A&S Honors program (Room M400M in Norlin) with <i>all required signatures!</i> www.colorado.edu/honors/graduation
6 weeks before your defense	Submit a working copy of your thesis to your advisor; by this time, you should have at least an outline of your thesis prepared
4 weeks before your defense	Submit a first full draft of your thesis to your advisor, and expect there to be 2-4 renditions after this draft before your final defense copy can be submitted to the committee
At least 1 week before your defense	Submit the final defense copy of your thesis to your whole committee.
November 4, 2016 at 3:00 p.m (this date may change from year to year).	Last day to defend thesis. Defense Copy of thesis due to Honors Program Office in Norlin (M400M) by 3:00 p.m.
November 7, 2016 at 3:00 pm (this date may change from year to year).	Upload the final copy of thesis to the Undergraduate Honors Theses repository on CU Scholar by 3:00 pm.