UF UNIVERSITY of FLORIDA
J. Crayton Pruitt Family Department of Biomedical Engineering

Guidelines and Recommendations for Defending an Undergraduate Honors Thesis in Biomedical Engineering

Overview

The Department of Biomedical Engineering defines active research as participating in the design of experiments, prototype development, data collection, and/or data analysis. Depending on your project, you may perform research that meets one or all these categories.

The senior undergraduate honors thesis defense involves an examination by three professors of the student's experience. The written thesis document and oral defense presentation will showcase the student's skills and contribution to an active project.

Students may defend internship projects toward the completion of their undergraduate honors thesis. The same criteria apply to the defense of internship projects as academic research projects. The project must be defended, both orally and via a written report, by a committee of three faculty members. The student must get written permission from their sponsoring company and submit this document to the Undergraduate Program Committee prior to the defense. This letter should note that the company is aware that the project will be presented to UF faculty members, both within and outside of the Department of Biomedical Engineering. If a company is concerned with intellectual property issues or intends to act on intellectual property related to the project, the student should not use the internship project as part of their undergraduate honors thesis.

Students defending during the spring semesters are expected to orally defend their thesis at the undergraduate research day poster session. Students unable to attend the session or are graduating during the fall semester may orally defend their thesis via a scheduled presentation to their committee.

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Requirements, Expectations, and Critical Deadlines

BME requires that all senior thesis or undergraduate honors thesis students be in good standing prior to graduation and to register and complete a minimum of two semesters of EGN4912: Engineering Undergraduate Research or BME3941: Internship Experience in Biomedical Engineering (*or a combination of the two courses – one semester of each). It is expected that most students completing a senior thesis or undergraduate honors thesis will register for these courses three or more times.

- Note that it is not required that EGN4912 be taken for credit.
- The second semester of EGN4912 or BME3941 may occur during the final semester for the graduating student, meaning the student must have enrolled in EGN4912 or BME3941 at least once prior to the declaration of the senior thesis and undergraduate honors thesis.
- The two semesters of EGN4912 must occur under the same faculty advisor. In rare instances, a change of academic advisor may be approved by the Associate Chair of Undergraduate Studies. These requests are only allowed when the project is clearly a continuation of a single research project (examples: student moved between collaborating labs, student begins data collection in medical center then completes analysis in engineering college).
- *To complete an honors thesis with one semester each of BME3941 and EGN4912, a clear collaboration must exist between the research faculty advisor (EGN4912) and the company that is sponsoring the internship (BME3941). Alternatively, a clear plan that involves a BME faculty member must be approved. Retroactive internships are not acceptable because the research faculty advisor must be aware of (and approve) the collaborating internship.

The supervisory committee must be identified by the second Friday of the graduating semester. The faculty committee should include:

- At least one primary BME faculty member (non-affiliate)
- An additional primary BME faculty member or affiliate faculty
- An affiliate faculty or external faculty member

Declaration Deadline: The student must identify their supervisory committee and submit the Supervisory Committee Form to the BME Academic Office by the end of the second week of classes during the graduating term.

Defense Deadline: The student must defend the thesis to the supervisory committee and submit the Final Oral Examination form to the BME Academic Office no later than one week prior to the last day of classes in the graduating semester. Forms submitted after this deadline will not be accepted. The student must also complete the necessary paperwork with the library and college (see links above).

Submission Deadline: An electronic copy (PDF) of the completed thesis must be submitted to undergrad@bme.ufl.edu by the last day of classes in the graduating semester.

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Defense Documents

A senior thesis and undergraduate honors thesis in biomedical engineering must include:

1) A written thesis.

The deadline for the written thesis should be determined by the committee. Most committees will request that the written thesis be completed 7 days prior to the oral examination. However, this is at the committee's discretion. For example, the committee may want to review the oral defense first (at the poster session), then review the written document after. This is acceptable; however, Final Oral Examination and Honors Thesis Submission forms must be completed and submitted to the BME Academic Office no later than one week prior to the last day of classes in the graduating semester to ensure that the student has enough time to meet the critical university deadline as described above.

The written thesis should include:

- A title page identifying the thesis title, presenting student, supervisory committee, and oral defense date.
- An abstract of 250 words or less.
- A main text with a minimum of 10 written pages.
- The abstract and title page are not included in this page count.
- References at the end of the thesis are not included in this page count.
- Appendices are not included in this page count.
- The main text should have margins no smaller than 1 inch.
- The main text should have fonts no smaller than 12 point.
- The main text should have line spacing of 1.5 lines exactly (do not single or double space).
- A bibliography for the thesis. There is no page limit for this section.
- Appendices are not required but may be used, if necessary. Applicants should be aware that the supervisory committee is not required to review appendices, and thus, appendices should only be used as supplementary material. Do not include critical figures in the appendices. Critical figures should be in the main text, as your committee is not required to review the appendices.

2) An oral examination and defense to a committee of three faculty.

The student is expected to present a poster during the departmental undergraduate research day during the spring semester. Alternatively, the students should prepare a 10-minute presentation that covers their thesis work and be prepared for a minimum of 20 minutes of questions and answers (total, not per committee member).

Tips and Recommendations for Preparing the Written Thesis

The undergraduate honors thesis in BME should be written in a similar format to the scientific literature in biomedical sciences: Abstract, Introduction, Materials and Methods, Results, and Conclusions.

The Abstract (250 words or less)

As with the scientific literature, the abstract should stand alone and not reference the main text. Many students find it easier to sub-divide the abstract into the same sections as the paper (also known as a structured abstract), writing a few of the main points from each section. This is completely acceptable but not required. However, the abstract should highlight the main objective(s) and conclusion(s) from the conducted research.

The Introduction

In biomedical sciences, problem identification and problem definition is paramount. Successful students should be able to identify the basic aim and/or scientific hypothesis of their research – what is it we that we do not know that we seek to understand better? This ideally should be identified early in the project and potentially prior to the plan of study.

Effective research aims should be identified in the introduction, with the introduction reviewing the relevant literature and defining the problem. Ultimately, the main aim or objective should be able to be stated in one sentence near the end of the introduction:

The aim/objective of my research is to…

1) Evaluate gene expression changes due to various inflammatory mediators in activated macrophages.
2) Design a drug delivery system to release a bioactive agent over five days.
3) Measure action potentials in the sciatic nerve following reconstructive surgery in the rat.

Also, research aims in biomedical engineering are typically paired with testable scientific hypotheses or with engineering objectives. Like aims, objectives and hypotheses are typically stated in one or two sentences, such as:

> Aim: Design a mechanical testing chamber to evaluate tissue engineering blood vessels
>
> Hypothesis: In engineered blood vessels, cyclic pressure will result in greater matrix deposition relative to static loads.

Being able to condense your research into definable aims, objectives, and hypotheses is a critical part of the thesis introduction.

Identifying the significance of a research activity is highly important, as is identifying what questions are left unanswered by your research activities. Why is your research activity significant and what can it add to the field that is not already known? What are the consequences if you are able to meet the goal of your research? What assumptions are you making and how may your conclusions change if your assumptions prove to be false? By nature, biological systems are highly complex and often interrelated. To analyze and assess these systems the following must be done:

a. Understand the field, what is known, and what is not known. To do this, students should demonstrate a reasonable understanding and ability to reference the scientific literature.
b. Define the problem space, such that the solution is possible. If your objective is to cure cancer, you are unlikely to achieve this during your undergraduate studies. The problem is too broad, and the problem space has too many variables. But if your objective is to understand how cell membrane mechanics differ between normal and cancerous cells, reasonable progress toward this objective could be made during your studies.
c. Finally, in defining BME problems, assumptions are almost always made. Understanding these assumptions and developing hypotheses for what may occur should the assumption prove invalid is an important skill in biomedical engineering.

This advice is critical to both the introduction and discussion of your thesis. If you can set up your problem effectively (items a and b above), you will be able to set up your discussion section (item c above) to generate new hypotheses and ideas to move your field of study forward.

The Materials and Methods

The methods should state what you did, when you did it, and how you did it. It generally reads as a chronological sequence of events with subheadings. While students often find this section the easiest to write, it is often an area of focus during the oral exam.

Understand what methods are typically used to accomplish similar research, as well as recognize the advantages and potential limitations of these methods. While you are not expected to be an expert at an analytical method or a sophisticated technique, you are expected to have a general idea of the basic principles of the key technique used in your research and how it was used to generate data.

Be cognizant of the biological aspects of systems/modeling used in their research. For example, familiarity with limitations of in vitro and in vivo models, specific features of cell lines, relationship between gene expression and protein expression.

The Results

The results section should show your data and your data analysis. Like materials and methods, it is fairly straightforward, noting significant scientific findings. As expected, this section is typically a major point of emphasis during the oral exam.

Understand your results and how your data was analyzed. It is understood that a typical undergraduate thesis will not contain voluminous data. If there are no results because a technique did not work, an instrument was broken, the simulation code had bugs in it, or cell lines were contaminated, the professors will understand. But only if you can explain how you attempted to circumvent these problems and diligently addressed these issues). Remember, you are ultimately being assessed on your skills in the design of experiments, prototype development, data collection, and/or data analysis, not whether your original hypothesis (i.e. scientific guess) was actually true.

It's ok to present negative results. If you have a negative result (i.e., the result was counter to expectations), that is valuable too! Research to demonstrate an outcome that is already known isn't necessarily research. Again, your hypothesis (i.e. scientific guess) does not need to be true in order for you to conduct quality research.

The Discussion

The discussion is your opportunity to present your data relative to what is known in your field (see introduction).

Don't punt the discussion: Students can feel the tendency to try and rush or skimp on this section, but this is your opportunity to really discuss what you learned, what you would have done differently, and what you would do next if you were to continue this work. This is a prime section to demonstrate your research skills – design of experiments, prototype development, data collection, and/or data analysis – by critically evaluating your own work and what you would do next to continue to solve problems in your field.

Understand your data analysis techniques and the interpretation of results. Biomedical experiments are often nuanced and quite dissimilar in design, as such, there are not necessarily boiler plate methods to analyze each experiment. But, if you have results, try to have a reasonable explanation/analysis of your findings. You should absolutely approach your advisor and graduate mentors, if any, for guidance on how to analyze your datasets. Remember, it is important to be critical of your data. Analyze it carefully. Do you have enough runs to be sure that your data is reproducible and consistent? How much variability is in the data? Are your simulations realistic and representative of the physical situation? What are the assumptions in your analysis? Comment on these limitations and on the statistical significance of your results.

Be your own critique. If you worked diligently but found roadblocks for which there was no time to overcome, or obvious problems with the research strategy or alternative approaches opened up toward the end of your dissertation, be sure to explain this. Your careful troubleshooting will save your professor and any others who attempt to continue your work valuable time, and you have accomplished a lot in a short time.