MASTER'S THESIS HANDBOOK

The writing of a graduate thesis is a personal process that is different from most academic writing experiences many students have. Distinct from many writing assignments at the undergraduate level, the process of writing a thesis is iterative and involves substantial back-and-forth with the Thesis Advisor and Thesis Committee. Students typically find that the thesis takes much more time and effort than anticipated. Thus, careful long-range planning is an important component of success. The information provided below describes the goals and purpose of the thesis, outlines the process of preparing a thesis, provides policies and procedures, and offers helpful hints.

Contents

THESIS OVERVIEW AND FORMAT

The thesis in CMM consists of a scholarly and thorough treatment of a novel research project. Laboratory, non-laboratory (literature-based) and hybrid projects are options for students. The research project will be agreed upon by the student and the thesis committee (comprised of at least three faculty members, at least one of whom must hold a faculty appointment in CMM). As a guideline, a laboratory-based thesis should be in the format of a publishable manuscript for an appropriate journal, typically with an expanded introduction.

A non-laboratory-based thesis should be in the format of a full-length review article in a major biomedical journal such as *Cell*, *Nature Cell Biology*, *New England Journal of Medicine*, and others,

typically between 10,000-20,000 words (not including references). A good literature-based thesis should convey a student's ability to think scientifically about a problem. A recommended approach is to present in the introduction a key outstanding problem or question in the field and then propose a model with hypothesis to explain the process or disease under study. In the remainder of the thesis, the model should be justified from the literature, and tests of the hypothesis should be offered, with consideration of the potential outcomes. In the discussion/conclusion section, potential future research paths that could follow the proposed research should be discussed. In other words, the thesis is not only an in-depth review of a field, but it also includes a novel, creative, and scholarly contribution to the field. Students are required to think critically about the field, identify gaps in our understanding, and propose new mechanisms to explain the process under study and propose future research to answer important questions.

THESIS POLICIES

Thesis Units: Students are required to take at least 5 units of "Thesis" (CMM 910) in order to graduate. All 5 units may NOT be taken within a single term. Benchmarks have been established for each thesis unit and can be found here. This information should be shared with the faculty advisor responsible for submitting grades for the student's thesis units.

Basic and Clinical Laboratory-Based Theses: Students who will be working in a laboratory **must** complete the University's Online Responsible Conduct of Research Training: RCR training. Likewise, students who will be working with patients or non-anonymized patient data must take the University's Health Insurance Portability and Accountability Act of 1996 (HIPAA) Training: HIPAA info. It might be appropriate for students in research laboratories (basic or clinical) to register for CMM 900 "research" units.

General Requirements: The University of Arizona has several requirements for all MS theses, and students in the CMM program must adhere to them. Links to many of the Graduate College policies are here. Students should familiarize themselves with these policies early in the thesis process to save time at the end.

TIMELINE AND STEPS TO THE THESIS

It is essential to observe the following deadlines to successfully complete and defend the thesis. This is not a process that can be done quickly! It is the responsibility of the student to organize this process and communicate the deadlines and expectations to the Thesis Committee.

1. During the first semester/term in which the student takes initial thesis unit(s), the student's Thesis Committee should be selected, and the Thesis Advisor identified. This committee must be approved by the Graduate College using the appropriate form within GradPath. Details on committee composition can be found in the handbook for the CMM MS Program.

2. Students should follow the policy described above to complete each thesis unit. This will facilitate interaction between the student and his/her committee members early during the thesis process.
3. Early during the semester in which the defense will take place, a meeting of the Thesis Committee should be of the held to ensure that the student and committee agree on the student's timeline and progress toward completion.
4. At least **seven weeks** before the thesis defense, a complete draft of the thesis should be distributed to the committee.
5. **Five weeks** before the defense date, the Thesis Committee will return the edited thesis draft along with a recommendation on whether a revised draft will be "defendable".
6. **Two weeks** before the defense date, the polished, fully-formatted thesis should be sent to the committee. Note, however, that additional revisions are likely following the defense.
7. All degree requirements including coursework and submission for open-access archiving of the final approved thesis (with all requested revisions and fully formatted) must be completed by the date set by the Graduate College for a given semester/term to ensure degree completion within that term. Therefore, the thesis defense must occur before this deadline (typically 1-2 weeks) to allow time for final revisions.

THESIS DEFENSE

How to prepare and what to expect for the thesis defense:

- The student should prepare a short presentation with slides that gives an overview of the thesis topic; this should be designed to take approximately 15-20 minutes. Figures from the thesis and additional background figures may be appropriate.
- At the beginning of the meeting, the student may be asked to leave the room briefly so the committee can discuss the process.
- During the presentation and afterward, the committee will ask questions about the thesis as well as relevant material from the student's coursework; this could last up to 60 minutes.
- The committee will ask the student to step out of the room while they discuss and vote.
- The committee will inform the student of its decision.
- Even following a "pass" vote, the committee may ask for additional revisions to the thesis. In this case, the changes must be approved by the Thesis Advisor or the entire committee, depending the decision of the committee.

If you have any questions, contact your Thesis Advisor well in advance of these deadlines! **Once your thesis has received final approval from the committee, please send a PDF copy to the Program Director and Program Coordinator.**

HELPFUL TIPS

Getting Started: A great place to start is by researching the literature on topics you find interesting, perhaps something that piqued your interest in a class. There is a way to develop a good thesis around most topics - you just need to do some digging.

UA students have access to most of the scientific literature. PubMed is a good source to find articles. Google works rather well, too. Begin with some searches using keywords of interest - such as "kinase diabetes". This will probably yield too many hits for most searches. In PubMed, you can enter your search term(s) and add "and review" ("kinase diabetes and review") and it will limit the search to review articles. Review articles are a good place to start, as they will summarize the latest findings in the field and point you to primary research articles.

Next, develop an outline on the selected topic. The outline starts with bullet points of the main sections of your thesis. Not just "intro" and "discussion", but a list of the subsections of the intro, for example. What are the major topics you plan to cover in the intro? You can add details to the outline as you do more reading and thinking. Concurrently, through your reading of the literature, identify gaps in our knowledge of the process under study and think about new models and hypotheses that explain a process/disease based on what you read. Consult with members of your committee to guide you in this phase of thesis development.

Writing Tips: It takes considerable time and effort to communicate well in writing. This is an essential career skill and part of the purpose of the thesis is help students become skillful written communicators. We refers students to Gopen and Swan, 1990, for some starting pointers on scientific writing. A few guiding principles from this source are:

- Provide context for your reader before asking that reader to consider anything new. That means, place appropriate "old information" (material already stated somewhere earlier in document) in the first sentence of any paragraph and then build on that information.
- Follow a grammatical subject as soon as possible with its verb.
- Place at the end of the paragraph, in the stress position, the "new information" you want the reader to remember.
- Keep your language as simple as you can and be accurate. It makes for easier reading. Always think of the reader. What is the main point of a sentence or paragraph or section? Each one should have a single point. Have you conveyed that clearly? Do not write to impress but to inform or persuade.
- Avoid jargon. All fields have their own set of important words but make sure that these are clearly defined and/or explained early in the document. Always define abbreviations. Remember that your reader is unlikely to be an expert in the field that you are writing about.
- Most writing takes several substantive revisions. A good editor to help you find the problems is invaluable.

The University Writing Center provides free drop-in tutoring to get constructive feedback on your writing. They also have professional staff who can provide private fee-based tutoring. While these services cannot address the scientific merit of your writing, they can help with general aspects of professional writing. In addition, the Graduate College links to many resources for writing and

publishing. Of course, you will also get practice and training in some of your graduate courses, especially CMM 603 (The Art of Scientific Communication).

Bibliographic Tools: It is strongly recommended that you use specialized software – referencing programs - to help you organize you organize your bibliographic information. There are several referencing programs on the market; some popular programs are EndNote Reference Manager, and Mendeley. The University of Arizona BookStores currently offers student pricing on EndNote. The University of Arizona Library system has links to some free resources for referencing and they can help you determine which product may be best for your needs. There is also a free program called Zotero that is used by many students and faculty. These programs work with your word processor to make is easy to insert and organize citations. Use of these programs will save a tremendous amount of time and headaches in the long run!

Figures: Figures should be included in your thesis. You are welcome and encouraged to create your own figures. However, you can also include published figures in your dissertation, but only with permission. Most journals have a web portal through which you can request permissions. Here is an example from the Nature family of journals: permission portal. Obtaining permissions as-you-go will save you time at the end. Keep copies of your permissions and include them at the end of the thesis as an appendix.

Examples theses: It can be helpful to look at examples of theses from former students in the program. Contact the MS Program Director to get copies of CMM MS theses.