

LMP Guidelines and Considerations for Thesis Preparation

Students often underestimate the time and effort required to write a thesis. A first draft typically takes approximately 3 months, and several rounds of revisions are common before the supervisory committee approves the thesis to be ready for defence at the final oral examination. There is often confusion about writing style, what to include (unpublished work, published work) and how to organize it. The following offers guidance on these matters based on questions commonly asked by students and comments frequently made by thesis examiners.

Writing style

Use of the active voice in your writing is more engaging for the reader than the passive voice. Writing in the third person provides an objective presentation of the work. Writing in the first person singular (I) is used to distinguish the work performed by you. The use of first person plural (we) is not appropriate in your thesis because it does not permit the examiners to clearly evaluate your specific contributions to your thesis research. Accordingly, it is critically important to clearly state what you did versus what was done by others because the final oral examination evaluates your work towards meeting the requirements of your degree - not the contributions of your collaborators.

What to include in your thesis

Unpublished work

Your thesis is the place to explain the rationale used in your investigations, and an opportunity to describe all the work that was done – even strategies that were unsuccessful. This includes the methods for approaches that were attempted that failed or were inconclusive, as well as methods that were successful. It is also the place to describe the troubleshooting that was performed to overcome difficulties. Much of this type of information would never appear in a publication due to page constraints, but it is important to document in your thesis to demonstrate the amount of work you carried out and your critical thinking skills. This information also serves as an important resource to your supervisor's lab about the specifics of work that was completed by you.

Published work

Students are encouraged to publish throughout their graduate program. The inclusion of published work (research or review article) in a thesis raises issues that must be considered and managed appropriately. These issues refer to work published by others as well as work published by students during their graduate program.

Consider the following if your work has been accepted or published in a peer-reviewed journal:

- Multiple author articles: All multiple author articles require a statement about the specific contributions by each author, an assessment of the relative contribution of each author to the article, and the complete article citation (See *Preface* section). The supervisory committee obtains feedback from the co-authors about their relative contributions, and arrives at a consensus. Generally, the student is the first author of an article. If the student is a co-first author of an article, only one of the students can include the article in his/her thesis, as an article can only be used for credit towards one degree. Work from a second author publication may be appropriate for inclusion in the thesis if the student's contribution to the article was

significant and essential to the development of his/her thesis. The determination to allow inclusion of a second author publication is made by the supervisory committee members.

- **Published article content:** A publication cannot simply be inserted as a chapter in a paper format thesis for a number of reasons. Some content in your publications may need to be reorganized or removed for inclusion in your thesis, while additional content may need to be inserted for your thesis. Examples of what might be removed from a publication include the abstract, work done by others that is not essential to the development of your thesis, writing by the co-authors, etc. Examples of what might be added to the published content include information that is important/useful for inclusion in your thesis but excluded due to publication page limitations (method details, more specific clarification of work performed by others), the introduction may be insufficient (clarification of the rationale for the work in relation to your thesis hypothesis is needed), work should refer or relate to other chapters in the thesis, etc.
- **Writing style:** Since you are the author of your thesis and you are being evaluated on your work, the use of “we” is not appropriate in your thesis. However, you cannot simply substitute “I” for “we” as it appears in the published version of your work. Consider writing in the third person to provide an objective style in your research writing. Use “I” to highlight your specific contributions, and link the name of the individual with their contributions to your research.

You must demonstrate compliance with copyright law by providing evidence that permission has been obtained from the copyright holder(s) for the inclusion of any accepted/published work, whether it is your work or another author’s work. You must determine who has copyright and obtain permission for publishing information from the article (even your own publications!). Be sure you know who holds the copyright – some publications may require permission from each co-author. *Contact the publisher or copyright office to address questions about copyright.*

How to organize your thesis

Students should consult their supervisory committee about which thesis format is appropriate for their work. In general, master’s students are strongly encouraged to use the traditional format for their thesis. Although some of the investigations conducted in a master’s project may be sufficient to generate a publication, there is often other data that does not stand on its own as a separate chapter in the thesis. This results in the problem of how to include this data in a paper format thesis to demonstrate the scope of work carried out by the student. A traditional format thesis easily allows the inclusion of all the work conducted by the student in a single Results chapter. Doctoral students are strongly encouraged to use the paper format for their thesis, keeping in mind that publications cannot simply be directly inserted as a chapter in the thesis (see previous section about published work).

Always refer to current FGSR Thesis Formatting Guidelines for what sections must be included and how they are to be formatted. Examiners frequently comment on errors in formatting (text, use of italics/capitals for scientific words/names, section numbering, etc.), layout and legibility of tables/figures, figure text legends, spelling, syntax and grammar.

Please note that any draft that you provide to your supervisory committee for review should include the Table of Contents to provide them with an overview of the organization of your thesis. This is particularly useful for Chapter 1.

Thesis Components

Title Page: The title should reflect the specific topic of your research inquiry.

Abstract: There is one abstract for the entire thesis, so write this last, after the rest of the thesis is completed. It is a concise summary of your research findings, what is novel, and its significance.

Preface: The names of all individuals that participated/contributed to your accepted and published work must be stated here, as well as the nature of their contributions. The complete journal article citations must also be stated and in which chapter(s) the work is located.

Evidence of the required ethics approval for your research must be stated here (obtain this from your supervisor(s)). Any work performed on humans or animals, or on samples obtained from humans or animals must have ethics approval from the ethics board where the work was performed as well as from the University of Alberta.

Dedication (optional)

Acknowledgements: Here you can thank those who provided guidance, those who impacted your graduate school experience, colleagues, friends and family, as well the sources of financial support received during your program.

Table of Contents: Use the word processing software to automatically generate/update the list of chapter/section headings and page numbers.

List of Tables, List of Figures: These lists are useful for the reader to quickly find data.

List of Abbreviations: This list defines the abbreviations that appear in your thesis, and is a useful reference to the reader who may not easily find an abbreviation where it was first defined in the thesis text.

Glossary (optional): This list of term definitions is useful to the reader when the terms are uncommon and specialized to a specific field.

Body of Thesis: Traditional Format and Paper Format Theses are permitted in LMP. Use numbered headings and subheadings to organize each section in either format.

Traditional Format Thesis:

Chapter 1 Literature Review: Allow 3-4 weeks to prepare the first draft. You have been reading the relevant scientific literature throughout your graduate program, and preparing small reviews along the way for lab group meetings, presentations, supervisory committee meetings, journal publications, etc.; some students may have published a review article. An updated literature review is needed for the thesis. Write the literature review using language for the *non-expert* reader. Define abbreviations where they are first used in the thesis text.

The introductory chapter begins with a general overview of your area of research (1-2 pages), which serves as the framework for the literature review of the topics required to understand your thesis research. Consider what concepts are essential to understanding your research; start broadly and gradually become more specific to your research, finally leading to the last section of

your literature review: “Rationale for thesis research”. This section reviews the key concepts/evidence and gaps in knowledge that led to your research questions and the development of your hypothesis. Then clearly state your hypothesis – it encapsulates your research question(s) and why it is important. Remember your hypothesis should be concise, specific and falsifiable. Lastly, state the objectives that will allow you to test your hypothesis. A thesis may have more than one hypothesis.

Chapter 2 Materials & Methods: Allow 1 week to prepare the first draft. This chapter includes the details regarding sources of samples (human, animal, microbiological, environmental, etc.) and any required ethics approvals from the relevant ethics boards, materials (company, location) and equipment (model, company, location) used, the principle of the methods (including those of commercial kits, company, location), the rationale for your choice of methods, statistical analysis (software, company, location) etc. Indicate the designated registered trademark □□or□□for commercial products (e.g. kits, equipment, instruments).

Your thesis documents your contributions to your supervisor’s research activities, and should include sufficient details so it is possible for others (e.g. future students) to reproduce your work. It is not enough to simply cite another publication for method details because there are typically some modifications to optimize the procedure for your application or lab environment. Similarly it is not enough to just cite the use of a commercial kit method because these may be discontinued in the future and therefore the principle of the method would be unavailable, and therefore prohibit the ability to reproduce the results. A flow chart figure may be useful illustrate a complex method, or the flow of sample processing and analysis. Your thesis provides the opportunity to describe all the work that was done (and not necessarily published) and to explain the rationale used in your investigations. Include the methods that were attempted and failed or resulted in inconclusive data, not just the methods that were successful. Clearly state which work was done by you and what others did. Keep in mind that for each method outlined in Chapter 2, there is a corresponding result described in Chapter 3.

Chapter 3 Results: Allow 2 weeks to prepare the first draft. You have already reported most of the data to your supervisory committee in your committee meeting reports. In this chapter you state the facts and describe the data and compare relative changes among different data groups, how results from one experiment led you to other experiments, and troubleshooting that was performed to overcome difficulties. Do not interpret the significance of the findings here – this is reserved for the Discussion section.

Provide summarized data, not raw data, in tables and figures. Make sure that all tables and figures provided are referred to in the text of the Results chapter. The legends under each table or figure state how the data were obtained and define any symbols/legends to allow the reader to interpret the data, but do not include a description of your interpretation of the data. This promotes readers to compare their interpretation of your data with your interpretation in the chapter text. Tables and figures can appear within the text or after the list of references at the end of the chapter.

Chapter 4 Discussion: Allow 2 weeks to prepare the first draft. This chapter compares and contrasts your findings with what has been reported in the literature. Discuss how your findings allow you to test your research questions and hypothesis/hypotheses. Clearly state conclusions and interpret the significance of your findings. Also consider alternative interpretations of your findings. Highlight your novel contributions to knowledge in your area of research, but be careful not to overstate their impact on the field of research. Describe the gaps in knowledge that remain, as this provides a natural connection to Chapter 5.

Chapter 5 Future Directions: Allow 1-2 weeks to prepare the first draft. This chapter discusses suggestions for future experiments/investigations arising from your research findings to address outstanding gaps in knowledge in your field. The proposed experiments should describe the

rationale and sufficient method detail to understand how the work would be carried out and explain how the results would contribute to your field of research.

References/Bibliography: References are cited in the order of appearance in the thesis. There is only one numbered list of references at the end of the thesis. Use of a reference management program is strongly recommended, but students are responsible for the accuracy of the information and consistency of the format. LMP recommends the format described at: www.icmje.org/

"International Committee of Medical Journal Editors (ICMJE) Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals: Sample References"

Appendices (optional): Supplemental (non-essential) information/data that is referred to in your thesis text is placed here.

Paper Format Thesis:

Published journal articles require some modifications when included as a thesis chapter (see previous section on *Published work*). References are cited in the order of appearance, with the numbered list of references at the end of each chapter.

Chapter 1 Introduction: Same content as for the traditional format thesis. In addition, it is helpful to refer to the relevant chapter # in brackets at the end of each objective listed at the end of the chapter text.

Chapters 2 to x Individual Studies: Each chapter contains its own Introduction, Materials & Methods, Results, Discussion and References, but no Abstract. Page limitations imposed on published articles limit the amount of information provided in the article. Your thesis must expand on the details, especially the connection to the thesis hypothesis and objectives, and the details in the methods section. Additional results may also be included that were not essential to the published article. Your thesis should provide the rationale and findings for different approaches used during your research that failed or were inconclusive, as well as those that led you to the approach that was successful and included in the publication.

Chapter # Title: Title should reflect the topic and outcome. If the chapter work is published, the chapter title is linked to a footnote at the bottom of the page that states the complete article citation and author affiliations.

#.1 Introduction: Includes a brief background on the topic, the rationale for the research, the hypothesis/objectives and why the research is important. Do not include a summary of your findings and conclusions in the introduction section. It is helpful to the reader if there is a link to the previous paper chapter – e.g. Chapter 3 introduction links back to the content in Chapter 2.

#.2 Materials and Methods: Same as for *Traditional Format Thesis*, but include only the materials and methods used in the study. There is no need to duplicate information already described in a previous chapter; simply cross-reference the relevant section of the previous chapter (e.g. see Chapter 2.2.3).

#.3 Results: Same as for *Traditional Format Thesis*. Figures in a thesis are usually not presented in the compressed format often used for publication. Consider breaking them up into several different figures so that they can be enlarged and clearly reviewed without the congestion of the other figures on the same page. Text font must be clearly legible in tables and axes of figures. Tables and figures can appear within the text or after the list of references at the end of the chapter.

2.4 Discussion: Same as for *Traditional Format Thesis*. It is helpful to the reader if there is a link to the content in the previous chapter, and a link to the content addressed in the following chapter.

2.5 References: Cited in order of appearance, and a list of references is located at the end of each chapter.

Chapter x+1 Summarizing Discussion: This chapter should connect the key findings presented in Chapters 2 to x. See *Discussion* in the *Traditional Format Thesis*.

Chapter x+2 Future Directions for Research: Same as for the *Traditional Format Thesis*

Bibliography: All sources cited in the thesis are listed here in un-numbered alphabetical order (by first author's last name) using the same format as for the *Traditional Format Thesis*.

Appendices (optional): Supplemental information/data that is referred to in your thesis text is placed here. This information/data should be non-essential for the continuity of the thesis content. Qualify why it's in the appendices and not part of the thesis proper.

