

A Guide to Thesis Preparation for Graduate Students in The Department of Plant Science

This guide has been prepared to aid graduate students in the Department of Plant Science in the organization and preparation of the M.Sc. and Ph.D. thesis.

Students must also consult the Faculty of Graduate Thesis Guidelines & Information (http://umanitoba.ca/faculties/graduate_studies/thesis/guidelines.html) for additional information and regulations regarding the thesis, and conditions which must be met before the degree is granted.

This guide is divided into five sections:

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SECTION 1

Overview of Thesis Styles

A thesis is a written document chronicling research conducted by the student in a particular area. Besides documentation of results and interpretation of experimental research, the document contains an extensive review of the literature pertaining to the subject area.

In general, the thesis begins with an overall statement of introduction and purpose for the study, including overall objectives. This section is followed by the literature review. This literature review stands alone, and is presented in addition to the literature cited when discussing the results of the research. The results of the research are then documented, including information on the methods, results and discussion of results. The last part of the thesis is usually a general discussion designed to draw broad conclusions, synthesize information, and suggest areas for future study. In most cases, a thesis contains more detailed information than would normally be submitted for publication.

In general, the master's thesis should demonstrate that the student has mastery of the field in which she/he presents her/himself, and is fully conversant with the relevant literature. An essential feature of Ph.D. study is the candidate's demonstration of competence to complete a research project and present the research findings. The Ph.D. thesis must constitute a distinct contribution to knowledge in her/his major field of study and the material must be of sufficient merit to be, in the judgement of the examiners, acceptable for publication.

There are two main thesis styles:

1. The **Traditional Style Thesis** in which the major components - the methods, results of the research and discussion - are presented in discrete sections following the overall introduction and literature review. As indicated above, a general discussion should normally follow the discussion of the research results.

2. The **Paper Style Thesis** is similar to the traditional style thesis in a broad sense, except that it may not contain as much detail as the traditional style thesis. The paper style thesis can be used if the manuscripts are published, accepted for publication, or are more or less ready for publication. In the paper style thesis, each manuscript has its own abstract, introduction, methods, results and discussion in addition to the overall abstract, general introduction and literature review. The thesis must contain connecting text between the different chapters providing logical links to allow the integration of the information.

The choice of thesis style depends to an extent on the kind of study that was done, whether discrete chapters are warranted or the material is best described as a single entity. The style is chosen in consultation with, and approved by, the student's advisory committee before writing commences. The following sections describe the main elements of each style of thesis.

SECTION 2

Guidelines for the Traditional Style Thesis

PARTS OF THE THESIS

A thesis in the **traditional style** is composed of three major parts. Each part contains several sections which are arranged in the following order:

PRELIMINARIES

- Title Page
- Acknowledgments
- Table of Contents
- Lists of Tables and Figures
- Abstract

TEXT

- Introduction
 - Literature Review
 - Materials and Methods
 - Results*
 - Discussion*
 - General Discussion and Conclusions
- *Results and Discussion may be combined

REFERENCE MATTER

- Literature Cited (Bibliography)
- Appendices
 - List of abbreviations

Ordering Headings in a Traditional Style Thesis

There are two systems of ordering headings in a thesis:

- **Numbered System of Ordering;**
- **Formatted System of Ordering.**

Numbered System of Ordering

All headings are typed in **bold**. Each major division of the thesis (**ACKNOWLEDGEMENTS**, **LITERATURE REVIEW**, etc.) begins on a new page with the heading typed in upper case, centred on the first line. Subdivision headings are left justified and typed in upper and lower case. Headings are double spaced beneath the previous heading or text. Text is double spaced beneath the heading.

The following is an example of a **numbered system of ordering**:

1.0 MAJOR DIVISION HEADING
1.1 Subdivision Heading
Text is double spaced beneath the heading.
1.2 Subdivision Heading

Formatted System of Ordering

All headings are typed in **bold**. Each major division of the thesis (**ACKNOWLEDGEMENTS**, **LITERATURE REVIEW**, etc.) begins on a new page with the heading typed in upper case, centred on the first line. First order subdivision headings are centred and typed in upper and lower case, double spaced below the preceding text or heading. Second order headings begin at the left margin and are typed in upper and lower case letters, double spaced below the preceding text or heading. No terminal punctuation is used after any of these headings. Text is double spaced beneath first and second order headings. Third order headings are treated as paragraph headings. They should follow the same rules as the other subheadings, but they run into the paragraph and are followed by a period and two spaces.

The following is an example of a **formatted system of ordering**:

MAJOR DIVISION HEADING
First Order Subdivision Heading
Second Order Subdivision Heading
Third Order Subdivision Heading. This heading runs into the paragraph that it begins.

-PRELIMINARIES-

Authorities to scientific names of plants and microorganisms should be cited the first time each scientific name is used.

Acknowledgments

This section may or may not be included. Most theses do, however, include a brief comment of thanks for any special or non-routine assistance received.

Table of Contents

This section will indicate by page number, the location of all sections of the thesis, from acknowledgments to appendices.

Titles of sections and their subsections are listed exactly as they appear in the body of the thesis, together with their page citations. Titles of main sections are typed in upper case, all sub-sections in upper and lower case i.e., all words are capitalized except prepositions, conjunctions and articles unless one of these is the initial word. A line of double spaced periods extends from the last word of the title or sub-title to the page number. The column of page numbers is headed "Page". The line of double spaced periods should be vertically aligned on the right. The page numbers are aligned by the last digit of the number.

Titles of the main sections begin at the left hand margin. Sub-titles are indented two spaces. Second sub-titles are indented two more spaces. Double space between main titles and between main titles and sub-titles. Single space between sub-titles. Whenever a title or sub-title is longer than one line, each line after the first is single spaced and indented two more spaces than the first line. No terminal punctuation is used for any line of the table of contents.

The following is an example of a Table of Contents using the Numbered System of ordering:

TABLE OF CONTENTS	
	Page
ACKNOWLEDGMENTS	ii
ABSTRACT	iv
1.0 INTRODUCTION	1
1.1 Objectives	3
2.0 LITERATURE REVIEW	6
2.1 Canola - Quality Oilseed Rape	6
2.1.1 History	6
2.1.2 Development	7
2.1.3 Description	8
2.2 Breeding Superior Canola-Quality Oilseed Rape	11
2.2.1 Breeding Objectives	11
2.2.2 Breeding Strategies	11
2.2.3 Doubled Haploid Production	12
2.2.3.1 Advantages	12
2.3 Production of <i>Brassica rapa</i> Canola-Quality Oilseed Rape Through Microspore Culture	15
2.3.1 Genotype	15
2.3.2 Donor Plant Physiology	16
2.3.3 Microspore Pretreatment	17
2.3.4 Development Stage of Pollen	18
2.3.5 Culture Media	19
2.3.6 Culture Conditions	22
2.3.7 Plant Regeneration	24
2.4 Utilization of Microspore Derived Embryos	26
3.0 MATERIALS AND METHODS	30

The following is an example of a Table of Contents using the Formatted System of ordering:

TABLE OF CONTENTS	
	Page
ACKNOWLEDGMENTS	ii
ABSTRACT	iv
INTRODUCTION	1
Objectives	3
LITERATURE REVIEW	6
Canola - Quality Oilseed Rape	6
History	6
Development	7
Description	8
Breeding Superior Canola-Quality Oilseed Rape	11
Breeding Objectives	11
Breeding Strategies	11
Doubled Haploid Production	12
Advantages	12
Production of <i>Brassica rapa</i> Canola-Quality Oilseed Rape Through	
Microspore Culture	15
Genotype	15
Donor Plant Physiology	16
Microspore Pretreatment	17
Microspore Pretreatment	17
Development Stage of Pollen	18
Culture Media	19
Culture Conditions	22
Plant Regeneration	24
Utilization of Microspore Derived Embryos	26
MATERIALS AND METHODS	28
Genotypes	28
Standard Microspore Culture Protocol	28

Abstract

The thesis must contain a short abstract. The first paragraph of the abstract is doubled spaced below the heading. It contains the following information: author's name (last name first); degree for which the thesis was written; university and date; complete title of the thesis; and, major professor. A double space is used between the author/thesis information and the text of the abstract. The following example indicates the correct form:

ABSTRACT	
Clark, Allan Bruce. M.Sc., The University of Manitoba, May, 1971. A Study of the Major Factors Influencing the Time Required to Obtain a Graduate Degree. Major Professor; Simon A. Legree.	
There are many factors influencing the length of time required to obtain a graduate degree and	

The abstract should give in essay form a short statement of the thesis problem, a brief exposition of the methods used, and a condensed summary of the findings. The statement of the problem and the summary of findings are most important. No citations of literature are allowed in the abstract.

- **TEXT** -

Introduction

This section contains a statement of the problem investigated, so that the reader can proceed with the nature and aim of the study. A brief review of past work is usually necessary in order to validate the importance of the problem, i.e., the reason for the author's interest in the problem.

Literature Review

This section is a detailed exposition of past work on the problem. Only the significant observations and conclusions of the literature need be included, and these should be included only if they are pertinent to the problem investigated. If the literature is very meagre, this section may be included in the introduction.

Materials and Methods

This section contains information on the materials and methods used in the study.

Results

This section contains a presentation of scientific data.

Discussion

This section contains a discussion of the scientific data and its relevance to the scientific literature.

General Discussion and Conclusions

This section contains a summary and discussion of the significant findings of the study. The author should take care to separate the findings from the conclusions. Literature citations are not allowed in this section. Recommendations for further study in the field of investigation may be included. General Discussion and Conclusions may be included as separate sections.

- **REFERENCE MATTER** -

Literature Cited

This section contains all references cited by the author in the thesis. The Department of Plant Science requires that students follow the **author-year system**. The author-number system should **not** be used in a thesis. The author-year system has a distinct advantage in the preparation of a thesis, especially if it contains numerous references. If the thesis is revised, additions or deletions to the bibliography can be made easily without affecting other references and their citations in the text.

In the author-year system, references are cited in the text by author and year of publication, e.g., "Smith (1970) investigated". In the text, all authors are mentioned in the citation if there are not more than two. If three or more authors are involved, the citation in the text reads "Smith et al. (1970)".

In the bibliography, the references should be arranged in alphabetical order by author's surname and year. All authors of a multi-author publication are listed surname first, followed by initials and year of publication. The full title of the paper follows the date. Only the first letter of the title is capitalized. This is followed by the name of the publication, volume number and page numbers. Except for single word titles, the title of journals are usually abbreviated. A list of standardized abbreviations can be found in the most recent edition of the *CSE Manual* published by the Council of Science Editors. A copy of this is available in the William R. Newman Library. References to books should list the author or editor, title of the book, the edition, the publishers, place of publication, year, and the page numbers. Latin binomials are italicized. Book titles are in upper and lower case.

When citing multiple works by the same author, list single authorship articles before those by several authors. Determine the sequence by alphabetizing the first author's surname and junior author's surname, by the year of publication (most recent last), and if necessary, by the page numbers of articles published in the same journal.

Line spacing is single within references and double between references.

The following examples indicate the correct format:

LITERATURE CITED

DeRobertis, E.C.P., Saez, F.A. and DeRobertis, E.M.F. 1975. *Cell Biology*. 6th ed. W.B. Saunders Co., Philadelphia. 346 pp.

Durum, W.D. 1982. Wheat quality effects on cooking time of pasta. *Can. J. Pl. Sci.* 80:12-18.

Livanou, T. and Nikas, A.A. 1972. A quick test for protein bound iodine based on the dry ash method. *Folia Biochim. Biol. Graeca.* 9:116-123.

Rotem, J. 1978. Climate and weather influence on epidemics. p. 317-337. In: *Plant Disease: An Advanced Treatise; Vol II: How Disease Develops in Populations*. Horsfall, J.G. and Cowling E.B. eds. Academic Press, New York.

USDA, ARS, National Genetic Resources Program. *Germplasm Resources Information Network-(GRIN)*. [Online Database] National Germplasm Resources Laboratory, Beltsville, Maryland. URL: www.ars-grin.gov/cgi-bin/npgs/html/coop.pl?86256 (25 November 1998)

Appendices

If this section is needed, it follows the literature cited. It includes supplementary illustrative material, original data and statistical tables too lengthy for inclusion in the text, or not immediately necessary for an understanding of the subject.

SECTION 3

Guidelines for the Paper Style Thesis

PARTS OF THE THESIS

A thesis in the **paper style** is composed of four major parts. Parts containing sections are arranged in the following order:

PRELIMINARIES

- Title Page
- Acknowledgments
- Table of Contents
- Lists of Tables and Figures
- Abstract
- Foreward
- Introduction
- Literature Review

MANUSCRIPTS - composed of:

- Abstract
- Introduction
- Materials and Methods
- Results*
- Discussion*

*Results and Discussion may be combined

GENERAL DISCUSSION AND CONCLUSIONS

REFERENCE MATTER - composed of:

- Literature Cited (Bibliography)
- Appendices
 - List of abbreviations

Manuscripts which have been published or accepted by a journal prior to thesis submission, may be included in the body of a thesis, provided that in the opinion of the Advisory Committee, the research described in the manuscripts was conducted by the student while registered in the Faculty of Graduate Studies at the University of Manitoba, under supervision of the advisor.

If several manuscripts are to be submitted, they should follow the style and format of a **single journal** even if they are to be submitted to different journals.

Ordering Headings Within a Paper Style Thesis

See guidelines for the Traditional Style Thesis.

- PRELIMINARIES -

Title Page, Acknowledgments, Table of Contents, List of Tables and Figures, Abstract

See guidelines for the Traditional Style thesis.

Foreword

This section contains a statement indicating which journal format is being used for preparation of the manuscripts within the thesis.

Introduction

This section contains a statement of the problem investigated, so that the reader is informed of the nature and aim of the study. A brief review of past work is usually necessary in order to validate the importance of the problem, i.e., the reason for the author's interest in the problem.

Literature Review

The literature review is written as in a “traditional thesis style”. This section contains a comprehensive coverage of past work on the problem. Only significant observations and conclusions of pertinent literature need be included. Review all areas that will be discussed in the body of the thesis (i.e., in the manuscripts) even though some duplication will occur with the literature review.

- MANUSCRIPTS -

The major headings within manuscripts in a paper style thesis are **ABSTRACT**, **INTRODUCTION**, **MATERIALS AND METHODS**, **RESULTS**, and **DISCUSSION**. Each manuscript in the thesis will include these sections.

Individual manuscripts are headed by “**CHAPTER #**” or “**MANUSCRIPT #**” centred on the first line of the page in **bold** upper case letters without punctuation followed by the title of the manuscript centred on the page in **bold** upper and lower case letters. Space between heading and title is double. Manuscripts constitute the body of the thesis and should be complete and prepared in accordance with instructions given to authors by the selected journal. Tables and figures should be prepared as recommended by the journal. A list of references should be included at the end of each unpublished paper. If the paper has been published, the references will be self-contained in that article. Reprints from the journal will not be allowed as part of the thesis.

Writing the **MATERIALS AND METHODS** sections of a manuscript style thesis in the concise manner recommended by a journal, is difficult to reconcile with the detailed presentation of the traditional thesis. This can be achieved, however, by presenting the details of procedures and methods in an Appendix. If a method has been published, the reference is cited, followed by the Appendix which contains the details. Thus, the reader is not required to consult additional references to obtain a clear picture of the methodology.

Since each manuscript is a separate entity in the thesis, the rules of citing authorities to scientific names of plants and microorganisms will apply to each manuscript. Authorities should be cited the first time each scientific name is used in each manuscript.

- GENERAL DISCUSSION AND CONCLUSIONS -

General Discussion and Conclusions

A thesis written in manuscript style should contain a general discussion section which inter-relates information presented in each manuscript of the thesis. The section should contain a critical discussion of the findings presented in relation to previous research cited in the literature review section. Literature citations are not allowed in this section. Recommendations for further study in the field of investigation may be included. General Discussion and Conclusions may be included as separate sections.

- REFERENCE MATTER -

Literature Cited

The format in this section should be the author-year system. References are listed in alphabetical order according to the author's surname, followed by the year, complete title, journal name, volume number and inclusive page numbers. All literature citations found in the thesis, including those in the manuscripts, should be listed in this section. See SECTION 2 for more detailed discussion.

Appendices

The appendix should contain all the necessary supporting data and procedures that are usually excluded from publications in scientific journals but are required in a thesis.

SECTION 4 Technical Information

Run your thesis through iThenticate, plagiarism detection software designed to be used by researchers to ensure the originality of written work.

http://umanitoba.ca/research/integrity/iThenticate%20.html#What_is_iThenticate

All theses must be written according to a standard style manual acknowledged by a particular field of study and recommended by the Department of Plant Science. Students should follow guidelines set forth in this document, the Faculty of Graduate Studies Thesis Guidelines and the most recent edition of the *CSE Manual* (details provided earlier in this document). It is also recommended that students refer to the most recent edition of *How to Write and Publish a Scientific Paper*, by Robert A. Day, Oryx Press.

All theses must be lucid, well-written and free from typing, spelling and grammatical errors. The last draft should be carefully edited before final printing to ensure it is free of errors. Spelling checkers are not infallible. For instance they will approve both "phosphorus" and "phosphorous".

Abbreviations

Abbreviations can be used in the abstract and the text. If used in the abstract, they must be defined in the abstract. If used in the text, they must be defined in the text.

Pagination

Each page in the thesis must be assigned a number, and the pages must be consecutively arranged. Although the title page does not bear a typed number, it will be counted as page "i". Preliminary pages, from this title page through the abstract, will be numbered consecutively in small Roman numerals (ii, iii, iv, etc.), typed in the upper right hand corner of the page, 1" from the top and 1" from the right edge.

Beginning with the first page of the text and including all separately paged figures and tables, the bibliography, and appendices, consecutive Arabic numerals are typed in the upper right hand corner of the page, 1" from the top and 1" from the right edge. Unnumbered pages or pages bearing a number and letter (e.g., 3A, 3B) can be easily lost and are not to be used.

To facilitate proof-reading, early copies should contain line numbers in the left margin which restart each page. Line numbers must be removed in final copies.

Figures

All figures should be understandable by referring to the legend or caption. Readers should not have to refer to the text for clarification. If figures (graphs, charts, maps or photographs) are used, they must be included in all copies of the thesis. Several figures or tables can be combined on a single page. All features and lettering must be clear and legible.

All figures should be functional. As a rule, they should not repeat material presented in tables unless this is necessary for analysis or clarification. Where a graph summarizes data from tables, and the data may be a useful resource for other researchers, the table should be placed in an appendix at the end of the thesis.

Photographs should be numbered as figures. If a legend describing a photograph cannot be placed below the figure, it should be typed on the back side of a blank numbered page so that the legend faces the illustration when the bound thesis is opened. When photographs are printed by a laser printer, the figure number should be printed in **bold** below the figure, followed by the legend (not bold). Several photographs can be combined on a single page.

Figures are numbered consecutively with Arabic numerals. The number in **bold** (e.g., **Figure 4.**) should be placed below the figure. The title and legend will follow the number. The first letter is typed two spaces after the period. If the legend consists of more than one line, the second and any following lines, are indented four spaces and single spaced.

Figure 1. The effect of temperature and light on rate of growth and seed production of *Fraxinus pennsylvanica* and *Fraxinus nigra*

Figures should be numbered consecutively in the order they appear in the text. Each figure should appear as closely as possible after the first citation in the text which refers to it.

Tables

All tables should be understandable by referring to the legend or caption. Readers should not have to refer to the text for clarification. The student is referred to the most recent addition of the *CSE Manual* (details provided earlier in this document). However, a few comments are pertinent.

No vertical lines are used in tables. Tables are usually typed parallel to the normal print line, i.e., portrait, but extensive data may be typed in landscape format.

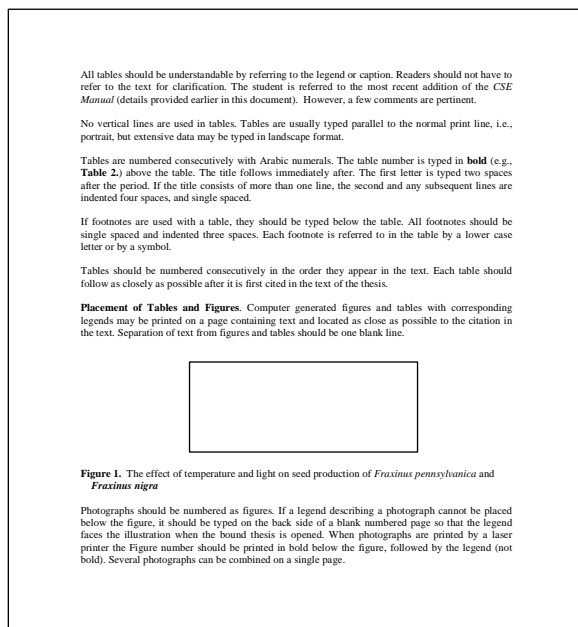
Tables are numbered consecutively with Arabic numerals. The table number is typed in **bold** (e.g., **Table 2.**) above the table. The title follows immediately after. The first letter is typed two spaces after the period. If the title consists of more than one line, the second and any subsequent lines are indented four spaces, and single spaced.

If footnotes are used with a table, they should be typed below the table. All footnotes should be single spaced and indented three spaces. Each footnote is referred to in the table by a lower case letter or by a symbol.

Tables should be numbered consecutively in the order they appear in the text. Each table should follow as closely as possible after it is first cited in the text of the thesis.

Placement of Tables and Figures

Figures and tables with corresponding legends may be printed on a page containing text and located as close as possible to the citation in the text. Separation of text from figures and tables should be one blank line.



Thesis Copies

Refer to the Faculty of Graduate Studies Thesis Guidelines for submission requirements.

Deadlines for Submission of Theses to the Faculty of Graduate Studies

Consult the University of Manitoba Graduate Calendar regarding deadlines for submission of the thesis to the Faculty of Graduate Studies.

SECTION 5

Final Examination for the M.Sc. and Ph.D. Degrees

The final examination proceeds in two stages:

1. examination of the candidate's thesis, and
2. oral examination of the candidate on the subject of the thesis and any matters relating thereto.

With approval of the advisor, a master's candidate may distribute the thesis to examiners. Prior to distribution, a *Thesis Title and Appointment of Examiners* form must be submitted to the Faculty of Graduate Studies.

Oral Examination of the M.Sc. Thesis

The advisor arranges the time and place of the examination. The Chair is arranged by the Head of the Department of Plant Science. At the oral examination, the student gives a 30 minute (approximately) presentation, highlighting and interpreting the research findings. Questioning by committee members follows, beginning with the external examiner and ending with the student's advisor. Each examiner is initially allowed approximately 15 minutes for questions. There is opportunity at the end of the first round of questioning to ask additional questions. Formal questioning by the examiners should normally not exceed 1.5 hours.

The advisor is normally responsible for ensuring that revisions are completed according to the instructions from the examining committee.

Examination of the Ph.D. Thesis

Refer to the Faculty of Graduate Studies Academic Guide.