

**GUIDELINES FOR THE PREPARATION OF A
SENIOR THESIS IN THE DEPARTMENT OF
BIOLOGICAL SCIENCES AT WAGNER
COLLEGE**

by

First Middle Last Name

Senior Thesis

(Senior Learning Community)

Experiential Component: Research or Internship

Department of Biological Sciences

Wagner College

Semester, Year

Approved by:

Signature _____ Date _____
Thesis Advisor, Chair of the Defense Committee: (Name and Title)

Signature _____ Date _____
Committee member: (Name and Title)

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ABBREVIATIONS, CONSTANTS AND SYMBOLS

Define all abbreviations that you use in the thesis and that may be unknown to a reader with a basic knowledge of biology or microbiology. Explanations for abbreviations like DNA or RNA should be known to every reader with a basic education in biology and should therefore not be included on the list. Some examples are:

SDS	Sodium dodecylsulfate
PAGE	Polyacrylamide Gel Electrophoresis
V	Voltage or electrical potential difference (measured in mV)
R	Electrical Resistance (measured in Ω)
TEM	Transmission Electron Microscope

You may also list constants, if they are used in the thesis. For example:

R	Gas constant ($8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)
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Symbols of dimensions that are not commonly known may be explained here:

Ω	Ohm (dimension of electrical resistance)
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ACKNOWLEDGMENTS

It is very likely that many people have supported you during your education in general and during the work that resulted in this thesis in particular. This page is the place to honor them. This is also where you acknowledge any funding sources that played a role in your research.

1. ABSTRACT

The ABSTRACT of your thesis is a summary of the paper. It should consist of one to maximally two introductory sentences. You may include one to two sentences about the techniques or methods used. You should focus on your results. Avoid or be very careful with interpretations. Do not use abbreviations or citations. The ABSTRACT should not exceed one page, and is typically written as one paragraph.

2. INTRODUCTION

2.1. General format instructions for all theses

Each thesis has to be written in exactly the same format as this guide. All margins on all pages are 1 inch. The text font is Times New Roman with a font size of 12. Line spacing is double spaced. The only exception for the font size is the cover page and section titles. See this guide for the font size of these pages. All pages are numbered in exactly the same way as used in this guide. All pages have Arabic page numbers (1, 2, 3, 4, ...). Each section of the thesis begins at the top of a new page. Figures and photographs are numbered and directly inserted into the text together with an informative legend.

Students must follow the formal instructions of this guide from the beginning of the *Senior Thesis* (BI 400 or MI 400) course, using a tab indent for each paragraph. The paper will ultimately be presented at the thesis defense to the committee using the here-described format. After the defense you will make the final corrections recommended by the committee and produce one hard copy for each committee member and one hard copy for the secretary of the Department of Biological Sciences.

Exceptions regarding this format (for example, all figures at the end of the thesis) are only possible if your thesis advisor recommends it and if all members of the senior thesis committee agree!

2.2. Citation format in the text

Citations of articles in scientific journals are either inserted into a sentence or placed in parentheses at the end of a sentence before the period (Roosevelt, 1942). If the reference has been published by a single author, use the last name and the year of appearance separated by a comma (Truman, 1950). If the article has been published by two authors, use the last names of the two authors in the sequence as it appears in the source separated by the word “and”, and followed by the year of publication (Ford and Nixon, 1975). If the article has more than two authors, give the last name of the first author followed by “*et al.*,” and the year of publication (Kennedy *et al.*, 1961). To directly insert a citation into a sentence follow the format of the following examples.

Mortimer (1988) interpreted his data as an indication for the presence of life on Mars. However, according to Harrison (1989) the data were ambiguous and did not allow an interpretation that reaches this far. Moreover, Grant (1990) re-collected similar data and analyzed her results with a more advanced technique, allowing one to come to a deeper understanding of the requirements for life on Mars. However, based on their results Hopkins et al. (1991) refused to believe that life on Mars is only possible at temperatures above 0 °C.

Of course, the full citations with the names of all authors, the year of appearance, the title, and the source must be given in the REFERENCES section (see below for the format). Citation of online sources is not desired for the senior thesis. Online sources can only be cited with permission of your thesis advisor. Visit, for example, the webpages at <http://www.bedfordstmartins.com/online/citex.html> to learn about different formats for citations of online sources and discuss them with your advisor.

2.3. Figures and other formal requirements

Sometimes it is very instructive for the reader to see figures from the literature in the INTRODUCTION and/or the DISCUSSION. The use of figures may save longer explanations and/or give your thesis a better appearance. You should directly insert the figure into the text where it is needed for a better understanding by the reader. Figures are inserted into the text together with a legend as shown in the following example:

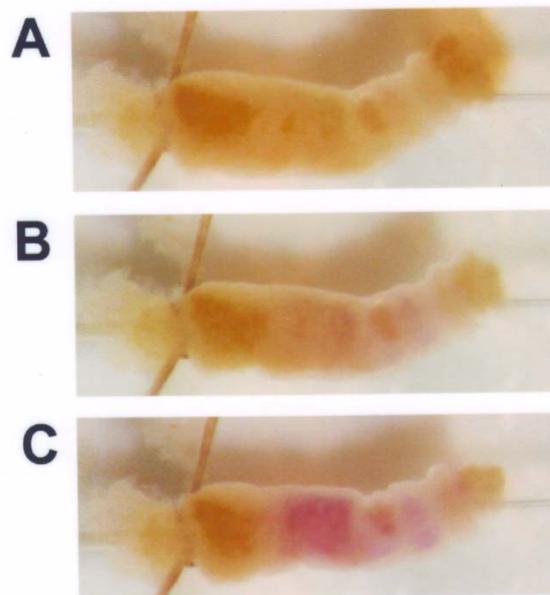


Figure 1: Include a complete description of what is to be seen in the figure into the legend. Do not forget to insert the correct and complete reference for the figure you use! (Figure taken from Onken *et al.*, 2008).

Note that the font of the figure legends is smaller than the regular text! Also **tables** are inserted like figures in the text and must have at least a title (see page 10 for an example).

2.4. General guidelines for the INTRODUCTION

Like your whole thesis, the INTRODUCTION should be written for a reader with a basic knowledge in biological sciences. The INTRODUCTION should give a comprehensive review of the literature in the specific field of your thesis. To give a structured overview, you may use subchapters, or sections of the INTRODUCTION, each with a heading. Use the INTRODUCTION to introduce the reader to the topic of your thesis. Prepare the reader for a better understanding of the results that you will present in the RESULTS section of your thesis and how you reflect on these results in the DISCUSSION section. Use as many subchapters as you think are adequate. The INTRODUCTION should be well structured and should contain at least five text pages in the exact same format as used in this guide!

3. OBJECTIVES

The OBJECTIVES chapter of your thesis should outline the objectives of your experimental work, the purpose of your research. This section should be relatively short and straightforward. Avoid longer, complicated descriptions. The reader should have been prepared for this part of your thesis in the INTRODUCTION. If you write a thesis about a complex experimental project, address the different objectives and their connections in subchapters or separate, indented points. This chapter of the senior thesis should be approximately one page and no longer than two pages. No figures are expected in this part of your thesis.

4. MATERIALS AND METHODS

4.1. General instructions for the MATERIALS AND METHODS section

In this section of the senior thesis all materials and methods used for the experiments are described in detail to allow the reader a comprehensive understanding about how the results presented in the RESULTS section were obtained. The aim of this section is to make the experiments as reproducible as possible. The MATERIALS AND METHODS section of your thesis should contain as much information as necessary for the reader to understand the results presented in the RESULTS section. Divide the MATERIALS AND METHODS in subchapters to structure this section of your thesis.

4.2. Biological material

Apart from just properly naming the experimental species the detailed taxonomic classification (domain, kingdom, phylum, class, order, family, genus, species) should be outlined. Moreover, it is essential to describe the source of the biological material and give a detailed outline of the maintenance of the organisms used in the laboratory. A photograph of the organism could be inserted in this part of your thesis.

4.3. Other materials

All solutions used for an experimental project must be listed and their compositions must be clearly given. For certain solutions it may be useful to give the reader instructions regarding how they were prepared and why. The sources and purities of all chemicals must be indicated. Use subchapters to further organize this section.

4.4. Techniques

Describe all techniques used in detail. It is recommended that you use subchapters for the different methods used for the experiments. It is important to describe preparations and all techniques used to acquire data. Do not forget to include in which way or with which devices data are collected, recorded, analyzed and edited.

If the description of a technique can be improved by insertion of a drawing or photograph, do not hesitate to insert it. Figure 2 provides an example.

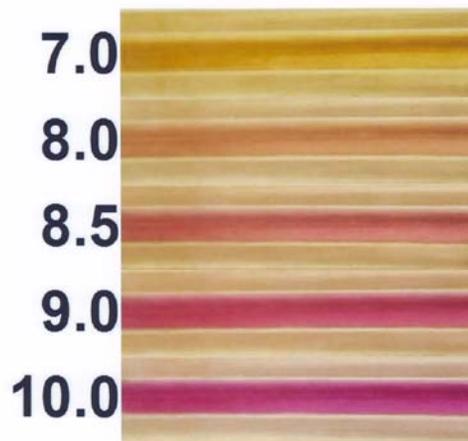


Figure 2: Photographs of low buffer salines containing 0.04 % m-cresol purple of indicated pH values perfused through PE10 tubing in the perfusion chamber used for the measurements with isolated and perfused anterior midguts of larval *Aedes aegypti*. (Figure taken from Onken *et al.*, 2008).

Again, if you use figures from a source, you must include the related citation in the text of the legend.

4.5. Statistics

If the analyses of your experimental data involve statistical methods for display or testing, you must describe the statistical techniques used in this subchapter.

5. RESULTS

This section of your thesis exclusively aims to present your data/observations. Refrain from inserting interpretations. Give this section structure by using subchapters. You may use one to two sentences in the beginning of a subchapter to introduce the reader to the rationale of the experiment. Write in paragraph form – you must have **text**, not just tables and figures.

5.1. Format of numerical data

All numerical data must be followed by a correct SI (Système International d'Unités) unit. Choose a format of the unit that fits best with your numerical result. Use the system of scientific factors, their Greek names and their correct abbreviations (MV KV, V, mV, μ V) to display your numerical results. Numbers must have a reasonable format. Do not use numbers that suggest a higher precision than your measurements actually allow. Make reasonable use of rounding! A result like $542.35292753891 \pm 21.347865378$ ml is wrong. Depending on the means used for such a volume measurement, 542.4 ± 21.35 ml would be a much better choice. If averages and their variations are displayed, the number of independent experimental repetitions and an explanation of the displayed variation (standard deviation, SD, or standard error, SE) must be indicated in parentheses ($n = 5, \pm SE$). If you tested for significant differences between groups of data, make sure that you used the correct statistical analysis (paired or unpaired Student's t-test, ANOVA). Whether you find a significant difference or not, insert the p value after the abbreviation of the variation ($n = 23, \pm SD, p < 0.05$). p values indicate the error of probability and should never be chosen larger than 0.05 (5 % probability of type I error possible). Different areas of quantitative science use different formats of displaying the variance of data. If

you have any doubts, do not hesitate to seek advice from your thesis advisor. Make sure that axes of graphs and line drawings are labeled correctly.

If results cannot easily be quantified, you may consider using arbitrary units that you have to define in the MATERIALS AND METHODS section. If you have any doubts about the display of numerical data contact your thesis advisor for help.

5.2. Display of non-numerical observations

If your results are not quantitative (like many microscopic observations), your results must still be documented. A more detailed description in words and additional photographs and/or drawings provide adequate means to document qualitative results. Make sure to insert a scale bar in photographs and drawings so that the reader gets a correct impression of the dimensions of the depicted object.

5.3. Further general guidelines for the writing of the Results section

Some more advice for the writing of the results section of a senior thesis can be found in Table 1.

Table 1: Some general hints for the writing of the Results section of a senior thesis.

Hint	Explanation
1	Insert figures and tables directly into the text where they are readily accessible for the reader without flipping a lot of pages.
2	Do not give lengthy descriptions that are not directly related to your results.
3	Do not insert any interpretations of results unless they are absolutely necessary for the reader to understand the following subchapter. Interpretations must be given in the DISCUSSION section of a thesis.
4	Display results in at least two formats. A text description of the results is absolutely essential. This text description must be accompanied by a graphic display (figure or photograph) or by numeric values in a table.
5	All results mentioned must be well documented.
6	If after a statistical analysis the means of A and B turn out to be not significantly different, you cannot write that A is larger than B.

6. DISCUSSION

The DISCUSSION section of a thesis is not a mere repetition of the results. In a discussion, the results are evaluated, analyzed, interpreted and compared with results and interpretations from scientific publications of the field of interest. Like all other sections before, the section heading (INTRODUCTION, ..., DISCUSSION) should be followed by a general, introductory paragraph (or perhaps a brief summary of the key results), before a subtopic is addressed in a subchapter.

6.1. Methodological aspects

All methods for scientific measurements involve errors that cannot be avoided. It is not a bad idea to address this topic in the first subchapter of the DISCUSSION. Reflect on and analyze or estimate the possible error of the techniques used.

6.2. Other advice for the writing of a Discussion

You may follow the structure of your RESULTS section and discuss your results subchapter by subchapter. Do not forget to refer the reader to figures and tables. Compare your results with the objectives. Did your results address each hypothesis and did your results satisfy your expectations? If your data open new questions for further study, mention them here. You could finish your discussion with a brief summary of your results and how they add to the literature of the field. Another option for a good “finish” of a discussion is to give an outlook to future studies that should be conducted to complete your contribution. If your results and their interpretation can be depicted in a summarizing graphical model, do not hesitate to prepare a respective line drawing and insert it as a figure.

7. REFERENCES

The list of references has to be written in exactly the same format as given below. Do not forget any of the citations found in the text. List only those references that you have cited in the body of your thesis.

References for articles from a scientific journal:

Einstein, A., Bohr, N. H. D. and Hahn, O. (1932). An experimental analysis of the role of plutonium atoms in the lateral nerves of the fruit fly *Drosophila melanogaster*. *Journal of Explosive Biology* **21**: 355-367.

References for book chapters:

Laughter, A. B. and Funny, Z. Y. (2032). Do centipedes trip more frequently than decapods? In: *The Biology of Arthropods*, Vol. 7, pp. 10306-12299 (eds. John Randolph McAbc and William Hangover). New York: Jupiter Press.

References for books:

Riley, A. (2003). *The Book of Bunny Suicide*. Ammanford: Goldstone Books.

Online Sources:

Citation of online sources is not desired for the senior thesis. Online sources can only be cited with permission of your thesis advisor. Visit, for example, <http://www.bedfordstmartins.com/online/citex.html> to learn about different formats for citations of online sources and discuss the format for the REFERENCES with your advisor.

8. APPENDIX

All theses involving an internship must contain an APPENDIX section behind the REFERENCES section. In this appendix you should describe your experiences during the internship and how it related to the topic of your thesis.

THE LENGTH OF THE COMPLETE THESIS IS, OF COURSE, TOPIC-DRIVEN. HOWEVER, NO THESIS SHOULD BE SHORTER THAN 35 PAGES, INCLUDING THE FIGURES AND TABLES.

THE BODY OF THE TEXT SHOULD CONTAIN A MINIMUM OF 6,000 WORDS (APPROXIMATELY 20 PAGES).

THIS DOES NOT INCLUDE THE TITLE PAGE, TABLE OF CONTENTS, ABBREVIATION PAGE, ACKNOWLEDGMENTS, ABSTRACT, DESCRIPTION OF FIGURES/TABLES, REFERENCES OR APPENDIX.