Department of Genetics
Guidelines for the Undergraduate Genetics Major
Written Honors Thesis

1. SUMMARY OF FORMAT AND EXPECTATIONS

Honors in Genetics is intended to provide highly motivated seniors with an opportunity to immerse themselves in an original scientific research project. Students are expected to conduct their own research project during their senior year, culminating in a written thesis around mid-April. The thesis should be more than a simple summary of the student's work; rather, it should be an extended written treatment of the subject of research. In particular, a student dissertation should substantiate a specific view. The student should construct an argument, not just regurgitate results. A properly written thesis should summarize the background literature for a project to adequately prepare a scientific reader otherwise unfamiliar with the specific field. For example, the student should pretend that they are writing a review of the field for another new undergraduate student who has just joined the lab. The student should then describe their own work in a single document. Since the thesis should describe the results of 12 credits of research (whether the work was done in one or two years), the length of the thesis should typically be around 40-50 pages of double-spaced type. These pages do not include the title page, table of contents, references and so forth. The thesis should thoroughly discuss the experiments and how they were performed. Keep in mind that your thesis will be one of the first resources that your mentor will grab when he or she needs to look up something about your work long after you are gone from the lab. Your thesis reading committee and the departmental honors committee is expecting a document of some heft and in the format described here. If your thesis falls short of these expectations, then expect your grade to suffer. In addition, you may not receive departmental honors.

Two Styles Are Possible for Your Thesis: Continuous and Multi-Chapter
There are two styles by which you might organize your thesis: a continuous style and a multi-chapter style. We have outlined examples of both styles below. Please note that the page ranges apply to just text; they do not include the additional pages needed for figures and data tables.

Continuous Style Thesis
This is the best model if your thesis is one set of cohesive experiments. It should include an Introduction section to explain the rationale of the thesis and describe the necessary background literature, a Materials and Methods section specific for the experiments described, a Results section in which the student walks the reader through the narrative of the experiments in a logical fashion, and a Discussion section that discusses the meaning of those results. The following outline is recommended:

- Title Page
- Acknowledgements Page (optional)
- Table of Contents
- Abstract (limited to 1 page)
- Introduction, typically 15-20 pages, broken into sections with subheadings)
- Materials and Methods (5-10 pages)
- Results (10-20 pages)
- Discussion (5-10 pages)
- Appendix (optional, could be anywhere from 1-20 pages)
- References (typically 5-15 pages, perhaps 50-100 references, with the majority being primary references. i.e., not reviews)

Multi-chapter Style Thesis
This is the best model if your thesis contains several sets of experiments that do not perfectly fit together in one cohesive section. Each individual set of experiments can be placed into its own individual chapter, with its own chapter introduction, materials and methods, results, and discussion sections.

- Title Page
- Acknowledgements Page (optional)
- Table of Contents
- Abstract (limited to 1 page)
- Chapter 1 (introduction chapter, typically 15-20 pages, has sections with subheadings)
- Chapter 2 (first data chapter, about 15-20 pages total)
    - Chapter Title Page
    - Introduction (3-5 pages)
    - Materials and Methods (3-5 pages)
    - Results (5-10 pages)
    - Discussion (3-5 pages)
- Chapter 3 (second data chapter, about 15-20 pages total)
    - Chapter Title Page
    - Introduction (3-5 pages)
    - Materials and Methods (3-5 pages)
    - Results (5-10 pages)
    - Discussion (3-5 pages)
- Additional Chapters As Needed - Same Format As Above
- Final Chapter: Conclusions and Future Directions (1-2 pages)
- Appendix (optional, could be anywhere from 1-20 pages)
- References (typically 5-15 pages, 50-100 references)

Note: any page recommendations do not include pages for your figures! They refer to the amount of double-spaced, 11-point Arial text that your committee will expect in the document.

2. GENERAL SPECIFICATIONS

Paper: 8 1/2"x11" sheets.

Print:
- Choose an easy-to-read font like 11-point Arial.
- Use one typeface throughout; script or italic typefaces are not acceptable for the main text.
- Proper nomenclature and terminology rules for your discipline should be followed.
- Abbreviations should be defined the first time you use them in the text.

Copies:
- Typed, photocopied, or computer-printed copies are acceptable.
- Light or unreadable print is NOT acceptable.
- Blurry or low resolution figures are NOT acceptable.
- Print on one side of the page only.

Page Format:

- Spacing should be double-spaced (except for figure legends, which can be single spaced).
- Margins should be 1" all around.
- The title page should not have a page number. Each page following the title page should have an Arabic numeral, centered 1/2 inch from the bottom of the page.

3. FORMATTING RULES

It is highly recommended that students use the Style function of MS Word to organize their thesis, as this will make formatting and the Table of Contents easier to organize and maintain. We have provided two boilerplate docx file to get you started:

- Thesis Template Multi-Chapter Style
- Thesis Template Continuous Style

Preliminary Pages Section

Title page (the following should appear in this order, double spaced and centered in the page):

- Title (a meaningful, accurate description of the content of your research).
- Your full, legal name.
- "Submitted to the Department of Genetics in Partial Fulfillment of the Requirements for the Degree of," then list your degree and major.
- "Rutgers The State University of New Jersey"
- "Written under the direction of" then your thesis advisor's name, degree, and departmental and university affiliation.
- Date of Defense.

Abstract page: Provides a succinct summary of the dissertation, summarizing clearly the problem or problems examined, the methods employed, and the major findings. Should be no longer than one (1) double-spaced page.

Acknowledgement and/or Dedication (optional): Typically a single page recognizing colleagues that supported the work, provided reagents, et cetera. The acknowledgement page is also a place to thank family and friends for their support.

Table of contents (with page references for each item):

- Includes all preliminary and main text sections.
- Includes subsections of Introduction and Chapters
- Page numbers should form an even column on the right-hand side of the page.

Main Text Section

Introduction:

- Should have a chapter title page with the title centered in the middle.

- Should be broken into subsections that cover all of the background topics relevant to the research, that support the hypothesis, and that provide the reader with information required to understand the experiments in the thesis.
- Should read like a review article in the field.
- Should include multiple figures that help summarize the background material.
- It is HIGHLY RECOMMENDED that the student write the Introductory chapter by the end of his or her fall semester of research so as to minimize the burden of thesis writing in the second semester.

Main body:

- Divided into chapters or sections, each having a title page beginning on a new page.
- If some of your data has been published, you need to say so. This should be indicated on the title page, with reference to specific figures or sections within the chapter that have been published.
- If some of the data presented in the chapter is not yours, you should indicate this on the title page, *noting the names of the contributors of such data, and with reference to specific figures or sections within the chapter that were done by these individuals.*
- Chapters should be further divided into subsections (Chapter Introduction, Material and Methods, Results, and Discussion).
- Graphs, Figures, Tables, Charts, and Photographs must be suitably sharp and clear. Figures should be appended at the end of each chapter.
- Should have a final short chapter (1-2 pages) where you discuss future directions for the project.

Appendices (optional):

- This is the place for experiments and data that do not fit well into the overall narrative of the thesis, but need to be included for archival reasons.
- Format can follow that of the individual chapters, but flexibility can be used here.

References:

- Citations should be clearly indicated in the Introduction and main body of the text.
- References should be alphabetized according to first author.
- Should include author names, year of publication, title, journal, volume, and page numbers.

4. SUBMISSION

- Your completed thesis is due in early to mid April, typically between April 10th and 15th. You will be notified of the exact date early in the spring semester.
- Give your research sponsor plenty of time (that is, several weeks) to review and approve the thesis before submission.
- Give your honors committee at least one week to read your thesis before the defense.

Included in the following pages are sample title pages and chapters to better illustrate the expected format. Two possible example outlines are also shown: one for a multi-chapter style, and one for the continuous style.

THE ROLE OF SOME GENE X IN DISEASE Y

by

John Quincy Undergrad

Submitted to the Department of Genetics
in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Arts
in Genetics

at

Rutgers The State University of New Jersey

April 2005

Written Under the Direction of
Dr. C. Evil, Ph.D.
Associate Professor
Department of Genetics
Rutgers The State University of New Jersey

ACKNOWLEDGEMENT

I joined Dr. Evil's lab two years ago, a clueless student, and now I am leaving a scientist. I would like to thank Dr. Evil for agreeing then, to be my mentor and sticking with me throughout this entire journey. I owe a very special thanks to two post docs in my lab, Dr. Igor and Dr. Scary. They've been my personal research consultants, helping me in every way possible. I also want to thank the rest of the Evil lab for their constant support and help in so many ways from finding materials to giving me strains. A special thanks to Dr. Cruel and Dr. Creepy for agreeing to be on my committee and taking time out to read and advise me on my thesis. Lastly, I want to thank my parents and friends for their constant support.

ABSTRACT

We want to determine how neural connections are formed and modified during development with specific emphasis on the localization of glutamate receptors to synapses. AMPA-type glutamate receptors conduct most of the excitatory signaling in our own brains, and their regulation has been found to play a role in long-term potentiation and depression. Understanding the trafficking and localization of these receptors will give us a better grasp on models of learning and memory, as well as insight into the neurodegenerative diseases with which these receptors are associated.

The trafficking and localization of AMPA glutamate receptor subunit GLR-1 can be easily understood through the protein secretory pathway. Folding and assembly of the subunits takes place in the ER and the receptors are subsequently transported to the synapse where they can stay or be later exocytosed as a means of regulating synaptic strength. I have investigated the necessity of the unfolded protein response (UPR) in AMPA receptor assembly and transport of out of the ER. Further, I have examined the role of *presenilins (PS)* genes in which dominant mutations cause Alzheimer's Disease, and LIN-12, whose activation is mediated by PSs, in facilitating GLR-1 localization.

I have found that only two specific components of the UPR are needed for proper GluR assembly and export in the ER. Moreover, I have found that LIN-12 and the *C. elegans* homologue of the *presenilins,* SEL-12, are part of a signaling pathway that somehow affects GLR-1 levels localized to the synapse. Further experiments are needed to characterize the origin of this effect.

TABLE OF CONTENTS (CONTINUOUS STYLE)

TABLE OF CONTENTS (MULTI-CHAPTER STYLE)

Chapter 1

Introduction and Background

Introduction

Humans are born with about 100 billion neurons and this number remains relatively stable throughout life. However, as development and learning occur, synaptic connections change and grow in response. Investigating the ways in which neural connections are formed and modified during development is an important area of study in neurobiology. Much previous research has shown that long-lasting changes at a synapse may play a role in learning and memory (Malinow, 2003). These learning and memory models suggest a central role for synaptic plasticity. Widely known examples of such synaptic plasticity are the mechanisms of long-term potentiation (LTP) and long-term depression (LTD), in which short periods of synaptic activity cause long-lasting responses. In recent years, it has been suggested that glutamate receptor trafficking plays a vital role in LTP and LTD (Malinow, 2002).

Neurons and Synapse Formation

The neuron is the main functional unit of the nervous system. Electrochemical signals travel through the body via action potentials across these neurons. These signals are potentiated at the junction between neurons: the synapse. For an action potential to cross the junction or synaptic cleft, it is converted from an electrical signal to a chemical signal, in the form of a neurotransmitter. As an action potential reaches the pre-synaptic terminal, it causes voltage changes in the membrane, allowing for an influx of calcium ions. These calcium ions facilitate the fusing of the synaptic vesicles to the pre-synaptic membrane and neurotransmitter is released. The neurotransmitter diffuses to the post-synaptic membrane and binds to specific receptors. Depending on the type of neuron and neurotransmitter, the post-synaptic cell may either be excited and continue transmission of the electrical signal, or inhibited.

Synaptic Plasticity

Even as some synapses are being formed, others are concordantly changing. It is crucial in the nervous system for synaptic connections to remain flexible and plastic. Many models of learning and memory are based in synaptic plasticity. In response to experience, synapses change through increase or decrease of synaptic strength and subsequently affect an organism. Synaptic modifications can take place in many ways. Modifying the amount of neurotransmitter released from the pre-synaptic cell effectively regulates synaptic strength. Moreover, changing receptor response alters post-synaptic response to pre-synaptic firing. Receptor response can be modulated by changing the amount of time receptors remain open or the amount of receptors present at the synapse. The localization and trafficking of glutamate receptors into and out of synapses plays an important role in synaptic plasticity.

Chapter 2

The Unfolded Protein Response regulates the export of GLR-1 from the Endoplasmic Reticulum

Dr. Igor and Dr. Scary initially cloned and characterized IRE-1 and XBP-1, including the data for Figure 2-1.
I conducted the experiments involving *sel-1, pek-1,* and *atf-6,* which includes the data for the remaining figures in the chapter.
The findings in this chapter have been previously published as Igor, I., Scary, T., Undgrad, J.Q., and Evil, C. (2004) *Molecular Biology of the Cell* 999:235-245.