Structure and Content of the MS Thesis Manuscript

1. Title
Draft a title that makes clear the main focus of your work and includes key words that readers could use to decide if your work was relevant to their interests (e.g., The effect of a low-fat diet on kidney function in the Agouti mouse; The influence of the maternal grandmother on newborn use of a pacifier in Hispanic families; The effects of growth factors on the phenotype of normal and breast cancer cells; Social and economic determinants of success in a school-based weight-loss intervention program).

2. Abstract
This should be written last, when you are certain what direction your thesis project has taken. It should provide a brief summary (generally one page) of the key points of the background, study design and implementation, with a description of the key findings (possibly with a brief set of key data) and the significance of the work.

3. Acknowledgements
Below the Abstract, acknowledge the contributions made to your thesis training and work by your mentor, colleagues, or students who played an important role in what you accomplished. This should be brief but can be specific, such as “My thanks to Leo Jones, M.D, Professor of Neurology, for mentoring me through the thesis work; to Marge Scot, Ph.D., postdoctoral fellow, who so deftly trained me to do the required assays; and to John Means, IHN Masters student, for assisting in the selection of eligible subjects.

4. Glossary (include if more than 3 abbreviations are used in the text)

5. Introduction and Review of the Literature
This section should provide the justification for the thesis study and allow the reader to understand its purpose, potential significance, and how it adds to the body of knowledge in the field.

The introduction should start with a review of the broad field of prior work and, after explaining what is known and still unknown, lead to a final statement of the research question or problem that is covered in the Thesis manuscript. Pertinent, prior, primary literature (not review articles or meta-analyses) that was important to the development of the thesis topic should be read in the original, and cited when discussed. This review of the literature should not just describe the findings of prior studies. It should discuss and analyze the relevant body of knowledge, presenting the reader with what is known and not known about the topic (particularly as it relates to the thesis work). It should assess and discuss, as warranted, the research methods used, the reliability, importance and limitations of the prior findings, and the gap in this knowledge base that makes your project useful.

6. Study Objectives; Research Questions and Hypotheses; Conceptual Diagram
In this section you should briefly specify your research question and how you will study it. If you have a specific hypothesis that you will test, include it. The null hypothesis (that there will be no effect of a particular intervention or no difference between two groups), is a common one to use when no particular results can be anticipated. Some examples are:

1. Our question is “Does a day of fasting in food-restricted pregnant rats have a greater effect on fetal growth than it does in previously well-fed rats?” We hypothesize that the one-day fast will reduce fetal weight in rats more if the mother was previously food-restricted.
2. Our first objective will be to determine if adding a structured exercise class to a school’s 8th grade program reduces body fat content in students. We hypothesize that a school year of structured, repeated exercise sessions will reduce body fat in 8th grade boys and girls.

3. Our study is designed to answer the question “Is diabetes associated with a reduction in circulating serotonin under stress conditions in humans?” We hypothesize that baseline serotonin levels will be higher, and the increase caused by stress will be blunted, in people with diabetes.

You can add other subsidiary questions and hypotheses embodied in your work. For the first example above, it could be “We also hypothesize that fetal number will be reduced as a result of fasting following food restriction, but not by fasting alone.” For the second example, “We also hypothesize that there will be no difference in the effects of the program on African-American and Hispanic students”. For the third one, “We also hypothesize that the serotonin effects of stress will increase as the subjects’ HbA1c levels increase.”

For some studies, it is very useful to diagram how the variables you plan to measure are related to each other, showing the directions of causality that reflects your conceptual framework. You can also show where your hypotheses fit into the diagrammatic framework, indicating where a specific factor may promote or inhibit a given relationship. This may be simple, such as saying “we propose that a factor (X) increases an outcome, (Y)”. In a particular case, this might be shown as:

```
fat gain → increases blood pressure
```

or more complex, because salt intake affects the relationship, such as:

```
fat gain → increases blood pressure
          ↑
salt intake
```

Below is an even more complex example of such a diagram, from a study of the effects of pregnancy weight gain (in black and white women) on birth weight and maternal body composition changes during pregnancy. It had several hypotheses, including

1. Increased pregnancy weight gain would increase maternal body fat;
2. The relation of weight gain to fat gain would differ in black and white women;
3. Increases in maternal lean tissue would be associated with improved fetal growth; and
4. The relationship in 3 would differ in blacks and whites.

Here is how this study would be diagrammed:

```
Maternal wt. gain
       ↑
(hypo 2) black race

(hypo 1) increased maternal fat
             →
(hypo 3) increased maternal lean
             ↑
(hypo 4) black race

(fetal growth (birth wt, length, & head circumference))
```

The next diagram would relate to a lab-based cell study:
Diagram 2. Cell phenotypes resulting from breast cancer and normal cells treated with growth factor IGF-1

<table>
<thead>
<tr>
<th>Cell type</th>
<th>Treatment groups</th>
<th>Outcomes (cell phenotype)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal cells</td>
<td>Untreated</td>
<td>Proliferation (H4)</td>
</tr>
<tr>
<td></td>
<td>(Hypothesis 2)</td>
<td>Adhesion (H5)</td>
</tr>
<tr>
<td></td>
<td>Growth factor</td>
<td>Invasiveness (H6)</td>
</tr>
<tr>
<td></td>
<td>Treated</td>
<td>Motility (H7)</td>
</tr>
<tr>
<td>Cancer cells</td>
<td>Untreated</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Hypothesis 3)</td>
<td></td>
</tr>
</tbody>
</table>

7. Specification of Variables and Measures
This section should include a list of all the variables that will be used to understand and analyze your results. It should indicate which hypotheses they will be needed for, how each will be measured, the unit of measurement, what type of variable it is (mediating, independent, etc.), and whether it is continuous or categorical. In some cases, a narrative description of the variables may be useful, but in general the information is best presented briefly in a table. Examples are shown in Tables 1 and 2, for the diagrams above. The hypothesis numbers refer to the hypotheses in the diagrams.

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Variable Type</th>
<th>Measures Used</th>
<th>Levels of Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal weight gain, from weights before &amp; during pregnancy</td>
<td>Independent (H1)</td>
<td>Maternal report of prepreg. wt* Weights at pregnancy visits*</td>
<td>Nearest quarter lb</td>
</tr>
<tr>
<td>Total maternal fat gain, from 3 measurements, at 1st pregnancy visit, near delivery, &amp; postpartum</td>
<td>Dependent (H1); Independent (H3)</td>
<td>Computed from body weight*, water* &amp; density* at pregnancy visits, and bone* measured postpartum</td>
<td>See formula in text</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td>Moderating (H2 &amp; H4)</td>
<td>Maternal report #</td>
<td>5 groups</td>
</tr>
<tr>
<td>Birth weight</td>
<td>Dependent (H3)</td>
<td>Medical record* or mother’s report*</td>
<td>± half oz.</td>
</tr>
<tr>
<td>Gestational age (not shown in above diagram)</td>
<td>Mediating (H1 &amp; H3)</td>
<td>Mother’s reported LMP* and date of delivery*</td>
<td>Days</td>
</tr>
</tbody>
</table>
Table 2. Summary of Variables for Diagram 2

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Variable Type (Hypothesis #)</th>
<th>Measures Used</th>
<th>Levels of Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell type (normal vs cancer)</td>
<td>Independent (H1)</td>
<td>Cancer cell markers (proteins, mRNA)</td>
<td>Two cell groups</td>
</tr>
<tr>
<td>Treatment (growth factor vs. no treatment)</td>
<td>Independent for normal cells, H2 for cancer cells, H3</td>
<td>Amt of growth factor added to cell dish*</td>
<td>To nearest microliter</td>
</tr>
<tr>
<td>Cell phenotype</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proliferation</td>
<td>Dependent (H4)</td>
<td>Cell density, #/dish</td>
<td>No. of cells/ mm²</td>
</tr>
<tr>
<td>Adhesion</td>
<td>Dependent (H5)</td>
<td>Adherent cells/dish</td>
<td>No. of adherent cells/ mm²</td>
</tr>
<tr>
<td>Motility</td>
<td>Dependent (H6)</td>
<td>Cell migration rate</td>
<td>Length of cell track (µm/time)</td>
</tr>
<tr>
<td>Invasiveness</td>
<td>Dependent (H7)</td>
<td>Formation of tumor cell colonies</td>
<td>No. colonies/ mm²</td>
</tr>
</tbody>
</table>

8. Methods (data collection studies)

This section describes how the data will be collected, including the specific tests, scales, questionnaires, etc., and how they will be used. It explains why each method was the most appropriate to use, referencing other uses or studies of the methods, as needed. Detail here every step of the data gathering and analysis processes. The following components should be included, if they are relevant for the particular project. The order can be changed if that helps make the material clear.

   a. Description of research design. For each component of the research, name the study type according to the classification outlined in Chapter 2 of Gehlbach (Gehlbach SH. Interpreting the Medical Literature, 5th edition, McGraw Hill, NY, 2006). For example, is the study descriptive or explanatory, experimental or observational, a clinical trial, intervention, or health care trial? Is it a case control, follow-up or cross-sectional study? Is it prospective or retrospective?

   b. Description of study population. This section tells what you knew about the items under study before you had collected data on them. Describe the “population” that was the source of the individuals, cells, schools, animals, tissues, etc., used in your work. Explain any criteria (age, tissue origin, disease status, sex, genetic characteristics, etc.) used to determine inclusion/exclusion or eligibility of each “individual”. Describe any randomization process used to classify them (whether they are cells, schools, children … etc.) at any stage prior to the final data analyses.

   c. Description of the materials and methods used and the timing for making observations and collecting data. Detailed background information about the way the study was conducted, such as the way cells were grown or subjects recruited, the detailed characteristics of businesses where an intervention was implemented, the number of subjects recruited at each of 3 schools, etc., should all be described in this section. Describe the sources (supplying company and its location) and the main features of materials used in the research, for example, the composition of provided diets, cognitive function tests, recombinant DNA,
antibodies, viral particles, cell strains (e.g., SV40-transformed human cells, ATCC, Rockville, MD), isolated tissues or organs, animal models and their background (e.g., mouse, C57BL background, Jackson Labs, CT), fMRI testing, body composition measures and the equipment used, etc.

Provide the scientific rationale for the selection of experimental models for basic science studies (e.g., use of mouse models over rat models, primary cell cultures over established cell lines; subcellular fractions over whole cell models), or for the particular tests or questionnaires used for human studies (e.g., Bayley scales of Infant Development, Stanford-Binet IQ Test, Block Food Frequency Questionnaire or 24-hr Dietary Recall. It is not sufficient to state that a method was chosen “because it is the gold standard” or “because the mentor used it.” For methods that are standard in the field, give information on their reliability and validity.

Lay out any time sequences that are important for understanding the implementation of the project, preferably in a time-scheduling figure that shows the sequencing of particular activities or measurements (e.g., interviews, tissue sampling, observations, sample analyses, focus groups, etc.). For the experiment in Diagram 1 above, it might look like this:

Time:       day 1-------------------day 2--------day 3--------day 4---------day 5--------day 6
Seed cells -----x
Preincubate cells------------------------x
Select samples -------------------------x
Treat cells w/ saline or IGF-1-------------------x
Treat cells w/ saline or IGF-1------------------------x
Harvest cells ---------------------------------x
Measure phenotypes:
    Formation of tumor cell colonies---------------------------x
    Cell density, #/dish-------------------------------------------x
    Adherent cells/dish----------------------------------x
    Cell migration rate----------------------------------------x

Methods should be described in sufficient detail so the experiments can be repeated by other researchers. The reader should be able to fully visualize how the data were collected.

d. Description of the development of any interviews/surveys, or new techniques or methods for making observations. Explain the development of any new methods, interviews, sampling schemes, etc., that were created for this study. Indicate any work done to validate them or determine their reliability. Where appropriate, provide copies in an Appendix.

e. Description of how data will be stored, used and analyzed. Describe how data were handled and stored to safeguard confidentiality. Describe the methods used for statistical analyses. What data analytical programs, statistical analyses and tests were used for different findings? What criteria (confidence intervals, p value, variability, other?) were used to determine their importance?

9. Findings/Results
Here you present the results of data collection and analyses, without discussing the meaning/ importance of the findings or referencing other published works.
a. **Descriptive Information.** Descriptive information that you determined about your population or sample generally comes first in the Results section. It is more detailed than what you knew when you first started the study (which you included in the Description of the Population in the Methods section). It should include information about the development of the final sample by explaining the number of potential subjects or samples excluded, losses to follow-up, samples where data were not complete for specific variables, etc. Provide descriptive statistics for demographic variables for human subjects (e.g., age groupings, mean body weight, ethnicity), or descriptive measures of animals, cells or tissues, or of schools, businesses or other entities being studied. Preliminary analyses can be reported here as background to the primary findings. These analyses might include, for example, bivariate correlations for the variables of interest or the results of power analyses done to determine the sample size. Use tables rather than text where suitable.

b. **Findings.** State the major findings of your work in a logical, sequential order. Numbered tables and/or figures should show the numerical information mentioned, and be referred to in the discussion of the findings. Describe the results of any exploratory/confirmatory analyses that were performed (e.g., reliability tests, factor analysis). Present the results of tests of hypotheses. Indicate the N used for the data presented. Distinguish analyses that were planned in advance from any analyses that were decided upon after the data were collected.

10. **Discussion**
This section integrates the study’s findings with what was already known about the subject. Thoroughly explain how the findings add to prior knowledge, how they differ from earlier findings, and why that might be. Where relevant, prior studies that were mentioned in the introduction should be discussed, sometimes in greater detail. For example, if your results conflict with earlier work, more information might need to be presented about the possible effects of differences in the study populations/samples, or in the study designs. The reader should be led to understand why and when your results are useful (or not). If there are subsidiary findings, or related observations that influence your conclusions, they can also be discussed. If these findings or observations are complex, they may need to be presented in more detail in the results section.

The limitations of the study should be presented and evaluated for the reader. Was the sample completely adequate and appropriate, were the methods suitable for the sample, are the results generalizable, and was the study design ideal? Any limitations of these aspects of the work should be presented objectively along with any countervailing factors that suggest whether these limitations affect your findings in a minor or major way. The reader should not have to identify or assess these limitations themselves, nor conclude that you were unaware of them.

Possible changes that your study results would support in policies, health care, theory, biological procedures, etc., should be made explicit. This indicates to the reader the practical significance of your work. The strength of the evidence that you have provided in this regard should be objectively discussed. Possible next steps for using the study findings or continuing the line of research can be presented. A brief summary paragraph should end the body of the manuscript. It should succinctly state the value of the study for you and the field.

11. **References**
List all the references you cited in your Thesis manuscript. Generally, the cited material should be original, peer-reviewed work available to the professional reader. Citations to on-line websites, personal communications, unpublished manuscripts and the like, should be limited to reputable, governmental or professional sources, unless they are explicitly being cited for comparison and you are not assuming the accuracy of their contents.
All cited articles should have been read by the Thesis manuscript’s author, not identified solely through citation or mention in other articles, unless this is unavoidable and intentional and is made explicit in the text.

You do not need to include every article you read, nor what is in your annotated bibliography. Only the articles you referred to in the Thesis should be included here, in the style of the American Journal of Clinical Nutrition. They can be listed in numerical or alphabetical order, depending on the method you choose for citing them in the Thesis (that is, by number, or by author’s name and date). You may use either method, although AJCN uses the numerical order. They also provide advice about tables. You can find the details for both here, under References: http://ajcn.nutrition.org/site/misc/ifa_format.xhtml. Endnote can be made to use AJCN format. All journal titles should be abbreviated in Medline style. Endnote may not abbreviate titles for some journals, so you should check them.

12. Appendices, Required or Optional
   a. Include an appendix that indicates in a narrative or outline form which activities that were essential for your Thesis manuscript were personally performed by you. The purpose is to give the reader a clear idea of what supportive materials you used that were the result of other people’s work, and which ones were developed or created as a result of your work.
   b. If you have done some work on projects other than your main project, you can select to include a description of that work in an appendix, if that seems better than presenting it in a different chapter of the Thesis, or integrated with the main material.
   c. Any materials that would be useful to the reader, but which are not central to the basic understanding of your work, can be put in an appendix. This might include questionnaire forms, educational materials developed, examples of coding used in the work, photos of equipment or the measurement setting, etc. Whatever is in an appendix should be as organized and as well explained as it would be in the body of the Thesis.

Notes on Formatting, etc.
   a. Tables and figures should be numbered sequentially according to when they are covered in the text. You can put them all in an appendix, but it is easier for the reader if they are placed within the relevant text section. They should have explanatory titles without abbreviations; legends and footnotes should make them understandable without reference to the text. In figures, use strong visual characteristics, such as hatch marks, shading, dashed lines, symbols, etc., that make it easy to distinguish the location and meaning of the bars, lines or points, even in copies. In tables replete with many numbers, use font differences, gridlines, or bold or italics to make the table easier to read and to highlight the items of particular importance.

   b. Proofread your work, paying attention to suggestions given by the spelling and grammar checks built into your word processing program (e.g., MS Word, WordPerfect, spell-check, etc.) and by anyone you can get to review the manuscript or sections of it. Consider whether each word choice is best and use terminology consistently for complex concepts. Make sure no spelling or grammatical errors persist into the final copy. Try to have friends, family, or other students review the draft before you submit it to your mentor.

   c. Limit or avoid abbreviations. Always define unfamiliar technical words and abbreviations at first usage, but recognize that the reader will not learn and remember a long list of abbreviations. Do not depend on the reader referring repeatedly to the glossary. Write out, in full, those terms that will be used a limited number
of times, to avoid an excess of abbreviations. For efficiency, you can use the abbreviations in your draft work and then, when the draft is final, use the replace command to change the abbreviations to their full wording.

**d. Headings.** Review how you have structured the manuscript in terms of headings and subheadings, sequencing of topics, and paragraph contents. Make a new paragraph when the focus of the text changes. Review and revise these components when the manuscript is almost final, to help to make your writing clear.

Leave time for your mentor to read and edit your completed Thesis well before the submission due-date. You should be prepared to do significant rewriting after the mentor’s review. Consult instructions on Courseworks for submission of the final Thesis to IHN. A copy of the approved Thesis manuscript must be given to the thesis mentor.

**Special Conditions.**

It is recognized that thesis projects do not always yield the intended results or those that are sufficient for publication. A clinical study may recruit only 3 patients in 3 months, an assay may never work out, an enzyme may not be isolated. Despite such limitations, every section should still be written as above to the extent possible, although the content would be affected. For example, the Results section might tabulate the data from the few patients recruited, but statistical analysis could be omitted or performed only to document analytic competence. The problems encountered during an attempted enzyme isolation could be discussed in the Results section; the Discussion section might then deal with possible future approaches. All of the background, workup, test runs, etc., would then be given in more detail since this material would constitute the whole of the thesis experience, if more definitive data were not obtained.

In some cases, the nature of the project calls for a somewhat different written presentation. For example, development of unusual materials, such as a phone application to monitor dietary intake from subject recordings, might necessitate inclusion of very different materials and data; development of an exercise regimen program might benefit from a different manuscript structure. The crucial consideration is how best to clearly document the thesis experience, the learning of the student, and the effort that was contributed to the project. However, wherever possible, a standard journal article format, as describe here, should be used. When in doubt, confer with the Director of the Program.

Some of the material above was derived from http://www.jou.ufl.edu/grad/forms/Guidelines-for-writing-thesis-or-dissertation.pdf; some comes from grant proposal directions circulated by the Maternal and Child health Bureau of DHHS.