

SENIOR RESEARCH PROPOSAL GUIDELINES

Most scientific research projects start with a written research proposal. A proposal is usually necessary to convince granting agencies to fund the project or (in graduate school) to convince your dissertation committee that you have come up with an interesting and feasible project that will ultimately earn you a Ph.D. (or M.S.). Writing a proposal before you begin a project can be an extremely useful means to evaluate its feasibility. Once you start to put the details down on paper in a convincing form, you may come up with additional ideas about the project and the means by which you can address your hypotheses. Organizing your thoughts on paper may reveal weaknesses in your theories, problems with your proposed methodology, or the potential for ambiguities in the outcome of your experiments. If such flaws are not apparent to you, a critical and knowledgeable reader may point them out! A thorough literature search (a necessary prerequisite to a good written proposal) may reveal that someone else has already done the project you had planned to do, or has proposed alternative hypotheses that you have not considered. All good research scientists keep abreast of the literature relevant to their field, stay in communication with other people working on similar topics (either informally or *via* the formal setting of scientific meetings), and submit their research proposals and papers to their peers for critical review. It is better to discover that your ideas and methods are flawed *before* you begin a project, than to find out after the project is completed that you overlooked a critical problem and therefore may have difficulty publishing your results.

We require all senior research students to submit a formal written proposal to the Biology Department during the fall semester and also to present the proposal orally to an audience of peers. We hope that this exercise will help you to polish aspects of the design and analysis of the experiments you plan to do during the year, to familiarize yourself with the literature relevant to your project and to clarify your understanding of the broader implications of your research project. Unfortunately, the academic year is too short for us to require you to write a formal proposal *before* you embark on actual experiments, and if you started work last year or over the summer, your project is probably (hopefully!) already well under way. This is often the situation in real life, too — before submitting a research proposal it is a good idea to have done some pilot experiments to determine which methods are going to work (or not work), and some preliminary data are often necessary to convince your reviewers that your proposed project is feasible.

Your written research proposal should adhere to the format outlined below, which is very similar to the standard format (and length) requirements specified by most granting agencies (such as NSF and NIH). Write for an audience of specialists (all biologists, but not all necessarily conversant with the specifics of research in your area) and use a professional scientific writing style. **The total length of the text of your proposal (including figures and tables) may not exceed 15 pages** (12 point type, double-spaced). Literature cited and budget forms do not need to be included in this page limit. Your proposal should consist of the following, clearly demarcated sections:

(1) Introduction: The *Introduction* should briefly summarize the proposal, and let the reader know where your proposal is headed *before* s/he reads the body of the proposal. In the *Introduction* you should: (1) state clearly and concisely the problem or question you intend to address in your research; (2) provide (no more than) a few sentences of background information to justify your interest in that problem; and (3) briefly state how you intend to address the problem (i.e. the methods you will use). Thus, the *Introduction* to a research proposal is very similar in content and purpose to the *Abstract* of a published report. The *Introduction* will typically be one to three paragraphs in length — certainly *no more than one page*.

(2) Background: The *Background* section should provide a thorough review of the literature that is *relevant to your research*. This literature review (which is usually more extensive than a typical introduction to a journal paper) sets the stage for your proposed work, describes techniques you are using (if they are unusual and require explanation), and supports or opposes the hypotheses you are investigating. Your advisor can help you decide on the proper scope for the literature review. Just as the *Introduction* to a lab report (or published journal article) should end with a paragraph in which the goals of the paper are stated clearly, your *Background* section should conclude with a clear statement of the question(s) your research will address and the goals you hope to achieve.

(3) Proposed Work: In this section you describe in as much detail as possible the work you actually intend to do. If appropriate, you should include statements of the various alternative hypotheses you intend to address and details of the methods you will use. You should state explicitly how you plan to collect your data and analyze your results. If a particular experiment may have several alternative outcomes, you should state what they might be, and how you will distinguish between them. Your proposed methods section should be as detailed as possible, preferably exactly as it will appear in the “Materials and Methods” section of your final report (writing these details now will save you time in the spring!). For instance, simply saying “I will extract DNA from leeches, use PCR to amplify the genes that control feeding behavior, and sequence them” does not give the reader enough information to determine whether the project is feasible or if you understand the techniques you plan to use. There are many different methods of extracting, amplifying and sequencing DNA, many of which may not be feasible to use with leeches! Your *Proposed Work* section should conclude with a **timeline** in which you state the deadlines by which you will complete the various steps outlined in your proposal (for instance, particular experiments or collection of data), including data analysis and writing your final report. The timeline may be included either as a table or text – if text, it should not exceed a paragraph in length.

Preliminary Results: We expect you to include preliminary results in your proposal (current up to the time of submission of the final draft of the proposal). Note that this is *not* a separate section of the proposal – preliminary results should simply be included as part of your *Background* and/or *Proposed Work* sections. The best section in which to include preliminary results will vary from proposal to proposal – your research advisor can help you determine which section will be most appropriate for your particular proposal.

(4) Literature Cited: As in a lab report or journal article, this section lists (in appropriate bibliographical format) any works you have cited in other sections of the proposal. **Please use the citation format described on pp. 81-82 in Pechenik (6th ed., 2007).**

(5) Budget and Budget Justification: As part of your proposal, we ask you to prepare an itemized budget for your proposed research, and to justify each of the specific requests in that budget. You should include *all* of the materials and supplies you will need (including those routinely provided by the department), any research-related travel costs, and a list of the major pieces of equipment you will need to use. This section is not included within the 15-page proposal limit, but should be ***no longer than two pages***; we recommend that you download the budget form provided at:

<http://www.hmc.edu/academicclinicresearch/academicdepartments/biology/research1/biologyseniorresearch1/requirements.html>

Your budget should include the following information:

1. Budget Line Items

A. Supplies. Indicate the type and cost of items specific to your project that you will need to purchase. Also include items that are normally available in the department (e.g., gloves, Petri dishes, pipette tips) that you will need *and their costs*.

B. Travel. Describe the type and extent of travel and its relation to the project. Itemize by destination and cost. The present mileage reimbursement rate is \$0.55/mile.

C. Other. Itemize and justify.

2. Budget Justification

In addition to the itemized budget, you should prepare a “Budget Justification Page” that documents and *justifies* the amounts requested in each category.

3. Available Equipment

Please list the major items of equipment available in the biology department (or elsewhere) that you will need for your project. Do not include costs for the equipment.

For a good general discussion of research proposals as well as specific examples of each section of a proposal, we highly recommend you read the chapter entitled *Writing Research Proposals* in:

Pechenik, J.A. 2007. *A Short Guide to Writing About Biology*, 6th ed. Pearson Education Inc., New York, NY.

Important Deadlines

Monday 12 October (5 pm): Draft of the **Background section** of your proposal and an *annotated* bibliography of *at least 20* relevant literature citations to be submitted to your research advisor.

Monday 16 November (5 pm): **Complete first draft** of your research proposal (including budget) to be submitted to your research advisor.

Friday 04 December (5 pm): *Three* copies of the **final version** of your proposal to be submitted to Prof. McFadden. Note that more than one faculty member will read and evaluate your proposal.

Biology Senior Thesis Research
SUMMARY PROPOSAL BUDGET
2009-2010

Principal Investigator: THAT'S YOU

Adviser: THAT'S YOUR FACULTY MENTOR

FUNDS
REQUESTED

FUNDS
GRANTED

A. SUPPLIES

1. Supplies specific to project (itemize)
2. General laboratory supplies (itemize)

B. TRAVEL (describe)

C. PUBLICATION/PRESENTATION COSTS

D. OTHER (itemize)