

Goals of the proposal. The goal of writing a research proposal is to convince your readers that the problem you are targeting will have an impact in your field of study. As such, with the guidance of your Faculty Mentor, you should have developed a clear idea of your goals and objectives (specific aims), your experimental approach (research strategy), and most importantly, the innovation of your research.

Ask your mentor for examples of proposals from previous students and/or proposals they have written themselves. They will give you an idea of how in-depth we expect you to go into your subject in the different sections. Read these before you begin, and feel free to come ask us questions!

ABSTRACT

The abstract will provide your reader context for the proposed work. It should help your reader remember the goals of the proposal (aims) and how you plan to meet the proposal goals (research strategy, i.e. main techniques and experimental plan) as they read the rest of your work. Include a short statement outlining the significance and innovative aspects of the proposal.

➤ Content

Foreword	Context	Why is the need so pressing or important
The before	Need	Why something needs to be done at all
	Task	What do you plan to do to address the need
	Object	What does the present document cover
Summary	Findings	What you hope the work will reveal
The after	Conclusion	What the findings mean for the audience
	Perspective	What the future holds, beyond this proposal

- Use these questions as a guide. When you write the abstract answer the questions implicitly instead of explicitly. Meaning, you will write the abstract like a story that flows as opposed to a series of choppy sentences that answer the questions above.

➤ Suggestions

- Write your abstract last. Think of your abstract like the preview of a movie. You have to make the movie (proposal) before you can synthesize the plot into a preview (abstract). It should give the audience a preview of what you want to do and what you hope to accomplish before they get into reading the rest of the proposal. That way they have already an idea of where you are leading them.
- Use specific aims as a template, but simplify the language. Both a scientist and a lay person should be able to read and understand your abstract.

- The first sentence of the abstract should state the significance of your research in the field. The rest of your abstract should include the gap in knowledge, your hypothesis, and innovation of your research
- Briefly describe your specific aim, including experimental approach, and long-term objectives.

INTRODUCTION

The Introduction section of a proposal aims to explain the basic science behind your subject of study and why it is important to study it. It should cover what is known about your project and the different variables you will be studying, and how it led you as a researcher to ask the question your proposal aims to solve. The introduction should also explain any technical details particular to your work or field of study. Your introduction must give your audience the information needed to understand the rest of your proposal. It is composed of a Literature Review (describing what is known), Specific Aims (which describe the phenomena you want to explain or the problem you want to solve, and your hypotheses), and a description of the innovation your works bring (how it pushes the boundaries of our knowledge and tell your audience why they should care).

Literature Review The goal of the literature review is to put your problem in context for your reader and convince them that you are addressing an important and clearly defined question. The literature review should provide any details your audience needs to understand your research (for example, imagine your audience is going to be a PRISM student in a different lab than yours). Your job is to highlight all literature that is relevant to your proposal, discuss the benefits and drawbacks of their approach, and how their findings fit into the bigger picture and your project.

➤ Content

For each article you review, you should ask yourself the following questions:

- Is the purpose of the paper clearly stated?
- What question are they trying to answer?
- What sources are cited? Are they relevant?
- What is their hypothesis?
- What experiments are they proposing? Do they answer the question being asked?
- What are the implications of the research?
- How is the research related to your project?

➤ Suggestions

- The review should be organized in chronological order and from least important/relevant to most important/relevant sources.
- Avoid outdated sources.
- Bold the main point of each paragraph (the paragraph's claim) and develop the paragraph with details (reasons) and support (evidence/data) from your sources.
- Use sections and subsections to organize the overall narrative. For example, in a proposal that aims to study the effect of chocolate in the expression of genes involved in the development of Parkinson's, there could be a first section about the medical uses of chocolate and other fruits containing antioxidants, a second section about how antioxidants modulate genes

involved in neurodegenerative diseases, leading to a section describing the effect of chocolate-derived antioxidant in the expression of genes linked to Parkinson's.

- Clearly signal the beginnings of each section and subsection by bolding them and starting each major section with words that signal how the new section relates to the one before. Doing this is key to making sure you are ordering your literature review logically
- Make sure that each section is relevant to your work by asking: what does this section answer?

Specific Aims. The specific aims section will give your readers a sense of what you want to accomplish with your research, and how this work fits into the bigger picture. It should aim to explain the basic science behind your subject of study and why it is important to study it. In this section, you will outline the goals of your project and summarize your expected outcomes, and discuss how the completion of your aims will advance your field.

A hypothesis is the proposed explanation or expectation of the phenomenon you are testing. It is an educated guess (meaning that it must be based on previous observations) of the anticipated results of your research. The hypothesis must be worded so that it can be tested by your research. Do this by expressing the hypothesis using your independent variable (the variable you change during your experiment) and your dependent variable (the variable you observe - changes in the dependent variable depend on changes in the independent variable). In fact, many hypotheses are stated exactly like this: "If a particular independent variable is changed, then we expect this change in the dependent variable."

Your proposal should be hypothesis driven. This means that you will write your proposal and specific aims section with a testable hypothesis in mind, and design your experimental approach so that you can confirm or reject your hypothesis and thus bridge the gap in knowledge in your field of study.

- Content should include
 - Long-term goals of the proposal
 - Short summary restating the current knowledge in field
 - Gap in knowledge in the field
 - Your testable hypothesis
 - Specific aims explaining how you will test your hypothesis (brief summary of your expected experimental approach)
 - A summary of the expected outcomes
 - Impact your proposed project will have on the field

- Suggestions

Paragraph 1/Introduction

- Start your specific aims by highlighting the important problem your application will address.
- Mention what is already known in the field (from your literature review) so to convince your reader that your research topic is important. Use what is known in your field to introduce the unmet need in your research area.
- The brief literature review of the specific aims should be organized from old information to new information.

- The background information of the specific aims section should only contain the *necessary* information for your reader to understand your research. Do not go overboard with references in this section; you used your literature review section to give your reader a better sense of what has been done in your field and therefore, restating this here will give them a clearer picture of why your proposal is so important.
- Clearly state the unmet need in your research area.

Paragraph 2

- Outline your long-term goal. Your long-term goal should answer how you plan to address the gap in knowledge in your field.
- Use your central hypothesis to give your readers a possible answer to the gap in knowledge and introduce your specific aims.
- Provide a rationale for your hypothesis. The rationale will tell your reader why you want to do this research. You started the proposal outlining what is known in the field and what is missing. Your rationale will offer your reader an explanation as to why your approach is the best approach to take to answer your questions.
- Bold your central hypothesis

Specific Aims

- The specific aim will be one sentence long. The sentence should be descriptive and short
- Since your entire proposal is designed around testing your hypothesis, your specific aims should be designed and written to test all the parts of your hypothesis. For each step required to test your hypothesis, you should have a specific aim.
- Because your proposal will be written to test your hypothesis, each aim should have a sub-hypothesis that you will test.
- Italicize your sub-hypothesis.
- Expected outcomes will tell your readers what you hope to learn by completing each of your aims and how these outcomes will help you answer your central hypothesis.
- Bold your aims

Innovation. As the author of your proposal, it is your job to convince your reader that successful completion of your project will shift the current paradigm in your field.

➤ Content

- What novel theoretical concepts, approaches, methodologies, instrumentation and interventions did you develop and/or improve upon?
- Why are your concepts and methods novel?

➤ Suggestions

- Describe how the application differs from current research paradigm.
- Use your literature review to support your research approach.
- Summarize any novel preliminary findings.
- Should answer: why should your reader be excited about your project?

RESEARCH APPROACH.

The goal of the research approach is to help your reader understand how you plan to test your hypothesis. This is your opportunity to convince your reader that you can handle the methods and the corresponding data analysis.

➤ Content

Preliminary results. The purpose of the preliminary results section is to show that you can complete your specific aims. The preliminary results section should include results from previous experiments on your lab that form the base for your project. Consult with your mentor, who can refer you to the appropriate source for this. It should also discuss the conclusions of this work, and a brief discussion on how these results inform your next steps.

Experiments. You should have a minimum of two proposed experiments. For each experiment you propose to do, you must have expected results and potential problems and resolutions.

- Add enough experimental detail so that your reader knows exactly what you will do but do not include exact measurements or numbers.

Expected results. In this section, you will:

- Explain how you will gather the data (technical methods).
- Explain how you plan to analyze the data

Potential pitfalls and resolutions. For each experiment you propose, you should prepare for the possibility that an experiment yielded negative results or surprising results. As such, you need to:

- Think of reasons why an experiment might fail and propose alternative experiments that will also help you test your hypothesis

➤ Suggestions

- Include enough experimental detail so that your reader can understand what you are doing, but use less experimental detail than you would include in a research paper.
- Offer explanations for all data you report, regardless if it is negative or positive.
- Include figures as needed.
- For a better idea on the type of information you should include in this section, refer to the proposal example.

CONCLUSION. The goal of the conclusion is to sum up your main argument as well as talk about next steps in your research.

➤ Suggestions

- Start your conclusion with the main point of your proposal.
- Briefly mention the significance of your proposal
- Emphasize the innovation of your proposal

REFERENCES. Include all the references that are relevant to your project and the experiments you are proposing.

- Include 8-10 references; 1/3 of your references should be secondary sources (reviews) and 2/3 of your references should be primary sources (research notes, journal articles, or manuscripts in preparations that present experimental data).
- Be consistent in the format of your references. Unlike the social sciences and humanities, which use APA and MLA style respectively, the physical and biological sciences do not have a single

standard format for references. Each sub-discipline and even each journal has their own unique variation on how references are made, both in-text and in the bibliography. Please discuss the issue of reference style with your mentor and select a style that you will use correctly and consistently in this proposal.

FORMAT

Section	Spacing	Font	Font Size	Page Length	Word Count
Abstract	2.0	Times New Roman	12	1 page	250 words
Introduction	2.0	Times New Roman	12	3-5 pages	2500 words
Research Approach	2.0	Times New Roman	12	2 pages	1000 words
Conclusion	2.0	Times New Roman	12	½ page	150 words
References	1.0	Times New Roman	10	8-10 references	N/A

Citations

Doumont, Jean-luc. "Trees, maps, and theorems." *Brussels: Principiae* (2009).

Booth, Wayne C., Gregory G. Colomb, and Joseph M. Williams. *The craft of research*. University of Chicago press, 2016.