

## Bioengineering PhD Proposal and Comprehensive Exam Guide

The following describes the format and other specifics for the Department of Bioengineering's Proposal and Comprehensive Exam.

### PhD Proposal and Comprehensive Exam – Introduction

Students must complete their proposal before the end of their third year in the program. Students should determine their committees as soon as possible after the completion of the Preliminary Exam. Approval of the dissertation committee will take place by filling out the online [Committee Approval Form](#) and submitting it to the Graduate Coordinator. The committee must be comprised of at least 4 faculty members with appointments in Bioengineering, with at least one member having a primary appointment outside of Bioengineering.

The Proposal and Comprehensive Exam has two parts, a written portion and an oral component. The written portion should be completed and submitted to the committee two weeks before the scheduled date of the oral defense of the written component. Students are encouraged to schedule their oral exam for a two-hour time period. Additionally, students should notify the Graduate Administrator as soon as their proposal has been scheduled, primarily to ensure that they have received the admission to candidacy form and will register for BIOENG 3999 credits in the subsequent semester.

The purpose of the Proposal and Comprehensive Exam is to create a basis for the dissertation and dissertation defense later in the students' career. The exam assesses the student's mastery of the general field of doctoral study, the student's acquisition of both depth and breadth in the area of specialization within the general field, and the ability to use the research methods of the discipline. The basis of the exam is a specific research problem chosen by the student and/or advisor and a written proposal on how the specific research problem will be investigated.

### Format and Information about the Written Proposal

#### Written Component

The written proposal is to be in NIH R01 format. The proposal will be 13 pages maximum, single-spaced, including tables and figures (but not including references).

The written component must contain the following sections:

<b><u>Section</u></b>	<b><u># Pages</u></b>
<b><i>Specific Aims</i></b>	<b>1</b>
<b><i>Research Strategy (Overview)</i></b>	<b>12 total</b>
<i>Research Strategy Part 1: Significance</i>	1-2 (of 12)
<i>Research Plan Part 2: Innovation</i>	½ - 1 (of 12)
<i>Research Plan Part 3: Approach</i>	9-10 (of 12)

A reference section must also be submitted but has no page limitations. If your research involves human subjects and/or animal research, those sections of an NIH R01 proposal describing appropriate protections must also be completed, but are not included in the page limit.

Examples of successful R01 grant applications can be found on the [National Institute of Allergy and Infectious Diseases site](#).

## **SPECIFIC AIMS**

### **Purpose**

The purpose of the specific aims is to describe concisely and realistically the goals of the proposed research and summarize the expected outcome(s), including the impact that the proposed research will exert on the research fields involved. This is the most important page of the entire application since it may be the only section the unassigned reviewers read to understand approach, impact, and innovation.

### **Length**

1 page maximum

### **Content**

The specific aims should cover:

- Big picture problem and impact of research on health and disease;
- Gap in knowledge;
- Broad, long-term goals;
- The specific objectives and hypotheses to be tested;
- Summarize expected outcomes; and
- Describe impact on the research field

### **Suggestions**

1. Generally, the Specific Aims section should begin with a brief narrative describing the long-term goals or objectives of the research project and the hypothesis to be tested. This is followed by a numbered list of the Aims.
2. List succinctly the specific objectives of the research proposed, e.g., to test a stated hypothesis, create a novel design, solve a specific problem, challenge an existing paradigm or clinical practice, address a critical barrier to progress in the field, or develop new technology.
3. Include a brief statement of the overall impact of the research studies.
4. Make sure your specific objectives or hypothesis are clearly stated, are testable, and adequately supported by citations and preliminary data. Be sure to explain how the results to be obtained will be used to test the hypothesis.
5. Be as brief and specific as possible. For clarity, each aim should consist of only one sentence. Use a brief paragraph under each aim if detail is needed. Most successful applications have 2 - 4 specific aims.
6. Don't be overly ambitious. A small, focused project is generally better received than a diffuse, multifaceted project.
7. Be certain that all aims are related but avoid having them be dependent on each other. Have someone read them for clarity and cohesiveness.
8. Focus on aims where you have good supporting preliminary data and scientific expertise.
9. Consider including your committee in your drafting process to build on their suggestions.

## **RESEARCH STRATEGY (Overview)**

### **Purpose**

The Research Strategy/Plan is organized into three sections: Significance, Innovation, and Approach. For an application with multiple Specific Aims, the applicant may address Significance, Innovation and Approach for each Specific Aim individually, or address Significance, Innovation and Approach for all of the Specific Aims collectively.

### **Length**

12 pages total

### **Content**

The Research Strategy should answer the following questions:

- What do you intend to do?
- Why is this worth doing or what is the significance of the research? How is it innovative?
- How does this research lend itself to a bigger picture goal?
- What has already been done in general, and what have other researchers done in this field? Use appropriate references. What will this new work add to the field of knowledge?
- What have you (and your collaborators) done to establish the feasibility of what you are proposing to do?
- How will the research be accomplished? Who? What? When? Where? Why?

### **Suggestions**

1. Make sure that all sections are internally consistent and that they dovetail with each other. Use a numbering system, and make sections easy to find. Lead the reviewers through your research plan.
2. Show knowledge of recent literature and explain how the proposed research will further what is already known.
3. Emphasize how some combination of a novel hypothesis, important preliminary data, a new experimental system and/or a new experimental approach will enable important progress to be made.
4. Establish credibility of the proposed principal investigator and the collaborating researchers.
5. Write for a scientifically trained audience, but don't assume that your reviewers will be experts in your field of research. Have a non-expert read and review your proposal.
6. Consider including your committee in your drafting process to build on their suggestions.

## **RESEARCH STRATEGY PART 1: Significance**

### **Purpose**

The Significance section should explain the importance of the problem or describe the critical barrier to progress in the field that is being addressed. Explain how the proposed research project will improve scientific knowledge, technical capability, and/or clinical practice in one or more broad fields. Describe how the concepts, methods, technologies, treatments, services, or preventative interventions that drive this field will be changed if the proposed aims are achieved.

## Recommended Length

1 - 2 pages

## Content

It should cover:

- The state of existing knowledge, including literature citations and highlights of relevant data; however, it should not be a comprehensive literature review;
- Rationale of the proposed research;
- Explain gaps that the project is intended to fill; and
- Potential contribution of this research to the scientific field(s) and public health.

## Suggestions

1. Make a compelling case for your proposed research project. Why is the topic important? Why are the specific research questions important? How are the researchers qualified to address these?
2. Establish significance through a careful review of published data in the field, including your own. Avoid outdated research. Use citations not only as support for specific statements but also to establish familiarity with all of the relevant publications and points of view. Your application may well be reviewed by someone working in your field. If their contributions and point of view are not mentioned, they are not likely to review your application sympathetically.
3. Highlight success of your related grants.
4. Highlight why research findings are important beyond the confines of a specific project i.e., how the results can be applied to further research in this field or related areas.
5. Clearly state public health implications.
6. Stress any innovations in experimental methods (e.g., new strategies, research methods used, interventions proposed).

## RESEARCH PLAN PART 2: Innovation

### Purpose

Explain how the application challenges and seeks to shift current research or clinical practice paradigms. Describe any novel theoretical concepts, approaches or methodologies, instrumentation or interventions to be developed or used, and any advantage over existing methodologies, instrumentation, or interventions. Explain any refinements, improvements, or new applications of theoretical concepts, approaches or methodologies, instrumentation, or interventions.

### Note: Significance is not the same as Innovation

Significance is WHY the work is important to do.

Innovation is HOW is the work different (better) than what has been done before.

## Recommended Length

½ - 1 page

## Content

The innovation section should include the following:

- Explain why concepts and methods are novel to the research field
- Focus on innovation in study design and outcomes
- Summarize novel findings to be presented as preliminary data in the Approach section

### **Suggestions**

1. Describe how the application differs from current research or clinical practice paradigms.
2. Provide a careful review of the current literature to support the innovative methodologies, approaches, or concepts of your research.
3. Demonstrate familiarity with novel methodologies by citing your publications or your collaborator's publications.
4. Summarize novel findings to be presented as preliminary data in the Approach section.
5. May want to consider presenting a bulleted list of innovative aspects of the project.

## **RESEARCH PLAN PART 3: Approach**

### **Purpose**

The purpose of the approach section is to describe how the research will be carried out. This section is crucial to how favorably an application is reviewed. The overall score of applications are most closely correlated with the score of the approach section.

### **Recommended Length**

9 - 10 pages

### **Content**

The research design and methods section should include the following:

- PI's preliminary studies, data, and experience relevant to the application and the experimental design;
- The overview of the experimental design;
- A description of methods and analyses to be used to accomplish the specific aims of the project;
- A discussion of potential difficulties and limitations and how these will be overcome or mitigated;
- Expected results, and alternative approaches that will be used if unexpected results are found;
- A projected sequence or timetable (work plan);
- If the project is in the early stages of development, describe any strategy to establish feasibility, and address the management of any high risk aspects of the proposed work;
- A detailed discussion of the way in which the results will be collected, analyzed, and interpreted;
- A description of any new methodology used and why it represents an improvement over the existing ones.

### **Suggestions**

1. Number the sections in this part of the application to correspond to the numbers of the Specific Aims.

2. Integrate preliminary data with the methods description for each Specific Aim. Preliminary data can be an essential part of a research grant application and help establish the likelihood of success of the proposed project.
3. Avoid excessive experimental detail by referring to publications that describe the methods to be employed. Publications cited should be by the applicants, if at all possible. Citing someone else's publication establishes that you know what method to use, but citing your own (or that of a collaborator) establishes that the applicant personnel are experienced with the necessary techniques.
4. If relevant, explain why one approach or method will be used in preference to others. This establishes that the alternatives were not simply overlooked. Give not only the "how" but the "why."
5. If employing a complex technology for the first time, take extra care to demonstrate familiarity with the experimental details and potential pitfalls. Add a co-investigator or consultant experienced with the technology, if necessary.
6. Explain how the research data will be collected, analyzed, and interpreted as well as any resource sharing plans as appropriate.
7. Develop alternative strategies for potential problems.
8. Document proposed collaborations and offers of materials or reagents of restricted availability with letters from the individuals involved.
9. Point out any procedures, situations, or materials that may be hazardous to personnel and precautions to be exercised (i.e., use of Select Agents).
10. Show that the objectives are attainable within the stated time frame. Include a time frame for each specific aim.

### **Oral Component**

The oral component will typically last from one and a half to two hours. The student will prepare and present **no more than 45 minutes of content (i.e. if uninterrupted)**, with the remaining time being allotted for questions from the committee and additional discussion. The students' committee chair (principal advisor) can determine whether the students' presentation be interruptible for questions or whether substantive questions should be reserved for the end. The primary focus of the oral presentation should be on presenting and defending all components of the written proposal including hypotheses, specific aims, relevant background, and methodologies and interpretation of data. Examiners are free to ask any questions they see fit as it relates to the proposal and its defense.

### **Committee Expectations**

Each student should have a solid understanding of all components of the written proposal including hypotheses, specific aims, relevant background, and methodologies and interpretation of data. They should also understand the fundamental principles underlying the techniques, methodologies, theory, and concepts utilized in their chosen proposal. One way the committee assesses expected familiarity is with relation to work being done in the student's research laboratory, as well as to others in similar fields of research who are performing similar work.