

Bioengineering PhD Preliminary Exam

The following describes the format and other specifics for the Department of Bioengineering 2018 PhD Preliminary Exam.

PhD Preliminary Exam Requirements

Students must be a Thesis MS Graduate Student in Bioengineering in good standing with the department. Note that according to University of Pittsburgh rules, all first year graduate students (except those pursuing the professional MS degree) are considered Thesis MS Graduate Students.

Students are required to pass the Preliminary Exam within their first two years (as determined by the number of academic credits taken at the University of Pittsburgh) to continue into the PhD program.

Not taking the exam your first year will have the same result as taking the exam and failing. If a student does not take the exam their first year, the student will have only one more opportunity to pass the Preliminary Exam.

Students admitted provisionally into the PhD program are not required to take the Preliminary Exam in their first year in the program, but may choose to do so. If the latter, it will count as the first of two attempts.

Students with other special circumstances wishing to delay their Preliminary Exam are required to petition the Graduate Committee, and do this by March 1st of the year they wish to delay the Preliminary Exam. There is no guarantee that the Graduate Committee will grant a request.

General Format for the PhD Preliminary Exam

The purpose of the Preliminary Exam is to evaluate the **student's ability to use fundamental principles of biomedical science and engineering to investigate creative solutions to bioengineering problems**. The basis of the Exam is a specific research question (problem) chosen by the student and a written proposal of seven single spaced pages (NIH RO3 format) on how the research questions/problem will be addressed scientifically. The proposal can be on **any topic** that the student chooses, **including his/her current PhD work in the lab**. If on current PhD work, the proposal is not meant to be a comprehensive proposal, as will be done for their Qualifying Exam later, but will be a proposal that describes a sub-set of their work with sufficient scope for about the next 1-1.5 years of research. **Students can choose to still do a different topic than their current PhD work**. The student may seek assistance from his/her advisor or any other faculty member for choosing the question. The Exam will consist of the written proposal document (see below for details) and an oral defense of it. The written document and oral presentation should demonstrate the student's ability to think, present, and defend in an academic environment, as well as a sufficient background in the biomedical science and engineering aspects of the chosen problem.

In addition to the written proposal, students will be required to submit a statement (as an Appendix to the proposal) signed by their advisor as to how the proposal is related to their PhD work in the lab. If the proposal is based on their PhD work in the lab, then the statement must describe the original contributions made by the student to the proposal and distinguish those from their advisors' input.

The Preliminary Exams will be coordinated within the current graduate tracks. They will take place at the end of the first year of graduate studies and be evaluated by a committee composed of at least 3 faculty members with expertise in engineering and life sciences. The track coordinators will determine the suitability of the research question (the problem, having

both engineering and biomedical science components). The student may get help from anyone in preparing the written proposal and oral presentation, but must observe the usual strict standards on plagiarism in preparing the documents. Proper referencing of sources (as well as personal communications) is required for both the oral and written components. The student should identify one important paper related to their proposal and make it available to the reviewers, who may ask for an explanation or critique of any aspect of the paper. The research proposal is not expected to be supported by preliminary data. Students will be required to perform a plagiarism check on the written proposal and submit the results of the plagiarism check along with their written proposal.

The track coordinators determine the composition of the examination committees. These typically include a broader spectrum of expertise than would normally be present on a dissertation committee and should include both biomedical science and engineering expertise. The student's advisor (or a representative) is encouraged to be in the room during the oral presentation, but must remain silent. The committee will solicit the advisor's input after the student has left the room. **The examination committee is expected to probe the student with challenging questions to establish the depth of his/her creative and analytical thinking, as well as knowledge in appropriate background areas.** The examiners' questions should be broad enough to include material that is relevant (or even remotely relevant) to the subject being presented, to test the student's ability to think on his/her feet.

The final result of the Preliminary Exam will be based on the combined evaluation of the written and oral components, with three possible outcomes: unconditional pass, conditional pass, and fail. Conditional pass will be accompanied by specific corrective actions, such as remedial courses to be taken by the student. In the case of failure from the first exam, the candidate may retake the Preliminary Exam one additional time in the following year.

General Timeline and Progression:

General Meeting:

All students are required to attend a general meeting given by the Exam Coordinator to go over exam format and answer questions.

Track-Specific Meeting:

All students are required to attend a track-specific exam meeting given by the Track Coordinator to discuss aspects of the Preliminary Exam particular to their track. The student's advisor (or a representative) is invited and encouraged to attend this meeting.

Abstract Approval:

The abstract is used by the track coordinator to assess the appropriateness of the proposed topic for the Bioengineering PhD Preliminary Exam. Approval of the topic does **not** ensure (or assume) that the student will successfully pass the Preliminary Exam. Students may be required to attend an individual meeting with their Track Coordinator before approval of the abstract will be granted. The pre-approval process will be conducted on a rolling basis. **Students are strongly encouraged to submit the abstract well in advance of the due date.**

Written Component:

The written component is used to assess the ability of the student to appropriately address the chosen topic. The quality of this document is used to determine a student's written abilities as well as ascertain how well the student might address the topic in an oral setting. The candidate should keep in mind that the oral component will not override substantial deficiencies in the written component.

Oral Component:

The candidate will be scheduled for an oral presentation to complete his/her Preliminary Exam. The date, time, and location of the oral exam will be set by the Track Coordinator.

Detailed instructions and Information

Abstract: The student will submit to the bioengineering Preliminary Exam website (1) the abstract (maximum 250 words) summarizing the research problem, (2) his/her choice of the track for all subsequent evaluations, and (3) names of the faculty member(s) who participated in the formulation of the question. **The abstract MUST clearly identify both the engineering and biomedical sciences aspects.** A reference paper should also be submitted at this time. This paper should be of limited focus and directly relevant to the proposed research question and would likely come from a peer-reviewed journal. Ideally, the paper should utilize engineering techniques with an application towards biological or medical problems

Written Component: The written component will be **7 pages maximum**, single-spaced, including tables and figures (not including references), to be distributed along with the abstract and reference paper to the Exam committee.

The written component for the research plan must follow the specific guidelines for an NIH RO3 research grant proposal. The R03 grant mechanism was created to support small research projects that can be carried out in a short period of time. An appropriate scope for your proposed project is research that can be conducted in about 1-1.5 years. Projects that are appropriate include: 1) Pilot or feasibility studies; 2) Secondary analysis of existing data; 3) Small, self-contained research projects; 4) Development of research methodology; and 5) Development of new research technology.

The written component must contain the following sections.

<u>Section</u>	<u># Pages</u>
<i>Specific Aims</i>	1
<i>Research Strategy</i>	
A. <i>Significance</i>	½ - 1
B. <i>Innovation</i>	½ - 1
C. <i>Approach</i>	4 - 5

A reference section must also be submitted but has no page limitations.

The *Specific Aims* section (1 page maximum) should introduce the problem and outline the major steps in the proposed solution. The *Research Strategy* section (**6 pages maximum**) should have subsections covering A) *Significance*; B) *Innovation*; and C) *Approach*. The *Significance* subsection should describe the existing state of the field and the motivation for the research, including relation to the research paper submitted. The *Innovation* subsection should discuss how the project seeks to shift current research or clinical practice paradigms by utilizing novel theoretical concepts, approaches or methodologies, instrumentation, or interventions. Discuss whether novelty is limited to one field of research or is broader. Also, be sure to point out whether the proposed work is a refinement, improvement, or new application of theoretical concepts, approaches or methodologies, instrumentation, or interventions. The *Approach* subsection should be organized by specific aims and describe the proposed research, including any new methods or custom equipment, how experimental results will be analyzed, and what problems may be expected, along with what alternate possible approaches might be pursued. This section may also contain preliminary results by the student if they exist to support any of the proposed methods.

The choice of exam topic is up to the student and should be of interest to the student. The exam topic can be on the student's current PhD work in his/her lab if the student wishes, but students

can choose to still do a different topic than their current PhD work. The research proposal is not meant to be of the same scope as will be done later for the PhD Qualifying Exam. The proposal should have sufficient scope for about 1-1.5 years of research to address the research question posed.

All students' written proposals must be checked with plagiarism software prior to submission. The results from the plagiarism software must be submitted along with the written proposal. Please be aware that all University regulations regarding academic integrity apply to the exam.

After the references, in an **Appendix to the proposal**, a statement must be written describing how the proposal is related to the student's PhD work in the lab. If the proposal is based on her/his PhD work in the lab, then the statement must describe the original contributions made by the student to the proposal and distinguish those from his/her advisor's input. **This statement must be signed by the student's PhD advisor.**

All written material, including the abstract and references should be in standard NIH format (Margins: Top: 0.8", Bottom, Left, Right: 0.5", single-spaced, Arial 11 font).

NIH RO3 Instructions:

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.

Length: The maximum length of the specific aims is one page.

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. Make sure your specific objectives or hypothesis are clearly stated, are testable, and adequately supported by citations and preliminary data (if available – not required for an R03). Be sure to explain how the results to be obtained will be used to test the hypothesis.
4. *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.
5. In general, two aims are appropriate for an R03 (however there is no set rule for number of aims).

6. Don't be overly ambitious.
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 scientific expertise.
9. Preliminary data can be presented if available. R03s do not require preliminary data but should be included if available.
10. Include a brief statement of the overall impact of the research studies.
11. 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.

RESEARCH STRATEGY (Overview)

Purpose: The Research Strategy/Plan is organized into three sections: Significance, Innovation, and Approach. The assessment of this research plan will largely determine whether or not the application is favorably recommended for funding. 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: Maximum of 6 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?
- 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?
- Examples of the types of projects supported by an R03 are: Pilot or feasibility studies, Secondary analysis of existing data, Small, self-contained research projects, Development of research methodology, Development of new research technology

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. Use headings and provide white space (spacing between paragraphs). Lead the reviewers through your research plan. One person should revise and edit the final draft.
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.

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: Approximately 1/2 - 1 page

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 can the results be applied to further research in this field or related areas.
5. Clearly state public health implications.

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.

Recommended Length: Approximately 1/4-1/2 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 (if applicable)

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 (if applicable).
5. May want to consider presenting a bulleted list of innovative aspects of the project.

Note: Significance is not the same as Innovation

Significance WHY is the work important to do?

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

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 is most closely correlated with the score of the approach section.

Recommended Length: The recommended length of the approach section is 4-5 pages.

Content: The research design and methods section should include the following:

- PI's preliminary studies (if applicable), 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 if available. Preliminary data is not required for an R03.

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 one hour, during which time the student will present for **no more than 20 minutes**, with the remaining time being allotted for questions from the committee. Examiners will not interrupt the presentation **except for questions of immediate clarification. Examination questions will be reserved until the student completes the oral presentation.** The primary focus of the oral presentation should be on presenting and defending the proposed research question and the approach to its solution. The background material, including the reference paper, may be discussed briefly if necessary, but the oral presentation is not meant to be a review of the background or a critique of the reference or other published papers. Examiners are free to ask any questions, typically related to the presentation, the reference paper, or core knowledge relevant to the student's track, with the primary intent of establishing the depth of the student's creative and analytical thinking, as well as knowledge in appropriate background areas.

Students must also bring printouts of the slides used in their oral presentation. The printouts must be 4 slides per page and double-sided (go green!)

Committee Expectations

Each student should have a solid understanding of the fundamental principles describing the techniques, methodologies and concepts utilized in their chosen proposal. The level of expectation will be dependent on the expected familiarity the student should have with the chosen topic. One way the committee assesses expected familiarity is with relation to work being done in the student's research laboratory. If the student chooses a proposal topic directly in line with work being done in her/his lab, it will be expected that the student be quite familiar with numerous detailed aspects of the chosen proposal. If the student chooses a proposal topic outside of things being done in his/her lab, the committee will likely have lower expectations on how familiar the student should be with the techniques and topics being proposed.

In addition to the techniques, methodologies and concepts of a given Preliminary Exam proposal, each Graduate Track has a core set of topics each student will be expected to understand and able to explain at the Undergraduate level. Students should feel comfortable discussing each of the topics listed in their chosen Track and may want to refresh their memory if they have not examined the topics recently. The Exam Committees may include questions relating to these topics, regardless of their perceived connection to the student's chosen Preliminary Exam proposal. Information on track specific core knowledge will be provided by the Track Coordinators.