Weldon School of Biomedical Engineering
PhD Qualifying Process:
Preliminary Examination and Mentoring-Committee

Overview of Rationale, Expectations, Logistics/Process, and Resources

Rationale:

A series of milestones have been developed to facilitate the training of our PhD students on their pathway to becoming independent researchers in biomedical engineering. The following skills are hallmarks of a Purdue PhD in Biomedical Engineering and place our students in a position to succeed and become leaders in one or more of many possible career paths (e.g., academia, industry, clinical, global health):

- Critically analyze the literature and identify research gaps in an area of Biomedical Engineering
- Develop a meaningful research question with a testable hypothesis
- Design rigorous and reproducible experiments to test this hypothesis and fill the identified gap
- Develop and/or use technology to perform these experiments and generate publishable data
- Critically analyze, interpret, and disseminate their own data to move the field forward in fundamental, translational, or clinically relevant ways
- Participate in all training, research, and related translational activities in an ethical manner

The PhD milestones are checkpoints for students to demonstrate expected competencies in the above skills as they progress through the three stages of our PhD program: *Pre-Qual*, *Post-Qual*, and *PhD Candidacy*. They are also critical opportunities to identify areas of professional growth for each trainee and for the faculty to provide them with the mentoring they need.

This document provides guidance to both students and faculty for understanding the expected standards of performance for the *second milestone in our PhD Training Program – The Preliminary Examination*, which consists of both Written and Oral components that are evaluated by the student's Thesis and Mentoring Preliminary Exam Committee. The Preliminary Examination is a formal requirement of Purdue's Graduate School, with successful completion of the Prelim advancing a PhD student into *PhD Candidacy.*

Expectations:

The expectations we have set for passing the Preliminary Exam represent a rigorous but attainable bar that is defined by our experience with the level of competency required to ensure likely success in completing impactful, and independent PhD dissertation research. *Note: this bar does not require substantial work on the Dissertation to be completed before the Preliminary Examination, merely that sufficient preliminary research has been completed to demonstrate the student's competencies in the areas detailed below.*

Purpose of the Preliminary Examination

> *Preliminary examinations must be completed no later than the end of the first semester of the third year of the PhD program.*

The Graduate School places responsibility on the department faculty to determine when a PhD student is ready to be admitted into candidacy for the PhD degree. This process culminates with a required preliminary examination, which is administered by the student's PhD Thesis and Mentoring Preliminary

Exam with the purpose of evaluating whether the student is prepared to undertake independent research for their dissertation.

In BME, candidacy requires that a student demonstrate through both written and oral formats that they have:

1) the appropriate depth and breadth of knowledge to complete their dissertation research,
2) the ability to conceptualize and perform meaningful research in their chosen area,
3) the technical skills required for their PhD dissertation work (or an appropriate plan for obtaining them in a timely manner according to their training plan timeline)
4) the intellectual ability to critically analyze and integrate knowledge from the literature to form a significant research question and testable hypothesis appropriate for a dissertation,
5) proposed an appropriate experimental design to address their research question adhering to all principles for ethical and responsible conduct of research (RCR)
6) the ability to communicate well in written and oral formats
7) developed an appropriate training plan to complete their dissertation research and professional development to position themselves to be successful in their chosen career path.

Importantly, candidacy does not require that substantial dissertation work be completed or that all training is completed, rather it only requires that the student can demonstrate their readiness to perform independent research for their dissertation project and to obtain the remaining necessary training for career development.

Multiple benefits to the student for completing the Preliminary Examination early include:

1) input from the entire thesis committee at a stage that can help to
    a. improve research-question formulation and experimental design,
    b. identify technical gaps in the student's knowledge early in the student's training so that courses or other remediation can be completed in a timely manner, and
    c. improve the student's training plan
2) preparation of the written prelim document in the form of a fellowship or grant proposal can help the student be ready to apply for a variety of national fellowships, and
3) many fellowships (on and off campus) require the student to be admitted to candidacy to apply.

The specific goals of our Preliminary Examination and associated mentoring-committee meeting are:

- to ensure all doctoral students have achieved the appropriate competencies listed above
- to identify areas of continued professional growth for each student
- to evaluate the student's training plan and ensure it will best support their career development

Logistics/Process:

Choice of Dissertation Research Question and Specific Aims

The research question should be chosen to allow the student to develop an original set of Specific Aims that will impactfully advance the current state of the chosen research field. The choice must be supported by a well-developed scientific premise based on the relevant scientific literature.

Specifically, the Research Question or Specific Aims:

1) must be novel and distinct from the student's past (i.e., prior to starting the PhD) research projects.
2) can be related to ongoing work in the mentor's lab but must be novel and distinct from ongoing or proposed research projects being conducted by the mentor, postdocs, graduate students, undergraduates, or technicians.
3) Must be different from those of research groups actively collaborating with the mentor's laboratory.

In choosing a Research Question and Specific Aims, focus on what you can do that is independent and that will have impact on the field. Challenge yourself to be innovative, but in impactful ways that will allow you to move the field forward.

Thesis Advisory and Mentoring Committee Makeup
Broad advising on the student's dissertation research and training plan is important throughout the PhD Training Program. The Thesis and Mentoring Committee must include:

- 4 members total
    - 2 BME Faculty Members (at least)
    - 1 Outside Faculty Member (Purdue or other institution)
    - 51% of committee must be Purdue faculty members

For **committee members from outside Purdue**, paperwork to request their special graduate faculty appointment needs to be filed with the Grad School at **least 30 days** prior to the preliminary examination date to ensure they are approved by BME and College of Engineering in time to be listed on the in order to be eligible to serve on your preliminary examining committee .

Timing and Logistics of the Preliminary Examination

The preliminary examination is to be completed before the end of the first semester of the third year of a student's PhD program. The oral exam must be formally scheduled with the Graduate School at least 15 days prior to the proposed exam date (via GS Form 8). This form must be initiated by the student and signed by the BME graduate office, the research advisor, and the BME Head at least 15 days before the proposed date of the exam. In the case of co-advisors, only one of them will need to sign. The exam is not officially scheduled until the Purdue Graduate School grants the final approval. A written prelim document (described below) must be submitted to the thesis committee two weeks prior to the scheduled oral exam (committee must approve any delays to this deadline).

The oral exam consists of a public presentation with questions from the audience and a closed-door exam session with more specific questions and discussion with the committee. Note: There must be at least two full registered semester sessions (can include summer) between when the preliminary exam is passed and when the final exam/defense is taken. However, we expect that Preliminary Exams are completed much earlier than this to allow for input and feedback from the Thesis Advisory and Mentoring Committee at an early stage to help improve research question formulation, experimental design and the student's training plan.

Scheduling:

- Your official electronic plan of study must be submitted and fully approved with the majority of your course work completed.
- Work with your research advisor to formalize and arrange an appropriate preliminary examining committee.
- Arrange a date, time and room for your preliminary exam with your research advisor and thesis advisory committee members.
    - Scheduling a Room and/or teleconference
        - Generally, a 2-hour period should be reserved.
        - Preferred room for in person or hybrid preliminary exam is MJIS 2001 scheduled through an MJIS computer via RAT.
        - If you do not have access to an MJIS computer, please email Jo Gelfand at jo@purdue.edu with the following information:
            - Name
            - Faculty Advisor Name
            - Purpose for Reservation
            - Date
            - Start and End Times

        - If MJIS is not available, contact Sandy May at smmay@purdue.edu for other acceptable room suggestions.
    - Other Scheduling Information:
        - Fully online prelims are allowable. If your prelim is hybrid or fully online, student is responsible for making all necessary teleconference arrangements.
- Submit the electronic GS Form 8 to officially schedule your exam with the Purdue Graduate School
    - Log in to myPurdue. Under the Academics tab, choose the link for requesting exam committee. This form must be initiated by you and be fully signed at least 15 days before the proposed exam date. Your exam is not officially scheduled until the Purdue Graduate School grants the final approval.
- Two weeks prior to your prelim exam, email smmay@purdue.edu the following information:
    - Your name
    - Research title
    - Names of thesis committee members, with major professor designated
    - Date, time and place of the preliminary examination
    - An abstract (no more than 250 words) of the prelim proposal clearly defining the problem and its significance

  BME Grad Office will coordinate the required preliminary examination forms with your research advisor(s).

Preparation of the Written Document

The written document for the Preliminary Examination will consist of two parts: ***The Research Proposal*** and ***The Training Plan***, both of which are generally designed based on common fellowship proposals. The motivation for requiring both sections, although not all students will pursue formal fellowships, is that the development of both are critical for ensuring that students obtain the research and professional-development training they need to develop into independent researchers who will have a sustained impact on biomedical research. Specific formatting requirements are described below; however, if a student is submitting a formal fellowship or grant proposal, they are encouraged to use that proposal as their prelim document if it covers all of the sections described below and can adequately demonstrate the required competencies listed above. This flexibility in format and length (at discretion of the thesis committee to best support the needs of the student) is allowed to provide the student with the benefit and efficiency in obtaining committee feedback on their actual proposal document; however, additional documents or sections will be required if the proposal does not include all of the BME-required sections (e.g., if a grant proposal does not include a training plan, one must be included in the prelim document). Significant deviations from the default formatting described below should be approved by the Graduate Committee prior to preparation of the prelim documents.

Format Requirements:

- Research Proposal of 6-12 pages single spaced (including figures, but not including Abstract, Specific Aims, or Reference sections and additional material); Training Plan of 3-6 pages single spaced (not including CV or optional pages); an unofficial transcript; and Individual Development Plan.
- 11 pt. font size or larger. Font must be no more than 15 characters per linear inch (including characters and spaces). At least 0.5-inch margins.
- Reference style in:
    - IEEE, listed and numbered in order of citation, not alphabetically. (https://owl.purdue.edu/owl/research_and_citation/ieee_style/ieee_overview.html)
      AMA format, also listed and numbered in order of citation, not alphabetically, but number are cited in test in superscript(https://owl.purdue.edu/owl/research_and_citation/ama_style/index.html),

- or APA format, cited in text with author, date and listed in bibliography in alphabetical order (https://owl.purdue.edu/owl/research_and_citation/apa_style/apa_formatting_and_style_guide/general_format.html)

Content: Research Proposal

- **Lay-Person (Public) Abstract (0.5 pages, separate page).** Concisely and accurately describe the proposed work, including the research topic and identified gap to be filled, the research question and testable hypothesis to be explored in this work, the research strategy and approach designed to fill the gap, and the significance of the work for the field in both the short- and long-term. This abstract should be written at a level that is understandable to a scientifically literate reader. This abstract will be used to advertise the Prelim exam to the Weldon School and broader Purdue community.
- **Specific Aims Page (1 page max, separate page)**. This is the most important page of your proposal, as it serves as both a sales pitch and scientific description of your proposal and why it is important. It is only 1 page, but typically takes the longest time to write – best practice is to iterate numerous times during the preparation of the proposal. The "story" of why your proposal is important and will be impactful on the field must be told in a strongly compelling way on this single page. It should include a statement of a biomedical problem, identification of a gap in current knowledge, and then a suggested research strategy to fill the gap by addressing a specific research question and testable hypothesis. A list of proposed Specific Aims should be described, with just enough detail to convince the reader your plans are well thought out and will be effective. A concluding paragraph should describe the impact this work will have on the field. Also see "Introduction to the Specific Aims Page of a Grant Proposal" for more guidance on an effective Specific Aims Page. Successful proposals are able to convince the reviewer to support the proposal based on this single page.
- **Significance and Scientific Premise of Proposed Work (~2-3 pages)**. Critical analysis and synthesis of the relevant literature on your research topic to establish the current state of the field. Significant scientific gaps must be identified, culminating in a concise and explicit statement of an appropriate research question and testable hypothesis. This section should explain the importance of the research problem, and how the proposed work will fill the identified gaps and the resulting impact on the field.
- **Innovation (~0.5 - 1 pages).** This section should briefly describe any innovative aspects of the proposed work, and the significance of this innovation. Innovation can be scientific or technical. Combining two established methods in a way that has never been done can be innovative.
- **Preliminary Data (~2-3 pages)**. Relevant (not necessarily all) preliminary data collected by the student should be presented and critically analyzed and interpreted. These data should be used to support the proposed hypotheses and/or demonstrate the feasibility of the proposed work by the student.
- **Research Approach (~3-6 pages).** Describe the general experimental strategy that will be used to test the stated hypothesis and fill the identified gap, and describe its rationale. Describe the specific methodology and procedures to be used in sufficient detail to allow the reader to evaluate the likelihood of success of the proposed work. General methods can be described in their own section before or after the detailed methods for each Specific Aim. For each Aim, describe the exact data to be collected, the planned analyses of the data (including appropriate statistical analyses), and how the data will be interpreted to test your hypothesis/research question. The reader should be convinced that if this work is carried out, that the hypothesis will be tested definitively and ideally that no matter if supported or refuted, the field will be moved forward.
- **Required subsections in Research Approach**
  - **Approaches to Increase Rigor and Reproducibility (0.25-0.5 pages).** Briefly describe any approaches you will use to increase rigor, including power analyses to justify number of subjects, randomization and blinding, examination of sex as a biological variable.

- **Caveats, Potential Problems, and Alternative Approaches (0.25-0.5 pages).** Discuss any potential issues you see in the proposed work and how you will address them if they arise.
- **TimeLine of Proposed Work (0.25 - 0.5 pages).** Describe the planned timeline of your proposed work to demonstrate appropriateness of scope. Include expected journal papers to be produced as a result of this work.
- **References** (does not count for page limit)

- **Additional Documents in the Research Proposal** (do not count for page limit, but are required to ensure ethical and reproducible research).
  - **Data Management and Sharing Plan (required).** Follow NIH or NSF suggestions on approaches to support open science (e.g., data and analysis code sharing).
  - **Vertebrate Animal Section (if applicable).** Follow NIH or NSF formats.
  - **Human Subjects: Inclusion, Protections (if applicable).** Follow NIH or NSF formats.
  - **Authentication of Key Biological and/or Chemical Resources (if applicable).** Follow NIH or NSF formats.
  - Additional proposal pages (not required) may be submitted if the student is preparing a specific fellowship or grant proposal and desires feedback from their committee, e.g.:
    - Budget
    - Facilities and Other Resources
    - Equipment

Content: Training-Plan

- **PhD Preliminary Exam Cover Sheet**
- **Student CV.** In whatever format is most beneficial to the student, given their career plans. May include a personal statement and/or be in the form of a Biosketch
- **Applicant's Background and Goals for Training (3-6 pages).** Include sections on
  1) Previous Research Experience
  2) Career Goals
  3) Training Goals and Objectives
  4) Activities Planned in Remaining Years of the PhD Training Program (Tables, with rows for various broad categories (e.g., research, coursework, profession development, conferences, paper or dissertation writing, with percentages (%) of time) are useful), and
  5) Training and Research Activity Timeline

- (Optional) Additional Training proposal pages may be submitted if the student is preparing a specific fellowship or grant proposal and desires feedback from their committee, e.g.:
  - Training in the Responsible Conduct of Research (RCR)
  - Selection of Mentor and Institution
  - Mentor and Co-Mentor Statements
  - Description of Institutional Environment and Commitment to Training

Content: Other Documents: (not included in page limit):

- **Unofficial transcript**
- **Individual Development Plan (IDP).** This must be discussed and signed by your primary advisor in the year the prelim is taken and prior to distribution to the Preliminary Exam and Mentoring Committee.

Evaluation of the Written Document
The written document is submitted by the student to the committee at least two (2) weeks before the oral prelim defense. Within a few days, the submitted written proposal will be passed through iThenticate plagiarism-detection software by the Chair (Advisor), with the report then distributed to all committee members for review and approval on their rubric. Plagiarism in the qualifying-exam document will be grounds for failure of the exam, and will be reported to the Office of Student Rights and Responsibilities (OSRR).

Based on the expectations in this Overview document and the Committee-Guidance document, all faculty on the committee should complete the BME rubric (fillable PDF) while evaluating the written document (e.g., checkboxes for specific criteria, plus a few bulleted strengths and weaknesses, and any significant concerns they wish to address in the defense). These rubrics should be forwarded to the committee Chair (mentor) prior to the oral defense if possible so that the mentor can compile these and inform the committee of any significant concerns going into the defense. During the end of the meeting, the Chair and Committee will compile all feedback into an online version of the rubric. The rubric is to be reviewed with the student at the end of the meeting to help them to understand their performance and areas for growth so everyone is on the same page. This feedback will be also provided after the meeting to the student, committee chair(s) and the BME Graduate Office.

Structure of Oral Component: Preliminary Examination and Mentoring Committee Meeting
A roughly two-hour (public for ~1st hour) meeting must be held by the official last day of the semester as set by the Purdue Registrar for the semester in which the student has registered to take the Preliminary Exam.
This meeting will consist of:

1. a ~45 min oral presentation of the material in the written submission (Research and Training Plans)
2. ~15 min questions from the public audience
3. ~20-30 min closed-door discussion on student's research proposal
4. ~15-20 min closed-door discussion on student's training plan
5. ~10 min private discussion among the committee, and completion of group rubric with constructive feedback
6. ~5-10 min discussion with student of rubric feedback

The committee, through questions and discussion, will be responsible for evaluating the student's competencies required for candidacy (listed above):

Overall Feedback and Potential Outcomes of the Preliminary Exam
At the end of the meeting, the committee will discuss privately the student's level of competency in key areas based on both the Written and Oral Components of the Exam. At the end of the meeting, the Chair and Committee will compile all feedback into an online version of the rubric. The rubric is to be reviewed with the student at the end of the meeting to help them to understand their performance and areas for growth so everyone is on the same page. This feedback will be also provided after the meeting to the student, committee chair(s) and the BME Graduate Office.

Possible outcomes (documented by committee on Form 8) are:

- Pass
- No Pass
    - Student can repeat the whole process (not in the same semester) at a later time as recommended by the committee
    - Student may not repeat the prelim a third time, without recommendation of the committee, approval of the BME Graduate Office and with special approval of the dean of the Graduate School. In such cases, the student would move to MS thesis option or

appropriate alternative program, with guidance and mentoring from BME Graduate Office.

Relevant Resources

- Monte and Libby (2018). Introduction to the Specific Aims Page of a Grant Proposal
- Landis et al. (2012). A call for transparent reporting to optimize the predictive value of preclinical research
- *The Elements of Style, by Strunck and White; Style: Lessons in Clarity and Grace (or similar) by J.M. Williams; or similar guides for clarity in writing*
- Career Development Path Advising Documents
- Purdue Writing Lab (OWL)

Questions should be addressed to:

- *Logistical*: Senior Graduate Program Assistant (Sandy May) or Graduate Assistant (Elizabeth Rowen)
- *Professional development*: Associate Director of Graduate Programs (Tammy Siemers)
- *Concerns, constructive comments*: Director of Graduate Programs (Michael Heinz); Associate Head of Academic Programs (Tamara Kinzer-Ursem)