BIOMEDICAL ENGINEERING AND PHYSIOLOGY (BMEP) – PH.D. DEGREE

- Kristin D. Zhao Ph.D., *Program Director*
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Admission

Appointment Requirements

Candidates for the Ph.D. Program must meet the following eligibility requirements:

- Completion of a bachelor's degree, preferably in the biological or physical sciences, from an accredited institution.
- A minimum cumulative undergraduate GPA of 3.0 on a 4.0 scale. GPAs from graduate degrees may also be considered for competitive candidates if improvement of academic record is evident.
- Applications are considered only if submitted within the application submission window of September 1 – December 1 each year, for appointment in the following academic year. See also Admissions and Application Process (https://college.mayo.edu/academics/biomedical-research-training/phd-program/how-to-apply/).
- Degree conferral before the program begins (program begins in July)
- The Ph.D. program does consider international applicants who can demonstrate proof of English language proficiency. See also international applicant information (https://college.mayo.edu/academics/biomedical-research-training/phd-program/how-to-apply/international-applicant-information/).

Suggested undergraduate coursework:

- Applicants to our Ph.D. program are encouraged to have completed coursework with demonstrated proficiency (B average or above) in their math and science courses. Additionally, advanced courses in biology, chemistry, and physiology are encouraged.
- Applicants interested in applying to the Biomedical Engineering and Physiology Track are advised to take courses in quantitative science and engineering, such as signal processing, computer science, and instrumentation.

Authority to make appointments rests with the Mayo Clinic Graduate School of Biomedical Sciences Education Committee. Falsifying or omitting information on or accompanying the application may disqualify an applicant from admission or subject a student to dismissal. The application and supporting documents become the property of MCGSBS upon receipt. The average number of years to degree is 5.2.

Inquiries regarding admission to the MCGSBS Ph.D. Program should be sent to this inquiry form (https://college.mayo.edu/academics/biomedical-research-training/contact/).

Admissions/Financial Support

- PhD students are fully supported through a guaranteed internal fellowship for five years, eliminating the need to identify a faculty member to provide financial support. The annual base stipend for PhD students funded by Mayo Clinic for the 2025-2026 academic year is $41,200, deposited electronically bi-monthly in the student's bank of choice. The annual tuition fee is waived in full ($27,000).
- Appointment and funding are conditional on remaining actively enrolled in the program, continuously meeting the qualifications, standards and requirements of the program and track.
- Funding may consist of graduate school, external fellowships and/or internal scholarships.
- Students are appointed for five years with designated program start and end dates.
- If required training exceeds the appointment length, a request for extension may be made for consideration. All extension requests require graduate school approval and funding to cover all student costs during the extension period are typically paid by the student's mentor.
- Training must be completed within a maximum of seven years, regardless of funding availability.
- Students who enter MCGSBS with pre-awarded Mayo department/division funding will continue under the terms of any such arrangements throughout the duration of their PhD training.

Transfer Credits

A total of 21 credits may be transferred into the Ph.D. Program. For more details, see the Credit Conversion, Transfer, Waiver, and Substitution Policy on the MCGSBS Policies and Procedures intranet site.

Course Work

The curriculum for the Predoctoral degree consists of **73 credits**, which can include a maximum of 24 Research credits.

Code	Title	Hours
MGS		
MGS 5000	Foundational Skills	1
MGS 5010	Rigor, Reproducibility, Experimental Design, and Data Management	1
MGS 5030	Core Concepts in Genome Dynamics, Biochemistry, Cellular Biology, and Physiology [1]	3
MGS 6000	Responsible Conduct of Research	1
MGS 5050	Critical Thinking and Scientific Writing [1]	2
MGS 5051	Critical Thinking and Scientific Writing, Part II	1
Statistics [2]		**1**
CTSC 5590	Foundations of Statistics in Clinical and Translational Research	
CTSC 5600	Introduction to Statistics in Clinical and Translational Research	
Track Requirements		
BME 5010	Integrative Physiology of Health and Disease	2
BME 5011	Integrative Physiology of Health and Disease II	2
BME 5012	Integrated Physiology of Health and Disease III	2
BME 5020	Quantitative Biomedical Imaging and Signal Processing	2
BME 5021	Quantitative Biomedical Imaging and Signal Processing II	2
BME 5022	Quantitative Biomedical Imaging and Signal Processing III	2
BME 5030	Biomedical Applications of Engineering Principles	2

BME 5031	Biomedical Applications of Engineering Principles II	2
BME 5032	Biomedical Applications of Engineering Principles III	2
BME 6600	Physiology & Biomedical Engineering Seminars (1cr./ term for 3 terms)	3
BME 6650	Biomedical Engineering & Physiology Journal Club (1cr./ term for 3 terms)	3
Lab Rotations [3]		
6 credits maximum, a minimum of 3 rotations		
MGS 5102	Ph.D. Laboratory Rotation	2
MGS 5107	Ph.D. Laboratory Rotation	2
MGS 5108	Ph.D. Laboratory Rotation	2
Research		
MGS 6890	Predoctoral Research (3 cr./qtr x minimum 8 terms) [4]	24
Advanced Coursework		**9**
Total Hours		**73**

1 M.D.-Ph.D. students may exclude these in accordance with M.D.-Ph.D. requirements.

2 Choose one of the following options. Students must complete a minimum of 1 credit of statistics courses.

3 M.D.-Ph.D. students satisfy this requirement with three one-month full-time rotations.

4 Must enroll every quarter once a thesis laboratory is selected for remainder of program. Directed research projects under the supervision of a faculty mentor.

Qualifying Exams and Thesis Research

During the first two years of the program, each student is expected to select a laboratory and thesis mentor. This occurs largely as a result of lab rotations. All students must take and satisfactorily pass a written comprehensive qualifying exam preparing an NIH style F award. The oral qualifying exam will include a presentation of proposed research and tests the synthesis of course work and research interests.

By January the second year of the program, it is expected that all students will have selected their thesis mentor. A Thesis Advisory Committee proposal must be submitted to the education committee for approval by February of the 2nd year. The Thesis Advisory Committee must be approved by the Biomedical Engineering & Physiology Education Committee. Students must have their first thesis committee meeting by August of their 3rd year.

Each student is expected to meet with their TAC at least twice a year to discuss progress towards their dissertation research. The TAC will decide when the research has progressed sufficiently so that a dissertation can be written, and the student will then write their dissertation and publicly defend it.

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Thesis Advisory Committee Guidelines

Thesis Advisory Committee (TAC) – must consist of five members with any additional members serving as ex-officio. Three committee members must have full faculty (FF) privileges in BMEP track and minimum of two members must be Experienced Examiners (EE) in BMEP track. Two committee members must have mentored a student to degree. The committee for MD-PhD students must include a member of MD-PhD Executive Committee either as voting member or ex-officio.

Proposed TAC membership must be approved by the BMEP Education Committee prior to submitting to the graduate school via the Ph.D. Thesis Advisory Committee eForm on the intranet. Please note any external TAC members require temporary MCGSBS faculty privileges: see the Graduate Faculty Privileges Request Procedure on the MCGSBS Policies and Procedures intranet site.

Written Qualifying Exam Guidelines

The purpose of the Written Qualifying Exam (WQE) is to evaluate the student's ability to apply the knowledge of key principles acquired during graduate study (i.e., MCGSBS and BMEP core coursework) toward generation and exploration of new testable hypotheses in an important area of BMEP research. The format of the WQE will be an NIH F31 proposal (i.e., 6 pages, plus 1 Specific Aim page) or similar grant proposal (Contact Education Committee if you intend to write a grant other than an F-award). The grant proposal will be evaluated to determine the student's understanding of and ability to integrate the principles of biomedical engineering and physiology, ability to establish a rigorous research plan to address the proposed question and ability for independent thought.

Expectations of Independent Work:

During the preparation of the proposal, it is expected that students will seek the advice and input of their mentor, members of their thesis advisory committee, laboratory members and others. Those providing input should not be involved in drafting, writing or directly editing the proposal but should provide generalized comments, suggestions and direction. The work product should be completed entirely by the student. It is acceptable for a mentor or other consulting individual to provide broad opinions and direction, review drafts and provide general comments, advise students on structure and content, provide topically unrelated grants as examples and be actively engaged in the conceptualization of the broad direction of the project. It is not acceptable for the mentor or another consulting individual to write portions of the proposal, provide direct edits to the proposal (such as proposing new wording, correcting grammar, or adding new or clarifying sentences), solely conceptualize, formulate or dictate the hypotheses and/or aims of the study, or provide closely related grant applications to the student as a guide. If students have closely related grant text prior to initiating the exam, they should not use the text in the preparation of their proposals.

Format and Topic:

WQE topics should be directly related to the student's proposed thesis research and must be related to Biomedical Engineering and/or Physiology. Students should discuss their proposed WQE topic with their mentor. After agreeing on the topic of the WQE proposal, the topic should be submitted to the BMEP Education Coordinator for approval (see timeline below). The preferred format of the proposal will be modeled on the NIH pre-doctoral F31 application. However, proposals that reflect a design applicable to other pre-doctoral grant applications (e.g., AHA) may also be acceptable. If a student would like to prepare the proposal in a

different grant format with the aim of a future submission to that granting agency, a request must be approved by the BMEP Education Committee for the non-NIH grant format at the time of topic approval.

Oral Qualifying Exams

This exam is scheduled to take place in September/October, following the successful completion of the written qualifying exam. The Oral Qualifying Committee is comprised of 4 members appointed by the BMEP education committee and the student's advisor. Attempts are made to populate the committee with one faculty member from each of the sub-tracks in BMEP.

Within the second year, all students must take and satisfactorily pass an oral qualifying exam. The oral qualifying exam will include a presentation of a proposed research project and tests the student's synthesis of BMEP course work and their proposed research interests.

Goal of the exam:

Our goal is to evaluate the student's ability to formulate a scientific approach to a complex research problem, present it clearly and succinctly, defend their scientific and subject-matter choices for the study design, and answer questions that challenge the student's ability to answer direct or peripheral questions in a logical, scientific and responsive manner.

Suggested Sequence

This is a suggested sequence based on a summer term start. Individual course plans may vary depending on true start date, program, and research interests. Be sure to confirm you have met your requirements using your degree planning tool. Course offerings may vary slightly. Current course offerings are posted in the course catalog. Electives are not shown.

**BMEP Seminar will begin the summer quarter of your first year (no classes in August). You will register for BMEP Seminar beginning the Fall Quarter of your first year, and register for 1 credit in the Fall, Winter and Spring. After the first year, attendance and participation is expected for the duration of your academic career with exception of the term you intend to defend your thesis.*

Code	Title	Hours
First Year - Summer Term		
MGS 5000	Foundational Skills	1
MGS 5010	Rigor, Reproducibility, Experimental Design, and Data Management	1
MGS 5030	Core Concepts in Genome Dynamics, Biochemistry, Cellular Biology, and Physiology	3
CTSC 5590	Foundations of Statistics in Clinical and Translational Research [1]	1
MGS 6000	Responsible Conduct of Research	1
MGS 5102	Ph.D. Laboratory Rotation	2
BME 6600	Physiology & Biomedical Engineering Seminars	1

Code	Title	Hours
First Year - Fall Term		
MGS 5107	Ph.D. Laboratory Rotation	2
MGS 5108	Ph.D. Laboratory Rotation	2
MGS 5051	Critical Thinking and Scientific Writing, Part II	1
BME 6600	Physiology & Biomedical Engineering Seminars	1
BME 5010	Integrative Physiology of Health and Disease	2
BME 5020	Quantitative Biomedical Imaging and Signal Processing	2
BME 5030	Biomedical Applications of Engineering Principles	2

Code	Title	Hours
First Year - Winter Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
BME 5011	Integrative Physiology of Health and Disease II	2
BME 5021	Quantitative Biomedical Imaging and Signal Processing II	2
BME 5031	Biomedical Applications of Engineering Principles II	2
CTSC 5600	Introduction to Statistics in Clinical and Translational Research [1]	3

Code	Title	Hours
First Year - Spring Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
BME 5012	Integrated Physiology of Health and Disease III	2
BME 5022	Quantitative Biomedical Imaging and Signal Processing III	2
BME 5032	Biomedical Applications of Engineering Principles III	2

Code	Title	Hours
Second Year - Summer Term		
MGS 5050	Critical Thinking and Scientific Writing	2
BME 6600	Physiology & Biomedical Engineering Seminars	1
Electives		1-3

Code	Title	Hours
Second Year - Fall Term		
MGS 5051	Critical Thinking and Scientific Writing, Part II	1
BME 6600	Physiology & Biomedical Engineering Seminars	1
Electives		1-3

Code	Title	Hours
Second Year - Winter Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
BME 6650	Biomedical Engineering & Physiology Journal Club	1
Electives		1-3

Code	Title	Hours
Second Year - Spring Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
BME 6650	Biomedical Engineering & Physiology Journal Club	1
Electives		1-3

Code	Title	Hours
Third Year - Summer Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
MGS 6890	Predoctoral Research	3

Code	Title	Hours
Third Year - Fall Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
MGS 6890	Predoctoral Research	3

Code	Title	Hours
Third Year - Winter Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
MGS 6890	Predoctoral Research	3

Code	Title	Hours
Third Year - Spring Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
MGS 6890	Predoctoral Research	3

Code	Title	Hours
Fourth Year - Summer Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
MGS 6890	Predoctoral Research	3

Code	Title	Hours
Fourth Year - Fall Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
MGS 6890	Predoctoral Research	3

Code	Title	Hours
Fourth Year - Winter Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
MGS 6890	Predoctoral Research	3

Code	Title	Hours
Fourth Year - Spring Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
MGS 6890	Predoctoral Research	3

Code	Title	Hours
Fifth Year - Summer Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
MGS 6890	Predoctoral Research	3

Code	Title	Hours
Fifth Year - Fall Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
MGS 6890	Predoctoral Research	3

Code	Title	Hours
Fifth Year - Winter Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
MGS 6890	Predoctoral Research	3

Code	Title	Hours
Fifth Year - Spring Term		
BME 6600	Physiology & Biomedical Engineering Seminars	1
MGS 6890	Predoctoral Research	3

[1] A minimum of 1 credit of statistics courses are required. See program requirements for course options and details.