BIOMEDICAL ENGINEERING, PHD

Biomedical Engineering (BME) has emerged as one of the most exciting interdisciplinary research fields in modern science. Biomedical engineers apply modern approaches from the experimental life sciences in conjunction with theoretical and computational methods from the disciplines of engineering, mathematics, and computer science to the solution of biomedical problems of fundamental importance. The Biomedical Engineering Graduate Program of the Johns Hopkins University is designed to train engineers to work at the cutting edge of this exciting discipline. There are two graduate programs in biomedical engineering. The master’s program is supported by the Whiting School of Engineering and leads to a Master’s of Science degree. The Ph.D. program is supported by the School of Medicine and leads to a Ph.D. in Biomedical Engineering.

Ph.D. in Biomedical Engineering

The cornerstone of the Program is our belief in the importance of in-depth training of students in both life sciences and modern engineering. In-depth training in life sciences is achieved in one of two ways. Many of our incoming Ph.D. students enroll in classes that are part of the first-year basic sciences curriculum of the Johns Hopkins University School of Medicine. That is, they learn human biology with the medical students. This is a unique and intensive curriculum covering a broad range of topics including molecules and cells, human anatomy, immunology, physiology, and neuroscience. This curriculum is an excellent way to build a broad and solid foundation in the life sciences. Alternatively, students may take graduate-level biology and life sciences courses from the many exceptional biosciences departments at Johns Hopkins. This option is often of particular value to students who enter the program already having a strong background in the life sciences. In-depth training in engineering, mathematics, and computer science is achieved through elective courses that are taken in the first and second years.

All students are fully supported during their time in the Ph.D. program. This covers tuition and provides a stipend for the duration of their Ph.D. Because of the interdisciplinary nature of Biomedical Engineering, students can choose to perform their dissertation research in almost any laboratory in the University (subject to the approval of the program directors). Some students choose their research lab before matriculating, and some students have the opportunity to do research rotations among several labs during their first academic year. The opportunities to do research rotations are generously funded by multiple training grants supported by the National Institutes of Health.

Emphasis is placed on original research leading to the doctoral dissertation. The research may be experimental or computational - the breadth of research in Biomedical Engineering is large, and we encourage students to attend various seminars to learn about cutting edge approaches. To explore the current range of research by labs within the Biomedical Engineering department, see here (https://www.bme.jhu.edu/research/research-areas/). In addition, many of our students work in labs outside the Biomedical Engineering department.

Program Directors

Rachel Karchin, Ph.D. and Patrick Kanold, Ph.D.

Financial Aid

All BME Ph.D. students (regardless of citizenship or national origin) are supported (tuition, stipend, health and dental insurance) for the duration of their Ph.D. U.S. citizens and Permanent Residents are eligible for support from training grants from the National Institutes of Health (NIH). Students are also encouraged to apply for individual graduate fellowships from the National Science Foundation, NRSA awards from the NIH, and fellowships from private foundations. Only online applications for admission are accepted, and must be received by December 1.

Admission Requirements

Note: up-to-date admissions requirements are maintained on the Biomedical Engineering website (https://www.bme.jhu.edu/academics/graduate/phd-program/), and applications are submitted through the School of Medicine’s application system (https://www.hopkinsmedicine.org/som/education-programs/graduate-programs/).

The application deadline for the School of Medicine Biomedical Engineering PhD program is December 1 of each year. We typically recruit students in seven broad areas that match the research strengths within the BME department: Biomedical Data Science, Computational Medicine, Genomics and Systems Biology, Imaging and Medical Devices, Immunonengineering, Neuroengineering, and Translational Cell and Tissue Engineering. Applicants do not have to fit into one of these areas, and much of the best research comes from interdisciplinary work. However, these areas help students identify faculty who match their research interests and form part of their community after they matriculate.

BME students come from a wide variety of academic and research backgrounds, but a typical BME thesis project involves applying engineering or quantitative approaches to address biological or health related questions. Therefore, students who apply to our program should have a strong background in engineering, physics, or mathematics as well as a sufficient experience in chemistry and biology.

The admission process is led by committees organized by the focus areas listed above. Applicants should specify the area (or areas) in which they are most interested and describe their future research goals. Each application is reviewed holistically, with emphasis placed on research experience, the personal statement, letters of recommendation, and how well the candidate’s goals and interests fit with those of the program. Faculty in each area vote and rank the applicants in the initial selection round, and the final pool of applicants is ranked and voted on by the entire admissions committee following the interview process.

Applications must be submitted and complete by the application deadline. To be considered for review, a complete application must include:

- A complete and submitted online application: https://www.bme.jhu.edu/johns-hopkins-biomedical-engineering/apply/.
- Transcripts from each college or university attended—Applicants may upload unofficial transcripts to the online application for review. Applicants who receive an offer or accept an offer of admission are required to submit official transcripts to the School of Medicine's Office of Graduate Biomedical Education via mail or email (gradadmissions@jhmi.edu).
- Three letters of recommendation—Letters of recommendation should come from faculty members who are acquainted with the applicant’s academic work and/or research. These letters should include
comments on the applicant’s aptitude and promise for independent research.

- **Personal Statement**—A typewritten personal statement (one page maximum) indicating the basis of the applicant’s interest in graduate study and their career objectives. Applicants should include discussion of any previous research and mention which faculty they would be most interested in working with and why. A separate personal statement describing how the applicant’s life experiences or identity shaped their goals is optional.

- **C.V.—**A current C.V. summarizing the applicant’s academic, professional, and research experience.

- **TOEFL scores**—For international students only; the TOEFL requirement is waived for applicants who completed their degree at an institution that used English as the primary language of instruction.


- **GRE scores are now optional.** Read more about our application requirements and GRE policy here: https://www.bme.jhu.edu/academics/graduate/phd-program/apply-to-the-phd-program/academics/graduate/phd-program/apply-to-the-phd-program/https://www.bme.jhu.edu/academics/graduate/phd-program/apply-to-the-phdprogram/ (https://www.bme.jhu.edu/academics/graduate/phd-program/apply-to-the-phd-program/).

Applicants for admission must fulfill the following course prerequisites:

- One year of college-level biology (may include quantitative biology or physiology)
- One semester of organic chemistry is required (for students interested in the Immunoengineering or Translational Cell & Tissue Engineering research areas)
- Sufficient mathematical training, typically including differential equations

Students interested in applying who do not have the prerequisite course experience may want to include in their application an explanatory note indicating any plans to fulfill the prerequisites before the start of the PhD program should their application be accepted. Courses taken at any accredited college or university are acceptable. Each applicant must have received a B.A. or B.S. degree or its equivalent prior to matriculation. A Master’s degree is not required for admission to our program.

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**Process:** The PhD program admissions committee will not consider any application until it is complete. Applicants may check the status of their application by logging into their online account.

**Interviews:** The admissions committee will review completed applications and invites elected applicants to interview with our faculty by phone, Zoom, or similar virtual platforms. Applicants must complete the interview process to be considered for admission, and final admissions decisions will be made from the pool of interviewed applicants. Interview invitations will be sent out to applicants via email in January and interviews will be conducted in January or early February. Selected students will be invited to an in-person campus visit in late February or early March to meet current faculty and graduate students, as well as learn more about the program and the Hopkins BME environment.

**Offers and Acceptance:** Applicants will be notified via email in March, or earlier, if possible, with the outcome of their application. The BME PhD program extends two types of offers: rotation offers and direct-match offers. The only difference between the offer types is how the student chooses their thesis lab; all other aspects of the program are the same for all BME students. Students who receive a direct-match offer typically join a specific research lab from day one, while students who receive a rotation offer are able to rotate in their choice of labs before selecting a thesis lab by the end of their first year.

A full offer of admission to the program will include a yearly stipend, full tuition, matriculation fee, medical and dental insurance and paid health benefits for children and some spouses. This applies to all admitted students regardless of citizenship or offer type. The deadline to accept an offer of admission is April 15.

**Program Requirements**

- Complete 30 credits of coursework in life sciences, engineering, mathematics, applied math, and/or computer science. Courses must be passed with a grade of B- or higher. Of the 30 credits, at least 12 credits must be in the life sciences and at least 12 credits must be in quantitative sciences. More detailed requirements can be found at our page on PhD degree requirements (https://www.bme.jhu.edu/academics/graduate/phd-program/phd-degree-requirements/)
- Complete at least 8 hours of face to face research ethics training
- Successfully pass the Doctor of Philosophy Board Oral Examination (this is a University-wide requirement)
- At least one year as a resident student at JHU (this is a University-wide requirement)
- Dissertation must be approved by at least two readers and certified by them to be a significant contribution to knowledge and worthy of publication
- Certification by the Program Director that all requirements have been fulfilled
- Submission of a dissertation to the library that adheres to the Doctor of Philosophy Board Dissertation Guidelines
- The program may determine the allowable time to complete degree requirements but in no case may that time exceed 9 years. Any approved leave of absence would not count toward the 9 years.

**Integrated M.D.-Ph.D. Program**

Candidates for the Ph.D. in Biomedical Engineering who wish to apply jointly for the M.D. degree must apply directly to the MSTP program (https://mdphd.johnshopkins.edu/) through the School of Medicine. Typically, MSTP students complete their PhD between their 2nd and 3rd medical school years, and in addition can do research during their 1st year summer. Good preparation in biology and chemistry as well as mathematics, engineering, and the physical sciences is essential. Life science graduate requirements are met by the first-year program of
the School of Medicine. This program is more arduous than the Ph.D. program alone, but it may have marked advantage for students interested in clinical research and applications in hospital systems and in the delivery of health care. The catalogue for the School of Medicine should be consulted for admissions requirements and procedures.

Information about applying to the combined M.D.-Ph.D. program can be found at the MSTP program (https://mdphd.johnshopkins.edu/admissions/) website, and applications are reviewed a separate MD-PhD Review Committee; a separate Graduate School application is not necessary, unless the student wishes to also be considered for the PhD program only. If offered admission by the MSTP program, students may choose to take part in the Biomedical Engineering PhD program, as long as they have sufficient background to succeed in the quantitative courses required by the program; matriculants and current MSTP students should schedule a meeting with the Program Director to discuss joining the program.