

BIOMEDICAL ENGINEERING, PHD THROUGH THE SCHOOL OF MEDICINE

The Department of Biomedical Engineering (BME) is uniquely positioned within the Johns Hopkins School of Medicine and the Whiting School of Engineering, giving students access to top clinicians, researchers, and engineers. 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 solve biomedical problems of fundamental importance. The Johns Hopkins University Biomedical Engineering Graduate Program is designed to train engineers to become leaders at the cutting edge of this field. Students are passionate about discovery and innovation that occurs across disciplinary boundaries.

The cornerstone of the Program is the belief in the importance of in-depth training of students in both life sciences and modern engineering. Upon completion of the Program, BME PhD graduates will be able to:

1. Demonstrate a deep understanding of core concepts in three key areas: Biology, Medicine, and Engineering (BME).
2. Conduct independent and original research.
3. Develop high standards for ethical and responsible conduct, scientific rigor, and reproducibility.
4. Develop advanced skills for communication and teamwork.
5. Participate in career awareness and career exploration opportunities.
6. Utilize high standards for leadership and citizenship to contribute to scientific discovery.
7. Advance the field of biomedical engineering.

In-depth training in life sciences is achieved in one of two ways. Many 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 and medicine alongside 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 with a strong background in the life sciences. In-depth training in engineering, mathematics, and computer science is achieved through elective courses that are taken during 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. As a result 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). Most students choose their research lab prior to matriculation, while a small number of 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 students are encouraged to attend various seminars to learn about cutting edge approaches across disciplines. To explore the current range of research by labs within the Biomedical Engineering department visit the website (<https://www.bme.jhu.edu/research/research-areas/>). In addition, many students work in labs in departments outside of Biomedical Engineering.

Program Directors

Program Director: Julia Massimelli Sewall, Ph.D.

Academic Program Co-Directors: Patrick Kanold, Ph.D. and Wojciech Zbijewski, 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 funded by 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.

Admission

Note: Up-to-date admissions requirements are maintained on the Biomedical Engineering website, and applications are submitted through the School of Medicine's application system.

The application deadline for the School of Medicine's 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, Immunoengineering, Neuroengineering, and Translational Cell and Tissue Engineering. Applicants need not fit into one of these areas, as much of the best research comes from interdisciplinary work. However, these focus 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. Thesis projects typically share a common theme which is the application of 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, and/or mathematics as well as sufficient experience in chemistry and biology.

The admission process is led by committees organized by the focus areas noted above. Applicants specify one or more areas in which they are most interested and describe their future research goals. Applications are reviewed holistically by faculty members within the specified focus areas, with emphasis placed on research experience, academic transcript, personal statement, letters of recommendation, and how well the candidate's goals and interests fit with those of the program. Faculty in each area rank the applicants in the initial selection round, interview the top ranked applicants, and then vote and provide their selected candidates to the BME program directors. The program directors then make a final determination in coordination with the faculty based on capacity and other university policy requirements.

Applications must be submitted online and completed 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/>): <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 of admission and accept the offer 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.
- **Faculty of Interest**—Applicants identify up to three faculty whose research programs align with their interests and future goals.
- **Personal Statement**—A personal statement (one page maximum) indicating the basis of the applicant's interest in graduate study and their career objectives. Applicants should discuss previous research and identify faculty members 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**—Required for international students only. The TOEFL requirement is waived for applicants who completed their degree at an institution where English is the primary language of instruction.
- **Application fee**—Information on requesting a fee waiver can be found on the School of Medicine website (<https://www.hopkinsmedicine.org/som/education-programs/graduate-programs/admissions/on-campus-programs/>): <https://www.hopkinsmedicine.org/som/education-programs/graduate-programs/admissions/on-campus-programs/> (<https://www.hopkinsmedicine.org/som/education-programs/graduate-programs/admissions/on-campus-programs/>)
- **GRE scores are optional.** Read more about our application requirements and GRE policy on our application page: <https://www.bme.jhu.edu/academics/graduate/phd-program/apply-to-the-phd-program> (<https://www.bme.jhu.edu/academics/graduate/phd-program/apply-to-the-phd-program/>)
- **Key Words**—Applicants provide key words that reflect their area(s) of research.
- **Academic Prerequisites:**
 - One year of college-level biology (may include quantitative biology or physiology)
 - One semester of organic chemistry (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 Ph.D. 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 equivalent) prior to matriculation. A Master's degree is not required for admission to our program.

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 invite selected 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 later 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 primarily makes direct-match offers. These offers are extended to applicants by one (or a few) specific faculty members and students who accept a direct-match offer typically join their research lab from day one. In select cases, the program may extend a limited number of rotation offers. Students who accept a rotation offer may rotate in their choice of labs during the first year and must select a thesis lab by the end of the spring semester. The only difference between these offer types is how the student chooses their thesis lab; all other aspects of the program are the same for all BME students.

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, medicine, engineering, mathematics, applied math, computer science, and/or other quantitative sciences. 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 math/sciences. A more detailed description of these requirements can be found on the BME PhD program website: <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 Doctoral Board Oral Examination within 2 years of matriculation (university-wide requirement)
- At least one year as a resident student at JHU (university-wide requirement)
- Annual thesis committee meetings
- Dissertation must be approved by at least two readers who must certify the results to be a significant contribution to knowledge in the field and worthy of publication

- Public dissertation presentation and defense
- Certification by the Program Directors that all requirements have been fulfilled
- Submission of the dissertation to the JHU 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. An approved leave of absence is not included in this time limit.

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 Medical Scientist Training Program (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 credit 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 a marked advantage for students interested in clinical research and applications in the delivery of health care and hospital systems. The catalogue for the School of Medicine should be consulted regarding admissions requirements and procedures. Information about applying to the combined M.D.-Ph.D. program can be found on the MSTP program website (<https://mdphd.johnshopkins.edu/admissions/>), and applications are reviewed by a separate M.D.-Ph.D. Review Committee. A separate application to the Biomedical Engineering PhD Program is not necessary unless the student wishes to be considered for admission only to the PhD program as well. If admitted to the MSTP program, students may choose to take part in the Biomedical Engineering PhD program as long as they have a sufficient level of background needed to succeed in the quantitative courses required by the program; matriculants and current MSTP students should schedule a meeting with the Program Directors to discuss joining the BME PhD program.