The Biomedical Engineering (BME) PhD Program Handbook

Welcome to the Biomedical Engineering PhD Program at JHU

Welcome to the PhD program in Biomedical Engineering at Johns Hopkins University! We are thrilled to have you join us on this exciting journey of research and discovery. As a PhD student, you will have the opportunity to delve deep into and make significant contributions to the advancement of biomedical engineering.

JHU launched one of the nation's first Biomedical Engineering (BME) PhD programs in 1961. The program was started within the School of Medicine, and our strong connection to clinical practice and translation continues to this day. Home to one of the longest continuously running NIH-supported training grants, and highly ranked for decades, the program has grown to become the largest doctoral program at JHU.

Because of the nature of our research, our location spans two campuses, Homewood and East Baltimore.

Homewood: School of Engineering   **East Baltimore: School of Medicine**

Our faculty members are recognized experts in different areas of the biomedical engineering field. You will have the chance to be part of and lead world-class, cutting-edge research with clinical collaborators. As a result, you will have access to cutting-edge resources and facilities that will allow you to conduct groundbreaking research and push the boundaries of your area of research. While here, you will build new tools, discover new knowledge, develop new diagnostics and treatments, and continue the program's long history of impact on biology and medicine. And from here, you will be ready to become a leader in academia, industry, government regulation, policy, or any other area of your interest.

Our program is designed to foster a sense of community and collaboration among our students. You will have the opportunity to interact with and learn from your supervisors, mentors, and peers, as well as participate in classes, seminars, retreats, and other activities that will enhance your academic and professional development. You will have the chance to take advanced and innovative classes in life science/medicine and engineering taught by world subject area experts. Our curriculum emphasizes hands-on instruction with emerging tools and techniques and gaining experience teaching and mentoring others.

JHU BME is a remarkable community of faculty, students, and staff; the members of our community are engaged, passionate, and supportive. We are committed to supporting our students throughout their PhD journey, and we are excited to see the contributions that you will make to the scientific community. We are confident that you will find the BME PhD program challenging, engaging, and rewarding.

With our best wishes,

Julia Massimelli Sewall, PhD, BME PhD Program Director

Rachel Karchin, PhD, Professor, BME PhD Academic Program Co-Director

Patrick Kanold PhD, Professor, BME PhD Academic Program Co-Director

1.0 Program Governance

1.1 Program leadership

Julia Massimelli Sewall, PhD
Senior Lecturer
Program Director

Patrick Kanold, PhD
Professor
Academic Program Co-Director

Rachel Karchin, PhD
Professor
Academic Program Co-Director

Joseph Greenstein, PhD
Lecturer
Program Associate Director

1.2 Program Administration

1.2.1 Program Directors

The program directors work as a team, but they each have some specializations and strengths:

The Program Director, Julia (pronounced "hoo – lyah" with a Spanish accent), provides oversight of the program. She serves the role of a primary resource person regarding rules, regulations, and procedures for graduate education. She advises students, oversees recruitment and admissions, services, support, and inclusivity, and manages pedagogical and curricular issues of the program. She also serves as the chair of the BME Curriculum Committee.

The Program Academic Co-Directors, Patrick and Rachel, provide leadership on the content and science curricula of the program. They provide advice in many areas, including on rules, regulations, recruitment and admission procedures, and pedagogical & curricular issues of the program. They advise students, appoint committee chairs, and oversee the BME training grants, program membership and rotation slots.

The Associate Director, Joe, focuses on enhancing the first-year experience by mentoring students in class selection and adherence to course requirements, doctoral board oral (DBO) exams, thesis committee choices, rotation choices, etc.

The program also has a steering committee, curriculum committee, and admissions committee. For more information about the role of these members in the governance of the program, please consult our BME PhD Policy file.

1.2.2 BME PhD Team

In addition to the Program Directors, academic coordinators, project leaders, and support staff participate in the day-to-day operations of the program. Our BME PhD team supports many aspects of the program, including admissions, orientations, matriculation, registration, forms, and much more.

1.3 Receiving support.

The following table outlines the generalities of contacts for different topics:

Who	How they can help	How to contact
Program Directors		
Dr. Julia Sewall	When you need advice in relation to rules, regulations, and procedures for BME PhD education. When you need someone to help you navigate questions about the program, need guidance on whom to go for what, or need signatures/approvals.	Julia.sewall@jhu.edu To set up a 1-1 meeting, please contact the Program Director.
CoDirectors • **Dr. Rachel Karchin** • **Dr. Patrick Kanold** • **Dr. Julia Sewall**	When you need advice with content/trajectory of the program or run into any issues with your course directors, research advisors, or mentors. For any questions related to rotations, program milestones or scientific training.	BMEPhDCoDirectors@jh.edu To meet with all directors, please email for Calendly link. 30 min meetings can typically be booked Fridays 11-12.
Associate Director		
Dr. Joseph Greenstein	When you need mentoring on class selection, Questions and approvals related to the DBO exam, Or you need overall help with thesis committee and rotation choices, etc.	jgreenst@jhu.edu
BME PhD Administration Team		
Kay Beard **Kristen Heisey** **Cathy Jancuk** **Dr. Kristen Swaney**	When you need help with or have questions about: • Your arrival to Hopkins • matriculation • forms/program paperwork • Payroll and fellowships • graduation paperwork.	BMEPhDTeam@lists.johnshopkins.edu
BMEAdminSupport	• reserving rooms. • parking vouchers, etc	BME-AdminSupport@jhu.edu
BMEPayMeBack	• Concur, • Reimbursements, etc	BMEPayMeBack@jhu.edu

2.0 Goals of the PhD Program in Biomedical Engineering (BME)

2.1 John Hopkins and Johns Hopkins University School of Medicine (JHUSOM)

The mission of John Hopkins University (JHU) is to educate its students and cultivate their capacity for lifelong learning, to foster independent and original research, and to bring the benefits of discovery to the world.[1]

The PhD in Biomedical Engineering is supported by the Johns Hopkins University School of Medicine (JHUSOM). The JHUSOM is committed to advancing biomedical education by creating an exemplary and collaborative learning environment for graduate students.

2.2 The Department of Biomedical Engineering

Within JHU, the BME PhD is hosted by the Department of Biomedical Engineering (BME), with Faculty both at the School of Medicine (SOM) and Whiting School of Engineering. The mission of BME is to advance human health by training biomedical engineers who will lead in Engineering the Future of Medicine through scientific discovery, translational research, and innovation that improves medicine and human health at scale.

2.3 The PhD in Biomedical Engineering

Advances in research often come at the interface between disciplines. In the BME PhD program, students gain a deep and broad grounding in three key areas: Biology, Medicine, and Engineering (BME). By being fluent in the languages of these three areas, students can conduct interdisciplinary research and lead interdisciplinary teams.

The objective of the BME program is to provide students with the breadth of knowledge, critical thinking, and technical and analytical research training that will prepare them for their own successful, independent careers at the interface of engineering and the biomedical sciences.

While in the program, students can engage in cutting-edge biomedical research of clinical relevance. Students work with research mentors that are leading (and in many cases creating) advanced research fields with real impact on patient health.

The program prepares students for post-graduation careers of their choice, including academia, industry, & governance. Our alumni have excelled in many fields, and our students can participate in external internships during the program.

The program also encourages students to consider the ethical and social implications of biomedical research.

Our graduate program is designed around a common program process with specific goals and personalized coursework. The program has been designed with specific learning goals and objectives, and students' progress is closely monitored.

2.3.1 BME PhD Learning Goals

Learning goal 1 (Years 1 & 2): Students will acquire literacy in medicine, engineering, and life sciences.

- **Objective 1:** They will be able to demonstrate knowledge of current literature and the state of the field in course exams, thesis proposals, and independently written paper drafts.

- **Objective 2:** They will gain the ability to critically assess biomedical engineering research and identify

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[1] https://www.jhu.edu/about/history/

gaps in the field. They will write a thesis proposal that outlines where novel contributions are needed. They will be able to read primary literature and identify open questions as participants in journal clubs and at conferences.

- **Objective 3:** They will be able to design research that closes gaps in knowledge or fills a critical need in their field. They will propose thesis research that addresses identified open questions. In addition, they will write fellowship proposals with coherent plans to address these questions.

    Learning goal 2 (Years 3-5): Students will learn to do rigorous research, using appropriate analytical and statistical methods, as well as designing experiments that lead to discernible outcomes.

- **Objective 4:** They will acquire technical skills to perform research. They will be able to conduct experiments in their field and acquire the data needed for those experiments.

- **Objective 5:** They will acquire analytical skills to perform research. They will be able to analyze data quantitatively and synthesize it into meaningful conclusions.

- **Objective 6:** They will learn how to design experiments with appropriate controls and sufficient statistical power.

    Learning goal 3 (Years 1-5): Students will learn how to be professional scientists.

- **Objective 7:** They will acquire communication skills to effectively work in a diverse professional team setting, respecting cultural sensitivities**.**

- **Objective 8:** They will learn professional presentation and writing skills through participation in conferences and publishing papers.

- **Objective 9:** They will develop the ability to lead a team professionally by setting goals and fostering team coherence. They will exhibit leadership in student team-based projects, and while mentoring undergraduates and junior PhD students in thesis lab.

- **Objective 10:** They will learn project management skills.

- **Objective 11:** They will learn how to integrate ethical thinking and behavior into the practice of science.

2.3.2 BME PhD Graduate profile

Based on the training goals outlined above, the expected profile of a BME graduate is as it follows:

1. Develop the capacity for lifelong learning, with equal access to gaining a deep understanding of the principles of biomedical engineering in three key areas: Biology, Medicine, and Engineering (BME).

2. Conduct independent and original research: Graduates have the academic skills to design, execute, communicate, and critique biomedical engineering research and identify gaps in the field to pursue their own creative ideas, demonstrating originality, critical thinking, and problem-solving skills.

3. Develop high standards for ethical and responsible conduct, scientific rigor, and reproducibility. Graduates are able to conduct ethical and rigorous research, using appropriate analytical and statistical methods, as well as design experiments that lead to discernible, reproducible outcomes. They can maintain high standards for rigor and reproducibility in all areas, from experimental design to critical review of published data.

4. Develop advanced skills for communication and teamwork. Graduates are able to communicate their

research findings to both specialists and broad audiences and cooperate in and lead diverse, international, and multidisciplinary teams, working closely with researchers, engineers, clinicians, and other health, academic, and industry professionals.

5. Contribute to scientific discovery: through the development of novel broad-impact approaches and techniques, and through the publication of high-impact research papers.

6. Advance the field of biomedical engineering. Graduates can identify unmet clinical needs, novel engineering challenges, and gaps of knowledge, as well as develop innovative solutions.

3.0 BME PhD Timeline and curriculum
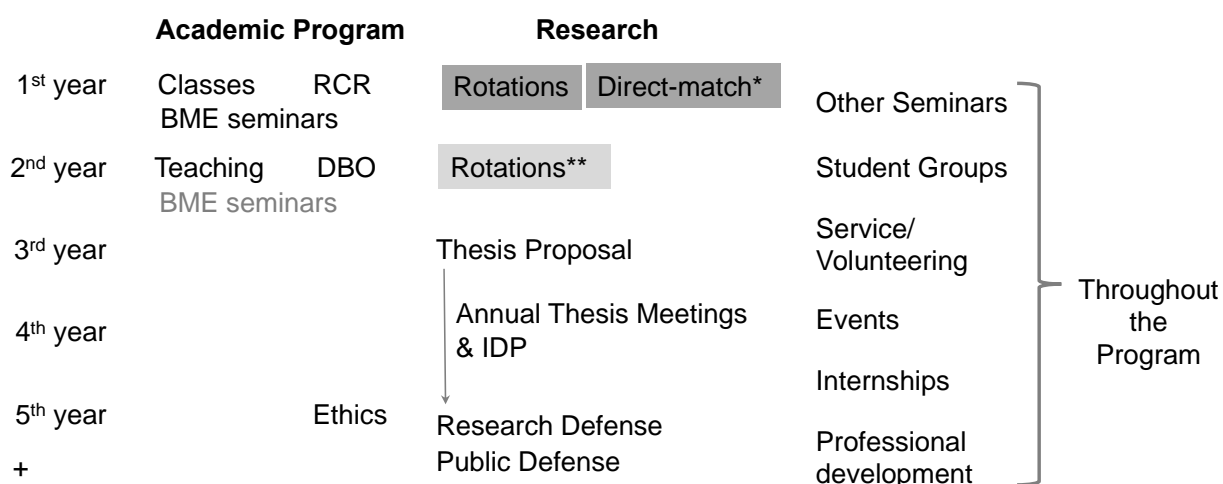
3.1 Overview

To achieve the goals outlined in section 2, the BME PhD program has been designed to include extensive classwork and independent laboratory research/training (rotations/direct match) in the first two years of the program to build a strong foundation and background knowledge required for biomedical engineering.

The BME PhD program has a focused set of standard course requirements, with few core course requirements but a very large course credit requirement (see section 4.4) that includes both life science and quantitative requirements.

To foster integration and exposure to different topics, you will be required to take two core courses in the first year: "Ethical Challenges in BME" and "Quantitative Methods in BME," which cover a great diversity of topics and introduce students to the diverse faculty in the department. In addition, you are required to attend BME seminars and take the Responsible Conduct of Research Training (**RCR**). Other than this fixed requirement, you can select the rest of your course curriculum based on your interest and the program's credit requirement (section 4.4).

The BME program laboratories offer training in diverse research fields ranging from cell and tissue engineering to imaging, neuroengineering, computational medicine, data science, and many other disciplines. In the first year, you will have the chance to do rotations or join your direct-matched lab (see section 4.5.2).

Within 24 months post-matriculation, you need to pass the Doctoral Board Oral exam (DBO), see section 4.9. After starting your thesis work in the second year, you can attend topical journal clubs and seminars in the lab's subfield but stay connected to the program via the attendance of seminars, workshops, regular program events, BME student organizations, peer mentoring, outreach, etc.

	Academic Program		Research		
1st year	Classes RCR BME seminars		Rotations	Direct-match*	Other Seminars
2nd year	Teaching DBO BME seminars		Rotations**		Student Groups
3rd year			Thesis Proposal		Service/ Volunteering
4th year			Annual Thesis Meetings & IDP		Events
					Internships
5th year +	Ethics		Research Defense Public Defense		Professional development

Throughout the Program

Direct match students might rotate amongst co-advisors.

** Because of the required extensive classwork in the first year, some rotation students rotate in only two laboratories during the first year. Therefore, a research rotation during the first semester of their second year is also allowed.

3.2 General Schedule

The tables below provide an outline of the general annual schedule.

Year 1 Fall Semester	Year 1 Spring Semester
Ethical Challenges in BME	Quantitative Methods in BME
Medical School/Life Science Courses/ Engineering Courses	
BME Seminars and RCR	
Rotation 1*/Direct Matched lab work	Rotation 2*/Direct Matched lab work
Career planning e.g.: Time Management Workshop; BME Edge; First-year student/faculty dinners	
Retreat; Departmental Seminars & Journal Clubs	
Advisory Meetings	IDP

Year 2 Fall Semester	Year 2 Spring Semester
Medical School/Life Science Courses/ Engineering Courses	
TAing	
BME Seminars	
Rotation 3 (if/as needed)	Thesis Research
Career planning e.g.: Time Management Workshop; BME Edge	
Departmental Seminars & Journal Clubs	

DBO

Coating ceremony

Advisory Meetings	IDP

Year 3+ Fall Semester	Year 3+ Spring Semester
Courses (if needed)	
Thesis Research	
BME Seminars (two semesters minimum)	
Career planning e.g.: Time Management Workshop; BME Edge	
Advisory Meetings	IDP

Description of each module in section 4.0.

Activities highlighted in grey are optional and at the discretion of the student.

Every student's journey is different, but the <u>typical timeline through the PhD program is</u>:

Year 1 Research Rotations (if any), Academic Courses, BME Seminars, Ethics/RCR, IDP

Year 2 Research, Teaching, DBO, Coating Ceremony, IDP

Year 3 Research, Thesis Proposal, IDP

Year 4 Research, Thesis Committee Meeting, IDP

Year 5 Research, Ethics/RCR, Internship, Thesis Committee Meeting, IDP

Year 6+ Research, Thesis Committee Meetings, IDP

4.0 Description of requirements

4.1 BME Core-courses

Incoming BME students take two core courses in their first year that expose them to the breadth of issues they will face, quantitative methods that are used, as well as a large fraction of department faculty:

- Ethical Challenges in BME course. This course is designed to provide students with the breadth of issues that they will confront in their future interdisciplinary careers. It exposes students to a very diverse range of topics ranging from immunology, AI, bioinformatics, and neural implants to cancer therapies. Moreover, this course is team-taught thus students get exposed to a range of faculty to facilitate matches for laboratory rotations. This course is designed to expose you to community building/ communication strategies and to explore gray areas in science that are not covered by RCR.

- Quantitative Methods in BME course. This course introduces students to the diverse quantitative approaches that are used to tackle BME research and design questions. It allows students to identify areas of interest by exposing them to quantitative methods that they had not been exposed to and to identify non-intuitive connections between seemingly disparate areas of BME. The topics range from methods used in bioinformatics, neuroengineering, immunoengineering, imaging, and cell and tissue engineering.

4.2 BME Seminars

The BME department hosts a weekly seminar series during the semesters. You are required to take a minimum of two semesters of BME seminars, typically in the first year, which provide a great way to survey different areas of research, as well as build an appreciation for the breadth and interdisciplinarity of Biomedical Engineering as a field. In addition to BME seminars, there are also many other excellent seminar series hosted by other departments, centers, and institutes at JHU that are available to you.

4.3 Ethics and the Responsible Conduct of Research (RCR)

In the first year, you are required to take training in Ethics and the Responsible Conduct of Research. Depending on your campus, you can register for a course to fulfill this requirement. For details, check the BME PhD policy file. We also host Ethics and RCR discussions at the BME PhD student-faculty retreat each year. An RCR refresher is also taken in year 5.

4.4 BME Life Sciences/Medicine and Quantitative course requirement

As a BME PhD student at JHU, you must take at least 30 credits of relevant coursework, a minimum of **12 credit hours** of coursework in the **life sciences/medicine**, and at least **12 credits of coursework in mathematics or engineering** (quantitative requirement). Ethics courses, seminar courses, and independent study courses do not count toward this 30-credit requirement. Courses that do not qualify as either life science or quantitative courses may be taken but do not count toward this 30-credit requirement.

Why we require courses: One goal of this training program is to help you become trilingual; fluent in biology, medicine, and engineering. Solving medical problems needs interdisciplinary approaches. Taking courses across these different disciplines will give you the ability to collaborate with and lead multidisciplinary teams. For policies on credit transfer, consult the BME PhD Policy document.

Many students fulfill their life science requirements in the first year by taking courses in the School of Medicine and then fulfill their engineering requirements in the second year by taking courses from the School of Engineering.

4.4.1 BME Life Sciences/Medicine course requirement

You are required to take at least 12 credits of graduate coursework in the life sciences/medicine area. The requirement may be met by taking medical school courses, life science, or a combination of these.

Medical School Courses

You may elect to take one or more courses of the first-year Medical School Basic Sciences Curriculum side-by-side with medical students.

For example, you could take:

Curriculum	Course name	Offering
Human Anatomy		Aug–Oct
Scientific Foundations of Medicine (SFM)	**SFM-Macromolecules** **SFM-Cell Physiology** **SFM-Genetics** **SFM-Metabolism**	Oct–Nov
	SFM-Pharmacology	Nov–Dec
	SFM-Histology/Pathology	Nov–Dec
Organ Systems Foundations of Medicine (OSFM) (formerly known as Genes to Society).	**OSFM-Immunology**	Jan
	OSFM-Infectious Disease and Microbiology	Jan –Feb
	OSFM-Nervous System & Special Senses (NSSS) **Block 1 (Neuroanatomy)** Apr **Block 2 (General Sensory & Motor)** Apr– May **Block 3 (Special Sensory & Motor)** May	Apr–May
	OSFM-Brain/Mind/Behavior (BMB)	Apr– May

* More detail on assignment of credit hours: Federal law and Johns Hopkins policy have established guidelines for the assignment of credit hours. For reference, at JHU a typical one-semester (16 wks, but 13 wks of class instruction) course that meets for four class hours each week and includes eight hours out of class work (study, homework, projects) is a four-credit course.

Immunology is the most popular of these classes among those interested in molecular, cellular, and tissue engineering (and Immunoengineering), whether they are experimentally or computationally oriented. Anatomy is also popular, for students interested in biomedical imaging (it includes human cadaver dissection and different imaging modalities). Pharmacology, macromolecules, metabolism, and genetics are popular, and some Neuroengineering students take some or all the Neuro and BMB classes (though many prefer to take the Neurocognition I & II classes offered by the Neuroscience department).

Each year we have an information session early in the summer about the requirements and challenges of the Med School courses. If you are interested in these please attend to learn about what it takes to succeed in these courses. Moreover, because of the limited availability of slots in some of these courses, before registering, all BME students must submit their interest and motivation to take medical courses to the BME PhD team. Based on this, students are chosen based on their academic background, research interest, and a lottery.

Schedule and Grading policies can be found in the BME Ph.D Policy document.

Life Science Courses

To fulfill the life sciences/medicine requirement many students prefer to take life science classes. You can do this at the Schools of Medicine, Public Health, Arts and Sciences, and Engineering. You can find these courses in the course catalog, including quantitative biology courses.

For instance, you could meet the life sciences requirement by taking graduate-level courses in the School of Medicine Biochemistry, Cellular, and Molecular Biology (BCMB) or Neuroscience program. These courses can be taken alongside PhD students in those programs.

JHU offers an extensive range of educational options in life sciences, making *it the leading life sciences discovery institution in the world*. Although we can't list all the options, we encourage you to explore the links above. You can take the popular courses listed below and many other interesting and challenging courses to meet your requirements. Many graduate courses offered within the BME department qualify for life science credit. If you need guidance, you can contact the Associate Director. Your advisor can also recommend elective courses that are particularly relevant to your research and training areas. Ultimately, the decision on what courses to take is yours. More detailed information about courses can be found on our BME PhD Dashboard: https://jhu.instructure.com/courses/57122/pages/academic-courses.

Popular courses in Life Sciences/ Quantitative Biology
520.610 Computational Functional Genomics
540.409 Modeling Dynamics and Control for Chemical and Biological Systems
580.460 Theory of Cancer
580.625 Structure and Function of Auditory and Vestibular Systems
580.630 Theoretical Neuroscience
580.631 Introduction to Computational Medicine: Imaging
580.633 Introduction to Computational Medicine: The Physiome
580.635 Applied Bioelectrical Engineering
520.636 Feedback Control in Biological Signaling Pathways
580.639 Models of Neuron
580.640 Systems Pharmacology and Personalized Medicine
580.641 Cellular Engineering
580.642 Tissue Engineering
580.680 Precision Care Medicine
580.683 Annotate a Genome
580.646 Molecular Immunoengineering
580.418 Principles of Pulmonary Physiology
580.643 Advanced Orthopaedic Tissue Engineering
580.444 Biomedical Applications of Glycobiology
580.632 Principles of Genomic Systems Engineering and Synthetic Biology
580.742 Neural Implants and Interfaces
601.647 Computational Genomics: Sequences
601.649 Computational Genomics: Applied Comparative Genomics

Credit and Grading policies can be found in the BME PhD Policy document.

4.4.2 Quantitative course requirement

You are required to take at least 12 credits of coursework in math, applied math, engineering, computer science, and/or quantitative biology. These courses must be at the 400 level or higher, with at least 6 credits at the 600/700 level. Of these 6 credits, at least 3 must come from courses with substantial theory content in engineering, mathematics, or computer science. The full course catalog is here: https://courses.jhu.edu/.

Here's just a selection of relevant electives offered by BME faculty members; there are many more, and there are many relevant courses taught outside our department. Please see the BME PhD Dashboard for more information: https://jhu.instructure.com/courses/57122/pages/academic-courses.

Popular courses	
Math/Applied Math	**Engineering Theory Electives**
110.405 Analysis	520.447 Introduction to Information Theory and Coding
110.607 Complex Variables	520.601 Introduction to Linear Dynamical Systems
553.391 Dynamical Systems	520.621 Nonlinear System Theory
553.426 Introduction to Stochastic Processes	520.651 Random Signals
553.430 Introduction to Statistics	530.659 Applied Analysis for Engineers and Scientists
553.437 Statistics Information and Vision	530.661 Applied Mathematics for Engineering
553.471 Combinatorial Analysis	530.730 Finite Element Methods
553.491 Applied Analysis for Engineers and Scientists	530.761 Mathematical Methods of Engineering I
553.620 Probability Theory I	530.762 Mathematical Methods of Engineering II
553.621 Probability Theory II	530.766 Introduction to Numerical Methods
553.626 Stochastic Processes	540.651 Advanced Transport Phenomena
553.630 Statistical Theory	580.692 Learning Theory
553.631 Statistical Inference	580.462 Representations of Choice
553.632 Multivariate Statistical Inference	580.668 The Art of Data Science
553.672 Graph Theory	580.693 Imaging Instrumentation
553.692 Matrix Analysis and Linear Algebra	580.788 Biomedical Photonics II
553.723 Markov Chains	
580.697 Biomedical Data Design I	
580.698 Biomedical Data Design II	

As mentioned above, the program director/s, Associate Director or Faculty mentors can advise you on specific electives of particular importance to each of the research and training areas. Ultimately, it is your decision what courses to take.

Grading policies can be found in the BME PhD Policy document.

4.4.3 Courses for JHU MD/PhD Students

JHU MD/PhD students enter the BME PhD Program after completing their 2nd year of JHU medical school. The medical school curriculum satisfies their life sciences requirement. Therefore, MD/PhD students spend spent their 1st year in the BME Program taking quantitative (mathematics, engineering) courses and taking part in laboratory rotations. Once they complete 12 credits of quantitative courses (typically by the end of 1st year in the program), the MD/PhD students will have completed the course requirements for the BME PhD Program. More information about MD/PhD students is in section 5.5. Please note that external MD/PhD programs (at other institutions) and students who have completed part or all an MD degree program outside of JHU do not qualify for this exception.

4.4.4 Frequently Asked Questions about course requirements

The procedures and policies for course registration, credit acquisition, and credit transfer are outlined in the BME PhD policy document.

Is there a complete list of courses satisfying the biology or engineering requirements? In brief, no. We have tried to do this in the past, but in truth, keeping up with new classes every year means that any list of what counts quickly becomes out of date and unnecessarily discourages students from taking new

and interesting classes. In addition, the definitions in each category are very broad and encompass a lot of classes. If the class obviously falls into one of the above categories it should count and be listed here. If questions remain ask the Associate Director or the BMEPhDTeam. Note that there are many quantitative biology classes – a particular strength at JHU – that you can count in either the engineering or life sciences categories.

Do seminar classes count? No. Seminar and independent study classes generally do not count toward these requirements.

Can I take classes anywhere at JHU? In general, yes, though there are a few exceptions that carry an extra charge, including the Krieger School of Arts & Sciences AAP classes, and Peabody Conservatory music classes. Please check! Any classes offered by the Whiting School of Engineering, the School of Medicine, or the Bloomberg School of Public Health during the Fall and Spring semesters should be available to you at no cost. Note that courses offered by the JHU Engineering for Professionals (EP) program can be taken but are generally not accepted for credit toward graduation.

What counts for the 'substantial theory' class requirement? As noted above, at least three credits should be in engineering, mathematics, or computer science classes that have a substantial theory component. As a guide, any class with a significant amount of coding or math counts for this, including biostatistics classes, mathematical or computational modeling classes, computational genomics classes, data science classes, and many more including classes in dynamical systems, numerical methods, mathematical foundations of imaging, transport phenomena, and signal processing. Most students satisfy this requirement many times over. If in doubt, check here, and if questions remain ask the Associate Director or the BMEPhDTeam.

4.5 Direct match or laboratory rotations

One of the major goals of the BME training is that you will learn to identify gaps in current knowledge and do rigorous research. The Program emphasizes research education, and every attempt is made to help you focus on your dissertation project as early as possible. Whether joining a lab directly from day one as a direct-match student or choosing a lab following research rotations as a rotation student, all other opportunities and requirements of the program are the same.

4.5.1 Rotation

We have a limited number of places on NIH-funded training grants (see section 5.2.1) that enable students to rotate through different laboratories in their first (and, if needed, second) year/s. The aim of lab rotations is to help you identify a suitable mentor and lab for thesis research. It also enables you to learn new techniques and approaches.

You can rotate with any BME faculty and JHU faculty outside BME who are accepting students. Most students declare a thesis lab within the first year from the date of their matriculation. On rare occasions, despite reasonable efforts by the student, a match might not be found by the end of their first 12 months in the program. This is especially true for students taking medical school courses in the first semester. In that case, one additional semester (in year two) is allowed. As a result, some students might settle on their thesis lab by the end of the second year.

4.5.2 Direct-Match

Some students are admitted to the program as a direct match, and hence, join specific research labs from day one of the program. These offers are often sponsored by at least two labs and might offer the student a choice of a small number of labs in which to potentially rotate, giving the student a more focused exposure to the BME community. More information is in Section 5.0.

4.6 BME Annual Retreat

The Program convenes an annual retreat in the Spring of each year. This retreat is mandatory for all 1st year students and is organized by the 2nd year students. The intent is to build community and to focus on integrating ethics into scientific practice Therefore, this retreat includes teaching responsible conduct of research, and issues that students deem important for discussion. The retreat is typically held at a remote conference center. A critical part of this retreat is 1.5 hours of discussion led by senior students on responsible conduct of research. The junior students are divided into teams of 4-5 students with one faculty member and present case studies on authorship, plagiarism, data integrity, and other elements of responsible conduct of research. In addition to this, senior students present their research in informal talks and poster sessions, and faculty present talks on philosophical and practical issues related to research and education. This annual event also reinforces to the students that professionalism, RCR, and ethics are not a "one-time- only" course to be passed, but a significant part of their training to be carried throughout their future careers. These sessions involve students at all stages of their training; first-year students are required to attend, and typically second-year students and above attend at least two additional retreats during their tenure. When possible, outside experts have also been invited, including institutional officers specializing in RCR.

4.7 Progress Report

To ensure the BME PhD and The School of Medicine (SOM) have access to current information about your progress, here is what you need to do:

1. In the first year, complete Rotation and Direct match reports.

To submit Lab rotation or Direct match year 1 **reports** (for students matriculated on or after 2022) check here.

2. Annually, complete the _BME PhD Survey_.

When the 2023-2024 survey opens, you will be notified. This includes information about courses you have taken and other required program milestones.

3. Within the first 24 months in the program, pass the DBO.

For more information about the DBO check here.

4. Annually, complete IDPs.

For more information about IDP check here.

5. Annually, Complete the School of Medicine (SOM) Advancement Checklist.

The school of medicine sends an "Advancement Checklist" shared with you through New Innovations

Links to an external site.. All BME students are required to complete this information.

Why complete this? This checklist provides an opportunity for you to save information on activities you engaged in during the previous year(s) at Hopkins. You can access the information you enter at any time (e.g. if you wish to update it or use it for your CV in the future). It also allows your graduate program to see how you are doing and collect other information as needed (e.g., your lab location).

How to do it? For instructions check this file

6. Once you chose a thesis lab, have annual or semi-annual thesis committee meetings

For more information check this page.

4.8 Individual Development Plans (IDPs)

Once you have committed to a research lab, you and your advisor should schedule an annual formal meeting to discuss the IDP. In preparation for this meeting, you must complete an Individual Development Plan, on your own. Then ask your faculty member to review and comment on it. After this initial round, organize a meeting to review and discuss the completed form and to discuss any key issues arising from it. The conversation should include professional and career development plans, using the written IDP document as a guide. More about IDPs in section 8.1 later in this document.

4.9 The DBO Qualifying Examination

Our program does not have a written qualifier exam but instead has an oral Doctoral Board Oral (DBO) Exam administered by five faculty. These five faculty members are specific for each student and most commonly are selected from among faculty instructors of courses that the student has taken. Although examiners are usually chosen from faculty who have taught the courses you might have taken, and questions often derive from coursework, there are no restrictions on the material which may be reviewed in the examination. Indeed, material you have previously learned, for instance as part of a bachelor's or master's degree, or material related to your line of research may also be covered.

The purpose of the examination is to

1) *Assess the depth and breadth of the student's knowledge in life sciences, engineering, and mathematics.*

2) *To test whether a student is ready to embark on independent thesis research work.*

3) *To test the ability of the student to elaborate an answer in real-time based on their reasoning and scientific knowledge.*

Why it's required: This is one of three university requirements for the PhD (the others are dissertation & residence).

When it takes place: The DBO can take place at any time of year you choose. It is typically scheduled once coursework is complete, which could be as soon as the end of 1st year for some students. *The DBO exam must be completed by 24 months into the program.* Please see the School of Medicine Graduate Biomedical Education Guidelines.

As you take classes, consider which faculty members may be good examiners. Ask potential examiners if they are willing in principle to participate on your DBO committee. It takes about a month to prepare for this exam. Make sure to assemble a mock committee and run practice sessions.

Steps and Tips on how to handle DBO scheduling are provided here: How to Schedule the DBO Exam.

More details about the DBO committee, scheduling, and possible outcomes are in the BME PhD policy document.

4.10 The Coating Ceremony

Johns Hopkins School of Medicine hosts a ceremony that celebrates graduate students embarking on thesis research. The Coating Ceremony typically takes place in the fall, and you will take part after they pass the Doctoral Board Oral (DBO) exam. You will receive an embroidered white lab coat – presented by their program directors – and jointly recite the Graduate Student oath. Here's a video that follows Amanda Edwards, a BME PhD student who took part in the ceremony in 2015.

4.11 Annual Thesis Committee Meetings

After passing your DBO exam, it will be time to set up your thesis committee and have annual meetings with them. The First thesis committee meetings typically happen in the fall of the third year (and regularly at that same time each subsequent year).

You will work together with your thesis advisor to select a committee composed of faculty members who are experts in your research projects along with a preceptor. The minimum size of the committee is three, but it can be larger if this best suits your needs.

There are three annual Thesis committee meetings that constitute major milestones in the program:

• Thesis Proposal

• Research Defense

• Public Defense

For the first meeting, you must write a thesis proposal (revised following the oral exam) and present it to the thesis committee one week in advance of the meeting. This serves as a professional development activity in the first committee meeting.

For subsequent meetings, you will prepare a brief written report on your research progress each year which must be distributed to the committee before the meeting. At the actual meeting, you will describe research results and obstacles, progress toward professional development goals, lab practices in data management, along with the action plan from their IDP/mentoring meeting (see above).

The members of the committee are tasked with providing you with critical feedback on the progress and direction of your thesis research, and the rigor of the scientific approach. They also provide guidance on directions to follow.

The committee's goals are to test your understanding and training in

(a) data management

(b) rigor and reproducibility

They also share their specific suggestions and/or concerns.

As a bonus, the committee also discusses your professional development outside of your thesis work and your progress toward future goals.

When you are nearing completion of your research, the thesis committee documents that you have reached your "final phase" on the thesis meeting form. The committee identifies the final, critical work necessary for the completion of your PhD thesis or gives "permission to write" approval for you to draft the thesis (must be complete in 6 months).

Your advisor and at least one other member of the thesis committee will read the completed written thesis. After this, you present a formal public seminar on your thesis research, attended by faculty members, postdoctoral fellows, and trainees in the program. This is a public defense and marks the end of the program!

4.11.1 Thesis Committee Composition

The Committee consists of at least three faculty members (including the research mentor) but can have more if you wish. We highly recommend that the committee be made up of greater than three members in case unforeseen circumstances arise (e.g., at the defense) to ensure that at least three members are present.

For policies on the thesis committee composition, please check the BME PhD policy document.

4.11.2 Thesis Proposal

You will start the process of writing the first draft of your proposal before you schedule your first thesis committee meeting, assisted by proposal workshops. You are required to send the thesis proposal to your thesis committee members before the first Thesis Committee meeting. The Thesis Proposal meeting should take place no later than the end of year 3. You will give an oral presentation of the Thesis Proposal open to the Hopkins community, and lab members and other students are encouraged to attend. After the presentation and a brief period of questions from the public, you will have a closed-door discussion with your committee. The committee discusses the proposal with you and can accept or reject it.

Details on the proposal format and first thesis committee meeting policies can be found in the BME PhD policy document.

4.11.3 Research Defense (aka the 'Permission-To-Write' meeting).

In your second to last meeting with your Thesis Committee, when they think you have conducted research that is appropriate and sufficient to provide the basis for a dissertation, you will receive permission to write. This is an advanced stage when you will have a draft thesis and might even have manuscripts accepted for publication. In this meeting, you will give an oral presentation and answer detailed technical questions on their methodologies, data, and conclusions, as well as contextual questions on the innovation and impact of your work. If all members are satisfied, the Committee will give you permission to draft your Dissertation.

4.11.4 The Dissertation (aka 'The Thesis').

Once you receive permission to write, you will dedicate the next month to writing your dissertation, prepared in consultation with your thesis advisor.

Once you are done writing, you will submit the Dissertation to the Thesis Advisory Committee in complete form with all figures embedded, as a final document. The document is typically sent to the committee at least two weeks before The Dissertation Defense.

The School of Medicine Commencement is only held in May. So, to 'walk' and be 'hooded' in May, we have strict deadlines for dissertation defense and forms, outlined in the BME PhD policy document. However, you can complete your requirements for graduation at any time, and once the requirements have been met the Registrar's Office can issue a letter attesting to this fact. That letter is sufficient to allow you to begin postdoctoral fellowships, employment, residencies, etc.

Details on the dissertation format and timeline policies for PhD and MD/PhD students can be found in the BME PhD policy document.

4.11.5 The Public Dissertation Defense

This is your final oral presentation (and last thesis committee meeting) of the PhD program. It is an open and public meeting, and often students will invite their family members, friends, and the broader JHU BME community to join. Because of the audience, it is common for the oral presentation to be more universally accessible than that for the Research Defense, but you are still expected to present both a summary of all your work and a more detailed description of a portion of your work (not everything can fit into a 45-minute presentation!)

Overall, the typical breakdown of thesis committee meetings includes:

Thesis committee Meeting	Discussion topic
First or second meeting	Discussion of Proposal
Meetings 2-4	Written report and research progress presentation
4th meeting	Written report and research progress presentation. A written plan for thesis completion and future career goals.
Second to last meeting	Research defense, permission to write
Last meeting	Public defense

4.12 Teaching requirement

Teaching experience plays an important role in consolidating knowledge and promoting professional values, even for those students who do not enter academic fields. A key feature in the BME Program is that we allow the students to design and teach their own courses during the intersession period. To satisfy the teaching requirements, you can choose from the following two options:

1) devote a total of one semester as a teaching assistant (TAs) in courses offered by the faculty, or

2) Creating a new course. Students may choose to create and teach a new course or teach a previously offered course during the University Intersession or during the summer. If the student chooses to do this in lieu of their TA-ship, it must be approved by the Program Directors

For more information, check our BME PhD rules file.

Why it's required: Learning how to teach is a hugely beneficial component of training, and not just for those students who might want to teach in the future: (1) you'll understand the material better if you teach it; (2) you'll better understand how people learn and how to communicate complex concepts to others of different backgrounds and levels of understanding.

Timing. The teaching requirement can be fulfilled at any time; it is commonly completed in years 2 or 3 of the program.

Teaching Academy. CTEI also offers a [Teaching Academy](#) through which you can use your teaching experience as part of a series of steps to earn a teaching certificate. Many of our students have taken advantage of this.

5.0 Admission to the PhD program

Prospective students can apply to the program through the School of Medicine, with a deadline of December 1st each year. Applications are reviewed, through a holistic process, by faculty in different areas of research. Admission offers are made to join our program before the Spring. Prospective students interested in our program are encouraged to reach out to program faculty whose research they are interested in and to contact the student-created and student-run Application Assistance Program (BMEAAP).

The BME admissions committee is led by the Directors and the subgroup leaders:

Subgroup leaders are subject to change each cycle.

Group name	Focus area	Core BME Faculty in this area
CTE	• **Immunoengineering** Including areas such as: *Biomimetic Materials; Regenerative Immunology and Aging; Immuno-Oncology; Host Defense; Systems Immunology and Computational Immunoengineering; Molecular Engineering; Synthetic Biology.* •**Translational Cell & Tissue Engineering focus areas.** Including areas such as: *Molecular and Cellular Biotechnologies; Instructive Materials; Cellular Therapeutics; Biomanufacturing; Computational Regenerative Engineering; Systems Biology*	Scott Wilson Joshua Doloff Jennifer Elisseeff Jordan Green Rachel Karchin Feilim Mac Gabhann Jude Phillip Aleksander Popel Jamie Spangler Kevin Yarema Eun Hyun Ahn Patrick Cahan Warren Grayson Reza Kalhor Deok-Ho Kim
CompBio	• **Computational Medicine** Including areas such as: *Computational Molecular Medicine; Computational Physiological Medicine; Computational Anatomical Medicine; Computational Healthcare.* •**Genomics and Systems Biology** Including areas such as: *Genome Assembly; Transcriptomics and RNA Sequencing; Personal Genomics and Data Modeling; Genomic and Epigenomic Engineering; Nanopore Sequencing; Engineering Cell Fate; Synthetic Biology*	Winston Timp Joel Bader Michael Beer Adam Charles Rama Chellappa Jean Fan Joseph Greenstein Alison Hill Rachel Karchin Feilim Mac Gabhann Michael Miller Casey Overby Taylor Aleksander Popel Sridevi Sarma Natalia Trayanova Joshua Vogelstein Raimond Winslow Eun Hyun Ahn Joel Bader Alexis Battle Patrick Cahan Andrew Feinberg Taekjip Ha Reza Kalhor Justus Kebschull Deok-Ho Kim Mihaela Pertea Steven Salzberg Jamie Spangler Kevin Yarema

Imaging	**Imaging and medical devices** Including areas such as: *Advanced Biophotonics; Image Analysis and Registration; Imaging Algorithms; Novel Imaging Systems; Image-Guided Interventions*	Wojciech Zbijewski Soumyadipta Acharya Adam Charles Rama Chellappa Nicholas Durr Taekjip Ha Deok-Ho Kim Scot Kuo Xingde Li Michael Miller Jeffrey Siewerdsen J. Webster Stayman Nitish Thakor Joshua Vogelstein Youseph Yazdi Ji Yi
Biomedical Data Science	**Biomedical Data Science** Including areas such as: *Computational Science; Machine Learning and Data Science; Biomedical Data; Science as a Service; Biomedical Clouds*	Adam Charles Joel Bader Michael Beer Rama Chellappa Nicholas Durr Jean Fan Joseph Greenstein Alison Hill Rachel Karchin Justus Kebschull Michael Miller Casey Overby Taylor Jude Phillip Steven Salzberg Sridevi Sarma Jeffrey Siewerdsen Jeremias Sulam Winston Timp Natalia Trayanova René Vidal Joshua Vogelstein Raimond Winslow
Neuro	**Neuroengineering** Including areas such as: *NeuroExperiments; NeuroTech; NeuroData; NeuroDiscovery; NeuroHealth.*	Kathleen Cullen Nitish Thakor Adam Charles Vikram Chib Patrick Kanold Justus Kebschull Deok-Ho Kim Xingde Li Michael Miller Sridevi Sarma Reza Shadmehr Joshua Vogelstein Xiaoqin Wang Ji Yi Kechen Zhang
VTSI*	The Vivien Thomas Scholars Initiative (VTSI) is focused on addressing historic underrepresentation in STEM.	All.

*VTSI has its own admissions process separate from the program's admissions process. They rely on feedback from the departments at a few stages, then confirm whether the programs will accept/deny their final candidates before making VTSI offers. Their timeline is usually earlier than ours, so one challenge is having feedback on VTSI decisions by their deadlines.

5.1 Rotation offers.

The BME PhD program and some groups have made an extra effort to secure NIH-funded training grants that provide funding for laboratory rotations, as discussed in section 4.5.1. Because these are federally funded grants, most rotation offers are targeted to permanent residents and citizens of the U.S.A.

Though there might be a couple of exceptions in the slots available. Rotation admitted students can rotate with any BME faculty and JHU faculty outside BME who are accepting students. Typically, students do 1-3 rotations before settling into their thesis lab by the end of their first year (i.e., by the first anniversary of their matriculation).

Training Program for Hearing and Balance

The Training Program in Hearing and Balance provides research training to pre-doctoral and postdoctoral students in the Center for Hearing and Balance. Focus areas include neurophysiology, human and animal behavior, theoretical and computational biology, neuroanatomy, molecular physiology, and cellular physiology minorities.

Biomedical Engineering Training Program

With eight slots available for pre-doctoral training, the Biomedical Engineering Training Grant Program offers selected students educational funding for the rigorous demands of the Johns Hopkins biomedical engineering graduate program. The cornerstone of the BME program is the in-depth training of students in life sciences, modern engineering, mathematics, and computer science, and in the conduct of original research leading to the doctoral dissertation.

Training Program in Neuroengineering

The NeuroEngineering Training Initiative at Johns Hopkins seeks to balance engineering, mathematics, and computer science with molecular, cellular, and systems neuroscience. The program leverages educational and research resources of both the engineering and medical schools.

5.2 Direct match offers

As explained in section 4.5.2, direct-matched students join a specific research lab from day one of the program. These offers are often sponsored by at least two labs so students can increase exposure to the BME community by rotating in the two co-sponsoring labs.

5.3 Understanding the difference between rotation and direct match offers.

The student-faculty advisor match is critical to success in a doctoral program. In addition to common research interests, a good match considers such factors as workstyle, personality, and lab culture.

By having two funding sources, mentor funding, and training grants, we have more slots to admit students! Moreover, having these options allows us to consider all views. To place students in these admissions slots, we look at applications to our program quite holistically. Some students indicate very niche research focus or potential faculty interests from the get-go. Other applicants have broader scientific interests and might be interested in more than one research emphasis. We strongly believe that both strategies have a place in our program. After all, you are coming to us to receive training in a very interdisciplinary research area.

Do not worry about "missing out" if you do not get to do rotations. Some matched students might be able to rotate between the co-sponsoring labs. And you will interact with your thesis mentor much earlier. Now, if you are doing rotations, you might not interact with your thesis mentor in the first year, but you can explore labs and take the time to find a match. Both options have strong benefits.

Overall, these admissions scenarios differ only on the funding source, and the timeline for picking a thesis advisor. However, they both offer exposure to the BME community either by broad rotations or rotating in co-funding labs, hence these offers, from the perspective of PhD training, are equal. Any other aspect of the degree, from courses to thesis work is the same.

5.4 Stipend and health insurance

The 2023-2024 stipend to PhD students is $37,600.; the stipend is set by the School of Medicine and typically increases 2% per year each July 1. Individual health, dental, and vision insurance (current year ~$4,130 for new students or ~$4,520 for continuing students) is covered by the program or by the research faculty mentor. BME PhD students pay no tuition to the school. Details on the health insurance benefits are maintained and updated by the School of Medicine – see this link for more, and some additional information here; partners and children can be covered but at additional cost to the student. Please direct all benefits questions (including those related to health and dental) to sombenefits@jhmi.edu.

5.5 Need-based Relocation Grants for Incoming PhD Students

Johns Hopkins University (JHU) is committed to ensuring the holistic well-being of each student. Part of a student's well-being is intimately connected with their fiscal stability. As such, the university will assist incoming PhD students who demonstrate significant financial need through a $1500 relocation grant. Specifically, we will provide funding to students who, without this money, may otherwise not be able to afford to relocate to JHU for their PhD program. For more information, check this website: https://provost.jhu.edu/need-based-relocation-grants-for-incoming-phd-students/

5.6 International students

Approximately a third of our students are from overseas (one of the current Program Co-Directors was such a student himself many years ago!). We can provide letters supporting international students for visas and other important pre-immigration and post-immigration purposes. While we cannot provide specific advice on immigration, JHU has an excellent Office of International Services (OIS) that can provide both general and specific guidance, and that handles all visa and immigration needs. Be sure to be in contact with OIS early and often when planning to come to JHU.

5.7 MD/PhD students

Students interested in the combined MD-PhD program do not apply directly to the BME PhD program, but rather to the MSTP (Medical Scientist Training Program) administered by the School of Medicine. Information about applying can be found at the Johns Hopkins Medical Scientist Training Program/MD-PhD Program website.

Applications submitted for consideration of the combined degree will be reviewed by the MD-PhD Program Admissions Committee. Each application is given a holistic review by the MD-PhD Program Admissions Committee. Any MD-PhD application with an interest in the BME graduate program that is selected for an interview is sent to the BME PhD Program for review to make sure the candidate is competitive for the BME graduate program, and typically one of the interested student's interviews for the MD-PhD program will be with a faculty member in the Department of Biomedical Engineering, specifically one who shares the applicant's research interest.

M.D./PhD Program Director: Dr. Andrea Cox
Administrative Director: Sharon Welling

BME PhD requirements for MD/PhD students are outlined in the BME PhD policy document.

6.0 Your research

6.1 Research at BME and JHU

Without doubt, one of the main reasons students come to Hopkins for their PhD is the outstanding array and depth of research opportunities. There are many ways to become acquainted with these opportunities – you should check out the websites of research groups, read some of their published work, and above all reach out and talk to potential mentors in whom you are interested.

Hopkins BME research faculty use their medical and engineering strengths as they conceptualize and develop experimental approaches to problem-solving.
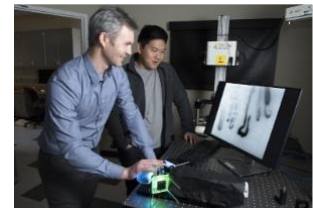

Biomedical Data Science
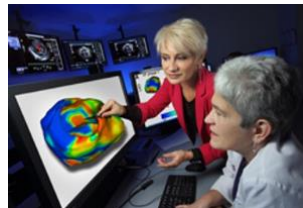
Computational Medicine

Genomics & Systems Biology

Imaging & Medical Devices

Immunoengineering

Neuroengineering

Translational Cell & Tissue Engineering

More information about these research areas is available here:

- Biomedical Data Science
- Computational Medicine
- Genomics & Systems Biology
- Imaging & Medical Devices
- Immunoengineering
- Neuroengineering
- Translational Cell & Tissue Engineering

BME PhD students are not restricted to labs of BME faculty members; our students can conduct research in almost any lab at JHU. The primary mentor must be a tenure-track faculty member (Assistant, Associate, or Full Professor). Other faculty may be part of a thesis committee, or act as a secondary advisor if approved by the Academic Program co-Directors.

Many of the laboratories at JHU are also organized into research communities, including interdisciplinary centers and institutes; here are a sampling of such communities with significant BME involvement:

Laboratories	Description
APL	Applied Physics Laboratory
CCSI	Carnegie Center for Surgical Innovation
CBID	Center for Bioengineering Innovation & Design
CCD	Center for Cell Dynamics
CCB	Center for Computational Biology
CfE	Center for Epigenetics
CHB	Center for Hearing and Balance
CIS	Center for Imaging Science
IBBS	Institute for Basic Biomedical Science
ICM	Institute for Computational Medicine
IGM	Institute for Genetic Medicine
MINDS	Mathematical Institute for Data Science
MBI	Mind-Brain Institute
ICE	Institute for Cell Engineering
KNDI	Kavli Neuroscience Discovery Institute
TTEC	Translational Tissue Engineering Center

And many more!

6.2 How to pick a mentor.

Rotation students can choose to work with almost any tenure-track faculty member at JHU. The faculty at JHU are great scientists, engineers, and clinicians doing pioneering work on tough medical problems. How do you choose a good lab *for you*? Note: Research Professors in WSE cannot be Primary advisors but can be Co-Advisors with tenure-track faculty members.

Topic. What are your interests – e.g., a specific disease, or a specific approach? Working on a problem or methodology that interests you will help you succeed.

Mentor style fit. Do you prefer lots of contact, lots of independence, or a mix of both? Do you like to work in teams or have a solo project? When you have a conversation with the mentor, do the ideas start flowing? In group meetings, do they encourage discussion and let the trainees talk? Do they set a good example for vigorous and inclusive discussion?

Remember that you will have a long relationship with your mentor (within and beyond the time you spend in the program) – do you think they are someone that will give you guidance and advice on what's best for you?

Lab Culture. How are the relationships between the other students and the PI? Are these colleagues you want to see regularly? Will they give you good feedback, and interesting suggestions, and challenge your thinking?

6.3 Commitment to good mentoring during your PhD

Mentoring is one of the most important components of your research experience. It's not just about good guidance in research – your PI and thesis committee members should keep your best interests in mind (regarding research, professional development, and career planning) on a regular basis. They should ask you about your goals and priorities, and what they can do to help you achieve them. JHU & BME are committed to quality mentoring. We will distribute the **JHU Mentorship Commitments of Faculty Advisors and PhD Students** to students & faculty annually. Do read it – there are responsibilities listed for both faculty and students.

7.0 Resources

7.1 Diversity and Inclusion

Johns Hopkins, and Biomedical Engineering, prides itself on building, maintaining, and supporting an inclusive environment for everyone – students, faculty, and staff. Our community is one that communicates, collaborates, and supports each other. This is important because diversity is a key component of excellence in science. Diverse voices bring new approaches and ideas and increase creativity – a key driver of scientific discovery.

We encourage students from many different backgrounds to apply to our program, and our student body is more diverse than is typical in engineering programs. Amongst students in 2022 (251 students total), 44% identify as females and 56% as males. In both 2020 and 2021, female students comprised 47% of the incoming class.

Of the US students who matriculated in the last five years, **23%** (33 out of 140) identify as belonging to racial or ethnic groups typically underrepresented in science and engineering. For more information, see this report: https://oir.jhu.edu/phd-statistics/.

Additional information can be found in the JHU most recent student composition report: https://provost.jhu.edu/wp-content/uploads/2023/04/JHU-Report-on-Graduate-Student-Composition-Spring-2023.pdf. Note that the BME PhD is in the school of medicine, and it is the largest program in this group.

We aim to provide the support each of our students needs to succeed and to be a full part of the BME and JHU communities. For example, we work with Student Disability Services staff at Homewood and the School of Medicine to make accommodations designed and requested by students. We also encourage you to get involved with student groups that foster inclusion and that provide a home and a voice for students, including the JHU BME Equity, Diversity & Inclusion Committee (**EDI**, twitter), and the following school-wide groups:

- The Biomedical Scholars Association (BSA) (email, twitter) supports graduate students from underrepresented minority backgrounds.

- The Gertrude Stein Society (GSS) (email, twitter) supports lesbian, gay, bisexual, transgender, queer, and allied members.

- Women of Whiting (WOW) (twitter) and The Graduate Women's Empowerment Network (GWEN) support women in STEM across JHU.

- Native Circle (email) supports Native American graduate students, staff, faculty and community members.

- The Society for the Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) (email) supports Chicanos/Hispanics and Native Americans in STEM, from college students to professionals.

There are likely even more clubs and groups that may interest you; if not, start one!

The BME department faculty also has a Diversity, Culture, Inclusion, and Equity committee (DICE), led by department Vice Chair Professor Warren Grayson, and a representative of the BME PhD students attends those meetings. For more on D & I issues at Hopkins, follow the websites of the SOM Office for Diversity & Inclusion, the JHU Diversity Leadership Council, and the Office of Institutional Equity.

This inclusive, communicative environment extends to how people interact intellectually and scientifically too.

At Johns Hopkins, and in Biomedical Engineering, you will find open doors to potential collaborators and expert advice; collaborative interdisciplinary projects; a culture of sharing equipment, resources, and ideas; and supportive faculty, staff, & peers who help you succeed.

7.2 Student Life, Outreach, and Volunteering

There are numerous student-led and student-run organizations that greatly enhance the student experience and contribute massively to the community of the BME department, Johns Hopkins University, and Baltimore. These include:

BME PhD Council: https://bme.PhD.council.students.jh.edu

BME EDI: https://bmeedi.wordpress.com (Equity, Diversity, & Inclusion Committee) BME AAP: https://jhubmeaap.wixsite.com/mainsite (Application Assistance Program) BME EDGE: http://edge.bme.jhu.edu (Extramural Development in Graduate Education)=

GSA (Graduate Student Association – School of Medicine): http://gsa.jhmi.edu

GRO (Graduate Representative Organization – Whiting School of Engineering): https://studentaffairs.jhu.edu/gro/

Women of Whiting: https://wow.jhu.edu

The Biomedical Scholars Association (BSA): email, twitter

The Gertrude Stein Society (GSS): https://gssjohnshopkins.wordpress.com

…and many other clubs and groups.

Our program has a long tradition of fielding Intramural sports teams, and some students are members of bands, acapella groups, and many more activities. Many students take the opportunity to conduct STEM outreach via organizations such as the Baltimore Underground Science Space, or mentoring of at-risk students via organizations such as Thread, which was founded and is led by a graduate of our program, Sarah Hemminger.

Every month, the BME PhD Council hosts student-faculty mixers, at which student achievements are celebrated; and organizes student holiday parties. Every year in the fall, a student-faculty retreat takes place with a particular focus on welcoming the new first year students.

7.3 Wellbeing Resources for graduate students

John Hopkins has strong resources for well-being.

For an overview, please check this presentation file: Wellbeing resources for graduate students.

Important resources include:

1. The John Hopkins student assistance program: https://jhsap.org/. JHSAP is a life management resource for students. JHSAP's licensed clinicians can help students identify and manage challenging issues in healthy ways. Getting help is free, convenient, confidential, and available 24/7/365 by calling 443.287.7000, option #1.
2. University Health Services (UHS) Mental Health: https://www.hopkinsmedicine.org/uhs/. Staffed by psychiatrists, licensed psychologists, licensed social workers, and support staff. To make an appointment, please call 410-955-1892.
3. TimelyCare: https://wellbeing.jhu.edu/blog/2020/08/26/timelymd-access-info-and-faqs/. To access TimelyMD, visit timelycare.com/jhu and use your Hopkins email address to log in. SOM students should use their @jhmi.edu email to access this resource; all other learners should use their @jhu.edu or @jh.edu emails.
   a. **TalkNow**. This online resource is staffed by mental health professionals (counselors, psychologists, marriage and family therapists, etc.). You can contact TalkNow about any issue at any time. Examples of topics you may want to discuss include (but are not

limited to) relationship challenges, anxiety surrounding COVID-19, transition issues, etc. Learners in the US and countries that permit web access can use the service.

    b. **Scheduled mental telehealth counseling**. Make an appointment to talk with a provider who is licensed in your state. This service, which is available to students located in all 50 states, will mitigate many of the limitations of state-by-state licensure restrictions for counseling services.

    c. **Psychiatric telehealth services, with referrals from JHU providers**. TimelyMD will be able to provided limited psychiatric telehealth services to students on a referral basis from JHU providers. Students interested in these services should first contact Homewood Counseling Center (Homewood & Peabody), University Health Services Mental Health (BSPH, SOM, SON), or JHSAP (AAP, CBS, EFP, SAIS, SOE), according to their current enrollment.

4. SilverCloud here: https://jhu.silvercloudhealth.com/signup/. SilverCloud is a suite of evidenced-based programs designed by clinical experts to help you think and feel better. It is a confidential online portal that teaches users about mental wellness and provides tips and tools for dealing with anxiety, depression, and stress. It frequently draws upon Cognitive Behavioral Therapy (CBT) methods.

5. Student Health & Well-Being https://studentaffairs.jhu.edu/chew/. Programs and events focused on awareness and skill development. Sign up for their weekly well-being newsletter.

6. University Health Services (UHS) Primary Care, https://studentaffairs.jhu.edu/university-health-services/. Staffed by physicians, nurse practitioners, nurses, medical assistants, patient service, coordinators, and dietitians.

7. Disability center: https://studentaffairs.jhu.edu/disabilities/. Getting Started with SDS and How to Access Your Accommodations

    a. New Students (first time working with SDS) will submit an Initial Request for accommodations through the AIM online application.

    b. Returning Students (who already have approved SDS accommodations) can access AIM here.

8. Use the Calm app for free. For more information, Calm.com/jhu.

If you are having difficulty, ask to talk to your mentor or ask to talk to the program director – at any time. The graduate students of BME EDI have put together an excellent guide to mental health resources at JHU. Student Assistance Program (SOM/SPH/SON): http://www.hopkinsmedicine.org/uhs/SAP

7.4 Parental Leave

Johns Hopkins University recognizes the importance of balancing the family and academic responsibilities faced by new parents and promoting the well-being of their families. The University is supportive of accommodating eligible full-time graduate students and full-time postdoctoral fellows, scholars, and trainees (collectively "postdoctoral trainees") who are expecting a new child. Consistent with grant funding policies that place a limit of 8 weeks for parental leave, all eligible full-time graduate students and postdoctoral trainees shall receive no less than 8 weeks of fully-paid new child accommodations. Each school has in place provisions for taking a formal leave of absence, which is an option at any time for students and trainees who are new parents. Electing this option relieves students of all university responsibilities but comes with consequences that may suspend students' privileges and access to university benefits and resources. This option may also have visa consequences for international students. The goal of this Policy is to put in place a set of guidelines for full-time graduate students and postdoctoral trainees who have new family additions who do not elect a formal leave of absence.

For details of the policy, see
https://www.jhu.edu/assets/uploads/2017/06/newchildaccommgradandpostdoc.pdf

7.5 Dealing with conflict

Building a community means treating each other with respect. When people do not live up to this, it's important to call it out. Bullying, harassment, racism, and other unacceptable behaviors should be reported, whether it comes from faculty members, students, or staff; and whether you or someone else is the victim of this behavior.

You have multiple possible people/institutions you can report to:

Program Director (Julia Massimelli Sewall, julia.sewall@jhu.edu)

Program Co-Directors (Patrick Kanold, and Rachel Karchin, BMEPhDCoDirectors@jh.edu)

Department Director (Michael Miller, mim@jhu.edu)

Associate Dean for Graduate Biomedical Education (Peter Espenshade, peter.espenshade@jhmi.edu)

Office of Institutional Equity (OIE, https://oie.jhu.edu/), including https://oie.jhu.edu/discrimination-and-harassment/ and https://oie.jhu.edu/sexual-misconduct/index.html

SOM mistreatment reporting (http://mistreatment-reporting.med.jhmi.edu/)

The Ombuds office (https://www.jhu.edu/ombuds-office/)

Graduate Student Policies and Resources (JH SOM Graduate Biomedical Education) (Complete List):

- JHU Mentorship Commitments of Faculty Advisors and PhD Students
- Graduate Policy on Conflict Resolution between Faculty Mentor/Advisee
- Grievance Procedure for Faculty Fellows and the Student Body
- Resources for Reporting Mistreatment

7.6 COVID resources

The university maintains websites with the most up-to-date information on operations during the pandemic. At the moment (January 2023), the University is in Phase 3 of its reopening plan.

- Coronavirus Information.
- Covid Vaccination and Booster Information.
- Information for Graduate Students.
- Return to Research.
- COVID dashboard.

Testing requirements and availability are subject to change and are campus dependent. Please refer to the Diagnostic Testing page for the latest information:

- Voluntary asymptomatic testing on demand is available at several locations. Graduate students at either campus may obtain an appointment for a free asymptomatic test via MyChart at any time.
- At the School of Medicine, affiliates must follow Johns Hopkins Medicine Testing Policies.

Adherence to COVID-19 workplace safety guidelines needs to be enforced at all times. Noncompliance with current guidelines will result in suspended campus access depending on the severity and frequency of the infraction.

Report abuse/problems/concerns to the PI/lab captain or through university provided channels: closecalls@jhu.edu for simpler, non-incident, issues;

SPEAK2US hotline at https://secure.ethicspoint.com/domain/media/en/gui/65464/index.html or 844-773-2528 for equity related issues;

Department of Health, Safety and Environment (410-516-8798) for lab safety reporting; Security (410-516-7777) or 911 for emergencies.

8.0 Professional and career development

8.1 Individual Development Plans

As mentioned in section 4.8, every year, you will complete Individual Development Plans in collaboration with their research mentor. This includes having a detailed conversation about professional and career development with your mentor each year, using the written IDP document as a guide. This is a program requirement and is also part of JHU policy.

There are multiple possible document formats that can be used for IDPs, and some labs that have their own. The SOM plans to unify these formats in the Spring of 2024. Access to current (or future unified) templates can be found here https://jhu.instructure.com/courses/57122/pages/idp. The document itself plays a key role in initiating professional development conversations, but it is the conversations themselves that are the most important element. At each meeting of the student's thesis committee, the committee will ask whether an IDP has been completed that year and whether there are key elements of it that need to be addressed.

If you are a rotating first-year student, we recommend completing the IDP document and having an IDP discussion with each mentor. We encourage you to conduct the IDP discussion with all of your research rotation mentors, partly because this is an excellent discussion that would help you learn more about each lab and its mentorship style. If as a rotating student, you prefer to conduct your IDP discussion with the program associate director, then you are welcome to do so.

8.2 Internships

The Johns Hopkins University School of Medicine and the Biomedical Engineering PhD program facilitate internships for PhD students in fields outside academic research, such as Research and Development in biotech companies; technology transfer; science administration; science policy; science education; and scientific writing. Students may express interest in internship opportunities by completing the "Preliminary Interest in Student Internship" Form – which should be shared with the JHU internship program manager (e.g. BME EDGE or BCI – see below). If there is not a JHU program facilitating the internship, then this form should be submitted to the BME PhD Program Director.

Students are encouraged to discuss their career goals with their thesis mentor and graduate program director and ask them to complete the relevant sections of the form.

Students who express interest through the above form may apply for an internship, either through a Johns Hopkins internship program or directly to a host organization. Students who are offered and wish to accept an internship must submit a Memorandum of Understanding (MOU) signed by the mentor, the director of the BME PhD program, and the Associate Dean of Graduate Biomedical Education, ensuring that all parties agree. This document should specify which entity will be responsible for the student stipend and health insurance for the duration of the internship. In our experience, most external internships are paid by the hosting organization, and the stipend is paused during this period.

A student who signs up for a full-time internship (2-6 months) may be placed on Leave of Absence (LOA) for the duration of the internship or enroll in an Internship Practicum Course for credit. International students are not eligible for LOA and must instead enroll in the course.

SOM Internship policies and documents

The appropriate SOM policies and links to the Preliminary Interest and MOU forms are available at this link.

8.3 Professional development organizations at JHU

8.3.1 BME-EDGE and BCI

BME graduate students started EDGE (Extramural Development Graduate Education) in 2013 as an internship program and to provide information on non-academic careers. It continues to be a student-led and student-run organization.

Dozens of BME PhD students have completed external internships since its founding, thanks to EDGE.

The School of Medicine also provides career resources and an organization that facilitates internships, the Biomedical Careers Initiative (BCI).

8.3.2 PDCO

The JHM Professional Development and Career Office (PDCO) is an excellent resource for students. Along with traditional professional development opportunities, workshops, seminars etc., they also host innovative programming, including longitudinal peer communities of interest for specific career tracks, known as OPTIONS.

8.3.3 Phutures

At the Provost level, in other words JHU-wide, a recent addition is the Phutures office, focused specifically on professional development at the PhD level.

8.4 Fellowships

There are a number of external fellowships that are available to graduate students; we encourage students to apply for these. The office of the Vice Provost for Research maintains a downloadable database of graduate student funding opportunities. They also maintain a searchable list of funding opportunities intended for underrepresented minority and/or low-income graduate students.

Below we describe some of the most popular opportunities, but you should always go back to the full list linked above.

In their first and second year, most graduate students who are US citizens or permanent residents are eligible to apply for an NSF fellowship (deadline is November annually), National defense science and Engineering graduate fellowship (deadline in early December annually), and a DOE Computational Science Fellowship (deadline is January annually). US students (any year) may apply for an NRSA fellowship from the NIH (deadlines in April, August, and December annually).

Note: To be eligible for the NSF fellowship you need to be within the first 2 years from matriculation. Thus, students who matriculate early (e.g. July) are disqualified for application in their second year.

New immigrants to the United States are eligible to apply for the Soros Graduate Fellowship. Students doing research in communication sciences can apply for New Century Scholars Fellowship. Women and URM students working in computational and data sciences may apply for the Computational and Data Science Fellowship (deadline in late April).

Gilliam Scholars are funded and organized by HHMI. This is just a selection; there are many other fellowships available, including field-specific ones e.g. the American Heart Association.

Summary of resources
- [downloadable database of graduate student funding opportunities.](#)
- [a searchable list of funding opportunities intended for underrepresented minority and/or low-income graduate students.](#)
- [Research at Johns Hopkins Webnotes](#)

Also worth checking:
FastWeb –a source of scholarships available-www.fastweb.com/

Interesting links to look at (complete list of fellowships above)
- [American Heart Association Predoctoral Fellowship](#).
- [Microsoft Graduate Fellowship](#)
- [Ford Foundation Fellowships Programs](#)
- [Ford Foundation Fellowships Programs](#)
- [The Hertz Foundation](#)
- [HHMI Gilliam Fellowships for Advanced Study](#)
- [HHMI International Student Research Fellowship](#)
- [National Science Foundation Graduate Research Fellowship Program](#)
- [National defense science and Engineering Graduate fellowship](#)
- [National Consortium for Graduate Degrees for Minorities in Engineering & Science Fellowships](#)
- [The National Academies of Sciences, Engineering & Medicine](#).
- [DOE Computational Science Fellowship](#)
- [DOD SMARTs scholarship](#)
- [NRSA fellowship](#)
- [Paul & Daisy Soros Fellowships for New Americans](#)
- [United Negro College Fund](#)
- [Science and SciLifeLab Prize for Young Scientists](#)
- [Modeling, Simulation, and Training Fellowships](#)
- [Boehringer Ingelheim Fonds PhD Fellowships](#)
- [Google Lime](#) Scholarship for Students with Disabilities
- [Microsoft Graduate Fellowship for Women](#)
- Etc. (see above)

Some examples of successfully funded grants are given here:
- https://www.ogrants.org
- https://riojournal.com
- https://www.niaid.nih.gov/grants-contracts/sample-applications
- https://cancercontrol.cancer.gov/IS/sample-grant-applications.html
- https://jabberwocky.weecology.org/2012/08/10/a-list-of-publicly-available-grant-proposals-in-the-biological-sciences/

Postdoctoral
- [Ford Foundation Fellowships Programs](#)
- [Predoctoral to Postdoctoral Fellow Transition Award (F99/K00)](#)
- [AAAS Mass Media Science & Engineering Fellowship](#)
- [L'Oreal USA Fellowships for Women In Science](#)

For policy on fellowship bonus please consult the BME PhD policy document.

8.4.1 Siebel Scholars

In the final year of the thesis research, all BME PhD students are eligible to apply for a Siebel fellowship. This [program](#) by the Siebel Foundation recognizes Biomedical Engineering graduate students who have demonstrated the highest levels of <u>academic achievement</u> and <u>leadership</u>. Johns Hopkins is one of 5 universities in the nation that have been selected for this program in the Biomedical Engineering category. It is a **$35,000** prize paid directly to the student, independent of the usual stipend that they receive. All JHU graduate students doing BME work (i.e., not just BME students) are eligible. [Applications](#) are due to the individual departments around May of each year. **Criteria:** nominee ranks within the top 10% of their Biomedical Engineering School class based on academic results; the nominee demonstrates excellent leadership in the BME community or more broadly; the nominee demonstrates a track record of distinguished research (published papers); the nominee is expected to complete the doctoral degree between November of the nomination year and October of the following year (therefore, the application process starts 6-12 months before expected thesis completion).

8.5 Young investigator day

The School of Medicine awards about 12 graduate students and postdocs each year across all disciplines. Applications are typically due in January. [Here's a video](#) with some students discussing Young Investigators Day.