Biomedical Engineering

Biomedical engineering (BME) seeks to advance and integrate life science knowledge with engineering methods and innovations that contribute to improvements in human health and well-being. Our vision is that lasting knowledge of biomedical systems and paradigm-shifting engineering technology will arise from integrating engineering concepts and basic science knowledge from the molecular level to the whole-body level. We believe that those taught to work across multiple disciplines and to integrate modeling and experimental systems approaches will be uniquely positioned to advance and generate new disciplines in biomedical engineering.

With this vision in mind, we are committed to educating the next generation of biomedical engineers. We have leveraged our interdisciplinary strengths in engineering and clinical and life sciences to build a biomedical engineering department around research programs of excellence and translational potential: Biomedical & Biological Imaging; Cardiovascular Engineering; Cellular & Molecular Bioengineering; Neural Engineering; Orthopedic Engineering; and Regenerative Engineering in Medicine. These areas provide exciting opportunities for students with a variety of backgrounds and interests.

Students seeking the PhD in Biomedical Engineering may choose to study in one of six multidisciplinary research programs that represent frontiers in biomedical engineering. Our core faculty work collaboratively with more than 90 affiliated faculty to offer students the opportunity to learn in a diverse and rich spectrum of BME research areas. Students graduating with the PhD in Biomedical Engineering are prepared to pursue paths in research and development in academic and industry settings, and they are also ready to contribute to teaching and research translation. The MD/PhD in Biomedical Engineering, which is offered jointly with the top-ranked School of Medicine, gives students in-depth training in modern biomedical research and clinical medicine. The typical MD/PhD career combines patient care and biomedical research but leans toward research.

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Faculty
Chair
Lori A. Setton (https://engineering.wustl.edu/Profiles/Pages/Lori-Setton.aspx)
Lucy and Stanley Lopata Distinguished Professor of Biomedical Engineering
PhD, Columbia University
Biomaterials for local drug delivery; tissue regenerations specific to the knee joints and spine

Endowed Professors
Rohit V. Pappu (https://engineering.wustl.edu/faculty/Rohit-Pappu.html)
Edwin H. Murty Professor of Engineering
PhD, Tufts University
Macromolecular self assembly and function; computational biophysics

Yoram Rudy (https://engineering.wustl.edu/faculty/Yoram-Rudy.html)
Fred Saigh Distinguished Professor of Engineering
PhD, Case Western Reserve University
Cardiac electrophysiology; modeling of the cardiac system

Professors
Jianmin Cui (https://engineering.wustl.edu/faculty/Jianmin-Cui.html)
PhD, State University of New York–Stony Brook
Ion channels; channel structure-function relationship; biophysics

PhD, Arizona State University
Motor control; neural engineering; neuroprosthetics; movement biomechanics

Baranidharan Raman (https://engineering.wustl.edu/faculty/Barani-Raman.html)
PhD, Texas A&M University
Computational and systems neuroscience; neuromorphic engineering; pattern recognition; sensor-based machine olfaction

Quing Zhu (https://engineering.wustl.edu/faculty/Quing-Zhu.html)
PhD, University of Pennsylvania
Biophotonics and multimodality ultrasound and optical imaging

Associate Professors
Dennis L. Barbour (https://engineering.wustl.edu/faculty/Dennis-Barbour.html)
MD, PhD, Johns Hopkins University
Application of novel machine learning tools to diagnose and treat disorders of perception and cognition
Song Hu
PhD, Washington University in St. Louis
Optical and photoacoustic technologies for high-resolution structural, functional, metabolic and molecular imaging in vivo.

Princess Imoukhuede (https://engineering.wustl.edu/faculty/Princess-Imoukhuede.html)
PhD, California Institute of Technology
Ligand-receptor signal transduction; angiogenesis; computational systems bioengineering

PhD, Duke University
Cell mechanics; receptor and ligand interactions; molecular biomechanics

PhD, Washington University
Ion channel biophysics

Kurt A. Thoroughman (https://engineering.wustl.edu/faculty/Kurt-Thoroughman.html)
PhD, Johns Hopkins University
Human motor control and motor learning; neural computation

Chao Zhou
PhD, University of Pennsylvania
Optical coherence tomography

Assistant Professors

Hong Chen (https://engineering.wustl.edu/faculty/Hong-Chen.html)
PhD, University of Washington
Physical acoustics; therapeutic ultrasound and ultrasound imaging

Nate Huebsch (https://engineering.wustl.edu/faculty/Nathaniel-Huebsch.html)
PhD, Harvard University
Cell-material Interactions, iPSC-based tissue modeling to study cardiac development and disease

Abhinav Kumar Jha (https://engineering.wustl.edu/faculty/Abhinav-Jha.html)
PhD, University of Arizona
Development of computational-imaging solutions for diagnosing and treating diseases

Jai S. Rudra (https://engineering.wustl.edu/faculty/Jai-Rudra.html)
PhD, Louisiana Tech University
Peptide-based biomaterials; immunoengineering; immunology of nanoscale aggregates; development of vaccines and immunotherapies

Michael D. Vahey (https://engineering.wustl.edu/faculty/Michael-Vahey.html)
PhD, Massachusetts Institute of Technology
Biophysical mechanisms of infectious disease; fluorescence microscopy; microfluidics

Principal Lecturer

Patricia Widder (https://engineering.wustl.edu/faculty/Patricia-Widder.html)
MS, Washington University

Lecturer

Katherine Schreiber
PhD, Saint Louis University

Senior Professor

Larry Taber
PhD, Stanford University
Mechanics of growth and development; cardiac mechanics

Senior Emeritus Professor

Frank Yin
MD, PhD, University of California, San Diego

Degree Requirements

PhD and Combined MD/PhD in Biomedical Engineering

The department offers programs that lead to the Doctor of Philosophy (PhD) in Biomedical Engineering as well as combined MD/PhD degrees. The latter degrees are conferred jointly with the School of Medicine.

The doctoral degree requires a minimum of 72 credits beyond the bachelor's level, with a minimum of 36 being course credits (including the core curriculum) and a minimum of 24 credits of doctoral dissertation research.

The core curriculum that must be satisfied by all PhD students consists of the following:

- One graduate-level course in life science from an approved list
- One graduate-level course in mathematics from an approved list
- One graduate-level course in computer science from an approved list or exemption by proficiency
- Four BME courses from an approved list

Please visit the Biomedical Engineering (BME) website (https://bme.wustl.edu/graduate/phd/Pages/default.aspx) for a comprehensive list of the approved courses.
Up to 9 credits of BME 601C Research Rotation and/or BME 501C Graduate Seminar may be counted toward the 36 credits of graduate courses required for the PhD, so a total of 27 additional credits (usually nine courses, including the core curriculum) are required for the PhD. Up to two 400-level courses may be counted toward the nine courses required for the PhD. Graduate courses may be transferred in (up to 24 credits) but must be evaluated and approved by the Director of Doctoral Studies. The evaluation and approval may occur at any time, but course transfer does not become official until after one year in residence at Washington University.

Students seeking the **PhD in Biomedical Engineering** enroll in two to three courses each semester and participate in one or two laboratory rotations during the first year. Before the end of their first 10 months of enrollment in the program, students take their oral qualifying exam, which consists of a presentation of their research done to date in the mentor's laboratory followed by an oral exam addressing any issues directly related to their rotation report or their oral presentation. Upon successfully passing the qualifying examination, they advance to candidacy and complete the balance of their requirements. During the second and third years, students complete their remaining courses, participate in one semester of a mentored teaching experience, and begin their thesis research. By the end of the third year, students must complete their thesis proposal. Students must also complete one accepted and one submitted first-author publication and complete a dissertation.

Students pursuing the combined **MD/PhD in Biomedical Engineering** must complete the degree requirements in both schools. MD/PhD students typically complete the first two years of the medical school preclinical curriculum while also performing one or more research rotations, then the remaining requirements for the doctoral degree, and finally the clinical training years of the medical degree. The department generally gives graduate course credits for some of the medical school courses toward the fulfillment of course requirements for the PhD degree. This is arranged on an individual basis between the student, their academic adviser and the Director of Doctoral Studies.