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 across molecular to whole-body levels. 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; Cancer Technologies; Cardiovascular Engineering; Molecular & Cellular Systems Engineering; 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 seven 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 are well-prepared to contribute to teaching and research translation. The **MD/PhD in Biomedical Engineering,** given 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/Profiles/Pages/Rohit-Pappu.aspx)
Edwin H. Murty Professor of Engineering
PhD, Tufts University
Macromolecular self assembly and function; computational biophysics

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

Professors

Mark Anastasio (https://engineering.wustl.edu/Profiles/Pages/Mark-Anastasio.aspx)
PhD, University of Chicago
Imaging sciences; phase-contrast; x-ray imaging

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

Daniel Moran (https://engineering.wustl.edu/Profiles/Pages/Daniel-Moran.aspx)
PhD, Arizona State University
Motor control; neural engineering; neuroprosthetics; movement biomechanics

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

Associate Professors

Dennis L. Barbour (https://engineering.wustl.edu/Profiles/Pages/Dennis-Barbour.aspx)
MD, PhD, Johns Hopkins University
Auditory physiology; sensory cortex neurocircuitry; novel perceptual diagnostics and therapeutics

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

Vitaly Klyachko (https://engineering.wustl.edu/Profiles/Pages/Vitaly-Klyachko.aspx)
PhD, University of Wisconsin-Madison
Synaptic function and plasticity; neural circuits; information analysis; neurological disorders

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

Jin-Yu Shao (https://engineering.wustl.edu/Profiles/Pages/Jin-Yu-Shao.aspx)
PhD, Duke University
Cell mechanics; receptor and ligand interactions; molecular biomechanics

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

Assistant Professors

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

Nate Huebsch (https://bme.wustl.edu/faculty/Pages/faculty.aspx?bio=114)
PhD, Harvard University
Cell-material Interactions, iPSC-based tissue modeling to study cardiac development and disease

Abhinav Kumar Jha (https://bme.wustl.edu/faculty/Pages/faculty.aspx?bio=125)
PhD, University of Arizona
Development of computational-imaging solutions for diagnosing and treating diseases

Kristen Naegle (https://engineering.wustl.edu/Profiles/Pages/Kristen-Naegle.aspx)
PhD, Massachusetts Institute of Technology
Computational systems biology with emphasis on cellular networks involved in cancer and diabetes

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

Jon Silva (https://engineering.wustl.edu/Profiles/Pages/Jonathan-Silva.aspx)
PhD, Washington University
Ion channel biophysics

Michael D. Vahey (https://bme.wustl.edu/faculty/Pages/faculty.aspx?bio=113)
PhD, Massachusetts Institute of Technology
Biophysical mechanisms of infectious disease; fluorescence microscopy; microfluidics

Senior Professor

Larry Taber (https://bme.wustl.edu/faculty/Pages/Larry-Taber.aspx)
PhD, Stanford University
Mechanics of growth and development; cardiac mechanics

Senior Lecturer

Patricia Widder (https://bme.wustl.edu/faculty/Pages/Patricia-Widder.aspx)
MS, Washington University

Lecturer

Noah Ledbetter (https://bme.wustl.edu/faculty/Pages/Noah-Ledbetter.aspx)
PhD, University of Utah

Senior Emeritus Professor

Frank Yin (https://bme.wustl.edu/faculty/Pages/Frank-Yin.aspx)
MD, PhD, University of California, San Diego

Degree Requirements

PhD and Combined MD/PhD in Biomedical Engineering

The department offers programs leading to the Doctor of Philosophy (PhD) in Biomedical Engineering and combined MD/PhD degrees. The latter degree is given 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 approved list
- One graduate-level course in computer science from 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 (https://courses.wustl.edu/CourseInfo.aspx?sch=E&dept=E62&crs=601C) and/or BME 501C Graduate Seminar (https://courses.wustl.edu/CourseInfo.aspx?sch=E&dept=E62&crs=501C) may be counted toward the 36 credits of graduate courses required for the PhD, so a total of 27 additional credits (~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 (not including independent study courses, journal clubs or seminar-based courses). 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 in the first year. Ten months after they enroll in the program, students take their oral qualifying exam consisting 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 pre-clinical 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 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.