Biomedical Engineering

Biomedical Engineering (https://engineering.brown.edu/undergraduate/concentrations/biomedical-engineering/) is a dynamic and growing field based upon the application of the tools of engineering to the subject matter of biology and medicine. The undergraduate program in biomedical engineering is an independent concentration structured as a joint program between the Division of Biology and Medicine and the School of Engineering. Students can take courses from and do research with faculty from engineering, the various departments of biology, and the Brown-affiliated hospitals in Rhode Island. The Biomedical Engineering concentration shares much of the core with the other engineering programs, but the program's primary emphasis is on the fundamentals of biomedical engineering, while also allowing students to personalize their curriculum. Biomedical engineers design new drugs, genetically engineer organisms, and devise new medical and medical instruments. They also use their understanding of biology to reinvent man-made materials and products. BME students learn to apply the principles of engineering and science, along with problem solving skills and critical thinking to a broad spectrum of engineering problems. Further, BME is a sound foundation for lifelong education with its emphasis on the use of teamwork, effective communication skills, and an understanding of broad social, ethical, economic and environmental consequences. The biomedical engineering curriculum at Brown prepares students for careers in biomedical engineering and biotechnology, as well as careers in diverse areas such as medicine, law, business, and health care delivery.

The Sc.B. program in Biomedical Engineering is accredited by the Engineering Accreditation Commission of ABET http://www.abet.org/. It is jointly offered by the School of Engineering and the Division of Biology and Medicine as an interdisciplinary concentration designed for students interested in applying the methods and tools of engineering to the subject matter of biology and the life sciences. Alumni of the Biomedical Engineering (BME) program will achieve one or more of these program educational objectives (PEOs) within five (5) years of graduation: (1) Serve society through work or advanced study in a broad range of fields including, but not limited to, medicine, healthcare, industry, government, and academia; (2) Apply their deeply creative and versatile biomedical engineering education to solve a broad spectrum of engineering and societal challenges; and (3) Contribute as role models, mentors, or leaders in their fields. The student outcomes of this program are the ABET (1) - (7) Student Outcomes as defined by the ABET Criteria for Accrediting Engineering Programs, available online at http://www.abet.org/accreditation-criteria-policies-documents/. The Biomedical Engineering concentration shares much of the core with the other engineering programs, but is structured to include more courses in biology and chemistry, and a somewhat different emphasis in mathematics.

The requirements regarding Mathematics, Advanced Placement, Transfer Credit, Substitutions for Required Courses, and Humanities and Social Science Courses are identical to those of the Sc.B. degree programs in Engineering. Please refer to the Engineering section of the University Bulletin (https://bulletin.brown.edu/engineering/) for explicit guidelines.

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Standard program for the Sc.B. degree

1. Core Courses		
ENGN 0030	Introduction to Engineering	1
or ENGN 0031	Honors Introduction to Engineering	
or ENGN 0032	Introduction to Engineering: Design	
ENGN 0040	Engineering Statics and Dynamics	1
ENGN 0510	Electricity and Magnetism	1
or ENGN 0520	Electrical Circuits and Signals	
ENGN 0720	Thermodynamics	1
ENGN 0810	Fluid Mechanics	1
CHEM 0330	Equilibrium, Rate, and Structure	1
MATH 0190	Single Variable Calculus, Part II (Physics/Engineering)	1
or MATH 0100	Single Variable Calculus, Part II	
CHEM 0350	Organic Chemistry I	1
MATH 0200	Multivariable Calculus (Physics/Engineering)	1
or MATH 0180	Multivariable Calculus	
or MATH 0350	Multivariable Calculus With Theory	
APMA 0350	Applied Ordinary Differential Equations [1]	1
APMA 1650	Statistical Inference I	1
or BIOL 0495	Statistical Analysis of Biological Data	
or PHP 1510	Principles of Biostatistics and Data Analysis	
or APMA 1655	Honors Statistical Inference I	
2. Upper Level Biomedical Engineering Curriculum		
ENGN 1110	Transport and Biotransport Processes	1
ENGN 1210	Biomechanics	1
ENGN 1230	Instrumentation Design	1
ENGN 1490	Biomaterials	1
BIOL 0800	Principles of Physiology	1
3. Additional Biomedical Engineering Electives: Complete at least 3 courses from the following groups; other upper-level courses are subject to Concentration Advisor approval.		**3**
Select one or two of the following:		
CSCI 1810	Computational Molecular Biology	
or CSCI 1820	Algorithmic Foundations of Computational Biology	
ENGN 0500	Digital Computing Systems	
ENGN 1220	Neuroengineering	
ENGN 1510	Nanoengineering and Nanomedicine	
ENGN 1520	Cardiovascular Engineering	
ENGN 1550	Recent Advances in Biomedical Engineering	
ENGN 1740	Computer Aided Visualization and Design	
ENGN 1930B	Biomedical Optics	
ENGN 2625	Optical Microscopy: Fundamentals and Applications	
ENGN 2910S	Cancer Nanotechnology	
ENGN 2911R	Analytical Modeling for Biomechanical and Biomedical Systems	
ENGN 2912R	Implantable Devices	
BIOL 1140	Tissue Engineering	
BIOL 1150	Stem Cell Engineering	
BIOL 2110	Drug and Gene Delivery	
At least one or two more courses from:		
BIOL 0280	Biochemistry	
BIOL 0470	Genetics	
BIOL 0500	Cell and Molecular Biology	
BIOL 0510	Introductory Microbiology	
BIOL 0530	Principles of Immunology	
BIOL 1090	Polymer Science for Biomaterials	
BIOL 1100	Cell Physiology and Biophysics	
BIOL 1555	Methods in Informatics and Data Science for Health	
APMA 1070	Quantitative Models of Biological Systems	
CHEM 0360	Organic Chemistry II	
ENGN 2910G	Topics in Translational Research and Technologies	
NEUR 1020	Principles of Neurobiology	
NEUR 1440	Mechanisms and Meaning of Neural Dynamics	

PHYS 1610	Biological Physics	
BIOL 1810	21st Century Applications in Cell and Molecular Biology	
4. Capstone Design [2]		
ENGN 1930L	Biomedical Engineering Design and Innovation [1]	1
ENGN 1931L	Biomedical Engineering Design and Innovation II [1]	1
5. General Education Requirement: At least four approved courses must be taken in the humanities and social sciences.		
Total Credits		**21**

1 Students who completed APMA 0330 and/or APMA 0340 prior to academic year 2021-22 may count these as satisfying the APMA 0350 and/or APMA 0360 requirements.

2 In some **rare cases**, Independent Study may be substituted, subject to Concentration Advisor approval.

Professional Track

While we do not give course credit for internships, we officially recognize their importance via the optional Professional Tracks. The requirements for the professional tracks include all those of the standard tracks, as well as the following: Students must complete full-time professional experiences (or part-time experiences of equivalent total effort) doing work that is related to their concentration programs, totaling 2-6 months, whereby each internship must be at least one month in duration in cases where students choose to do more than one internship experience. Such work is normally done at a company, but may also be at a university under the supervision of a faculty member. Internships that take place between the end of the fall and the start of the spring semesters cannot be used to fulfill this requirement. On completion of each professional experience, the student must write and upload to ASK a reflective essay about the experience addressing the following prompts:

- Describe the organization you worked in and the nature of your responsibilities.
- Which courses were put to use in your work?
- Which topics, in particular, were important?
- In retrospect, which courses should you have taken before embarking on your work experience?
- What are the topics from these courses that would have helped you if you had been more familiar with them?
- What topics would have been helpful in preparation for this work experience that you did not learn at Brown?
- What did you learn from the experience that probably could not have been picked up from course work?
- Is the sort of work you did something you would like to continue doing once you graduate? Explain.
- Would you recommend your work experience to other Brown students? Explain.

The reflective essays are subject to the approval of the student's Concentration Advisor.

Entry to the Professional Track requires a simple application form to be completed by the student and approved by the Concentration Advisor at the time of the concentration declaration. If the student has not yet declared a concentration, the form may be approved by the Chair of the Concentration Committee. The Concentration Advisor will certify that all Professional Track students have completed the necessary internships and will grant approval for the associated reflective essays. All other requirements remain identical to those in the standard tracks in the concentrations.