BIOMEDICAL ENGINEERING

**Director of undergraduate studies:** James Duncan, N309 D TAC, 785-2427, 313 MEC, 432-9917, james.duncan@yale.edu; seas.yale.edu/departments/biomedical-engineering

Engineering methods and strategies are used to address biomedical problems ranging from studies of physiological function using images to the development of artificial organs and new biomaterials. The B.S. degree in Biomedical Engineering is designed to provide students with an understanding of common fundamental methodologies and the ability to develop quantitative approaches to one of four biomedical engineering tracks: Bioimaging, Biomechanics and Mechanobiology, Biomolecular Engineering, and Systems Biology. The flexible course structure of the major permits students to bridge basic concepts in the life sciences and traditional areas of engineering, while also gaining a comprehensive understanding of biomedical engineering as a field of study.

**PREREQUISITES**

The following prerequisites are common to all tracks in the major: BIOL 101 and 102 (or a higher-level course in MCDB or MB&B, with permission of the director of undergraduate studies); a lecture course in chemistry numbered CHEM 161 or higher; ENAS 194; MATH 115; MATH 120 or ENAS 151; PHYS 180, 181, 205L, and 206L (or 165L and 166L, with DUS permission).

**REQUIREMENTS OF THE MAJOR**

The **major for the Class of 2018 and the Class of 2019** With DUS approval, the following changes to the requirements of the major may be fulfilled by students who declared their major under previous requirements.

The **major for the Class of 2020 and subsequent classes** Students must complete twelve term courses, totaling at least eleven course credits, beyond the prerequisites, including at least three required courses in the chosen track, two terms of a biomedical engineering laboratory (BENG 355L, 356L), and the senior requirement (see below). During the first year, students study basic mathematics, chemistry, and biology. By the end of the sophomore year, they have taken physics, ENAS 194, BENG 249, and BENG 350. In the junior year, students gain a comprehensive grounding in the field through BENG 351, BENG 352, BENG 353, BENG 355L, and BENG 356L. During the junior and senior years students also acquire depth by taking electives in one of the four areas of concentration. A senior seminar and a senior project give students practical, detailed information about their chosen area of concentration. By the end of senior year, two term courses in the life sciences must have been included among the prerequisite and required courses for the major. One relevant course (e.g. MB&B 300) may be substituted with the permission of the DUS.

Students in all tracks are required to take the following seven term courses: BENG 249, 350, 351, 352, 353, 355L, and 356L.

Students in the Bioimaging track must also take three courses chosen from BENG 404, 406, 410, 444, 445, 475, 476, or 485.

Students in the Biomechanics and Mechanobiology track must also take three courses chosen from MENG 185, 280, 361, BENG 404, 410, 434, 453, 455, 456, 457, or 458.

Students in the Biomolecular Engineering track must also take three courses chosen from BENG 404, BENG 410, 411, 434, 435, 463, 464, 465, 467, or MENG 361.

Students in the Systems Biology track must also take three courses chosen from BENG 404, 410, 411, 434, 435, 463, 464, 465, 467, or MENG 361.

Research Courses Students are permitted, and encouraged, to engage in research before the senior year by enrolling in BENG 471 and/or BENG 472. These courses, offered Pass/Fail, may be taken more than once for credit, but repeated courses do not count toward the major. See Course Credits and Course Loads in the Academic Regulations.

Credit/D/Fail No course taken Credit/D/Fail may count toward the major, including prerequisites.

**SENIOR REQUIREMENT**

In their senior year, all students must enroll in BENG 480. They must also complete a one-term senior project in their final term of enrollment (BENG 474) or a two-term, yearlong project (BENG 473, 474).

**ADVISING**

**Preparation for graduate study** The Biomedical Engineering curriculum is excellent preparation for graduate study in engineering, science, and medicine. In some cases, organic chemistry and/or certain biology courses may be substituted for one course in the major after consultation with the director of undergraduate studies.

**REQUIREMENTS OF THE MAJOR**

**Prerequisites** BIOL 101 and 102, or higher-level course in MCDB or MB&B with DUS permission; 1 lecture course in chemistry numbered CHEM 161 or higher; ENAS 194; MATH 115; MATH 120 or ENAS 151; PHYS 180, 181, and 205L, 206L (or 165L and 166L, with DUS permission)

**Number of courses** 12 term courses, totaling at least 11 course credits, beyond prereqs (incl senior req)

Distribution of courses  2 term courses in life sciences among prereq and req courses

Substitution permitted  Relevant course with DUS permission

Senior requirement  BENG 480 and one-term senior project in final term of enrollment (BENG 474) or yearlong senior project (BENG 473 and 474)

FACULTY OF THE DEPARTMENT OF BIOMEDICAL ENGINEERING

Professors  Richard Carson, †Nicholas Christakis, James Duncan, Jay Humphrey, Fahmeed Hyder, Andre Levchenko, †Laura Niklason, Douglas Rothman, Mark Saltzman, †Martin Schwartz, †Frederick Sigworth, †Brian Smith, Lawrence Staib, †Hemant Tagare, †Paul Van Tassel, Steven Zucker

Associate Professors  †Robin de Graaf, Tarek Fahmy, Themis Kyriakides, †Evan Morris, †Xenophon Papademetris, †Corey Wilson

Assistant Professors  †Joerg Bewersdorf, Stuart Campbell, †Michael Choma, Rong Fan, Anjelica Gonzalez, †Chi Liu, Michael Mak, Kathryn Miller-Jensen, Michael Murrell, †Steven Tommasini, †Jiangbing Zhou

Lecturers  †Liqiong Gui, †Jing Zhou

†A joint appointment with primary affiliation in another department or school.