BIOENGINEERING
UNDERGRADUATE MAJOR

See the "Department of Bioengineering (http://exploredegrees.stanford.edu/schoolofengineering/bioengineering)" section of this bulletin for additional information on the department, and its programs and faculty.

Bioengineering (BIOE)

Completion of the undergraduate program in Bioengineering leads to the conferral of the Bachelor of Science in Bioengineering.

Mission of the Undergraduate Program in Bioengineering

The Stanford Bioengineering major enables students to combine engineering and the life sciences in ways that advance scientific discovery, healthcare and medicine, manufacturing, environmental quality, culture, education, and policy. Students who major in BIOE earn a fundamental engineering degree for which the raw materials, underlying basic sciences, fundamental toolkit, and future frontiers are all defined by the unique properties of living systems.

Students will complete engineering fundamentals courses, including an introduction to bioengineering and computer programming. A series of core BIOE classes beginning in the second year leads to a student-selected depth area and a senior capstone design project. The department also organizes a summer Research Experience for Undergraduates (REU) (http://bioengineering.stanford.edu/student-resources/reu) program. BIOE graduates are well prepared to pursue careers and lead projects in research, medicine, business, law, and policy.

Requirements

Mathematics

14 units minimum (Prerequisites: 10 units of AP or IB credit or Mathematics 20-series)\(^1\) Select one of the following sequences:

- CME 100 & CME 102 Vector Calculus for Engineers and Ordinary Differential Equations for Engineers (Recommended) 10
- MATH 51 & MATH 53 Linear Algebra, Multivariable Calculus, and Modern Applications and Ordinary Differential Equations with Linear Algebra 10

Select one of the following:

- CME 106 Introduction to Probability and Statistics for Engineers (Recommended) 4-5
- or STATS 110 Statistical Methods in Engineering and the Physical Sciences
- or STATS 141 Biostatistics

Science

26 units minimum \(^2\)

- CHEM 31M Chemical Principles: From Molecules to Solids (formerly 31X) 5
- or CHEM 31A & CHEM 31B Chemical Principles I and Chemical Principles II 5
- CHEM 33 Structure and Reactivity of Organic Molecules 5
- BIO 83 Biochemistry & Molecular Biology (Recommended) 4
- or BIO 82 Genetics
- BIO 84 Physiology 4
- PHYSICS 41 Mechanics 4
- PHYSICS 43 Electricity and Magnetism 4
- Technology in Society
- BIOE 131 Ethics in Bioengineering (WIM) 3
- Engineering Fundamentals
- BIOE 80 Introduction to Bioengineering (Engineering Living Matter) 4
- CS 106A Programming Methodology (or CS 106B or CS 106X) 5

Fundamentals Elective; see UGHB for approved course list; only one CS class allowed to count toward Fundamentals requirements.

Bioengineering Core

- BIOE 42 Physical Biology 4
- BIOE 44 Fundamentals for Engineering Biology Lab 4
- BIOE 101 Systems Biology 3
- BIOE 103 Systems Physiology and Design 4
- BIOE 123 Biomedical System Prototyping Lab 4
- BIOE 141A Senior Capstone Design I 4
- BIOE 141B Senior Capstone Design II 4

Bioengineering Depth Electives

Four courses, minimum 12 units:

- BIOE 102 Physical Biology of Macromolecules
- BIOE 122 Bioscience and Bioterrorism Response
- BIOE 201C Diagnostic Devices Lab
- BIOE 211 Biophysics of Multi-cellular Systems and Amorphous Computing
- BIOE 212 Introduction to Biomedical Informatics Research Methodology
- BIOE 214 Representations and Algorithms for Computational Molecular Biology
- BIOE 217 Translational Bioinformatics
- BIOE 220 Introduction to Imaging and Image-based Human Anatomy
- or BIOE 51 Anatomy for Bioengineers
- BIOE 221 Physics and Engineering of Radionuclide-based Medical Imaging
- BIOE 222 Physics and Engineering Principles of Multi-modality Molecular Imaging of Living Subjects
- BIOE 223 Physics and Engineering of X-Ray Computed Tomography
- BIOE 224 Probes and Applications for Multi-modality Molecular Imaging of Living Subjects
- BIOE 225 Ultrasound Imaging and Therapeutic Applications
- BIOE 227 Functional MRI Methods
- BIOE 231 Protein Engineering
- BIOE 244 Advanced Frameworks and Approaches for Engineering Integrated Genetic Systems
- BIOE 260 Tissue Engineering
- BIOE 279 Computational Biology: Structure and Organization of Biomolecules and Cells
- BIOE 281 Biomechanics of Movement
- BIOE 291 Principles and Practice of Optogenetics for Optical Control of Biological Tissues

Total Units 104-107

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It is strongly recommended that CME 100 Vector Calculus for Engineers and CME 102 Ordinary Differential Equations for Engineers be taken rather than MATH 51 Linear Algebra, Multivariable Calculus, and Modern Applications and MATH 53 Ordinary Differential Equations with Linear Algebra. If you are taking the MATH 50 series, it is strongly recommended to take CME 192 Introduction to MATLAB. CME 106 Introduction to Probability and Statistics for Engineers utilizes MATLAB, a powerful technical computing program, and should be taken rather than STATS 110 Statistical Methods in Engineering and the Physical Sciences or STATS 141 Biostatistics. Although not required, CME 104 Linear Algebra and Partial Differential Equations for Engineers is recommended for some Bioengineering courses.

Science must include both Chemistry (CHEM 31A Chemical Principles I and CHEM 31B Chemical Principles II; or CHEM 31M Chemical Principles: From Molecules to Solids) and calculus-based Physics (PHYSICS 41 Mechanics and PHYSICS 43 Electricity and Magnetism), with two quarters of course work in each, in addition to two courses of BIO core. CHEM 31A Chemical Principles I and CHEM 31B Chemical Principles II are considered one course even though given over two quarters.

A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu). Students pursuing a premed program need to take additional courses; see the UGHB, BioE Premed 4-Year Plan.

Honors Program

The School of Engineering offers a program leading to a Bachelor of Science in Bioengineering with Honors (BIOE-BSH). This program provides the opportunity for qualified BioE majors to conduct independent research at an advanced level with a faculty research adviser and documented in an honors thesis.

In order to receive departmental honors, students admitted to the program must:

1. Declare the honors program in Axess (BIOE-BSH).
2. Maintain an overall grade point average (GPA) of at least 3.5 as calculated on the unofficial transcript.
3. Complete at least two quarters of research with a minimum of nine units of BIOE 191 Bioengineering Problems and Experimental Investigation or BIOE 191X Out-of-Department Advanced Research Laboratory in Bioengineering for a letter grade; up to three units may be used towards the bioengineering depth elective requirements.
4. Students submit a pdf of their thesis, including the signature page signed by both readers, to the student services officer by May 15. Students are sent email instructions on how to archive a permanent electronic copy in Terman Engineering library.
5. Attend and present thesis synopsis at the Bioengineering Honors Poster Fair at the end of Spring Quarter.

For more information and application instructions, see the Bioengineering Honors Program (http://bioengineering.stanford.edu/academics/undergraduate-programs/bioengineering-honors-program) web site.