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 31X Chemical Principles Accelerated 5-10
- or CHEM 31A & CHEM 31B Chemical Principles I and Chemical Principles II
- 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: 12

BIOE 115 Computational Modeling of Microbial Communities
BIOE 122 Biosecurity and Bioterrorism Response
BIOE 140
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
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

¹ The prerequisite includes a background in calculus (Mathematics 21-series) or AP or IB credit.

² The prerequisite includes a background in chemistry (Chemistry 1-series or AP or IB credit) and physics (Physics 1-series or AP or IB credit).
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 31X Chemical Principles Accelerated) 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. Submit a completed thesis draft to the honors adviser and second reader by the third week of Spring Quarter. Further revisions and final endorsement are to be finished by the second Monday in May, when two signed bound copies plus one PC-compatible CD-ROM are to be submitted to the student services officer.
5. Attend the Bioengineering Honors Symposium at the end of Spring Quarter and give a poster or oral presentation, or present in another approved suitable forum.

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