BIOENGINEERING

Courses offered by the Department of Bioengineering are listed under the subject code BIOE (https://explorecourses.stanford.edu/search?q=BIOE&view=catalog&page=0&academicYear=&collapse=&filter-coursestatus=Active-on&filter-departmentcode=BIOE=on&filter-catalognumber-BIOE=on) on the Stanford Bulletin's ExploreCourses web site.

Bioengineering is jointly supported by the School of Engineering and the School of Medicine. The facilities and personnel of the Department of Bioengineering are housed in the Shriram Center, James H. Clark Center, the William F. Durand Building for Space Engineering and Science, the William M. Keck Science Building, the Jerry Yang and Akiko Yamazaki Environment and Energy Building, and the Richard M. Lucas Center for Magnetic Resonance Spectroscopy and Imaging. The departmental headquarters is in the Shriram Center for Bioengineering and Chemical Engineering.

Courses in the teaching program lead to the degrees of Bachelor of Science in Bioengineering, Master of Science and Doctor of Philosophy. The department collaborates in research and teaching programs with faculty members in Chemical Engineering, Mechanical Engineering, Electrical Engineering, and departments in the School of Medicine. Quantitative biology is the core science base of the department. The research and educational thrusts are in biomedical computation, biomedical imaging, biomedical devices, regenerative medicine, and cell/molecular engineering. The clinical dimension of the department includes cardiovascular medicine, neuroscience, orthopedics, cancer care, neurology, and the environment.

Mission of the Undergraduate Program in Bioengineering

The Stanford Bioengineering (BIOE) 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 bioengineering 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.

The department offers an undergraduate major in Bioengineering leading to the B.S. degree in Bioengineering.

Learning Outcomes (Undergraduate)

The learning outcomes are used in evaluating students as well as the department’s undergraduate program. The department expects undergraduate majors in the program to be able to demonstrate the ability to:

1. Apply the knowledge of mathematics, science, and engineering.
2. Design and conduct experiments, as well to analyze and interpret data.
3. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. Function on multidisciplinary teams.
5. Identify, formulate, and solve engineering problems.
6. Understand professional and ethical responsibility.
7. Communicate effectively.
8. Understand the impact of engineering solutions in a global, economic, environmental, and societal context.
9. Demonstrate a working knowledge of contemporary issues.
10. Apply the techniques, skills, and modern engineering tools necessary for engineering practice.
11. Transition from engineering concepts and theory to real engineering applications.

Learning Outcomes (Graduate)

The purpose of the master’s program is to provide students with the knowledge and skills necessary for a professional career or doctoral studies. This is done through coursework with specialization in an area of the field, including biomedical computation, regenerative medicine and tissue engineering, molecular and cell bioengineering, biomedical imaging, and biomedical devices.

The PhD is conferred upon candidates who have demonstrated substantial scholarship and the ability to conduct independent research. Through coursework and guided research, the program prepares students to make original contributions in Bioengineering and related fields.

Graduate Programs in Bioengineering

The University’s requirements for the M.S. and Ph.D. degrees are outlined in the “Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees)” section of this bulletin.

Admission

Students are expected to enter with a series of core competencies in mathematics, biology, chemistry, physics, computing, and engineering. Specific requirements may be found at the Stanford Bulletin 2018-19.

Qualified applicants are encouraged to apply for predoctoral national competitive fellowships, especially those from the National Science Foundation. Applicants to the Ph.D. program should consult with their financial aid officers for information and applications.

The deadline for receiving applications is December 3, 2019. The Graduate Record Examination (GRE) is not required for admission to the M.S. or Ph.D. program in Bioengineering.

Further information and application instructions for all graduate degree programs may be obtained from Graduate Admissions (http://gradadmissions.stanford.edu).

Bachelor of Science in Bioengineering

The department offers an undergraduate major in Bioengineering (BIOE) leading to the B.S. degree in Engineering. For additional information, see the Handbook for Undergraduate Engineering Programs (UGHB).

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**

<table>
<thead>
<tr>
<th>Mathematics</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 units minimum (Prerequisites: 10 units of AP or IB credit or Mathematics 20-series)</td>
<td></td>
</tr>
<tr>
<td>CME 100 &amp; CME 102</td>
<td>Vector Calculus for Engineers and Ordinary Differential Equations for Engineers (Recommended)</td>
</tr>
<tr>
<td>MATH 51 &amp; MATH 53</td>
<td>Linear Algebra, Multivariable Calculus, and Modern Applications and Ordinary Differential Equations with Linear Algebra</td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>Science</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 31M</td>
<td>Chemical Principles: From Molecules to Solids (formerly 31X)</td>
</tr>
<tr>
<td>or CHEM 31A &amp; CHEM 31B</td>
<td>Chemical Principles I and Chemical Principles II</td>
</tr>
<tr>
<td>CHEM 33</td>
<td>Structure and Reactivity of Organic Molecules</td>
</tr>
<tr>
<td>BIO 83</td>
<td>Biochemistry &amp; Molecular Biology (Recommended)</td>
</tr>
<tr>
<td>or BIO 84</td>
<td>Genetics</td>
</tr>
<tr>
<td>or BIO 82</td>
<td>Physiology</td>
</tr>
<tr>
<td>PHYSICS 41</td>
<td>Mechanics</td>
</tr>
<tr>
<td>PHYSICS 43</td>
<td>Electricity and Magnetism</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology in Society</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIE 131</td>
<td>Ethics in Bioengineering (WIM)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Engineering Fundamentals</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOE 80</td>
<td>Introduction to Bioengineering (Engineering Living Matter)</td>
</tr>
<tr>
<td>CS 106A</td>
<td>Programming Methodology (or CS 106B or CS 106X)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Bioengineering Core</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOE 42</td>
<td>Physical Biology</td>
</tr>
<tr>
<td>BIOE 44</td>
<td>Fundamentals for Engineering Biology Lab</td>
</tr>
<tr>
<td>BIOE 101</td>
<td>Systems Biology</td>
</tr>
<tr>
<td>BIOE 103</td>
<td>Systems Physiology and Design</td>
</tr>
<tr>
<td>BIOE 123</td>
<td>Bioengineering Systems Prototyping Lab</td>
</tr>
<tr>
<td>BIOE 141A</td>
<td>Senior Capstone Design I</td>
</tr>
<tr>
<td>BIOE 141B</td>
<td>Senior Capstone Design II</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bioengineering Depth Electives</th>
<th>Units</th>
</tr>
</thead>
</table>

Four courses, minimum 12 units:

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

Total Units: 104-107

---

1. 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.

2. 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.
For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

**Prospective applicants should see the department’s website.**

Examination (GRE)

**Students should apply directly to the Bioengineering student and must have declared the undergraduate major. They must be accepted quarters for transfer students), have completed 120 undergraduate units, have completed six, non-summer quarters at Stanford (two non-summer units for the bachelor's degree plus 45 unduplicated units for the master's degree.**

Bioengineering. The degrees may be granted simultaneously or at the later date.

The application must provide evidence of potential for strong academic performance as a graduate student. The application is evaluated and acted upon by the graduate admissions committee of the department. Students are expected to enter with a strong background in mathematics, biology, chemistry, physics, computing, and engineering. Typically, a GPA of at least 3.5 in engineering, science, and math is expected.

**University Coterminal Requirements**

Coterminal master's degree candidates are expected to complete all master's degree requirements as described in this bulletin. University requirements for the coterminal master's degree are described in the "Coterminal Master’s Program (http://exploredegrees.stanford.edu/cotermdegrees)" section. University requirements for the master's degree are described in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees/#masterstext)" section of this bulletin.

After accepting admission to this coterminal master's degree program, students may request transfer of courses from the undergraduate to the graduate career to satisfy requirements for the master's degree. Transfer of courses to the graduate career requires review and approval of both the undergraduate and graduate programs on a case by case basis.

In this master's program, courses taken during or after the first quarter of the sophomore year are eligible for consideration for transfer to the graduate career; the timing of the first graduate quarter is not a factor. No courses taken prior to the first quarter of the sophomore year may be used to meet master's degree requirements.

Course transfers are not possible after the bachelor's degree has been conferred.

The University requires that the graduate adviser be assigned in the student's first graduate quarter even though the undergraduate career may still be open. The University also requires that the Master's Degree Program Proposal be completed by the student and approved by the department by the end of the student's first graduate quarter.

**Master of Science in Bioengineering**

The Master of Science in Bioengineering requires 45 units of coursework. The curriculum consists of core bioengineering courses, technical electives, core seminars and unrestricted electives. Core courses focus on quantitative biology and biological systems analysis. Approved technical electives are chosen by the student in consultation with his/her graduate adviser, and can be selected from graduate course offerings in mathematics, statistics, engineering, physical sciences, life sciences, and medicine. Seminars highlight emerging research in bioengineering and provide training in research ethics. Unrestricted electives can be freely chosen by the student in association with his/her adviser.

**Requirements**

The department's requirements for the M.S. in Bioengineering are:

**1. Core Bioengineering courses (10 units)**

The following courses are required:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOE 300A</td>
<td>Molecular and Cellular Bioengineering</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 300B</td>
<td>Quantitative Physiology</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 301A</td>
<td>Molecular and Cellular Engineering Lab</td>
<td>-4-5</td>
</tr>
<tr>
<td>BIOE 301B</td>
<td>Clinical Needs and Technology</td>
<td></td>
</tr>
<tr>
<td>BIOE 301C</td>
<td>Diagnostic Devices Lab</td>
<td></td>
</tr>
</tbody>
</table>

In order to apply for the coterminal master's program students must have completed six, non-summer quarters at Stanford (two non-summer quarters for transfer students), have completed 120 undergraduate units, and must have declared the undergraduate major. They must be accepted into our program one quarter before receiving the B.S. degree.

Students should apply directly to the Bioengineering student service office by December 3, 2019. The Graduate Record Examination (GRE) (http://www.gre.org) is not required for admission. Prospective applicants should see the department's website (http://bioengineering.stanford.edu/admissions/coterm) for application instructions and supporting documents.

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

**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.

**Coterminal Master's Program in Bioengineering**

This option is available to Stanford undergraduates who wish to work simultaneously toward a B.S. one major as well as an M.S. in Bioengineering. The degrees may be granted simultaneously or at the conclusion of different quarters, though the bachelor's degree cannot be awarded after the master's degree has been granted.

The University minimum requirements for the coterminal program are 180 units for the bachelor's degree plus 45 unduplicated units for the master's degree.

In order to apply for the coterminal master's program students must have completed six, non-summer quarters at Stanford (two non-summer quarters for transfer students), have completed 120 undergraduate units, and must have declared the undergraduate major. They must be accepted into our program one quarter before receiving the B.S. degree.

Students should apply directly to the Bioengineering student service office by December 3, 2019. The Graduate Record Examination (GRE) (http://www.gre.org) is not required for admission. Prospective applicants should see the department's website (http://bioengineering.stanford.edu/admissions/coterm) for application instructions and supporting documents.

The University requires that the graduate adviser be assigned in the student's first graduate quarter even though the undergraduate career may still be open. The University also requires that the Master's Degree Program Proposal be completed by the student and approved by the department by the end of the student's first graduate quarter.

1. Core Bioengineering courses (10 units)

The following courses are required:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOE 300A</td>
<td>Molecular and Cellular Bioengineering</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 300B</td>
<td>Quantitative Physiology</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 301A</td>
<td>Molecular and Cellular Engineering Lab</td>
<td>-4-5</td>
</tr>
<tr>
<td>BIOE 301B</td>
<td>Clinical Needs and Technology</td>
<td></td>
</tr>
<tr>
<td>BIOE 301C</td>
<td>Diagnostic Devices Lab</td>
<td></td>
</tr>
</tbody>
</table>
choosing courses and identifying research opportunities. One of the most
students are assigned an initial faculty adviser who assists them in
On the basis of the research interests expressed in their application,
complete at least 90 units of work at Stanford. The maximum number of
Students admitted to the Ph.D. program with an M.S. degree must
the completion of a minimum of 135 units of graduate work as well
be counted towards the degree. The Ph.D. degree is awarded after
Bioengineering. Up to 45 units of master's degree residency units may
A student studying for the Ph.D. degree must complete a master's
degree (45 units) comparable to that of the Stanford M.S. degree in
are offered directly through the Bioengineering Department but many are
Due to the interdisciplinary nature of Bioengineering, a number of courses
provide a cohesive course of study that provides depth and breadth.

2. Approved Technical Electives (27 units)
These units must be selected from graduate courses in mathematics,
statistics, engineering, physical science, life science, and medicine.
They should be chosen in concert with the bioengineering courses to
provide a cohesive degree program in a bioengineering focus area.
Students are required to take at least one course in some area of device
or instrumentation. Up to 9 units of directed study and research may be
used as approved electives.

3. Core Seminars (2 units)
The seminar units should be fulfilled through:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOE 393</td>
<td>Bioengineering Departmental Research Colloquium</td>
<td>1</td>
</tr>
<tr>
<td>MED 255</td>
<td>The Responsible Conduct of Research</td>
<td>1</td>
</tr>
</tbody>
</table>

Other relevant seminar units may also be used with the approval of
the faculty adviser. One of the seminar units must be MED 255 The
Responsible Conduct of Research.

4. Unrestricted Electives (6 units).
Students are assigned an initial faculty adviser to assist them in
designing a plan of study that creates a cohesive degree program.

To ensure that an appropriate program is pursued by all M.S. candidates,
students who first matriculate at Stanford at the graduate level must:

1. submit an adviser-approved Program Proposal for a Master's Degree
form to the student services office during the first month of the first
quarter of enrollment
2. obtain approval from the M.S. adviser and the Chair of Graduate
Studies for any subsequent program change or changes.

It is expected that the requirements for the M.S. in Bioengineering can be
completed within approximately one year. There is no thesis requirement
for the M.S..

Due to the interdisciplinary nature of Bioengineering, a number of courses
are offered directly through the Bioengineering Department but many are
available through other departments. See respective ExploreCourses for
course descriptions.

Doctor of Philosophy in Bioengineering
The University's basic requirements for the Ph.D. degree are outlined in the "Graduate Degrees (http://exploredegrees.stanford.edu/
gradiuatedegrees)" section of this bulletin.

A student studying for the Ph.D. degree must complete a master's
degree (45 units) comparable to that of the Stanford M.S. degree in
Bioengineering. Up to 45 units of master's degree residency units may
be counted towards the degree. The Ph.D. degree is awarded after
the completion of a minimum of 135 units of graduate work as well
as satisfactory completion of any additional University requirements.
Students admitted to the Ph.D. program with an M.S. degree must
complete at least 90 units of work at Stanford. The maximum number of
transfer units is 45.

On the basis of the research interests expressed in their application,
students are assigned an initial faculty adviser who assists them in
choosing courses and identifying research opportunities. One of the most
important goals of the first year is to identify a primary research adviser.

The department does not require formal lab rotations, but students are
encouraged to explore research activities in three or a maximum of four
labs during their first academic year.

Prior to being formally admitted to candidacy for the Ph.D. degree, the
student must demonstrate knowledge of Bioengineering fundamentals
and a potential for research by passing a qualifying oral examination
before the end of the second year.

In the beginning of the second year, the student is required to select a
quantitative topic and a biology/medicine topic on which to be examined.
Approximately one month before the exam, the student must submit
an application containing items including a curriculum vitae, 2-3 page
research project proposal, and transcript to the student services office.
The exams are taken during a two-day period in Spring Quarter for all
students. More information about the exam may be obtained from the
student services office.

Successfully passing the qualifying exam, as well as completing the
master's degree requirements, is required for students to advance to
candidacy. Advancement to candidacy by University requirements must
occur by the end of the Summer of the second year. Thus, all required
master's degree coursework must be completed during the first two years
of graduate study. Students who transfer master's degree residency
units to the Bioengineering Ph.D. degree are still required to fulfill the
core course and core seminar requirements. In cases where students
have already completed an equivalent course as part of their master's
degree, they may submit a petition to the graduate studies committee to
have their previous coursework applied to the core bioengineering course
requirement.

In addition to the course requirements of the M.S. degree, doctoral
candidates must complete a minimum of 15 additional units of approved
formal course work (excluding research, directed study, and seminars).
Finally, serving as a teaching assistant for two courses is a requirement
for the Ph.D. in Bioengineering. Both the 15 additional units and the
teaching assistant requirement must be completed before the end of the
3rd year.

Dissertation Reading Committee
Each Ph.D. candidate is required to establish a reading committee for the
dissertation within six months after passing the department's
Ph.D. qualifying exams. Thereafter, the student should consult frequently
with all members of the committee about the direction and progress of the
dissertation research, no less than once per year.

A dissertation reading committee consists of the principal dissertation
adviser and at least two other readers. Reading committees in
Bioengineering may include faculty from another department. It is
required that two members of the Bioengineering faculty, including
primary and/or courtesy faculty be on each reading committee. The initial
committee and any subsequent changes must be officially approved by the
Department Chair.

University Oral and Dissertation
The Ph.D. candidate is required to take the University oral examination
after the dissertation is substantially completed (with the dissertation
draft in writing) but before final approval. The examination consists of
a public presentation of dissertation research, followed by substantive
private questioning on the dissertation and related fields by the University
oral committee (four selected faculty members, plus a chair from another
department). Once the oral has been passed, the student finalizes the
dissertation for reading committee review and final approval.

Ph.D. Minor in Bioengineering
Doctoral students pursuing a Ph.D. degree in a degree program other than
Bioengineering may apply for the Ph.D. minor in Bioengineering. A minor
is not a requirement for any degree but is available when agreed upon by
the student and the major and minor department.

A student desiring a Ph.D. minor in Bioengineering must have a minor
program adviser who is a regular Bioengineering faculty member. This
adviser must be a member of the student’s reading committee for
the doctoral dissertation, and the entire reading committee must meet at
least one year prior to the date of the student’s dissertation defense.

The Ph.D. minor program must include at least 20 units of course work
in Stanford Bioengineering or Bioengineering cognate courses at or
above the 200 level. Of these 20 units, no more than 10 can be in cognate
courses. All courses listed to fulfill the 20-unit requirement must be taken
for a letter grade and the GPA must be at least 3.25. Courses used for
a minor may not be used to also meet the requirements for a master’s
degree.

**M.D./Ph.D. Dual Degree Program**

Students interested in a career oriented towards bioengineering and
medicine can pursue the combined M.D./Ph.D. degree program. Stanford
has two ways to do an M.D./Ph.D. U.S. citizens and permanent residents
can apply to the Medical Scientist Training Program and can be accepted
with funding from both M.D. and Ph.D. programs for stipend and tuition.
They then apply to the Bioengineering Ph.D. during their first or second
year of M.D. training. Students not admitted to the Medical Scientist
Training Program must apply to be admitted separately to the M.D.
program and the Ph.D. program of their choice.

The Ph.D. is administered by the Department of Bioengineering. To be
formally admitted as a Ph.D. degree candidate in this combined degree
program, the student must apply through normal departmental channels
and must have earned or have plans to earn an M.S. in Bioengineering or
another engineering discipline at Stanford or another university. The M.S.
requires 45 units of course work which consists of core bioengineering
courses, technical electives, seminars, and 6 unrestricted units. It is not
permissible to substitute medical school courses for the bioengineering
core course requirements. Students must also pass the Department of
Bioengineering Ph.D. qualifying examination.

For students fulfilling the M.D. requirements who earned their
master’s level engineering degree at Stanford, the Department of
Bioengineering waives the normal departmental requirement of 15
units applied towards the Ph.D. degree beyond the master’s degree
level through formal coursework. Consistent with the University Ph.D.
requirements, the department accepts 15 units comprised of courses,
research, or seminars approved by the student’s academic adviser
and the department chair. Students not completing their M.S. engineering
degree at Stanford are required to take 15 units of formal course work in
engineering-related areas as determined by their academic adviser.

**Joint Degree Programs in Bioengineering and the School of Law**

The School of Law and the Department of Bioengineering offer joint
programs leading to either a J.D. degree combined with an M.S.
degree in Bioengineering or to a J.D. degree combined with a Ph.D. in
Bioengineering.

The J.D./M.S. and J.D./Ph.D. degree programs are designed for students
who wish to prepare themselves intensively for careers in areas relating
to both law and bioengineering. Students interested in either joint
degree program must apply and gain entrance separately to the School
of Law and the Department of Bioengineering and, as an additional
step, must secure permission from both academic units to pursue
degrees in those units as part of a joint degree program. Interest in
either joint degree program should be noted on the student’s admission
applications and may be considered by the admissions committee
of each program. Alternatively, an enrolled student in either the Law
School or the Bioengineering Department may apply for admission to the
other program and for joint degree status in both academic units after
commencing study in either program.

Joint degree students may elect to begin their course of study in either
the School of Law or the Department of Bioengineering. Faculty advisers
from each academic unit will participate in the planning and supervision
of the student’s joint program. Students must be enrolled full time in the
Law School for the first year of law school, and, at some point during the
joint program, may be required to devote one or more quarters mainly
or exclusively to studies in the Bioengineering program regardless of
whether enrollment at that time is in the Law School or in the Department
of Bioengineering. At all other times, enrollment may be in the graduate
school or the Law School, and students may choose courses from
either program regardless of where enrolled. Students must satisfy the
requirements for both the J.D. and the M.S. or Ph.D. degrees as specified
in the *Stanford Bulletin* or elsewhere.

The Law School shall approve courses from the Bioengineering
Department that may count toward the J.D. degree, and the
Bioengineering Department shall approve courses from the Law School
that may count toward the M.S. or Ph.D. degree in Bioengineering. In
either case, approval may consist of a list applicable to all joint degree
students or may be tailored to each individual student’s program. The
lists may differ depending on whether the student is pursuing an M.S.
or a Ph.D. in Bioengineering.

In the case of a J.D./MS program, no more than 45 units of approved
courses may be counted toward both degrees. In the case of a J.D./
Ph.D. program, no more than 54 units of approved courses may be
counted toward both degrees. In either case, no more than 36 units of
courses that originate outside the Law School may count toward the
law degree. To the extent that courses under this joint degree program
originate outside of the Law School but count toward the law degree,
the law school credits that may be counted toward the M.S. or Ph.D. in Bioengineering is the greater of: (i) 15 units; or (ii) the
maximum number of units from courses outside of the department that
M.S. or Ph.D. candidates in Bioengineering are permitted to count toward
the applicable degree under general departmental guidelines or in the
case of a particular student’s individual program. Tuition and financial aid
arrangements will normally be through the school in which the student is
then enrolled.

**Graduate Advising Expectations**

The Department of Bioengineering is committed to providing academic
advising in support of graduate student scholarly and professional
development. When most effective, this advising relationship entails
collaborative and sustained engagement by both the adviser and the
advisee. As a best practice, advising expectations should be periodically
discussed and reviewed to ensure mutual understanding. Both the
adviser and the advisee are expected to maintain professionalism and
integrity.

Graduate students are active contributors to the advising relationship,
proactively seeking academic and professional guidance and taking
responsibility for informing themselves of policies and degree
requirements for their graduate program.

For a statement of University policy on graduate advising, see
the “Graduate Advising” section of this bulletin.

**Master’s Advising**

At the start of graduate study, each student is assigned a master’s
program adviser: a member of our faculty who provide guidance
in course selection and in exploring academic opportunities and
professional pathways. The department’s graduate handbook provides information and suggested timelines for advising meetings. Usually, the same faculty member serves as a program adviser for the duration of master’s study, but the handbook does describe a process for formal adviser changes.

In addition, the faculty Director of Graduate Studies (DGS) is available during the academic year by email and during office hours.

The department’s student services office is also an important part of the master’s advising team. They inform students and advisers about University and department requirements, procedures, and opportunities, and they maintain the official records of advising assignments and approvals.

**Doctoral Advising**

Faculty advisers guide students in key areas such as selecting courses, designing and conducting research, developing of teaching pedagogy, navigating policies and degree requirements, and exploring academic opportunities and professional pathways. The department's graduate handbook provides information and suggested timelines for advising meetings in the different stages of the doctoral program.

Ph.D. students are initially assigned a program adviser on the basis of the interests expressed in their application. This faculty member provides initial guidance in course selection, in exploring academic opportunities and professional pathways, and in identifying doctoral research opportunities.

Students identify their doctoral research/thesis adviser prior to the end of the first year of study. The research adviser assumes primary responsibility for the future direction of the student, taking on the roles previously filled by the program adviser, and ultimately directs the student’s dissertation. Most students find an adviser from among the primary faculty members of our department. However, the research adviser may be a faculty member from another Stanford department who is a member of the Academic Council, familiar with supervising doctoral students, and able to provide both advising and funding for the duration of the doctoral program. When the research adviser is from outside our department, the student must also identify a program adviser from the department’s primary faculty to provide guidance on departmental requirements and opportunities.

MCL faculty may not be the primary advisers of students. Although a co-adviser from the MCL line is permissible in some situations, the primary adviser must provide at least 50% of the mentoring for the student. Evidence that a student is receiving greater than 50% of mentoring from the primary adviser include: full attendance of lab meetings, regular one-on-one meetings, dedicated space in the primary adviser’s lab, funding provided by the primary adviser, and research being performed in an area that is of current relevance to the primary adviser. Advising situations that do not meet these criteria are subject to review by the graduate studies committee.

Throughout the Ph.D., each student is required to fill out an annual Individual Developmental Plan (IDP), usually in the Summer. The IDP is then discussed with the research adviser, as a way to facilitate: advising the student, both during and beyond the PhD; establishing clear expectations on both sides with respect to degree progress and timely graduation; and emphasizing the importance of wellness in graduate school, together with access to University wellness resources.

The Faculty Director of Graduate Studies (DGS) is also available during the academic year by email and during office hours. The department’s student services office is also an important part of the doctoral advising team: they inform students and advisers about University and department requirements, procedures, and opportunities, and they maintain the official records of advising assignments and approvals. Students are encouraged to talk with the DGS and the student services office as they consider adviser selection or for guidance in working with their adviser(s).

**Chair:** Jennifer R. Cochran

**Director of Undergraduate Studies:** Karl Deisseroth

**Director of Graduate Studies:** Markus Willard Covert

**Professors:** Russ B. Altman, Kwabena Boahen, Wah Chiu, Jennifer R. Cochran, Karl Deisseroth, Scott L. Delp, Norbert J. Pelc, Stephen R. Quake, Christina D. Smolke, James R. Swartz, Paul Yock

**Associate Professors:** Annelise E. Barron, Zev David Bryant, Markus Willard Covert, Andrew Endy, Michael Fischbach, Kerwyn C. Huang, Jin Hyung Lee, Michael Z. Lin, Jan T. Liphardt, Alison Lesley Marsden, Manu Prakash, Fan Yang

**Assistant Professors:** Lacramioara Bintu, David B. Camarillo, Polly M. Fordyce, Possu Huang, Paul Nuyujukian, Lei Stanley Qi, Bo Wang


**Associate Professors, by courtesy:** Sarah Heilshorn, Marc E. Levenston, Sakti Srivastava, Yunzhi Peter Yang

**Assistant Professors, by courtesy:** Eric Appel, Mary Frances Nunez Teruel, James K. Wall

**Adjunct Professors:** Uday Kumar, John Linehan, Vijay Pande, Marc L. Salit, Gordon Saul, Charles A. Taylor

**Lecturers:** Siavash Ahrar, Todd Brinton, Natalia Khuri, Joseph Mandato, Ryan K. Pierce, Joseph Towles, Ross D. Venook, Paul Vorster

**Graduate Related Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOMEDIN 210</td>
<td>Modeling Biomedical Systems: Ontology, Terminology, Problem Solving</td>
<td>3</td>
</tr>
<tr>
<td>BIOMEDIN 217</td>
<td>Translational Bioinformatics</td>
<td>4</td>
</tr>
<tr>
<td>EE 369A</td>
<td>Medical Imaging Systems I</td>
<td>3</td>
</tr>
<tr>
<td>EE 369B</td>
<td>Medical Imaging Systems II</td>
<td>3</td>
</tr>
<tr>
<td>ME 287</td>
<td>Mechanics of Biological Tissues</td>
<td>4</td>
</tr>
</tbody>
</table>