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Welcome
Welcome to the Nancy E. and Peter C. Meinig School of Biomedical Engineering. In this handbook you will find everything you need to know to affiliating with the biomedical engineering bachelor of science major. If you have any additional questions, you can contact the School undergraduate coordinator:

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Nancy E. and Peter C. Meinig School of Biomedical Engineering
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**Program Mission**

The mission of the B.S. program in biomedical engineering (BME) is to train students in the practice of design, fabrication, and analysis of biomedical systems, devices, diagnostics, and therapeutics. Specifically, Cornell’s vision for biomedical engineering centers around a quantitative approach to understanding biology across length and time scales, with a focus on issues related to human health. The quantitative nature of this program distinguishes the major from traditional programs in biology, while the focus on human health is distinct from other programs in engineering that include the study of biological systems (e.g. Biological and Environmental Engineering and Chemical and Biomolecular Engineering). Additionally, its focus on multiscale analysis of biological systems is a unique signature of Cornell Biomedical Engineering relative to programs at peer institutions.

**Program Objectives**

Biomedical Engineering is a leader in developing research that spans the Ithaca and New York City campuses, including Weill Cornell Medical College and Cornell Tech. Our objective is to create world-class graduates to meet the 21st century needs of biomedical-related industries focused on medical devices and pharmaceuticals, as well as government and private consulting practice. We also aim to produce intellectual and technical leaders for graduate education in medicine or engineering. Most importantly, we aim to create a diverse community of life-long learners who are innovation confident, collaborative across disciplines, and community engaged.

**Objective 1:** Teach our students to apply engineering principles to understand and predict the behavior of biological and physiological systems relevant to human health and disease

**Objective 2:** Train our students in the theory and practice of biomedical engineering design and technology creation

**Objective 3:** Train our students to engineer robust solutions within highly variable and complex biomedical problems

**Objective 4:** Build critical leadership, interpersonal and professional skills to thrive within diverse team environments and prepare for life-long learning

**Objective 5:** Provide our students with opportunities for an experiential learning approach based on biomedical applications

**Objective 6:** To provide a complementary liberal education in humanities, history and social sciences
Enrolling in the Biomedical Engineering Undergraduate Program
The undergraduate biomedical engineering major for the College of Engineering was approved by the State of New York in summer 2015. We are working hard to finalize the details of the curriculum. We have received many inquiries, so we have created a general set of guidelines to share at this stage.

Non-engineering Students (Incoming or Returning)
During the start-up phase of the major, which is likely to be a few years, only incoming first-year students and rising sophomores in the College of Engineering will be eligible to apply for affiliation (i.e., internal transfers and external transfers will not be eligible to apply for affiliation with BME).

Incoming Engineering Students
More complete information about course offerings, affiliation requirements, major requirements, and advising resources will be available soon. At this point in time, first-year students with a primary interest in BME should follow the process outlined for all first-year students for selecting and pre-enrolling as per our website:

http://www.engineering.cornell.edu/resources/advising/orientation/index.cfm

(NOTE: information in the SCIENCE section of the website will assist students who are considering BME).

Finally, and most importantly, students will be able to adjust course enrollment during the add/drop period in August after meeting with their faculty adviser and learning more about BME.

Returning Engineering Students
At this time, only incoming first-year students and qualifying rising sophomores (see NOTE below) in the College of Engineering will be eligible to apply for affiliation. More complete information about course offerings, affiliation requirements, major requirements, and advising resources will be available by mid-August, prior to add/drop.
**Important note for rising sophomores interested in BME:**

Advanced placement (AP, GCE, and IB credit) can NOT be used to satisfy the Introduction to Biology requirement for Biomedical Engineering. Biomedical Engineering requires students to satisfy the introductory Biology requirement by completing college level Biology as per follows:

1. **Completing ONE of the following two introductory Biology lectures (3 credits each):**
   - BIOMG 1350, Principles of Cell and Developmental Biology
   - BIOG 1440, Introduction to Comparative Physiology* (Students may substitute BIOG 1445 - Comparative Physiology, Individualized Instruction (4 credits) in place of BIOG 1440. Students are strongly cautioned that this is a self-paced class, and they should consult with Engineering Advising before enrolling).

2. **Completing one semester of BIOG 1500, Investigative Laboratory (2 credits)**

Therefore, rising sophomores who have not completed AT LEAST ONE OF BIOG 1350/1440 and BIOG 1500 during their first year AND can NOT complete the remaining Biology requirements during Fall of Sophomore year will NOT be eligible to apply for affiliation.

**Affiliation Requirements**

To affiliate with the BME Major, applicants must meet the following requirements:

- Minimum GPA of 2.5 in required math, science, and engineering courses completed with at most one grade below C-. Research/project team credit does not apply to this GPA.
- Completion of BIOG (1350 or 1440) and BIOG 1500 with grades of at least C. Advanced Placement (AP, IB, GCE credit) CANNOT be used to satisfy this requirement.
- Completion of CS1110/1112/1114/1115 and ENGRD2202 with minimum combined GPA of 2.5 and no grade less than C-.
- Completion of designated College of Engineering common curriculum by the end of semester 3 of sophomore year (see list below).
- For any course that is repeated, the two grades will be averaged.
- Meeting the above requirements does not guarantee affiliation with the BME major. During the first years of this new major a selection process balancing the above criteria will be required to manage enrollment. A supplemental application will be distributed by BME upon receipt of the College of Engineering’s "Application for Major Affiliation".
- Participation in volunteer engagement/science-based community / internship / project team / laboratory research activity at Cornell is encouraged.
• Engineering Common Curriculum to be completed by end of semester 3 of sophomore year:
  o MATH 1910, 1920, 2930
  o PHYS 1112, 2213
  o CHEM 2090
  o BION 1440/1350, 1500
  o BME/ENGRD 2202
  o Any ENGR

Good Standing Requirements

• Semester GPA > 2.3
• Cumulative GPA > 2.1
• No grade below C- in any Core or Concentration Course Required for Graduation
• No failing grades
• Minimum of 12 credits per semester completed with passing grades

1Only one course below a C- within major required courses is allowed for graduation.
2No course with a grade lower than C- may be used to satisfy a prerequisite for a subsequent BME course.

Honors Program

To participate in this honors program, students must meet the Majors Honors Programs criteria as delineated above, and must have at least 11 credits beyond the minimum required for graduation in BME (therefore the minimum number of credits to graduate is 141). These 11 credits shall include:

• BTRY 3020 Biological Statistics II –With a grade of at least B+ (4 credits)
• A significant research experience or honors project under the supervision of a BME faculty member using BME 4990 (Undergraduate Research) and BME 4991 (Honors Thesis), to be completed in their fourth year. A written senior honors thesis must be submitted as part of the second component. A minimum grade of A- in both courses is required for successful completion of this honors requirement. The two research courses will be taken in consecutive semesters. (6+ credits)
• A significant teaching experience under the supervision of a BME faculty member or as part of a regularly recognized course in the Meinig School under BME 4980: Undergraduate Teaching. (1+ credits)
In addition:

- The student must present a poster or oral presentation in a public research forum such as a national or regional professional society meeting, Bio Expo, or other public university event by the end of the student’s project.
- Project teams are not acceptable for Honors Thesis research unless there is a clearly defined project outside of the team effort attested by the project faculty advisor.
- No research, independent study, or teaching experience for which the student is paid may be counted towards the credits required for the honors program.

Timing
All interested students must complete a written application (available 1xx Weill Hall) no later than the end of the third week of their 7th semester, but students are encouraged to make arrangements with a faculty member during their junior year.

Procedures
Each applicant to the BME Honors Program must have a BME faculty advisor to supervise their honors program. Before enrolling into BME 4990, a written application must be submitted to the director for undergraduate studies. This application must include a brief proposal outlining a research topic, the significance of the topic with respect to human health, and the scope of the proposed project or thesis. A written approval of the faculty member who will direct the research is required to accompany this application. The proposal will be reviewed and either approved, returned back to the student for revision, or rejected. The proposed project must consist of a research, development, and/or design project that fills a clear knowledge or technical gap in the literature. A written report in the format of a technical paper is required at the conclusion of the project. Such reports include sections such as: Introduction, Materials and methods, Results, Discussion, Conclusions. It is expected that the report contain sufficient completeness and detail to be submitted to a peer reviewed journal publication. The report and an associated oral presentation will be evaluated by the BME Honors committee.
Curriculum at a Glance

BME Design and Practice

Core Engineering Analysis of Biological Systems + Concentration Specific Engineering Expertise

Cornerstones Applications and Fundamentals of BME

Engineering Core Curriculum
BME Undergraduate Course Flow Chart
Engineering Distributions

ENGRD 2202: Biomedical Transport Phenomena (Required)
ENGRD 2020: Statics and Mechanics of Solids (Required)

Required Major Course Sequence (Core and Cornerstones)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BME 2010</td>
<td>Physiology of Human Health and Disease</td>
</tr>
<tr>
<td>BME 2110*</td>
<td>Biomolecular Thermodynamics and Physical Chemistry</td>
</tr>
<tr>
<td>BME 2310</td>
<td>Biomedical Signals and Systems</td>
</tr>
<tr>
<td>MATH 2940</td>
<td>Linear Algebra</td>
</tr>
<tr>
<td>BTRY 3010*</td>
<td>Biological Statistics</td>
</tr>
<tr>
<td>BME 2210</td>
<td>Biomaterials: Foundation and Application in Medicine</td>
</tr>
<tr>
<td>BME 3010</td>
<td>Molecular Principles of Biomedical Engineering</td>
</tr>
<tr>
<td>BME 3020</td>
<td>Cellular Principles of Biomedical Engineering</td>
</tr>
<tr>
<td>BME 3030</td>
<td>Biomedical Instrumentation and Technology Fabrication</td>
</tr>
<tr>
<td>BME 4010</td>
<td>Biomedical Engineering Analysis of Metabolic and Structural Systems</td>
</tr>
<tr>
<td>BME 4020</td>
<td>Electrical and Chemical Physiology</td>
</tr>
<tr>
<td>BME 4080/4090:</td>
<td>Biomedical Engineering Design Laboratory</td>
</tr>
</tbody>
</table>

* BME 2110 is temporarily satisfied by BEE 2220
+ ENGRD 2700 or CEE 3040 alternatively satisfies this course

Biomedical Engineering Concentrations (Must Choose 1)

**Molecular, Cellular, and Tissue Engineering (MCTE)**

Required Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1570a</td>
<td>Introduction to Organic and Biological Chemistry</td>
</tr>
<tr>
<td>BME 3110</td>
<td>Engineering and Computational Analysis of Cellular Systems</td>
</tr>
<tr>
<td>BME 4190</td>
<td>MCTE Practicum Laboratory</td>
</tr>
</tbody>
</table>

Electives:

Choose 6 credits from the following courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTRY 4381</td>
<td>Bioinformatics Programming</td>
</tr>
<tr>
<td>BME 5850</td>
<td>Current Practices in Tissue Engineering</td>
</tr>
<tr>
<td>BME 5830</td>
<td>Cell-Biomaterials Interactions</td>
</tr>
<tr>
<td>CHEME 5430</td>
<td>Bioprocess Engineering</td>
</tr>
</tbody>
</table>

Or 1 3xxx/4xxx course from another BME Concentration
**Biomedical Materials and Drug Delivery (BMDD)**

Required Courses:
- CHEM 1570: Introduction to Organic and Biological Chemistry
- BME 3210: BDD Concentration Course
- BME 4190 or MCTE Practicum Laboratory
- BME 4490: BMMB Practicum Laboratory

Electives:
Choose 6 credits from the following courses:
- BEE 3650: Properties of Biological Materials
- MSE 4020 or MAE 4640: Mechanics of Materials; Processing and Design
- MSE 5230 or MSE 5810: Physics of Soft Materials
- BME 5850: Soft Tissue Biomechanics
- MSE 5550: Biomedical Materials and Their Applications
- MSE 5620: Biomineralization
- BME 5830: Cell-Biomaterial Interactions
- BME 5850: Current Advances in Tissue Engineering
- BME 6310: Engineering Principles in Drug Delivery

**Biomedical Imaging and Instrumentation (BII)**

Required Courses:
- PHYS 2214: Physics III: Oscillations, Waves, and Quantum Physics
- BME 3310: Medical and Preclinical Imaging
- BME 4390: Electronics for Biomedical Engineers (Practicum Laboratory)

Electives:
Choose 6 credits from the following courses:
- ECE 2100: Introduction to Circuits for Electrical and Computer Engineers
- ECE 3100: Introduction to Probability and Inference for Random Signals and Systems
- AEP 3300: Modern Experimental Optics
- ECE 4300: Lasers and Optoelectronics
- BEE 4590: Biosensors and Bioanalytical Techniques
- ECE 4910: Principles of Neurophysiology
ECE 4760  Designing with Microcontrollers  
ECE 5470  Computer Vision  
ECE 5780  Computer Analysis of Biomedical Images

**Biomedical Mechanics and Mechanobiology (BMMB)**

Required Courses:
- PHYS 2214  Physics III: Oscillations, Waves, and Quantum Physics  
- BME 4410  BMMB Concentration Course  
- BME 4490  BMMB Practicum Laboratory

Electives:
Choose 6 credits from the following courses:
- MAE 4640  Orthopaedic Biomechanics  
- MAE 4680  Biofluid Mechanics  
- BME 5810  Soft Tissue Biomechanics  
- MSE 5130  Mechanobiology of Materials and Cells  
- BEE 3310  Bio-Fluid Mechanics  
- BEE 4530  Computer Aided Engineering

Approved Electives (6 credits)

aCHEM 1570 requirement can also be satisfied by the Premed Organic/Biological Chemistry Sequence.
**Biomedical Engineering Major Course Check List**

See also the [Engineering Undergraduate Handbook](#) for the Course Checklist

<table>
<thead>
<tr>
<th>Core Science &amp; Engineering Courses (69 credit minimum)</th>
<th>Min. Credit Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1910 (Calculus For Engineers)</td>
<td>4</td>
</tr>
<tr>
<td>MATH 1920 Multivariable Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MATH 2930 Differential Equations for Engineers</td>
<td>4</td>
</tr>
<tr>
<td>MATH 2940 Linear Algebra for Engineers</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 2090 <em>(or 2150)</em> Engineering General Chemistry (Honors General and Inorganic Chemistry)</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 1112 <em>(or 1116)</em> Physics I: Mechanics (Physics I: Mechanics and Special Relativity)</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 2213 <em>(or 2218)</em> Physics II: Heat/Electromagnetism (Physics III: Waves and Thermal Physics)</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 2214 or CHEM 1570 Physics III: Oscillations, Waves, and Quantum Physics (Introduction to Organic and Biological Chemistry)</td>
<td>4</td>
</tr>
<tr>
<td>CS 1112 <em>(or 1110 or 1114 or 1115)</em></td>
<td>4</td>
</tr>
<tr>
<td>Introduction to Engineering: ENGRI 1XXX</td>
<td>3</td>
</tr>
<tr>
<td>Engineering Distribution 1: ENGRD 2202 (required)</td>
<td>3</td>
</tr>
<tr>
<td>First year Writing Seminar 1</td>
<td>3</td>
</tr>
<tr>
<td>First year Writing Seminar 2</td>
<td>3</td>
</tr>
<tr>
<td>Liberal Studies Distribution: six courses, 18-credit minimum</td>
<td>18</td>
</tr>
<tr>
<td>Liberal Studies 1</td>
<td></td>
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<tr>
<td>Liberal Studies 2</td>
<td></td>
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<tr>
<td>Liberal Studies 3</td>
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<td>Liberal Studies 4</td>
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<td>Liberal Studies 5</td>
<td></td>
</tr>
<tr>
<td>Liberal Studies 6</td>
<td></td>
</tr>
<tr>
<td>Approved Elective 1: two courses, 6-credit minimum</td>
<td>6</td>
</tr>
<tr>
<td>Approved Elective 2</td>
<td></td>
</tr>
<tr>
<td>Physical Education: two semesters and swim test</td>
<td>2</td>
</tr>
</tbody>
</table>

**Required Major Courses (50 credit minimum)**

<table>
<thead>
<tr>
<th>Required Major Courses</th>
<th>Min. Credit Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOMG 1350 or BLOG 1440</td>
<td>3</td>
</tr>
<tr>
<td>BLOG 1500</td>
<td>2</td>
</tr>
<tr>
<td>BTRY 3010 or CEE 3040</td>
<td>4</td>
</tr>
<tr>
<td>ENGRD 2020</td>
<td>3</td>
</tr>
<tr>
<td>BME 2010</td>
<td>3</td>
</tr>
<tr>
<td>BME 2110 / BEE 2220</td>
<td>3</td>
</tr>
<tr>
<td>BME 2210</td>
<td>3</td>
</tr>
<tr>
<td>BME 2310</td>
<td>3</td>
</tr>
<tr>
<td>BME 3010</td>
<td>3</td>
</tr>
</tbody>
</table>
BME 3020 3
BME 3030 3
BME 4010 3
BME 4020 3
BME 4080 3
BME 4090 3

BME Concentration (13-credit minimum)

BME Concentration 1 3
BME Concentration 2 3
BME Concentration 3 3
BME Concentration Laboratory (BME 4190, BME 4390, or BME 4490) 4

Total Required Credits: 132

Notes:

a. The choice between PHYS 2214 or CHEM 1570 depends on the concentration chosen within the major. CHEM 1570 can also be satisfied by the pre-medicine organic chemistry/biochemistry sequence. PHYS 2214 is required for Biomedical Imaging and Instrumentation (BII), and Biomedical Mechanics and Mechanobiology (BMMB); CHEM 1570 is required for Molecular/Cellular/Tissue Engineering (MCTE), and Biomaterials and Drug Delivery (BDD).
b. Introduction to Computing using Matlab (CS 1112, CS 1114, or CS 1115) is recommended.
c. In addition to the first-year writing seminars, a technical writing course must be taken as an engineering distribution, liberal studies, approved elective, or Major course. This requirement will be satisfied with the BME Concentration Laboratory.
d. ENGRD 2020 currently fulfills the BME course requirements. Best taken during semester 3, and must be completed before semester 5.
e. BEE 2220 currently satisfies BME 2110.
f. Students will choose 3 BME Concentration Courses and one BME Concentration Laboratory in one of the following concentration areas: Molecular/Cellular/Tissue Engineering (MCTE), Biomaterials and Drug Delivery (BDD), Biomedical Imaging and Instrumentation (BII), and Biomedical Mechanics and Mechanobiology (BMMB).
Advising Resources
Supplemental Form
Contact:
For questions about the BME major or minor, contact Ryan Sauve, 108 Weill Hall, bmeugrad@cornell.edu
See also, our FAQ list online.