Requirements

Mathematics

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 19</td>
<td>Calculus (or AP Calculus)</td>
<td>3</td>
</tr>
<tr>
<td>MATH 20</td>
<td>Calculus (or AP Calculus)</td>
<td>3</td>
</tr>
<tr>
<td>MATH 21</td>
<td>Calculus (or AP Calculus)</td>
<td>4</td>
</tr>
<tr>
<td>CS 103</td>
<td>Mathematical Foundations of Computing</td>
<td>3-5</td>
</tr>
<tr>
<td>CS 109</td>
<td>Introduction to Probability for Computer Scientists</td>
<td>3-5</td>
</tr>
</tbody>
</table>

Science

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 41</td>
<td>Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>or PHYSICS 41E</td>
<td>Mechanics, Concepts, Calculations, and Context</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 31M</td>
<td>Chemical Principles: From Molecules to Solids (formerly CHEM 31X)</td>
<td>5</td>
</tr>
<tr>
<td>or CHEM 31B</td>
<td>Chemical Principles II</td>
<td></td>
</tr>
<tr>
<td>CHEM 33</td>
<td>Structure and Reactivity of Organic Molecules</td>
<td>5</td>
</tr>
<tr>
<td>BIO 82</td>
<td>Genetics (or HUMBIO 2A)</td>
<td>4</td>
</tr>
<tr>
<td>BIO 83</td>
<td>Biochemistry &amp; Molecular Biology (or BIO 84 or HUMBIO 3A)</td>
<td>4</td>
</tr>
<tr>
<td>BIO 86</td>
<td>Cell Biology (or HUMBIO 4A)</td>
<td>4</td>
</tr>
</tbody>
</table>

Engineering Fundamentals

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 106B</td>
<td>Programming Abstractions</td>
<td>3-5</td>
</tr>
<tr>
<td>or CS 106X</td>
<td>Programming Abstractions</td>
<td></td>
</tr>
</tbody>
</table>

For the second required course, see concentrations

Technology in Society

One course required, see Basic Requirement 4; course used must be on the School of Engineering Approved Courses list in the UGHB the year taken.

Engineering

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 107</td>
<td>Computer Organization and Systems</td>
<td>3-5</td>
</tr>
</tbody>
</table>

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<th>Course</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 161</td>
<td>Design and Analysis of Algorithms</td>
<td>3-5</td>
</tr>
</tbody>
</table>

Select one of the following:

- CS 270 Modeling Biomedical Systems: Ontology, Terminology, Problem Solving 3
- CS 273A The Human Genome Source Code
- CS 274 Representations and Algorithms for Computational Molecular Biology
- CS 275 Translational Bioinformatics
- CS 279 Computational Biology: Structure and Organization of Biomolecules and Cells

Research: 6 units of biomedical computation research in any department

Cellular/Molecular Concentration

Mathematics: Select one of the following:

- STATS 141 Biostatistics
- MATH 51 Linear Algebra, Multivariable Calculus, and Modern Applications

One additional Engineering Fundamental

- BIO 104 Advance Molecular Biology: Epigenetics and Proteostasis
- CHEM 141 The Chemical Principles of Life I (or CHEM 171)

Informatics Electives (two courses)

- STATS 205 Introduction to Nonparametric Statistics
- STATS 215 Statistical Models in Biology

Informatics Core (three courses):

- CS 145 Data Management and Data Systems
- or CS 147 Introduction to Human-Computer Interaction Design
- CS 221 Artificial Intelligence: Principles and Techniques
- or CS 228 Probabilistic Graphical Models: Principles and Techniques
- or CS 229 Machine Learning

Organic/Organisms Concentration

One additional course from the previous two lines

Informatics Electives (three courses)

- Cell/Mol Electives (two courses)
- Organs Electives (two courses) 6-10

Informatics Electives (two courses)

- Cell/Mol Electives (two courses)
- Organs Electives (two courses)

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- Organs Electives (two courses)

Informatics Electives (two courses)

- Cell/Mol Electives (two courses)
- Organs Electives (two courses)
Two additional Organs Electives 5, 6
Simulation Electives (two courses) 5, 6
Informatics Electives (two courses) 5, 6
Simulation, Informatics, or Organs Elective (one course) 5, 6
Simulation Concentration
Mathematics:
CME 100 or MATH 51 Vector Calculus for Engineers 5, 6
Linear Algebra, Multivariable Calculus, and Modern Applications
ME 30 Engineering Thermodynamics (Fulfills 2nd Engineering Fundamental) 3
Simulation Core:
CME 102 or MATH 53 Ordinary Differential Equations for Engineers 5
Ordinary Differential Equations with Linear Algebra
ENG 80 Introduction to Bioengineering (Engineering Living Matter) 4
BIOE 101 Systems Biology 3
BIOE 103 Systems Physiology and Design 4
Simulation Electives (two courses) 5, 6
Cellular Elective (one course) 5, 6
Organs Elective (one course) 5, 6
Simulation, Cellular, or Organs Elective (two courses) 5, 6

Total Units 88-104

1 Acceptable substitutes for CS 109 are STATS 116 Theory of Probability, MS&E 120 Probabilistic Analysis, MS&E 220 Probabilistic Analysis, EE 178 Probabilistic Systems Analysis, and CME 106 Introduction to Probability and Statistics for Engineers.
2 Research projects require pre-approval of BMC Coordinators.
3 Research units taken as CS 191W Writing Intensive Senior Project or in conjunction with ENGR 199W Writing of Original Research for Engineers fulfill the Writing in the Major (WIM) requirement. CS 272 Introduction to Biomedical Informatics Research Methodology, which does not have to be taken in conjunction with research, also fulfills the WIM requirement.
4 One 3-5 unit course required; CS 106A Programming Methodology may not be used. See Engineering Fundamentals list in Handbook for Undergraduate Engineering Programs or on Approved Courses page at ughb.stanford.edu.
5 The list of electives is continually updated to include all applicable courses. For the current list of electives, see http://bmc.stanford.edu.
6 A course may only be counted towards one elective or core 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 Topics (Engineering Fundamentals and Depth courses) is 2.0.
7 A total of 40 Engineering Fundamentals and Core/Depth units must be taken. The core classes only provide 27 Engineering units, so the remaining units must be taken from within the electives.

Honors Program
The Biomedical Computation program offers an honors option for qualified students, resulting in a B.S. with Honors degree in Engineering (ENGR-BSH, Biomedical Computation). An honors project is meant to be a substantial research project during the later part of a student's undergraduate career, culminating in a final written and oral presentation describing the student's project and its significance. There is no limit to the number of majors who can graduate with honors; any BMC major who is interested and meets the qualifications is considered.

1. Students apply by submitting a 1-2 page proposal describing the problem the student has chosen to investigate, its significance, and the student's research plan. This plan must be endorsed by the student's research and academic advisers, one of whom must be a member of the Academic Council. In making its decision, the department evaluates the overall scope and significance of the student's proposed work.
2. Students must maintain a 3.5 GPA.
3. Students must complete three quarters of research. All three quarters must be on the same project with the same adviser. A Summer Quarter counts as one quarter of research.
   • Ideally, funding should not be obtained through summer research college sources, but rather through the UAR's Student Grants Program (http://exploredegrees.stanford.edu/soe-ug-majors/biomedicalcomputation/%20http://studentgrants.stanford.edu). In no case can the same work be double-paid by two sources.
4. Students must complete a substantial write-up of the research in the format of a publishable research paper. This research paper is expected to be approximately 15-20 pages and must be approved by the student's research adviser and by a second reader.
5. As the culmination of the honors project, each student presents the results in a public forum. This can either be in the honors presentation venue of the home department of the student's adviser, or in a suitable alternate venue.
6. 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.

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