BIOMEDICAL COMPUTATION UNDERGRADUATE MAJOR

COVID-19-Related Degree Requirement Changes

The BMC Program counts all courses taken in academic year 2020-21 with a grade of 'CR' (credit) or 'S' (satisfactory) towards satisfaction of undergraduate degree requirements that otherwise require a letter grade. Students are encouraged to enroll in the letter grade option for degree requirements whenever possible.

Biomedical Computation (BMC)

Completion of the undergraduate program in Biomedical Computation leads to the conferral of the Bachelor of Science in Engineering. The subplan "Biomedical Computation" appears on the transcript and on the diploma.

Mission of the Undergraduate Program in Biomedical Computation

Quantitative and computational methods are central to the advancement of biology and medicine in the 21st century. These methods span the analysis of biomedical data, the construction of computational models for biological systems, and the design of computer systems that help biologists and physicians create and administer treatments to patients. The Biomedical Computation major prepares students to work at the cutting edge of this interface between computer science, biology, and medicine. Students begin their journey by acquiring foundational knowledge in the underlying biological and computational disciplines. They learn techniques in informatics and simulation and their numerous applications in understanding and analyzing biology at all levels, from individual molecules in cells to entire organs, organisms, and populations. Students then focus their efforts in a depth area of their choosing, and participate in a substantial research project with a Stanford faculty member. Upon graduation, students are prepared to enter a range of disciplines in either academia or industry.

Requirements

		Units
Mathematics		
21 unit minimum, see Basic Requirement 1		
MATH 19	Calculus (or AP Calculus)	3
MATH 20	Calculus (or AP Calculus)	3
MATH 21	Calculus (or AP Calculus)	4
CS 103	Mathematical Foundations of Computing	3-5
CS 109	Introduction to Probability for Computer Scientists	3-5
Science		
17 units minimum, see Basic Requirement 2		
PHYSICS 41	Mechanics	4
CHEM 31M	Chemical Principles: From Molecules to Solids (formerly CHEM 31X)	5
or CHEM 31B	Chemical Principles II	
CHEM 33	Structure and Reactivity of Organic Molecules	5
BIO 82	Genetics (or HUMBIO 2A)	4
BIO 83	Biochemistry & Molecular Biology (or BIO 84 or HUMBIO 3A)	4
BIO 86	Cell Biology (or HUMBIO 4A)	4
Engineering Fundamentals		
CS 106B	Programming Abstractions [4]	5
or CS 106X	Programming Abstractions	
For the second required course, see concentrations [4]		
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.		3-5
Engineering		
CS 107	Computer Organization and Systems	3-5
CS 161	Design and Analysis of Algorithms	3-5
Select one of the following:		3
CS 270	Modeling Biomedical Systems	
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	
CME 209	Mathematical Modeling of Biological Systems	
Research: 6 units of biomedical computation research in any department [2,3]		6
Engineering Depth Concentration (select one of the following concentrations): [7]		
Cellular/Molecular Concentration		
Mathematics: Select one of the following:		
CME 100	Vector Calculus for Engineers	
STATS 141	Biostatistics	
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
One additional Engineering Fundamental [4]		
BIO 104	Advance Molecular Biology: Epigenetics and Proteostasis	
CHEM 141	The Chemical Principles of Life I (or CHEM 171) [4]	
Cell/Mol Electives (two courses) [5,6]		
Informatics Electives (two courses) [5,6]		
Simulation Electives (two courses) [5, 6]		
Simulation, Informatics, or Cell/Mol Elective (one course) [5,6]		
Informatics Concentration		
Mathematics: Select one of the following:		
STATS 141	Biostatistics	
STATS 203	Introduction to Regression Models and Analysis of Variance	
STATS 205	Introduction to Nonparametric Statistics	
STATS 215	Statistical Models in Biology	
One additional Engineering Fundamental [4]		
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	
One additional course from the previous two lines		
Informatics Electives (three courses) [5,6]		
Cellular Electives (two courses) [5,6]		
Organs Electives (two courses) [5,6]		6-10

Organs/Organisms Concentration		
Mathematics (select one of the following):		
CME 100	Vector Calculus for Engineers	
STATS 141	Biostatistics	
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
One additional Engineering Fundamental [4]		
Biology (two courses):		
BIO 112	Human Physiology	
CHEM 141	The Chemical Principles of Life I (or BIOE 220)	
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	Vector Calculus for Engineers	
or MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
ME 30	Engineering Thermodynamics (Fulfills 2nd Engineering Fundamental)	3
Simulation Core:		
CME 102	Ordinary Differential Equations for Engineers	5
or MATH 53	Ordinary Differential Equations with Linear Algebra	
ENGR 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		90-104

1. Acceptable substitutes for CS 109 are STATS 116 Theory of Probability, MS&E 120 Introduction to Probability, MS&E 220 Probabilistic Analysis, EE 178 Probabilistic Systems Analysis, MATH 151, 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 the Honors Program Application Webform found on the BMC website and should be prepared to upload 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://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 20-30 pages and must be approved by the student's research adviser and by a second reader.
5. Students submit an electronic pdf of their thesis, including the signature page signed by both readers, to Bioengineering student services. Students should review deadlines on the BMC website. (https://bioengineering.stanford.edu/academics/undergraduate-programs/biomedical-computation/honors/) Students are sent email instructions on how to archive a permanent electronic copy in Terman Engineering library.
6. As the culmination of the honors project, each student presents their results in the Bioengineering Honors Poster Fair in spring quarter of their senior year.

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