

BIOMEDICAL COMPUTATION

Computational techniques are now being used to ask and answer fundamental questions in biology and medicine in ways never before possible. The Biomedical Computation (BMC) major allows students to focus on this exciting interdisciplinary field – the use of advanced computational techniques in biology and medicine.

BMC is an IDP, or interdisciplinary program, with its home in the School of Engineering. Students who major in BMC will gain a rigorous foundation in the many component fields that go into biomedical computation, including computer science, math and statistics, biology, and chemistry. Each student then has the opportunity to pursue one of four tracks most suited to his or her interests.

Our graduates have gone on to pursue a wide range of paths after graduation. Many of our students have chosen to continue their studies and pursue advanced degrees in various fields, including bioinformatics, bioengineering, or any of the pure biological or computational sciences. We have also had a number of students enroll in medical school or MD/PhD programs. BMC graduates have also ended up in fields a bit farther away from biomedical computation, such as law school, management consulting, and others. BMC gives students a solid foundation in a number of different fields, and students have the ability to pursue a variety of career paths in any of the fields that make up the major.

COMPONENTS OF BMC:

BMC Core: Math, Science, Engineering Fundamentals, and TIS

All BMC students take courses to get a solid foundation in the component disciplines of biomedical computation. Most of these courses are typically taken during freshman and sophomore year. These courses include:

Math: Math 41, 42, Stat116 (or equivalent), and one additional math course specific to your track.

Chemistry: Chem31A+B *or* X; Chem 33

Biology: BIO Core or Human Biology Core (each is a 3-quarter sequence, ideally taken in sophomore year)

Physics: Physics 41

Computer Science: CS 107; CS106B or X; CS107; CS 161

Engineering Fundamentals: CS 106 (see above) plus one additional elective (see Chapter 3, Figure 3-4 for list of SoE approved courses)

Technology in Society (TIS): One course required; see list of SoE approved courses in Chapter 3, Figure 3-3

Please see the program sheets for the exact course list.

Tracks

For the upper division courses in the major, a student must choose between one of the four tracks of BMC. The four tracks are

Informatics

Simulation

Cellular/Molecular

Organs/Organ Systems

Two of the tracks, Informatics and Simulation, put a bit more emphasis on the computational aspects of the discipline, while the other two, Cellular/Molecular and Organs/Organ Systems, provide more depth in biology.

Each of the tracks consists of a core of about three to five courses. These are courses that provide students the core knowledge related to their in-depth area of study. The tracks also have elective requirements, to ensure students gain breadth in upper division courses as well. The entire track portion of BMC is composed of nine to ten courses in total. Lists of electives can be found on the BMC website at bmc.stanford.edu.

BMC Depth: Research, Writing in the Major, and Capstone Class

Research: Every BMC student must complete 6 units of directed research under a faculty member. This requirement of research is fairly unique to BMC among majors at Stanford. It allows our students to work on cutting-edge projects as a part of their undergraduate curriculum. This research typically occurs during the junior or senior year, and may be undertaken with faculty members from any School at Stanford. The main requirement is that the student be doing actual, hands-on biomedical computation as a part of the research project. The student must get approval from the BMC Program Directors before undertaking his or her research project.

WIM: The Writing in the Major requirement gives students an opportunity to learn to effectively communicate ideas in their fields of study. In BMC, there are two ways to satisfy this requirement:

1. Students may fulfill the WIM requirement by writing a ~15 page technical report concurrently with performing the research for the research requirement. This report is in the form of a technical publication about the students work, and is completed under supervision of your research mentor and the School of Engineering writing tutors. For this option, student can either 1) Enroll in least 3 of the 6 research units as CS191W, or 2) enroll in 5 units of research and 1 unit of E199W.
2. Students wishing to satisfy their WIM requirement independently of their research work may enroll in CS272.

Capstone Class: The BMC Capstone class gives students the chance to take a rigorous course that thoroughly integrates various aspects of biology and computation. This course is typically taken during junior or senior year. Currently, this requirement is satisfied by one of the following courses: CS270, CS273A, CS274, CS275, CS278, or CS279

ADVISING IN BMC

There are two types of advisors for the major: an academic advisor and a research advisor. The academic advisor is the person who oversees your path through BMC. It is necessary to have found an academic advisor in order to declare the major. Because BMC is in the School of

Engineering, the student's academic advisor must have an appointment in the School of Engineering. The one major commitment that this advisor makes in BMC that is different from other majors is that, in the case that the BMC student has trouble finding a research mentor, the academic advisor agrees that the student can work in his or her lab to fulfill the BMC research requirement.

The other advisor is the research mentor. Because there is interesting biomedical computation work being done throughout Stanford, not just in the School of Engineering, we place no restrictions as to where within Stanford the faculty mentor conducts his or her research. It is not necessary to have a research advisor at the time of declaring; many of our students do not.

One question we often get is whether it is possible or advisable for the student's academic and research advisor to be the same person. We do not have an opinion either way on this – plenty of students have chosen to do research with their academic advisor and plenty have done their research with a different faculty member. Either way is fine by us.

For additional information about the major, and for step-by-step instructions on how to declare, please visit the BMC website at <http://bmc.stanford.edu>. If you have further questions, please contact the student advisor for the major, Amit Kaushal, at akaushal@stanford.edu.

PROGRAM OPTIONS

If I do BMC can I also...

Be Premed?

Yes. This requires taking about six additional chemistry, physics, and biology lab courses. While we can offer some advice here, it is important to talk to a premed advisor to cover which additional courses you need to take.

Study abroad?

Absolutely! Though the major requirements are many, it is quite possible to go abroad. The earlier you start planning, the easier this will be.

Do an Honor thesis?

No. The BMC subplan lives under the School of Engineering, which does not grant honors. However, you will be doing a significant amount of research, and you can satisfy your WIM requirement by writing a thesis-like report on that research.

Do an additional major or minor in something else?

Yes. While the major is demanding, some students have managed to squeeze in other areas of study as well. Some students have asked about double-majoring or minoring in Computer Science or Biology. It does not make much sense to do so, since the BMC major has a large number of courses from these departments already. BMC majors can tailor their curriculum so that they are quite well trained in either of these disciplines.

Coterm?

Absolutely. Stanford offers students the opportunity to study an additional year or so and obtain a coterminal Master's degree. Many of our students have gone on to coterm in various departments at Stanford. Please contact the department in which you wish to coterm in your junior year – requirements vary from department to department, and this will leave enough time to plan for the application process and the courses you might have to take before enrolling.

MAJOR REQUIREMENTS FOR ALL BMC TRACKS:

See chart on next page for course requirements for all four tracks. For the most up-to-date information on BMC courses, go to <http://bmc.stanford.edu>

Note: The online version of the UGHB is considered the definitive and final version of SoE requirements for each major. Since corrections or updates may have been made after this Handbook went to press in August 2008, download an online BMC program sheet from ughb.stanford.edu to ensure you are using an accurate major plan

	Informatics	Simulation	Cellular/Molecular	Organs/Organisms
SoE: Math Requirement		Math 41: Calculus		
		Math 42: Calculus		
		CS109 or Stat116 or MS&E120 or MS&E220 or EE178 or CME106: Probability		
SoE: Science Requirement		CS103: Mathematical Foundations of Computing		
		CS161: Data Structures and Algorithms		
	STAT141 or STAT 203 or STAT 205 or STAT 215 or STAT 225: Advanced Statistics/Biostatistics	CME100 or MATH 51: Advanced Calculus I	CME100, MATH 51, or STAT 141: Advanced Calculus or Biostatistics	CME100, MATH 51, or STAT 141: Advanced Calculus or Biostatistics
		Physics 41: Mechanics		
		CHEM 31A and B, or CHEM 31X: Chemical Principles (regular or accelerated)		
SoE: TIS		CHEM 33: Structure and Reactivity		
		BIO 41 or HUMBIO 2A: Biology or Human Biology Core I		
		BIO 42 or HUMBIO 3A: Biology or Human Biology Core II		
		BIO 43 or HUMBIO 4A: Biology or Human Biology Core III		
SoE: Engineering Fundamentals		Technology in Society: 1 course; see UGHB, Fig. 3-3 for approved list		
	Any additional fundamental	CS106B or CS106X: Programming Abstractions	Any additional fundamental	Any additional fundamental
BMC Depth: Additional BMC Core requirements		CS107: Programming Paradigms		
		Capstone Class: One of CS270, CS273A, CS274, CS275, CS278, or CS279		
		Independent Research: 6 units, any department		
BMC Depth: Track Core and Elective Requirements		CS191W, E199W, or CS272: Writing in the Major (see note 1)		
	CS145: Databases or CS147: HCI	CME102 or MATH 52: Advanced Calculus II	BIO129A: Cell Bio I	BIO112: Physiology
	CS121 or 221, or CS228 or CS229 or CS 223B (AI/Machine Learning)	CME 104 or Math 53: Advanced Calculus III	BIO129B: Cell Bio II	BIO188 or BIOE/Rad200: Biochemistry or Intro to Imaging
	One additional course from the Informatics core (CS145, 147, 121, 221, 228, 229 or 223B)	PHYS 43 or 45: Electricity and Magnetism, or Light/Heat	BIO188 or CHEM135 or CHEM171: Biochemistry or Physical Chemistry	Organs Elective
	Informatics Elective	One of: E14, E15, or ME80	BIO203 or 118: Genetics	Organs Elective
	Informatics Elective	One more of: E14, E15, or ME80	Informatics Elective	Informatics Elective
	Informatics Elective	Simulation Elective	Informatics Elective	Informatics Elective
	Cell/Mol Elective	Simulation Elective	Simulation Elective	Simulation Elective
	Cell/Mol Elective	Cell/Mol Elective	Simulation Elective	Simulation Elective
	Organs Elective	Organs Elective	Inf, Sim, or Cell/Mol Elec.	Inf, Sim, or Organs Elec.

(1) Students may fulfill Writing in the Major and research requirements with E199W or CS191W, or they may take CS272 to fulfill WIM only. See program sheet for details

Biomedical Computation

Typical Sequence of Courses

<i>Freshman</i>	<i>Sophomore</i>	<i>Junior</i>	<i>Senior</i>
CS 106B or CS 106X	CS 107	Track-specific math course	
MATH 41 (A)	CS103, CS161	Core and elective courses for specific track** (-9-10 courses)	
MATH 42 (A,W)	BIO 41 or HUMBIO 2A (A)		
PHYS 41 (W)	BIO 42 or HUMBIO 3A (W)		
	BIO 43 or HUMBIO 4A (S)		
CHEM 31A+B (A,W) or CHEM 31X (A)		Capstone Course	
CHEM 33 (W,S)		Research (6 units) + WIM	
STAT 116 or equivalent (see program sheets)			
Engineering Fundamentals - 1 elective (in addition to CS 106, above)			
TIS Requirement - 1 course			

*The CS, Math, Stat, Chem, and BIO courses listed under freshman and sophomore year tend to be prerequisites for the upper-division core and elective courses in the major. Thus, it is worth taking these courses during the first two years of study if possible.

** For complete details about courses for each of the BMC tracks, visit bmc.stanford.edu.

Biomedical Computation

Molecular and Cellular

	<i>Fall</i>			<i>Winter</i>			<i>Spring</i>					
	Class	Math/ Sci.	Engr.	Other	Class	Math/ Sci.	Engr.	Other	Class	Math/ Sci.	Engr.	Other
<i>Freshman</i>	MATH 41	5	-	-	MATH 42	5	-	-	CS107	-	5	-
	CHEM 31X	4	-	-	CHEM 33	4	-	-	STAT 116	5	-	-
	CS106A	-	4	-	CS106B	-	4	-				
	<i>Subtotals</i>	<i>9</i>	<i>4</i>	<i>0</i>	<i>Subtotals</i>	<i>9</i>	<i>4</i>	<i>0</i>	<i>Subtotals</i>	<i>5</i>	<i>5</i>	<i>0</i>
	Total	13		Total	13		Total	10				
<i>Sophomore</i>	BIO 41	5	-	-	BIO 42	5	-	-	BIO 43	5	-	-
	CS103	-	5	-	CS161	-	4	-				
	STAT 141	4	-	-	PHYS 41	4	-	-				
	<i>Subtotals</i>	<i>9</i>	<i>5</i>	<i>0</i>	<i>Subtotals</i>	<i>9</i>	<i>4</i>	<i>0</i>	<i>Subtotals</i>	<i>5</i>	<i>0</i>	<i>0</i>
	Total	14		Total	13		Total	5				
<i>Junior</i>	Info Elective	-	3	-	BIO 129A	4	-	-	BIO 129B	4	-	-
	E30	-	3	-	BIO 188	5	-	-	Simul elct	-	3	-
	E130	-	4	-	BMI 210	-	3	-				
	<i>Subtotals</i>	<i>0</i>	<i>10</i>	<i>0</i>	<i>Subtotals</i>	<i>9</i>	<i>3</i>	<i>0</i>	<i>Subtotals</i>	<i>4</i>	<i>3</i>	<i>0</i>
	Total	10		Total	12		Total	7				
<i>Senior</i>	Genetics 203	4	-	-	CS/ME191	-	3	-	CS/ME191W	-	3	-
	Elective	-	-	3	Info elective	-	3	-	Simul elct	-	3	-
	<i>Subtotals</i>	<i>4</i>	<i>0</i>	<i>3</i>	<i>Subtotals</i>	<i>0</i>	<i>6</i>	<i>0</i>	<i>Subtotals</i>	<i>0</i>	<i>6</i>	<i>0</i>
	Total	7		Total	6		Total	6				

Total Math & Science Units:	63
Total Engineering Units:	50
Total Other Units:	3
Total Units:	116

Biomedical Computation
Organs and Organisms

	<i>Fall</i>			<i>Winter</i>			<i>Spring</i>					
	Math/			Math/			Math/					
	Class	Sci.	Engr.	Other	Class	Sci.	Engr.	Other	Class	Sci.	Engr.	Other
<i>Freshman</i>	MATH 41	5	-	-	MATH 42	5	-	-	CS107	-	5	-
	CHEM 31X	4	-	-	CHEM 33	4	-	-	STAT 116	5	-	-
	CS106A	-	4		CS106B	-	4	-				
	<i>Subtotals</i>	<i>9</i>	<i>4</i>	<i>0</i>	<i>Subtotals</i>	<i>9</i>	<i>4</i>	<i>0</i>	<i>Subtotals</i>	<i>5</i>	<i>5</i>	<i>0</i>
Total	13			Total	13			Total	10			
<i>Sophomore</i>	BIO 41	5	-	-	BIO 42	5	-	-	BIO 43	5	-	-
	CS103	-	5	-	CS161	-	4	-				
	MATH 51	5	-	-	PHYS 53	4	-	-				
	<i>Subtotals</i>	<i>10</i>	<i>5</i>	<i>0</i>	<i>Subtotals</i>	<i>9</i>	<i>4</i>	<i>0</i>	<i>Subtotals</i>	<i>5</i>	<i>0</i>	<i>0</i>
Total	15			Total	13			Total	5			
<i>Junior</i>	ENGR 30	-	3	-	BIO 112	4	-	-	Elective	3	-	-
	Organs elect	3	-	-	BIO 188	5	-	-	Simul elct	-	3	-
					CS 201	-	4	-				
	<i>Subtotals</i>	<i>3</i>	<i>3</i>	<i>0</i>	<i>Subtotals</i>	<i>9</i>	<i>4</i>	<i>0</i>	<i>Subtotals</i>	<i>3</i>	<i>3</i>	<i>0</i>
Total	6			Total	13			Total	6			
<i>Senior</i>	Info Elective	-	3	-	CS/ME191	-	3	-	CS/ME191W	-	3	-
	Simul elct	-	3	-	BMI 210	-	3	-	Info elective	-	3	-
	<i>Subtotals</i>	<i>0</i>	<i>6</i>	<i>0</i>	<i>Subtotals</i>	<i>0</i>	<i>6</i>	<i>0</i>	<i>Subtotals</i>	<i>0</i>	<i>6</i>	<i>0</i>
Total	6			Total	6			Total	6			

Total Math & Science Units: 62
 Total Engineering Units: 50
 Total Other Units: 0
Total Units: 112

Biomedical Computation *Simulation*

	<i>Fall</i>			<i>Winter</i>			<i>Spring</i>					
	Math/			Math/			Math/					
	Class	Sci.	Engr.	Other	Class	Sci.	Engr.	Other	Class	Sci.	Engr.	Other
<i>Freshman</i>	MATH 41	5	-	-	MATH 42	5	-	-	ENGR 14	-	3	-
	CHEM 31X	4	-	-	CHEM 33	4	-	-	PHYS 43	3	-	-
	CS106X	-	5	-	PHYS 41	4	-	-	MATH 51	5	-	-
	<i>Subtotals</i>	<i>9</i>	<i>5</i>	<i>0</i>	<i>Subtotals</i>	<i>13</i>	<i>0</i>	<i>0</i>	<i>Subtotals</i>	<i>8</i>	<i>3</i>	<i>0</i>
Total	14			Total	13			Total	11			
<i>Sophomore</i>	BIO 41	5	-	-	BIO 42	5	-	-	BIO 43	5	-	-
	ENGR 15	-	3	-	ENGR155A	-	5	-	ENGR155B	-	5	-
	ENGR 30	-	3	-								
	<i>Subtotals</i>	<i>5</i>	<i>6</i>	<i>0</i>	<i>Subtotals</i>	<i>5</i>	<i>5</i>	<i>0</i>	<i>Subtotals</i>	<i>5</i>	<i>5</i>	<i>0</i>
Total	11			Total	10			Total	10			
<i>Junior</i>	CS107	-	5	-	Simul Elct	-	3	-	Simul Elct	-	3	-
	CS103	-	5	-	BIO Elective	3	-	-	BIO Elective	3	-	-
					CS161	-	4	-	STAT 116	5	-	-
	<i>Subtotals</i>	<i>0</i>	<i>10</i>	<i>0</i>	<i>Subtotals</i>	<i>3</i>	<i>7</i>	<i>0</i>	<i>Subtotals</i>	<i>8</i>	<i>3</i>	<i>0</i>
Total	10			Total	10			Total	11			
<i>Senior</i>	BMI 210	-	3	-	ME 191	-	3	-	ME 191W	-	3	-
					CS 201	-	4	-				
	<i>Subtotals</i>	<i>0</i>	<i>3</i>	<i>0</i>	<i>Subtotals</i>	<i>0</i>	<i>7</i>	<i>0</i>	<i>Subtotals</i>	<i>0</i>	<i>3</i>	<i>0</i>
Total	3			Total	7			Total	3			

Total Math & Science Units: 56
 Total Engineering Units: 57
 Total Other Units: 0
Total Units: 113

Biomedical Computation
Informatics (early)

	<i>Fall</i>			<i>Winter</i>			<i>Spring</i>					
	Math/			Math/			Math/					
	Class	Sci.	Engr.	Other	Class	Sci.	Engr.	Other	Class	Sci.	Engr.	Other
<i>Freshman</i>	MATH 41	5	-	-	MATH 42	5	-	-	CS107	-	5	-
	CHEM 31X	4	-	-	CHEM 33	4	-	-	ENGR 62	-	4	-
	CS106X	-	5	-	PHYS 41	4	-	-	STAT 116	5	-	-
	<i>Subtotals</i>	9	5	0	<i>Subtotals</i>	13	0	0	<i>Subtotals</i>	5	9	0
Total			14	Total			13	Total			14	
<i>Sophomore</i>	BIO 41	5	-	-	BIO 42	5	-	-	BIO 43	5	-	-
	CS103	-	5	-	CS161	-	4	-	CS145	-	4	-
	STAT 141	4	-	-	CS 201	-	4	-				
	<i>Subtotals</i>	9	5	0	<i>Subtotals</i>	5	8	0	<i>Subtotals</i>	5	4	0
Total			14	Total			13	Total			9	
<i>Junior</i>	CS147	-	4	-	Cellular Elct	3	-	-	Info Elective	-	3	-
	CS 221	-	4	-	Info Elective	-	-	-	Organs Elct	3	-	-
	<i>Subtotals</i>	0	8	0	<i>Subtotals</i>	3	0	0	<i>Subtotals</i>	3	3	0
Total			8	Total			3	Total			6	
<i>Senior</i>	Info Elective	-	3	-	CS191	-	3	-	Cellular Elct	3	-	-
	BMI 210	-	3	-	Organs Elct	3	-	-	CS191W	-	3	-
	<i>Subtotals</i>	0	6	0	<i>Subtotals</i>	3	6	0	<i>Subtotals</i>	3	3	0
Total			6	Total			9	Total			6	

Total Math & Science Units: 58
 Total Engineering Units: 57
 Total Other Units: 0
Total Units: 115

Biomedical Computation
Informatics (late)

	<i>Fall</i>			<i>Winter</i>			<i>Spring</i>					
	Math/			Math/			Math/					
	Class	Sci.	Engr.	Other	Class	Sci.	Engr.	Other	Class	Sci.	Engr.	Other
<i>Freshman</i>	MATH 41	5	-	-	MATH 42	5	-	-				
					PHYS 41	4	-	-				
	<i>Subtotals</i>	5	0	0	<i>Subtotals</i>	9	0	0	<i>Subtotals</i>	0	0	0
	Total			5	Total			9	Total			0
<i>Sophomore</i>	STAT 116	5	-	-	CS103	-	5	-	CS161	-	4	-
	CHEM 31X	4	-	-	CHEM 33	4	-	-	CS107	-	5	-
	CS106A	-	4		CS106B	-	4	-	ENGR 62	-	4	-
	<i>Subtotals</i>	9	4	0	<i>Subtotals</i>	4	9	0	<i>Subtotals</i>	0	13	0
Total			13	Total			13	Total			13	
<i>Junior</i>	BIO 41	5	-	-	BIO 42	5	-	-	BIO 43	5	-	-
	STAT 141	4	-	-	CS 201	-	4	-	CS145	-	4	-
	CS147	-	4	-	CS121	-	3	-	Info Elective	-	3	-
	<i>Subtotals</i>	9	4	0	<i>Subtotals</i>	5	7	0	<i>Subtotals</i>	5	7	0
Total			13	Total			12	Total			12	
<i>Senior</i>	Cellular Elct	3	-	-	CS191	-	3	-	Organs Elct	3	-	-
	BMI 210	-	3	-	Cellular Elct	3	-	-	CS191W	-	3	-
	Organs Elct	3	-	-	Info elective	-	3	-	Info Elective	-	3	-
	<i>Subtotals</i>	6	3	0	<i>Subtotals</i>	3	6	0	<i>Subtotals</i>	3	6	0
Total			9	Total			9	Total			9	

Total Math & Science Units: 58
 Total Engineering Units: 59
 Total Other Units: 0
Total Units: 117

INSTRUCTIONS FOR DECLARING MAJOR IN ENGINEERING: BIOMEDICAL COMPUTATION (BS-ENGR)

1. Gather information about the major by talking to students and professors.
2. Design a 4-year plan based on the samples previous pages.
3. Print a copy of your transcript from Axess.
4. Select an advisor (choose from the list of faculty listed under “BMC Faculty Advisors” on the BMC website at <http://bmc.stanford.edu>).
5. Download the BSE:BMC program sheet from the School of Engineering web site (<http://ughb.stanford.edu>).
6. Meet with your advisor to review the 4-year plan
7. Based on your plan, fill out your program sheet
8. Meet with either Prof. Russ Altman or Prof. Daphne Koller to get approval; have them sign your program sheet.
9. Turn in your completed and signed Program Sheet, 4-Year Plan, and an unofficial Stanford transcript to Darlene Lazar in Terman 201. She will review for completion. You must then declare your major in Axess:
 - a. Select “Engineering” as your Major
 - b. Select “BMC” as your subplan
 - c. Ask Bertha Love (love@stanford.edu) to approve your major in PeopleSoft
10. When your major is approved, Bertha will notify you via email.

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Stanford University ♦ School of Engineering
Biomedical Computation - Informatics Track
2008–2009 Program Sheet

Final version of completed and signed program due to the department no later than one month prior to the last quarter of senior year.

Follow all requirements as stated for the year of the program sheet used.

Name: _____ SU ID: _____
 Email: _____ Local Phone: _____
 Date: _____ Date B.S. expected: _____

Mathematics and Science Requirements

Dept	Course	Title	Transfer/AP Approval			Unit	Grade
			✓ if Transfer	Initials	Date		
Mathematics (21 units minimum)							
MATH	41	Calculus				5	
MATH	42	Calculus				5	
CS109 or Stat116 or MS&E120 or MS&E220 or		Probability				4 or 5	
CS	103	Mathematical Foundations of Computing				5	
CS	161	Data Structures and Algorithms				4	
Stat141, Stat203, Stat205, Stat215 OR Stat225		Advanced Statistics or Biostatistics				3 or 4	
<i>Mathematics Unit Total (21 units minimum)</i>							

Science (17 units minimum)

PHYS	41	Mechanics				4	
CHEM 31A&B or 31X		Chemical Principles (regular or accelerated)				4 or 8	
CHEM	33	Structure & Reactivity				4	
BIO41 or HumBio2A		Biology or Human Biology Core I				5	
BIO42 or HumBio3A		Biology or Human Biology Core II				5	
BIO43 or HumBio4A		Biology or Human Biology Core III				5	
<i>Science Unit Total (17 units minimum)</i>							
<i>Math + Science Total (41 units minimum)</i>							

Technology in Society Requirement (1 course required; see UGHB, Fig. 3-3 for approved list)

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Engineering Fundamentals (2 courses required)

CS	106B or X	Programming Abstractions				5	
		Elective (see note 1)				3	
<i>Engineering Fundamentals Total</i>							

NOTES

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 - * Minimum Combined Grade Point Average for all courses in the major (combined) is 2.0.
 - * Transfer & AP credits in Math, Science, Funds., & TIS must be approved by the SoE Dean's office. Transfer credits in Engr Depth must be approved by the Advisor. Information & petitions at <http://ughb.stanford.edu/>
 - * All courses listed on this form must only be included under one category. Delete courses not taken.
- (1) One course required, 3 to 5 units. See Engineering Fundamentals list in UGHB.

BMC Depth (42 units minimum; see note 2)

Dept	Course	Title	Transfer/AP Approval			Units	Grade
			✓ if Transfer	Initials	Date		
Additional BMC Core requirements							
CS	107	Programming Paradigms				5	
CS270, CS273A, CS274, CS275, CS278, or CS279		Capstone Class - select one				3 or 4	
(any department)		Independent Research (see note 3)				6	
CS191W, E199W, or CS272		WIM (if not already satisfied by Independent Research - see note 3)					

Track Core (3 courses required)

CS145 or CS147		Databases or Human-Computer Interaction				4	
CS121 or 221, or CS228, or CS229, or CS223B		Artificial Intelligence/Machine Learning				3 or 4	
(additional course from above)		One additional course from Infomatics track core (see previous two lines)				3 or 4	

Track Depth (7 courses required)

Informatics Electives (3 courses required: see note 4)

						3	
						3	
						3	

Cellular/Molecular Electives (2 courses required: see note 4)

						3	
						3	

Organs/Organisms Electives (2 courses required: see note 4)

						3	
						3	

BMC Depth Total (Total of all units on this page) (42 units minimum)

Program Totals

<i>Mathematics and Science (41 units minimum)</i>	
<i>BMC Depth Total (Total of all units on this page) (42 units minimum)</i>	
<i>Engineering (Fundamentals + Depth) Units (see note 2) (40 units minimum)</i>	

Program Approvals

Advisor

Printed Name: _____ Date: _____

Signature: _____

Departmental

Printed Name: _____ Date: _____

Signature: _____

School of Engineering (signature not required prior to graduation)

Printed Name: _____ Date: _____

Signature: _____

NOTES (continued from page 1)

- (2) 40 units of engineering courses are required, to be met through the Engr Fundamentals and BMC Depth courses.
- (3) Students must complete 6 units of BMC research in any department, with project approval from BMC program coordinators. Research can satisfy WIM if student enrolls in CS191W or E199W. See bmc.stanford.edu for details.
- (4) The list of electives is continually updated to include all applicable courses. For the current list of electives, please visit <http://bmc.stanford.edu>. Electives may only be listed once on program sheet; no double-counting.

Stanford University ♦ School of Engineering
Biomedical Computation - Simulation Track
2008–2009 Program Sheet

Final version of completed and signed program due to the department no later than one month prior to the last quarter of senior year.

Follow all requirements as stated for the year of the program sheet used.

Name: _____	SU ID: _____
Email: _____	Local Phone: _____
Date: _____	Date B.S. expected: _____

Mathematics and Science Requirements

Dept	Course	Title	Transfer/AP Approval		Unit	Grade
			✓ if Transfer	Initials		
<i>Mathematics (21 units minimum)</i>						
MATH	41	Calculus			5	
MATH	42	Calculus			5	
CS109 or Stat116 or MS&E120 or MS&E220 or		Probability			4 or 5	
CS	103	Mathematical Foundations of Computing			5	
CS	161	Data Structures and Algorithms			4	
CME100 or Math51		Advanced Calculus I			5	
<i>Mathematics Unit Total (21 units minimum)</i>						

Science (17 units minimum)

PHYS	41	Mechanics			4	
CHEM 31A&B or CHEM 31X		Chemical Principles (regular sequence or accelerated)			8 or 4	
CHEM	33	Structure & Reactivity			4	
BIO41 or HumBio2A		Biology or Human Biology Core I			5	
BIO42 or HumBio3A		Biology or Human Biology Core II			5	
BIO43 or HumBio4A		Biology or Human Biology Core III			5	
<i>Science Unit Total (17 units minimum)</i>						
<i>Math + Science Total (41 units minimum)</i>						

Technology in Society Requirement (1 course required; see UGHB, Fig. 3-3 for approved list)

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Engineering Fundamentals (2 courses required)

CS	106B or X	Programming Abstractions			5	
ENGR	30	Eng. Thermodynamics			3	
<i>Engineering Fundamentals Total</i>						

NOTES

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- * Transfer & AP credits in Math, Science, Funds., & TIS must be approved by the SoE Dean's office. Transfer credits in Engr Depth must be approved by the Advisor. Information & petitions at <http://ughb.stanford.edu/>
- * All courses listed on this form must only be included under one category. Delete courses not taken.

program sheet continues on page 2

BMC Depth (42 units minimum; see note 2)

Dept	Course	Title	Transfer/AP Approval		Units	Grade
			✓ if Transfer	Initials		
Additional BMC Core requirements						
CS	107	Programming Paradigms			5	
CS270, CS273A, CS274, CS275, CS278, or CS279		Capstone Class - select one			3 or 4	
(any department)		Independent Research (see note 3)			6	
CS191W, E199W, or CS272		WIM (if not already satisfied by Independent Research - see note 3)				

Track Core (5 courses required)

CME102 or Math52		Advanced Calculus II			5	
CME104 or Math53		Advanced Calculus III			5	
Physics 43 or 45		Electricity/Magnetism or Light/Heat			4	
E14, E15, or ME80		Statics or Dynamics or Stress/Strain			3	
E14, E15, or ME80		(do not repeat from previous)			3 or 4	

Track Depth (4 courses required)

Simulation Electives (2 courses required: see note 4)

					3	
					3	

Cellular/Molecular Elective (1 course required: see note 4)

					3	
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Organs/Organ Systems Elective (1 courses required: see note 4)

					3	
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BMC Depth Total (Total of all units on this page) (42 units minimum)

Program Totals

Mathematics and Science (41 units minimum)	
BMC Depth Total (Total of all units on this page) (42 units minimum)	
Engineering (Fundamentals + Depth) Units (see note 2) (40 units minimum)	

Program Approvals

Advisor

Printed Name: _____ Date: _____
Signature: _____

Departmental

Printed Name: _____ Date: _____
Signature: _____

School of Engineering (signature not required prior to graduation)

Printed Name: _____ Date: _____
Signature: _____

NOTES (continued from page 1)

- (2) 40 units of engineering courses are required, to be met through the Engr Fundamentals and BMC Depth courses.
- (3) Students must complete 6 units of BMC research in any department, with project approval from BMC program coordinators. Research can satisfy WIM if student enrolls in CS191W or E199W. See bmc.stanford.edu for details.
- (4) The list of electives is continually updated to include all applicable courses. For the current list of electives, please visit <http://bmc.stanford.edu>. Electives may only be listed once on program sheet; no double-counting.

Stanford University ♦ School of Engineering
Biomedical Computation - Cellular/Molecular Track
2008–2009 Program Sheet

Final version of completed and signed program due to the department no later than one month prior to the last quarter of senior year.

Follow all requirements as stated for the year of the program sheet used.

Name: _____ SU ID: _____
 Email: _____ Local Phone: _____
 Date: _____ Date B.S. expected: _____

Mathematics and Science Requirements

Dept	Course	Title	Transfer/AP Approval			Unit	Grade
			✓ if Transfer	Initials	Date		
<i>Mathematics (21 units minimum)</i>							
MATH	41	Calculus				5	
MATH	42	Calculus				5	
CS 109 or STAT 116 or MS&E 120 or MS&E 220 or EE 178 or CME 106		Probability				4 or 5	
CS	103	Mathematical Foundations of Computing				5	
CS	161	Data Structures and Algorithms				4	
CME100, MATH 51, or STAT 141		Advanced Calculus or Biostatistics				5	
<i>Mathematics Unit Total (21 units minimum)</i>							

Science (17 units minimum)

PHYS	41	Mechanics				4	
CHEM 31A&B or 31X		Chemical Principles (regular seq. or accelerated)				8 or 4	
CHEM	33	Structure & Reactivity				4	
BIO41 or HumBio2A		Biology or Human Biology Core I				5	
BIO42 or HumBio3A		Biology or Human Biology Core II				5	
BIO43 or HumBio4A		Biology or Human Biology Core III				5	
<i>Science Unit Total (17 units minimum)</i>							
<i>Math + Science Total (41 units minimum)</i>							

Technology in Society Requirement (1 course required; see UGHB, Fig. 3-3 for approved list)

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Engineering Fundamentals (2 courses required)

CS	106B or X	Programming Abstractions				5	
		Elective (see note 1)				3	
<i>Engineering Fundamentals Total</i>							

NOTES

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 - * All courses listed on this form must only be included under one category. Delete courses not taken.
- (1) One course required, 3 to 5 units. See Engineering Fundamentals list in UGHB.

BMC Depth (42 units minimum; delete courses not taken. See note 2)

Dept	Course	Title	Transfer/AP Approval			Units	Grade
			✓ if Transfer	Initials	Date		
Additional BMC Core requirements							
CS	107	Programming Paradigms				5	
CS270, CS273A, CS274, CS275, CS278, or CS279		Capstone Class - select one				3 or 4	
(any department)		Independent Research (see note 3)				6	
CS191W, E199W, or CS272		WIM (if not already satisfied by Independent Research - see note 3)					

Track Core (4 courses required)

BIO	129A	Cellular Dynamics I				4	
BIO	129B	Cellular Dynamics II				4	
BIO 188 or CHEM 135 or 171		Biochemistry or Physical Chemistry				3	
BIO 203 or 118		Genetics				4 or 5	

Track Depth (5 courses required)

Informatics Electives (2 courses required: see note 4)

						3	
						3	

Simulation Electives (2 courses required: see note 4)

						3	
						3	

Informatics, Simulation, or Cell/Mol Elective (1 courses required: see note 4)

						3	
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BMC Depth Total (Total of all units on this page) (42 units minimum)

Program Totals

<i>Mathematics and Science (41 units minimum)</i>	<input type="text"/>
<i>BMC Depth Total (Total of all units on this page) (42 units minimum)</i>	<input type="text"/>
<i>Engineering (Fundamentals + Depth) Units (see note 2) (40 units minimum)</i>	<input type="text"/>

Program Approvals

Advisor

Printed Name: _____ Date: _____
 Signature: _____

Departmental

Printed Name: _____ Date: _____
 Signature: _____

School of Engineering (signature not required prior to graduation)

Printed Name: _____ Date: _____
 Signature: _____

NOTES (continued from page 1)

- (2) 40 units of engineering courses are required, to be met through the Engr Fundamentals and BMC Depth courses.
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Stanford University ♦ School of Engineering
Biomedical Computation - Organs and Organisms Track
2008–2009 Program Sheet

Final version of completed and signed program due to the department no later than one month prior to the last quarter of senior year.

Follow all requirements as stated for the year of the program sheet used.

Name: _____ SU ID: _____
 Email: _____ Local Phone: _____
 Date: _____ Date B.S. expected: _____

Mathematics and Science Requirements

Dept	Course	Title	Transfer/AP Approval			Unit	Grade
			✓ if Transfer	Initials	Date		
<i>Mathematics (21 units minimum)</i>							
MATH	41	Calculus				5	
MATH	42	Calculus				5	
CS109 or Stat116 or MS&E120 or MS&E220 or EE178 or CME106		Probability				4 or 5	
CS	103	Mathematical Foundations of Computing				5	
CS	161	Data Structures and Algorithms				4	
CME100, Math51, or Stat141		Advanced Calculus or Biostatistics				5	
<i>Mathematics Unit Total (21 units minimum)</i>							

Science (17 units minimum)

PHYS	41	Mechanics				4	
CHEM 31A&B or 31X		Chemical Principles (regular seq. or accelerated)				8	
CHEM	33	Structure & Reactivity				4	
BIO41 or HumBio2A		Biology or Human Biology Core I				5	
Bio42 or HumBio3A		Biology or Human Biology Core II				5	
Bio43 or HumBio4A		Biology or Human Biology Core III				5	
<i>Science Unit Total (17 units minimum)</i>							
<i>Math + Science Total (41 units minimum)</i>							

Technology in Society Requirement (1 course required; see UGHB, Fig. 3-3 for approved list)

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Engineering Fundamentals (2 courses required)

CS	106B or X	Programming Abstractions				5	
		Elective (see note 1)				3	
<i>Engineering Fundamentals Total</i>							

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- (1) One course required, 3 to 5 units. See Engineering Fundamentals list in Chapter 3 of UGHB.

BMC Depth (42 units minimum; see note 2)

Dept	Course	Title	Transfer/AP Approval			Units	Grade
			✓ if Transfer	Initials	Date		
Additional BMC Core requirements							
CS	107	Programming Paradigms				5	
CS270, CS273A, CS274, CS275, CS278, or CS279		Capstone Class - select one				3 or 4	
(any department)		Independent Research (see note 3)				6	
CS191W, E199W, or CS272		WIM (if not already satisfied by Independent Research - see note 3)					

Track Core (2 courses required)

BIO	112	Human Physiology				4	
BIO 188 or BioE/Rad 220		Biochemistry or Introduction to Imaging				3	

Track Depth (6 courses required)

Organs/Organ Systems Elective (2 courses required: see note 4)

						3	
						3	

Informatics Electives (2 courses required: see note 4)

						3	
						3	

Simulation Electives (2 courses required: see note 4)

						3	
						3	

Informatics, Simulation, or Organs/Organ Systems Elective (1 course required: see note 4)

						3	
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BMC Depth Total (Total of all units on this page) (42 units minimum)

Program Totals

<i>Mathematics and Science (41 units minimum)</i>	
<i>BMC Depth Total (Total of all units on this page) (42 units minimum)</i>	
<i>Engineering (Fundamentals + Depth) Units (see note 2) (40 units minimum)</i>	

Program Approvals

Advisor

Printed Name: _____
Signature: _____

Date: _____

Departmental

Printed Name: _____
Signature: _____

Date: _____

School of Engineering (signature not required prior to graduation)

Printed Name: _____
Signature: _____

Date: _____

NOTES (continued from page 1)

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