

Concentration in Biochemical Engineering

Interested in pursuing an undergraduate degree at the interface of life sciences and engineering?

The **Concentration in Biochemical Engineering** is for students majoring in **Chemical Engineering** who have an interest in pursuing careers or graduate studies in biotechnology, bioengineering, or the pharmaceutical industry. This program represents the first formal training program in bioengineering at UMass Amherst, and we are very excited about it! We hope you are excited about this opportunity as well.

What will I be able to do with this Concentration?

At the end of the program, you will have a BS degree in Chemical Engineering, and you can pursue a career in the chemical, petroleum, or advanced materials industry, just as any other BS Chemical Engineer would. However, you will also have specialized training that will make you a better candidate for a career in the biotechnology and pharmaceutical industries. Employers of chemical engineers in Massachusetts and Connecticut are heavily based in the life sciences and pharmaceutical sectors. ChemE students taking the courses listed on the next page have also gone on to graduate programs in Bioengineering and to medical schools.

Why a Biochemical Engineering Concentration rather than a degree in Bioengineering?

You may be considering other universities that offer B.S. degrees in Bioengineering. Our faculty has given much thought to how to integrate bioengineering with the traditional engineering disciplines, and whether or not to offer a distinct degree program. However, nationwide statistics show that students with core training in a traditional area of engineering and a specialization in bioengineering have **much better placement** than students with an undergraduate degree in bioengineering. This feedback has been echoed by our Departmental Advisory Board, which includes representatives from Bayer Healthcare, Amgen, Merck, Pfizer, and Millennium Pharmaceuticals.

What will I learn?

Students in the program will gain the skills necessary to design, analyze, and control biochemical processes:

- A basic understanding of molecular and cellular biology, including structure and function at the cellular, subcellular, and molecular levels
- An understanding of the chemical principles underlying the molecular components and the networks of reactions in living cells, including protein structure, reaction networks involved in metabolism, biosynthesis, signaling, transfer of genetic information, and recombinant DNA technology
- An appreciation for the application of chemical engineering and biochemistry principles to the design and optimization of processes in the food and pharmaceutical industries, including enzyme catalysis, metabolic engineering, fermentation, microbial growth, bioreactor design, and product recovery and purification
- An appreciation for emerging areas in bioengineering, gained through research or special topics courses

Will I get any hands-on experience?

YES! Students will have the opportunity to take ChE/Biochem 590A, Biotechnology Process Engineering Laboratory. This is an interdisciplinary lab focusing on the laboratory skills necessary to bring a biotechnology product to the marketplace. Engineers, biologists, and biochemists work in teams to design a process to supply a high-value product. Students gain experience with molecular biology tools for engineering cells lines to express proteins of interest, cultivation of cells in bioreactors, design of bioreactors, recovery and purification of biomolecules using filtration and chromatography, and characterization of protein quality and function. State-of-the-art techniques using high-throughput technologies are integrated throughout the course.

Students will also have the opportunity to perform bioengineering research with faculty through independent study projects and senior theses. Faculty members associated with the concentration are leaders in their field and include four NSF CAREER Award winners and leaders of interdisciplinary initiatives on campus, including the Institute for Cellular Engineering, ICE (www.umass.edu/ice). For more information on faculty research, see the Chemical Engineering website or the ICE website.

How do I sign up for the Concentration?

You may sign up any time after you become a Chemical Engineering major. Fill out a “Change of Major, Track, Honors, and/or Degree Form,” available from Marston 126 or from the wall outside Tami’s office (158F Goessmann). Fill in “Chemical Engineering” as your Major and “Biochemical Engineering” as the Subplan. This form needs to be signed by Professor Roberts and then brought to 126 Marston (The Office of Student Affairs) for the Dean’s signature and processing. If you have questions, contact the advisor for the Concentration, Prof. Susan Roberts (sroberts@ecs.umass.edu) or Undergraduate Advisor, Tami Paluca (paluca@ecs.umass.edu).

The Curriculum

Students must take a total of 15 credits. The following nine credits are required:

Biochem 275 – Cellular and Molecular Biology¹
Chem 423 – Biochemistry²
ChE 592 – Introduction to Biochemical Engineering³

Students must also take an additional **six credits** of advanced coursework or research in *special topics in bioengineering*. Courses **MUST** be engineering courses. Approved courses are below. Additional courses may be used to meet this requirement, but advance approval of Prof. Roberts is required.

ChE 290B – ChE Principles of Biological Systems
ChE 590A – Bioprocessing Engineering Laboratory (may be taken in lieu of ChE 402 Senior Lab)
ChE 590B – Tissue Engineering
ChE 597B – Soft Materials and Biomaterials
ChE 597C – Introduction to Biomolecular Engineering
ChE 597D – Nanostructured Biomaterials
ChE 296, 396, 496 – Independent Study in bioengineering⁴
ChE 296H, 396H, 496H – Honors Independent Study in bioengineering⁴
ChE 499Y, 499T – Honors Senior Thesis in bioengineering⁴
ChE 697A – Special Topics: Molecular and Systems Biotechnology

The required courses for this program fit into the required Advanced Chemistry elective and Technical Electives that all Chemical Engineering students are required to take, so you do not have to take “extra” courses on top of what is required for the Chemical Engineering major. See the next page for a recommended sequence of courses.

Students are strongly encouraged to take Biochem 275 during the fall semester. A small section may be offered in the spring but enrollment may prove difficult.

¹Students must take ChE 290B or Bio 100* (a requirement for all Chemical Engineering majors) *before* enrolling in Biochem 275. Students should not expect that the Biochemistry department will waive this requirement. ChE majors are however exempt from the Bio 101 prerequisite of Biochem 275 and should email paluca@ecs.umass.edu with “Biochem 275” in the subject line to request a course override. In the body of your email please include your full name, spire ID, email address and contact phone number. For the complete list of prerequisites for Biochem 275, please refer to the “Course Catalog” section of “Course Guides” in Spire. *Bio 100 is being renumbered. It will be Bio 151 as of Fall 2012.

²It is the student’s responsibility to ensure that he or she has the correct pre-requisites for this course. Chemical Engineering students will typically take this course junior year, after completing a year of organic chemistry. Students may elect to take Biochem 523 rather than Chem 423; however, it is the responsibility of the student to arrange to take the necessary pre-requisites before enrolling in this course. Pre-requisites will not be waived. (Chem 490A is now Chem 423)

³ChE 592 is typically offered once a year or once every two years. Students should check with the most recent instructor of the course to determine when it will be offered, and make plans accordingly. Some students may have to take this course during their junior year.

⁴Only three-credit independent study courses may be used to fulfill this requirement. Students wishing to fulfill this requirement with an independent study or thesis must gain approval of the topic by the Concentration advisors **BEFORE** enrolling for credit. This will typically occur at the start of the semester.

Recommended Sequence of Courses for Students Completing BioChE Concentration

<u>Freshman, Fall</u>	<u>Freshman, Spring</u>	<u>Sophomore, Fall</u>	<u>Sophomore, Spring</u>
ENGLWP 112 (3credits)	ChE 120 (3)	PHYSIC 152 (3)	ChE 226 (3)
ENGIN 110 (3)	PHYSIC 151 (3)	ChE 291A (1)	MATH 331 (3)
MATH 131 (4)	PHYSIC 153 (1)	ChE 290B (4) OR BIO 100 ⁵ (4)	CHEM 262 (3)
CHEM 111 (4)	MATH 132 (4)	MATH 233 (3)	CHEM 269 (2)
Social World (3)	CHEM 112 (4)	CHEM 261 (3)	Social World (3)
		Biochem 285 (3)	Social World (3)
<i>17 credits</i>	<i>15 credits</i>	<i>17 credits</i>	<i>17 credits</i>
<u>Junior, Fall</u>	<u>Junior, Spring</u>	<u>Senior, Fall</u>	<u>Senior, Spring</u>
ENGIN 351 (3)	ChE 333 (3)	ChE 401 ⁶ (4)	ChE 590A (4)
ChE 325 (3)	ChE 338 (3)	ChE 444 (3)	Bioeng Special Topic ⁷ (3)
ChE 330 (3)	CHEM 423 (3)	ChE 446 (3)	Technical Elective ⁸ (3)
ChE 391A (1)	ChE 361 (3)	ChE 491A (1)	Social World (3)
ChE 320 (3)	Social World (3)	ChE 592 (3)	Social World (3)
ChE 475 (3) (PChem)			
<i>16 credits</i>	<i>15 credits</i>	<i>14 credits</i>	<i>16 credits</i>

⁵ Bio 100 is being renumbered to Bio 151. The renumbering is tentatively planned to take effect as of fall 2012.

⁶ Completion of a General Education Integrative Experience (IE) course is a senior year requirement for all students who entered the University after June 2010. ChE 401 will fulfill this IE requirement.

⁷ See previous page for list of approved special topics courses in bioengineering.

⁸ See ChE curriculum flowchart for list of approved technical electives.

**Recommended Sequence of Courses for Students Completing BioChE Concentration
For Students Entering the University after June 2010**

<u>Freshman, Fall</u>	<u>Freshman, Spring</u>	<u>Sophomore, Fall</u>	<u>Sophomore, Spring</u>
ENGLWP 112 (3credits)	ChE 120 (3)	PHYSIC 152 (4)	ChE 226 (3)
ENGIN 110 (3)	PHYSIC 151 (4)	ChE 291A (1)	MATH 331 (3)
MATH 131 (4)	Math 132 (4)	ChE 290B (4) OR BIO 100 (4) ⁵	CHEM 262 (3)
CHEM 111 (4)	CHEM 112 (4)	MATH 233 (3)	CHEM 269 (2)
Social World (4)		CHEM 261 (3)	Social World (4)
<i>18 credits</i>	<i>15 credits</i>	<i>15 credits</i>	<i>15 credits</i>
<u>Junior, Fall</u>	<u>Junior, Spring</u>	<u>Senior, Fall</u> *	<u>Senior, Spring</u>
Biochem 275 (3)	ChE 333 (3)	ChE 401 ⁶ (4)	ChE 590A (4)
ChE 325 (3)	ChE 338 (3)	ChE 444 (3)	Bioeng Special Topic ⁷ (3)
ChE 330 (3)	CHEM 423 (3)	ChE 446 (3)	Technical Elective ⁸ (3)
ChE 391A (1)	ChE 361 (3)	ChE 491A (1)	Social World (4)
ChE 320 (3)	ENGIN 351 (3)	ChE 592 (3)	Social World (4)
ChE 475 (3) (PChem)			
<i>16 credits</i>	<i>15 credits</i>	<i>14 credits</i>	<i>18 credits</i>

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⁷ See page two for list of approved special topics courses in bioengineering.

⁸ See ChE curriculum flowchart for list of approved technical electives.