

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 below have also gone on to graduate school in Bioengineering and to medical school. **Your transcript and diploma will show the Concentration in Biochemical Engineering**, so potential employers and graduate schools will know that you have completed a formal training program in bioengineering.

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 have given much thought to how to integrate bioengineering together 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 members of our Departmental Advisory Board, which includes representatives from Bayer Healthcare, Amgen, Merck, Pfizer, and Millennium Pharmaceuticals. Employers overwhelmingly prefer students with a BS degree in a traditional engineering field and with specialized training in biochemistry and the life sciences.

What will I learn?

Students in the program will gain the skills necessary to design, analyze, and control biological processes. Specifically, students will acquire the following skills:

- 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 and regulation, fermentation, microbial growth, bioreactor design, and product recovery and purification,

- An appreciation for emerging areas in biochemical engineering, gained through independent study 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 laboratory focusing on the laboratory skills necessary to bring a biotechnology product to the marketplace. Engineers, biologists, and biochemists work in interdisciplinary 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 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, which is typically after the spring of your freshman year. Fill out a “Change of Major, Track, Honors, and/or Degree Form,” available during the Pre-registration Advising Period. Fill in “Chemical Engineering” as your Major and “Biochemical Engineering” as the Subplan. Turn this form in to the ChemE main office (159 Goessmann) for processing. If you have any questions, please contact the advisors for the Concentration, Prof. Susan Roberts (sroberts@ecs.umass.edu) or Prof. Neil Forbes (forbes@ecs.umass.edu).

The Curriculum

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

Biochem 285 – Cellular and Molecular Biology¹
 Chem 490 – 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 or Prof. Forbes is required.

ChE 590A – Biotechnology Processing Engineering Laboratory
 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. A recommended sequence of courses is below. **Students are strongly encouraged to take Biochem 285 during the spring semester.** This course is typically over-enrolled in the fall semester, and Biochemistry majors will have first priority for taking this course in the fall.

<u>Freshman, Fall</u>	<u>Freshman, Spring</u>	<u>Sophomore, Fall</u>	<u>Sophomore, Spring</u>
ENGLWP 112	ChE 120	PHYSIC 152	ChE 226
ENGIN 110	PHYSIC 151	ChE 291A	MATH 331
MATH 131	PHYSIC 153	BIO 100	CHEM 262
CHEM 111	MATH 132	MATH 233	CHEM 269A
Social World	CHEM 112	CHEM 261	Biochem 285
		Social World	Social World
<u>Junior, Fall</u>	<u>Junior, Spring</u>	<u>Senior, Fall</u>	<u>Senior, Spring</u>
ENGIN 351	Social World	ChE 401	ChE 402 or ChE 590A
ChE 325	ChE 333	ChE 444	Bioeng Special Topic
ChE 330	ChE 338	ChE 446	ChE 592
ChE 391A	CHEM 490	ChE 491A	Social World
ChE 320	ChE 361	Bioeng Special Topic	Social World
CHEM 475			

¹Students must take Bio 100 (a requirement for all Chemical Engineering majors) before enrolling in Biochem 285. Students should not expect that the Biochemistry department will waive this requirement.

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 490; 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.

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.