

## Concentration in Biochemical Engineering

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*For chemical engineering students who are interested in the interface of engineering and the life sciences*

The Concentration in Biochemical Engineering is an ideal track for students majoring in Chemical Engineering who would like to pursue **careers or graduate studies in biotechnology, bioengineering or the pharmaceutical industry.**

### How will the Biochemical Engineering Concentration prepare me for a career in biotechnology?

Students who have completed the Biochemical Engineering Concentration often reflect that it was a highlight of their academic studies and prepared them to be highly competitive for positions and careers in biotechnology. The specialized training and curriculum make our graduates ideally suited to work in the pharmaceutical and biotechnology sectors, which are a large proportion of the Massachusetts and New England jobs for chemical engineers. Our graduates who complete the concentration often go on to work in bioprocess engineering, jobs at biotech companies, or to pursue post-graduate studies related to biological engineering.

### Why choose the Biochemical Engineering Concentration rather than a degree in bioengineering?

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 members, including representatives from Bayer Healthcare, Amgen, Merck, Pfizer, AbbVie and Millennium Pharmaceuticals. The Chemical Engineering B.S. degree is a highly versatile and well-respected degree that offers a wide range of career opportunities, extending far beyond the biotechnology sector. This concentration gives students the opportunity to enhance their rigorous chemical engineering training with formal biochemical engineering study listed on their transcript.

### What will I learn?

Students in the concentration will learn:

- How to engineer and operate systems that contain living cells and biomolecules
- How to design and operate a bioprocess to manufacture biomolecules, drugs, and therapeutics
- How to apply biological principles to the engineering of living cells
- Foundational knowledge of basic molecular biology and cellular biology that enables engineering cells
- The chemical principles underlying the molecular components and the networks of reactions in living cells
- How to apply chemical engineering principles to the design and operation of bioprocesses, including the biotechnology, food, and pharmaceutical industries as well as industrial biomanufacturing
- Cutting-edge areas in bioengineering, gained through research or bioengineering special topics courses

### Will I need to take extra credits to fulfill the Concentration and the Chemical Engineering B.S.?

The concentration is set up to fit into the requirements of the major without the need to take any extra courses. Normally, students pursuing the Biochemical Engineering Concentration from the beginning of their studies do not need to take additional credits beyond those required for the Chemical Engineering B.S. degree. Completing the concentration requires a specific subset of elective courses that will also fulfill the advanced chemistry and engineering elective requirements for the Chemical Engineering degree. Students who join the concentration later may need to take additional courses, depending on their prior courses completed.

### Will I get hands-on experience?

Students have the opportunity to perform biological engineering research with faculty through independent study projects and senior theses. Faculty members associated with the concentration are widely recognized in their fields. For more information on faculty research, see the Chemical Engineering website. Students may also be able to take a specialized laboratory course focusing on biochemical engineering lab techniques in their final semester.

### What if I change my mind and do not want a career in biotech when I graduate?

Students who complete the concentration and chemical engineering degree still have earned a BS degree in Chemical Engineering. They can pursue a career in any area of chemical engineering (e.g., chemical, petroleum, energy, and materials engineering industries), just as any other bachelor's level chemical engineer. The concentration broadens students' opportunities in bio-related areas.

### When should I sign up for the Biochemical Engineering Concentration?

You may sign up any time after you become a Chemical Engineering major. Students are strongly encouraged to **sign up early** in their undergraduate studies. It is best to sign up in the fall semester of the sophomore year. Students that wait to sign up may not be able to complete the concentration curriculum requirements within the typical chemical engineering degree course sequence. It is important to sign up early so that you and your academic advisors can check that you are completing all requirements in SPIRE.

### How do I sign up for the Biochemical Engineering Concentration?

You can sign up for the concentration by emailing Tami Paluca ([paluca@ecs.umass.edu](mailto:paluca@ecs.umass.edu)) with your request to join the concentration. Requests are evaluated to ensure students can reasonably complete the concentration in their remaining studies. It can take up to two weeks for requests to be processed and approved. Then students should see the Biochemical Engineering Concentration requirements on their ARR in SPIRE under Degree Requirements.

### When do I need to start following the Biochemical Engineering Concentration course sequence?

Starting in the sophomore year, students are encouraged to follow the recommended course sequence for the concentration to ensure that they have completed the necessary prerequisites for each required course. If you develop an interest in the Biochemical Engineering Concentration at a later time, please speak with your academic advisor or Tami Paluca to determine if there are alternative routes to complete the concentration.

### Can I complete the Biochemical Engineering Concentration if I am not a Chemical Engineering student?

No, this concentration is only available to students majoring in chemical engineering at this time.

### What should I do if I have more questions about the Biochemical Engineering Concentration?

Please contact us! If you have any questions, please contact:

- **Prof. Lauren Andrews**, Advisor for the Biochemical Engineering Concentration ([lbandrews@umass.edu](mailto:lbandrews@umass.edu)) or
- **Tami Paluca**, Undergraduate Advisor in Chemical Engineering ([paluca@ecs.umass.edu](mailto:paluca@ecs.umass.edu))



Prof. Lauren Andrews



Tami Paluca

## Curriculum for the Biochemical Engineering Concentration

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- The required courses for this program fulfill the Advanced Chemistry elective and Technical Electives that all Chemical Engineering students are required to take. See the Concentration Recommended Course Sequence.

Students must take **a total of 15 credits** as outlined below to fulfill the Biochemical Engineering Concentration.

The following **3 courses (9 credits)** are required:

1. **BIOCHEM 275** – Molecular Biology<sup>1</sup> or **BIOCHEM 285** - Cellular and Molecular Biology<sup>1</sup> (3 credits)
2. **CHEM 423** – Biochemistry<sup>2</sup> (3 credits)
3. **CHEM-ENG 592** – Introduction to Biochemical Engineering<sup>3</sup> (3 credits)

An additional **6 credits** of **advanced coursework in bioengineering** are required. Approved electives are listed below. Additional courses may be used to meet this requirement, but advance approval of Prof. Andrews is required.

BIOCHEM 657 – Drug Design  
BIOLOGY 383H – Gene and Genome Analysis  
CHEM-ENG 220 – ChE Principles of Biological Systems  
CHEM-ENG 510 – Immunoengineering  
CHEM-ENG 535 – Microfluidics and Microscale Analysis in Materials and Biology  
CHEM-ENG 575 – Tissue Engineering  
CHEM-ENG 589 – Nanostructured Biomaterials

With approval, students may fulfill ONE 3-credit coursework requirement with an independent study or thesis in a relevant research area. Approval of the research topic by Prof. Andrews is required *before* enrolling for credit.

CHEM-ENG 296, 396, 496 – Independent Study in Bioengineering  
CHEM-ENG 296ISH, 396ISH, 496ISH – Honors Independent Study in Bioengineering  
CHEM-ENG 499Y, 499T – Honors Senior Thesis in Bioengineering

<sup>1</sup> Biochem 275 or Biochem 285 is typically taken during the fall semester of the junior year. However, students who are ahead in the curriculum can consider taking this course in the spring semester of sophomore year. A smaller section is offered in the spring, and enrollment is not guaranteed. Note that completion of ChE 220 or Bio 151 or Bio 161H is a prerequisite for enrolling in Biochem 275 or Biochem 285. *For complete list of prerequisites, refer to the Course Catalog under Course Guides in Spire.*

<sup>2</sup> Taking this course junior year after completing a year of organic chemistry fulfills the prerequisites. Students may elect to take Biochem 423 rather than Chem 423. However, it is the student's responsibility to arrange to take the necessary prerequisites *before* enrolling in this course. Prerequisites will not be waived. If you take Biochem 423 instead of Chem 423, you must contact Tami (paluca@ecs.umass.edu) so that she can make the necessary exceptions in Spire.

<sup>3</sup> CHEM-ENG 592 is only offered in the fall semester. Students typically take this course the fall of their senior year.

## Recommended Course Sequence for the Biochemical Engineering Concentration

First Year, Fall	First Year, Spring
ENGLWP 112 (3 cr)	ChE 120 (3 cr)
ENGIN 110 (3)	PHYSIC 151 (4)
MATH 131 (4)	MATH 132 (4)
CHEM 111 (4)	CHEM 112 (4)
Social World (4)	
ENGIN 191 (1)	

19 credits

15 credits

Sophomore, Fall	Sophomore, Spring
PHYSIC 152 (4 cr)	ChE 231 (3 cr)
ChE 226 (3)	ChE 325 (3)
ChE 220* (4) - BIO Requirement	MATH 331(3)
ChE 291A (1)	CHEM 262 (3)
MATH 233 (4)	CHEM 269 (2)
CHEM 261 (3)	

19 credits

14 credits

Junior, Fall	Junior, Spring
BIOCHEM 275 or BIOCHEM 285 (3 cr)	ChE 333 (3 cr)
ChE 320 (3)	ChE 338 (3)
ChE 330 (3)	CHEM 423 (3)
ChE 391A (1)	Social World (4)
ChE 475 (3)	Social World (4)
ENGIN 351 (3)	

16 credits

17credits

Senior, Fall	Senior, Spring
ChE 401 (4 cr)	ChE 402 (4 cr)
ChE 444 (3)	Bioeng Special Topic <sup>‡</sup> (3)
ChE 446 (3)	Bioeng Special Topic <sup>‡</sup> (3) or Tech Elective
ChE 491A (1)	Social World (4)
ChE 592 (3)	

14 credits

14 credits

- At the start of each semester, **always check your Academic Requirements Report (ARR)** on Spire to be sure that **both** your Chemical Engineering degree and Concentration requirements are being fulfilled.

\*All ChE majors are expected to take ChE 220. NOTE: AP Bio credit does not fulfill the prerequisite for Biochem 275 or 285. While you can complete the chemical engineering degree with AP Bio, you will NOT be able to complete the Concentration without ChE 220 or Bio 151 or Bio 190H to fulfill the prereq for Biochem 275 or 285. For exceptions, contact Tami Paluca and the instructor.

‡ See the Curriculum for the Biochemical Engineering Concentration for list of approved special topics courses in bioengineering. The Chemical Engineering degree requires at least 2 engineering technical electives. Advanced Biochem and Bio courses fulfill non-engineering tech electives. It is recommended to select Bioeng Special Topics courses to fulfill at least 1 engineering technical elective. Please remember that you are allowed to count only ONE Independent Study towards your required technical electives. IMPORTANT: ChE 220 fulfills your departmental Bio requirement and 4 of the 6 Bioeng Special Topic credits for the Concentration. However, ChE 220 does not also fulfill a technical elective for the chemical engineering major.

Refer to the general Chemical Engineering Flowsheet for the rules regarding the technical electives and social world courses.