

Concentration in Biochemical Engineering

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

The Concentration in Biochemical Engineering is for students majoring in Chemical Engineering who are interested 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 and Chemical Engineering degree?

Students with core training in a traditional area of engineering and a specialization in bioengineering have a very high job placement rate and are well prepared to work in biotechnology. 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. Our program has a track record of excellent placement after graduation. For examples, see the Student Spotlights of Recent Graduates on our website.

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 curriculum of the concentration is designed to fulfill the requirements of the major. Normally, students who pursue 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 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 by 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 the Undergraduate Advising Office in Chemical Engineering or the faculty advisor for the concentration (Prof. Andrews) with your request to join. 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 in their Academic Requirements Report (ARR) in SPIRE.

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 the Chemical Engineering Undergraduate Advising Office 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, you can contact:

- Prof. Lauren Andrews (lbandrews@umass.edu), Advisor for the Biochemical Engineering Concentration OR
- Dr. Matt Langer (mlanger@umass.edu), the Chemical Engineering Undergraduate Advisor

Curriculum for the Biochemical Engineering Concentration

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 285** – Cellular and Molecular Biology¹ (3 credits) or ANIMSCI 285⁴ with instructor permission
2. **CHEM 423** – Biochemistry² (3 credits) or BIOCHEM 423⁴
3. **CHEM-ENG 592B** – Introduction to Biochemical Engineering³ (3 credits)

An additional **6 credits** of **advanced coursework in bioengineering** are required. Pre-approved electives are:

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
BIOCHEM 657 – Drug Design
BIOLOGY 383H – Gene and Genome Analysis (4 credit)
BMED-ENG 504⁴ – Introduction to Gene Therapy
ANIMSCI 385⁴ – Biotechnology Laboratory
BIOLOGY 379H⁴ – Genomics and Bioinformatics
BIOLOGY 385H⁴ – Cellular & Molecular Biology Lab
CHEM 581⁴ – Chemical Biology
CHEM 658⁴ – Frontiers in Biotechnology

Students may fulfill up to 3 credits of the above advanced coursework in bioengineering with an independent study or thesis in a bioengineering-related research area. Approval of the topic by Prof. Andrews is required.

CHEM-ENG 296, 396, 496⁴ – Independent Study in Bioengineering
CHEM-ENG 296ISH, 396ISH, 496ISH⁴ – Honors Independent Study in Bioengineering
CHEM-ENG 499Y, 499T⁴ – Honors Senior Thesis in Bioengineering

Other courses may be used for this requirement with approval from Prof. Andrews (ibandrews@umass.edu).

***For all courses, students are required to meet all course prerequisites listed in the Course Catalog in SPIRE.**

¹ BIOCHEM 285 is typically taken in the fall of the junior year. Students ahead in the curriculum can consider taking this course in spring of the sophomore year. Smaller sections are offered in spring, and enrollment is not guaranteed. Note: completion of ChE 220 fulfills the prerequisite for BIOCHEM 285. *For complete list of prerequisites, refer to the Course Catalog in SPIRE.*

² 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.

³ CHEM-ENG 592B is only offered in the fall semester. Students typically take this course in their junior or senior year.

⁴ If you take this alternate course, contact ChemE Undergraduate Advisor (Dr. Matt Langer) to enter the exception in SPIRE.

Recommended Course Sequence for the Biochemical Engineering Concentration

First Year, Fall	First Year, Spring	Sophomore, Fall	Sophomore, Spring
ENGLWP 112 (3 cr)	ChE 120 (3 cr)	PHYSIC 152 (4 cr)	ChE 231 (3 cr)
ENGIN 110 (3)	PHYSIC 151 (4)	ChE 226 (3)	ChE 325 (3)
MATH 131 (4)	MATH 132 (4)	ChE 220* (4) - BIO Requirement	MATH 331(3)
CHEM 111 (4)	CHEM 112 (4)	MATH 233 (4)	CHEM 262 (3)
Social World (4)		CHEM 261 (3)	CHEM 269 (2)
ENGIN 191 (1)			
19 credits	15 credits	18 credits	14 credits

Junior, Fall	Junior, Spring	Senior, Fall	Senior, Spring
BIOCHEM 285 (3 cr)	ChE 333 (3 cr)	ChE 401 (4 cr)	ChE 402 (4 cr)
ChE 320 (3)	ChE 338 (3)	ChE 444 (3)	ChE 447 (2)
ChE 330 (3)	CHEM 423 (3)	ChE 446 (3)	Bioeng Special Topic* (3)
ChE 475 (3)	Social World (4)	ChE 592B (3)	Bioeng Special Topic* (3) or Tech Elective
ENGIN 351 (3)	Social World (4)		Social World (4)
15 credits	17 credits	13 credits	16 credits

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

*ChE majors typically take ChE 220. Note: AP Bio credit does not fulfill the prerequisite for BIOCHEM 285. You can complete the chemical engineering degree with AP Bio. However, you will not be able to complete the Concentration without ChE 220, BIO 151, or BIO 161H to fulfill the prerequisite for BIOCHEM 285.

* 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 other courses.