

# BIOCHEMICAL ENGINEERING, BACHELOR OF SCIENCE

## College of Engineering

The Department of Chemical Engineering offers two undergraduate programs: Chemical Engineering (<https://catalog.ucdavis.edu/departments-programs-degrees/chemical-engineering/chemical-engineering-bs/#requirements-text>) and Biochemical Engineering (p. 1).

## Biochemical Engineering Undergraduate Program

The Biochemical Engineering program is accredited by the Engineering Accreditation Commission of ABET (<http://www.abet.org>).

As the biotechnology industry expands and matures, there is an increasing need for engineers who can move products from the research stage to large-scale manufacturing. As they fill this need, engineers must also understand the production, purification, and regulatory issues surrounding biopharmaceutical manufacturing.

Biochemical engineers—with their strong foundations in chemistry, biological sciences, and chemical process engineering—are in a unique position to tackle these problems. Biochemical engineers apply the principles of cell and molecular biology, biochemistry, and engineering to develop, design, scale up, optimize, and operate processes that use living cells, organisms, or biological molecules for the production and purification of products (such as monoclonal antibodies, vaccines, therapeutic proteins, antibiotics, and industrial enzymes); for health and/or environmental monitoring (such as diagnostic kits, microarrays, biosensors); or for environmental improvement (such as bioremediation). An understanding of biological processes is also becoming increasingly important in the industries that traditionally employ chemical engineers, including the industries that process materials, chemicals, foods, energy, fuels, and semiconductors.

## Objectives

We educate students in the fundamentals of chemical and biochemical engineering, balanced with the application of these principles to practical problems; educate students as independent, critical thinkers who can also function effectively in a team; prepare students with a sense of community, ethical responsibility, and professionalism; prepare students for careers in industry, government, and academia; teach students the necessity for continuing education and self-learning; and foster proficiency in written and oral communications.

Students are encouraged to adhere carefully to all prerequisite requirements. The instructor is authorized to drop students from a course for which stated prerequisites have not been completed.

Exclusive of General Education units, the minimum number of units required for the Biochemical Engineering major is 161.

## Honors Program

An Honors Program is available to qualified students in the Chemical Engineering & Biochemical Engineering majors. It is a two-year program designed to challenge the most talented students in these majors. Students are invited to participate in their sophomore year. In the upper division coursework, students will complete either an honors thesis or a

project that might involve local industry. Students must maintain a grade point average of 3.500 to continue in the program. Successful completion of the Honors Program will be acknowledged on the student's transcript.

Code	Title	Units
<b>Lower Division Required Courses</b>		
<i>Mathematics</i>		
MAT 021A	Calculus	4
MAT 021B	Calculus	4
MAT 021C	Calculus	4
MAT 021D	Vector Analysis	4
MAT 022A	Linear Algebra	3-4
or MAT 027A	Linear Algebra with Applications to Biology	
or BIS 027A	Linear Algebra with Applications to Biology	
MAT 022B	Differential Equations	3-4
or MAT 027B	Differential Equations with Applications to Biology	
or BIS 027B	Differential Equations with Applications to Biology	
<i>Physics</i>		
PHY 009A	Classical Physics	5
PHY 009B	Classical Physics	5
PHY 009C	Classical Physics	5
<i>Chemistry</i>		
Choose one:		5
CHE 002A	General Chemistry	
CHE 002AH	Honors General Chemistry	
CHE 004A	General Chemistry for the Physical Sciences & Engineering	
Choose one:		5
CHE 002B	General Chemistry	
CHE 002BH	Honors General Chemistry	
CHE 004B	General Chemistry for the Physical Sciences & Engineering	
Choose one:		5
CHE 002C	General Chemistry	
CHE 002CH	Honors General Chemistry	
CHE 004C	General Chemistry for the Physical Sciences & Engineering	
<i>Biological Science</i>		
BIS 002A	Introduction to Biology: Essentials of Life on Earth	5
<i>Chemical Engineering &amp; Programming</i>		
ECH 005	Introduction to Analysis & Design in Chemical Engineering	3
ECH 051	Material Balances	4
ECH 060	Numerical Methods in Engineering	4
or ECS 032A	Introduction to Programming	
ECH 080	Chemical Engineering Profession	1
<i>Engineering</i>		
Choose one:		4
ENG 017	Circuits I	
or ENG 017V	Circuits I	
ENG 035	Statics	
ENG 045	Properties of Materials	
or ENG 045Y	Properties of Materials	

Lower Division Composition/Writing; choose one; a grade of C- or better is required: 4

COM 001	Major Works of the Ancient World	
COM 002	Major Works of the Medieval & Early Modern World	
COM 003	Major Works of the Modern World	
COM 004	Major Works of the Contemporary World	
ENL 003	Introduction to Literature	
or ENL 003V	Introduction to Literature	
NAS 005	Introduction to Native American Literature	
UWP 001	Introduction to Academic Literacies (Recommended)	
UWP 001V	Introduction to Academic Literacies: Online (Recommended)	
UWP 001Y	Introduction to Academic Literacies (Recommended)	

Lower Division Required Courses Subtotal 77-79

### Upper Division Required Courses

#### Engineering Chemical

ECH 140	Mathematical Methods in Biochemical & Chemical Engineering	4
ECH 141	Fluid Mechanics for Biochemical & Chemical Engineers	4
ECH 142	Heat Transfer for Biochemical & Chemical Engineers	4
ECH 143	Mass Transfer for Biochemical & Chemical Engineers	4
ECH 145A	Chemical Engineering Thermodynamics Laboratory	3
ECH 145B	Chemical Engineering Transport Lab	3
ECH 148A	Chemical Kinetics & Reaction Engineering	3
ECH 152A	Chemical Engineering Thermodynamics	3
ECH 152B	Chemical Engineering Thermodynamics	4
ECH 157	Process Dynamics & Control	4
ECH 158BN	Process Economics & Green Design	4
ECH 158C	Plant Design Project	4
ECH 161AN	Bioseparations (Pending Approval)	4
ECH 161BN	Biochemical Engineering Fundamentals	4
ECH 161C	Biotechnology Facility Design & Regulatory Compliance	4
ECH 161L	Bioprocess Engineering Laboratory	4

#### Biological Science

BIS 102	Structure & Function of Biomolecules	3
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#### Microbiology

MIC 102	Introductory Microbiology	3
MIC 103L	Introductory Microbiology Laboratory	2

#### Chemistry

CHE 128A	Organic Chemistry	3
CHE 128B	Organic Chemistry	3
CHE 129A	Organic Chemistry Laboratory	2

#### Biochemical Engineering Technical Electives

Choose eight units from the following: 8

1. Choose at least one laboratory course from the Laboratory Elective list.

2. Complete at least 3 units in any upper division engineering course(s) not numbered 190C and/or 198.

3. Remainder of units, for a total of 8 units, may be completed in any upper division engineering and/or science course(s)<sup>1</sup> excluding courses numbered 190 and 198.<sup>2</sup>

4. You may receive biochemical engineering elective credit up to a maximum of 4 units of an internship (192) and/or independent study (199). Research does not replace the required lab elective.

a. Credit for independent studies (199s) or internships (192s) completed outside of the department must be approved by the department's Undergraduate Affairs Committee. Additionally, students applying for these credits must submit an essay of at least 4 pages and no more than 10 pages detailing the engineering and/or science aspects of their work, results or outcomes (figures and graphs may be included), and how the experience relates to their educational program and objectives. The report must be submitted in pdf format and use 1.5 line spacing, 1" margins, and 12pt Times New Roman font. No intellectual property should be contained in the report. Applications must also include a written evaluation of the students' performance by the student's supervisor or faculty advisor.

5. Courses used to satisfy other major requirements cannot be used to satisfy the technical elective requirements.

#### Laboratory Electives

BIM 161L	Biomolecular Engineering Laboratory
BIT 161A	Genetics & Biotechnology Laboratory
BIT 161B	Plant Genetics & Biotechnology Laboratory
FST 102B	Practical Malting & Brewing
FST 104L	Food Microbiology Laboratory
FST 123L	Enzymology Laboratory
MCB 120L	Molecular Biology & Biochemistry Laboratory
MCB 160L	Principles of Genetics Laboratory
NPB 101L	Systemic Physiology Laboratory
NPB 104L	Cellular Physiology/Neurobiology Laboratory
VEN 123L	Analysis of Musts & Wines Laboratory
VEN 124L	Wine Production Laboratory

#### Upper Division Composition Requirement

A grade of C- or better is required:

Choose one: 0-4

UWP 102E	Writing in the Disciplines: Engineering
UWP 102F	Writing in the Disciplines: Food Science & Technology
UWP 104A	Writing in the Professions: Business Writing
or UWP 104AV	Writing in the Professions: Business Writing
or UWP 104AY	Writing in the Professions: Business Writing
UWP 104E	Writing in the Professions: Science
UWP 104T	Writing in the Professions: Technical Writing

Passing the Upper Division Composition Exam.

Upper Division Required Courses Subtotal	84-88
<b>Total Units</b>	<b>161-167</b>

<sup>1</sup> Acceptable science courses must carry one of the following subject designations: BIS, BIT, FST, MIC, MCB, NPB, PLB, PLS, STA, and VEN.

<sup>2</sup> With the exception for ECH 198.