

MAJOR IN CHEMICAL AND BIOLOGICAL ENGINEERING, ADVANCED MATERIALS CONCENTRATION

An education in chemical and biological engineering provides the intellectual foundation for our graduates to work on solutions to society's biggest problems (both current and future problems). For example, our graduates could go on to develop innovative materials and products, to design new devices to improve animal or human health or environmental health, and to design processes for the safe production of chemicals and biochemicals, the production of alternative energy sources, and prevention of hazardous waste. The possibilities are limitless. Chemical and biological engineering is a powerful blend of basic sciences and the skills to quantitatively describe, predict, and control all changes of matter. Our curriculum is based on the sciences of physics, chemistry, biology, and mathematics. It includes engineering science and design methods, as well as humanities and social sciences. The Chemical and Biological Engineering program provides an environment that promotes a sense of professionalism, the development of project management skills, and an appreciation for the value of life-long learning. Graduates of our program are well prepared to enter a variety of professions, or to pursue further advanced education. The broad, strong scientific basis of chemical and

biological engineering has kept our graduates consistently near or at the top in salary and demand among B.S. graduates.

Advanced Materials Concentration

The Advanced Materials concentration aims to educate students on understanding the relationship between the properties of a material and its molecular structure. This knowledge will provide students with the principles and tools to either modify existing materials for enhanced performance, or to generate new materials with tailored properties for addressing issues of high relevance in modern society, such as those related to efficiency, health, and sustainability. Examples include smart biomaterials that are responsive to external stimuli, bio-inspired materials, biodegradable and sustainable materials, materials for additive manufacturing, nano-engineered materials, and materials for extreme environments. The coursework in this concentration encompasses a wide range of disciplines, including polymer science and engineering, nanotechnology, biomaterials science, and tissue engineering.

The Chemical and Biological Engineering major is accredited by the Engineering Accreditation Commission of ABET (<http://abet.org>).

Requirements Effective Fall 2024

Students may enroll in either the standalone major or (at most) one of the concentrations under the Major in Chemical and Biological Engineering.

Freshman

		AUCC	Credits
CBE 160	MATLAB for Chemical and Biological Eng		1
CHEM 111	General Chemistry I (GT-SC2)	3A	4
CHEM 112	General Chemistry Lab I (GT-SC1)	3A	1
CHEM 113	General Chemistry II		3
CHEM 114	General Chemistry Lab II		1
CO 150	College Composition (GT-CO2)	1A	3
LIFE 102	Attributes of Living Systems (GT-SC1)	3A	4
MATH 160	Calculus for Physical Scientists I (GT-MA1)	1B	4
MATH 161	Calculus for Physical Scientists II (GT-MA1)	1B	4
PH 141	Physics for Scientists and Engineers I (GT-SC1)	3A	5
Select one group from the following:			3

Group A:

CBE 101 Introduction to Chemical and Biological Engr

Group B:

CBE 101A Introduction to Chemical and Biological Engr: Lecture

CBE 101B Introduction to Chemical and Biological Engr: Laboratory

Group C:

CBE 104A Study Abroad--Denmark: Intro to Chemical and Biological Engineering

Total Credits

33

Sophomore

CBE 201	Material and Energy Balances		3
CBE 205	Fundamentals of Biological Engineering		3
CBE 210	Thermodynamic Process Analysis		3
CHEM 341	Modern Organic Chemistry I		3
CHEM 343	Modern Organic Chemistry II		3

CHEM 344	Modern Organic Chemistry Laboratory		2
MATH 261	Calculus for Physical Scientists III		4
MATH 340	Intro to Ordinary Differential Equations		4
PH 142	Physics for Scientists and Engineers II (GT-SC1)	3A	5
Diversity, Equity, and Inclusion (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion)		1C	3

Total Credits **33**

Junior

BC 351	Principles of Biochemistry		4
CBE 310	Molecular Concepts and Applications		3
CBE 320	Chemical and Biological Reactor Design		3
CBE 330	Process Simulation		3
CBE 331	Momentum Transfer and Mechanical Separations		3
CBE 332	Heat and Mass Transfer Fundamentals		3
CBE 393	Professional Development Seminar		1
Bioscience Elective (see list below)			3
Technical Elective (see list below)			3
Advanced Writing (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing)		2	3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)		3B	3

Total Credits **32**

Senior

CBE 333	Chemical and Biological Engineering Lab I		2
CBE 430	Process Control and Instrumentation		3
CBE 442	Separation Processes		4
CBE 443	Chemical and Biological Engineering Lab II		2
CBE 451	Chemical and Biological Engineering Design I	4A,4B,4C	3
CBE 452	Chemical and Biological Engineering Design II	4A,4B,4C	3
Engineering Elective (see list below)			3
Technical Elective (see list below)			3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)		3B	3
Historical Perspectives (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives)		3D	3
Social and Behavioral Sciences (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sceinces)		3C	3

Total Credits **32**

Program Total Credits: **130**

Bioscience Electives

Select a minimum of 3 credits from the following.

Code	Title	Credits
BC 411	Physical Biochemistry	4
BC 521/CHEM 521	Principles of Chemical Biology	3
BIOM 525/MECH 525	Cell and Tissue Engineering	3
CBE 570	Biomolecular Engineering/Synthetic Biology	3

Technical Electives

Select a minimum of 6 credits from the following, or select additional credits from the Bioscience Electives or Engineering Electives lists.

Code	Title	Credits
BIOM 441	Biomechanics and Biomaterials	3
CHEM 315	Foundations of Polymer Chemistry	3
CHEM 461	Inorganic Chemistry	3
CHEM 462	Inorganic Chemistry Laboratory	2
MSE 502A	Materials Science and Engineering Methods: Materials Structure and Scattering	1

Code	Title	Credits
MSE 502B	Materials Science and Engineering Methods: Computational Materials Methods	1
MSE 502C	Materials Science and Engineering Methods: Materials Microscopy	1
MSE 502D	Materials Science and Engineering Methods: Materials Spectroscopy	1
MSE 502E	Materials Science and Engineering Methods: Bulk Properties and Performance	1
MSE 502F	Materials Science and Engineering Methods: Experimental Methods for Materials Research	1
MSE 503	Mechanical Behavior of Materials	3
MSE 504	Thermodynamics of Materials	3
MSE 505	Kinetics of Materials	3
BIOM 574/MECH 574	Bio-Inspired Surfaces	3
CBE 514	Polymer Science and Engineering	3
MECH 331	Introduction to Engineering Materials	4
MECH 432	Engineering of Nanomaterials	3
MECH 525/BIOM 525	Cell and Tissue Engineering	3
MECH 530	Advanced Composite Materials	3
MECH 531/BIOM 531	Materials Engineering	3
MECH 532/BIOM 532	Materials Issues in Mechanical Design	3
MECH 573/BIOM 573	Structure and Function of Biomaterials	3

Major Completion Map

Students may enroll in either the standalone major or (at most) one of the concentrations under the Major in Chemical and Biological Engineering.

Distinctive Requirements for Degree Program:

TO PREPARE FOR FIRST SEMESTER: The curriculum for this major assumes students enter college prepared to take calculus.

Engineering Electives

Select a minimum of 3 credits from the following.

Freshman

Semester 1

	Critical	Recommended	AUCC	Credits
CBE 160	MATLAB for Chemical and Biological Eng	X		1
CHEM 111	General Chemistry I (GT-SC2)	X	3A	4
CHEM 112	General Chemistry Lab I (GT-SC1)	X	3A	1
LIFE 102	Attributes of Living Systems (GT-SC1)	X	3A	4
MATH 160	Calculus for Physical Scientists I (GT-MA1)	X	1B	4
Select one group from the following:	X			3

Group A:

CBE 101 Introduction to Chemical and Biological Engr

Group B:

CBE 101A Introduction to Chemical and Biological Engr: Lecture

CBE 101B Introduction to Chemical and Biological Engr: Laboratory

Group C:

CBE 104A Study Abroad--Denmark: Intro to Chemical and Biological Engineering

Total Credits

17

Semester 2

	Critical	Recommended	AUCC	Credits
CHEM 113	General Chemistry II	X		3
CHEM 114	General Chemistry Lab II	X		1
CO 150	College Composition (GT-CO2)	X	1A	3
MATH 161	Calculus for Physical Scientists II (GT-MA1)	X	1B	4
PH 141	Physics for Scientists and Engineers I (GT-SC1)	X	3A	5

Total Credits

16

Sophomore

Semester 3

	Critical	Recommended	AUCC	Credits
CBE 201	Material and Energy Balances	X		3
CBE 205	Fundamentals of Biological Engineering	X		3
CHEM 341	Modern Organic Chemistry I	X		3
MATH 261	Calculus for Physical Scientists III	X		4
Diversity, Equity, and Inclusion (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion)			1C	3

Total Credits

16

Semester 4		Critical	Recommended	AUCC	Credits
CBE 210	Thermodynamic Process Analysis	X			3
CHEM 343	Modern Organic Chemistry II	X			3
CHEM 344	Modern Organic Chemistry Laboratory	X			2
MATH 340	Intro to Ordinary Differential Equations	X			4
PH 142	Physics for Scientists and Engineers II (GT-SC1)	X		3A	5
Total Credits					17
Junior					
Semester 5		Critical	Recommended	AUCC	Credits
BC 351	Principles of Biochemistry	X			4
CBE 310	Molecular Concepts and Applications	X			3
CBE 330	Process Simulation	X			3
CBE 331	Momentum Transfer and Mechanical Separations	X			3
Advanced Writing (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing)		X		2	3
Total Credits					16
Semester 6		Critical	Recommended	AUCC	Credits
CBE 320	Chemical and Biological Reactor Design	X			3
CBE 332	Heat and Mass Transfer Fundamentals	X			3
CBE 393	Professional Development Seminar	X			1
Bioscience Elective (see list on Program Requirements tab)		X			3
Technical Elective (see list on Program Requirements tab)		X			3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)				3B	3
Total Credits					16
Senior					
Semester 7		Critical	Recommended	AUCC	Credits
CBE 333	Chemical and Biological Engineering Lab I	X			2
CBE 442	Separation Processes	X			4
CBE 451	Chemical and Biological Engineering Design I	X		4A,4B,4C	3
Technical Elective (see list on Program Requirements tab)		X			3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)			X	3B	3
Total Credits					15
Semester 8		Critical	Recommended	AUCC	Credits
CBE 430	Process Control and Instrumentation	X			3
CBE 443	Chemical and Biological Engineering Lab II	X			2
CBE 452	Chemical and Biological Engineering Design II	X		4A,4B,4C	3
Engineering Elective (see list on Program Requirements tab)		X			3
Historical Perspectives (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives)		X		3D	3
Social and Behavioral Sciences (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences)		X		3C	3
The benchmark courses for the 8th semester are the remaining courses in the entire program of study.		X			
Total Credits					17
Program Total Credits:					130