BIOCHEMISTRY - BACHELOR OF ARTS (BA)

The biochemistry major provides interdisciplinary training, education and experience in the chemical and biological sciences. Biochemistry focuses on understanding the chemical processes of living organisms, the reaction pathways that sustain life, the principles of how structure defines function, and the physical basis of biomolecular interactions. Students who major in biochemistry are prepared for diverse careers in medicine, scientific research, biotechnology, pharmacy, biomedical consulting, teaching and education, among other professions.

The undergraduate degree in biochemistry emphasizes knowledge and understanding of:

- Foundational principles of biology and chemistry.
- The building blocks of life (DNA, RNA and proteins), how they evolved, how they interact and how organisms make and degrade these building blocks.
- How living organisms maintain homeostasis and regulate metabolism.
- The molecular mechanisms of how living systems respond to changes, such as environmental perturbations, disease and chemical therapeutics.
- How chemical reactions impact human health.

The undergraduate degree in biochemistry also emphasizes and cultivates development of the following skills:

- Quantitative problem solving.
- Critical thinking and analytical reasoning.
- Communication of scientific concepts and ideas.

Because biochemistry connects to scientific disciplines ranging from genetics, human physiology, microbiology, neuroscience, cell biology, chemistry and geology, biochemistry majors are given the freedom to explore advanced electives in many of these subjects. Additional information about the biochemistry BA can be found on the Biochemistry Department website (https://www.colorado.edu/biochemistry/).

Biochemistry major students are prepared for many different careers after graduation. Career Services (http://www.colorado.edu/careerservices/) offers a number of programs and services designed to help students plan their career, including workshops, internships, and placement services after graduation. For an appointment with a career counselor or for more information, call 303-492-6541 or stop by Center for Community, N352.

Undergraduate Research

Undergraduates are encouraged to participate in research to prepare themselves for graduate school, professional school, or industry. There are multiple opportunities for undergraduates to be involved in research within the Department of Biochemistry. For more information, visit our Departmental Undergraduate research page (https://www.colorado.edu/biochemistry/current-students/undergraduate/undergraduate-research/).

Study Abroad

The experience of studying abroad can prove invaluable. For information about study abroad programs, visit the Education Abroad (https://abroad.colorado.edu/) website.

Teaching Certification

Biochemistry majors can also earn certification as teachers through the School of Education. The program for a secondary school science-teaching certificate is challenging requiring a broad, strong background in science, as well as coursework in education and practice teaching. It usually requires at least five years of study. Students interested in teacher certification are encouraged to contact the School of Education (http://www.colorado.edu/education/).

Requirements

Program Requirements

The biochemistry major provides interdisciplinary training in the biological and chemical sciences, including courses in general chemistry, organic chemistry, physical chemistry and biochemistry, as well as in biology, calculus and physics.

Students must complete the general requirements of the College of Arts and Sciences and the required courses listed below. No more than 45 credits of CHEM and BCHM courses can be applied to the 120-credit minimum to graduate. All courses counted towards the major must be completed with a grade of C- or better and none of the courses may be taken for a pass/fail grade. The cumulative Grade Point Average (GPA) in courses that can count toward the major must be at least 2.0.

Transfer students who plan to complete a BA degree in biochemistry must complete at the Boulder campus a minimum of 12 credits of upper-division courses in biochemistry covering at least two of the sub-disciplines in their major: organic, physical and biochemistry.

Students may want to consult each semester's Registration Handbook and Schedule of Courses (http://www.colorado.edu/registrar/), as well as the Professor Performance Guide (http://www.colorado.edu/pba/fcq/) for further information about course offerings and faculty.

Required Courses and Credits

Code	Title	Credit Hours
General Chemistry		
CHEM 1400 & CHEM 1401	Foundations of Chemistry and Foundations of Chemistry Lab (Recommended)	5
or CHEM 1113 & CHEM 1114 & CHEM 1133 & CHEM 1134	General Chemistry 1 and Laboratory in General Chemistry 1 and General Chemistry 2 and Laboratory in General Chemistry 2	
Organic Chemistry		
CHEM 3451	Organic Chemistry 1 for Chemistry and Biochemistry Majors (Recommended)	4
or CHEM 3311	Organic Chemistry 1	
CHEM 3321	Laboratory in Organic Chemistry 1	1-2
or CHEM 3361	Laboratory in Organic Chemistry 1 for Chemistry Majors	
BCHM 3491	Organic Chemistry 2 for Biochemistry Majors (Recommended)	4

or CHEM 3471	Organic Chemistry 2 for Chemistry Majors	
or CHEM 3331	Organic Chemistry 2	
CHEM 3341	Laboratory in Organic Chemistry 2	1-2
or CHEM 3381	Laboratory in Organic Chemistry 2 for Chemistry Majors	
Biochemistry		
BCHM 2700	Foundations of Biochemistry	4
BCHM 4720	Metabolic Pathways and Human Disease	4
BCHM 4740	Biochemistry of Gene Transmission, Expression and Regulation [1]	4
BCHM 4761	Biochemistry Laboratory	3
Physical Chemistry		
BCHM 4400	Core Concepts in Physical Chemistry for Biochemists [2]	4
Advanced Major Electives		
Select three of the following elective courses:		9-12
BCHM 4631	Statistical and Computational Analysis of the Human Genome	
BCHM 4751	Current Topics in Biochemical Research	
BCHM 5341	Chemical Biology and Drug Design	
CHEM 4011	Modern Inorganic Chemistry	
CHEM 4171	Instrumental Analysis - Lecture and Laboratory 1	
CHEM 4181	Instrumental Analysis - Lecture and Laboratory 2	
MCDB 2150	Principles of Genetics (cannot also count EBIO 2070 as a required ancillary course or an advanced elective)	
MCDB 3000	Synthetic Biology: Engineering Biomolecular Systems in the Laboratory	
MCDB 3145	Cell Biology	
MCDB 3150	Biology of the Cancer Cell	
MCDB 3160	Infectious Disease	
MCDB 3350	Fertility, Sterility, and Early Mammalian Development	
MCDB 3450	Biological Data Science	
MCDB 3501	Structural Methods for Biological Macromolecules	
MCDB 3650	The Brain - From Molecules to Behavior	
MCDB 3990	Introduction to Systems Biololgy for Biologists	
MCDB 4300	Immunology (cannot also count IPHY 4600 as a required Advanced Major Elective)	
MCDB 4310	Microbial Genetics and Physiology	
MCDB 4350	Microbial Diversity and the Biosphere	
MCDB 4410	Human Molecular Genetics	
MCDB 4426	Cell Signaling and Developmental Regulation	
MCDB 4444	Cellular Basis of Disease	
MCDB 4471	Mechanisms of Gene Regulation in Eukaryotes	
MCDB 4520	Bioinformatics and Genomics	
MCDB 4615	Biology of Stem Cells	
MCDB 4750	Animal Virology	
MCDB 4790	Oocytes, Stem Cells, Organisms: Experiments to Discoveries	
EBIO 2070	Genetics: Molecules to Populations (cannot also count MCDB 2150 as a required ancillary course or an advanced elective)	
EBIO 3040	Conservation Biology	
EBIO 3080	Evolutionary Biology	
EBIO 3180	Global Ecology	
EBIO 3190	Tropical Marine Ecology	
EBIO 3240	Animal Behavior	
EBIO 3400	Microbiology	
EBIO 3523	The Art and Strategy of Science Communication: Branding Climate Change	
EBIO 3590	Plants and Society	
EBIO 3630	Parasitology	
EBIO 3850	Animal Diversity: Invertebrates	
EBIO 4030	Limnology	
EBIO 4060	Landscape Ecology	
EBIO 4080	Freshwater Phycology	
EBIO 4140	Plant Ecology	
EBIO 4155	Ecosystem Ecology	
EBIO 4290	Phylogenetics and Comparative Biology	
EBIO 4410	Biological Statistics	
EBIO 4420	Computational Biology	
EBIO 4440	Animal Developmental Diversity	
EBIO 4500	Plant Biodiversity and Evolution	
EBIO 4510	Plant Anatomy and Development	
IPHY 3400	Nutrition for IPHY Majors	
IPHY 3410	Human Anatomy	
IPHY 3430	Human Physiology	
IPHY 3470	Human Physiology 1	
IPHY 3480	Human Physiology 2	
IPHY 3490	Introduction to Epidemiology	
IPHY 4440	Endocrinology	
IPHY 4470	Biology of Human Reproduction	
IPHY 4600	Immunology (cannot also count MCDB 4300 as a required Advanced Major Elective)	
IPHY 4720	Neurophysiology	
NRSC 2100	Introduction to Neuroscience	
NRSC 4032	Neurobiology of Learning and Memory	
NRSC 4082	Neural Circuits of Learning and Decision Making	
NRSC 4092	Behavioral Neuroendocrinology	
NRSC 4132	Neuropharmacology	
NRSC 4545	Neurobiology of Addiction	
ATOC 4200	Biogeochemical Oceanography	
PSYC 3102	Behavioral Genetics	
PSYC 3112	Behavioral Genetics II	
PSYC 4052	Behavioral Neuroscience	
GEOL 3320	Introduction to Geochemistry	
GEOL 4160	Introduction to Biogeochemistry	

GEOL 4270	Marine Chemistry and Geochemistry
GEOL 4330	Cosmochemistry
GEOL 4670	Isotope Geology
GEOL 4675	Stable Isotopes in Paleoclimate and Paleoecology
PHIL 3140	Environmental Ethics (cannot also count PHIL 3160 as a required Advanced Major Elective)
PHIL 3160	Bioethics (cannot also count PHIL 3140 as a required Advanced Major Elective)
Total Credit Hours	43-48

Required Ancillary Coursework from Outside Biochemistry

Code	Title	Credit Hours
Physics		
PHYS 1110	General Physics 1	4
PHYS 1120	General Physics 2	4
PHYS 1140	Experimental Physics 1	1
Calculus		
MATH 1300	Calculus 1	4-5
or MATH 1310	Calculus for Life Sciences	
or APPM 1350	Calculus 1 for Engineers	
MATH 2300	Calculus 2	4-5
or APPM 1360	Calculus 2 for Engineers	
Biology Sequence with Labs		
Lectures (One of the following sequences)		*6*
MCDB 1150 & MCDB 2150	Introduction to Cellular and Molecular Biology and Principles of Genetics	
MCDB 1111 & MCDB 2222	Core Concepts in Biology I: Evolutionary, Molecular and Cell Biology and Core Concepts in Biology II: Genes, Genetics and Phenotypes	
EBIO 1210 & EBIO 1220	General Biology 1 and General Biology 2	
Labs (One of the following sequences)		*2*
MCDB 1161	From Dirt to DNA: Phage Genomics Laboratory I	
or MCDB 1171	Drug Discovery Through Hands-on Screens I	
or MCDB 2171	Drug Discovery Through Hands-On Screens 2	
EBIO 1230 & EBIO 1240	General Biology Laboratory 1 and General Biology Laboratory 2	
Total Credit Hours		25-27

[1] BCHM 4740 can be waived upon completion of the MCDB major.

[2] Or CHEM 4511 and CHEM 4531

All students, and especially those intending to go onto graduate school in biochemistry, will benefit from additional advanced courses. Recommended electives include graduate courses in various fields of chemistry, or advanced courses in biology or mathematics.

Graduating in Four Years

Consult the Four-Year Guarantee Requirements for information on eligibility. The concept of "adequate progress" as it is used here only refers to maintaining eligibility for the four-year guarantee; it is not a requirement for the major. To maintain progress in biochemistry, students should declare the biochemistry major in the first semester.

Students must consult with a major advisor to determine adequate progress toward completion of the major.

Recommended Four-Year Plan of Study

Through the required coursework for the major, students will fulfill all 12 credits of the Natural Sciences area of the Gen Ed Distribution Requirement, including the required laboratory or field experience, and the QRMS component of the Gen Ed Skills Requirement.

Course	Title	Credit Hours
Year One		
Fall Semester		
CHEM 1400	Foundations of Chemistry	4
CHEM 1401	Foundations of Chemistry Lab	1
MATH 1300 or MATH 1310 or APPM 1350	Calculus 1 or Calculus for Life Sciences or Calculus 1 for Engineers	4-5
Gen. Ed. Distribution course (example: Social Sciences)		3
Gen. Ed. Skills course (example: Lower-division Written Communication)		3
	Credit Hours	15-16
Spring Semester		
CHEM 3451	Organic Chemistry 1 for Chemistry and Biochemistry Majors	4
CHEM 3321	Laboratory in Organic Chemistry 1	1
MATH 2300 or APPM 1360	Calculus 2 or Calculus 2 for Engineers	4-5
Gen. Ed. Distribution/Diversity course (example: Arts & Humanities/US Perspective)		3
Gen. Ed. Distribution/Diversity course (example: Social Sciences/Global Perspective)		3
	Credit Hours	15-16
Year Two		
Fall Semester		
BCHM 3491	Organic Chemistry 2 for Biochemistry Majors	4
CHEM 3341	Laboratory in Organic Chemistry 2	1
MCDB 1150 or MCDB 1111 or EBIO 1210	Introduction to Cellular and Molecular Biology or Core Concepts in Biology I: Evolutionary, Molecular and Cell Biology or General Biology 1	3
MCDB 1161 or MCDB 1171 or EBIO 1230	From Dirt to DNA: Phage Genomics Laboratory I or Drug Discovery Through Hands-on Screens I or General Biology Laboratory 1	2
Gen. Ed. Distribution course (example: Social Sciences)		3
Gen. Ed. Distribution course (example: Arts & Humanities)		3
	Credit Hours	16
Spring Semester		
BCHM 2700	Foundations of Biochemistry	4

MCDB 2150 or MCDB 2222 or EBIO 1220	Principles of Genetics or Core Concepts in Biology II: Genes, Genetics and Phenotypes or General Biology 2	3
MCDB 1171 or MCDB 2171 or EBIO 1240	Drug Discovery Through Hands-on Screens I or Drug Discovery Through Hands-On Screens 2 or General Biology Laboratory 2	2
Gen. Ed. Distribution course (example: Social Sciences)		3
Elective or MAPS		3
	Credit Hours	15
Year Three		
Fall Semester		
BCHM 4720	Metabolic Pathways and Human Disease	4
PHYS 1110	General Physics 1	4
Gen. Ed. Distribution course (example: Social Sciences)		3
Free Elective		3
	Credit Hours	14
Spring Semester		
BCHM 4740	Biochemistry of Gene Transmission, Expression and Regulation	4
PHYS 1120	General Physics 2	4
PHYS 1140	Experimental Physics 1	1
Gen. Ed. Skills course (example: Upper-division Written Communication)		3
Elective/MAPS		3
	Credit Hours	15
Year Four		
Fall Semester		
BCHM 4400	Core Concepts in Physical Chemistry for Biochemists	4
Advanced Major Elective		3
Advanced Major Elective		3
Gen. Ed. Distribution (example: Arts & Humanities)		3
Elective		3
	Credit Hours	16
Spring Semester		
BCHM 4761	Biochemistry Laboratory	3
Advanced Major Elective		3
Gen. Ed. Distribution course (example: Arts & Humanities)		3
Elective		3
Elective		3
	Credit Hours	15
	Total Credit Hours	121-123