

Quantitative Biosciences and Engineering

Degrees Offered:

BS in Quantitative Biosciences and Engineering

Program Requirements

Student admissions to the QBE major will have the same requirements as admissions to Colorado School of Mines. There will be no additional requirements.

Program Description

The undergraduate program in Quantitative Biosciences and Engineering (QBE) is designed to provide a rigorous interdisciplinary training at the interface between biology, mathematics, computer sciences, material sciences, and chemistry, establishing a new hallmark for Colorado School of Mines. The students in the major will complete a program that includes the general Mines core, plus a set of required courses in biological sciences and data sciences along with an approved selection of biology electives. Electives are designed to support students with an interest in particular areas of biology (e.g., medicine, ecology, geobiology, systems biology, or molecular biology) along with critical quantitative and computational skills. Hands-on lab skill development and research opportunities through course-based research, undergraduate research, and independent study credit will be offered in partnership with several Mines research labs and/or corporate internships and co-ops. The curriculum will also focus on the entrepreneurial applications of biological discovery as well as the ethical, societal, and environmental concerns presented by modern biological advances.

QBE Program Level Learning Outcomes

At the end of the QBE curriculum, students should be able to:

1. Explain and apply foundational biological concepts in the areas of 1) evolution, 2) structure-function relationships, 3) biological networks and systems, 4) information storage and transfer, and 5) transformations of energy and matter.
2. Explain and apply core skills and concepts in mathematical, physical, and data sciences including basic programming, working with biological datasets, modeling biological processes, and visualizing data
3. Conduct rigorous experimental biological research through hypothesis testing, experimental design, use of research equipment, data collection, data analysis, and written and oral communication of results to diverse audiences.
4. Work in diverse teams using technical expertise, multidisciplinary skills, effective communication, and entrepreneurship to establish goals, plan tasks, and solve problems.
5. Evaluate the ethical and cultural impacts of modern biology and data science on local communities, worldwide society, and the environment.
6. Obtain a position in quantitative biosciences in industry, government, or graduate/professional school.

Admission Requirements

Student admissions to the QBE major will have the same requirements as admissions to Colorado School of Mines. There will be no additional requirements.

Program Faculty

Joel Bach, Associate Professor of Mechanical Engineering

Linda Battalora, Teaching Professor of Petroleum Engineering

Suzannah Beeler, Assistant Teaching Professor of Chemical and Biological Engineering

Cecilia Diniz Behn, Associate Professor of Applied Mathematics & Statistics

Nanette Boyle, Associate Professor of Chemical and Biological Engineering

Kevin Cash, Assistant Professor of Chemical and Biological Engineering

Anuj Chauhan, Professor of Chemical and Biological Engineering

Kristine Csavina, Teaching Professor of Mechanical Engineering

Dylan Domaille, Assistant Professor of Chemistry

Alina Handorean, Teaching Professor of Engineering, Design & Society

Christopher Higgins, Professor of Civil and Environmental Engineering

Melissa Krebs, Co-Director, QBE Graduate Program and Associate Professor of Chemical and Biological Engineering

Ramya Kumar, Assistant Professor of Chemical and Biological Engineering

Karin Leiderman, Co-Director, QBE Graduate Program and Associate Professor of Applied Mathematics & Statistics

Terry Lowe, Research Professor of Materials and Metallurgical Engineering

David Marr, Professor of Chemical and Biological Engineering

Christine Morrison, Assistant Professor of Chemistry

Cynthia Norrgran, Teaching Associate Professor of Chemical and Biological Engineering

Alexander Pak, Assistant Professor, Chemical and Biological Engineering

Steve Pankavich, Associate Professor of Applied Mathematics & Statistics

Anthony Petrella, Associate Professor of Mechanical Engineering

Andrew Petruska, Assistant Professor of Mechanical Engineering

Matthew Posewitz, Professor of Chemistry

Josh Ramey, Director of the QBE Undergraduate Program and Teaching Associate Professor of Chemical and Biological Engineering

James Ranville, Professor of Chemistry

Susanta Sarkar, Assistant Professor of Physics

Justin Shaffer, Teaching Associate Professor of Chemical and Biological Engineering

Jonathan Sharp, Associate Professor of Civil and Environmental Engineering

Anne Silverman, Associate Professor of Mechanical Engineering

E. Dendy Sloan, Emeritus Professor of Chemical and Biological Engineering

John Spear, Professor, Civil and Environmental Engineering

Jeff Squier, Professor of Physics

Amadeu Sum, Professor of Chemical and Biological Engineering

Brian Trewyn, Associate Professor of Chemistry

Shubham Vyas, Associate Professor of Chemistry

Hua Wang, Associate Professor of Computer Science

Kim Williams, Professor of Chemistry

Xiaoli Zhang, Associate Professor of Mechanical Engineering

Bachelor of Science in Quantitative Biosciences and Engineering Degree Requirements:

Biology Core Requirements

CBEN110	FUNDAMENTALS OF BIOLOGY I	4.0
CBEN120	FUNDAMENTALS OF BIOLOGY II	4.0
BIOL300	INTRODUCTION TO QUANTITATIVE BIOLOGY I	3.0
BIOL301	INTRODUCTION TO QUANTITATIVE BIOLOGY II	3.0
CBEN320	CELL BIOLOGY AND PHYSIOLOGY	3.0
CBEN321	INTRO TO GENETICS	4.0
CHGN428	BIOCHEMISTRY	3.0
CHGN431	INTRODUCTORY BIOCHEMISTRY LABORATORY	2.0
CHGN462	MICROBIOLOGY	3.0
or CEEN460	MOLECULAR MICROBIAL ECOLOGY AND THE ENVIRONMENT	
BIOL410	ENTREPRENEURSHIP IN BIOTECHNOLOGY SEMINAR	1.0
BIOL415	QUANTITATIVE BIOSCIENCES AND ENGINEERING FIELD SESSION	3.0
CSCI478	INTRODUCTION TO BIOINFORMATICS	3.0

Fundamental Science and General Requirements

MATH111	CALCULUS FOR SCIENTISTS AND ENGINEERS I	4.0
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II	4.0
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III	4.0
MATH225	DIFFERENTIAL EQUATIONS	3.0
MATH201	INTRODUCTION TO STATISTICS	3.0
CHGN121	PRINCIPLES OF CHEMISTRY I	4.0

CHGN122	PRINCIPLES OF CHEMISTRY II (SC1)	4.0
CHGN221	ORGANIC CHEMISTRY I	3.0
CHGN223	ORGANIC CHEMISTRY I LABORATORY	1.0
CHGN222	ORGANIC CHEMISTRY II	3.0
EBGN201	PRINCIPLES OF ECONOMICS	3.0
EDNS151	CORNERSTONE - DESIGN I	3.0
HASS100	NATURE AND HUMAN VALUES	3.0
HASS200	GLOBAL STUDIES	3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective Courses	
ELECTIVE	CULTURE AND SOCIETY (CAS) 400-Level Restricted Elective Courses	
PHGN100	PHYSICS I - MECHANICS	4.0
PHGN200	PHYSICS II-ELECTROMAGNETISM AND OPTICS	4.0
S&W	Success and Wellness (4 electives)	
CSCI128	COMPUTER SCIENCE FOR STEM	3.0
CSM101	FRESHMAN SUCCESS SEMINAR	1.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES	1.0

Free electives

9 credits of free electives. These can be used to cover prerequisites if necessary.

Technical Electives available

Technical electives with emphasis on biology-related courses, chosen from the following:

BIOL500	CELL BIOLOGY AND BIOCHEMISTRY	4.0
BIOL501	ADVANCED BIOCHEMISTRY	3.0
BIOL520	SYSTEMS BIOLOGY	3.0
CBEN304	ANATOMY AND PHYSIOLOGY	3.0
CBEN305	ANATOMY AND PHYSIOLOGY LAB	1.0
CBEN310	INTRODUCTION TO BIOMEDICAL ENGINEERING	3.0
CBEN311	INTRODUCTION TO NEUROSCIENCE	3.0
CBEN322	BIOLOGICAL PSYCHOLOGY	3.0
CBEN324	INTRODUCTION TO BREWING SCIENCE	3.0
CBEN411	NEUROSCIENCE, MEMORY, AND LEARNING	3.0
CBEN412	INTRODUCTION TO PHARMACOLOGY	3.0
CBEN413	QUANTITATIVE HUMAN BIOLOGY	3.0
CBEN431	IMMUNOLOGY FOR ENGINEERS AND SCIENTISTS	3.0
CBEN4XX	CAPSTONE	
CEEN461	FUNDAMENTALS OF ECOLOGY	3.0
CHGN311	INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY	3.0
CHGN409	BIOLOGICAL INORGANIC CHEMISTRY	3.0
CHGN429	BIOCHEMISTRY II	3.0
CHGN441	THE CHEMISTRY AND BIOCHEMISTRY OF PHARMACEUTICALS	3.0
CHGN445	CHEMICAL BIOLOGY	3.0
CSCI220	DATA STRUCTURES AND ALGORITHMS	3.0

CSCI303	INTRODUCTION TO DATA SCIENCE	3.0
CSCI470	INTRODUCTION TO MACHINE LEARNING	3.0
MATH332	LINEAR ALGEBRA	3.0
MATH431	MATHEMATICAL BIOLOGY	3.0
MATH472	MATHEMATICAL AND COMPUTATIONAL NEUROSCIENCE	3.0
PHGN433	BIOPHYSICS	3.0
BIOL499	INDEPENDENT STUDIES (up to 6 credits)	
INNO444	INNOV8X CREATE	3.0
INNO544	INNOV8X CREATE DSCI	1.0

Free Technical Elective totals 28 credits**Freshman**

Fall		lec	lab	sem.hrs
CBEN110	FUNDAMENTALS OF BIOLOGY I			4.0
MATH111	CALCULUS FOR SCIENTISTS AND ENGINEERS I			4.0
CHGN121	PRINCIPLES OF CHEMISTRY I			4.0
EDNS151	CORNERSTONE - DESIGN I			3.0
CSM101	FRESHMAN SUCCESS SEMINAR			1.0
				16.0

Spring		lec	lab	sem.hrs
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II			4.0
CHGN122	PRINCIPLES OF CHEMISTRY II (SC1)			4.0
HASS100	NATURE AND HUMAN VALUES			3.0
S&W	SUCCESS AND WELLNESS			1.0
CBEN120	FUNDAMENTALS OF BIOLOGY II			4.0
				16.0

Sophomore

Fall		lec	lab	sem.hrs
CHGN221	ORGANIC CHEMISTRY I	3.0		3.0
CHGN223	ORGANIC CHEMISTRY I LABORATORY		3.0	1.0
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III	4.0		4.0
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
PHGN100	PHYSICS I - MECHANICS			4.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0
				16.0

Spring		lec	lab	sem.hrs
CHGN222	ORGANIC CHEMISTRY II	3.0		3.0
MATH225	DIFFERENTIAL EQUATIONS	3.0		3.0
BIOL300	INTRODUCTION TO QUANTITATIVE BIOLOGY I			3.0

PHGN200	PHYSICS II- ELECTROMAGNETISM AND OPTICS	4.0
MATH201	INTRODUCTION TO STATISTICS	3.0
		16.0

Junior

Fall		lec	lab	sem.hrs
CHGN428	BIOCHEMISTRY			3.0
CHGN431	INTRODUCTORY BIOCHEMISTRY LABORATORY			2.0
HASS200	GLOBAL STUDIES			3.0
BIOL301	INTRODUCTION TO QUANTITATIVE BIOLOGY II			3.0
CBEN320	CELL BIOLOGY AND PHYSIOLOGY			3.0
TECH	TECH ELECTIVE INTERDISCIPLINARY BIO TECHNICAL ELECTIVE I			3.0
				17.0

Spring		lec	lab	sem.hrs
ELECTIVE	CULTURE AND SOCIETY (CAS) RESTRICTED ELECTIVE I	3.0		3.0
CBEN321	INTRO TO GENETICS			4.0
TECH	TECH ELECTIVE INTERDISCIPLINARY BIO TECHNICAL ELECTIVE II			3.0
TECH	TECH ELECTIVE INTERDISCIPLINARY BIO TECHNICAL ELECTIVE III	3.0		3.0
CHGN462	MICROBIOLOGY or CEEN 460			3.0
				16.0

Summer		lec	lab	sem.hrs
BIOL415	QUANTITATIVE BIOSCIENCES AND ENGINEERING FIELD SESSION			3.0
				3.0

Senior

Fall		lec	lab	sem.hrs
ELECTIVE	CULTURE AND SOCIETY (CAS) RESTRICTED ELECTIVE II	3.0		3.0
FREE	FREE ELECTIVE I			3.0
TECH	TECH ELECTIVE INTERDISCIPLINARY BIO TECHNICAL ELECTIVE IV			3.0

EBGN321	ENGINEERING ECONOMICS [*] For the 2023 Catalog EBGN321 replaced EBG201 as a Core requirement. EBG321 was added to the core, but has a prerequisite of 60 credit hours. Students whose programs that required EBG201 the sophomore year may need to wait to take EBG321 until their junior year. For complete details, please visit: https://www.mines.edu/registrar/core- curriculum/	3.0
BIOL410	ENTREPRENEURSHIP IN BIOTECHNOLOGY SEMINAR	1.0
CSCI478	INTRODUCTION TO BIOINFORMATICS	3.0
		16.0
Spring		lec lab sem.hrs
FREE	FREE ELECTIVE II	3.0
FREE	FREE ELECTIVE III	3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) RESTRICTED ELECTIVE III	3.0
TECH	TECH ELECTIVE INTERDISCIPLINARY BIO TECHNICAL ELECTIVE V	3.0
TECH	TECH ELECTIVE INTERDISCIPLINARY BIO TECHNICAL ELECTIVE VI	3.0
		15.0
Total Semester Hrs: 131.0		

* Signifies a new course needed for major degree offering.