BIOCHEMISTRY

The Department of Biochemistry is internationally recognized for its research and education and offers a world-class interdisciplinary research environment in a beautiful mountain setting. As part of a commitment to continuing this tradition of excellence, the department provides a graduate program that integrates opportunities for cutting-edge creative research and study across a wide range of areas including:

- Computational biology
- Nucleic acids
- Gene expression
- Cell signaling
- Membranes
- Proteins and enzymology
- Molecular biophysics
- Structural biology
- Systems biology

Graduate students enjoy extensive scientific collaboration with biochemistry faculty, with other departments such as molecular, cellular and developmental biology, chemistry, and physics, and with research institutes and agencies such as the BioFrontiers Institute, Joint Institutes of Laboratory Astrophysics (JILA) and the Renewable and Sustainable Energy Institute.

Course code for this program is BCHM.

Master's Degree

- Biochemistry - Master of Science (MS) (https://catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/biochemistry/biochemistry-master-science-ms/)

Doctoral Degree

- Biochemistry - Doctor of Philosophy (PhD) (https://catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/biochemistry/biochemistry-doctor-philosophy-phd/)

Certificate

- Molecular Biophysics - Graduate Certificate (https://catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/biochemistry/molecular-biophysics-graduate-certificate/)

Faculty

While many faculty teach both undergraduate and graduate students, some instruct students at the undergraduate level only. For more information, contact the faculty member's home department.

Ahn, Natalie (https://experts.colorado.edu/display/fisid_106044/)
Distinguished Professor; PhD, University of California, Berkeley

Batey, Robert T. (https://experts.colorado.edu/display/fisid_122668/)
Professor; PhD, Massachusetts Institute of Technology

Belliveau, Nathan (https://experts.colorado.edu/display/fisid_177322/)
Assistant Professor; PhD, California Institute of Technology

Caruthers, Marvin H. (https://experts.colorado.edu/display/fisid_103328/)
Distinguished Professor; PhD, Northwestern University

Cech, Thomas R. (https://experts.colorado.edu/display/fisid_103252/)
Distinguished Professor; PhD, University of California, Berkeley

Falke, Joseph J. (https://experts.colorado.edu/display/fisid_101970/)
Professor; PhD, California Institute of Technology

Goodrich, James (https://experts.colorado.edu/display/fisid_109239/)
Professor, Chair; PhD, Carnegie Mellon University

Keeling, Novella (https://experts.colorado.edu/display/fisid_169539/)
Assistant Teaching Professor; PhD, Oregon Health Science University

Khanal, Akhil
Assistant Teaching Professor; PhD, University of Delaware

Kuchta, Robert (https://experts.colorado.edu/display/fisid_100844/)
Professor; PhD, Brandeis University

Kugel, Jennifer F. (https://experts.colorado.edu/display/fisid_109472/)
Research Professor; PhD, University of Colorado Boulder

Liu, Xuedong (https://experts.colorado.edu/display/fisid_118458/)
Professor; PhD, University of Wisconsin–Madison

Mchenry, Charles
Professor Emeritus; PhD, University of California, Santa Barbara

Mendoza, Adelita (https://experts.colorado.edu/display/fisid_176157/)
Assistant Professor; PhD, Northwestern University

Palmer, Amy E. (https://experts.colorado.edu/display/fisid_141901/)
Professor; PhD, Stanford University

Pardi, Arthur
Professor Emeritus; PhD, University of California, Berkeley

Parker, Roy Robert (https://experts.colorado.edu/display/fisid_151440/)
Distinguished Professor; PhD, University of California, San Francisco

Rinn, John (https://experts.colorado.edu/display/fisid_159338/)
Professor; PhD, Yale University

Schnizer-Luger, Karoline (https://experts.colorado.edu/display/fisid_156579/)
Endowed Chair, Professor; PhD, Univ of Basel (Switzerland)

Sousa, Marcelo Carlos (https://experts.colorado.edu/display/fisid_122806/)
Professor; PhD, Univ of Buenos Aires (Argentina)

Spencer, Sabrina Leigh (https://experts.colorado.edu/display/fisid_154911/)
Associate Professor; PhD, Massachusetts Institute of Technology

Stephen, Ricardo Hugh (https://experts.colorado.edu/display/fisid_145994/)
Associate Teaching Professor; PhD, University of Colorado Boulder

Taatjes, Dylan J. (https://experts.colorado.edu/display/fisid_102436/)
Professor; PhD, University of Colorado Boulder

Whiteley, Aaron (https://experts.colorado.edu/display/fisid_166299/)
Assistant Professor; PhD, University of California, Berkeley

Whiteley, Alexandra (https://experts.colorado.edu/display/fisid_166300/)
Assistant Professor; PhD, University of California, San Francisco

Wuttke, Deborah S. (https://experts.colorado.edu/display/fisid_108412/)
Professor, Associate Chair; PhD, California Institute of Technology

Courses

BCHM 5312 (3) Quantitative Optical Imaging
Explores the fundamentals of optical imaging in biology, especially molecular and cellular biology. Covered topics include an introduction to optics and microscopes, fluorescence microscopy and image analysis, and biological applications. MATLAB will be taught at the beginning of the course and used throughout for image processing. Prior experience with MATLAB (or Python) is highly recommended but not required.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5312, MCDB 4312 and BCHM 4312
Grading Basis: Letter Grade

BCHM 5341 (3) Chemical Biology and Molecular Therapeutics
The "chemical biology" aspect of this course will focus on enzyme mechanisms and strategies for drug or molecular probe design, as well as challenges and opportunities for targeting general cellular components such as membranes or molecular condensates. The "molecular therapeutics" topics will include target discovery, genome editing, and biologics. The course will develop and require critical thinking skills and will emphasize biochemical and biophysical mechanisms.
Equivalent - Duplicate Degree Credit Not Granted: BCHM 3341
Requisites: Restricted to graduate students only.

BCHM 5400 (4) Core Concepts in Physical Chemistry for Biochemists
Introduces thermodynamics, kinetics and spectroscopy, emphasizing macromolecule and biochemical applications. Includes thermodynamics, chemical and physical equilibriums, solution chemistry, rates of chemical and biochemical reactions, chemical bonds and principles and selected examples of spectroscopies applied to biological systems. Formerly CHEM 5400.
Equivalent - Duplicate Degree Credit Not Granted: CHEM 4511 BCHM 4400
Requisites: Restricted to graduate students only.

BCHM 5410 (3) Mechanisms of Cancer
This course is devoted to the mechanisms that drive cancer, with an emphasis on how the biochemistry of normal cells teaches us how regulation goes awry in cancer cells. The course will include an analysis of historical and current developments in cancer biology. Topics covered: principles of transformation, viral and cellular oncogenes, tumor suppressor genes, signal transduction, cell cycle, cell death, DNA damage and repair, cancer genetics, cancer genomics, cancer risk factors, carcinogens, chemotherapies, targeted therapies, drug resistance, modern technologies in cancer research.
Equivalent - Duplicate Degree Credit Not Granted: BCHM 3400
Requisites: Restricted to graduate students only.

BCHM 5450 (3) Principles of Pharmacology and Toxicology
This is a course presenting the fundamentals of Pharmacology and Toxicology. This course will be divided into four sections. Section I introduces the mechanisms of drug action, their cellular targets, their absorption and distribution, and elimination pharmacokinetics. Section II will discuss the interaction of drugs with physiological systems via the role of chemical mediators and how this affects major organ systems. This will introduce broad principles of pharmacology, pharmacokinetics, pharmacodynamics, toxicology, membrane transporters, metabolism, cell signaling, and an introduction to pharmacogenetics. Section III will focus on specific cases of drugs used for the treatment of cancer, antibacterials, and antifungals. Section IV will discuss the harmful nature of drugs, their use in lifestyle and in sports.
Equivalent - Duplicate Degree Credit Not Granted: BCHM 3450
Requisites: Restricted to graduate students only.

BCHM 5491 (3) Modern Biophysical Methods
Covers the basic theory of biophysical methods widely employed in biochemistry and biology, including: electrophoresis, mass spec, calorimetry, evanescent waves, plasmon resonance, Xray diffraction, absorbance and fluorescence spectroscopy, magnetic resonance, electron and optical microscopy and single molecule methods. Discusses ways to maximize rigor and reproducibility in biophysical studies. Department enforced prerequisites: undergraduate chemistry (general, organic, physical), biochemistry, physics, calculus.
Equivalent - Duplicate Degree Credit Not Granted: BCHM 4491
Requisites: Restricted to graduate students only.
Grading Basis: Letter Grade

BCHM 5611 (3) Principles of Biochemistry
One-semester overview of the main themes of modern biochemistry: biomolecular structure/function, metabolism, biosynthesis, DNA from genome to proteome and cellular signaling. For biology and engineering majors and others wanting an overview of biochemistry.
Equivalent - Duplicate Degree Credit Not Granted: BCHM 4611
Requisites: Restricted to graduate students only.

BCHM 5631 (3) Computational Genomics Lab
Designed as an inquiry based computational genomics laboratory course. Students will learn fundamental principles of BASH, R, NEXTFLOW, GIT and more by applying these skills to publicly available genomic data. The course aims to mimic a real world genomics research project. Overall this course aims to provide students with key skills needed for future research and career opportunities.
Equivalent - Duplicate Degree Credit Not Granted: BCHM 4631
Requisites: Restricted to graduate students only.

BCHM 5661 (3) Advances in Molecular Biophysics
Discuss recent literature concerning biophysical studies of macromolecular structure and mechanism, including DNA, RNA, proteins, and their interactions.
Recommended: Prerequisites one year of physical chemistry or quantum mechanics, one year of biology, graduate standing, or instructor consent.

BCHM 5720 (4) Metabolic Pathways and Human Disease
Covers energy metabolism and anabolic/catabolic pathways; metabolism of carbohydrates, lipids, amino acids, and nucleic acids; photosynthesis; special topics on human diseases with pathologies and metabolic pathways. Formerly CHEM 5720.
Equivalent - Duplicate Degree Credit Not Granted: BCHM 4720
Requisites: Restricted to graduate students only.

BCHM 5740 (4) Biochemistry of Gene Transmission, Expression and Regulation
Covers biosynthesis and function of macromolecules including DNA, RNA and proteins; molecular basis of replication, transcription and translation; biochemistry of subcellular systems; signaling and regulation of gene expression in eukaryotes; and special topics. Formerly CHEM 5740.
Equivalent - Duplicate Degree Credit Not Granted: BCHM 4740
Requisites: Restricted to graduate students only.

BCHM 5751 (3) Current Topics in Biochemical Research
Lec. Covers current topics in modern biochemical research through lectures, reading recent research articles, critical thinking and class discussion. Topics include protein and nucleic acid structure and function, biomolecular interactions, enzyme function and cellular signaling and regulation. Department consent required. Formerly CHEM 5751.
Equivalent - Duplicate Degree Credit Not Granted: BCHM 4751
Requisites: Restricted to graduate students only.

BCHM 5770 (3) Fundamentals of Biochemistry I
Introduction to conducting research in Biochemistry, including covering foundational topics in Biochemistry that include concepts such as protein structure and function, experimental approaches to study biochemical processes, and analysis and interpretation of data. Topics will be taught through the perspective of the scientific literature with an emphasis on critical analysis of research. Additional subject areas will include discussions of aspects of conducting biochemical research in academic and industrial settings. Intended for entering Biochemistry graduate students. Formerly CHEM 5770.
Requisites: Restricted to graduate students only.
Grading Basis: Letter Grade

BCHM 5771 (5) Advanced General Biochemistry 1
Lect. In-depth analysis of DNA structure and replication, RNA synthesis and processing, protein synthesis, enzyme function and mechanism, protein structure, protein dynamics, and physical chemistry of macromolecules. Intended as a comprehensive treatment of areas central to modern biochemistry for entering graduate students. Formerly CHEM 5771.

BCHM 5772 (1) Quantitative Reasoning in Biochemistry
An introduction to quantitative reasoning used by Biochemists. Intended for entering Biochemistry graduate students.
Requisites: Restricted to graduate students only.
Grading Basis: Letter Grade

BCHM 5774 (1) Introduction to your Biochemistry PhD
This course provides an introduction to various aspects of the Biochemistry Ph.D. program. Students will be introduced to various research programs conducted by Biochemistry faculty in preparation to choose a Ph.D. dissertation research laboratory and mentor. Various topics related to successful navigation of the graduate program and career pathways after graduation will be discussed.
Requisites: Restricted to graduate students only.
Grading Basis: Letter Grade

BCHM 5776 (1) Scientific Ethics and Responsible Conduct in Research
Lect. Advanced discussion of topics in scientific ethics, including requirements for responsible conduct of research, case histories of fraud, research misconduct, ethical misconduct and development of professional values and ethical standards.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5776
Requisites: Requires prerequisite course of BCHM 5771 or CHEM 5271 (minimum grade B-). Restricted to graduate students only.

BCHM 5780 (3) Fundamentals of Biochemistry II
Analysis of topics in biochemistry including protein structure, methods of structure determination and prediction, protein folding, and protein dynamics. Intended as a comprehensive treatment of areas central to modern biochemistry for entering graduate students. Lectures concurrent with CHEM 5781, covering the same topics except for the requirement of a written research proposal. Formerly CHEM 5780.
Requisites: Requires prerequisite course of BCHM 5770 (minimum grade B-). Restricted to graduate students only.

BCHM 5781 (5) Advanced General Biochemistry 2
Detailed consideration of contemporary topics in biochemistry. Formerly CHEM 5781.
Requisites: Requires prerequisite course of BCHM 5770 or BCHM 5771 (minimum grade B-). Restricted to graduate students only.
Grading Basis: Letter Grade

BCHM 5801 (3) Advanced Signal Transduction and Cell Cycle Regulation
Lect. Advanced discussion of current research and literature in signal transduction, including ligands, receptors, and intracellular signaling pathways, as well as control on transcription, chromatin structure, DNA replication, mitosis, and cell cycle progression. Formerly CHEM 5801.
Requisites: Restricted to graduate students only.
Recommended: Prerequisites CHEM 5771 and CHEM 5781 and MCDB 5210 or MCDB 5220.

BCHM 5811 (3) Advanced Methods in Protein Sequencing and Analysis
Lect. Advanced discussion of current methods in protein sequencing, sequence analysis, and posttranslational modifications, emphasizing techniques of mass spectrometry, use of protein databases, sequence alignment and motifs, structure prediction, and modeling of signaling pathways. Department consent required. Formerly CHEM 5811.
Requisites: Restricted to graduate students only.
Recommended: Prerequisites CHEM 5771 and CHEM 5781 and MCDB 5210.

BCHM 5821 (1) Special Topics in Signaling and Cell Regulation
Lect. Reviews and evaluates literature on subjects of current interest in signal transduction transcription, cell cycle progression, and cell regulation. Primarily for graduate level presentation of special topics by students, faculty, and research staff. Department consent required. Formerly CHEM 5821.
Repeatable: Repeatable for up to 5.0 total credit hours.
Requisites: Restricted to graduate students only.

BCHM 5830 (1) Scientific Communication in Biochemistry
This course focuses on the development and writing of NIH- and NSF-style grant proposals in the field of Biochemistry and the oral communication of scientific ideas and results before fellow scientists.
Requisites: Requires prerequisite courses of BCHM 5770 and BCHM 5772 and BCHM 5781 (all minimum grade C-). Restricted to graduate students only.
Grading Basis: Letter Grade

BCHM 5850 (3) Therapeutic and Diagnostic Nucleic Acids
A comprehensive course in topics of the application of nucleic acids to the advancement of human health. Topics will include an introduction to the basic principles of pharmacology and drug development, action of small molecule therapeutics based upon nucleosides and nucleotides, antisense oligonucleotides and emerging CRISPR-based therapeutics, gene therapy, application of nucleic acids in commonly used diagnostics and emerging applications of nucleic acids.
Equivalent - Duplicate Degree Credit Not Granted: BCHM 4850
Requisites: Restricted to graduate students only.
Grading Basis: Letter Grade

BCHM 6601 (1) Biophysics Seminar
Restricted to and required for all currently funded NIH/CU Biophysics trainees and current NIH/CU Biophysics affiliates. Credit is deferred until presentation of satisfactory seminar. Formerly CHEM 6601.
Repeatable: Repeatable for up to 6.0 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to graduate students only.

BCHM 6711 (3-6) Advanced Topics in Biochemistry
Detailed study of current literature relative to one main topic is undertaken each semester. Topics covered on a rotating basis include enzyme kinetics and mechanisms; lipids and lipoproteins; chemistry and enzymology of nucleic acids; biochemistry of nucleic acids in eukaryotic cells; protein chemistry. Presentations include faculty lectures and student reports. Department enforced prerequisite: one year of biochemistry courses. Department consent required. Formerly CHEM 6711.
Repeatable: Repeatable for up to 12.0 total credit hours.
Requisites: Restricted to graduate students only.

BCHM 6731 (3-6) Advanced Topics in Biochemistry
Detailed study of current literature relative to one main topic is undertaken each semester. Topics covered on a rotating basis include enzyme kinetics and mechanisms; lipids and lipoproteins; chemistry and enzymology of nucleic acids; biochemistry of nucleic acids in eukaryotic cells; protein chemistry. Presentations include faculty lectures and student reports. Department enforced prerequisite: one year of biochemistry courses. Department consent required. Formerly CHEM 6731.
Repeatable: Repeatable for up to 12.0 total credit hours.
Requisites: Restricted to graduate students only.

BCHM 6901 (1-6) Research in Biochemistry
Repeatable: Repeatable for up to 15.0 total credit hours.
Requisites: Restricted to graduate students only.

BCHM 6941 (1) Master's Candidate for Degree
Students are not admitted for the master's degree but may be transferred to the MS plan if they are unable to meet the demands of the PhD program.
Requisites: Restricted to graduate students only.

BCHM 6951 (1-6) Master's Thesis
Students are not admitted for the master's degree but may be transferred to the MS plan if they are unable to meet the demands of the PhD program.
Requisites: Restricted to graduate students only.

BCHM 7601 (2) Seminar: Nucleic Acid Chemistry
Topics in various aspects of current research; emphasizes student readings and presentations. Department consent required.
Repeatable: Repeatable for up to 6.0 total credit hours.
Requisites: Restricted to graduate students only.

BCHM 7611 (1) Seminar: Structures and Dynamics of Biopolymers in Solution
Discussion of experimental and theoretical approaches for probing structures and dynamics of proteins, peptides, and nucleic acids; and computations in molecular dynamics simulation, modeling, and geometry. Department consent required. Formerly CHEM 7611.
Repeatable: Repeatable for up to 6.0 total credit hours.
Requisites: Restricted to graduate students only.

BCHM 7621 (1) Seminar: Biochemistry and Molecular Biology of Signal Transduction
Discusses and reviews the current literature and experimental results in signal transduction, cell cycle and tumor suppressor gene regulation. Emphasizes the understandings of molecular and biochemical mechanisms of the origin of human tumor cells. Formerly CHEM 7621.
Requisites: Restricted to graduate students only.

BCHM 7651 (2) Seminar: Environmental Biochemistry
Topics in various aspects of current biochemical and environmental research. Department consent required. Formerly CHEM 7651.
Repeatable: Repeatable for up to 6.0 total credit hours.
Requisites: Restricted to graduate students only.

BCHM 7661 (1) Structure/Function of Human Mediator Transcription Complexes
Study of the mechanisms of eukaryotic gene expression with an emphasis on the structure and function of human mediator transcription complexes. Formerly CHEM 7661.
Requisites: Restricted to graduate students only.

BCHM 7671 (1) Seminar: Topics in Designing Probes for Signaling Reactions
Discussion of advances and developments in biomolecular dynamics, with emphasis on experimental studies via ultrafast laser spectroscopy. The connection of protein dynamics with function will also be considered. Formerly CHEM 7671.
Requisites: Restricted to graduate students only.

BCHM 7691 (1) Seminar: Protein Dynamics and the Mechanism of Sensory Proteins
Discusses recent results and current literature in the areas of the mechanism of sensory proteins, internal motions of proteins, and protein folding. Department consent required. Formerly CHEM 7691.
Repeatable: Repeatable for up to 6.0 total credit hours.
Requisites: Restricted to graduate students only.

BCHM 7701 (1) Seminar: Enzyme Mechanisms and Kinetics
Studies experimental approaches to understand the mechanisms of enzymic catalysis. Techniques include steady-state and pre-steady-state kinetics, isotope trapping and partitioning, inhibition by substrate analogues, and covalent modification of proteins. Department consent required. Formerly CHEM 7701.
Repeatable: Repeatable for up to 6.0 total credit hours.
Requisites: Restricted to graduate students only.

BCHM 7711 (1) RNA Mediated Inorganic and Organic Reactions
Discussion of advances and developments in biomolecular dynamics, with emphasis on experimentalstudies via ultrafast laser spectroscopy. The connection of protein dynamics with function will also be considered. Formerly CHEM 7711.
Requisites: Restricted to graduate students only.

BCHM 7741 (1) Seminar: Signal Transduction and Protein Phosphorylation
Devoted to experimental methods for understanding mechanisms of signal transduction in mammalian cells through pathways involving regulation of protein phosphorylation. Department consent required. Formerly CHEM 7741.
Repeatable: Repeatable for up to 6.0 total credit hours.
Requisites: Restricted to graduate students only.

BCHM 7751 (1) Seminar: Protein Structure and Folding
Studies structure and folding of proteins and protein complexes using biophysical methods, including nuclear magnetic resonance (NMR), circular dichroism, and fluorescence spectroscopies. Department consent required. Formerly CHEM 7751.
Repeatable: Repeatable for up to 6.0 total credit hours.
Requisites: Restricted to graduate students only.

BCHM 7761 (1) Seminar: Eukaryotic Transcriptional Regulation
Studies the regulation of transcription by RNA Polymerase II from human promoters. Department consent required. Formerly CHEM 7761.
Repeatable: Repeatable for up to 6.0 total credit hours.
Requisites: Restricted to graduate students only.

BCHM 7781 (1) Seminar: Topics in Structural Biology
Discussion of advances and developments in structural biology with emphasis on new methods for protein expression, purification and crystallization; and structure solution implementation. Formerly CHEM 7781.
Requisites: Restricted to graduate students only.

BCHM 7791 (1) Seminar: Topics in Ribonucleoprotein Assemblies
Studies aspects of the biochemical and structural analysis of ribonucleic acid (RNA) and its interactions with proteins and assemblies into functional ribonucleoprotein (RNP) enzymes. Techniques focus on x-ray crystallography, spectroscopic methods, and biochemical probing. Formerly CHEM 7791.
Requisites: Restricted to graduate students only.

BCHM 8991 (1-10) Doctoral Dissertation
All doctoral students must register for 30 hours of dissertation credit as part of the requirements for the degree. For a detailed discussion of doctoral dissertation credit, refer to the Graduate School section.
Repeatable: Repeatable for up to 30.0 total credit hours.
Requisites: Restricted to graduate students only.