

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), 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/chemistry-biochemistry/biochemistry-master-science-ms/>)

Doctoral Degree

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

Certificate

- Molecular Biophysics - Graduate Certificate (<https://catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/chemistry-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

Aydin, Halil (https://experts.colorado.edu/display/fisid_167398/)
Assistant Professor; PhD, University of Toronto

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

Cameron, Jeffrey C. (https://experts.colorado.edu/display/fisid_156473/)
Assistant Professor; PhD, Washington University

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

Khanal, Akhil
Instructor; 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

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/)
Senior Instructor; 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 Drug Design

Develop knowledge base and skills in the interdisciplinary field of chemical biology, including aspects of chemistry and biology, and integrating both with respect to hierarchical levels of structure (atomic, molecular, cellular). Students will receive training that helps to develop their careers in biotech, pharmaceutical and other research-oriented industries as well as in academia. Department enforced prerequisites: introductory organic chemistry and general biochemistry. Formerly CHEM 5341.

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 equilibria, 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: BCHM 4400 CHEM 4511

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, X-ray 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

BCHM 5621 (3) Genome Databases: Mining and Management

Lec. Develops essential skills for performing genomic analyses, with focus on developing practical research tools. Introduces human genome and microbiome projects, Python/Sql scripting, accessing and understanding genomic data, sequence alignment and search, evolutionary models, expression data, biological networks, and macromolecular structure.

Equivalent - Duplicate Degree Credit Not Granted: MCDB 5621, MCDB 4621 and BCHM 5621

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.

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 5.00 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) Biochemistry 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.

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 12.00 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 12.00 total credit hours.

Requisites: Restricted to graduate students only.

BCHM 6901 (1-6) Research in Biochemistry

Repeatable: Repeatable for up to 15.00 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 6.00 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 6.00 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 6.00 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 6.00 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 6.00 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 experimental studies 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 6.00 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 6.00 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 6.00 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 30.00 total credit hours.

Requisites: Restricted to graduate students only.