Biochemistry

Chair
• Charles M. Brenner

Undergraduate major: biochemistry (B.A., B.S.)
Faculty: https://medicine.uiowa.edu/biochemistry/people/
primary-appointments
Website: https://medicine.uiowa.edu/biochemistry/

Biochemistry is the study of basic chemical processes that occur in and govern all living systems. Nearly all areas of the life sciences engage in biochemical research.

The Department of Biochemistry offers undergraduate majors and determines the curricula for those programs. Undergraduate students majoring in biochemistry receive their degrees (Bachelor of Arts or Bachelor of Science) from the College of Liberal Arts and Sciences, and their studies are governed by that college’s undergraduate academic policies.

Faculty and Research

The department’s faculty members supervise research in biochemistry; molecular, cellular, developmental, computational, and structural biology; and model system genetics. Their work is supported by grants from the National Institutes of Health, the National Science Foundation, the American Heart Association, the American Cancer Society, the Muscular Dystrophy Association, and other sources. To learn more about the department’s faculty members and areas of research, visit the Department of Biochemistry website.

Programs

Undergraduate Programs of Study

Majors
• Major in Biochemistry (Bachelor of Arts)
• Major in Biochemistry (Bachelor of Science)

Graduate Programs of Study

Majors
• Master of Science in Biochemistry
• Doctor of Philosophy in Biochemistry

Students interested in doctoral studies in biochemistry should apply under the umbrella program in Biomedical Science (select biochemistry subprogram). Direct applications to the M.S. and Ph.D. in biochemistry are not currently being considered.

Facilities

The Department of Biochemistry occupies 36,700 square feet on the fourth floor of the Bowen Science Building, 7,500 square feet on the third floor of the Medical Education Research Facility, and 2,900 square feet on the fourth floor of the Pappajohn Biomedical Discovery Building in the Fraternal Order of Eagles Diabetes Research Center on the University’s health sciences campus. It has a number of well-equipped research laboratories; other departmental facilities include the Beckman Coulter ultra XLI analytical centrifuge.

Biochemistry makes available a number of shared instruments; among them are an Applied PhotoPhysics stopped flow spectrometer SX20; a Jasco spectropolarimeter, model J815; a Horiba fluorlog-3 spectrofluorometer; and a Beckman Coulter ultra XLI analytical centrifuge.

Faculty, staff, and students in the department have access to a variety of shared Carver College of Medicine resources, including the Protein Crystallography Facility, the Iowa Institute of Human Genetics Genomics Division (DNA Facility), the Nuclear Magnetic Resonance Facility, the Proteomics Facility, the Flow Cytometry Facility, the Viral Vector Core Facility, the Small Animal Imaging Core Facility, and the Genome Editing Facility. The University also supports resources such as the Central Microscopy Research Facilities and the High Throughput Screening Facility.

Courses

Biochemistry Courses

BIOC:1001 CLAS Master Class 1-3 s.h.

BIOC:2120 Life-Oriented Organic Chemistry I 3 s.h.
Rigorous treatment of organic chemistry with emphasis on reactivity of biological molecules and reactions of functionalized organic molecules; prepares students to major in any life science including biochemistry, biology, health and human physiology, microbiology, neuroscience, and psychology; satisfies the organic chemistry requirement for further study in the health professions; preparation for biochemistry course work, conducting research, teaching and/or pursuing policy, regulatory, or legal careers in the life sciences. Requirements: Advanced Placement (AP) chemistry score of 5 or CHEM:1110 or one semester of collegiate chemistry.

BIOC:3110 Biochemistry 3 s.h.
One-semester survey of basic concepts in modern biochemistry and molecular biology; emphasis on application of biochemical concepts to human metabolism; appropriate for students who plan to pursue a career in health care or want an overview of biochemistry as a discipline. Requirements: one year each of college-level biology and chemistry. Recommendations: one semester of organic chemistry.

BIOC:3120 Biochemistry and Molecular Biology I 3 s.h.
Physical and chemical foundations of biochemistry, structure of biological molecules, catalysis, transport, and oxidative reactions in biology; first course of two-semester sequence that concludes with BIOC:3130. Requirements: two semesters of general chemistry and one of organic chemistry. Recommendations: BIOL:1411, BIOL:1412, and an additional organic chemistry course.
BIOC:3130 Biochemistry and Molecular Biology II 3 s.h.
Carbohydrate biosynthesis, lipid metabolism, hormone regulation and integration of metabolism, signal transduction, genes and chromosomes, DNA replication and repair, transcription, RNA processing, protein translation and regulation of gene expression. Prerequisites: BIOC:3120 with a minimum grade of C-.

BIOC:3140 Experimental Biochemistry 2 s.h.
Use of modern instruments and techniques to fractionate, identify, and characterize constituents of biochemical systems. Prerequisites: BIOC:3120 with a minimum grade of C. Requirements: two semesters of general chemistry and one semester of organic chemistry.

BIOC:3150 Development of Senior Research Project 2 s.h.
Preparation for biochemistry majors pursuing a senior research project in BIOC:4999; communicating technical information through writing and speaking; presenting scientific journal articles and writing experimental protocols; developing detailed proposal for one-year senior research project. Prerequisites: BIOC:3130 or BIOC:3120 or BIOC:3140. Requirements: biochemistry major, and junior or senior standing.

BIOC:3310 Introduction to Data Science and Bioinformatics 3 s.h.
Understanding how to access large biological data sets and use them to answer biological questions is an important skill for researchers; immersive introduction to computational handling of data; how to access and analyze publicly available data; critically evaluate data quality and analysis in context of measuring gene expression; basic coding in R/RStudio, plotting and data display, fitting and regression, statistical inference, statistical models, downloading and data wrangling; basic introduction to machine learning (clustering); for students with no computational background. Prerequisites: BIOL:1411 with a minimum grade of C- and BIOL:1412 with a minimum grade of C-. Requirements: college algebra. Recommendations: BIOC:3110, or BIOC:3120 and BIOC:3130, or other upper-level life sciences courses. Same as CBIO:3310, MMED:3310.

BIOC:3800 Biochemistry Teaching Practicum arr.
Training for qualified junior or senior undergraduates majoring in biochemistry or a related field to contribute to undergraduate courses; interns may hold review sessions, offer regular office hours, draft questions for homework or exams, assist in proctoring exams, assist students in a laboratory setting, and help with course implementation; guidance from the faculty director and instructors in each course; interns are expected to work approximately three hours per week for each semester hour of credit earned. Requirements: completion of a course covering the same or equivalent material with a grade of B or higher, and must arrange for a short interview with the appropriate course director prior to registration.

BIOC:3993 Undergraduate Biochemistry Research arr.
Preparation for BIOC:4999; directed research with a biochemistry faculty member; experience in an active biochemistry research lab, learning and performing experiments relevant to current projects in that lab, including exposure to scientific literature; arranged in advance by student and biochemistry faculty member.

BIOC:4241 Biophysical Chemistry I 3 s.h.
Principles and experimental approaches used to study structure and function of biological macromolecules; protein structure, stability, and dynamics; macromolecular interactions; common biophysical methods. Prerequisites: BIOC:3120 with a minimum grade of C- and BIOC:3130 with a minimum grade of C-. Requirements: one year of biochemistry. Recommendations: physical chemistry course and one semester of calculus.

BIOC:4242 Biophysical Chemistry II 3 s.h.
Principles and experimental approaches used to study structure and function of biological macromolecules; ligand binding and enzyme catalysis; X-ray crystallography; NMR spectroscopy. Prerequisites: BIOC:3120 with a minimum grade of C- and BIOC:3130 with a minimum grade of C-. Requirements: one year of biochemistry. Recommendations: physical chemistry course and one semester of calculus.

BIOC:4310 Computational Biochemistry 3 s.h.
Introduction to biomolecular modeling and computer simulation techniques; biomolecular structure and molecular driving forces; principles of structural optimization and conformational sampling; applications to biomolecular phenotypes; scripting and molecular visualization in PyMol, setting up and running molecular dynamics simulations using VMD and NAMD, performing refinement of X-ray diffraction data sets using Phenix, and executing Poisson-Boltzmann electrostatic calculations using APBS. Prerequisites: (MATH:1560 or MATH:1860) and CHEM:1120. Recommendations: BIOC:3110 or BIOC:3120. Same as BME:4310.

BIOC:4999 Advanced Undergraduate Biochemistry Research arr.
Advanced directed research with a biochemistry faculty member; work on an individualized research project relevant to research goals of that lab; learning related scientific literature and presentation of research results; arranged in advance by student and biochemistry faculty member and taken after completion of core biochemistry curriculum. Prerequisites: BIOC:3120 with a minimum grade of B- and BIOC:3130 with a minimum grade of B- and BIOC:3140 with a minimum grade of B-. Requirements: BIOC:3993 or URES:3994 or HONR:3994 or prior research experience or lab practicum.

BIOC:5215 Directed Readings for Graduate Students arr.
Directed readings with course content arranged with professor.

BIOC:5241 Biophysical Chemistry I 3 s.h.
Principles and experimental approaches used to study structure and function of biological macromolecules; protein structure, stability, and dynamics; macromolecular interactions; common biophysical methods. Requirements: one year of biochemistry. Recommendations: physical chemistry course and one semester of calculus.

BIOC:5242 Biophysical Chemistry II 3 s.h.
Principles and experimental approaches used to study structure and function of biological macromolecules; ligand binding and enzyme catalysis; X-ray crystallography; NMR spectroscopy. Requirements: one year of biochemistry. Recommendations: physical chemistry course and one semester of calculus.
BIOC:5243 Biophysical Chemistry I, Module I  
1 s.h.
Overview of principles of protein structure, stability, folding, and dynamics; a brief treatment of structural biology approaches to help students become critical users of models derived from X-ray crystallography and NMR; taken alone or as part of BIOC:5241. Requirements: introductory course in biochemistry.

BIOC:5244 Biophysical Chemistry II, Module I  
1 s.h.
Enzymes as unparalleled catalysts that represent a unique class of drug targets; focus on organic chemistry of enzyme catalyzed reactions and enzyme inhibition by small molecules from a medicinal chemistry perspective; chemical and enzyme kinetics, sources of catalytic power, chemical mechanisms used in enzyme catalysis, role of coenzymes; strategies in enzyme inhibition, drug resistance, drug synergism, reversible enzyme inhibitors, transition state analogs, slow tight binding inhibitors, irreversible inhibition; taken alone or as part of BIOC:5242. Requirements: introductory course in biochemistry. Same as PHAR:5542.

BIOC:5245 Biophysical Chemistry I, Module II  
1 s.h.
In-depth examination of statistical thermodynamics and molecular forces in biological systems as related to protein structure, stability, and folding; nucleic acid structure and stability; taken alone or as part of BIOC:5241. Requirements: introductory course in biochemistry.

BIOC:5246 Biophysical Chemistry II, Module II  
1 s.h.
Utilization of X-ray crystallography and NMR spectroscopy in determining atomic resolution biomolecular structures; crystal geometry, X-ray diffraction, the phase problem, data collection, structure solving and refinement; basic principles of NMR spectroscopy including magnetic properties of nuclei, chemical shift, resonance assignments, determination of NOEs, scalar couplings, RDCs, and simulated annealing approaches to structure determination; for students interested in structural biology; taken alone or as part of BIOC:5242. Requirements: introductory course in biochemistry.

BIOC:5247 Biophysical Chemistry I, Module III  
1 s.h.
In-depth examination of protein-protein interactions and protein-nucleic acid interactions; implications in biological motility, transcription, and replication; taken alone or as part of BIOC:5241. Requirements: introductory course in biochemistry.

BIOC:5248 Biophysical Chemistry II, Module III  
1 s.h.
Methods for studying biomolecular dynamics, structure of large biomolecules and biomolecular complexes; measurement and analysis of NMR parameters for characterization of dynamics including T1, T2, hetNOE, CPMG-RD, and RDCs; introduction to computational approaches (e.g., molecular dynamics); NMR methods for studying large biomolecular systems and survey of other approaches including cryoEM and SAX; for students interested in structural biology; taken alone or as part of BIOC:5242. Requirements: one year of biochemistry. Recommendations: basic knowledge of spectroscopy and some previous exposure to NMR from basic chemistry courses.

BIOC:5261 Research Techniques  
1-6 s.h.
Laboratory rotation for first-year graduate students in biochemistry.

BIOC:5282 Seminar  
0-2 s.h.
How to evaluate reports of scientific investigations critically; techniques for presenting scientific information.

BIOC:5875 Perspectives in Biocatalysis  
1-3 s.h.
Applied enzymology, protein design, structure-activity relationships, biosensor technology, microbial transformations, biodegradation of environmental pollutants. Requirements: graduate standing in a participating department supported by the Predoctoral Training Program in Biotechnology. Same as CBE:5875, CEE:5875, CHEM:5875, MCR:5875, PHAR:5875.

BIOC:7251 Introduction to Protein Structures  
1 s.h.
Basics of protein structures and amino acids; module covers chapters 1-5 of Lehninger's Principles of Biochemistry. Recommendations: first-year graduate standing in biosciences or physical sciences.

BIOC:7252 Enzymes, Carbohydrates, Nucleic Acids, and Bioenergetics  
1 s.h.
Basics of enzyme kinetics and enzyme mechanisms, carbohydrates, nucleic acids, and bioenergetics; module covers chapters 6, 7, 8, and 13 of Lehninger's Principles of Biochemistry. Recommendations: first-year graduate standing in biosciences or physical sciences.

BIOC:7253 Metabolism I  
1 s.h.
Basics of carbohydrate metabolism (glycolysis, gluconeogenesis, the pentose phosphate pathway), hormonal regulation of carbohydrate metabolism, the citric acid cycle, amino acid catabolism, oxidative phosphorylation; assignment of an advanced topic related to material, typically a recent research paper, extending inquiry beyond that presented in class and presented orally at end of five-week module. Requirements: undergraduate biochemistry course or background in enzyme function.

BIOC:7254 Cellular Biochemistry  
1 s.h.
Carbohydrate biosynthesis in plants and bacteria, lipid structure/function, biological membranes and transport, signaling, and protein turnover; can be taken alone or as part of BIOC:3130; for graduate students who wish to refresh or advance their knowledge of cellular biochemistry. Recommendations: first-year graduate standing in biosciences or physical sciences.

BIOC:7255 Metabolism II  
1 s.h.
Fatty acid metabolism, lipid biosynthesis, synthesis of nitrogen containing compounds (amino acids, nucleotides) and principles of hormonal regulation of metabolic pathways; can be taken alone or as part of BIOC:3130; for graduate students who wish to refresh or advance their knowledge of metabolism. Recommendations: first-year graduate standing in biosciences or physical sciences.

BIOC:7256 Molecular Biology  
1 s.h.
Chromosomal organization, DNA replication, gene expression, RNA processing, and translation; can be taken alone or as part of BIOC:3130; for graduate students who wish to refresh or advance their knowledge of the central dogma of molecular biology. Recommendations: first-year graduate standing in biosciences or physical sciences.

BIOC:7292 Research Biochemistry  
arr.
Thesis research.

BIOC:8101 Biochemistry for Dental Students  
3 s.h.