

BIOCHEMISTRY

Overview & Learning Goals

Learning Goals

Biochemistry lies at the interface of chemistry and biology, a diffuse and ever-changing junction. A student of this reductionist way of evaluating our natural world must master multiple disciplines and approaches to understand this interface.

The Bowdoin biochemistry curriculum provides the tools and the chemical and biological fundamentals needed to evaluate and explain observed phenomena. Students will understand the basic chemistry of molecules that form the basis of life, including nucleic acids, proteins, lipids, and carbohydrates. How these molecules combine to form the flow of information within and between cells and species, and from generation to generation, is fundamental.

Students start by learning principles of chemistry and biology as underpinned by mathematics and physics, and move on to mid-level courses that combine these concepts and apply them to the understanding of biochemistry. These courses also provide more advanced approaches for solving biochemical problems through experimentation.

Subsequent upper-level courses continue to explore the basis of energy and information flow in chemical and biological systems, and critically analyze structure and complex biochemical interactions that form the basis of life.

Download the Biochemistry Core Competencies map (<https://www.bowdoin.edu/biochemistry/pdf/biochemistry-core-competencies.pdf>)

Fundamental Learning Goals

A. Knowledge competencies:

1. Master the foundational concepts of general and organic chemistry, including equilibrium, kinetics, and reactivity, and apply these concepts to biological systems
2. Identify the factors that determine the three-dimensional structures of biological macromolecules and the organization of cells
3. Evaluate how the structure of biological macromolecules relates to function, and predict how changes in structure will impact function
4. Develop a conceptual, mechanistic, and mathematical understanding of biomolecular interactions, including binding and catalysis
5. Explain how energy is stored, transformed, and harnessed in biological systems
6. Understand how information is stored, retrieved, and transmitted in biological systems

B. Skill-based competencies

1. Solve complex data-based problems
2. Critically evaluate the primary literature
3. Independently propose and design experiments and approaches to address questions in biochemistry
4. Safely perform laboratory-based experiments

5. Effectively communicate scientific information in oral, written, and visual formats to specialized and general audiences
6. Interpret and critically analyze data, while appropriately invoking the principles of probability and statistics
7. Understand and apply theoretical, conceptual, and empirical models

Department/Program Website (<https://www.bowdoin.edu/biochemistry/>)

Faculty

Danielle H. Dube, *Program Director*
Emily Murphy, *Program Coordinator*

Professors: Danielle H. Dube (Chemistry), Bruce D. Kohorn (Biology)
Associate Professors: Benjamin C. Gorske (Chemistry), Anne E. McBride (Biology)
Assistant Professor: Kana Takematsu (Chemistry)
Laboratory Instructors: Aimee Eldridge, Kate R. Farnham

Contributing Faculty: Stephanie Richards

Faculty/Staff Website (<https://www.bowdoin.edu/biochemistry/faculty-and-staff/>)

Requirements

Biochemistry Major

Code	Title	Credits
Required Courses		
BIOL 1102	Biological Principles II	1
or BIOL 1109	Scientific Reasoning in Biology	
BIOL 2124	Biochemistry and Cell Biology	1
Select one of the following:		
CHEM 1092	Introductory Chemistry and Quantitative Reasoning II	
CHEM 1102	Introductory Chemistry II	
CHEM 1109	General Chemistry	
CHEM 2250	Organic Chemistry I	1
CHEM 2260	Organic Chemistry II	1
CHEM 2320	Biochemistry	1
CHEM 2510	Chemical Thermodynamics and Kinetics	1
MATH 1700	Integral Calculus (or higher)	1
PHYS 1130	Introductory Physics I	1
or PHYS 1140	Introductory Physics II	
Select two electives from the following (one must be 3000 or above):		
BIOL 2210	Plant Ecophysiology	
BIOL 2112	Genetics and Molecular Biology	
BIOL 2118	Microbiology	
BIOL 2175	Developmental Biology	
BIOL 2566	Molecular Neurobiology	
BIOL 3304	The RNA World	
BIOL 3314	Advanced Genetics and Epigenetics	
BIOL 3333	Advanced Cell and Molecular Biology	
CHEM 2100	Chemical Analysis	
CHEM 3250	Structure Determination in Organic Chemistry	
CHEM 3270	Biomimetic and Supramolecular Chemistry	

CHEM 3310	Chemical Biology
CHEM 3510	Reactivity and Kinetics

A minimum of eleven courses from among the required and elective biochemistry courses must be completed for the major. Students placing into MATH 1800 Multivariate Calculus or higher must take MATH 1300 Biostatistics, MATH 1400 Statistics in the Sciences, or one math course at the 1800-level or above.

Students placing out of BIOL 1109 Scientific Reasoning in Biology, CHEM 1109 General Chemistry, PHYS 1130 Introductory Physics I, or PHYS 1140 Introductory Physics II must still complete a minimum of eleven courses related to biochemistry.

Additional Information

Additional Information and Program Policies

- Only one D grade is allowed in courses required for the major. This D must be offset by a grade of B or higher in another course also required for the major.
- Students may not count courses taken Credit/D/Fail toward the major.
- Advanced placement exams are used for placement in courses for the biochemistry major, but do not count toward the eleven courses required for the major.
- Biochemistry majors cannot minor or major in biology, chemistry, or neuroscience, and may only double-count courses to a second major or a minor with permission of the Biochemistry Program.
- Bowdoin does not offer a minor in biochemistry.
- Students may request transfer credit by talking with the program director the semester prior to enrolling in a course.
- Independent studies do not count as an elective, but can count as one of the eleven required courses for the major.

Courses

BIOC 2124 (a, INS, MCSR) Biochemistry and Cell Biology

Bruce Kohorn.

Every Fall. Fall 2020. Enrollment limit: 35.

Focuses on the structure and function of cells as we have come to know them through the interpretation of direct observations and experimental results. Emphasis is on the scientific (thought) processes that have allowed us to understand what we know today, emphasizing the use of genetic, biochemical, and optical analysis to understand fundamental biological processes. Covers details of the organization and expression of genetic information, and the biosynthesis, sorting, and function of cellular components within the cell. Concludes with examples of how cells perceive signals from other cells within cell populations, tissues, organisms, and the environment. Three hours of lab each week. Not open to students who have credit for Biology 2423. (Same as: BIOL 2124)

Prerequisites: BIOL 1102 or BIOL 1109 or Placement in BIOL 2000 level.

Previous terms offered: Fall 2019, Fall 2018, Fall 2017, Fall 2016.

BIOC 2320 (a, MCSR) Biochemistry

Every Spring. Enrollment limit: 36.

Focuses on the chemistry of living organisms. Topics include structure, conformation, and properties of the major classes of biomolecules (proteins, nucleic acids, carbohydrates, and lipids); enzyme mechanisms, kinetics, and regulation; metabolic transformations; energetics and metabolic control. Lectures and four hours of laboratory work per week. This course satisfies a requirement for the biochemistry major. (Same as: CHEM 2320)

Prerequisites: CHEM 2260 or CHEM 2261.

Previous terms offered: Spring 2020, Spring 2019, Spring 2018, Spring 2017.

BIOC 2423 (a, INS) Biochemistry of Cellular Processes

Non-Standard Rotation. Enrollment limit: 35.

Explores the biochemical mechanisms that underlie the basis of life. Starts with the chemistry of proteins, DNA, lipids, and carbohydrates to build the main elements of a cell. Moves on to the process of gene organization and expression, emphasizing the biochemical mechanisms that regulate these events. Explores next the organization of the cell with emphasis on genetic and biochemical regulation. Concludes with specific examples of multicellular interactions, including development, cancer, and perception of the environment. This course does NOT satisfy a requirement for the biochemistry major and is not open to students who have credit for Biology 2124. Students who intend to enroll in Biology 2124 should not register for Biology 2423. (Same as: BIOL 2423)

Prerequisites: Two of: either BIOL 1102 or BIOL 1109 or BIOL 2100 or higher and CHEM 1092 or either CHEM 1102 or CHEM 1109 or CHEM 2250.

Previous terms offered: Spring 2020, Spring 2019, Spring 2018.