BIOCHEMISTRY AND MOLECULAR BIOLOGY (Div III)

Chair: Professor Luana Maroja


On leave fall/spring: P. Chen

On leave fall only: K. Hart, D. Richardson

Biochemistry and molecular biology are dynamic fields that lie at the forefront of science. Through elucidation of the structure and function of biologically important molecules (such as nucleic acids, lipids, proteins, and carbohydrates) these disciplines have provided important insights and advances in the fields of molecular engineering (recombinant DNA technology, “intelligent” drug design, “in vitro evolution”), genomics and proteomics, signal transduction, immunology, developmental biology, and evolution.

The Biochemistry and Molecular Biology Program is designed to provide students with an opportunity to explore living systems in molecular terms. Biochemistry and molecular biology are at the interface between the chemical and biological methods of looking at nature; therefore, the program draws heavily from these disciplines. While chemistry is concerned with the relationship between molecular structure and reactions, and biology focuses on cells and organisms, biochemistry and molecular biology probe the details of the structures and interactions of molecules in living systems in order to provide the foundation for a better understanding of biological molecules both individually and as members of more complex structures.

PROGRAM

While aspects of biochemistry and molecular biology can be very diverse, a common set of chemical and biological principles underlie the more advanced topics. With this in mind, the program has been structured to provide the necessary background in chemistry and biology and the opportunity to study the many facets of the modern areas of the biochemical sciences. Students interested in the Biochemistry and Molecular Biology Program should plan their course selection carefully. Since it is expected that Biochemistry 321 and 322 would be taken in the junior year, students are advised to take the prerequisites for those courses in both chemistry and biology during their first two years at Williams. While the program is open to all students, it is expected that it will appeal primarily to majors in biology and chemistry because of the number of courses required in those fields. In addition to taking the required courses, students planning to complete the Biochemistry and Molecular Biology Program are strongly encouraged to elect courses in mathematics and physics.

The following interdepartmental courses serve as the core of the Biochemistry and Molecular Biology Program. BIMO 321 and 322 provide a comprehensive introduction to biochemistry. BIMO 401, the capstone course for the concentration, provides students the opportunity to examine the current scientific literature in a wide variety of BIMO-related research areas.

To complete the concentration in Biochemistry and Molecular Biology, a student must complete all of the required courses listed below, take at least one elective in biology and one elective in chemistry from the list below, and attend at least eight Biology and/or Chemistry Department colloquia. Since the Chemistry Department counts two biology courses and the Biology Department counts two chemistry courses toward the majors (each of which can be completed with only eight other courses), a student majoring in either chemistry or biology would have to take only two or three additional courses to complete the program.

Required Courses

- **BIMO 321 / BIOL 321 / CHEM 321(F, S)** Biochemistry I: Structure and Function of Biological Molecules
  - Taught by: Katie Hart, Bob Rawle
  - Catalog details

- **BIMO 322 / BIOL 322 / CHEM 322(S)** Biochemistry II: Metabolism
  - Taught by: Steven Swoap
  - Catalog details

- **BIMO 401(S)** Topics in Biochemistry and Molecular Biology
  - Taught by: Amy Gehring, Robert Savage
  - Catalog details

- **BIOL 101(F)** The Cell
  - Taught by: Daniel Lynch, Damian Turner
  - Catalog details

- **BIOL 102(S)** The Organism
  - Taught by: Ron Bassar, Heather Williams
  - Catalog details

- **BIOL 202(F)** Genetics
  - Taught by: David Loehlin
  - Catalog details

- **CHEM 151(F)** Introductory Chemistry
  - Taught by: Christine Ting
  - Catalog details
Taught by: Christopher Goh
Catalog details
CHEM 153(F) Concepts of Chemistry

Taught by: Amy Gehring
Catalog details
CHEM 155(F) Principles of Modern Chemistry

Taught by: Enrique Peacock-López
Catalog details
CHEM 156(S) Organic Chemistry: Introductory Level

Taught by: Sarah Goh, Ben Thuronyi
Catalog details
CHEM 251(F) Organic Chemistry: Intermediate Level

Taught by: Thomas Smith, Amanda Turek
Catalog details
CHEM 256(S) Advanced Chemical Concepts

Elective Courses
Students can check with the program chair to see if other courses not listed here might count as electives.

BIOL 305(S) Evolution
Taught by: Luana Maroja
Catalog details

BIOL 308(F) Integrative Plant Biology: Fundamentals and New Frontiers
Taught by: Claire Ting
Catalog details

BIOL 310 / NSCI 310 Neural Development and Plasticity
Taught by: Tim Lebestky
Catalog details

BIOL 313(S) Immunology
Taught by: Damian Turner
Catalog details

BIOL 315(S) Microbiology: Diversity, Cellular Physiology, and Interactions
Taught by: Lois Banta
Catalog details

BIOL 319 / CHEM 319 / CSCI 319 / MATH 319 / PHYS 319 Integrative Bioinformatics, Genomics, and Proteomics Lab
Taught by: Lois Banta
Catalog details

BIOL 326 Cellular Assembly and Movement
Taught by: Pei-Wen Chen
Catalog details

BIOL 407 / NSCI 347(S) Neurobiology of Emotion
Taught by: Tim Lebestky
Catalog details

BIOL 410 Nanomachines in Living Systems
Taught by: Pei-Wen Chen
Catalog details

BIOL 414 Life at Extremes: Molecular Mechanisms
Taught by: Claire Ting
Catalog details

BIOL 418(F) Signal Transduction to Cancer
Taught by: Robert Savage
Catalog details

BIOL 419(S) Secrets of Enzymes: Fidelity, Promiscuity, and Disease
Taught by: Cynthia Holland
Catalog details

BIOL 430 T(S) Genome Sciences: At the Cutting Edge
Taught by: Claire Ting
Catalog details

CHEM 324(S) Enzyme Kinetics and Reaction Mechanisms
Taught by: Amy Gehring
Catalog details

CHEM 326(F) Chemical and Synthetic Biology
Taught by: Ben Thuronyi
Catalog details
Colloquium Requirement

Concentrators must attend at least eight Biology and/or Chemistry Department colloquia. The Biology and Chemistry Departments hold colloquia on Friday afternoons during the fall and spring semesters. Scientists from other academic or research institutions are invited to present their research to students and faculty. There are approximately a dozen colloquia offered each semester among which BIMO concentrators may choose. Attendance at the honors student research presentations and the Biology/BIMO Alumni Reunion poster session also count toward the colloquium requirement. Concentrators may receive credit for colloquia attended during any of their semesters at Williams College.

BIMO 321 (F)(S) Biochemistry I: Structure and Function of Biological Molecules (QFR)

Cross-listings: CHEM 321 BIMO 321 BIOL 321

Primary Cross-listing

This course introduces the basic concepts of biochemistry with an emphasis on the structure and function of biological macromolecules. Specifically, the structure of proteins and nucleic acids are examined in detail in order to determine how their chemical properties and their biological behavior result from those structures. Other topics covered include catalysis, enzyme kinetics, mechanism and regulation; the molecular organization of biomembranes; and the flow of information from nucleic acids to proteins. In addition, the principles and applications of the methods used to characterize macromolecules in solution and the interactions between macromolecules are discussed. The laboratory provides a hands-on opportunity to study macromolecules and to learn the fundamental experimental techniques of biochemistry including electrophoresis, chromatography, and principles of enzymatic assays.

Class Format: lecture, three hours per week; laboratory, four hours per week

Requirements/Evaluation: evaluation is based on quizzes, a midterm exam, a final exam, problem sets and performance in the laboratories including lab reports

Prerequisites: BIOL 101 and CHEM 251/255 and CHEM 155/256

Enrollment Limit: 16/lab

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 16/lab

Grading: no pass/fail option, yes fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major

Distributions: (D3) (QFR)
This course is cross-listed and the prefixes carry the following divisional credit:
CHEM 321 (D3) BIMO 321 (D3) BIOL 321 (D3)

Attributes: BIGP Related Courses  BIMO Required Courses

Fall 2019
LAB Section: 02  M 1:00 pm - 5:00 pm     Bob Rawle
LAB Section: 03  R 1:00 pm - 5:00 pm     Jenna L. MacIntire
LAB Section: 04  W 1:00 pm - 5:00 pm     Bob Rawle

Spring 2020
LEC Section: 01    MWF 9:00 am - 9:50 am     Katie M. Hart
LAB Section: 02    M 1:00 pm - 5:00 pm
LAB Section: 03    T 8:30 am - 12:30 pm

BIMO 322 (S) Biochemistry II: Metabolism  (QFR)
Cross-listings: BIOL 322  CHEM 322  BIMO 322

Primary Cross-listing
This lecture course provides an in-depth presentation of the complex metabolic reactions which are central to life. Emphasis is placed on the biological flow of energy including alternative modes of energy generation (aerobic, anaerobic, photosynthetic); the regulation and integration of the metabolic pathways including compartmentalization and the transport of metabolites; and biochemical reaction mechanisms including the structures and mechanisms of coenzymes. This comprehensive study also includes the biosynthesis and catabolism of small molecules (carbohydrates, lipids, amino acids, and nucleotides). Laboratory experiments introduce the principles and procedures used to study enzymatic reactions, bioenergetics, and metabolic pathways.

Class Format: lecture, three hours per week; laboratory, three hours per week
Requirements/Evaluation: several exams and performance in the laboratories including lab reports that emphasize conceptual and quantitative and/or graphic analysis of the

Prerequisites: BIOL 101 and CHEM 251/255 or permission of instructor

Enrollment Limit: 64

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 64

Grading: no pass/fail option, no fifth course option

Unit Notes: does not satisfy the distribution requirement for the Biology major; cannot be counted towards the Biology major in addition to BIOL 222

Distributions: (D3)  (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
BIOL 322 (D3) CHEM 322 (D3) BIMO 322 (D3)

Attributes: BIGP Related Courses  BIMO Required Courses

Spring 2020
LEC Section: 01    MWF 11:00 am - 11:50 am     Steven J. Swoap
LAB Section: 02    T 1:00 pm - 4:00 pm     Janis E. Bravo
LAB Section: 03    W 1:00 pm - 4:00 pm     Janis E. Bravo
LAB Section: 04    R 1:00 pm - 4:00 pm     Cynthia K. Holland

BIMO 401 (S) Topics in Biochemistry and Molecular Biology  (WS)
This seminar course involves critical reading, analysis, and discussion of papers from the current biochemistry and molecular biology literature. Specific topics vary from year to year but are chosen to illustrate the importance of a wide range of both biological and chemical approaches to
addressing important questions in the biochemical and molecular biological fields. To facilitate discussion, students will prepare written critiques analyzing the data and conclusions of the chosen literature.

**Class Format:** seminar, three hours per week

**Requirements/Evaluation:** evaluation will be based on class presentations and discussions, frequent short papers, and a final paper

**Prerequisites:** BIOL 202 and BIMO 321

**Enrollment Limit:** 12

**Enrollment Preferences:** those completing the BIMO program; open to others with permission of instructor

**Expected Class Size:** 10

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D3) (WS)

**Writing Skills Notes:** The critical analysis of published papers in the biochem literature, as expressed in clear and succinct writing, is a key learning goal for the course. The students write seven literature critiques (typically 5-6 pages long) throughout the semester. While the specific topic each week differs, the parameters of the assignment are the same each time, allowing students to progressively improve their writing. I provide extensive written feedback on each critique, returned before the next due date.

**Attributes:** BIMO Required Courses

**Spring 2020**

SEM Section: 01  TR 9:55 am - 11:10 am  Robert M. Savage

SEM Section: 02  W 1:10 pm - 3:50 pm  Amy Gehring

**Winter Study**

**BIMO 99 (W) Independent Study: Biochemistry and Molecular Biology**

Open to upperclass students. Students interested in doing an independent project (99) during Winter Study must make prior arrangements with a faculty sponsor. The student and professor then complete the independent study proposal form available online. The deadline is typically in late September. Proposals are reviewed by the pertinent department and the Winter Study Committee. Students will be notified if their proposal is approved prior to the Winter Study registration period.

**Class Format:** independent study

**Grading:** pass/fail only

**Winter 2020**

IND Section: 01  TBA  Luana S. Maroja