BIOCHEMISTRY AND BIOPHYSICS

Overview

The Roy J. Carver Department of Biochemistry, Biophysics and Molecular Biology (https://www.bbmb.iastate.edu) offers majors in biochemistry in the College of Liberal Arts and Sciences and in the College of Agriculture and Life Sciences. Biochemists seek to understand life processes in terms of chemical and physical principles. Students in the biochemistry majors develop foundational analytical skills while exploring frontiers in biotechnology and medicine. Graduates in biochemistry will have a rigorous background in chemistry, biology, and physics. Biochemistry coursework focuses on the development of problem-solving skills, critical thinking, communication, and research design. The Biochemistry degree includes focused specializations towards professional goals, including three prescribed options: **Research & Biotechnology**, **Pre-Medicine**, and **Biophysics**.

Graduates with a Biochemistry B.S. degree will be prepared for postgraduate studies in the chemical or biological sciences, medical and health professional training, or immediate laboratory research in biochemistry, biotechnology, or pharmacy. Graduates are also equipped to pursue careers in teaching, technical writing, science communication and policy, intellectual property law, and biotechnology entrepreneurship. The biochemistry major is accredited by the American Society for Biochemistry and Molecular Biology (ASBMB). As such our learning objectives align with ASBMB core concepts.

Student Learning Outcomes

Upon graduation, students should be able to:

- Explain and provide examples to illustrate the biochemical principles underlying the following:
  a. How energy is required and transformed in biological systems.
  b. How macromolecular structure determines function and regulation.
  c. How information storage and flow are dynamic and interactive.
  d. How biochemistry and biology are driven by evolution and homeostasis
- Apply and justify appropriate techniques to characterize and quantify biomolecules in biological systems.
- Execute effective multimodal communication of the research process and results.
- Implement and justify best practices for laboratory safety and research ethics.

Biochemistry Major in the College of Liberal Arts and Sciences

The Bachelor of Science (B.S.) degree in Biochemistry requires the Biochemistry Core and one of the following three prescribed options. The options represent focused specializations for professional goals, including *Research & Biotechnology*, *Pre-Medicine*, and *Biophysics*. As majors in the College of Liberal Arts and Sciences, Biochemistry students must meet College of Liberal Arts and Sciences (http://catalog.iastate.edu/previouscatalogs/2023-2024/collegeofliberalartsandsciences/#lascollegerequirementstext) and University-wide requirements (http://catalog.iastate.edu/previouscatalogs/2023-2024/collegescurricula/) for graduation in addition to those stated below. Focus option-approved science course lists can be found on the Biochemistry website (https://www.bbmb.iastate.edu/approved-course-lists/).

Biochemistry Core

The major in biochemistry requires completion of the Biochemistry Core and one of three focus options. Each defined option includes specific supporting coursework in Biology; Chemistry; Mathematics and/or Statistics.

BBMB 101	Introduction to Biochemistry	1
BBMB 102	Introduction to Biochemistry Laboratory	1
BBMB 201	Chemical Principles in Biological Systems	2
BBMB 311	Writing Scientific Reports in Biochemistry [1]	1
BBMB 312	Experimental Research Skills in Biochemistry	2
BBMB 404	Biochemistry I	3-4
or BBMB 504 & BBMB 505	Amino Acids and Proteins and Bioenergetics and Metabolism	
BBMB 405	Biochemistry II	3-4
or BBMB 506 & BBMB 507	Membrane Biochemistry and Biochemistry of Nucleic Acids	
BBMB 410	Analysis of Scientific Literature	2
BBMB 411	Techniques in Biochemical Research	4
BBMB 461	Molecular Biophysics	2
BBMB 561L	Laboratory in Molecular Biophysics	2-3
or CHEM 322L	Laboratory in Physical Chemistry	
PHYS 231 & 231L	Introduction to Classical Physics I and Introduction to Classical Physics I Laboratory	5
PHYS 232 & 232L	Introduction to Classical Physics II and Introduction to Classical Physics II Laboratory	5

BBMB 499	Undergraduate Research (highly encouraged elective)	arr †
Total Credits		**33-36 †**

† Arranged with instructor.

[1] BBMB 311 fulfills the ISU upper-level Communication Proficiency requirement.

Biochemistry Program of Study: Research & Biotechnology

Students interested in careers in biotechnology research and/or graduate studies in biochemistry, chemistry, or bioscience fields may opt for the Research & Biotechnology Option.

In addition to the Biochemistry Core (above):

CHEM 201	Advanced General Chemistry	5-7
or CHEM 177 & CHEM 178	General Chemistry I and General Chemistry II	
CHEM 201L	Laboratory in Advanced General Chemistry	1
or CHEM 177N	Laboratory in General Chemistry I	
or CHEM 177L	Laboratory in General Chemistry I	
CHEM 325	Chemical Thermodynamics	3
CHEM 331	Organic Chemistry I	3
CHEM 332	Organic Chemistry II	3
CHEM 333L	Laboratory in Organic Chemistry I (for Chemistry and Biochemistry Majors)	1-2
or CHEM 331L	Laboratory in Organic Chemistry I	
CHEM 334L	Laboratory in Organic Chemistry II (for Chemistry and Biochemistry Majors)	1-2
or CHEM 332L	Laboratory in Organic Chemistry II	
MATH 165 & MATH 166	Calculus I and Calculus II	8
MATH 265	Calculus III	3-4
or MATH 266	Elementary Differential Equations	
or MATH 267	Elementary Differential Equations and Laplace Transforms	
or STAT 201	Introduction to Statistical Concepts and Methods	
or STAT 305	Engineering Statistics	
BIOL 211	Principles of Biology I	3
BIOL 212	Principles of Biology II	3
BIOL 313 & 313L	Principles of Genetics and Genetics Laboratory	4
BIOL 314	Principles of Molecular Cell Biology	3
Molecular Sciences from approved list		3
Total Credits		**44-49**

Biochemistry Program of Study: Pre-Medicine

Students interested in qualifying for medical school training for careers as a Doctor of Medicine (MD) or Doctor of Osteopathic Medicine (DO) may opt for the Pre-Medicine Option. Allied health professions (e.g., Physician Assistant, Dentistry, and Ophthalmology) may also consider the Pre-Medicine Option.

In addition to the Biochemistry Core (above):

CHEM 177 & 177L & CHEM 178 & CHEM 178L	General Chemistry I and Laboratory in General Chemistry I and General Chemistry II and Laboratory in College Chemistry II	6-9
or CHEM 201 & 201L	Advanced General Chemistry and Laboratory in Advanced General Chemistry	
CHEM 325	Chemical Thermodynamics	3
CHEM 331 & 331L	Organic Chemistry I and Laboratory in Organic Chemistry I	4
CHEM 332 & 332L	Organic Chemistry II and Laboratory in Organic Chemistry II	4
MATH 165 & MATH 166	Calculus I and Calculus II	8
STAT 201	Introduction to Statistical Concepts and Methods	3-4
or STAT 305	Engineering Statistics	
PSYCH 101	Introduction to Psychology	3
or PSYCH 230	Developmental Psychology	
SOC 134	Introduction to Sociology	3
BIOL 211	Principles of Biology I	3
BIOL 211L	Principles of Biology Laboratory I	1
BIOL 212	Principles of Biology II	3
BIOL 212L	Principles of Biology Laboratory II	1
BIOL 313	Principles of Genetics	3
BIOL 314	Principles of Molecular Cell Biology	3
Health & Biosciences from approved list		3
Total Credits		**51-55**

Biochemistry Program of Study: Biophysics

Students interested in research careers focused on the biophysical basis of life processes may opt for the Biophysics Option. *The Biophysics major will be discontinued Fall 2023 pending Board of Regents State of Iowa approval; the Biochemistry major now has a formal program focus in biophysics.*

In addition to the Biochemistry Core (above):

CHEM 201	Advanced General Chemistry	5-7
or CHEM 177 & CHEM 178	General Chemistry I and General Chemistry II	
CHEM 201L	Laboratory in Advanced General Chemistry	1
or CHEM 177N	Laboratory in General Chemistry I	
or CHEM 177L	Laboratory in General Chemistry I	
CHEM 324	Introductory Quantum Mechanics	3
CHEM 325	Chemical Thermodynamics	3
CHEM 331	Organic Chemistry I	3
CHEM 332	Organic Chemistry II	3
MATH 165 & MATH 166	Calculus I and Calculus II	8
MATH 265	Calculus III	4
MATH 266	Elementary Differential Equations	3
MATH 317	Theory of Linear Algebra	4
COM S 207	Fundamentals of Computer Programming	3
BIOL 211	Principles of Biology I	3
BIOL 212	Principles of Biology II	3
Physical Sciences from approved list		3
Total Credits		**49-51**

As majors in the College of Liberal Arts and Sciences, Biochemistry students must meet College of Liberal Arts and Sciences (http://catalog.iastate.edu/previouscatalogs/2023-2024/collegeofliberalartsandsciences/#lascollegerequirementstext) and University-wide requirements (http://catalog.iastate.edu/previouscatalogs/2023-2024/collegescurricula/) for graduation in addition to the requirements for the major.

LAS majors require a minimum of 120 credits, including a minimum of 45 credits at the 300/400 level. You must also complete the LAS world language requirement and LAS career proficiency requirement.

Communication Proficiency requirement: According to the university-wide Communication Proficiency Grade Requirement, students must demonstrate their communication proficiency by earning a grade of C or better in ENGL 250.

Students in all ISU majors must complete a three-credit course in U.S. diversity and a three-credit course in international perspectives. Check (http://www.registrar.iastate.edu/courses/div-ip-guide.html) for a list of approved courses. Discuss with your advisor how the two courses that you select can be applied to your graduation plan.

Four Year Plans

Biochemistry B.S. Program of Study, College of Liberal Arts and Sciences

Research & Biotechnology Option

Sample Four-Year Plan

First Year

Fall	Credits	Spring	Credits
BBMB 101	1	BBMB 102	1
BBMB 110	1	BBMB 111	1
MATH 165	4	MATH 166	4
CHEM 177	4	CHEM 178	3
CHEM 177N	1	BIOL 211	3
LIB 160	1	General Education Elective	3
ENGL 150	3		
	15		**15**

Second Year

Fall	Credits	Spring	Credits
MATH 265, 266, 267, STAT 201, or STAT 305	3-4	BBMB 201	2
CHEM 331	3	CHEM 332	3
CHEM 331L	1	CHEM 332L	1
PHYS 231	4	PHYS 232	4
PHYS 231L	1	PHYS 232L	1
BIOL 212	3	ENGL 250	3
		BBMB 499	1
		LAS 203	1
	15-16		**16**

Third Year

Fall	Credits	Spring	Credits
BBMB 404	3	BBMB 405	3
BBMB 311*	1	BIOL 314	3
BBMB 312	2	BBMB 410	2
BIOL 313	3	BBMB 499	1
BIOL 313L	1	International Perspectives Elective	3
BBMB 499	1	General Education Elective	3
U.S. Diversity Elective	3		
General Education Elective	3		
	17		**15**

Fourth Year

Fall	Credits	Spring	Credits
BBMB 411	4	CHEM 325	3

BBMB 499	2 CHEM 322L or BBMB 461 ***and*** BBMB 561L	3-4
Upper-level Mol. Sciences Elective	3 BBMB 499	3
General Education Elective	3 General Education Elective	3
General Education Elective	3 General Education Elective	3
	15	**15-16**

"General Education Electives" include credits in LAS-approved courses in *Arts & Humanities* and *Social Sciences*

* BBMB 311 fulfills the upper-level communication proficiency requirement.

Biochemistry B.S. Program of Study, College of Liberal Arts and Sciences
Pre-Medicine Option
Sample Four-Year Plan

First Year

Fall	Credits	Spring	Credits
BBMB 101	1	BBMB 102	1
BBMB 110	1	BBMB 111	1
MATH 165	4	MATH 166	4
CHEM 177	4	CHEM 178	3
CHEM 177N	1	CHEM 178L	1
LIB 160	1	BIOL 211	3
ENGL 150	3	BIOL 211L	1
	15		**14**

Second Year

Fall	Credits	Spring	Credits
CHEM 331	3	BBMB 201	2
CHEM 331L	1	CHEM 332	3
PHYS 231	4	CHEM 332L	1
PHYS 231L	1	PHYS 232	4
BIOL 212	3	PHYS 232L	1
BIOL 212L	1	ENGL 250	3
PSYCH 101	3	LAS 203	1
	16		**15**

Third Year

Fall	Credits	Spring	Credits
BBMB 404	3	BBMB 405	3
BBMB 311*	1	BIOL 314	3
BBMB 312	2	BBMB 410	2
BIOL 313	3	BBMB 499	1
STAT 201	4	SOC 134	3
PHIL 235[1]	3	International Perspectives Elective	3
	16		**15**

Fourth Year

Fall	Credits	Spring	Credits
BBMB 411	4	CHEM 325	3
BBMB 499	2	CHEM 322L or BBMB 461 ***and*** BBMB 561L	3-4
Upper-level Health or Mol. Biosci. Elective	3	BBMB 499	3
General Education Elective	3	General Education Elective	3
General Education Elective	3	General Education Elective	3
	15		**15-16**

"General Education Electives" include credits in LAS-approved courses in *Arts & Humanities* and *Social Sciences*. MCAT-recommended SOC 134 and PSYCH 101 apply towards *Social Sciences* requirement.

* BBMB 311 fulfills the upper-level communication proficiency requirement.

[1] Fulfills university U.S. Diversity requirement

Biochemistry B.S. Program of Study, College of Liberal Arts and Sciences
Biophysics Option
Sample Four-Year Plan

First Year

Fall	Credits	Spring	Credits
BBMB 101	1	BBMB 102	1
BBMB 110	1	BBMB 111	1
MATH 165	4	MATH 166	4
CHEM 177	4	CHEM 178	3
CHEM 177N	1	BIOL 211	3
LIB 160	1	General Education Elective	3
ENGL 150	3		
	15		**15**

Second Year

Fall	Credits	Spring	Credits
MATH 265	4	BBMB 201	2
CHEM 331	3	CHEM 332	3
PHYS 231	4	PHYS 232	4
PHYS 231L	1	PHYS 232L	1
BIOL 212	3	ENGL 250	3

		LAS 203	1
	15		**14**
Third Year			
Fall	**Credits**	**Spring**	**Credits**
BBMB 404	3	BBMB 405	3
BBMB 311*	1	CHEM 325	3
BBMB 312	2	BBMB 410	2
COM S 207	3	MATH 317	4
U.S. Diversity Elective	3	BBMB 499	1
General Education Elective	3	General Education Elective	3
	15		**16**
Fourth Year			
Fall	**Credits**	**Spring**	**Credits**
BBMB 411	4	CHEM 324	3
STAT 305	3	CHEM 322L or BBMB 461 ***and*** BBMB 561L	3-4
BBMB 499	1	Upper-level Physical Sci. Elective	3
International Perspectives Elective	3	BBMB 499	1
General Education Elective	3	General Education Elective	3
General Education Elective	3	General Education Elective	3
	17		**16-17**

"General Education Electives" include credits in LAS-approved courses in *Arts & Humanities* and *Social Sciences*.

* BBMB 311 fulfills the upper-level communication proficiency requirement.

Minor

The Roy J. Carver Department of Biochemistry, Biophysics, and Molecular Biology offers a minor in Biochemistry.

BBMB 404	Biochemistry I	3
BBMB 405	Biochemistry II	3
BBMB 312	Experimental Research Skills in Biochemistry	2
One course from the following:		2-3
BBMB 461	Molecular Biophysics (2 cr)	
BBMB 561	Molecular Biophysics (2 cr)	
CHEM 325	Chemical Thermodynamics (3 cr)	
300+ level courses in BBMB or CHEM to 15 cr total		5-6
Total Credits		**15-17**

All minors require at least 15 credits, including at least 6 credits in course numbered 300 or above taken at Iowa State University. The minor must include at least 9 credits that are not used to meet any other department, college, or university requirement.

Concurrent Programs

Concurrent Bachelor of Science (B.S.)/ Master of Science (M.S.) Degrees

The department offers a concurrent enrollment degree program in either Biochemistry or Biophysics that allows ISU undergraduate students to obtain both the B.S. and M.S. degrees in about five years. The program is open to undergraduate students in the College of Liberal Arts and Sciences and in the College of Agriculture and Life Sciences. The concurrent degrees can be useful to students entering various career tracks. For those considering careers as research specialists, entry positions with higher-level responsibilities, and a higher-level salary, are made possible with the M.S. degree. For those considering careers as research directors, which require advanced study, the M.S. degree provides an advantage for admission into Ph.D. programs at the most competitive and prestigious graduate schools. Similarly, the M.S. degree can be a competitive advantage for admission in to medical, dental, law, veterinary medicine, or other professional schools.

Application to the program is made near the end of the junior undergraduate (third) year. Concurrent B.S/M.S. degree students begin research for the M.S. thesis during the summer semester after their junior year and are eligible for research assistantships, which are renewable based on academic standing and satisfactory research performance. The M.S. thesis requires intensive experience in original, independent laboratory research under the close supervision of a faculty mentor. To apply, see the concurrent B.S./M.S. application instructions found on the department's Graduate Study web page.

Concurrent Bachelor of Science/Graduate Certificate

The Bachelor of Science /Graduate Certificate program is intended for exceptional undergraduate students majoring in Biochemistry. In this program, the student completes all of the requirements for the B.S. degree and the graduate certificate in a four-year period by combining the requirements of the two programs. The student enters the Graduate College after he/she achieves junior status and develops a plan of coursework (graduate and undergraduate) subject to the approval of the Director of Certificate (DOC). Required graduate courses are BBMB 504, 505, 506, 507, 561 and 561L. The student must satisfy the requirements of the B.S. in Biochemistry (121 credits) and the Graduate Certificate in Biochemistry (12 credits). Six credits of graduate coursework can satisfy some requirements of the B.S. degree. To apply for the B.S./Graduate Certificate, submit the application form found on the Graduate College Forms web page.

Graduate Programs

Introduction

Biochemistry and Biophysics are the science and technology used to understand the mechanisms underlying biological processes at the molecular level, with an emphasis on the fundamental relationships among the chemical, physical, and biological sciences. The Roy J. Carver Department of Biochemistry, Biophysics, and Molecular Biology (BBMB) administers Doctor of Philosophy (Ph.D.), Master's (M.S.), and Graduate Certificate programs that lead to an advanced degree or certificate in these disciplines. The prerequisite to graduate study is a sound undergraduate background in biology, chemistry, mathematics, and physics.

BBMB offers Doctor of Philosophy and Master's degrees in Biochemistry and in Biophysics that are designed to train students to independently conceive and carry out original research. BBMB also offers two graduate certificate programs in Biochemistry that provide a mechanism for formal recognition of focused graduate study in a specialized area that is less comprehensive than that required for a master's degree. BBMB participates in the Interdepartmental majors of Bioinformatics and Computational Biology; Genetics and Genomics; Immunobiology; Molecular, Cellular, and Developmental Biology; Neuroscience; Plant Biology; and Toxicology. All graduate degree students in BBMB are required to teach as part of their training.

Master of Science (M.S.) Degree

The M.S. degree programs in Biochemistry and in Biophysics are useful for students who prefer to undertake research training without the longer-term commitment required for the Ph.D. degree. It is also useful for students interested more in the technical aspects of research rather than in careers as research directors. The program requires about 3 years on average to complete and the successful defense of an independent research dissertation is required. About half the time required to earn the degree is spent on advanced coursework and professional seminars, and the other half is devoted to research undertaken in the laboratory under the close supervision of a faculty mentor. Financial support is available. To apply, applicants first submit the free BBMB online application found on the department website, which is used as a screening tool.

NOTE: Students interested in a research career are encouraged to consider the Ph.D. track. Students may enter the Biochemistry or Biophysics M.S. degree program as a direct admit to a faculty research group at any time during the year.

Doctor of Philosophy (Ph.D.) Degree

The Ph.D. programs in Biochemistry and in Biophysics are designed to train students in the ability to independently conceive and carry out original research in the general area of the chemistry or physics of the processes of life. The programs require about 5-6 years on average to complete and the successful defense of an independent research dissertation. The majority of the time required to earn the degree is spent doing research on the dissertation project in the laboratory under the close supervision of a faculty mentor. Considerable time also is devoted to advanced coursework and professional seminars. Financial support is available. To apply, applicants first submit the free BBMB online application found on the department website, which is used as a screening tool. Students may enter the Biochemistry or Biophysics Ph.D. degree programs either as a rotation student in the fall semester or as a direct admit to a faculty research group at any time during the year.

Graduate Minor in Biochemistry

Graduate students in other M.S. and/or Ph.D. programs at ISU can earn a graduate minor in Biochemistry by completing 12 credits of the following courses with a grade point average of 3.0 or above: at least 6 credits from BBMB 504, BBMB 505, BBMB 506 and BBMB 507 and at least 6 credits of other BBMB 500- and 600-level courses. A student wishing to declare a minor in Biochemistry should arrange for a member of the graduate faculty in Biochemistry to serve on the POS Committee and submit the required form found on the Graduate College Forms page.

Graduate Certificate Programs

The graduate certificate program is designed for students who wish to continue or expand their knowledge in Biochemistry at the graduate level without the time commitment or lab experience required for a formal Master's or Ph.D. program. A certificate program can be an attractive option for individuals who have a bachelor's degree and are interested in broadening their expertise, or who are working in the sciences or industry and want to continue their education at the graduate level. BBMB offers two graduate certificate programs in Biochemistry: a concurrent B.S. / Graduate Certificate and a Graduate Certificate. The standards of admission and the course standards to which a certificate student are held are equivalent to those expected of a master's student. Each graduate certificate requires at least 12 graduate credits, all of which are available either on campus or on line. A graduate supervisor will be appointed to oversee the certification for each student.

If a person who completes a graduate certificate program decides to continue for a graduate degree in Biochemistry or Biophysics, program approval is required. Credits earned for the graduate certificate may be used to meet course requirements for the graduate degree program.

Graduate Certificate in Biochemistry

The graduate certificate in Biochemistry is designed for students who have a B.S. degree in Biochemistry or a related field and wish to advance their knowledge by taking additional coursework at the graduate level. The graduate certificate courses may be taken either on-line or on campus. Candidates for a graduate certificate in Biochemistry are admitted in the Graduate College. A total of 12 credits is required that include BBMB 504, BBMB 505, BBMB 506 and BBMB 507, plus four

additional credits of BBMB coursework at the 500-level. The 12 credits earned in the graduate certificate program may be applied to meet the course requirements of a M.S. or Ph.D. program in Biochemistry at Iowa State University (ISU) if the student is accepted into one of these programs. To apply for the graduate certificate in Biochemistry, submit the ISU online application.