

BIOCHEMISTRY AND BIOPHYSICS

Overview

The department of Biochemistry, Biophysics & Molecular Biology (<http://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. Graduates in biochemistry will have a rigorous background in chemistry, biology, and physics that will prepare them for graduate studies in the chemical or biological sciences, medical and health professional training, or immediate laboratory research in biochemistry, biotechnology, or pharmacy. The biochemistry major is accredited by the American Society for Biochemistry and Molecular Biology (ASBMB). As such our learning objectives are in-line with ASBMB core concepts.

Student Learning Outcomes

Upon graduation, students should be able to:

- Demonstrate that energy is required by and transformed in biological systems.
- Demonstrate that macromolecular structure determines function and regulation.
- Demonstrate that information storage and flow are dynamic and interactive.
- Articulate the principals of biochemistry and biology within the overarching context of evolution and homeostasis.
- Use the tools and techniques required for objective measurement and quantitative analysis of biochemicals in biological systems.
- Write and orally present clear communication following the rules of the scientific method.
- Implement rigorous standards for laboratory safety and research ethics.

Degree Requirements

As majors in the College of Liberal Arts and Sciences, Biochemistry and Biophysics students must meet College of Liberal Arts and Sciences (<http://catalog.iastate.edu/previouscatalogs/2022-2023/collegeofliberalartsandsciences/#lascollegerequirementstext>) and University-wide requirements (<http://catalog.iastate.edu/previouscatalogs/2022-2023/collegescurricula/>) for graduation in addition to those stated below for each major.

Biochemistry undergraduate major program of study

BBMB 101	Introduction to Biochemistry	1
BBMB 102	Introduction to Biochemistry Laboratory	1

BBMB 201	Chemical Principles in Biological Systems	2
BBMB 311X	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 411	Techniques in Biochemical Research	4
BBMB 461	Molecular Biophysics	2
or BBMB 561	Molecular Biophysics	
BBMB 561L	Laboratory in Molecular Biophysics	2-3
or CHEM 322L	Laboratory in Physical Chemistry	
BBMB 490	Independent Study (Elective) ^{max. 9 cr. can be applied}	arr t
BBMB 499	Undergraduate Research (Elective) ^{highly encouraged}	arr t
Take one of the following:		5-7
CHEM 201	Advanced General Chemistry	
or CHEM 177	General Chemistry I & CHEM 178 and General Chemistry II	
Take one of the following:		1
CHEM 201L	Laboratory in Advanced General Chemistry	
or CHEM 177	Laboratory in General Chemistry I	
or CHEM 177	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
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	Calculus I	4
MATH 166	Calculus II	4
Take one of the following		
MATH 265	Calculus III	
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		
PHYS 231	Introduction to Classical Physics I	4
PHYS 231L	Introduction to Classical Physics I Laboratory	1
PHYS 232	Introduction to Classical Physics II	4
PHYS 232L	Introduction to Classical Physics II Laboratory	1
BIOL 211	Principles of Biology I	3
BIOL 212	Principles of Biology II	3
BIOL 313	Principles of Genetics	3
BIOL 314	Principles of Molecular Cell Biology	3

Take one of the following

BIOL 211L Principles of Biology Laboratory I or BIOL 212L Principles of Biology Laboratory II or BIOL 313L Genetics Laboratory		
Biological Science electives	from Biochemistry, Biology, Chemistry, Genetics, Microbiology	4

† Arranged with instructor.

¹ BBMB 311X with concurrent enrollment in BBMB 312 fulfills the upper level communication requirement.

Biophysics undergraduate major program of study

BBMB 101	Introduction to Biochemistry	1
BBMB 102	Introduction to Biochemistry Laboratory	1
BBMB 201	Chemical Principles in Biological Systems	2
BBMB 311X	Writing Scientific Reports in Biochemistry ¹	1
BBMB 312	Experimental Research Skills in Biochemistry	2
BBMB 404	Biochemistry I	3
or BBMB 420 Mammalian Biochemistry		
BBMB 411	Techniques in Biochemical Research	4
BBMB 461	Molecular Biophysics	2
or BBMB 561 Molecular Biophysics		
BBMB 561L	Laboratory in Molecular Biophysics	2-3
or CHEM 322L Laboratory in Physical Chemistry		
BBMB 490	Independent Study (Elective) ^{max. 9 cr. can be applied}	arr
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BBMB 499	Undergraduate Research (Elective) ^{highly encouraged}	arr
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Take one of the following: 5-7

CHEM 201	Advanced General Chemistry	
CHEM 177	General Chemistry I	
& CHEM 178	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	6
& CHEM 332	and Organic Chemistry II	
MATH 165	Calculus I	4
MATH 166	Calculus II	4
MATH 265	Calculus III	4
MATH 266	Elementary Differential Equations	3
MATH 207	Matrices and Linear Algebra	3
or MATH 317 Theory of Linear Algebra		

PHYS 231	Introduction to Classical Physics I	4
PHYS 231L	Introduction to Classical Physics I Laboratory	1
PHYS 232	Introduction to Classical Physics II	4
PHYS 232L	Introduction to Classical Physics II Laboratory	1

One course from the following:

MATH 481	Numerical Methods for Differential Equations	3
or STAT 475 Introduction to Multivariate Data Analysis		
or STAT 483 Empirical Methods for the Computational Sciences		
COM S 207	Fundamentals of Computer Programming	3
STAT 305	Engineering Statistics	3-4
or STAT 231 Probability and Statistical Inference for Engineers		

BIOL 211	Principles of Biology I	6
& BIOL 212	and Principles of Biology II	
BIOL 211L	Principles of Biology Laboratory I	1
or BIOL 212L Principles of Biology Laboratory II		

Additional 300+ or higher level courses in biochemistry, biophysics, biological sciences, chemistry or physics. 7

† Arranged with instructor.

¹ BBMB 311X with concurrent enrollment in BBMB 312 fulfills the upper level communication requirement.

Four Year Plans

Biochemistry, B.S.

Freshman

Fall	Credits Spring	Credits
BBMB 101	1 BBMB 102	1
CHEM 201*	5 MATH 166	4
CHEM 201L*	1 BIOL 211	3
MATH 165**	4 BIOL 211L ³	1
ENGL 150	3 LAS General Education requirement	3

LIB 160 ¹	1 LAS General Education requirement	3
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Sophomore

Fall	Credits Spring	Credits
CHEM 331	3 BBMB 201	2
CHEM 331L or 333L	1-2 CHEM 332	3
Upper Level Math or Statistics	3-4 CHEM 332L or 334L	1-2
BIOL 212	3 ENGL 250	3
PHYS 231	4 PHYS 232	4
PHYS 231L	1 PHYS 232L	1

15-17	14-15
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Junior

Fall	Credits Spring	Credits
BBMB 404	3 BBMB 405	3
BIOL 313	3 BIOL 314	3
BBMB 311X ¹	1 LAS General Education Requirement ²	3
BBMB 312 ¹	2 LAS General Education Requirement ²	3
LAS General Education Requirement ²	3 LAS World Language Requirement ⁷	4
LAS World Language Requirement ⁸	4	

16	16
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Senior

Fall	Credits Spring	Credits
BBMB 411	4 BBMB 461	2
CHEM 324	3 Biological Science Elective	4
LAS General Education Requirement ²	3 CHEM 325	3
LAS General Education Requirement ²	3 BBMB 561L	2
BBMB 499 ²	var BBMB 499 ²	var

13	11
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Total Credits: 115-118

* General Chemistry I and II (177, 177N or 177L and 178) are acceptable substitutes for CHEM 201 and 201L.

** ALEKS assessment determines math placement.

¹ BBMB 311X with concurrent enrollment in BBMB 312 fulfills the upper level communication requirement.

² Undergraduate study or research, BBMB 490 or 499, is recommended but not required. Credit value is variable.

Biophysics, B.S.
Freshman

Fall	Credits Spring	Credits
BBMB 101	1 BBMB 102	1
CHEM 201 or 177 <i>and</i> 178*	5 MATH 166	4
CHEM 201L or 177L*	1 BIOL 211	3
MATH 165**	4 BIOL 211L	1
ENGL 150	3 COM S 207	3
LIB 160 ¹	1 LAS World Language Requirement	4

15	16
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Sophomore

Fall	Credits Spring	Credits
CHEM 331	3 BBMB 201	2
MATH 265	4 CHEM 332	3
BIOL 212	3 MATH 266	3
PHYS 231	4 ENGL 250	3
PHYS 231L	1 PHYS 232	4
	PHYS 232L	1

15	16
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Junior

Fall	Credits Spring	Credits
BBMB 404	3 CHEM 325	3
CHEM 324	3 BBMB 461	2
BBMB 311X ¹	1 BBMB 561L	2
BBMB 312 ¹	2 MATH 317	4
Science Elective	3 LAS World Language Requirement	4
LAS General Education requirement	3	

15	15
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Senior

Fall	Credits Spring	Credits
BBMB 411	4 Science Elective ³	
Science Elective 300+	3 LAS General Education Requirement	3
LAS General Education Requirement	3 LAS General Education Requirement	3
STAT 231 or 305	4 LAS General Education Requirement	3

LAS General Education Requirement	3 BBMB 499 ²	var
BBMB 499 or 490 ²	var	
	17	9

Total Credits: 118

* General Chemistry I and II (177, 177n or 177l and 178) are acceptable substitutes for CHEM 201 and 201L.

** ALEKS assessment determines math placement.

¹ BBMB 311X with concurrent enrollment in BBMB 312 fulfills the upper level communication requirement.

² Undergraduate study or research, BBMB 490 or 499, is recommended but not required. Credit value is variable.

Minor

Biochemistry minor is offered in both the College of Liberal Arts and Sciences and Agriculture and Life Sciences

BBMB 404	Biochemistry I	3
BBMB 405	Biochemistry II	3
BBMB 411	Techniques in Biochemical Research	4
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		3-4
Total Credits		15-17

These lists of courses should not be regarded as statements of fixed requirements or as complete outlines of the work necessary for the major. They are given solely for the convenience of students or advisors who wish to estimate the amount of basic study that may be needed.

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, 505, 506 and 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, 505, 506 and 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.