

BIOCHEMISTRY AND MOLECULAR BIOLOGY, B.S. (SCIENCE)

Begin Campus: Any Penn State Campus

End Campus: University Park

Program Description

Students in this major apply basic principles of chemistry and physics to the study of living cells and their components to explain biology at molecular, genetic, and cellular levels. Students will develop a strong foundation in quantitative and analytical biological sciences, including molecular biology, biochemistry, enzymology, metabolism, cell biology, and molecular genetics.

Biochemistry Option

Available at the following campuses: Berks, University Park

The Biochemistry Option is offered for students who have interests in the structures, properties and functions of macromolecules, and in the quantitative and analytical techniques used to characterize these macromolecules.

Molecular and Cell Biology Option

Available at the following campuses: Berks, University Park

The Molecular and Cell Biology Option is available to students whose interests relate to the growth, reproduction and differentiation of cells and to signaling processes that occur in multicellular systems that activate and modulate these processes. The curriculum is designed to prepare students for advanced study leading to careers in research, medicine, and education, or to secure employment in biotechnology and health-related industries, including government, academic, and private laboratories.

What is Biochemistry and Molecular Biology?

Biochemistry and Molecular Biology is the study of the molecular basis of life. Biochemistry uses the principles of chemistry and physics to understand biological molecules, structures, and reactions. Molecular biology focuses on how biological molecules interact to form cells, organisms, and behaviors.

You Might Like This Program If...

- You like learning by doing experiments.
- You want to know how life works at the most fundamental level.
- You are interested in understanding the molecular basis of health, disease, and behavior.
- You want to learn how molecules can be manipulated to address global challenges such as disease, famine, and energy needs.

Entrance to Major

In order to be eligible for entrance to the Biochemistry and Molecular Biology major, a student must have:

1. attained at least a 2.00 cumulative grade-point average, and
2. completed CHEM 110, CHEM 111, CHEM 112, and MATH 140; and
3. earned a grade of C or better in each of these courses.

Degree Requirements

For the Bachelor of Science degree in Biochemistry and Molecular Biology, a minimum of 125 credits is required:

Requirement	Credits
General Education	45
Requirements for the Major	95

General Education

Connecting career and curiosity, the General Education curriculum provides the opportunity for students to acquire transferable skills necessary to be successful in the future and to thrive while living in interconnected contexts. General Education aids students in developing intellectual curiosity, a strengthened ability to think, and a deeper sense of aesthetic appreciation. These are requirements for all baccalaureate students and are often partially incorporated into the requirements of a program. For additional information, see the General Education Requirements (<http://bulletins.psu.edu/undergraduate/general-education/baccalaureate-degree-general-education-program>) section of the Bulletin and consult your academic adviser.

The keystone symbol appears next to the title of any course that is designated as a General Education course. Program requirements may also satisfy General Education requirements and vary for each program.

Foundations (grade of C or better is required.)

- **Quantification (GQ):** 6 credits
- **Writing and Speaking (GWS):** 9 credits

Knowledge Domains

- **Arts (GA):** 6 credits
- **Health and Wellness (GHW):** 3 credits
- **Humanities (GH):** 6 credits
- **Social and Behavioral Sciences (GS):** 6 credits
- **Natural Sciences (GN):** 9 credits

Integrative Studies (may also complete a Knowledge Domain requirement)

- **Inter-Domain or Approved Linked Courses:** 6 credits

15 of these 45 credits are included in the Requirements for the Major.

University Degree Requirements

First Year Engagement

All students enrolled in a college or the Division of Undergraduate Studies at University Park, and the World Campus are required to take 1 to 3 credits of the First-Year Seminar, as specified by their college First-Year Engagement Plan.

Other Penn State colleges and campuses may require the First-Year Seminar; colleges and campuses that do not require a First-Year Seminar provide students with a first-year engagement experience.

First-year baccalaureate students entering Penn State should consult their academic adviser for these requirements.

Cultures Requirement

6 credits are required and may satisfy other requirements

- United States Cultures: 3 credits
- International Cultures: 3 credits

Writing Across the Curriculum

3 credits required from the college of graduation and likely prescribed as part of major requirements.

Total Minimum Credits

A minimum of 120 degree credits must be earned for a baccalaureate degree. The requirements for some programs may exceed 120 credits. Students should consult with their college or department adviser for information on specific credit requirements.

Quality of Work

Candidates must complete the degree requirements for their major and earn at least a 2.00 grade-point average for all courses completed within their degree program.

Limitations on Source and Time for Credit Acquisition

The college dean or campus chancellor and program faculty may require up to 24 credits of course work in the major to be taken at the location or in the college or program where the degree is earned. Credit used toward degree programs may need to be earned from a particular source or within time constraints (see Senate Policy 83-80 (<http://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#83-80>)). For more information, check the Suggested Academic Plan for your intended program.

Requirements for the Major

This includes 15 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses.

To graduate, a grade of C or better is required in 9 credits of any BMB or MICRB 400-level course except: BMB 408, BMB 442, BMB 443W, BMB 445W, BMB 448, BMB 488, BMB 496 MICRB 408, MICRB 421W, MICRB 422, MICRB 447.

To graduate, a student enrolled in the major must earn a grade of C or better in each course designated by the major as a C-required course, as specified by Senate Policy 82-44 (<http://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#82-44>).

Common Requirements for the Major (All Options)

Code	Title	Credits
Prescribed Courses		
CHEM 113	Experimental Chemistry II	1
MATH 141	Calculus with Analytic Geometry II	4
MICRB 201	Introductory Microbiology ¹	3
MICRB 202	Introductory Microbiology Laboratory	2
PSU 16	First-Year Seminar Science	1
BMB 251	Molecular and Cell Biology I ¹	3
BMB 252	Molecular and Cell Biology II ¹	3
BMB 442	Laboratory in Proteins, Nucleic Acids, and Molecular Cloning	3
BIOL 322	Genetic Analysis	3
CHEM 210	Organic Chemistry I	3
CHEM 212	Organic Chemistry II	3

CHEM 213	Laboratory in Organic Chemistry	2
BMB 400	Molecular Biology of the Gene	2
BMB 401	General Biochemistry	3
BMB 402	General Biochemistry	3
BMB 443W	Laboratory in Protein Purification and Enzymology	3

Prescribed Courses: Require a grade of C or better

CHEM 110	Chemical Principles I	3
CHEM 111	Experimental Chemistry I	1
CHEM 112	Chemical Principles II	3
MATH 140	Calculus With Analytic Geometry I	4

Additional Courses

BMB 445W	Laboratory in Molecular Genetics I	2
or BMB 448	Model Systems and Approaches in Cell Biology Inquiry	

Requirements for the Option

Select an option	40
------------------	----

¹ To graduate, a grade of C or better is required in two of the following courses: MICRB 201, BMB 251/MICRB 251, and/or BMB 252/MICRB 252.

Requirements for the Option Biochemistry Option (40 credits)

Available at the following campuses: Berks, University Park

Code	Title	Credits
Prescribed Courses		
PHYS 211	General Physics: Mechanics	4
PHYS 212	General Physics: Electricity and Magnetism	4
PHYS 213	General Physics: Fluids and Thermal Physics	2
PHYS 214	General Physics: Wave Motion and Quantum Physics	2
CHEM 450	Physical Chemistry - Thermodynamics	3
CHEM 452	Physical Chemistry - Quantum Chemistry	3
BMB 474	Analytical Biochemistry	3

Supporting Courses and Related Areas

Select 7-9 credits from any 400-level BMB/CHEM/MICRB course or from department list D (additional 400-level courses)¹

Select 2-3 credits in the mathematical sciences from department list B

Select 7-10 credits from department list C

¹ With a maximum of 3 credits in BMB 408 and/or MICRB 408 and a maximum of 4 credits in BMB 488 and/or BMB 496.

Molecular and Cell Biology Option (40 credits)

Available at the following campuses: Berks, University Park

Code	Title	Credits
Prescribed Courses		
BMB 430	Developmental Biology	3
BMB 460	Cell Growth and Differentiation	3
MICRB 410	Principles of Immunology	3

Additional Courses

Select 8 credits of the following: 8

PHYS 211 General Physics: Mechanics
or PHYS 212 General Physics: Electricity and Magnetism

PHYS 250	Introductory Physics I or PHYS 251 Introductory Physics II	
Select 3-6 credits of the following:		3-6
CHEM 450 & CHEM 452	Physical Chemistry - Thermodynamics and Physical Chemistry - Quantum Chemistry	
BMB 428	Physical Chemistry with Biological Applications	

Supporting Courses and Related Areas

Select 5-6 credits from any 400-level BMB/MICRB course or from department list D (additional 400-level courses) ¹	5-6
Select 2-3 credits in the mathematical sciences from department list B	2-3
Select 4-13 credits from department list C	4-13

¹ With a total maximum of 3 credits in BMB 408 and/or MICRB 408 and a maximum of 4 credits in BMB 488 and/or BMB 496.

Academic Advising

The objectives of the university's academic advising program are to help advisees identify and achieve their academic goals, to promote their intellectual discovery, and to encourage students to take advantage of both in-and out-of class educational opportunities in order that they become self-directed learners and decision makers.

Both advisers and advisees share responsibility for making the advising relationship succeed. By encouraging their advisees to become engaged in their education, to meet their educational goals, and to develop the habit of learning, advisers assume a significant educational role. The advisee's unit of enrollment will provide each advisee with a primary academic adviser, the information need to plan the chosen program of study, and referrals to other specialized resources.

READ SENATE POLICY 32-00: ADVISING POLICY (<http://senate.psu.edu/policies-and-rules-for-undergraduate-students/32-00-advising-policy>)

University Park

Jennifer Keefer
Academic Adviser
239 Ritenour Building
University Park, PA
814-863-5487
jls227@psu.edu

Berks

Maureen Dunbar
Program Coordinator, Associate Professor
Luerssen 101H
Reading, PA 19610
640-396-6328
med18@psu.edu

Suggested Academic Plan

Biochemistry and Molecular Biology - Biochemistry Option - University Park Campus

The course series listed below provides **only one** of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an **Academic Requirements** or **What If**

report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

First Year

Fall	Credits Spring	Credits
PSU 16	1 MICRB 201 ¹	3
CHEM 110 ^{*#†}	3 MICRB 202 or 203 (consult with an academic adviser for options)	2
CHEM 111 ^{*#†}	1 CHEM 112 ^{*#†}	3
MATH 140 or 140B ^{*†#†}	4 CHEM 113 [†]	1
ENGL 15, 30, or ESL 15 [†]	3 MATH 141 or 141B ^{††}	4
General Education Course	3 CAS 100A, 100B, or 100C [†]	3
	15	16

Second Year

Fall	Credits Spring	Credits
BMB 251 ¹	3 BMB 252 ¹	3
CHEM 210	3 CHEM 212	3
PHYS 211 [†]	4 CHEM 213	2
Department List C (consult with an academic adviser for options)	3 PHYS 212	4
General Education Course	3 BIOL 322	3
	16	15

Third Year

Fall	Credits Spring	Credits
BMB 400 ²	2 BMB 402 ²	3
BMB 401 ²	3 BMB 445W or 443W	2
BMB 442	3 BMB, CHEM, or MICRB 400-Level Selections (consult with an academic adviser for options) ²	3
MATH 231 (consult with an academic adviser for options)	2 General Education Course	6
PHYS 213	2 General Education Course (GHW)	1.5
PHYS 214	2	
Department List C (consult with an academic adviser for options)	1	
	15	15.5

Fourth Year

Fall	Credits Spring	Credits
BMB 443W, 445W, or 448	3 BMB 474 ²	3
BMB, CHEM, or MICRB 400-Level Selections (consult with an academic adviser for options) ²	3 BMB, CHEM, or MICRB 400-Level Selections (consult with an academic adviser for options) ²	3
CHEM 450	3 CHEM 452	3
	ENGL 202C, 202A, 202B, or 202D [†]	3
Department List C Selection (consult with an academic adviser for options)	3 Department List C (consult with an academic adviser for options)	1

General Education Course	3 General Education Course	3
General Education Course (GHW)	1.5	
	16.5	16

Total Credits 125

* Course requires a grade of C or better for the major

‡ Course requires a grade of C or better for General Education

Course is an Entrance to Major requirement

† Course satisfies General Education and degree requirement

University Requirements and General Education Notes:

US and IL are abbreviations used to designate courses that satisfy University Requirements (United States and International Cultures).

W, M, X, and Y are the suffixes at the end of a course number used to designate courses that satisfy University Writing Across the Curriculum requirement.

GWS, GQ, GHW, GN, GA, GH, and GS are abbreviations used to identify General Education program courses. General Education includes Foundations (GWS and GQ) and Knowledge Domains (GHW, GN, GA, GH, GS, and Integrative Studies). Foundations courses (GWS and GQ) require a grade of 'C' or better.

Integrative Studies courses are required for the General Education program. N is the suffix at the end of a course number used to designate an Inter-Domain course and Z is the suffix at the end of a course number used to designate a Linked course.

All incoming Schreyer Honors College first-year students at University Park will take ENGL/CAS 137 in the fall semester and ENGL/CAS 138 in the spring semester. These courses carry the GWS designation and replace both ENGL 30 and CAS 100. Each course is 3 credits.

¹ To graduate, a grade of C or better is required in two of the following courses: Introductory Microbiology (MICRB 201), Molecular and Cell Biology I (BMB 251)/Molecular and Cell Biology I (MICRB 251), and/or Molecular and Cell Biology II (BMB 252)/Molecular and Cell Biology II (MICRB 252).

² To graduate, a grade of C or better is required in 9 credits of any BMB or MICRB 400-level course except those listed in the requirements for the major (consult with an academic adviser for clarification)

Biochemistry and Molecular Biology - Molecular and Cell Biology Option - University Park Campus

The course series listed below provides **only one** of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an **Academic Requirements** or **What If** report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

First Year		
Fall	Credits Spring	Credits
PSU 16	1 MICRB 201 ¹	3
CHEM 110 ^{*#†}	3 MICRB 202 or 203 (Consult with an academic adviser for options)	2
CHEM 111 ^{*#†}	1 CHEM 112 ^{*#†}	3
MATH 140 or 140B ^{*†##}	4 CHEM 113 [†]	1
ENGL 15, ESL 15, or ENGL 30 [†]	3 MATH 141 or 140B ^{††}	4
General Education [†]	3 CAS 100A, 100B, or 100C [‡]	3
	15	16

Second Year		
Fall	Credits Spring	Credits
BMB 251 ¹	3 BMB 252 ¹	3
CHEM 210	3 CHEM 212	3
PHYS 250 (Consult with and academic adviser for alternative options) [†]	4 CHEM 213	2
Department List B MATH Selection (consult with an academic adviser for options)	3 PHYS 251 (Consult with an academic adviser for alternative options)	4
General Educaiton	3 BIOL 322	3
	16	15

Third Year		
Fall	Credits Spring	Credits
BMB 400 ²	2 BMB 402 ²	3
BMB 401 ²	3 BMB 460 ²	3
BMB 442	3 BMB 443W or 445W	3
MICRB 410 ²	3 General Education Course	6
Department List C (consult with an academic adviser for options)	2 General Education Course (GHW) [†]	1.5
General Education Course (GHW)	1.5	
	14.5	16.5

Fourth Year		
Fall	Credits Spring	Credits
BMB 428 ²	3 BMB, CHEM, or MICRB 400-Level Selection (Consult with an academic advsier for options) ²	3
BMB 430 ²	3 ENGL 202C, 202A, 202B, or 202D [†]	3
BMB or MICRB 400-Level Selections (Consult with an academic adviser for options) ²	2 Department List C (consult with an academic adviser for options)	7
BMB 448 (or BMB 445W or BMB 443W)	2 General Education Course	3
General Education Course	3	

Department List C (consult with an academic adviser for options)	3	
	16	16

Total Credits 125

* Course requires a grade of C or better for the major

‡ Course requires a grade of C or better for General Education

Course is an Entrance to Major requirement

† Course satisfies General Education and degree requirement

University Requirements and General Education Notes:

US and IL are abbreviations used to designate courses that satisfy University Requirements (United States and International Cultures).

W, M, X, and Y are the suffixes at the end of a course number used to designate courses that satisfy University Writing Across the Curriculum requirement.

GWS, GQ, GHW, GN, GA, GH, and GS are abbreviations used to identify General Education program courses. General Education includes Foundations (GWS and GQ) and Knowledge Domains (GHW, GN, GA, GH, GS, and Integrative Studies). Foundations courses (GWS and GQ) require a grade of 'C' or better.

Integrative Studies courses are required for the General Education program. N is the suffix at the end of a course number used to designate an Inter-Domain course and Z is the suffix at the end of a course number used to designate a Linked course.

All incoming Schreyer Honors College first-year students at University Park will take ENGL/CAS 137 in the fall semester and ENGL/CAS 138 in the spring semester. These courses carry the GWS designation and replace both ENGL 30 and CAS 100. Each course is 3 credits.

¹ To graduate, a grade of C or better is required in two of the following courses: Introductory Microbiology (MICRB 201), Molecular and Cell Biology I (BMB 251)/Molecular and Cell Biology I (MICRB 251), and/or Molecular and Cell Biology II (BMB 252)/Molecular and Cell Biology II (MICRB 252).

² To graduate, a grade of C or better is required in 9 credits of any BMB or MICRB 400-level course except those listed in the requirements for the major (consult with an academic advisor for clarification)

Career Paths

Penn State students with a B.S. in Biochemistry & Molecular Biology are prepared for jobs in industry as well as government, medical, and university research laboratories. Many students also decide to continue their studies by attending graduate programs or professional schools including medical, dental, business, and law school.

Careers

A B.S. in Biochemistry and Molecular Biology prepares students for a wide variety of careers, including health related professions, professions in academia, government, and industry. Examples of biochemistry related careers are:

- Agricultural Scientist
- Biological / Media Illustrator

- Biomedical Researcher
- Drug Development
- Genetic Counselor
- Genetic Engineer
- Health Professions – e.g. Dentist, Optometrist, Pharmacist, Physician, Physician Assistant
- Industry Scientist
- Pharmaceutical Sales
- Pharmaceutical Sciences
- Professor
- Science Policy Expert
- Optometrist
- Science Writer / Editor
- Patent Attorney
- Research Technician

MORE INFORMATION (<http://www.asbmb.org/careers/paths>)

Opportunities for Graduate Study

Many Penn State students with a BS in Biochemistry and Molecular Biology will pursue graduate education in biochemistry or other related disciplines (biology, bioinformatics, chemistry, genomics, immunology, neurobiology, toxicology, pharmacology, and others). A B.S. in Biochemistry and Molecular Biology also prepares students to pursue higher degrees in the health professions. Opportunities for graduate studies include, but are not limited to, the following:

- Graduate Studies (M.S. or Ph.D.)
- Dental School Medical School (MD or DO)
- Optometry School, Pharmacy School
- Physical Therapy School
- Veterinary School.

In addition, graduates with a BMB degree may decide to pursue further education in law or business.

Professional Resources

- American Society for Biochemistry and Molecular Biology (<https://www.asbmb.org>)

Accreditation

The B.S. in Biochemistry and Molecular Biology is accredited by the American Society for Biochemistry and Molecular Biology (ASBMB).

MORE INFORMATION (<http://www.asbmb.org/accreditation>)

Contact

University Park

DEPARTMENT OF BIOCHEMISTRY AND MOLECULAR BIOLOGY
108 Althouse Laboratory
University Park, PA 16802
814-863-5487
bmbundergrad@psu.edu

http://bmb.psu.edu/about/copy_of_contact

Berks

DIVISION OF SCIENCE

Luerssen Science Building
Reading, PA 19610
610-396-6328
med18@psu.edu

<http://berks.psu.edu/bs-biochemistry-molecular-biology>