

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

Begin Campus: Any Penn State Campus

End Campus: Berks

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

15 of the 45 credits for General Education are included in the Requirements for the Major. This: 9 credits of GN courses; 6 credits of GQ courses.

Requirements for the Major

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		
BIOL 322	Genetic Analysis	3
BMB 251	Molecular and Cell Biology I ¹	3
BMB 252	Molecular and Cell Biology II ¹	3
BMB 400	Molecular Biology of the Gene	2
BMB 401	General Biochemistry	3
BMB 402	General Biochemistry	3
BMB 442	Laboratory in Proteins, Nucleic Acids, and Molecular Cloning	3
BMB 443W	Laboratory in Protein Purification and Enzymology	3
CHEM 113	Experimental Chemistry II	1
CHEM 210	Organic Chemistry I	3
CHEM 212	Organic Chemistry II	3
CHEM 213	Laboratory in Organic Chemistry	2
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
<i>Prescribed Courses: Require a grade of C or better</i>		
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 or BMB 448	Laboratory in Molecular Genetics I Model Systems and Approaches in Cell Biology Inquiry	2

Requirements for the Option

Select an option	40
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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		
BMB 474	Analytical Biochemistry	3
CHEM 450	Physical Chemistry - Thermodynamics	3
CHEM 452	Physical Chemistry - Quantum Chemistry	3
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

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	7-9
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Select 2-3 credits in the mathematical sciences from department list B	2-3
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Select 7-10 credits from department list C	7-10
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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 & PHYS 212	General Physics: Mechanics and General Physics: Electricity and Magnetism	
PHYS 250 & PHYS 251	Introductory Physics I and Introductory Physics II	
Select 3-6 credits of the following:		3-6
BMB 428	Physical Chemistry with Biological Applications	
CHEM 450 & CHEM 452	Physical Chemistry - Thermodynamics and Physical Chemistry - Quantum Chemistry	

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
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Select 2-3 credits in the mathematical sciences from department list B	2-3
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Select 8-13 credits from department list C	8-13
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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.

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 (<https://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

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.

Program Learning Objectives

- Students will be able to explain the following core concepts as recommended by the American Society for Biochemistry and Molecular Biology (ASBMB):
 - Energy:
 - Students will explain how energy is utilized and transformed in biological systems.
 - Students will explain their knowledge of basic chemical thermodynamics to biological systems.
 - Structure and Function:
 - Students will explain the importance of macromolecular structure in biological systems.
 - Students will be able to discuss the diversity and complexity of various biologically relevant macromolecules and macromolecular assemblies in terms of the basic repeating units of the polymer and the types of linkages between them.
 - Information Storage:
 - Students will be define what a genome and explain how the information in the various genes and other sequence classes within each genome are used to store and express genetic information.
 - Students should be able to explain the central dogma of biology and relate the commonality of the process to all of life.
 - Students should be able to illustrate how DNA is replicated and genes are transmitted from one generation to the next in multiple types of organisms including bacteria, eukaryotes, viruses, and retroviruses.
- Students will demonstrate competence in the following skills related to experimental design:
 - Students will be able to develop a hypothesis, design and conduct appropriate experiments.
 - Students will analyze and interpret data using appropriate quantitative modeling and simulation tools.
 - Students will keep an accurate laboratory notebook.
- Students will demonstrate competency in the following skills related to information technology:
 - Students will be able to assess and use available information.
 - Find and use the primary literature.
 - Use databases and bioinformatics tools.
 - Students will be able to present scientific data in both written and oral formats.

- Students will use visual and verbal tools to explain concepts and data.
- Students will translate science into everyday examples.
- Students will be able to read, interpret and critically analyze primary literature.
- Students will be able to recognize and apply ethical principles to basic and applies practice and seek opportunities for interdisciplinary.
- Students will be able to work effectively as a member of a team.

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 needed to plan the chosen program of study, and referrals to other specialized resources.

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

Berks

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Suggested Academic Plan

The suggested academic plan(s) listed on this page are the plan(s) that are in effect during the 2022-23 academic year. To access previous years' suggested academic plans, please visit the archive (<https://bulletins.psu.edu/undergraduate/archive/>) to view the appropriate Undergraduate Bulletin edition (*Note: the archive only contains suggested academic plans beginning with the 2018-19 edition of the Undergraduate Bulletin*).

Biochemistry Option: Biochemistry and Molecular Biology, B.S. at Berks 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
ENGL 15 or 30H (GWS) [†]	3 CAS 100A or 100B (GWS) [†]	3
MATH 140 or 140B (GQ) ^{*‡#}	4 MATH 141 or 141B (GQ) [†]	4
CHEM 110 (GN) ^{*##†}	3 CHEM 112 (GN) ^{*##†}	3
CHEM 111 (GN) ^{*##†}	1 CHEM 113 (GN) [†]	1
General Education Course (GA or GH or GS)	3 PHYS 211 (GN) [†]	4
First-Year Seminar	1 General Education Course (GHW)	1.5
	15	16.5

Second Year

Fall	Credits Spring	Credits
BMB 251 [*]	3 ENGL 202C (GWS) [†]	3
CHEM 210	3 BMB 252 [*]	3
PHYS 212	4 CHEM 212	3
MICRB 201 [*]	3 CHEM 213	2
MICRB 202	2 PHYS 213	2
	PHYS 214	2
	General Education Course (GHW)	1.5
	15	16.5

Third Year

Fall	Credits Spring	Credits
BMB 401	3 BMB 402	3
BMB 442	3 BMB 443W	3
BIOL 322	3 CHEM 452	3
CHEM 450	3 STAT 250	3
General Education Course (GA or GH or GS)	3 General Education Course (GA or GH or GS)	3
	15	15

Fourth Year

Fall	Credits Spring	Credits
BMB 448 (Students must complete either BMB 445W or BMB 448. BMB 445W is offered Spring Semester only and BMB 448 is offered Fall Semester only.)	2 BMB 445W (Students must complete either BMB 445W or BMB 448. BMB 445W is offered Spring Semester only and BMB 448 is offered Fall Semester only.)	2
400 Level BIOL or BMB or CHEM or MICRB Selection	3 BMB 400	3
400 Level BIOL or BMB or CHEM or MICRB Selection	3 BMB 474	3
Department List Selection	3 400 Level BIOL or BMB or CHEM or MICRB Selection	3
General Education Course (GA or GH or GS)	3 Department List Selection	3
General Education Course (GA or GH or GS)	3 General Education Course (GA or GH or GS)	3
	17	17

Total Credits 127

* 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

¹ For General Education Course notations, please be sure to include six (6) credits of Inter-Domain (N courses), three (3) credits of United States (US) Cultures, and three (3) credits of International (IL) Cultures. Consult adviser for details.

² The following courses are offered Fall Semester only: BIOL 322, BMB 251, BMB 401, BMB 442, CHEM 210, CHEM 450.

³ The following courses are offered Spring Semester only: BMB 252, BMB 400, BMB 402, BMB 443W, BMB 474, CHEM 452, PHYS 213, PHYS 214.

⁴ Students must earn a quality grade of C or better in nine (9) credits of BMB and/or MICRB courses. Consult adviser for details.

⁵ For STAT 250, the following courses may be substituted: CMPSC 101, CMPSC 201, MATH 220, MATH 231, MATH 250, STAT 200, or STAT 401. STAT 401 is offered Spring Semester only.

Molecular and Cell Biology Option: Biochemistry and Molecular Biology, B.S. at Berks 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
ENGL 15 or 30H (GWS) [†]	3 CAS 100A or 100B (GWS) [‡]	3
MATH 140 or 140B (GQ) ^{‡#}	4 MATH 141 or 141B (GQ) [‡]	4
CHEM 110 (GN) ^{**†}	3 CHEM 112 (GN) ^{**†}	3
CHEM 111 (GN) ^{**†}	1 CHEM 113 (GN) [†]	1
General Education Course (GA or GH or GS)	3 General Education Course (GA or GH or GS)	3
First-Year Seminar	1 General Education Course (GA or GH or GS)	3
	15	17

Second Year

Fall	Credits Spring	Credits
BMB 251 [*]	3 ENGL 202C (GWS) [‡]	3
CHEM 210	3 BMB 252 [*]	3
PHYS 250 (GN) [†]	4 CHEM 212	3
MICRB 201 [*]	3 CHEM 213	2
MICRB 202	2 PHYS 251	4
General Education Course (GHW)	1.5 General Education Course (GHW)	1.5
	16.5	16.5

Third Year

Fall	Credits Spring	Credits
BMB 401	3 BMB 402	3
BMB 430	3 BMB 443W	3
BMB 442	3 MICRB 410	3
BIOL 322	3 STAT 250	3
General Education Course (GA or GH or GS)	3 General Education Course (GA or GH or GS)	3
	15	15

Fourth Year

Fall	Credits Spring	Credits
BMB 448 (Students must complete either BMB 445W or BMB 448. BMB 445W is offered Spring Semester only and BMB 448 is offered Fall Semester only.)	2 BMB 445W (Students must complete either BMB 445W or BMB 448. BMB 445W is offered Spring Semester only and BMB 448 is offered Fall Semester only.)	2
BMB 428	3 BMB 400	3
BMB 460	3 400 Level BIOL or BMB or CHEM or MICRB Selection	3
400 Level BIOL or BMB or CHEM or MICRB Selection	3 Department List Selection	3
Department List Selection	3 General Education Course (GA or GH or GS)	3

Department List Selection	3	
	17	14

Total Credits 126

- * 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

¹ For General Education Course notations, please be sure to include six (6) credits of Inter-Domain (N courses), three (3) credits of United States (US) Cultures, and three (3) credits of International (IL) Cultures. Consult adviser for details.

² The following courses are offered Fall Semester only: BIOL 322, BMB 251, BMB 401, BMB 430, BMB 442, BMB 460, CHEM 210, PHYS 250.

³ The following courses are offered Spring Semester only: BMB 252, BMB 400, BMB 402, BMB 443W, MICRB 410, PHYS 251.

⁴ Students must earn a quality grade of C or better in nine (9) credits of BMB and/or MICRB courses. Consult adviser for details.

⁵ For PHYS 250 and PHYS 251, the following course sequence may be substituted: PHYS 211, PHYS 212, PHYS 213, PHYS 214. PHYS 213 and PHYS 214 are offered Spring Semester only.

⁶ For STAT 250, the following courses may be substituted: CMPSC 101, CMPSC 201, MATH 220, MATH 231, MATH 250, STAT 200, or STAT 401. STAT 401 is offered Spring Semester only.

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.

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

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MORE INFORMATION ABOUT POTENTIAL CAREER OPTIONS FOR GRADUATES OF THE BIOCHEMISTRY AND MOLECULAR BIOLOGY PROGRAM (<https://www.asbmb.org/career-resources/>)

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/>)

Contact

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University Park

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