

MICROBIOLOGY, B.S.

Begin Campus: Any Penn State Campus

End Campus: University Park

Program Description

Microbiology is the science of the "simple" forms of life and of the response of more complex life forms to their presence and activities. Students in the Microbiology major will

1. complete a comprehensive study of life processes at the molecular and cellular level, with particular emphasis on prokaryotes, and
2. perform basic and advanced techniques in laboratory methodology.

Through advanced course study, the many subdisciplines of microbiology such as molecular genetics, immunology, and virology may be explored more fully. Ample opportunities exist for participation in faculty-initiated research projects. Extensive laboratory experience is a particular strength of the major. Courses in such applied areas as industrial, medical, and food microbiology help prepare students for careers in the pharmaceutical, biotechnical, and agricultural industries.

What is Microbiology?

Microbiology is the study of microscopic organisms and how they interact with other organisms and the environment. Topics in microbiology include how microbes benefit and harm human health, the role of microbes in the environment, and how microbes can be used in medicine, agriculture, and engineering.

You Might Like This Program If...

- You like learning by doing experiments.
- You are fascinated by the diversity and interconnectedness of life.
- You are interested in learning about the interplay between infectious disease and the immune response.
- You want to pursue a career in genetic engineering, medicine, public health, or environmental studies.

Entrance to Major

In order to be eligible for entrance to the Microbiology major, a student must have:

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

Degree Requirements

For the Bachelor of Science degree in Microbiology, 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 includes: 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 443W, BMB 445W, BMB 448, BMB 488, BMB 496, 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 (<https://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#82-44>).

Code	Title	Credits
Prescribed Courses		
BIOL 322	Genetic Analysis	3
BMB 400	Molecular Biology of the Gene	2
BMB 401	General Biochemistry	3
BMB 402	General Biochemistry	3
BMB 428	Physical Chemistry with Biological Applications	3
BMB 442	Laboratory in Proteins, Nucleic Acids, and Molecular Cloning	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
MICRB 251	Molecular and Cell Biology I ¹	3
MICRB 252	Molecular and Cell Biology II ¹	3
MICRB 421W	Laboratory of General and Applied Microbiology	3
PHYS 250	Introductory Physics I	4
PHYS 251	Introductory Physics II	4
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		
Select four of the following:		11-12
MICRB 401	Microbial Physiology and Structure	
MICRB 410	Principles of Immunology	
MICRB 412	Medical Microbiology	
MICRB 415	General Virology: Bacterial and Animal Viruses	
MICRB 450	Microbial/Molecular Genetics	
Select 3-4 credits of the following:		3-4
BMB 445W	Laboratory in Molecular Genetics	
BMB 448	Model Systems and Approaches in Cell Biology Inquiry	
MICRB 422	Medical Microbiology Laboratory	
MICRB 447	Laboratory in Molecular Immunology	
Select 6-7 credits of the following: ²		6-7
BMB 408	Instructional Practice	

BMB 488	Communities of Practice in Biochemistry and Molecular Biology
BMB 496	Independent Studies
FDSC 408	Food Microbiology
Any other MICRB 400-level course	

Supporting Courses and Related Areas

Select 8-10 credits from department list 8-10

¹ To graduate, a grade of C or better is required in two of the following courses:

- MICRB 201
- BMB 251/MICRB 251
- BMB 252/MICRB 252

² 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.

Note: A student enrolled in an ROTC program may, after consultation with the head of the microbiology program, substitute up to 6 credits of ROTC in the categories of Additional Courses and Supporting Courses and Related Areas.

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 and Inter-Domain courses do not meet this requirement.)

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

Breadth in the Knowledge Domains (Inter-Domain courses do not meet this requirement.)

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

Integrative Studies

- **Inter-Domain Courses (Inter-Domain):** 6 credits

Exploration

- **GN**, may be completed with Inter-Domain courses: 3 credits
- **GA, GH, GN, GS, Inter-Domain courses.** This may include 3 credits of World Language course work beyond the 12th credit level or the

requirements for the student's degree program, whichever is higher: 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 (<https://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.

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/>)

University Park

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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 2023-24 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*).

Microbiology, B.S. at 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 203 or 202 (Consult with an academic adviser for options)	2
CHEM 111 ^{*#†}	1 CHEM 112 ^{*#†}	3
MATH 140 or 140B ^{*†#†}	4 CHEM 113 [†]	1
ENGL 15, 30H, 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
MICRB 251 ¹	3 MICRB 252 ¹	3
CHEM 210	3 CHEM 212	3
PHYS 250 (Consult with an academic adviser for alternative options) [†]	4 CHEM 213	2
Department List C (Consult with an academic adviser for options)	3 PHYS 251 (Consult with an academic adviser for alternative options) [†]	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 442	3

MICRB 401 (Consult with an academic adviser for alternative options) ²	3 MICRB 412 or 415 (Consult with an academic adviser for alternative options) ²	3
MICRB 421W	3 MICRB 422 (Consult with an academic adviser for alternative options)	2
General Education Course	3 General Education Course	6
General Education Course (GHW)	1.5	
	15.5	17

Fourth Year

Fall	Credits Spring	Credits
MICRB 450 (Consult with an academic adviser for alternative options) ²	2 MICRB 400-Level Selections (Consult with an academic adviser for options) ²	3
MICRB 400-Level Selections (Consult with an academic adviser for options) ²	5 MICRB 410 or 415 (Consult with an academic adviser for alternative options) ²	3
BMB 428 ²	3 MICRB 447 (Consult with an academic adviser for options)	1
Department List C (consult with an academic adviser for options)	4 ENGL 202C, 202A, 202B, or 202D [†]	3
General Education Course (GHW)	1.5 Department List C (consult with an academic adviser for options)	2
	General Education Course	3
	15.5	15

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

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)

University Requirements and General Education Notes:

US and IL are abbreviations used to designate courses that satisfy Cultural Diversity 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.

General Education includes Foundations (GWS and GQ), Knowledge Domains (GHW, GN, GA, GH, GS) and Integrative Studies (Inter-domain) requirements. N or Q (Honors) is the suffix at the end of a course number used to help identify an Inter-domain course, but the inter-domain

attribute is used to fill audit requirements. Foundations courses (GWS and GQ) require a grade of 'C' or better.

All incoming Schreyer Honors College first-year students at University Park will take ENGL 137H/CAS 137H in the fall semester and ENGL 138T/CAS 138T in the spring semester. These courses carry the GWS designation and satisfy a portion of that General Education requirement. If the student's program prescribes GWS these courses will replace both ENGL 15/ENGL 30H and CAS 100A/CAS 100B/CAS 100C. Each course is 3 credits.

Microbiology, B.S. at University Park Campus (MATH 22 Start)

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	CreditsSpring	CreditsSummer	Credits
BIOL 110 [†]	4 CHEM 110 ^{*#†}	3 CHEM 112 ^{*#†}	3
MATH 22 ¹	3 CHEM 111 ^{*#†}	1 CHEM 113 [†]	1
MATH 26 ¹	3 MATH 140 ^{*#†1}	4	
ENGL 15, ESL 15, or ENGL 30H [†]	3 CAS 100A, 100B, or 100C [‡]	3	
General Education Course	3 General Education Course	3	
	16	14	4

Second Year

Fall	CreditsSpring	CreditsSummer	Credits
MICRB 201 ²	3 BIOL 230W ^{†2}	4 PHYS 251 (Consult with an academic adviser for alternative options) [†]	4
MICRB 202	2 CHEM 212	3	
CHEM 210	3 CHEM 213	2	
MATH 141 ^{†1}	4 PHYS 250 (Consult with an academic adviser for alternative options) [†]	4	
General Education Course	3 General Education Course	3	
	15	16	4

Third Year

Fall	CreditsSpring	Credits
BIOL 222 ⁴	3 BMB 402 ³	3
BMB 252 ²	3 BMB 442	3
BMB 401 ³	3 MICRB 412 or 415 (Consult with an academic adviser for alternative options) ³	3

MICRB 421W	3 MICRB 422 (Consult with an academic adviser for alternative options)	2
General Education Course	3 General Education Course	3
	15	14

Fourth Year

Fall	CreditsSpring	Credits
BMB 428 ³	3 BMB 400 ³	2
MICRB 401 (Consult with an academic adviser for alternative options) ³	3 MICRB 410 or 415 (Consult with an academic adviser for alternative options) ³	3
MICRB 450 (Consult with an academic adviser for alternative options) ³	3 MICRB 447 (Consult with an academic adviser for options)	1
MICRB 400-Level Selections (Consult with an academic adviser for options) ³	3 MICRB 400-Level Selections (Consult with an academic adviser for options) ³	3
ENGL 202C, 202A, 202B, or 202D [†]	3 General Education Course (GHW)	3
	15	12

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

¹ 6 credits of MATH 22, MATH 26, MATH 140, or MATH 141 require a grade of C or better for General Education.

² 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) or Biology: Molecules and Cells (BIOL 230W), and/or Molecular and Cell Biology II (BMB 252)/Molecular and Cell Biology II (MICRB 252).

³ 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).

⁴ BIOL 222 is an approved substitute for BIOL 322.

University Requirements and General Education Notes:

US and IL are abbreviations used to designate courses that satisfy Cultural Diversity 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.

General Education includes Foundations (GWS and GQ), Knowledge Domains (GHW, GN, GA, GH, GS) and Integrative Studies (Inter-domain) requirements. N or Q (Honors) is the suffix at the end of a course number used to help identify an Inter-domain course, but the inter-domain attribute is used to fill audit requirements. Foundations courses (GWS and GQ) require a grade of 'C' or better.

All incoming Schreyer Honors College first-year students at University Park will take ENGL 137H/CAS 137H in the fall semester and ENGL 138T/CAS 138T in the spring semester. These courses carry the GWS designation and satisfy a portion of that General Education requirement. If the student's program prescribes GWS these courses will replace both ENGL 15/ENGL 30H and CAS 100A/CAS 100B/CAS 100C. Each course is 3 credits.

Microbiology, B.S. at Commonwealth Campuses

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
CHEM 110 ^{*#†}	3 BIOL 230W ^{†1}	4
CHEM 111 ^{*#†}	1 CHEM 112 ^{*#†}	3
MATH 140 ^{*†#†}	4 CHEM 113 [†]	1
BIOL 110 [†]	4 MATH 141 ^{††}	4
ENGL 15, ESL 15, or ENGL 30H [†]	3 CAS 100A, 100B, or 100C [‡]	3
General Education Course (GHW)	1.5 General Education Course (GHW)	1.5
16.5		16.5

Second Year

Fall	Credits Spring	Credits
MICRB 201 ¹	3 BIOL 322 or 222 ³	3
MICRB 202	2 CHEM 212	3
CHEM 210	3 CHEM 213	2
PHYS 250 (Consult with an academic adviser for alternative options) [†]	4 PHYS 251 (Consult with an academic adviser for alternative options) [†]	4
General Education Course	3 General Education Course	3
15		15

Third Year

Fall	Credits Spring	Credits
BMB 252 ¹	3 BMB 402 ²	3
BMB 401 ²	3 BMB 442	3
MICRB 421W	3 MICRB 412 or 415 (Consult with an academic adviser for alternative options) ²	3
MICRB 401 (Consult with an academic adviser for alternative options) ²	3 MICRB 422 (Consult with an academic adviser for alternative options)	2
General Education Course	3 General Education Course	3
Department List C (Consult with an academic adviser for options)	1 Department List C (Consult with an academic adviser for options)	1
16		15

Fourth Year

Fall	Credits Spring	Credits
BMB 428 ²	3 BMB 400 ²	2
MICRB 410 or 450 (Consult with an academic adviser for alternative options) ²	3 MICRB 412 or 415 (Consult with an academic adviser for alternative options) ²	3
MICRB 400-Level Selections (Consult with an academic adviser for options) ²	3 MICRB 447 (Consult with an academic adviser for options)	1

ENGL 202C, 202A, 202B, or 202D [‡]	3 MICRB 400-Level Selections (Consult with an academic adviser for options)	3
General Education Course	3 General Education Course	3
Department List C (Consult with an academic adviser for options)	1 Department List C (Consult with an academic adviser for options)	3
16		15

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

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) or Biology: Molecules and Cells (BIOL 230W), 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).

³ BIOL 222 is an approved substitute for BIOL 322.

University Requirements and General Education Notes:

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General Education includes Foundations (GWS and GQ), Knowledge Domains (GHW, GN, GA, GH, GS) and Integrative Studies (Inter-domain) requirements. N or Q (Honors) is the suffix at the end of a course number used to help identify an Inter-domain course, but the inter-domain attribute is used to fill audit requirements. Foundations courses (GWS and GQ) require a grade of 'C' or better.

Career Paths

Penn State students with a BS in Microbiology 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 BS in Microbiology prepares students for a wide variety of careers, including health related professions, professions in academia, government, and industry. Examples of microbiology related careers are:

- Agricultural or Environmental Scientist
- Biological / Media Illustrator
- Biomedical Researcher
- Biosecurity and Biodefense
- Brewery Scientist

- Clinical Microbiology Lab Director
- Drug Development
- Food Safety Expert
- Genetic Engineer
- Health Professions – e.g. Dentist, Optometrist, Pharmacist, Physician, Physician Assistant
- Industrial Microbiologist
- Patent Attorney
- Pharmaceutical Sales
- Pharmaceutical Sciences
- Professor
- Public Health Scientist
- Research Technician
- Science Policy Expert
- Science Writer / Editor

MORE INFORMATION ABOUT POTENTIAL CAREER OPTIONS FOR GRADUATES OF THE MICROBIOLOGY PROGRAM (<https://asm.org/careers/>)

Opportunities for Graduate Studies

Many Penn State students with a BS in Microbiology will pursue graduate education (MS or PhD) in microbiology or other related disciplines (biochemistry, biology, bioinformatics, cell biology, chemistry, genomics, geo-microbiology, immunology, neurobiology, toxicology, pharmacology, plant pathology, and others). A BS in microbiology will also prepare students to pursue higher degrees in the health professions. Opportunities for graduate studies include, but are not limited to, the following:

- Graduate Studies (MS or PhD)
- Dental School Medical School (MD or DO)
- Optometry School
- Pharmacy School
- Physical Therapy School
- Public Health (MPH)
- Veterinary School

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

Professional Resources

- American Society for Microbiology (<https://asm.org>)

Contact

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