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:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Education</td>
<td>45</td>
</tr>
<tr>
<td>Requirements for the Major</td>
<td>95</td>
</tr>
</tbody>
</table>

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.

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

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

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).

Select four of the following:
MICRB 401 Microbial Physiology and Structure
MICRB 410 Principles of Immunology

Select 3-4 credits of the following:
BMB 445W Laboratory in Molecular Genetics I
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:
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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 322</td>
<td>Genetic Analysis</td>
<td>3</td>
</tr>
<tr>
<td>BMB 400</td>
<td>Molecular Biology of the Gene</td>
<td>2</td>
</tr>
<tr>
<td>BMB 401</td>
<td>General Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>BMB 402</td>
<td>General Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>BMB 428</td>
<td>Physical Chemistry with Biological Applications</td>
<td>3</td>
</tr>
<tr>
<td>BMB 442</td>
<td>Laboratory in Proteins, Nucleic Acids, and Molecular Cloning</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 113</td>
<td>Experimental Chemistry II</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 210</td>
<td>Organic Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 212</td>
<td>Organic Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 213</td>
<td>Laboratory in Organic Chemistry</td>
<td>2</td>
</tr>
<tr>
<td>MATH 141</td>
<td>Calculus with Analytic Geometry II</td>
<td>4</td>
</tr>
<tr>
<td>MICRB 201</td>
<td>Introductory Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>MICRB 202</td>
<td>Introductory Microbiology Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>MICRB 251</td>
<td>Molecular and Cell Biology I</td>
<td>3</td>
</tr>
<tr>
<td>MICRB 252</td>
<td>Molecular and Cell Biology II</td>
<td>3</td>
</tr>
<tr>
<td>MICRB 421W</td>
<td>Laboratory of General and Applied Microbiology</td>
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</tr>
<tr>
<td>PHYS 250</td>
<td>Introductory Physics I</td>
<td>4</td>
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<tr>
<td>PHYS 251</td>
<td>Introductory Physics II</td>
<td>4</td>
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<tr>
<td>PSU 16</td>
<td>First-Year Seminar Science</td>
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Prescribed Courses: Require a grade of C or better
<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>CHEM 110</td>
<td>Chemical Principles I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 111</td>
<td>Experimental Chemistry I</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 112</td>
<td>Chemical Principles II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 140</td>
<td>Calculus With Analytic Geometry I</td>
<td>4</td>
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</table>

Additional Courses
Select four of the following:
MICRB 401 Microbial Physiology and Structure
MICRB 410 Principles of Immunology

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 (http://senate.psu.edu/policies-and-rules-for-undergraduate-students/32-00-advising-policy)

University Park
Jennifer Keefer
Academic Adviser
Address 1: 239 Ritenour Building
University Park (UP)
814-863-5487
jls227@psu.edu
Suggested Academic Plan

The suggested academic plan(s) listed on this page are the plan(s) that are in effect during the 2019-20 academic year. To access previous years' suggested academic plans, please visit the archive (http://bulletins.psu.edu/undergraduate/archive) to view the appropriate Undergraduate Bulletin edition (Note: the archive only contain suggested academic plans beginning with the 2018-19 edition of the Undergraduate Bulletin).

Microbiology - 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

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
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<tbody>
<tr>
<td>PSU 16</td>
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<td>MICRB 201</td>
<td>3</td>
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<tr>
<td>CHEM 110 $#^\ddagger$</td>
<td>2</td>
<td>3 MICRB 203 or 202 (Consult with an academic adviser for options)</td>
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<tr>
<td>CHEM 111 $#^\ddagger$</td>
<td>1</td>
<td>1 CHEM 112 $#^\ddagger$</td>
<td>3</td>
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<tr>
<td>MATH 140 $#^\ddagger$†</td>
<td>4</td>
<td>4 CHEM 113†</td>
<td>1</td>
</tr>
<tr>
<td>ENGL 15, 30, or ESL 15†</td>
<td>3</td>
<td>3 MATH 141†</td>
<td>4</td>
</tr>
<tr>
<td>General Education†</td>
<td>3</td>
<td>3 CAS 100A, 100B, or 100C$\ddagger$</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>16</td>
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Second Year

<table>
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<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
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</tr>
</thead>
<tbody>
<tr>
<td>MICRB 251</td>
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<td>3 MICRB 252†</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 210</td>
<td>3</td>
<td>3 CHEM 212</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 250†</td>
<td>4</td>
<td>4 CHEM 213</td>
<td>2</td>
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<tr>
<td>Department List C (Consult with an academic adviser for options)</td>
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<td>PHYS 251</td>
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<tr>
<td>General Education</td>
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<td>3 BIOL 322</td>
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<td></td>
<td>16</td>
<td>15</td>
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Third Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMB 400$^2$</td>
<td>2</td>
<td>2 BMB 402$^2$</td>
<td>3</td>
</tr>
<tr>
<td>BMB 401$^2$</td>
<td>3</td>
<td>3 BMB 442</td>
<td>3</td>
</tr>
<tr>
<td>MICRB 401 (Consult with an academic adviser for alternative options)$^2$</td>
<td>3</td>
<td>3 MICRB 412 or 415 (Consult with an academic adviser for alternative options)$^2$</td>
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<tr>
<td>MICRB 421W</td>
<td>2</td>
<td>3 MICRB 422 (Consult with an academic adviser for alternative options)</td>
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<tr>
<td>General Education</td>
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<td>General Education Course</td>
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<tr>
<td>General Education (GHW)</td>
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<tr>
<td></td>
<td>15.5</td>
<td>17</td>
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</table>

Fourth Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICRB 450 (Consult with an academic adviser for alternative options)$^2$</td>
<td>2</td>
<td>2 MICRB 400-Level Selections (Consult with an academic adviser for options)$^2$</td>
<td>3</td>
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<tr>
<td>MICRB 400-Level Selections (Consult with an academic adviser for options)$^2$</td>
<td>5</td>
<td>5 MICRB 410 or 415 (Consult with an academic adviser for alternative options)$^2$</td>
<td>3</td>
</tr>
<tr>
<td>BMB 428$^2$</td>
<td>3</td>
<td>3 MICRB 447 (Consult with an academic adviser for options)</td>
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<tr>
<td>Department List C (Consult with an academic adviser for options)</td>
<td>4</td>
<td>ENGL 202C, 202A, 202B, or 2020†</td>
<td>3</td>
</tr>
<tr>
<td>General Education Course (GHW)</td>
<td>1.5</td>
<td>Department List C (consult with an academic adviser for options)</td>
<td>2</td>
</tr>
</tbody>
</table>

General Education Course  | General Education | 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

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).
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://www.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://www.asm.org)

Contact
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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