BIOTECHNOLOGY, B.S.

Begin Campus: Any Penn State Campus
End Campus: University Park

Program Description

Biotechnology may be broadly defined as the application of principles of molecular and cell science in the production of biologically important or industrially useful products. Therefore, students in the Biotechnology major will

1. acquire a strong foundation in the life and chemical sciences,
2. learn how fundamental science is applied to problems through biotechnology,
3. develop basic laboratory skills, perform standard techniques, work with state-of-the-art instrumentation, describe and evaluate analytical methodology used in biotechnology, and
4. become familiar with societal concerns and governmental regulations regarding the biotechnology industry.

One very important strength of this major is the extensive laboratory experience each student receives. In the General option, students are very strongly encouraged to consider Cooperative Education with industry as an integral part of their curriculum. In addition to the General option in Biotechnology, the major also offers the Clinical Laboratory Science option.

What is Biotechnology?

Biotechnology is broadly defined as the application of principles of molecular and cell science to the production of biologically important or industrially useful products. Topics in biotechnology include genetic engineering, pharmaceutical development, and bio-manufacturing.

You Might Like This Program If...

• You like learning by doing experiments.
• You enjoy complex problem solving, teamwork, and collaboration with specialists from different fields (e.g. sciences and engineering).
• You desire to understand how to apply scientific concepts to the development of new products and technologies for human benefit or to benefit human surroundings.
• You are interested in medicine but don't want to work directly with patients (Clinical Lab Science Option).

Entrance to Major

In order to be eligible for entrance to the Biotechnology 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 earned a grade of C or better in each of these courses.

Degree Requirements

For the Bachelor of Science degree in Biotechnology, 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 with a B.S. degree in Biotechnology, a grade of C or better is required in two of the following courses: MICRB 201, BMB 251/MICRB 251, and BMB 252/MICRB 252.

1 To graduate with a B.S. degree in Biotechnology, a grade of C or better is required in two of the following courses:
- MICRB 201
- BMB 251/MICRB 251
- BMB 252/MICRB 252

Requirements for the Option
General Biotechnology Option (48 credits)

<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>BIOTC 416</td>
<td>Microbial Biotechnology</td>
<td>2</td>
</tr>
<tr>
<td>BIOTC 459</td>
<td>Plant Tissue Culture and Biotechnology</td>
<td>3</td>
</tr>
<tr>
<td>BIOTC 479</td>
<td>Methods in Biofermentations</td>
<td>3</td>
</tr>
<tr>
<td>BIOTC 489</td>
<td>Animal Cell Culture Methods</td>
<td>3</td>
</tr>
<tr>
<td>BMB 442</td>
<td>Laboratory in Proteins, Nucleic Acids, and</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Molecular Cloning</td>
<td></td>
</tr>
<tr>
<td>STAT 250</td>
<td>Introduction to Biostatistics</td>
<td>3</td>
</tr>
</tbody>
</table>

Additional Courses
Select one of the following sequences: 6-8
- CHEM 202 & CHEM 203 and Fundamentals of Organic Chemistry II
- CHEM 210 & CHEM 212 and Organic Chemistry II
- CHEM 213 and Laboratory in Organic Chemistry

Supporting Courses and Related Areas
Select 14-16 credits from department list C 14-16
Select 6 credits of the following: 6
- Any 400-level BMB/BIOTC/MICRB lecture course
- FDSC 408 Food Microbiology
- Additional courses from department list D

Clinical Laboratory Science Option (48 credits)

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<tr>
<td>BMB 212</td>
<td>Elementary Biochemistry Laboratory</td>
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</tr>
<tr>
<td>MICRB 405A</td>
<td>Seminar and Practicum in Medical Technology</td>
<td>8</td>
</tr>
<tr>
<td>MICRB 405B</td>
<td>Seminar and Practicum in Medical Technology</td>
<td>1</td>
</tr>
<tr>
<td>MICRB 405C</td>
<td>Seminar and Practicum in Medical Technology</td>
<td>6</td>
</tr>
<tr>
<td>MICRB 405D</td>
<td>Seminar and Practicum in Medical Technology</td>
<td>5</td>
</tr>
</tbody>
</table>

Clinical Laboratory Science Option (48 credits)

This option provides both the academic and clinical preparation for students interested in a career as a clinical laboratory scientist. Positions are found in hospital, physician-office, reference, industrial, and research laboratories. To complete baccalaureate degree requirements, students enter a ten-month clinical practicum (MICRB 405A, MICRB 405B, MICRB 405C, MICRB 405D, MICRB 405E, MICRB 405F) at an affiliate hospital for the senior year. (Current affiliations are with Mount Nittany Medical Center, State College and Pennsylvania Hospital, Philadelphia.)

Students are recommended for a fixed number of hospital positions on a competitive basis. Cumulative grade-point average and hospital school admission requirements serve as criteria for recommendation. The B.S. degree is awarded at the first commencement following completion of the clinical practicum.

Clinical Laboratory Science Option (48 credits)

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Students are recommended for a fixed number of hospital positions on a competitive basis. Cumulative grade-point average and hospital school admission requirements serve as criteria for recommendation. The B.S. degree is awarded at the first commencement following completion of the clinical practicum.
Required courses: 16-19 credits

Total credits required: 30 (18 of which must be from 500-level courses)

**Master of Biotechnology Requirements**

- Additional courses: 6-9 credits
- Prescribed courses: 67 credits

**REQUIREMENTS FOR THE MAJOR:** 94-95 credits

**GENERAL EDUCATION:** 46 credits (15 of these are included in the Total credits required: 125

B.S. Biotechnology Requirements

- Total credits required: 125
- GENERAL EDUCATION: 46 credits (15 of these are included in the REQUIREMENTS FOR THE MAJOR)
- REQUIREMENTS FOR THE MAJOR: 94-95 credits
- Prescribed courses: 67 credits
- Additional courses: 6-9 credits
- Supporting courses and related areas: 18-21 credits

**Master of Biotechnology Requirements**

- Total credits required: 30 (18 of which must be from 500-level courses)
- Required courses: 16-19 credits

**Integrated B.S. in Biotechnology - Master of Biotechnology in Biotechnology**

PROFESSOR Loida Escote-Carlson, in charge

The integrated B.S. in Biotechnology-Master of Biotechnology degree program is designed to enable qualified undergraduate students in the B.S. Biotechnology program to graduate in five years with the Master of Biotechnology degree. The requirements of the Master of Biotechnology degree are designed to prepare students for diverse career opportunities in the burgeoning biotechnology industry. The integrated B.S. Biotechnology-Master of Biotechnology program will enhance the preparation and qualifications of B.S. Biotechnology students seeking entry-level positions in biotechnology and related industries. At the same time, students develop a practical knowledge of the laboratory techniques that underlie current research in the life sciences that will serve as excellent preparation for those students in the Master of Biotechnology program who later decide to pursue further graduate degrees.

A maximum of 12 credits will be cross-counted towards the B.S. and Masters degrees, from the following courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMB 400</td>
<td>Molecular Biology of the Gene</td>
<td>2-3</td>
</tr>
<tr>
<td>BIOTC 479</td>
<td>Methods in Biofermentations</td>
<td>3</td>
</tr>
<tr>
<td>IBIOS 593</td>
<td>Molecular biology Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>MCIBS 591</td>
<td>Ethics in the Life Sciences</td>
<td>1</td>
</tr>
<tr>
<td>MCIBS 571</td>
<td>Current Issues in Biotechnology</td>
<td>2</td>
</tr>
</tbody>
</table>

**Supporting Courses and Related Areas**

Select 1-3 credits from department list 1-3

**B.S. Biotechnology Requirements**

- Total credits required: 125
- GENERAL EDUCATION: 46 credits (15 of these are included in the REQUIREMENTS FOR THE MAJOR)
- REQUIREMENTS FOR THE MAJOR: 94-95 credits
- Prescribed courses: 67 credits
- Additional courses: 6-9 credits
- Supporting courses and related areas: 18-21 credits

**Master of Biotechnology Requirements**

- Total credits required: 30 (18 of which must be from 500-level courses)
- Required courses: 16-19 credits

**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
239 Ritenour Building
University Park, PA 16802
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).

**Biotechnology - General 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**

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

|                      | 15      | 16                     |

Note: the archive only contain suggested academic plans beginning with the 2018-19 edition of the Undergraduate Bulletin.
### Second Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMB 251&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td>3 BMB 252&lt;sup&gt;1&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 202 (or Chem 210)</td>
<td></td>
<td>3 CHEM 203 (or Chem 212 and Chem 213)</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 250&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td>4 PHYS 251</td>
<td>4</td>
</tr>
<tr>
<td>Department List C (consult with an academic adviser for options)</td>
<td></td>
<td>3 General Education Course</td>
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</tr>
<tr>
<td>General Education Course</td>
<td></td>
<td>3 General Education Course</td>
<td>3</td>
</tr>
</tbody>
</table>

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

### Third Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
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<tr>
<td>BIOTC 489&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td>3 BIOTC 459&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>BMB 211</td>
<td></td>
<td>3 BMB 221</td>
<td>2</td>
</tr>
<tr>
<td>MICRB 421W</td>
<td></td>
<td>3 BMB 442</td>
<td>3</td>
</tr>
<tr>
<td>Department List C (Consult with an academic adviser for options)</td>
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<td>3 BIOL 322</td>
<td>3</td>
</tr>
<tr>
<td>General Education Course&lt;sup&gt;†&lt;/sup&gt;</td>
<td></td>
<td>3 ENGL 202C, 202A, 202B, or 202C&lt;sup&gt;‡&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>General Education Course (GHW)</td>
<td></td>
<td>1.5 General Education Course (GHW)&lt;sup&gt;†&lt;/sup&gt;</td>
<td>1.5</td>
</tr>
</tbody>
</table>

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### Fourth Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOTC 416&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td>2 MICRB 410&lt;sup&gt;2&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>BIOTC 479&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td>3 BIOTC 400-Level Lecture Selections (Consult with an academic adviser for options)&lt;sup&gt;‡&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>BIOTC 400 Level Lecture Selections (Consult with an academic adviser for options)&lt;sup&gt;‡&lt;/sup&gt;</td>
<td></td>
<td>3 STAT 250</td>
<td>3</td>
</tr>
<tr>
<td>Department List C Free (Consult with an academic adviser for options)&lt;sup&gt;‡&lt;/sup&gt;</td>
<td></td>
<td>4 Department List C (Consult with an academic adviser for options)</td>
<td>3</td>
</tr>
<tr>
<td>General Education Course</td>
<td></td>
<td>3 Department List C (Consult with an academic adviser for options)</td>
<td>3</td>
</tr>
</tbody>
</table>

16.5 15.5

Total Credits 125

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 BIOTC, BMB or MICRB 400-level course except those listed in the requirements for the major (consult with an academic adviser for clarification)

### Biotechnology - Clinical Laboratory Science 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 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.

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<tr>
<td>PSU 16</td>
<td></td>
<td>1 MICRB 201&lt;sup&gt;1&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 110&lt;sup&gt;**†&lt;/sup&gt;</td>
<td></td>
<td>3 MICRB 202 or 203 (Consult with an academic adviser for options)</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 111&lt;sup&gt;**†&lt;/sup&gt;</td>
<td></td>
<td>1 CHEM 112&lt;sup&gt;**†&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>MATH 140 or 140B&lt;sup&gt;**†&lt;/sup&gt;</td>
<td></td>
<td>4 CHEM 113&lt;sup&gt;†&lt;/sup&gt;</td>
<td>1</td>
</tr>
<tr>
<td>ENGL 15, 30, or ESL 15&lt;sup&gt;‡&lt;/sup&gt;</td>
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To graduate, a grade of C or better is required in 9 credits of any BIOTC, BMB or MICRB 400-level course except those listed in the requirements for the major (consult with an academic adviser for clarification)

### Career Paths

This major has two options: Clinical Laboratory Option or General Option. Graduates from the General option frequently accept positions in the bio-pharmaceutical industry or with newly-emerging biotechnology companies bringing new products to market. Graduates from the Clinical Lab Science Option are prepared to complete the certification exam necessary to work as a Medical Laboratory Scientist in a hospital or other medical laboratory.

### Careers

A BS in Biotechnology prepares students for a wide variety of careers, including industry, health related professions, and careers in academic or government labs. Examples of biotechnology related careers are:

- Biomedical or Clinical Research Health Professions – e.g. Dentist, Optometrist, Pharmacist, Physician, Physician Assistant
- Manufacturing Associate
- Medical Lab Scientist (CLS option)
- Pharmaceutical Sales
- Pharmaceutical Sciences
- Quality Control and Assurance
- Research and Development
- Science Policy Expert
- Science Writer
- Patent Attorney
- Professor

### Opportunities for Graduate Studies

Many students with a BS in Biotechnology will pursue graduate education in biotechnology, management, policy or other related disciplines. Penn State students interested in pursuing a MS in Biotechnology can enroll in the integrated undergraduate graduate (IUG) program. IUG students complete a BS and MS with 5 years of coursework, which includes a nine-month internship in industry, government or academia. A BS in Biotechnology 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 (MS or PhD)
- Dental School Medical School (MD or DO)
- Optometry School
- Pharmacy School
- Veterinary School

MORE INFORMATION ABOUT OPPORTUNITIES FOR GRADUATE STUDIES (http://bmb.psu.edu/undergraduate/academic-planning/the-integrated-graduate-degree-program-in-biotechnology)
Accreditation

All affiliated programs that provide the fourth-year clinical experience for the Biotechnology major, CLS option students are accredited by the National Accreditation Agency for Clinical Laboratory Science.

MORE INFORMATION ABOUT THE NATIONAL ACCREDITATION AGENCY FOR CLINICAL LABORATORY SCIENCE (https://www.naacls.org/about.aspx)

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