BIOLOGY, B.S. (ABINGTON)

Begin Campus: Any Penn State Campus
End Campus: Abington

Program Description
Not all options are available at every campus. Contact the campus you are interested in attending to determine which options are offered.

The curriculum in Biology is planned for preparation for professions requiring competence in biological science or for gaining an understanding of the world of living things. The professional group includes students who intend to secure advanced degrees through graduate study, students who are interested in work with various governmental agencies or industries having biological responsibilities, and students who want to prepare for careers in medicine or other health-related professions. Students whose interests are not professional select the curriculum because its broad approach can result in an educated view of the structure and function of living things. Achievement of these goals, including a special interest in a particular area of biology, can be met by selecting one of five options offered by the Department of Biology that will lead to the B.S. degree in Biology. The options and their key areas are:

Ecology Option
Available at the following campuses: Altoona, University Park

Behavior, and population and community biology of plants and animals.

General Biology Option
Available at the following campuses: Abington, Altoona, Beaver, Berks, Brandywine, Harrisburg, Schuylkill, Scranton, University Park, York

All aspects of modern biology.

Genetics and Developmental Biology Option
Available at the following campuses: Abington, Berks, Harrisburg, University Park, York

Genetics, genetic engineering, and plant and animal development.

Neuroscience Option
Available at the following campuses: University Park

Development, biochemistry, physiology and aging of the central and peripheral nervous system.

Plant Biology Option
Available at the following campuses: University Park

Morphology, systematics, and physiology of plants and fungi.

Vertebrate Physiology Option
Available at the following campuses: Abington, Altoona, Brandywine, University Park

Pre-medicine, pre-dentistry, pharmacology, and animal physiology.

What is Biology?
Biology is the scientific study of life: the diversity and organization of organisms, from single-celled bacteria to multi-cellular plants and animals, including humans. These different levels of biological organization range from the molecules and cells that compose an organism, to the interacting organisms that make up an ecosystem. Hands-on experiences, from designing and conducting lab experiments to making field observations using different procedures and instruments play an important role in gaining biological knowledge. Biologists explore ways to cure neurological diseases, conserve coral populations in tropical oceans, discover more efficient ways to use plants for food and bio-energy, develop vaccines for infectious diseases, and investigate many other facets of Biology.

You Might Like This Program If...
• You are interested in learning about aspects of the biology of organisms that live on Earth.
• You enjoy a dynamic field of study, with new discoveries being made every day.
• You are interested in hands-on experiences, including courses with integrated laboratories and conducting research with faculty.
• You plan to pursue a career in biology research, education or outreach, or attend professional school in areas including medicine and dentistry.

Entrance Requirements
In order to be eligible for entrance to the Biology major, a student must have:

1. attained at least a 2.00 cumulative grade point average;
2. completed BIOL 110, CHEM 110, MATH 140, and earned a grade of C or better in each of these courses; and
3. completed at least one of the following courses with a grade of C or better: BIOL 220W, BIOL 230W, or BIOL 240W.

Degree Requirements
For the Bachelor of Science degree in Biology, a minimum of 124 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>94</td>
</tr>
</tbody>
</table>

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

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

Foundations (grade of C or better is required.)
• Quantification (GQ): 6 credits
• Writing and Speaking (GWS): 9 credits
Knowledge Domains
- Arts (GA): 6 credits
- Health and Wellness (GHW): 3 credits
- Humanities (GH): 6 credits
- Social and Behavioral Sciences (GS): 6 credits
- Natural Sciences (GN): 9 credits

Integrative Studies (may also complete a Knowledge Domain requirement)
- Inter-Domain or Approved Linked Courses: 6 credits

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

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

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

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

Cultures Requirement
6 credits are required and may satisfy other requirements
- United States Cultures: 3 credits
- International Cultures: 3 credits

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

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

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

Limitations on Source and Time for Credit Acquisition
The college dean or campus chancellor and program faculty may require up to 24 credits of coursework 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/#82-44)). For more information, check the Suggested Academic Plan for your intended program.

Requirements for the Major
This includes 15 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses.

To graduate, a 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)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 111</td>
<td>Experimental Chemistry I</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 113</td>
<td>Experimental Chemistry II</td>
<td>1</td>
</tr>
<tr>
<td>MATH 141</td>
<td>Calculus with Analytic Geometry II</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 110</td>
<td>Chemical Principles I</td>
<td>3</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>
</tr>
<tr>
<td>BIOL 110</td>
<td>Biology: Basic Concepts and Biodiversity</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 220W</td>
<td>Biology: Populations and Communities</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 230W</td>
<td>Biology: Molecules and Cells</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 240W</td>
<td>Biology: Function and Development of Organisms</td>
<td>4</td>
</tr>
</tbody>
</table>

Additional Courses
Select one of the following: 8-12

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 250 &amp; PHYS 251</td>
<td>Introductory Physics I and Introductory Physics II</td>
<td>2-4</td>
</tr>
<tr>
<td>PHYS 211</td>
<td>General Physics: Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>&amp; PHYS 212 &amp; PHYS 213 &amp; PHYS 214</td>
<td>and General Physics: Electricity and Magnetism and General Physics: Fluids and Thermal Physics and General Physics: Wave Motion and Quantum Physics</td>
<td>3-4</td>
</tr>
</tbody>
</table>

Requirements for the Option
Select an option 50-54

Ecology Option (50-54 credits)

Available at the following campuses: Altoona, University Park

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 210 &amp; CHEM 212 &amp; CHEM 213</td>
<td>Organic Chemistry I and Organic Chemistry II and Laboratory in Organic Chemistry</td>
<td>3-4</td>
</tr>
</tbody>
</table>

Select 3-4 credits of the following: 3-4

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<thead>
<tr>
<th>Code</th>
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</thead>
<tbody>
<tr>
<td>STAT 200</td>
<td>Elementary Statistics</td>
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</tr>
<tr>
<td>STAT 240</td>
<td>Introduction to Biometry</td>
<td>3</td>
</tr>
<tr>
<td>STAT 250</td>
<td>Introduction to Biostatistics</td>
<td>3</td>
</tr>
<tr>
<td>STAT 462 or STAT 464</td>
<td>Applied Regression Analysis or Applied Nonparametric Statistics</td>
<td>3</td>
</tr>
</tbody>
</table>

Groups
Select a minimum of 18 credits of 400-level biology courses, with at least 3 credits from each of the following groups: 18

Group I:
- BIOL 412 | Ecology of Infectious Diseases |
- BIOL 419 | Ecological and Environmental Problem Solving |
- BIOL 435 | Ecology of Lakes and Streams |
- BIOL 436 | Population Ecology and Global Climate Change |
Biology, B.S. (Abington)

BIO 444  Field Ecology
BIO 450W Experimental Field Biology
BIO 463  General Ecology
BIO 482  Coastal Biology
BIO 499A Tropical Field Ecology

Group II:

BIO 414 Taxonomy of Seed Plants
BIO 427 Evolution
BIO 428 Population Genetics
BIO 429 Animal Behavior
BIO 448 Ecology of Plant Reproduction
BIO 463 General Ecology
BIO 482 Coastal Biology

Group III:

BIO 414 Taxonomy of Seed Plants
BIO 427 Evolution
BIO 428 Population Genetics
BIO 429 Animal Behavior
BIO 448 Ecology of Plant Reproduction
BIO 450W Experimental Field Biology
BIO 463 General Ecology
BIO 482 Coastal Biology

Group IV:

Select a minimum of 18 credits of 400-level biology courses, with at least 3 credits from each of the following groups: 1

Group I:

BIO 407 Plant Developmental Anatomy
BIO 414 Taxonomy of Seed Plants
BIO 417 Invertebrate Zoology
BIO 443 Evo-devo: Evolution of Developmental Mechanisms
BIO 444 Field Ecology
BIO 446 Physiological Ecology
BIO 448 Ecology of Plant Reproduction
BIO 499A Tropical Field Ecology
HORT 407 Plant Breeding
PPEM 416 Plant Virology: Molecules to Populations
PPEM 425 Biology of Fungi

Group II:

BIO 405 Molecular Evolution
BIO 411 Medical Embryology
BIO 414 Taxonomy of Seed Plants
BIO 417 Invertebrate Zoology
BIO 420 Paleobotany
BIO 421 Comparative Anatomy of Vertebrates
BIO 425 Biology of Fungi
BIO 427 Evolution
BIO 428 Population Genetics
BIO 438 Theoretical Population Ecology
BIO 443 Evo-devo: Evolution of Developmental Mechanisms
BIO 460 Human Genetics
BIO 474 Astrobiology

Group III:

BMB 400 Molecular Biology of the Gene
BMB 450 Microbial/Molecular Genetics
BIO 404 Cellular Mechanisms in Vertebrate Physiology
BIO 405 Molecular Evolution
BIO 407 Plant Developmental Anatomy
BIO 411 Medical Embryology
BIO 416 Biology of Cancer
BIO 422 Advanced Genetics
BIO 426 Developmental Neurobiology
BIO 428 Population Genetics
BIO 430 Developmental Biology
BIO 432 Developmental Genetics
BIO 439 Practical Bioinformatics
BIO 443 Evo-devo: Evolution of Developmental Mechanisms
BIO 448 Ecology of Plant Reproduction
BIO 460 Human Genetics
BIO 499A Tropical Field Ecology
HORT 407 Plant Breeding

Supporting Courses and Related Areas

Select 17-24 credits from department list 17-24

1 Courses in Group IV-except BIO 496, SC 295, SC 395, SC 495-may be used to satisfy requirements in other groups.

2 A maximum of 3 credits of BIO 496 or 4 credits of SC 295, SC 395, SC 495 may be used to fulfill the 18-credit minimum in the 400-level biology course requirement.

General Biology Option (50-54 credits)

Available at the following campuses: Abington, Altoona, Beaver, Berks, Brandywine, Harrisburg, Schuylkill, Scranton, University Park, York

Code  Title  Credits

Additional Courses

Select one of the following: 6-8

CHEM 202  Fundamentals of Organic Chemistry I
& CHEM 203  and Fundamentals of Organic Chemistry II

CHEM 210  Organic Chemistry I
& CHEM 212  and Organic Chemistry II
& CHEM 213  and Laboratory in Organic Chemistry

Select 3-4 credits of the following: 3-4

STAT 200  Elementary Statistics
STAT 240  Introduction to Biometry
STAT 250  Introduction to Biostatistics

Groups

Select a minimum of 18 credits of 400-level biology courses, with at least 3 credits from each of the following groups: 1
### Group V:
- **BIOL 404** Cellular Mechanisms in Vertebrate Physiology
- **BIOL 406** Symbiosis
- **BIOL 409** Biology of Aging
- **BIOL 411** Medical Embryology
- **BIOL 413** Cell Signaling and Regulation
- **BIOL 416** Biology of Cancer
- **BIOL 421** Comparative Anatomy of Vertebrates
- **BIOL 426** Developmental Neurobiology
- **BIOL 430** Developmental Biology
- **BIOL 432** Developmental Genetics
- **BIOL 437** Histology
- **BIOL 443** Evo-devo: Evolution of Developmental Mechanisms
- **BIOL 446** Physiological Ecology
- **BIOL 460** Human Genetics
- **BIOL 469** Neurobiology
- **BIOL 470** Functional and Integrative Neuroscience
- **BIOL 472** Mammalian Physiology
- **BIOL 479** General Endocrinology

### Group VI:
- **BIOL 400** Teaching in Biology
- **BIOL 407** Plant Developmental Anatomy
- **BIOL 414** Taxonomy of Seed Plants
- **BIOL 417** Invertebrate Zoology
- **BIOL 419** Ecological and Environmental Problem Solving
- **BIOL 421** Comparative Anatomy of Vertebrates
- **BIOL 437** Histology
- **BIOL 439** Practical Bioinformatics
- **BIOL 444** Field Ecology
- **BIOL 448** Ecology of Plant Reproduction
- **BIOL 450**
- **BIOL 461** Contemporary Issues in Science and Medicine
- **BIOL 473** Laboratory in Mammalian Physiology
- **BIOL 496** Independent Studies (1-3 credits)

### Supporting Courses and Related Areas
- Select 20-27 credits from department list

### Genetics and Developmental Biology Option (50-54 credits)

### Additional Courses
- Select 2-5 credits of the following:
  - **MATH 220** Matrices
  - **MATH 231** Calculus of Several Variables
  - **MICRB 201** Introductory Microbiology
  - **MICRB 202** Introductory Microbiology Laboratory
- Select 3-4 credits of the following:
  - **STAT 200** Elementary Statistics
  - **STAT 240** Introduction to Biometry
  - **STAT 250** Introduction to Biostatistics
  - **STAT 319** Applied Statistics in Science

### Groups
- Select a minimum of 12 credits of 400-level courses, with at least 6 credits from Group I, 3 credits from Group II, and 3 credits from Group III:
<table>
<thead>
<tr>
<th>Code</th>
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<tbody>
<tr>
<td>BIOL 448</td>
<td>Ecology of Plant Reproduction</td>
<td></td>
</tr>
<tr>
<td>BIOL 460</td>
<td>Human Genetics</td>
<td></td>
</tr>
<tr>
<td>BIOL 469</td>
<td>Neurobiology</td>
<td></td>
</tr>
<tr>
<td>HORT 407</td>
<td>Plant Breeding</td>
<td></td>
</tr>
<tr>
<td>MICRB 410</td>
<td>Principles of Immunology</td>
<td></td>
</tr>
</tbody>
</table>

**Group II:**
- BIOL 405 Molecular Evolution
- BIOL 411 Medical Embryology
- BIOL 414 Taxonomy of Seed Plants
- BIOL 417 Invertebrate Zoology
- BIOL 420 Paleobotany
- BIOL 421 Comparative Anatomy of Vertebrates
- BIOL 425 Biology of Fungi
- BIOL 427 Evolution
- BIOL 428 Population Genetics
- BIOL 438 Theoretical Population Ecology
- BIOL 443 Evo-devo: Evolution of Developmental Mechanisms
- BIOL 460 Human Genetics
- BIOL 474 Astrobiology

**Group III:**
- BIOL 400 Teaching in Biology
- BIOL 407 Plant Developmental Anatomy
- BIOL 437 Histology
- BIOL 439 Practical Bioinformatics
- BIOL 448 Ecology of Plant Reproduction
- BIOL 461 Contemporary Issues in Science and Medicine
- BIOL 473 Laboratory in Mammalian Physiology
- BIOL 496 Independent Studies (1-3 credits)
- BIOL 499A Tropical Field Ecology
- BMB 442 Laboratory in Proteins, Nucleic Acids, and Molecular Cloning
- PPBM 425 Biology of Fungi
- SC 295 Science Co-op Work Experience I
- SC 395 Science Co-op Work Experience II
- SC 495 Science Co-op Work Experience III

**Supporting Courses and Related Areas**
Select 9-17 credits from department list  

**Neuroscience Option (50-54 credits)**

*Available at the following campuses: University Park*

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BMB 401</td>
<td>General Biochemistry</td>
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<tr>
<td>BMB 402</td>
<td>General Biochemistry</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 469</td>
<td>Neurobiology</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 470</td>
<td>Functional and Integrative Neuroscience</td>
<td>3</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>
</tbody>
</table>

**Additional Courses**
Select 3-4 credits of the following:

- STAT 200 Elementary Statistics

**Groups**
Select a minimum of 12 credits of 400-level biology courses, with at least 6 credits from Group I, 3 credits from Group II, and 3 credits from Group III:

**Group I**
- BMB 400 Molecular Biology of the Gene
- BIOL 404 Cellular Mechanisms in Vertebrate Physiology
- BIOL 409 Biology of Aging
- BIOL 411 Medical Embryology
- BIOL 413 Cell Signaling and Regulation
- BIOL 421 Comparative Anatomy of Vertebrates
- BIOL 426 Developmental Neurobiology
- BIOL 430 Developmental Biology
- BIOL 437 Histology
- BIOL 443 Evo-devo: Evolution of Developmental Mechanisms
- BIOL 460 Human Genetics
- BIOL 472 Mammalian Physiology
- BIOL 473 Laboratory in Mammalian Physiology
- BIOL 479 General Endocrinology

**Group II**
- BIOL 405 Molecular Evolution
- BIOL 411 Medical Embryology
- BIOL 414 Taxonomy of Seed Plants
- BIOL 417 Invertebrate Zoology
- BIOL 420 Paleobotany
- BIOL 421 Comparative Anatomy of Vertebrates
- BIOL 425 Biology of Fungi
- BIOL 427 Evolution
- BIOL 428 Population Genetics
- BIOL 438 Theoretical Population Ecology
- BIOL 443 Evo-devo: Evolution of Developmental Mechanisms
- BIOL 460 Human Genetics
- BIOL 474 Astrobiology

**Group III**
- BIOL 400 Teaching in Biology
- BIOL 414 Taxonomy of Seed Plants
- BIOL 417 Invertebrate Zoology
- BIOL 419 Ecological and Environmental Problem Solving
- BIOL 421 Comparative Anatomy of Vertebrates
- BIOL 437 Histology
- BIOL 439 Practical Bioinformatics
- BIOL 444 Field Ecology
- BIOL 448 Ecology of Plant Reproduction
- BIOL 450W Experimental Field Biology
- BIOL 461 Contemporary Issues in Science and Medicine
- BIOL 473 Laboratory in Mammalian Physiology
- BIOL 496 Independent Studies (1-3 credits)
- BIOL 499A Tropical Field Ecology
- SC 295 Science Co-op Work Experience I
- SC 395 Science Co-op Work Experience II
SC 495  Science Co-op Work Experience III

Supporting Courses and Related Areas
Select 14-19 credits from department list 14-19

1 May select up to 6 credits from department list

Plant Biology Option (50-54 credits)
Available at the following campuses: University Park

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
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</tr>
</thead>
<tbody>
<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>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>BIOL 407</td>
<td>Plant Developmental Anatomy</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 414</td>
<td>Taxonomy of Seed Plants</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 441</td>
<td>Plant Physiology</td>
<td>3</td>
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</table>

Additional Courses
Select 3-4 credits of the following: 3-4

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>STAT 200</td>
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</tr>
<tr>
<td>STAT 240</td>
<td>Introduction to Biometry</td>
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<tr>
<td>STAT 250</td>
<td>Introduction to Biostatistics</td>
<td></td>
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</tbody>
</table>

Advanced statistics course

Groups
Select a minimum of 12 credits of 400-level courses, with at least 6 credits from Group I, 3 credits from Group II, and 3 credits from Group III: 12

Group I:

<table>
<thead>
<tr>
<th>Code</th>
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<tbody>
<tr>
<td>BIOL 413</td>
<td>Cell Signaling and Regulation</td>
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<td>BIOL 427</td>
<td>Evolution</td>
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<td>BIOL 430</td>
<td>Developmental Biology</td>
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</tr>
<tr>
<td>BIOL 443</td>
<td>Evo-devo: Evolution of Developmental Mechanisms</td>
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<tr>
<td>BIOL 444</td>
<td>Field Ecology</td>
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<td>BIOL 446</td>
<td>Physiological Ecology</td>
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<tr>
<td>BIOL 448</td>
<td>Ecology of Plant Reproduction</td>
<td></td>
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<tr>
<td>BIOL 499A</td>
<td>Tropical Field Ecology</td>
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<tr>
<td>BIOTC 459</td>
<td>Plant Tissue Culture and Biotechnology</td>
<td></td>
</tr>
<tr>
<td>HORT 407</td>
<td>Plant Breeding</td>
<td></td>
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<tr>
<td>PPEM 416</td>
<td>Plant Virology: Molecules to Populations</td>
<td></td>
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<tr>
<td>PPEM 425</td>
<td>Biology of Fungi</td>
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</table>

Group II:

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<tr>
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<tbody>
<tr>
<td>BIOL 400</td>
<td>Teaching in Biology</td>
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<td>BIOL 450W</td>
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<td>BIOL 496</td>
<td>Independent Studies (1-3 credits)</td>
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<td>BIOL 499A</td>
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<tr>
<td>SC 295</td>
<td>Science Co-op Work Experience I</td>
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<tr>
<td>SC 395</td>
<td>Science Co-op Work Experience II</td>
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Vertebrate Physiology Option (50-54 credits)
Available at the following campuses: Abington, Altoona, Brandywine, University Park

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</thead>
<tbody>
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<td>CHEM 210</td>
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<td>CHEM 212</td>
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<tr>
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<td>BMB 402</td>
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</tr>
<tr>
<td>BIOL 472</td>
<td>Mammalian Physiology</td>
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<tr>
<td>BIOL 473</td>
<td>Laboratory in Mammalian Physiology</td>
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Additional Courses
Select 3-4 credits of the following: 3-4

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<tbody>
<tr>
<td>STAT 200</td>
<td>Elementary Statistics</td>
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<tr>
<td>STAT 240</td>
<td>Introduction to Biometry</td>
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</tr>
<tr>
<td>STAT 250</td>
<td>Introduction to Biostatistics</td>
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</table>

Groups
Select a minimum of 12 credits of 400-level courses, with at least 6 credits from Group I, 3 credits from Group II, and 3 credits from Group III:

Group I:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 404</td>
<td>Cellular Mechanisms in Vertebrate Physiology</td>
<td></td>
</tr>
<tr>
<td>BIOL 406</td>
<td>Symbiosis</td>
<td></td>
</tr>
<tr>
<td>BIOL 409</td>
<td>Biology of Aging</td>
<td></td>
</tr>
<tr>
<td>BIOL 411</td>
<td>Medical Embryology</td>
<td></td>
</tr>
<tr>
<td>BIOL 412</td>
<td>Ecology of Infectious Diseases</td>
<td></td>
</tr>
<tr>
<td>BIOL 413</td>
<td>Cell Signaling and Regulation</td>
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<tr>
<td>BIOL 416</td>
<td>Biology of Cancer</td>
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<tr>
<td>BIOL 421</td>
<td>Comparative Anatomy of Vertebrates</td>
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<td>BIOL 426</td>
<td>Developmental Neurobiology</td>
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<tr>
<td>BIOL 430</td>
<td>Developmental Biology</td>
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<td>BIOL 432</td>
<td>Developmental Genetics</td>
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<td>BIOL 437</td>
<td>Histology</td>
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<td>BIOL 443</td>
<td>Evo-devo: Evolution of Developmental Mechanisms</td>
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<tr>
<td>BIOL 446</td>
<td>Physiological Ecology</td>
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<td>BIOL 460</td>
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<td>BIOL 469</td>
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<td>BIOL 470</td>
<td>Functional and Integrative Neuroscience</td>
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<td>BIOL 479</td>
<td>General Endocrinology</td>
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Group II:

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<tr>
<td>BIOL 405</td>
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<td>BIOL 411</td>
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<td>BIOL 417</td>
<td>Invertebrate Zoology</td>
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<td>BIOL 420</td>
<td>Paleobotany</td>
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<td>BIOL 421</td>
<td>Comparative Anatomy of Vertebrates</td>
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<tr>
<td>BIOL 425</td>
<td>Biology of Fungi</td>
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<tr>
<td>BIOL 427</td>
<td>Evolution</td>
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</table>
Integrated B.S. in Biology/M.Ed. in Curriculum and Instruction

This Integrated Undergraduate/Graduate (IUG) degree program combines the Bachelor of Science in Biology with the Master of Education in Curriculum and Instruction, Science Education emphasis. The program is designed to be completed in five years. The program enables highly qualified and motivated students to delve deeply into a scientific content area and to pursue graduate level preparation in the theory and practice of teaching. Most students in this option intend to seek Pennsylvania teacher certification and, a semester of student teaching comprises part of their final year of studies. The IUG may also be suitable for a student who does not need to become certified, because they intend to teach in a private secondary school or a non-formal educational setting; in such cases, the second graduate semester will be a program of studies determined through consultation with the graduate advisor and customized for the student’s specific needs.

For specific instructions on applying to the program, please consult the “Application Process” section of the IUG description for the Biology B.S. degree in the Undergraduate Bulletin. Application materials to be submitted include an undergraduate transcript, statement of purpose, draft plan of study, two letters of recommendation, and concurrent submission of an application for master’s study to the graduate program in Curriculum and Instruction, Science Education emphasis area. Additional details about the graduate application procedure can be found above in the section, “Admissions Requirements.”

IUG students fulfill all degree requirements for a B.S. in the Eberly College of Science. If a student chooses to leave the program without completing M.Ed. requirements, he or she may still receive the relevant B.S. degree, after all B.S. requirements are completed.

For the M.Ed. degree, students must earn at least 30 credits at the 400/500 level, at least 18 of them at the 500 level. One graduate semester is usually devoted to full time student teaching. Additional graduate coursework is completed in a second semester. Courses required for the M.Ed. degree include a course in learning theory (e.g., SCIED 552), a course in research methods (e.g., SCIED 558), a course in curriculum (e.g., SCIED 550), and a course in research ethics (CI 590).

Students pursuing teacher certification (the usual option) additionally complete a 500-level EDTHP course (3), CI 595, and CI 496. SCIED 558, CI 496, and CI 595 comprise the student-teaching semester course load. Students who are not pursuing teacher certification substitute 15 credits of other 400 or 500-level coursework for the student-teaching semester; those courses are selected in consultation with their advisors, in order to address the students’ specific career aspirations.

124 credits are required for the B.S. degree and 30 credits for the M.Ed. degree. The following courses may be double-counted toward both the B.S. and the M.Ed. degrees, up to a limit of 12 credits: EDTHP 500-level courses (3), SCIED 411 & SCIED 412, and SCIED 500-level courses. Note that at least 50% of credits proposed for double-counting must be at the 500 level.

There are a number of other requirements for Pennsylvania teacher certification, including state-required tests and clearances, as well as coursework that can be completed at either the undergraduate or graduate level. Some courses, not enumerated above, that are usually required to satisfy teacher certification requirements include CI 280, SPLED 400, and CI 495C. Please note that changes in Pennsylvania certification requirements are common; students should check the Certification FAQ page at the Penn State Science Education website for updates and clarification about the specific requirements that affect them, based on their admission date to the IUG program option. Note also that students in the IUG program option are not required to complete all Penn State teacher certification requirements in order to receive their B.S. and M.Ed. degrees, as long as they have completed the requirements for those degrees, as described in the undergraduate and graduate Bulletins. For example, a student who has completed all degree requirements but has not yet received a score for the Pennsylvania-required Biology PRAXIS exam may be awarded both of his or her earned degrees.

Program Learning Objectives

1. **Evolution**: The diversity of life evolved over time by processes of mutation, selection, and genetic change.
2. **Structure and Function**: Basic units of structure define the function of all living things.
3. **Information Flow, Exchange, and Storage**: The growth and behavior of organisms are activated through the expression of genetic information in context.
4. **Pathways and Transformations of Energy and Matter**: Biological systems grow and change by processes based upon chemical transformation pathways and are governed by the laws of thermodynamics.
5. **Systems**: Living systems are interconnected and interacting.

Academic Advising

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

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

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

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amv12@psu.edu

Suggested Academic Plan

General Biology Option at Abington 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.

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<thead>
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<th>First Year</th>
<th>Credits</th>
<th>Spring Credits</th>
<th>Second Year</th>
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<td>ENGL 15 or 30 (GWS)</td>
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<td>BOL 240W (GN)*</td>
<td>BIOL 230W (GN)*</td>
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<td>MATH 140 or 140B (GQ)**</td>
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<td>MATH 141 or 141B (GQ)**</td>
<td>BIOL 230W (GN)*</td>
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<td>BIOL 110 (GN)**</td>
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<td>CHEM 112 (GN)**</td>
<td>BIOL 220W (GN)**</td>
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<td></td>
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* Recommended for students entering as first-year students.
** Recommended for students entering as second-year students.
† Recommended for students entering as third-year students.
<table>
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<tr>
<th>Course</th>
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**Third Year**

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<td>ENGL 202C (GWS)</td>
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**Fourth Year**

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<td>BIOL 400-Level Group V Course</td>
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<td>BIOL 400-Level Group IV Course</td>
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<td>BIOL 400-Level Group VI Course</td>
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<tr>
<td></td>
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</table>

Total Credits 126-127

* 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

**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.

**Course Lists**

GROUP I - PLANTS AND FUNGI
- BIOL 406 Symbiosis (3 cr.)
- BIOL 441 Plant Physiology (3 cr.)
- BIOL 443 Evo-devo: Evolution of Developmental Mechanisms (3 cr.)
- BIOL 482 Coastal Biology (3-4 cr.)

GROUP II - EVOLUTIONARY BIOLOGY
- BIOL 406 Symbiosis (3 cr.)
- BIOL 427 Evolution (3 cr.)
- BIOL 429 Animal Behavior (3 cr.)
- BIOL 433 Evolution of Vertebrates (3 cr.)
- BIOL 443 Evo-devo: Evolution of Developmental Mechanisms (3 cr.)
- BIOL 460 Human Genetics (3 cr.)

GROUP III - GENETICS
- BIOL 416 Biology of Cancer (3 cr.)
- BIOL 422 Advanced Genetics (3 cr.)
- BIOL 430 Developmental Biology (3 cr.)
- BIOL 443 Evo-devo: Evolution of Developmental Mechanisms (3 cr.)
- BIOL 460 Human Genetics (3 cr.)
- BMB 400 Molecular Biology of the Gene (2-3 cr.)
- MICRB 410 Principles of Immunology (3 cr.)
- MICRB 415 General Virology: Bacterial and Animal Viruses (3 cr.)

GROUP IV - ECOLOGY
- BIOL 406 Symbiosis (3 cr.)
- BIOL 429 Animal Behavior (3 cr.)
- BIOL 436 Population Ecology and Global Climate Change (3 cr.)
- BIOL 482 Coastal Biology (3-4 cr.)

GROUP V - ANIMAL PHYSIOLOGY
- BIOL 406 Symbiosis (3 cr.)
- BIOL 409 Biology of Aging (3 cr.)
- BIOL 416 Biology of Cancer (3 cr.)
- BIOL 437 Histology (4 cr.)
- BIOL 443 Evo-devo: Evolution of Developmental Mechanisms (3 cr.)
- BIOL 460 Human Genetics (3 cr.)
- BIOL 469 Neurobiology (3 cr.)
- BIOL 472 Mammalian Physiology (3 cr.)
- BIOL 479 General Endocrinology (3 cr.)

GROUP VI - PRACTICUM
- BIOL 402 (cr.)
- BIOL 437 Histology (4 cr.)
- BIOL 461 Contemporary Issues in Science and Medicine (3 cr.)
- BIOL 473 Laboratory in Mammalian Physiology (2 cr.)

**Disallowed Courses**

Students may select free elective courses from nearly the entire range of the University's offerings. However, the following courses may NOT be used to satisfy degree requirements in the Biology major, regardless of option, not even as free electives.

- ASTRO 001**, 010**, 011**, 120**, 140**
- BIOL 011**, 012**
- BISC 001, 002, 003**, 004**
- BMB 001**
- CHEM 001, 002, 006, 101
- CMPSC 001, 100, 110
- ENGL 004, 005
- LL ED 005, 010
MATH 001, 002, 003, 004, 017, 018, 021, 022, 026, 030, 035, 036, 040, 041, 081, 082, 083, 110, 111, 200
MICRB 106, 107, 120, 121A, 121B, 150, 151A, 151C, 151D, 151E, 151F, 151W
PHYS 001, 150, 151
CAS 004, 126
STAT 100

In addition, the following types of courses may NOT be used to satisfy degree requirements in the Biology major:

- Courses which are remedial in nature or which focus on reading improvement or study skills. NOTE: Only 3 credits of CHEM 017 and only 4 credits of MATH 140A may be used to satisfy degree requirements.
- Courses which substantially duplicate the subject matter covered in other completed courses taught at a comparable level.
- No more than 6 credits of ROTC and 12 credits of Independent Study (296, 496) may be used to satisfy degree requirements. Unless special permission is granted, Independent Study credit may only be used in the “Free Electives” category.
- No more than 5 credits of KINES may be used to satisfy degree requirements.
- ** On rare occasions, with adequate justification, a student may be permitted to use one or more of these courses to satisfy degree requirements. A petition must be submitted to request such an exception and will be considered on a case-by-case basis.

** Genetics and Developmental Biology Option at Abington 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>
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<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ENGL 15 or 30 (GWS)</td>
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<td>BIOL 240W (GN)</td>
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Total: 15 credits

### Second Year

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Total: 16-17 credits

### Third Year

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<tbody>
<tr>
<td>BIOL 400-Level Group I Course</td>
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<td>BIOL 430 (or BIOL 400-Level Group II Course)</td>
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<td>PHYS 250 (GN)</td>
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<td>CAS 100A or 100B (GWS)</td>
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Total: 16-17 credits

### Fourth Year

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<td>BMB 401</td>
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<td>BMB 402</td>
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<td>General Education Course</td>
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<td>BIOL 422 (or BIOL 400-Level Group I Course)</td>
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Total Credits 125-126

* Course requires a grade of C or better for the major
† Course requires a grade of C or better for General Education
‡ 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.

** Course Lists **

GROUP I - CHOOSE 6 CREDITS FROM THE FOLLOWING COURSES:

- BMB 400 Molecular Biology of the Gene (2-3 cr.)
- BIOL 416 Biology of Cancer (3 cr.)
- BIOL 427 Evolution (3 cr.)
BIOL 437 Histology (4 cr.)
BIOL 443 Evo-devo: Evolution of Developmental Mechanisms (3 cr.)
BIOL 460 Human Genetics (3 cr.)
BIOL 469 Neurobiology (3 cr.)
MICRB 410 Principles of Immunology (3 cr.)

GROUP II - CHOOSE 3 CREDITS FROM THE FOLLOWING COURSES:
BIOL 406 Symbiosis (3 cr.)
BIOL 427 Evolution (3 cr.)
BIOL 429 Animal Behavior (3 cr.)
BIOL 443 Evo-devo: Evolution of Developmental Mechanisms (3 cr.)
BIOL 460 Human Genetics (3 cr.)
MICRB 415 General Virology: Bacterial and Animal Viruses (3 cr.)

GROUP III - CHOOSE 3 CREDITS FROM THE FOLLOWING COURSES:
BIOL 402 ( cr.)
BIOL 437 Histology (4 cr.)
BIOL 473 Laboratory in Mammalian Physiology (2 cr.)
BIOL 496 Independent Studies
BMB 442 Laboratory in Proteins, Nucleic Acids, and Molecular Cloning (3 cr.)

Disallowed Courses
Students may select free elective courses from nearly the entire range of the University’s offerings. However, the following courses may NOT be used to satisfy degree requirements in the Biology major, regardless of option, not even as free electives.

ASTRO 001**, 010**, 011**, 120**, 140**
BIOL 011**, 012**
BISC 001, 002, 003**, 004**
BMB 001**
CHEM 001, 002, 006, 101
CMPSC 001, 100, 110
ENGL 004, 005
LL ED 005, 010
MATH 001, 002, 003, 004, 017, 018, 021, 022, 026, 030, 035, 036, 040, 041, 081, 082, 083, 110, 111, 200
MICRB 106, 107, 120, 121A, 121B, 150 151A, 151C, 151D, 151F, 151W
PHYS 001, 150, 151
CAS 004, 126
STAT 100

In addition, the following types of courses may NOT be used to satisfy degree requirements in the Biology major:

• Courses which are remedial in nature or which focus on reading improvement or study skills. NOTE: Only 3 credits of CHEM 017 and only 4 credits of MATH 140A may be used to satisfy degree requirements.

• Courses which substantially duplicate the subject matter covered in other completed courses taught at a comparable level.

• No more than 6 credits of ROTC and 12 credits of Independent Study (296, 496) may be used to satisfy degree requirements. Unless special permission is granted, Independent Study credit may only be used in the “Free Electives” category.

• No more than 5 credits of KINES may be used to satisfy degree requirements.

• ** On rare occasions, with adequate justification, a student may be permitted to use one or more of these courses to satisfy degree requirements. A petition must be submitted to request such an exception and will be considered on a case-by-case basis.

Vertebrate Physiology Option at Abington 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.

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In addition, the following types of courses may NOT be used to satisfy degree requirements in the Biology major:

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• ** On rare occasions, with adequate justification, a student may be permitted to use one or more of these courses to satisfy degree requirements. A petition must be submitted to request such an exception and will be considered on a case-by-case basis.

Vertebrate Physiology Option at Abington 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.

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| Total Credits          | 15            | 15         |

* 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:

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### Course Lists

**GROUP I** - CHOOSE 6 CREDITS FROM THE FOLLOWING COURSES:

- BIOL 406 Symbiosis (3 cr.)
- BIOL 409 Biology of Aging (3 cr.)
- BIOL 416 Biology of Cancer (3 cr.)
- BIOL 430 Developmental Biology (3 cr.)
- BIOL 437 Histology (4 cr.)
- BIOL 443 Evo-devo: Evolution of Developmental Mechanisms (3 cr.)
- BIOL 460 Human Genetics (3 cr.)
- BIOL 469 Neurobiology (3 cr.)
- BIOL 479 General Endocrinology (3 cr.)
- MICRB 410 Principles of Immunology (3 cr.)

**GROUP II** - CHOOSE 3 CREDITS FROM THE FOLLOWING COURSES:

- BIOL 406 Symbiosis (3 cr.)
- BIOL 427 Evolution (3 cr.)
- BIOL 429 Animal Behavior (3 cr.)
- BIOL 443 Evo-devo: Evolution of Developmental Mechanisms (3 cr.)
- BIOL 460 Human Genetics (3 cr.)
- MICRB 415 General Virology: Bacterial and Animal Viruses (3 cr.)

**GROUP III**

- BIOL 473 Laboratory in Mammalian Physiology (2 cr.)

### Disallowed Courses

Students may select free elective courses from nearly the entire range of the University's offerings. However, the following courses may **NOT** be used to satisfy degree requirements in the Biology major, regardless of option, not even as free electives.

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- BIOL 011**, 012**
- BISC 001, 002, 003**, 004**
- BMB 001**
- CHEM 001, 002, 006, 101
- CMPSC 001, 100, 110
- ENGL 004, 005
- LL ED 005, 010
- MATH 001, 002, 003, 004, 017, 018, 021, 022, 026, 030, 035, 036, 040, 041, 081, 082, 083, 110, 111, 200
- MICRB 106, 107, 120, 121A, 121B, 150 151A, 151C, 151D, 151E, 151F, 151W
- PHYS 001, 150, 151
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- STAT 100

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### Career Paths

A Biology BS degree provides an excellent foundation and the skills required for a wide range of technical careers. While many majors use a Biology degree to prepare for entrance into health professional schools, others follow career paths in research, education, and business. Students...
also pursue graduate study at universities both across the U.S. and internationally.

MORE INFORMATION ABOUT CAREERS (http://bio.psu.edu/undergraduate-portal/after-graduation)

MORE INFORMATION ABOUT OPPORTUNITIES FOR GRADUATE STUDIES (http://bio.psu.edu/graduate-portal)

**Contact**

**Abington**
DIVISION OF SCIENCE AND ENGINEERING
1600 Woodland Road
Abington, PA 19001
215-881-7300
epi1@psu.edu
http://abington.psu.edu/biology

**Altoona**
DIVISION OF MATHEMATICS AND NATURAL SCIENCES
Hawthorn Building 109
300 Ivyside Park
Altoona, PA 16601
814-949-5205
lkp3@psu.edu
http://altoona.psu.edu/academics/bachelors-degrees/biology/request-information

**Beaver**
100 University Drive
Monaca, PA 15061
724-773-3527
cmm48@psu.edu
http://beaver.psu.edu/biology

**Berks**
DIVISION OF SCIENCE
Luerssen Science Building
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610-396-6328
med18@psu.edu
http://berks.psu.edu/bs-biology

**Brandywine**
25 Yearsley Mill Road
Media, PA 19063
610-892-1459
ead9@psu.edu
http://brandywine.psu.edu/biology

**Harrisburg**
SCHOOL OF SCIENCE, ENGINEERING, AND TECHNOLOGY
Science & Tech Building, 177 TL
Middletown, PA 17057
717-948-6358
tlh46@psu.edu

https://harrisburg.psu.edu/science-engineering-technology/biology-science/bachelor-science-biology

**Schuylkill**
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Schuylkill Haven, PA 17972
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rmh11@psu.edu
http://www.schuylkill.psu.edu/biology

**Scranton**
211 Dawson Building
Dunmore, PA 18512
570-963-2529
mih10@psu.edu
http://worthingtonscranton.psu.edu/biology-degree

**University Park**
DEPARTMENT OF BIOLOGY
228 Ritenour Building
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**York**
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717-718-6705
amv12@psu.edu
http://york.psu.edu/academics/baccalaureate/biology