Biology

Majors:

• Bachelor of Science, Biology (p. 1)
• Bachelor of Science, Environmental Biology (p. 3)

Minor:

• Biology (p. 5)

The Bachelor of Science program in biology is designed to prepare a student for a career in the life sciences. Graduates of the program are competitive for entry into graduate programs in the biological sciences as well as professional schools, such as medical, dental, osteopathic, and veterinary science, as well as physician assistant (PA) and advanced nursing programs.

The department has two primary areas of focus:

1. Basic biomedical science
2. Environmental/ecological science

Biomedical science course offerings includes:

• Cell biology
• Comparative and human anatomy
• Developmental biology
• General and medical microbiology
• Genetics
• Genetics of human disease
• Mammalian physiology
• Neurobiology

Environmental/ecological science course offerings include:

• Community and restoration ecology
• Ecological physiology
• Ecology
• Entomology
• Analysis of biological data
• Environmental biology
• Environmental microbiology
• Evolutionary biology

In addition, advanced undergraduates may enroll in graduate courses for undergraduate credit with the consent of the department chairperson. In line with the two areas of research interests, the department encourages students (in consultation with their advisors) to declare one of the two as an area of concentration of study no later than the end of their sophomore year. For the student more interested in a broad approach to biology, the department recommends a third option, the general biology option (any combination of upper-level biology courses that fulfills the program requirements).

The department offers a research mentorship program for upper-level students majoring in biology. The program allows a student to work closely with both faculty and graduate students in laboratory and/or field research. Participation in the program is based on the recommendation of a member of the faculty. The mentorship program is designed to provide a significant advantage for those students who intend to enter a graduate program.

The department also offers a combined five-year Bachelor and Master of Science (SY B.S.-M.S.) degree in Biology. This accelerated program is designed for students who display strong potential for research in biology. It provides a liberal arts education, a broad background in biology, the development of expertise in a biological subfield, and a thorough introduction to research instrumentation and techniques. Graduates from the program are prepared for either direct entry into the job market or continuation toward the Ph.D. A detailed description of the five-year B.S.-M.S. program may be obtained from the departmental office.

A minor in biology consists of 20 semester hours.

Faculty
Karolyn Hansen, Chairperson
Distinguished Service Professor: Noland
Professors Emeriti: Geiger, Kearns, Ramsey
Professors: Burky, Krane, Nielsen, Robinson, Singh, P. Williams, S. Wright
Associate Professors: Friese, Hansen, Kango-Singh, McEwan, Pitychoutis, T. Williams, D. Wright
Assistant Professors: Prather, Sun
Lecturers: Dillon, Kavanaugh, Rhoads, Wolters

Bachelor of Science, Biology (BIO) minimum 120 hours

| Common Academic Program (CAP) 1 |  
|---------------------------------|---|
| First-Year Humanities Commons 2 | 12 cr. hrs. |
| HST 103 The West & the World    |  
| REL 103 Introduction to Religious and Theological Studies |  
| PHL 103 Introduction to Philosophy |  
| ENG 100 Writing Seminar I 3     |  
| Second-Year Writing Seminar 4   | 0-3 cr. hrs. |
| Oral Communication              | 3 cr. hrs. |
| ENG 200 Writing Seminar II      |  
| Mathematics                     | 3 cr. hrs. |
| Social Science                  | 3 cr. hrs. |
| SSC 200 Social Science Integrated |  
| Arts                            | 3 cr. hrs. |
| Natural Sciences 5              | 7 cr. hrs. |

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2. A minor in biology consists of 20 semester hours.

3. In addition, advanced undergraduates may enroll in graduate courses for undergraduate credit with the consent of the department chairperson. In line with the two areas of research interests, the department encourages students (in consultation with their advisors) to declare one of the two as an area of concentration of study no later than the end of their sophomore year. For the student more interested in a broad approach to biology, the department recommends a third option, the general biology option (any combination of upper-level biology courses that fulfills the program requirements).

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Crossing Boundaries

Faith Traditions
Practical Ethical Action
Inquiry

Integrative

Advanced Study
Philosophy and/or Religious Studies (6 cr. hrs.)
Historical Studies (3 cr. hrs.)

Diversity and Social Justice

Major Capstone

The credit hours listed reflect what is needed to complete each CAP component. However, they should not be viewed as a cumulative addition to a student’s degree requirements because many CAP courses are designed to satisfy more than one CAP component (e.g., Crossing Boundaries and Advanced Studies) and may also satisfy requirements in the student’s major.

May be completed with ASI 110 and ASI 120 through the Core Program.

May be completed with ENG 100A and ENG 100B, by placement.

May be completed with ENG 114 or ENG 198 or ASI 120.

Must include two different disciplines and at least one accompanying lab.

U.S. History AP and CLEP credit will not satisfy this requirement.

May be completed with ASI 110 and ASI 120 through the Core Program. U.S. History AP and CLEP credit will not satisfy this requirement.

May not double count with First-Year Humanities Commons, Second-Year Writing, Oral Communication, Social Science, Arts, or Natural Sciences CAP components, but may double count with courses taken to satisfy other CAP components and/or courses taken in the student’s major.

The course or experience is designed by faculty in each major; it may, or may not, be assigned credit hours.

Science Breadth Requirements
(Satisfies CAP Mathematics and CAP Natural Science)

CHM 123 & 123L General Chemistry and General Chemistry Laboratory 4
CHM 124 & 124L General Chemistry and General Chemistry Laboratory 4
CHM 313 & 313L Organic Chemistry and Organic Chemistry Laboratory 4
CHM 314 & 314L Organic Chemistry and Organic Chemistry Laboratory 4
PHY 201 & 201L College Physics I and College Physics Laboratory I 4
PHY 202 & 202L General Physics and General Physics Laboratory 4

Select one mathematics sequence from:

MTH 116 & MTH 148 Precalculus Math and Introductory Calculus I
MTH 148 & MTH 149 Introductory Calculus I and Introductory Calculus II
MTH 168 & MTH 169 Analytic Geometry & Calculus I and Analytic Geometry & Calculus II

Major Requirements

BIO 151 & 151L Concepts of Biology I: Cellular & Molecular Biology and Concepts of Biology Laboratory I: Cellular & Molecular Biology 4
BIO 152 & 152L Concepts of Biology II: Evolution & Ecology and Concepts of Biology Laboratory II: Evolution & Ecology 4
BIO 299 Biology Seminar 1
BIO 310 Ecology 3
BIO 312 General Genetics 3
BIO 420 Biology Capstone Seminar (Satisfies Cap Major Capstone) 1

Select two environmental/ecological courses from:

BIO 301 Evolution
BIO 309 & 309L Comparative Anatomy of the Vertebrates and Comparative Anatomy Laboratory
BIO 310L Ecology Laboratory
BIO 311 Introductory Entomology
BIO 312L Genetics Laboratory
BIO 314 & 314L Plant Biology and Plant Biology Laboratory
BIO 320 & 320L Marine Biology and Marine Biology Laboratory
BIO 359 Sustainability & the Biosphere
BIO 370 Conservation Biology
BIO 402 & 402L Vertebrate Zoology and Vertebrate Zoology Laboratory
BIO 407 & 407L Plant Diversity & Ecology and Plant Diversity & Ecology Laboratory
BIO 409 & 409L Ecological Restoration and Ecological Restoration Laboratory
BIO 411 & 411L General Microbiology and General Microbiology Laboratory
BIO 421 Biological Problems 4
BIO 435 & 435L Microbial Ecology and Microbial Ecology Laboratory
BIO 439 Analysis & Interpretation of Biological Data
BIO 445 Evolution & Development
BIO 450 & 450L Comparative Animal Physiology and Comparative Animal Physiology Laboratory
BIO 452 Biology of Rivers & Lakes and Biology of Rivers & Lakes Laboratory
BIO 459 Environmental Ecology and Environmental Ecology Laboratory
BIO 461 Invertebrate Zoology and Invertebrate Zoology Laboratory
BIO 480 Principles of Microscopy and Principles of Microscopy Laboratory
BIO 489  Mycology  

Select two basic biomedical courses from 3, 6  7

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>BIO 301</td>
<td>Evolution</td>
</tr>
<tr>
<td>BIO 309</td>
<td>Comparative Anatomy of the Vertebrates</td>
</tr>
<tr>
<td>&amp; 309L</td>
<td>and Comparative Anatomy Laboratory</td>
</tr>
<tr>
<td>BIO 311</td>
<td>Introductory Entomology</td>
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<tr>
<td>BIO 312L</td>
<td>Genetics Laboratory</td>
</tr>
<tr>
<td>BIO 403</td>
<td>Physiology I</td>
</tr>
<tr>
<td>&amp; 403L</td>
<td>and Physiology Laboratory I</td>
</tr>
<tr>
<td>BIO 404</td>
<td>Physiology II</td>
</tr>
<tr>
<td>BIO 411</td>
<td>General Microbiology</td>
</tr>
<tr>
<td>&amp; 411L</td>
<td>and General Microbiology Laboratory</td>
</tr>
<tr>
<td>BIO 412</td>
<td>Genetics Human Diseases</td>
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<tr>
<td>BIO 415</td>
<td>Neurobiology</td>
</tr>
<tr>
<td>&amp; 415L</td>
<td>and Neurobiology Laboratory</td>
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<tr>
<td>BIO 421</td>
<td>Biological Problems 4</td>
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<tr>
<td>BIO 427</td>
<td>Immunology</td>
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<td>BIO 439</td>
<td>Analysis &amp; Interpretation of Biological Data</td>
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<td>BIO 440</td>
<td>Cell Biology</td>
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<tr>
<td>&amp; 440L</td>
<td>and Cell Biology Laboratory</td>
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<td>BIO 442</td>
<td>Developmental Biology</td>
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<tr>
<td>&amp; 442L</td>
<td>and Developmental Biology Laboratory</td>
</tr>
<tr>
<td>BIO 445</td>
<td>Evolution &amp; Development</td>
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<tr>
<td>BIO 460</td>
<td>Introduction to Bioinformatics</td>
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<td>BIO 461</td>
<td>Invertebrate Zoology</td>
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<tr>
<td>&amp; 461L</td>
<td>and Invertebrate Zoology Laboratory</td>
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<tr>
<td>BIO 462</td>
<td>Molecular Biology</td>
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<tr>
<td>BIO 465</td>
<td>Disease Ecology</td>
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<td>BIO 466</td>
<td>Biology of Infectious Disease</td>
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<tr>
<td>BIO 470</td>
<td>Cancer Biology</td>
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<tr>
<td>BIO 475</td>
<td>Human Anatomy</td>
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<tr>
<td>&amp; 475L</td>
<td>and Human Anatomy Laboratory</td>
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<tr>
<td>BIO 480</td>
<td>Principles of Microscopy</td>
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<tr>
<td>&amp; 480L</td>
<td>and Principles of Microscopy Laboratory</td>
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<tr>
<td>BIO 489</td>
<td>Mycology</td>
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<tr>
<td>CHM 420</td>
<td>Biochemistry</td>
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</tbody>
</table>

Select four electives, two with accompanying labs, from the group above. 3, 6  14

<table>
<thead>
<tr>
<th>Course</th>
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</thead>
<tbody>
<tr>
<td>ASI 150</td>
<td>Introduction to the University Experience</td>
</tr>
<tr>
<td></td>
<td>Social &amp; Behavioral Sciences (includes CAP Social Science)</td>
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<td></td>
<td>Total Hours to total at least</td>
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</tbody>
</table>

Breadth 7

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>HST 103</td>
<td>The West &amp; the World</td>
</tr>
<tr>
<td>REL 103</td>
<td>Introduction to Religious and Theological Studies</td>
</tr>
<tr>
<td>PHL 103</td>
<td>Introduction to Philosophy</td>
</tr>
<tr>
<td>ENG 100</td>
<td>Writing Seminar I 3</td>
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</tbody>
</table>

Bachelor of Science, Environmental Biology (EVB) minimum 120 hours

Environmental biology is a science specialization based upon the fundamentals of biology and ecology, applying interdisciplinary skills, knowledge, and principles to the environmental problems facing society today. Students entering this dynamic field could become directly involved in addressing some of the significant global problems related to human impact on the environment. In addition to the standard base of courses required of most biology majors, the curriculum also requires a challenging core of environmentally related science courses and course work drawn from a multidisciplinary elective pool that includes offerings in the humanities and social sciences.

Internship Program: Majors will participate in the EVB internship program (BIO 499, see course prerequisites), where they will have the unique opportunity to obtain valuable training and experience under the mentorship of established scientists and other environmental professionals.

Common Academic Program (CAP) 1

<table>
<thead>
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<tr>
<td>HST 103</td>
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<td>REL 103</td>
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<tr>
<td>PHL 103</td>
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<tr>
<td>ENG 100</td>
<td>Writing Seminar I 3</td>
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<td>Course Code</td>
<td>Course Title</td>
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<tr>
<td>ENG 200</td>
<td>Writing Seminar II</td>
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<tr>
<td>CMM 100</td>
<td>Principles of Oral Communication</td>
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<td>SSC 200</td>
<td>Social Science Integrated</td>
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<tr>
<td>CHM 123</td>
<td>General Chemistry</td>
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<tr>
<td>CHM 124</td>
<td>General Chemistry</td>
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<tr>
<td>CHM 313</td>
<td>Organic Chemistry</td>
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<tr>
<td>GEO 115</td>
<td>Physical Geology</td>
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<td>GEO 116</td>
<td>Geological History of the Earth</td>
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<tr>
<td>GEO 450</td>
<td>Applied Geographic Information Systems</td>
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<tr>
<td>MTH 116</td>
<td>Precalculus Math</td>
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<tr>
<td>MTH 148</td>
<td>Introductory Calculus I</td>
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<tr>
<td>MTH 149</td>
<td>Introductory Calculus II</td>
</tr>
<tr>
<td>MTH 207</td>
<td>Introduction to Statistics</td>
</tr>
<tr>
<td>BIO 151</td>
<td>Concepts of Biology I: Cellular &amp; Molecular Biology</td>
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<tr>
<td>BIO 152</td>
<td>Concepts of Biology II: Evolution &amp; Ecology</td>
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<tr>
<td>BIO 299</td>
<td>Biology Seminar</td>
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<td>BIO 310</td>
<td>Ecology</td>
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<td>BIO 312</td>
<td>General Genetics</td>
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<td>BIO 420</td>
<td>Biology Capstone Seminar (Satisfies CAP Major Capstone)</td>
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<tr>
<td>BIO 479L</td>
<td>Environmental Instrumentation Laboratory</td>
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<tr>
<td>BIO 499</td>
<td>Environmental Biology Internship</td>
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<tr>
<td>BIO 301</td>
<td>Evolution</td>
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<td>BIO 311</td>
<td>Introductory Entomology</td>
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<td>Conservation Biology</td>
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1. The credit hours listed reflect what is needed to complete each CAP component. However, they should not be viewed as a cumulative addition to a student's degree requirements because many CAP courses are designed to satisfy more than one CAP component (e.g., Crossing Boundaries and Advanced Studies) and may also satisfy requirements in the student’s major.

2. May be completed with ASI 110 and ASI 120 through the Core Program.

3. May be completed with ENG 100A and ENG 100B, by placement.

4. May be completed with ENG 114 or ENG 198 or ASI 120.

5. Must include two different disciplines and at least one accompanying lab.

6. U.S. History AP and CLEP credit will not satisfy this requirement.

7. May be completed with ASI 110 and ASI 120 through the Core Program. U.S. History AP and CLEP credit will not satisfy this requirement.

8. May not double count with First-Year Humanities Commons, Second-Year Writing, Oral Communication, Social Science, Arts, or Natural Sciences CAP components, but may double count with courses taken to satisfy other CAP components and/or courses taken in the student's major.

9. The course or experience is designed by faculty in each major; it may, or may not, be assigned credit hours.
BIO 402 & 402L Vertebrate Zoology and Vertebrate Zoology Laboratory
BIO 407 & 407L Plant Diversity & Ecology and Plant Diversity & Ecology Laboratory
BIO 409 & 409L Ecological Restoration and Ecological Restoration Laboratory
BIO 421 Biological Problems
BIO 439 Analysis & Interpretation of Biological Data
BIO 450 & 450L Comparative Animal Physiology and Comparative Animal Physiology Laboratory
BIO 452 & 452L Biology of Rivers & Lakes and Biology of Rivers & Lakes Laboratory
BIO 459 & 459L Environmental Ecology and Environmental Ecology Laboratory
BIO 478 Honors Thesis Project
BIO 489 Mycology
BIO 496 Special Topics in Biology

Biology Elective: Select one course from: 2, 3, 5, 6

BIO 309 & 309L Comparative Anatomy of the Vertebrates and Comparative Anatomy Laboratory
BIO 403 & 403L Physiology I and Physiology Laboratory I
BIO 404 Physiology II
BIO 411 & 411L General Microbiology and General Microbiology Laboratory
BIO 412 Genetics Human Diseases
BIO 415 Neurobiology
BIO 427 Immunology
BIO 435 & 435L Microbial Ecology and Microbial Ecology Laboratory
BIO 440 & 440L Cell Biology and Cell Biology Laboratory
BIO 442 & 442L Developmental Biology and Developmental Biology Laboratory
BIO 445 Evolution & Development
BIO 462 Molecular Biology
BIO 466 Biology of Infectious Disease
BIO 475 & 475L Human Anatomy and Human Anatomy Laboratory
BIO 480 & 480L Principles of Microscopy and Principles of Microscopy Laboratory

Breadth
ASI 150 Introduction to the University Experience
Social and Behavioral Sciences

Total Hours to total at least 120

1. Other appropriate statistics courses may be substituted with the approval of the EVB Program Director or Department Chairperson.
2. A minimum grade of C- is required for all BIO courses.
3. BIO 499 requires the permission of the EVB Program Director.
4. One Laboratory from the Biology Electives can count toward Environmental & Ecological requirements.
5. BIO 421 and BIO 496 are permission only. Qualify as laboratory electives.

Minor in Biology (BIO)

Biology

BIO 151 & 151L Concepts of Biology I: Cellular & Molecular Biology and Concepts of Biology Laboratory I: Cellular & Molecular Biology
BIO 310 Ecology
BIO 312 General Genetics

Select two BIO courses (300/400 level)

Total Hours 20

- Bachelor of Science, Biology (p. 1)
- Bachelor of Science, Environmental Biology (p. 3)

Biology

First Year

Fall
ASI 150

Spring
BIO 152

BIO 151 & 151L (CAP Natural Science w/lab)
CHM 123 & 123L
MTH 148 (Satisfies CAP Mathematics)

ENG 100 (CAP Humanities Commons)
REL 103, PHL 103, or HST 103 (CAP Humanities Commons)

18

Second Year

Fall
BIO 299

Spring
BIO 310

CHM 313 & 313L
PHY 202 & 202L

PHY 201 & 201L (CAP Natural Science w/lab)

ENG 200 (CAP Writing Seminar)
REL 103, PHL 103, or HST 103 (CAP Humanities Commons)

15

Third Year

Fall
BIO Elective Biomed

Spring
BIO 420 (Satisfies CAP Major Capstone)
BIO Elective Env/Eco

1

1. One of the following non-BIO science courses may be substituted as a Biology Elective Course: SEE 301, CHM 314, MTH 367, GEO 208.
### First Year

**Fall**
- ASI 150
- BIO 151
  - & 151L (CAP Natural Science w/lab)
- CHM 123
  - & 123L
- MTH 148 (Satisfies CAP Mathematics)
- ENG 100 (CAP Humanities Commons)

**Spring**
- 1 BIO 152
  - & 152L
- 4 CHM 124
  - & 124L
- 4 MTH 149
- 3 HST 103, PHL 103, or REL 103 (CAP Humanities Commons)
- 3 HST 103, PHL 103, or REL 103 (CAP Humanities Commons)

**Total credit hours: 132**

### Courses

**BIO 101. Life, Environment, and Society. 3 Hours**
An introductory course covering the study of life in all its forms, understanding how life interacts with the environment and the role of biological inquiry in society. Emphasis will be placed on discussing topical issues relevant to evaluating the critical role of the life sciences in society today. Supporting laboratory strongly recommended, but optional. No prerequisite. For non-science majors only.

**BIO 101L. Life, Environment, and Society Laboratory. 1 Hour**
A hands-on approach to the study of life, understanding how life interacts with the environment, and the role of biological inquiry in society. Lab activities will stress an experiential, inquiry-based approach to topics relevant in today's society in an effort to increase student's abilities to critically evaluate modern science media. Laboratory topics are designed to run parallel to lecture topics. Recommended that the laboratory be taken concurrently with BIO 101 lecture. One two-hour laboratory per week. For non-science majors. Corequisite(s): BIO 101.

**BIO 151. Concepts of Biology I: Cellular & Molecular Biology. 3 Hours**
Introduction to the biological concepts surrounding cell and molecular biology. Topics include scientific practice, molecular basis of life, cellular composition and energy processes, genetics, and biotechnology. Intended for science majors. Core biology course.
BIO 151L. Concepts of Biology Laboratory I: Cellular & Molecular Biology. 1 Hour
Laboratory-based introduction to the biological concepts surrounding cell and molecular biology. Utilizing a hands-on approach to the study of life, students will take part in experiential, inquiry-based activities as they observe the properties of cellular, micro-scale biology while concurrently defining proper laboratory procedures, operating modern scientific instrumentation, and practicing effective documentation of experiments. Topics include scientific practice, biological instrumentation, cellular composition and processes, genetics, and biotechnology. One three-hour lab per week. Intended for science majors. Core biology course. Corequisite(s): BIO 151.

BIO 152. Concepts of Biology II: Evolution & Ecology. 3 Hours
Introduction to the biological concepts surrounding evolution and ecology. Topics include scientific practice, evolutionary basis of life, phylogeny and systematics, biodiversity, ecology and biosphere sustainability. Intended for science majors. Core biology course.

BIO 152L. Concepts of Biology Laboratory II: Evolution & Ecology. 1 Hour
Laboratory-based introduction to the biological concepts surrounding evolution, diversity and ecology. Utilizing a hands-on approach, students will take part in experiential, inquiry-based activities as they explore the concepts of evolution and macro-scale biology while concurrently developing proper laboratory procedures, operating modern scientific instrumentation, and practicing effective scientific presentation of research through the two most widely accepted formats: the scientific journal article and the research poster presentation. Topics include evolution and phylogeny, the diversity of life, ecology, and human impact on ecosystems. One three-hour laboratory per week. Intended for science majors. Core biology course. Corequisite(s): BIO 152.

BIO 299. Biology Seminar. 1 Hour
Introduction to biological journals and abstracting materials. Practice in reviewing, abstracting, and presenting biological information, and career development. Core biology course. Biology and environmental biology majors only. Prerequisite(s): BIO 152.

BIO 301. Evolution. 3 Hours
Theory and evidence of organic evolution, with emphasis on microevolutionary change and population genetics. Prerequisite(s): BIO 152.

BIO 309. Comparative Anatomy of the Vertebrates. 3 Hours
Study of changes that have occurred in the vertebrate body with the passage of time, and analysis of their significance. Prerequisite(s): BIO 152.

BIO 309L. Comparative Anatomy Laboratory. 1 Hour
Dissection and study of the anatomical structure of representative vertebrate animals. One three-hour laboratory per week. Corequisite(s): BIO 309.

BIO 310. Ecology. 3 Hours
Interrelationship of plants, animals, and micro-organisms with the physical-chemical environment: nutrient cycles, energy flow, ecosystems, and factors affecting distribution and abundance of organisms. Core biology course. Prerequisite(s): BIO 152.

BIO 310L. Ecology Laboratory. 1 Hour
Measurement of population, community, and environmental variables in terrestrial and aquatic systems. The lab is field-based using local ecological resources. One three-hour laboratory per week and weekend field trips. Corequisite(s): BIO 310.

BIO 311. Introductory Entomology. 3 Hours
Classification, physiology, ecology, and impact of insects on society. Prerequisite(s): BIO 152.

BIO 312. General Genetics. 3 Hours
Study of the principles of variation and heredity covering both Mendelian and molecular genetics. Core biology course. Prerequisite(s): BIO 152.

BIO 312L. Genetics Laboratory. 1 Hour
Exploration of heredity using molecular genetic methods. One three-hour laboratory per week. Corequisite(s): BIO 312.

BIO 314. Plant Biology. 3 Hours
Consideration of structure, function, reproduction, and inheritance as applicable in the plant patterns of life. Emphasis on the vascular plants. Prerequisite(s): BIO 152.

BIO 314L. Plant Biology Laboratory. 1 Hour
Emphasis on generalized structure and function of plants. One three-hour laboratory per week. Corequisite(s): BIO 314.

BIO 320. Marine Biology. 2 Hours
Introduction to the diversity of marine life including the physical-chemical environment. Prerequisite(s): Permission of instructor. Corequisite(s): BIO 320.

BIO 320L. Marine Biology Laboratory. 2 Hours
Examination of marine organisms and processes. Laboratory work conducted on UD campus and at off-campus field sites in the southern United States or Hawaii. Prerequisite(s): Permission of instructor. Corequisite(s): BIO 320.

BIO 359. Sustainability & the Biosphere. 3 Hours
Study of the principles of sustainability. All areas of sustainability will be covered with emphasis on ecological facets of sustainability. Discussion of loss of habitat and biodiversity in the context of sustaining natural resources for future generations. Prerequisite(s): BIO 152 or SCI 230.

BIO 370. Conservation Biology. 3 Hours
An ecosystem approach to the study of and threat to local, regional, and global biodiversity. Application of ecological principles of conservation of species and habitats. Prerequisite(s): BIO 152.

BIO 395. Global Environmental Biology. 3 Hours
Presentation of the biological and ecological principles needed for the critical discussion and evaluation of current global issues related to human impact on the environment. Ecological data on the current extinction crisis and sustainable solutions will be addressed. No credit toward a biology major or minor. Prerequisite(s): BIO 101, BIO 151 or SCI 230.

BIO 402. Vertebrate Zoology. 3 Hours
The morphology, physiology, ecology, and distribution of representative vertebrate groups. Prerequisite(s): BIO 310 or BIO 312.

BIO 402L. Vertebrate Zoology Laboratory. 1 Hour
Laboratory focused on the diversity, systematics and ecology of vertebrates. One three-hour laboratory per week. Corequisite(s): BIO 402.

BIO 403. Physiology I. 3 Hours
Physical-chemical examination of the physiological events occurring in a living system with emphasis on physiology of the cell, excretion, nerves, muscles, bone, blood, heart, circulation, and respiration. Prerequisite(s): BIO 152; CHM 314.

BIO 403L. Physiology Laboratory I. 1 Hour
Systematic approach to the acquisition and interpretation of information about the physiology of living systems. One three-hour laboratory per week. Corequisite(s): BIO 403 or HSS 307.
BIO 404. Physiology II. 3 Hours
Integrated systems based examination of physiological processes in humans with a special emphasis on molecular mechanisms of pathophysiological conditions in humans and experimental animal systems. Prerequisite(s): BIO 403.

BIO 407. Plant Diversity & Ecology. 3 Hours
Lecture course addressing plant diversity and ecology. Course includes an overview of plant systematics and aspects of plant anatomy, population ecology, community ecology, ecosystem ecology, and global ecology. Prerequisite(s): BIO 310.

BIO 407L. Plant Diversity & Ecology Laboratory. 1 Hour
Field laboratory course addressing plant diversity and ecology. Includes a series of field labs focused on plant identification, followed by labs focused on quantitatively assessing plants, plant communities, and ecosystems. Labs will take place in a variety of natural areas. Corequisite(s): BIO 407.

BIO 409. Ecological Restoration. 3 Hours
Principles and practices of ecological restoration. The course presents the rationale and knowledge needed to understand, appreciate, plan and perform ecological restoration. Prerequisite(s): BIO 310.

BIO 409L. Ecological Restoration Laboratory. 1 Hour
Practical applications of the principles of ecological restoration to a variety of ecosystems. One three-hour laboratory per week. Corequisite(s): BIO 409.

BIO 411. General Microbiology. 3 Hours
Introductory course stressing the physiology, cultivation, and classification of microbial organisms; their role in medicine, agriculture, and industry. Prerequisite(s): BIO 152; CHM 313.

BIO 411L. General Microbiology Laboratory. 1 Hour
Lab exercises focusing on the basic techniques involved in the isolation and identification of bacteria, including assessment of biochemical activities, growth characteristics of bacteria, and the impact of the environment on microbial growth. One three-hour laboratory per week. Corequisite(s): BIO 411.

BIO 412. Genetics Human Diseases. 3 Hours
Study of the molecular genetics of inherited human diseases using a systems approach. Survey of inherited diseases linked to major organs and organ systems. Prerequisite(s): BIO 312; CHM 313.

BIO 415. Neurobiology. 3 Hours
Structure and function of the brain and nervous system. Emphasis on understanding cellular and molecular events within the nervous system using model organisms. Prerequisite(s): BIO 152; CHM 124.

BIO 415L. Neurobiology Laboratory. 1 Hour
Laboratory research experience in neuroscience with emphasis on cellular, molecular and behavioral neurobiology and neurochemistry. Prerequisite(s): BIO 152, BIO 415 (may be taken as a co-req), CHM 124.

BIO 420. Biology Capstone Seminar. 1 Hour
Seminar course designed to further develop students' ability to communicate and synthesize within their discipline and prepare them for their chosen career paths in the Biological and Environmental professions. All class activities, including presentations, relate to key issues facing society today in addition to continued career development skills. Biology core and capstone course. Prerequisite(s): BIO 299, BIO 310, BIO 312.

BIO 421. Biological Problems. 1-2 Hours
Laboratory research problems. Topics arranged with faculty advisors. Prerequisite(s): (BIO 310 or BIO 312); Permission of department chairperson.

BIO 422. Biological Problems. 1-2 Hours
Library research problems. Topics arranged with faculty advisors. Prerequisite(s): (BIO 310 or BIO 312); Permission of department chairperson.

BIO 427. Immunology. 3 Hours
Discussions of antigens, antibodies, antigenicity, immunogenicity, and antigen-antibody reactions including hypersensitivity, immune tolerance, and transplants. Prerequisite(s): (BIO 403 or BIO 411 or BIO 440 or BIO 442) or CHM 420.

BIO 435. Microbial Ecology. 3 Hours
Study of the diversity and activity of microorganisms and the interrelationships between microorganisms and their environments with emphasis on aquatic ecosystems. Prerequisite(s): BIO 411; CHM 314.

BIO 435L. Microbial Ecology Laboratory. 1 Hour
Examination of the methods of isolation and enumeration of microorganisms and techniques for determining their activities in the field and laboratory. One three-hour laboratory per week. Corequisite(s): BIO 435.

BIO 439. Analysis & Interpretation of Biological Data. 3 Hours
Introducing the nature of some of the important types of data that are generated in biological research, the databases that warehouse such data, the principles involved in the analysis of such data, the use of appropriate software to analyze such data, and the biological interpretation of the results of analysis. Prerequisite(s): BIO 152.

BIO 440. Cell Biology. 3 Hours
Study of the function, structure, composition, heredity, and growth of cells. Analysis of cell concepts in biochemical terms. Prerequisite(s): BIO 152; CHM 314.

BIO 440L. Cell Biology Laboratory. 1 Hour
Experimental approaches to explore modern concepts in cell structure, function, and biology. One three-hour laboratory per week. Corequisite(s): BIO 440.

BIO 442. Developmental Biology. 3 Hours
Study of animal development, including morphological patterns of development, mechanisms of cellular differentiation, cell-cell interactions during development, and mechanisms of differential gene expression. Emphasis on understanding development at the cellular and molecular levels. Prerequisite(s): BIO 152; CHM 314.

BIO 442L. Developmental Biology Laboratory. 1 Hour
Exploration of the development of key model organisms from the morphological and molecular perspectives with an emphasis on basic developmental laboratory techniques. One three-hour laboratory per week. Corequisite(s): BIO 442.

BIO 445. Evolution & Development. 3 Hours
Molecular and population genetic examination of the evolution of animal form. Topics include comparative developmental biology, population genetics, and molecular evolution. Prerequisite(s): BIO 312.

BIO 450. Comparative Animal Physiology. 3 Hours
Organized on a function-system basis, course dealing with environment-organism interaction and with integrative systems of the principle phyla of animals. Prerequisite(s): (BIO 310 or BIO 312); CHM 124.
BIO 450L. Comparative Animal Physiology Laboratory. 1 Hour
Examination of physiological responses to the physical environment. Variations of the physical environment are examined in the field. Study of animals under controlled laboratory conditions with experimental design, data collection and analysis to assess physiological adaptations. One three-hour laboratory or field trip per week. Corequisite(s): BIO 450.

BIO 452. Biology of Rivers & Lakes. 3 Hours
The biological interrelationships of organisms in rivers, streams, lakes and ponds including biodiversity, ecological/evolutionary adaptations and structure of aquatic ecosystems. Prerequisite(s): BIO 310.

BIO 452L. Biology of Rivers & Lakes Laboratory. 1 Hour
Laboratory and field exercises emphasizing the biological, chemical and physical attributes of freshwater ecological systems. One three-hour laboratory or field trip per week. Corequisite(s): BIO 452.

BIO 459. Environmental Ecology. 3 Hours
The application of current ecological knowledge and principles toward the study of human impact on the environment. Emphasis on ecosystem dynamics, applied ecology, disturbance ecology, and approaches to solving global environmental problems. Prerequisite(s): BIO 310.

BIO 459L. Environmental Ecology Laboratory. 1 Hour
Analytical approach to studying applied ecology and human impact on the environment. Emphasis on laboratory and field approaches to solving environmental problems through the use of ecological principles. One three-hour laboratory per week. Corequisite(s): BIO 459.

BIO 461. Invertebrate Zoology. 3 Hours
Survey of the structure, activities, life histories, and relationships of the invertebrate animals, with some emphasis on their origin and development. Prerequisite(s): BIO 310 or BIO 312.

BIO 461L. Invertebrate Zoology Laboratory. 1 Hour
Examination of the structure and function of the major invertebrate phyla. Survey of representative animals with an emphasis on observational skills for analysis of the structural adaptations of live animals. One three-hour laboratory per week. Corequisite(s): BIO 461.

BIO 462. Molecular Biology. 3 Hours
Analysis of the nature of the gene and gene action. Particular attention to genetic regulation and to recent advances in molecular genetics. Prerequisite(s): BIO 312; CHM 314.

BIO 466. Biology of Infectious Disease. 3 Hours
The nature of infectious diseases, host-parasite relationships in resistance and infection, defense mechanism (antigen-antibody response); survey of the bacteria causing disease in humans. Prerequisite(s): BIO 411.

BIO 470. Cancer Biology. 3 Hours
Study of growth patterns and causes of cancer at the cellular and molecular levels. Discussion of the hereditary and environmental factors that contribute to the development of the disease in cancer patients. Description of the research being conducted to understand and cure the disease. Prerequisite(s): BIO 403 or BIO 440.

BIO 475. Human Anatomy. 3 Hours
Study of the fundamental principles of human gross anatomy with emphasis on all organ systems. Prerequisite(s): BIO 152; CHM 314.

BIO 475L. Human Anatomy Laboratory. 1 Hour
Study of human gross anatomy emphasizing all organs systems using computer-assisted dissection, anatomical human models and occasional dissection of nonhuman cadaver organs. One three-hour laboratory per week. Corequisite(s): BIO 475.

BIO 477. Honors Thesis Project. 3 Hours
First of two courses leading to the selection, design, investigation, and completion of an independent, original Honors Thesis project under the guidance of a faculty research advisor. Restricted to students in the University Honors Program with permission of the program director and department chairperson. Students pursuing an interdisciplinary thesis topic may register for three semester hours each in two separate disciplines in consultation with the department chairpersons. Prerequisite(s): Approval of University Honors Program.

BIO 478. Honors Thesis Project. 3 Hours
Second of two courses leading to the selection, design, investigation, and completion of an independent, original Honors Thesis project under the guidance of a faculty research advisor. Restricted to students in the University Honors Program with permission of the program director and department chairperson. Students pursuing an interdisciplinary thesis topic may register for three semester hours each in two separate disciplines in consultation with the department chairpersons. Prerequisite(s): Approved 477; approval of University Honors Program.

BIO 479L. Environmental Instrumentation Laboratory. 2 Hours
The understanding and use of field- and laboratory-based equipment to study current environmental issues. Emphasis on team-centered approaches to investigating environmental problems. Same as GEO 479L. One five-hour laboratory or field trip per week. Prerequisite(s): BIO 310; GEO 116.

BIO 480. Principles of Microscopy. 3 Hours
Focus on basic principles and theory of light and electron microscopy, and how these techniques address fundamental questions in science. Prerequisite(s): BIO 152.

BIO 480L. Principles of Microscopy Laboratory. 1 Hour
Application and practice of light and electron microscopy. One three-hour laboratory per week. Corequisite(s): BIO 480.

BIO 489. Mycology. 3 Hours
Introductory course stressing the interrelationship between fungi and the rest of the biological world. Emphasis on the basic biology and ecology of fungi, decomposition, species interactions, plant pathology and medical mycology. Prerequisite(s): BIO 152.

BIO 496. Special Topics in Biology. 1-3 Hours
Lecture course addressing advanced topics in biology. Topics are variable depending on faculty teaching the course and the course aims. Students should consult the class schedule. May be repeated. Prerequisite(s): BIO 151, BIO 152.

BIO 499. Environmental Biology Internship. 3 Hours
Majors will have the opportunity to obtain valuable training and experience under the mentorship of established scientists and professionals. Emphasis on approaches to solving environmental problems including such research areas as bioremediation, risk assessment, and ecological restoration. May be repeated up to six semester hours. No science credit for biology majors. Prerequisite(s): Permission of Environmental Biology Program Coordinator.