Biology
Department of Biology/Toxicology
The College of Arts and Sciences

Chair
Mason Posner, Professor of Biology

Faculty
Soren Brauner, Professor of Biology
Douglas A. Dawson, Professor of Biology/Toxicology
Richard L. Stoffer, Professor of Biology
Steven D. Fenster, Associate Professor of Biology
Patricia A. Saunders, Associate Professor of Biology
Andrew V. Greene, Assistant Professor of Biology
Paul Hyman, Assistant Professor of Biology
Andrew J. Trimble, Assistant Professor of Biology/Toxicology
Merrill Tawse, Professional Instructor of Biology

Degrees Offered
Bachelor of Science
Bachelor of Science in Education

Mission and Goals
The mission and goals of the Department of Biology/Toxicology are:

- to educate B.S. and B.S.Ed. students in biology and toxicology, and to successfully prepare them for jobs or graduate/professional schools;
- to educate future teachers, providing them with the knowledge and skills necessary to teach children biology;
- to educate students from other disciplines, encouraging them to become citizens who are knowledgeable about biological issues;
- to advance biological knowledge through research and scholarship; and
- to enhance the knowledge and understanding of biology in the community at large.

Student Learning Outcomes
Students graduating with a major in biology or toxicology will:

- be able to understand and use the scientific method (including experimental design, sampling strategy, and data analysis) as a means of investigating biological problems;
- be able to demonstrate a breadth of knowledge commensurate with their coursework, including an understanding of cellular structure and function, homeostasis, growth and reproduction, molecular and population genetics and evolution, taxonomic organization, and principles of ecology;
- be able to demonstrate practical knowledge in the use and application of equipment employed in the study of biology, including sampling techniques, separation techniques (e.g., gel electrophoresis and chromatography), microscopy, and appropriate techniques for quantitative analysis (e.g., spectroscopy, ion-specific electrodes);
- be able to read, analyze and summarize biological literature and communicate research findings through oral presentation and written papers.

Facilities and Equipment
The $12 million renovation and addition to the Kettering Science Center includes five teaching and three faculty/student research laboratories; a microscopy room and tissue culture facility; an animal facility with multiple rooms for different species; a collections room for preserved specimens; and a 2500 square foot greenhouse with an adjoining laboratory that houses a permanent plant collection and provides space for student and faculty research. The department is well-equipped to provide students with a broad hands-on experience in biological techniques. Equipment available for student use includes:

- Large number of compound and dissecting microscopes as well as an Olympus inverted microscope with phase, Nomarsky and fluorescence optics and Nikon research grade microscope with phase optics. These microscopes are equipped with digital cameras and image analysis software.
- Wide range of tools for molecular and cellular biology, including two refrigerated centrifuges, ultracentrifuge, shaking incubator, five thermal cyclers for PCR (including real-time PCR), Kodak digital imaging station, and a full complement of DNA and protein electrophoresis equipment including 2D gel electrophoresis.
- Tissue culture facility with biological containment
hood, CO$_2$ incubator and inverted microscope.

- A Leica cryostat and microtomes for histological studies.
- Two UV/Vis spectrophotometers for diverse biological applications.
- Tecan fluorescent microplate reader for diverse techniques in toxicology and microbiology.
- Microtox system for studies in aquatic toxicology.
- Tools for environmental studies, including a Seabird profiling instrument for lakes and oceans, a YSI handheld instrument for streams and shallow wetlands, a photosynthesis measuring system for studies of plant physiology, and GPS instruments and GIS software for mapping and collection of spatial data.
- Field sampling equipment, including gear appropriate to both aquatic and terrestrial studies.
- Numerous growth chambers, environmental chambers and incubators.
- Multiple aquariums, including a 75-gallon saltwater tank for study of marine organisms.
- Anatomy laboratory housing up to four human cadavers and extensive anatomy model collection.
- Physiology analysis equipment including the Vernier system with a wide range of sensors (EKG, spirometry, etc.) and the iworx system.
- Access to a large number of laptops and desktop workstations for use in the classroom and laboratory.

Field Studies

In addition to five Environmental Preserves managed by the Environmental Science Program, Ashland University's location enhances field study opportunities. Various field courses utilize the close proximity of diverse bodies of water (including Lake Erie), swamps, bogs, prairie habitats, rich deciduous forests (including Mohican State Forest) and the boundary between glaciated and unglaciated Appalachian Plateau. Summer field studies give students the opportunity to study other unique habitats around the country.

Student Honor Society

Beta Beta Beta, Xi Mu chapter, honors biology majors and minors. Regular members maintain a 3.0 and have completed at least three biology courses. Associate membership is available to all other students with an interest in biology.

Pre-Professional Programs

Biology courses make up a substantial component of the required curriculum for a number of pre-professional programs. For minimum requirements, see the Academic Affairs section on pre-professional programs. The Biology Department along with other departments has prepared recommended course sequences which give students the greatest probability of acceptance into professional schools. In most of these programs a biology major is a strong preparation. Those programs with a strong biology component include pre-medicine, pre-dentistry, pre-veterinary medicine, pre-medical technology, pre-pharmacy, pre-physical therapy, pre-physician assistant and pre-optometry.

Description of Majors

Biology Major – Majors in the Biology program explore the characteristics of life, living organisms, and the environments that support life. This exploration comes at many levels—from the molecular and cellular to the interactions between organisms and their environment. Along with classroom work, students gain extensive laboratory and field exposure and are encouraged to conduct undergraduate research. Biology majors have many career options, including medicine and other health-related fields, pharmaceuticals, biochemistry, engineering, forensics, education, environment, or agriculture. They may work with animals, manage wildlife, work with plants, manage forests, work in the field or parks, or work in laboratories. **Biology majors may choose to add a concentration in one of two specialized programs: biotechnology or forensic biology.**

Biotechnology Concentration – Biotechnology involves the use of biological systems to make products for human use in areas such as medicine and agriculture. The Biotechnology program provides students with the knowledge and skills to succeed in the growing and diverse biotechnology field, including careers directly out of the Bachelors program or advanced degrees in professional or graduate school. The program incorporates integrated coursework in biology, chemistry and business, as well as independent research and internship opportunities. Students can choose to concentrate in one of three advising paths or design their own curriculum by choosing from a large number of electives.

Forensic Biology Concentration – The Forensic Biology program was developed to meet the needs of
students interested in pursuing a career in forensic biology, the application of biological principles to law enforcement. The major provides a strong basic background in both biology and chemistry, along with specialized upper level courses specifically applicable to forensics. Course work in criminal justice and other areas provide additional perspectives. After graduation, forensic biology majors will be well prepared for either on-the-job training in a forensics laboratory or for graduate study in the area of forensics.

Toxicology Major — Toxicology is a field that combines elements of biology and chemistry to study the actions of poisons (toxicants) on living systems. Toxicologists apply their knowledge and skills to interesting and relevant biomedical and environmental problems in areas such as cancer research, drug development, environmental health, forensics, and ecological toxicology. While at AU, toxicology majors take courses in basic and applied toxicology and have the opportunity to participate in undergraduate research and/or internships. After graduation, toxicology majors may choose to go on to graduate or professional school, or may choose to enter the workforce directly.

Degree Requirements

Assessment — All majors will begin the assessment process during the freshman year with a standardized assessment test and research project papers written in BIO 201/202 and continue the process during the junior year in BIO 301 and senior year in BIO 495.

Bachelor of Science with a comprehensive major in Biology

Course Number and Title Hrs. Prerequisites

Biology Core:
BIO 201 Molec. & Cellular Basis of Life 4 none
BIO 202 Organisms, Adapt. & Divers. 4 BIO 201
BIO 301 Professional Preparation 1 major, jr. status
BIO 303 Genetics 4 BIO 126 or 202
BIO 495 Biology Senior Seminar 1 major, sr. status
CHEM 103 General Chemistry I 4 hs chem.; 3 yrs hs math
CHEM 104 General Chemistry II 4 CHEM 103
CHEM 307 Organic Chemistry 5 CHEM 104
CHEM 307L Organic Chemistry Lab 0 CHEM 104
2 Semesters of mathematics* 6-10

(Calc. and or Stats. Recomm.) 33-37 hrs.

Remaining Biology Courses:
BIO 205 General Zoology 4 BIO 202
OR
BIO 207 General Botany 4 BIO 202
Biology electives to reach 60 hrs. 19-23
60 hrs.

Plus Institutional Baccalaureate Degree Requirements, page 30.

*For the Forensic Biology concentration, take calculus and statistics. See specifics in the concentration listing below. **Biology electives must include at least 12 hours of courses at the 300 level and above. May include up to 3 hours of BIO 493, and no more than 9 hours of BIO 493, 497, or 498 combined.

Notes: Students obtaining a double major in biology and chemistry may count BIO/CHEM 429 Biochemistry toward both majors. Students planning to attend a graduate or professional school should take a full year of physics and organic chemistry.

BIOTECHNOLOGY CONCENTRATION

Course Number and Title Hrs. Prerequisites

Biology Core 33-37
BIO 224 Intro to Biotechnology 3 BIO 201
BIO 340 Microbiology 4 BIO 201, CHEM 104
BIO 424 Cell Biology 4 12 hrs bio, BIO 303
BIO 428 Molecular Biology 4 BIO 303
BIO 429 Biochemistry (with lab) 4 CHEM 307
BIO 493 Internship 3 see catalog; permission

OR
BIO 497 Directed Lab/Field Res.(3) permission
CHEM 308/308L Organ Chem. II 4 CHEM 307
ENTP 245 Intro. to Ent. 3 none

OR
MGT 240 Intro to Mgmt. (3) none
PHYS 201 General Physics 4 hs alg. & geom

OR
PHYS 205 University Physics (5) MATH 206
Electives (choose 3 courses): 9-12
BIO 207 General Botany (4) BIO 202
BIO 219 Entomology (4) BIO 202
BIO 325/326 Anat. & Phys. I/II (4/4) BIO 201; 225 for 226
BIO 327 Plant Physiology (4) BIO 207
BIO 329 Dev. Biology (4) BIO 202, 303
BIO 330 Princ. of Toxicology (3) BIO 202, CHEM 104
BIO 331 Meth. in Toxicology (4) BIO 330
BIO 348 Emerging Pathogens (3) BIO 340
BIO 420 Histology (3) 16 hrs. biology
BIO 454 Immunology (4) BIO 340 or 424 or 428

CHEM 320 Quant. Analysis (4) CHEM 104
CHEM 420 Instr. Analysis (3) CHEM 320
*ENTP 245 Intro. to Ent. (3) none
* MGT 240 Intro. to Mgmt. (3) soph status

75-83 hrs.

Plus Institutional Baccalaureate Degree Requirements, page 30.

*The choice of elective for ENTP 245 or MGT 240 would be the one not taken as a requirement above.

FORENSIC BIOLOGY CONCENTRATION

<table>
<thead>
<tr>
<th>Course Number and Title</th>
<th>Hrs.</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology Core</td>
<td>27*</td>
<td>(minus math, specified below)</td>
</tr>
<tr>
<td>BIO 205 General Zoology</td>
<td>4</td>
<td>BIO 202</td>
</tr>
<tr>
<td>OR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIO 207 General Botany</td>
<td>4</td>
<td>BIO 202</td>
</tr>
<tr>
<td>BIO 234 Forensic Science</td>
<td>3</td>
<td>4 hrs bio, 4 hrs chem.</td>
</tr>
<tr>
<td>BIO 428 Molecular Biology</td>
<td>4</td>
<td>BIO 303</td>
</tr>
<tr>
<td>BIO 429 Biochemistry</td>
<td>4</td>
<td>CHEM 307</td>
</tr>
<tr>
<td>Two of the following courses:</td>
<td>6-8</td>
<td>BIO 202 or perm.</td>
</tr>
<tr>
<td>BIO 219 Entomology</td>
<td>4</td>
<td>BIO 202, CHEM 104</td>
</tr>
<tr>
<td>BIO 330 Principles of Tox.</td>
<td>3</td>
<td>BIO 202, CHEM 104</td>
</tr>
<tr>
<td>BIO 424 Cell Biology</td>
<td>4</td>
<td>12 hrs. bio, BIO 303</td>
</tr>
<tr>
<td>BIO 454 Immunology</td>
<td>4</td>
<td>BIO 340 or 424 or 428</td>
</tr>
<tr>
<td>BIO 493 Professional Int.</td>
<td>3</td>
<td>12 hrs. credit; jr or sr status, perm</td>
</tr>
</tbody>
</table>

CHEM 320 Quant. Analysis (4) CHEM 104
CHEM 420 Instr. Analysis (4) CHEM 320
CHEM 308/308L Org. Chem. II 4 CHEM 307
CJ 130 Intro to Criminal Justice 3 none
One of the following courses: 3
CJ 200 Criminal Invest. I (3) CJ 130
CJ 235 Courts and Justice (3) CJ 130
CJ 242 Criminology (3) CJ 130 or SOC 111
CJ 362 Criminal Law (3) CJ 130
CJ 450 Ethics in Criminal Justice (3) CJ 130, 362, sr. status

Specific math courses for biology core: 6-8
MATH 201 Calc. with Appl. (3) 2 yrs. hs alg; 1 yr. hs geom
OR
MATH 205 The Calculus I (5) MATH 111 or equiv.
MATH 208 Elementary Stat. (3) MATH 100 or ACT 18 or SAT 480
PHYS 201-202 Gen. Physics 4/4 hs alg. & geom; 201 for 202
OR
PHYS 205-206 Univ. Physics (5/5) MATH 206; 205 for 206

72-78

Plus Institutional Baccalaureate Degree Requirements, page 30.

Students obtaining a double major in biology and chemistry may count BIO/CHEM 429 Biochemistry toward both majors.

Note: Students planning to attend graduate or professional school should take a full year of physics and organic chemistry, although not required for all the tracks in Biology.

*This concentration specifies which math courses may be chosen to fulfill the Biology Core requirement, so those hours are removed from the Core total.
Biology/Toxicology

**Bachelor of Science with a comprehensive major in Toxicology**

<table>
<thead>
<tr>
<th>Course Number and Title</th>
<th>Hrs.</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 201 Molec. &amp; Cellular Basis of Life</td>
<td>4</td>
<td>none</td>
</tr>
<tr>
<td>BIO 202 Organisms, Adapt. &amp; Divers.</td>
<td>4</td>
<td>BIO 201</td>
</tr>
<tr>
<td>BIO 301 Professional Preparation</td>
<td>1</td>
<td>bio. or tox. maj. jr. status</td>
</tr>
<tr>
<td>BIO 303 Genetics</td>
<td>4</td>
<td>BIO 126 or 202</td>
</tr>
<tr>
<td>BIO 330 Princ. of Toxicology</td>
<td>3</td>
<td>BIO 202, CHEM 104</td>
</tr>
<tr>
<td>BIO 331 Methods in Toxicology</td>
<td>4</td>
<td>BIO 330</td>
</tr>
<tr>
<td>BIO 429 Biochemistry (with lab)</td>
<td>4</td>
<td>CHEM 307</td>
</tr>
<tr>
<td>BIO 430 Applied Toxicology</td>
<td>3</td>
<td>BIO 330</td>
</tr>
<tr>
<td>BIO 495 Biology Senior Seminar</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>BIO Electives</td>
<td>8</td>
<td>(courses numbered 200 or above. See department chair for any course(s) not permitted)</td>
</tr>
</tbody>
</table>

**CHEM 103/104 Gen. Chemistry**

<table>
<thead>
<tr>
<th>Hrs.</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/4</td>
<td>h.s. chem., 3 yrs. h.s. math</td>
</tr>
<tr>
<td>CHEM 320 Quant. Analysis</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 307 Organic Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 420 Instr. Analysis</td>
<td>4</td>
</tr>
<tr>
<td>MATH 201/202 Calc. Applied</td>
<td>3/3</td>
</tr>
</tbody>
</table>

**OR**

<table>
<thead>
<tr>
<th>MATH 205/206 The Calculus</th>
<th>(5/5)</th>
<th>MATH 111 or equiv.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 208 Elementary Statistics</td>
<td>2</td>
<td>MATH 100 or ACT 18 or SAT 480</td>
</tr>
</tbody>
</table>

71-75 hrs.

**Plus Institutional Baccalaureate Degree Requirements, page 30.**

**Note:** Students planning to attend a graduate or professional school should take a full year of physics and organic chemistry, although not required for a major in toxicology.

**Bachelor of Science in Education with a comprehensive major in Integrated Science**

**Grades 7-12**

See listing in Education.

**Bachelor of Science in Education with a comprehensive major in Biology (Life Sciences Licensure) Grades 7-12**

**Assessment** — Assessment in teacher education programs begins with admission to teacher education and continues throughout the program. Exit assessment includes a professional portfolio and completion of all appropriate interim assessments. See the Education section of the catalog for the detailed description of the entire process.

<table>
<thead>
<tr>
<th>Course Number and Title</th>
<th>Hrs.</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 201 Molec. &amp; Cellular Basis of Life</td>
<td>4</td>
<td>none</td>
</tr>
<tr>
<td>BIO 202 Organisms, Adapt. &amp; Divers.</td>
<td>4</td>
<td>BIO 201</td>
</tr>
<tr>
<td>BIO 205 General Zoology</td>
<td>(4)</td>
<td>BIO 202</td>
</tr>
<tr>
<td>BIO 207 General Botany</td>
<td>(4)</td>
<td>BIO 202</td>
</tr>
<tr>
<td>BIO 301 Prof. Preparation</td>
<td>1</td>
<td>bio. major, junior status</td>
</tr>
<tr>
<td>BIO 303 Genetics</td>
<td>4</td>
<td>BIO 126 or 202</td>
</tr>
<tr>
<td>BIO 325 Anat. and Physiology</td>
<td>4</td>
<td>BIO 201</td>
</tr>
<tr>
<td>BIO 326 Anat. and Physiology</td>
<td>4</td>
<td>BIO 325</td>
</tr>
<tr>
<td>BIO 495 Biology Senior Sem.</td>
<td>1</td>
<td>sr. status bio, Tox. Env. Sci./bio</td>
</tr>
</tbody>
</table>

**Choose from one:**

<table>
<thead>
<tr>
<th>Hrs.</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4</td>
<td>Choose from one:</td>
</tr>
<tr>
<td>BIO 305 Evolution</td>
<td>(3)</td>
</tr>
<tr>
<td>BIO 310 Ecology</td>
<td>(4)</td>
</tr>
<tr>
<td>BIO 411 Limnology</td>
<td>(4)</td>
</tr>
<tr>
<td>Choose from one:</td>
<td>4</td>
</tr>
<tr>
<td>BIO 340 Microbiology</td>
<td>(4)</td>
</tr>
<tr>
<td>BIO 424 Cell Biology</td>
<td>(4)</td>
</tr>
<tr>
<td>BIO 428 Molecular Biology</td>
<td>(4)</td>
</tr>
<tr>
<td>CHEM 103 General Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 104 General Chemistry II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 208 Elementary Statistics</td>
<td>3</td>
</tr>
<tr>
<td>PHSY 201 General Physics</td>
<td>4</td>
</tr>
<tr>
<td>Choose from one:</td>
<td>3-4</td>
</tr>
<tr>
<td>BIO 493 Internship</td>
<td>(3)</td>
</tr>
</tbody>
</table>
BIO 497 Directed Lab/Field Research (3) Permission
GEOL 101 Physical Geology (4)
Math Elective (3)

**Related Concentration:**
EDCI 287 Curr./Instr./Assess. 7-12 3 EDFN 202
EDCI 432 Secondary Methods 3 EDCI 230
Choose one from:
- FCS 270 Lifespan
- Human Develop. (3)
- PSYC 209 Dev. Psych (3) PSYC 101
- PSYC 218 Psych. of Adolescence (3) none

64-66 hrs.

**Remaining Education requirements:**
EDCI 230SEC Workshop in Education 2 EDFN 130, 202
EDCI 232 Intro. to Prin. of Instr. Tech. 3 none
EDCI 330SEC Educ. for Diversity 7-12 2 EDCI 230, 287; PSYC 209, 218, or FCS 270
EDCI 392 Content Area Reading 3 none
EDCI 461 Student Int. Gr. 7-12 10 all student internship req.
EDFN 130 Intro. to Teaching 2 none
EDFN 202 Teaching and Learn. Process 3 EDFN 130
EDFN 402 Social and Prof. Issues 3 sr. status
EDIS 250 Intro. Educational Intervention 3 none
93-95 hrs.

**Plus Institutional Baccalaureate Degree Requirements, page 30.**

*Biology electives must include at least 3 hours at the 300 level or above. They may not include BIO 493 and may include no more than 3 hours of BIO 497 and 498 combined.

**Minor in Biology**

**Course Number and Title**  \( \text{Hrs.} \quad \text{Prerequisites} \)