Faculty

Mark Bolyard (2006). University Professor of Biology and Department Chair. B.A., Hanover College; Ph.D., University of North Carolina; Additional study, Michigan State University; Penn State College of Medicine.

Jeremy Blaschke (2015). Assistant Professor of Biology. B.S., Bryan College; Ph.D., University of Tennessee.

Euna (Esther) Choi (2016). Assistant Professor of Biology. B.S. and M.S., Hallym University (Chuncheon, South Korea); Ph.D., University of Illinois; Additional Study, University of Nebraska

Hannah Henson (2016). Assistant Professor of Biology. B.S., Union University; Ph.D., University of Tennessee; Additional Study, University of Kentucky.

James A. Huggins (1987). University Professor of Biology. B.S.A. and M.S., Arkansas State University; Ph.D., University of Memphis; Additional study, University of Tennessee at Memphis, Mid-America Baptist Theological Seminary, and University of Memphis.

James Kerfoot, Jr. (2009). Associate Professor of Biology. B.S. and M.S., Southern Illinois University Edwardsville; Ph.D., Florida Institute of Technology.

James Marcus Lockett (2004). Professor of Biology. B.S. and M.S., Murray State University; Ph.D., University of Tennessee.

Andy Madison (2002). Professor of Biology. B.S., University of Tennessee; M.S., University of Kentucky; Ph.D., Kansas State University.

James Mahan (2010). Associate Professor of Biology. B.A., Vanderbilt University; M.S. and Ph.D., University of Memphis.

Tamara Popplewell (2008). Assistant Professor of Biology. B.S. and M.A.Ed., Union University; M.S., Mississippi State University.

Michael Schiebout (2012). Associate Professor of Biology. B.A., Dordt College; M.S. and Ph.D., University of Northern Colorado.

William Thierfelder (2014). Associate Professor of Biology. Sc.B, Brown University; Ph.D., University of Pennsylvania; Additional study, St. Jude Children’s Research Hospital.

Faith A. Zamamiri-Davis (2011). Assistant Professor of Biology. B.S., Westmont College; Ph.D., Pennsylvania State University; Additional study, St. Jude Children’s Research Hospital.

Instructional Staff


Cathy Huggins (2009). Laboratory Specialist. B.S. and B.S.M.T., Arkansas State University; M.B.A., Union University.

Staff

Frances Lancaster (2016). Academic Secretary—Biology and Chemistry. B.A., Rhodes College; Johan Wolfgang Goethe University, Frankfurt, Germany.

Curriculum

The curriculum in biology is designed to acquaint students with living organisms as whole, functioning entities that, in their diversity, share many common features. In addition to providing the scientific background required of all educated citizens, the courses provide a foundation upon which the student may build a graduate program, undertake training in health-related or other professions, or prepare for secondary-level science teaching. Students participate in independent or group research as well as specific courses.

Because contemporary biology leans heavily on mathematics and physical sciences, students majoring in biology should include mathematics, statistics, chemistry, and physics. In the freshman year students in BIO 112 will build a foundation for study of biological processes. Students can proceed to the first 200-level biology course during the second semester of the freshman year. In the sophomore year, students will continue the survey of the kingdoms of life by taking additional 200-level biology courses. Students should strengthen their understanding of mathematics and obtain a background in organic chemistry as appropriate. Biology courses at the 300-400 level should be taken during the junior and senior years, with seminar reserved for the senior year. Students will examine in detail how organisms function and interact with their environment and each other.

General Biology, Botany, and Zoology majors are required to complete a minor and are encouraged to minor in chemistry. Conservation Biology and Cell and Molecular Biology majors are exempt from the minor requirement.

Conservation Biology Majors may meet the requirements to become a Certified Wildlife Biologist by taking twelve hours of communication. The General Core requirement for COM 112 and electives of COM 121 and COM 235 may be used to fulfill 9 hours of this requirement. The remaining hours may be selected in consultation with your assigned faculty advisor.
I. Major in General Biology – 42–45 hours
   A. Independent Research Option
      1. BIO 112, 210, 211, 215, 315, 318 – 24 hours
      2. Four 300-level BIO courses – 14 hours minimum
      3. BIO 425, 426, 437, 498 – 4 hours
   B. Collaborative Research Option
      1. BIO 112, 210, 211, 215, 315, 318 – 24 hours
      2. Four 300-level BIO courses – 14 hours minimum
      3. BIO 304, 415, 498 – 7 hours

II. Major in Zoology – 43–47 hours
   A. Independent Research Option
      1. BIO 112, 200, 210, 211, 301, 312, 316, 336 – 32 hours
      2. Select one from: BIO 304, 310, 315, 317, 323, 325 – 4 hours
      3. Select one from: BIO 318, 321, 324, 356, 357, 360 – 3 or 4 hours
      4. BIO 425, 426, 437, 498 – 4 hours
   B. Collaborative Research Option
      1. BIO 112, 200, 210, 211, 301, 312, 316, 336 – 32 hours
      2. Select one from: BIO 310, 315, 317, 323, 325 – 4 hours
      3. Select one from: BIO 318, 321, 324, 356, 357, 360 – 3 or 4 hours
      4. BIO 304, 415, 498 – 7 hours

III. Major in Cell and Molecular Biology—72–76 hours
   A. Independent Research Option
      1. BIO 112, 211; 210 or 215—12 hours
      2. BIO 315, 323, 325, 397—15 hours
      3. Three of BIO 307, 309, 310, 316, 317, 320, 321, or 324—12 hours
      4. One 300-level BIO Elective—3 or 4 hours
      5. CHE 111, 112, 314, 315, 324, 326, 319, 329—26 hours
      6. BIO 425, 426, 437, 498—4 hours
      7. No minor is required
   B. Collaborative Research Option
      1. BIO 112, 211; 210, 215—12 hours
      2. BIO 315, 323, 325, 397—15 hours
      3. Three of BIO 307, 309, 310, 316, 317, 320, 321, or 324—12 hours
      4. One 300-level BIO Elective—3 or 4 hours
      5. CHE 111, 112, 314, 315, 324, 326, 319, 329—26 hours
      6. BIO 304, 415, 498—7 hours
      7. No minor is required

IV. Major in Conservation Biology—66–68 hours
   A. Prerequisites or Corequisites: CHE 111; 2 MAT courses 111 or higher
   B. BIO 112, 200, 210, 215; PHY 112 or higher—20 hours
   C. BIO 303, 304, 305, 318, 335, 355—20 hours
   D. BIO 425, 426, 437, 498—4 hours
   E. Two of BIO 337, 358, 359, or 360—8 hours
      Four of BIO 301, 312, 315, 316, 321, 324, 336, 356, 357—14–16 hours
   F. No minor is required.

V. Major in Botany—43-47 hours
   A. Independent Research Option
      1. BIO 112, 211, 215, 337, 358, 359, 360 – 28 hours
      2. Select three electives (at least one from each group):
         Group A: BIO 304, 318, 321, 355
         Group B: BIO 315, 323, 325
      3. BIO 425, 426, 437, 498 – 4 hours
   B. Collaborative Research Option
      1. BIO 112, 211, 215, 337, 358, 359, 360 – 28 hours
      2. Select three electives (at least one from each group):
         Group A: BIO 318, 321, 355
         Group B: BIO 315, 323, 325
      3. BIO 304, 415, 498 – 7 hours

VI. Teacher Licensure in Biology (Grades 6–12)
   A. Major requirements as shown above with General Biology Major (I.A or B) to include 316 (or 307 and 309).
   B. Additional requirements: PHY 111 and 112; CHE 111 and 112; MAT 114 or 208 (in B.S. core); CSC 105; and membership in BIOME.
   C. Professional Education:
      2. Fall of Internship Year – EDU 306, 340, 418, 440
      3. Spring of Internship Year – EDU 441 and 451
      4. CSC 105 is required in the BA core
   D. Completion of applicable portions of the Praxis II.
   E. For additional information, see the Assistant Dean for Teacher Education and Accreditation.

VII. Minor in Biology—21–24 hours
   A. BIO 112
   B. Two 200-level BIO courses—8 hours
   C. Three 300-level BIO courses—9–12 hours, no more than 2 may be from BIO 307, 309, 322.

Major in Biology with Discipline-Specific Honors

The Biology Discipline-Specific Honors program offers advanced training in laboratory and library research through completion of contract courses with expanded requirements, an original research project, as well as colloquium attendance.

Application Timeline/Process

- At least three full semesters, preferably four, must remain before graduation
- Applications are submitted to the Office of the Director of the Honors Community after the student has met with the Chair of the Department of Biology

Admission Requirements

- Minimum GPA of 3.50 both overall and in Biology
- Completion of at least one semester at Union prior to application
- Completion of 16 credit hours applicable toward the Biology major including BIO 112 and at least one 300-level BIO course.
Progression

- Maintain at least a 3.50 GPA both overall and in Biology
- Complete each honors contract course with a B or better

A one-time, one-semester probation will be allowed to correct a deficient GPA. If the deficiency is not corrected, the student will be dismissed from the Honors program. A one-time, one-semester probation also will be allowed for students failing to meet other expectations, as determined by their thesis adviser and/or Biology Chair. Appeals may be instituted by students in the manner stipulated in the Student Handbook. Application forms may be obtained from the Department Chair.

Honors Requirements
Accepted students will
1. Complete 12 hours of contract courses, selected from among the 300-level biology courses that count toward the Biology major, by entering into a contract with the instructor of each chosen course that outlines the additional course requirements
2. Attend at least four colloquia during each year (8 total) and, within one week of attendance, submit a reflection paper on each colloquium to his or her thesis adviser. At least one of the four colloquia attended each year must be sponsored by the Biology Department.
3. Design and complete an honors project/thesis that will lead to either an off-campus presentation or to a paper suitable for submission to an appropriate professional journal. This project meets the research requirement for all Biology majors.

Assessment of Majors

Biology majors are required to take two terminal courses as a requirement for graduation: BIO 415, Collaborative Research Experience or BIO 437 Research Experience; and BIO 498, Seminar. The Department may administer the Major Field Examination to senior biology majors in BIO 415 and 437.

Student Organizations

Biology In Observation of the Master's Earth, BIOME, serves students interested in exploring the world of biology beyond the classroom. BIOME is designed primarily for biology majors and minors but is open to anyone with an interest in biology.

Union’s Biology department has formed a local chapter of Tri-Beta, which is an honorary society for students, particularly undergraduates, dedicated to improving the understanding and appreciation of biological study and extending boundaries of human knowledge through scientific research (www.tri-beta.org).

Student Awards

The Biology Research Award is given by the faculty of the Department of Biology to the student in BIO 437 who presents the best research paper of the year, based on an original piece of work.

Whiteaker Freshman Biology Award. The Department selects a freshman major or minor based on outstanding scholastic achievement, financial need, Christian service, and school spirit.

Course Offerings in Biology (BIO)

100. Survey of Biological Concepts (4) F, W, S
A course for non-science majors focused on the basic ideas to enable students to appreciate the living world and their relationship to it. Topics: the cell, genetic basis of life, biodiversity, survey of the 5 kingdoms of life, ecology, and the environment. Three hours lecture and 2 hours laboratory/week. No credit toward BIO major/minor.

110. Global Biology (4) S
A course for non-science majors focused on global issues in biology, including global diversity, global health; agriculture and biotechnology; and the interactions between humans and nature. Three hours lecture and 2 hours laboratory/week. No credit toward BIO major/minor.

112. Principles of Biology (4) F, S
A study of the basic characteristics of organisms, dealing with structure, function, reproduction, and ecology. Three hours lecture and 3 hours laboratory/week.

200. Wildlife Biology (4) S
Prerequisite: BIO 100 or 112.
Biological concepts involved in fisheries and wildlife biology, their application in practice, and exploration of contemporary issues facing the organisms, habitats, and human consumers. Three hours lecture and 3 hours laboratory/week.

201. Survey of Microbiology (4) F, S
Pre- or Corequisites: BIO 221 and BIO 222.
Emphasis on observation, growth, identification and control of microbes with focus on selected microbial diseases. Four hours lecture per week to include lab demonstrations and simulations. No credit toward BIO major/minor.

210. Zoology (4) F, S
Prerequisite: BIO 112.
Classification, morphology, physiology, and ecology of vertebrate and invertebrate animals. Three hours of Lecture and 3 hours of laboratory/week.
211. Microbiology (4) F, S
Prerequisites: BIO 112
Pre- or Corequisite: CHE 111
Classification, morphology, physiology, and ecology of bacteria and viruses, with special emphasis on bacteria. Three hours lecture and 3 hours laboratory/week.

215. Botany (4) F, S
Prerequisite: BIO 112.
Pre- or Corequisite: CHE 111.
Classification, morphology, physiology, and ecology of the algae, fungi, bryophytes, and vascular plants. Three hours lecture and 3 hours laboratory/week.

221. Human Anatomy and Physiology I (4) F, Su
The first semester of a 2-semester course for nursing, physical education, and allied health students. Body systems studied include the integumentary, nervous, skeletal, and muscular. Three hours lecture and 2 hours laboratory/week. No credit toward BIO major/minor.

222. Human Anatomy and Physiology II (4) S, Su
A continuation of BIO 221. Systems studied include: urinary, cardiovascular, lymphatic, endocrine, digestive, and respiratory. Three hours lecture and 2 hours laboratory/week. No credit toward a BIO major/minor.

300. Pathophysiology (3) F, W, S
Prerequisite: BIO 221 and 222.
Study of various states of altered health. Topics: stress, shock, altered acid-base balance, altered fluid and electrolyte balance, neoplasia, hypertension, immunodeficiency, genetic disorders, altered cardiac rhythms, renal failure and uremia. No credit toward a BIO major/minor.

301. Invertebrate Zoology (4) F–Even Years
Prerequisite: BIO 112, 210, and 4 hours applicable to the BIO major.
Classification, morphology, physiology, and ecology of the invertebrate animals. Three hours lecture and 3 hours laboratory/week.

303. Natural Resources Policy (3) F–Odd Years
Prerequisites: BIO 112, 200, and 4 hours applicable to the BIO major.
Examines current laws and policies governing public and private lands and the conservation of wildlife in the United States.

304. Experimental Design and Biostatistics (4) F
Prerequisites: 12 BIO hours; MAT 111 or higher (MAT 114 or 208 recommended).
Introduces students to the basic concepts and techniques underlying statistical analysis of data in a biological context. Students will be given the opportunity to identify a variety of biological problems, develop specific questions, design and conduct experiments to address these questions, formulate and test hypotheses, choose and run the appropriate statistical test, and interpret the outcomes of such test. Three hours lecture and 3 hours laboratory/week.

305. Conservation Techniques (3) S—Even Years
Prerequisites: BIO 112, 200, and 4 hours applicable to the BIO major.
A field intensive introduction to techniques for determining the age of many species, trapping for population assessments, terrestrial and aquatic sampling methods, methods for assessing population health through necropsies, and habitat management techniques. One hour lecture and 6 hours laboratory/week.

307. Advanced Human Anatomy and Physiology I (4) F
Prerequisite: BIO 112, 210 and 4 hours applicable to the BIO major.
The 1st of a 2-semester sequence designed primarily for science majors seeking to establish a knowledge base of human anatomy and physiology. Body systems studied include the integumentary, skeletal, muscular, and nervous systems. Three hours lecture and 3 hours laboratory/week.

309. Advanced Human Anatomy and Physiology II (4) S
Prerequisite: BIO 307.
A continuation of BIO 307 studying body systems: endocrine, cardiovascular, respiratory, urinary, digestive, and lymphatic. Three hours lecture and 3 hours laboratory/week.

310. Histology (4) W–Odd Years
Prerequisite: BIO 112 and 8 hours applicable to the BIO Major.
The branch of anatomy that deals with structure, composition, design and function of body tissues as it relates to the principles of physiology, biochemistry, molecular biology and medicine. Three hours lecture and 3 hours laboratory/week.

312. Comparative Vertebrate Anatomy (4) F–Odd Years
Prerequisite: BIO 112, 210, and 4 hours applicable to the BIO major.
Study of the similarities of anatomy and early development of vertebrates, complemented by dissection of representative adults. Three hours lecture and 3 hours laboratory/week.

315. Genetics (4) S
Prerequisites: BIO 112, BIO 211, and 4 hours applicable to the BIO major.
A study of the principles of heredity including both classical and molecular genetics. Three hours lecture and 3 hours laboratory/week.

316. Physiology (4) S
Prerequisite: BIO 112, 8 hours applicable to the BIO major, CHE 111-112. BIO 210 and CHE 314 are recommended.
A study of the principles of physiology, emphasizing metabolic processes common to many organisms. Three hours lecture and 3 hours laboratory/week.

317. Developmental Biology (4) F
Prerequisite: BIO 112 and 8 hours applicable to the BIO major. BIO 210 is recommended.
A study of development in organisms, including both classical, descriptive embryology and contemporary investigations of processes involved in morphogenesis and differentiation.
318. Ecology (4) S
Prerequisite: BIO 112 and 8 hours applicable to the BIO major.
A study of the interactions between organisms and their biological and physical environments. Three hours lecture and 3 hours laboratory/week.

320. Immunology (4) F
Prerequisite: BIO 112, 211, and 4 hours applicable to the BIO major; CHE 314/324 is recommended.
Structure and function of the immune system and some diseases related to the immune system. Laboratory will focus on a group research project. Three hours lecture and 3 hours laboratory/week.

321. Ecotoxicology (4) As Needed
Prerequisites: BIO 112, 8 hours applicable to the BIO major and CHE 111-2.
A comprehensive overview of the ecological consequences of environmental pollution, the effects of toxic substances on the ecosystem as a whole and on individuals within that ecosystem, and the methodology of assessing pollutant damage. Three hours lecture and 3 hours laboratory/week.

322. Human Gross Anatomy (3) S
Prerequisite: BIO 221 and 222 or 210.
Cadaver anatomy and dissection for nursing, preprofessional, and physical education students to enhance understanding of anatomy and prepare for work on living humans.

323. Cell Biology (4) S
Prerequisites: BIO 112 and 8 hours applicable to the BIO major.
A study of biological systems at the cellular and subcellular levels emphasizing functional aspects such as protein procession and sorting, membrane systems, energy generation in mitochondria and chloroplasts, and cell signaling. Three hours lecture and three hours laboratory/week.

324. Medical Parasitology (4) W—Even Years
Prerequisite: BIO 112 and 8 hours applicable to the BIO major.
Parasitology is a course that will apply information learned in a variety of Biology courses to the study of parasites and parasitic diseases. Specifically, this course will address the ecology, epidemiology and biochemistry of parasites and diseases caused by parasites. The laboratory will focus on the identification of important parasite groups and methods for host examination and diagnosis. Three hours of lecture and 3 hours laboratory/week.

325. Molecular Biology (4) F
Prerequisites: BIO 112, 211 and 4 hours applicable to the BIO major; CHE 314/324 is recommended.
Basic principles of molecular biology focusing on recombinant DNA methods as applied to a variety of biological questions. Students will learn basic research laboratory skills through a wide range of methods from gel electrophoresis to subcloning. Three hours lecture and three hours laboratory/week.

335. Conservation Biology (3) S—Even Years
Prerequisites: BIO 112, 200, and 4 hours applicable to the BIO major.
A study of the principles of conservation and wildlife management. Examines the ecology of species of interest and the habitat manipulation techniques used in the conservation of such organisms.

336. Ecology and Conservation of the Vertebrates (4) F—Even Years
Prerequisite: BIO 112, 210 and 4 hours applicable to the BIO major.
Study of the natural history and ecology of North American vertebrates, including fish, amphibians, reptiles, birds and mammals. Conservation concerns of particular vertebrates will be examined. Three hours lecture and 3 hours laboratory/week.

337. Taxonomy of the Vascular Plants (4) S–Odd Years
Prerequisite: BIO 112, 215 and 4 hours applicable to the BIO major.
A study of the vascular plants of the eastern United States, focusing on the common herbaceous plants, vines, shrubs, and trees and their identification in the field. Field trips required. Two hours lecture and 6 hours laboratory/week.

355. Environmental Ethics (3) S—Odd Years
Prerequisite: BIO 112 and 8 hours applicable to the BIO major.
This course will examine the relationship between humans and their natural environment; addressing the problems confronting the necessity to balance conservation with human need and the use of natural resources. Topics to be explored include an ethical consideration for the urban environment and of wilderness preservation, the interplay of local and global environmental ethics, and the ethics of sustainability. An overarching view of the scope of historical and modern bioethical issues will also enter into our discussions.

356. Marine Biology (3) W-Even Years
Pre-requisite: BIO 112 and 8 hours applicable to the BIO major.
Co-requisite: BIO 357
Lectures and labs on the nature of life in the ocean and in coastal environments. The first part of the semester is spent at Union University facilities and the second part is spent exploring the coastal environments of South Georgia and the Atlantic Coast of Florida. There is an extra fee associated with this class.

357. Ornithology (3) W-Even Years
Pre-requisite: BIO 112 and 8 hours applicable to the BIO major.
Co-requisite: BIO 356
Focuses on the identification and ecology of birds in the eastern United States. Multiple field trips are required, culminating with a 10-day trip to South Georgia and Florida. There is an extra fee associated with this class.
358. Plant Physiology (4) S-Even Years  
Pre-requisites: BIO 112, 215, 4 additional hours applicable to the BIO major, and CHE 111 (CHE 112 recommended)  
Study of physiological factors influencing the chemical and structural composition of plant absorption and utilization of water and minerals; photosynthesis, translocation, respiration, nitrogen metabolism; and growth and development.  
Physiology is the study of how plants function, including resource acquisition, energy creation and use, resource allocation, life cycle, and stress response. Three hours lecture and three hours laboratory/week.

359. Dendrology (4) F-Even Years  
Pre-requisites: BIO 112, 215, and 4 additional hours applicable to the BIO major.  
This course will focus on the identification and management of trees, focusing on forest ecology and silvicultural practices.  
The laboratory will include field trips that will focus on tree identification. Three hours lecture and three hours laboratory/week.

360. Plant-Insect Interactions (4) F-Odd Years  
Pre-requisites: BIO 112, 215 and 4 hours applicable to the BIO major. BIO 210 is strongly recommended.  
This course is designed to introduce the student to insects and their relationships with plants. Lecture will cover insect ecology, taxonomy, and biology, as well as plant strategies to overcome insect damage and mutualism between plants and insects. The laboratory and field portions of the class will involve insect collection and identification, along with the evaluation of positive and negative impacts of insects on plants. Three hours lecture and 3 hours laboratory/week.

415. Collaborative Research Experience (2) S  
Prerequisite: Junior Standing, 20 hours applicable to the BIO major, minimum BIO GPA 2.0.  
An introduction to the skills necessary to conduct scientific research in a group setting. Each group will develop a research question and submit research addressing that question. Students will attend all scheduled presentations. Course is not available by Audit.

425. Introduction to Research (1) F, S  
Pre-requisites: Junior Standing, 20 hours applicable to the BIO major, minimum BIO GPA of 2.0.  
An introduction to the skills necessary to conduct scientific research, prepare a manuscript and make a presentation at a scientific meeting. Each student will develop and submit a research proposal for approval. Students will attend all scheduled presentations. Course not available by Audit.

426. Research Experience I (1) F, S, Su, W  
Prerequisite: BIO 425 or 415, minimum BIO GPA of 2.0.  
Individual research in accordance with the proposal developed and approved in 425. Students will attend all scheduled presentations. Course is not available by Audit.  
Students may only take this course during Winter or Summer if the student is also registered for Experience II (428) for a Fall or Spring Semester.

428. Research Experience II (1) F, W, S, Su  
Prerequisite: BIO 425 and minimum BIO GPA of 2.0; Continuation of individual research initiated during BIO 426. Course is graded Pass/Fail and is not available for Audit.  
Students will attend all presentations in BIO 437.

437. Research Presentation (1) F, S  
Prerequisite: BIO 426, minimum BIO GPA of 2.0.  
Presentation of results of 426 as a publishable manuscript and oral presentation. Not available by audit.

498. Biology Seminar (1) F, S  
Prerequisite: 28 hours applicable to any BIO major, minimum BIO GPA of 2.0, and senior standing.  
Written and oral presentation of a library research paper and weekly discussions of current biological research. May be modified at the discretion of the department. Not available by Audit.

Course Offerings for Au Sable Institute of Environmental Studies

The following courses are taught only at AuSable Institute. In addition, other courses are taught at AuSable Institute. See their catalog for course descriptions of courses currently offered at www.ausable.org:

Land Resources (4)  
A systems-level perspective on land forms and ecosystems. Includes analysis and interpretation of field data, remote-sensing data derived from satellites and aircraft and geographic information systems (GIS), including field trips to and analysis of forests, wetlands, lakeshores, and rivers. Includes application to policy and land use planning.  
Prerequisite: one year of introductory science.

Applied Biodiversity Genetics (4)  
A field class introducing recent advances in molecular biology techniques, computation, and storage for applied ecological work. The ability to utilize these techniques is becoming more and more important to scientists for addressing fundamental questions in biology. This course will expose you to a broad range of techniques and concepts in molecular biology and phylogenetics. Emphasis is placed on the strengths and limitations of each method and its application to a wide range of organisms, including plants, animals, and microorganisms, as well as foundations for molecular applications to issues of environmental stewardship. Prerequisites: Two years of biology, one year of chemistry.
### Environmental Applications for Geographic Information Systems (4)
Theory and application of spatial analysis for applied social and ecological problem-solving. This course combines GPS field data collection; ArcGIS use for storage, processing, interpretation, and presentation of data; location and integration of existing source information; and remote sensing integration with GIS applications. The course is designed around an environmental project to apply GIS techniques for real-world problem-solving in protecting and restoring ecosystems.

### Restoration Ecology (4)
Ecological and theoretical foundations for ecosystem and biotic community restoration. This course develops ecological principles for ecosystem restoration and applies them to redeeming and restoring degraded and damaged ecosystems and endangered species. Field studies include analysis of restoration and rehabilitation work with the Kirtland Warbler, an officially designated wild river, coastal dunes, kettle-hole bogs, deforested lands, degraded residential and farming sites, and abandoned oil wells. A practical field laboratory is included in which techniques are applied to a specific site. Prerequisite: one year of biology and one course in ecology or field biology, or permission of professor.

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Notes</th>
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<tbody>
<tr>
<td>179-279-379-479</td>
<td>External Domestic Study Programs (1-3) As Needed</td>
<td>1-3</td>
<td>All courses and their applications must be defined and approved prior to registering.</td>
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<td>(Pass/Fail)</td>
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<td>(Pass/Fail)</td>
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<td>Lower-level group studies that do not appear in the regular departmental offerings.</td>
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<td>295-6-7</td>
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<td>395-6</td>
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<td>F or S</td>
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<td>Upper-level group studies that do not appear in the regular departmental offerings.</td>
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<td>397</td>
<td>Special Studies in Cell and Molecular Biology (3)</td>
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<td>F or S</td>
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<td>495-6-7</td>
<td>Independent Study (1-4)</td>
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<td>Individual research under the guidance of a faculty member(s).</td>
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