Faculty
Mark Bolyard (2006). Professor of Biology and Department Chair. B.A., Hanover College; Ph.D., University of North Carolina.

Jennifer Gruenke (2009). Professor of Biology and Director of the Center for Scientific Studies. B.S., Bryan College; Ph.D., University of Virginia.

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). Assistant Professor of Biology. B.S. and M.S., Southern Illinois University Edwardsville; Ph.D., Kansas State University.

Andy Madison (2002). Associate 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; additional study, Mississippi State University.

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

Elsie Y. Smith (1962). Associate Professor of Biology. B.S., Union University; M.S., University of Illinois; Additional study in Radiation Biology, University of Tennessee at Memphis.

Carol Weaver (1998). Professor of Biology. B.S., Union University; M.S., University of Missouri–St. Louis; Ph.D., St. Louis University.

Wayne Wofford (1987). Professor of Biology. B.S., Union University; M.S. and Ph.D., Texas A&M University.

Faith A. Zamamiri-Davis (2011). Assistant Professor of Biology. B.S., Westmont College; Ph.D., Pennsylvania State University.

Instructional Staff

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


Staff

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 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.

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

Upper-level students may enroll in courses by cooperative agreement with the Gulf Coast Research Laboratory and the Au Sable Institute of Environmental Studies. For information, see the Department Chair.

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 10 hours of this requirement. The remaining hours may be selected in consultation with your assigned faculty advisor.
I. Major in Biology—42-48 hours
   A. General Biology Concentration/Independent Research Option—42-44 hours
      1. BIO 112, 302, 425, 426, 437, and 498—8 hours
      2. BIO 211, 213, 214, 215, and 315—20 hours
      3. Four 300-level BIO courses—14 hours minimum
   B. General Biology Concentration/Collaborative Research Option—45-47 hours
      1. BIO 112, 302, 415, and 498—7 hours
      2. BIO 211, 213, 214, 215, 304 and 315—24 hours
      3. Four 300-level BIO courses—14 hours minimum
   C. Zoology Concentration/Independent Research Option—43-44 hours
      1. BIO 112, 302, 425, 426, 437, and 498—8 hours
      2. BIO 213, 214; 200 or 211—12 hours
      3. BIO 316, five -300 level BIO excluding 307, 309, 322 and 337—23 hours minimum
   D. Zoology Concentration/Collaborative Research Option—47-48 hours
      1. BIO 112, 302, 415, and 498—7 hours
      2. BIO 213, 214; 200 or 211; 304—16 hours
      3. BIO 316, five 300-level BIO excluding 307, 309, 322 and 337—23 hours minimum

II. Major in Cell and Molecular Biology—72–76 hours
   A. Independent Research Option—72–73 hours
      1. BIO 112, 211; 214 or 215—12 hours
      2. BIO 302, 315, 323, 325, 397, 498—16 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 and 437—3 hours
      7. No minor is required
   B. Collaborative Research Option—75–76 hours
      1. BIO 112, 211; 214 or 215—12 hours
      2. BIO 302, 315, 323, 325, 397, 498—16 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 and 415—6 hours
      7. No minor is required

III. Major in Conservation Biology—66-68 hours
   A. Prerequisites or Corequisites: CHE 111; 2 MAT courses 111 or higher
   B. BIO 112, 200, 213, 214, 215; PHY 112—24 hours
   C. BIO 302, 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
      Three of BIO 312, 315, 316, 321, 324, 336, 356, 357—10-12 hours
   F. No minor is required

IV. Teacher Licensure in Biology (Grades 7-12)
   A. Major requirements as shown above with General Biology Concentration (I.A.or B) to include 316 (or 307 and 309) and 318.
   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: EDU 150, 250, 326, 418, 433; PSY 213, 318; SE 225
   D. Completion of applicable portions of the Praxis II.
   E. For additional information, see the Assistant Dean for Teacher Education and Accreditation.

V. Minor in Biology—21–24 hours
   A. BIO 112
   B. Two 200-level BIO courses—7–8 hours
   C. Three 300-level BIO courses—10–12 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, a 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 all Biology majors must complete prior to graduation.

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
Biologists 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 a 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)

<table>
<thead>
<tr>
<th>Course Description</th>
<th>Credits</th>
<th>Prerequisites</th>
</tr>
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<tbody>
<tr>
<td>100. Survey of Biological Concepts (4) F, W, S</td>
<td>4</td>
<td>BIO 100 or 112.</td>
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<tr>
<td>110. Global Biology (4) S</td>
<td>4</td>
<td></td>
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<tr>
<td>112. Principles of Biology (4) F, S</td>
<td>4</td>
<td></td>
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<tr>
<td>200. Wildlife Biology (4) S</td>
<td>4</td>
<td>BIO 100 or 112.</td>
</tr>
<tr>
<td>201. Survey of Microbiology (4) F, S</td>
<td>4</td>
<td>BIO 221 and BIO 222.</td>
</tr>
<tr>
<td>211. Microbiology (4) F, S</td>
<td>4</td>
<td>BIO 112 and CHE 111.</td>
</tr>
<tr>
<td>213. Invertebrate Zoology (4) F</td>
<td>4</td>
<td>BIO 112.</td>
</tr>
<tr>
<td>215. Botany (4) F</td>
<td>4</td>
<td>BIO 112 and CHE 111.</td>
</tr>
</tbody>
</table>
221. Human Anatomy and Physiology (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, cardiovascular, lymphatic, skeletal, and muscular. Three hours lecture and 2 hours laboratory/week. No credit toward BIO major/minor.

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

302. Seminar Attendance (0) F, S
Prerequisites: 12 BIO hours, graded on a Pass/Fail basis. Students are required to attend all seminar presentations made by students enrolled in BIO 498 during the semester. Must be taken before enrolling in BIO 498.

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, 214 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) W—Odd Years
Prerequisite: BIO 112, 214, 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 214 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 214 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—Odd Years
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 211, CHE 314, and 8 additional BIO hours.
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) W—Even Years
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 with that ecosystem, and the methodology of assessing pollutant damage. Three hours lecture and 3 hours laboratory/week.

322. Human Gross Anatomy (3) Su
Prerequisite: BIO 221 and 222 or 214.
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 211 and 8 additional BIO hours applicable to the major; CHE 314 and 324.
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.

326. Ecology and Conservation of the Vertebrates (4) F—Even Years
Prerequisite: BIO 112, 214 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.

327. 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.

328. Immunology (4) F—Odd Years
Prerequisite: BIO 112, 200, and 4 additional hours applicable to the BIO major.
Studies 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.
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, 213, and 215
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; Corequisite: BIO 437.
Continuation of individual research initiated during BIO 426. Course is graded Pass/Fail and is not available for Audit.

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.

179-279-379-479. External Domestic Study Programs (1-3) As Needed
All courses and their applications must be defined and approved prior to registering.

180-280-380-480. Study Abroad Programs (1-4)
All courses and their application must be defined and approved prior to travel.

195-6-7. Special Studies (1-4)
Lower-level group studies that do not appear in the regular departmental offerings.

395-6. Special Studies (1-4)
Upper-level group studies that do not appear in the regular departmental offerings.

397. Special Studies in Cell and Molecular Biology (3) S
Upper-level group studies that do not appear in the regular departmental offerings.

495-6-7. Independent Study (1-4)
Individual research under the guidance of a faculty member(s).