Biology

Degrees Offered

• Master of Science
• Doctor of Philosophy

Nature of the Program

The Department of Biology's graduate program is dedicated to scholarship in academics and research. The objectives of the program are to empower students through the following:

1. Recognize important biological problems
2. Design, execute, and analyze experiments aimed at solving important problems
3. Communicate their findings in oral and written form
4. Foster an awareness of the social and political issues of the day related to biology
5. Create a desire to continue independent study after graduation

The Department of Biology offers graduate courses and research that lead to M.S. and Ph.D. degrees in biology. The focal areas of research in the graduate program are: plant sciences, biochemistry and molecular biology, bioinformatics, genetics, genomics and evolutionary biology, biology education, cell and developmental biology, ecology, forensic biology, neuroanatomy and neurophysiology and behavioral neurobiology.

FACULTY

CHAIRPERSON

• Richard B. Thomas - Ph.D. (Clemson University)

ASSOCIATE CHAIR

• Jennifer Hawkins - Ph.D. (University of Iowa)
  Associate Chair for Graduate Studies
• Stephanie Young - Ph.D. (West Virginia University)
  Associate Chair for Undergraduate Studies

PROFESSORS

• Ashok Bidwai - Ph.D. (Utah State University)
  Biochemical and Molecular Genetic Analysis of Protein Kinases
• Jonathan R. Cumming - Ph.D. (Cornell University)
  Plant Physiology, Rhizosphere Ecology
• Kevin C. Daly - Ph.D. (University of Arizona)
  Sensory motor integration and behavior
• Stephen DiFazio - Ph.D. (Oregon State University)
  Plant Genomics, Ecological Genetics
• James B. McGraw - Ph.D. (Duke University)
  Plant Ecology, Plant Population Biology, Conservation Biology
• William Peterjohn - Ph.D. (Duke University)
  Biogeochemistry, Ecosystem Ecology
• Rita V.M. Rio - Ph.D. (Yale University)
  Symbioses
• Richard B. Thomas - Ph.D. (Clemson University)
  Physiological Plant Ecology, Global Environmental Change

ASSOCIATE PROFESSOR

• Clifton P. Bishop - Ph.D. (University of Virginia)
  Developmental and Molecular Biology of Drosophila
• Andrew M. Dacks - Ph.D. (University of Arizona)
  Neural Basis of Behavior States, Nervous System Evolution
• Sarah M. Farris - Ph.D. (University of Illinois)
Nervous System Evolution and Development, Entomology
• Jennifer Hawkins - Ph.D. (University of Iowa)
  Plant comparative genomics, Molecular evolution.

ASSISTANT PROFESSOR
• Craig Barrett - PhD The Ohio State University
  Plant evolutionary Biology
• Sadie Bergeron - Ph.D. (University of Massachusetts - Amherst)
  Developmental Neuroscience
• Edward Brzostek - Ph.D. (Boston University)
  Forest ecology, ecosystem modeling
• Timothy Driscoll - Ph.D. (Virginia Tech)
  Bioinformatics, microbial metagenomics
• Jennifer Gallagher - Ph.D. (Yale University)
  Molecular Mechanisms of Genetic Variation
• Gary Marsat - Ph.D. (McGill University)
  Sensory Processing of Communication Signals; Systems Neuroscience and Computational Neuroscience

CLINICAL ASSOCIATE PROFESSOR
• Donna Ford-Werntz - Ph.D. (Washington University, St. Louis)
  Plant Systematics

CLINICAL ASSISTANT PROFESSOR
• Zachariah Fowler - Ph.D (West Virginia University)
  Forest ecology

Admissions

MASTER OF SCIENCE
Applicants for the MS in Biology should have earned a bachelor's degree with a cumulative GPA of 3.0 or higher, and should possess an adequate background in science and mathematics. A fortieth percentile ranking or higher for the verbal, quantitative, and analytical sections of the GRE is expected. Applicants should submit a thoughtful essay that demonstrates their strong interest in scientific research, and addresses the match between their research interests and those of the faculty. Application materials should include three supportive letters of recommendation from people (typically faculty) who are familiar with the applicant's abilities. International students should have a TOEFL score greater than 250 for the computer-based exam, greater than 600-603 on the paper-based test or greater than 100 for the internet-based test.

DOCTOR OF PHILOSOPHY
The program for the degree of doctor of philosophy reflects a flexible, research-oriented approach geared to develop the interests, capabilities, and potentials of mature students. Applicants must have met all the entrance requirements listed above for the master of science program, but a fiftieth percentile ranking or higher in the verbal quantitative and analytical section of the Graduate Record Examination is expected.

Acceptance into the Ph.D. or the M.S. program is by vote of the Graduate Committee of the Department of Biology. This committee ensures that all entrance requirements are met or that provisions have been made to remedy the deficiencies, and that facilities and personnel are adequate to support the program to a successful conclusion. If after reviewing all the application materials there is no faculty member willing to serve as the applicant's academic advisor, then the potential student will not be accepted into the program.

Master of Science

Degree Requirements
• Credit Hours: Students are required to complete a minimum of 33 graduate credit hours in Biology at the 400 level or above. Only 12 credit of coursework at the 400 level may be used.

• Grade Point Average: Students must earn a minimum overall GPA of a 2.75, and a minimum GPA of 3.00 in coursework applied to their graduate program.

• Program of Study: The Program of Study is a written document consisting of two parts: 1) an outline of past, present, and future course work for a student's graduate career; and 2) a written plan of a student's proposed research project. A written Program of Study must be approved by the student's Masters Advisory Committee.
• **Graduation Requirement:** Students must write and defend a Master's Thesis. A final oral defense is administered after an original, written thesis has been submitted to and approved by the Advisory Committee. For complete guidelines, please see the graduate student handbook at http://biology.wvu.edu/students/graduate-students/forms-and-policies.

• **Progress toward completion:** Year 1: Formation of an Advisory Committee and complete the Program of Study. Year 2: submit written Thesis and perform an oral defense. At the beginning of each academic year, students are evaluated by the department to insure timely progress in their degree programs.

• **Additional Requirements:** Students must have a program of study formulated and approved by an Advisory Committee at the end of the second semester of entering the M.S. program. The program of study outlines the coursework to be taken in support of the proposed research. The advisory committee ensures that all of the Department of Biology, Eberly College of Arts and Sciences, and University requirements are met during the course of the student’s program of study.

**Curriculum Requirements**

Minimum GPA of 3.0 is required.

| Biology Coursework at the 400 level or above. | 18 |
| Research | 6 |
| BIOL 797 | Research (Repeated) |
| Graduate Professional Development Seminars | 6 |
| BIOL 796 | Graduate Seminar (Repeated each Fall) |
| BMS 700 | Scientific Integrity |
| Professional development courses (2 cr. min) selected with the graduate adviser. | |
| Departmental Seminars | 3 |
| BIOL 794 | Seminar (Departmental Colloquium) |
| Total Hours | 33 |

* Excludes BIOL 486, BIOL 490, BIOL 796, BIOL 797, BIOL 799

**Doctor of Philosophy**

**Degree Requirements**

• **Credit Hours:** Students are required to complete a minimum of 37 graduate credit hours in Biology and/or related areas at the 400 level or above.

• **Grade Point Average:** Students must earn a minimum cumulative GPA of 2.75, and a GPA of 3.00 in all coursework applied to their graduate program.

• **Program of Study:** The Program of Study is a written document consisting of two parts: 1) an outline of past, present, and future course work for a student’s graduate career; and 2) a written plan of a student’s proposed research project. A written Program of Study must be approved by a Ph.D. student’s Advisory Committee.

• **Comprehensive Examination:** The Comprehensive or Preliminary Exam has two parts, the written and an oral. The Written Examination determines whether students understand various biological processes and abstractions covered in the readings provided by the student’s committee members, and is able to solve problems based on these concepts. The Oral Qualifying Examination tests students' understanding of classic papers and fundamental concepts in their area of research emphasis. Mastery of this basic knowledge indicates a readiness to proceed with original research.

• **Proposal Exam:** The Proposal Exam has a written and oral component and is used to determine whether students can formulate a coherent, convincing research plan.

• **Dissertation:** The dissertation must demonstrate an ability to carry out independent research. Chapters of the dissertation should meet the standards required for publications in a reputable biological journal. Ph.D. Candidates must present a formal Departmental seminar on their research topic as part of their graduation requirements.

• **Progress toward completion:** At the beginning of each academic year, students are evaluated by the department to insure timely progress in their degree programs. Students must adhere to the following timeline:
  • Year 1: Form a committee and present the program of study.
  • Year 2: Complete the Comprehensive and Proposal exams.
• Year 3: Conduct dissertation research.
• Year 4: Submit Written Dissertation and present Oral Dissertation Defense.

• Additional Requirements:
  • A minimum of 2 semesters of Teaching Practicum
  • All Ph.D. students must register for, and attend, the graduate seminar (BIOL 796) every Fall semester while they are in residence. A maximum of 3 hours of BIOL 796 can be counted towards the 37-hour coursework requirement.
  • All Ph.D. students are required to register for and attend BMS 700 Scientific Integrity (1 credit hour) or like course and a minimum of 2 additional credit hours of professional development
  • Graduate students are expected to attend Departmental Seminars (BIOL 794 Seminar) in order to become acquainted with research being conducted within and outside the department. All Ph.D. students are required to register for and attend the Departmental Seminars given during at least five (5) semesters of their degree program.

For complete guidelines, please see the graduate student handbook at https://biology.wvu.edu/students/graduate-students/forms-and-policies.

### Curriculum Requirements

Minimum GPA of 3.0 is required.

<table>
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<tr>
<th>Requirement</th>
<th>Hours</th>
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<tbody>
<tr>
<td>Biology Coursework at the 400 level or above</td>
<td>18</td>
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<td>6</td>
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<tr>
<td>BIOL 797 Research (Repeated)</td>
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<tr>
<td>Departmental Seminars</td>
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<tr>
<td>BIOL 794 Seminar</td>
<td></td>
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<tr>
<td>Teaching Practicum</td>
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<tr>
<td>BIOL 790 Teaching Practicum</td>
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<tr>
<td><strong>Total Hours</strong></td>
<td><strong>37</strong></td>
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* Excludes BIOL 481, BIOL 486, BIOL 490, BIOL 796, BIOL 797, BIOL 799

### Degree Progress

**MASTER’S BENCHMARKS**

• **Progress toward completion:** Year 1: Formation of an Advisory Committee and complete the Program of Study. Year 2: submit written Thesis and perform an oral defense. At the beginning of each academic year, students are evaluated by the department to insure timely progress in their degree programs.

• **Additional Requirements:** Students must have a program of study formulated and approved by an Advisory Committee at the end of the second semester of entering the M.S. program. The program of study outlines the coursework to be taken in support of the proposed research. The advisory committee ensures that all of the Department of Biology, Eberly College of Arts and Sciences, and University requirements are met during the course of the student’s program of study.

**DOCTORAL BENCHMARKS**

At the beginning of each academic year, students are evaluated by the department to insure timely progress in their degree programs. Students must adhere to the following timeline:

• Year 1: Form a committee and present the program of study.
• Year 2: Complete the Comprehensive and Proposal exams.
• Year 3: Conduct dissertation research.
• Year 4: Submit Written Dissertation and present Oral Dissertation Defense.
Major Learning Outcomes

BIOLOGY

The graduate programs in the Department of Biology provide rigorous training in several fields of biology. The central mission of our graduate program is to train the next generation of Biologists for careers in the field, laboratory and several other professional settings that rely on deep expertise in the biological sciences.

Students earning a M.S. or Ph.D. in Biology will be able to:

- Explain general biological principles as well as those specific to their research sub-discipline.
- Comprehend and critically evaluate literature published within their field.
- Independently design and execute experiments and provide quality data, analysis and interpretation, critical to progress in their research area.
- Effectively communicate their research in oral and written formats, including the ability to author manuscripts suitable for publication in peer reviewed scientific journals.
- Understand the role of ethics in personal and professional behavior.
- Learn and apply best laboratory practices (i.e. proper laboratory safety procedures and experimental protocols).

COURSES

BIOL 548. Introduction to Cellular and Molecular Neuroscience. 3 Hours.
PR: Consent. An advanced course that synthesizes topics such as gene regulation, cell signaling and neural network structure into a comprehensive picture of the cellular basis of nervous system function.

BIOL 576. Computational Neuroscience. 4 Hours.
PR: Consent. This course focuses on the tools and concepts used to probe and characterize the dynamics of neurons, neural networks and neural coding mechanisms. Lectures introducing concepts and discussion sessions of the current research literature complement computer laboratories where the student learns programming skills, analytical tools and neural modeling methods used in computational neuroscience research.

BIOL 577. Central Nervous System Evolution and Development. 3 Hours.
PR: BIOL 219 and BIOL 348 or equivalent. Origin and evolution of the animal nervous system, focusing on developmental and genetic mechanisms underlying structural modifications that serve as the basis for the evolution of behavioral repertoires.

BIOL 579. Principles of Systems Neuroscience. 3 Hours.
PR: BIOL 348 or Consent. Fundamental principles of nervous system organization with an emphasis on interactions between neurons and the consequences for behavior. There will be a focus on recent advances in our understanding of each organizational principle.

BIOL 591A. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

BIOL 593A-Z. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

BIOL 611. Epigenetics. 3 Hours.
Explores the molecular mechanisms, phenotypic phenomena and current application of epigenetics and the study of how genetic information is regulated and maintained. Students may not earn credit for both BIOL 415 and BIOL 611.

BIOL 615. Microbial Symbiosis. 3 Hours.
Molecular techniques used towards identifying the composition, structure and functions of microbial communities in various ecological contexts will be discussed. An understanding of the significance of microbial symbioses towards ecological and health processes will be developed. (Also listed as BIOL 456.).

BIOL 620. Genomics. 3 Hours.
PR: BIOL 219 or consent. Advanced elective examining biology and evolution on a genome-wide scale. Topics include fields of study and methods of DNA sequence acquisition and annotation, including exploration of the human genome and its contribution to disease discovery.

BIOL 651. Evolution of Infectious Diseases. 3 Hours.
The application of phylogenetics, microbiology, immunology, and epidemiology towards comprehending the evolution of infectious diseases. Students will develop a fundamental understanding of the significance of evolution and ecology towards infectious disease emergence and control.

BIOL 658. Systems Biology. 3 Hours.
PR: Consent. Systems Biology is an approach to understanding the dynamics of biological processes by integrating and assessing changes in and across networks. Technologies driving this approach include genome-wide sequencing of DNA and RNA, measurements of genome-protein interactions, and measurement of proteome levels and post-translational protein modifications.

BIOL 690. Teaching Practicum. 1-3 Hours.
PR: Consent. Supervised practice in college teaching of biology. Note: This course is intended to insure that graduate assistants are adequately prepared and supervised when they are given college teaching responsibility. It also provides a mechanism for students not on assistantships to gain teaching experience. (Grading will be S/U.).
BIOL 691A. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

BIOL 692. Directed Study. 1-6 Hours.
Directed study, reading, and/or research.

BIOL 693A-Z. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

BIOL 695. Independent Study. 1-6 Hours.
Faculty supervised study of topics not available through regular course offerings.

BIOL 697. Research. 1-15 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U).

BIOL 698. Thesis or Dissertation. 1-6 Hours.
PR: Consent. This is an optional course for programs that wish to provide formal supervision during the writing of student reports (698), or dissertations (798). Grading is normal.

BIOL 711. Molecular Basis of Virology. 3 Hours.
PR: BIOL 219 or equivalent or consent. Lectures on bacterial, animal, and plant viruses; their structure, replication, and interaction with host cells. Discussion of the contributions virology has made to the understanding of molecular mechanisms in biology.

BIOL 714. Advances in Protein Science. 3 Hours.
An examination of proteins from a structural, functional, and biological perspective. Discussions will include biochemical, genetic, phylogenetic, structural, computational, and proteomic approaches.

BIOL 715. Extracellular Matrix in Cell Signaling. 3 Hours.
The course emphasizes the fundamental role that the extracellular matrix plays in the process of morphogenesis, differentiation, development and maintenance of the differentiated state.

BIOL 737. Developmental Biology. 3 Hours.
PR: BIOL 336 or equiv., organic chemistry or biochemistry, or consent. The molecular and cellular basis of differentiation and morphogenesis. (Offered in fall of odd years.)

BIOL 738. Fundamentals of Gerontology. 3 Hours.
PR: MDS 212 or consent. An advanced multidisciplinary examination of current research in biological, psychological, and sociological issues of human aging and the ways in which these impinge on the individual to create both problems and new opportunities. (Also listed as PSYC 524.)

BIOL 752. Physiological Plant Ecology. 3 Hours.
PR: BIOL 350 and consent. Advanced studies on the interactions between plants and their environment focusing on whole-plant carbon exchange, water relations, and nutrient uptake, with reference to specific biomes.

BIOL 753. Water and Nutrient Relations of Plants. 3 Hours.
PR: BIOL 350 and consent. Advanced studies on water and nutrient acquisition, use, and transformation in plants with focus on plant-soil interactions, symbiotic associations, and acclimation and adaption mechanisms operating in plants.

BIOL 754. Plant Growth and Development. 3 Hours.
PR: BIOL 350 and consent. Advanced studies of the mechanisms and patterns underlying growth and development, with emphasis on hormonal regulation and molecular processes in plants.

BIOL 761. Ecosystem Dynamics. 3 Hours.
PR: Consent. A survey of our current understanding of the biogeochemistry that occurs at and near the surface of the Earth. Emphasis is placed on the biogeochemical cycles of carbon, nitrogen, phosphorus, and sulfur. The origin and dynamics of the atmosphere, lithosphere and hydrosphere are also considered. (Offered in even-numbered years).

BIOL 762. Plant Population Biology. 3 Hours.
PR: Graduate status or undergraduate status with the completion of BIOL 221 and the instructor's permit. Plant population biology examines the interplay of ecological theory and the real world of experimental ecology of natural populations using a case study approach. Each student will research a current topic in greater depth.

BIOL 790. Teaching Practicum. 1-3 Hours.
PR: Consent. Supervised practice in college teaching of biology. Note: This course is intended to insure that graduate assistants are adequately prepared and supervised when they are given college teaching responsibility. It will also present a mechanism for students not on assistantships to gain teaching experience. (Grading will be S/U).

BIOL 791A. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 792A. Directed Study. 1-6 Hours.
Directed study, reading, and/or research.
BIOL 793A-Z. Special Topics. 6 Hours.
A study of contemporary topics selected from recent developments in the field.

BIOL 794A-Z. Seminar. 1-6 Hours.
Seminars arranged for advanced graduate students.

BIOL 795. Independent Study. 1-9 Hours.
Faculty supervised study of topics not available through regular course offerings.

BIOL 796. Graduate Seminar. 1 Hour.
PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his or her program.

BIOL 797. Research. 1-15 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper, or equivalent scholarly project, or a dissertation. (Grading may be S/U.)

BIOL 798. Thesis or Dissertation. 1-6 Hours.
PR: Consent. This is an optional course for programs that wish to provide formal supervision during the writing of student reports (698), or dissertations (798). Grading is normal.

BIOL 799. Graduate Colloquium. 1-6 Hours.
PR: Consent. For graduate students not seeking coursework credit but who wish to meet residency requirements, use of the University's facilities, and participate in its academic and cultural programs. Note: Graduate students who are not actively involved in coursework or research are entitled, through enrollment in their department's 699/799 Graduate Colloquium to consult with graduate faculty, participate in both formal and informal academic activities sponsored by their program, and retain all of the rights and privileges of duly enrolled students. Grading is P/F; colloquium credit may not be counted against credit requirements for masters programs. Registration for one credit of 699/799 graduate colloquium satisfies the University requirement of registration in the semester in which graduation occurs.

BIOL 930. Professional Development. 1-6 Hours.
Professional development courses provide skill renewal or enhancement in a professional field or content area (e.g., education, community health, geology.) These tuition-waived continuing education courses are graded on a pass or fail grading scale and do not apply as graduate credit toward a degree program.