Biology

Degrees Offered

- Bachelor of Arts
- Bachelor of Science

Areas of Emphasis Offered

- Cellular and Molecular Biology
- Neuroscience
- Genomics
- Ecology and Environmental Biology

Nature of the Program

The Department of Biology offers two degree programs: the bachelor of science and the bachelor of arts in biology. These two programs are structured to meet the foundational needs of all students who are interested in a career in the broad area of the life sciences. The two programs are similar during the first two years. They differ primarily in their language requirements and in their Biology requirements. A pre-medical track is available in either degree program. Please consult with your academic advisor about track options.

The undergraduate programs in biology provide excellent preparation for students planning to apply to graduate programs in the biological sciences or to professional schools and programs including medical, osteopathic, dental, physical or occupational therapy, optometry, pharmacy, veterinary medicine, physician assistant, and chiropractic. A degree in biology prepares students for a wide range of careers in the biological sciences including medicine, biotechnology, genetics, forensics, ecology, environmental biology, and other biologically-related technical fields in government and private industry. With appropriate electives, a student with a degree in biology may also choose to enter the fields of law, journalism, education, business, health care administration, pharmaceutical sales, or work for a variety of federal agencies.

After completing an initial four-semester core sequence in the biological sciences, students in the biology B.A. program may choose to specialize in courses from four major areas of biology: cellular and molecular biology, organismal biology, ecology and evolution, or integrative biology. Those students pursuing the B.S. degree in biology are required to take at least one course from each of the major areas of biology to ensure an advanced, broad-based knowledge of biology.

Regardless of the degree program chosen, students will experience a wide variety of classroom environments from large lecture sections to small group discussions and intensive laboratory-oriented courses. Laboratory courses include topics such as comparative anatomy, molecular genetics, recombinant DNA technology, plant ecology, and plant physiology as well as many other laboratory experiences across the biological disciplines.

Students who earn a degree in the Eberly College of Arts and Sciences must complete the University requirements, the College requirements for their specific degree program, and their major requirements.

Minors

All students have the possibility of earning one or more minors; follow link for a list of all available minors and their requirements. Please note that students may not earn a minor in their major field.

Certificate of Global Engagement

Students in the Eberly College, regardless of their major, can earn a Certificate of Global Engagement. Completion of the Certificate demonstrates the student’s knowledge of diverse cultures, as well as the ability to communicate and interact effectively with people of different cultural backgrounds. Students will be required to apply their knowledge of contemporary issues and global social contexts to their course work and their broader citizenship. For details regarding Certificate requirements, please visit the Eberly College page.

FACULTY

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

ASSOCIATE CHAIR
- Jennifer Hawkins - Ph.D. (University of Iowa
  Plant comparative genomics, Molecular evolution.)
• Stephanie T. Young - Ph.D. (West Virginia University)
  Associate Chair for Undergraduate Studies

PROFESSORS
• Ashok P. Bidwai - Ph.D. (University of Utah)
  Molecular genetic analysis of protein kinase, CK2 in Drosophila
• Jonathan R. Cumming - Ph.D. (Cornell University)
  Environmental plant physiology, Ecophysiology of root-mycorrhizal-soil interactions, Urban ecology
• Steven DiFazio - Ph.D. (Oregon State University)
  Plant genomics, Molecular ecology, Plant population genetics, Biotechnology risk assessment
• William T. Peterjohn - Ph.D. (Duke University)
  Ecosystem ecology: Effects of global change on ecosystem dynamics, Nitrogen cycling in natural ecosystems.
• Rita V.M. Rio - Ph.D. (Yale University)
  Symbioses
• Richard B. Thomas - Ph.D. (Clemson University)
  Chair. Physiological plant ecology, Forest ecology, Global climate change

ASSOCIATE PROFESSORS
• Clifton P. Bishop - Ph.D. (University of Virginia)
  Molecular genetics, Developmental biology, Forensic biology
• Andrew Dacks - Ph.D. (University of Arizona)
  Neurobiology
• Kevin C. Daly - Ph.D. (University of Arizona)
  Sensory neurobiology, Neural coding, Brain-behavior interactions, Comparative psycho-biology
• Sarah M. Farris - Ph.D. (University of Illinois at Urbana-Champaign)
  Evolution and development of the insect brain, Neuroanatomy
• Donna Ford-Werntz - Ph.D. (Washington University/Missouri Botanical Garden)
  Plant systematics: Portulacaceae, West Virginia flora.
• Jennifer Hawkins - Ph.D. (University of Iowa)
  Plant comparative genomics, Molecular evolution.
• Dana Huebert Lima - Ph.D. (University of Wisconsin)
  Cellular and Molecular Biology, Epigenetics, Science Communication
• Jennifer Stueckle - Ph.D. (West Virginia University)
  Aquatic toxicology
• Stephanie T. Young - Ph.D. (West Virginia University)
  Molecular and Forensic biology

ASSISTANT PROFESSORS
• Craig Barrett - Ph.D. (Ohio State University)
  Plant evolutionary biology
• Kevin Barry - Ph.D. (University of Maryland)
  Conservation ecology
• Sadie Bergeron - Ph.D. (University of Massachusetts - Amherst)
  Developmental Neurobiology
• Edward Brzostek - Ph.D. (Boston University)
  Forest ecology, ecosystem modeling
• Timothy Driscoll - Ph.D. (Virginia Tech)
  Bioinformatics, microbial metagenomics
• Zachariah Fowler - Ph.D (West Virginia University)
  Forest ecology
• Jennifer Gallagher - Ph.D. (Yale University)
  Functional genomics of yeast
• Amaris Guardiola - Ph.D. (Duke University)
• Gary Marsat - Ph.D. (McGill University)
  Neurobiology
• John Navaratnam - Ph.D. (West Virginia University)
  Wetland ecology

SENIOR LECTURERS
• Susan Raylman - Ph.D. (North Carolina State University)
  Animal behavior
• Beth Thomas - M.S. (Clemson University)
  Invertebrate zoology

LECTURER
• Sydha Salihu - Ph.D. (Virginia Tech)

PROFESSORS EMERITI
• David F. Blaydes
• Roy B. Clarkson
• William E. Collins
• Dorothy C. Dunning
• Jorge Flores
• Philip E. Keeting
• Kevin Lee
• Joseph A. Marshall
• James B. McGraw
• Richard P. Sutter
• Leah A. Williams

Admissions
• First Time Freshmen with a Math ACT of 19, or a MATH SAT of 510 or above, or place in Math 124 or above are are admitted directly into the Biology major.
• Students moving from another WVU unit or Transfer students should meet the following requirements prior to being admitted into either the B.S. or the B.A. program:
  • completion BIOL 115, BIOL 116, BIOL 117, BIOL 118, CHEM 115, and CHEM 115L with a minimum grade of C- in each course and
  • have a 2.0 overall GPA.

Degree Progress
Students remain in the Biology major provided they meet the benchmark expectations listed below.

• B.A. Biology: By the end of their third semester into the major, students intending to graduate with a B.A. in Biology are expected to have completed BIOL 115, BIOL 116, BIOL 117, BIOL 118, CHEM 115, and CHEM 115L with a minimum grade of C- in each course and a 2.0 GPA overall. In addition, students must meet with their Biology adviser every semester. Students who do not meet their benchmarks may be removed from their major.
• B.S. Biology: By the end of their third semester into the major, students intending to graduate with a B.S. in Biology are expected to have completed BIOL 115, BIOL 116, BIOL 117, BIOL 118, CHEM 115, and CHEM 115L with a minimum grade of C- in each course and a 2.0 GPA overall. In addition, students must meet with their Biology adviser every semester. Students who do not meet their benchmarks may be removed from their major.

Major Learning Outcomes

BIOLOGY
Upon successful completion of the B.A. or B.S. degree, Biology majors will demonstrate competency in these areas:

1. Students will demonstrate competency in five content areas (listed below) at three biological levels - cellular/molecular, organismal/physiological, ecological and populations)
   • Information flow
   • Transformations of energy and matter
   • Structure-function relationships
• Evolution
• Systems and interactions

2. Students will be able to apply science process skills, including: reading the primary literature, developing a testable hypothesis, designing and experiment, collecting and analyzing data statistically.

3. Students will be able to communicate effectively with both fellow scientists and non-scientists in both written and oral forms.

4. Students will be able to synthesize knowledge and skills from across the curriculum and apply them to societal issues and problems.

Biology Minor

MINOR CODE - U075

Grades of C or higher must be earned in all courses applied to the minor.

Core Courses:

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<th>Course</th>
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<tr>
<td>BIOL 115 &amp; BIOL 116</td>
<td>Principles of Biology and Principles of Biology Laboratory</td>
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<tr>
<td>BIOL 117 &amp; BIOL 118</td>
<td>Introductory Physiology and Introductory Physiology Laboratory</td>
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<tr>
<td>BIOL 219 &amp; BIOL 220</td>
<td>The Living Cell and The Living Cell Laboratory</td>
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<tr>
<td>or BIOL 221</td>
<td>Ecology and Evolution</td>
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Upper Division Electives:

Select any BIOL courses at the 300- or 400-level courses, except BIOL 327, 386, 486, 490, 491, 494 and above.

Total Hours 20

COURSES

BIOL 101. General Biology. 3 Hours.
PR or CONC: BIOL 103. Introductory course in biology: cellular, organismal, and population genetics, including reproduction, growth and development, and evolution.

BIOL 102. General Biology. 3 Hours.
PR or CONC: BIOL 104. Introductory biology: energetics and physiology of cells, organisms, and populations, including regulation and control of multicellular organisms.

BIOL 103. General Biology Laboratory. 1 Hour.
PR or CONC: BIOL 101. Experiments in biology: genetics and evolution; reproduction, growth, and development of cells, organisms, and populations.

BIOL 104. General Biology Laboratory. 1 Hour.

BIOL 105. Environmental Biology. 3 Hours.
(Reserved for non-biology majors.) Population growth and human impacts on the environment, including ecosystem destruction, biological diversity, pollution, and global climate change are explored to obtain the concepts necessary to understand complex environmental issues of our time.

BIOL 106. Environmental Biology Laboratory. 1 Hour.
Field and laboratory exercises explore fundamental ecological concepts and environmental problems, such as biodiversity, pollution, and natural resource utilization.

BIOL 107. Biotechnology and Society. 3 Hours.
An overview of the use of biotechnology to solve agricultural, medical, and environmental problems. Bioethical concerns and sociocultural impacts of the use of the technologies will be discussed.

BIOL 108. Drugs and the Body. 3 Hours.
An overview of how common prescription, street and over-the-counter drugs alter body functions. How the body absorbs and metabolizes various drugs, drug interactions, and the biology of addiction will also be presented.

BIOL 109A. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109B. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.
BIOL 109C. 1-4 Hours.
(May be repeated for a max. of 6 Hr.) PR: Permission required. Topics and problems in contemporary biology. All topics and problems must be selected in consultation with the instructor.

BIOL 109D. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109E. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109F. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109G. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109H. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109I. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109J. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109K. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109L. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109M. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109N. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109O. 1-4 Hours.
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BIOL 109P. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109Q. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 109R. 1-4 Hours.
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BIOL 109S. 1-4 Hours.
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BIOL 109T. 1-4 Hours.
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BIOL 109U. 1-4 Hours.
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BIOL 109W. 1-4 Hours.
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BIOL 109X. 1-4 Hours.
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BIOL 109Y. 1-4 Hours.
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BIOL 109Z. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 113. Inquiry and Reasoning for Biologists. 1 Hour.
PR or CONC: BIOL 115 or consent. Problem-based and team-based learning approach using topics from BIOL 115 to help students build foundational knowledge in biological principles as well as develop and practice critical thinking skills essential for success as a science major.
BIOL 115. Principles of Biology. 3 Hours.
PR or CONC: BIOL 116. An introductory course presenting basic principles of modern biology. This course represents the first in a four-course, integrated sequence required of biology majors. Topics include ecology and evolution, organismal biology, and cellular/molecular biology.

BIOL 116. Principles of Biology Laboratory. 1 Hour.
PR or CONC: BIOL 115. BIOL 116 is the corequisite laboratory course associated with BIOL 115 lecture. This laboratory course emphasizes the proper understanding and use of the scientific method to design and perform biological experiments. Discipline-specific communication techniques, including scientific writing, are also emphasized.

BIOL 117. Introductory Physiology. 3 Hours.
PR: (BIOL 115 and BIOL 116) or (BIOL 101 and BIOL 102 and BIOL 103 and BIOL 104) and PR or CONC: BIOL 118. Continuation of BIOL 115. The diversity of reproductive, developmental, functional, and integrative mechanisms in plants and animals.

BIOL 118. Introductory Physiology Laboratory. 1 Hour.
PR: (BIOL 115 and BIOL 116) or (BIOL 101 and BIOL 102 and BIOL 103 and BIOL 104) and PR or CONC: BIOL 117. BIOL 118 is the corequisite laboratory course associated with BIOL 117 lecture. This laboratory is a continuation of BIOL 116 and utilizes themes from plant and animal physiology to enhance student skill when applying the scientific method. Emphasis is placed on experimental design and discipline-specific communication methods.

BIOL 122. Human Sexuality. 3 Hours.
A study of biological, behavioral and societal aspects of sexuality. Issues considered include changing fecundity, social-legal implications, sex roles, sexually transmitted diseases, populations, erotica, aging, dysfunctions, and decision-making skills for sex related issues.

BIOL 191. First-Year Seminar. 1-3 Hours.
Engages students in active learning strategies that enable effective transition to college life at WVU. Students will explore school, college and university programs, policies and services relevant to academic success. Provides active learning activities that enable effective transition to the academic environment. Students examine school, college and university programs, policies and services.

BIOL 209A. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 209B. 1-4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 209C. 1-4 Hours.

BIOL 209D. 4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 209E. 4 Hours.
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BIOL 209F. 4 Hours.
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BIOL 209G. 4 Hours.
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BIOL 209H. 4 Hours.
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BIOL 209I. 4 Hours.
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BIOL 209X. 4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 209Y. 4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 209Z. 4 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 215. Cell Biology for Pre-Pharmacy. 3 Hours.
PR: BIOL 115 and BIOL 117 and (CHEM 115 or CHEM 117). Structure, function and diversity of cells with an emphasis on gene expression and cellular phenotype including cell chemistry, energetics, and regulation of cell activities. This course is offered only to Pre-Pharmacy majors.

BIOL 219. The Living Cell. 3 Hours.
PR: (CHEM 115 or CHEM 117) and ((BIOL 117 and BIOL 118) or BIOL 240) and PR or CONC: BIOL 220. This is the third course in the core curriculum required for biology-related majors. It will expand on topics from BIOL 115/117, especially with regard to cell chemistry, bioenergetics, cell physiology and gene expression.

BIOL 220. The Living Cell Laboratory. 1 Hour.
PR: (CHEM 115 or CHEM 117) and ((BIOL 117 and BIOL 118) or BIOL 240) and PR or CONC: BIOL 219. BIOL 220 is the laboratory that accompanies BIOL 219 (The Living Cell).

BIOL 221. Ecology and Evolution. 3 Hours.

BIOL 235. Human Physiology. 3 Hours.
PR: (BIOL 101 and BIOL 102 and BIOL 103 and BIOL 104) or BIOL 115. (Intended for non-biology majors.) An introductory course in the function of the human.

BIOL 236. Human Physiology: Quantitative Laboratory. 1 Hour.
PR: MATH 156 and CHEM 116 and (BIOL 115 or (BIOL 101 and BIOL 102 and BIOL 103 and BIOL 104) or PR or CONC: BIOL 235). Optional lab for BIOL 235 incorporating engineering concepts, such as mass and energy balances, circuit theory, and chemical kinetics to quantify and help understand many aspects of human physiology.

BIOL 293. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 298. Honors. 1-3 Hours.
PR: Students in the Honors Program and consent by the honors director. Independent reading, study, or research.

BIOL 301. History of Biology. 3 Hours.
PR: (BIOL 101 and BIOL 103 and BIOL 102 and BIOL 104) or BIOL 115. History of development of biological knowledge with philosophical and social backgrounds.

BIOL 302. Biometry. 3 Hours.
PR: STAT 211. Application of quantitative methods and statistics to biological data with emphasis on hands-on hypothesis construction, experimental design, data analysis and biological interpretation of statistical results.

BIOL 309A. 1-4 Hours.
A study of contemporary topics selected from recent developments in the field.

BIOL 309B. 4 Hours.
A study of contemporary topics selected from recent developments in the field.
BIOL 309C. 4 Hours.
A study of contemporary topics selected from recent developments in the field.

BIOL 309D. 4 Hours.
A study of contemporary topics selected from recent developments in the field.

BIOL 309E. 4 Hours.
A study of contemporary topics selected from recent developments in the field.

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A study of contemporary topics selected from recent developments in the field.

BIOL 309Y. 4 Hours.
A study of contemporary topics selected from recent developments in the field.

BIOL 309Z. 4 Hours.
A study of contemporary topic selected from recent developments in the field.

BIOL 310. Advanced Cellular/Molecular Biology. 3 Hours.

BIOL 311. Advanced Cellular/Molecular Biology-Laboratory. 2 Hours.
PR or Conc: BIOL 310. Experimental approaches to the study of cellular systems.
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<tr>
<th>Course Code</th>
<th>Credits</th>
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<tr>
<td>BIOL 311A</td>
<td>1 Hour</td>
<td>Seminars arranged for advanced graduate students.</td>
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</table>
BIO 312. Introduction to Virology. 3 Hours.

BIO 313. Molecular Basis of Cellular Growth. 3 Hours.
PR: BIOL 219. Study of the integration of internal and external influences as they regulate the division, growth, and differentiation of cells. Topics include hormones as cell effectors, cancer, and stem cells.

BIO 315. Communicating Natural Science. 3 Hours.
PR: BIOL 219 or BIOL 221. Teaches students to effectively communicate about scientific discoveries and scientific issues in both written and oral forms to professional scientists, the public, the media and politicians. Students will learn to consider the knowledge, biases and goals of their intended audience to communicate thoughtfully and effectively.

BIO 316. Developmental Biology. 3 Hours.
PR: BIOL 219. A molecular genetic analysis of the mechanisms by which multicellular organisms develop from single cells.

BIO 317. Developmental Biology Laboratory. 1 Hour.
PR: BIOL 219. CoReq: BIOL 316. Experimental approaches to the genetic analysis of the mechanisms by which multicellular organisms develop from single cells.

BIO 318. Writing Appalachian Ecology. 3 Hours.
This course encourages students to think about the long-term future of our planet. What could our world be like in 200 years? How will current environmental problems change the future? How will relationships with the natural world change? Students address questions like these in creative nonfiction essays they write about research being conducted at the Fernow Experimental Forest in WV.

BIO 320. The Total Science Experience: Genomics. 2 Hours.
PR: BIOL 219. Biological research experience incorporating critical skills of being a research scientist, including writing grant proposals, manuscripts, and materials for presentation of results in a public forum. Students conceive, design, propose, execute, analyze, and report an experiment with a genomics focus. Fulfills the capstone requirement in Biology and provides a realistic exposure to joys and challenges of performing scientific research.

BIO 321. Total Science Experience Lab. 2 Hours.
PR or Conc: BIOL 221. Biological research experience incorporating diverse learning experiences that take place in the process of being a research scientist; including writing grant proposals, manuscripts, and presentation of results in a public forum.

BIO 324. Molecular Genetics. 3 Hours.
PR: BIOL 219. Theoretical and practical knowledge in genetics as a field of study and as an approach for investigating biological problems.

BIO 325. Molecular Genetics Laboratory. 1 Hour.
PR: BIOL 219. CoReq: BIOL 324. The laboratory is a logical sequence of experiments providing actual research experience in molecular genetics. Must be taken at the same time as BIOL 324.

BIO 327. Professional Development. 1 Hour.
PR: BIOL 219. This course provides an overview of opportunities for students graduating with degrees in the biological sciences. An assessment test will help identify strengths and weaknesses within the field.

BIO 335. Cell Physiology. 3 Hours.
PR: BIOL 219. Emphasis on the unity and diversity of cells; membrane structure and function; and the role that intracellular compartments, cytoskeleton, and extracellular matrix play in cell physiology.

BIO 336. Vertebrate Embryology. 4 Hours.
PR: BIOL 112 or BIOL 219. An experimental and descriptive analysis of vertebrate development. Students on the Morgantown campus will be required to complete BIOL 219.

BIO 337. Physiological Psychology. 3 Hours.
PR: PSYC 301 and junior or senior standing. Advanced study of the physiological mechanisms of behavior. Topics include neural and endocrine mechanisms of behavior and issues, methods, and findings in behavioral neuroscience. (Also listed as PSYC 426.)

BIO 338. Behavioral Ecology. 3 Hours.
PR: BIOL 112 or BIOL 221. Consideration of the influences of environmental factors on short-and long-term regulation, control, and evolution of the behavior of animals. Students on the Morgantown campus will be required to complete BIOL 221.

BIO 339. Animal Communication. 3 Hours.
PR: BIOL 221 or consent. Communication mediates most interactions between individuals and the brain dedicates much of its resources to generating and processing these signals. This course examines why and how animals communicate, the physiological mechanisms involved in generating / sensing communication signals, how evolution shapes communication, and how communication signals can influence decision making.

BIO 340. Invertebrate Zoology. 3 Hours.
PR: BIOL 221. The evolution of animals without vertebral columns.

BIO 341. Ichthyology. 4 Hours.
Study of the internal and external structure of fishes, their systematic and ecological relationships, and their distribution in time and space. (Dissection kit required.)
BIOL 348. Neuroscience 1. 3 Hours.
PR: BIOL 219. An introduction to neuroscience, including basic neuroanatomical neurophysiology, and the relationship between the central nervous system, physiology, and behavior.

BIOL 349. Neuroscience 2. 3 Hours.
PR: BIOL 348. An introductory systems level course on organization of the nervous system, from an evolutionary to a clinical perspective. Topics include development and functional organization of sensory, motor, autonomic and cognitive systems. The evolutionary history and human health concerns associated with these systems will be addressed, through lecture, discussion, and readings in the primary literature.

BIOL 350. Plant Physiology. 4 Hours.
PR: (BIOL 117 and CHEM 116) or (CHEM 112 and PLSC 206). Physiochemical processes of plants.

BIOL 351. Plant Diversity. 4 Hours.
PR: (BIOL 101 and BIOL 102 and BIOL 103 and BIOL 104) or BIOL 115. Evolution, morphology, life cycles, ecology, and uses of cyanobacteria, lichens, algae, bryophytes, ferns, gymnosperms, and angiosperms. Laboratory emphasizes comparing living specimens with local field trips.

BIOL 352. Plant Anatomy and Development. 4 Hours.
PR: BIOL 117 or PLSC 206. How plants (especially angiosperms) develop, stand up, defend themselves, transport food and water, and reproduce; also evolution and uses of wood and bark. Students observe development from spores, seeds, and cuttings. (Two local field trips.)

BIOL 353. Flora of West Virginia. 3 Hours.
PR: (BIOL 101 and BIOL 103 and BIOL 102 and BIOL 104) or BIOL 115. Identification of local woody and herbaceous seed plants, with emphasis on common native and introduced species. Conducted primarily through field trips to nearby areas with the use of dichotomous keys to determine the scientific names of observed specimens.

BIOL 354. Flora of West Virginia. 3 Hours.
PR: BIOL 115. Identification of local woody and herbaceous seed plants, with emphasis on common native and introduced species. Conducted primarily through field trips to nearby areas with the use of dichotomous keys to determine the scientific names of observed specimens.

BIOL 355. Flora of West Virginia. 3 Hours.
PR: BIOL 115. Identification of local woody and herbaceous seed plants, with emphasis on common native and introduced species. Conducted primarily through field trips to nearby areas with the use of dichotomous keys to determine the scientific names of observed specimens.

BIOL 356. Flora of West Virginia. 3 Hours.
PR: BIOL 115. Identification of local woody and herbaceous seed plants, with emphasis on common native and introduced species. Conducted primarily through field trips to nearby areas with the use of dichotomous keys to determine the scientific names of observed specimens.

BIOL 357. Flora of West Virginia. 3 Hours.
PR: BIOL 115. Identification of local woody and herbaceous seed plants, with emphasis on common native and introduced species. Conducted primarily through field trips to nearby areas with the use of dichotomous keys to determine the scientific names of observed specimens.

BIOL 358. Flora of West Virginia. 3 Hours.
PR: BIOL 115. Identification of local woody and herbaceous seed plants, with emphasis on common native and introduced species. Conducted primarily through field trips to nearby areas with the use of dichotomous keys to determine the scientific names of observed specimens.

BIOL 359. Flora of West Virginia. 3 Hours.
PR: BIOL 115. Identification of local woody and herbaceous seed plants, with emphasis on common native and introduced species. Conducted primarily through field trips to nearby areas with the use of dichotomous keys to determine the scientific names of observed specimens.

BIOL 360. Flora of West Virginia. 3 Hours.
PR: BIOL 115. Identification of local woody and herbaceous seed plants, with emphasis on common native and introduced species. Conducted primarily through field trips to nearby areas with the use of dichotomous keys to determine the scientific names of observed specimens.

BIOL 361. Plant Ecology. 4 Hours.
PR: BIOL 221. Introduction to the four divisions of plant ecology, including physiological ecology, population ecology, community ecology and ecosystem ecology.

BIOL 362. Plant Geography. 3 Hours.
PR: BIOL 221. World-wide distribution patterns of plants and factors related to these distributions, including dispersal. Limiting factors, climate, isolation, evolutionary history, plate tectonics, pleistocene glaciations, and human activities. Plant communities and soils of polar, temperate, and tropical biomes are discussed.

BIOL 363. Conservation Biology. 3 Hours.
PR: BIOL 221 or WMAN 313. Review of literature, research, and application of topics including biodiversity, endangered species, population biology, extinction, invasive species, conservation, restoration, and sustainability.

BIOL 364. Research Methods. 3 Hours.
PR or CONC: BIOL 221 (may be taken as a corequisite). An introduction to the tools and mathematics that scientists use to solve scientific problems. Mathematical modeling, experimental design, hypothesis formulation, data collection, use of statistics, reading and evaluating the scientific literature, writing and reviewing scientific papers, and oral presentation of scientific research.

BIOL 365. Undergraduate Research. 1-4 Hours.
PR: Written consent of chair and a 2.7 grade point average in biology. (May be repeated for a maximum of 6 credit hours.) Individual laboratory or field experiments supervised by a faculty member.

BIOL 366. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BIOL 367. Biochemical Basis of Therapeutics. 3 Hours.
PR: BIOL 219. This course explores the process of drug discovery and development. The topics emphasized include the biological factors that determine success, failure, or limitation of therapeutics. Other topics include, specific therapeutic areas and regulation.

BIOL 368. Cell and Molecular Biology Methods. 3 Hours.
PR: BIOL 219. Introduction to the theory, application, ethic and economics of biotechnologies.
BIOL 411. Introduction to Recombinant DNA. 4 Hours.
PR: BIOL 219. An introductory course covering the basic principles and techniques of recombinant DNA technology, includes molecular cloning, isolation of plasmid DNA, agarose/acrylamide gel electrophoresis, restriction enzyme mapping, nucleic acid hybridization, and DNA sequencing.

BIOL 413. Molecular Endocrinology. 3 Hours.
PR: BIOL 219. Hormonal action is discussed at the cellular and molecular levels. Topics include hormone production and regulation, receptor kinetics and activation, and receptor output.

BIOL 414. Molecular Endocrinology-Laboratory. 1 Hour.
CoReq: BIOL 413. Experimental techniques used to study hormones and receptors.

BIOL 415. Epigenetics. 3 Hours.
PR: BIOL 219 or consent. Explores the molecular mechanisms, phenotypic phenomena and current applications of epigenetics and the study of how genetic information is used and maintained.

BIOL 416. Medical Genetics. 3 Hours.

BIOL 417. Experimental Biochemistry. 2 Hours.
PR: AGBI 410 and PR or CONC: BIOL 423. Advanced biochemistry laboratory. Research and hypothesis design, manipulation of DNA and proteins, use of biochemical techniques to express protein and analyze function.

BIOL 418. Current Topics in Genome Biology. 1 Hour.
PR: BIOL 219. Exploration of modern topics in genomics research through interactive discussion of current literature. Students learn approaches to critical evaluation of manuscripts while exploring current research in this rapidly growing field. The course is organized around student-led discussions of manuscripts selected by the class. Undergraduate students are paired with graduate students to facilitate interpretation of complex material.

BIOL 419. Molecular Endocrinology-Laboratory. 1 Hour.
PR or CONC: BIOL 413. Prepares students in the processing of biological samples for DNA analysis, including presumptive and confirmatory testing, isolation of nucleic DNA, quantification, amplification, and analysis of DNA. Extensive hands-on practical experience and application of knowledge.

BIOL 420. Genomics. 3 Hours.
PR: BIOL 219. 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 421. Bioinformatics. 3 Hours.
PR: BIOL 219 or Consent. An introduction to algorithms and tools for analysis of genetic and genomic data in an evolutionary context.

BIOL 422. Forensic Biology. 3 Hours.
PR: BIOL 219 and (CHEM 231 or CHEM 233). Explores fundamentals of the protein structure; methods of structure determination; features of globular, membrane, and fibrous proteins; and approaches to protein classification.

BIOL 423. Herpetology. 3 Hours.
Investigation into the biology, ecology, and evolution of reptiles and amphibians, emphasizing North American species especially those found in the state of West Virginia. (One field exercise outside of regular time is required.).

BIOL 424. Forensic Biology Laboratory. 1 Hour.
PR or CONC: BIOL 432. Prepares students in the processing of biological samples for DNA analysis, including presumptive and confirmatory testing, isolation of nuclear DNA, quantification, amplification, and analysis of DNA. Extensive hands-on practical experience and application of knowledge.

BIOL 425. General Animal Physiology. 3 Hours.
PR: BIOL 221. In-depth, current treatment of physiological principles which operate at various levels of biological organization in animals of diverse taxonomic relationships. Understanding is developed from background lectures and student analyses in discussion sessions of research literature.

BIOL 426. Animal Behavior. 4 Hours.
PR: BIOL 221. Introduction to animal behavior (ethology) emphasizing the ecology and evolution of individual and social behaviors. Laboratory includes independent investigation of behavioral phenomena. (Offered in even numbered years.).
BIO 439. Neuroethology. 3 Hours.
PR: BIOL 219. Explores the way sensory systems process information to mediate behavior in a wide variety of animals in order to understand similarities and differences in neural mechanisms.

BIO 440. Comparative Anatomy. 4 Hours.
PR: WVU sections require BIOL 219 and BIOL 221 or consent, WVUIT sections require BIOL 112. A functional and evolutionary study of vertebrate structure. (Dissection kit required.).

BIO 441. Vertebrate Microanatomy. 5 Hours.

BIO 446. Freshwater Ecology. 4 Hours.
PR: (BIOL 101 and BIOL 102 and BIOL 103 and BIOL 104) or BIOL 115 or WMAN 224 or consent. Physical, chemical, and biological characteristics of inland waters with emphasis on the structure and function of stream ecosystems. (Also listed as WMAN 446.).

BIO 450. Plant Systematics. 4 Hours.
PR: BIOL 117. Study of the taxonomy of flowering plants worldwide and related topics in angiosperm classification and evolution. Laboratories emphasize characteristics of selected families of monocotyledons and dicotyledons using living and herbarium material.

BIO 451. Plant Development. 4 Hours.
PR: BIOL 221 and (CHEM 235 or AGBI 410). Experimental studies of plant growth and development.

BIO 453. Molecular Basis of Disease. 3 Hours.
PR: BIOL 219. Examine medical, ethical, and legal/regulatory issues emerging from the Human Genome Project and its applications to personalized medicine.

BIO 454. Immunology. 3 Hours.
PR: BIOL 240 or BIOL 219. Explores the fundamental principles and practices of immunology including how the immune system is organized, how it functions to keep us healthy, and how it can cause allergies and autoimmune disease.

BIO 455. Evolution of Infectious Diseases. 3 Hours.
PR: BIOL 221. The application of phylogenetics, microbiology, immunology, and epidemiology towards understanding the evolution of infectious diseases. Students will develop a fundamental understanding of the significance of evolution and ecology in infectious disease emergence and control.

BIO 456. Microbial Symbiosis. 3 Hours.
PR: BIOL 221. An understanding of the significance of microbial symbioses towards ecological and health processes will be developed. Molecular techniques used towards identifying the composition and functions of microbial communities will be discussed. (Also listed as BIOL 615.).

BIO 457. Ecology of Parasites. 3 Hours.
PR: BIOL 219 and BIOL 220. An introduction to the wide diversity of evolved relationships between parasites and their hosts. This course incorporates topics such as gene regulation, cell signaling, animal physiology, and evolution into a complete picture of host/parasite interactions.

BIO 461. Principles of Evolution. 3 Hours.
PR: BIOL 112 or BIOL 221. Introduction to the study of evolution, including genetics of evolutionary change, speciation and adaptation molecular evolution, the history of life, extinction, co-evolution and the origins of humans. Students on the Morgantown campus will be required to complete BIOL 221.

BIO 462. Ecosystem Models. 3 Hours.
PR: BIOL 221. Students will gain an understanding of the theory and mechanics behind ecosystem model, including models that predict soil decomposition and photosynthesis, ecosystem and terrestrial biosphere models. Students will also learn basic coding behind these models.

BIO 463. Global Ecology. 3 Hours.
PR: BIOL 221. The Earth viewed as a changing biogeochemical system. Topics include the structure, composition and dynamics of the ecosphere, nutrient cycles, changing atmospheric composition, climate change, ozone depletion, land-use change, biological invasions, and changes in biodiversity.

BIO 464. Population and Quantitative Genetics. 3 Hours.
PR: BIOL 221. Relationship of gene and genotype frequencies in populations of diploid organisms and the effects of mutation, selection, and non-random mating in relation to single gene pairs. Application of these concepts to multigenic inheritance of quantitative traits.

BIO 474. Neurogenetics and Behavior. 3 Hours.
PR: BIOL 219 with a minimum grade of C-. Covers the principles and techniques that define the field of neurogenetics. Analysis the development and function of the nervous system at cellular and molecular levels. Particular emphasis placed on genetic and environmental factors that contribute to human neurological disorders and the study of how genes control behavior.

BIO 475. Neurobiological Diseases. 3 Hours.

BIO 476. Computational Neuroscience. 4 Hours.
PR: BIOL 348 or consent. Tools and concepts used to probe and characterize the dynamics of neurons, neural networks and neural coding mechanisms. Lectures introducing concepts and discussion sessions focusing on current research literature complement computer laboratories where the student learns programming skills, analytical tools and neural modeling methods used in computational neuroscience research.
BiOL 477. Central Nervous System Evolution and Development. 3 Hours.
PR: BIOL 348. Origin and evolution of the central nervous system, focusing on developmental and genetic mechanisms underlying structural modifications that serve as the basis for the evolution of animal behavior.

BiOL 478. Sensory Neural Systems and Behavior. 3 Hours.
PR: BIOL 348. This course explores how brains acquire information about the external world and process this information to produce sensory perceptions. Students gain a deep understanding of sensory transduction and neural processing at the cellular, network and systems levels. Additionally the class is aimed at enhancing science communication.

BiOL 479. Principles of Systems Neuroscience. 3 Hours.
PR: BIOL 348. 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 486. Honors Investigation and Thesis. 1-4 Hours.
(May be repeated for credit; max credit 12 hr.) PR: Second semester of junior year, recommendation of advisor, biology majors only. Permission required. Supervised readings, investigation, and study.

BiOL 490. Teaching Practicum. 1-3 Hours.
PR: Consent. (May be repeated for a maximum of 9 credit hours.) Teaching practice as a tutor or assistant.

BiOL 491. Professional Field Experience. 1-18 Hours.
PR: Consent. (May be repeated up to a maximum of 18 hours.) Prearranged experiential learning program, to be planned, supervised, and evaluated for credit by faculty and field supervisors. Involves temporary placement with public or private enterprise for professional competence development.

BiOL 492. Directed Study. 1-3 Hours.
Directed study, reading, and/or research.

BiOL 493. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

BiOL 494. Seminar. 1-3 Hours.
PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

BiOL 495. Independent Study. 1-6 Hours.
Faculty supervised study of topics not available through regular course offerings.

BiOL 496. Senior Thesis. 1-3 Hours.
PR: Consent.

BiOL 497. Research. 1-6 Hours.
Independent research projects.

BiOL 498. Honors. 1-3 Hours.
PR: Students in Honors Program and consent by the honors director. Independent reading, study or research.