Biology (M.S.)

Biology

Admission Criteria

Prospective graduate students for the Master of Science degree should have completed an undergraduate major consisting of a minimum of 20 credit hours in biology, including courses covering the areas of organismal biology, cell and molecular biology, ecology, evolution, and genetics. A student may be admitted with deficiencies in one or more of these areas but should be aware that the Graduate Advisory Committee may require the student to make up deficiencies with no credit toward the master's degree. The applicant should have completed a minimum of a year (two semesters) of general chemistry and one semester of organic chemistry. A course in general physics is strongly recommended, especially for those students interested in physiology.

Certain areas of study may require additional background in biochemistry, statistics, calculus or computer programming.

Students are required to submit with their application the Graduate Record Examination General Test scores, three letters of recommendation from individuals who know the student's scientific potential, and a statement of professional goals and interests.

Students typically matriculate only in the fall semester. Application deadline is February 1.

Mission

The Department of Biology Masters of Science Program is committed to providing a strong and unique training plan for advanced students of the discipline that will prepare them well for their future career goals. The program takes advantage of the current strengths of the department, basic scientific research and excellent biology pedagogy. Students will develop their intellectual potential by pursuing advanced course work in biology and by successfully completing a research thesis. They will have the option to develop their teaching skills by participating in mentored teaching.

Program Description

The biology graduate program is a thesis/research concentration for students who wish to continue the study of biology as a scholarly pursuit and who later continue work toward the Ph.D., work for industry or government, or wish to teach, primarily in two year colleges. The primary objective of the program is to enrich the student's subject knowledge and give the student a rigorous experience in research and thesis-writing. Students can also acquire training and experience in teaching. Training in teaching
is provided through courses and the mentored teaching of biology laboratories. Thus, students not only gain research experience, they also learn to be effective teachers and communicators.

Currently, the biology department has research strengths in the following areas:

- Cell Biology and Genetics
- Comparative and Functional Morphology
- Developmental Biology
- Ecology, Evolution, Behavior and Systematics
- Microbiology
- Neurobiology
- Plant Biology

More information regarding faculty research can be found at the Department of Biology website at [http://www.jmu.edu/biology/graduate/index.shtml](http://www.jmu.edu/biology/graduate/index.shtml).

### Course Requirements

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<th>Minimum Requirements</th>
<th>Credit Hours</th>
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<td>BIO 700, Thesis</td>
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<td>Electives (15 credits must be at the 600- or 700-level, including BIO 700)</td>
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### Additional Requirements

Students wishing to receive training and mentoring in teaching and who wish to teach biology laboratories are also required to take BIO 600, Effective Teaching (2 credits) and BIO 601, Mentored Teaching (1 credit).

BIO 602, Effective Scientific Communication (2 credits), is strongly recommended for all students. Exemptions require approval of the student's advisory committee.

All students must have their individual program of study approved by the student's Thesis Advisory Committee and the head of the academic unit.

Up to nine hours of graduate credit from accredited institutions may be accepted toward the Master of Science degree, subject to the general regulations and procedures of The Graduate School regarding transfer credit.

Full-time biology graduate students are required to attend and participate in the Biology departmental seminars while in residence.

### Course Offerings

**Biology**

For a student to enroll in any biology graduate course the department assumes the student meets minimal course requirements for entrance into the Master of Science degree program in biology. Permission of the instructor is required if this is not the case.

**BIO 500. Effective Scientific Communication.** 2 credits.
Students will develop skills in effective oral and written communications in the biological sciences. Emphasis will be placed on how to prepare an effective lecture or research seminar, effective use of presentation technologies and effective scientific writing.

**BIO 502. Forest Ecology. 4 credits.**
A study of the function, structure and composition of forested ecosystems. The effect of physical geography on the distribution of forest communities will be explored. Issues of forest management and restoration will also be considered. Field laboratory topics will include dendrology and sampling techniques within different forest successional stages. **Prerequisite:** BIO 124 or equivalent.

**BIO 504. Evolution. 3 credits.**
Population change as brought about by mechanisms of organic evolution. Molecular biology is integrated with evolutionary biology and concepts of phylogenetic relationships resulting from the process of speciation are stressed. A seminar/research project is required. Credit may not be earned in both BIO 404 and BIO 504.

**BIO 513. Human Gross Anatomy with Clinical Applications (4, 8). 9 credits.** An advanced study of human anatomy with cadaver dissection. Emphasis is given to a clinical perspective and the evolution and development of human structure within a comparative context. **Prerequisite:** A rigorous undergraduate course in anatomy, admission to the Physician Assistant program or permission of the instructor.

**BIO 514. Clinical Anatomy for Occupational Therapists. 4 credits.** This course offers an in-depth study of the structure of the musculoskeletal and peripheral nervous system of the human body. Specific structural and neural pathologies will be examined in regards to impact on occupational performance. Laboratory experiences involving cadaver dissection, skeletal material, models and audiovisual technology will be utilized. **Prerequisite:** Admission to the occupational therapy program.

**BIO 516. Pathophysiology for Physician Assistants I. 6 credits.** An advanced clinically-oriented study of human physiology and the alterations in body functions that underlie diseases in humans. It serves as a foundation for courses in clinical medicine. **Prerequisite:** Admission to the physician assistant concentration.

**BIO 517. Pathophysiology for Physician Assistants II. 6 credits.** An advanced clinically-oriented study of human physiology and the alterations in body functions that underlie diseases in humans. It serves as a foundation for courses in clinical medicine. **Prerequisite:** Successful completion of all previous courses in the physician assistant concentration or permission of the program director.

**BIO 520. Medical Parasitology. 3 credits.**
The study and medical implications of parasites that infect humans. Class activities will emphasis parasite morphology, modes of transmission, mechanisms of host entry and infection, niche selection, life cycles, pathogenesis, diagnosis, and treatment and control. Additional assignments required for graduate students.

**BIO 526. Graduate Topics in Biology. 3-4 credits.**
Studies in special areas of biology. May be repeated with change in topic or change in subject matter within a topic.

**BIO 532. Light Microscopy (2, 4). 4 credits.**
This course covers the principles behind light microscopy, from the properties of light to the latest technologies in microscopy. Students will get hands-on experience with the different kinds of microscopes, including the confocal microscope. The course also
covers fluorescent probes, advanced fluorescence techniques, digital imaging, methods of quantification and figure preparation for publication, with an emphasis on biological applications.

**BIO 540. Functional Neuroscience for Occupational Therapists. 3 credits.**

This course will examine the functional performance of all aspects of the human nervous system. Specific nervous system conditions will be introduced and their impact on occupational performance, performance components and environmental contexts discussed. **Prerequisites:** Admittance to the occupational therapy program and satisfactory completion of previous concentration work. Credit may not be applied to the biology major or minor.

**BIO 544. Virology. 3 credits.**

A lecture seminar course considering the fundamental principles of basic and medical virology and an analysis of the structure, chemistry and replication of representative RNA and DNA animal viruses at the molecular level. **Prerequisite:** A course in microbiology or genetics or consent of the instructor. Credit may not be earned in both **BIO 444** and **BIO 544**.

**BIO 547. Evolution and Ecology of Infectious Disease. 3 credits.**

An introduction to the evolution and ecology of pathogenic microorganisms, with an emphasis on the bacteria. Emphasis will be placed on the study, discussion, and critique of scientific literature, as well as formal presentation of scientific information and data.

**BIO 548. Medical Microbiology. 4 credits.**

This class focuses on microorganisms of medical importance, mainly bacteria and viruses. Lecture follows an organism-by-organism approach. Key topics for each organism include general cell structure, unique structures/functions, epidemiology of the disease that the organism causes, mechanisms of pathogenesis, isolation and identification of the organism, and treatment options. **Prerequisite:** Undergraduate general microbiology course or permission of instructor.

**BIO 549. Insect Ecology. 4 credits.**

An overview of insect ecology from an evolutionary perspective, focusing on the processes that affect the diversity, distribution, and abundance of insects in natural and managed ecosystems. The role of insects as model systems in understanding ecological and evolutionary principles is included, and current literature in the field is highlighted. Field surveys and experiments are emphasized, including general insect collection and identification. **Prerequisite:** **BIO 124. Credit may not be earned in both BIO 449 and BIO 549.**

**BIO 550. Neurobiology (3,3). 4 credits.**

Molecular, cellular and network mechanisms underlying behavior will be studied using problem-solving, discussion, lecture and critical reading of the primary literature. Similarities and differences between nervous systems and computers will be explored. Laboratorilies will utilize contemporary electrophysiology and computer simulation to examine the neurobiology of simple animal model systems. Credit may not be earned in both **BIO 450** and **BIO 550**.

**BIO 552. Population Biology (2,4). 4 credits.**
Theoretical and applied aspects of distribution and abundance, population regulation, interactions between populations, and conservation will be studied in selected organisms, including humans. An independent research project will be required. Credit may not be earned in both BIO 452 and BIO 552.

BIO 553. Microbial Ecology and Evolution (2,4). 3 credits.
Advanced ecology of microorganisms will be covered, including those important in human health and in natural environments. Emphasis will be placed on the study and critique of scientific literature. Prerequisites: Introductory ecology and microbiology. Credit may not be earned in both BIO 453 and BIO 553.

BIO 554. Biometrics. 4 credits.
The design of biological experiments and applications of statistical techniques in ecology, cell biology, physiology, behavior, systematics, genetics and evolution. Experiments and data from the biological literatures will be emphasized. Statistical software packages will be used. A seminar/research project involving advanced applications is required. Prerequisite: MATH 220 or equivalent. Credit may not be earned in both BIO 454 and BIO 554.

BIO 555. Plant Physiology (3,3). 4 credits.
An in-depth study of plant function including metabolism, water relations, transport phenomena, growth and development, physiological ecology, and responses to pathogens and abiotic stress. Credit may not be earned in both BIO 455 and 555. Prerequisite: BIO 214.

This course will explore the various ways geographic information systems (GIS) can be used to answer biological questions. Students will use GIS software to study applications in ecology, conservation biology and environmental biology. A seminar/research project involving advanced applications is required. No prior GIS experience is required. Credit may not be earned in BIO 457 and BIO 557.

BIO 559. Aquatic Ecology (2,4). 4 credits.
Functional relationships and productivity of freshwater communities are examined as they are affected by their physical, chemical and biotic environment. Organisms inhabiting lakes, ponds, rivers, streams and estuaries are studied at the population, community and ecosystem levels. Preparation of seminar topic papers required. Credit may not be earned in both BIO 459 and BIO 559.

BIO 560. Plant Cell and Tissue Culture (2,4). 4 credits.
Theory and practice of growing isolated plant cells, tissues and organs. Independent research project and class seminar expected. Prerequisites: General botany and chemistry. Credit may not be earned in both BIO 460 and BIO 560.

BIO 565. Environmental Toxicology (3,3). 4 credits.
The study of types, sources and biological effects of environmental pollutants. Class activities will include discussions of the biological effects of a broad range of pollutants. Labs will focus on the use of simulation models, geographic information systems and other software currently used in environmental toxicology for the analysis of environmental data. A presentation/research paper involving advanced applications is
required. Prerequisite: BIO 224 or equivalent. Credit may not be earned in both BIO 465 and BIO 565.

BIO 566. Toxicology Seminar. 3 credits.
Advanced readings and discussions of the primary scientific literature with a focus on the biological effects of toxins at the genetic, cellular, physiological, and ecological level. An independent literature research project is required. Prerequisite: BIO 224 or equivalent. Credit may not be earned in both BIO 466 and BIO 566.

BIO 570. Morphology of Non-Vascular Plants. 3 credits.
Comparative morphology, ecology and taxonomy of representative algae, fungi and bryophytes.

BIO 575. Advanced Cell and Molecular Biology. 3 credits.
This seminar-style course covers topics in advanced cell and molecular biology at the graduate level. Class format will be discussions from assigned review articles, followed by student-led presentations of assigned primary literature. Students write a research grant proposal and give an oral presentation of their proposal in class. Prerequisite: BIO 224.

BIO 577. The Genetics of Cancer. 3 credits.
Exploration of the genetic and epigenetic factors that drive the evolution of cancer cells, taking into account both inherited and environmental contributions to this process. The cellular mechanisms debilitated or subverted during cancer development will be studied, and student teams will demonstrate their understanding of the material through the diagnosis, genetic characterization and treatment of a hypothetical cancer patient.

BIO 580. Advanced Molecular Biology (2,4). 4 credits.
Cellular constituents and genetics are emphasized at the molecular level. Credit may not be earned in both BIO 480 and 580.

BIO 582. Human Histology (3, 3). 4 credits.
This course presents the microscopic structure of cells, tissues and organs to explain normal physiological function and provides a basis for understanding disease mechanisms and altered cellular states. A special research project is required. Prerequisite: BIO 270 or BIO 290, or equivalent.

BIO 583. Bioinformatics (3, 3). 4 credits.
Focuses on building databases and computer programs to manage and analyze biological sequence data, and secondarily on theoretical aspects. The overall objective is to learn current information about the intersection of information science and biology, to develop facility in the many web-based tools and resources for further studies and research in genomics/bioinformatics, and to appreciate the power and limitations of current resources and knowledge.

BIO 584. Comparative Endocrinology. 3 credits.
This course will study the hormonal regulation of physiological activity in different animals, from the cellular to the whole-organism level. Special emphasis will be paid to recent advances in cellular and molecular endocrinology as well as human endocrine disorders. A special research project is required. Prerequisite: BIO 270 or BIO 370, or equivalent.

BIO 586. Systematics of Vascular Plants (2,4). 4 credits.
Study of systematic theory and an overview of the classification and evolution of higher plants with particular attention to flowering plant families. Techniques for plant identification and collection and for construction of phylogenies will be taught in lab. An independent project and presentation will be required. Prerequisites: General botany and cell biology or equivalents. Credit may not be earned in both BIO 486 and BIO 586.

BIO 590. Biomechanics (3,3). 4 credits.
A study of the interactions of organisms with their physical environment. Concepts from fluid and solid mechanics are applied to biological form and function. Independent research is required. Prerequisite: BIO 220 or permission of the instructor. Credit may not be earned in both BIO 490 and BIO 590.

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BIO 595. Topics in Integrative Biology. 1-3 credits.
This course will examine the interrelationships of various biological topics with related scientific and mathematical disciplines that are not offered by the biology department. A seminar/research project involving advanced applications is required. Course may be repeated as topics change. Prerequisite: Permission of the instructor.

BIO 600. Effective Teaching I. 2 credits.
Students will explore effective teaching strategies in the biological sciences. Emphasis will be placed on how to prepare and teach laboratory and lecture courses, including effective instructional technologies and exam preparation. Discussions of teaching experiences and mentor and peer evaluations of the students' teaching skills will be included. Corequisite: BIO 601.

BIO 601. Mentored Teaching. 1 credit.
Students continue their exploration of effective teaching strategies in the biological sciences as they enter into their first teaching assignment in the department. Students will work under a faculty teaching mentor who will guide the students through their first teaching experience in the Department of Biology. Emphasis will be placed on mentor and peer evaluations of the students' teaching skills. May be repeated for up to two credits for different teaching assignments. Corequisite: BIO 600.

BIO 602. Effective Scientific Communication. 2 credits.
Students will develop skills in effective oral and written communications in the biological sciences. Emphasis will be placed on student learning styles, how to prepare an effective lecture or research seminar, effective use of presentation technologies, and effective scientific writing.

BIO 603. Scientific Presentations. 1 credit.
A forum for students to present their research and/or teaching materials to their peers and receive constructive feedback on their progress. Presentations may take the form of informal "chalk talks," journal club presentations and/or formal presentations. This course is graded on a satisfactory/unsatisfactory (S/U) basis. May be repeated for up to two credits.

BIO 615. Managing Anatomy and Physiology Laboratories. 2 credits.
This course will teach students how to manage an anatomy and physiology laboratory. Course topics will include lab safety, course budgets, the acquisition of supplies, facility layout and design, cadaver maintenance, and the use and maintenance of equipment and inventory control.

**BIO 630. Advanced Graduate Topics in Cell, Molecular and Developmental Biology. 1-3 credits.**

Studies in advanced special areas of biology. May be repeated with change in topic or change in subject matter within a topic.

**BIO 660. Advanced Graduate Topics in Ecology, Evolution and Organismal Biology. 1-3 credits.**

Seminar in special areas of biology. May be repeated up to a total of 12 hours with change in subject matter.

**BIO 697. Biological Research. 1-6 credits.**

Laboratory and/or field research will be conducted under the direction of the Graduate Advisory Committee. The course will emphasize the development of research techniques and data collection. Can be repeated for credit. This course is graded on the satisfactory/unsatisfactory (S/U) basis. Hours do not apply toward 30 hours required for graduation.

**BIO 698. Comprehensive Continuance. 1 credit.**

Continued preparation in anticipation of the comprehensive examination. Course may be repeated as needed. A grade of "NC" (no credit) will be automatically entered for continuance hours. Hours do not apply toward 30 hours required for graduation.

**BIO 699. Thesis Continuance. 2 credits.**

Continued study, research and writing in the area of thesis concentration. Course may be repeated as needed. A grade of "NC" (no credit) will be automatically entered for continuance hours. Hours do not apply toward 30 hours required for graduation.

**BIO 700. Thesis Research. 1-6 credits.**

Thesis research to be directed by the Graduate Advisory Committee. This course is graded on a satisfactory/unsatisfactory (S/U) basis. **Prerequisites:** Unconditional admission status in the graduate program and completion of an approved thesis research proposal.