BIOSCIENCES, PHD

Banner Code: SC-PHD-BIOS

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This program is a research-oriented field of study that prepares students for significant contributions in academic or industrial settings. It is broken down into three concentrations: Cell and Molecular Biology, Microbiology and Infectious Disease, and Biocomplexity and Evolutionary Biology.

The academic component is a three-tiered structure. The first tier provides a set of core courses designed to advance research skills across all disciplines. The second tier comprises additional core courses and elective courses. The first two tiers are designed to be completed in approximately two years, including the comprehensive qualifying exam. Only on completion of these requirements, the qualifying exam, and a successful dissertation proposal can the students advance to candidacy status. The third tier focuses on research and culminates in a dissertation.

Admissions & Policies

Admissions

University-wide admissions policies can be found in the Graduate Admissions Policies section of this catalog.

To apply for this program, please complete the George Mason University Admissions Application (https://www2.gmu.edu/admissions-aid/apply-now).

Application Requirements

The following are required of applicants to this program:

- Minimum 3.25 GPA in previous coursework with significant training in the biological sciences.
- Three letters of recommendation from faculty members or individuals who have firsthand knowledge of the applicant's academic or professional capabilities.
- Statement of purpose consistent with the research interests of at least one faculty member in the program.
- Scores on GRE general exam (required) and biology or biochemistry subject exam (recommended) taken within the past five years prior to date of application submission. The GRE exam is waived if applicants hold a master's Degree from a fully-accredited U.S. university at the time of their application.
- A TOEFL score of 575 on the paper-based exam or 230 on the computer-based exam is required of international students.

An interview may also be required. Applications should be submitted by January 1st for fall admission. Under unusual circumstances, applications may be considered for spring admission if they are received by October 1st. Applications will be considered until positions are filled. Students are encouraged to meet application deadlines to be considered for scholarships and stipends.

Strong candidates who lack several prerequisites may be admitted to provisional status. Removal from provisional status and continuation in the program is contingent on earning a GPA of 3.25 in the program's fundamental courses, plus completion of missing prerequisites.

Students who have not taken a course in basic biochemistry will be required to complete one prior to BIOS 701 Systems Biology.

Policies

For policies governing all graduate programs, see AP6 Graduate Policies.

Reduction of Credits

For students entering the doctoral program with a master's degree in a related field from a regionally accredited institution, the number of required credits may be reduced up to 30 credits, subject to approval of the program faculty and the college's associate dean for student affairs.

Transfer of Credit

Graduate credits taken previously and not used toward another degree may be transferred, subject to the approval of the advisor, the program director, and the associate dean. See AP6.5 Credit by Exam, Reduction or Transfer for more information.

Requirements

Degree Requirements

Total credits: 72

Students should refer to the Admissions & Policies tab for specific policies related to this program.

Students in the doctoral program are required to present two research papers at a meeting or conference any time before graduation.

Doctoral Coursework

Bioscience Core

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIOL 682</td>
<td>Advanced Eukaryotic Cell Biology</td>
<td>3</td>
</tr>
<tr>
<td>Six credits or two instances of BIOS 703</td>
<td>Laboratory Rotation</td>
<td>6</td>
</tr>
<tr>
<td>Three credits of BIOS 704</td>
<td>Topics in Biosciences</td>
<td>3</td>
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</tbody>
</table>

Total Credits: 12

Concentration in Cell and Molecular Biology (CMB)

This concentration prepares students for significant contributions in an academic or industrial research career. Coursework covers microarray analysis of gene expression, proteome analysis, sequencing and analysis of gene polymorphisms, gene and genome evolution, molecular studies of disease mechanisms, mechanisms of toxicology and mutagenesis, developmental neuroscience, and biotechnological applications.
## Concentration in Microbiology and Infectious Disease (MID)

Students in this concentration will be prepared for employment in academia, government, or industry. By stressing mechanisms of pathogenicity, physiology, metabolism, and genomic and proteomic analysis of pathogens, students will have a firm foundation for future research in infectious disease. Students will also be introduced to advanced laboratory practices, such as animal research methodologies and biocontainment laboratory work.

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<thead>
<tr>
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<tbody>
<tr>
<td>BIOS 740</td>
<td>Laboratory Methods in Functional Genomics and Biotechnology</td>
<td>12</td>
</tr>
<tr>
<td>BIOS 741</td>
<td>Genomics</td>
<td></td>
</tr>
<tr>
<td>BIOS 742</td>
<td>Biotechnology</td>
<td></td>
</tr>
<tr>
<td>BIOS 743</td>
<td>Genomics, Proteomics, and Bioinformatics</td>
<td></td>
</tr>
<tr>
<td>BIOS 744</td>
<td>Molecular Genetics</td>
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</tbody>
</table>

Total Credits: 12

## Concentration in Biocomplexity and Evolutionary Biology (BEB)

This concentration prepares students for careers in academia, government or industry. Through this concentration students will learn laboratory and quantitative skills that will enable them to investigate evolutionary relationships among organisms at the population, species or ecosystem level. Students will be encouraged to explore a wide range of coursework in order to develop a broad background in evolutionary biology and a deep knowledge of relevant methodologies necessary to keep abreast in this rapidly changing field.

The science of evolutionary biology is fundamentally concerned with documenting not only genetic change, but also the processes that cause it. Evolutionary biology includes paleobiology, population genetics, evolutionary ecology and phylogenetics. Biocomplexity is the study of living organisms, including their unique structural, chemical and genetic properties, their distribution and abundance in nature, and their evolutionary relationships to all other organisms. Given the fact that most of the earth's biodiversity is unknown, collecting, cataloging and studying organisms have always been and will continue to be one of the most challenging aspects of biology.

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<tbody>
<tr>
<td>BIOL 553</td>
<td>Advanced Topics in Immunology</td>
<td>12</td>
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<tr>
<td>BIOL 563</td>
<td>Virology</td>
<td></td>
</tr>
<tr>
<td>BIOL 669</td>
<td>Pathogenic Microbiology</td>
<td></td>
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<tr>
<td>BIOL 715</td>
<td>Microbial Physiology</td>
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<tr>
<td>BIOL 718</td>
<td>Techniques in Microbial Pathogenesis</td>
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Total Credits: 12

## Electives

Select 24-36 credits from the following lists associated with the chosen concentration:

### Cell and Molecular Biology & Microbiology and Infectious Disease Concentrations

- BIOL 564 Techniques in Virology
- BIOL 568 Advanced Topics in Molecular Genetics
- BIOL 579 Molecular Evolution and Conservation Genetics
- BIOL 580 Computer Applications for the Life Sciences
- BIOL 685 Emerging Infectious Diseases
- BIOS 701 Systems Biology
- BIOS 702 Research Methods
- BIOS 710 Current Topics in Bioscience
- BIOS 740 Laboratory Methods in Functional Genomics and Biotechnology
- BIOS 741 Genomics
- BIOS 742 Biotechnology
- BIOS 743 Genomics, Proteomics, and Bioinformatics
- BIOS 744 Molecular Genetics
- BIOS 760 Seminar in Molecular Systematics
- BIOS 898 Directed Studies in Biosciences
- BIOS 899 Directed Research in Biosciences
- BINF 633 Molecular Biotechnology
- BINF 636 Microarray Methodology and Analysis
- BINF 705 Research Ethics

### Biocomplexity and Evolutionary Biology Concentration

- BIOL 506 Selected Topics in Microbiology
- BIOL 507 Selected Topics in Ecology
- BIOL 508 Selected Topics in Animal Biology
- BIOL 518 Conservation Biology
- BIOL 532 Animal Behavior
- BIOL 533 Selected Topics in Plant Biology
- BIOL 537 Ornithology
- BIOL 538 Mammalogy
- BIOL 539 Herpetology
- BIOL 543 Tropical Ecosystems
- BIOL 559 Fungi and Ecosystems
- BIOL 561 Comparative Animal Physiology
- BIOL 566 Cancer Genomics
- BIOL 572 Human Genetics
- BIOL 573 Developmental Genetics
- BIOL 643 Microbial Ecology
- BIOL 715 Microbial Physiology
- BIOS 741 Genomics
- BIOS 742 Biotechnology

Total Credits: 12

### BIOS 767 Molecular Evolution

Total Credits: 12

Total Credits: 24-36
<table>
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<tbody>
<tr>
<td>BIOS 743</td>
<td>Genomics, Proteomics, and Bioinformatics</td>
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<tr>
<td>BIOS 744</td>
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<tr>
<td>BIOS 898</td>
<td>Directed Studies in Biosciences</td>
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</tr>
<tr>
<td>BIOS 899</td>
<td>Directed Research in Biosciences</td>
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<tr>
<td>EVPP 536</td>
<td>The Diversity of Fishes</td>
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<tr>
<td>GEOL 501</td>
<td>Selected Topics in Modern Geology (may be repeated once)</td>
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<tr>
<td>GEOL 534</td>
<td>Vertebrate Paleontology</td>
<td></td>
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</tbody>
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|                      | Total Credits          | 24-36   |

1 Students may take other courses related to their research topic if approved by their committee. Courses in Geographic Information Systems or Statistics are encouraged.

**Dissertation Committee**

Upon admission to the program, each student is assigned an advisor from the bioscience faculty. The advisor may be changed by mutual consent of student and advisor, or petition to the program director and associate dean. With their advisor, students adopt an individual program that focuses on a specific area of research.

By the end of the fourth semester of coursework, students assemble a dissertation committee of four graduate faculty members with representation from at least two academic departments. The faculty advisor and the program director approve the program of study.

**Qualifying Examination**

On nearing completion of course requirements, students take a qualifying exam with a written and an oral component. At the discretion of the committee, the written qualifying exam may be retaken once if the student’s performance was deemed below satisfaction.

**Advancement to Candidacy**

Upon successful completion of the qualifying exam, the majority of all coursework, and an accepted dissertation proposal, students will be recommended for advancement to candidacy by the committee and the program director.

The semester after advancement to candidacy, students are eligible to enroll in dissertation research (BIOS 999 Doctoral Dissertation Research). Students must review their progress on the dissertation with their graduate committee on a regular basis until graduation.

**Dissertation Research**

No more than 24 combined credits from BIOS 998 Doctoral Dissertation Proposal and BIOS 999 Doctoral Dissertation Research may be applied toward satisfying doctoral degree requirements. Students register for a minimum of 3 credits of BIOS 999 Doctoral Dissertation Research in the first semester of advancement.

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<tbody>
<tr>
<td>BIOS 998</td>
<td>Doctoral Dissertation Proposal</td>
<td>12-24</td>
</tr>
<tr>
<td>BIOS 999</td>
<td>Doctoral Dissertation Research</td>
<td>12-24</td>
</tr>
</tbody>
</table>

|                      | Total Credits          | 12-24   |

**Doctoral Dissertation**

After advancing to doctoral candidacy, students work with their dissertation committee to develop their dissertation proposal into a completed doctoral dissertation. The dissertation research should represent a significant contribution that is publishable in a refereed scientific journal. When the dissertation is complete, students will present their results to their graduate committee and defend their dissertation in a public forum.