Department of Biology
Dr. Joanna B. Mott, Department Head
Phone: (540) 568-6225
Location: Bioscience Building, Room 2001C
Website: http://www.jmu.edu/biology

Undergraduate Coordinator
Dr. Dean Cocking

Professors
D. Brakke, J. Dilts, M. Gabriele, N. Garrison, R. Harris, C. Hurney, C. Lantz, C. McMullen, J. Monroe, J. Mott,
M. Renfroe, C. Rose, B. Wiggins, R. Wunderlich, G. Wyngaard

Associate Professors
S. Babcock, M. Bechtel, T. Bloss, J. Brown, C. Cleland, D. Cocking, S. Cresawn, J. Daniel, K. Gobetz,

Assistant Professors
I. Cooper, K. Cresawn, R. Enke, C. May, P. Vasudevan

Visiting Assistant Professors
B. Berkeley, P. Klim, P. Ludwig, J. Newnam-Baicy, K. Roth, S. Thomas, B. Velayudhan

Lecturer
E. Doyle, O. Hyman, T. Hynd, P. Kilkenny, A. Pesce

Mission Statement
The Department of Biology holds as its primary core value a commitment to providing superlative teaching for students. To accomplish this mission, we will create an environment for learning that will include opportunities for undergraduate research, a broadly based academic program, a supportive, diverse and collaborative faculty, an understanding of the process of science and a recognition of the importance of community outreach and involvement.

Career Opportunities
- Anthropology
- Aquatic Science
- Biodiversity
- Bioinformatics
- Biotechnology
- Botany
- Clinical Laboratory Sciences
- Dentistry
- Ecology and Environmental Science
- Epidemiology
- Forensic Science
- Forestry
- Genetic Counseling
- Graduate School in the Biological Sciences
- Immunology
- Landscape Architecture
- Medicine
- Microbiology
- Microscopy
- Neurobiology
- Nursing
- Occupational Therapy
- Optometry
- Pharmacology
- Physical Therapy
- Physician Assistant
- Physiology
- Research Assistant
- Scientific Writing
- Secondary Education
- U.S. Fish and Wildlife Service
- Veterinary Medicine
- Virology
- Zoology

1. See additional information regarding this affiliate program.
2. See additional information regarding this affiliate program.

Students interested in pursuing any of these career opportunities should contact the biology office. An appropriate adviser will be assigned for mentoring and course selection purposes.

Co-Curricular Activities and Organizations
Biology majors participate in activities such as:
- Weekly departmental seminars
- Tri-Beta, a national biology society
- Pre-professional health clubs and honor society
- EARTH, an environmental action club
- Summer and academic-year research opportunities
- Summer courses at biological field stations
- Internships with various organizations
- Aiding in teaching as student assistants
- Presenting papers at meetings
- Volunteering at Rockingham Memorial Hospital and with the rescue squad

Special Requirements
To be used as prerequisites for biology courses, grades of “C-” or higher should be earned in the following: BIO 103, BIO 114, BIO 124, BIO 214, BIO 224, CHEM 131, CHEM 131L, CHEM 132, and CHEM 132L. In order to be considered as possible transfer credit for BIO 114 and 124, the entire year of a freshman course must be completed at the “C” or higher level.

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It is the student's responsibility to provide evidence to demonstrate that the subject content of the sequence taken is the same as BIO 114 and BIO 124 combined. Matriculated JMU students may not obtain BIO 114 and 124 through transfer credit. In order for BIO 270 and BIO 290 credit to be transferred, both semesters of an Anatomy and Physiology course (A&P I and A&P II) must be completed at the "C" or higher level. A single semester of either of these sequences transfers as BIO 000. Practical hands-on experience in the field and/or laboratory is important content of laboratory based courses.

Transfer credit for courses including laboratories will only be awarded for those having skill and application content comparable to that of JMU courses. A maximum of four hours of lower division biology elective credit applicable toward the major or minor may be transferred as BIO 200. Upper division biology credits applicable toward the major or minor are transferred as specific courses, or as BIO 300 or BIO 426. Credits not applicable toward the major or minor, but applicable toward the 120 hour degree requirement, are transferred as BIO 000. A maximum of eight credit hours of first year (100) level BIO courses may be applied to the biology major or minor requirements.

Degree and Major Requirements
Bachelor of Science in Biology

The department offers a four-year B.S. degree program for a major in biology and for a major in biology qualifying for the Secondary Collegiate Professional License. Requirements for the B.A. degree can be met by adding the completion of an intermediate level foreign language and three credit hours in philosophy. Students may not receive dual credit toward the biology major for 300- and 400-level BIO courses that are applied toward the biotechnology major.

Biology majors must complete 40 credit hours of biology courses including 20 credit hours at the 300 and 400 level. Specific requirements include four core courses (BIO 114, BIO 124, BIO 214 and BIO 224), at least two upper-division laboratory courses and one course from a list of courses with an emphasis on organismal diversity. In addition, biology majors must complete a set of cognate courses in chemistry, mathematics, statistics and physics that are listed below. Students are encouraged to participate in independent research with a faculty mentor. Credits earned doing research will count toward the biology major but some restrictions apply. When requested, senior biology majors are expected to participate in program assessment test activities as a graduation requirement. Assessment information helps the department modify the curriculum to meet student needs.

Degree Requirements

<table>
<thead>
<tr>
<th>Required Courses</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Education</td>
<td>41</td>
</tr>
<tr>
<td>Quantitative requirement (in addition to General Education)</td>
<td>3</td>
</tr>
<tr>
<td>Scientific Literacy requirement (in addition to General Education)</td>
<td>3-4</td>
</tr>
<tr>
<td>Biology requirements (listed below)</td>
<td>40</td>
</tr>
<tr>
<td>Cognate requirements (listed below)</td>
<td>31-36</td>
</tr>
<tr>
<td></td>
<td>120</td>
</tr>
</tbody>
</table>

1 The General Education program contains a set of requirements each student must fulfill. The number of credit hours necessary to fulfill these requirements may vary.

http://www.jmu.edu/catalog/14
BIO 457. Biological Applications of Geographic Information Systems
BIO 459. Freshwater Ecology
BIO 460. Plant Cell and Tissue Culture
BIO 465. Environmental Toxicology
BIO 470. Morphology of Nonvascular Plants
BIO 480. Advanced Molecular Biology
BIO 481. Genomics
BIO 482. Human Histology
BIO 486. Systemsatics of Vascular Plants
BIO 490. Biomechanics

Only one Topics in Biology (BIO 426/427) may fulfill one of the laboratory course and/or organismal requirements. A list of the topics that may be used is available in the biology department office. These can be repeated with a change in topic, but only 12 credits from BIO 426/427 can be applied toward the 40-hour biology course requirement.

When choosing additional biology courses to complete the 40 credit hour requirement, students are strongly encouraged to discuss their career interests with an adviser who can help select courses best suited to their needs. Students are encouraged to participate in independent research and teaching courses with a faculty mentor, though a maximum of eight credits of BIO 492, BIO 494, BIO 495, BIO 496, BIO 497, BIO 499 and ISCI 450 can be counted toward the biology major.

Cognate Requirements
The following five groups of support courses are required for the biology major. Consult your academic adviser about which courses are appropriate.

Required Courses
1) Complete all of the following:
   - CHEM 131. General Chemistry I
   - CHEM 131L. General Chemistry Laboratory
   - CHEM 132. General Chemistry II
   - CHEM 132L. General Chemistry Laboratory
   - CHEM 241. Organic Chemistry I
   - CHEM 242. Organic Chemistry II
   - BIO/CM 361. Biochemistry I
   - CHEM 353. Environmental Chemistry
   - GEOL/CM 355. Geochemistry of Natural Waters
   - MATH 231. Calculus with Functions I
   - MATH 232. Calculus with Functions II
   - MATH 235. Calculus I
   - MATH 236. Calculus II
   - MATH 237. Calculus III
   - MATH 238. Calculus IV
   - MATH 318. Introduction to Probability and Statistics
   - PHYS 140-140L. College Physics I with Laboratory
   - PHYS 150-150L. College Physics II with Laboratory
   - PHYS 240-240L. University Physics I with Laboratory
   - PHYS 250-250L. University Physics II with Laboratory

2) Choose one of the following:
   - CHEM 241. Organic Chemistry I
   - CHEM 361. Biochemistry I
   - CHEM 353. Environmental Chemistry
   - GEOL/CM 355. Geochemistry of Natural Waters

3) Choose one of the following sets of courses:
   - MATH 231. Calculus with Functions I
   - MATH 232. Calculus with Functions II
   - MATH 235. Calculus I

4) Choose one of the following courses:
   - MATH 220. Elementary Statistics
   - MATH 285. Data Analysis
   - MATH 318. Introduction to Probability and Statistics

5) Choose one of the following sets of courses:
   - PHYS 140-140L. College Physics I with Laboratory
   - PHYS 150-150L. College Physics II with Laboratory
   - PHYS 240-240L. University Physics I with Laboratory
   - PHYS 250-250L. University Physics II with Laboratory

Recommended Schedule for Majors

First semester first year biology majors are encouraged to start with a 14-15 hour course load. This will generally include BIO 114, CHEM 131 and CHEM 131L, and/or a math course plus General Education. The work load will then be increased in the second semester based on the level of first semester success.

First Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 114. Organisms</td>
<td>4</td>
</tr>
<tr>
<td>BIO 124. Ecology and Evolution</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 131-132. General Chemistry Lectures</td>
<td>6</td>
</tr>
<tr>
<td>CHEM 131L-132L. General Chemistry Laboratories</td>
<td>2</td>
</tr>
<tr>
<td>Mathematics courses</td>
<td>4-8</td>
</tr>
<tr>
<td>General Education: Cluster One</td>
<td>9-12</td>
</tr>
<tr>
<td>Total</td>
<td>29-33</td>
</tr>
</tbody>
</table>

Second Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 214. Cell and Molecular Biology</td>
<td>4</td>
</tr>
<tr>
<td>BIO 224. Genetics and Development</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 241. Organic Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 242, BIO/CM 361, CHEM 353 or GEOL/CM 355</td>
<td>3</td>
</tr>
<tr>
<td>Mathematics course</td>
<td>3-4</td>
</tr>
<tr>
<td>General Education: from Clusters Two, Four and Five</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>31-32</td>
</tr>
</tbody>
</table>

Third Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper-level biology laboratory courses</td>
<td>8</td>
</tr>
<tr>
<td>Biology elective</td>
<td>3-4</td>
</tr>
<tr>
<td>Physics courses</td>
<td>8</td>
</tr>
<tr>
<td>General Education: from Clusters Two, Four and Five</td>
<td>7</td>
</tr>
<tr>
<td>Electives</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>32-33</td>
</tr>
</tbody>
</table>

Fourth Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper-level biology laboratory course</td>
<td>4</td>
</tr>
<tr>
<td>Biology electives</td>
<td>9</td>
</tr>
<tr>
<td>General Education: from Clusters Two, Four and Five</td>
<td>3</td>
</tr>
<tr>
<td>Electives</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
</tr>
</tbody>
</table>

Concentrations

Concentration in Ecology and Environmental Biology

Students choosing a concentration in ecology and environmental biology (biology/EEB majors) must complete 40 credit hours of biology courses. Specific requirements include four core courses and at least 24 credit hours chosen from a list of elective courses at the 300 and 400 level. This must include one course with an emphasis on organismal diversity and at least two upper-division laboratory or field courses. Three credit hours of independent research (BIO 497 and/or BIO 499) may be used for one, but only one, of the laboratory courses.

In addition, biology/EEB majors must choose from a set of cognate courses that include chemistry, geography, mathematics, statistics and physics. Students are encouraged to participate in independent research with a faculty mentor. Credits earned doing research will count toward the biology/EEB major, but some restrictions apply.

Concentration in Ecology and Environmental Biology

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 214. Cell and Molecular Biology</td>
<td>4</td>
</tr>
<tr>
<td>BIO 224. Genetics and Development</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 241. Organic Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 242, BIO/CM 361, CHEM 353 or GEOL/CM 355</td>
<td>3</td>
</tr>
<tr>
<td>Mathematics course</td>
<td>3-4</td>
</tr>
<tr>
<td>General Education: from Clusters Two, Four and Five</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>31-32</td>
</tr>
</tbody>
</table>

1 Chemistry beyond the minimum requirement is recommended in many areas of biology. Consult with your adviser about which courses are appropriate. Students counting CHEM 242 or CHEM 355 toward their cognate requirement may petition to count BIO/CM 361 for biology major credit. BIO/CM 361 may not be used for both a chemistry cognate and a biology major elective.

2 Mathematics beyond the minimum requirement is desirable in many areas of biology. Consult your adviser about which courses are appropriate.

3 Statistics beyond the minimum requirement is desirable in many areas of biology. Consult your adviser about which courses are appropriate.

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The biology/EEB concentration differs from the biology major in the following ways:

1) Students must take two additional cognate courses:
   - MATH 321. Analysis of Variance and Experimental Design or BIO 454. Introduction to Biometrics
   - GEOG 366. Introduction to Geographic Information Science or BIO 457. Biological Applications of Geographic Information Systems

2) For their upper-level biology course requirements, students must complete at least 24 credit hours from the following list. At least one of these must be an organismal diversity course ¹ and at least two must be laboratory/field courses. With prior approval from the concentration coordinator, BIO 426 and/or BIO 427 may be substituted. Students are strongly encouraged to discuss their career interests with an adviser who can help select courses best suited to their needs. Students are encouraged to participate in independent research with a faculty mentor (to a maximum of eight credits).

In addition to the courses listed below, a maximum of eight credits of BIO 494, BIO 495, BIO 496, BIO 497, BIO 499 and ISCI 450 can be counted toward the biology/EEB concentration.

BIO 305. Ornithology ¹, ²
BIO 309. Marine and Freshwater Invertebrates ¹
BIO 310. General Entomology ¹, ²
BIO 320. Comparative Anatomy of Vertebrates ¹, ²
BIO 340. Morphology and Anatomy of Vascular Plants ¹, ²
BIO/MATH 342. Mathematical Models in Biology
BIO 345. Animal Field Biology ¹, ²
BIO 354. Global Climate Change and Life
BIO 360. Plant Biology ¹
BIO 370. Animal Physiology ²
BIO 380. General Microbiology ¹, ²
BIO 386. Field Botany ¹, ²
BIO/PSYC 395. Comparative Animal Behavior
BIO/GEOL 400. Geology and Ecology of the Bahamas
BIO/GEOG 402. Forest Ecology ²
BIO 403. Animal Communication ²
BIO 404. Evolutionary Analysis
BIO 412. Mammalogy ¹, ²
BIO 451. Ecological Systems ²
BIO 452. Population Ecology ²
BIO 453. Microbial Ecology and Evolution
BIO 454. Introduction to Biometrics
BIO 455. Plant Physiology ²
BIO 456. Landscape Ecology ²
BIO 457. Biological Applications of Geographic Information Systems ²
BIO 459. Freshwater Ecology ²
BIO 465. Environmental Toxicology ²
BIO 466. Toxicology Seminar
BIO 470. Morphology of Nonvascular Plants ¹, ²
BIO 486. Systematics of Vascular Plants ¹, ²

¹ Meets the requirement for an organismal diversity course.
² Meets one of the two requirements for laboratory/field courses.

Note: It is highly recommended that students take additional upper-level degree elective courses in geography/GIS (such as GEOG 466, GIS and Geographic Databases, or GEOG 467, GIS Project Management) and in statistics (such as MATH 322, Applied Linear Regression, or MATH 324, Applied Nonparametric Statistics). Students should consult with their adviser about which courses are appropriate.

Biotechnology

Director: Dr. Matra Bechtel
Phone: (540) 568-5525
Website: http://www.jmu.edu/biology/biotechnology.shtml

In cooperation with the Department of Integrated Science and Technology and the Department of Chemistry and Biochemistry, the Department of Biology offers a four year, cross discipline B.S. degree program for a major in biotechnology. Students majoring in biotechnology will be prepared to enter the biotechnology workforce or to pursue graduate education in a wide array of fields including medical, agricultural or industrial biotechnology. Fields of research in biotechnology include applied molecular biology, bioinformatics and genomics.

Biotechnology majors must complete 47-53 credit hours of science foundation courses, 17 credit hours of biotechnology transition and core courses, and 15 credit hours of elective courses. Students may not receive dual credit toward the biotechnology major for 300 and 400-level biology courses that are applied toward the biology major. Refer to Biotechnology for a complete description of the major.

Dual Degree Programs

Forestry

James Madison University Liaison: Heather Griscom
Phone: (540) 568-5525
Website: http://www.jmu.edu/catalog/14

This dual degree program makes it possible for the student to earn a B.S. degree in biology from James Madison University and a Master of Forestry degree from Virginia Tech in five years.

There are two ways to pursue the dual degree program:
- For their upper-level biology course requirements, students must complete 96 credit hours, all JMU general education requirements, the biology core requirements, BIO 455 and five additional hours in biology.
- The student must take the cognate courses for biology majors in chemistry, mathematics and physics, courses in business (ACTG 241, ECON 201 and ECON 200) and a course in geology (GEOL 110).

During the fourth year of study the student will take further courses (at least 30 hours) at Virginia Tech for credit toward the B.S. in biology from JMU.

A total of 38 semester hours of biology and biology-related courses (taken at JMU and Virginia Tech) will be required for the JMU B.S. in biology, which will be conferred after the fourth year of study. If the student’s academic record is satisfactory, then they will be admitted into the graduate program of the Department of Forestry at Virginia Tech, where they will spend approximately three semesters (12 months) taking additional forestry and forestry-related courses to obtain the degree of Master of Forestry. To apply for the dual degree program, the student must have the permission of the dean of the College of Science and Mathematics. Information about the program can be obtained from the Department of Biology. Students are encouraged to inquire as early as possible in their undergraduate careers.
Minor Requirements
Biochemistry and Molecular Biology Minor
For more detailed information on this cross disciplinary minor, refer to the Biochemistry and Molecular Biology page.

Biology Minor
Students choosing to minor in biology must complete the following courses:

<table>
<thead>
<tr>
<th>Courses</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 114. Organisms</td>
<td>4</td>
</tr>
<tr>
<td>BIO 124. Ecology and Evolution</td>
<td>4</td>
</tr>
<tr>
<td>BIO 214. Cell and Molecular Biology</td>
<td>4</td>
</tr>
<tr>
<td>BIO 224. Genetics and Development</td>
<td>4</td>
</tr>
<tr>
<td>Biology elective (300-level and above)</td>
<td>3-4</td>
</tr>
</tbody>
</table>

Total: 19-20

Credit by Examination
When evidence of sufficient background or preparation is presented, the Department of Biology offers credit by examination in many of its non-lab courses at the discretion of the course instructor or coordinator. Students seeking such credit should make arrangements with the course instructor or coordinator and obtain approval of the department head.

Teaching Licensure
Biology majors need courses in physics and geology as well as inorganic and organic chemistry for many science education positions.

In addition to the general education and academic major requirements, biology majors desiring secondary teacher licensure must be admitted to teacher education, complete the pre-professional program in secondary education at the undergraduate level and complete the graduate level Master of Arts in Teaching degree.

It is critical that students seeking licensure consult regularly with both their education adviser and their major adviser to support their progression through the programs. For a full description of the program in secondary teaching, refer to the Department of Middle, Secondary and Mathematics Education, in addition to the College of Education.