

Department of Biology

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Assistant Professors

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Instructor

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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 and Advanced Fields of Study

- Anthropology
- Aquatic Science
- Biodiversity
- Bioinformatics
- Biotechnology¹
- Botany
- Clinical Laboratory Sciences
- Dentistry
- Ecology and Environmental Science
- Epidemiology
- Forensic Science
- Forestry¹
- 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 these affiliate programs on Pages 152-153.

Students interested in pursuing any of the career opportunities mentioned above should contact the biology office at (540) 568-6225. 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 research opportunities
- Summer courses at biological field stations
- Internships with various organizations
- Aiding in teaching and research 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: **GBIO** 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. Matriculated **JMU** students may not obtain **BIO** 114 and 124 through transfer credit. In order for **BIO** 270 and 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 three 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 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

Required Courses	Credit Hours
General Education ¹	41
Quantitative requirement (in addition to General Education)	3
Scientific Literacy requirement (in addition to General Education)	3-4
Major requirements (listed below) and electives	70-74
	<hr/> 120

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.

Major Requirements

Core Courses	Credit Hours
BIO 114. Organisms	4
BIO 124. Ecology and Evolution	4
BIO 214. Cell and Molecular Biology	4
BIO 224. Genetics and Development	4

Cognate Requirements

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

	Credit Hours
1) Complete all of the following:	8
CHEM 131. General Chemistry I	3
CHEM 131L. General Chemistry Laboratory	1
CHEM 132. General Chemistry II	3
CHEM 132L. General Chemistry Laboratory	1
2) Complete all of the following:	8
CHEM 341. Organic Chemistry Lecture I	3
CHEM 342. Organic Chemistry Lecture II	3
CHEM 346L. Organic Chemistry Laboratory	2
Note: Chemistry beyond the minimum requirement, especially biochemistry, is recommended in many areas of biology. Consult with your adviser about which courses are appropriate.	
3) Choose one of the following sets of courses:	4-8
MATH 231. Calculus with Functions I	4
MATH 232. Calculus with Functions II	4
OR	
MATH 235. Calculus I	4
Note: Mathematics beyond the minimum requirement is desirable in many areas of biology. Consult your adviser about which courses are appropriate.	
4) Choose one of the following courses:	3-4
MATH 220. Elementary Statistics	3
MATH 285. Data Analysis	4
MATH 318. Introduction to Probability and Statistics	4
Note: Statistics beyond the minimum requirement is desirable in many areas of biology. Consult your adviser about which courses are appropriate.	
5) Choose one of the following sets of courses:	8
PHYS 125. Principles of Physics with Biological Applications I	4
PHYS 126. Principles of Physics with Biological Applications II	4
OR	
PHYS 140-140L. College Physics I with Laboratory	4
PHYS 150-150L. College Physics II with Laboratory	4

Upper-level Biology Course Requirements

Students in the Biology major must complete at least 20 credit hours at the 300 and 400 level. One course must be from a group of courses on organismal diversity. Three courses must have a laboratory component. Independent research (BIO 495, 497 and 499) will not count for this laboratory course requirement.

1) Choose at least one course from the following list of organismal diversity courses:	
BIO 305. Ornithology	
BIO 310. General Entomology	
BIO 320. Comparative Anatomy of Vertebrates	
BIO 340. Morphology and Anatomy of Vascular Plants	
BIO 380. General Microbiology	
BIO 386. Field Botany	
BIO 409. Marine and Freshwater Invertebrates	
BIO 470. Morphology of Nonvascular Plants	
BIO 486. Systematics of Vascular Plants	
2) Choose at least three courses from the following list of laboratory courses:	
BIO 305. Ornithology	
BIO 310. General Entomology	
BIO 316. Principles of Animal Development	
BIO 320. Comparative Anatomy of Vertebrates	
BIO 340. Morphology and Anatomy of Vascular Plants	
BIO/GEOL 350. Invertebrate Paleontology	
BIO 365. Laboratory in Human Uses of Plants (must be taken with BIO 364)	
BIO 370. Animal Physiology	
BIO 380. General Microbiology	
BIO 386. Field Botany	
BIO 410. Advanced Human Anatomy	

BIO 416. Human Embryology
BIO 420. Medical Parasitology
BIO 443. Immunology Laboratory (must be taken with BIO 442)
BIO 445. Neurobiology
BIO 448. Medical Microbiology
BIO 451. Ecological Systems
BIO 452. Population Ecology
BIO 455. Plant Physiology
BIO 456. Landscape Ecology
BIO 457. Biological Applications of Geographic Information Systems
BIO 458. Comparative Animal Physiology
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. Systematics of Vascular Plants
BIO 490. Biomechanics

Only one Topics in Biology (BIO 426/427) or the previously offered BIO 325/326 may fulfill one of the laboratory course and/or organismal requirements. A list of the topics that may be used is available in the Department of Biology Office, Burruss 242. These can be repeated with a change in topic. However, only up to 12 credits can be applied toward the 40-hour biology course requirement.

Elective Biology Courses

Additional biology courses must be selected to complete the 40 credit hour program. 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).

A maximum of eight credits of BIO 494, 495, 496, 497, 499 and ISCI 450 can be counted toward the biology major.

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	Credit Hours
BIO 114. Organisms ¹	4
BIO 124. Ecology and Evolution	4
CHEM 131-132. General Chemistry Lectures ¹	6
CHEM 131L-132L. General Chemistry Laboratories	2
Mathematics courses ¹	4-8
General Education: Cluster One	9-12
	<hr/> 29-33

¹ Fulfills General Education: Cluster Three.

Second Year	Credit Hours
BIO 214. Cell and Molecular Biology	4
BIO 224. Genetics and Development	4
CHEM 341-342. Organic Chemistry Lecture	6
CHEM 346L. Organic Chemistry Laboratory	2
Mathematics course	3-4
General Education: from Clusters Two, Four and Five	12
	<hr/> 31-32

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Third Year	Credit Hours
Upper-level Biology laboratory courses	8
Biology elective	3-4
Physics courses	8
General Education: from Clusters Two, Four and Five	7
Electives	6
	<hr/> 32-33

Fourth Year	Credit Hours
Upper-level Biology laboratory course	4
Biology electives	9
General Education: from Clusters Two, Four and Five	3
Electives	15
	<hr/> 31

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 (including at least three upper-division laboratory or field courses, and one course with an emphasis on organismal diversity). 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.

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

- 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
- 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 course¹ and at least three must be laboratory/field courses². 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, 495, 496, 497, 499 and ISCI 450 can be counted toward the biology/EEB concentration.
 - BIO 305. Ornithology^{1,2}
 - 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 370. Animal Physiology²
 - BIO 380. General Microbiology^{1,2}
 - BIO 386. Field Botany^{1,2}
 - BIO/PSYC 395. Comparative Animal Behavior
 - BIO 404. Evolutionary Analysis
 - BIO 409. Marine and Freshwater Invertebrates¹
 - BIO 451. Ecological Systems²
 - BIO 452. Population Ecology²

- BIO 453. Microbial Ecology
 BIO 454. Introduction to Biometrics
 BIO 455. Plant Physiology²
 BIO 456. Landscape Ecology
 BIO 457. Biological Applications of Geographic Information Systems²
 BIO 458. Comparative Animal Physiology²
 BIO 459. Freshwater Ecology²
 BIO 465. Environmental Toxicology
 BIO 466. Ecotoxicology Seminar
 BIO 470. Morphology of Nonvascular Plants^{1,2}
 BIO 486. Systematics of Vascular Plants^{1,2}

Note: It is highly recommended that students take additional upper-level degree elective courses in geography/GIS (such as GEOG 466, GIS & 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

Dr. Robert McKown, Coordinator

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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, interdisciplinary B.S. degree program for a major in biotechnology. Students may not receive dual credit toward the biotechnology major for 300- and 400-level biology courses that are applied toward the biology major.

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 concentration courses including a capstone experience. With the advice and approval of a concentration adviser, each student selects the courses for his or her concentration area. Three broad areas of concentrations are suggested to serve a spectrum of student needs and desires. A research concentration would prepare students for graduate school or entry into a research laboratory. An industry concentration would prepare students for entry into the biotechnology industry. A custom concentration can be assembled for a specialized area of study such as bioinformatics, genomics or agricultural biotechnology.

Major and Degree Requirements

Bachelor of Science in Biotechnology Degree Requirements

General Education ¹	41
Quantitative requirement ²	3
Scientific Literacy requirement ²	3-4
Major requirements (listed below) and electives	<u>79</u>
	126

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.

² In addition to General Education.

Major Requirements

Science Foundation Courses	Credit Hours
Complete all of the following:	
BIO 114. Organisms	4
BIO 124. Ecology and Evolution	4
BIO 214. Cell and Molecular Biology	4
BIO 224. Genetics and Development	4
CHEM 131. General Chemistry I	3
CHEM 131L. General Chemistry Laboratory	1
CHEM 132. General Chemistry II	3
CHEM 132L. General Chemistry Laboratory	1
CHEM 341. Organic Chemistry Lecture I	3
CHEM 342. Organic Chemistry Lecture II	3
CHEM 346L. Organic Chemistry Laboratory	2
Choose one of the following sets of courses:	
MATH 231. Calculus with Functions I	4
MATH 232. Calculus with Functions II	4
OR	
MATH 235. Calculus I	4
Choose one of the following courses:	
MATH 220. Elementary Statistics	3
MATH 285. Data Analysis	4
Choose one of the following sets of courses:	
PHYS 125. Principles of Physics with Biological Applications I	4
PHYS 126. Principles of Physics with Biological Applications II	4
OR	
PHYS 140-140L. College of Physics I with Laboratory	4
PHYS 150-150L. College of Physics II with Laboratory	4
Biotechnology Transition and Core Courses	Credit Hours
Complete all of the following:	
BIOT 260. Biotechnology Seminar	1
ISAT 305. Biotechnology Lab	1
CHEM/BIO 361. Biochemistry I	3
CHEM 366L. Biochemistry Lab	2
BIO 480. Advanced Molecular Biology	4
ISAT 451. Biotechnology in Industry and Agriculture	3
ISAT 456. Ethical, Legal and Social Implications of Biotechnology	3

Biotechnology Area Concentration

Students must complete 12 credit hours of courses in one of the biotechnology concentrations areas listed below.

Research Concentration: Preparation for graduate school research program or employment in a research laboratory.

Industry Concentration: Preparation for entry-level positions in the biotechnology industry.

Custom Concentration: Specialized in specific areas of biotechnology, including bioinformatics, genomics and agricultural biotechnology.

Upon declaration of the major, each student will be assigned a concentration adviser. The student and the adviser will define the specific courses taken to fulfill the concentration requirement. The student will choose upper division (300 level or higher) BIO, ISAT, CHEM, PHYS or MATH courses, but other appropriate course offerings from other academic units may be substituted with the approval of the concentration adviser. Students are encouraged to include academic credit for research and/or internship experience.

Capstone Experience

To meet the requirement for a capstone experience, students must complete three credit hours of one of the following:

- ISAT 493. Senior Thesis
- BIO or CHEM or ISAT 499. Honors Research

Three credit hours of BIO or CHEM 497, Biological/Chemical Research, may be substituted to meet the capstone requirement, provided that the experience includes a presentation or paper as a requirement for completing the experience.

Recommended Schedule for Majors

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

First Year	Credit Hours
BIO 114. Organisms ¹	4
BIO 124. Ecology and Evolution	4
CHEM 131 and CHEM 131L. General Chemistry I ¹	4
CHEM 132 and CHEM 132L. General Chemistry II	4
Quantitative course ¹	4-8
General Education: Cluster One	9
	<hr/> 29-33

¹ Fulfills General Education: Cluster Three.

Second Year	Credit Hours
BIOT 260. Biotechnology Seminar	1
ISAT 305. Biotechnology Lab	1
BIO 214. Cell and Molecular Biology	4
BIO 224. Genetics and Development	4
CHEM 341-342. Organic Chemistry Lecture	6
CHEM 346L. Organic Chemistry Laboratory	2
Quantitative course	3-4
General Education: from Clusters Two, Four and Five	9
	<hr/> 30-31

Third Year	Credit Hours
CHEM/BIO 361 and CHEM 366L. Biochemistry Lab	5
BIO 480. Advanced Molecular Biology	4
Concentration Electives	4
Physics courses	8
General Education: from Clusters Two, Four and Five	7
Electives	4
	<hr/> 32

Fourth Year	Credit Hours
ISAT 456. Social and Ethical Issues	3
ISAT 451. Biotechnology in Industry	3
Concentration Electives	8
Capstone Course	3
General Education: from Clusters Two, Four and Five	6
Electives	6
	<hr/> 29

Dual Degree Programs Forestry

Mark Hudy, James Madison University Liaison

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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.

During the first three years at JMU, the student must complete 96 credit hours, all JMU general education requirements, the biology core requirements, BIO 455 and five additional hours in biology. Also, the student must take the cognate courses for

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biology majors in chemistry, mathematics and physics, courses in business (ACTG 241, ECON 201 and GECON 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

See Page 106 for the description of the interdisciplinary biochemistry and molecular biology minor.

Biology Minor

Students choosing to minor in biology must complete a program of at least 20 credit hours including:

	Credit Hours
BIO 114. Organisms	4
BIO 124. Ecology and Evolution	4
BIO 214. Cell and Molecular Biology or BIO 220. Cell Biology	3-4
Biology electives	8-9
	<hr/> 20

Credit by Examination

When evidence of sufficient background or preparation is presented, the Department of Biology offers credit by examination in most of its 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 section of the catalog.