

Biology

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Degrees offered: Bachelor of Science (BS), Bachelor of Arts (BA), Master of Science (MS), and Doctor of Philosophy (PhD) in Biology; BS and BA in Composite Teaching—Biological Science; BS in Public Health; MS and PhD in Ecology; MS and PhD in Toxicology is available through the Interdepartmental Program in Toxicology.

Undergraduate emphases: *Biology BS, BA*—Biology, Cellular/Molecular, Ecology/Biodiversity, Environmental; *Public Health BS*—Industrial Hygiene, Environmental Health, Public Health Education

Undergraduate Programs

Objectives

Biology. The Department of Biology offers programs leading to a Bachelor of Science or Bachelor of Arts degree. Majors will complete a core of courses which provide an understanding of biological principles. Upper-division courses provide integration, in-depth study, and an opportunity for specialization within the

different degree emphases. Additional coursework in chemistry, physics, statistics, and mathematics provides knowledge and analytical skills in these important related fields. Most biology degrees provide a foundation for graduate work. Biology majors can add a minor area of study, such as business or chemistry, to enhance their employment opportunities.

Prehealth Professions Programs. The Department of Biology supervises premedical, pre-dental, and other health professions. These programs satisfy entrance requirements for most medical and dental schools in the United States and Canada and are recognized for the high quality preprofessional preparation they provide. After four years, the student receives a BS degree in Biology or another major. **Coordinator:** Susan L. Haddock, Biology-Natural Resources 101. **Advisor:** D. M. Andy Anderson, Veterinary Science and Bacteriology 231.

Composite Teaching—Biological Science. This major combines content training in biology and related fields (including chemistry, physics, geology, mathematics, and statistics) with education courses. Graduates are licensed to teach at the secondary level. **Advisor:** Richard J. Mueller, Eccles Science Learning Center 245.

Public Health. The Department of Biology offers preprofessional training in public health. Individuals completing the BS degree have employment opportunities in such areas as environmental health, industrial hygiene, public health education, administration, nursing, nutrition, mental health, and social work. **Advisor:** David O. Wallace, Biology-Natural Resources 333.

The Department Head, the Director of Undergraduate Studies, and advisors in the Department of Biology are available to provide undergraduate majors with additional information regarding specific programs and career opportunities. The Biology Advising Center and the Director of Undergraduate Studies are located in BNR 101. Program requirements, advising information, and an “Ask an Advisor” e-mail service are on the Department of Biology web page at <http://www.biology.usu.edu>.

Students with majors in the Department of Biology should consult with their advisors regularly as they plan their course of study. Students have the responsibility to keep themselves aware of major requirements and course prerequisites. General requirements, specific course offerings, and the semesters that courses are taught may change.

Mathematics is an important and required skill to enhance one’s success in the sciences. Proper course level placement in mathematics at the beginning of the degree program is essential. Students should consult with an advisor to determine the appropriate level to begin their mathematics studies for meeting requirements and completion of their major. For detailed information, obtain an official Major Requirement Sheet from the Biology Advising Center.

Requirements

University Requirements. Students are responsible for meeting all University requirements for total credits, upper-division credits, credits of C- or better, and the University Studies Program. (See pages 42-52 in this catalog.)

College of Science Requirements. All college requirements are met by completing the departmental degree requirements; no additional coursework is required.

Departmental Admission Requirements. New freshmen admitted to USU in good standing qualify for admission to the Biology and Public Health majors. Transfer students from other institutions need a 2.25 transfer GPA, and students transferring from other USU majors need a 2.25 cumulative GPA for admission to the Biology and Public Health majors in good standing. Admission requirements differ for the Composite Teaching—Biological Science Major, as explained below.

Admission Requirements for the Composite Teaching—Biological Science Major. New freshmen admitted to USU in good standing qualify for admission to this major. To qualify for admission to the Secondary Teacher Education Program (STEP), new freshmen must acquire a cumulative 2.75 GPA and 60 credits of coursework. Transfer students from other institutions or other USU majors need a cumulative 2.75 GPA and 60 credits of coursework to be admitted to the major and the STEP. For information on additional admission criteria, students should contact the Department of Secondary Education.

GPA Requirement. To graduate, a candidate for any bachelor's degree offered by the Department of Biology must maintain a grade point average of 2.25 in all Department of Biology (BIOL or PUBH prefix) courses required for the major (Composite Teaching also requires a 2.75 cumulative GPA) and a grade of C- or better in BIOL 1210 and 1220. The *Pass-Fail* option is not acceptable for any course required for the degree, but D grades are permitted within the restrictions of the 2.25 GPA. The Composite Teaching—Biological Science Major requires a cumulative overall GPA of 2.75 for admission and graduation. The 2.25 GPA requirement applies to the Biology, Public Health, and BioMath minors.

BS Degree in Biology. Four different emphases are available within the Biology degree. The **Biology Emphasis** is the most flexible option. Electives may be selected in any subdiscipline the student wishes to emphasize (e.g., botany, ecology, zoology, entomology, microbiology, etc.). The **Cellular/Molecular and Ecology/Biodiversity** emphases provide more directed training that is appropriate for research or other technical employment in academic institutions, government agencies, and the private sector. They also provide excellent preparation for graduate work. The **Environmental Emphasis** prepares students in the biological and physical sciences as they relate to environmental problems and concerns. This degree serves as a foundation for graduate work and provides practical training for employment at the bachelor's degree level. Emphases will be listed on transcripts to indicate the student's specialization. The course requirements are as follows:

Biology Emphasis: BIOL 1210, 1220, 2220, 3200; BIOL 3300 or 5210; BIOL 5250; one of BIOL 2410, 3050, 3220, 4500, 5400, 5530, 5550, 5560, or 5570; a physiology course with a lab selected from: BIOL 4400 or 5300 or 5540 or BIOL 5600 and 5610 or BIOL 5620 and 5610; 10 credits of 4000-level and above BIOL or PUBH prefix courses as electives. In addition, students must complete: CHEM 1210, 1220, 1230, 1240, 2300, 2330, 3700, 3710; PHYX 2110 and 2120 or PHYX 2210 and 2220; MATH 1210; and STAT 3000.

Cellular/Molecular Emphasis: BIOL 1210, 1220, 2220, 3200, 4100, 5190, 5210, 5220, 5250; a physiology course with a lab selected from: BIOL 4400 or 5300 or 5540 or BIOL 5600 and 5610

or BIOL 5620 and 5610; one of BIOL 5160, 5240, or 5260; nine credits of 4000-level and above BIOL prefix courses as electives. In addition, students must complete: CHEM 1210, 1220, 1230, 1240, 2310, 2320, 2330, 2340, 5700, 5710, 5720; PHYX 2110 and 2120, or PHYX 2210 and 2220; MATH 1210; and STAT 3000.

Ecology/Biodiversity Emphasis: BIOL 1210, 1220, 2220, 3200, 3220, 3300, 5250; a physiology course with a lab selected from: BIOL 4400 or 5300 or 5540 or BIOL 5600 and 5610; one of BIOL 2410, 3400, or 5400; one of BIOL 4500, 5530, 5550, 5560, 5570 or 5580; one of BIOL 4060, 5010, 5020, 5170, or 5590; an additional course from one of the three previous groups or the following list: BIOL 4100, 4410, 5280, 5310, 5350 or 5800. In addition, students must complete: CHEM 1210, 1220, 1230, 1240, 2300, 2330, 3700, 3710; PHYX 2110 and 2120, or PHYX 2210 and 2220; MATH 1210; STAT 3000; Soil 3000; and GEOL 1150.

Environmental Emphasis: BIOL 1210, 1220, 2220, 3200, 3220, 3300, 5250; a physiology course with a lab selected from: BIOL 4400 or 5300 or 5540 or BIOL 5600 and 5610; one of BIOL 2410, 3400, or 5400; twelve elective credits from: BIOL 4500, 5020, 5050, 5310, 5320, 5410, 5800; PUBH 3610; CEE 5620; ADVS 5400; GEOL 1150; SOIL 3000. In addition, students must complete: CHEM 1210, 1220, 1230, 1240, 2310, 2320, 2330, 2340, 3600, 3610, 3700, 3710; PHYX 2110 and 2120, or PHYX 2210 and 2220; MATH 1210; and STAT 3000.

BS Degree in Composite Teaching—Biological Science. The Composite Teaching—Biological Science Major leads to licensure to teach in secondary schools. The course requirements are as follows: BIOL 1210, 1220, 2000, 2220, 3200, 3220, 3300, 4100, 5250; a physiology course with a lab selected from: BIOL 4400 or 5300 or 5540 or BIOL 5600 and 5610 or BIOL 5620 and 5610; GEOL 1150; SCI 4300; MATH 1210; STAT 3000; PHYX 2110, 2120; CHEM 1110, 1120, 1130. In addition, students must be accepted into the Secondary Teacher Education Program (STEP) and complete the following: Instructional Technology course (contact advisor for course number); SPED 4000; SCED 3100, 3210, 3300, 3400, 4200, 4210, 4300, 4400, 5500, and 5630.

BA Degrees in Biology and Composite Teaching—Biological Science. The student must complete the requirements for the BS (above) plus two years of a foreign language. (See page 50 of this catalog.)

BS Degree in Public Health. A four-year program leading to the Bachelor of Science in Public Health is offered by the Department of Biology with options in the following areas: environmental health, industrial hygiene, and public health education. Individuals completing the environmental health option are qualified to take the Registered Sanitarian's Examination. Those completing the industrial hygiene option qualify to sit for examination by the American Board of Industrial Hygiene following one year of professional experience. The Public Health degree requires a core of biology courses similar to that required for the biology degrees; additional biology and public health courses; and chemistry, physics, mathematics, statistics, and allied science and engineering courses appropriate to each emphasis. Three different emphases are available. The course requirements are as follows:

Industrial Hygiene Emphasis: BIOL 1210, 1220, 2000, 2220, 3200, 3300; PUBH 3310, 3610, 5020, 5310, 5320, 5330, 5350, 5500; ADVS 5400; three elective credits from: CEE 5610, 5670, 5730, 5790, or PUBH 5300. In addition, students must complete: CHEM 1210, 1220, 1230, 1240, 2300, 2330, 3600, 3610, 3700, 3710; PHYX 2110 and 2120, or PHYX 2210 and 2220; MATH 1210; and STAT 3000.

Public Health Education Emphasis: BIOL 1210, 1220, 2000, 2220, 3200, 3300; PUBH 3120, 4000, 5000, 5010, 5020, 5500; SPCH 1050; NFS 1020, 5210; SOC 3330, 3500; HEP 2000, 2500, 3000, 3600, 3800, 3900, 4200. In addition, students must complete: CHEM 1120, 1210, 1220, 1230, 1240; PHYX 1200; MATH 1210; and STAT 3000.

Environmental Health Emphasis: BIOL 1210, 1220, 2000, 2220, 3200, 3300; PUBH 3310, 3610, 4000, 5000, 5010, 5020, 5310, 5500; NFS 5110; CEE 5730; ten elective credits from: BIOL 3050, 3220, 3400, 5550; SOIL 3000; SPCH 1050; ADVS 5400; and CHEM 3700, 3710. In addition, students must complete: CHEM 1210, 1220, 1230, 1240, 2300, 2330; PHYX 2110 and 2120, or PHYX 2210 and 2220; MATH 1210; and STAT 3000.

Biology Minor. The Biology minor requires completion of the following: BIOL 1210, 1220; and 12 credits of upper-division (3000-level and above) BIOL prefix courses.

BioMath Minor. This minor requires mathematics and quantitative biology courses beyond those required for the basic biology degrees. It is an excellent option for students considering graduate work. Biology majors may take this minor through the Mathematics and Statistics Department. For details, contact the Biology Advising Center (BNR 101) or James W. Haefner (BNR 233).

Public Health Minor. The Public Health minor requires completion of the following: BIOL 1210, 1220; and 12 credits of upper-division (3000-level and above) Public Health elective courses.

Honors. An Honors Plan is available for students desiring a BS or BA degree “with Honors” in Biology. Departmental Honors requires the completion of 9 credits of Honors coursework in upper-division BIOL courses, BIOL 5800H, and a research-based Bachelor’s Thesis. For details, students should contact Kimberly A. Sullivan (BNR 313).

Field Trips. Many biology courses require field trips. Those enrolled are expected to dress appropriately for the conditions and observe any safety precautions issued by instructors. Many courses require modest laboratory fees.

Undergraduate Research— Bachelor’s Thesis in Biology

Students may do undergraduate research work under the supervision of selected faculty members. To receive academic credit, a student must enroll in BIOL 5800, Undergraduate Research. To complete the research project and write a thesis, a student must be enrolled in BIOL 5810, Bachelor’s Thesis, for 3 credits. A thesis supervisory committee must be organized, consisting of an approved biology faculty member and at least one other faculty member. The supervisory committee is subject to the approval of the Director of Undergraduate Studies. Three credits of BIOL 5800H or 5810 may be applied toward elective requirements in

some degree programs. Contact the Director of Undergraduate Studies, BNR 101, or Kimberly A. Sullivan (BNR 313) for assistance.

Financial Support

Scholarships, assistantships, grants-in-aid, and work-study programs are available from the University. Both the College of Science and the Department of Biology offer scholarships. Contact the College of Science office (SER 101) and the Biology Advising Center (BNR 101) for details.

Graduate Programs

Admission Requirements

See general admission requirements on pages 90-91. To be recommended for matriculated status, an applicant must have earned a bachelor’s degree (or equivalent) from an accredited institution, and a Biology faculty member must agree to serve as major professor for that applicant. The Department of Biology also considers these guidelines for admission: (1) the transcript should show a minimum GPA of 3.0 (*B*); and (2) the scores on the verbal and quantitative GRE should be above the 50th percentile and the analytical writing score should be 3.5 or above. Advanced GREs (especially biology) are also recommended. Applicants for whom English is not the primary language must have scored at least 575 on the TOEFL. The applicant’s undergraduate program should be similar to that offered by the Department of Biology at Utah State University, which includes the following and their prerequisites: general biology, microbiology, genetics, ecology, physiology, cell biology, developmental biology, and evolution; general and organic chemistry; calculus; statistics; and physics. Other preparatory courses may be specified by the student’s supervisory committee.

Degree Programs

For those who have demonstrated strong academic capability as well as research interest, the Department of Biology offers the **Master of Science Degree** and the **Doctor of Philosophy Degree** in either Biology or Ecology. Graduate degrees in **Toxicology** are available through the Interdepartmental Program in Toxicology.

Undergraduate majors in Biology at USU with especially strong backgrounds and interest in research may apply for study of the Master of Science degree as **transitional students**. Acceptance as a transitional student allows undergraduates with advanced standing to integrate up to 9 credits of graduate work into the final semesters of their Bachelor of Science study. Acceptance into this program, as into all graduate programs in Biology, is closely regulated. Formal application through the School of Graduate Studies is required.

Course Requirements

Biology MS and PhD Degrees. Course requirements are determined by the student’s supervisory committee. They will vary depending on the research emphasis selected and the background of the student.

Ecology MS and PhD Degrees. For specific requirements, see the description of the Ecology Interdepartmental Program (pages 179-180).

Research

The Department of Biology provides a dynamic and broad base for research and graduate study through a balanced program of basic and applied studies at ecosystem, population, organismal, cellular, and molecular levels. An outstanding variety of field sites; animal, plant, and microbe growth facilities; and modern well-equipped laboratories are available. Also, the Intermountain Herbarium, an excellent insect collection, the USDA/ARS U.S. National Pollinating Insects Collection, the Stable Isotope Laboratory, and the Center for Integrated BioSystems exist as research and support facilities.

Faculty members participate in and are supported by several interdepartmental programs, including the Ecology Center and the Center for Environmental Toxicology. In addition, many less formal contacts and interactions exist with colleagues in the colleges of Agriculture, Natural Resources, and Science.

Students are encouraged to carefully consider how their career goals match the faculty's research interests. Prospective students are strongly encouraged to contact faculty members with whom they are interested in working. Because of the combination of a diverse interdisciplinary base and excellent focused research programs, students have an opportunity to learn the philosophies and methods of many branches of biology.

Financial Assistance

Research assistantships are available from the grants of major professors and from Utah Agricultural Experiment Station funds. Teaching assistantships are awarded annually. All awards are made on a competitive basis and specific teaching needs are considered in awarding teaching assistantships. Given satisfactory performance, MS students are supported for at least two years and PhD candidates for at least four years on teaching assistantships. The department may also recommend particularly qualified students for College of Science or University fellowships. Admission to the graduate program of the Department of Biology does not guarantee financial support; however, applicants will not normally be admitted without financial support.

Career Opportunities

Completion of graduate degrees in Biology prepares students for careers in teaching and research in universities and colleges. Many graduates also find employment with private industry and state and national governmental agencies. Specific employment possibilities will depend on the nature of the graduate program pursued. The extensive background provided by a graduate degree also prepares students for eventual administrative responsibilities.

Research Emphases

Research areas of departmental faculty are diverse. Areas of research currently include: **Cellular and Molecular Biology:** plant-microbial interactions; molecular neurobiology and biophysics; gene regulation and signal transduction; membrane transport; molecular virology; **Ecology and Behavior:** community and ecosystem ecology; insect ecology and behavior; pollination biology; plant-insect interactions; vertebrate behavioral ecology; mathematical and computer modeling; soil microbiology; fungal ecology; biological control; integrated pest management (IPM); **Physiology and Comparative Biology:** toxicology and industrial hygiene; insect pathology; plant physiology and pathology; and

Systematics and Evolution: systematics and evolution of plants, fungi, insects, reptiles, and amphibians; evolutionary quantitative genetics; biogeography; evolution of chemical defenses and resistance in microorganisms, insects, reptiles, and amphibians.

Research and Teaching Facilities

Herbarium. Graduate study in plant taxonomy offered in the Department of Biology utilizes the extensive facilities of the Intermountain Herbarium. The collection includes over 220,000 research specimens. About 50 percent are from the Intermountain Region, while most of the remainder are from other regions of North America.

Insect Collection. Comprising over a million specimens, the insect collection is available to scientists and graduate students involved in taxonomic research and to those requiring identification of insects in various research projects. The collection primarily covers the Intermountain Region, but it also contains species from nearly all areas of the world. The BNR Building also houses the USDA/ARS U.S. National Pollinating Insect Collection.

Laser Scanning Confocal Microscope. The Department of Biology has a BioRad 1024 Laser Scanning Confocal Microscope. This state-of-the-art technology utilizes highly tuned lasers to give detailed sectional views of the interior of intact structures such as cells and tissues, and greatly extends the advantages of fluorescence microscopy. This microscope is utilized by researchers campuswide, and is an indispensable tool for molecular and cellular studies.

Center for Integrated BioSystems (CIB). The CIB operates three service laboratories and a variety of research projects. The service laboratories provide essential biological resources for biotechnology research and development including: DNA sequencing, peptide synthesis, protein sequencing, antibodies, and fermentation.

Biology Faculty

Professors

Anne J. Anderson, microbiology and plant pathology
Kandy D. Baumgardner, genetics
Edmund D. Brodie, Jr., behavior and evolution
E. W. "Ted" Evans, insect ecology
James W. Haefner, systems analysis
Joseph K.-K. Li, virology
James A. MacMahon, community ecology
Frank J. Messina, insect biology
Keith A. Mott, plant physiology
William J. Popendorf, industrial hygiene
Peter C. Ruben, neurobiology
Jon Y. Takemoto, microbiology

Associate Professors

Brett A. Adams, cell signaling
Diane G. Alston, integrated pest management
Mary E. Barkworth, plant systematics
Daryll B. DeWald, cell biology
Timothy A. Gilbertson, neurobiology
Bradley R. Kropp, mycology

Joseph R. Mendelson, III, vertebrate systematics
Richard J. Mueller, plant morphology
Gregory J. Podgorski, developmental biology
John M. Stark, microbial ecology and biogeochemistry
Kimberly A. Sullivan, behavioral ecology
Carol D. von Dohlen, insect biology
Dennis L. Welker, molecular biology
Paul G. Wolf, systematics and molecular biology

Assistant Professors

Michelle A. Baker, aquatic ecology
Michael E. Pfrender, evolutionary quantitative genetics

Professors Emeriti

William A. Brindley, entomology and toxicology
Donald W. Davis, entomology and pest management
Keith L. Dixon, ornithology and mammalogy
LeGrande C. Ellis, endocrinology and reproductive physiology
James A. Gessaman, vertebrate physiological ecology
Ting H. Hsiao, insect physiology and biochemistry
Gene W. Miller, plant biochemistry and physiology
Ivan G. Palmblad, evolutionary ecology
Frederick J. Post, aquatic microbiology and microbial ecology
Reed S. Roberts, entomology
Richard J. Shaw, vascular plant taxonomy
John R. Simmons, biochemical genetics
John J. Skujins, soil biochemistry and microbial ecology
Sherman V. Thomson, plant pathology
Nabil N. Youssef, cell biology and parasitology

Associate Professors Emeriti

David B. Drown, environmental health
Wilford J. Hansen, systematic entomology
Raymond I. Lynn, algology and microbial ecology
George W. Welkie, plant physiology and virology

Research Professor

Donald W. Roberts, insect pathology

Research Associate Professor

Vijendra K. Singh, immunology

Research Assistant Professors

Michelle A. Grilley, molecular biology
Joanne E. Hughes, molecular genetics
Charles D. Miller, plant pathology
Mark P. Miller, genetics

Adjunct Professors

James H. Cane, bee biology
Noelle E. Cockett, biotechnology
Robert Fogel, mycology
William P. Kemp, insect ecology
J. Russell Mason, predation, ecology, and behavior
Darwin L. Sorensen, aquatic microbiology
Rex S. Spendlove, virology

Adjunct Associate Professors

John C. Bailey, public health
Dale L. Barnard, chemotherapy of viruses
Jay B. Karren, entomology
Vincent J. Tepedino, entomology

Adjunct Assistant Professors

Daniel A. Boston, DDS, dentistry
Terry Griswold, bee biology
Rosalind R. James, entomology
James P. Pitts, entomology
Theresa L. Pitts-Singer, entomology

Principal Lecturer

David M. "Andy" Anderson, medical technology

Lecturers

John A. Flores II, public health, industrial hygiene
Alice M. Lindahl, invertebrate biology
David O. Wallace, public health, industrial hygiene

Course Descriptions

Biology (BIOL), pages 349-354
Public Health (PUBH), page 472