Biological Sciences

D. Schulz, Director
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The Division of Biological Sciences offers both a Bachelor of Arts and a Bachelor of Science with a major in Biological Sciences, in addition to a minor in biological sciences for students majoring in other departments. The department also offers MA and PhD degrees in Biological Sciences.

Faculty

Curators Professor J. A. Birchler**, J. C. Walker**
Curators Distinguished-Teaching Professor T. E. Phillips**
Assistant Professor R. Angelovici**, C. Y. Chabu**, E. King**, L. Sullivan**
Research Assistant Professor R. Bhandari
Teaching Professor S. L. Bush*, B. Stone*
Teaching Associate Professor R. D. Hurst
Teaching Assistant Professor A. Durbak
Curators Professor Emeritus H. C. Gerhardt**, G. P. Smith**, F. S. Vom Saal**
Distinguished Teaching-Professor Emeritus J. E. Carrel**

* Graduate Faculty Member - membership is required to teach graduate-level courses, chair master's thesis committees, and serve on doctoral examination and dissertation committees.
** Doctoral Faculty Member - membership is required to chair doctoral examination or dissertation committees. Graduate faculty membership is a prerequisite for Doctoral faculty membership.

Undergraduate

- Department Level Requirements (http://catalog.missouri.edu/undergraduategraduate/collegeofartsandscience/biologicalsciences/biological_science_major_requirements/)
- BA in Biological Sciences (http://catalog.missouri.edu/undergraduategraduate/collegeofartsandscience/biologicalsciences/ba_in_biological_sciences/)
- BS in Biological Sciences (http://catalog.missouri.edu/undergraduategraduate/collegeofartsandscience/biologicalsciences/bs_in_biological_sciences/)
  - with emphasis Medical Science and Human Biology (http://catalog.missouri.edu/undergraduategraduate/collegeofartsandscience/biologicalsciences/bs-biol-science-emphasis-med-science-human-bio/)
- Minor in Biological Sciences (http://catalog.missouri.edu/undergraduategraduate/collegeofartsandscience/biologicalsciences/minor_in_biological_sciences/)
offer special outreach programs for secondary school science teachers, students and citizens in Missouri.

The Division of Biological Sciences actively recruits outstanding graduate students from both national and international pools. Selected candidates are interviewed. The best are admitted to the division for graduate study. Even more important than the quantitative Grade Point Average, we are interested in evidence of critical qualitative characteristics including: undergraduate research experiences and presentation of research results; ability to face and overcome obstacles; exceptional motivation, work ethic, intellectual vitality, initiative, creativity, critical thinking ability and leadership ability.

Areas of Study
The division offers primarily PhD degrees. General areas of research emphasis within the division include evolutionary biology, ecology and behavior; genetic, cellular, molecular and developmental biology; neurobiology and behavior; and plant sciences. Within these general areas, students may devise more specific graduate programs in, for example, plant genetics, invertebrate chemical communication or neurophysiology.

Interdisciplinary Research
Several students are currently involved in interdepartmental programs in neurosciences, genetics, plant biochemistry and physiology, cellular and molecular biology, the Conservation Biology Program, microbiology, and physiology. In addition, the presence on this campus of a School of Medicine, College of Agriculture, Food and Natural Resources and College of Veterinary Medicine provides opportunities for direct interaction with a variety of established research scientists. Faculty in the division also participate in the Genetics Area Program, the Pathobiology Area Program, the Molecular Biology Program, the Interdisciplinary Program in Plant Biochemistry and Physiology, the Interdisciplinary Neuroscience Program and the Conservation Biology Program.

All entering graduate students should have a broad background in biology and should have completed courses in mathematics through integral calculus, chemistry through organic chemistry and a year of physics. Exceptions may be made for individual students. Outstanding students with undergraduate degrees in areas other than biology (such as biochemistry, chemistry, physics, engineering, mathematics or psychology) are encouraged to apply with the understanding that subject matter in biology will be addressed in the first year of graduate study.

Research Facilities and Resources
Divisional faculty have ready access to the campus computing network and microcomputers in their laboratories. Beyond the specialized equipment in each faculty research laboratory, departmental and campus equipment and facilities available to graduate students include:

- molecular and cellular biology core facilities, including DNA (with Next Generation Sequencing), Electron Microscopy, Cell and Immunobiology, Informatics, Nuclear Magnetic Resonance, Molecular Cytology, Proteomics, Structural Biology, and Transgenic Animal;
- a 15,000-square-foot greenhouse complex;
- animal-care facilities suitable for mice, rats, rabbits and amphibians;
- a 14-acre botany preserve on the campus and a 146-acre prairie research station;
- 24 walk-in plant growth chambers with regulated light, temperature and humidity controls;
- cell and tissue culture facilities;
- growth chambers;
- scanning spectrophotometers and kinetic fluorimeters;
- ultracentrifuges and scintillation counters;
- HPLC facilities;
- sound isolation acoustic chambers;
- neurophysiological recorders, oscilloscopes and amplifiers; and,
- microneurosurgery facilities and equipment.

Funding
Financial support is available through research training grants, fellowships, scholarships, graduate research assistantships, and graduate teaching assistantships.

**BIO_SC 1001: Topics in Biological Science - General**
Selected topics not covered in current offerings. May not be used in partial fulfillment of requirements for a biological science in general education. May be graded on A-F or S/U basis only.

**Credit Hour:** 1-3

**BIO_SC 1002: Topics in Biological Sciences - Biological Sciences**
Selected topics not in regularly offered courses. Selected sections of this course may be graded either on A-F or S/U basis only.

**Credit Hour:** 1-3

**BIO_SC 1006: Topics in Biological Sciences - Mathematical Sciences**
Selected topics not in regularly offered courses. Selected sections of this course may be graded either on A-F or S/U basis only.

**Credit Hour:** 1-31

**BIO_SC 1007: Topics in Biological Sciences - Physical Sciences**
Selected topics not in regularly offered courses. Selected sections of this course may be graded either on A-F or S/U basis only.

**Credit Hour:** 1-3

**BIO_SC 1010: General Principles and Concepts of Biology**
Emphasizes connections and applications to society and the human condition, science literacy, and critical thinking skills. A discussion of general principles and fundamental concepts of living things. This course is intended for non-science majors. No more than 5 credits for BIO_SC 1010, BIO_SC 1020, and BIO_SC 1030.

**Credit Hours:** 3

**Recommended:** MATH 1100

**BIO_SC 1020: General Biology Laboratory**
Laboratory exercises dealing with representative organisms and methods of modern biological sciences. This course is intended for non-science majors. No more than 5 credits for BIO_SC 1010, BIO_SC 1020, and BIO_SC 1030.

**Credit Hours:** 2

**Prerequisites or Corequisites:** BIO_SC 1010
BIO_SC 1030: General Principles and Concepts of Biology with Laboratory
Survey of general principles and basic concepts of life science, emphasizing applications to society and the human condition. Lectures address science literacy and critical thinking and laboratory exercises use representative organisms to complement lecture topics. This course is intended for non-science majors. No more than 5 credits for BIO_SC 1010, BIO_SC 1020, and BIO_SC 1030.
Credit Hours: 5
Recommended: MATH 1100 or concurrent enrollment

BIO_SC 1060: Basic Environmental Studies
Considers the ecosystem, energy and biogeochemical cycles and population dynamics; relation of the environment to agriculture and technology, pollution, power and food production; politico-economic considerations; moral and ethical issues. For non-science majors.
Credit Hours: 3

BIO_SC 1200: General Botany with Laboratory
Introduction to study of plants. Emphasis on structure, growth, physiology, genetics and reproduction of plants.
Credit Hours: 5

BIO_SC 1400: Evolution for Everyone
This course will explore the application of evolutionary theory to modern human affairs. We will study the processes involved in evolution and investigate evolutionary interpretations of human social behavior (e.g., psychology, mate choice, economics, religion, and morality). No credit if student has received credit for BIO_SC 2060 or BIO_SC 4600.
Credit Hours: 3

BIO_SC 1500: Introduction to Biological Systems with Laboratory
Basic concepts and principles of the structure and function of living systems, from cells to populations. Foundation course for science students intending to complete a 3-semester sequence that also includes genetics and cell biology.
Credit Hours: 5
Recommended: MATH 1100 or sufficient ALEKS score

BIO_SC 1500H: Introduction to Biological Systems with Laboratory - Honors
Basic concepts and principles of the structure and function of living systems, from cells to populations. Foundation course for science students intending to complete a 3-semester sequence that also includes genetics and cell biology.
Credit Hours: 3-5
Prerequisites: MATH 1100 and high school chemistry. Honors eligibility required

BIO_SC 2001: Topics in Biological Sciences - General
Selected topics not covered in current offerings. May not be used in partial fulfillment of requirements for a biological science in general education. May be graded on A-F or S/U basis.
Credit Hour: 1-3
Recommended: One course in Biology
BIO_SC 2020: How the Brain Works
Basic structure and function of the brain; left and right brain studies; gender differences; learning and memory; brain disorders.
Credit Hour: 1
Prerequisites: C- or above in BIO_SC 1010 or BIO_SC 1500

BIO_SC 2030: Life of the Cell
This course will help students understand basic concepts of biomolecular structure, cell organization, cell membranes, energy and metabolism, cellular communication, and cell division. This course is intended for non-science majors and may not be used to satisfy requirements for either a major or a minor in biological sciences.
Credit Hours: 3
Prerequisites: BIO_SC 1010

BIO_SC 2060: Community Biology
Principles of population biology, ecology, and evolution, including consideration of human impacts on biological communities and ecosystems.
Credit Hours: 3
Prerequisites: BIO_SC 1010 or equivalent. Not open to biology majors

BIO_SC 2100: Infectious Diseases
An introduction to the basic science of bacterial, viral, protozoan, fungal and helminth infections, including discussions of how illness has influenced or been affected by public policy and culture.
Credit Hours: 3
Prerequisites: BIO_SC 1010, BIO_SC 1200 or BIO_SC 1500. Not open to Biology Majors

BIO_SC 2150: Genetic Diseases
This course will discuss the biological basis for genetic diseases, including inherited diseases and non-inherited diseases such as cancer. The units will include an introduction providing necessary background information, as section studying the technology used to study genetic diseases and several units discussing specific diseases and their impact on history and society. This course is intended for non-science majors. Cannot be used to satisfy degree requirements for biology major or biology minor.
Credit Hours: 3
Prerequisites: BIO_SC 1010

BIO_SC 2200: General Genetics
Principles of inheritance in plants and animals; structure and use of genetic material, transmission of genetic information, linkage, modification of genetic information, regulation of genetic activity, population genetics.
Credit Hours: 4
Prerequisites: BIO_SC 1100, BIO_SC 1200 or BIO_SC 1500 and CHEM 1320 (or concurrent enrollment)

BIO_SC 2200H: General Genetics - Honors
Principles of inheritance in plants and animals; structure and use of genetic material, transmission of genetic information, linkage, modification of genetic information, regulation of genetic activity, population genetics. Prerequisites:
Credit Hours: 4
Prerequisites: BIO_SC 1100, BIO_SC 1200 or BIO_SC 1500 and CHEM 1320 (or concurrent enrollment). Honors eligibility required

BIO_SC 2300: Introduction to Cell Biology
Analysis of cellular organization and function at the molecular level. The mechanisms underlying cellular trafficking, cell motility, and signaling within cells and between cells and their environment will be emphasized.
Credit Hours: 4
Prerequisites: BIO_SC 2200

BIO_SC 2300H: Introduction to Cell Biology- Honors
Analysis of cellular organization and function at the molecular level. The mechanisms underlying cellular trafficking, cell motility, and signaling within cells and between cells and their environment will be emphasized.
Credit Hours: 5
Prerequisites: BIO_SC 2200 or 2200H. Honors eligibility required

BIO_SC 2300HW: Introduction to Cell Biology - Honors/Writing Intensive
Analysis of cellular organization and function at the molecular level. The mechanisms underlying cellular trafficking, cell motility, and signaling within cells and between cells and their environment will be emphasized.
Credit Hours: 5
Prerequisites: BIO_SC 2200 or 2200H. Honors eligibility required

BIO_SC 2940: Internship in Biological Science
Work experience in a non-profit, for profit, or governmental organization relevant to the biological sciences. Intended for students doing internships in which independent research is less than 50% of the experience. Graded on S/U basis only.
Credit Hour: 1-3
Prerequisites: instructor’s consent
Recommended: junior standing, 12 hours of biological science and 2.70 GPA

BIO_SC 2950: Directed Independent Research
Participation in faculty research activities. May not be used to satisfy degree requirements for BA or BS in biological sciences or the minor in biological sciences.
Credit Hour: 1-3
Prerequisites: Departmental consent

BIO_SC 2960: Readings in Biological Science
Supervised reading in biological literature. May be repeated up to six hours total credit. Selected sections of this course may be graded either on A-F or S/U basis only. May not be used in partial fulfillment of Arts and Science foundation requirement.
Credit Hour: 1-3
Prerequisites: instructor’s consent
**BIO_SC 2965H: Honors Readings in Biological Literature**
Selected readings in biological literature for Honors, in consultation with instructor. May not be used in partial fulfillment of Arts and Science foundation requirement.

**Credit Hour:** 1-3  
**Prerequisites:** overall 3.3 GPA; instructor's consent. Honors eligibility required

**BIO_SC 3002: Topics in Biological Sciences - Biological Sciences**
Selected topics not in regularly offered courses. Selected sections of this course may be graded either on A-F or S/U basis only.

**Credit Hour:** 1-3  
**Recommended:** Junior Standing

**BIO_SC 3002H: Topics in Biological Sciences - Biological Sciences - Honors**
Selected topics not offered in regular curriculum.

**Credit Hour:** 1-3  
**Prerequisites:** Honors eligibility required

**BIO_SC 3002W: Topics in Biological Sciences - Biological Sciences - Writing Intensive**
Selected topics not in regularly offered courses. Selected sections of this course may be graded either on A-F or S/U basis only.

**Credit Hour:** 1-3  
**Recommended:** Junior Standing

**BIO_SC 3006: Topics in Biological Sciences - Mathematical Sciences**
Selected topics not in regularly offered courses. Selected sections of this course may be graded either on A-F or S/U basis only.

**Credit Hour:** 1-3  
**Recommended:** Junior Standing

**BIO_SC 3006H: Topics in Biological Sciences - Mathematical Sciences - Honors**
Selected topics not offered in regular curriculum.

**Credit Hour:** 1-3  
**Prerequisites:** Honors eligibility required

**BIO_SC 3006W: Topics in Biological Sciences - Mathematical Sciences - Writing Intensive**
Selected topics not in regularly offered courses. Selected sections of this course may be graded either on A-F or S/U basis only.

**Credit Hour:** 1-3  
**Recommended:** Junior Standing

**BIO_SC 3007: Topics in Biological Sciences - Physical Sciences**
Selected topics not in regularly offered courses. Selected sections of this course may be graded either on A-F or S/U basis only.

**Credit Hour:** 1-3  
**Recommended:** Junior Standing

**BIO_SC 3007H: Topics in Biological Sciences - Physical Sciences - Honors**
Selected topics not offered in regular curriculum.

**Credit Hour:** 1-3  
**Prerequisites:** Honors eligibility required

**BIO_SC 3007W: Topics in Biological Sciences - Physical Sciences - Writing Intensive**
Selected topics not in regularly offered courses. Selected sections of this course may be graded either on A-F or S/U basis only.

**Credit Hour:** 1-3  
**Recommended:** Junior Standing

**BIO_SC 3010: Professional Skills**
This course will focus on application and interview skills for students interested in medical school. Graded on S/U basis only.

**Credit Hour:** 1  
**Prerequisites:** instructor's consent  
**Recommended:** junior standing; 3.4 GPA, and biological sciences majors

**BIO_SC 3050: Genetics and Society**
Introduction to genetics, emphasizing the impact of genetics on human society. Human evolution, molecular genetics, genetic engineering in medicine and agriculture. An intensive writing course.

**Credit Hours:** 3

**BIO_SC 3050W: Genetics and Society - Writing Intensive**
Introduction to genetics, emphasizing the impact of genetics on human society. Human evolution, molecular genetics, genetic engineering in medicine and agriculture. An intensive writing course.

**Credit Hours:** 3

**BIO_SC 3075: The Human Microbiome**
This course examines the astonishing diversity and medical significance of the microbes that inhabit our bodies. Interactive discussions explore scientific and ethical dimensions of topics ranging from probiotics and 'poop transplants' to the role of microbes in asthma and obesity.

**Credit Hours:** 3

**BIO_SC 3075W: The Human Microbiome - Writing Intensive**
This course examines the astonishing diversity and medical significance of the microbes that inhabit our bodies. Interactive discussions explore scientific and ethical dimensions of topics ranging from probiotics and 'poop transplants' to the role of microbes in asthma and obesity.

**Credit Hours:** 3

**BIO_SC 3075W: The Human Microbiome - Writing Intensive**
This course examines the astonishing diversity and medical significance of the microbes that inhabit our bodies. Interactive discussions explore scientific and ethical dimensions of topics ranging from probiotics and 'poop transplants' to the role of microbes in asthma and obesity.

**Credit Hours:** 3

**BIO_SC 3210: Plant Systematics**
Principles of classification of plants; survey of diversity in flowering plant families; identification of local flora; use of keys. Includes lab.

**Credit Hours:** 4  
**Recommended:** 8 hours of Biological Sciences
**BIO_SC 3210W: Plant Systematics - Writing Intensive**
Principles of classification of plants; survey of diversity in flowering plant families; identification of local flora; use of keys. Includes lab.

Credit Hours: 4  
Recommended: 8 hours of Biological Sciences

**BIO_SC 3260: Invertebrate Zoology**
Structure, ecology and phylogeny of the invertebrate phyla. Includes lab.

Credit Hours: 4  
Prerequisites: BIO_SC 1100 or BIO_SC 1500  
Recommended: Junior Standing

**BIO_SC 3260W: Invertebrate Zoology - Writing Intensive**
Structure, ecology and phylogeny of the invertebrate phyla. Includes lab.

Credit Hours: 4  
Prerequisites: BIO_SC 1100 or BIO_SC 1500  
Recommended: Junior Standing

**BIO_SC 3360: Herpetology**
The biology, ecology, taxonomy, and distribution of amphibians and reptiles. Some Saturday field trips.

Credit Hours: 4  
Recommended: 8 hours Biological Sciences or equivalent

**BIO_SC 3400: Evolution and Ecology**
Introduction to principles of evolution and ecology. Topics include natural selection, adaptation, phylogenetic analysis, human evolution, population growth and regulation, population interactions, ecosystem ecology, and human impacts on ecological processes. No credit for this course if either BIO_SC 3650 or BIO_SC 4600 already completed; may not co-enroll in this course and BIO_SC 4600.

Credit Hours: 3  
Prerequisites: BIO_SC 2200

**BIO_SC 3510: Biology of Fungi**
(same as PLNT_S 3510). The diverse roles of fungi in the biosphere will be explored by considering fungi we eat, fungi which destroy our food, fungi in folklore and fungi as global nutrient recyclers. Includes lab.

Credit Hours: 3  
Prerequisites: BIO_SC 1200 or BIO_SC 1500 or equivalent

**BIO_SC 3560: General Ecology**
Principles of populations, coevolution, density factors, competition; physical environment; concept of community, trophic structure, biotic succession; characterization of biomes, man in ecosystem. Biology majors having completed BIO_SC 3100: 2 hours credit.

Credit Hours: 5  
Prerequisites: junior standing  
Recommended: 10 hours in Biology

**BIO_SC 3650: General Ecology - Writing Intensive**
Principles of populations, coevolution, density factors, competition; physical environment; concept of community, trophic structure, biotic succession; characterization of biomes, man in ecosystem. Biology majors having completed BIO_SC 3100: 2 hours credit.

Credit Hours: 5  
Prerequisites: junior standing  
Recommended: 10 hours in Biology

**BIO_SC 3655: Tropical Ecology: Methods and Applications**
Field study of tropical community; additional fee for transportation and accommodations required.

Credit Hours: 3  
Prerequisites: BIO_SC 3650 or BIO_SC 4600 or BIO_SC 4660

**BIO_SC 3700: Animal Physiology**
Introduces concepts of vertebrate organ function and homeostatic control emphasizing mammalian physiology. Some comparisons to function in other vertebrates and strategies for coping with environmental stresses introduced. Includes lab.

Credit Hours: 5  
Prerequisites: BIO_SC 2300

**BIO_SC 3710: Introductory Entomology**
(same as PLNT_S 3710). Emphasizes the role insects play in the scheme of life. Topics include insect structure, development, diversity, ecology, communication and behavior, and management. Prerequisites: Completion of 60 credit hours and one of the following: BIO_SC 1100 (or F_W 1100) or BIO_SC 1200, or BIO_SC 1500.

Credit Hours: 3  
Prerequisites: PLNT_S 3710 (or BIO_SC 3710) or concurrent registration

**BIO_SC 3715: Insect Diversity**
(same as PLNT_S 3715). Laboratory exercises emphasizing external insect anatomy, classification, and identification (to family level). Preparation of an insect collection is required.

Credit Hours: 2  
Prerequisites: PLNT_S 3710 (or BIO_SC 3710) or concurrent registration

**BIO_SC 3750: General Microbiology**
Explores the diversity and adaptive capabilities of microbial life. Topics include bacterial cell structure, metabolism, genetics, and ecology.

Credit Hours: 3  
Prerequisites: BIO_SC 2200 and BIO_SC 2300  
Recommended: grades in C range for prerequisites

**BIO_SC 3760: Microbiology Laboratory**
This is a hands-on microbiology lab course which provides students with training in microbiology techniques, data collection and analysis, writing a research proposal and completing an independent project.

Credit Hours: 2  
Prerequisites or Corequisites: BIO_SC 3750 or MICROB 3200 or concurrent enrollment in BIO_SC 3750

**BIO_SC 3780: Genetics Laboratory**
Experimental genetic studies of Drosophila, corn and microorganisms.

Credit Hours: 2
Prerequisites: C range grade or better in BIO_SC 2200 or instructor's consent

**BIO_SC 4002: Topics in Biological Science - Biological Science**
Selected topics not in regularly offered courses. May be repeated up to 2 times for credit.

**Credit Hour:** 1-3
**Prerequisites:** senior standing

**BIO_SC 4006: Topics in Biological Science - Mathematical Science**
Selected topics not in regularly offered courses. May be repeated up to 2 times for credit.

**Credit Hour:** 1-3
**Prerequisites:** senior standing

**BIO_SC 4007: Topics in Biological Science - Physical Science**
Selected topics not in regularly offered courses. May be repeated up to 2 times for credit.

**Credit Hour:** 1-3
**Prerequisites:** senior standing

**BIO_SC 4085: Problems in Biological Sciences**
Individual supervised work to supplement regularly organized courses in biology; introduction to research. Selected sections of this course may be graded either on A-F or S/U basis only.

**Credit Hour:** 1-3
**Prerequisites:** instructor's consent
**Recommended:** Junior Standing

**BIO_SC 4085W: Problems in Biological Sciences - Writing Intensive**
Individual supervised work to supplement regularly organized courses in biology; introduction to research. Selected sections of this course may be graded either on A-F or S/U basis only.

**Credit Hour:** 1-3
**Prerequisites:** instructor's consent
**Recommended:** Junior Standing

**BIO_SC 4320: Molecular Plant Physiology**
(same as PLNT_S 4320; cross-leveled with BIO_SC 7320, PLNT_S 7320). Modern physiology of higher plants using common cultivated plants as examples.

**Credit Hours:** 3
**Prerequisites:** BIO_SC 1200 or BIO_SC 1500 and CHEM 1320

**BIO_SC 4328: Introductory Radiation Biology**
(same as NU_ENG 4328, RADIOL 4328; cross-leveled with BIO_SC 7328, NU_ENG 7328, RADIOL 7328). Concepts of ionizing radiations, their actions on matter through effects on simple chemical systems, biological molecules, cell, organisms, man.

**Credit Hours:** 3
**Prerequisites:** junior standing, Sciences/Engineering; one course in Biological Sciences and Physics/Chemistry; or instructor's consent

**BIO_SC 4400: Plant Anatomy**
(same as PLNT_S 4400; cross-leveled with BIO_SC 7400, PLNT_S 7400). Comparative structure, growth of meristems; development, structure of important cell types, tissues, tissue systems; comparative anatomy of stem, root, leaf. Emphasizes anatomy of gymnosperms, angiosperms. Includes lab.

**Credit Hours:** 4
**Prerequisites:** BIO_SC 1200 or BIO_SC 1500

**BIO_SC 4500: Neurobiology**
(cross-leveled with BIO_SC 7500). Vertebrate and invertebrate neurobiology, including cell and molecular biology of the neuron, neurophysiology, neuroanatomy, neuroethology and developmental neurobiology.

**Credit Hours:** 3
**Prerequisites:** BIO_SC 2300 or instructor's consent
**Recommended:** BIO_SC 3700

**BIO_SC 4560: Sensory Physiology and Behavior**
(cross-leveled with BIO_SC 7560). Basic principles of coding and integration of sensory stimuli; neural correlates of animal behavior; environmental influences on postnatal sensory development. Graded on A-F basis only.

**Credit Hours:** 3
**Prerequisites:** BIO_SC 4500

**BIO_SC 4590: Computational Neuroscience**
(same as ECE 4590, BIOL_EN 4590, BME 4590; cross-leveled with ECE 7590, BIOL_EN 7590, BIO_SC 7590). An interdisciplinary course with a strong foundation in quantitative sciences for students in biological and behavioral science and an introduction to experimental methods for students from quantitative sciences.

**Credit Hours:** 4
**Prerequisites:** BIO_SC 1010 or BIO_SC 1500; MATH 1500

**BIO_SC 4600: Evolution**
Surveys various processes in organic evolution and underlying genetic mechanisms.

**Credit Hours:** 3

**BIO_SC 4640: Behavioral Biology**
(cross-level with BIO_SC 7640). Comparative study of animal ethology. Principles of animal ethology illustrated in different animal phyla. May be taken with Laboratory for 4 credits.

**Credit Hours:** 3-4
**Prerequisites:** BIO_SC 1500
**Recommended:** one additional upper-level course in Biological Sciences or Psychology

**BIO_SC 4642: Animal Communication**
Physical properties of sensory stimuli, receptor mechanisms, functional significance of communication behavior, and multidisciplinary and experimental approaches to current research in animal communication.

**Credit Hours:** 3
Prerequisites: BIO_SC 3400 or BIO_SC 4600

**BIO_SC 4642W: Animal Communication - Writing Intensive**
Physical properties of sensory stimuli, receptor mechanisms, functional significance of communication behavior, and multidisciplinary and experimental approaches to current research in animal communication.

**Credit Hours:** 3  
**Prerequisites:** BIO_SC 3400 or BIO_SC 4600

**BIO_SC 4670: Avian Ecology**
(cross-level with BIO_SC 7670). Advanced examination of ecological patterns in birds. Explores the environmental factors affecting the evolution of avian behavior, morphology, community structure and distribution.

**Credit Hours:** 3  
**Prerequisites:** BIO_SC 2600 or BIO_SC 3650

**BIO_SC 4950: Undergraduate Research in Biology**
Individually directed field or laboratory research for upperclass students under faculty supervision. Project must be arranged by student and faculty member prior to registration. May be repeated to a maximum of 6 hours.

**Credit Hour:** 1-3  
**Prerequisites:** instructor's consent  
**Recommended:** Overall GPA 2.75; 20 hours of Biological Sciences and/ or Chemistry

**BIO_SC 4950H: Honors Research in Biology**
Individually directed field or laboratory research for upper-level Honors students, in consultation with a faculty member. Project must be arranged by student and faculty member prior to registration. May be repeated for credit. Graded on A-F basis only.

**Credit Hour:** 1-3  
**Prerequisites:** overall GPA 3.3; instructor's consent; biology or microbiology major. Honors eligibility required

**BIO_SC 4952: Undergraduate Research in Biology**
Individually directed field or laboratory research for upperclass students under faculty supervision. Project must be arranged by student and faculty member prior to registration. May be repeated to a maximum of 6 hours.

**Credit Hour:** 1-3  
**Prerequisites:** BIO_SC 4950; overall GPA 2.75; instructor's consent

**BIO_SC 4952H: Honors Research in Biology**
Continuation of research program. Successful completion requires public presentation and leads to degree with Honors in biological sciences. May be repeated for credit for maximum of 6 hours. Graded on A-F basis only.

**Credit Hour:** 1-3  
**Prerequisites:** BIO_SC 4950H; overall GPA 3.3; instructor's consent. Honors eligibility required

**BIO_SC 4960: Special Readings in Biological Sciences**
Independent readings and discussions of topics in biology selected in consultation with supervising faculty member. Selected sections of this course may be graded either on A-F or S/U basis only.

**Credit Hours:** 1-3  
**Prerequisites:** senior standing in Biological Sciences and instructor's consent

**BIO_SC 4972: Developmental Biology**
Analysis of the molecular, genetic, cellular, and morphological processes responsible for phenotypic changes in developing organisms. A variety of experimental systems are discussed to identify common mechanisms used by developing organisms.

**Credit Hours:** 3  
**Prerequisites:** BIO_SC 2200, BIO_SC 2300, CHEM 2100

**BIO_SC 4972W: Developmental Biology**
Analysis of the molecular, genetic, cellular, and morphological processes responsible for phenotypic changes in developing organisms. A variety of experimental systems are discussed to identify common mechanisms used by developing organisms.

**Credit Hours:** 3  
**Prerequisites:** BIO_SC 2200, BIO_SC 2300

**BIO_SC 4976: Molecular Biology**
(cross-leveled with BIO_SC 7976). Molecular mechanisms of DNA replication, mutation, recombination and gene expression in prokaryotes, eukaryotes, and their viruses; gene fine structure; genetic engineering.

**Credit Hours:** 3  
**Prerequisites:** BIO_SC 2200 and BIO_SC 2300  
**Recommended:** BIO_SC 4976 or BIOCHM 4270 and BIOCHM 4272

**BIO_SC 4978: Cancer Biology**
(same as BIOCHM 4978; cross-leveled with BIO_SC 7978, BIOCHM 7978). The cellular and molecular basis of cancer, with emphasis on the application of genomics, proteomics, and genetic manipulations in model organisms to the study of cancer biology.

**Credit Hours:** 3  
**Prerequisites:** BIO_SC 2200 and BIO_SC 2300

**BIO_SC 4982: Human Inherited Diseases**
(cross-leveled with BIO_SC 7982). Advances in molecular genetics have led to a revolution in our understanding of human disease. This course will examine how molecular technologies, combined with detailed information on cell biology and biochemistry, have been used to unravel the causes of human inherited disease. In addition, we will examine how this new understanding is being used to design therapies for the diseases, and we will discuss some of the ethical and moral questions that have been generated by recent scientific progress.

**Credit Hours:** 3  
**Prerequisites:** BIO_SC 2200 and BIO_SC 2300

**BIO_SC 4982W: Human Inherited Diseases - Writing Intensive**
(cross-leveled with BIO_SC 7982). Advances in molecular genetics have led to a revolution in our understanding of human disease. This course
will examine how these technologies, combined with detailed information on cell biology and biochemistry, have been used to unravel the causes of human inherited disease. In addition, we will examine how this new understanding is being used to design therapies for the diseases, and we will discuss some of the ethical and moral questions that have been generated by recent scientific progress. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIO_SC 2200 and BIO_SC 2300

BIO_SC 4983: Molecular Ecology
Application of molecular genetic techniques to topics in ecology and population biology such as sex ratios, dispersal, mating systems, biogeography and conservation genetics.

Credit Hours: 4
Prerequisites: BIO_SC 3400 or BIO_SC 2200 and BIO_SC 3650

BIO_SC 4984: Mammalian Reproductive Biology
Adult reproductive anatomy, physiology and behavior; gametogenesis and fertilization; placentation; sexual differentiation; parturition; maternal behavior and lactation; puberty; reproductive aging; reproductive ecology.

Credit Hours: 3
Prerequisites: junior standing
Recommended: 15 hours of Biological Sciences

BIO_SC 4986: Neurology of Motor Systems
(cross-leveled with BIO_SC 7986). Examination of the function of neural networks at all levels, from properties of single neurons to large collections of neural elements.

Credit Hours: 3
Prerequisites: BIO_SC 3700 or instructor's consent

BIO_SC 4988: Nerve Cells and Behavior
The cellular basis of behavior. Molecular and cellular properties of nerve cells, as related to behavior, will be represented and discussed.

Credit Hours: 3
Prerequisites: BIO_SC 3700 or instructor's consent

BIO_SC 4990: Vertebrate Histology and Microscopic Anatomy
Microscopic anatomy of vertebrate tissues and organs. Includes lab.

Credit Hours: 5
Prerequisites: junior standing
Recommended: BIO_SC 3700, or equivalent

BIO_SC 4994: Senior Seminar
Readings and critical evaluation of selected problems and theories in biology. Offered in one or more sections, with specialized subdisciplinary emphasis.

Credit Hours: 3
Prerequisites: Biological Sciences major, senior standing; Honors eligibility required

BIO_SC 4994HW: Senior Seminar - Honors/Writing Intensive
Readings and critical evaluation of selected problems and theories in biology. Offered in one or more sections, with specialized subdisciplinary emphasis.

Credit Hours: 3
Prerequisites: Biological Sciences major, senior standing; Honors eligibility required

BIO_SC 4994W: Senior Seminar - Writing Intensive
Readings and critical evaluation of selected problems and theories in biology. Offered in one or more sections, with specialized subdisciplinary emphasis.

Credit Hours: 3
Prerequisites: Biological Sciences major, senior standing

BIO_SC 7002: Topics in Biological Sciences
Advanced topics not in regularly offered courses. May be repeated for credit. Graded on A-F basis only.

Credit Hour: 1-6

BIO_SC 7320: Molecular Plant Physiology
(same as PLNT_S 7320; cross-leveled with BIO_SC 4320, PLNT_S 4320). Modern physiology of higher plants using common cultivated plants as examples. May be taken with or without laboratory.

Credit Hours: 3
Prerequisites: BIO_SC 1200 or BIO_SC 1500 and 5 hours Chemistry

BIO_SC 7328: Introductory Radiation Biology
(same as NU_ENG 7328, RADIOL 7328, V_M_S 7328; cross-leveled with BIO_SC 4328, NU_ENG 4328, RADIOL 4328). Concepts of ionizing radiations, their actions on matter through effects on simple chemical systems, biological molecules, cell, organisms, man.

Credit Hours: 3
Prerequisites: Sciences/Engineering; one course in Biological Sciences and Physics/Chemistry; or instructor's consent

BIO_SC 7400: Vertebrate Histology and Microscopic Anatomy
Microscopic anatomy of vertebrate tissues and organs. Graded on A-F basis only.

Credit Hours: 5
Prerequisites: BIO_SC 2300 and BIO_SC 3700, or equivalent
BIO_SC 7500: Neurobiology
(cross-leveled with BIO_SC 4500). Vertebrate and invertebrate neurobiology, including cell and molecular biology of the neuron, neurophysiology, neuranatomy, neuroethology and developmental biology. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIO_SC 2300 or BIO_SC 3700

BIO_SC 7560: Sensory Physiology and Behavior
(cross-leveled with BIO_SC 4560). Basic principles of coding and integration of sensory stimuli; neural correlates of animal behavior; environmental influences on postnatal sensory development.

Credit Hours: 3
Prerequisites: BIO_SC 4500 or equivalent

BIO_SC 7590: Computational Neuroscience
(same as BIOL_EN 7590, ECE 7590; cross-leveled with BIO_SC 4590, BIOL_EN 4590, ECE 4590, BME 4590). An interdisciplinary course with a strong foundation in quantitative sciences for students in biological and behavioral sciences and an introduction to experimental methods for students from quantitative sciences.

Credit Hours: 4
Prerequisites: BIO_SC 1010 or BIO_SC 1500, MATH 1500

BIO_SC 7640: Behavioral Biology

Credit Hours: 3
Prerequisites: BIO_SC 1500 and one additional upper-level course in Biological Sciences or Psychology

BIO_SC 7670: Avian Ecology
(cross-leveled with BIO_SC 4670). Advanced examination of ecological patterns in birds. Explores the environmental factors affecting the evolution of avian behavior, morphology, community structure and distribution.

Credit Hours: 3
Prerequisites: BIO_SC 2060 or BIO_SC 3650; BIO_SC 2600

BIO_SC 7760: Molecular Biology
(cross-leveled with BIO_SC 4976). Molecular mechanisms of DNA replication, mutation, recombination and gene expression in prokaryotes, eukaryotes, and their viruses; gene fine structure; genetic engineering.

Credit Hours: 3
Prerequisites: BIO_SC 2200 and BIO_SC 2300

BIO_SC 7982: Human Inherited Diseases
(cross-leveled with BIO_SC 4982). Advances in molecular genetics have led to a revolution in our understanding of human disease. This course will examine how molecular technologies, combined with detailed information on cell biology and biochemistry, have been used to unravel the causes of human inherited disease. In addition, we will examine how this new understanding is being used to design therapies for the diseases, and we will discuss some of the ethical and moral questions that have been generated by recent scientific progress. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIO_SC 2200 and instructor's consent

BIO_SC 7986: Neurology of Motor Systems
(cross-leveled with BIO_SC 4986). Examination of the function of neural networks at all levels, from properties of single neurons to large collections of neural elements. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: BIO_SC 3700

BIO_SC 7990: Non-thesis Research
Independent research not leading to a thesis. Some sections may be offered on either A-F or S/U grading basis.

Credit Hour: 1-99
Prerequisites: instructor's consent

BIO_SC 8002: Topics in Biological Sciences-Biological/Physical/Mathematics
Advanced topics not in regularly offered courses.

Credit Hour: 1-6

BIO_SC 8050: Professional Survival Skills
Introduction to resources, facilities, and communication skills for professional careers in biological sciences. Topics include computer resources, accessing scientific literature, making slides and figures, grantsmanship, resume preparation, manuscript review, and research presentation.

Credit Hour: 2

BIO_SC 8060: Ethical Conduct of Research
(same as BIOCHM 8060). Discussion of ethical issues in biological research, including the rules and conventions for appropriate research conduct. Graded on S/U basis only.

Credit Hour: 1

BIO_SC 8070: Professional Communication Development
The purpose of this course is to develop professional communication skills in students that are planning to attend (or are in their first year of) graduate training. Some sections may be offered with A-F or S/U grading option.

Credit Hour: 1-2
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
<th>Credit Hours</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO_SC 8085</td>
<td>Problems in Biological Sciences</td>
<td>Research not expected to terminate in thesis, or individual advanced study in special subjects.</td>
<td>1-99</td>
<td>Instructor's consent</td>
</tr>
<tr>
<td>BIO_SC 8087</td>
<td>Seminar</td>
<td>Current topics in the biological sciences. Open to all graduate students. Graded S/U basis only.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>BIO_SC 8090</td>
<td>Research in Biological Sciences</td>
<td>Research leading to thesis. Graded on S/U basis only.</td>
<td>1-99</td>
<td>Instructor's consent</td>
</tr>
<tr>
<td>BIO_SC 8187</td>
<td>Seminar in Areas of Specialization</td>
<td>Offered each semester in one or more specialized sections followed by the topic title of the seminar. Graded on S/U basis only.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>BIO_SC 8300</td>
<td>Advanced Plant Genetics</td>
<td>Genetic approaches to molecular and biochemical studies in maize, wheat, and Arabidopsis.</td>
<td>3</td>
<td>General Genetics and course in Cell Biology or Plant Physiology</td>
</tr>
<tr>
<td>BIO_SC 8310</td>
<td>Fungal Genetics and Biology</td>
<td>Introduction to fungal research, with an emphasis on genetics, biochemistry, cell and molecular biology, and pathogenicity of fungi. Graded A-F only.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>BIO_SC 8320</td>
<td>Developmental Genetics</td>
<td>An overview of various developing systems amenable to classical and molecular genetic analysis. Specific developmental phenomena will be introduced in particular model systems, with an emphasis on experimental approaches used to address the underlying mechanisms.</td>
<td>3</td>
<td>BIO_SC 2200 and BIOCHM 7270, BIOCHM 7272, or equivalent</td>
</tr>
<tr>
<td>BIO_SC 8440</td>
<td>Integrative Neuroscience I</td>
<td>(same as NEUROSCI 8440). Organization, development and function of the nervous system focusing on cellular and molecular processes. Graded on A-F basis only.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>BIO_SC 8442</td>
<td>Integrative Neuroscience II</td>
<td>(same as NEUROSCI 8442). Organization and function of the nervous system at the systems level to examine processes of behavior and cognition. Graded on A-F basis only.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>BIO_SC 8460</td>
<td>Advanced Cancer Biology</td>
<td>A study of the molecular basis of cancer, including topics in tumor cell biology, interactions between cancer cells and normal cells, mechanisms of metastasis, and novel approaches to development of new chemotherapies.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>BIO_SC 8505</td>
<td>Introduction to Plant Stress Biology</td>
<td>(same as PLNT_S 8505). This course is part of a series that aims to provide a solid conceptual foundation to interdisciplinary plant biology for graduate students with a research emphasis in plant biology. This course examines the basic concepts and techniques used to understand plant stress biology. Graded on A-F basis only</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>BIO_SC 8600</td>
<td>Design of Ecological Experiments</td>
<td>Principles of experimental design in the context of ecological, behavioral, and evolutionary research.</td>
<td>2</td>
<td>STAT 1400</td>
</tr>
<tr>
<td>BIO_SC 8610</td>
<td>Current Concepts in Conservation Biology</td>
<td>Survey of current concepts in conservation biology literature. Discussions will provide students with an appreciation of the historical development of concepts, the interdisciplinary nature of conservation problems, and the research required for effective solutions.</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>BIO_SC 8633</td>
<td>Molecular and Network Evolution</td>
<td>(same as AN_SCI 8633). Evolution of biological macromolecules and networks, including sequence analysis algorithms and theory, phylogenetics, gene duplication, genome evolution, principles of biological networks. Development of computational skills emphasized.</td>
<td>3</td>
<td>Instructor's consent required</td>
</tr>
<tr>
<td>BIO_SC 8700</td>
<td>Ecological Genetics</td>
<td>Population genetics and evolutionary theory, with emphasis on studies of natural populations.</td>
<td>3</td>
<td>BIO_SC 2200, BIO_SC 3100 or BIO_SC 3650, and STAT 1400 or equivalent</td>
</tr>
<tr>
<td>BIO_SC 8720</td>
<td>Speciation</td>
<td>Advanced discussion of species concepts and the processes of formation of species.</td>
<td>3</td>
<td>BIO_SC 2200 and BIO_SC 4600</td>
</tr>
</tbody>
</table>
**BIO_SC 8724: College Science Teaching**  
(same as LTC 8724, PHYSCS 8310, ASTRON 8310). Study of learner characteristics, teaching strategies, and research findings related to teaching science at the post-secondary level.  
**Credit Hours:** 3

**BIO_SC 8725: Science Outreach: Public Understanding of Science**  
(same as AN_SCI 8725, PHYSCS 8350, LTC 8725). Development of presentations to adult audiences on the science underlying issues of current interest. May be repeated for credit.  
**Credit Hour:** 1-2

**BIO_SC 8726: Integrating Science with Outreach**  
(same as LTC 8726). This course provides an opportunity for students to earn credit for outreach activities in the community. Students will capitalize on their area of study and scientific expertise in developing, implementing, and evaluating related outreach activities. May be repeated for credit.  
**Credit Hour:** 1-6

**BIO_SC 8740: Plant/Animal Interactions**  
Discussion and lectures on herbivory, pollination biology, and dynamics of fruit and seed dispersal from ecological and evolutionary perspectives.  
**Credit Hours:** 3  
**Prerequisites:** BIO_SC 3650 or BIO_SC 4660 or equivalent

**BIO_SC 9090: Research in Biological Sciences**  
Research leading to dissertation. Graded on S/U basis only.  
**Credit Hour:** 1-99  
**Prerequisites:** instructor's consent

**BIO_SC 9432: Molecular Biology II**  
(same as MICROB 9432, BIOCHM 9432) Detailed experimental analysis of eukaryotic cellular and molecular biology relevant to cellular and viral gene expression, post-transcriptional and post-translational modifications and genome replication. Models for developmental genetic analysis and genetic determinants controlling processes utilizing the current literature will be examined.  
**Credit Hours:** 4  
**Prerequisites:** MICROB 9430

**BIO_SC 9468: Molecular Biology of Plant Growth and Development**  
(same as BIOCHM 9468). Molecular biology of plant hormones, signal transduction, environmental signals.  
**Credit Hours:** 3  
**Prerequisites:** BIO_SC 4976