# Biological Sciences

D. Schulz, Director
College of Arts and Science
105 Tucker Hall
(573) 882-6659

The Division of Biological Sciences offers both a Bachelor of Arts and a Bachelor of Science in Biological Sciences, in addition to a minor in biological sciences for students majoring in other departments. Students may complete an emphasis area in Medical Science and Human Biology as part of the Bachelor of Science degree. The department also offers MS and PhD degrees in Biological Sciences.

## Faculty

**Curators Distinguished Professor** J. A. Birchler**
**Curators Distinguished Teaching Professor** B. Stone*
**Professor** D. Braun**, A. Chandrasekhar**, R. B. Cocroft**, D. Cornelison**, M. Leal**, A. L. Lin**, E. Liscum III**, P. McSteen**, J. Schul**, D. Schulz**, P. Shiu**, R. K. Slotkin**, B. Zhang**
**Associate Professor** R. Angelovici**, R. Bhandari**, D. Bergstralh**, P. Brown**, C. Y. Chabu**, J. D. David*, M. Garcia**, E. King**, K. Middleton**, G. F. Summers*, S. Xu**
**Assistant Professor** J. Goyes Vallejos**, C. Grunenwald**, C. D. Hamilton**, E. Ng'oma**, A. Roth*, J. Santin**, J. Van Goor*, J. Zhu**
**Teaching Professor** S. L. Bush*
**Teaching Associate Professor** A. Durbak
**Teaching Assistant Professor** M. Asgari*, N. Blay, N. Downer, M. Faheem, S. Michael, A. Paz Herrera
**Research Assistant Professor** T. Finegan
**Curators Distinguished Professor Emeritus** H. C. Gerhardt**, G. P. Smith**, F. S. Vom Saal, J. C. Walker**
**Curators Distinguished Teaching Professor Emeritus** J. E. Carrel, T. E. Phillips
**Professor Emeritus** S. Alexander**, B. G. Cumbie, L. Eggert, J. R. Faaborg, C. Galen**, P. H. S. Jen, M. D. Kirk, A. D. McClellan, C. D. Miles, K. J. Newton**, D. Setzer
**Associate Professor Emeritus** L. Chapman, M. Golomb, T. Holtsford, J. Maruniak, G. F. Summers*, D. L. Worcester

* 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

- BA in Biological Sciences (https://catalog.missouri.edu/collegeofartsandscience/biologicalsciences/ba-biological-sciences/)
- BS in Biological Sciences (https://catalog.missouri.edu/collegeofartsandscience/biologicalsciences/bs-biological-sciences/)
  - with emphasis Medical Science and Human Biology (https://catalog.missouri.edu/collegeofartsandscience/biologicalsciences/bs-biological-sciences-emphasis-medical-science-human-biology/)
- Minor in Biological Sciences (https://catalog.missouri.edu/collegeofartsandscience/biologicalsciences/minor-biological-sciences/)

**Undergraduate Advising Center**
3 Tucker Hall
(573) 882-4068
bioadvising@missouri.edu

## Departmental Honors

The department strongly encourages participation in departmental honors. The heart of the honors program is a year-long experience in laboratory, field, or theoretical work in any area of biology. Students work directly with outstanding faculty mentors from the Division of Biological Sciences or other life science units on campus.

Biological Sciences majors earning a BA or a BS may graduate with honors by completing BIO_SC 4950H and BIO_SC 4952H (6 credits), preparing a manuscript suitable for publication in a journal or the abstract of an oral or poster presentation at an on-campus symposium or at a regional or national meeting of a professional society, and completing a reflection on their research experience. Students must meet with the honors program director to discuss their research experience. The honors program requires junior standing (or higher) in biological sciences and a GPA of 3.3. Students with a GPA between 3.0 and 3.29 may petition the director of the honors program for admission, but all students must graduate with a GPA of 3.3 to receive departmental honors. Please contact the Biology Advising Center (3 Tucker Hall, 882-4068) or consult with the Director of the Honors Program, Dr. Pam Brown (brownp@missouri.edu; 423 Tucker Hall, 884-0214).

## Graduate

- MS in Biological Sciences (https://catalog.missouri.edu/collegeofartsandscience/biologicalsciences/ms-biological-sciences/)
- PhD in Biological Sciences (https://catalog.missouri.edu/collegeofartsandscience/biologicalsciences/phd-biological-sciences/)

**Division of Biological Sciences**
218 Tucker Hall
(573) 884-4144
https://biology.missouri.edu/

**Director of Graduate Studies:** Manuel Leal

## About Biological Sciences

The Division of Biological Sciences offers a unique integration of world-class research, award-winning graduate and undergraduate training, and outstanding community outreach. Our goal is to foster a community in which excellence in research, teaching and community engagement are recognized as synergistic activities of equal importance. At the forefront of this goal is the recognition that inclusion and equity are the foundations of a community in which diverse ideas and perspectives are likely to flourish, thus providing the needed building blocks for a thriving environment. Graduate training programs emphasize the excitement of discovery and the development of individual creativity and critical reasoning skills, with graduate mentors who are experts at the frontiers of their field.

The Division of Biological Sciences prioritizes evidence of attributes such as drive, diligence, passion for sharing scientific knowledge, and a willingness to take scientific risk over metrics such as GPA, standardized test scores and other similar qualifications that have been

shown to bias the admission process against underrepresented groups. Therefore, the application process should be seen as an opportunity to highlight your attributes as a potential graduate student, including contributions that you will make to our community and to MU in general.

## Areas of Study

The division offers primarily the PhD degree. Students interested in pursuing an MS degree are encouraged to directly contact a potential mentor to further explore this possibility. General areas of research emphasis within the division include EEOB (ecology, evolution, organismal biology, and behavior); genetics and genomics; cellular, molecular and developmental biology; neurobiology and behavior; and plant sciences.

## Interdisciplinary Research

The extent of interdisciplinary research and the absence of departmental boundaries among disciplines in the life sciences are hallmarks of the Division of Biological Sciences and of the training that we provide to our students. Research in the Division of Biological Sciences spans all levels of biological organization, from molecules to ecosystems, using a diversity of organisms and modern approaches. This is mirrored in the dissertation projects of many of our students that commonly include partnerships between multiple laboratories. In addition, the presence on this campus of a School of Medicine, College of Agriculture, Food and Natural Resources, and a College of Veterinary Medicine provide opportunities for direct interaction with a variety of established research scientists. Faculty in the division also participate in the Genetics Area Program, the Molecular Pathogenesis and Therapeutics Program, the Interdisciplinary Plant Group, the Interdisciplinary Neuroscience Program, and the MU Institute for Data Science and Informatics.

## Research Facilities and Resources

Divisional faculty have ready access to high-performance computing resources with the power and flexibility needed to meet the demands of researchers conducting computationally intensive research projects. Beyond the specialized equipment in each faculty research laboratory, departmental and campus equipment and facilities available to graduate students include:

- advanced research cores, including the Cell and Immunobiology Core, the DNA Core, the Gehrke Proteomics Center, the Advanced Light Microscopy Core, the Molecular Cytology Core, the Molecular Interactions Core, the Research Reactor, the Rat Resource and Research Center, the Metabolomics Center, the Metagenomics Center, and the Bioinformatics and Analytics Core;
- state-of-the-art plant growth facilities that include greenhouse modules, controlled environmental growth chambers, seed storage and drying rooms, and a Plant Transformation Core;
- animal-care facilities suitable for both vertebrates and invertebrates, including (but not limited to) marine and freshwater invertebrates, mice, rats, lizards, and amphibians;
- a 14-acre botany preserve on the campus and a 146-acre prairie research station;
- walk-in plant growth chambers with regulated light, temperature and humidity controls;
- cell and tissue culture facilities;
- ultracentrifuges;
- sound isolation acoustic chambers;
- multiplex quantitative PCR machines;
- neurophysiological recording rigs for intra- and extracellular recording techniques; 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.

**Credit Hour**: 1-3

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**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

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**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

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**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

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**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

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**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

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**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

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**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

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**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

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**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

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**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 Hour**: 3-5
**Prerequisites:** MATH 1100 and high school chemistry. Honors eligibility required

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**BIO_SC 1550: Introduction to Life Science Research**
This course is an introduction to research in the life sciences. Students will learn basic laboratory skills essential in preparation for later research experiences.

**Credit Hours**: 2
**Prerequisites:** Biological Sciences majors, only
**Recommended:** BIO_SC 1500

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**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

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**BIO_SC 2002: Topics in Biological Sciences- Biological Sciences**
Selected topics not covered 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:** a course in general biology

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**BIO_SC 2002H: Topics in Biological Sciences- Biological Science - Honors**
Selected topics not covered in regularly offered courses. Recommended: a course in biology

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

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**BIO_SC 2007: Topics in Biological Sciences- Physical Sciences**
Selected topics not covered 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:** a course in general biology

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**BIO_SC 2007H: Topics in Biological Sciences- Physical Science - Honors**
Selected topics not covered in regularly offered courses. Recommended: a course in biology

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

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**BIO_SC 2010: Undergraduate Seminar in Biological Sciences**
Discussion and critical evaluation of current topics in biological sciences for intermediate-level students. Some sections may be graded on either A-F or S/U basis only.

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

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**BIO_SC 2015: Biological Career Explorations**
Students will learn about career options and choices, construct career portfolios, and interact with current biological professionals. Graded on S/U basis only.

**Credit Hour**: 1
**Prerequisites:** Departmental consent
**Recommended:** Sophomore standing

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**BIO_SC 2017: World of Neuroscience**
(same as PSYCH 2017, CMP_SC 2017, ECE 2017, BIOL_EN 2017, BME 2017). This course will introduce undergraduates to the growing area of neuroscience from the perspectives of 3 disciplines: engineering, biology and psychology. May not be used to satisfy degree requirements for the major or minor in biological sciences.

**Credit Hour**: 1
**Prerequisites:** Sophomore standing

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**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

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**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

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**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

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**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

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**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

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**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 1010 and 1020, or BIO_SC 1030 or BIO_SC 1100 or BIO_SC 1200 or BIO_SC 1500; CHEM 1320 or 1400 (or concurrent enrollment in either chemistry course)

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**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 1010 and 1020, or BIO_SC 1030 or BIO_SC 1100 or BIO_SC 1200 or BIO_SC 1500; CHEM 1320 or 1400 (or concurrent enrollment in either chemistry course). Honors eligibility required

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**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

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**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 BIO_SC 2200H. Honors eligibility required

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**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 BIO_SC 2200H. Honors eligibility required

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**BIO_SC 2888: Research in Biological Sciences**
Introductory field or laboratory research under faculty supervision. Project must be arranged with faculty member prior to registration. Course appears on transcript for zero credit and does not count toward full-time enrollment. No tuition or fees are charged. Graded on S/U basis only. Prerequisites; instructor's consent.

**Credit Hours**: 0

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**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

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**BIO_SC 2950: Directed Independent Research**
Participation in faculty research activities. May be repeated to a maximum of 6 hours.

**Credit Hour**: 1-3
**Prerequisites:** Departmental consent

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**BIO_SC 2960: Readings in Biological Science**
Supervised reading in biological literature. May be repeated up to six hours total credit. May not be used in partial fulfillment of Arts and Science foundation requirement.

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

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**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

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**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

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**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

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**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

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**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

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**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

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**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

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**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

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**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

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**BIO_SC 3040: Eugenics Past, Present and Future: An Ugly Partnership Between Science and Society**
Eugenics - "the improvement of humanity through selective breeding" - is both historical and current; it has been utopian and idealist, as well as prejudicial and genocidal. In this class students will examine eugenics as a lens to explore the historical breadth of science and its interfaces with society - the good, the bad and the ugly. By exploring this disturbing scientific history, students will develop skills to think critically about, discuss, and debate the past and potential future intersections of science and society.

**Credit Hours**: 3
**Prerequisites:** Sophomore standing or higher

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**BIO_SC 3040H: Eugenics Past, Present and Future: An Ugly Partnership Between Science and Society - Honors**
Eugenics - "the improvement of humanity through selective breeding" - is both historical and current; it has been utopian and idealist, as well as prejudicial and genocidal. In this class students will examine eugenics as a lens to explore the historical breadth of science and its interfaces with society - the good, the bad and the ugly. By exploring this disturbing scientific history, students will develop skills to think critically about, discuss, and debate the past and potential future intersections of science and society.

**Credit Hours**: 3
**Prerequisites:** Sophomore standing or higher. Honors eligibility required

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**BIO_SC 3050: Genetics and Society**
Examines topics in human biomedical genetics from both a scientific and a social standpoint. Current topics include gene editing and gene drive, prenatal testing and genetic counseling, hemoglobin genes and gene therapy, COVID-19 and inequality, racial disparities in medicine, gender issues in STEM fields, sports federations and the intersex athlete, ancient DNA and human migrations, altitude adaptations. Students choose their own text and research subject based on personal interest.

**Credit Hours**: 3
**Prerequisites:** BIO_SC 1010 and 1020, or BIO_SC 1030, or BIO_SC 1500
**Recommended:** BIO_SC 2200

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**BIO_SC 3050W: Genetics and Society - Writing Intensive**
Examines topics in human biomedical genetics from both a scientific and a social standpoint. Current topics include gene editing and gene drive, prenatal testing and genetic counseling, hemoglobin genes and gene therapy, COVID-19 and inequality, racial disparities in medicine, gender issues in STEM fields, sports federations and the intersex athlete, ancient DNA and human migrations, altitude adaptations. Students choose their own text and research subject based on personal interest.

**Credit Hours**: 3
**Prerequisites:** BIO_SC 1010 and BIO_SC 1020, or BIO_SC 1030, or BIO_SC 1500
**Recommended:** BIO_SC 2200

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**BIO_SC 3060: Science and Society: Past, Present and Future**
This course will examine the scientific process and how it has evolved over the years, starting from the inception of the scientific method in the Middle Ages through the present day. The course will focus on the impact of advancements in technology and societal and cultural views on some of the most significant breakthroughs in biology.

**Credit Hours**: 3
**Prerequisites:** BIO_SC 1010 or BIO_SC 1500 or equivalent

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**BIO_SC 3060HW: Science and Society: Past, Present and Future - Honors/Writing Intensive**
This course will examine the scientific process and how it has evolved over the years, starting from the inception of the scientific method in the Middle Ages through the present day. The course will focus on the impact of advancements in technology and societal and cultural views on some of the most significant breakthroughs in biology.

**Credit Hours**: 3
**Prerequisites:** BIO_SC 1010 or BIO_SC 1500 or equivalent; Honors eligibility required

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**BIO_SC 3060W: Science and Society: Past, Present and Future - Writing Intensive**
This course will examine the scientific process and how it has evolved over the years, starting from the inception of the scientific method in the Middle Ages through the present day. The course will focus on the impact of advancements in technology and societal and cultural views on some of the most significant breakthroughs in biology.

**Credit Hours**: 3
**Prerequisites:** BIO_SC 1010 or BIO_SC 1500 or equivalent

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**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
**Prerequisites:** BIO_SC 2200

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**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
**Prerequisites:** BIO_SC 2200

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**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

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**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

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**BIO_SC 3240: Vertebrate Biology**
This course will investigate the evolutionary origins and history of vertebrate lineages with emphasis on key morphological adaptations of each major vertebrate group. Topics will focus on the structural modifications relating to various functions and the phylogenetic histories of the groups.

**Credit Hours**: 3
**Prerequisites:** BIO_SC 1010 and BIO_SC 1020, or BIO_SC 1030, or BIO_SC 1500

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

**Credit Hours**: 4
**Prerequisites:** BIO_SC 1010 and BIO_SC 1020, or BIO_SC 1030, or BIO_SC 1100, or BIO_SC 1500

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**BIO_SC 3260W: Invertebrate Zoology - Writing Intensive**
Structure, ecology and phylogeny of the invertebrate phyla. Includes lab when offered for 4 credits.

**Credit Hour**: 3-4
**Prerequisites:** BIO_SC 1010 and BIO_SC 1020, or BIO_SC 1030, or BIO_SC 1100, or BIO_SC 1500
**Recommended:** Junior Standing

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

**Credit Hour**: 3-4
**Recommended:** 8 hours Biological Sciences or equivalent

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**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

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**BIO_SC 3400H: Evolution and Ecology - Honors**
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; Honors eligibility required

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**BIO_SC 3510: Biology of Fungi**
(same as PLNT_SCI 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

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**BIO_SC 3650: 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 2060: 2 hours credit.

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

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**BIO_SC 3650W: 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 2060: 2 hours credit.

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

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**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

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**BIO_SC 3700: Human Physiology**
Introduces concepts of vertebrate organ function and homeostatic control emphasizing human physiology. Includes lab.

**Credit Hours**: 5
**Prerequisites:** BIO_SC 2300

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**BIO_SC 3710: Introductory Entomology**
(same as PLNT_SCI 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

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**BIO_SC 3715: Insect Diversity**
(same as PLNT_SCI 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_SCI 3710 (or BIO_SC 3710) or concurrent registration

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**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 1010 and BIO_SC 1020, or BIO_SC 1030, or BIO_SC 1500
**Recommended:** grades in C range for prerequisites

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**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

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**BIO_SC 3760H: Microbiology Laboratory - Honors**
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; Honors eligibility required

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**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 3888: Research in Biological Sciences**
Supervised field or laboratory research for students with prior experience or exposure to research practices under faculty supervision. Project must be arranged by student and faculty member prior to registration. Course appears on transcript for zero credit and does not count toward full-time enrollment. No tuition of fees are charged. Graded on S/U basis only.

**Credit Hours**: 0
**Prerequisites:** 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.

**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.

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

**BIO_SC 4320: Molecular Plant Physiology**
(same as PLNT_SCI 4320; cross-leveled with BIO_SC 7320, PLNT_SCI 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, V_M_S 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_SCI 4400; cross-leveled with BIO_SC 7400, PLNT_SCI 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, CMP_SC 4590, PSYCH 4591; cross-leveled with ECE 7590, BIOL_EN 7590, BIO_SC 7590, CMP_SC 7590, PSYCH 7591). 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

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

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

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

**Credit Hours**: 3
**Prerequisites:** BIO_SC 2200; Honors eligibility required

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**BIO_SC 4640: Behavioral Biology**
(cross-leveled 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 Hour**: 3-4
**Prerequisites:** BIO SCI 1010 and BIO_SC 1020, or BIO_SC 1030, or BIO_SC 1500
**Recommended:** one additional upper-level course in Biological Sciences or Psychology

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**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

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**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

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**BIO_SC 4670: Avian Ecology**
(cross-leveled 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 3650

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**BIO_SC 4888: Research in Biological Science**
Individually directed field or laboratory research for upper-level students under faculty supervision. Project must be arranged by student and faculty member prior to registration. Course appears on transcript for zero credit and does not count toward full-time enrollment. No tuition or fees are charged. Graded on S/U basis only.

**Credit Hours**: 0
**Prerequisites:** instructor's consent

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**BIO_SC 4950: Undergraduate Research in Biology**
Individually directed field or laboratory research for upper-level 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. Graded on A-F basis only.

**Credit Hour**: 1-3
**Prerequisites:** Departmental consent. 20 hours of Biological Sciences and/or Chemistry

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**BIO_SC 4950H: Honors Research in Biology**
Individually directed field or laboratory research for upper-level 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. Graded on A-F basis only.

**Credit Hour**: 1-3
**Prerequisites:** Overall GPA 3.3; 20 hours of Biological Sciences and/or Chemistry; Departmental Consent. Honors eligibility required

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**BIO_SC 4952: Undergraduate Research in Biology**
Continuation of undergraduate research in biology. Successful completion requires public presentation. May be repeated to a maximum of 6 hours. Graded on A-F basis only.

**Credit Hour**: 1-3
**Prerequisites:** BIO_SC 4950; Departmental consent

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**BIO_SC 4952H: Honors Research in Biology**
Continuation of undergraduate research in biology. Successful completion requires public presentation and Biological Science majors

will receive a 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; Departmental consent. Honors eligibility required

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

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**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

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**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, CHEM 2100

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**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

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**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
**Recommended:** BIO_SC 4976 or BIOCHM 4270 and BIOCHM 4272

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**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

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**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

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**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

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**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

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**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

**BIO_SC 4994H: Senior Seminar - Honors**
Readings and critical evaluation of selected problems and theories in biology. Offered in one or more sections, with specialized sub disciplinary 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 sub disciplinary 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_SCI 7320; cross-leveled with BIO_SC 4320, PLNT_SCI 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: Plant Anatomy**
(same as PLNT_SCI 7400; cross-leveled with BIO_SC 4400, PLNT_SCI 4400). Comparative structure, growth of meristems; development, structure of important cell types, tissues systems; comparative anatomy of stem root, leaf. Emphasizes anatomy of gymnosperms, angiosperms. Includes lab. Graded on A-F basis only.

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

**BIO_SC 7490: 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, neurothology 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, CMP_SC 7590, PSYCH 7591; cross-leveled with BIO_SC 4590, BIOL_EN 4590, ECE 4590, BME 4590, CMP_SC 4590, PSYCH 4591). 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**
(cross-leveled with BIO_SC 4640). Comparative study of animal ethology. Principles of animal ethology illustrated in different animal phyla.

**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 7976: 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 7978: Cancer Biology**
(same as BIOCHM 7978; cross-leveled with BIO_SC 4978, BIOCHM 4978). The course will cover major molecular and cellular aspects of cancer. Students will read original research articles, present overviews and lead class discussions.

**Credit Hours**: 3
**Prerequisites:** BIOCHM 4270, BIO_SC 2300 and BIO_SC 4976 or equivalent

**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 Hours**: 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

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**BIO_SC 8070: Professional Communication Development**
(same as BIOCHM 8070, MICROB 8070). 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

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**BIO_SC 8085: Problems in Biological Sciences**
Research not expected to terminate in thesis, or individual advanced study in special subjects.

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

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**BIO_SC 8087: Seminar**
Current topics in the biological sciences. Open to all graduate students. Graded S/U basis only.

**Credit Hour**: 1

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**BIO_SC 8090: Research in Biological Sciences**
Research leading to thesis. Graded on S/U basis only.

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

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**BIO_SC 8187: Seminar in Areas of Specialization**
Offered each semester in one or more specialized sections followed by the topic title of the seminar. Graded on S/U basis only.

**Credit Hour**: 1

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**BIO_SC 8300: Advanced Plant Genetics**
Genetic approaches to molecular and biochemical studies in maize, wheat, and Arabidopsis.

**Credit Hours**: 3
**Prerequisites:** General Genetics and course in Cell Biology or Plant Physiology

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**BIO_SC 8310: Fungal Genetics and Biology**
Introduction to fungal research, with an emphasis on genetics, biochemistry, cell and molecular biology, and pathogenicity of fungi. Graded A-F only.

**Credit Hours**: 3

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**BIO_SC 8320: Developmental Genetics**
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.

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

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**BIO_SC 8440: Integrative Neuroscience I**
(same as NEUROSCI 8440). Organization, development and function of the nervous system focusing on cellular and molecular processes. Graded on A-F basis only.

**Credit Hours**: 3

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**BIO_SC 8442: Integrative Neuroscience II**
(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.

**Credit Hours**: 3

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**BIO_SC 8460: Advanced Cancer Biology**
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.

**Credit Hours**: 3

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**BIO_SC 8505: Plant Stress Biology**
(same as PLNT_SCI 8505). This course will introduce the basic concepts of abiotic and biotic plant stress agents and discuss how to conduct research with plant stress agents alone or in combination. Graded on A-F basis only.

**Credit Hours**: 3

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**BIO_SC 8600: Design of Ecological Experiments**
Principles of experimental design in the context of ecological, behavioral, and evolutionary research.

**Credit Hours**: 2
**Prerequisites:** STAT 1400

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**BIO_SC 8610: Current Concepts in Conservation Biology**
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.

**Credit Hours**: 2

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**BIO_SC 8633: Molecular and Network Evolution**
(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.

**Credit Hours**: 3
**Prerequisites:** Instructor's consent required

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**BIO_SC 8640: Quantitative Methods in Life Sciences**
(same as PTH_AS 8640). Quantitative Methods in Life Sciences is a graduate-level course in statistical analysis designed for the specific needs of students in life sciences, focusing on statistical literacy: performing, interpreting, and writing about biological data analysis. As such, the course assumes a basic understanding of some topics and little understanding of other topics. The course will cover most topics broadly and occasionally in great depth, highlighting the perils and pitfalls of different methods, while providing guidelines for a wide array of statistical approaches to data analysis. The course seeks to find the balance between really understanding all the math involved and learning to be a competent practitioner and consumer of analysis, emphasizing the practical over the theoretical, with additional focus on the communication of data (plotting, graphs, figures) and of results. Graded on A-F basis only.

**Credit Hours**: 3
**Prerequisites:** Consent of instructor

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**BIO_SC 8642: Quantitative Methods in Life Sciences II**
(same as PTH_AS 8642). A graduate-level course in statistical analysis designed for the needs of students in life sciences, focusing on advanced statistical methods: nonlinear statistics, multivariate statistics, structural equation modeling, correlation structures (phylogenetic and kinship methods), experimental design, Baysian statistics, permutation and distribution-free methods, mathematical modeling. This course assumes a background knowledge of statistics and analysis in R. The course consists of 5-week modules and students select modules of interest for variable credit.

**Credit Hour**: 1-3
**Prerequisites:** BIO_SC 8640 or permission of instructor

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**BIO_SC 8700: Ecological Genetics**
Population genetics and evolutionary theory, with emphasis on studies of natural populations.

**Credit Hours**: 3
**Prerequisites:** BIO_SC 2200, BIO_SC 2060 or BIO_SC 3650, and STAT 1400 or equivalent

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**BIO_SC 8720: Speciation**
Advanced discussion of species concepts and the processes of formation of species.

**Credit Hours**: 3
**Prerequisites:** BIO_SC 2200 and BIO_SC 4600

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**BIO_SC 8723: Pedagogical Preparation for Graduate Teaching Assistants**
This course is designed for graduate students with different levels of teaching experience and familiarity with pedagogical concepts. The main goals are for students to become familiar with basic elements of scientific teaching, to practice and improve inclusive and evidence-based teaching techniques, and to monitor, reflect and improve the quality of teaching and learning in their classrooms.

**Credit Hours**: 3

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**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

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**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

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**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