

Department of Biological Sciences

Purpose and Focus

Biology is the study of life. The earth is filled with an enormous variety of living organisms, and therefore an understanding of the basic biological processes common to all organisms is essential to understanding the world. In recent decades great strides have been made in understanding important biological processes, particularly those at the molecular, cellular, and ecosystem levels. An understanding of biological systems depends, in part, on the principles of physics and chemistry; thus a firm background in the physical sciences is also important in the study of biology. For many, an undergraduate major in biology serves as a basis for postgraduate study in the life sciences. Department of Biological Sciences graduates have gone on to advanced graduate study, leading to careers in college or university teaching, basic and applied research, and public health. Many have entered professional programs in medicine, veterinary medicine, and dentistry. Other graduates have gone directly into secondary (high school) science teaching, the biomedical industry, independent laboratory research, natural resources management or environmental education.

Accreditation

Northwestern Association of Schools and Colleges

Undergraduate Major

Biological Sciences

Degree Objectives/Learning Outcomes

The primary mission of the Department of Biological Sciences is to provide a rich, contemporary learning environment that ensures an integrated educational experience spanning the full spectrum of biology, with focused training available to advanced undergraduate students. Through these efforts, the Department of Biological Sciences will occupy central roles in creating scientific literacy among the diverse array of UNLV students, and in addressing biological issues, of local, regional and global interest.

Students who graduate with a major in biology at UNLV will acquire:

1. Knowledge of the diversity and similarity of living organisms at organizational levels ranging from molecules to the community.
2. Knowledge of processes of inheritance and natural selection as they influence the development of populations and species.
3. Knowledge of scientific methods and the relationships among theory, experiment, analysis of data, and general knowledge.
4. The ability to articulate, in verbal and written form, knowledge of biology, biological methods, and biological issues in context.

Learning Outcome

Students who graduate with a major in biology will have fulfilled their personal expectations and will indicate they have been accepted to a graduate or professional school or an entry-level career position.

Areas of Concentration

Biological Sciences majors at the University of Nevada have a choice of five areas of specialized study (concentrations) that prepare them for a variety of professional fields. In addition to attending graduate, medical, and other professional schools, Biological Sciences majors may move directly to governmental and private-sector careers in such fields as health care, laboratory sciences, environmental sciences, and teaching. **All concentrations provide the necessary background for application to graduate or professional postgraduate work, differing mainly in their emphasis on specialized career trajectories within the life sciences.**

Biology - Comprehensive

The Biology - Comprehensive concentration provides the educational background necessary for a career in modern life science, including all requirements for admission to graduate school or related postgraduate study. The Biology - Comprehensive curriculum provides a solid foundation in fundamental areas of biology while permitting wide choice in course selection, allowing majors to explore and develop areas of molecular, physiological, ecological and evolutionary biology.

Biology - Preprofessional

The Preprofessional Biology concentration provides Biological Sciences majors with the intellectual tools essential for application to health care-related professional schools, including medical, dental, veterinary, optometric and related programs.

Biology - Biotechnology

The Biotechnology concentration provides strong preparation for careers in biotechnology, biomedical science research and the pharmaceutical industry, as well as for transition to graduate or other advanced educational programs.

Biology - Education

The Biology - Education concentration is designed for students seeking exceptionally strong backgrounds for professional teaching careers that include biology as a first teaching field. Students completing the Biology - Education curriculum also enroll in course work to satisfy the Minor in Secondary Science Education in the UNLV College of Education.

Biology - Environmental

The Biology - Environmental concentration is intended for students with interests in applied aspects of the environmental life sciences. The curriculum prepares students for careers in applied ecology, environmental horticulture, and land management. Also appropriate for students planning to pursue an advanced degree in conservation biology, species management and environmental law.

Minor

Biological Sciences (20 credits)

The Biological Sciences Minor is appropriate for all students with interests in the life sciences and especially for those who seek careers that may be enhanced by a background in biology. These include, but are not limited to biochemistry, chemistry, geology, psychology, anthropology and sociology. To minor in biology, students must complete BIO 189, 190, 191, and 12 upper-division credits. BIO 251 or BIO 209 may be taken in lieu of four upper-division credits. BIO 300 is recommended. No more than three units of independent study (BIO 492, 493, 495, 496) may be applied towards the minor. BIO 499 may not be used to fulfill requirements towards the minor. A Biological Sciences Minor will be awarded only if the overall GPA in applicable BIO courses is 2.0 or above.

Admission to the Major

GPA: 2.50

Admission Policies: Prospective majors with GPAs less than 2.50, but at least 2.30 may be admitted on probationary status. Students who enter on probation must meet with an advisor to establish a probationary course of study. Specific details pertaining to probationary status can be found in the College of Science listing of the *Undergraduate Catalog*.

Transfer Policies: Transfer students must have a minimum GPA of 2.50. All students are required to meet with an advisor to determine course work that can be used to satisfy degree requirements. The last 30 credit hours must be taken at UNLV.

Although rare, it is possible for superior preprofessional students to gain admission to a professional school upon completion of 94 units of undergraduate work. Such students may, under certain circumstances, be awarded a baccalaureate degree from UNLV upon successfully completing one year of full-time study with courses equivalent to the Department of Biological Sciences major at the professional school. To apply for a degree after one year of professional school, students must have completed 94 units at UNLV with a GPA of 3.5 and meet university and college graduation requirements. Any student contemplating such a program must obtain approval for the Departmental Chair and College Dean in advance of departure from UNLV.

Community College Articulation

The Department of Biological Sciences has course articulation agreements with several community colleges both within and outside Nevada. For specific information about transfer of credits from two-year institutions, students should seek advising about specific courses of study from the department.

Department Policies

Academic Policies: In addition to the General Education Core requirements, all study courses must include a minimum of 39 credits in the Biological Sciences and satisfy the specific requirements of one of the five concentration areas offered by the department.

Department of Biological Sciences.

In accord with UNLV requirements, at least 40 credits must be earned in upper-division level courses. This requirement may be satisfied

by selecting courses within and outside the Department of Biological Sciences.

To graduate with a degree in the biological sciences, a GPA of at least 2.00 must be maintained for all courses in the major field (BIO). All BIO Core courses taken (BIO 189, 190, 191, 300 and 310) must be passed with a grade of C- or better to fulfill prerequisites for other upper-division courses or to apply to the B.S. degree in the Biological Sciences.

BIO 100, 109, 113, 120, 122, 148, 208, 223, 224 and 280 are designed for non-biology majors and do not fulfill the Department of Biological Sciences curricular requirements. Although these credits will apply to the general university total credit requirement, or might be required or advised for other programs or career tracks (e.g. primary or secondary teaching), they are not recommended for Biological Sciences majors and do not fulfill any requirements for the biology major.

Advisement

All majors in the Department of Biological Sciences are required to meet with an advisor once a year at the College Advising Center located in White Hall. Students who fail to meet with an advisor will not be able to register for courses in the Fall Semesters.

Note:

Requirements for the major have been revised. The new requirements apply to biology majors in the class of Fall 2002 and later. Students in prior classes follow the requirements that were in place when they entered the program. Students needing help in bridging gaps between old and new programs should contact the Biological Sciences department office (WHI 101).

Degree Requirements

Biological Sciences

Biology - Comprehensive

English Composition and Literature	9 credits
Logic or Finite Mathematics	3 credits
Constitutions	4-6 credits
Social Sciences	9 credits
Fine Arts	3 credits
Humanities	6 credits
Multicultural	(see notes)
International	(see notes)
Biology Core Requirements	19 credits

BIO 189, BIO 190, BIO 191, BIO 300, BIO 310

*Students with strong high school preparation in biology (honors or AP biology courses with lab or the equivalent) and who have achieved a score of 4 or better on the AP Biology exam or a score of 600 or better on the SAT II Biology E/M exam or a satisfactory score on the UNLV Biological Sciences Placement Exam may have BIO 189 waived.

Other Required Courses

CHE 115, 116, 225, 227, 325, 327, 474, MAT 181	34 credits
STA 391 or 491, PHY 151, 152	

Other Recommended Courses

CHE 475, MAT 182	7 credits
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Biology-Comprehensive Requirements

20-24 credits	
A maximum of three courses from any one list (A,B,C, D or E)	

depending on the areas of interest, with the remaining credits selected from at least two other lists; including an approved capstone in the Biological Sciences (see notes)

- a. Ecological and Evolutionary Biology; BIO 301, 302, 305, 341, 411, 441, 444, 472, 486, 487, 490
- b. Molecular and Genetic Biology; BIO 404, 407, 410, 411, 445, 448, 453, 460, 466, 470, 473, 481, 485, 489,
- c. Anatomical and Morphological Biology; BIO 350, 426, 465, 468,
- d. Physiological Biology; BIO 360, 367, 404, 442, 445, 447, 448, 460
- e. Systematic Biology; BIO 301, 302, 320, 422, 431, 432, 433, 434, 437, 486

Electives 15-26 credits
 Total 128 credits

Notes:

1. Every student must complete a three-credit multicultural course and a three-credit international course. Courses satisfying other requirements may simultaneously satisfy the multicultural and international requirements except one course cannot satisfy both the multicultural and the international requirements.
2. Lists of approved capstone courses may be obtained in the departmental office.

Biological Sciences

Biology - Preprofessional

English Composition and Literature 9 credits
 Logic or Finite Mathematics 3 credits
 Constitutions 4-6 credits
 Social Sciences 9 credits
 Fine Arts 3 credits
 Humanities 6 credits
 Multicultural (see notes)
 International (see notes)
 Biology Core Requirements 19 credits
 BIO 189, 190, 191, 300, 310

*Students with strong high school preparation in biology (honors or AP biology courses with lab or the equivalent) and who have achieved a score of 4 or better on the AP Biology exam or a score of 600 or better on the SAT II Biology E/M exam or satisfactory score on the UNLV Biological Sciences Placement Examination may have BIO 189 waived.

Other Required Courses 34 credits
 CHE 115, 116, 225, 227, 325, 327, 474, MAT 181, STA 391 or 491, PHY 151, 152

Other Recommended Courses 4 credits
 MAT 182

Biology-Preprofessional Requirements 20-24 credit
 BIO 251 and a minimum of three upper-division BIO courses with at least one each from B,C and D with one additional course from A or E; including an approved capstone in Biology-Preprofessional (see notes). CHE 475

- a. Ecological and Evolutionary Biology; BIO 301, 302, 305, 341, 411, 441, 444, 472, 486, 487, 490
- b. Molecular and Genetic Biology; BIO 404, 407, 410, 411,

- 445, 448, 453, 460, 466,470, 473, 481, 485, 489
- c. Anatomical and Morphological Biology; BIO 350, 426, 465, 468
- d. Physiological Biology; BIO 360, 367, 404, 442, 445, 447, 448, 460
- e. Systematic Biology; BIO 301, 302, 320, 422, 431, 432, 433, 434,437, 486

Electives 15-26 credits
 Total 128 credits

Notes:

1. Every student must complete a three-credit multicultural course and a three-credit international course. Courses satisfying other requirements may simultaneously satisfy the multicultural and international requirements except one course cannot satisfy both the multicultural and the international requirements.
2. Lists of approved capstone courses may be obtained in the departmental office.

Biological Sciences

Biology - Biotechnology

English Composition and Literature 9 credits
 Logic or Finite Mathematics 3 credits
 Constitutions 4-6 credits
 Social Sciences 9 credits
 Fine Arts 3 credits
 Humanities 6 credits
 Multicultural (see notes)
 International (see notes)
 Biology Core Requirements 19 credits

BIO 189, 190, 191, 300, 310

*Students with strong high school preparation in biology (honors or AP biology courses with lab or the equivalent) and who have achieved a score of 4 or better on the AP Biology exam or a score of 600 or better on the SAT II Biology E/M exam or a satisfactory score on the UNLV Biological Sciences Placement Examination may have BIO 189 waived.

Other Required Courses 34 credits
 CHE 115, 116, 225, 227, 325, 327, 474, MAT 181
 STA 391 or 491, PHY 151, 152

Other Recommended Courses 4 credits
 MAT 182

Biology-Biotechnology Requirements 20-24 credits
 BIO 251, BIO 407 and a minimum of two upper-division BIO courses from lists B and D with at least one from list A; including an approved capstone for Biology-Biotechnology (see notes). CHE 475. Other course work important for biotechnology careers, such as Quality Assurance/Quality Control may be petitioned to be substituted for UNLV courses.

- a. Ecological and Evolutionary Biology; BIO 301, 301, 305, 341, 411, 441, 444, 472, 486, 487, 490
- b. Molecular and Genetic Biology; BIO 404, 407, 410, 411, 445, 448, 453, 460, 466, 470, 473, 481, 485, 489
- c. Anatomical and Morphological Biology; BIO 350, 426, 465, 468
- d. Physiological Biology; BIO 360, 367, 404, 442, 445, 447, 448, 460

- e. Systematic Biology; BIO 301, 302, 320, 422, 431, 432, 433, 434, 437, 486

Electives 15-26 credits
 Total 128 credits

Notes:

1. Every student must complete a three-credit multicultural course and three-credit international course. Courses satisfying other requirements may simultaneously satisfy the multicultural and international requirements except one course cannot satisfy both the multicultural and the international requirements.
2. Lists of approved capstone courses may be obtained in the departmental office.

Biological Sciences

Biology - Education

English Composition and Literature 9 credits
 Logic or Finite Mathematics 3 credits
 Constitutions 4-6 credits
 Social Sciences 9 credits
 Fine Arts 3 credits
 Humanities (see notes)
 International (see notes)
 Biology Core Requirements 19 credits
 BIO 189, 190, 191, 300, 310

*Students with strong high school preparation in biology (honors or AP biology courses with lab or the equivalent) and who have achieved a score of 4 or better on the AP Biology exam or a score of 600 or better on the SAT II Biology E/M exam or a satisfactory score on the UNLV Biological Sciences Placement Examination may have BIO 189 waived.

Other Required Courses 34 credits
 CHE 115, 116, 225, 227, 325, 327, 474, MAT 181, STA 391 or 491, PHY 151, 152
 Other Recommended Courses 7 credits
 CHE 475, MAT 182

Biology-Education Requirements 20-24 credits
 a. Ecological and Evolutionary Biology; BIO 301, 302, 305, 341, 411, 441, 444, 472, 486, 487, 490
 b. Molecular and Genetic Biology; BIO 404, 407, 410, 411, 445, 448, 453, 460, 466, 470, 473, 481, 485, 489,
 c. Anatomical and Morphological Biology; BIO 350, 426, 465, 468
 d. Physiological Biology; BIO 360, 367, 404, 442, 445, 447, 448, 460
 e. Systematic Biology; BIO 301, 302, 320, 422, 431, 432, 433, 434, 437, 486

Electives 15-26 credits
 Total 128 credits

Notes:

1. Every student must complete a three-credit multicultural course and a three-credit international course. Courses satisfying other requirements may simultaneously satisfy the multicultural and international requirements except one course cannot satisfy both the multicultural and the international requirements.

2. Lists of approved capstone courses may be obtained in the departmental office.

Biological Sciences

Biology - Environmental

English Composition and Literature 9 credits
 Logic or Finite Mathematics 3 credits
 Constitutions 4-6 credits
 Social Sciences 9 credits
 Fine Arts 3 credits
 Humanities 6 credits
 Multicultural (see notes)
 International (see notes)
 Biology Core Requirements 19 credits
 BIO 189, 190, 191, 300, 310

*Students with strong high school preparation in biology (honors or AP biology courses with lab or the equivalent) and who have achieved a score of 4 or better on the AP Biology exam or a score of 600 or better on the SAT II Biology E/M exam or a satisfactory score on the UNLV Biological Sciences Placement Examination may have BIO 189 waived.

Other Required Courses 34 credits
 CHE 115, 116, 225, 227, 325, 327, 474, MAT 181, STA 391 or 491, PHY 151, 152
 Other Recommended Courses 7 credits
 CHE 475, MAT 182

Biology-Environmental Requirements 20-24 credits
 BIO 341 and a minimum of two courses from any A and E, and two courses from any two of B, C and D; including an approved capstone for Biology-Environmental (see notes)

- a. Ecological and Evolutionary Biology; BIO 301, 302, 305, 341, 411, 441, 444, 472, 486, 487, 490
- b. BIO 404, 407, 410, 411, 445, 448, 453, 460, 466, 470, 473, 481, 485, 489
- c. Anatomical and Morphological Biology; BIO 350, 426, 465, 468
- d. Physiological Biology; BIO 360, 367, 404, 442, 445, 447, 448, 460
- e. Systematic Biology; BIO 301, 302, 320, 422, 431, 432, 433, 434, 437, 486

Electives 15-26 credits
 Total 128 credits

Notes:

1. Every student must complete a three-credit multicultural course and a three-credit international course. Courses satisfying other requirements may simultaneously satisfy the multicultural and international requirements except one course cannot satisfy both the multicultural and the international requirements.
2. Lists of approved capstone courses may be obtained in the departmental office.

BIO 100**Human Biology**

Introduction to biology of the human species. For non-majors; emphasizing those aspects of structure, function, ecology, and evolution which provide a biological perspective for problems facing modern society. Three hours lecture and three hours laboratory. Satisfies the General Education Core requirement for a laboratory science course. 4 credits.

BIO 103**Biology Laboratory**

For transfer students only. Laboratory portion of either BIO 100 or BIO 190, for students who have had course work without a laboratory at a previous institution. Prerequisites: Credits for the lecture portion of either a majors or non-majors entry-level course and consent of instructor. 1 credit.

BIO 109**Principles of Nutrition**

(*Same as NTR 109.*) Description of the nature and role of carbohydrates, lipids, proteins, water, vitamins, and minerals in the human body. Energy relations and various controversies in nutrition examined, as well as the relationships among nutrition, health, and disease. 3 credits.

BIO 113**Life in the Oceans**

Introduction to the environments and inhabitants of the sea. 3 credits.

BIO 120**Plants and People**

Introduction for non-biology majors to the social, cultural, and economic role of useful and harmful plants and plant products in modern society. Consideration given to the origin, history, and human value of selected plants, especially those used for food, medicine, and industrial raw materials, or religious purposes. 3 credits.

BIO 122**Plants of the Southwestern Deserts**

Study of typical desert plant communities, along with the identification of more common species. Additional topics include morphological and physiological adaptations to aridity; and the nature, origin, and occurrence of arid environments. Two hours lecture and three hours laboratory. Satisfies the General Education Core requirement for a laboratory science course. 3 credits.

BIO 148**Natural History of the Desert Southwest**

Introduction for biology non-majors to the desert environments of the American Southwest. Includes the study of climate, geology, plants, animals, and man in desert regions. Includes field trips. Three hours lecture and three hours laboratory. Satisfies the General Education Core requirement for a laboratory science course. 4 credits.

BIO 189**Fundamentals of Life Science**

Survey of contemporary biology; includes structure, function, interactions and evolutionary origins of living systems. For Biological Sciences majors and others who require biology as part of their professional career preparation. Satisfies General Education Core requirements for laboratory sciences. Aligned with State of Nevada life science content standards for K-8 certification. 4 credits.

BIO 190**Principles of Modern Biology I**

For biological science and health science majors. Includes a study of the basic characteristics of living systems including the chemical and physical structure of cells, classification of living organisms, and principles of genetics, ecology, and evolution. Three hours lecture and three hours laboratory. Satisfies the General Education Core requirement for a laboratory science course. Prerequisite: BIO 189 or equivalent. 4 credits.

BIO 191**Principles of Modern Biology II**

Organismic biology in an evolutionary context, including biodiversity, structure and function, reproduction, and physiology of major groups of organisms, from viruses to mammals. Prerequisite: BIO 189. 4 credits.

BIO 208**Human Genetics**

For non-majors. Aspects of human inheritance and evolution considered. Prerequisite: BIO 100 or BIO 190. 3 credits.

BIO 209**Introduction to Cell Biology**

Provides undergraduate biology majors with a basic knowledge of cell structure and function. Subjects discussed include chemical components of cells, molecular and cellular organization of organelles and their function, and specialized cells. Corequisite: BIO 209D. Prerequisite: BIO 190, BIO 191, CHE 115. 3 credits.

BIO 209D**Introduction to Cell Biology Discussion**

Discussion of material covered in BIO 209. One hour meeting per week. Corequisite: BIO 209. 1 credit.

BIO 223**Human Anatomy and Physiology I**

Review of the basic organization of human cells and tissues and the structure and function of the skeletal, muscular, nervous, and sensory systems. Three hours lecture and three hours laboratory. Prerequisite: BIO 189. 4 credits.

BIO 224**Human Anatomy and Physiology II**

Structure and function of the human digestive, circulatory, urogenital, and endocrine systems. Three hours lecture and three hours laboratory. Prerequisite: BIO 189, BIO 223. 4 credits.

BIO 251**General Microbiology**

Introduction to general microbiology. Aspects of microbiology including soil, aquatic, ecological, and pathogenic bacteriology; virology and molecular genetics discussed. Laboratory presents basic principles of bacterial physiology and identification. Three hours lecture and three hours laboratory. Prerequisites: BIO 189, CHE 110 or CHE 115, or consent of instructor. 4 credits.

BIO 280**Introduction to Ecological Principles**

(*Same as ENV 220.*) Introduction for environmental science students to the major ecological principles at work in the environment. Focuses not only on these principles but also on understanding the processes that underlie them. Prerequisites: ENS 100 for Environmental Studies majors, and BIO 191 for BIO majors. 3 credits.

BIO 300**General Genetics**

Study of the transmission of traits from one generation to the next, the structure and function of genes, and the variation of genes between and within populations. Three hours lecture and three hours laboratory. Prerequisites: BIO 190, BIO 191, CHE 225 and CHE 227. 4 credits.

BIO 302**Evolutionary Survey of Vascular Plants**

Evolutionary survey of vascular plants: their classification, appearance in geologic time, comparative life cycles and morphological characteristics. Three hours lecture and three hours laboratory. Prerequisite: BIO 191. 4 credits.

BIO 305**Introduction to Conservation Biology**

Fundamental issues in conservation biology including biodiversity, invasive and endangered species, reserve design, and environmental legislation to provide a scientific examination of the biological underpinnings of conservation issues. Prerequisites: BIO 191 or BIO 280 or consent of instructor. 3 credits.

BIO 310**Evolution**

Evolutionary principles, designed to provide a synthesis of biological relationships essential for the professional biologist. Prerequisite: BIO 300. 3 credits.

BIO 320**Invertebrate Zoology**

Discussion of the taxonomy, morphology, and physiology of the phyla and classes of invertebrate animals, including some ecological and phylogenetic relationships. Two hours lecture and three hours laboratory. Prerequisite: BIO 191. 4 credits.

BIO 341**Principles of Ecology**

Fundamentals of ecology of levels of population, community, and ecosystem. Three hours lecture. Prerequisite: BIO 191. 3 credits.

BIO 345**Urban Horticulture**

New field of urban horticulture, which deals with how plants respond to urban stresses. Includes readings on and discussion of the following topics: plant sciences and development, horticultural practices, and stress physiology. Prerequisite: BIO 189. 3 credits.

BIO 350**Comparative Vertebrate Anatomy**

Introduction to comparative vertebrate zoology with emphasis on structure and evolution. Laboratory includes dissection of all major classes of vertebrates and study of gross and microscopic structures. Three hours lecture and six hours laboratory. Prerequisite: BIO 191. 5 credits.

BIO 360**Mammalian Physiology**

Principles of mammalian physiology, normal functioning of mammalian body as a whole, and interrelationships of organs and organ systems. Emphasis on physiological processes and their interrelationships. Corequisite: CHE 325 and CHE 327. Prerequisites: BIO 190, 191, CHE 225 and CHE 227. 3 credits.

BIO 367**Mammalian Physiology Laboratory**

Practical experience with physiological techniques. Emphasis on the integration of tissue, organ, and organ system physiological functions. Corequisite: BIO 360. 1 or 2 credits.

BIO 404**Principles of Neurobiology**

Introduction to the neurosciences, emphasizing cellular, molecular, and physiological aspects. Establishes a foundation of cellular neurobiology and moves on to selected topics in the organization, function, and development of neural systems. Prerequisites: BIO 190, BIO 191. 3 credits.

BIO 407**Molecular Biology**

Introductory molecular biology. Study of genes and their activities at the molecular level, including transcription, translation, DNA replication, and recombination. Concepts of molecular biology presented along with experimental strategies and data that led to those concepts. Prerequisite: BIO 300. 3 credits.

BIO 410**Virology**

Systematic examination of animal, plant, and bacterial viruses including their structure and genome organization, their reproduction and assembly, and their effects on host organisms. Prerequisites: BIO 251, BIO 300. 3 credits.

BIO 411**Molecular Evolution**

Molecular evolution of genes and genomes. Origin of life from the prebiotic soup through the RNA world to current DNA replication systems. Determination of the universal tree of life by inferring molecular phylogenies of genes and proteins. Emphasis on evolution by duplication, recombination, and transposition. Prerequisites: BIO 190, BIO 300; CHE 474 recommended, or consent of instructor. 3 credits.

BIO 422**Taxonomy of Vascular Plants**

Study of the evolutionary relationships of the principal orders, families and genera; systems of classification; collection and identification of local flora. Two hours lecture and six hours laboratory. Prerequisite: BIO 191. 4 credits.

BIO 426**Plant Anatomy**

Study of the basic structure of plant organs and tissues, particularly with regard to relationships between structure and function. Two hours lecture and four hours laboratory. Prerequisite: BIO 191. 3 credits.

BIO 430**Bryology**

Biology of mosses, including taxonomy, morphology, reproduction, speciation, desiccation tolerance, resource transfer, spore biology, and biology of the ecologically important soil crusts. Arid environments highlighted. Lab focuses on local identification and includes field trips. Prerequisite: BIO 209 or higher number BIO course, or consent of instructor. 3 credits.

BIO 431**Ichthyology**

Study of biology of fishes, including morphology, physiology, ecology, and evolution. Emphasis on local fish, field work with state and federal agency biologists. Three hours lecture, three hours laboratory, some overnight or weekend field trips. Prerequisite: BIO 191. 4 credits.

BIO 432**Herpetology**

Systematics, ecology, and evolution of amphibians and reptiles. Three hours lecture and three hours laboratory. Prerequisite: BIO 190, BIO 191. 4 credits.

BIO 433**Ornithology**

Principles of avian biology and evolution. Laboratory sessions involve bird identification and include field trips. Two hours lecture and six hours laboratory. Prerequisite: BIO 191. 4 credits.

BIO 434**Mammalogy**

Study of mammalian biology, evolution, and ecology, with attention to issues in mammal conservation biology. Three hours lecture and three hours laboratory with possible weekend and overnight field trips. Prerequisite: BIO 191. 4 credits.

BIO 437**General Entomology**

Introduction to the principles of insect classification and biology. Three hours lecture and three hours laboratory. Prerequisite: BIO 190, BIO 191. 4 credits.

BIO 441**Field Ecology**

Introduction to ecological research. Weekly field projects emphasize population biology, interactions among species, and ecosystem processes. Six hours of combined lecture and field or laboratory work. Prerequisites: BIO 341 or BIO 280, or consent of instructor. 3 credits.

BIO 442**Principles of Plant Physiology**

Introduction to the basic physiological processes in plants: metabolism, nutrition, growth, and development. Three hours lecture and three hours laboratory. Prerequisites: BIO 190, BIO 191, CHE 225 and CHE 227. 4 credits.

BIO 444**Principles of Plant Ecology**

Introduction to the ecology of wild plants, particularly structure, ecology of populations, interactions of plants with their environment and other organisms, and survey of the major global vegetation types. Prerequisite: BIO 341 or consent of instructor. 3 credits.

BIO 445**Cell Physiology Laboratory**

Provides laboratory experience in the study of cellular processes. Topics include cellular organelles, respiration, enzyme kinetics, and active transport. Prerequisite: BIO 190 or consent of instructors. 2 credits.

BIO 447**Comparative Animal Physiology**

Comparative examination of the function of animal systems. Three hours lecture and three hours laboratory. Prerequisites: BIO 190, BIO 191, CHE 225 and CHE 227. 4 credits.

BIO 448**Endocrinology**

(Same as CHE 478.) Survey of the structure and function of vertebrate endocrine systems, with emphasis on the biochemical basis of hormone action and the role of cell communication in endocrine physiology. Prerequisites: BIO 190, CHE 474 recommended. 3 credits.

BIO 453**Immunology**

Study of the immune response, cell-mediated and humoral. Topics include the diversity of antibodies and antigen receptors, evolution of immunity, cell-cell interactions, importance of major histocompatibility complex immune regulation, and immunity to microorganisms. Prerequisites: BIO 251 and BIO 300. 3 credits.

BIO 460**Microbial Physiology**

Exploration of the major aspects of microbial physiology, including structure and growth of bacteria, generation of ATP and intermediary metabolism, synthesis of macromolecules and cellular components, and coordination of intracellular activities. Three hours lecture and three hours laboratory per week. Prerequisites: BIO 251, CHE 225 and CHE 227. 4 credits.

BIO 465**Vertebrate Embryology**

Development of vertebrates, with emphasis on amphibians, birds, and mammals. Considerations of gametogenesis, fertilization, cleavage, early morphogenesis, and organogenesis included. Two hours lecture and six hours laboratory. Prerequisite: BIO 191. 4 credits.

BIO 466**Principles of Developmental Biology**

Incorporates information from such diverse fields as molecular biology, genetics, cell structure and physiology, endocrinology, embryology, histology, and anatomy. Knowledge integrated to answer the question of how single-celled zygotes undergo programmed changes over time to emerge as diverse organisms. Three hours lecture and three hours laboratory. Prerequisite: BIO 300 or consent of instructor. 4 credits.

BIO 468**Histology**

Microscopic structure and function of vertebrate tissues with emphasis on mammals. Two hours lecture and six hours laboratory. Prerequisite: BIO 190, BIO 191. 4 credits.

BIO 470**Topics in Applied Microbiology**

Applications may include bioremediation, food, agriculture, pharmaceuticals, vaccine development, water treatment, or genetic engineering. Presentation and discussion of current literature. Topics published in the class schedule. Maximum of two different topics may be selected for a total of six credits. Prerequisites: BIO 251 and BIO 300, or consent of instructor. 3 credits.

BIO 472**Limnology**

Acquaints advanced students with the biological, chemical, and physical characteristics of the aquatic environment. Two hours lecture and seven hours laboratory. Prerequisites: CHE 116 and BIO 191 or consent of instructor. 4 credits.

BIO 473**Advanced Topics in Cell and Molecular Biology**

Discussion of current literature on a specific topic in cell and molecular biology. Topics published in the class schedule. May be repeated to a maximum of six credits. Prerequisites: BIO 300 and consent of instructor. 3 credits.

BIO 480**Introduction to Biological Modeling**

Introduction to the modeling of biological systems and processes through the use of computers. Prerequisites: BIO 191. 3 credits.

BIO 481**Advanced Cell Biology**

Advanced topics in cell and molecular biology, including membrane structure and function, cytoskeleton, signal transduction, and current research methods. Prerequisites: BIO 190, CHE 474. 3 credits.

BIO 485**Microbial Genetics**

Examines genetics of prokaryotic microorganisms, including induction of mutations and selection of mutants, alternative processes of genetic exchange and gene mapping, and gene organization and regulation. Three hours lecture and three hours laboratory each week. Prerequisites: BIO 251 and BIO 300. 4 credits.

BIO 486**Animal Behavior**

Evolutionary analysis of vertebrate and invertebrate behavior. Prerequisite: BIO 191. 3 credits.

BIO 487**Principles of Systematics**

Principles and applications of methods used to reconstruct history and biotic diversity among genes, species, and higher taxa. Considers several approaches to tree construction and significance of phylogenetic history within the context of evolution, biogeography, and conservation biology. Emphasis on molecular approaches to systematics. Prerequisite: BIO 310 or consent of instructor. 3 credits.

BIO 489**Developmental Genetics**

Topics in molecular genetics of developmental processes explored through current literature. May be repeated to a maximum of six credits. Prerequisite: BIO 300. 3 credits.

BIO 490**Biogeography**

Study of distributional patterns of plant and animal groups, including consideration of theories and principles, derived from a variety of disciplines, related to those patterns. Prerequisite: BIO 191. 3 credits.

BIO 492**Undergraduate Research**

Special problems in some field of the biological sciences for investigation and report. May be repeated to a maximum of eight credits. Prerequisites: Two years of biological sciences and consent of instructor. 1-3 credits.

BIO 493**Undergraduate Seminar**

Preparation and presentation of seminars on topics of current interest in biology. Topic changes by semester; see class schedule. May be repeated to a maximum of three credits. Prerequisites: Two years of biological sciences and consent of instructor. 1 credit.

BIO 495**Current Topics in Biology**

Analysis and critique of topics as presented by speakers drawn from the national biological research community. May be repeated to a maximum of three credits. S/F grading only. Prerequisite: Two years of biological sciences. 1 credit.

BIO 496**Special Topics in Modern Biology**

Advanced study in a specialized area of biology. Topics selected and published in class schedule. Maximum of three different topics may be selected for a total of six credits. Prerequisites: BIO 190, BIO 191 and consent of instructor. 1-3 credits.

BIO 499**Instruction in Biological Sciences**

Significant involvement in instruction of courses in biological sciences. May include laboratory preparation, instruction, and grading. May be repeated to a maximum of two credits. S/F grading only. Prerequisite: Consent of instructor. 1-2 credits.

Department of Chemistry

Purpose and Focus

The science of chemistry deals with the composition, analysis, structure, and properties of matter and the various transformations matter may undergo. Chemical processes are at the heart of many diverse systems that are of great interest to mankind, including biological functions, the natural and polluted environment, industrial processes, biotechnology, food and agriculture, mining technology, etc. The Bachelor of Arts degree is designed to allow a student sufficient flexibility to obtain expertise in a discipline other than chemistry so that chemical knowledge can be applied to another field. The Bachelor of Science degree is an accredited program that requires more chemistry, math, and physics than the Bachelor of Arts degree and is intended for students wishing to pursue a career in chemistry. The Bachelor of Science degree in Biochemistry is intended to provide a student with the theoretical and technical skills necessary for employment in industry or to pursue a graduate degree in biochemistry or a related field.

Degree Objectives/Learning Outcomes**Objectives of the Bachelor of Arts degree in Chemistry:**

1. Graduates shall be able to demonstrate technical competency in the performance of basic laboratory operations, including solution preparation and standardization, common synthetic procedures, standard qualitative and quantitative analysis procedures, and operation of standard laboratory equipment.
2. Graduates shall understand the concepts underlying the theoretical basis of chemistry, as well as areas of application of chemical principles.
3. Graduates shall be capable of critical analysis and, under supervision, shall be able to apply the scientific method to a chemical problem.
4. Graduates must be well versed in the language of chemistry, should be capable of accessing chemical information in its various forms, and should be capable of effectively communicating chemical knowledge in both written and oral forms.

Objectives of the Bachelor of Science degree in Chemistry:

1. Graduates shall be able to demonstrate technical competency in the performance of basic laboratory operations, including solution preparation and standardization, common synthetic procedures, standard qualitative and quantitative analysis procedures, and operation of standard laboratory equipment.
2. Graduates shall have an in-depth understanding of the theoretical basis of chemistry, as well as areas of application of chemical principles.
3. Graduates shall be capable of critical analysis and shall have had experience in applying the scientific method to a chemical problem.