Biology Undergraduate Program

Why study biology?
Study biology because undergraduates should have the opportunity to explore the breadth of biology that allows them to succeed in their chosen paths beyond the university.

Advising and Career Counseling
Undergraduate majors are encouraged to consult a faculty member as soon as possible to discuss degree options and course choices. Opportunities for independent study, research, field experience, student hourly employment, undergraduate teaching assistantships, and participation in student organizations are available. Students may consult faculty members in their areas of interest.

Undergraduate Biology Program staff can direct students to faculty members, and lists of faculty members who can advise students are available on the UBP website (http://kuub.ku.edu). Information about curricula, careers, and opportunities in the biological and health-related sciences are available on the UBP website (http://kuub.ku.edu), in the UBP office in 2045 Haworth, and the Biology Teaching Resource Center in 1004 Haworth. See the KU career resource website (http://career.ku.edu) for help with career choices and job searches.

Undergraduate Programs
The KU Undergraduate Biology Program (UBP) administers the

- B.A. and B.S. in biochemistry,
- B.A. in biology,
- B.S. in biology (ecology, evolution, and organismal biology),
- B.S. in biology (molecular, cellular, and developmental biology),
- B.S. in biology (teaching biology),
- B.A.S. in biotechnology (KU Edwards Campus),
- B.A. in human biology (anthropology),
- B.A. in human biology (applied behavioral science),
- B.A. in human biology (biology),
- B.A. in human biology (psychology),
- B.A. in human biology (speech-language-hearing science),
- B.A. and B.S. in microbiology, and
- B.S. in molecular biosciences (KU Edwards Campus).

Courses for Nonmajors
BIOL 100 Principles of Biology, BIOL 116 Introduction to Evolutionary Biology, and BIOL 120 Insects in Your World offer undergraduate nonmajors an introduction to biology and biological facts or concepts. A laboratory, BIOL 102, supplements BIOL 100. Honors sections (BIOL 101/BIOL 103) are offered for students with superior academic records. Except when specifically listed in the major requirements, these courses do not count toward a biology major.

Double Majors
Students may earn degrees in a biological science and an area outside biology by meeting the requirements of both degree programs and taking at least 15 hours of courses unique to each major.

Undergraduate Research Opportunities
The Undergraduate Biology Program encourages independent study and participation in faculty research programs. Consult an advisor or the UBP website (http://www.kuub.ku.edu) to find a faculty sponsor for research or independent study. After receiving permission, the student may enroll in that faculty member’s section of BIOL 424 Independent Study for the number of hours specified by the faculty member. Depending upon the specific major, three to five independent study hours can be applied to elective requirements in the major. Independent study is required for graduation with departmental honors. By special arrangement with a faculty member, students may earn independent study credit by participating in research programs offered by other units (e.g., faculty members in the School of Medicine).

Student Organizations
Biology clubs (http://kuub.ku.edu/students) allow students to interact with faculty and students while expanding their interest in biology. The biology majors advisory committee—part of the KU biology club—advises the UBP director on all undergraduate issues and provides a forum for concerns and suggestions.

Biology Courses by Topics
For a list of biology courses by topics, see Degrees. (http://kuub.ku.edu/degrees)

Related Biology Courses
A biological course from departments outside the Undergraduate Biology Program may count toward a B.A. degree (up to 4 hours of credit). Check with a biology faculty advisor to determine whether nonbiology courses are acceptable to satisfy biology degree requirements.

Ecology and Evolutionary Biology
The Department of Ecology and Evolutionary Biology (http://www2.ku.edu/~eeb) offers M.A. and Ph.D. degrees in ecology and evolutionary biology, botany, and entomology. In addition, students may concentrate in ecology and evolutionary biology by seeking a B.S. in biology.

Molecular Biosciences
The Department of Molecular Biosciences (http://www.molecularbiosciences.ku.edu) offers Ph.D. degrees in biochemistry and biophysics; microbiology; and molecular, cellular, and developmental biology.

The B.S. degree in molecular biosciences is offered on the KU Edwards Campus (http://edwardscampus.ku.edu).

Courses

BIOL 100. Principles of Biology. 3 Hours NB GE3N / N.
Intended for non-science majors. The basic concepts of biology at the cellular, organismal, and population levels of organization and their applications to humans and modern society. An honors section, BIOL 101, is offered for students with superior academic records. BIOL 100 and BIOL 102 (or BIOL 101 and BIOL 103, honors) satisfy the College natural
science with laboratory requirement. Concurrent enrollment in BIOL 102 is recommended. LEC.

**BIOL 101. Principles of Biology, Honors. 3 Hours NB GE3N / N.**
Intended for non-science majors with superior academic records. The basic concepts of biology at the cellular, organisal, and population levels of organization and their applications to humans and modern society. Concurrent enrollment in BIOL 102 or BIOL 103 is recommended. BIOL 101 and either BIOL 102 or BIOL 103 satisfy the College natural science with laboratory requirement. Prerequisite: Membership in the College Honors Program or consent of instructor. LEC.

**BIOL 102. Principles of Biology Laboratory. 1 Hour U / LFE.**
Intended for non-science majors. Exercises are designed to give the student hands-on experience with selected topics from the associated lecture course (BIOL 100). An honors laboratory (BIOL 103) is offered for students with superior academic records. Prerequisite: Concurrent enrollment in BIOL 100 is recommended. LAB.

**BIOL 103. Principles of Biology Laboratory, Honors. 1 Hour U / LFE.**
Intended for non-science majors with superior academic records. Exercises are designed to give the students hands-on experience with selected topics from the associated lecture course (BIOL 101). Prerequisite: Membership in the College Honors Program or consent of instructor. Concurrent enrollment in BIOL 103 is recommended. LAB.

**BIOL 105. Biology Orientation Seminar. 1 Hour N.**
Introduces interested students to information about majoring in the biological sciences at the University of Kansas. Students learn about degree requirements, academic advising, research opportunities, and career options, as well as how to align academic and professional goals. Graded on a satisfactory/unsatisfactory basis. LEC.

**BIOL 110. Microorganisms in Your World. 3 Hours NB / N.**
A course for students who are not science majors. Designed to acquaint students with some microbial activities which affect their lives. Includes the historical development of microbiology, the basic principles of microbial growth, disinfection, antibiotics, infection, and immunity; and some commercial, agricultural, and industrial uses of microorganisms. Emphasis is on infectious diseases. Not open to students with any credit in microbiology. May not be counted as a prerequisite for any other microbiology course. LEC.

**BIOL 116. Introduction to Evolutionary Biology. 3 Hours N / LFE.**
An account of evolutionary thinking from classical to contemporary time. The emphasis is on mainstream developments (Darwinism, Mendelism, the Modern Synthesis, Cultural Ecology), but certain social issues will be examined (social Darwinism, creationism). LEC.

**BIOL 120. Insects in Your World. 3 Hours NB GE3N / N.**
Students will learn about the global impact of insects on human concerns, both positive (pollination and decomposition) and negative (competition with humans for food, fiber, and shelter, and disease transmission) while developing an appreciation for the ways in which scientists work with real problems involving insects. The course will cover the overwhelming abundance and diversity of insects, and their life history, ecology, behavior, and physiology. This course is intended for both nonbiology and biology majors. Format: two lectures and one discussion section per week. LEC.

**BIOL 150. Principles of Molecular and Cellular Biology. 4 Hours NB GE3N / N / LFE.**
An integrated lecture and laboratory course for biology majors and students planning to take additional courses in biology. This course covers basic biochemistry, cell structure and function, molecular biology, genetics, physiology, and development of plants and animals. Three hours of lecture and three hours of laboratory per week. An honors section (BIOL 151) is offered for students with superior academic records. Prerequisite: Concurrent or prior enrollment in CHEM 130, CHEM 190, CHEM 150, or CHEM 170, or consent of instructor. LEC.

**BIOL 151. Principles of Molecular and Cellular Biology, Honors. 4 Hours NB GE3N / N / LFE.**
An integrated lecture and laboratory course for students with superior academic records who are biology majors or who plan to take additional courses in biology. This course covers basic biochemistry, cell structure and function, molecular biology, genetics, physiology, and development of plants and animals. Three hours of lecture and three hours of laboratory per week. Prerequisite: Membership in the University Honors Program and concurrent or prior enrollment in CHEM 130, CHEM 190, CHEM 150, or CHEM 170, or consent of instructor. LEC.

**BIOL 152. Principles of Organismal Biology. 4 Hours NB GE3N / N / LFE.**
An integrated lecture and laboratory course for biology majors and students who plan to take additional courses in biology. This course covers basic elements of plant and animal morphology and physiology, principles of evolution, organismal diversity and phylogeny, population biology, population genetics, ecology, and behavior. Three hours of lecture and three hours of laboratory per week. An honors section (BIOL 153) is offered for students with superior academic records. Prerequisite: BIOL 150 or BIOL 151 with a grade of C- or higher; or consent of instructor. LEC.

**BIOL 153. Principles of Organismal Biology, Honors. 4 Hours NB GE3N / N / LFE.**
An integrated lecture and laboratory course for students with superior academic records who are biology majors or planning to take additional courses in biology. This course covers basic elements of plant and animal morphology and physiology, principles of evolution, organismal diversity and phylogeny, population biology, population genetics, ecology, and behavior. Three hours of lecture and three hours of laboratory per week. Prerequisite: BIOL 150 or BIOL 151 with a grade of C- or higher and membership in the University Honors Program; or consent of instructor. LEC.

**BIOL 155. Principle Lab in: ____, 1-3 Hours U / LFE.**
This introductory laboratory exposes the students to basic principles in biology and modern experimental techniques through an open-ended authentic research experience directed by a faculty member. Prerequisite: Consent of instructor. LEC.

**BIOL 177. First Year Seminar: ____. 3 Hours NB GE11.**
A limited-enrollment, seminar course for first-time freshmen, organized around current issues in biology. Does not contribute to major requirements in biology. First year seminar topics are coordinated and approved through the Office of First Year Experiences. Prerequisite: First-time freshman status. LEC.

**BIOL 200. Basic Microbiology. 3 Hours NB GE3N / N.**
Introduction to bacteria and viruses. Topics include historical development of microbiology, bacterial structure and growth, enzymes and energy production, disinfection, antibacterial drugs, gene transfer, viral replication, infection and immunity, with emphasis on infectious diseases. Can be substituted for BIOL 201 as a prerequisite for other microbiology courses by consent of department. Not open to those with credit in BIOL 110, BIOL 201, BIOL 400, or BIOL 401. Prerequisite: A course in high school biology and a course in high school chemistry. This course is not recommended for first semester freshmen. LEC.

**BIOL 203. Introductory Microbiology Laboratory. 2 Hours U / LFE.**
Laboratory exercises to complement BIOL 200. Prerequisite: BIOL 200. May be taken concurrently. LAB.
BIOL 210. Introduction to Clinical Laboratory Sciences. 1 Hour U.
An introductory overview of medical technology as a profession including types of analyses performed, specialties, interrelationships in the health care system and a visit to a clinical laboratory. This course will enable those considering a major in medical technology to have a clear definition of the profession. This course does not meet any degree requirements in biology. No prerequisite. (Same as CLS 210.) LEC.

BIOL 215. Plants Through Time. 3 Hours NB / N.
Examines the evolution of plants and their environments from the origin of life to the present, including the historical development of the biosphere, mass extinctions (past and present), and social implications of future climate changes and deforestation. Not recommended for students with credit in GEOL 121. LEC.

BIOL 225. Evolution and the History of Life. 3 Hours GE3N / N.
This introductory course for non-majors focuses on the significance of the history of life and the fossil record for our understanding of evolution. Key events in the history of life are considered, including the origins of life, the eukaryotic cell, and humans, and also various mass extinctions. The focus is on general scientific and evolutionary principles and mechanisms that can be extracted from the study of the fossil record. It also uses the lessons of the fossil record to consider the prospects for our own species. LEC.

BIOL 240. Fundamentals of Human Anatomy. 3 Hours N.
Introduction to the gross anatomy of the human body. Covers the spatial arrangement and appearance of structures throughout the body, including visual identification of these structures. Musculoskeletal relationships, and the anatomy of major organ systems, are emphasized. Not intended for biology majors. Prerequisite: BIOL 100, or equivalent. LEC.

BIOL 241. Human Anatomy Observation Laboratory. 2 Hours U / LFE.
One of the two laboratories in gross anatomy designed to complement BIOL 240. Emphasizes the three-dimensional appearance and spatial relationships of anatomical structures through supervised observations of pre-dissected human cadavers. Limited to students enrolled in, or seeking admission to, programs that require a human anatomy observation laboratory. Prerequisite: Concurrent or prior enrollment in BIOL 240 is required. LAB.

BIOL 242. Human Anatomy Dissection Laboratory. 3 Hours U / LFE.
One of the two laboratories in gross anatomy designed to complement BIOL 240. Provides an opportunity to develop a comprehensive three-dimensional understanding of anatomical structures and spatial relationships while gaining substantial dissecting experience. Student perform supervised dissection of human cadavers. Limited to students enrolled in, or seeking admission to, programs that require a human anatomy laboratory. Concurrent or prior enrollment in BIOL 240 is required. LAB.

BIOL 246. Principles of Human Physiology. 3 Hours N.
An introduction to the physiological and biochemical processes and general physiological principles necessary to sustain life. Organ and organ system processes are emphasized. Intended for students majoring in allied health or sports related curricula who require a course in human physiology. Not intended for biology majors. Prerequisite: BIOL 100 or equivalent. LEC.

BIOL 247. Principles of Human Physiology Laboratory. 2 Hours U / LFE.
Designed to complement BIOL 246. Uses experiments and simulations to demonstrate laboratory techniques and representative processes in areas of human physiology. Concurrent or prior enrollment in BIOL 246 required. LAB.

BIOL 350. Principles of Genetics. 4 Hours N.
Why are related individuals more similar than unrelated individuals and what is the basis for heritable traits? From Mendel's discoveries of the patterns of genetic inheritance, to the study of transmissible hereditary factors, genetics is central to understanding the biological sciences. Topics include molecular genetics and genetic engineering; Mendelian genetics and mapping; control of gene expression; cytotgenetics; epigenetics and non-Mendelian genetics; and population and quantitative genetics. Examples are taken from a wide variety of organisms, including viruses, bacteria, plants, fungi, insects, and humans. Prerequisite: CHEM 135 or CHEM 175 or CHEM 195 with a grade of C- or higher and BIOL 150 or BIOL 151 with a grade of C- or higher and BIOL 152 or BIOL 153 with a grade of C- or higher; or consent of instructor. LEC.

BIOL 360. Principles of Genetics, Honors. 4 Hours N.
The science of genetics aims to explain why individuals differ from one another and how these differences are inherited. Honors Genetics covers all core topics in fundamental genetics: Mendelian inheritance, meiosis and recombination, mutation, molecular genetics, population genetics, quantitative genetics and genomics. Special attention given to the practice of genetics and the complex relationship between genotype, phenotype and environment. A broader goal of Honors Genetics is to provide students a framework for understanding recent advances in medical genetics and the modern era of personal genomics. Prerequisite: CHEM 135 or CHEM 175 or CHEM 195 with a grade of C- or higher and BIOL 150 or BIOL 151 with a grade of C- or higher and BIOL 152 or BIOL 153 with a grade of C- or higher and membership in the University Honors Program; or consent of the instructor. LEC.

BIOL 400. Fundamentals of Microbiology. 3 Hours NB GE3N / N.
Fundamental principles of microbiology with emphasis on physical and chemical properties of the bacterial cell; microbial metabolism, cultivation, growth and death of bacteria; microbial genetics, pathogenesis and immunity, industrially important microorganisms. Prerequisite: BIOL 150 or BIOL 151 and two semesters of college chemistry, or consent of the instructor. LEC.

BIOL 401. Fundamentals of Microbiology, Honors. 4 Hours N.
Honors section of BIOL 400 and BIOL 612, by application and invitation. Prerequisite: BIOL 151, two semesters of college chemistry, and membership in the University Honors Program, or consent of the instructor. LEC.

BIOL 402. Fundamentals of Microbiology Laboratory. 2 Hours U / LFE.
Laboratory exercises designed to complement BIOL 400 or BIOL 700. Prerequisite: BIOL 400 or BIOL 612, or BIOL 400 or BIOL 612 concurrently. LAB.

BIOL 405. Laboratory in Genetics. 2 Hours U / LFE.
A laboratory program which includes written reports on fruit fly crosses, exercises on meiosis, probability and statistics, human genetics and computer simulations of genetics problems. Prerequisite: Concurrent or prior (preferred) enrollment in BIOL 350 or its equivalent. LAB.

BIOL 408. Physiology of Organisms. 3 Hours N.
A comprehensive and integrative approach to the study of organisms with an emphasis on physiological, ecological, structural, and behavioral adaptations to differing environments. Prerequisite: BIOL 152 or BIOL 153 and CHEM 130 or CHEM 190 or CHEM 170; or consent of the instructor. LEC.

BIOL 409. Physiology of Organisms, Laboratory. 2 Hours U / LFE.
The laboratory exposes the students to the structure and function of the major groups of animals and plants. Students use basic techniques of biological observation, such as microscopy and dissection, and
experimental techniques to analyze plant and animal function. 
Prerequisite: Concurrent or prior enrollment in BIOL 408, or consent of the instructor. LAB.

BIOL 410. Human Biogeography, Honors. 3 Hours N.
Principles of evolution and earth change are used to examine distributions of human populations, wealth, and resources. Readings from the current literature will be included. Lecture and discussion. (Same as GEOG 410.) Prerequisite: BIOL 152 or BIOL 153 or GEOG 107 and membership in the University Honors Program or consent of instructor. LEC.

BIOL 412. Evolutionary Biology. 4 Hours N.
Introduction to the patterns and processes of organic evolution. Considered are the history of evolutionary thought, molecular evolution, genetics and microevolution, selection and adaptation, and speciation and macroevolution. Emphasis will be placed on how scientists study and document change over time in natural populations, methods for testing hypotheses about events in evolutionary history, and how discovering evolutionary mechanisms at one level of organization can help to explicate general processes in the natural world. Prerequisite: BIOL 152 and BIOL 350, or consent of the instructor. LEC.

BIOL 413. History and Diversity of Organisms. 3 Hours N / LFE.
An integrated lecture and laboratory course presenting an overview of the variety and ancestry of life on earth. Using representatives from prokaryotes, protists, plants, fungi, and animals, principles of phylogenetic reconstruction are illustrated and evolutionary trends in the life history features, functional morphology, and structural complexity of extant and extinct organisms are presented. Two hours of lecture and three hours of laboratory per week. Prerequisite: BIOL 152 or BIOL 153, or consent of the instructor. LEC.

BIOL 414. Principles of Ecology. 3 Hours N.
Study of the principles underlying species population density changes, community structure and dynamics, biogeochemical cycles, and energy flow and nutrient cycling in ecosystems. Prerequisite: BIOL 152 or BIOL 153, or consent of the instructor. LEC.

BIOL 415. Field and Laboratory Methods in Ecology. 2 Hours N.
This course complements BIOL 414 with field trips and laboratory exercises that illustrate the basic concepts of ecology. Topics covered include methodologies for quantitative sampling of terrestrial and aquatic systems, design of field studies, computer simulation and digital data analysis techniques, and scientific writing. Prerequisite: Concurrent or prior enrollment in BIOL 414. A statistics course is recommended. FLD.

BIOL 416. Cell Structure and Function. 3 Hours N.
Lecture survey of molecular cell biology with emphasis on experimental approaches to understanding cell function; topics include biological membranes and transmembrane transport, vesicular trafficking (secretion and endocytosis), cell signaling, cell motility and the cytoskeleton, and the regulation of the cell division cycle. Prerequisite: BIOL 150 or BIOL 151; BIOL 350 or BIOL 360; CHEM 130 or CHEM 190 or CHEM 170; and CHEM 135 or CHEM 195 or CHEM 175, or consent of the instructor. LEC.

BIOL 417. Biology of Development. 3 Hours N.
A general course designed to introduce students to the developmental biology of animals. Emphasis is placed on understanding how a single-celled fertilized egg develops into a complex multicellular organism by the processes of cell division, differentiation, growth, and morphogenesis. Lectures stress experimental approaches to investigating development, including classic embryology and modern molecular genetics. Prerequisite: BIOL 350 or consent of the instructor. LEC.

BIOL 418. Laboratory in: ____. 1-3 Hours U / LFE.
A varied program of laboratory and fieldwork designed to introduce students to investigative approaches in the study of the basic concepts of biological science. Students may enroll in more than one section. Prerequisite: BIOL 100, BIOL 101, BIOL 150, BIOL 151, or exemption. Each section may have additional prerequisites to be determined by instructor. LAB.

BIOL 419. Topics in: ____. 1-3 Hours N / LFE.
Courses on special topics in biology, given as need arises. May be lectures, discussions, readings, laboratory, or fieldwork. Students may select sections according to their special needs. IND.

BIOL 420. Seminar: ____. 1-3 Hours N.
The preparation and presentation of oral reports on selected topics from the recent research literature. Students may choose one interest group each semester, but may enroll in a given interest group only once. Enrollment in each interest group limited to twenty students. Prerequisite: Course work varying with the topic of the seminar, or consent of instructor. LEC.

BIOL 421. Topics in Molecular Biosciences: ____. 3 Hours N.
Lecture instruction and the preparation and presentation of oral and written reports on selected topics from the recent research literature in molecular biosciences. Students may enroll in a given topic only once. Prerequisite: Course work varying with the topic of the seminar; or consent of instructor. LEC.

BIOL 423. Non-laboratory Independent Study. 1-9 Hours AE61 / N.
Original study in discussion or preparation of review papers on selected topics of current interest. May be undertaken only with the consent of the major advisor and of the faculty member who will guide the research. Prerequisite: Consent of instructor. IND.

BIOL 424. Independent Study. 1-9 Hours AE61 / N.
Original study in laboratory or field in selected topics of current research interest. May be undertaken only with the consent of the major advisor and of the faculty member who will guide the research. Prerequisite: Consent of instructor. IND.

BIOL 425. Teaching Apprenticeship in Biology. 1-9 Hours N.
Involvement as teaching assistant for a course in Biology. Credit hours shall not exceed the credits offered for the course being taught. May be undertaken only with the consent of the Director of Undergraduate Biology and of the faculty member who will teach the course. Prerequisite: Consent of instructor and Director of Undergraduate Biology. FLD.

BIOL 426. Laboratory in Cell Biology. 3 Hours U / LFE.
Laboratory exercises will examine the function, organization, and composition of eukaryotic cells. Prerequisite: BIOL 150 or BIOL 151, CHEM 130 or CHEM 190 or CHEM 170; concurrent or prior enrollment in BIOL 416 or BIOL 536; or consent of the instructor. BIOL 350 or BIOL 360 is highly recommended. LAB.

BIOL 428. Introduction to Systematics. 3 Hours N.
Basic elements of systematic theory and practice; phylogenetic reconstruction using morphological and molecular data; interpretation of phylogenetic hypotheses; principles of nomenclature and classification; evolutionary processes and patterns of species diversity; discussion of the aims and needs of taxonomy; species and speciation; construction of keys; significance of biological collections. Prerequisite: BIOL 152 or BIOL 153. Not intended for students with advanced systematics background. LEC.

BIOL 430. Laboratory in Molecular Biology. 3 Hours U / LFE.
Practical experience in recombinant DNA technology and molecular cloning. Prerequisite: BIOL 416 or a course in biochemistry or microbiology. LAB.
BIOL 432. Human Behavioral Genetics. 3 Hours S.
A survey of human behavioral genetics for upper division undergraduates. Emphasis is on how the methods and theories of quantitative, population, medical, and molecular genetics can be applied to individual and group differences in humans. Both normal and abnormal behaviors are covered, including intelligence, mental retardation, language and language disorders, communication, learning, personality, and psychopathology. (Same as ANTH 447, PSYC 432, SPLH 432.) Prerequisite: Introductory courses in biology/genetics or biological anthropology and psychology are recommended. LEC.

BIOL 435. Introduction to Neurobiology. 3 Hours N.
Basic principles of neurobiology. The focus will be on the nature of communication among nerve cells and their targets. Topics will include the development, structure and function of nerve cells, chemistry of neurotransmission, processing and integration including the cellular and molecular basis of higher functions and neurological disorders. Prerequisite: BIOL 150 or BIOL 151. LEC.

BIOL 440. Advanced Human Anatomy. 6 Hours N / LFE.
Integrated lecture and laboratory course designed to provide students with a detailed understanding of the structure of the human body. Cadaver dissection will reinforce three-dimensional relationships discussed in lecture and each of the main organ systems will be considered using a regional approach to the body. Prerequisite: BIOL 152 or equivalent; BIOL 240, BIOL 241, or BIOL 242; and instructor consent. LEC.

BIOL 448. Kansas Plants. 3 Hours N.
A study of common and important non-cultivated Kansas plants, with special emphasis on the ecology of the state: paleoclimate and paleobotanical background of the central prairies and plains; present climate, physiography and vegetation; poisonous, edible, and medicinal plants; identification by means of simplified keys. Prerequisite: BIOL 100, BIOL 101, BIOL 150, or BIOL 151 and BIOL 152 or BIOL 153. LEC.

BIOL 449. Laboratory/Field Work in Human Biology. 1-3 Hours AE61 / N.
Faculty supervised laboratory or field research for Human Biology majors. Students design and complete a research project in collaboration with a Human Biology faculty member. (Same as ANTH 449, PSYC 449, and SPLH 449.) Prerequisite: Consent of instructor and Human Biology major. FLD.

BIOL 454. Brain Diseases and Neurological Disorders. 3 Hours N.
Major brain diseases and neurological disorders such as stroke, Alzheimer's Disease, Parkinson's Disease, Huntington's Disease, Multiple Sclerosis, Epilepsy, Schizophrenia, etc., are discussed in terms of the etiology, molecular, and cellular basis of potential therapeutic interventions. Prerequisite: BIOL 408 or BIOL 416 or BIOL 435 or BIOL 646, or consent of instructor. LEC.

BIOL 461. Biodiversity of the Rainforest. 3 Hours N.
An introduction to birds, bats, and plants of the rainforest, with emphasis on general characteristics of each of the taxa and their relationship to the tropical ecosystem, as well as their particular anatomy, ecology, behavior, and diversity. Field work focuses on identification of birds and bats (at species level), plants (at family level), and on capturing and preservation techniques. Taught in Golfito, Costa Rica. Contact Undergraduate Biology, or the Office of Study Abroad. Prerequisite: BIOL 150 or BIOL 151 and BIOL 152 or BIOL 153, or equivalent. Fall and spring semester courses are taught in Spanish; therefore, four semesters of Spanish are required. Summer courses are taught in English. LEC.

BIOL 463. Introduction to Ornithology of the Tropics. 4 Hours N.
A theory and practice course on birds. Course covers morphology, reproduction, evolution, ecology, and behavior, as well as systematics of Costa Rican birds. Course includes field work on bird identification. Taught in Golfito, Costa Rica. Contact Undergraduate Biology, or the Office of Study Abroad. Prerequisite: BIOL 150 or BIOL 151 and BIOL 152 or BIOL 153, or equivalent. Fall and spring semester courses are taught in Spanish; therefore, four semesters of Spanish are required. Summer courses are taught in English. LEC.

BIOL 465. Marine Biology. 4 Hours N.
A theory and practice course on biotic relations, the role of organisms and marine biodiversity. It covers basic marine principles and physico-chemical processes (temperature, salinity, dissolved oxygen, nutrients, and pH in the water) and their effect on the abundance, and horizontal and vertical distribution of marine organisms. Course includes field work on data collection. Taught in Golfito, Costa Rica. Contact Undergraduate Biology, or the Office of Study Abroad. Prerequisite: BIOL 150 or BIOL 151 and BIOL 152 or BIOL 153, or equivalent. Fall and spring semester courses are taught in Spanish; therefore, four semesters of Spanish are required. Summer courses are taught in English. LEC.

BIOL 466. Fresh Water Ecology. 4 Hours N.
A theory and practice course which focuses on the techniques used for monitoring the growth of fish, shrimp, and mollusks, with the purpose of understanding the variables that could produce the best yields. The course covers ecology (population growth, competition, predators, ecosystem dynamics), and fishery biology (growth, fish yield, capture efficiency) applicable in the field experiments. Taught in Golfito, Costa Rica. Contact Undergraduate Biology, or the Office of Study Abroad. Prerequisite: BIOL 150 or BIOL 151 and BIOL 152 or BIOL 153, or equivalent. Fall and spring semester courses are taught in Spanish; therefore, four semesters of Spanish are required. Summer courses are taught in English. LEC.

BIOL 467. Marine Resources Management. 3 Hours N.
A theory and practice class on the study of rivers and lagoons. It includes systematics of rivers, lagoons, and reservoirs. Course includes theory and field work to monitor physical (stream topography, flow, edge vegetation), chemical (nutrients, temperature, pH levels, dissolved oxygen), and biological (collecting and identification of aquatic insects) conditions in rivers. Taught in Golfito, Costa Rica. Contact Undergraduate Biology, or the Office of Study Abroad. Prerequisite: BIOL 150 or BIOL 151 and BIOL 152 or BIOL 153, or equivalent. Fall and spring semester courses are taught in Spanish; therefore, four semesters of Spanish are required. Summer courses are taught in English. LEC.

BIOL 477. Ecology and Global Change. 3 Hours N.
Humans influence both natural and managed ecosystems. This course studies the effects of climate change, land-use change, and reductions in biodiversity on ecosystems. Emphasis is placed on how biological and physical processes may be perturbed by human influences. Topics include the greenhouse effect, species extinctions, human disease expansion, and the effects of global change on agricultural productivity. A combination of lectures and discussion address issues from a scientific basis and link these ecological issues to our everyday lives and society as a whole. Prerequisite: BIOL 152, BIOL 153, or equivalent, or permission of instructor. LEC.

BIOL 480. Biology and Diversity of Parasites. 3 Hours N.
Introductory lecture course to the field of Parasitology. Provides basic knowledge about the morphology and biology of parasitic animals. Coverage includes a diversity of protozoan and metazoan groups parasitizing animals, including humans (e.g., malaria, amoebas, hookworms, tapeworms). Some emphasis is given to groups of parasites of particular medical and/or economic importance. Selected principles of parasitism are introduced. Prerequisite: BIOL 152 or BIOL 153, or permission of instructor. LEC.
Biol 481. Parasitology Laboratory. 1 Hour U / LFE.
Laboratory course in the study of protozoan and metazoan parasites of animal, including humans, emphasizing their diversity, classification, morphology, and identification. One three-hour laboratory each week. Prerequisite: Concurrent or prior enrollment in BIOL 480. LAB.

Biol 494. Introduction to Mammalogy. 3 Hours U / LFE.
A study of mammals, with emphasis on evolution, biogeography, systematics, and natural history. Lectures, laboratory, and field study. Prerequisite: BIOL 152 or 153 or permission of instructor. LEC.

Biol 499. Introduction to Honors Research. 2 Hours N.
Intended for sophomores planning to enroll in the Biology Honors Program. Students interested in pursuing Biology Honors discuss with Biology faculty members the rationale, methods, and interpretations of research being carried out in individual faculty labs to learn how scientific research is conducted. Prerequisite: At least 17 credit hours of college level natural sciences coursework or consent of instructor. LEC.

Biol 500. Biology of Insects. 3 Hours N.
Lectures and demonstrations providing an introduction to the study of insects, including general classification, structure, phylogeny, identification, development, physiology, behavior, ecology, and relations to human affairs. Prerequisite: BIOL 152, 153, or equivalent, or permission of instructor. LEC.

Biol 502. Laboratory in Insect Biology and Diversity. 2 Hours U / LFE.
Laboratory and field studies of insects, emphasizing their diversity, classification, ecological relationships, morphology, and behavior. Course provides practical application of principles covered in BIOL 500. Prerequisite: Concurrent or prior enrollment in BIOL 500 or the equivalent. LAB.

Biol 503. Immunology. 3 Hours N.
Lectures on the nature and mechanisms of natural and acquired resistance including humoral and cellular immunity. Characteristics of antigens and antibodies and of their interaction; ontogeny and cellular basis of immune responsiveness, hypersensitivity; specific immunologic tolerance. Prerequisite: BIOL 400 or BIOL 401, or consent of instructor. LEC.

Biol 504. Immunology Laboratory. 2 Hours U / LFE.
Laboratory designed to complement BIOL 503. Prerequisite: BIOL 503, or BIOL 503 concurrently. LAB.

Biol 505. Social Insects. 3 Hours N.
Lectures and laboratory demonstrations on presocial and social insects, specifically termites, ants, wasps, and bees. Emphasis will be placed on evolution of social behavior and the place of social insects in sociobiology. Prerequisite: BIOL 152, 153, or equivalent. LEC.

Biol 506. Bacterial Infectious Diseases. 3 Hours N.
Explores bacterial infectious diseases from the perspective of how disease is established and the mechanisms that underlie disease, as well as how to treat and prevent infectious disease. Not open to freshmen or sophomores. Prerequisite: BIOL 400 or BIOL 401, or consent of instructor. LEC.

Biol 507. Pathogenic Microbiology Laboratory. 2 Hours U / LFE.
Laboratory to complement BIOL 506. Cultivation of pathogenic microorganisms, diagnostic procedures, and experiments to demonstrate various aspects of microbial pathogenicity and host responses. Prerequisite: BIOL 402 and BIOL 506 (or concurrent enrollment) or consent of instructor. LAB.

Biol 509. Biology of Spiders. 3 Hours N.
An introduction to the evolution, anatomy, physiology, behavior, and ecology of spiders and other arachnids. Special topics include the action of spider venoms; the composition and uses of silk; courtship and mating; predation; social behavior; and the role of spiders in natural and agricultural ecosystems. Concurrent enrollment in BIOL 511 is encouraged. Prerequisite: BIOL 152 and BIOL 153 or permission of instructor. LEC.

Biol 510. Comparative Anatomy. 5 Hours N / LFE.
Structure, function, and evolution of the vertebrates. Lectures and laboratory study. A course designed for zoologists. Prerequisite: BIOL 100, BIOL 101, BIOL 150, or BIOL 151 and BIOL 152 or BIOL 153. LEC.

Biol 511. Biology of Spiders Laboratory. 1 Hour U / LFE.
Topics will include comparative biology of arachnid orders (spiders, scorpions, harvestmen, mites, and others), internal and external anatomy of spiders, identification of common spider families and genera, and spider behavior. Students will be required to make a small collection (collect, preserve, and identify specimens). Prerequisite: BIOL 509; concurrent enrollment is preferred. LAB.

Biol 512. General Virology. 3 Hours N.
Lectures and discussions covering the basic nature and characteristics of viruses from a general biological point of view: viruses of bacteria, animals and plants, physical-chemical properties; host cell-viral interactions; mode of replication of DNA and RNA viruses, tumor viruses. Prerequisite: BIOL 400, BIOL 401 or consent of instructor. LEC.

Biol 513. Virology Laboratory. 2 Hours U / LFE.
Experiments involving cultivation, quantitation, and identification of animal viruses, continuous cell culture and primary chicken embryo culture techniques. Molecular biology techniques are used to demonstrate the steps in virus replication. The value of viruses as tools to understand normal cellular processes is emphasized in experiments which demonstrate the relative simplicity of viruses and the relative complexity of eukaryotic cells. Demonstrations include transformation of cells by tumor viruses and electron microscopy of virus particles. Prerequisite: BIOL 402 and BIOL 512, or consent of instructor. LAB.

Biol 514. Principles of Ecology, Honors. 3 Hours N.
Honors section of BIOL 414 for students with superior academic records. Course covers core concepts on the ecology of individuals, populations, communities, and ecosystems. Relative to BIOL 414, topics are presented in greater depth with increased student participation and stronger emphasis on the primary scientific literature. Prerequisite: BIOL 100, BIOL 101, BIOL 150, or BIOL 151 and BIOL 152 or BIOL 153. Open only to students admitted to the University Honors Program or by consent of instructor. LEC.

Biol 516. Microbial Physiology. 3 Hours N.
Elements of microbial physiology. Carbohydrate metabolism; enzymes and coenzymes; microbial nutrition; quantitative problems in microbial physiology; a survey of microbial metabolic types. Prerequisite: BIOL 400 or BIOL 612 and BIOL 402, and five hours of organic chemistry. LEC.

Biol 517. Microbial Physiology Laboratory. 2 Hours U / LFE.
Laboratory designed to complement BIOL 516. Prerequisite: BIOL 516, or BIOL 516 concurrently. LAB.

Biol 518. Microbial Genetics. 3 Hours N.
Bacteria and viruses as models of genetic systems. Mutagenesis and repair. Transformation, transductions, and recombination. Molecular biology of gene expression. Prerequisite: An introductory microbiology course. LEC.
BIOL 519. Microbial Genetics Laboratory. 2 Hours U / LFE.
Laboratory designed to complement BIOL 518. Prerequisite: BIOL 402, BIOL 518, or BIOL 518 concurrently. LAB.

BIOL 520. Marine Biology. 3 Hours N.
This introductory course covers biological, physical, and chemical ocean sciences, with an emphasis on ecological aspects. In addition to this Lawrence campus course, students may enroll for a supplementary 1 credit field trip class to a Caribbean coral reef island offered in December or January. Prerequisite: BIOL 414 or permission of the instructor. LEC.

BIOL 521. Insect Systematics. 4 Hours N.
A study of the diversity of insects, including the classification of all living and fossil orders and the more common families primarily on the basis of external morphology. The biology, ecology, phylogeny, and geological history of each order is covered. Includes both lectures and laboratory exercises. The course is offered at the 500 and 700 levels, with additional assignments at the 700 level. Prerequisite: BIOL 500, BIOL 502 or equivalent, or permission of instructor. LEC.

BIOL 525. Aquatic Entomology. 4 Hours N.
Designed to enable students to develop skill in the area of identification of aquatic insects and to gain a detailed comprehension of their community structure and dynamics. The external morphology of all aquatic orders is covered, followed by consideration of specific physiological and behavioral adaptations that facilitate an aquatic existence. Includes both lectures and laboratory exercises. Requirements include making a collection of aquatic insects. The course is offered at the 500 and 700 levels, with additional assignments at the 700 level. Prerequisite: BIOL 414 or BIOL 500. LEC.

BIOL 526. Insect Physiology and Internal Morphology. 3 Hours N.
Mechanisms and integration of the internal life-supporting systems of insects, emphasizing the interdependence of structure and function. The course is offered at the 500 and 700 levels, with additional assignments at the 700 level. Prerequisite: BIOL 408 and BIOL 500, or permission of instructor. LEC.

BIOL 527. Primate Evolution and the Fossil Record. 3 Hours N.
This course exposes students to fundamental concepts of paleontology and evolutionary biology using the mammalian order Primates as a high-profile case study. Primates are interesting partly because humans are primates. Hence, scientific understanding of human origins and human evolution must be grounded in knowledge of our nearest relatives. This course places human origins within the broader framework of how primates have evolved over the course of the Cenozoic Era, often in response to radical changes in the Earth's physical environment. Prerequisite: BIOL 412 or BIOL 413, or consent of the instructor. LEC.

BIOL 528. External Morphology of Insects. 4 Hours N.
A study of external structure common to all insect orders, with detailed comparative laboratory studies of representative species. Includes both lectures and laboratory exercises. The course is offered at the 500 and 700 levels, with additional assignments at the 700 level. Prerequisite: BIOL 500, BIOL 502 or equivalent, or permission of instructor. LEC.

BIOL 529. Immature Insects. 3 Hours N.
The classification, structure, and ecological distribution of immature insects, especially larvae of Holometabola. Includes both lectures and laboratory exercises. The course is offered at the 500 and 700 levels, with additional assignments at the 700 level. Prerequisite: BIOL 502 or permission of instructor. LEC.

BIOL 530. Biodiversity Discovery and Assessment. 2 Hours N.
An integrated lecture and laboratory course designed to provide an overview of modern methods in biodiversity exploration and discovery. Lectures cover the theory and practice of planning fieldwork in remote locations, documenting species and their natural history, how museum collections are made, calculating and comparing species richness estimates, and the process of describing and naming new species. The laboratory component provides students experience in documenting species and their natural history, processing and curating samples of natural history specimens, and the statistical analysis of biodiversity data. (Same as EVRN 530.) Prerequisite: BIOL 152, 153, or equivalent, or permission of instructor. LEC.

BIOL 531. Tropical Fieldwork in Biodiversity Discovery. 1 Hour U.
An introduction to modern field methods of assessing biodiversity. Fieldwork employs insects and various field methods to estimate and compare species diversity between different habitats and field sites. Taught at different sites in tropical South America over Spring Break. Contact Undergraduate Biology, or the Office of Study Abroad. (Same as EVRN 531.) Prerequisite: BIOL 152, 153, or equivalent, or permission of instructor. Concurrent or prior enrollment of BIOL 530 is strongly encouraged. LAB.

BIOL 532. Cell Structure and Function (Honors). 3 Hours N.
BIOL 532 is the honors version of BIOL 416. Completion of this class will satisfy the BIOL 416 requirement. Open to students in the Honors program or by permission of instructor. Prerequisite: BIOL 350 or consent of instructor. LEC.

BIOL 540. General Invertebrate Zoology. 4 Hours N / LFE.
Phylogeny, physiology, and embryology; evolutionary processes; characteristics of major ecological groupings. Laboratory will consider major taxonomic categories with emphasis on functional morphology and its evolutionary modifications. Prerequisite: BIOL 152 or BIOL 153. LEC.

BIOL 541. Biology of Freshwater Invertebrates. 3 Hours N.
A lecture and laboratory course examining the classification, biological characteristics, and ecology of invertebrates in rivers, lakes, and wetlands. Major groups of benthic and planktonic invertebrates will be studied, including aquatic insects, crustaceans, molluscs, and others. Prerequisite: BIOL 152 or BIOL 153; recommended BIOL 414 or BIOL 514, and/or BIOL 540. LEC.

BIOL 545. Evolution of Development. 5 Hours N.
An advanced course designed to expose students to evolutionary change in the developmental patterning of plant and animal form. This course includes a lecture component and a laboratory component to integrate multiple biological disciplines including comparative morphology, molecular evolution, developmental genetics and experimental development, to explore biodiversity at a mechanistic level. Lectures are designed to give students background on topics ranging from homology assessment to empirical examples of how changes in gene expression or function may have shaped morphological diversity. The laboratory complements these topics through observations of normal development in a diversity of plant and animal model organisms, and through conducting independent research experiments. Prerequisite: BIOL 350 or equivalent. LEC.

BIOL 555. General Plant Physiology. 3 Hours N.
The principal physiological processes of higher plants including photosynthesis, respiration, water relations, mineral nutrition, and factors
associated with morphogenesis. Prerequisite: BIOL 408 or consent of instructor. LEC.

**BIOL 560. Histology. 3 Hours N.**
Study of detailed microscopic anatomy of cells, tissues, and organs of mammals. Examples are drawn from normal and abnormal tissue, histochemistry, and electron microscopy. Lecture and demonstrations. A course in anatomy and physiology is highly recommended. Prerequisite: BIOL 152 or BIOL 153. LEC.

**BIOL 570. Introduction to Biostatistics. 3 Hours N / LFE.**
Statistical concepts related to biological problems. Topics include the scientific method, data representation, descriptive statistics, elementary probability distributions, estimation and hypothesis testing, emphasizing the analysis of variation. Prerequisite: College algebra and ten hours of natural science. LEC.

**BIOL 571. Introduction to Biostatistics Laboratory. 2 Hours U / LFE.**
Introductory statistical analyses on microcomputers. Data entry and export; simple graphs and exploratory data analysis; descriptive statistics; sampling; point and interval estimation; one and two sample t-tests; Chi-square; regression and correlation; analysis of variance; and nonparametric methods. Prerequisite: BIOL 570 or equivalent (may be taken concurrently). LAB.

**BIOL 582. Principles of Biogeography. 3 Hours N.**
An introduction to the study of the distribution of life on earth. Covers geographical patterns of species diversity and the processes that give rise to those patterns: speciation, extinction, dispersal, vicariance, continental drift, ecological interactions, and phylogeny. Topics are presented within the framework of evolutionary history and include discussion of the biology of species on islands, terrestrial biomes, altitudinal zonation of species, latitudinal species gradients, historical factors governing species distributions, macroevolutionary trends in the fossil record, and application of modern molecular techniques for testing biogeographical hypotheses. Prerequisite: BIOL 152 or 153 and past or concurrent enrollment in BIOL 412, 413, 414, or 550; or permission of Instructor. LEC.

**BIOL 583. Herpetology. 3 Hours N.**
A study of amphibians and reptiles. This lecture course will explore the taxonomic diversity of amphibians and reptiles, and current areas of active research in herpetology. Topics will be considered within a phylogenetic framework, and include discussion on systematics, biogeography, tetrapod origins, skeletal systems, growth, circulatory system, locomotion, thermal and water regulation, hibernation, ecology, sexual behavior, parental care, and mimicry. LEC.

**BIOL 592. Ichthyology. 4 Hours N / LFE.**
A study of fishes. Lecture topics include the structure and adaptations of fishes to the aquatic environment and a survey of major fish groups with emphasis on their evolution and biogeography. Laboratory topics include a survey of fish diversity using specimens and the use of keys to identify fishes, with emphasis on the Kansas fish fauna. This course meets with BIOL 792. Students taking this course at the 700 level will have additional work required of them. Prerequisite: BIOL 152 and/or BIOL 413. LEC.

**BIOL 593. Ornithology. 3 Hours N / LFE.**
A lecture and laboratory course on the biology, evolution, and diversity of birds. Prerequisite: BIOL 412 (or BIOL 413), or permission of instructor. LEC.

**BIOL 594. Forest Ecosystems. 3 Hours.**
Students learn basic concepts of forest productivity, forest water relations, forest hydrology, nutrient cycling, through soils and vegetation, nutrient uptake, carbon cycling, decomposition, linkages to aquatic ecosystems, and agents of disturbance to these cycles. The class spends a significant part of the semester exploring forest soil profiles and the challenges they present to different forest ecosystems. We discuss the function of forested ecosystems in a global context and identify and understand smaller-scale processes that drive forest function. Prerequisite: CHEM 135 or CHEM 195 or CHEM 175, and BIOL 414. LEC.

**BIOL 595. Human Genetics. 3 Hours N.**
A lecture course providing balanced coverage of Mendelian and molecular genetics of humans; includes discussions and presentations on current issues in human and medical genetics. Prerequisite: BIOL 350. LEC.

**BIOL 598. Research Methods. 3 Hours N / LFE.**
An introduction for pre-service teachers to the tools used by scientists to solve scientific problems. Topics include design of experiments and interpretation of their results, use of statistics, mathematical modeling, laboratory safety, ethical treatment of human subjects, writing scientific papers, giving oral presentations, and obtaining data from the scientific literature. Open only to students in the UKanTeach program. LEC.

**BIOL 599. Senior Seminar: ______. 1 Hour AE61 / N.**
A synthesis and discussion of current trends in a discipline or disciplines related to one of the degrees offered in the biological sciences. Emphasis is placed on providing seniors with an appreciation of the discipline’s state-of-the-art and on developing skills for success in the next stage of a career in the biological sciences. Topics depend on the associated degree program. Prerequisite: Must be taken in the final year of a degree and students must have completed most of the course work required for one of the degrees in the biological sciences. LEC.

**BIOL 600. Introductory Biochemistry, Lectures. 3 Hours N.**
Designed to offer the essentials of the chemistry of the constituents of living organisms and the changes these constituents undergo (during life processes) in the human body and other living forms. Prerequisite: BIOL 150 or BIOL 151 and one semester of organic chemistry. LEC.

**BIOL 601. Principles of Biochemistry Laboratory. 2 Hours.**
Theory and methods in the development of protein separation and purification, enzyme structure/function, and enzyme kinetics derived from primary literature searches and readings. Prerequisite: Corequisite: BIOL 600; or consent of instructor. LAB.

**BIOL 602. Plant Ecology. 3 Hours N.**
Introduction to basic concepts, focused at community and species level. Architectural ecomorphology of plants and their physiological responses to physical factors: solar radiation, climate, and soils. Plant succession as an interaction among species differing in ecomorphology and life style. Classification and ordination of plant communities: practice and theory. Other topics include: species diversity and lognormal distribution as to abundance classes; species/area relations and theory of island biogeography; allelochemic defenses; genealogy; paleoecology. Prerequisite: BIOL 414 or consent of instructor. Concurrent enrollment in parallel laboratory, BIOL 607, recommended. LEC.

**BIOL 603. Systematic Botany. 3 Hours N / LFE.**
A lecture/laboratory course providing hands-on experience with plant identification, a history of plant classification, the principles of nomenclature and character analysis, the basics of systematics theory, and a phylogenically-oriented introduction to vascular plant diversity. Prerequisite: BIOL 413 or equivalent. LEC.

**BIOL 606. Ecological Plant Physiology. 3 Hours N.**
Physiological responses of higher plants to environmental factors are discussed. Major topics are: water relations, heat transfer, resistance to water and temperature stress, dormancy, photoperiodism, photosynthesis and respiration under natural conditions, and effects of environmental pollution. Prerequisite: BIOL 408 or consent of instructor. LEC.
BIOL 607. Field and Laboratory Exercises in Plant Ecology. 2 Hours U / LFE.
Introduction to quantitative analysis of plant communities and correlated environmental parameters; field and/or laboratory measurements of ecophysiological traits and comparative ecomorphology of principal species. Prerequisite: BIOL 414. Concurrent enrollment in parallel lecture, BIOL 602, recommended, but not required. LAB.

BIOL 609. Current Progress in Microbiology. 1 Hour U.
A seminar course which will focus on current research in microbiology. A term paper will be required of each student. May be repeated for credit. Required of all majors in the senior year. Prerequisite: Two courses in microbiology. LEC.

BIOL 611. Molecular Systematics and Evolution. 4 Hours N / LFE.
An introduction to the use of molecular data in systematics and population biology. Topics include: evolution of genes and proteins; properties of mitochondrial DNA, chloroplast DNA, ribosomal RNA genes, protein-coding genes, and repetitive DNAs; laboratory methods for data collection; and data analysis. Prerequisite: BIOL 350. BIOL 550 or equivalent is recommended. LEC.

BIOL 612. Fundamentals of Microbiology. 3 Hours NB / N.
Lectures. Fundamental principles of microbiology with emphasis in physical and chemical properties of the bacterial cell; microbial metabolism, cultivation, growth and death of bacteria; microbial genetics; pathogenesis and immunity, industrially important microorganisms. Meets with BIOL 400, but students will be given additional and more advanced assignments, and will carry higher expectations. Prerequisite: BIOL 150 or BIOL 151 and two semesters of college chemistry, or consent of instructor. LEC.

BIOL 613. Biology of Honeybees. 3 Hours N.
Social organization, evolution, behavior, morphology, communication, pollination biology, and ecology of honeybees. Experience will be gained with colony dynamics and behavior while working with bees in the field. Prerequisite: BIOL 152, BIOL 153, or consent of instructor. LEC.

BIOL 616. Medical Entomology. 3 Hours N.
A study of the major human diseases transmitted by arthropods with emphasis on the biology and ecology of vectors, vector feeding mechanisms as related to disease transmission, epidemiology of arthropod-borne diseases, and the impact of arthropod-borne diseases on humans. Laboratory work on recognition of vector species, information sources, and use of taxonomic keys. Prerequisite: BIOL 152 or BIOL 153 and a course in microbiology or consent of instructor. LEC.

BIOL 622. Paleontology. 3 Hours N.
A study of the structure and evolution of ancient life; the nature and diversity of life through time; the interactions of ancient organisms with their environments and the information that the study of fossils provides about ancient environments; the use of fossils to determine the ages of rocks and the timing of past events in earth history; and the patterns of extinction through time. (Same as GEOL 521.) Prerequisite: BIOL 100, BIOL 101, BIOL 152, BIOL 153, GEOL 105, or GEOL 304. LEC.

BIOL 623. Paleontology Laboratory. 1 Hour U / LFE.
Laboratory course in the study of fossils with emphasis on the practice of paleontology and the morphology of ancient organisms. (Same as GEOL 523.) LAB.

BIOL 625. Behavioral Ecology and Sociobiology. 3 Hours N.
The role of natural selection in animal behavior, and the influence of behavior on population biology and social dynamics of animal species. Topics include: game theory and optimization as applied to animal behavior; altruism, cooperation and competition; kin recognition and interactions; group formation and dynamics, dominance, aggression, and territoriality; feeding strategies; reproductive behavior including mate choice, parental care, and mating systems. Prerequisite: BIOL 152; either BIOL 350, BIOL 412 or BIOL 414 recommended; or consent of instructor. LEC.

BIOL 630. Conservation and Wildlife Biology. 3 Hours N.
Examination of the concepts and processes involved in conservation of plant and animal populations and communities. Topics to be covered include conservation of endangered species, problems with invasions of exotic species and habitat fragmentation, wildlife management, and design of nature reserves. Prerequisite: BIOL 414, BIOL 412 strongly recommended. LEC.

BIOL 636. Biochemistry I. 3 Hours N.
First semester of a two-semester lecture course in introductory biochemistry. Emphasis upon the physical structure of macromolecules and membranes, enzyme structure/function, and enzyme kinetics. Prerequisite: CHEM 335 or consent of instructor. LEC.

BIOL 637. Introductory Biochemistry Laboratory. 2 Hours U / LFE.
The laboratory portion of BIOL 600 or 636. Experiments have been selected to introduce the student to cell constituents and biochemical reactions. One four-hour laboratory and one-hour lecture each week. Prerequisite: BIOL 600 or BIOL 636, or concurrent enrollment. LAB.

BIOL 638. Biochemistry II. 3 Hours N.
Second semester of a two-semester lecture course in introductory biochemistry. Emphasis upon the metabolism of carbohydrates, lipids, amino acids, proteins, and nucleic acids. Prerequisite: BIOL 636. LEC.

BIOL 639. Advanced Biochemistry Laboratory. 2 Hours U / LFE.
The laboratory portion of BIOL 638. One four-hour laboratory and a one-hour lecture each week. Experiments have been selected to familiarize students with experimental biochemical techniques using state-of-the-art methodology. Prerequisite: BIOL 637 and 638 (BIOL 638 may be taken concurrently). LAB.

BIOL 640. The Biology and Evolution of Fossil Plants. 3 Hours N.
A lecture course in which fossil plants, protists and fungi are examined throughout geologic time. Emphasis will be directed at paleoecology, biogeography and the stratigraphic distribution and composition of ancient floras. (Same as GEOL 528.) Prerequisite: BIOL 413 or permission of instructor. LEC.

BIOL 641. Laboratory in Paleobotany. 1 Hour U / LFE.
An examination of selected fossil plants throughout geological time and the techniques used to study them; laboratory will include identification and the use of plant fossils in biostratigraphy. (Same as GEOL 529.) Prerequisite: BIOL 413 or permission of instructor. Must be taken concurrently with BIOL 640. LAB.

BIOL 644. Comparative Animal Physiology. 3 Hours N.
Lecture and discussion of the basic mechanism of organic maintenance and integration; a comparative treatment of the uniformities and diversity of animal function; emphasis on environmental adaptations and evolutionary relationships. Prerequisite: BIOL 152 or BIOL 153, and a course in organic chemistry, or consent of instructor. A college physics course is recommended but not required. LEC.

BIOL 646. Mammalian Physiology. 4 Hours N.
Lectures and demonstrations. An intermediate course in the functions, mechanisms and interactions of mammalian organ systems. Discussions span topics from molecular to whole animal functions. Required for pharmacy students and strongly recommended for students planning advanced work in any area of physiology. The student is assumed to have the knowledge and ability to utilize their math and science background.
Prerequisite: Five hours of organic chemistry, a course of college physics.

LEC.

BIOL 647. Mammalian Physiology Laboratory. 2 Hours U / LFE. Laboratory experiments in representative areas of mammalian physiology designed to complement BIOL 646. Not open to students with credit in BIOL 247. Prerequisite: Corequisite: BIOL 646. LAB.

BIOL 648. Systematics and Macroevolution. 3 Hours N. An introduction to the theory of macroevolution and the fundamental principles of systematics. Intended for students planning to pursue advanced studies in organismal biology, evolution, and/or systematics. Topics in macroevolution will include hierarchy theory, species concepts, speciation and species selection. Methods of phylogenetic estimation will be discussed and include parsimony, Maximum likelihood and Bayesain inference. Evolutionary studies utilizing phylogenies including tests of homology, studies of character evolution, and biogeography will be discussed. An overview of classification and nomenclature will also be provided. Prerequisite: BIOL 412 or equivalent. LEC.

BIOL 650. Advanced Neurobiology. 3 Hours N. The course builds an in depth knowledge about basic mechanisms of synaptic communication among nerve cells and their targets, and the structure and function of nervous systems. Topics include nerve system development and synapse formation, structure and function of neurons, physiological and molecular basis of synaptic communication between neurons, mechanisms of synaptic plasticity involved in learning and memory, sensory systems (vision, auditory, vestibular, motor reflexes and pain), processing of neural information at cellular and system levels, synapse regeneration and diseases of the nervous system. Prerequisite: BIOL 435 (Introduction to Neurobiology), or consent of instructor. LEC.

BIOL 652. Comparative Animal Behavior. 3 Hours N. A comparative analysis of behavior as an adaptive mechanism; emphasis on ontogenetic and evolutionary aspects of behavior. Prerequisite: BIOL 152 or BIOL 153; and BIOL 412. Alternatively, BIOL 412 may be taken as a corequisite. LEC.

BIOL 654. Comparative Animal Behavior, Laboratory. 1 Hour U / LFE. Laboratory and field phase of BIOL 652. Students may elect sections according to their special interests. Prerequisite: Prior or concurrent enrollment in BIOL 652. LAB.

BIOL 655. Behavioral Genetics. 3 Hours N. A survey of behavioral genetics in animals and humans. Emphasis is on how the methods and theories of quantitative, population and molecular genetics can be applied to individual and group differences in animals. Behaviors covered may include circadian rhythms, foraging, courtship, learning and memory, anxiety, social structures and human behaviors. Prerequisite: BIOL 350 or consent of instructor. LEC.

BIOL 656. Ecosystem Ecology. 3 Hours N. An introduction to the patterns and processes that affect terrestrial ecosystems. Emphasis is placed on understanding nutrient cycles (e.g., carbon, nitrogen, phosphorous), hydrologic cycles, and patterns of net primary productivity. The role of both natural and anthropogenic disturbances in structuring terrestrial ecosystems is examined in the context of global land-use patterns. Discussion of current research literature will be expected. (Same as EVRN 656.) Prerequisite: BIOL 414 and CHEM 130. LEC.

BIOL 661. Ecology of Rivers and Lakes. 3 Hours N. Study of the ecology and structure of creeks, rivers, ponds, lakes, and wetlands as well as some of the major human impacts. Prerequisite: One year of biology or permission of the instructor. BIOL 414 recommended. LEC.

BIOL 662. Aquatic Ecology Laboratory. 2 Hours U / LFE. A field and laboratory course introducing biological, physical, and chemical characteristics of lentic (ponds and lakes) and lotic (creeks and rivers) habitats. Students learn sampling and monitoring techniques and how to classify aquatic biota at higher taxonomic levels. Co- or prerequisite: CHEM 130 or CHEM 190 or CHEM 170, and BIOL 661. LAB.

BIOL 664. Vertebrate Biology. 3 Hours N. A laboratory course emphasizing principles of systematics and identification and the behavioral ecology of local vertebrate animals. Prerequisite: BIOL 152, BIOL 153 or consent of instructor. LAB.

BIOL 667. Chemical Communication in Sex, Feeding, and Fighting. 3 Hours N. The course focuses on the role of chemical information molecules in the interrelationships among organisms, with particular attention to interactions (a) within and between animal species, (b) within and between plant species, (c) between animals and plants, (d) between predators and prey, and (e) between parasites and hosts. Prerequisite: BIOL 100 or BIOL 101 or BIOL 152 or BIOL 153 or consent of instructor. LEC.

BIOL 668. Evolutionary Ecology. 3 Hours N. Emphasis will be on the themes that interface ecology and evolutionary studies. Topics will include selection theory; reproductive, foraging, and sex allocation problems; coevolution; patterns or morphological and behavioral adaptations; competition, predation, and population regulation. Special attention will be given to the philosophy and practice of resolving unanswered questions in evolutionary ecology. Prerequisite: BIOL 412 or permission of instructor. LEC.

BIOL 672. Gene Expression. 3 Hours N. A study of the structure and expression of genes in prokaryotes and eukaryotes. Emphasis on the mechanisms of DNA, RNA, and protein biosynthesis. Prerequisite: A course in biochemistry or consent of instructor. LEC.

BIOL 673. Cellular and Molecular Neurobiology. 3 Hours. Mechanisms of neural function and development will be considered at the cellular and molecular levels. Synaptic mechanisms of learning and memory, modulation of transmitter release, and the molecular basis of neurodegenerative disorders will also be discussed. Prerequisite: BIOL 435, BIOL 646, or permission of instructor. LEC.

BIOL 676. Mammalian Neuroanatomy. 3 Hours N. Lectures, video tape demonstrations, and laboratory dissection of mammalian nervous system with some attention to human material. Major emphasis on nervous system structure as it relates to function. For neurobiology and pre-health science majors. Prerequisite: Corequisite: A course in neurobiology (BIOL 435, BIOL 650), or permission of the instructor. LAB.

BIOL 688. The Molecular Biology of Cancer. 3 Hours N. The basic concepts of molecular biology are examined and used to probe the process by which a normal cell becomes a cancer cell. The course investigates DNA damage and repair, chemical carcinogenesis, gene cloning and manipulation, the control of gene expression in eukaryotes, tumor viruses, the roles of oncogenes and tumor suppressor genes in carcinogenesis, and cancer therapy. Prerequisite: BIOL 350 and BIOL 416; or BIOL 536; or consent of instructor. LEC.

BIOL 694. The Art of Becoming a Professional Scientist. 3 Hours N. Discusses aspects of graduate education that are directed at students entering graduate school and that focus on how to be successful in the post PhD phases of a career, but that must be initiated early in the
graduate student program of study. One three hour discussion per week. Senior standing and planning on entering graduate school. LEC.

**BIOL 695.** Animal Communication and Sensory Ecology. 3 Hours N. Lectures and discussion sessions. A study of the propagation and perception of olfactory, acoustic, and visual signals produced by animals in the context of communication. Both physiological and evolutionary perspectives will be treated. Prerequisite: A course in behavior or consent of instructor. LEC.

**BIOL 699.** Biology Honors Research Colloquium. 1 Hour AE61 / U. Students pursuing Honors in Biology will meet weekly to discuss, both formally and informally, their honors research. Background information and experimental approaches of the research will be examined and critiqued. Prerequisite: Enrollment in Biology Honors program and consent of instructor. LEC.

**BIOL 700.** Conservation Principles and Practices. 3 Hours. This course will acquaint the future museum professional with problems in conserving all types of collections. Philosophical and ethical approaches will be discussed, as well as the changing practices regarding conservation techniques. Emphasis will be placed on detection and identification of causes of deterioration in objects made of organic and inorganic materials, and how these problems can be remedied. Storage and care of objects will also be considered. (Same as AMS 714, GEOL 780, HIST 722 and MUSE 706.) Prerequisite: Museum Studies student, Indigenous Nations Studies student, or consent of instructor. LEC.

**BIOL 701.** Topics in: _____. 1-3 Hours. Advanced courses on special topics in biology, given as need arises. Lectures, discussions, readings, laboratory, or field work. Students may select sections according to their special interests. LEC.

**BIOL 702.** Laboratory Practice: Radiation Safety Procedures. 0.75 Hours. An introduction to the basic properties of radioisotopes, and the fundamental safety practices needed for the safe use of low levels of radioactive materials. Risks associated with radiation exposures and applicable state and federal regulations are discussed. (Normally the content of the first ten hours of BIOL 703.) Prerequisite: Senior standing in one of the sciences. LAB.

**BIOL 703.** Radioisotopes and Radiation Safety in Research. 1.25 Hour. An introduction to the properties of radioactive materials, radiations, and their interaction with matter, methods of radiation detection and measurement, protective measures, applicable state and federal regulations, design and implementation of safety management systems in the research laboratory, design of tracer experiments, and the risks associated with radiation exposure. Prerequisite: BIOL 702 or concurrent enrollment in BIOL 702, algebra and two semesters of either physics or chemistry. LEC.

**BIOL 704.** Research Animal Methods. 3 Hours. Lectures, discussions, and laboratory sessions. Selection of proper animal models for specific research studies. Various external influences that alter research data. Routine techniques including restraint, sample collection, injection, anesthesia and euthanasia. Prevention and handling of common research animal problems or diseases. Proper and humane animal care as defined by the Federal Animal Welfare Act. Prerequisite: Senior or graduate standing in one of the biological sciences or permission of instructor. LEC.

**BIOL 706.** Current Trends in Curation and Collection Management. 2 Hours. Seminar course to provide students with a working knowledge of the primary issues and current trends in building, administration, and care of scientific collections. Topics include permits, collecting, accessioning, cataloging, preservation, preventive conservation, and access to collections and data. The course format consists of readings, lectures, guest speakers, discussions, and visits to scientific collections on campus. (Same as MUSE 710.) LEC.

**BIOL 708.** External Morphology of Insects. 4 Hours. A study of the external structure common to all insect orders, with detailed comparative laboratory studies of representative species. The course is offered at the 500 and 700 levels, with additional assignments at the 700 level. Prerequisite: BIOL 500, BIOL 502 or equivalent, or permission of instructor. LEC.

**BIOL 709.** Immature Insects. 3 Hours. The classification, structure, and ecological distribution of immature insects, especially larvae of Holometabola. Includes both lectures and laboratories. The course is offered at the 500 and 700 levels, with additional assignments at the 700 level. Prerequisite: BIOL 502 or consent of instructor. LEC.

**BIOL 710.** Insect Development. 3 Hours. A study of the embryonic and postembryonic development of insects. Emphasis is placed on developmental physiology of the early embryonic stage, the morphogenesis of organ systems, and the action of hormones in postembryonic development. Laboratory includes demonstrations and histological and experimental work. Prerequisite: Consent of instructor or BIOL 500. LEC.

**BIOL 711.** Insect Systematics. 4 Hours N. A study of the diversity of insects, including the classification of all living and fossil orders and the more common families primarily on the basis of external morphology. The biology, ecology, phylogeny, and geological history of each order will be covered. Includes both lectures and laboratory exercises. The course is offered at the 500 and 700 levels, with additional assignments at the 700 level. Prerequisite: BIOL 500 and BIOL 502 or equivalent, or permission of instructor. LEC.

**BIOL 712.** Evolutionary Biology - Graduate. 3 Hours. A thorough survey of evolutionary biology. Topics include: the history of evolutionary thought, genetics and the nature of variation, adaptation, speciation, coevolution, macroevolution, the comparative method, and the history of life. Prerequisite: BIOL 350 or equivalent or consent of instructor. LEC.

**BIOL 714.** Community and Ecosystem Ecology. 3 Hours. Study of factors determining distribution of organisms, community structures, energy flow in ecosystems, and functional analysis of ecosystems. Discussion periods will include reading from current scientific literature. Prerequisite: Intended for graduate students in biology who did not have an undergraduate course in community ecology. Consent of instructor. LEC.

**BIOL 716.** Insect Physiology and Internal Morphology. 3 Hours. Mechanisms and integration of the internal life-supporting systems of insects, emphasizing the interdependence of structure and function. The course is offered at the 500 and 700 levels, with additional assignments at the 700 level. Prerequisite: BIOL 408 and BIOL 500, or permission of instructor. LEC.

**BIOL 717.** Insect Ecology and Behavior. 3 Hours. Lectures and laboratory demonstrations. A study of insect population dynamics, life history strategies, co-evolutionary interactions, foraging, and reproductive and social behaviors. Approaches from basic population biology and behavioral ecology are emphasized. Prerequisite: A course in ecology or behavior, or consent of instructor. LEC.
BIOL 718. Laboratory in Molecular Biology. 3 Hours.
Practical experience in recombinant DNA technology and molecular cloning. Given concurrent with BIOL 418. Prerequisite: BIOL 416 or course in biochemistry or microbiology. Training in radiation safety preferred. LAB.

BIOL 719. Light and Electron Microscopy. 3 Hours.
A lecture and laboratory class emphasizing the theoretical and practical use of light microscopes and scanning and transmission electron microscopes. A variety of approaches using light microscopy will be employed, including brightfield, phase, fluorescence, DIC, polarization, and darkfield optics. A variety of techniques will be used to prepare specimens and view them using scanning and transmission electron microscopy. Video and computer-aided analysis of images as well as conventional photographic techniques will be included. Prerequisite: Permission of instructor. LEC.

BIOL 720. Scientific Illustration. 3 Hours.
Lectures, demonstrations, and studio participation. Instruction in the preparation of illustrations for scientific publications, theses, and oral presentation, and by collaborator. Emphasis on basic drafting and layout skills, and pen and ink and tone renderings intended for publication. Attention given to preparation of photographs for publication and oral presentations. Instruction provided in use of specialized optical equipment for drawing. Prerequisite: Upper division or graduate standing and permission of instructor. LEC.

BIOL 721. Microbial Genetics. 3 Hours.
Bacteria and viruses as models of genetic systems. Mutagenesis and repair. Transformation, transduction, and recombination. Molecular biology of gene expression. This course is the graduate-level section of BIOL 518 and MCR 510. Graduate students will be assigned additional and more advanced studies. Prerequisite: An introductory microbiology course or permission of instructor. LEC.

BIOL 725. Aquatic Entomology. 4 Hours.
Identification of aquatic insects and detailed study of their community structure and dynamics. The external morphology of all aquatic orders will be covered, followed by consideration of specific physiological and behavioral adaptations that facilitate an aquatic existence. Includes both lectures and laboratory exercises. Requirements include making a collection of aquatic insects. The course is offered at the 500 and 700 levels, with additional assignments at the 700 level. Prerequisite: BIOL 414 or BIOL 500 or permission of instructor. LEC.

BIOL 741. Biology of Freshwater Invertebrates. 3 Hours.
A lecture and laboratory course examining the classification, biological characteristics, and ecology of invertebrates in rivers, lakes, and wetlands. Major groups of benthic and planktonic invertebrates will be studied, including aquatic insects, crustaceans, molluscs, and others. Graduate students will be expected to submit either an original collection of freshwater invertebrates or write a research essay on a topic mutually agreed upon with the professor. Not open to students who have taken BIOL 541. Prerequisite: Graduate standing; recommended: undergraduate invertebrate biology class. LEC.

BIOL 742. Plant Population Biology. 3 Hours.
A survey of the major areas of plant population ecology and genetics including competition, demography, pollination ecology, gene flow, natural selection and mating systems. Each topic is introduced by a lecture and is further explored by discussion of the current literature. Prerequisite: BIOL 412 or equivalent. LEC.

BIOL 743. Population Genetics. 3 Hours.
Description and discussion of genetic variation in natural populations. The effects and interaction of selection, migration, mutation, mating systems, and finite population size on the maintenance of genetic variation. Discussion of the interface with evolution and population ecology. Prerequisite: BIOL 350 and BIOL 412 or equivalent. LEC.

BIOL 747. Quantitative Genetics. 3 Hours.
A discussion of genetic traits for which individual gene differences do not separate a population into qualitatively distinct groups. Includes the estimation of heritability, genetic determination, and number of loci, and a study of selection theory. Prerequisite: BIOL 404 or BIOL 412 or equivalent and a course in statistics. LEC.

BIOL 749. Topics in Stable Isotopes in the Natural Sciences. 2-3 Hours.
Isotopic compositions of substances provide powerful insights into many topics in the natural sciences. Applications of isotopic analyses of carbon, hydrogen, oxygen, and nitrogen to selected research topics such as plant resource use, food web analysis, paleoecology, paleodiet reconstruction, hydrology, and soils genesis will be examined. Knowledge of isotope chemistry is not required. Concepts necessary to understand pertinent articles will be taught during the first class meetings. May be repeated. (Same as GEOG 749.) LEC.

BIOL 750. Advanced Biochemistry. 3 Hours.
The structures and dynamics of proteins and nucleic acids will be developed in terms of well-understood examples which will also be used to discuss the function of major classes of proteins. The application of structural and dynamical principles to biological membranes and their function will also be discussed. Prerequisite: BIOL 807 and BIOL 808, a general biochemistry course, or permission of instructor. LEC.

BIOL 751. Plant Communities of North America. 3 Hours.
Physiognomic and floristic analysis of the vegetation, with emphasis on the Southwest; distribution of communities in relation to climate, substrate, and disturbance; recognition of dominant elements of vegetation through study of specimens and illustrative material. Prerequisite: BIOL 602. LEC.

BIOL 752. Cell Biology. 3 Hours.
A lecture course emphasizing biochemical, developmental, and molecular aspects of cell structure and function. Prerequisite: BIOL 807 and BIOL 808, or BIOL 416 or BIOL 536, or permission of instructor. LEC.
BIOL 753. Advanced Genetics. 3 Hours.
An advanced course in modern genetic analysis of eukaryotes. Course material will consist mainly of primary literature in the field of genetics. Topics covered include: genomic structure and genome projects; nature of mutations; mutant analysis; genetic recombination and mapping; analysis of gene function; genetic buffering; RNAi and epigenetics; and the genetics of model organisms. This course is meant for graduate students in the Molecular Biosciences and Genetics programs. Prerequisite: BIOL 807 and BIOL 808, or a course in genetics and a course in biochemistry, or permission of the instructor. LEC.

BIOL 754. Brain Diseases and Neurological Disorders. 3 Hours.
Major brain diseases and neurological disorders such as stroke, Alzheimer's Disease, Parkinson's Disease, Huntington's Disease, Multiple Sclerosis, Epilepsy, Schizophrenia, etc., will be discussed in terms of the etiology, molecular, and cellular basis of potential therapeutic interventions. Graduate students are required to present original research paper assigned by the instructor to the class in addition to the other assignments for all the students enrolled. Prerequisite: BIOL 150, or consent of instructor. LEC.

BIOL 755. Mechanisms of Development. 3 Hours.
Molecular aspects of differential gene function, signal transduction, and cell polarity in the regulation of morphogenesis. Prerequisite: BIOL 807 and BIOL 808 for graduate students; BIOL 417 or equivalent for undergraduate students; or permission of instructor. LEC.

BIOL 756. Cell and Tissue Culture Laboratory. 3 Hours.
An introduction to current laboratory methods of cell and tissue culture, intended to provide an understanding of and substantial experience in several aspects of animal cell growth, cell synchrony, cell nutrition, the production and selection of mutant cell lines, the production and use of heterokaryons and interspecific hybrids, cell transformation in vitro, the cultivation and characterization of differentiated cells in culture, enzyme induction, and cell karyotyping. LAB.

BIOL 757. Carcinogenesis and Cancer Biology. 3 Hours.
This course surveys the field of cancer research. The major goal is to introduce the breadth of cancer research while, at the same time, providing sufficient depth to allow the student to recognize problems in cancer and to design experiments which study cancer biology. Toward that end, the student should (at the conclusion of the course) be able to: define cancer, identify and discuss its causes; identify and discuss the genetic basis for cancer development and progression; discuss the theoretical basis for cancer therapy design and efficacy testing; discuss the biochemical, molecular and cellular events involved in the natural history of major human neoplasms. Prerequisite: Permission of instructor. LEC.

BIOL 767. The Vegetation of the Earth. 3 Hours.
A discussion of the world's vegetation in its natural condition and as affected by man. Included are aspects of its economic and cultural usefulness and the problem of its preservation. Prerequisite: BIOL 634. LEC.

BIOL 768. Plant Molecular Biology. 3 Hours.
Gene expression in chloroplasts, mitochondria, and plant nuclei, and regulatory interactions among these genomes. Special topics include the molecular biology of the photosynthetic apparatus, nitrogen fixation, stress and development, viruses and viroids, transposable genetic elements and gene evolution, and gene transfer and plant genetic engineering. Prerequisite: A course in biochemistry, cell or molecular biology, or permission of instructor. LEC.

BIOL 770. Plant Biochemistry. 3 Hours.
A detailed study of plant biochemistry with emphasis on metabolic and regulatory processes particularly characteristic or unique in plants. Prerequisite: BIOL 600 or equivalent. LEC.

BIOL 772. Gene Expression. 4 Hours.
A study of the structure and expression of genes in prokaryotes and eukaryotes. Emphasis on the mechanisms of DNA, RNA, and protein biosynthesis. This course meets concurrently with BIOL 672 and is open to graduate students seeking a more rigorous treatment of techniques in molecular biology that students receive in BIOL 672. Prerequisite: A course in biochemistry or consent of instructor. LEC.

BIOL 775. Chemistry of the Nervous System. 3 Hours.
A detailed study of the molecular aspects of nerve transmission will be covered with special emphasis on the uptake, storage, release, biosynthesis and metabolism of specific neurotransmitters. Drugs affecting these processes and current research on receptor isolation and receptor mechanisms will be discussed from a chemical viewpoint. (Same as CHEM 775, MDCM 775, NURO 775, PTX 775, and PHCH 775.) Prerequisite: BIOL 600 or equivalent or consent of instructor. LEC.

BIOL 777. Integrative and Developmental Neurobiology. 3 Hours.
Cellular processing of neural information both at the local level and in long distance integration. Local computing functions, and integration of these functions among the various areas to produce coherent movement and perceptions will be discussed. A description of forces guiding the development of the nervous system to form a coherent working system in both invertebrate and vertebrate animals will be presented, as will determinants of brain sexual dimorphism. Prerequisite: An upper level course in physiology or BIOL 520. LEC.

BIOL 780. Fisheries. 2 Hours.
Philosophy and practice of conservation as it applies to major world fisheries. Species principally utilized, factors affecting production, methods for appraisal and management of stocks. Historical and prospective roles of the fisheries in relation to human food supplies and recreational needs. Prerequisite: BIOL 412. LEC.

BIOL 781. Fisheries, Laboratory. 2 Hours.
Training in field and laboratory techniques for fishery research and management. Prerequisite: Concurrent or prior enrollment in BIOL 780. LAB.

BIOL 782. Principles of Biogeography. 3 Hours.
A synthesis of historical and ecological biogeography of plants and animals, treating vicariance, dispersal, and community patterns; lectures, readings, discussions. A course in systematics and a course in ecology are recommended. LEC.

BIOL 783. Herpetology. 3 Hours N.
A study of amphibians and reptiles. This lecture course will explore the taxonomic diversity of amphibians and reptiles, and current areas of active research in herpetology. Topics will be considered within a phylogenetic framework, and include discussion on systematics, biogeography, tetrapod origins, skeletal systems, growth, circulatory system, locomotion, thermal and water regulation, hibernation, ecology, sexual behavior, parental care, and mimicry. Students taking the course at the 700 level will have additional work required of them. Prerequisite: BIOL 152 Principles of Organismal Biology, and/or BIOL 413 History and Diversity of Organisms. LEC.

BIOL 784. Introduction to Museum Public Education. 3 Hours.
Consideration of the goals of an institution's public education services, developing programs, identifying potential audiences, developing audiences, and funding. Workshops and demonstrations are designed for students to gain practical experience working with various programs
and developing model programs. (Same as AMS 797, GEOL 784, HIST 721, and MUSE 705.) Prerequisite: Museum Studies student, Indigenous Nations Studies student, or consent of instructor. LEC.

BIOL 785. Museum Management. 3 Hours.
Lecture, discussion, and laboratory exercises on the nature of museums as organizations; accounting, budget cycles, personnel management, and related topics will be presented using, as appropriate, case studies and a simulated museum organization model. (Same as AMS 731, GEOL 783, HIST 728, and MUSE 701.) Prerequisite: Museum Studies student, Indigenous Nations Studies student, or consent of instructor. LEC.

BIOL 786. Fundamentals of Tropical Biology. 1-8 Hours.
The tropical environment and biota; ecologic relations, communities and evolution in the tropics. Primarily a field course, taught in Costa Rica; two sessions per year, February-March, July-August. FLD.

BIOL 787. Introduction to Museum Exhibits. 3 Hours.
This course will consider the role of exhibits as an integrated part of museum collection management, research, and public service. Lecture and discussion will focus on issues involved in planning and producing museum exhibits. Laboratory exercises will provide first hand experience with basic preparation techniques. Emphasis will be placed on the management of an exhibit program in both large and small museums in the major disciplines. (Same as AMS 700, GEOL 781, HIST 723, and MUSE 703.) Prerequisite: Museum Studies student, Indigenous Nations Studies student, or consent of instructor. LEC.

BIOL 788. The Nature of Museums. 3 Hours.
The purpose of this course is to provide an overview of the kinds of museums, their various missions, and their characteristics and potentials as research, education, and public service institutions responsible for collections of natural and cultural objects. (Same as AMS 720, GEOL 782, HIST 720, and MUSE 702.) Prerequisite: Museum Studies student, Indigenous Nations Studies student, or consent of instructor. LEC.

BIOL 789. Field Course in Entomology. 1-6 Hours.
Field experiences in various habitats, with an emphasis in ecology, systematics, behavior, and collection techniques. FLD.

BIOL 790. Paleontology of Lower Vertebrates. 3 Hours.
General account of the osteology, geological distribution, and evolution of the principal groups of fishes, amphibians, reptiles, and birds. Lectures and laboratory. (Same as GEOL 725.) LEC.

BIOL 791. Paleontology of Higher Vertebrates. 3 Hours.
Evolution of mammals, and anatomical modifications involved in the process as ascertained from the fossil record. Lectures and laboratory. (Same as GEOL 726.) LEC.

BIOL 792. Ichthyology. 4 Hours.
A study of fishes. Lecture topics include the structure and function of fishes; the adaptations of fishes to the aquatic environment; and a survey of major fish groups with emphasis on evolutionary relationships and biogeography. Laboratory topics include a survey of fishes using specimens, and the use of keys to identify fishes with emphasis on the Kansas fish fauna. A research paper using primary scientific literature is required. Prerequisite: Graduate standing or permission of the instructor. LEC.

BIOL 794. Mammalogy. 3 Hours.
A study of mammals, with emphasis on systematics, biogeography, and natural history. Lectures, laboratory, and field study. Prerequisite: BIOL 100 or BIOL 413. LEC.

BIOL 795. Biology of Amphibians. 3 Hours.
Evolutionary biology of amphibians with emphasis on systematics, morphology, development, reproductive strategies, and distribution; lectures and laboratory. Prerequisite: BIOL 664 or permission of instructor. LEC.

BIOL 796. Biology of Reptiles. 3 Hours.
Evolutionary biology of reptiles with emphasis on systematics, morphology, reproductive strategies, and distribution; lectures and laboratory. Prerequisite: BIOL 664 or permission of instructor. LEC.

BIOL 797. Field Course in Vertebrate Paleontology. 3-6 Hours.
Training in the techniques of collecting vertebrate fossils, description and interpretation of the stratigraphy of fossiliferous sediments, and interpretation of the adequacy and bias of samples. FLD.

BIOL 798. Principles and Practices of Museum Collection Management. 3 Hours.
Lecture, discussion, and laboratory exercises on the nature of museum collections, their associated data, and their use in scholarly research; cataloging, storage, fumigation, automated information management and related topics will be presented for museums of art, history, natural history and anthropology. (Same as AMS 730, GEOL 785, HIST 725, and MUSE 704.) Prerequisite: Museum Studies student, Indigenous Nations Studies student, or consent of instructor. LEC.

BIOL 799. Natural History Museum Apprenticeship. 1-6 Hours.
Provides directed, practical experience in collection care and management, public education, exhibits and administration with emphases to suit the particular requirements of each student. Full time for one semester or half time for two semesters. (Same as AMS 799, ANTH 799, GEOL 723, HIST 799, and MUSE 799.) FLD.

BIOL 801. Topics in: ____. 1-3 Hours.
Advanced courses on special topics in biology, given as need arises. Lectures, discussing readings, laboratory or field work. Students may select sections according to their special interests. LEC.

BIOL 802. The Art of Becoming a Professional Scientist. 3 Hours.
Discusses aspects of graduate education that are directed at the post PhD phases of a career, but that must be initiated early in the graduate student program of study. One 3-hour discussion per week. LEC.

BIOL 804. Scientific Integrity: Molecular Biosciences. 1 Hour.
This course introduces aspects and issues associated with being an ethical, responsible, and professional research scientist. Included topics are professional practices, regulations, and rules that define the responsible and ethical conduct of research. Graduate students will become familiar with and prepare to navigate through challenges that occur during a career in research science. The format of individual classes is expected to incorporate both instruction and discussion. Prerequisite: Admission to the graduate program in Molecular Biosciences, or consent of instructor. LEC.

BIOL 806. Major Patterns in Insect Evolution. 3 Hours.
Extensive reading and discussion of the primary literature on topics relating to major patterns in the evolutionary history of insects, including the fossil history of insects, the monophyly of arthropods, the origin of wings, the changing role of insects in ecological communities, the origins of social behavior, modes and mechanisms of speciation, and patterns of species diversity. Assigned readings require a solid background in evolutionary theory and insect biology, especially morphology, development, and classification. Prerequisite: Permission of instructor. LEC.

BIOL 807. Graduate Molecular Biosciences. 6 Hours.
An introduction to the advanced study of biochemistry, microbiology, genetics, cell and developmental biology, and neurobiology for all Molecular Biosciences graduate students. Topics can include macromolecular structure, metabolism, kinetics and thermodynamics,
bioinformatics, prokaryotic and eukaryotic genetic mechanisms, cell structure and function, signal transduction, basic and pathogenic bacteriology, immunology, virology, membrane potentials, synaptic transmission, and sensory neurophysiology. Prerequisite: Admission to the graduate program in Molecular Biosciences, or consent of instructor. LEC.

BIOL 809. Graduate Molecular Biosciences for Medicinal Chemists. 4 Hours.
An introduction to the advanced study of biochemistry, microbiology, and neurobiology for graduate students in Medicinal Chemistry. Prerequisite: Admission to the graduate program in Medicinal Chemistry and consent of instructor. LEC.

BIOL 810. Seminar in Biochemistry. 1 Hour.
Presentation and discussion of specific areas of recent research in biochemistry. This course may be taken more than once. LEC.

BIOL 811. Advanced Molecular and Cellular Immunology. 2 Hours.
Covers recent advances in immunoochemistry and immunobiology. Topics include structure and function of antibodies, hybridoma systems, idiotypes, induction and regulation of the immune response through cell interactions and cytokine action, and the role of immune activity in disease states such as hypersensitivity, autoreactivity, and cancer. Prerequisite: BIOL 807 and BIOL 808, or an introductory course in immunology, or consent of instructor. LEC.

BIOL 812. Mechanisms of Host-Parasite Relationships. 2 Hours.
Emphasis is on virulence factors of microorganisms and the host response to infection. Topics will include pathogenesis of intracellular and extracellular parasites, bacterial adhesins, and toxins, and the role of innate and acquired immunity in host resistance and the response to infection. Prerequisite: BIOL 807 and BIOL 808, or a course in biochemistry, or consent of instructor. LEC.

BIOL 813. Advanced Bacterial Physiology. 2 Hours.
The intermediary reactions catalyzed by the bacterial cell during energy-requiring processes. Thermodynamic considerations of these processes are discussed. Knowledge of calculus is recommended. Prerequisite: BIOL 807 and BIOL 808, or a course in microbiology and a course in virology, or consent of instructor. LEC.

BIOL 814. Advanced Molecular Virology. 2 Hours.
The course concentrates on evaluation of current literature concerning all aspects of molecular biology, biochemical characterization, and pathogenic mechanisms involved in host-virus interactions. Students will be expected to present articles and participate in discussions. Prerequisite: BIOL 807 and BIOL 808, or a course in microbiology and a course in virology, or consent of instructor. LEC.

BIOL 815. Advanced Molecular Genetics. 2 Hours.
A literature-based course that covers recent advances in microbial molecular genetics. Topics include transcription, translation, mutagenesis and repair, genetic exchange mechanisms, and regulation of gene expression. Prerequisite: BIOL 807 and BIOL 808, or a course in microbial genetics, or consent of instructor. LEC.

BIOL 816. Careers in Chemical Biology. 1 Hour.
Advanced course examining current research topics in chemical biology. An emphasis will be placed on career options open to PhD scientists in Chemical Biology, and preparation for the different career paths. Extensive student/faculty interaction is emphasized utilizing lectures, class discussion of assigned readings of research reports, and oral presentations. This course will be graded satisfactory/unsatisfactory. (Same as CHEM 816, MDCM 816 and PHCH 816.) Prerequisite: Permission of instructor. SEM.

BIOL 818. Techniques in Molecular Biosciences. 2 Hours.
This course provides an introduction to common techniques used for research strategies in molecular biosciences. The course will cover common techniques in cell biology, biochemistry, microbiology, and neurobiology. Information will be presented in lectures and through practical demonstrations. This course is primarily intended for first year graduate students in the Department of Molecular Biosciences. Prerequisite: Enrollment in the Molecular Biosciences Graduate Program or consent of instructor. LAB.

BIOL 840. Scientific Communication. 2 Hours N.
Principles of English communication skills for the professional scientist. The course explores the form, function, and practice (including ethics) of scientific communication, emphasizing elements of writing and speech that are important to clarity and precision. The course covers written and verbal communication of primary research results as well as composing correspondence, a curriculum vitae, reviews, etc. Prerequisite: Graduate standing. LEC.

BIOL 841. Biometry I. 5 Hours.
The application of statistical methods to data from various fields of biological research. Special emphasis is placed on practical computational procedures. Prerequisite: College algebra. LEC.

BIOL 842. Biometry II. 3 Hours.
This course is primarily devoted to special advanced topics in analysis of variance, analysis of covariance and regression analysis. Polynomial regression and multiple linear regression will be presented as well the general linear model. Elementary matrix algebra will be developed as needed. Prerequisite: BIOL 841. LEC.

BIOL 847. Phylogenetics. 3 Hours.
An introduction to the theory and practice of phylogenetic systematics. Includes principles of character analysis including determination of homology and determination of character polarity, testing alternate phylogenetic trees, and reconstructing trees using computer techniques. Also includes principles of constructing phylogenetic classifications and the nature of taxa in the phylogenetic system. Other topics, such as the nature of species and principles of biogeography are included. Prerequisite: Twenty hours natural history. LEC.

BIOL 848. Phylogenetic Methods. 4 Hours.
A survey of methods for inferring phylogenetic trees from character data and using phylogenies to address evolutionary questions. Lectures will present the relevant theory and algorithmic description of methods. Computer lab will familiarize students with software that implements the analyses discussed in lecture. Intended for graduate students specializing in systematics. Prerequisite: BIOL 845 and BIOL 841 or consent of instructor. LEC.

BIOL 860. Principles and Practice of Chemical Biology. 3 Hours.
A survey of topics investigated by chemical biology methods including: transcription and translation, cell signaling, genetic and genomics, biochemical pathways, macromolecular structure, and the biosynthesis of peptides, carbohydrates, natural products, and nucleic acids. Concepts of thermodynamics and kinetics, bioconjugations and bioorthogonal chemistry will also be presented. (Same as CHEM 860, MDCM 860 and PHCH 860.) Prerequisite: Permission of instructor. LEC.

BIOL 872. Gene Expression II. 3 Hours.
Second semester of a two-semester lecture course on gene expression. Emphasis on control of gene expression at the transcriptional and post-transcriptional levels. Prerequisite: BIOL 772 or consent of instructor. LEC.
BIOL 888. Topics in Evolutionary Morphology: ______. 2 Hours.
Presentation and discussion by graduate students and faculty of selected topics centered on observed changes in structure and function of organisms from a phylogenetic point of view. Presentation will include results of original research when possible and appropriate, and otherwise, will be based on syntheses of recent literature. RSH.

BIOL 890. Advanced Study in Microbiology. 1-10 Hours.
Original investigation by students at the master's degree level. Graded on a satisfactory/unsatisfactory basis. Prerequisite: Ten or more hours of microbiology and consent of department. RSH.

BIOL 895. Human Genetics. 3 Hours.
A lecture course providing balanced coverage of Mendelian and molecular genetics of humans; includes discussions and presentations on current issues in human and medical genetics. Prerequisite: A course in genetics. LEC.

BIOL 899. Master's Thesis. 1-10 Hours.
Research which is to be incorporated into an M.A. thesis. Not more than ten hours may be earned. Graded on a satisfactory/unsatisfactory basis. THE.

BIOL 901. Graduate Seminar in Biochemistry and Biophysics. 1 Hour.
Advanced course examining current research topics in biochemistry and biophysics. Extensive student/faculty interaction is emphasized utilizing lectures, class discussion of assigned readings of research reports, and oral presentations. Prerequisite: Enrollment in graduate school, and departmental admission. LEC.

BIOL 902. Graduate Seminar in Molecular, Cellular, and Developmental Biology. 1 Hour.
Advanced course examining current research topics in molecular, cellular, and developmental biology. Extensive student/faculty interaction is emphasized utilizing lectures, class discussion of assigned readings of research reports, and oral presentations. Prerequisite: Enrollment in graduate school, and departmental permission. SEM.

BIOL 903. Graduate Seminar in Neurobiology. 1 Hour.
Advanced course examining current research topics in neurobiology. Extensive student/faculty interaction is emphasized utilizing lectures, class discussion of assigned readings of research reports, and oral presentations. Prerequisite: Enrollment in graduate school, and departmental permission. LEC.

BIOL 904. Graduate Seminar in Microbiology. 1 Hour.
Advanced course examining current research topics in microbiology. Extensive student/faculty interaction is emphasized utilizing lectures, class discussion of assigned readings of research reports, and oral presentations. Graded on a satisfactory/unsatisfactory basis. Prerequisite: Enrollment in graduate school, and departmental permission. RSH.

BIOL 905. Advanced Molecular Genetics. 1-3 Hours.
A review of current literature in molecular genetics. RSH.

BIOL 906. Advanced Genetics. 1-3 Hours.
May be repeated for credit up to six hours. Review of current literature and genetic theory of selected topics such as population, molecular, quantitative, and physiological genetics. RSH.

BIOL 911. Research Topics in Plant Physiology and Biochemistry. 1-6 Hours.
Directed research on selected topics. Prerequisite: BIOL 770 or equivalent. RSH.

BIOL 918. Modern Biochemical and Biophysical Methods. 4 Hours.
This course emphasizes the use of techniques for solving problems of structure and function of biological macromolecules. Students will complete several modules that consist of lectures relating to theory and practical aspects of each methodological approach, and apply these techniques to solving a specific problem. Students will submit a paper describing the resulting data and conclusions. Prerequisite: BIOL 807, BIOL 808, and BIOL 818, or permission of instructor. LEC.

BIOL 925. Research Grant Proposal Preparation. 3 Hours.
This course introduces the basics of preparing a successful scientific grant application. Topics to be covered include how to develop a novel, fundable project, scientific writing and grantsmanship, and what criteria reviewers consider in evaluating grants. The course will be a mix of instruction and class discussion. Prerequisite: Admission to the graduate program in Molecular Biosciences, or consent of instructor. LEC.

BIOL 930. Ultrastructure and Cellular Mechanisms. 3 Hours.
Two lectures and one seminar-recitation. A detailed consideration of electron microscopic analyses of cell structure as related to cell function. Prerequisite: BIOL 416. LEC.

BIOL 943. Multivariate Data Analysis. 3 Hours.
Matrix formulation of multivariate models and data. Specific methods covered include Principal Components Analysis, Factor Analysis, Multiple Group Discriminant Analysis and Canonical Analysis, and Canonical Correlation Analysis. Prerequisite: BIOL 842 or knowledge of elementary matrix algebra. LEC.

BIOL 944. Topics in Quantitative Ecology: ______. 1-3 Hours.
Presentation and discussion by instructor and students of mathematical and statistical concepts in ecology. Topics are selected from texts or sets of readings. LEC.

BIOL 950. Evolutionary Mechanisms. 3 Hours.
Reading and discussions of evolutionary mechanisms from the genetic, ecologic, and systematic viewpoints. Prerequisite: BIOL 412. LEC.

BIOL 952. Introduction to Molecular Modeling. 3 Hours.
Introduction to theory and practice of contemporary molecular modeling, including molecular mechanics, molecular dynamics, computer graphics, data analysis, use of structure and sequence databases, docking, and homology modeling. Weekly computer laboratory section aimed at allowing participants to pursue independent research projects that incorporate modeling aspects. Lectures, laboratory manuals, program descriptions, and technical notes are presented on course web page. Prerequisite: Graduate standing or consent of instructor. LEC.

BIOL 968. Seminar in Vegetation Geography. 2-3 Hours.
(Same as GEOG 937.) LEC.

BIOL 985. Advanced Study. 1-10 Hours.
Individual investigations; laboratory, field or museum; or reading assignments in specialized topics not ordinarily treated in other courses. Graded on a satisfactory/unsatisfactory basis. RSH.

BIOL 999. Doctoral Dissertation. 1-12 Hours.
Original research that is to be incorporated into a Ph.D. dissertation. Graded on a satisfactory/unsatisfactory basis. THE.