Department of Ecology and Evolutionary Biology

Ecology and Evolutionary Biology Graduate Programs

The department comprises a large number of biologists with a variety of research interests. 3 broad overlapping themes capture the interests and activities in EEB — biodiversity and macroevolution, ecology and global change biology, and evolutionary mechanisms. The department offers graduate study leading to Master of Arts and Doctor of Philosophy degrees in ecology and evolutionary biology. General information about the department and its faculty, current graduate students, admission, and financial support may be found on the EEB website (https://eeb.ku.edu/). Students who are interested in enrolling in EEB graduate-level coursework without admission to a graduate program are encouraged to apply for graduate non-degree seeking student status. See the EEB admission page (https://eeb.ku.edu/how-apply/) for further details.

Neotropical biodiversity is a special area of concentration among EEB faculty. Many faculty members have courtesy appointments in the Latin American Area Studies Program, which fosters multidisciplinary research in Latin America across the campus. KU is a member of the Organization for Tropical Studies, and many faculty members and students participate in advanced, field-oriented OTS courses. Graduate students can receive fellowships for courses, e.g. BIOL 786 Fundamentals of Tropical Biology, or research projects in Costa Rica. Other EEB faculty have research concentrations in Asia, Africa, Antarctica, and elsewhere, creating a genuinely global reach for EEB research activities.

(B.A. and B.S. degree programs in biology are listed under Biology Undergraduate Programs (https://catalog.ku.edu/liberal-arts-sciences/biology/).)

Facilities

Departmental physical facilities include laboratories, natural history collections, and field-study sites near the university. Most laboratory facilities are in Dyche Hall, Higuchi Hall, McGregor Herbarium, Haworth Hall, and the Public Safety Building. Special facilities in Haworth include controlled-environment rooms, greenhouses, and various instrument rooms, including an excellent microscopy and analytical imaging facility (https://mai.ku.edu/).

The natural history collections are housed by the Biodiversity Institute (https://biodiversity.ku.edu/) and include approximately 8 million specimens, including mammals, birds, reptiles, amphibians, fishes, arthropods and other invertebrates, parasites, and plants, as well as fossils of vertebrates, arthropods, other invertebrates, and plants. Collections support diverse research in evolutionary biology, paleobiology, and ecology including systematics, phylogenetics, biogeography, morphology, behavior, biodiversity informatics, and biotic surveys and inventories. The BI also has leading facilities for diverse analyses of biodiversity information, including well-equipped spatial analysis laboratories, and extensive facilities for molecular systematics.

The Kansas Biological Survey (https://biosurvey.ku.edu/) is a KU research and service unit and a non-regulatory state agency, whose mission it is to gather information on the kinds, distribution, and abundance of plants and animals in Kansas, and to compile, analyze, interpret, and distribute this information broadly. KBS is a nationally recognized leader in several fields of environmental research and maintains a strong tradition of natural history studies. Scientists at KBS study terrestrial ecosystem ecology, aquatic ecology, water quality, evolution, biodiversity, ecology and population biology of animals and plants, and conservation and restoration of natural communities. KBS researchers routinely use technologies such as satellite and airborne remote sensing, aerial photography, and Geographic Information Systems.

KBS administers the University of Kansas Field Station (https://biosurvey.ku.edu/field-station/), 3,700 acres of field-sites dedicated to environmental research and education, and is part of the prestigious National Ecological Observatory Network. KUFS sites are in the transition zone between the Eastern Deciduous Forest and Tallgrass Prairie biomes and include woodland, prairie, old fields, and wetlands. The Fitch Natural History Reservation and Baldwin Woods are used primarily to study unmanipulated ecological processes in undisturbed habitats. The John H. Nelson Environmental Study Area is used for experimental ecological studies and has experimental ponds, a dedicated lake and watershed, a common garden, small-mammal enclosures, and a succession facility.

Courses

BIOL 100. Principles of Biology. 3 Credits.
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, honors) satisfy the College natural science with laboratory requirement. Concurrent enrollment in BIOL 102 is recommended.

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

BIOL 102. Principles of Biology Laboratory. 1 Credits. LFE
In this online laboratory geared for non-biology majors, students will be engaged in learning biology by completing a series of lab simulations. Students will then use easily accessible household materials to explore biology through hands-on and computer-based activities that reinforce the lab simulations. Students will learn selected fundamentals of biology and scientific inquiry at a level appropriate for a non-biology major, including various laboratory skills, collecting data, graphing and interpreting data. Prerequisite: Concurrent enrollment in BIOL 100 is recommended.

BIOL 105. Biology Orientation Seminar. 1 Credits.
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.

BIOL 116. Introduction to Evolutionary Biology. 3 Credits. 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).

BIOL 150. Principles of Molecular and Cellular Biology. 3 Credits. LFE
A 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 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 and CHEM 191; CHEM 150; or CHEM 170; or consent of instructor.

BIOL 151. Principles of Molecular and Cellular Biology, Honors. 3 Credits. LFE
A 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 per week. Prerequisite: Membership in the University Honors Program and concurrent or prior enrollment in CHEM 130, CHEM 190 and CHEM 191, CHEM 150, or CHEM 170; or consent of instructor.

BIOL 152. Principles of Organismal Biology. 3 Credits. LFE
A 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 per week. An honors section (BIOL 153) is offered for students with superior academic records. Prerequisite: Concurrent or prior enrollment in CHEM 130; CHEM 190 and CHEM 191; CHEM 150; or CHEM 170; or consent of instructor.

BIOL 153. Principles of Organismal Biology, Honors. 3 Credits. LFE
A 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 per week. Prerequisite: Concurrent or prior enrollment in CHEM 130; CHEM 190 and CHEM 191; CHEM 150; or CHEM 170 and membership in the University Honors Program; or consent of instructor.

BIOL 154. Introductory Biology Lab for STEM Majors. 2 Credits. LFE
A hybrid laboratory course for majors in science, technology, engineering and math fields. This course will use online modules (~ 3 hours per week) to introduce students to key core competencies (e.g., critical thinking, quantitative reasoning, scientific communication, collaboration, etc.) that are applicable to all STEM fields. Three hours of face-to-face instruction will provide students hands-on opportunities to apply these core competencies and skills to research questions in the biological sciences. Students will apply research skills and engage in an authentic research activity during the second half of the course and will present the results to their peers in an oral format.

BIOL 155. Principle Lab in: _____. 1-3 Credits. 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.

BIOL 177. First Year Seminar: _____. 3 Credits.
A limited-enrollment, seminar course for first-time freshmen, organized around current issues in biology. Course is designed to meet the critical thinking learning outcome of the KU Core. Does not contribute to major requirements in biology. First-year seminar topics are coordinated and approved by the Office of Academic Programs and Experiential Learning. Prerequisite: Open to Freshmen only (less than 30 hours).

BIOL 200. Basic Microbiology. 3 Credits.
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 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.

BIOL 203. Introductory Microbiology Laboratory. 2 Credits. LFE
Laboratory exercises to complement BIOL 200. Prerequisite: BIOL 200. May be taken concurrently.

BIOL 210. Introduction to Clinical Laboratory Sciences. 1 Credits.
An introductory overview of the professions of Clinical Laboratory Sciences 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 the Clinical Laboratory Sciences to have a clear definition of the professions. (Same as CLS 210.)

BIOL 225. Evolution and the History of Life. 3 Credits.
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.

BIOL 240. Fundamentals of Human Anatomy. 3 Credits.
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.

BIOL 241. Human Anatomy Observation Laboratory. 2 Credits. 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.

BIOL 246. Principles of Human Physiology. 3 Credits.
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.

BIOL 247. Principles of Human Physiology Laboratory. 2 Credits. 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.

BIOL 350. Principles of Genetics. 4 Credits.
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; cytogenetics; 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. Not open to students with credit in BSCI 350. Prerequisite: BIOL 150 or 151 with a grade of C- or higher and concurrent enrollment or prior completion of CHEM 135 or CHEM 175 or CHEM 195 and CHEM 196, and concurrent enrollment or prior completion of BIOL 152 or BIOL 153; or consent of instructor.

BIOL 360. Principles of Genetics, Honors. 4 Credits.
The science of genetics aims to explain why individuals differ from one another and how these differences are inherited. Honors Genetics has a strong focus on probability and 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. An introduction to genetic simulation in the R programming language is also provided. Not open to students with credit in BSCI 350. Prerequisite: Membership in the University Honors Program, BIOL 150 or 151 with a grade of C- or higher, and concurrent enrollment or prior completion of CHEM 135, or CHEM 175, or CHEM 195 and CHEM 196, and concurrent enrollment or prior completion of BIOL 152 or BIOL 153; or consent of instructor.

BIOL 370. Introduction to Biostatistics. 4 Credits.
This course introduces key statistical concepts and how they are used to solve biological problems. Topics include the scientific method, data representation, descriptive statistics, elementary probability distributions, estimation and hypothesis testing, and analysis of variance. Formerly known as BIOL 570. Not open to students with credit in BIOL 570. Prerequisite: MATH 101 or MATH 104 and BIOL 150 or BIOL 151 or BIOL 152 or BIOL 153.

BIOL 400. Fundamentals of Microbiology. 3 Credits.
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. Not open to students with credit in BSCI 400. Prerequisite: BIOL 150 or BIOL 151 with a grade of C- or higher and two semesters of college chemistry with a grade of C- or higher, or consent of the instructor.

BIOL 401. Fundamentals of Microbiology, Honors. 4 Credits.
Honors section of BIOL 400 and BIOL 612, by application and invitation. Not open to students with credit in BSCI 400. Prerequisite: BIOL 150 or BIOL 151 with a grade of C- or higher and two semesters of college chemistry with a grade of C- or higher, and membership in the University Honors Program, or consent of the instructor.

BIOL 402. Fundamentals of Microbiology Laboratory. 2 Credits. LFE
Laboratory exercises designed to complement BIOL 400 or BIOL 700. Not open to students with credit in BSCI 401. Prerequisite: BIOL 400 or BIOL 612, or BIOL 400 or BIOL 612 concurrently.

BIOL 405. Laboratory in Genetics. 3 Credits. LFE
A laboratory course that provides hands-on experience with classical genetics and modern molecular genetics. Experiments involve Mendelian genetics (dominance/recessivity, complementation, segregation, independent assortment) in eukaryotic organisms; recombinant DNA; basic bacterial genetics; polymerase chain reaction; DNA sequencing; computational genetics; and genome editing. Not open to students with credit in BSCI 351. Prerequisite: Concurrent or prior enrollment in BIOL 350.

BIOL 412. Evolutionary Biology. 4 Credits.
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.

BIOL 413. The Tree of Life. 4 Credits.
A tour of the tree of life that introduces the major groups of organisms on Earth, their important traits, phylogenetic relationships, life histories, roles in global ecosystems, and interactions with humanity. Our primary guide to this tour is the “Tree of Life,” a branching diagram (phylogenetic tree) that illustrates how life evolved over the few billion years. Learning to read and interpret phylogenetic trees is central to the course, with lessons addressing general tree literacy, as well as advanced topics like mapping traits onto trees and reconstructing their evolution, interpreting fossils and timetrees, and biogeography. Weekly in-person and virtual labs offer opportunities for students to interact directly with physical specimens while also gaining practical experience with simple algorithms and software applications that can be used to reconstruct and interpret how major groups of organisms evolved over time. Two of the four credit hours from this course will apply towards BIOL lab elective requirements numbered 400 or higher for biology majors. Prerequisite: BIOL 152 or BIOL 153, or consent of the instructor.

BIOL 414. Principles of Ecology. 3 Credits.
Study of the principles underlying species population density changes, community structure and dynamics, biogeochemical cycles, and energy flow and nutrient cycling in ecosystems. (Same as EVRN 414.) Prerequisite: BIOL 152 or BIOL 153, or consent of the instructor.

BIOL 415. Field and Laboratory Methods in Ecology. 2 Credits.
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.

BIOL 416. Cell Structure and Function. 3 Credits.
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. Not open to students with credit in BSCI 416. Prerequisite: BIOL 350 or BIOL 360; CHEM 130,

or CHEM 170, or CHEM 190 and CHEM 191; and CHEM 135, or CHEM 175, or CHEM 195 and CHEM 196; or consent of the instructor.

BIOL 417. Biology of Development. 3 Credits.
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. Not open to students with credit in BSCI 417. Prerequisite: BIOL 350 or BIOL 360 and BIOL 416 or consent of the instructor.

BIOL 418. Laboratory in: _____. 1-3 Credits. 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.

BIOL 419. Topics in: _____. 1-3 Credits. 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.

BIOL 420. Seminar: _____. 1-3 Credits.
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.

BIOL 423. Non-laboratory Independent Study. 1-9 Credits.
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.

BIOL 424. Independent Study. 1-9 Credits.
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.

BIOL 425. Teaching Apprenticeship in Biology. 1-9 Credits.
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.

BIOL 426. Laboratory in Cell Biology. 3 Credits. LFE
Laboratory exercises will examine the function, organization, and composition of eukaryotic cells. Prerequisite: BIOL 150 or BIOL 151; CHEM 130, or CHEM 170, or CHEM 190 and CHEM 191; concurrent or prior enrollment in BIOL 416; or consent of the instructor. BIOL 350 or BIOL 360 is highly recommended.

BIOL 428. Introduction to Systematics. 3 Credits.
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.

BIOL 430. Laboratory in Molecular Biology. 3 Credits. LFE
Practical experience in recombinant DNA technology and molecular cloning. Prerequisite: BIOL 416 or a course in biochemistry or microbiology.

BIOL 435. Introduction to Neurobiology. 3 Credits.
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. Not open to students with credit in BSCI 435. Prerequisite: BIOL 350 or BIOL 360 and BIOL 416 or consent of the instructor.

BIOL 442. Human Anatomy Dissection Laboratory. 3 Credits.
Laboratory in gross anatomy designed to build on content from BIOL 240 and BIOL 241. Provides an opportunity to develop a comprehensive three-dimensional understanding of anatomical structures and spatial relationships while gaining substantial dissecting experience. Students perform supervised dissection of human cadavers. Limited to students enrolled in, or seeking admission to, programs that require a human anatomy laboratory. Prerequisite: BIOL 240 and BIOL 241, and consent of the instructor.

BIOL 446. Biology of Sleep. 3 Credits.
The course integrates the impact of sleep across all of biology including physiology, endocrinology, health, neurobiology, learning and memory, evolution, and behavior. Students are expected to apply concepts from previous courses to understanding the role of sleep in well-being. Prerequisite: BIOL 150 or BIOL 151, or BIOL 152 or BIOL 153, and one BIOL course 300-level or above.

BIOL 449. Laboratory/Field Work in Human Biology. 1-3 Credits. LFE
This biological anthropology lab course builds upon concepts introduced in ANTH 150 and ANTH 304. It provides students with practical, hands-on experience in biological anthropology laboratory methods and theory. Topics include: genetics, osteology, forensic anthropology, modern human biological variation, primatology, paleoanthropology, and human evolution. Students integrate their knowledge of human variation, genetics, and critical approaches to the concept of social and biological race. For the final project, students analyze genetic markers using a commercial ancestry test. They will either be given anonymous data to work with, or, if they pay an optional laboratory fee, they can investigate their own genome for the final project. This fee for self-study is not required for full participation in the final project. (Same as ANTH 449, PSYC 449, and SPLH 449.) Prerequisite: Either ANTH 304, ANTH 340, Human Biology major, or permission of instructor.

BIOL 451. Ecosystems Stewardship. 3 Credits.
This course sits at the crossroads between the discipline of ecology and the practice of stewardship, specifically the Indigenous Knowledge that is born from these landscapes over millennia in a place. Students will interact with research that establishes scientific foundations as a method to engage environmental problems in the anthropocene. The concept of stewardship is a core tenet of this course, students will engage with many approaches of stewardship, centering primarily on humans as a part of, not apart from, the environment. This course is offered at the 400 and 700 level with additional assignments at the 700 level. Not open to students with credit in EVRN 451 or EVRN 751, GEOG 451 or GEOG 759, BIOL 451 or BIOL 759. (Same as EVRN 451 and GEOG 451.)

BIOL 454. Brain Diseases and Neurological Disorders. 3 Credits.

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 416 or BIOL 435 or BIOL 546, or consent of instructor.

BIOL 480. Medical Parasitology. 3 Credits.
Introductory lecture course focused on parasites (protozoans and metazoans) causing disease in humans, including zoonotic diseases (diseases or infections that are naturally transmissible to humans from non-human vertebrates). Provides basic knowledge about the morphology, epidemiology, evolution, and ecology of parasites infecting humans globally (e.g., malaria, amoebas, hookworms, tapeworms). Emphasis is placed on life-cycles, course of infection, modes of reproduction, diagnosis, and pathology of human parasites; relevant parasites of veterinary importance are also discussed. Prerequisite: BIOL 152 or BIOL 153, or permission of instructor.

BIOL 481. Medical Parasitology Laboratory. 2 Credits. LFE
Laboratory course in the study of parasites causing disease in humans, including zoonotic diseases (diseases or infections that are naturally transmissible to humans from non-human vertebrates) with emphasis on morphology and diagnostics of various life-cycle stages, including introduction to parasitological methods. Prerequisite: Concurrent or prior enrollment in BIOL 480.

BIOL 490. Internship and Practical Applications. 1-6 Credits.
This course provides credit for supervised practical experiences in an occupational area of interest. In addition to the work-related activity, students will be expected to complete reading and writing assignments, participate in on-line discussions, and create a final summary of internship accomplishments. Hours of credit earned (1-6) are based on number of hours at internship site and agreement of instructor. Repeatable for up to 6 credit hours, provided the internship experiences are different. Prerequisite: Consent of Instructor.

BIOL 499. Introduction to Honors Research. 2 Credits.
Intended for sophomores planning to enroll in the Biology Honors Program. Students interested in pursing 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.

BIOL 500. Biology of Insects. 3 Credits.
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.

BIOL 502. Laboratory in Insect Biology and Diversity. 2 Credits. 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.

BIOL 503. Immunology. 3 Credits.
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. Not open to students with credit in BSCI 503. Prerequisite: BIOL 400 or BIOL 401, or consent of instructor. BIOL 416 is recommended but not required.

BIOL 504. Immunology Laboratory. 2 Credits. LFE
Laboratory designed to complement BIOL 503. Prerequisite: BIOL 503, or BIOL 503 concurrently.

BIOL 506. Bacterial Infectious Diseases. 3 Credits.
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. Not open to students with credit in BSCI 506. Prerequisite: BIOL 400 or BIOL 401 with a grade of C- or higher, or consent of instructor.

BIOL 507. Bacterial Infectious Diseases Laboratory. 3 Credits. 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.

BIOL 509. Biology of Spiders. 3 Credits.
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 , BIOL 153 or permission of instructor.

BIOL 511. Biology of Spiders Laboratory. 1 Credits. LFE
Topics will include comparative biology of arachnid orders (spiders, scorpions, harvestmen, mites, and others), external and internal 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.

BIOL 512. General Virology. 3 Credits.
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. Not open to students with credit in BSCI 512. Prerequisite: BIOL 400 or BIOL 401 with a grade of C- or higher, or consent of instructor. BIOL 416 is recommended but not required.

BIOL 513. Virology Laboratory. 2 Credits. 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.

BIOL 518. Bacterial Genetics. 3 Credits.
Bacteria and viruses as models of genetic systems. Mutagenesis and repair. Transformation, transductions, and recombination. Molecular biology of gene expression. Prerequisite: BIOL 400 or BIOL 401 with a grade of C- or higher or consent of instructor.

BIOL 519. Bacterial Genetics Laboratory. 2 Credits. LFE

A laboratory course on the genetic analysis of bacteria. Includes mutagenesis, cloning, agarose and polyacrylamide gel electrophoresis, PCR, regulation of gene expression, and computational analysis of DNA sequences and protein structures. Prerequisite: BIOL 402 and concurrent or prior enrollment in BIOL 518; or consent of instructor.

BIOL 520. Marine Biology. 3 Credits.
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.

BIOL 524. Mammalian Paleontology. 3 Credits.
Evolution of mammals, and anatomical modifications involved in the process as ascertained from the fossil record. Lectures and laboratory. (Same as GEOL 524.) Prerequisite: One of the following: BIOL 225, BIOL 412, BIOL 413, GEOL 304, GEOL 521, or consent of the instructor.

BIOL 527. Primate Evolution and the Fossil Record. 3 Credits.
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.

BIOL 530. Biodiversity Discovery and Assessment. 2 Credits.
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.

BIOL 531. Tropical Fieldwork in Biodiversity Discovery. 1 Credits.

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.

BIOL 533. Biology of Fungi. 4 Credits. LFE
A study of the major groups of fungi from slime molds to mushrooms. Emphasis on their activities in natural substrates, isolation techniques, parasitic and mutualistic relationships with other organisms, uses in research, industrial applications, production of mycotoxins and poisons, and physiological, genetic and reproductive behavior. Lectures, laboratory, and field trips. Prerequisite: BIOL 100, BIOL 101, BIOL 150, or BIOL 151 and BIOL 152 or BIOL 153.

BIOL 536. Cell Structure and Function (Honors). 3 Credits.
BIOL 536 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. Not open to students with credit in BSCI 416. Prerequisite: BIOL 350 or BIOL 360 or consent of instructor.

BIOL 540. General Invertebrate Zoology. 4 Credits. LFE
This course will cover the diversity and evolution of freshwater and marine invertebrate animals. The class includes an overview of phylogenetic relationships, focusing on understanding patterns of key evolutionary innovations in the history of life. Throughout this course, students will have the opportunity to examine living and preserved specimens and identify unique and convergent features across non-terrestrial invertebrates. Students will gain an appreciation of the remarkable diversity of invertebrate morphologies, function and life cycles. Two of the four credit hours from this course will apply towards BIOL lab elective requirements numbered 400 or higher for biology majors. Prerequisite: BIOL 152 or BIOL 153.

BIOL 544. Comparative Animal Physiology. 3 Credits.
An intermediate physiology course with lectures and discussions of the structures, functions, mechanisms, and interactions of vertebrate and invertebrate organ systems with a focus on the different ways in which animals adapt to their environments. Topics include digestion and nutrition, metabolism, gas exchange, circulation, excretion, neurophysiology, endocrinology, and muscle physiology. Prerequisite: BIOL 152 or BIOL 153, concurrent or prior enrollment in CHEM 330 or CHEM 380, or consent of instructor. A college physics course is recommended but not required.

BIOL 545. Evolution of Development. 4 Credits.
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.

BIOL 546. Mammalian Physiology. 3 Credits.
An intermediate course in the structures, functions, mechanisms, and interactions of mammalian organ systems. Discussions span topics from molecular to whole animal functions. Not open to students with credit in BSCI 546. Prerequisite: BIOL 150; BIOL 152 or BIOL 240; and concurrent or prior enrollment in CHEM 330 or CHEM 380, or consent of instructor.

BIOL 547. Mammalian Physiology Laboratory. 2 Credits. LFE
Laboratory experiments in representative areas of mammalian physiology designed to complement BIOL 546. Not open to students with credit in BIOL 247. Prerequisite: Corequisite: BIOL 546 or BIOL 646.

BIOL 548. Human Osteology. 4 Credits. LFE
This course examines the structure and function of the human skeleton from an evolutionary and biomedical perspective. Students will learn to identify bones comprising the human skeleton and how osteological information aids in reconstructing sex, age, race, stature, and health status. Major transformations of the human skeleton from hominoid precursors, and some of the biomedical consequences of these transformations, will be addressed. (Same as ANTH 648.) Prerequisite: An introductory course in physical anthropology, biology, or permission of instructor.

BIOL 555. General Plant Physiology. 3 Credits.

The principal physiological processes of higher plants including photosynthesis, respiration, water relations, mineral nutrition, and factors associated with morphogenesis. Prerequisite: Consent of instructor.

BIOL 560. Histology. 3 Credits.
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.

BIOL 567. Mammalogy. 4 Credits. LFE
A lecture and lab course on the biology, evolution, and diversity of mammals. Two of the four credit hours from this course will apply towards BIOL lab elective requirements numbered 400 or higher for biology majors. Prerequisite: BIOL 152 or BIOL 153, and BIOL 154, or permission of instructor.

BIOL 582. Principles of Biogeography. 3 Credits.
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.

BIOL 583. Herpetology. 4 Credits.
Herpetology introduces students to the global diversity of amphibians and reptiles. Students will learn about the major groups of frogs, salamanders, snakes, lizards, crocodiles and turtles through classroom lectures and hands-on laboratories built around the world-class specimen collections housed in the KU Biodiversity Institute. We will also cover a broad range of other important topics through a herpetological lens, including systematics, evolution, ecology, conservation, life histories, biogeography, communication, locomotion, physiology, diet, behavior, and reproduction. One of the four credit hours from this course will apply towards BIOL lab elective requirements numbered 400 or higher for biology majors.

BIOL 592. Ichthyology. 4 Credits. 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. The course is offered at the 500 and 700 levels, with additional assignments at the 700 level. Prerequisite: BIOL 152 and/or BIOL 413.

BIOL 593. Ornithology. 3 Credits. LFE
A lecture and laboratory course on the biology, evolution, and diversity of birds. One of the three credit hours from this course will apply towards BIOL lab elective requirements numbered 400 or higher for biology majors. Prerequisite: BIOL 152 or BIOL 153 and BIOL 154, or permission of instructor.

BIOL 594. Forest Ecosystems. 3 Credits.
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 175, or CHEM 195 and CHEM 196; and BIOL 414.

BIOL 595. Human Genetics. 3 Credits.
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 or BIOL 360.

BIOL 598. Research Methods. 3 Credits. LFE
An introduction to the foundational concepts that underpin scientific inquiry and problem solving. Coursework is built around three student-designed inquiries, and topics considered within that context include experimental variables, basic principles of statistics, safety and ethics of investigation, professional communication techniques, and appropriate literature review. Enrollment priority will be given to students currently admitted to the UKanTeach program.

BIOL 599. Senior Seminar: _____. 1 Credits.
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.

BIOL 600. Introductory Biochemistry, Lectures. 3 Credits.
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. Not open to students with credit in BSCI 600. Prerequisite: BIOL 150 or BIOL 151 and one semester of organic chemistry.

BIOL 601. Principles of Biochemistry Laboratory. 2 Credits.
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.

BIOL 602. Plant Ecology. 3 Credits.
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; genecology; paleoecology. Prerequisite: BIOL 414 or consent of instructor.

BIOL 603. Systematic Botany. 3 Credits. 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.

BIOL 606. Ecological Plant Physiology. 3 Credits.
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: Consent of instructor.

BIOL 612. Fundamentals of Microbiology. 3 Credits.
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. Not open to students with credit in BSCI 612. Prerequisite: BIOL 150 or BIOL 151 and two semesters of college chemistry, or consent of instructor.

BIOL 622. Paleontology. 3 Credits.
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.

BIOL 623. Paleontology Laboratory. 1 Credits. 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.)

BIOL 625. Behavioral Ecology and Sociobiology. 3 Credits.
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 or BIOL 153.

BIOL 630. Conservation and Wildlife Biology. 3 Credits.
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 152 or BIOL 153.

BIOL 636. Biochemistry I. 4 Credits.
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.

BIOL 637. Introductory Biochemistry Laboratory. 2 Credits. LFE
The laboratory portion of BIOL 600 or BIOL 636. Experiments have been selected to introduce the student to cell constituents and biochemical reactions. Prerequisite: BIOL 600 or BIOL 636, or concurrent enrollment.

BIOL 638. Biochemistry II. 4 Credits.
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: CHEM 335 with a grade of C or higher and BIOL 636 with a grade of C or higher, or consent of instructor.

BIOL 639. Advanced Biochemistry Laboratory. 3 Credits. 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 BIOL 638 (BIOL 638 may be taken concurrently).

BIOL 640. The Biology and Evolution of Fossil Plants. 3 Credits.
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. Prerequisite: BIOL 413, or permission of instructor.

BIOL 642. Biochemistry III: Machines on Genes. 4 Credits.
This one-semester lecture course for biochemistry majors is designed to complement the topics covered in BIOL 636 and BIOL 638. Emphasis will be placed on the various molecular machines involved in the transmission and utilization of genetic information, providing a biochemical perspective of replication, transcription, and translation. Prerequisite: BIOL 636 and BIOL 638 with a grade of C or higher.

BIOL 648. Systematics and Macroevolution. 3 Credits.
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 Baysian 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.

BIOL 650. Advanced Neurobiology. 3 Credits.
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 nervous 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.

BIOL 652. Animal Behavior. 3 Credits.
An analysis of behavior including causation, development, evolution, and adaptation. The course integrates studies at all levels from genetic through organismal analysis. Students are expected to apply concepts from previous courses to understanding the expression of behavior in animals. All types of animals, from invertebrates to primates, will be used as examples. Prerequisite: BIOL 150/151, BIOL 152/153, BIOL 154, BIOL 370, and one other BIOL course level 300 or above.

BIOL 655. Behavioral Genetics. 3 Credits.
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 BIOL 360 or consent of instructor.

BIOL 660. Summer Field Ecology. 3 Credits.
An introduction to research methods for environmental science. Similar to EVRN 460, formatted for summer term. The course includes fieldwork in diverse ecosystems (lakes, streams, forests, prairies). Assignments and group work emphasize analysis and interpretation of field data. (Same as EVRN 660.) Prerequisite: Junior, Senior, or graduate standing with 60 + Credit hours.

BIOL 661. Ecology of Rivers and Lakes. 3 Credits.
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.

BIOL 667. Chemical Communication in Sex, Feeding, and Fighting. 3 Credits.
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.

BIOL 668. Evolutionary Ecology. 3 Credits.
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 152 or BIOL 153.

BIOL 672. Gene Expression. 3 Credits.
The molecular biology of gene expression in eukaryotes: A study of the structure of genes and the molecular mechanisms used by cells to control and regulate gene expression. Emphasis on enzymatic mechanisms related to transcription, translation, post-transcriptional and post-translational modifications, and epigenetics. This course is offered at the 600 and 700 level with additional assignments at the 700 level. Not open to students with credit in BIOL 772. Prerequisite: BIOL 350 or BIOL 360, or consent of instructor. A course in biochemistry is recommended.

BIOL 680. Genomics. 3 Credits.
Genomics is the study of the structure, function and evolution of the genome. High-throughput technologies have given us the ability to easily and quickly sequence genomes, and measure genomewide patterns of gene expression. These tools, and the vast amounts of genome-scale data they provide, have transformed biology and medicine. This course will cover the key technological and computational methods by which genomic DNA is sequenced, genomes are assembled, and how RNA and epigenetic patterns are measured. Subsequently, we will emphasize how these genomics tools and techniques have deepened our understanding of biology, covering questions from diverse fields to illustrate the impact of genomics on evolutionary biology, molecular and developmental genetics, human medical genetics and personalized, precision medicine. Prerequisite: BIOL 350 or BIOL 360, or consent of instructor.

BIOL 688. The Molecular Biology of Cancer. 3 Credits.
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 consent of instructor.

BIOL 699. Biology Honors Research Colloquium. 1 Credits.
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.

BIOL 700. Conservation Principles and Practices. 3 Credits.
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 or consent of instructor.

BIOL 701. Topics in: _____. 1-3 Credits.
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.

BIOL 702. Laboratory Practice: Radiation Safety Procedures. 0.75 Credits.
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.

BIOL 703. Radioisotopes and Radiation Safety in Research. 1.25 Credits.
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.

BIOL 706. Natural Sciences Curation and Collections Management. 3 Credits.
This course explores collections in the KU Museum of Natural History through the eyes of their curators and collection managers. It addresses aspects of collecting, cataloguing, preserving, storing, managing, and digitally archiving different types of natural science collections. The course format consists of lectures, readings, workshops, and guided tours of the museum's paleontological, biological (flora and fauna) and archaeological division collections, as well as the Spencer Museum of Art's ethnographic collections. Student projects will involve one of the museum's collections with the opportunity for hands-on experience. (Same as MUSE 710.)

BIOL 712. Evolutionary Biology - Graduate. 3 Credits.
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.

BIOL 714. Graduate Ecology. 3 Credits.
A thorough survey of the discipline of ecology. Topics include elements in physiological, population, community and ecosystem ecology. Overarching themes are 1) pattern and process, 2) ecology and evolution, 3) hierarchical nature of ecology, 4) variation in space and time, and 5) human dimensions of ecology. Prerequisite: Graduate standing or consent of instructor.

BIOL 720. Scientific Illustration. 3 Credits.
Lectures, demonstrations, and studio participation. Instruction in the preparation of illustrations for scientific publications, theses, and oral and poster presentations. 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.

BIOL 735. Scientific Communication. 3 Credits.

Principles of English communication skills for the professional scientist. The course begins by exploring the role of narrative in all forms of scientific communication; it then applies the use of narrative tools to scientific writing, message honing and speaking. The course covers written and verbal communication of primary research. Students must have an independent research project on which to focus their communication assignments. (Same as EVRN 735.)

BIOL 743. Population Genetics. 3 Credits.
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.

BIOL 750. Advanced Biochemistry. 3 Credits.
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.

BIOL 752. Cell Biology. 3 Credits.
A lecture course emphasizing biochemical, developmental, and molecular aspects of cell structure and function. Prerequisite: BIOL 807 and BIOL 808, or BIOL 416, or permission of instructor.

BIOL 754. Brain Diseases and Neurological Disorders. 3 Credits.
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.

BIOL 755. Mechanisms of Development. 3 Credits.
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.

BIOL 757. Carcinogenesis and Cancer Biology. 3 Credits.
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.

BIOL 759. Ecosystems Stewardship. 3 Credits.
This course sits at the crossroads between the discipline of ecology and the practice of stewardship, specifically the Indigenous Knowledge that is born from these landscapes over millennia in a place. Students will interact with research that establishes scientific foundations as a method to engage environmental problems in the anthropocene. The concept of stewardship is a core tenet of this course, students will engage with many approaches of stewardship, centering primarily on humans as a part of, not apart from, the environment. This course is offered at the 400 and 700 level with additional assignments at the 700 level. Not open to students with credit in EVRN 451 or EVRN 751, GEOG 451 or GEOG 759, BIOL 451 or BIOL 759. (Same as EVRN 751 and GEOG 759.)

BIOL 772. Gene Expression. 4 Credits.
The molecular biology of gene expression in eukaryotes: A study of the structure of genes and the molecular mechanisms used by cells to control and regulate gene expression. Emphasis on enzymatic mechanisms related to transcription, translation, post-transcriptional and post-translational modifications, and epigenetics. This course is offered at the 600 and 700 level with additional assignments at the 700 level. Not open to students with credit in BIOL 672. Prerequisite: BIOL 350 or BIOL 360, or consent of instructor. A course in biochemistry is recommended.

BIOL 782. Principles of Biogeography. 3 Credits.
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.

BIOL 784. Introduction to Museum Public Education. 3 Credits.
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 or consent of instructor.

BIOL 785. Museum Management. 3 Credits.
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 or consent of instructor.

BIOL 786. Fundamentals of Tropical Biology. 1-8 Credits.
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.

BIOL 787. Introduction to Museum Exhibits. 3 Credits.
Presentation of principles and practices of exhibit management, design, and production. Topics will include developing a master plan for museum exhibits; concept development; design, installation, and maintenance of exhibits; design theory; design process; label writing and editing; selection of materials architectural requirements and building codes; cost estimating; publicity; security; and exhibit evaluation. Consideration will be given to exhibition problems in public and private museums in the areas of anthropology, art, history, natural history, and technology. (Same as AMS 700, GEOL 781, HIST 723, and MUSE 703.) Prerequisite: Museum Studies student or consent of instructor.

BIOL 798. Introduction to Collections Management and Utilization. 3 Credits.
This course examines the roles collections play in fulfilling a museum's mission; the obligations ownership/preservation of collections materials create for a museum; and the policies, practices, and professional standards that museums are required to put in place. The course will cover utilization of collections for research, education, and public engagement; address how that utilization informs the need for and structure of collections policies, and introduce the basic practices of professional collections management. (Same as ANTH 798, AMS 730, GEOL 785, HIST 725, and MUSE 704.) Prerequisite: Museum Studies student or consent of instructor.

BIOL 801. Topics in: _____. 1-3 Credits.

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.

BIOL 805. Scientific Integrity in Ecology and Evolutionary Biology. 1 Credits.
This course covers the responsible conduct of research to help students initiate research projects ethically. Topics covered include expectations of federal granting agencies and the university, best practices for data management and publishing, and professional development as a graduate student. Prerequisite: Admission to the graduate program in Ecology and Evolutionary Biology, or consent of instructor.

BIOL 807. Graduate Molecular Biosciences. 3 Credits.
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.

BIOL 809. Graduate Molecular Biosciences for Medicinal Chemists. 4 Credits.
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.

BIOL 811. Advanced Molecular and Cellular Immunology. 2 Credits.

Covers recent advances in immunochemistry 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.

BIOL 812. Mechanisms of Host-Parasite Relationships. 2 Credits.
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.

BIOL 814. Advanced Molecular Virology. 2 Credits.
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 microbial genetics and a course in virology, or consent of instructor.

BIOL 815. Advanced Molecular Genetics. 2 Credits.
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.

BIOL 816. Careers in the Biomedical Sciences. 1 Credits.
Advanced course examining career options open to PhD scientists in the biomedical sciences, and providing preparation for the different career paths. Extensive student/faculty interaction is emphasized utilizing lectures, class discussion of assigned readings, and oral presentations. Graded on a satisfactory/unsatisfactory basis. (Same as CHEM 816 and PHCH 816.) Prerequisite: Permission of instructor.

BIOL 817. Rigor, Reproducibility and Responsible Conduct in Research. 3 Credits.
This class addresses the recognized problems in rigor, reproducibility, and transparency that are plaguing modern science. Students will learn the fundamentals of hypothesis design, avoiding bias, randomization, sampling, and appropriate statistical analyses, reagent validation, among other key topics. This course also introduces principles for being an ethical, responsible, and professional research scientist. Topics include: plagiarism, fabrication and falsification of data, record keeping and data sharing, mentor/mentee and collaborative relationships, among others. The class will include a mixture of lecture, case studies and discussion. (Same as CHEM 817/MDCM 817/PHCH 817.) Prerequisite: Graduate student.

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

BIOL 848. Phylogenetic Methods. 4 Credits.
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.

BIOL 860. Principles and Practice of Chemical Biology. 3 Credits.
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.

BIOL 899. Master's Thesis. 1-10 Credits.
Research which is to be incorporated into an M.A. thesis. Not more than ten hours may be earned. Graded on a satisfactory progress/limited progress/no progress basis.

BIOL 901. Graduate Seminar in Biochemistry and Biophysics. 1 Credits.
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.

BIOL 902. Advanced Molecular Cellular Biology Seminar. 1 Credits.

Seminar presentation and discussion opportunity for advanced Molecular, Cellular, and Developmental Biology graduate students. Graded on a satisfactory/unsatisfactory basis.

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

BIOL 918. Modern Biochemical and Biophysical Methods. 4 Credits.

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 817, or permission of instructor.

BIOL 925. Research Grant Proposal Preparation. 3 Credits.
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.

BIOL 943. Multivariate Data Analysis. 3 Credits.
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: Knowledge of elementary matrix algebra.

BIOL 952. Introduction to Molecular Modeling. 3 Credits.
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.

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

BIOL 999. Doctoral Dissertation. 1-12 Credits.
Original research that is to be incorporated into a Ph.D. dissertation. Graded on a satisfactory progress/limited progress/no progress basis.