594. Veterinary Toxicology

Fall. 4(4-0) Ninth-term Veterinary Medicine students. Pharmacological basis and pathological features of diseases of animals caused by common toxic chemicals with emphasis on clinical manifestations, diagnosis, prevention, and treatment.

596. Diseases of Bones and Joints

Spring. 3(3-0) Ninth-term Veterinary Medicine students. Anatomy and pathophysiology of diseases of bones and joints. Diagnosis, prognosis, and treatment of abnormalities involving bones and joints.

602. Veterinary Practice and Management

Spring. 2(2-0) Ninth-term Veterinary Medicine students, approval of college. Establishment of a veterinary practice.

610. Veterinary Externship

Fall, Winter, Spring, Summer. 8 to 16 credits. May enroll for a maximum of 16 credits. Veterinary Medicine students, completion of preclinical courses and approval of college. Students may not receive credit in both V M 610 and LSM 674. Clinical or research experience in an off-campus setting.

ZOLOGY ZOL

College of Human Medicine
College of Natural Science
College of Osteopathic Medicine

1DC. Resource Ecology and Man

For course description, see Interdisciplinary Courses.

301. Nature and Man

Fall. 4(2-6) Three terms of natural science; not open to zoology majors. Relates man to his natural environment. Chief emphasis on identifying characteristic animal life in broad areas of nature and how man fits or misfits into these. Lectures, laboratory and field trips illustrate this relationship.

302. Vertebrate Life of the Past

Fall 3(3-0) One course in physical or biological science or Juniors. Interdepartmental with and administered by the Department of Geology. Fossil vertebrates from fish to man.

303. Introductory Animal Systematics

Fall. 3(5-0) B S 212. General survey of animals including origin, evolution, and dispersal, morphological characteristics, reproductive patterns, behavior, ecology and zoogeography of invertebrates and vertebrates.

304. Biology, Behavior and Man

Winter 3(3-0) Juniors; not open to zoology majors. Examines philosophical and biological issues which make the study of animal behavior relevant to man. Emphasizes history of animal behavior, current theories, and experiments relating biological and environmental determinants of adaptive and non-adaptive behavior patterns.

317. Principles of Development

Fall, Spring. 3(3-0) B S 212. Development of animals, especially vertebrates. Principles are illustrated by modern experimental studies of developmental problems.

318. Principles of Development Laboratory

Fall, Spring. 2(0-4) ZOL 317 or concurrently. B S 212. Principles of development illustrated by analysis of the ontogeny of selected organisms.

320. Vertebrate Systematics Laboratory

Winter. 2(0-5) ZOL 303. Open to Zoology majors only; others: approval of department. Systematics, morphology and natural history of vertebrate animals as illustrated by representative species within the seven classes.

325. Invertebrate Systematics Laboratory

Winter. 2(0-5) ZOL 303. Open to Zoology majors only; others: approval of department. Comparative morphology and taxonomy of the major invertebrate phyla and an examination of their characteristic behavior and physiology.

337. The Fossil Record of Organic Evolution

Spring. 3(4-0) One course in a natural science; Juniors. Interdepartmental with and administered by the Department of Geology. The direct evidence for organic evolution in the fossil record. Evolution of life from prebiological stage to man. Impact of fossil discoveries on human thought.

341. Human Heredity

Fall, Winter, Summer. 4(4-0) Three terms of Natural Science; Sophomores; not open to zoology majors. Students may not receive credit in more than one of the following: ZOL 410, ZOL 441. Inheritance of human physiological, and psychological traits. Forces that influence human evolution. Applications of heredity in fields of education, sociology, anthropology, psychology, dentistry, and medicine.

344. Introductory Animal Systematics Laboratory

Fall. 2(1-3) ZOL 303 concurrently. Interdepartmental with and administered by Lyman Briggs College. Laboratory examination of form and function of representative vertebrate and invertebrate animals.

389. Animal Ecology

Winter. 4(4-0) B S 212 or concurrently. Animals in relation to their environment. Factors affecting the distribution and abundance of animals. Interrelationships between climate, soils, vegetation, geologic history and animal life. Population characteristics as related to reproduction and mortality factors.

391. Zoological Problems

Fall, Winter, Spring. Summer. 1 to 8 credits. May enroll for a maximum of 12 credits. Juniors: B S 212: 6 credits in zoology; approval of department. Advanced work in morphology, field zoology, genetics, physiology, ecology, ethology, or ichthyology.

400H. Honors Work

Fall, Winter, Spring. Variable credit. Juniors.

401. Comparative Physiology I

Fall. 4(3-4) PSL 240 or B S 212; CEM 131 or CEM 141. Interdepartmental with and administered by the Department of Physiology. A comparison of osmoregulation, digestion, respiration, and other physiological processes in a wide range of organisms.

402. Comparative Physiology II

Winter. 4(4-0) PSL 401 or approval of department. Interdepartmental with the Department of Physiology. A comparison of sensory, motor, endocrine and other integrative mechanisms in animals.

404. Biological and Ecological Concepts for Engineers and Mathematicians

Winter. 3(3-0) Approval of department. Interdepartmental with Systems Science and Plant Biology. Biological and ecological concepts important to formal analysis of living systems, vital properties, processes, and limitations; population dynamics, selection, competition, and predation; ecological community structure and function; industrialized ecosystem.

405H. Experiments in Zoology I

[405.] Fall. 4(0-12) Approval of instructor. An integrated series of selected experiments in the topics of behavior, ecology, morphology and physiology.

406. Experiments in Zoology II

Winter. 5(2-9) Approval of instructor. An integrated series of selected experiments in topics of cell biology, embryology and genetics.

407. Experiments in Zoology III

Spring. 3(0-9) ZOL 405 or ZOL 406, approval of instructor. Special problems.

408. Freshwater Ecology

Summer. 6 credits. B S 212 or approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with Biological Science and the Department of Botany and Plant Pathology and administered by Biological Science. The ecology of freshwater ecosystems, their biotic structure and the functional interrelationships of environmental variables regulating population dynamics, productivity and community structure. Extensive field investigations.

410. Terrestrial Ecology

Summer. 6 credits. B S 212 or approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with Biological Science and the Department of Botany and Plant Pathology and administered by Biological Science. Factors determining distribution and abundance. Interrelationships of plants, animals, and environment. Extensive field investigations of several types of terrestrial communities in light of current theory.

413. Animal Behavior

Spring. 4(4-0) B S 212. Description of the known behavior of the various vertebrate and invertebrate phyla with emphasis upon adaptive significance. Thus, special attention will be given to mating, defensive, and nutritive behavior. The genetics and ontogeny of behavioral patterns will be presented where known. Behavior will be related to the ecology of various animal populations.
414. Biological Mechanisms of Animal Behavior
Winter, odd-numbered years, 3(3-0) or 5(3-6) ZOL 413 recommended.
Consideration of neurological and hormonal mechanisms regulating behavior. Emphasis will be upon mammalian systems, and will deal with the assumptions which underlie current concepts in the biology of behavior.

415. Ecological Aspects of Animal Behavior
Fall, 4(4-0) ZOL 413.
Consideration of orientation, navigation and homing behavior, food preferences, habitat selection, exploration, behavioral periodicity, communication, social organization and the embryology of behavior. In both vertebrates and invertebrates.

417. Advanced Developmental Biology
Spring, 3(3-0) or 5(3-6) ZOL 317. Molecular and cellular biology of development. Complementary laboratory exercises with emphasis on experiments.

420. Ecology of Animal Parasites
Summer, 4 credits. B.S. 212 or approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with the departments of Microbiology and Public Health, and Fisheries and Wildlife. Administered by the Department of Microbiology and Public Health. Parasitism of animals by protozoa, helminths and arthropods with emphasis on the interrelationships of host-parasite associations with the natural environments.

428. Morphology of the Chordates
(3-1) Winter, Spring, 3(3-0) B.S. 212. Comparative and functional morphology of chordates. Laboratory includes dissection of representatives of most vertebrate classes.

430. Vertebrate Paleontology
Winter, 4(3-0) ZOL 428 or approval of department. Interdepartmental with and administered by the Department of Geology. Fossil vertebrates with emphasis on the evolution of major groups. Laboratory on modern techniques and on the identification and interpretation of fossils.

437. Invertebrate Paleontology
Fall, 4(3-4) GLG 202 or ZOL 303 or approval of department. Interdepartmental with and administered by the Department of Geology. Systematics and evolution of marine invertebrates; uses of fossils in correlation and delineation of geologic time; structure and morphology of fossils as related to evolutionary development.

438. Paleocology
Spring, 4(3-4) GLG 202 or ZOL 389 or approval of department. Interdepartmental with and administered by the Department of Geology. Distribution and abundance of marine fossils; response of skeletal morphology to environmental conditions; uses of fossils in reconstructing ancient climates and depositional environments.

441. Fundamental Genetics
Fall, Spring, 5(5-6) B.S. 212. Students may not receive credit in more than one of the following: ZOL 341, ZOL 441. Survey of principles of heredity in animals, plants, and microorganisms. Serves as single course for biology majors in any of the biological sciences, and as prerequisite for further work in genetics.

442. Advanced Genetics
Winter, 3(3-0) ZOL 441 or approval of instructor. Classical and molecular examination of eight to ten advanced topics and recent discoveries in genetics.

443. Developmental Genetics
Spring, 4(4-0) ZOL 441 and ZOL 317. Mechanisms of gene action. Role of genes in the embryology, morphology, and physiology of organisms.

450. Comparative Histology
Fall, 4(3-3) B.S. 212. The comparative structure of cells of selected invertebrate and vertebrate organisms and their interactions to form tissues.

456. Foundations of Developmental Biology
Winter of even-numbered years, 3(3-0) ZOL 317; ZOL 417 recommended. Reading and discussion of original research which posed significant problems of modern developmental biology.

460. Field Ornithology
Summer, 3 credits. B.S. 212 or approval of department. Given at W. K. Kellogg Biological Station. The study of birds of the regional area, with emphasis on field techniques in relation to problems in avian identification, ecology and behavior.

461. Ornithology

462. Laboratory in Ornithology
Spring, 3(0-9) ZOL 461. Field work with avian populations, foraging behavior, territoriality, time-activity, habitat selection and selected research topics.

471. Ichthyology
Spring, 3(2-3) F.W. 301 or ZOL 320 or ZOL 454. Interdepartmental with and administered by the Department of Fisheries and Wildlife. Classification and natural history of fishes. Emphasis on food, game, and forage fishes.

476. Limnology
Winter, 3(2-0) CEM 131 and CEM 161; BOT 450 or ZOL 389. Students may not receive credit for both F.W. 370 and F.W. 476. Interdepartmental with and administered by the Department of Fisheries and Wildlife. Ecology of lakes and streams with special reference to physical, chemical and biological factors affecting their productivity.

477. Limnological Methods
Winter, 3(0-9) ZOL 481; F.W. 476 concurrently; ENT 301, ENT 302 recommended. Interdepartmental with and administered by the Department of Fisheries and Wildlife. Methods and instruments of limnological field investigation on lakes and streams.

480. Biology of Fresh-Water and Terrestrial Invertebrates
Summer, 6 credits. ZOL 325 or approval of department. Given at W. K. Kellogg Biological Station. Systematics and ecology of invertebrates with emphasis on the local fauna.

481. Invertebrate Zoology
Fall, 3(3-6) ZOL 325 or approval of department. Biology of invertebrates with special reference to their natural history, classification, distribution, and economic importance.

482. Biology of the Protozoa
Winter, 3(3-0) or 5(3-6) B.S. 212. Structures and functions of animal-like, eukaryotic microorganisms.

483. Physiological Ecology
Winter, 4(3-2) B.S. 212. Aspects of physiology that bear particularly on the interrelationships between animals and their environments.

484. Herpetology
Spring, 3(3-6) ZOL 120 or ZOL 428. Classification and natural history of amphibians and reptiles, with emphasis on Michigan species.

486. Mammalogy
Fall, 4(2-6) ZOL 320 or ZOL 428. Classification, distribution, natural history of mammals with emphasis on Michigan species. Field studies, preparation of study specimens.

489. Animal Distribution
Fall, 3(3-0) ZOL 303 or approval of instructor. Principles and patterns of animal distribution. Emphasis on major faunal regions, centers of origin, and concepts relating to the distribution of modern vertebrates.

492. Cytocohemistry
Spring, 4(3-1) B.S. 212. General principles of microscopy, microtomy, fixation, embedding and sectioning of animal tissues; study of various cellular organelles and the localization of lipids, carbohydrates, proteins, nucleic acids and various hydrolytic enzymes in the cells.

495. Undergraduate Seminar
Fall, Winter, Spring, 1(1-4) May reenroll for a maximum of 6 credits. Juniors, and approval of department. Reading and discussion of articles relating to economic, social and environmental impact of new discoveries in biological sciences.

497. Principles of Endocrinology
Winter, 4(4-0) One year organic chemistry, ZOL 317. Interdepartmental with the Department of Physiology. Hernonial principles, illustrated by experimental observations, in vertebrates and invertebrates. Emphasis on cellular endocrinology. Group discussion, background in organic chemistry and cell biology strongly recommended. Term paper required.

499. Undergraduate Thesis
Fall, Winter, Spring. Summer, 1 to 6 credits. May reenroll for a maximum of 12 credits. Juniors, written approval of instructor. Laboratory research culminating in the preparation and defense of an undergraduate thesis.

8044. Neuroscience Laboratory I
Winter, 4(2-4) Approval of instructor. Interdepartmental with the departments of Biophysics, Physiology and Psychology, administered by the Department of Psychology. Development of skills in the methods, techniques and instrumentation necessary for research in a variety of areas concerned with neuroscience.
A-216

847. Experimental Morphology
Spring, 4(4-0) ZOL 317.
Analysis of mechanisms of morphogenesis, particularly as these occur in post-gastrular stages of development. The significance of tissue interactions in developing and regenerating systems will be emphasized.

859. Analysis of Hormone Action
Spring, 4(4-0) ZOL 317 or approval of department. Interdepartmental with the Department of Physiology.
Studies of recent work on the molecular and developmental aspects of hormone action in vertebrates and invertebrates. Selected topics to vary from year to year.

865. Advanced Neurobiology
Spring, 4(4-0) BFY 827.
Interdepartmental with the departments of Anatomy, Biophysics, Physiology, and Psychology. Administered by the Department of Anatomy.
Basic organization, structure and function of neural networks comprising sensory, motor, and autonomic systems including examples from invertebrates and vertebrates. Attendance at neuroscience seminar is required.

871. Ecology of Fishes
Summer, 3(1-0) Approval of instructor or ZOL 389 or F W 473. Given at the W. K. Kellogg Biological Station. Interdepartmental with the Department of Fisheries and Wildlife.
Exploration of ecological problems with particular emphasis on growth, food and habitat selection, population biology and niche relations. Field and experimental investigations of fish communities.

878. Comparative Limnology
(478) Summer, 6 credits. Approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with the Department of Botany and Plant Pathology.
Theoretical concepts and methods of analysis of environmental parameters influencing productivity of freshwaters. Comparative field investigations of lakes, streams, and other aquatic habitats.

881. Biology of the Arthropoda
Winter, 5(3-6) ZOL 481 or approval of department. Interdepartmental with the Department of Entomology.
Ecology, life cycles, morphology, taxonomy, and distribution of arthropoda other than insects.

882. Cellular Morphogenesis
Winter, 2(2-0) One course in biochemistry, approval of department. Selected topics on the structure, biological processes and differentiation of living cells.

883. Laboratory in Cellular Morphogenesis
Winter, 2(0-0) Approval of department. Laboratory work in cellular morphogenesis accompanying 4(4-0) ZOL 481.

885. Vertebrate Neral Systems I
Fall of odd-numbered years, 5(3-4) Approval of department, ANT 815 and BFY 827 recommended. Interdepartmental with the departments of Biophysics, Physiology, and Psychology. Administered by the Department of Psychology.
Structure and function of major component systems of vertebrate brains, their evolution, ontogeny and comparative analysis in mammals, birds, reptiles, amphibians and fish. Interrelation of behavioral, anatomical and physiological studies.
886. **Vertebrate Neural Systems II**  
Winter of even-numbered years. 5(3-4)  
PSY 885. Interdepartmental with the departments of Psychology, Biophysics, and Physiology.  
Continuation of ZOL 885. Major component systems of vertebrate brains, their evolution, ontogeny, and comparative analysis in mammals, birds, reptiles, amphibians and fish. Interrelation of behavioral, anatomical, and physiological studies.

890. **Special Problems**  
Fall, Winter, Spring, Summer. 1 to 15 credits. Two years of undergraduate zoology. Approval of department. Consideration of current problems.

891. **Current Topics in Ecological Research**  
Summer, 1 credit. May reenroll for a maximum of 4 credits. Approval of department. Given at W. K. Kellogg Biological Station. Discussions and special problem work; current theoretical views and investigations; treatment of the dynamics of energy and biomass in terrestrial and aquatic ecosystems; methods of analysis.

892. **Dynamics of Biologic Populations**  
Winter. 5(4-3) One statistics course, 1 ecology course or approval of department. Growth, regulation, competition, predator-prey, life history strategies and spatial dynamics of animal populations.

893. **Fertilization and Early Embryogenesis**  
Fall. 3(3-0) Developmental biology, biochemistry and approval of department. ZOL 894 recommended concurrently. Developmental biology of early stages of animal life, emphasis on physiology and biochemistry of marine invertebrate eggs.

894. **Methods in Cellular and Developmental Biology**  
Fall. 3(1-6) Cellular and developmental biology, biochemistry and approval of department. Theory and practice of research methods in cellular and developmental biology, with emphasis on physicochemical approaches.

895. **Seminar Topics**  
Fall, Winter, Spring. 1 credit per term. May reenroll for a maximum of 8 credits. Approval of department. Graduate level seminars on current research topics in biology.

896. **Animal Community Ecology**  
Winter. 4(4-0) ZOL 892, approval of instructor. Patterns and processes in animal communities with emphasis on structure, species diversity and stability.

897. **Ecosystem Ecology**  
Fall. 3(3-0) ZOL 380 or BOT 450. Concepts of ecosystem structure, energy flow, and nutrient cycling in representative terrestrial and aquatic ecosystems.

899. **Doctoral Dissertation Research**  
Fall, Winter, Spring. Variable credit. Fifteen graduate credits in organizational behavior courses and approval of instructor. Research for the Ph.D. degree in genetics, morphology, mammalogy, wildlife management, ornithology, fisheries biology, limnology.