524. Integumentary System  
Winter. 4(3-3) Seventh-term Veterinary Medicine students.  
Diseases of the integumentary system of animals with emphasis on laboratory examinations, interpretation of pathological features, diagnosis, and treatment.

526. Musculoskeletal System I  
Winter. 4(2-6) Seventh-term Veterinary Medicine students.  
Diagnosis and treatment of musculoskeletal diseases of animals with emphasis on pathological changes, radiological techniques, and interpretation of radiographs. Surgical procedures applicable to small animals will be demonstrated.

530. Veterinary Toxicology  
Spring. 4(2-0) Eighth-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.

532. Visual and Auditory Systems  
Spring. 3(2-3) Eighth-term Veterinary Medicine students.  
Methods of examination, diagnosis, and treatment of diseases of the eyes or ears of animals with emphasis on the anatomical, physiological, and pathological features.

534. Musculoskeletal System II  
Spring. 5(2-9) Eighth-term Veterinary Medicine student.  
Diagnosis, prognosis, and management of musculoskeletal diseases of the equine with emphasis on anatomical relationships to normal and abnormal function. Surgical procedures applicable to equine and ruminant will be performed.

536. Orthopedic Surgery  
Spring. 6(4-0) Eighth-term Veterinary Medicine students.  
Principles of orthopedic surgery and anatomical relations of the musculoskeletal systems in the canine and feline.

538. Veterinary Medical History, Ethics, Jurisprudence, and Epidemiology  
Spring. 3(2-0) Eighth-term Veterinary Medicine students.  
Historical background, ethical principles, and legal responsibilities of the veterinary medical profession. Epidemiological problems will be resolved and discussed.

600. Veterinary Medical History, Ethics, and Jurisprudence  
Fall, Summer. 3(1-0) Admission to the veterinary professional program.  
Seminar on historical background, ethical principles, and legal responsibilities of the veterinary medical profession.

ZOLOGY ZOL

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

200. Resource Ecology and Man  
For course description, see Interdisciplinary Courses.

204. Natural History of Birds  
Fall. 4(2-6) These terms of natural science; not open to zoology majors.  
Identification of Michigan birds in field and laboratory, including life histories, habits, and considerations of their economics, aesthetic and recreational value.

301. Nature and Man  
Spring. 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(2-0) One course in physical or biological Science or Juniors. Interdepartmental with and administered by the Zoology Department.  
Fossil vertebrates from fish to man.

303. Introductory Animal Systematics  
Fall. 4(2-0) B S 212. Not open to Zoology majors, except those working for teacher certification. LBG 344 concurrently.  
A general survey of the animal kingdom. Topics include origin, evolution and diversity of invertebrate and vertebrate groups, their systematic and present status.

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

305. Biology of Vertebrates  
Fall. 4(3-2) B S 212. Not suggested for students having previous experience in vertebrate taxonomy or morphology.  
Primarily concerned with natural history of vertebrates. Topics include morphological characteristics, ecology, zoogeography, and taxonomy of vertebrate animal groups. Laboratory involves recognition of representative species within the various classes.

314. Comparative Anatomy of Vertebrates  
Winter. 6(5-6) B S 212.  
Comparative anatomy and evolution of vertebrates. The dogfish and a mammal dissected in the laboratory.

317. Principles of Development  
Fall. Spring. 3(0-9) 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(0-6) 317 or concurrently; B S 212.  
Principles of development illustrated by analysis of the ontogeny of selected organisms.

341. Human Heredity  
Fall. Winter. Spring. 4(3-3)  
Three terms of natural Science; Seniornores; not open to zoology majors. Students may not receive credit in more than one of the following: 341, 441, 459.  
Inheritance of human, physical, physiological, and psychological traits, and forces that influence human evolution. Foundation is laid on which applications of basic science in fields of education, sociology, anthropology, psychology, dentistry, and medicine must rest. Course includes field trips to state institutions.

344. Introductory Animal Systematics Laboratory  
Fall. 1(0-3) 303 concurrently. Interdepartmental with and administered by Lyman Briggs College.  
Laboratory examination of form and function of representatives vertebrate and invertebrate animals.

381. Fundamentals of Invertebrate Zoology  
Winter. 4(3-3) B S 212.  
Form and function of representative invertebrates. Meets requirements for a course in Invertebrate Zoology. Students expecting to obtain advanced degree in Zoology or those more interested in a systematic or ecological approach should select Zoology 481.

389. Animal Ecology  
Spring. 4(3-4) B S 212 or concurrently.  
Animals in relation to their environment. Factors affecting the distribution and abundances 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 6 credits. May re-enroll for a maximum of 12 credits. Juniors; B S 212; 6 credits in zoology; approval of department.

400H. Honors Work  
Fall, Winter, Spring. Variable credit. Juniors.

401. Comparative Physiology I  
Fall. 4(3-4) PST 240 or B S 212 and CEM 152. 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) 401 or approval of department. Interdepartmental with the Department of Physiology.

404. Biological and Ecological Concepts for Engineers and Mathematicians  
Winter. 3(3-0) Approval of department. Interdepartmental with Systems Science. Biological and ecological concepts important to formal analysis of living systems, vital properties, processes, and limitations; population dynamics, selection, competition, predation; ecological community structure and function; industrialized ecosystems.

412. Principles of Animal Behavior  
Summer. 4(4-0) For teachers of biology. Not applicable toward major in zoology. Evolutionary, behavioral, and neurological bases of animal behavior.
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. 3(3-0) or 5(3-6) 413.
Consideration of neurological and hormonal mechanisms controlling 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) 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) 317.
Molecular and cellular biology of development. Complementary laboratory exercises with emphasis on experiments.

430. Vertebrate Paleontology  
Winter. 4(3-3) 314, or approval of department. Interdepartmental with and administered by the Geology Department. Fossil vertebrates with emphasis on the evolution of major groups. Laboratories on modern techniques and on the identification and interpretation of fossils.

437. Invertebrate Paleontology  
Fall. 4(3-4) GLC 202 or ZOL 391 or approval of department. Interdepartmental with and administered by the Geology Department. Systemsatics and evolution of marine invertebrates, of fossils in reconstruction of geologic time, structure and morphology of fossils as related to evolutionary development.

439. Paleontology  
Spring. 4(3-4) GLC 202 or ZOL 389 or approval of department. Interdepartmental with and administered by the Geology Department. 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: 341, 441, 459.
Survey of principles of heredity in animals, plants, and microorganisms. Serves as single course in genetics for majors in any of the biological sciences, and as prerequisite for further work in genetics.

442. Advanced Genetics  
Winter. 3(3-0) or 5(3-9) 441; MTH 108 or 111 recommended.
Population genetics and the genetic analysis of evolution. Optional laboratory with individual research projects.

443. Developmental Genetics  
(S61.) Spring. 4(4-0) 441 and 317.
Mechanisms of gene action. Role of genes in the embryology, morphology, and physiology of organisms.

455. Experimental Ecology  
Spring. 5(5-0) Approval of department. Interdepartmental with the Botany and Plant Pathology Department. Dynamics, regulation and production of ecological populations, structure composition and stability of biotic communities; biogeochemical and energetic characteristics of ecosystems.

456. Experimental Analysis of Development  
Winter. 3(3-0) or 5(3-6) 317 and 318.
Analysis of development biology of selected forms, emphasis on cellular and sub-cellular basis of differentiation, stressing modern experimental techniques. Individual laboratory problems as introduction to research methods.

457. Vertebrate Morphology for Teachers  
Summer. 4(3-4) B S 219.
A comprehensive survey of developmental processes, with special emphasis on results of experimental analysis as they explain the morphogenesis of cells, tissues and organs.

459. Genetics for Teachers of Biology  
Summer. 5(5-0) B S 212. Students may not receive credit in more than one of the following: 341, 441, 459.
Principles of heredity in animals, plants and microorganisms.

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

461. Ornithology  
Spring. 4(2-6) 305 or 314.
Principles of classification, structure, distribution, migration, life histories, and habits. Laboratory and field identification of birds by size, form, color, song and habitat.

471. Ichthyology  
Spring. 3(2-3) 305 or 314, Interdepartmental with and administered by Fisheries and Wildlife Department. Classification and natural history of fishes. Emphasis on food, game, and forage fishes.

476. Limnology  
Winter. 3(3-0) B S 212. Interdepartmental with and administered by the Fisheries and Wildlife Department. Ecology of lakes and streams with special reference to physical, chemical, and biological factors affecting their productivity.

477. Limnological Methods  
Winter. 3(0-9) 481; F W 476 concurrent. ENT 203, 309 recommended. Interdepartmental with and administered by the Fisheries and Wildlife Department. Methods and instruments of limnological field investigation on lakes and streams.

480. Biology of Fresh-water and Territorial Invertebrates  
Summer. 5(5-0) B S 212 and 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. 5(5-0) 391 or B S 212 and 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. Morphology, physiology and natural habitats of protozoa.

493. Physiological Ecology  
Fall. 4(3-3) 391 or 481.
Physiological aspects of basic ecological principles and concepts.

494. Herpetology  
Spring. 5(3-6) 305 or 314.
Classification and natural history of amphibians and reptiles, with emphasis on Michigan species.

496. Mammalogy  
Fall. 4(3-5) 305 or 314.
Classification: distribution, natural history of mammals, with emphasis on Michigan species. Field studies, preparation of study specimens.

499. Animal Distribution  
Winter. 3(3-0) 441; 389 recommended. Principles and patterns of animal distribution. Emphasis on major faunal regions, centers of origin, and concepts relating to the distribution of modern vertebrates.

501. Quantitative Biology  
Fall. 4(4-4) STT 433 or approval of department. Application of biometrical techniques to biological problems.

502. Cytogenetics  
Fall. 4(3-5) 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.

507. Principles of Endocrinology  

817. Ecology of Zooplankton  
Summer of every third year. Given at W. K. Kellogg Biological Station.
Biological, distribution, and abundance of planktonic animals with special emphasis on life tables, filtering rates, food selection, production dynamics, fish predation, niche and species diversity.

820. Behavior of Animal Populations  
Fall. 4(4-0) 413.
Behavior on the ecological level. Characteristics of populations rather than individuals will be stressed. Evolution will be considered on the population level.
821. Ontogeny of Behavior
Winter. 4(4-0) 317, 413.
Changing patterns of behavior during the development of individual animals; effects of experimental control of external environment, and neurological and chemical intervention upon behavior.

822. Behavior of Aquatic Animals
Fall. 4(3-3) 413; F W 479 recommended.
Emphasis will be upon vertebrates. Approach will be primarily ecological on adaptation to special aquatic environments.

823. Neurological and Hormonal Correlates of Animal Behavior
Spring. 4(4-0) 414, 415.
Lectures, papers and discussions on the neural and hormonal determinants of animal behavior. Emphasis will be placed upon mammalian behavior.

825. Tropical Biology: An Ecological Approach
Winter, Summer. 12 credits. Approval of department and acceptance by Organization for Tropical Studies. A field course concerning the adaptation, evolution and physiological characteristics of tropical animal life. The subject of the course may vary from term to term and will be given in the field in Latin America.

826. Advanced Vertebrate Paleontology
Winter. 4(4-0) May re-enroll for a maximum of 12 credits. 305; two years of undergraduate zoology and approval of department. Advanced vertebrate paleontology including systematic, distribution, and historical aspects.

830. Advanced Vertebrate Anatomy
Spring. 3(2-4) 457 or 458. Interdepartmental with and administered by the Geology Department. Skeletal morphology of fossil vertebrates, emphasizing the multivariate morphometrics approach and other modern methods of morphological analysis.

831. Advanced Vertebrate Paleontology
Winter of even-numbered years. 3(3-0) 490 or approval of department. Interdepartmental with an administered by the Geology Department.
Recent advances and controversial issues in vertebrate paleontology including origin, classification, phylogeny, and stratigraphic relationships of fossil vertebrates.

839. Population Ecology
Summer. 6 credits. Approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with the Botany and Plant Pathology Department.
An experimental field approach to the study of populations and communities. Selected topics will deal with population growth, composition, predation, community structure and species abundance. This course is intended to complement 592.

843. Ecosystem Analysis, Design and Management
Spring. 3(3-0) SYS 442 or Zool 404. Interdepartmental with and administered by Systems Science.
Groups of students from various biological and non-biological disciplines will synthesize and analyze models of selected biological systems. Projects should yield information relevant to solution of contemporary ecological problems.

844. Problems in Human Genetics
Fall. 5(3-0) 441 or approval of department. Methods used in the study of human genetics and their application to medical, physiological and social problems. Laboratory consists of field trips and independent study selected by the student in consultation with the instructor.

845. Organic Evolution
Winter. 4(4-0) 441 and a course in comparative biology. A historical view of evolutionary thought, a presentation of the evaluation of prebiological systems and a critical evaluation of the evolution of genetic systems.

847. Analysis of Gene Organization and Transmission
Winter. 4(4-0) 441 and approval of department.
Formal and molecular analysis of gene organization and transmission in higher eucaryotes. Intended for graduate students with background in genetics and/or cyto genetics.

850. Ultrastructure
Spring. 4(2-6) MOL 427.
New developments in instrumentation and techniques of electron microscopy and their practical application in morphological and physiological changes in various organ systems.

857. Experimental Morphology
Spring. 4(3-1) 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.

858. Neuroembryology
Spring. 4(4-0) 318 and approval of department.
Experimental analysis of morphogenesis of vertebrate nervous systems.

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

875. Comparative Limnology
Fall of odd-numbered years. 5(5-0) 317 or approval of department. 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(3-0) 481 or approval of department. Interdepartmental with the Entomology Department.
Ecology, life cycles, morphology, taxonomy, and distribution of arthropods other than insects.

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

883. Laboratory in Cellular Morphogenesis
Fall. 2(0-6) Approval of department. Laboratory work in cellular morphogenesis accompanying 882.

884. Invertebrate Neural Systems
Fall of odd-numbered years. 4(3-3) Biochemistry and neurophysiology recommended. Nervous systems in the invertebrates, including sense organs, effector organs, central nervous systems and integrative mechanisms.

885. Vertebrate Neural Systems I
Fall of odd-numbered years. 5(3-4) Approval of department; ANT 815 and 875 recommended. Interdepartmental with the Biophysics, Physiology and Psychology Departments, and administered by the Psychology Department.
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 865. Interdepartmental with the Psychology, Biophysics, and Physiology Department.
Continuation of 885. Major component systems of vertebrate brains, their evolution, ontogeny, and comparative analysis in mammals, birds, reptiles, amphibia 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**

Fall, Winter, Spring, Summer. 1 credit. May re-enroll 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. 3(4-3) 491; one course in ecology or approval of department.

Quantitative analyses of the dynamics, production, regulation, energetics and distribution of animal populations.

893. **Fertilization and Early Embryogenesis**

Fall. 3(3-0) Developmental biology, biochemistry and approval of department. 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 re-enroll for a maximum of 6 credits. Approval of department.

Graduate level seminars on current research topics in biology.

899. **Research**

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

Research for the master's degree in genetics, morphology, mammalogy, wildlife management, ornithology, fisheries biology, limnology, quantitative biology, invertebrate, experimental embryology, animal behavior, herpetology.

999. **Research**

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

Research of the Ph.D. degree in genetics, morphology, mammalogy, wildlife management, ornithology, fisheries biology, limnology, quantitative biology, invertebrate, experimental embryology, animal behavior, herpetology.