524. Integumentary System  
Winter. 4(3-3) Seventh-term Veterinary Medicine students.  
Diseases of the integumentary system of animals with emphasis on laboratory examinations, interpretations 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 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(4-0) 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(3-3) Eighth-term Veterinary Medicine students.  
Methods of examination, diagnosis, and treatment of diseases involving the eyes or ears of animals with emphasis on the anatomical, physiological, and pathological features.

534. Musculoskeletal System II  
Spring. 5(5-9) 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 human will be performed.

536. Orthopedic Surgery  
Spring. 6(4-6) 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. 8(3-0) Eighth-term Veterinary Medicine student.  
Historical background, ethical principles, and legal responsibilities of the veterinary medical profession. Epidemiological problems will be reviewed and discussed.

600. Veterinary Medical History, Ethics, and Jurisprudence  
Fall, Spring. 11(2-0) Admission to the veterinary professional program.  
Seminars on historical background, ethical principles, and legal responsibilities of the veterinary medical profession.

ZOOLOGY ZOL
College of Human Medicine  
College of Natural Science  
College of Osteopathic Medicine

1DC. Resource Ecology and Man  
For course description, see Interdisciplinary Courses.

204. Natural History of Birds  
Fall. 4(3-6) Three terms of natural science; not open to zoology majors.  
Identification of Michigan birds in field and laboratory, including life histories, habits, and consideration of their economies, aesthetic and recreational value.

230. The Role of the Natural Sciences in Future Environments  
Fall. 4(4-0) Approval of department. Interdepartmental with the departments of Entomology, Geology, and Physics. The College of Natural Science and administered by the College of Natural Science.  
Physical and biological science concepts relevant to current environmental problems. Options for action in areas of population size, energy and life support systems. Illustrated by case studies.

301. Nature and Man  
Spring. 4(3-3) 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 major. Interdepartmental with and administered by the Geology Department.  
Study of fossil vertebrates from fish to man.

303. Introductory Animal Systematics Laboratory  
Fall. 4(4-0) B S 212, 481 concurrently, not open to zoology majors. Students may not receive credit in 303 and 305 or 351.  
Fossil vertebrates from fish to man.  
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 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.

305. Biology of Vertebrates  
Fall. 4(3-3) B S 212. Students may not receive credit in both 303 and 305.  
Primarily concerned with natural history of vertebrates with special emphasis on 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  
(315.) Fall, Winter. 5(3-6) 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(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(0-6) 317 or concurrently B S 212.  
Principles of development illustrated by analysis of the anatomy of selected organisms.

341. Human Heredity  
Fall, Winter, Spring, Summer. 4(3-3) Three terms of Natural Science; Sophomores; 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 heredity 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 representative vertebrate and invertebrate animals.

381. Fundamentals of Invertebrate Zoology  
Winter. 4(3-3) B S 212. Students may not receive credit in both 381 and 303.  
Form and function of representative invertebrates. Meets requirements for a course in Invertebrate Zoology. Students expecting to obtain advanced degrees in Zoology or those more interested in a systematic or ecological approach should elect Zoology 481.

389. Animal Ecology  
Spring. 4(4-4) 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 and related to reproduction and mortality factors.

391. Zoological Problems  
Fall, Winter, Spring, Summer. 1 to 8 credits. May re-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, mammalogy, ornithology, or ichthyology.

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

401. Comparative Physiology I  
Fall. 4(2-4) PSL 340 or B S 212 and CEM 132. 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.  
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. 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.

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. Interrelationship of plants, animals, and environment. Extensive field investigations of several types of terrestrial communities in light of current theory.

412. Principles of Animal Behavior
Summer. 4(4-0) For teachers of biology. Not applicable toward major in zoology. Evolutionary, hormonal, 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 anatomy 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 of odd-numbered years. 3(3-0) or 5(3-6) 413 recommended. Consideration of neural 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.

420. Ecology of Animal Parasites
Summer. 8 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 and administered by the Department of Microbiology and Public Health. Parasites of animals by protozoa, helminths and arthropods with emphasis on the interrelationships of host-parasite associations with the natural environments.

430. Vertebrate Paleontology
Winter. 4(3-3) 214, 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(4-0) GLG 202 or ZOL 391 or approval of department. Interdepartmental with and administered by the Geology Department. 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. Paleoecology
Spring. 4(4-0) GLG 202 or ZOL 399 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(5-0) 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
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(3-0) Approval of department. Interdepartmental with the Botany and Plant Pathology Department. Dynamics, regulation and production of biological populations; structure composition and stability of biotic communities; biogeochemical and energetic characteristics of ecosystems.

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

457. Vertebrate Morphology for Teachers
Summer. 4(3-3) B S 212. 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.

490. Field Ornithology
Summer. 3 credits. B S 212 or approval of department. Glen 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.

491. Ornithology
Spring. 3(5-5) 305. Principles of classification, structure, distribution, migration, life histories, and habits. Laboratory and field identification of birds by size, form, color, song and habitat.

497. 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.

497. Limnological Methods
Winter. 3(3-0) 481; F W 301 or ZOL 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.

498. Biology of Fresh-Water and Terrestrial Invertebrates
Summer. 6 credits. 381 or 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.

498. Invertebrate Zoology
Fall. 3(3-0) 381 or B S 212 and approval of department. Biology of invertebrates with special reference to their natural history, classification, distribution, and economic importance.

499. Biology of the Protozoa
Winter. 3(3-0) or 3(3-6) B S 212. Morphology, physiology and natural habitats of protozoans.

499. Physiological Ecology
Fall. 4(3-3) B S 212. Physiological aspects of basic ecological principles and concepts.
484. Herpetology
Spring. 5(3-8) 305 or 314.
Classification and natural history of amphibians and reptiles, with emphasis on Michigan species.

486. Mammalogy
Fall. 4(2-6) 305 or 314.
Classification, distribution, natural history of mammals, with emphasis on Michigan species. Field studies, preparation of study specimens.

489. 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.

491. Quantitative Biology
Fall. 4(4-0) STT 433 or approval of department.
Application of biometrical techniques to biological problems.

492. Cytology
Spring. 4(3-3) BS 212.
General principles of microscopy, microtomy, fixation, embedding, and staining 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(1-0) May re-enroll for a maximum of 3 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
Fall. 4(4-0) Organic chemistry; 317. Interdepartmental with the Department of Physiology.
Hormonal 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.

817. Ecology of Zooplankton
Summers of every third year. Given in 1963. 3 credits. Given at W. K. Kellogg Biological Station.
Ecology, 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 476 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 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. Interdepartmental with and administered by the Botany and Plant Pathology Department.
An introduction in the field to the principles of ecology as they operate in the tropics, especially concerning the tropical environment and biota, ecologic relations, communities and evolution in the tropics. Offered in Costa Rica by Organization for Tropical Studies.

826. Advanced Tropical Zoology
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 might vary from term to term and will be given in the field in Latin America.

830. Advanced Vertebrate Zoology
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 biology including systematics, ecology, distribution, morphology.

833. Advanced Invertebrate Paleontology
A. MICROPALeontoloby
Spring. 3(2-4) 437 or 438. Interdepartmental with and administered by the Geology Department.
Functional and adaptive morphology of microscopic fossil invertebrates, emphasizing foraminifera, ostracoda, and conodontodontochordata.
B. QUANTITATIVE PALEONTOLOGY
Spring. 3(2-4) 437 or 439. Interdepartmental with and administered by the Geology Department.
Application of mathematical tools to paleontological problems, including statistical applications and numerical taxonomy, computer applications.

834. Advanced Vertebrate Paleontology
Winter of even-numbered years. 3(3-0)
430 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 989.

843. Ecosystem Analysis, Design and Management
Spring. 3(2-4) SYS 442 or ZOL 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
Spring. 5(5-0) 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 evolution of physiological 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 eukaryotes. Intended for graduate students with background in genetics and/or cytogenetics.

850. Ultrastructure
Fall. 4(3-6). BOT 427.
New developments in instrumentation and techniques of electron microscopy and their practical application in studying morphological and physiological changes in various organs 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 time interactions in developing and regenerating systems will be emphasized.

858. Neuroembryology
Spring. 4(4-0) 318 and approval of department.
Experimental analyses of morphogenesis of vertebrate nervous systems.
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 BPY 885 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) FST 885. Interdepartmental with the Psychology, Biophysics, and Physiology Departments. Continuation of 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
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(4-0) One course in ecology or approval of department. Quantitative analyses of the dynamics, production, regulation, energetics and distribution of animal populations.

893. Fertilisation 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) Interdepartmental with the Psychology Department. Theory and practice of research methods in cellular and developmental biology, with emphasis on biochemical 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.

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

899. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department. Research for the master's degree in genetics, morphology, mammalogy, wildlife management, entomology, fisheries biology, limnology, quantitative biology, invertebrate, experimental embryology, animal behavior, herpetology.

899. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department. Research for the Ph.D. degree in genetics, morphology, mammalogy, wildlife management, entomology, fisheries biology, limnology, quantitative biology, invertebrate, experimental embryology, animal behavior, herpetology.