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, radiological, and interpretive studies 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(2-3) 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(2-5) 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. 4(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. 2(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.

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 are based. Course includes field trips to state institutions.

344. Introductory Animal Systematics Laboratory
Fall, Winter, Spring. 1-2-3 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(3-1) 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 select Zoology 481.

389. Animal Ecology
Spring. 4(4-3) 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 related to reproduction and mortality factors.

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

ZOOLOGY  ZOL

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

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

204. Natural History of Birds
Fall. 4(2-6) Three 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 economies, aesthetic and recreational value.

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 ontogeny of selected organisms.

401. Comparative Physiology I
Fall. 4(3-4) PSL 240 or B S 212 and CMB 132.
Interdepartmental with and administered by the Department of Physiology. A comparison of ommotropism, 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.
Description — Zoology

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.

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. Special attention will be given to mating, defensive and nutritive behavior. The genetics and endogenous factors 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 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.

420. Ecology of Animal Parasites
Summer. 6 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.

425. Marine Ecology
Winter. 3(3-0) 361, 303. Relation of marine organisms to their environment. Food webs, productivity, diversity and adaptability, estuaries, coral reef, open water and sea floor communities. Harvesting, aquaculture and marine food resources.

430. Vertebrate Paleontology
Winter. 4(3-4) 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(4-3) GLG 302 or ZOL 381 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.

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.

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.

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.

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.

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
Spring. 5(3-6) 305. 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(3-6) FW 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.

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) or 481; FW 476 concurrently. ENT 301, 302 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 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.

481. Invertebrate Zoology
Fall. 5(3-6) 381 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.

483. Physiological Ecology
Fall. 4(3-3) B S 212. Physiological aspects of basic ecological principles and concepts.

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

486. Mammalogy
Fall. 4(3-6) 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 origins, and concepts relating to the distribution of modern vertebrates.

491. Quantitative Biology  Fall, 4(4-0) STT 423 or approval of department.
Application of biometrical techniques to biological problems.

492. Cytochemistry  Spring, 4(3-3) BS 212.
General principles of microscopy, microtomy, embedding, sectioning 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. Junior and senior year, approval of department.
Reading and discussion of articles relating to taxonomy, 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 in biochemistry and cell biology strongly recommended. Term paper required.

817. Ecology of Zooplankton  Winter, Fall, Spring, or Summer, significant. Given in 1974, 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, predation, niche and species diversity.

820. Behavior of Animal Populations  Fall, 4(4-0) 413 and written approval of department.
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 neuroendocrine and chemical intervention upon behavior.

822. Behavior of Aquatic Animals  Fall, 4(3-3) 413; F W 478 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 Organizational for Tropical Studies. Interdepartmental with and administered by the Botany and Plant Pathology Department.
An introduction to the field to the principles of ecology as they operate in the tropics, especially concerning the tropical environment and biota, ecological relations, communities and evolution in the tropics. Given in Costa Rica by Organization for Tropical Studies.

830. Advanced Vertebrate Zoology  Winter, 4(4-0) May re-enroll for a maximum of 12 credits. 365; two years of undergraduate zoology and approval of department.
Advanced vertebrate biology including systems, ecology, distribution, morphology.

833. Advanced Invertebrate Paleontology  A. MICROPALeONTology  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, ostracods, and conodonts.

B. QUANTITATIVE PALeONTology  Spring, 3(2-4) 437 or 438. 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(2-0) 430 or approval of department. Interdepartmental with and administered by the Geology Department.
Recent advances and controversial issues in vertebrate paleontology including origins, 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.
Analysis of mechanisms of morphogenesis, particularly as these occur in post-gastrular stages of development. The significances of tissue interactions in developing and regenerating systems will be emphasized.

857. Experimental Morphology  Spring, 4(4-1) 317.
Analysis of mechanisms of morphogenesis, particularly as these occur in post-gastrular stages of development. The significances of tissue interactions in developing and regenerating systems will be emphasized.

865. Advanced Neurobiology  Winter of odd-numbered years, 3(3-0) BPR 825. Interdepartmental with the departments of Biophysics, Biomechanics, Physiology, and Psychology, and administered by the Department of Biomechanics.
Basic organization, structure and function of neural networks comprising sensory, motor, and autonomic systems including examples from invertebrates and vertebrates.
871. Ecology of Fishes
Summer. 6 credits. Approval of instructor or FW 473. Given at 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.

872. Comparative Limnology
(478.) Summer. 6 credits. Approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with the Botany and Plant Pathology Department.

Theoretical concepts and methods of analysis of environmental parameters influencing productivity of freshwater. Comparative field investigations of lakes, streams, and other aquatic habitats.

881. Biology of the Arthropoda
Winter. 3(3-6) 481 or approval of department. Interdepartmental with the Entomology Department.

Ecology, life cycles, morphology, taxonomy, and distribution of arthropoda 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.

883. Laboratory in Cellular Morphogenesis
Fall. 2(0-6) Approval of department.

Laboratory work in cellular morphogenesis accompanying 882.

884. Vertebrate Neural Systems
Fall of odd-numbered years. 4(3-3) Biochemistry and neurophysiology recommended. Nervous systems in the invertebrates, including sense organs, effectors 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 BPF 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) PSY 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 6 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) 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. 884 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.

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, ornithology, 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, ornithology, fisheries biology, limnology, quantitative biology, invertebrate, experimental embryology, animal behavior, herpetology.