542. *Principles of Radiology*

Fall. 2(2-0) Fourth-term Veterinary Medicine students.

Fundamentals of veterinary radiography. Normal radiographic anatomy. Principles of radiographic interpretation. Radiation safety.

544. *Veterinary Epidemiology*

Fall. 4(4-0) Fourth-term Veterinary Medicine students.

Meaning and relevancy of biostatistics in veterinary medicine. Descriptive and inferential statistics. Study design and critical literature review. Disease determinants, ecology, distribution and populations at risk. Analytic-clinical investigative epidemiology.

550. *Preventive Veterinary Medicine and Public Health*

Spring. 4(4-0) Sixth-term veterinary medicine students.

Public health aspects of veterinary medicine. Preventive and regulatory medicine including meat and milk hygiene, water supply and treatment, solid and liquid waste treatment and disposal and zoonosis.

560. *Urinary System*

Spring. 3(3-0) Sixth-term Veterinary Medicine students.

Normal and abnormal structure and function, diagnostic methods, and the medical and surgical manipulation of the urinary system.

561. *Core of Medicine Laboratories I*

Spring. 2(0-6) Sixth-term Veterinary Medicine students.

Classification diagnosis and treatment of diseases of the urinary, hematopoietic, nervous, integumetary and visual systems of animals.

562. *Hematopoietic System*

Spring. 2(2-0) Sixth-term Veterinary Medicine students.

Normal structure and function of the hematopoietic system and pathophysiologic effects of hematopoletic diseases. Clinical manifestations, laboratory evaluation and medical management.

563. *Visual System*

Spring. 2(2-0) Sixth-term Veterinary Medicine students.

Methods of examination, diagnosis, and treatment of ocular diseases.

564. *Survey of Infectious Agents*

Winter. 4(4-0) Fifth-term veterinary medicine students.

Host-microorganism relationship in diseases of animals; laboratory diagnosis, treatment, control, and public health significance.

566. *Nervous System*

Spring. 3(3-0) Sixth-term Veterinary Medicine students.

Normal and abnormal neural structure and function in animals with emphasis on clinical neurology and neuropathology.

568. *Integumentary System*

Spring. 3(3-0) Sixth-term Veterinary Medicine students.

Diseases of the integumentary system of animals with emphasis on laboratory examinations, interpretations of pathological features, diagnosis and treatment.

570. *Principles of Anesthesia*

Fall. 2(2-0) Seventh-term Veterinary Medicine students.

Principles and techniques of administering anesthetic agents. Supportive care including fluid therapy. Emergency procedures. Euthanasia agents.

571. *Core of Medicine Laboratories II*

Fall. 1(0-3) Seventh-term Veterinary Medicine students.

Classification, diagnosis and treatment of diseases of the cardiovascular, respiratory and digestive systems of animals. Preanesthetic and anesthetic procedures and skills.

572. *Cardiovascular System*

(513.) Fall. 3(3-0) Seventh-term Veterinary Medicine students.

Pathogenesis, diagnosis, and management of cardiovascular diseases of animals. Anatomical, physiological, pathological and pharmacological principles providing basis for medical and surgical treatment. Diagnostic and surgical procedures and radiologic interpretation.

574. *Respiratory System*

(515.) Winter. 4(4-0) Eighth-term Veterinary Medicine students.

Pathogenesis, diagnosis, and management of respiratory diseases of animals; anatomical, physiological and surgical treatments. Diagnostic and surgical procedures and radiologic interpretation.

576. *Digestive System I*

(522.) Fall. 4(4-0) Seventh-term Veterinary Medicine students.

Pathogenesis, diagnosis, and treatment of diseases of the alimentary tract and digestive organs of small animals.

578. *Principles of Surgery I*

Fall. 3(2-3) Seventh-term Veterinary Medicine students.

Fundamentals of surgery. Common procedures used in soft tissue surgery with small animals.

580. *Theriogenology*

(516.) Fall. 6(5-3) Seventh-term Veterinary Medicine students.

Reproductive function and diseases of animals' genital structure and function and endocrine controls. Examination, diagnosis and treatment of the mammary gland and reproductive tract.

581. *Core of Medicine Laboratories III*

Winter. 3(0-9) Eighth-term Veterinary Medicine students.

Diagnosis and treatment of diseases of the reproductive, digestive and musculosketal systems.

582. *Musculoskeletal System I*

(526.) Winter. 3(3-0) Eighth-term Veterinary Medicine students.

Diagnosis and treatment of musculoskeletal diseases of animals with emphasis on pathological changes, radiological techniques, and interpretation of radiographs.

586. *Digestive System II*

Winter. 4(4-0) Eighth-term Veterinary Medicine students.

Pathogenesis, diagnosis and treatment of diseases of the alimentary tract and digestive organs of food animals and horses.

588. *Principles of Surgery II*

Winter. 3(2-3) Eighth-term Veterinary Medicine students.

Fundamental large animal surgery. Surgical techniques and management of animals before, during and after surgery.

590. *Client Communication and Jurisprudence*

(501.) Spring. 2(2-0) Ninth-term Veterinary Medicine students.

Communication and interviewing skills for effective client relations. Communication aspects of medical records and their use in medical problem solving. Legal responsibilities of the veterinary medical profession.

591. *Core of Medicine Laboratories IV*

Spring. 2(0-6) Ninth-term Veterinary Medicine students.

Diagnosis and treatment of common toxicologic conditions, musculoskeletal disorders and orthopedic conditions in animals.

592. *Musculoskeletal System II*

(534.) Spring. 4(4-0) Eighth-term Veterinary Medicine students.

Diagnosis, prognosis and management of musculoskeletal diseases of large animals. Anatomical relationships of normal to abnormal function. Surgical procedures applicable to the equine and ruminant. Radiographic diagnosis and interpretation of various lameness conditions.

594. *Veterinary Toxicology*

(530.) Spring. 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*

(536.) 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 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 reenroll 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 LCS 674.

Clinical or research experience in an off-campus setting.

ZOOLOGY ZOL

College of Human Medicine
College of Natural Science

203. *Resource Ecology*

(IDC 200.) Fall, Winter, Spring, Summer. 3(3-0) Interdepartmental with the departments of Fisheries and Wildlife, Forestry, Geography, and Resource Development. Administered by the Department of Fisheries and Wildlife.

Basic concepts of ecology which are the unifying basis for resource management, conservation policy and the analysis of environmental quality. Extensive use of guest lecturers.

301. Nature and Homo Sapiens

Spring. 4(2-6) Three terms of natural science; not open to zoology majors.

Relates humans to their natural environment. Chief emphasis on identifying characteristic animal life in broad areas of nature and how humans fit or misfit 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 Geology.

Fossil vertebrates from fish to humans.

304. Biology, Behavior and Humans

Winter. 3(3-0) Juniors; not open to zoology majors.

Examines philosophical and biological issues which make the study of animal behavior relevant to humans. Emphasizes history of animal behavior, current theories, and experiments relating biological and environmental determinants of adaptive and non-adaptive behavior patterns.

306. Invertebrate Biology

Fall. 4(3-3) B S 212.

Systematics, morphology, and natural history of invertebrate animals. Laboratory includes identification of live and preserved animals and recognition of morphological characteristics of selected groups.

307. Vertebrate Biology

Winter. 4(3-3) B S 212.

Systematics, morphology and natural history of vertebrate animals. Laboratory includes identification of live and preserved animals and recognition of morphological characteristics of selected groups.

313. Animal Behavior

(413.) Spring: 4(4-0). Given at W. K. Kellogg Biological Station Summer term of odd-numbered years: 4 credits. B S 211.

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.

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) ZOL 317 or concurrently; B S 212.

Principles of development illustrated by analysis of the ontogeny of selected organisms.

337. The Fossil Record of Organic Evolution

Spring. 3(3-0) One course in a natural science; Juniors. Interdepartmental with and administered by Geology.

The direct evidence for organic evolution in the fossil record. Evolution of life from prebiological systems to humans. Impact of fossil discoveries on human thought.

341. Human Heredity

Fall, Winter. 4(4-0) Sophomores. Not open to zoology majors. Students may not receive credit in more than one of the following: ZOL 341, 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.

389. Animal Ecology

Winter, Summer. Given at W. K. Kellogg Biological Station Summer term. Winter: 4(3-4) Summer: 4 credits. 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 reenroll 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. 1 to 5 credits. May reenroll for a maximum of 15 credits. Juniors; approval of department.

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.

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

Fall of even-numbered years. 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. 4(0-12) Approval of instructor.

An integrated series of selected experiments in topics of cell biology, embryology and genetics.

414. Biological Mechanisms of Animal Behavior

Winter. 3(3-0) or 5(3-6) ZOL 313 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) ZOL 313.

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.

416. General Parasitology

Fall, Summer. Given at W. K. Kellogg Biological Station Summer term. Fall: 3(3-0) Summer: 3 credits. B S 210, B S 211, B S 212 or LBS 141. Interdepartmental with and administered by the Department of Microbiology and Public Health.

Life history, host-parasite relationships (including physiology, immunology, immunopathology and pathology) and epidemiology of selected groups and species of protozoan, tremotode, cestode and nematode parasites.

417. Advanced Developmental Biology

Fall. 3(3-0) ZOL 317.

Molecular and cellular biology of development.

418. General Parasitology Laboratory

(MPH 417.) Fall, Summer. Given at W. K. Kellogg Biological Station Summer term. Fall: 2(0-4) Summer: 2 credits. MPH 416 or concurrently or approval of department. Interdepartmental with and administered by the Department of Microbiology and Public Health.

Identification and life histories of representative species of major groups of animal parasites. Selected concepts of host-parasite associations will be tested experimentally.

420. Biology 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. Administered by the Department of Microbiology and Public Health.

Parasitism of animals by protozoa, helminths and anthropods with emphasis on the interrelationships of host-parasite associations with the natural environments.

Approved through Spring 1986.

428. Morphology of the Chordates

(314.) Winter. 5(3-6) B S 212.

Comparative and functional morphology of chordates. Laboratory includes dissection of representatives of most vertebrate classes.

430. Vertebrate Paleontology

Winter. 4(3-3) ZOL 428, or approval of department. Interdepartmental with and administered by Geology.

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) GLG 202 or ZOL 306 or approval of department. Interdepartmental with and administered by 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. Paleoecology

Spring. 4(3-4) GLG 202 or ZOL 389 or approval of department. Interdepartmental with and administered by 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(5-0) 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 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) ZOL 441 or approval of instructor.

Classical and molecular examination of eight to ten advanced topics and recent discoveries in genetics.

443. Developmental Genetics

Winter. 4(4-0) ZOL 441 and ZOL 317.

Mechanisms of gene action. Role of genes in the embryology, morphology, and physiology organisms.

445. Evolution

Fall of even-numbered years. 4(4-0) B S 211.

Processes of evolutionary change including the origin of species and homo sapiens, fossils and the geological record, and applications in genetic engineering, agriculture, and medicine.

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.

453. Marine Ecology and Physiology

Spring. 4(4-0) B S 212.

Life histories of marine animals. Physiological problems of marine life. Biology of special marine habitats. Ecological analysis of community structure and energetics.

456. Foundations of Developmental Biology

Winter of even-numbered years. 3(3-0) ZOL 317; ZOL 417 recommended. Interdepartmental with the Department of Natural Science.

Reading and discussion of original research which posed significant problems of modern developmental biology.

460. Ornithology for Teachers

Summer. 3 credits. A course in biology or approval of department. Not open to Zoology majors. Given at W. K. Kellogg Biological Station. Interdepartmental with Biological Science.

Distribution, breeding cycles, migration, food and feeding habits, voice and other important areas of avian biology. Emphasis on field identification and natural history.

461. Ornithology

Winter, Summer. Given at W. K. Kellogg Biological Station Summer term. Winter: 4(3-2) Summer: 4 credits. ZOL 307 or ZOL 428.

Principles of classification, structure, distribution, migration, population biology and life history of birds. Identification of birds by size, form and song.

464. Comparative Limnology

(ZOL 478., ZOL 878.) Summer. 6 credits. B S 212. 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.

465. Field Evolutionary Ecology

Summer. 3 credits. May reenroll for a maximum of 6 credits. ZOL 389. Given at W. K. Kellogg Biological Station.

Major questions of evolutionary ecology, along with field projects designed to explore these questions. Course concludes with individual field project.

Approved through Spring 1986.

468. Behavioral Ecology

Summer. 3 credits. May reenroll for a maximum of 6 credits if different topic is taken. ZOL 413 or ZOL 415, ZOL 389. Given at Kellogg Biological Station.

Current theoretical issues in behavioral ecology with illustrative field problems and an individual field project.

Approved through Spring 1986.

471. Ichthyology

Spring. 3(2-3) F W 301 or ZOL 307 or ZOL 428. 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(3-0) CEM 141B, CEM 161; BOT 450 or ZOL 389. Students may not receive credit for both F W 376 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) 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.

478. Stream Ecology

Fall. 3(3-0) ENT 420, ZOL 389 or BOT 450 or F W 302 or approval of department. Students may not receive credit in both F W 478 and ENT 421. Interdepartmental with the departments of Entomology and Fisheries and Wildlife. Administered by the Department of Fisheries and Wildlife.

Biological, chemical, physical, and geological processes which determine the structure and function of stream ecosystems.

480. Biology of Fresh-Water and Terrestrial Invertebrates

Summer. 6 credits. B S 212 or approval of department. Given at W. K. Kellogg Biological Station.

Systematics and ecology of invertebrates with emphasis on the local fauna. Extensive field and laboratory work with living animals.

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. 5(3-6) ZOL 307 or ZOL 428.

Classification and natural history of amphibians and reptiles, with emphasis on Michigan species.

486. Mammalogy

Fall. 4(2-6) ZOL 307 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 306 or ZOL 307.

Principles and patterns of animal distribution. Emphasis on major faunal regions, centers of origins, and concepts relating to the distribution of modern vertebrates.

492. Cytochemistry

Spring. 4(3-3) 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(1-0) May reenroll 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

Winter. 4(4-0) One year organic chemistry; ZOL 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.

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.

804A. Neuroscience Laboratory I

Winter. 4(2-4) ZOL 827 and approval of instructor. Interdepartmental with the departments of Physiology and Psychology. Administered by the Department of Psychology.

Development of skills in the methods, techniques and instrumentation necessary for reseach in a variety of areas concerned with neuroscience.

804B. Neuroscience Laboratory II

Spring. 4(2-4) PSY 804A. Interdepartmental with the departments of Physiology and Psychology. Administered by the Department of Psychology.

Continuation of ZOL 804A.

815. Current Trends in Primatology

Winter of odd-numbered years. 4(4-0) Approval of instructor.

Lectures and discussion of current concepts in primate research. Emphasis will be upon the nonhuman primate as a model for research into biomedical and zoological problems.

817. Ecology of Zooplankton

Summer of odd-numbered years. 3 credits. Approval of department. Given at W. K. Kellogg Biological Station.

Biology, distribution, and abundance of planktonic animals with special emphasis on life tables, filtering rates, food selection, production dynamics, fish predation, niche relationships and species diversity.

820. Behavior of Animal Populations

Spring. 4(4-0) ZOL 313, 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.

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 Department of Botany and Plant Pathology.

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. Given in Costa Rica by Organization for Tropical Studies.

827. Basic Neurobiology

(BPY 827.) Fall. 4(4-0) Approval of department.

Neural structure and function at cellular and intercellular levels. Membrane and synaptic potentials, receptor transduction, and intracellular transport with an introduction to comparative and evolutionary aspects.

830. Advanced Vertebrate Zoology

Winter. 4(4-0) May reenroll for a maximum of 12 credits. ZOL 307; two years of undergraduate zoology, approval of department.

Advanced vertebrate biology including systematics, ecology, distribution, morphology.

833. Advanced Invertebrate Paleontology

B. Quantitative Paleontology

Fall. 3(2-4) GLG 437 or GLG 438. Interdepartmental with and administered by Geology.

Application of mathematical tools to paleontological problems, including statistical applications and numerical taxonomy; computer applications.

C. Paleocology

Fall. 3(2-4) GLG 437 or GLG 438. Interdepartmental with and administered by Geology.

Advanced problems in population, community, and province level paleoecology, primarily of marine invertebrates, including study of taxonomy, diversity, and adaptation.

D. Developmental Paleontology

Fall. 3(2-4) GLG 437 or GLG 438, ZOL 317 or approval of department. Interdepartmental with and administered by Geology.

Application of the principles of development to the ontogeny and phylogeny of fossil invertebrates as known from skeletal morphology.

E. Evolutionary Paleontology

Fall. 3(2-4) GLG 437 or GLG 438. Interdepartmental with and administered by Geology.

Aspects of evolutionary biology that can be studied in the fossil record, with emphasis on marine invertebrates.

834. Advanced Vertebrate Paleontology

Winter of even-numbered years. 3(3-0) GLG 430 or approval of department. Interdepartmental with and administered by Geology.

Recent advances and controversial issues in vertebrate paleontology including origin, classification, phylogeny, and stratigraphic relationships of fossil vertebrates.

839. Population Ecology

Summer of even-numbered years. 3 credits. May reenroll for a maximum of 6 credits. Approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with the Department of Botany and Plant Pathology.

A field-experimental approach to the study of adaptations. Selected topics will deal with population growth, competition, predation, mutation, community structure and species abundance.

842. Chromosome Structure and Genetics

Winter of even-numbered years. 4(4-0) Introductory genetics course. Interdepartmental with Genetics and the Department of Botany and Plant Pathology. Administered by Genetics.

Mechanisms of mitosis and meiosis, classical and molecular genetics of chromosome structure, alterations in chromosome number and structure, transposable elements, meiotic drive.

843. Ecosystem Analysis, Design and Management

Spring. 3(3-0) 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) ZOL 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.

846. Advanced Topics in Evolution

Winter. 4(4-0) May reenroll for a maximum of 12 credits if different topics are taken. ZOL 445 or approval of instructor.

Mechanistic and theoretical aspects of the evolutionary process. Topics will be drawn from the current literature and will deal with one of the following areas: microevolution, macroevolution, and speciation.

850. Ultrastructure

Fall. 4(2-6) BOT 427.

New developments in instrumentation and techniques of electron microscopy and their practical application in studying morphological and physiological changes in various organ systems.

859. Analysis of Hormone Action

Spring. 4(4-0) ZOL 317 or approval of department. Interdepartmental with the Department of Physiology.

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.

862. Avian Behavioral Ecology

Fall. 4(4-0) ZOL 313, ZOL 389, ZOL 461.

Theory of habitat selection. Optimal foraging theory dealing with breadth of diet, patch utilization and sampling theory. Coloniality, cooperation and optimal group size, and refuging systems as they apply to avian populations.

865. Advanced Neurobiology

(BIM 865.) Spring. 4(4-0) ZOL 827. Interdepartmental with the departments ofAnatomy, 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 of even-numbered years. 3 credits. Approval of department. 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.

881. Biology of the Arthropoda

Winter. 5(3-6) ZOL 306 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.

885. Vertebrate Neural Systems I

(PSY 885.) Winter of even-numbered years. 5(3-4) ANT 815, ANT 865 recommended. Interdepartmental with the departments of Anatomy, Physiology and Psychology. Administered by the Department of Anatomy.

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

Spring of even-numbered years. 5(3-4) ANT 885. Interdepartmental with the departments of Anatomy, Physiology, and Psychology. Administered by the Department of Anatomy.

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 or 2 credits. May reenroll for a maximum of 12 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 of odd-numbered years. 3(3-0) Developmental biology, biochemistry, approval of department.

Developmental biology of early stages of animal life, emphasis on physiology and biochemistry of marine invertebrate eggs.

895. *Seminar Topics*

Fall, Winter, Spring. 1 credit per term. May reenroll for a maximum of 6 credits. Approval of department.

Graduate level seminars on current research topics in biology.

896. *Animal Community Ecology*

Winter of even-numbered years. 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 389 or BOT 450. Interdepartmental with the Department of Fisheries and Wildlife.

Concepts of ecosystem structure, energy flow, and nutrient cycling in representative terrestrial and aquatic ecosystems.

899. *Master's Thesis 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. *Doctoral Dissertation 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.