566. Nervous System
(312.) 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
(324.) 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.

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 control. 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 musculoskeletal systems.
337. The Fossil Record of Organic Evolution
Spring. 3(3-0) One course in a natural science; Juniors. Interdepartmental with and administered by Geology.

341. Human Heredity
Fall, Winter, Summer. 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.

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

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

391. Zoological Problems
Fall. Winter, Spring. Summer. 1 to 8 credits. May recertify 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 recertify 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 neuroregulation, 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 analysts of living systems, vital properties, processes, and limitations; population dynamics, selection, competition, and predation; ecological community structure and function; industrialized ecosystem.

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

406. Experiments in Zoology II
Winter. 4(0-12) Approval of instructor.
An integrated series of selected experiments in topics of cell biology, embryology and genetics.

407. Experiments in Zoology III
Spring. 3(0-9) ZOL 405 or ZOL 406. Approval of instructor.
Special problems.

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

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

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 413.
Consideration of orientation, navigation and homing behavior, and preferences, habitat selection, exploration, behavioral periodicity, communication, social organization and the embryology of behavior. In both vertebrates and invertebrates.

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

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 arthropods with emphasis on the interrelationships of host-parasite associations with the natural environments.

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 the Department of 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(3-1) GLC 202 or ZOL 303 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. Paleocology
Spring. 4(3-4) GLC 202 or ZOL 388 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
Spring. 4(4-0) ZOL 441 and ZOL 317.
Mechanisms of gene action. Role of genes in the embryology, morphology, and physiology of organisms.

445. Evolution
Fall. 4(4-0) B S 211.
Processes of evolutionary change including the origin of species and hominid sapiens, fossils and the geological record, and applications in genetic engineering, agriculture, and medicine.

450. Comparative Histology
Fall. 4(4-0) B S 312.
The comparative structure of cells of selected invertebrate and vertebrate organisms and their interactions to form tissues.
456. Foundations of Developmental Biology
Winter. 3 credits. 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. 4 credits. ZOL 330 or ZOL 428.

465. Field Evolutionary Ecology
Summer. 3 credits. May reenroll for a maximum of 6 credits. ZOL 389. Given at W. K. Kellogg Biological Station. Interdepartmental with Biological Science.
Major questions of evolutionary ecology, along with field projects designed to explore these questions. Course concludes with individual field project.

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

471. Ichthyology
Spring. 3-2-3 credits. F W 301 or ZOL 320 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. 3-4 credits. CEM 131 and 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 emphasis on physical, chemical and biological factors affecting their productivity.

477. Limnological Methods
Winter. 3-4 credits. ZOL 481; F W 478 concurrently. ENT 301, ENT 302 recommended. Interdepartmental with and administered by the Department of Fisheries and Wildlife.
Methods and instruments of limnological field investigations on lakes and streams.

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

481. Invertebrate Zoology
Fall. 3-4 credits. ZOL 325 or approval of department.
Biological systematics of invertebrates with special reference to their natural history, classification, distribution, and economic importance.

482. Biology of the Protista
Winter. 3-4 credits or 5-3-6 credits. S B 5 212.
Structures and functions of animal-like, eukaryotic microorganisms.

485. Field Evolutionary Ecology
Winter, Spring, Summer. 3 credits. ZOL 320 or ZOL 428. Given at Kellogg Biological Station. Interdepartmental with Biological Science.
Classification and natural history of amphipods and reptiles, with emphasis on Michigan species.

486. Mannology
Fall. 3-4 credits. ZOL 303 or ZOL 428.
Classification distribution, natural history of mammals with emphasis on Michigan species. Field studies, preparation of study specimens.

488. Animal Distribution
Fall. 3-4 credits. ZOL 303 or ZOL 428.
Animal distribution and classification systematics of animal-like, eukaryotic microorganisms. Emphasis on major faunal regions, centers of origin, and concepts relating to the distribution of modern vertebrates.

492. Cytology
Spring. 3-4 credits. S B 5 212.
General principles of cytology, micrometry, 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 credit. 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 credits. ZOL 317. Interdepartmental with the Department of Physiology.

498. Undergraduate Thesis
Fall, Winter, Spring, Summer. 1 to 6 credits. May reenroll for a maximum of 12 credits. Juniors, written approval of instructor.
Lectures about the preparation and defense of an undergraduate thesis.
### Zoology - Descriptions of Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
<th>Credits</th>
<th>Semester(s)</th>
<th>Department/Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLG 833</td>
<td>Advanced Invertebrate Paleontology</td>
<td>Advanced problems in population, community, and province level paleontology, particularly of marine invertebrates, including study of taxonomy, diversity, and adaptation.</td>
<td>3</td>
<td>Fall</td>
<td>Geology</td>
</tr>
<tr>
<td>GLG 834</td>
<td>Advanced Vertebrate Paleontology</td>
<td>Winter of even-numbered years. 3(3-0) GLC 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.</td>
<td>3</td>
<td>Winter</td>
<td>Geology</td>
</tr>
<tr>
<td>GLG 837</td>
<td>Application of the Evolutionary Process</td>
<td>Topics will be drawn from the current literature and will deal with one of the following areas: microevolution, macroevolution, and speciation.</td>
<td>3</td>
<td>Winter</td>
<td>Geology</td>
</tr>
<tr>
<td>GLG 838</td>
<td>Analysis of Gene Organization and Transmission</td>
<td>Winter of odd-numbered years. 4(4-0) ZOL 441 and approval of department. Formal and molecular analysis of gene organization and transmission in higher eukaryotes.</td>
<td>4</td>
<td>Winter</td>
<td>Geology</td>
</tr>
<tr>
<td>GLG 839</td>
<td>Ultrastructure</td>
<td>New developments in instrumentation and techniques of electron microscopy and their practical application in studying morphological and physiological changes in various organ systems.</td>
<td>3</td>
<td>Winter</td>
<td>Geology</td>
</tr>
<tr>
<td>GLG 840</td>
<td>Avian Behavioral Ecology</td>
<td>Theory of habitat selection. Optimal foraging theory dealing with breadth of diet, patch utilization and sampling theory. Coloniality, cooperation and optimal group size, and reframing systems as they apply to avian populations.</td>
<td>3</td>
<td>Winter</td>
<td>Geology</td>
</tr>
<tr>
<td>GLG 841</td>
<td>Advanced Neurobiology</td>
<td>Summer of even-numbered years. 3 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.</td>
<td>3</td>
<td>Fall</td>
<td>Geology</td>
</tr>
<tr>
<td>GLG 842</td>
<td>Ecosystem Analysis, Design and Management</td>
<td>Spring (3-3-0) SYS 442 or ZOL 404. Interdepartmental with and administered by Systems Science. Projects should yield information relevant to solution of contemporary ecological problems.</td>
<td>3</td>
<td>Spring</td>
<td>Geology</td>
</tr>
<tr>
<td>GLG 843</td>
<td>Problems in Human Genetics</td>
<td>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.</td>
<td>5</td>
<td>Spring</td>
<td>Geology</td>
</tr>
</tbody>
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838. **Biological of the Arthropoda**
Winter. 3(3-0) ZOL 481 or approval of department. Interdepartmental with the Department of Entomology.
Ecology, life-cycles, morphology, taxonomy, and distribution of arthropoda other than insects.

839. **Laboratory in Cellular Morphogenesis**
Winter. 2(0-5) Approval of department. Laboratory work in cellular morphogenesis accompanying ZOL 881.

840. **Vertebrate Neural Systems**
- **I (PSY 885)** Winter of even-numbered years. 5(4-0) 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.
- **II (PSY 886)** Spring of even-numbered years. 3(3-0) 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.

841. **Current Topics in Ecological Research**
Summer. 1 or 2 credits. May re-enroll for a maximum of 4 credits. Approval of department. Consideration of current problems.

842. **Dynamics of Biologic Populations**
Winter. 3(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.

843. **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.