

- 331. Design Implementation: Theory and Application II**  
Winter. 4(1-6) 330.  
Continuation of grading and introduction to surface drainage, quantity estimates, and horizontal and vertical road alignments.
- 332. Design Implementation: Theory and Application III**  
(432) Spring. 3(1-4) 331, 345.  
Problems of intermediate complexity in site engineering and an introduction to contract documents including working drawings and specification.
- 343. Intermediate Landscape Design**  
Fall. 4(1-6) 242, 330; HRT 212.  
Continuation of 242, with concentration on investigation, analysis and synthesis in the design of moderately complex landscape projects.
- 344. Intermediate Landscape Design**  
Winter. 4(1-6) 343.  
Continuation of 343 with emphasis on more complex landscape architectural projects.
- 345. Intermediate Landscape Design**  
Spring. 4(1-6) 344.  
Continuation of 344, with concentration on the design of broad scale landscape architectural projects.
- 421. Selected Topics**  
(471.) Fall. 4(4-0) Senior majors.  
Critical examination of theories and applications of landscape architecture through lectures, discussions, oral presentations and written reports.
- 430. Advanced Landscape Design**  
(480.) Fall, Winter, Spring, Summer. 4(1-6) May re-enroll for a maximum of 16 credits. 224, 318, 331, 345.  
Lectures and studio projects involving investigation, analysis, solution and presentation relative to the physical aspects of environmental design.
- 440. Graphic Communication**  
Fall. 3(0-6) Bachelor of Science in Landscape Architecture.  
Development and perfection of individual delineation techniques as applied to landscape design projects.
- 445. Design Theory and Implementation—Natural Materials**  
Fall. 3(0-6) Bachelor of Science in Landscape Architecture.  
Designs, working drawings and specifications related to the use of vegetation and other natural materials on various projects in a wide range of scales.
- 450. Architectural Design**  
Winter. 4(0-6) Bachelor of Science in Landscape Architecture.  
Lectures, discussions, assigned readings, written reports, and studio projects in architectural design, emphasizing complex architectural planning, form structure and site relationships.
- 455. History of Landscape Design**  
Winter. 3(3-0) Bachelor of Science in Landscape Architecture.  
Significant movements, personalities, and projects in landscape design, from ancient to contemporary times, with emphasis on the development of the current practice of landscape architecture.

- 460. Research Methods**  
Winter. 3(3-0) Bachelor of Science in Landscape Architecture.  
Review of traditional and proven research methods in the physical and social sciences utilizing representative case studies as applied to environmental considerations.
- 465. Seminar**  
Spring. 3(3-0) Bachelor of Science in Landscape Architecture.  
Professional philosophy of landscape architecture; the social responsibility of the landscape architect; administrative processes and methods essential for effective professional practice.
- 470. Design Theory and Implementation—Construction**  
Spring. 3(3-0) Bachelor of Science in Landscape Architecture.  
Comprehensive site projects involving construction plans, working drawings, contract documents, cost estimates and office practice.
- 475. Comprehensive Design**  
Fall, Winter, Spring. 4(0-8) Must be repeated for a total of twelve credits. Bachelor of Science in Landscape Architecture.  
Studio projects and discussions emphasizing the synthesis of landscape architectural principles and related disciplines as applied to a wide range of design scales and sites in both urban and regional contexts.
- 485. Professional Contact**  
Summer. 4(0-8) Bachelor of Science in Landscape Architecture.  
Similar to 475, but taught by a sequence of highly regarded professional practitioners and educators in the environmental design professions.
- 490. Special Problems**  
Fall, Winter, Spring, Summer. 2 to 5 credits. May re-enroll for a maximum of 8 credits. Approval of school.  
Investigation, for advanced undergraduate students in landscape architecture, developed from special interest areas.
- 801. Graduate Landscape Architecture I**  
Fall, Winter, Spring. 5 to 12 credits.  
A series of complex problems of variable subject matter adjusted to the interests and needs of each individual student and designed to emphasize the various phases of landscape architecture such as plant materials and planting design, drafting and delineation, surveying and construction, contracts, specifications and reports, architecture and city planning and landscape design.
- 802. Graduate Landscape Architecture II**  
Fall, Winter, Spring. 5 to 12 credits.  
801.  
Continuation of 801.
- 803. Graduate Landscape Architecture III**  
Fall, Winter, Spring. 5 to 12 credits.  
802.  
Continuation of 802.
- 804. Comprehensive Problem**  
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 15 credits. 803.  
Development of a terminal, creative project of subject matter selected by the student and approved by the department, involving the various phases of landscape architecture and submitted to the faculty as evidence of his mastery of the principles of his profession.

## ZOOLOGY

## ZOL

College of Human Medicine  
College of Natural Science

- 200. Resource Ecology and Man**  
For course description, see Interdisciplinary Courses.
- 204. Natural History of Birds**  
Fall. 4(2-6) N S 193; not open to zoology majors.  
Identification of Michigan birds in field and laboratory, including life histories, habits, and consideration of their economics, aesthetic and recreational value.
- 301. Nature and Man**  
Spring. 4(2-6) N S 193; 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) Not open to zoology majors. Interdepartmental with and administered by the Geology Department.  
Fossil vertebrates from fish to man.
- 305. Biology of Vertebrates**  
Fall. 5(3-6) B S 212.  
Primarily concerned with natural history of vertebrates. Topics include morphological characteristics and relationships, ecology, zoogeography, and behavior of higher animals. Laboratory involves recognition of representative species within various groups.
- 315. Comparative Anatomy of Vertebrates**  
Winter. 3(3-0) B S 212.  
Comparative anatomy and evolution of vertebrates. The dogfish and a mammal dissected in the laboratory.
- 316. Comparative Anatomy Laboratory**  
Winter. 2(0-6) 315 or concurrently.
- 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.
- 341. Human Heredity**  
Fall, Winter, Spring, Summer. 4(3-3) N S 193; 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.

**381. Fundamentals of Invertebrate Zoology**

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

Form and function of representative invertebrates. Meets requirements for a course in Invertebrate Zoology. Students expecting to obtain advanced degrees in Zoology or those more interested in a systematic or ecological approach should elect Zoology 481.

**389. Animal Ecology**

Spring. 4(3-4) B S 212 or concurrently.

Animals in relation to their environment. Factors affecting the distribution and 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 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.

**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 ontogeny of behavioral patterns will be presented where known. Behavior will be related to the ecology of various animal populations.

**414. Invertebrate Behavior**

Spring. 3(3-0) or 5(3-6) 413.

Concerned with evolutionary, hormonal, and neurological bases of invertebrate behavior. Behavioral topics studied include taxes, reflexes, instincts, learning, periodicity, and social organization.

**415. Vertebrate Behavior**

Fall. 4(4-0) 413.

Concerned with evolutionary, hormonal, and neurological bases of vertebrate behavior. Topics studied include sensory processes, instincts, learning, periodicity, complex processes, motivation, individual differences, and social organization.

**430. Vertebrate Paleontology**

Winter. 4(3-3) 305 or 315 or GLG 302 of approval of department. Interdepartmental with 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.

**441. Fundamental Genetics**

Fall. 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(2-9) 441; MTH 108 or 111 recommended.

Thorough discussion of quantitative inheritance, linkage and crossing-over, genetic consequences of chromosome aberrations, results of differences in life cycles of animals, plants and microorganisms. Breeding experiments with *Drosophila* and *Neurospora*.

**453. Animal Histology**

Spring. 5(3-6) B S 212.

Study of vertebrate tissues.

**455. Experimental Ecology**

Spring. 5(2-9) 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. Experimental Analysis of Development**

Winter. 3(3-0) or 5(3-6) 317 and 318.

Analysis of developmental biology of selected forms, emphasis on cellular and sub-cellular basis of differentiation, stressing modern experimental techniques. Individual laboratory problems as introduction to research methods.

**457. Vertebrate Morphology for Teachers**

Summer. 4(3-4) B S 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.

**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. 4(2-6) 305 or 315.

Principles of classification, structure, distribution, migration, life histories, and habits. Laboratory and field identification of birds by size, form, color, song and habitat.

**471. Ichthyology**

Spring. 3(2-3) 305 or 315. Interdepartmental with the Fisheries and Wildlife Department.

Classification and natural history of fishes. Emphasis on food, game, and forage fishes.

**473. Field Ichthyology**

Summer of odd-numbered years. 3 credits. B S 212 or approval of department. Given at W. K. Kellogg Biological Station.

Taxonomy, life history and ecological relationships of fishes of the Great Lakes region.

**476. Limnology**

Winter. 3(3-0) B S 212. Interdepartmental with and administered by the Fisheries and Wildlife Department.

Ecology of lakes and streams with special reference to physical, chemical, and biological factors affecting their productivity.

**477. Limnological Methods**

Winter. 3(0-9) 481; F W 476 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.

**478. Comparative Limnology**

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

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

**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.

**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. 4(3-3) 381 or 481.

Morphology, physiology and natural habitats of protozoa.

**483. Physiological Ecology**

Fall. 4(3-3) 381 or 481.

Physiological aspects of basic ecological principles and concepts.

**484. Herpetology**

Spring. 5(3-6) 305 or 315.

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

**485. Field Herpetology**

Summer of even-numbered years. 3 credits. B S 212 or approval of department. Given at W. K. Kellogg Biological Station.

Study of the amphibians and reptiles of the regional area, with special reference to classification and natural history.

**486. Mammalogy**

Fall. 4(2-6) 305 or 315.

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. 5(4-3) STT 421 or approval of department.

Application of biometrical techniques to biological problems.

**492. Cytochemistry**

Fall. 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.

**816. Malacology**

Summer of even-numbered years. 3 credits. 481 or approval of department. Given at W. K. Kellogg Biological Station.

Biology of the mollusks; morphology, classification, distribution, evolution, ecology, and economics. Laboratory and field work will emphasize identification and biology of the local land and fresh-water colluscan fauna.

**817. Ecology of Zooplankton**

Summer of every third year; given in 1968. 3 credits. 481 or approval of department. Given at W. K. Kellogg Biological Station.

Factors affecting distribution and abundance of planktonic animals. Physiological ecology, secondary production, nutrition, and behavior.

**820. Behavior of Animal Populations**

Spring. 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.

**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. Given 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.

**839. Population Ecology**

Summer of odd-numbered years. 6 credits. Approval of department. Given at W. K. Kellogg Biological Station. Interdepartmental with the Botany and Plant Pathology Department.

A synopsis of growth and regulation of plant and animal populations; interrelationships of biotic and environmental factors that control population responses and interactions. Laboratory and field experiments.

**841. Developmental Genetics**

Spring. 4(4-0) 441 or approval of department.

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

**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.

**850. Ultrastructure**

Spring. 4(4-0) BOT 827.

Morphological, histochemical and physiological changes in various organ systems at the ultrastructural level as a function of development, taking the cell as the basic unit.

**854. Histochemistry**

Winter. 4(3-4) Two years of undergraduate zoology including 453.

**857. Experimental Morphology**

Spring. 4(3-1) 317.

Analysis of mechanisms of morphogenesis, particularly as these occur in post-gastrular stages of development. The significance of tissue interactions in developing and regenerating systems will be emphasized.

**858. Neuroembryology**

Spring. 4(4-0) 318 and approval of department.

Experimental analyses of morphogenesis of vertebrate nervous systems.

**859. Analysis of Hormone Action**

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

Discussion of recent work on the molecular and developmental aspects of hormone action in vertebrates and invertebrates. Selected topics to vary from year to year.

**862. Advanced Ornithology: Systematics**

Winter of odd-numbered years. 5(3-6)

461.

Courses 862 and 863 constitute an advanced series preferably to be taken in sequence. The first term deals primarily with systematics, including a brief survey of the birds of the world.

**863. Advanced Ornithology: Anatomy and Physiology**

Winter of even-numbered years. 4(2-6)

461.

Feathers, plumages, and the internal anatomy of birds, including dissection of a pigeon and comparisons with other birds.

**881. Biology of the Arthropoda**

Winter. 5(3-6) 481 or approval of department.

Ecology, life cycles, morphology, taxonomy, and distribution of arthropods other than insects.

**882. Cellular Morphogenesis**

Fall. 2(2-0) One course in biochemistry, approval of department.

Selected topics on the structure, biological processes and differentiation of living cells as related to development.

**883. Laboratory in Cellular Morphogenesis**

Fall. 2(0-6) Approval of department.

Laboratory work in cellular morphogenesis accompanying 882.

**884. Invertebrate Neural Systems**

Winter of even-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.

**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. 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.

**895. Seminar Topics**

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

Graduate level seminars on current research topics in biology.

**899. Research**

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

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

**999. Research**

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

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