

492. Women's Studies Senior Seminar (W)
Spring. 4(4-0)
P: WS 201, WS 203; WS 301 or WS 302. R: Not open to freshmen and sophomores. Completion of Tier I writing requirement.
Synthesis and elaboration of ideas and perspectives central to Women's studies. Current areas of interest and research in feminist scholarship.

493. Internship
Fall, Spring, Summer. 2 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course.
P: WS 201 or WS 202 or WS 203. R: Not open to freshmen or sophomores. Approval of program.
Integration of feminist knowledge through work experience related to women's concerns. Experience in legislative, community, or educational settings.

890. Individual Reading
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course.
R: Approval of program.
Faculty supervised graduate level reading in special topics.

ZOOLOGY

ZOL

Department of Zoology College of Natural Science

111L. Cell and Molecular Biology Laboratory
Fall, Spring, Summer. 2 credits. Interdepartmental with Biological Science, Microbiology, and Botany and Plant Pathology. Administered by Biological Science.
P: BS 111 or concurrently
Principles and applications of common techniques used in cell and molecular biology.

141. Introductory Human Genetics
Spring. 3(3-0)
R: Not open to students in Biochemistry, Botany, Entomology, Medical Technology, Clinical Laboratory Sciences, Physiology, Zoology, Microbiology or Interdepartmental Biological Science or to students in the corresponding Lyman Briggs School coordinate majors or to students in the Lyman Briggs School Biology Field of concentration. Not open to students with credit in ZOL 341 or ZOL 344.
Inheritance of human traits. Impact of genetic technology on society. Ethical and legal issues. Risks and benefits of genetic technology.

306. Invertebrate Biology
Fall. 4(3-3)
P: BS 110.
Systematics, morphology, and natural history of invertebrate animals. Identification of live and preserved specimens. Recognition of selected groups.

313. Animal Behavior
Fall. 3(3-0)
P: BS 110, BS 111 or LBS 144, LBS 145. R: Not open to freshmen.
Mechanisms and evolution of behavior (ethology).
SA: ZOL 213

316. General Parasitology
Spring. 3(3-0)
P: BS 110, BS 111 or LBS 145.
Identification, life history, host-parasite relationships, and epidemiology of protozoan, helminth, acanthocephalan, copepod, and arthropod parasites of animals and humans.

316L. General Parasitology Laboratory
Spring. 1 credit.
P: BS 110, BS 111 or LBS 145. C: ZOL 316 concurrently.
Laboratory diagnosis of protozoans, helminths, acanthocephalans, copepods, and arthropods that infect humans and animals. Animal necropsy.

319. Introduction to Earth System Science
Fall. 3 credits. Interdepartmental with Entomology, Botany and Plant Pathology, Geological Sciences, and Sociology. Administered by Entomology.
P: Completion of one course in biological or physical science.
Systems approach to Earth as an integration of geochemical, geophysical, biological and social components. Global dynamics at a variety of spatio-temporal scales. Sustainability of the Earth system.

320. Developmental Biology
Fall. 4(3-3)
P: BS 110, BS 111 or LBS 144, LBS 145.
Principles of development, emphasizing vertebrates. Illustrations from morphological and experimental investigations.
SA: ZOL 220

328. Comparative Anatomy and Biology of Vertebrates
Spring. 4(3-3)
P: BS 110 or LBS 144. R: Completion of Tier I writing requirement.
Comparative morphology and natural history of vertebrates. Dissection of representatives of most vertebrate classes.
SA: ZOL 228

331. Vertebrate Life of the Past
Spring. 3(3-0) Interdepartmental with Geological Sciences. Administered by Geological Sciences.
P: BS 110 or BS 111 or juniors and above. R: Not open Zoology majors. Not open to students with credit in GLG 433.
Evolution and diversity of fossil vertebrates from fish to humans with emphasis on dinosaurs and Pleistocene events.

341. Fundamental Genetics
Fall, Spring, Summer. 4(4-0) Interdepartmental with Botany and Plant Pathology.
P: BS 111 or LBS 145.
Principles of heredity in animals, plants and microorganisms. Formal and molecular methods in the study of gene structure, transmission, expression and evolution.

342. Advanced Genetics
Spring. 3(3-0)
P: ZOL 341. R: Completion of Tier I writing requirement.
Advanced topics in classical and molecular genetics including various forms of genetic mapping.

343. Genetics Laboratory
Spring. 2 credits.
P: ZOL 341 or concurrently. R: Completion of Tier I writing requirement.
Experiments involving genetics of *Drosophila* and other eucaryotic organisms.

344. Human Genetics
Spring. 3(3-0)
P: ZOL 341. R: Not open to freshmen.
Inheritance of human traits. Medical, physiological and forensic applications. Biochemical and molecular genetics of human disease. Chromosomal disorders and their consequences. Prenatal and pre-symptomatic diagnosis. Legal and ethical considerations.

350. Histology
Fall. 4(3-3)
P: BS 111 or LBS 145.
The structure of cells and their interactions to form tissues.

353. Marine Biology
Fall of even-numbered years. 4(4-0)
P: BS 110; BOT 250 or ZOL 250 or ZOL 306.
Analysis of marine and estuarine systems. Integration of biology, chemistry, and physics. Life histories of marine organisms. Biology of special marine habitats. Physiological problems of marine life.

355. Ecology
Fall. 3(3-0) Summer. 3 credits. Given only at W.K. Kellogg Biological Station. Interdepartmental with Botany and Plant Pathology.
P: BS 110 or LBS 144. R: Completion of Tier I writing requirement.
Plant and animal ecology. Interrelationships of plants and animals with the environment. Principles of population, community, and ecosystem ecology. Application of ecological principles to global sustainability.
SA: ZOL 250

355L. Ecology Laboratory
Fall. 1 credit. Summer. 1 credit. Given only at W.K. Kellogg Biological Station. Interdepartmental with Botany and Plant Pathology.
P: ZOL 355 or concurrently. R: Completion of Tier I writing requirement.
Population, community and ecosystem ecology utilizing plant and animal examples to demonstrate general field principles.

360. Biology of Birds
Spring. 4(3-3) Summer. 4 credits. Given only at W.K. Kellogg Biological Station.
P: BS 110 or LBS 144.
The behavior, ecology, evolution, and systematics of birds with emphasis on biodiversity. Laboratories emphasize diversity of form and function, life history patterns, and identification.

361. Michigan Birds
Summer. 4 credits. Given only at W.K. Kellogg Biological Station.
P: BS 110 or LBS 144 R: Not open to students with credit in ZOL 384 or ZOL 360.
Field study of avian diversity, ecology, and behavior using current systematics and habitat identification techniques.

365. Biology of Mammals
Fall. 4(3-3)
P: BS 110 or LBS 144
Analysis of the behavior, ecology, evolution, and systematics of mammals. Laboratories emphasize diversity of form and function, life history patterns, and identification. Field trips required.

366. Biology of Great Lakes Mammals
Summer. 4 credits. Given only at W.K. Kellogg Biological Station.
P: BS 110 or LBS 144
Diversity, ecology, and behavior of mammals. Laboratory and field studies emphasizing systematics, life-history and field techniques.

369. Introduction to Zoo and Aquarium Science
Spring. 3(3-0) Interdepartmental with Landscape Architecture, Fisheries and Wildlife, and Veterinary Medicine.
P: BS 110.
Fundamentals of zoo and aquarium operations including research, interpretation, design, nutrition, captive breeding, conservation, ethics and management.

**Descriptions — Zoology
of
Courses**

- 384. Biology of Amphibians and Reptiles**
Fall of odd-numbered years. 3(2-3) Summer of even-numbered years. 3 credits. Given only at W.K. Kellogg Biological Station.
P: ZOL 228.
Biology of amphibians and reptiles. Laboratory emphasis on diversity and on Michigan species. Field trips required.
- 400H. Honors Work**
Fall, Spring. 1 to 5 credits. A student may earn a maximum of 5 credits in all enrollments for this course.
R: Not open to freshmen and sophomores. Approval of department.
Honors work on a topic in zoology.
- 402. Neurobiology**
Fall. 3(3-0)
P: BS 110, BS 111 or LBS 144, LBS 145. R: Not open to freshmen and sophomores.
Structure and function of nerve cells and nervous systems.
- 412. Invertebrate Ecology**
Summer of odd-numbered years. 4 credits. Given only at W.K. Kellogg Biological Station.
P: BS 110.
Ecology and systematics of selected invertebrate phyla with emphasis on the local fauna. Extensive field and laboratory work with living animals.
- 415. Ecological Aspects of Animal Behavior**
Spring. 3(3-0)
P: ZOL 213. R: Completion of Tier I writing requirement.
Advanced topics in the ecology and evolution of animal behavior.
- 417. Advanced Developmental Biology**
Spring. 3(3-0)
P: ZOL 220 or ZOL 221. R: Not open to freshmen and sophomores.
Multidisciplinary approaches to major current concepts. Historic perspectives, analyses from molecular to organismal level, and practical applications.
SA: ZOL 417H
- 419. Advanced Earth System Science**
Spring. 3 credits. Interdepartmental with Entomology, Botany and Plant Pathology, Geological Sciences, and Sociology. Administered by Entomology.
P: ENT 319
Systems science theory applied to analysis of the biological, geological, physical, and social causes and consequences of global changes. Issues of sustaining the Earth system.
- 420. Stream Ecology**
Fall. 3 credits. Interdepartmental with Fisheries and Wildlife. Administered by Fisheries and Wildlife.
P: BS 110, CEM 141, ZOL 355
Biological and environmental factors determining structure and function of stream ecosystems.
- 421. Hormones and Development**
Fall. 3(3-0) Interdepartmental with Physiology.
P: ZOL 320. R: Completion of Tier I writing requirement.
Hormonal regulation of development, growth and cancer. Hormonal decline in aging.
- 425. Cells and Development**
Spring. 4(3-3)
P: BS 110, BS 111 or LBS 144, LBS 145. R: Completion of Tier I writing requirement.
The role of cells in growth, differentiation and development of animals from protozoa to mammals.
SA: ZOL 221
- 426. Biogeochemistry**
Summer. 3 credits. Given only at W.K. Kellogg Biological Station. Interdepartmental with Microbiology, Geological Sciences, and Crop and Soil Sciences. Administered by Microbiology.
P: BS 110 or BS 111, CEM 143 or CEM 251.
Integration of the principles of ecology, microbiology, geochemistry, and environmental chemistry. Societal applications of research in aquatic and terrestrial habitats.
- 427. Protozoology**
Spring. 3(3-0)
P: BS 110, BS 111
Structure and function of animal-like, eukaryotic microorganisms. Evolutionary relationships with other protists and higher organisms. Their interaction with other organisms and use in applied areas of biology.
- 431. Comparative Limnology**
Summer. 4 credits. Given only at W.K. Kellogg Biological Station. Interdepartmental with Botany and Plant Pathology, and Fisheries and Wildlife.
P: CEM 141 or CEM 151; ZOL 250. R: Not open to students with credit in FW 472.
Physical, chemical, and biological aspects of lakes and streams. Introduction to freshwater biology, and population and community ecology.
- 433. Vertebrate Paleontology**
Fall of even-numbered years. 4(3-2) Interdepartmental with Geological Sciences. Administered by Geological Sciences.
P: ZOL 228. R: Not open to students with credit in GLG 331.
Fossil vertebrates with emphasis on evolution of major groups. Modern techniques of collection, identification and interpretation of fossils.
- 434. Evolutionary Paleobiology**
Fall. 4(3-2) Interdepartmental with Geological Sciences. Administered by Geological Sciences.
P: BS 110 or GLG 201.
Patterns and processes of evolution known from the fossil record including speciation, phylogeny, extinction, heterochrony and biogeography.
- 444. Conservation Biology**
Fall. 3 credits. Interdepartmental with Fisheries and Wildlife. Administered by Fisheries and Wildlife.
P: BS 110. R: Completion of Tier I writing requirement.
Ecological theories and methodologies to manage species, communities and genetic diversity on a local and global scale.
- 445. Evolution**
Fall. 3(3-0) Interdepartmental with Botany and Plant Pathology.
P: ZOL 341. R: Not open to freshmen. Completion of Tier I Writing Requirement
Processes of evolutionary change in animals, plants. Microbes. Population genetics, microevolution, speciation, adaptive radiation, macroevolution. Origin of Homo sapiens.
SA: ZOL 345
- 446. Environmental Issues and Public Policy**
Spring. 3(3-0) Interdepartmental with Resource Development.
R: Not open to freshmen and sophomores.
The interrelationship of science and public policy in resolving environmental issues. Technical, social, economic, and legal influences. Case study approach.
- 450. Cancer Biology**
Spring. 3(3-0) Interdepartmental with Medicine.
P: BCH 200 or BCH 401; ZOL 221.
Cancer biology: cellular and molecular aspects. Applications of modern biotechnology to cancer research. Causes, treatment and prevention of cancer. World distribution and risk factors of cancer.
- 453. Field Studies in Marine and Estuarine Biology**
Summer. 2 to 3 credits. A student may earn a maximum of 5 credits in all enrollments for this course.
R: Approval of instructor.
Marine and estuarine communities emphasizing ecology, life histories, behavior, and resource ecology of the organisms present. Field trip to seacoast.
- 457. Foundations of Evolutionary Biology**
Spring. 3(3-0)
P: BS 110. R: Completion of Tier I writing requirement.
Reading and discussion of original works in evolutionary biology which have shaped modern evolutionary thought.
- 460. The Biology of Molluscs**
Spring. 3(3-0)
P: ZOL 306 or approval of department
Biology, economic importance, and role of molluscs in biological research.
- 472. Limnology**
Fall. 3(3-0) Interdepartmental with Fisheries and Wildlife. Administered by Fisheries and Wildlife.
P: CEM 141, ZOL 250. R: Not open to students with credit in ZOL 431.
Ecology of lakes with emphasis on interacting physical, chemical, and biological factors affecting their structure and function.
- 474. Fishery and Limnological Techniques**
Fall. 3(1-6) Interdepartmental with Fisheries and Wildlife. Administered by Fisheries and Wildlife.
P: FW 472 or concurrently.
Field and laboratory investigations of physical, chemical, and biological parameters of lakes and streams. Field trips required.
- 482. Cytochemistry**
Spring. 4(3-3)
P: ZOL 350. R: Completion of Tier I writing requirement.
Principles of microscopy, microtomy. Cells and organelles. Localization of lipids, carbohydrates, proteins, nucleic acids and enzymes using cytochemical, immunological and autoradiographic methods.
- 483. Environmental Physiology**
Spring. 4(4-0) Interdepartmental with Physiology.
P: ZOL 328 or ZOL 355. R: Completion of Tier I writing requirement.
Aspects of physiology important to the environmental relations of vertebrates and invertebrates: energetics, thermal relations, osmotic-ionic relations, and exercise physiology.
- 485. Tropical Biology**
Spring. 3(3-0) Interdepartmental with Botany and Plant Pathology, and Entomology.
P: ZOL 250. R: Open only to juniors and seniors.
Tropical biota emphasizing evolutionary and ecological principles compared across tropical ecosystems.
- 485L. Field Tropical Biology**
Spring, Summer. 2 credits. Interdepartmental with Botany and Plant Pathology, and Entomology.
P: ZOL 485 or concurrently. R: Open only to juniors and seniors. Approval of department.
Intensive field experience to study tropical ecosystems. Individual project required. Given at various sites in Costa Rica by the Organization for Tropical Studies.
- 489. Capstone: Seminar in Zoo and Aquarium Science**
Fall, Spring. 1(1-0) A student may earn a maximum of 3 credits in all enrollments for this course. Interdepartmental with Park, Recreation and Tourism Resources, and Fisheries and Wildlife.
R: Approval of department.
Scientific writing and oral presentations related to zoo and aquarium studies.

- 494. Capstone: Independent Study**
Fall. 1 to 6 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Approval of department.
Supervised research on a topic not normally covered in the classroom.
- 495. Capstone: Undergraduate Seminar**
Fall, Spring. 1(1-0) A student may earn a maximum of 3 credits in all enrollments for this course. R: Open only to senior Zoology majors.
Economic, social and environmental impact of current developments in Zoology.
- 496. Capstone: Internship in Zoology**
Fall, Spring, Summer. 1 to 6 credits. Given only at various off-campus sites. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open only to seniors. Approval of department.
Practical experience applying Zoology training in a setting outside the University.
- 498. Capstone: Internship in Zoo and Aquarium Science**
Fall, Spring, Summer. 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. Interdepartmental with Fisheries and Wildlife, and Landscape Architecture. R: Open only to juniors or seniors. Approval of department
Experience in applying zoological experience in a zoo or aquarium setting outside the university.
- 499. Capstone: Undergraduate Thesis**
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open only to seniors. Completion of Tier I writing requirement. Approval of department.
Laboratory research culminating in the preparation and defense of an undergraduate thesis.
- 811. Cellular and Neurophysiology**
Fall. 6(6-0) Interdepartmental with Physiology. Administered by Physiology.
P: BCH 462, PSL 432.
Advanced bioenergetics, transport, regulation of metabolic reactions, specialized cell functions, and neurophysiology.
- 817. Ecology and Evolution in Aquatic Systems**
Summer. 4 credits. Given only at W.K. Kellogg Biological Station. Interdepartmental with Botany and Plant Pathology, and Fisheries and Wildlife.
P: ZOL 250 or ZOL 431.
Experimental field studies of population and community ecology of freshwater lakes and streams. Emphasis on interactions among species and between biotic and abiotic factors.
- 822. Topics in Ethology and Behavioral Ecology**
Spring of odd-numbered years. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course.
P: ZOL 415. R: Open only to graduate students.
Critical analysis through seminar-discussions of the primary research literature.
- 826. Tropical Biology: An Ecological Approach**
Spring, Summer. 8 credits. Interdepartmental with Botany and Plant Pathology. Administered by Botany and Plant Pathology.
R: Approval of department; application required.
Principles of tropical ecology at the population, community, and ecosystem levels. Given at various sites in Costa Rica by the Organization for Tropical Studies.
- 827. Advanced Neurobiology**
Fall. 4(4-0) Interdepartmental with Pharmacology and Toxicology, and Physiology. Administered by Pharmacology and Toxicology.
Nervous system function at the cellular level: membrane biophysics and potentials, synaptic transmission.
- 830. Neuroendocrine Aspects of Behavior**
Spring of even-numbered years. 3(3-0)
P: ZOL 402.
Neural mechanisms by which hormones influence the reproductive, parental, and aggressive behavior of vertebrates. Plasticity.
- 831. Quantitative Paleobiology**
Spring of even-numbered years. 3(2-2) Interdepartmental with Geological Sciences. Administered by Geological Sciences.
P: GLG 431 or ZOL 345.
Analysis of paleobiological problems using quantitative techniques such as cladistics, morphometrics, ordination, and stereology.
- 841. Chromosome Structure and Genetics**
Spring of even-numbered years. 3(3-0) Interdepartmental with Genetics.
R: Approval of department.
Classical and molecular genetics of chromosome structure and behavior in mitosis and meiosis. Synapsis and disjunction, exchange, centromeres, euchromatin, heterochromatin and transposable elements.
- 842. Application of Ecological Principles**
Spring. 2 credits. Given only at W.K. Kellogg Biological Station. A student may earn a maximum of 8 credits in all enrollments for this course. Interdepartmental with Botany and Plant Pathology. Administered by Botany and Plant Pathology.
R: Approval of department.
Workshops and discussions with experts from industry, regulatory agencies, conservation groups, and academe on application of basic ecology and evolutionary biology to real-world problems.
- 843. Selected Topics in Human Genetics**
Fall. 3(3-0)
P: ZOL 344. R: Open only to seniors and graduate students.
Inheritance of human traits including medical, physiologic, forensic, biochemical, molecular and chromosomal areas.
- 844. Organelle Genetics**
Spring of odd-numbered years. 3(3-0) Interdepartmental with Botany and Plant Pathology. Administered by Botany and Plant Pathology.
P: BCH 462; ZOL 341.
Organization, structure, function, heredity, molecular biology and manipulation of chloroplasts and mitochondria. Biological interaction between nucleus and organelles.
- 845. Ecology and Evolution: the Interface**
Fall. 3(3-0) Interdepartmental with Botany and Plant Pathology, and Entomology.
P: BOT 849
Conceptual and methodological issues common to both ecology and evolutionary biology.
- 849. Evolutionary Biology**
Spring of even-numbered years. 3 credits. Interdepartmental with Botany and Plant Pathology. Administered by Botany and Plant Pathology.
P: ZOL 341, STT 422 or concurrently.
Major conceptual, theoretical and empirical questions in evolutionary biology. Readings and lectures are synthesized in student discussions and on paper.
- 851. Quantitative Methods in Ecology and Evolution**
Fall. 3(3-0) Interdepartmental with Botany and Plant Pathology.
P: STT 465.
Interpretation and analysis of ecological and evolutionary biology data. Statistical computer software.
- 853. Applied Systems Modeling and Simulation for Natural Resource Management**
Spring of odd-numbered years. 3 credits. Interdepartmental with Fisheries and Wildlife, Forestry, Resource Development, and Agricultural Engineering. Administered by Fisheries and Wildlife.
P: FW 820 or BE 486 or ZOL 851 or approval of department. R: Open only to seniors and graduate students
Mathematical models for evaluating resource management strategies. Stochastic and deterministic simulation for optimization. System control structures. Team modelling approach.
- 860. Ecology and Evolution in Terrestrial Systems**
Summer. 4 credits. Given only at W.K. Kellogg Biological Station. Interdepartmental with Botany and Plant Pathology, and Crop and Soil Sciences. Administered by Botany and Plant Pathology.
P: STT 422.
Field experimental and quantitative approaches to ecological and evolutionary mechanisms.
- 881. Soil Zoology**
Spring of even-numbered years. 4(2-6)
P: ENT 404 or ZOL 306. R: Open only to seniors and graduate students in College of Natural Science or College of Agriculture and Natural Resources.
Soil fauna and their ecology, biology, and systematics.
- 888. Molecular and Cellular Aspects of Development**
Spring. 4(4-0)
R: Approval of department.
Current research topics in developmental biology. Cell interactions. Molecular regulation of cellular function in fertilization, morphogenesis, differentiation, oncogenesis, terato-genesis and regeneration.
- 890. Special Problems**
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 10 credits in all enrollments for this course.
R: Approval of department.
Current problems in Zoology.
- 891. Current Topics in Ecology and Evolution**
Summer. 1 credit. Given only at W.K. Kellogg Biological Station. A student may earn a maximum of 8 credits in all enrollments for this course. Interdepartmental with Botany and Plant Pathology, and Crop and Soil Sciences.
Presentation and critical evaluation of theoretical and empirical developments by visiting scientists.
- 892. Biodiversity**
Spring. 2(2-0) A student may earn a maximum of 4 credits in all enrollments for this course. Interdepartmental with Fisheries and Wildlife.
P: ZOL 250.
Status of world biota and factors in the decline and extinction of major groups of plants and animals. Theory and design of natural reserves. Assessment and ecological meaning of diversity. Management for global and local diversity.
- 895. Seminar**
Fall, Spring. 1(1-0) A student may earn a maximum of 6 credits in all enrollments for this course. Graduate seminar on current research topics in Zoology.

**Descriptions — Zoology
of
Courses**

896. Population and Community Ecology

Fall. 4(4-0)

Population dynamics of animals and plants utilizing life tables and projection matrices. Species interactions. Life history theory. Structure and dynamics of communities. Succession.

897. Community and Ecosystem Ecology

Spring. 4(4-0) Interdepartmental with Botany and Plant Pathology, and Fisheries and Wildlife

Structure and function of natural communities and ecosystems. Community analysis along environmental gradients. Succession, food web analysis, energy flow, nutrient cycling, and effects of human activities on ecosystems.

899. Master's Thesis Research

Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 24 credits in all enrollments for this course.

999. Doctoral Dissertation Research

Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course.