

## Women's Studies—WS

- 490 Independent Study**  
Fall, Spring. 1 to 3 credits. A student may earn a maximum of 8 credits in all enrollments for this course. RB: (WS 201 or WS 202 or WS 203) R: Open only to juniors or seniors; approval of program.  
Individual reading and research on women and gender.
- 491 Special Topics**  
Fall, Spring. 3 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. RB: (WS 201 Or WS 202 Or WS 203) R: Not open to freshmen or sophomores.  
In-depth study of special topic emphasizing women and gender.
- 492 Women's Studies Senior Seminar (W)**  
Spring. 4(4-0) P:M: (WS 201 and WS 203) and completion of Tier I writing requirement. R: Not open to freshmen or sophomores.  
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:M: (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.

## ZOOLOGY

## ZOL

### Department of Zoology College of Natural Science

- 101 Preview of Zoology**  
Fall, Spring. 1(1-0) R: Open only to freshmen in the Zoology major.  
Zoology as a discipline. Availability of diverse career options. Integration of human and technical skills in scientific problem solving.
- 111L Cell and Molecular Biology Laboratory**  
Fall, Spring, Summer. 2(1-3) Interdepartmental with Biological Science; Microbiology and Molecular Genetics; Plant Biology. Administered by College of Natural Science. P:M: (BS111 or concurrently) Not open to students with credit in LBS 159H.  
Principles and applications of common techniques used in cell and molecular biology.
- 141 Introductory Human Genetics**  
Fall, Spring. 3(3-0) R: Not open to students in the Biochemistry, Plant Biology, Entomology, Medical Technology, Clinical Laboratory Science, Physiology, Zoology, Microbiology, Biological Science-Interdepartmental, or Human Biology majors 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:M: (BS 110 or LBS 144 or LBS 148H)  
Systematics, morphology, and natural history of invertebrate animals. Identification of live and preserved specimens. Recognition of selected groups.
- 313 Animal Behavior**  
Fall, Spring. 3(3-0) P:M: (BS 110 or LBS 144 or LBS 148H) R: Not open to freshmen. SA: ZOL 213  
Development, physiological mediation, adaptive significance and evolution of behavior.
- 316 General Parasitology**  
Spring. 3(3-0) P:M: (LBS 144 or LBS 145 or LBS 148H or LBS 149H or BS 110) or (BS 111 and BS 111L)  
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(0-2) P:M: (ZOL 316 or concurrently) R: Not Open to freshman  
Laboratory diagnosis of protozoans, helminths, acanthocephalans, copepods, and arthropods that infect humans and animals. Animal necropsy.
- 319 Introduction to Earth System Science**  
Fall. 3(3-0) Interdepartmental with Entomology; Plant Biology; Geological Sciences; Sociology. Administered by Department of Entomology. RB: 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:M: (BS 110 or LBS 144 or LBS 148H) and (BS 111 or LBS 145 or LBS 149H) SA: ZOL 220  
Principles of development, emphasizing vertebrates. Illustrations from morphological and experimental investigations.
- 328 Comparative Anatomy and Biology of Vertebrates**  
Spring. 4(3-3) P:M: (BS 110 or LBS 144 or LBS 148H) and completion of Tier I writing requirement. SA: ZOL 228  
Comparative morphology and natural history of vertebrates. Dissection of representatives of most vertebrate classes.
- 341 Fundamental Genetics**  
Fall, Spring, Summer. 4(4-0) Interdepartmental with Plant Biology. P:M: (BS 111 or LBS 145 or LBS 149H)  
Principles of heredity in animals, plants and microorganisms. Classical and molecular methods in the study of gene structure, transmission, expression and evolution.
- 343 Genetics Laboratory**  
Spring. 2(0-4) P:M: (ZOL 341 or concurrently) and completion of Tier I writing requirement.  
Experiments involving genetics of *Drosophila* and other eucaryotic organisms.

- 353 Marine Biology**  
Fall. 4(4-0) P:M: (BS 110 or LBS 144 or LBS 148H) and completion of Tier I writing requirement.  
Analysis of marine and estuarine systems. Integration of biology, chemistry, and physics. Life histories of marine organisms. Biology of special marine habitats including rocky intertidal zones, upwellings, coral reefs and deep sea.
- 355 Ecology**  
Fall, Spring, Summer. 3(3-0) Interdepartmental with Plant Biology. P:M: (BS 110 or LBS 144 or LBS 148H) SA: ZOL 250  
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.
- 355L Ecology Laboratory**  
Fall, Spring, Summer. 1(0-3) Interdepartmental with Plant Biology. P:M: (ZOL 355 or concurrently or PLB 355 or concurrently) and 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**  
Fall. 4(3-3) P:M: (BS 110 or LBS 144 or LBS 148H)  
Behavior, ecology, evolution, and systematics of birds; biodiversity. Laboratories emphasize diversity of form and function, life history patterns, and identification.
- 361 Michigan Birds**  
Summer. 4(3-3) Summer: Given only at W.K. Kellogg Biological Station. P:M: (BS 110 or LBS 144 or LBS 148H) Not open to students with credit in ZOL 360.  
Field study of avian diversity, ecology, and behavior using current systematics and habitat identification techniques.
- 365 Biology of Mammals**  
Spring. 4(3-3) P:M: (BS 110 or LBS 144 or LBS 148H)  
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.
- 369 Introduction to Zoo and Aquarium Science**  
Spring. 3(3-0) Interdepartmental with Landscape Architecture; Fisheries and Wildlife; Veterinary Medicine. P:M: (BS 110 or LBS 144 or LBS 148H)  
Fundamentals of zoo and aquarium operations including research, interpretation, design, nutrition, captive breeding, conservation, ethics and management.
- 370 Introduction to Zoogeography**  
Fall. 3(3-0) Interdepartmental with Fisheries and Wildlife; Geography. P:M: (ZOL 355)  
Patterns of geographical distribution of animals and the ecological and historical processes leading to these patterns.
- 384 Biology of Amphibians and Reptiles**  
Fall. 4(3-3) P:M: (BS 110 or LBS 144 or LBS 148H)  
The evolution, systematics, ecology, and behavior of amphibians and reptiles. Laboratory emphasizes diversity and identification of families and Great Lakes species. Field trips may be 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 or sophomores. Approval of the department.  
Honors work on a topic in zoology.
- 402 Neurobiology**  
Fall, Spring. 3(3-0) P:M: (BS 110 or LBS 144 or LBS 148H) and (BS 111 or LBS 145 or LBS 149H) R: Not open to freshmen or sophomores.  
Structure and function of nerve cells and nervous systems.
- 404 Human Genetics**  
Spring. 3(3-0) P:M: (ZOL 341) and (BMB 401 or concurrently or BMB 461 or concurrently) and completion of Tier I writing requirement. SA: ZOL 344  
Inheritance of human traits. Medical, molecular, physiological and forensic applications. Biochemical, clinical, and molecular genetics of human disease. Prenatal, pre-symptomatic, and clinical diagnosis. Ethical, legal and social considerations.
- 408 Histology**  
Fall. 4(3-3) P:M: (BS 111 or LBS 145 or LBS 149H) SA: ZOL 350  
Structure of cells and their interactions to form tissues.
- 413 Laboratory in Behavioral Neuroscience (W)**  
Fall. 4(2-4) Interdepartmental with Psychology. Administered by Department of Psychology. P:M: (PSY 209 or ZOL 402) and (PSY 295 or concurrently or STT 201) and completion of Tier I writing requirement. SA: PSY 309  
Theory and laboratory experience in the study of behavioral neuroscience. Relationship among hormones, brain, and behavior.
- 415 Ecological Aspects of Animal Behavior**  
Spring. 3(3-0) P:M: (ZOL 313) and completion of Tier I writing requirement.  
Advanced topics in the ecology and evolution of animal behavior.
- 419 Advanced Earth System Science**  
Spring. 3(2-2) Interdepartmental with Entomology; Plant Biology; Geological Sciences; Sociology. Administered by Department of Entomology. P:M: (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(3-0) Interdepartmental with Fisheries and Wildlife. Administered by Department of Fisheries and Wildlife. P:M: (BS 110) RB: (CEM 141 and ZOL 355)  
Biological and environmental factors determining structure and function of stream ecosystems.
- 422 Aquatic Entomology**  
Fall of odd years. 3(2-3) Interdepartmental with Entomology; Fisheries and Wildlife. Administered by Department of Entomology. P:M: (BS 110) SA: ENT 420  
Biology, ecology and systematics of aquatic insects in streams, rivers and lakes. Field trips and aquatic insect collection required.
- 424 Algal Biology**  
Fall of even years. Summer of odd years. 4(2-4) Summer: KBS. Interdepartmental with Plant Biology. Administered by Department of Plant Biology. P:M: (BS 110 or LBS 144 or LBS 148H) and completion of Tier I writing requirement. RB: (ZOL 355 and ZOL 355L) or (PLB 441) SA: BOT 424  
Algal taxonomy, systematics, physiology, ecology, and environmental assessment. Lab focus on identification of freshwater algal genera collected from regional habitats. Field trips required.
- 425 Cells and Development**  
Spring. 4(3-3) P:M: (BS 111 and BS 111L) or (LBS 145) or (LBS 149H) and completion of Tier I writing requirement. SA: ZOL 221  
The role of cells in growth, differentiation and development of animals from protozoa to mammals.
- 426 Biogeochemistry**  
Summer. 3 credits. Summer: Given only at W.K. Kellogg Biological Station. Interdepartmental with Microbiology and Molecular Genetics; Crop and Soil Sciences; Geological Sciences. Administered by Department of Microbiology and Molecular Genetics. RB: (BS 110 or LBS 144 or LBS 148H or BS 111 or LBS 145 or LBS 149H) and (CEM 143 or CEM 251) SA: MPH 426  
Integration of the principles of ecology, microbiology, geochemistry, and environmental chemistry. Societal applications of research in aquatic and terrestrial habitats.
- 428 Frontiers in Developmental and Tissue Biology**  
Fall. 3(3-0) RB: (BS 111 or ZOL 320) or (ZOL 408 and BMB 401) and completion of Tier I writing requirement.  
Integrated approach to common cellular mechanisms in normal and abnormal development, tissue regeneration, stem cell biology and differentiation. Tissue engineering, tissue and organ replacement and chronic diseases, such as arthritis, cancer, diabetes and Parkinson's disease.
- 430 Neuroendocrine Aspects of Behavior**  
Spring of odd years. 3(3-0) P:M: (ZOL 313 and ZOL 402) R: Open only to juniors or seniors in the Psychology or Zoology major. SA: ZOL 830  
Neural mechanisms by which hormones influence the reproductive, parental, aggressive and social behavior of vertebrates. Plasticity.
- 431 Comparative Limnology**  
Summer. 4(2-6) Summer: Given only at W.K. Kellogg Biological Station. Interdepartmental with Plant Biology; Fisheries and Wildlife. P:M: (CEM 141 or CEM 151) and (ZOL 355) 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 years. 4(3-2) Interdepartmental with Geological Sciences. Administered by Department of Geological Sciences. P:M: (ZOL 328)  
Fossil vertebrates with emphasis on evolution and interrelationships of major groups. Modern techniques of identification and interpretation of fossils.
- 434 Evolutionary Paleobiology**  
Fall. 4(3-2) Interdepartmental with Geological Sciences. Administered by Department of Geological Sciences. RB: (BS 110 or GLG 304 or LBS 144 or LBS 148H)  
Patterns and processes of evolution known from the fossil record including speciation, phylogeny, extinction, heterochrony and biogeography.
- 440 Field Ecology and Evolution**  
Summer. 4 credits. Summer: Given only at W.K. Kellogg Biological Station. Interdepartmental with Plant Biology. P:M: (ZOL 355)  
Solving conceptual and practical research problems in ecology and evolution under field conditions.
- 443 Restoration Ecology**  
Spring. 3(2-2) Interdepartmental with Fisheries and Wildlife; Biosystems Engineering. Administered by Department of Fisheries and Wildlife. RB: (CSS 210 or BE 230) and (FOR 404 or FW 364 or ZOL 355)  
Principles of ecological restoration of disturbed or damaged ecosystems. Design, implementation, and presentation of restoration plans. Field trips required.
- 444 Conservation Biology**  
Fall. 3(3-0) Interdepartmental with Fisheries and Wildlife. Administered by Department of Fisheries and Wildlife. P:M: (ZOL 355 or FOR 404) and 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 Plant Biology. P:M: (ZOL 341) and completion of Tier I writing requirement. R: Not open to freshmen. SA: ZOL 345  
Processes of evolutionary change in animals, plants, microbes. Population genetics, microevolution, speciation, adaptive radiation, macroevolution. Origin of Homo sapiens.
- 446 Environmental Issues and Public Policy**  
Fall, Spring. 3(3-0) Interdepartmental with Resource Development. R: Not open to freshmen or sophomores.  
Interrelationship of science and public policy in resolving environmental issues. Technical, social, economic, and legal influences. Case study approach.
- 447 Practical Applications of Landscape Ecology**  
Fall. 3(1-4) P:M: (BS 110) RB: (CSE 101) and (ZOL 355)  
Concepts and techniques of landscape ecology. Issues and resource management. Simulation of changes in landscape metrics, disturbance, and connectivity and metapopulations.
- 450 Cancer Biology**  
Spring. 3(3-0) P:M: (BMB 200 or BMB 401 or ZOL 425) or (BMB 461 and BMB 462) and completion of Tier I writing requirement.  
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.

## Zoology—ZOL

- 453 Field Studies in Marine and Estuarine Biology**  
Spring. 2 to 3 credits. A student may earn a maximum of 5 credits in all enrollments for this course. R: Approval of department.  
Marine and estuarine communities emphasizing ecology, life histories, behavior, identification, morphology, and resource ecology of the organisms present. Field trip to sea coast.
- 457 Foundations of Evolutionary Biology**  
Spring. 3(3-0) P:M: (BS 110 or LBS 144 or LBS 148H) and 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 of even years. 3(3-0) P:M: (ZOL 306)  
Biology, economic importance, and role of molluscs in biological research.
- 471 Ichthyology**  
Fall. 4(3-3) Interdepartmental with Fisheries and Wildlife. Administered by Department of Fisheries and Wildlife. P:M: (BS 110) and completion of Tier I writing requirement.  
Fish morphology, physiology. Development, behavior, evolution and ecology. World fishes with emphasis on freshwater fishes.
- 472 Limnology**  
Spring. 3(3-0) Interdepartmental with Fisheries and Wildlife. Administered by Department of Fisheries and Wildlife. P:M: (CEM 141 and ZOL 355) Not open to students with credit in BOT 431 or FW 431 or ZOL 431.  
Ecology of lakes with emphasis on interacting physical, chemical, and biological factors affecting their structure and function.
- 474 Limnological and Fisheries Techniques**  
Fall. 3(1-6) Interdepartmental with Fisheries and Wildlife. Administered by Department of Fisheries and Wildlife. P:M: (FW 472 or FW 414 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:M: (BS 111) and 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:M: (BS 110 or LBS 144 or LBS 148H) and (BS 111 or LBS 145 or LBS 149H) and (CEM 141 or CEM 151 or CEM 181H or LBS 171) and 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 Plant Biology; Entomology. P:M: (ZOL 355) R: Open only to juniors or seniors.  
Tropical biota emphasizing evolutionary and ecological principles compared across tropical ecosystems.
- 489 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; Fisheries and Wildlife; Landscape Architecture. R: Approval of department.  
Scientific writing and oral presentations related to zoo and aquarium studies.
- 490 Overseas Study in Zoology**  
Fall, Spring, Summer. 3 to 6 credits. A student may earn a maximum of 6 credits in all enrollments for this course. RB: (BS 110 and BS 111) R: Open only to juniors or seniors or graduate students. Approval of department.  
Topical problems course in Zoology or coordinated by Zoology faculty in foreign countries.
- 491 Seminar in Marine Biology**  
Fall, Spring. 1(1-0) RB: (ZOL 355 or ZOL 353 or GLG 303) R: Open only to seniors in the Department of Zoology.  
Reading and discussion of articles relating to current developments in marine biology and the economic, social and environmental impact of these discoveries.
- 494 Independent Study**  
Fall, Spring, Summer. 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 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 Internship in Zoology**  
Fall, Spring, Summer. 1 to 6 credits. Summer: 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 Internship in Zoo and Aquarium Science**  
Fall, Spring, Summer. 3 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. Interdepartmental with Fisheries and Wildlife; Landscape Architecture. R: Open only to juniors or seniors. Approval of department.  
Application of zoological experience in a zoo or aquarium setting outside the university.
- 499 Undergraduate Thesis**  
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 8 credits in all enrollments for this course. P:M: Completion of Tier I writing requirement. R: Open only to seniors. Approval of department.  
Laboratory research culminating in the preparation and defense of an undergraduate thesis.