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.

141  Introductory Human Genetics
Fall, Spring. 3(3-0) R: Not open to students in the Biochemistry and Molecular Biology major or Plant Biology major or Entomology major or Medical Technology major or Clinical Laboratory Sciences major or Physiology major or Zoology major or Microbiology and Molecular Genetics major or Biological Science-Interdepartmental major or Human Biology major. Not open 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.

162  Organismal and Population Biology
Fall, Summer. 3(3-0) Interdepartmental with Biological Science and Plant Biology. Administered by Biological Science. P: BS 161 or BS 181H or LB 145 SA; BS 110, BS 148H Not open to students with credit in BS 182H or LB 144.

172  Organismal and Population Biology Laboratory
Fall, Summer. 2(1-3) Interdepartmental with Biological Science and Plant Biology. Administered by Biological Science. P: (BS 162 or concurrently) or (BS 182H or concurrently) SA: BS 110, BS 158H Not open to students with credit in BS 192H or LB 144.
Nature and process of organismal biology including experimental design, statistical methods, hypothesis testing in genetics, ecology, and evolution.

192H  Honors Organismal and Population Biology Laboratory
Fall, 2(1-3) Interdepartmental with Biological Science and Lyman Briggs and Plant Biology. Administered by Biological Science. P: BS 182H or concurrently SA: BS 184H, BS 110 Not open to students with credit in BS 172 or LB 144.
Nature and process of organismal biology, including experimental design and statistical methods, hypothesis testing, genetics, ecology, and evolution.

303  Oceanography
Fall, 4(4-0) Interdepartmental with Geological Sciences. Administered by Zoology. P: (CEM 141 or CEM 181H or LB 171) and (PHY 231 or PHY 181 or PHY 193H or LB 273)
Physical, chemical, biological, and geological aspects of oceanography: ocean circulation, waves, tides, air-sea interactions, chemical properties of ocean water, ocean productivity, shoreline processes, and sediments.

306  Invertebrate Biology
Fall, 4(3-3) P: BS 162 or LB 144 or BS 182H Systematics, morphology, and natural history of invertebrate animals. Identification of live and preserved specimens. Recognition of selected groups.

310  Psychology and Biology of Human Sexuality
Fall, Spring. 3(3-0) Interdepartmental with Neuroscience and Psychology. Administered by Neuroscience. P: (PSY 101 or concurrently) and (BS 161 or concurrently) or (BS 162 or concurrently) or (BS 181H or concurrently) or (BS 182H or concurrently) or (BS 192H or concurrently) Not open to students with credit in HDFS 445.

313  Animal Behavior
Fall, Spring. 3(3-0) P: BS 162 or LB 144 or BS 182H 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: LB 144 or BS 162 or BS 182H
Identification, life history, host-parasite relationships, and epidemiology of protozoan, helminth, arthropod parasites of animals and humans.

319  Introduction to Earth System Science
Fall, 3(3-0) Interdepartmental with Entomology and Geological Sciences and Plant Biology and Sociology. Administered by 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.
369 Introduction to Zoo and Aquarium Science
Spring. 3(3-0) Interdepartmental with Fisheries and Wildlife and Landscape Architecture and Veterinary Medicine. Administered by Zoology. P: BS 162 or LB 144 or BS 182H 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 and Geography. FOr Zoology. P: (ZOL 355) Patterns of geographical distribution of animals and the ecological and historical processes leading to these patterns.

384 Biology of Amphibians and Reptiles (W)
Fall. 4(3-3) P: (BS 162 or LB 144 or BS 182H) and completion of Tier I writing requirement.
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 department. Honors work on a topic in zoology.

402 Neurobiology
Fall, Spring. 3(3-0) P: (BS 162 or LB 144 or BS 182H) and (BS 161 or LB 145 or BS 181H) R: Not open to freshmen or sophomores. Structure and function of nerve cells and nervous systems.

403 Integrative Neurobiology
Spring. 3(3-0) P: ZOL 402 or PSY 209 RB: Junior or Senior level
How the nervous system has evolved mechanisms to determine the location and significance of physical and social sensory information. Epigenetic factors that guide nervous system development.

408 Histology
Fall. 4(3-3) P: BS 161 or LB 145 or BS 181H 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 Psychology. P: (PSY 209 or ZOL 402) and (IPSY 295 or STT 231) 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 (W)
Spring. 3(3-0) P: (ZOL 313) and completion of Tier I writing requirement
Advanced topics in the ecology and evolution of animal behavior.

420 Stream Ecology
Fall. 3(3-3) Interdepartmental with Fisheries and Wildlife. Administered by Fisheries and Wildlife. P: ZOL 355 or approval of department RB: CEM 141
Biological and environmental factors determining structure and function of stream ecosystems.

422 Aquatic Entomology
Fall of odd years. 3(2-3) Interdepartmental with Entomology and Fisheries and Wildlife.
Administered by Entomology. P: BS 162 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) Interdepartmental with Plant Biology. Administered by Plant Biology. P: (BS 162 or LB 144 or BS 182H) and (BS 172 and completion of Tier I writing requirement) RB: ZOL 355 and ZOL 355L SA: BOT 424
Algal taxonomy, systematics, physiology, ecology, and environmental assessment. Lab focus on identification of freshwater algal genera collected from regional habitats.

425 Cells and Development (W)
Spring. 4(3-3) P: (BS 161 and BS 171) or LB 145 or (BS 181H and BS 191H) 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.

433 Vertebrate Paleontology
Fall of even years. 4(3-2) Interdepartmental with Geological Sciences. Administered by Geological Sciences. P: ZOL 328 or GLG 304
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 Geologi- cal Sciences. Administered by Geological Sciences. RB: BS 162 or GLG 304 or LB 144 or BS 182H 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. Interdepartmental with Plant Biology. Administered by Zoology. P:
ZOL 355
Solving conceptual and practical research problems in ecology and evolution under field conditions.

443 Restoration Ecology
Spring. 3(2-2) Interdepartmental with Bio- systems Engineering and Fisheries and Wildlife and Plant Biology. Administered by Fisheries and Wildlife. P: FOR 404 or PLB 441 or ZOL 355 RB: CSS 210 or BE 230 Principles of ecological restoration of disturbed or damaged ecosystems. Design, implementation, and presentation of restoration plans. Field trips required.

444 Conservation Biology
Spring. 3(3-0) Interdepartmental with Fisheries and Wildlife. Administered by Fisheries and Wildlife. P: (ZOL 355 or FOR 404 or PLB 441) and completion of Tier I writing requirement
Eological theories and methodologies to manage species, communities and genetic diversity on a local and global scale.

445 Evolution (W)
Fall. 3(3-0) Interdepartmental with Crop and Soil Sciences and Plant Biology. Administered by Zoology. P: (ZOL 341 or CSS 350) and completion of Tier I writing requirement R: Not open to freshmen. SA: ZOL 345

445L Evolution Laboratory
Spring. 1(0-3) P: ZOL 445 or concurrently Computer, laboratory and field based studies of evolution, utilizing plant, animal and microbiological examples to demonstrate general evolutionary principles.

446 Environmental Issues and Public Policy
Fall. 3(3-0) Interdepartmental with Environ- mental Studies and Agriscience. Adminis- tered by Zoology. 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.

450 Cancer Biology (W)
Spring. 3(3-0) P: (BMB 200 or BMB 401 or ZOL 425) or (BMB 461 and BMB 462) and completion of Tier I writing requirement.

471 Ichthyology
Spring. 4(3-3) P: ZOL 461 and ZOL 462 RB: ZOL 461 and ZOL 462

472 Limnology
Spring. 3(3-0) Interdepartmental with Fisher- ies and Wildlife. Administered by Fisheries and Wildlife. P: (BS 162 and BS 172) or (BS 182H and BS 192H) or LB 144) and Completion of Tier I Writing Requirement Fish morphology and physiology. Development, behavior, evolution, and ecology. World fishes with emphasis on freshwater fishes. Field trips required.

474 Field and Laboratory Techniques for Aquatic Studies
Fall. 3(2-3) Interdepartmental with Fisheries and Wildlife. Administered by Fisheries and Wildlife. P: (FW 101L or FW 238) and completion of Tier I writing requirement SA: FW 470
Field and laboratory techniques for the investigation and analysis of lake and stream ecosystems and their biota. Field trips required.
483 Environmental Physiology (W) Spring. 4(4-0) Interdepartmental with Physiology. Administered by Zoology. P: (BS 161 or LB 145 or BS 181H) and completion of Tier I writing requirement) and (BS 162 or LB 144 or BS 182H) and (CEM 141 or CEM 151 or CEM 181H or LB 171)

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 Entomology and Plant Biology. Administered by Zoology. P: 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 6 credits in all enrollments for this course. Prerequisites: (BS 162 or LB 144 or BS 182H) and (BS 161 or LB 145 or BS 181H) R: Open to seniors or graduate students. Approval of department.

Topical problems course in Zoology or coordinated by Zoology faculty in foreign countries.

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 162 or LB 144 or BS 182H) and (BS 161 or LB 145 or BS 181H) R: Open to seniors or graduate students. Approval of department.

Scientific writing and oral presentations related to zoo and aquarium studies.

498 Internship in Zoo and Aquarium Science Fall, Spring, Summer. 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. Prerequisites: (BS 162 or LB 144 or BS 182H) and (BS 161 or LB 145 or BS 181H) R: Open to juniors or seniors. Approval of department.

Application of zoological experience in a zoo or aquarium setting outside the University.

801 Professional Development Fall. 1(2-0) R: Open only to graduate students in the Department of Zoology.

Ethical conduct in research. Selecting research topics and approaches. Scientific writing, grantmanship, and publication. Career paths inside and outside academia.

804 Molecular and Developmental Neurobiology Fall. 3(3-0) Interdepartmental with Neuroscience and Pathobiology and Diagnostic Investigation and Pharmacology and Toxicology and Psychology. Administered by Neuroscience. RB: Bachelor's degree in a Biological Science or Psychology. R: Open to graduate students in Neuroscience major.

Nervous system specific gene transcription and translation. Maturation, degeneration, plasticity, and repair in the nervous system.

822 Topics in Ethology and Behavioral Ecology Spring of odd years. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course. RB: ZOL 415 R: Open only to graduate students.

Critical analysis through seminar-discussions of the primary research literature.

824 Stable Isotope Biogeochemistry Spring. 2(1-2) Interdepartmental with Geological Sciences. Administered by Zoology. RB: CEM 142 or CEM 152 or CEM 182H or LB 171

Principles of stable isotope chemistry applied to biogeochemical problems: climate change, ecology, contaminants, oceanography, limnology, and paleobiology.

826 Tropical Biology: An Ecological Approach Spring. Summer. 8 credits. Interdepartmental with Plant Biology. Administered by Plant Biology. R: Approval of department; application required. SA: BOT 826

Principles of tropical ecology at the community level. Given at various sites in Costa Rica by the Organization for Tropical Studies.

839 Systems Neuroscience Spring. 4(4-0) Interdepartmental with Human Anatomy and Neuroscience and Pharmacology and Toxicology and Psychology. Administered by Neuroscience. R: Open only to graduate students in the Colleges of Human Medicine, Osteopathic Medicine, Agriculture and Natural Resources, Natural Science, Social Science, and Veterinary Medicine. SA: ANT 839

Anatomy, pharmacology, and physiology of multicellular nervous systems. Sensory, motor, autonomic, and chemo-regulatory systems in vertebrate brains.

848 Current Topics in Evolutionary Development Biology Spring. 3(3) R: ZOL 450 or ZOL 320 or ZOL 425 or ZOL 341 or background in evolutionary biology or developmental biology.

Genetic and developmental basis for evolutionary change. Synthesis of molecular and developmental genetics with evolutionary biology. Discussion of primary literature in evolutionary development.
Evolutionary Biology
Spring. 3(3-0) Interdepartmental with Plant Biology. Administered by Plant Biology. RB: ZOL 341 and (STT 422 or concurrently) SA: BOT 849
Major conceptual, theoretical and empirical questions in evolutionary biology. Readings and lectures are synthesized in student discussions and papers.

Statistical Methods for Ecology and Evolution
Fall. 3(2-2) Interdepartmental with Plant Biology. Administered by Zoology. RB: (STT 814) or an equivalent course.
Statistical modeling and interpretation of biological data using computationally intensive methods for estimation and inference. General linear models, mixed and process models, and estimation strategies applied to students using their own data using the R language.

Molecular Evolution: Principles and Techniques
Fall of odd years. 3(3-0) Interdepartmental with Microbiology and Molecular Genetics and Plant Biology. Administered by Zoology. RB: ZOL 341 or ZOL 445
Current techniques used to characterize and compare genes and genomes. Genetic variation, assays of variation. Data analysis and computer use to conduct a phylogenetic analysis to compare organisms and infer relationships.

Wildlife Disease Ecology
Spring of even years. 3(3-0) Interdepartmental with Fisheries and Wildlife and Large Animal Clinical Sciences. Administered by Zoology and Fisheries and Wildlife. RB: Additional course work in ecology, zoology, microbiology and environmental sciences. R: Open to graduate students. Not open to students with credit in FW 463.
Role of wildlife disease in ecological interactions, factors underlying pathogen emergence, mathematical modeling of infectious diseases, conservation medicine.

Nature and Practice of Cognitive Science
Spring. 3(3-0) Interdepartmental with Computer Science and Engineering and Linguistics and Philosophy and Psychology. Administered by Zoology. RB: Undergraduate course work in behavioral biology, cognitive psychology, philosophy, linguistics, or artificial intelligence.
Survey of how different disciplines explore the cognitive processes underlying intelligent behavior.

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.

Current Topics in Ecology and Evolution
Summer. 1 to 2 credits. A student may earn a maximum of 10 credits in all enrollments for this course. Interdepartmental with Crop and Soil Sciences and Plant Biology. Administered by Zoology.
Presentation and critical evaluation of theoretical and empirical developments in ecology and evolutionary biology by visiting scientists.

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.

Population and Community Ecology
Fall. 4(4-0) Interdepartmental with Plant Biology. Administered by Zoology.

Ecosystem Ecology and Global Change
Spring of odd years. 4(4-0) Interdepartmental with Fisheries and Wildlife and Plant Biology. Administered by Zoology.
Structure and function of natural ecosystems and their responses to global environmental change. Biogeochemical cycles, food webs, energy flow, nutrient cycling, and ecosystem management and restoration.

Population and Community Ecology Theory Laboratory
Fall. 1(0-3) Interdepartmental with Plant Biology. Administered by Plant Biology. RB: 1 semester of calculus
Practical experience designing and analyzing mathematical models in ecology from single species to communities, food webs and ecosystems.

Master's Thesis Research
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 36 credits in all enrollments for this course.
Master's thesis research.

Doctoral Dissertation Research
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 36 credits in all enrollments for this course.
Doctoral dissertation research.