

INTEGRATIVE BIOLOGY

IBIO

Department of Integrative Biology College of Natural Science

101 Exploring Biology

Fall, Spring. 1(1-0) R: Open to freshmen or sophomores in the Department of Integrative Biology or in the Lyman Briggs College or in the Environmental Biology/Zoology Major or in the Bachelor of Science in Zoology or in the Bachelor of Arts in Zoology or in the Lyman Briggs Environmental Biology/Zoology Coordinate Major or in the Lyman Briggs Zoology Coordinate Major. SA: ZOL 101

Biology as a discipline. Investigation of diverse career options and of skills and background knowledge required to be a modern biologist. Integration of human and technical skills in scientific scholarship and inquiry.

150 Integrating Biology: From DNA to Populations

Fall, Spring. 3(3-0) P: ((MTH 103 or concurrently) or (MTH 110 or concurrently) or (MTH 112 or concurrently) or (MTH 116 or concurrently) or (MTH 124 or concurrently) or (MTH 132 or concurrently) or (LB 118 or concurrently) or (MTH 201 or concurrently) or (STT 200 or concurrently) or (STT 201 or concurrently)) or designated score on Mathematics Placement test R: Not open to undergraduate students in the Department of Integrative Biology.

Examine biological systems across multiple levels of organization - spatial, temporal, taxonomic - using evolutionary biology as the common thread.

162 Organismal and Population Biology

Fall, Spring, 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.

Biological diversity and organismal biology. Principles of evolution, transmission genetics, population biology, community structure, ecology.

172 Organismal and Population Biology Laboratory

Fall, Spring, 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.

182H Honors Organismal and Population Biology

Fall. 3(3-0) Interdepartmental with Biological Science and Lyman Briggs and Plant Biology. Administered by Biological Science. SA: BS 148H, BS 110 Not open to students with credit in LB 144.

Diversity and basic properties of organisms, with emphasis on genetic principles, ecological interactions, and the evolutionary process. Historical approach to knowledge discovery.

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 158H, BS 110 Not open to students with credit in LB 144.

Nature and process of organismal biology, including experimental design and statistical methods, hypothesis testing, genetics, ecology, and evolution.

300 Neurobiology

Fall, Spring. 3(3-0) Interdepartmental with Neuroscience. Administered by Neuroscience. 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 and not open to students in the Program in Neuroscience and not open to students in the Lyman Briggs Neuroscience Major. SA: ZOL 402

Structure and function of nerve cells and nervous systems.

303 Oceanography

Fall. 4(4-0) Interdepartmental with Geological Sciences. Administered by Integrative Biology. P: (CEM 141 or CEM 181H or LB 171 or CEM 151) and (PHY 231 or PHY 183 or PHY 193H or LB 273 or PHY 183B or PHY 231C) SA: ZOL 303

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 SA: ZOL 306

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

Spring of even years. 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 (LB 144 or concurrently) or (LB 145 or concurrently) or (BS 181H or concurrently) or (BS 182H or concurrently)) Not open to students with credit in HDF5 445.

Sexual behavior from biological, psychological and neuroscience perspectives. Sexual differentiation of the body. Role of hormones in development and reproduction in humans and other animals. Human sexual orientation. Fertility and contraception. Sexual disorders. Sexually transmitted diseases.

313 Animal Behavior

Fall, Spring, Summer. 3(3-0) P: BS 162 or LB 144 or BS 182H R: Not open to freshmen. SA: ZOL 213, ZOL 313

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 SA: ZOL 316

Identification, life history, host-parasite relationships, and epidemiology of protozoan, helminth, acanthocephalan, copepod, and 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.

320 Developmental Biology

Fall. 4(3-3) P: (BS 161 or LB 145 or BS 181H) and (BS 162 or LB 144 or BS 182H) SA: ZOL 220, ZOL 320

Principles of development, emphasizing vertebrates. Illustrations from morphological and experimental investigations.

328 Comparative Anatomy and Biology of Vertebrates

Spring. 4(3-3) P: BS 162 or LB 144 or BS 182H SA: ZOL 228, ZOL 328

Comparative morphology, evolution and biodiversity of vertebrates. Dissection of representatives of most vertebrate classes.

341 Fundamental Genetics

Fall, Spring, Summer. 4(4-0) Interdepartmental with Plant Biology. Administered by Integrative Biology. P: (BS 161 or LB 145 or BS 181H) and (BS 162 or LB 144 or BS 182H) SA: ZOL 341

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. 3(0-6) P: (IBIO 341 or concurrently) and completion of Tier I writing requirement SA: ZOL 343

Experiments involving genetics of *Drosophila* and other eukaryotic organisms.

353 Marine Biology (W)

Fall. 4(4-0) P: (BS 162 or LB 144 or BS 182H) and completion of Tier I writing requirement SA: ZOL 353

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. Administered by Integrative Biology. P: BS 162 or LB 144 or BS 182H SA: ZOL 250, ZOL 355

Interrelationships of plants and animals with each other and the environment. Principles of individual, population, community, and ecosystem ecology. Application of ecological principles to global change and other anthropogenic stressors.

IBIO—Integrative Biology

- 355L Ecology Laboratory (W)**
Fall, Spring, Summer. 1(0-3) Interdepartmental with Plant Biology. Administered by Integrative Biology. P: (IBIO 355 or concurrently) and completion of Tier I writing requirement SA: ZOL 355L
Population, community, and ecosystem ecology, utilizing plant and animal examples to demonstrate general field principles.
- 357 Global Change Biology (W)**
Spring. 3(3-0) P: (IBIO 355) and completion of Tier I writing requirement RB: Intended for science or engineering majors R: Not open to freshmen. SA: ZOL 357
Causes and consequences of modes of contemporary global change that are caused by biological systems or impact biological systems. Theories, evidence, and predictions in global warming, ocean acidification, desertification, eutrophication, food security, and mass extinction.
- 360 Biology of Birds**
Fall. 4(3-3) P: BS 162 or LB 144 or BS 182H SA: ZOL 360
Behavior, ecology, evolution, and systematics of birds; biodiversity. Laboratories emphasize diversity of form and function, life history patterns, and identification.
- 365 Biology of Mammals**
Spring. 4(3-3) P: BS 162 or LB 144 or BS 182H SA: ZOL 365
Analysis of the behavior, ecology, evolution, and systematics of mammals. Laboratories emphasize diversity of form and function, life history patterns, and identification.
- 368 Zoo Animal Biology and Conservation**
Summer. 3(3-0) Interdepartmental with Animal Science and Fisheries and Wildlife and Landscape Architecture. Administered by Integrative Biology. P: BS 162 or approval of department RB: Previous work in biology
Captive animal biology including illustrated examples of care, behavioral welfare and conservation work.
- 369 Introduction to Zoo and Aquarium Science**
Spring. 3(3-0) Interdepartmental with Fisheries and Wildlife and Landscape Architecture and Veterinary Medicine. Administered by Integrative Biology. P: BS 162 or LB 144 or BS 182H SA: ZOL 369
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. Administered by Integrative Biology. P: IBIO 355 SA: ZOL 370
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 SA: ZOL 384
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.
- 390 Practicum in Zoo/Aquarium Careers**
Summer. 4 credits. SA: ZOL 390
Practical application of science, business and education methods through typical workdays with zoo professionals.
- 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. SA: ZOL 400H
Honors work on a topic in zoology.
- 403 Integrative Neurobiology**
Spring of odd years. 3(3-0) P: IBIO 402 or PSY 209 RB: Junior or Senior level SA: ZOL 403
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.
- 405 Neural Basis of Animal Behavior**
Spring. 3(3-0) P: (BS 161 or LB 145 or BS 181H) and (BS 162 or LB 144 or BS 182H) SA: ZOL 405
Structure and function of neurons and neural circuits underlying naturally-occurring animal behaviors.
- 408 Histology**
Fall. 4(3-3) P: BS 161 or LB 145 or BS 181H SA: ZOL 350, ZOL 408
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 IBIO 402) and ((PSY 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)**
Fall. 3(3-0) P: (IBIO 313) and completion of Tier I writing requirement SA: ZOL 415
Advanced topics in the ecology and evolution of animal behavior.
- 416 Development of the Nervous System Through the Lifespan**
Fall. 3(3-0) Interdepartmental with Neuroscience. Administered by Neuroscience. P: NEU 302 or IBIO 300 or PSY 209 RB: IBIO 341 R: Open to undergraduate students in the Program in Neuroscience or in the Department of Integrative Biology or in the Department of Psychology or in the Lyman Briggs Neuroscience Major or in the Lyman Briggs Zoology Coordinate Major.
Development of neurons and their connections, roles of both genetics and behavioral experience in shaping the mammalian nervous system.
- 420 Stream Ecology**
Fall. 3(3-0) Interdepartmental with Fisheries and Wildlife. Administered by Fisheries and Wildlife. P: IBIO 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. 3(2-2) Interdepartmental with Plant Biology. Administered by Plant Biology. P: (BS 162 or LB 144 or BS 182H) and ((BS 172 or BS 192H) and completion of Tier I writing requirement) RB: IBIO 355 and IBIO 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, ZOL 425
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: IBIO 328 or GLG 304 or IBIO 360 or IBIO 365 or IBIO 384 or IBIO 445 or GLG 434 or FW 471
Fossil vertebrates with emphasis on evolution and interrelationships of major groups. Modern techniques of identification and interpretation of fossils.
- 434 Evolutionary Paleobiology**
Fall of odd years. 4(3-2) Interdepartmental with Geological 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
- 435 Ion Channels of Excitable Membranes**
Fall. 3(3-0) Interdepartmental with Neuroscience. Administered by Neuroscience. P: (NEU 302 and NEU 311L) or IBIO 402 RB: (PHM 350 or PSL 431) and IBIO 341 R: Open to undergraduate students in the Neuroscience Major or in the Bachelor of Science in Zoology or in the Lyman Briggs Neuroscience Major or in the Lyman Briggs Zoology Coordinate Major.
Introduction to ion channels and their critical role in normal physiological functioning, sensory and neuromuscular diseases and disorders, as well as targets of toxins and poisons.
- 440 Field Ecology and Evolution**
Summer. 4 credits. Interdepartmental with Plant Biology. Administered by Integrative Biology. P: IBIO 355 SA: ZOL 440
Solving conceptual and practical research problems in ecology and evolution under field conditions.

- 443 Restoration Ecology**
Fall of odd years. 3(2-2) Interdepartmental with Biosystems Engineering and Fisheries and Wildlife and Plant Biology. Administered by Plant Biology. P: FOR 404 or PLB 441 or IBIO 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: (IBIO 355 or FOR 404 or PLB 441) 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 (W)**
Fall, Spring, Summer. 3(3-0) Interdepartmental with Crop and Soil Sciences and Plant Biology. Administered by Integrative Biology. P: (IBIO 341 or CSS 350) and completion of Tier I writing requirement R: Not open to freshmen. SA: ZOL 345, ZOL 445
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. 3(3-0) Interdepartmental with Community Sustainability. Administered by Integrative Biology. R: Not open to freshmen or sophomores. SA: ZOL 446
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 IBIO 425) or ((BMB 461 and BMB 462) and completion of Tier I writing requirement) SA: ZOL 450
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.
- 471 Ichthyology**
Spring. 4(3-3) Interdepartmental with Fisheries 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.
- 472 Limnology**
Spring. 3(3-0) Interdepartmental with Fisheries and Wildlife. Administered by Fisheries and Wildlife. P: (CEM 141 or LB 171) and IBIO 355
Ecology of lakes with emphasis on interacting physical, chemical, and biological factors affecting their structure and function.
- 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) 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) SA: ZOL 483
Aspects of physiology important to the environmental relations of vertebrates and invertebrates: energetics, thermal relations, osmotic-ionic relations, and exercise physiology.
- 485 Tropical Biology (W)**
Fall. 3(3-0) Interdepartmental with Plant Biology. Administered by Integrative Biology. P: (IBIO 355) and completion of Tier I writing requirement R: Open to juniors or seniors. SA: ZOL 485
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 Community Sustainability and Fisheries and Wildlife and Landscape Architecture. Administered by Integrative Biology. R: Approval of department. SA: ZOL 489
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. P: (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. SA: ZOL 490
Topical problems course in Zoology or coordinated by Zoology faculty in foreign countries.
- 492 Interdisciplinary Studies in Conservation Medicine**
Spring. 4(4-0) Spring: Abroad. Interdepartmental with Fisheries and Wildlife. Administered by Integrative Biology. P: (BS 161 and BS 162) or (BS 181H and BS 182H) or (LB 144 and LB 145) R: Approval of department.
Interdisciplinary studies focused on "health" as defined by the interactions of animal health, ecosystem health, and human health, viewed through the lens of human culture in an off-campus, multicultural setting.
- 492L Advanced Research Applications in Conservation Medicine**
Spring. 4(0-12) Spring: Abroad. Interdepartmental with Fisheries and Wildlife. Administered by Integrative Biology. P: (BS 161 and BS 162) or (BS 181H and BS 182H) or (LB 144 and LB 145) R: Approval of department.
Field and laboratory techniques for assessing and monitoring biodiversity and health of humans, animals, and ecosystems in an off-campus, multicultural setting. Tools and techniques will be drawn from ecology, microbiology, molecular biology, genetics, histopathology, bioinformatics and statistics.
- 493 International Communications in Conservation Medicine (W)**
Spring. 4(4-0) P: ((BS 161 and BS 162) and completion of Tier I writing requirement) or ((BS 181H and BS 182H) and completion of Tier I writing requirement) or ((LB 144 and LB 145) and completion of Tier I writing requirement)
Development of communication skills (written and oral) to convey scientific information to scientists, health professionals, general public, and indigenous communities.
- 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. SA: ZOL 494
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 to seniors in the Zoology Major. SA: ZOL 495
Economic, social and environmental impact of current developments in Zoology.
- 496 Internship in Zoology**
Fall, Spring, Summer. 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Open to seniors. Approval of department. SA: ZOL 496
Practical experience applying zoology training in a setting outside the University.
- 497 International 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. A student may earn a maximum of 8 credits IBIO 496, IBIO 497, IBIO 498 RB: Biological Sciences R: Open to juniors or seniors or graduate students. Approval of department; application required. SA: ZOL 497
Application of zoological experience in a zoo or aquarium setting outside the United States.
- 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. Interdepartmental with Fisheries and Wildlife and Landscape Architecture. Administered by Integrative Biology. R: Open to juniors or seniors. Approval of department. SA: ZOL 498
Application of zoological experience in a zoo or aquarium setting outside the university.

IBIO—Integrative Biology

- 801 Professional Development**
Fall. 1(2-0) R: Open to graduate students in the Department of Integrative Biology. SA: ZOL 801
Ethical conduct in research. Selecting research topics and approaches. Scientific writing, grantsmanship, 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.
- 805 Animal Welfare Assessment**
Fall. 3(3-0) Interdepartmental with Animal Science. Administered by Animal Science. RB: (ANS 305 or IBIO 313) or background in animal science or zoology including exposure to topics such as animal behavior, physiology, management, and husbandry.
Multidisciplinary online computer-based instruction in animal welfare science and related issues including physiology, behavior, human-animal interactions, suffering and pain, ethics, health, assessment and standards, and economics.
- 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: IBIO 415 SA: ZOL 822
Critical analysis through seminar-discussions of the primary research literature.
- 824 Stable Isotope Biogeochemistry**
Spring of even years. 2(1-2) Interdepartmental with Geological Sciences. Administered by Integrative Biology. RB: CEM 142 or CEM 152 or CEM 182H or LB 171 SA: ZOL 824
Principles of stable isotope chemistry applied to biogeochemical problems: climate change, ecology, contaminants, oceanography, limnology, and paleoecology.
- 826 Tropical Biology: An Ecological Approach**
Summer. 8 credits. Summer: Costa Rica. Interdepartmental with Plant Biology. Administered by Plant Biology. R: Approval of department; application required. SA: BOT 826
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 Physiology and Pharmacology of Excitable Cells**
Fall. 4(4-0) Interdepartmental with Neuroscience and Pharmacology and Toxicology and Physiology. Administered by Pharmacology and Toxicology. R: Open to graduate students in the College of Natural Science or in the Department of Pharmacology and Toxicology or approval of department.
Function of neurons and muscle at the cellular level: membrane biophysics and potentials, synaptic transmission, sensory nervous system function.
- 828 Molecular Ecology and Conservation Genetics**
Fall of even years. 3(2-2) Interdepartmental with Fisheries and Wildlife and Plant Biology. Administered by Fisheries and Wildlife. RB: IBIO 341 or CSS 350 or ANS 314
Population and evolutionary genetic principles applied to ecology, conservation, and management of fish and wildlife at the individual, population, and species level.
- 830 Statistical Methods in Ecology and Evolution I**
Fall. 3(3-0) Interdepartmental with Entomology and Plant Biology. Administered by Integrative Biology.
Fundamental elements of data analysis in ecology and evolution. Programming fundamentals in the R computing language. Introduction to modeling biological data with modern methods for estimation and inference.
- 831 Statistical Methods in Ecology and Evolution II**
Spring. 3(3-0) Interdepartmental with Entomology and Plant Biology. Administered by Integrative Biology. P: IBIO 830
Advanced interpretation and modeling of biological data with modern methods for estimation and inference using the R computing language.
- 832 Evolution of Nervous Systems**
Spring of odd years. 3(3-0) Interdepartmental with Neuroscience. Administered by Integrative Biology. RB: Background in neurobiology or evolutionary biology recommended. R: Open to graduate students in the Department of Computer Science and Engineering or in the Department of Integrative Biology or in the Program in Neuroscience or in the Department of Psychology or approval of department. SA: ZOL 832
Evolutionary origins, mechanisms, and consequences of evolutionary change in nervous systems.
- 839 Systems Neuroscience**
Spring. 4(4-0) Interdepartmental with Human Anatomy and Neuroscience and Pharmacology and Toxicology and Physiology and Psychology. Administered by Neuroscience. R: Open to graduate students or human medicine students or osteopathic medicine students in the College of Natural Science or in the College of Agriculture and Natural Resources or in the College of Human Medicine or in the College of Osteopathic Medicine or in the College of Social Science or in the College of Veterinary Medicine. SA: ANT 839
Anatomy, pharmacology, and physiology of multicellular neural systems. Sensory, motor, autonomic, and chemo-regulatory systems in vertebrate brains.
- 845 Multi-disciplinary Research Methods for the Study of Evolution**
Spring. 3(3-0) Interdepartmental with Computer Science and Engineering and Microbiology and Molecular Genetics. Administered by Computer Science and Engineering.
Techniques for engaging in multi-disciplinary research collaborations, including biology, computer science, and engineering. Students engage in group projects to answer fundamental questions about the dynamics of actively evolving systems including both natural and computational. Multi-disciplinary teams will learn to overcome discipline-specific language and conceptual issues. Experimental design, statistical analysis, data visualization, and paper and grant writing for multi-disciplinary audiences.
- 848 Current Topics in Evolutionary Developmental Biology**
Spring. 3(3-0) RB: (IBIO 445 or IBIO 320 or IBIO 425 or IBIO 341) or background in evolutionary biology or developmental biology. SA: ZOL 848
Genetic and developmental basis for evolutionary change. Synthesis of molecular and developmental genetics with evolutionary biology. Discussion of primary literature in evolutionary development.
- 849 Evolutionary Biology**
Spring. 3(3-0) Interdepartmental with Plant Biology. Administered by Plant Biology. RB: IBIO 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.
- 855 Molecular Evolution: Principles and Techniques**
Fall of odd years. 3(2-2) Interdepartmental with Microbiology and Molecular Genetics and Plant Biology. Administered by Integrative Biology. RB: IBIO 341 or IBIO 445 SA: ZOL 855
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.
- 860 Modern Statistical Models in Ecology**
On Demand. 2(2-0) RB: A thorough understanding of probability and distributions, linear models, generalized linear models, and programming knowledge.
Analysis of population and community dynamics with an emphasis on practical applications including model development and open source statistical programs.
- 863 Wildlife Disease Ecology**
Spring of even years. 3(3-0) Interdepartmental with Fisheries and Wildlife and Large Animal Clinical Sciences. Administered by 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.

867 Nature and Practice of Cognitive Science
 Spring. 3(3-0) Interdepartmental with Computer Science and Engineering and Linguistics and Philosophy and Psychology. Administered by Psychology. RB: Undergraduate course work in behavioral biology, cognitive psychology, philosophy, linguistics, or artificial intelligence. SA: ZOL 867

Survey of how different disciplines explore the cognitive processes underlying intelligent behavior.

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. SA: ZOL 890

Current problems in Zoology.

891 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 Integrative Biology. SA: ZOL 891

Presentation and critical evaluation of theoretical and empirical developments in ecology and evolutionary biology by visiting scientists.

895 Seminar

Fall, Spring. 1(1-0) A student may earn a maximum of 6 credits in all enrollments for this course. SA: ZOL 895

Graduate seminar on current research topics in Zoology.

896 Population and Community Ecology

Fall. 4(4-0) Interdepartmental with Plant Biology. Administered by Integrative Biology. SA: ZOL 896

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

897 Ecosystem Ecology and Global Change

Fall of odd years. 4(4-0) Interdepartmental with Fisheries and Wildlife and Plant Biology. Administered by Integrative Biology. SA: ZOL 897

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.

898 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.

899 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. SA: ZOL 899

Master's thesis research.

999 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. SA: ZOL 999

Doctoral dissertation research.