

# INTEGRATIVE BIOLOGY

# IBIO

## Department of Integrative Biology College of Natural Science

- 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 201 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.
- 200 Animal Biodiversity**  
Fall, Spring. 2(2-0) R: Open to students in the Integrative Biology major.  
Importance of animal biodiversity in the context of evolution, ecology, conservation, and resource use.
- 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. 3(3-0) Interdepartmental with Geological Sciences. Administered by Geological Sciences. 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 or PHY 241)  
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.
- 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.
- 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.
- 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.
- 358 Streams to Gulf: Environmental Change in America's Deep South**  
Summer. 3(3-0) Interdepartmental with Fisheries and Wildlife and Plant Biology. Administered by Integrative Biology. P: IBIO 355 RB: IBIO 357 R: Approval of department; application required.  
A study away course of anthropogenic impacts, habitat alteration, and environmental policy in surrounding water.
- 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.

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- 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 LB 144 or BS 182H 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.
- 391 Emerging Scholars in Integrative Biology**  
Fall. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Approval of department  
Professional development topics aimed at preparing for participating in research and beyond, the scientific method, research methods, and communication in science.
- 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.
- 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.
- 451 Insect Physiology**  
Spring of even years. 3(3-0) Interdepartmental with Entomology. Administered by Entomology. P: BS 161 or LB 145 or ENT 404  
Structure/function of insect physiological systems. Molecular mechanisms underlying insect development. Physiological evolution in insects.
- 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.
- 480 Epigenetics**  
Spring of even years. 3(3-0) Interdepartmental with Plant Biology. Administered by Plant Biology. P: IBIO 341 or CSS 350 R: Approval of college.  
Molecular mechanisms of epigenetic modifications of eukaryotic genomes and their roles in biological processes, human diseases and cancer, plant development, and production.
- 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**  
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) 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) 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.

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- 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 paleobiology.
- 826 Tropical Biology: An Ecological Approach**  
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 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. R: Open to graduate students in the Department of Entomology or in the Ecology, Evolutionary Biology and Behavior Specialization or in the Ecology, Evolutionary Biology and Behavior Major or approval of department.  
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 R: Open to graduate students in the Department of Entomology or in the Ecology, Evolutionary Biology and Behavior Specialization or in the Ecology, Evolutionary Biology and Behavior Major or approval of department.  
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.
- 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.