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 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.

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. 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. 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 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 (BS 145 or concurrently) or (BS 181H or concurrently) or (BS 182H or concurrently)) Not open to students with credit in HDFS 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.

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 355L 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. 4(3-3) P: BS 162 or LB 144 or BS 182H SA: ZOL 355L Interrelationships of plants and animals with each other and the environment. Principles of individual, 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.
### IBIO—Integrative Biology

#### 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.

#### 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—Summer
- 4 credits. SA: ZOL 391
- 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 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.

#### 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) 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**: 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**: 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 or BS 194) 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 151H 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**: 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**: 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.

#### 443 Restoration Ecology
- **Fall**: 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
- **Fall**: odd years. 3(2-2) 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

#### 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
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.

452 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.

453 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.

454 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.

455 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.

456 Environmental Physiology (W) Spring. 4(4-0) P: (BS 161 or BS 145 or BS 181H) and completion of Tier I writing requirement) and (BS 162 or BS 144 or BS 182H) and (CEM 141 or CEM 151 or CEM 191H 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.

457 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.

458 Seminar in Zoo and Aquarium Science Fall. Spring. 11(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.

459 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.

460 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.

461 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.

462 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.

463 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.

464 Undergraduate Seminar Fall. Spring, Summer. 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.

465 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.

466 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.

467 Internship in Zoology 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.

468 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.

469 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.

470 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.

471 Advanced Principles and Applications of Epigenetics Spring of odd years. 3(3-0) Interdepartmental with Plant Biology. Administered by Plant Biology. P: IBIO 341 or CSS 350 R: Open to graduate students or approval of college. Not open to undergraduate students or approval of college. Not open to students with credit in PLB 480. Epigenetics and epigenomics including the molecular mechanisms of epigenetic modifications of eukaryotic genomes.

IBIO—Integrative Biology
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. 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. Administered by Pharmacology and Toxicology. SA: ZOL 827
Anatomy, pharmacology, and physiology of multicellular neural systems. Sensory, motor, autonomic, and chemo-regulatory systems in vertebrate brains.

828 Molecular Ecology and Conservation Genetics
Fall of even years. 3(2-2) Interdepartmental with Fisheries and Wildlife. SA: ZOL 828
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
Fall. 3(3-0) Interdepartmental with Entomology and Plant Biology. Administered by Integrative Biology. RB: IBIO 415 and (STT 422 or concurrently) SA: ZOL 830
Principles of statistical methods and modeling of biological data with modern methods for estimation and inference. Understanding probability and distributions, linear models, generalized linear models, and programming knowledge.

831 Statistical Methods in Ecology and Evolution II
Spring. 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. SA: ZOL 832
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 833
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 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. SA: ZOL 845
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 or (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.
896  Population and Community Ecology  
Fall. 4(4-0) Interdepartmental with Plant Biology. Administered by Integrative Biology. SA: ZOL 896


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.