AMERICAN MUSEUM of NATURAL HISTORY
Richard Gilder Graduate School

Richard Gilder Graduate School Course Catalog: Electives
Fall 2015 – Spring 2016

Comparative Biology PhD Program

ELECTIVE COURSES

Elective courses consist of a combination of lecture, workshop, lab, and fieldwork, as appropriate to the specific topic or discipline, and are offered on either a semester-long or immersive schedule to maximize fulfillment of the learning objectives of each course. Elective courses are meant to be flexible and to assist students in achieving a concentration and a depth of knowledge in an area of individual interest.

RGGS601 Phylogenetics Applications

Credits: 3

This readings course will delve into the myriad ways in which phylogenetic methods are applied across the diversity of biological disciplines including their use for studying disease, ecology, conservation, population biology, genomics, anthropology, biogeography, and even astrobiology.

RGGS602 GIS Methods and Applications

Credits: 2

This course will focus on the application of Geographic Information Systems (GIS) to address questions relating to evolution and conservation. Students will gain hands-on experience with multiple GIS software packages, and will learn the fundamentals of species distribution modeling and remote sensing. The course will combine lectures and computer lab exercises, and each student will undertake an individual project.

RGGS603 Marine Zoological Biodiversity Surveys & Inventory

Credits: 3

This course will familiarize students with the nature of the DEB-BSI granting panel priorities at the National Science Foundation with a focus on the broad zoological diversity in marine and associated environments. Passamaquoddy Bay, at the mouth of the Bay of Fundy, exhibits a tidal range of 30 feet. From low water to high water takes about 6.2 hours and in that time, up to 2-1/4 billion tons of water swill into Passamaquoddy Bay through the passages. Few places on this planet have such a huge tidal variation and, consequently, few offer as great a diversity of marine organisms and habitats. Lectures will cover basic principals of physical oceanography,

biological oceanography, marine taphonomy, phylum-by-phylum marine metazoan diversity (from sponges to mammals), marine protozoology, and parasitology. Field work will focus on survey-based marine sampling strategies from I-meter plots, to transects and trawling effort across a range of habitats that includes benthic, pelagic, inshore, meiofaunal, intertidal, salt marshes and rocky shores.

RGGS604 Understanding Biological Disparity

Credits: 3

Disparity analyses attempt to characterize and explain extreme differences in morphology and diversity in closely related groups of organisms. Through group discussion of a series of contemporary readings covering both the fossil record and modern organisms, students will explore the basic concepts of biological disparity and learn how to apply these in their own research.

RGGS609 Molecular and Genome Evolution

Credits: 3

The techniques and analytical approaches to examining the genomes of organisms will be the focus of this course. This course will begin with detailed examination of the high throughput approaches used to analyze and collect information on genomes. Such approaches include estimating genome size, obtaining genome level maps, estimating gene content in genomes, sequence alignment, and genome level shotgun sequencing approaches. This course will then proceed to annotation of genomes and discovery of ortholog/paraolog relationships. It will conclude with detailed examination of data basemanipulation, PERL scripting to mine the burgeoning database, and the incorporation of phylogenetic approaches into studying genomes.

RGGS611 Parasitism

Credits: 3

Parasitism is the most successful life history strategy on Earth. There are more and more varied species of parasites than there are free-living species hosting them. Students will discover a full range of eukaryotic parasites ranging from the protistan causative agents of malaria, sleeping sickness, Chagas disease, and leishmania to the metazoan tapeworms, flukes, nematodes, and arthropod parasites. Subject matter will include comparative anatomy, life cycles, pathology, phylogenetic relationships, and coevolutionary parasitology.

RGGS612 Biogeographic Analysis

Credits: 3

The course will explore historical biogeographic methods as well as how biogeography is relevant for answering questions within evolutionary biology, from speciation analysis to the origin of biotas and patterns of diversity. An ecological biogeographic approach will not be taken in this course, although the evolution of ecological assemblages and patterns of diversity will be discussed.

RGGS628 Systematic Ichthyology

Credits: 3

This course will be a taxonomic survey and introduction to the science of ichthyology. It will focus on the systematic relationships among the major clades of fishes, and will also include discussions focusing on ecology, biogeography, and the natural history of fishes. This course will consist of lectures, readings from the primary literature, and laboratory sections focusing on a taxonomic review

RGGS637 How the Cosmos & Earth's History Affect Life

Credits: 1

The complex phenomenon that we call life has evolved on an average planet, orbiting an average star, in a very humdrum part of the Milky Way galaxy. Is this an accident? Are there other abodes for life in our galaxy? How has the Earth's history driven the evolution of life? These and related questions will be addressed by the museum's astrophysicists and planetary scientists. The focus will be on processes that constrained and drove evolution on Earth over the past 4.6 Billion years.

RGGS652 *Anolis* Lizards: Model System in Ecology and Evolution

Credits: 3

The *Anolis* lizards of the New World tropics are one of the best-studied groups of vertebrates in evolution and ecology, making them a model system for adaptive radiation and island biogeography. The literature on this group is rich and varied and includes both hundreds of primary journal articles and book chapters as well as a new synthetic volume, just published by Jonathan Losos. This course uses the *Anolis* lizards as a gateway to teach diverse topics in evolutionary biology, biogeography, systematics, behavior and ecology through readings and discussion and a field experience where students will design and conduct research on these lizards. This course would be appropriate for students interested in herpetology, West Indian biogeography, or who just want to expand their exposure to evolution, ecology and behavioral research in comparative biology.

RGGS655 Advanced Invertebrate Zoology

Credits: 3

The course will familiarize students with physiology, development and classification of each invertebrate phylum of the animal kingdom. The different topics will be discussed using scientific literature. Laboratory exercises will introduce students to diversity of invertebrate phyla and subgroups, and will comprise structure and function of representatives of each phylum as well as physiology and embryology of exemplar organisms. Students will also carry out two field trips to collect local invertebrates.

RGGS655L Advanced Invertebrate Zoology Lab

Credits: 1

Lab component for Advanced Invertebrate Zoology course.

RGGS656 Major Events in Evolution: Paleozoic-Mesozoic Transition

Credits: 2

This course will present major themes in terrestrial vertebrate evolution, using the Paleozoic-Mesozoic transition as a source of case studies. The end of the Paleozoic was a time of important transitions in Earth history, with profound effects on vertebrates and their ecosystems. Discussion topics will address outstanding issues in research on this period, including causes of the Permo-Triassic mass extinction, biotic shifts and climate-mediated endemicity in the Triassic, and timing of origin of the major modern clades.

RGGS656L Major Events in Evolution: Paleozoic-Mesozoic Transition Lab

*Credits**:*** 0-3

Lab component for Major Events in Evolution (for the Paleozoic-Mesozoic Transition course, the lab is considered part of the main course, so no additional credits assigned).

RGGS658 Vertebrate Paleobiology

Credits: 3

Students will develop an understanding of the general morphology, phylogeny and evolutionary history of major vertebrate clades. These will be taught in association with current issues that convey knowledge of environment-organism interaction, evo-devo, Tree of Life, molecular-morphological views in divergence and phylogeny, paleobiogeography, and contemporary analytical methods in morphological studies (CTscans, microstructures, histology, etc.).

RGGS658L Vertebrate Paleobiology Lab

*Credits**:*** 1

Lab component for Vertebrate Paleontology course.

RGGS659 Insect Taxonomy

Credits: 3

The primary objective is to increase knowledge of the diversity of insects down to the family level. Students will become familiar with the families that are commonly encountered, and be able to key out those which are not so common. Students will learn sight recognition of important North American groups (about 200), how to use keys and literature, and techniques for collection, preservation, and preparation. Students will also gain an understanding of insect phylogeny and biology.

RGGS659L Insect Taxonomy Lab

*Credits**:*** 0

Lab component for Insect Taxonomy course.

RGGS660 Extinction Science

Credits: 2

This course is concerned with explaining the causes and consequences of biological extinction through time. Importantly, perspectives from both the physical and organismic sciences will be employed throughout. This survey course will use a broad historical perspective, i.e., the vicissitudes of life on this planet during the past 600 million years, with a special focus on three events that illustrate many of the most important phenomena and puzzles connected with major losses—the Permo-Triassic, Cretaceous-Paleogene, and Late Quaternary extinctions. Topics covered include: the fossil record of extinction; “mass” vs. “background” extinction; extinction rates: computation and meaning; assessing causation in theory and practice; biotic and abiotic factors in extinction; understanding modern-day biotic losses.

RGGS661 Reptile Biology and Diversity

Credits: 3

Reptile Biology and Diversity is a course in the systematics, life history, morphology and anatomy, and evolution of living reptiles and their immediate extinct ancestors.

RGGS662 Next Generation Sequencing

Credits: 3

This course covers genomics and genome analysis, with the goal of lowering the learning curve of, and increasing familiarity with, wet-chemistry and bioinformatic techniques as related to next-generation sequencing (NGS). While students will explore the different types of genetic material, the polymerase chain reaction, traditional Sanger sequencing, and some of the first methods of screening random pieces of the genome and/or transcriptome (cloning and colony picking), the major focus will be NGS technologies and applications.

RGGS663 Biological Specimen Informatics

Credits: 3

Lectures and labs will focus on introducing students to various specimen databases and demonstrating the value of using a specimen database to manage research data. In addition, the course will offer best practices in specimen data acquisition, handling and management, georeferencing, imaging, basics of MySQL, and import and export tools.

RGGS664 Next Generation Sequencing Informatics

Credits: 2

The course will build on the extensive technical and lab oriented RGGS course, Next Generation Sequencing (RGGS-662), offered in Spring 2013 and 2014. In that course students were exposed to next generation sequencing (NGS) approaches in the lab. In this course we will take up where that course left off and develop the necessary computational approaches that are required for NGS data processing – including data quality assessment, assembly, annotation and accessioning. The completion of Next

Generation Sequencing (RGGS-662) is not, however, a prerequisite to taking this course.

RGGS666 The Tree of Life and Invertebrate Zoology
Credits: 2
This uniqueness of the course of lectures and labs will lie in its use of morphological and molecular characters to interpret the major groups of invertebrates on the planet. At the end of week two of the course, each student will choose a well-defined monophyletic phylum or a well-defined group of phyla and compile a phylogenetic matrix for the taxa in their chosen group. They will then rigidly analyze their matrices and extensively compare these to the published record on their chosen group.

RGGS668 Microscopy and Imaging Methods
Credits: 2
The course will introduce and demonstrate a variety of imaging and analyses tools used in comparative biology as well as in planetary science. These include light and epifluorescence microscopy, confocal microscopy, advanced stereoscopy, scanning and transmission electron microscopy, energy-dispersive and wavelength dispersive x-ray spectroscopy, x-ray diffractometry, high resolution x-ray CT scanning, and flow cytometry.

RGGS669 Geometric Morphometrics
Credits: 1
Lectures will focus primarily on methods of biological shape measurements, multivariate statistics and comparative methods associated with shape data. Labs will concentrate on application of the techniques and methods presented during the lectures using either data provided during the course or student's personal data.

RGGS670 Algorithmic Approaches to Biological Data
Credits*:* 4
An intensive introduction to programming in the Python programming language, culminating with an in-depth analysis of several biological topics and the algorithmic approaches needed to analyze the relevant data. Programming topics include the basic concepts of loops, decisions, strings, lists, interacting with files, functions, data collections, common libraries, and recursion. Biology topics are sequence alignment with dynamic programming, genome assembly with deBruijn graphs, and algorithms for phylogenetic tree reconstruction. No previous programming experience is required. This course is appropriate for students working with genomic or phenomic data and other collections-oriented work.

ELECTIVE COURSES that may be offered if there is student interest and curricular need, pending approval of the Comparative Biology Ph.D. Program Committee (CBPPC)

RGGS605 Conservation Biology

Credits: 1

This course, the first semester of a two-semester course, will serve as an introduction to the applied science of maintaining the Earth's biological diversity, landscapes, and wilderness. The course will focus on the biological principles relevant to the conservation of biodiversity at the genetic, population, community and landscape levels. Due to the cross-disciplinary nature of Conservation Biology, some of the social, philosophical, and economic dimensions of biological conservation will also be addressed. Major themes to be covered include what biodiversity is, why it is important, and what threatens it. In the second half, the class will concentrate on different strategies for addressing the biodiversity crisis. The focus will be on applications and problem solving in conservation biology, drawing from international and national examples. The course is intended to link perspectives gained in other courses offered in the AMNH graduate program under the common theme of how biological principles can be applied to the conservation of biological resources.

RGGS606 Earth System Science

Credits: 2

This course will survey Earth's dynamic systems and show how they have interacted through time to give the planet its present character. It will cover plate tectonics, the ocean/atmosphere system, and the global carbon and sulfur cycles. It will explore how Earth, particularly conditions on its surface, has changed through time, the emergence of life and evolution of metabolic pathways, and the feedbacks between the biological and physical world that determined planetary evolution, and it will seek to provide insight into terrestrial evolution by comparing Earth with Venus and Mars.

RGGS607 Sedimentology, Stratigraphy and Sedimentary Environments

Credits: 2

This course will describe the types of sediments distributed in modern environments of the Earth's surface and the physical and/or chemical processes that lead to their deposition. Earth's depositional environments will be presented in a plate tectonic context. The course will also illustrate how sediments and sedimentary rock sequences record events in Earth's history, and it will address burial and fossilization processes.

RGGS608 Biological Diversification

Credits: 2

This course will examine the patterns and processes of the diversification of life. Topics

include species and speciation analysis, the rate-controls of speciation and extinction, understanding how biotas evolve, and explaining patterns of diversity through space and time. Prerequisites: a course in evolution, systematics, and ecology.

RGGS610 Molecular Evolution

Credits: 2

This course will focus on current paradigms of molecular evolution. These include the evolution of the genetic code, molecular clocks, and the measurement of selection and adaptation at the molecular level. The evolution of the genetic code will introduce the student to the dynamics of the coding regions of the genome and introduce basic concepts such as synonymous and non-synonymous substitutions, as well as codon bias selection. The molecular clock section of the course will focus on the utility and vagaries of molecular clocks and the final section on selection will focus on the use of synonymous and non-synonymous measurements (Dn/Ds; Ka/Ks) to detect selection. Examples from a wide array of organisms will be used to demonstrate the utility of these three major subjects in modern molecular evolution.

RGGS613 Arthropod Morphology

Credits: 3

Students will investigate basic structural characteristics and theories of homology through selected readings in the literature and intensive laboratory work on exemplar organisms. Participation of multiple staff members will assist in the examination of a broad range of lineages within the Arthropoda.

RGGS614 Higher-Level Relationships in the Arthropoda

Credits: 1

This course will deal with the diversity and relationships of the Arthropoda. Units will cover living taxa in the Onychophora, Tardigrada, Chelicerata, Crustacea, Myriapoda, and Hexapoda. The extensive fossil record of arthropods will also be explored with special reference to Trilobita, Anomalocarida, and Orsten Crustacea. Information will be drawn from anatomy, physiology, and developmental and molecular data.

RGGS615 Insect Diversity

Credits: 3

As the most diverse lineage of living organisms, the Insecta will be examined down to the family-group level. Field, laboratory, and lecture components will allow for students to master skills in taxon recognition and understand the basis for existing classificatory schemes.

RGGS616 Metazoan Diversity

Credits: 3

Taking a phylogenetic approach to the origins and diversification of animals, this course will cover the full scope of animal life from the origins of multicellularity through the

major synapomorphies that unite and define the Tree of Life. This course will cover more than 30 non-vertebrate phyla in the context of the most up-to-date hypotheses of their relationships to each other and the evolution of morphological diversity within each group. This course will consist of lectures and examination of museum and fresh collections.

RGGS617 Digital Visualization Techniques

Credits: 1

This course will be a hands-on course, under the direction of the MIF staff. Students will gain practical knowledge and experience using laser surface scanner and image processing software for volumetric data (MRI, CT, laser surface, confocal).

RGGS618 Microscopy

Credits: 1

This course will be a hands-on course, under the direction of the MIF staff, where students will gain practical knowledge and experience using the confocal and electron microscopes. Topics will include sample preparation, use of equipment, image capture, and processing.

RGGS619 Molecular Techniques

Credits: 1

This laboratory course will expose students to the basic techniques of evolutionary molecular analysis, including DNA extraction, primer design, PCR amplification, cloning, and sequencing. Basic sequence analysis will also be covered.

RGGS620 Phylogenetic Algorithms

Credits: 1

This course will cover the fundamental procedures and algorithms of systematic analysis. Tree construction (Wagner), refinement (SPR, TBR), simulated annealing, genetical algorithm, and character-optimization techniques will be examined in depth through analysis and use of open-source software.

RGGS621 Systematic Computation

Credits: 1

This course will cover basic techniques in the use of computers in systematic analysis. It will be an introduction to operating systems, especially LINUX, scripting languages, and use of parallel computers. Several phylogenetic computer software packages will be examined.

RGGS622 Bone Histology

Credits: 1

This course will provide an introduction to both mechanical and interpretive aspects of analyzing fossil bone. It will introduce the identification of tissue types and their

interpretation relative to specific hypotheses of growth, longevity, and life history. Part of the class will include practical preparation of specimens. A general review and discussion of several contemporary studies will also be included.

RGGS623 Fish Paleontology

Credits: 2

This course will examine the origins and early radiations among primitive vertebrates ("fish"), especially the major gnathostome groups (chondrichthyans, osteichthyans, placoderms, and acanthodians). Aspects of modern vertebrate morphology, the fossil record (including collections-based study), classical embryology, and modern evolutionary-developmental investigations will all be included. The course will therefore provide an integrated perspective of past, current, and future directions in research on early vertebrate evolution.

RGGS624 Invertebrate Paleontology

Credits: 2

This course will concentrate on one or more fossil invertebrate groups, emphasizing their morphology, evolutionary history, biostratigraphy, and systematics. Study of actual specimens, drawing on the AMNH collections, will be an important part of the course. Work will feed into broader issues of functional morphology, biodiversity over time, crises in the history of life, and geologic events.

RGGS625 Paleontology Field Methods

Credits: 1

This will be a tutorial on how fossils are collected.

RGGS626 Readings in Contemporary Paleobiology

Credits: 1

This course will concentrate on the critical examination of recent studies in paleobiology. Students will be required to lead and participate in focused discussions.

RGGS627 Herpetology

Credits: 3

This course will address the anatomical, ecological, and life history diversity of reptiles and amphibians. It will be structured around the evolutionary history of living and relevant fossil groups with special attention to scientific evidence.

RGGS629 Mammal Section/Vertebrate Morphology

Credits: 1

Framed within an explicitly phylogenetic context, this course will provide students with an overview of mammalian musculoskeletal anatomy. Anatomical variation will be investigated utilizing a suite of exemplar taxa spanning the morphological diversity of

the group.

RGGS630 Mammalogy

Credits: 3

This course will survey the structural, ecological, and behavioral diversity of extant mammals from an evolutionary perspective. Students will be expected to gain familiarity with all of the mammalian orders and the specializations associated with different functional complexes and lifestyles. These and other patterns of mammalian diversity will be investigated in a phylogenetic context.

RGGS631 Ornithology

Credits: 3

This course will present an overview of avian history and evolution. Topics to be considered include origin of birds; avian phylogenetics, speciation, and biogeography; structural and functional evolution; general ecology; and behavior. Field trips will be required.

RGGS632 Ethnoscientific Perspectives

Credits: 1

Although their forms vary, classification and explanation of the natural world are human universals. "Ethnoscience" examines the epistemological bases and concrete applications of analytical procedures in non-Western cultures. Focusing on small-scale, "traditional" societies, this course will introduce key anthropological inquiries into principles of natural classification and explanation, both comparatively and in specific cases.

RGGS633 Evolutionary Theory and Study of Culture Change

Credits: 1

A number of anthropologists and archaeologists have used principles from evolutionary biology in their efforts to understand patterns of major culture change, such as the transition from hunting-gathering to agriculture, the emergence of social inequality, and the rise of the state. Such efforts will be critically examined, both in terms of their theoretical rationale and their consistency with the empirical record.
The course will consist of lectures, readings, discussions, and a final project.

RGGS634 Natural Metaphors

Credits: 1

In the words of Claude Levi-Strauss, natural species and elements are "good to think," providing a primary analogical scheme for human self-conceptions. What does it mean for the Bororo of Central Brazil to say, "We are red macaws," or for the Hopi of Arizona to identify themselves as sparrow hawks, rain, or rattlesnakes? This course will address how and why conceptions of the biological world suffuse thinking about humanity-and vice versa.

RGGS635 Insect Ecology and Conservation

Credits: 2

This course will present an overview of the ecology and conservation of the Earth's most diverse group of organisms-insects. The first part of this course will cover ecological concepts as they apply to insects. How these concepts are applied to the conservation of this important taxon will be the focus of the second part. Students will emerge from the course with an understanding of the unique problems and solutions that insects have evolved and how these solutions can be applied to their conservation.

RGGS636 Isotope Geochemistry

Credits: 2

This course will present the fundamentals of radiogenic and stable isotope systems. It will focus on those systems that most closely bear on global biogeochemical cycles, including the uranium-thorium-lead decay series, rubidium-strontium, carbon-14, and the stable isotope systems for carbon, sulfur, and oxygen. It will use examples to illustrate the utility of isotopes in deducing changing conditions on Earth's surface at present and during the past 600 million years.

RGGS638 Techniques in Earth Materials

Credits: 2

This course will deal with minerals and organic compounds and how they are identified/analyzed to extract useful physical and chemical information. Applications include research on biomaterials, sediments, and sedimentary rocks. Analytical methodologies of interest include: basic petrography, SEM, electron microprobe, ion microprobe, ICPMS and LA-ICPMS, X-ray diffraction, and (potentially) other techniques.

RGGS639 Arachnid Diversity

Credits: 2

Arachnid Diversity will provide an overview of the orders of arachnids, including their interrelationships, natural history, systematics, and biogeography. Lectures and labs will enable students to become familiar with the most commonly encountered families and their diversity.

RGGS640 Hemipteran Phylogeny and Biology

Credits: 2

This course will examine the classification and relationships of the Hemiptera down to the family-group level. Morphological, molecular, and biological data will be examined as a way of comprehending diversity and relationships. The extensive collections of the AMNH will be used to augment literature

RGGS641 Evolution of Eukaryotic Microbes

Credits: 3

Although they may consist of just single cells, the eukaryotic microbes present fascinating studies in the evolution of life. This course will include discussions on the origins of organelles in eukaryotes, adaptations for motility, and phylogenetic relationships among eukaryotic microbes based on genetic and genomic data. There will also be a focus on several groups of parasitic protists such as malaria parasites (Plasmodium), trypanosomes, and Trichomonas and their unusual evolutionary genetic adaptations to the pathogenic lifestyle.

RGGS642 Microbial Diversity

Credits: 3

This course will explore the diversity of microbial life, focusing on bacteria and archaea. Major groups of microbes will be covered along with the conceptual issues pertinent to how microbial diversity is studied. This course will include lectures and discussions of the major evolutionary transitions in the microbial world and how these are thought to have come about, the patterns of evolutionary change, theinteraction of microbes within diverse communities and the ways in which phylogenetics and genomics are shaping our understanding of microbial diversity.

RGGS643 Virologenetics

Credits: 3

The specifics of the placement of viruses in the Tree of Life remain enigmatic, and their monophyly is doubted by most. Following an introductory period focusing on traditional modes of viral classification (strandedness, morphology, and pathology), this course will engage in an in-depth investigation into the evolutionary relationships of viral species and larger taxonomic groups.

RGGS644 Molding and Casting

Credits: 1

This will be a tutorial on how to construct molds for the replication of fossil materials.

RGGS645 Paleomammalogy

Credits: 2

An introduction to the major features of mammalian evolution, this course will survey major groups of mammals, focusing on fossil taxa as well as the broader context of their relationships to living groups. We will focus on phylogeny, morphology, biogeography, and patterns of diversification and extinction, using illustrations from the AMNH's world-class collections.

RGGS646 Paleontology in the U.S. Western Interior

Credits: 2

This intensive two-week field course/collecting expedition will travel to paleontological sites in the U.S. Northern Great Plains (Colorado, South Dakota, Wyoming, and

Montana). Emphasis is on marine deposits containing invertebrate and vertebrate fossils deposited in the Epicontinental Sea that once covered this area. Themes will include changes in biodiversity, paleoceanographic reconstructions, modes of fossil preservation, and anoxic events.

RGGS647 Reptile and Amphibian Paleontology

Credits: 2

This course will be a general overview of the systematics and morphology of all nonsynapsid tetrapods. Special attention will be placed on the origins of extant groups. The course will consist of a detailed review of systematic patterns in these groups and will include the examination of specimens in the museum collections.

RGGS648 Actinopterygian Section/Vertebrate

Credits: 1

Framed within an explicitly phylogenetic context, this course will provide students with an overview of actinopterygian musculoskeletal anatomy. Anatomical variation will be investigated utilizing a suite of exemplar taxa spanning the morphological diversity of the group.

RGGS649 Fish Bioluminescence

Credits: 1

Bioluminescence is a complex relationship between host fishes and luminescent bacteria. Recent work has shown that the phylogeny of bacteria and host are not necessarily congruent. Furthermore, methods of transmission are poorly understood. This course will review current work in this area.

RGGS650 Reptile & Amphibian Section/Vertebrate Morphology

Credits: 2

Framed within an explicitly phylogenetic context, this course will provide students with an overview of amphibian and reptile musculoskeletal anatomy. Anatomical variation will be investigated utilizing a suite of exemplar taxa spanning the morphological diversity of the group.

RGGS651 Vertebrate Biogeography of Madagascar

Credits: 1

The unique vertebrate fauna of Madagascar is of great interest. This course will examine the origin of major groups of vertebrates of the island including taxa known only from the fossil record.

RGGS657 Ichthyology: Morphological Techniques in Systematic Icthyology

Credits: 3

The course will be designed with the students' interests and research needs in mind,

and will be taught at an advanced level. Anatomically, lectures and labwork will focus on osteology, neurology, myology, and internal soft anatomy (using various comparative approaches), and from a methodological/analytical standpoint we will concentrate on specimen preparation, character coding, missing data, combining different types of data, and the use of various methods to generate and interpret a phylogenetic hypothesis.