AMERICAN MUSEUM of NATURAL HISTORY
Richard Gilder Graduate School

Richard Gilder Graduate School
Electives Course Catalog
Fall 2016 - Spring 2017

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 Applied Phylogenetics

Credits: 1-3
This course is designed to teach students how to consider questions in evolution and ecology in a statistically rigorous manner using phylogeny as a key component for addressing hypotheses. The course will cover methods of molecular evolution, phylogenetic inference using species tree methods, biogeographic reconstruction, trait inference and correlation, species diversification, and community assembly using Bayesian inference and maximum likelihood modeling methods. Importantly, the course will provide a strong background in ecological and evolutionary theory and how to practically address major questions intersecting both of these fields using and modifying existing packages and developing novel code needed.

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 and 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

RGGS630 Mammalogy

Credits: 3

This course will provide an integrative survey of the biology, diversity, and evolution of mammals with a focus on extant taxa. Class sessions will be topic-focused and will cover various aspects of mammalian phylogeny, biogeography, anatomy, physiology, functional morphology, reproduction, life histories, behavior, ecology, and conservation. Labs will be taxon-focused and will cover diversity and morphology of all of the extant mammalian orders.

RGGS637 How the Cosmos and 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 Paleobiology 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: 2-3
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: 2-3
The course will build on the extensive technical and lab oriented RGGS course, Next Generation Sequencing (RGGS-662). 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 for Comparative Biology
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.