Graduate Program in Integrative Biology

**Chair:** Robert K. Ho  
**Director of Graduate Studies:** Mark Westneat

**Professors**

- Zeray Alemseged
- Michael I. Coates
- Martin Feder
- Edwin L. Ferguson, Molecular Genetics & Cell Biology
- Melina E. Hale
- Nicholas G. Hatsopoulos
- Robert K. Ho
- David Jablonski, Geophysical Sciences
- Raphael Lee, Surgery
- Zhe-Xi Luo
- Daniel Margoliash
- Victoria E. Prince
- Clifton Ragsdale, Neurobiology
- Callum Ross
- Paul Sereno
- Neil H. Shubin
- Mark Westneat

**Associate Professors**

- Sliman Bensmaia
- Urs Schmidt-Ott

**Assistant Professors**

- Vincent Lynch, Human Genetics
- Stephanie Palmer

**Emeritus Faculty**

- James A. Hopson
- Michael LaBarbera
The graduate program in integrative biology is housed in the Department of Organismal Biology and Anatomy (OBA), which has a long history of training students in integrative organismal biology. During the 1970s, the focus of the (then) Department of Anatomy shifted from the classic purview of anatomy departments in the middle of the 20th century — histology, neurobiology, and cell biology — to more comparative and functionally oriented topics and an explicit focus on evolutionary biology and functional morphology. The neurobiology section of the department expanded first into explicitly comparative areas and later into neuroethology. Over the next twenty years the department evolved into its present configuration with research and teaching foci which include biomechanics/functional morphology, organismal neurobiology, developmental biology, and evolutionary biology, all unified by a shared reference point in the biological hierarchy — the organism — an entity we see as the natural reference for all of the biological sciences since it is the natural unit of selection. We see the intellectual areas presently housed in OBA as inextricably and naturally connected. To understand the organismal level in biology requires an understanding of both how organisms have been shaped over evolutionary time scales and how they are generated on developmental time scales, the various interacting tissue and organ systems that generate organismal functions, and the mutual feedback among these functional, evolutionary, and developmental processes. The high degree of connectivity among our core disciplines is exemplified by the integrative nature of student dissertation projects in OBA and by the high level of interaction and collaboration among our faculty; both faculty and graduate student research in OBA frequently span several of these areas. In recent years there has been a resurgence of interest in and appreciation for organismal-level biology on the national level, putting molecular, genetic, and computational tools and information to use to understand broader systems-level questions. OBA and its integrative biology program has been actively positioning itself as a leader in research and graduate training in this endeavor.

Research and training in the graduate program focus on the integration of four overlapping areas:

1. **Biomechanics**: the application of methods from engineering and physics to understanding the design of organisms.
2. **Developmental Biology**: understanding how information coded into the genome is translated into the patterns seen in organisms. Our developmental biology program has a special emphasis on the interface between evolution and development, an area sometimes called “EvoDevo”.
3. **Neurobiology**: understanding how the nervous system regulates and controls the behavior of animals. Our neurobiology program has a special emphasis on the relationship of the nervous system to behavior (or neuroethology) and the application of quantitative methods to understanding neural function (computational neuroscience).
4. **Paleontology**: documenting and understanding evolutionary patterns and processes through analyses of the fossil record.
Training in the department places an emphasis on familiarity with a broad range of ideas and skills in organismal biology. Although students can conduct research in any of the areas represented in the department, they are encouraged to develop research programs that capitalize on the talents of two or more faculty members with different perspectives. The department also encourages students to interact with other units on campus (such as the Department of Ecology and Evolution and the Committees on Development, Regeneration and Stem Cell Biology; Evolutionary Biology; Genetics, Genomics and Systems Biology; and Neurobiology) as well as the Field Museum of Natural History, the Brookfield and Lincoln Park zoos, the Shedd Aquarium, and the Marine Biological Lab at Woods Hole. Students earning doctorates through the department will be qualified, following suitable postdoctoral training, for research and teaching careers in biology departments, anatomy departments and museums.

Degrees

Master of Science

Students are not admitted to the program for the sole purpose of obtaining a Master of Science degree, but this degree is awarded to students from other academic units who require a Master of Science degree as one requirement for the doctorate.

Doctor of Philosophy

The requirements for the Doctor of Philosophy are as follows:

- Course requirements are individualized and are defined for students early in their stay in the program, based on the student's background and interests. Students will complete a course distribution requirement by the end of their second year. Students must fulfill the divisional requirement of serving as a teaching assistant in two courses and completing ethics training.
- The preliminary examination, consisting of a written segment which covers a range of topics in organismal biology, as well as both the oral and written presentation of a directed research project or dissertation research proposal.
- The completion of a research project and the presentation of a dissertation satisfactory to the department faculty.
- The passing of a final oral examination.

Admission

We strongly advise students considering application to the department to begin preparation of their application early in the autumn quarter, so that all materials will arrive by the December 1 deadline. The department requires GRE General Test scores from all applicants. Foreign applicants whose first language is not English also must submit TOEFL test scores with their application materials. Further information also may be obtained from the department’s home page at http://pondside.uchicago.edu/.
Courses

Didactic and seminar courses are offered in each of the departmental research foci. The specific courses presented vary from year to year. A list of current courses can be obtained by contacting the graduate program administrator. Students are encouraged to take courses related to their interests in other academic units on campus.

Organismal Biology & Anatomy Courses

**ORGB 30001. The Human Body. 125 Units.**

The Human Body course is the first component of the Scientific Foundations of Medicine curriculum in Year 1. The Human Body course will provide you with a foundation in the structural organization of the body. You will learn gross anatomy of the back, thorax, abdomen, pelvis, head and neck, and upper and lower limbs through large and small group teaching sessions, as well as cadaver dissection. Correlations with Radiology and Surgery are an integral part of the course and provide real world clinical context for the anatomic material.

Instructor(s): C. Ross Terms Offered: Summer

Note(s): For Pritzker students only, unless by instructor consent

**ORGB 30250. Chordates: Evolution and Comparative Anatomy. 100 Units.**

Chordate biology emphasizes the diversity and evolution of modern vertebrate life, drawing on a range of sources (from comparative anatomy and embryology to paleontology, biomechanics, and developmental genetics). Much of the work is lab-based, with ample opportunity to gain firsthand experience of the repeated themes of vertebrate body plans, as well as some of the extraordinary specializations manifest in living forms. The instructors, who are both actively engaged in vertebrate-centered research, take this course beyond the boundaries of standard textbook content.

Instructor(s): M. Coates Terms Offered: Spring. L.

Prerequisite(s): Three quarters of a Biological Sciences Fundamentals sequence.

Recommended for Advanced Biology students.

Equivalent Course(s): EVOL 30250, BIOS 22250
ORGB 31201. Mammalian Evolutionary Biology. 100 Units.
This course examines mammalian evolution—the rise of living mammals from ancient fossil ancestors stretching back over 300 million years. Lectures focus on the evolutionary diversification of mammals, including anatomical structure, evolutionary adaptations, life history, and developmental patterns. Labs involve detailed comparative study of mammalian skeletons, dissection of muscular and other systems, trips to the Field Museum to study fossil collections, and studies of human anatomy at the Pritzker School of Medicine. Students will learn mammalian evolution, functional morphology, and development, and will gain hands-on experience in dissection. Taught by instructors who are active in scientific research on mammalian evolution, the course is aimed to convey new insights and the latest progress in mammalian paleontology, functional morphology, and evolution.
Instructor(s): Z. Luo, K. Angielczyk Terms Offered: Autumn. L.
Prerequisite(s): Second-year standing and three quarters of a Biological Sciences Fundamentals sequence; or GEOS 13100-13200 or GEOS 22300, or consent of instructors.
Equivalent Course(s): BIOS 23262

ORGB 31300. Key Issues in Early Vertebrate Evolution. 100 Units.
The course addresses questions about the origin of vertebrates, the interrelationships of major gnathostome clades, and the fish-tetrapod transition.
Instructor(s): M. I. Coates Terms Offered: Winter
Prerequisite(s): Undergraduate level chordate biology required; familiarity with methods in systematic biology advantageous.
Equivalent Course(s): EVOL 30300

ORGB 32500. Survey of Systems Neuroscience. 100 Units.
This lab-centered course teaches students the fundamental principles of vertebrate nervous system organization. Students learn the major structures and the basic circuitry of the brain, spinal cord and peripheral nervous system. Somatic, visual, auditory, vestibular and olfactory sensory systems are presented in particular depth. A highlight of this course is that students become practiced at recognizing the nuclear organization and cellular architecture of many regions of brain in rodents, cats and primates.
Instructor(s): Staff Terms Offered: Autumn
Prerequisite(s): undergraduates with consent of instructor
Equivalent Course(s): NURB 31600

ORGB 33600. Vertebrate Development. 100 Units.
This advanced-level course combines lectures, student presentations, and discussion sessions. It covers major topics on the developmental biology of embryos (e.g. formation of the germ line, gastrulation, segmentation, nervous system development, limb patterning, organogenesis). We make extensive use of the primary literature and emphasize experimental approaches including embryology, genetics, and molecular genetics.
Instructor(s): V. Prince, C. Ragsdale. Terms Offered: Spring
Prerequisite(s): For College students: Three quarters of a Biological Sciences Fundamentals sequence.
Equivalent Course(s): DVBI 35600, MGCB 35600, BIOS 21356
ORGB 33850. Evolution and Development. 100 Units.
The course examines the evolution of animal development. Special attention is given to the
development of invertebrate phyla from sponges to lower chordates. References to vertebrate
body plans are included. Original research papers will be assigned to introduce current
debates. Students will be asked to contribute an oral presentation on a selected research topic
that fits the broader goal of the course.
Instructor(s): U. Schmidt-Ott Terms Offered: Autumn
Prerequisite(s): Advanced undergraduates may enroll with the consent of the instructor.
Equivalent Course(s): BIOS 22306,DVBI 33850,EVOL 33850

ORGB 34650. Computational Approaches for Cognitive Neuroscience. 100 Units.
This course is concerned with the relationship of the nervous system to higher order
behaviors such as perception and encoding, action, attention, and learning and memory.
Modern methods of imaging neural activity are introduced, and information theoretic
methods for studying neural coding in individual neurons and populations of neurons are
discussed.
Instructor(s): N. Hatsopoulos Terms Offered: Spring
Prerequisite(s): BIOS 24222 or CPNS 33100
Equivalent Course(s): PSYC 34410,CPNS 33200

ORGB 39500. Historical and Conceptual Foundations of Evolutionary Devpt. 100
Units.
The goal of this course is to explore the historical and conceptual foundations of
Developmental Evolution (DevoEvo) through readings and group discussions of historical
and philosophical literature on evolutionary and developmental biology.
Instructor(s): V. Lynch Terms Offered: Spring
Equivalent Course(s): HGEN 39500

ORGB 40000. Introduction to Integrative Organismal Biology. 100 Units.
A graduate seminar to introduce students to research of faculty in the Department of
Organismal Biology and Anatomy.
Instructor(s): M. Westneat Terms Offered: Autumn
Prerequisite(s): Required for first and second year graduate students in Integrative Biology.

ORGB 40001. Topics: Integrative Organismal Biology. 100 Units.
No description available.
Instructor(s): U. Schmidt-Ott, S. Palmer Terms Offered: Winter
Prerequisite(s): Required for first and second year graduate students in Integrative Biology.

ORGB 40100. Grants, Publications and Professional Issues. 100 Units.
Covers professional topics in evolutionary biology, primarily strategies in grant writing and
review. Each student will work towards the submission of an application of their choice. The
course meets weekly and involves extensive writing and discussion.
Instructor(s): J. Bergelson, R. Ho, M. Coates Terms Offered: Autumn
Note(s): Open to first and second year graduate students in the Darwinian Sciences Cluster
Equivalent Course(s): EVOL 40100,ECEV 40100
ORGB 40200. Advanced Topics in Ethics for the Darwinian Sciences. 100 Units.
This course covers advanced topics in ethics relevant to senior Ph.D. students in the Darwinian Sciences. CEB students are required to successfully complete this course before being awarded the Ph.D.
Instructor(s): M. Coates, P. Herendeen, S. Hackett Terms Offered: Winter. offered in alternate (even) years
Prerequisite(s): Open to Ph.D. students in the Darwinian Sciences
Note(s): not offered in 2016-17
Equivalent Course(s): ECEV 40200,EVOL 40200

ORGB 42600. Theoretical Neuroscience: Statistics and Information Theory. 100 Units.
This course is the third part of a three-quarter sequence in theoretical/computational neuroscience. It begins with the spike sorting problem, used as an introduction to inference and statistical methods in data analysis. We then cover the two main sections of the course: I) Encoding and II) Decoding in single neurons and populations. The encoding section will cover receptive field analysis (STA, STC and non-linear methods such as maximally informative dimensions) and will explore linear-nonlinear-Poisson models of neural encoding as well as generalized linear models and newer population coding models. The decoding section will cover basic methods for inferring the stimulus from spike train data, including both linear and correlational approaches to population decoding. The course will use examples from real data (where appropriate) in the problem sets which students will solve using MATLAB.
Instructor(s): S. Palmer Terms Offered: Spring
Prerequisite(s): Prior exposure to basic calculus and probability theory, CPNS 35500 or instructor consent.
Equivalent Course(s): CPNS 35600,STAT 42600

ORGB 57500. Cell Growth, Injury, Repair and Death. 100 Units.
This course reviews the various modes of cell injury that can occur, the basic molecular healing responses, and pathways of metabolic survival or death. This course may be of interest to those interested in wound healing, biological stress responses, molecular chaperones, radiobiology, biomechanics, biomedical engineering, as well as trauma and critical care medicine.
Instructor(s): R. Lee Terms Offered: Autumn
Equivalent Course(s): MOLM 57500,MPMM 57500
Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Times was used instead of Trajan.

Times was used instead of Palatino.

The editor may contact Leepfrog for a draft with the correct fonts in place.