GMS 6074: Comparative and Evolutionary Neurobiology

Spring 2012

Tuesday and Thursday, 1:00 – 3:00 PM
B2-028 of the Basic Science Building
3 credits

Course Coordinators:
Roger Reep (reep@mbi.ufl.edu)
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This 3 credit course is open to undergraduate and graduate students. It provides an introduction to the origins and diversity of nervous systems, examines the developmental and evolutionary processes that have molded the complex nervous systems of invertebrates and vertebrates, discusses the use of specific systems as models for understanding nervous system function, and investigates the relationships between nervous system organization and behavioral ecology.

Undergraduates: sign up for VME 4906, section 08FH, 3 credits

We will meet Tuesdays and Thursdays at 1:00 – 3:00 PM in room B2-028 of the Basic Science Building (a four story building attached to the northwest corner of the Health Center complex, next to the Biomedical Engineering building) for lecture/discussion sessions, with readings assigned from books, review articles, and the primary literature. Three laboratory sessions will be held. One of these is a full day excursion to the Whitney Labs near St. Augustine. Another will focus on dissection of insect nervous systems, and the third deals with gross and microscopic anatomy of vertebrate brains.

This is a participatory course. There is no prerequisite other than enthusiasm for the subject and a willingness to develop and share your ideas. Students will be expected to do the assigned reading and come to class prepared to ask questions, participate in lively discussion, and engage in critical reasoning. On several occasions, students will be responsible for working together in groups of 2-3, presenting and leading discussion of selected readings.

In consultation with the course coordinators, each student will choose a topic of interest, write an in-depth paper of ~15 pages, and give a 30 minute verbal presentation on the topic at the end of the course.

Students will be graded 50% on quality of participation in discussions and labs, 25% on their in-class presentations, and 25% on their final paper and presentation.
Reconstructing vertebrate evolutionary history  Reep  Tues Jan 10
Introduction to cladistic methods of comparison across taxa. Includes defining characters, character weighting, character polarity and outgroup analysis, the principle of parsimony, homology and homoplaspy, the use of adult vs. developmental characters. Vertebrate phylogeny.

The Tree of Life, Animal Origin & Phylogeny  Leonid Moroz  Thurs Jan 12
Lectures will review the current classification of eukaryotic organisms, position of Animals among other major kingdoms, paleontological and molecular data related to the origin of animals and the origin of main animal phyla.

How to build an animal? Evolution & Development  Leonid Moroz  Tues Jan 17
This lecture will discuss the origin, evolution and development of major bodyplans across animal phyla including characterization of five major types of the organization of nervous systems within the animal kingdom.

Cnidaria  Peter Anderson  Thurs Jan 19
Lectures will review the structure, function and capabilities of the earliest known nervous system, that of members of the Phylum Cnidaria. They will also highlight the amount of fundamental neurobiological information that can be learned by studying these nervous systems, particularly information that is revealed by their phylogenetic separation from mammals.

Molluscs  Leonid Moroz  Tues Jan 24
This lecture will review the structure and function of nervous systems in the phylum Mollusca from the most basal nerve net type of organization to the level of highly centralized brain in Cephalopods (e.g. Octopus or cuttlefish). Many unique characteristics of molluscan nervous system provide unique models and opportunities to study cellular bases of behavior as well as learning and memory mechanisms at all levels of neuronal organization (from genes to behavior).

Drosophila and C. elegans  Gerry Shaw  Thurs Jan 26
The essentials of these two powerful models of animal function and development will be discussed, with an emphasis on what each has contributed to our understanding of basic cellular mechanisms. Some historical context will be provided.

Arthropod nervous systems  Barbara Battelle  Tues Jan 31
The basic plan of the arthropod nervous system will be introduced. Those characteristics that make arthropods useful experimental animals for studies of the nervous system will be emphasized. Classic experiments in neurobiology that have used the arthropod nervous system will be discussed.

Motor Pattern Generation  Dirk Bucher  Thurs Feb 2
Evolution of eyes

Barbara Battelle  
Tues Feb 7

This lecture will focus on the diversity of eyes and photoreceptor function in both vertebrates and invertebrates and probe the question of how eyes have evolved.

Lab 1: Whitney Lab field trip

Whitney faculty  
Thurs Feb 9 (all day)

Battelle: Dissections of the nervous systems of both the horseshoe crab (*Limulus polyphemus*) and American lobster (*Homarus americanus*).

Bucher: Electrophysiological recordings from the lobster stomatogastric network.

Insects I – CNS organization

Roger Reep  
Tues Feb 14

Segmentation of the insect body, internal structure of the ganglia, identified neurons, segmental homologies, motor neurons, interneurons, sensory neurons. Circuitry for the cercal escape response, flying, and walking.

Insects II – Olfaction

Tom Dykstra  
Thurs Feb 16

Overview of insect olfactory systems in regards to peripheral structures such as chemoreceptors and internal structures such as antennal nerves, deutocerebrum, and glomeruli. Basic anatomy and how each structure relates to another (neurophysiology). Comparisons are made with other arthropods.

Insects III – Readings and presentations

Students  
Tues Feb 21

Lab 2: Insects  
BG-003 Basic Science Building  
Tom Dykstra  
Thurs Feb 23

1:00-5:00

Gross dissection of an insect nerve cord is conducted to familiarize students with the generalized insect nervous system. The lab is also designed to introduce students to the skill of conducting a dissection under the dissecting microscope while using forceps.

Deuterostomes: Echinoderms, Hemichordata and Basal Chordata

Leonid Moroz  
Tues Feb 28

This lecture will review the organization and functions of nervous systems in four deuterostome phyla: Echinoderms (sea pens, sea stars, sea urchins etc), Hemichordata, Chordata (cephalochordate-Amphioxus and tunicates) as well as Xenoturbellida – a newly discovered deuterostome phylum with the most basal neuronal organization (even simpler than in extant Cnidaria).

Origin & Parallel Evolution of Neural Systems

Leonid Moroz  
Thurs Mar 1

Independent origin of neurons and central nervous systems within different animal lineages will be discussed and illustrated using examples from many basal and derived animal groups. We will also discuss parallel evolution of many neuron-like characteristics, origin and evolution of transmitters as well as homologous neurons and behaviors.
Vertebrate nervous system organization  
Roger Reep  
Tues Mar 6
Major divisions of the vertebrate brain. Introduction to basic organizational variations and specializations present in agnathans, fish, amphibians, reptiles, birds and mammals. Regions and circuitry involved in spinal reflexes, vision, audition, somatic sensation, olfaction and taste. Motor circuits involving cerebral cortex, basal ganglia and cerebellum. Limbic system and motivated behaviors.

Vertebrate nervous system development  
Roger Reep  
Thurs Mar 8

Brain size  
Roger Reep  
Tues Mar 20
Allometric tools for assessing relative growth. Isometry, negative and positive allometry. Relation of growth dynamics to relative brain size within and across vertebrate taxa. Relative vs. absolute brain size in relation to computational capacity. The association of variation in whole brain size with variation in ecological variables, including metabolic rate, social structure and mating system.

Fish  
Jimmy Liao  
Thurs Mar 22

Amphibians and Reptiles  
Students  
Tues Mar 27

Birds  
Students  
Thurs Mar 29
Basic internal structural organization of the brain; extent of variation. Birdsong and food caching behavior. Horizontal vs. vertical organization in pallium. Homologies based upon connections vs. developmental characters.

Mammals I  
Roger Reep  
Tues Apr 3
Gyrals patterns and their determinants, cortical geometry in relations to information processing, sensory specializations and their effect on CNS organization and behavior. Monotremes, insectivores and bats offer different insights into patterns of mammalian brain evolution.

Motor Systems  
Roger Reep  
Thurs Apr 5
Diversity of motor systems in vertebrates. Mauthner cells and escape systems; reticulospinal and vestibulospinal systems for postural control and locomotion; rubrospinal systems related to limbs; reflex vs. voluntary control.
Lab 3: Vertebrates BG-003 Basic Science Building Roger Reep Tues Apr 10
Diversity of gross morphology in vertebrate brains; examples of internal architecture on sections stained for cells, axons, neuronal trees, neurotransmitters; experimental techniques for examining brain circuitry.

Mammals II - Readings and presentations Students Thurs Apr 12

Mechanisms of vertebrate brain evolution Roger Reep Tues Apr 17
Prosomeres as developmental modules that constrain phenotypic space; the role of neurogenesis and developmental timing. Molecular variation within and among species, and its relationship to behavior and evolution.

Student presentations Students Thurs Apr 19
1:00-5:00