Comparative Neurobiology

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Key Numbers: UG 04710; G 25963

This course will survey the Neuroethology and mechanisms of simple neural systems in invertebrates and lower vertebrates. Lecture material will emphasize experimental approaches from the literature.

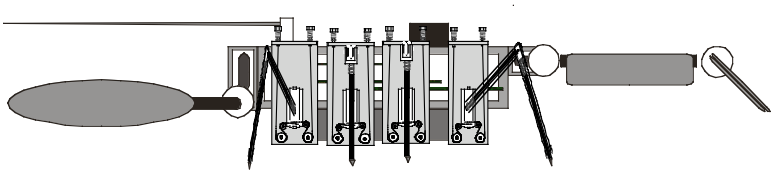
Date	Topic	Subject
Jan 8	INTRODUCTION	Neuroscience and Neurotechnology
10	VISUALIZING and RECORDING from NEURONS	Anatomical and Physiological Techniques
15	*Martin Luther King Birthday* No Class	
17	SURVEY of NERVOUS SYSTEMS	Invertebrates and Lower Vertebrates
22	BIOELECTRICITY I.	Membrane Channels and Resting Potentials
24	BIOELECTRICITY II.	Fast Membrane Conductances
29	BIOELECTRICITY III.	Slow Membrane Conductances
31	SYNAPTIC TRANSMISSION I.	Conduction, Electrotonic Transmission
Feb 5	SYNAPTIC TRANSMISSION II.	Chemical Synapses, PSP's
8	SYNAPTIC INTEGRATION I.	Complex Synapses
12	**Midterm Exam I.**	
14	SYNAPTIC INTEGRATION II.	Summation and Facilitatio,n, Heterosynaptic Effects
19	*Presidents Day:* No Class	
21	SYNAPTIC INTEGRATION III.	Neuromodulation
26	NEUROETHOLOGY	Types of Behavior
28	NERVE NETWORKS I	Sensory Integration
Mar.5-7	*Spring Break* No Class	
12	NERVE NETWORKS II	Motor Pattern Generation
14	MOTOR SYSTEMS I.	Command and Coordinating Systems
19	SENSORY SYSTEMS	Proprioceptors and Exteroceptors
21	**Midterm Exam II.**	
26	MOTOR SYSTEMS II.	Types of Motor Systems
28	SENSORY-MOTOR INTEGRATION I	Proprioceptive and Exteroceptive Reflexe
Apr. 2	MOTOR PATTERN SELECTION	Behavioral Choice and Hierarchies
4	MOTOR PATTERN SEQUENCING	Leech Feeding and Lobster Agonistic Behavior
9	LEARNING and MEMORY	Simple learning
11	NEURONALREPAIR	Regeneration and Recovery of Function
16	*Patriots Day:* No Class	
18	BIOMIMETICS & NEUROPROSTHES	Artificial Muscle and Electronic Neurons, FES

GRADING

Course credit will be based on midterm and final exams as well as on a term paper. The term paper will involve the design of a hypothetical nervous system to generate the behavioral repertoire of a hypothetical organism. The final grade will be weighted as follows:

Midterm exams (Feb 12, Mar 21)	40%
Final Exam (Week of April 20)	35%
Term Paper (Due April 9)	25%

Text: Fred Delcomyn (1998) **Foundations of *Neurobiology*** . W.H. Freeman & Co.



Neurocreation

Instructions - This term paper is to be returned to either the Biology Department Office or mailed to the Marine Science Center (East Point, Nahant, MA 01908) or emailed to **lobster@neu.edu** by April 9, 2007. The manuscript is to be typed double-spaced. Use color in the diagrams where appropriate for clarification. The relative weightings of the answers in the determination of your final mark of are indicated below. Use care in composing your answers correspondingly as this will be the schema by which your grade will be determined.

Based on your knowledge of the organization of nervous systems you are to design a hypothetical nervous system for an organism which exhibits the following behaviors: **(a).** *Feeding*; **(b).** *Locomotion*; **(c).** *Escape*; and **(d)**. *Courtship*. All of the behaviors are to be mediated by a mechanism of your choice, (i.e. walking or swimming for locomotion etc.), however, your description should include the relevant anatomy (eg. joints, muscles, chromatophores etc).

The locomotory and feeding behaviors are to be generated by a *network oscillator* and an *endogenous pacemaker oscillator*, respectively. In both cases, you are to provide a detailed explanation of the underlying cellular processes sufficient to explain the timing and amplitude of the oscillation of motor neuron discharge in terms of synaptic connections, ionic conductance properties and conduction delays. Either repetitive or episodic movements can generate the escape and courtship behaviors, but the underlying mechanisms must be specified in sufficient detail to explain the timing and amplitude of the evoked behavior.

In addition, the organism is to possess several sense organs: **(a).** Distance (smell) and contact (taste) chemoreceptors that reflexively initiate locomotion and feeding respectively; **(b).** an *optical courtship receptor* which sustains courtship by positive feedback **(c).** A *locomotory velocity detector* that regulates the velocity of locomotion by negative feedback; **(d).** *Amplitude and phase modulating proprioceptors* for the locomotory effector(s); **(e).** A *"fright" receptor* which initiates escape and **(f).** A *gut stretch receptor* that terminates feeding. Your description should include the temporal coding of the sensory inputs in labeled lines.

The behaviors are to be arranged in a hierarchy such that feeding dominates locomotion and courtship, courtship dominates locomotion hormonally (in other words, they don't run away from it) and escape dominates the other three. The organism should locomote during the appetitive phase of feeding (eg. in response to distance chemoreceptors), but feed during the consummatory phase.

The actual network should be composed of known components including: sensory afferents and interneurons, command systems, coordinating systems, neuronal oscillators and motor neurons. In addition any special synaptic properties (facilitation, fatigue, neuromodulation, etc.), should be explicitly specified.

Your answer should be organized in the following fashion:

(1). A brief description of the animal, including a summary of the anatomical relationships of the sense and effector organs and the CNS ganglia (10%).

(2). A description with diagrams of the effector organs including the relvant properties of the participating skeletal and/or hydrostatic components and muscular properties (10%).

3). A description with diagrams of the sense organs including the activating energy, the receptor cells, the labeled lines and the overall properties of the transductive process (20%).

4). Descriptions and diagrams of the pattern generating networks, treating each of the components individually. Included here should be a summary of the relevant cellular and synaptic mechanisms which underly the generation of the motor rhythm (30%).

(5). A summary diagram of the whole CNS network indicating the logial structure which gives rise to the observed behavioral hierarchy and the sequencing of behavioral acts (20%).

(6). A cogent description of how the thing copes (10%).`