Northeastern University **Department of Biology**

Comparative Neurobiology

Joseph Ayers
Marine Science Center, East Point, Nahant MA 01908
(781) 581-7370, Email: lobster@neu.edu http://www.neurotechnology.neu.edu/
Key Numbers: Ugrad 14125; Grad 23932

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

Date	Topic	Subject
5-Jan	NEUROTECHNOLOGY	Biomimetics
6	CELLULAR NEUROANATOMY	Cells and Systems
10	VISUALIZING NEURONS	Anatomical Techniques
12	RECORDING from NEURONS	Physiological Techniques
13	SURVEY of NERVOUS SYSTEMS I	Invertebrates
17	Martin Luther King Birthday	
19	SURVEY of NERVOUS SYSTEMS II	Spinal Cord and Brainstem
20	SURVEY of NERVOUS SYSTEMS III	Mammalian Brains
24	ARCHITECTRONICS of GANGLIA & BRAINS	Ganglionic Structure and Function
26	BIOELECTRICITY I.	Membrane Channels
27	Midterm I	
31	BIOELECTRICITY II.	Resting Potentials
2-Feb	BIOELECTRICITY III.	Fast Membrane Conductances
3	BIOELECTRICITY IV.	Action Potentials
7	BIOELECTRICITY V.	Slow Membrane Conductances
9	SYNAPTIC TRANSMISSION I.	Conduction, Electrotonic Transmission
10	SYNAPTIC TRANSMISSION II.	Chemical Synapses, PSPs
14	SYNAPTIC INTEGRATION I.	Complex Synapses
16	SYNAPTIC INTEGRATION II.	Summation and Facilitation, Heterosynaptic Effects
17	SYNAPTIC INTEGRATION III.	Neuromodulation
21	Presidents Day	
23	Midterm II	
24	NEUROETHOLOGY	Types of Animal Behavior
Mar. 7	NERVE NETWORKS I	Sensory Integration
9	NERVE NETWORKS II	CPGs: and Motor Pattern Generation
10	MOTOR SYSTEMS I.	Properties of Muscle
14	MOTOR SYSTEMS II.	Types of Motor Systems
16	MOTOR SYSTEMS III.	Command and Coordinating Systems
17	SENSORY SYSTEMS	Proprioceptors & Exteroceptors
21	SENSORY-MOTOR INTEGRATION	Proprioceptive & Exteroceptive Reflexes
23	Midterm III	
24	MOTOR PATTERN SELECTION	Behavioral Choice and Hierarchies
28	MOTOR PATTERN SEQUENCING	Chain Reflexes vs. Central Programming
30	BIOMIMETICS	Artificial Muscle and Electronic Neurons
31	BIOMIMETICS	Biomimetic Robots
4-Apr	LEARNING and MEMORY	Types of Learning
6	LEARNING and MEMORY	Mechanisms of Learning
7	NEURONALREPAIR	Regeneration
11	NEURONAL REPAIR	Recovery of Function
13	NEUROPROSTHES	Functional Electrical Stimulation
14	Reading Day	

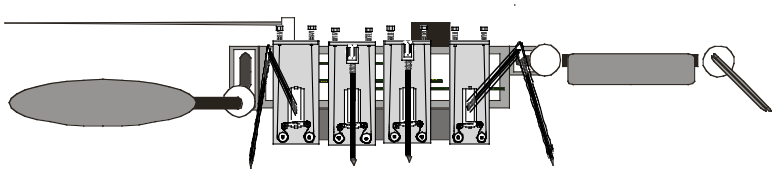
GRADING

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 (Jan 27, Feb 23, Mar 23)	45%
Final Exam (Week of April 15)	30%
Term Paper (Due April 11)	25%

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

BIOU587/BIOG287 *Mon, Wed, Thur: 4:35-5:40 135 SH* Spring, 2005



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) by April 4, 2005. 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 that* 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 relevant 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 logical 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%). `