CGS 310-601, STRUCTURE OF THE NERVOUS SYSTEM, FALL 2006`

Dr. Richard Miselis, V.M.D., Ph.D.
rmiselis@vet.upenn.edu
215-898-6781

LABORATORY MANUAL -- TABLE OF CONTENTS

11-22-2006	**No Lab - Thanksgiving Eve**	
11/29/06	Laboratory 11, Cerebellum	
	Background	218
	Lab Work	236
12/6/06	Laboratory 12, Systems I: Somatosensory and Somatomotor	
	Background	242
	Lab Work	260
12/13/06	**FINAL EXAM**	

CGS 310—601 Structure of the Nervous System

Laboratory Guide

Introduction

This introductory course in neurobiology is intended to provide an understanding of the principles of neuroscience. This includes neuroanatomical organization, the characteristics of functional systems and neurochemistry in the mammalian nervous system. Laboratories in the first part of the course cover regional organization of the nervous system ascending from the peripheral components of the nervous system, to the spinal cord, caudal regions of the brain including the medulla (myelencephalon), the pons (metencephalon), the midbrain (mesencephalon), and higher divisions of the brain which are the diencephalon the telencephalon, and the cerebelllum. Evolutionarily there has been a greater development of these higher divisions and more concentration of higher functions in the upper divisions of the nervous system. This process is called cephalization.

The course will also cover functional systems of the nervous system. Although we will not cover all of the systems, you should know that these include the primary sensory systems--i.e., visual, somatosensory (several submodalities), vestibular, auditory, gustatory, and olfactory. Also included is the somatomotor system (complex and multifaceted) which controls the skeletal musculature. It interacts with primary sensory systems and the cerebellum, which also has important interactions with the sensory systems.

There is a visceral sensory system which monitors parameters of the internal environment and the viscera. The viscera (organs with smooth muscle, cardiac muscle, glandular epithelium or otherwise specialized epithelium) are controlled by the endocrine hypothalamus and the visceromotor system known as the autonomic nervous system (ANS). The ANS has parasympathetic, sympathetic and enteric divisions.

There are other systems with less direct control over the somatic or visceral organs. They are characterized by being more remote from external signals and by being governed largely by "endogenous" factors or "endogenous" programs. An example is the reticular activating system of the brainstem which functions in arousal of consciousness (sleep-waking cycle) and arousal of awareness, action or behavior. Another example is the limbic system which is classically thought to control emotional behavior, feelings, drives, and motivations, as well as participating in learning. It influences or gives to an individual animal's or person's behavior those attributes which we perceive as the "personality" of the individual. This is called affect. It functions in approach-avoidance conflicts or fear-motivated behavior in animals. The establishment of pecking orders and social hierarchies are related behaviors which involve the limbic system. Lastly, the limbic system is involved in homeostasis which is the process of controlling the physiological parameters of the internal environment within acceptable ranges (i.e., compatible with life). It accomplishes this through modulation of the endocrine hypothalamus, the ANS and behavior. There are other functional systems which underlie higher functions and are more poorly understood. These include learning and memory and the cognitive functions characteristic of human behavior.

The above functions are extremely complex and do not act independently. There are many interactions between systems. Some are obvious as in the withdrawal reflex of a limb upon painful stimulation of the extremity of the limb. This is a somatosensory (nociceptor submodality) and somatomotor system interaction. It occurs at a low level in the neuraxis, in the spinal cord, and is called a segmental reflex. Other interactions can occur at higher levels in the neuraxis.

The strategy in this course is to review the cell biology of neurons and the important gross anatomical (brain dissection) and histological features of each CNS division. There will be brief consideration of the elemental functions of each division for each is capable of particular functions in and of itself or is involved in others as one part of a larger network of neural connectivity. Following this there will be lectures and laboratories, which focus on individual functional systems in which you will learn their functional characteristics and networks of connectivity.

To summarize the above in terms of the objectives of the course, you should achieve a basic understanding of the cell biology of the neuron, regional organization of the nervous system and the functional systems which utilize different or common anatomical features of the divisions of the nervous system. You will build in your mind images of networks of connectivity which make up the prominent functional systems and understand how they involve various divisions of the CNS.

General Laboratory Instructions

Our approach in the laboratory will be a combination of brief didactic presentation of material and of independent work on your part as groups, pairs and/or individuals to convey the basic elements of neuroscience, neuroanatomical organization, and neural function. You will be led through exercises designed to illustrate concepts, organization, and location. A number of teaching methods will be used to train you. First, you will have preserved material to dissect and to observe.

Second, each group of 4 students (at a table of 8 students) will have a carousel tray containing 2 series of 2 x 2 slides of which one is a neurocytology set prepared by Dr. E.G. Jones and the other a series of 2 x 2 slides of stained coronal sections of the cat brain (cat atlas set). Third, for demonstration purposes there will be various prosections and plastic models to illustrate certain aspects of nervous system organization.

The 2 x 2 cat brain atlas slides are to be used and studied repeatedly in order to learn the basic neuroanatomy. There is an accompanying set of labeled drawings of these brain sections. Use them over and over to learn the names and locations of important nuclei (collections of neuronal cell bodies or somas) and pathways (tracts; collections of axons).

Each student will be issued a set of figures (including the tract diagrams) referred to in the lab text as well as labeled cat atlas drawings.

Penn Web Site

Much of the material presented in these laboratories is available to you over the CAL website for the Veterinary School. You should go to:

1. Best site: **http://caltest.upenn.edu/neuro/**

2. Older site: http://cal.vet.upenn.edu/neuro/N_Index.html

Under Animal Biology Projects choose Neuroscience

Materials Needed for the Laboratory (and lecture) part of the course:
Recommended texts:

1. Brodal, P. The Central Nervous System, 3rd ed., Oxford, 2004

2. Purves, D., et al Neuroscience, 3rd ed., Sinauer, 2004

3. Kandel, Schwartz, and Jessel, Principles of Neuroscience, 4th ed., McGraw-Hill, 2000

Materials:

We'll supply dissecting instruments. However, you may want to have your own: these should include a scalpel (#3 handle), very fine scissors - iris type, two probes – blunt and sharp, and fine and medium forceps with serrated tips. We also supply non-sterile disposable surgical gloves to protect your hands from the formalin solution used to preserve the brains.

The brain and spinal cord specimens were originally preserved in formalin solution and are now stored in tap water. They should always be kept in tightly sealed containers when not in use. When you use tissue for dissection, remove the material from the jars and rinse in fresh tap water to remove any residual formalin, which can be noxious. It is important to prevent the tissue from drying out, however, so cover the tissue with a damp paper towel when not in use during lab.