I. DEVLIN-KELLY BAKERSFIELD COLLEGE

BIOLOGY 14
HUMAN ANATOMY

NERVOUS SYSTEM UNIT

LABORATORY EXERCISE 10
Neurons and the Central Nervous System

EX.10

INTRODUCTION:

The nervous system consists of the brain, spinal cord, all nerves, nerve plexuses, nerve roots, and ganglia. These are the divisions of the nervous system:

I. **Central Nervous System (CNS)** which consists of the

   a. Spinal Cord
   b. Brain

II. **Peripheral Nervous System (PNS)** which consists of all nerves, plexuses, roots, and ganglia in the:

   a. **Somatic Division** (skin and skeletal muscle)
   b. **Autonomic Division** (smooth muscle, cardiac muscle and glands)

      1. **Sympathetic**
      2. **Parasympathetic**

The primary cell type of the nervous system is the neuron. Neurons are very unique cells, both in their appearance and their way of working. The body uses neurons to deliver messages to and from all parts of the body. Sometimes a message will have to go to several different locations all at the same time. Some of the locations may be as far as 3 feet away from the cell body. Have you ever stubbed your toe? You probably grabbed your sore toe, jumped around on the other foot, and may have even yelled! Messages have to go from your toe to your brain and then from your brain to all those locations telling them how to make those moves.

LEARNING OBJECTIVES:

1. To learn the components of the nervous system
2. To learn the parts of a neuron and be able to identify them on a diagram or model.
3. To understand that structure and function are intimately related.
4. To understand the role of neurons and why they have the structure that they do.
5. To learn the direction of impulse conduction through a neuron.
6. To understand the structure and function of the myelin sheath.
7. To learn the names, functions, and locations of the membranes which cover the spinal cord and brain.

MATERIALS AND EQUIPMENT NEEDED:

Neuron cell models (if available)
Neuron axon kits (1/person) consisting of:
- Zip-lock bag
- 1 round hard candy
- pencil
- construction paper
- scissors
- Scotch tape

Microscopes
Slides:
- Neuromuscular junction
- Spinal cord x.s.
- Neurons

Spinal Cord Models

PROCEDURE:

A. How would you design a neuron?

If you were going to design a cell which could do all those things above, what would it look like? As you have found in other systems, form follows function. In other words, structure and function are so closely related that cells which do the same kind of work often have a similar appearance. Often you can predict the job that something does just by the way it looks. Neurons need to transmit messages to other parts of the body. How do you think the structure of the neuron would reflect its function?

First, discuss in your group how you might build a neuron so that it can do what it needs to do. What would it look like? When you have come up with some ideas, try sketching them until you like the way your cell looks. (There is no right or wrong way to do this assignment.) Everyone's drawing may look different from everyone else's. That's because every drawing is the product of each student's creative and critical thinking skills.

In the space below, draw a structure which you think could do the job of a neuron.

Neuron Diagram

Label the neuron diagram below using your text, Lab atlas or lecture notes for reference. Be sure to label the following structures:

- Neuron cell body
- Nucleus
- Nucleoli
- Nissl bodies
- Axon
- Dendrites
- Schwann cell
- Schwann cell nucleus
- Myelinated sheath
- Nodes of Ranvier
- Motor end feet
- Neuromuscular junction

This is the way a neuron really looks. How closely does your experimental neuron resemble this one?

[*Diagram of a neuron goes here*]

C. Building a myelinated axon:

1. Use a pencil to represent the axon of a neuron. Put a round hard candy into a ziplock bag and zip it leaving a small amount of air inside. The ziplock bag is a **Schwann cell**. What does the candy represent?

2. Now place the bottom of the bag (Schwann cell) along the length of the pencil (axon) and tape it there. Begin to wind the bag around the pencil until it is completely wound up. Scotch tape the top of the bag in place to hold it on the pencil. You now have built a **myelinated axon**. Nerve impulses can travel down the length of this axon.

3. Do you see how the Schwann cell is mostly cell membrane? What is the cell membrane made of? _____
What is the myelin sheath mostly made of?_____

4. Now put your axon down in the middle of the lab table. Line up all the axons at your table end to end (like beads on a string). You now have a longer axon, made up of several pencils and Schwann cells. Find the **nodes of Ranvier**. Next semester in Physiology you will learn that myelinated axons are able to transmit messages very rapidly by allowing the nerve impulse to jump from one node to the next. This type of impulse transmission is called **saltatory motion.** (If you speak Spanish you will find this term easy to remember. The Spanish verb *saltar*, to jump, comes from the same Latin root.)

D. Observing neuron models:

Observe the neuron models in the lab. Have your lab partner quiz you on the parts of the neuron until you can identify all the parts above without looking at your books.

E. Observing slides of neurons under the microscope

If the following slides are available in the laboratory, observe them and sketch them in the space below.

1. Neuromuscular junction

This is where the neuron connects to a muscle so it can deliver the message to contract that muscle unit. Look for the motor end feet and label them in your sketch.

2. Neurons

Examine this slide to see how these neurons look. Do you observe any differences between these and the model or diagram above? Why are there differences?

F. Gross Anatomy of the Spinal Cord.

1. Coverings

These are the coverings of the spinal cord known as the spinal meninges. They are continuous with the meninges of the brain.

(What part of the body do you suppose the disease meningitis affects?)

_____

Their purpose is to protect the spinal cord.

Identify the indicated structures which are listed in order from most external to most internal.

a. Dura mater
b. Subdural space
c. Arachnoid mater
d. Subarachnoid space
e. Pia mater
f. Spinal cord

Have you heard of the anaesthetic called **epidural**? It is often given during labor and childbirth because it blocks sensory information about pain from getting to the brain. When it is given it will block motor and sensory messages from and to the waist down.
Why is it called epidural? _____

What is the meaning of the prefix "epi"?_____

[*Diag. of spinal cord with meninges to label*]

2. Cross section of Spinal Cord
When you slice the spinal cord in a transverse or cross section you see a structure which resembles a butterfly. This pattern is visible because the spinal cord is made of two different kinds of neurons which make up the grey matter and white matter. The grey matter consists of non-myelinated neurons. The white matter consists of myelinated neurons. What material makes up the myelin sheath?_____
What color is lipid? (Think raw steak here)_____
Why is this called white matter?_____

Identify these anatomical structures in the spinal cord and label them in the diagram below.

a. Dorsal horn of grey matter
b. Anterior horn of grey matter
c. Central canal
d. Posterior sulcus
e. Anterior fissure
f. Dorsal root ganglion
g. Anterior ramus of spinal nerve.
h. Posterior ramus of spinal nerve
i. Dorsal root of spinal nerve
j. Lateral funiculus of white matter
k. Anterior funiculus of white matter
l. Ventral root of spinal nerve
m. Dorsal funiculus of white matter
n. Dorsal commissural gray matter
o. Anterior commissural gray matter

[*Diagram of a cross section of a spinal cord to label*]

3. **Cross Section of Spinal Cord**

Observe a slide of a spinal cord cross section on low power.
First find the **central canal**. This will be an opening in approximately the center of the entire spinal cord.

Find the butterfly-shaped structure which surrounds the canal. This is the **grey matter**. The remainder of the cord is the **white matter**.

The fanning out portions of the grey matter (the wings of the butterfly) are the horns.

Then determine the anterior and posterior of the cord. In the anterior, are the **ventral horns.** This is the location of the greatest density of neuron cell bodies. These are **multipolar neurons** and they contain the cell bodies of the **efferent motor neurons** which extend out to contact the skeletal muscle cells. Examine one of these neuron cell bodies under high power. Look for the following:

a. nucleus
b. nucleolus
c. axon
d. dendrites

Observe the clump of tissue which is located dorsally outside the spinal cord. This is the **dorsal root ganglion.** The cell bodies located here are **unipolar neurons** which are the **afferent sensory neurons** which bring sensory information from the body to the central nervous system.

STUDY QUESTIONS:

When you have completed this laboratory exercise you should be able to answer the questions below. Use your books for help if you need it.

1. The main nervous cell type is the _____

2. The outgoing (efferent) transmissions travel along the _____

3. The incoming (afferent) transmissions travel along the _____

4. Some axons are covered by a structure called the _____

5. The myelin sheath is made up of cells called _____

6. Schwann cells make up the _____

7. The _____ _____allows the nervous impulse to travel at a much faster speed than normal in a process called _____

8. Saltatory conduction is a nervous impulse which travels along the axon by jumping from one _____ _____to the next.

9. Of what material is the myelin sheath composed? _____

10. Of what material is the cell membrane composed?_____

11. What is the function of neurons?_____

12. To what location do neurons conduct impulses?_____

13. Name the coverings and the spaces of the spinal cord in order from most external to most internal.

_____

_____

_____

_____

_____

_____

14. Explain why part of the spinal cord looks grey and part looks white.

_____

15. What neuron cell bodies are located in the ventral horns?

_____

16. What neuron cell bodies are located in the dorsal root ganglion?

_____

17. What is a ganglion?_____

18. What two things come together at the neuromuscular junction?

_____

REFERENCES AND ACTIVITIES:

1. Watch the one-hour video on the nervous system which is on reserve in the library. You may either watch it in the library or check it out overnight to watch at home. (Sorry, Not Available Spring 2005)

2. Search the Internet for **Diseases of the Nervous System.** Some diseases that are particularly related to the topics you studied in this lab are:

    a. *Multiple Sclerosis*
    b. *Meningitis*
    c. *Spina bifida*
    d. Nerve regeneration following injury

LAB PRACTICAL SAMPLE QUESTIONS:

1. Micrograph photo of spinal cord with dorsal root ganglion or ventral horn indicated by the pointer with question asking you to identify the structure, or the type of cell (unipolar or multipolar neuron)

2. Model of spinal cord with structures indicated to be identified.

3. Diagram or student-built model of myelinated neuron with questions such as: Identify this structure (Schwann cell) or area (node of Ranvier) or Identify this entire structure (Myelinated axon) What Chemical is it composed of? (lipid)