# **Exercise 9: Nervous Tissue with an Overview of Brain and Spinal Cord Anatomy**

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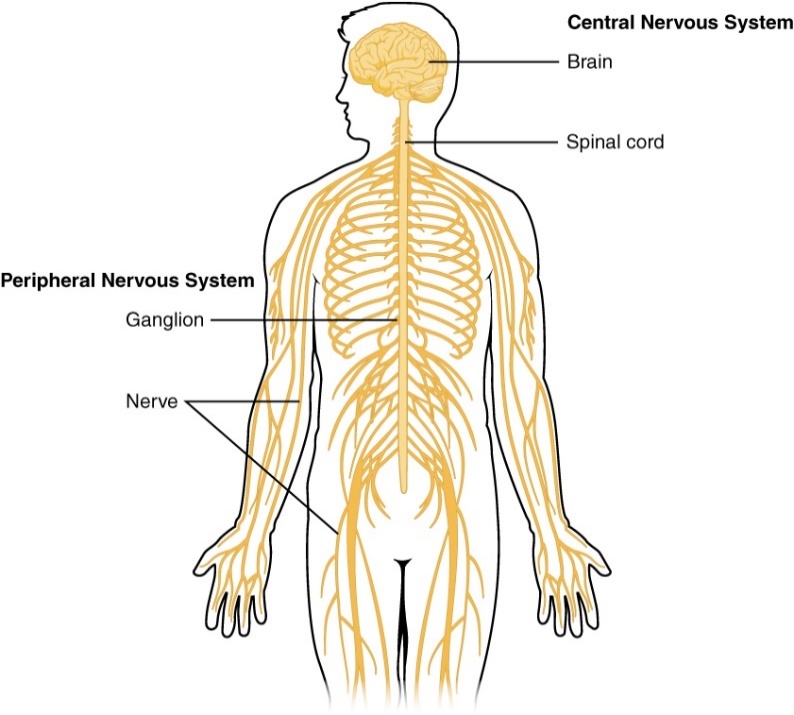
Figure 9.1 One of two cell types found in the nervous system, neurons are responsible for the electrical signals that results in stimulus responses. The image shows a cortical multipolar neuron which constitutes most cells in the brain and spinal cord. This cell was isolated from a mouse and was stained with a fluorescent dye to show the elaborate processes of the neuron. https://commons.wikimedia.org/wiki/File:A\_Cortical\_Neuron\_In\_Isolation.jpg

# **Exercise 9 Learning Goals**

# After completing this lab, you should be able to:

* Understand the anatomic and functional divisions of the nervous system
* Identify and explain the differences between neurons and neuroglia
* Examine nervous tissue and identify neurons vs glia
* Describe the structure and function of dendrites, axons, axon hillock, synaptic end bulbs, myelin sheath and Node of Ranvier
* Identify and define structures of the spinal cord

# Pre-Lab Activity 9.1: Divisions of the Nervous System



The nervous system is responsible for perceptions, behaviors, memories and voluntary movements. It is subdivided based on anatomical or functional description. Anatomically we have a **central nervous system** which includes the brain and spinal cord and a **peripheral nervous system** which encompasses the 12 pairs of cranial nerves, 31 pairs of spinal nerves, ganglia and sensory receptors. The functional division of the nervous system is based on neuron activity including sensory, integrative and motor functions. Explore the divisions of the human nervous system by completing the table below.

|  |  |  |
| --- | --- | --- |
| **Division** | **Structures** | **Function** |
| **Central Nervous System** |  |  |
| **Peripheral Nervous System** |  | **Somatic:** |
| **Autonomic:** |
| **Enteric:** |
| **Sensory** |  |  |
| **Integrative** |  |  |
| **Motor** |  |  |

**List the major functions of the nervous system:**

# Pre-Lab Activity 9.2: Introduction to Neurons and Glia

Nervous tissue is one of the four major tissue types and is composed of two distinct cell types: **neurons** and **neuroglia**. Within the two cell types there is further variation based on number of processes, cell body shape and function. Neurons are the electrically excitable cells responsible for sending nerve impulses, while glial cells play a supporting role to neurons; however, glia out number neuron approximately 20 to 1. Study the cells of nervous tissue by completing the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Neurons** | **Function** | **Shape/structure** | **Location** | |
| **Multipolar** |  |  |  |
| **Bipolar** |  |  |  |
| **Pseudounipolar** |  |  |  |
| **Pyramidal cells** |  |  |  |
| **Purkinje cells** |  |  |  |
| **Sensory** |  |  |  |
| **Motor** |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Neuroglia** | **Function** | **Shape/structure** | **Location** | |
| **Astrocytes** |  |  |  |
| **Oligodendrocytes** |  |  |  |
| **Microglia** |  |  |  |
| **Schwann cells** |  |  |  |
| **Ependymal cells** |  |  |  |

**What is the main difference between function of neurons and neuroglial cells?**

# Pre-Lab Activity 9.3: Structure of a Neuron

Neuron structure is important because these cells are responsible for transmission of electrical signals throughout the nervous system. Neurons are composed of three main parts: **dendrites** which receive input signals from other cells, **cell body** and **axons** which convey output signal to other cells. Investigate all parts of the neuron by completing the table below.

|  |  |
| --- | --- |
| **Neuron Cell Part** | **Function** |
| **Cell body** |  |
| **Dendrites** |  |
| **Axon** |  |
| **Axon hillock** |  |
| **Synaptic end bulb** |  |
| **Myelin sheath** |  |
| **Node of Ranvier** |  |

**What is the difference between an axon and a dendrite?**

**Why are some but not all axons myelinated?**

# Pre-Lab Activity 9.4: Brain Anatomy

The brain is an extremely important part of the central nervous system protected by the bony skull. It is a jelly-like mass of cells located in the cranium that integrates information, stores memories, makes decisions, receives sensory input and executes motor output. The mature brain consists of 4 main parts: the **brainstem**, **cerebellum**, **diencephalon** and **cerebrum**. The brainstem is further divided into the midbrain, pons and medulla oblongata and the cerebrum is further divided into functional lobes named after cranial bones above that region of the brain (the frontal lobe, temporal lobes, parietal lobes and occipital lobe). Explore the functions of the basic brain structures by completing the table below.

|  |  |  |
| --- | --- | --- |
| **Structure** | **Description** | **Importance** |
| **Brainstem** |  |  |
| **Cerebellum** |  |  |
| **Diencephalon** |  |  |
| **Cerebrum** |  |  |
| **Meninges** |  |  |

**Approximately, how much of our brain do we use?**

**What is the purpose of the meninges?**

# Pre-Lab Activity 9.5: Spinal Cord Anatomy

The spinal cord is an oval shaped structure located in the vertebral canal that is continuous with the medulla oblongata of the brainstem and connects the central nervous system with peripheral nervous system structures. Explore the functions of important spinal cord structures by completing the table below.

|  |  |  |
| --- | --- | --- |
| **Structure** | **Description** | **Location** |
| **Conus Medullaris** |  |  |
| **Filum terminale** |  |  |
| **Cauda equina** |  |  |
| **Central canal** |  |  |
| **Cervical enlargement** |  |  |
| **Lumbar enlargement** |  |  |
| **Meninges** |  |  |

**What protects the brain and spinal cord?**

**What is the difference between the cranial meninges and the spinal meninges?**

# **Lab Activity 9.1: Nervous System Histology**

There is a large amount of cellular diversity in the nervous system even though there are only two types of cells: neurons and neuroglial. The diversity originates from differences in cellular morphology, molecular identity and varying physiology. There are fewer neurons in the nervous system compared to neuroglial cells; however, only the neurons transmit nerve impulses to muscle and other neurons. The neuroglial cells far outnumber neurons, undergo cell division and are responsible for maintaining the homeostatic environment for the neurons. Some of the neurons you may observe while examining nervous system slides include a multipolar neuron which has many branching processes including many dendrites an elaborate axon that may or may not be visible. A motor neuron may also be a multipolar neuron; however, it is categorized functionally because its synapses transmits nerve impulses to stimulate muscle fibers. The spinal ganglion slide includes collections of nerve cell bodies as part of the peripheral nervous system. Ganglia are closely associated with spinal nerves that exit on the dorsal side of the spinal cord. Obtain prepared slides of multipolar neurons, motor neurons and spinal ganglion.

Activity 9.1.1 Examine a multipolar neuron slide

**Using low power magnification identify a multipolar neuron, nuclei of nearby glial cells, dendrites of the neuron, axon of the neuron and cell body of the neuron**

# Activity 9.1.2**:** Examine a motor neuron slide

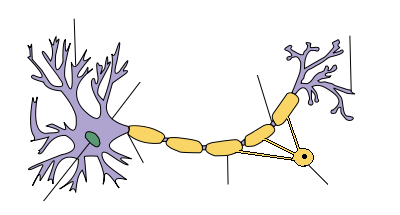
**Using low power magnification identify a motor neuron, nuclei of nearby glial cells, dendrites of the neuron, axon of the neuron and cell body of the neuron**

# Activity 9.1.3**:** Examine a spinal ganglion slide.

**Using low power magnification identify the cell bodies and nuclei of nearby glial cells**

# Activity 9.2: Label the parts of a neuron

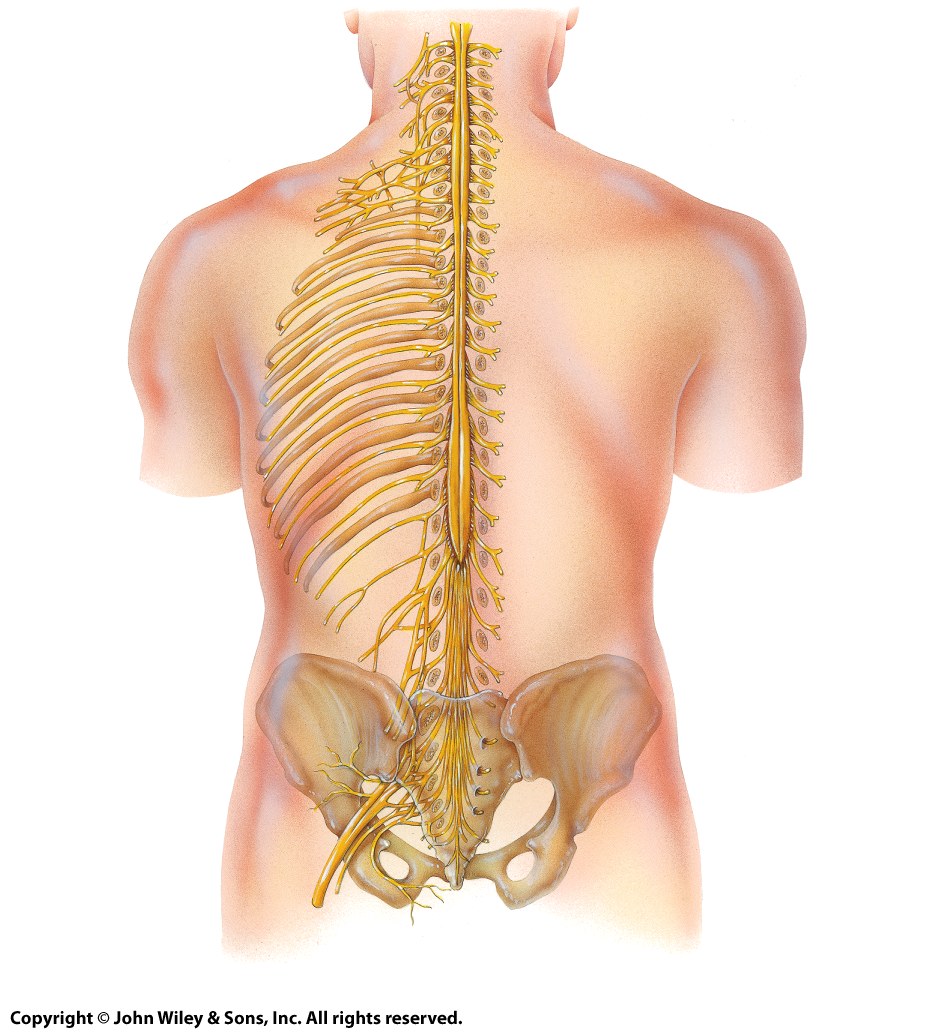
A neuron is composed of three mains parts including the cell body, which includes the nucleus and carries out the same functions as in other cells, dendrites the many processes originating from the cell body which receives electrical and chemical signals from other neurons and a single axon which may be long or short and conveys electrical signals to the cell synapse communicating with other neurons or muscle cells. Other structures include the **axon hillock**, **Node of Ranvier**, **myelin sheath** and **synaptic end bulb**. Label the parts of the neuron below.



https://commons.wikimedia.org/w/index.php?search=neuron&title=Special%3ASearch&profile=advanced&fulltext=1&advancedSearchcurrent=%7B%22namespaces%22%3A%5B6%2C12%2C14%2C100%2C106%2C0%5D%7D&ns6=1&ns12=1&ns14=1&ns100=1&ns106=1&ns0=1#/media/File:Neuron\_CNS\_-\_no\_labels.png

Activity 9.3: Label the Parts of the Spinal Cord

Identify the following structures using the diagram below: **conus medullaris**, **cervical enlargement**, **lumbar enlargement**, **filum terminale** and **cauda equina**.



Activity 9.4: Spinal Cord Dissection

The brain and spinal cord are covered by a three-layered protective connective tissue covering known as the **meninges.** The meninges is composed of the **dura mater** (outermost layer), the **arachnoid mater** (middle layer) and the **pia mater** (innermost layer), attached to CNS tissue.

**Important Safety Information:**

**Most of our dissection specimens were preserved in formalin, an aqueous colorless solution that is a suspected carcinogen. In most cases the formalin has been replaced with a nontoxic preservative that may cause mild skin irritation. There is no need for concern provided you follow the guidelines outlined here and wear proper protective equipment.**

1) WEAR GLOVES when handling your preserved specimen, tray, tools, or soiled paper towels.

2) WEAR SAFETY GLASSES when actively dissecting.

3) REMOVE GLOVES when you are not working at the lab bench or handling your specimen.

4) ALWAYS CONTAIN YOUR SPECIMEN inside the dissection tray.

5) ALL ORGANIC MATERIAL (identifiable animal parts) should be placed in the orange biohazard bins.

6) IN THE EVENT OF CONTACT: DO NOT PANIC. Wash skin with soap and water; flush eyes with water. There is an eye-wash station at every sink in the lab.Also, please inform your instructor immediately.

Spinal Cord Dissection procedures:

**1) Put on safety goggles and gloves**

**2) Obtain your dissecting tray and instruments**

**3) Obtain a section of preserved spinal cord**

Whole spinal cord:

1. Examine the spinal cord section and observe the connective tissue and fat covering where the spinal nerves exit. The **spinal nerves** are typically small, white, cylindrical, fibrous structures occurring in pairs about every 1.5 inches along the length of the cord. If the cord were still encased within the vertebral column, one pair of spinal nerves would extend outward between each two vertebrae.

2. Carefully remove the connective tissues until the spinal nerves can be seen. To do this, lift the outermost covering (the **dura mater**) from the main mass of tissue at one end of the cord. Cut the dura mater along the entire anterior or posterior side of the cord.

4. Try to tear a piece of the dura mater with your fingers. This is a very tough white fibrous connective tissue.

6. The **pia mater** which covers the spinal cord directly, notice that it contains the blood vessels of the cord’s surface.

Cross-section of the spinal cord

1. Use a sharp scalpel to cut the spinal cord in cross section at the point where a pair of spinal nerves exit.

2. Look at the cut end and identify the H-shaped inner core of **gray matter**. The gray matter is composed of the cell bodies of neurons.

3. The surrounding **white matter** contains nerve fibers (axons) and appears white due to the **myelin** which wraps around the axons. The white matter contains bundles of nerve fibers called **spinal tracts** which conduct impulses to and from the brain.

4. Identify the **central canal**. Observe the shape of the central canal.

Is it oval or circular? What fills this canal in the living animal?

Clean up procedure:

**Dispose of all organic debris in the appropriate biohazard containers and clean the dissecting instruments and tray with soap and water before leaving the laboratory. Do not forget to wash your hands with water and soap, and to disinfect the table tops.**

What structures make up gray matter?

What structures make up white matter?

Why does white matter look white?

Draw and describe the features observed in a cross section of the spinal cord.

Describe the anatomy and location of the spinal cord within the human body.

Is the central canal oval or circular? What fills this canal in a living human?

How many spinal nerves exit the spinal cord?

How would you determine dorsal from ventral spinal cord?

Describe how the spinal cord is suspended in the spinal column.

What is the overall importance of the spinal cord?