

MODULE 9: NERVOUS SYSTEM

An Introduction to the Anatomy of the Nervous System

The nervous system can be divided into two parts: 1) the central nervous system, which includes the brain and spinal cord, and 2) the peripheral nervous system, which is made up of nerves and ganglia. The nerves in the peripheral nervous system are classified according to their origin. Cranial nerves arise directly from the brain while spinal nerves arise from the spinal cord. In this lab you will learn to identify various components of the both the central and peripheral nervous system.

LIST OF TERMS FOR THE ANATOMY OF THE NERVOUS SYSTEM

Coverings of the Brain and Brain Blood Vessels

- **Meninges**
 - **Dura Mater**
 - **Arachnoid Mater**
 - **Pia Mater**
- **Falx Cerebri**
- **Falx Cerebelli**
- **Tentorium Cerebelli**
- **Dural Sinus**
- **Vertebral Arteries**
- **Basilar Artery**
- **Internal Carotid Arteries**
- **Arterial Circle (Circle of Willis)**

Meninges is a word that comes from ancient Greek and it means membranes. Dura means durable or “tough” and Mater means “mother”. The **dura mater** is a meningeal layer around the brain that is made of dense connective tissue and helps contain and protect the soft tissues and fluids around the brain. Arachnoid means spider and refers to the “spider web” looking processes that extend from the **arachnoid mater** to the pia mater. Look for these in some of the pictures. Pia means “tender” and refers to the very delicate membrane that lies right against the brain surface called the **pia mater**.

Falx means “sickle” and refers to the shape of the dura mater as it divides the hemispheres of the cerebrum and the cerebellum. Note that the **falx cerebelli** is not nearly as large as the **falx cerebri**.

Tentorium refers to a “tent” like structure. The **tentorium cerebelli** is a tent like membrane the covers the superior surface of the cerebellum.

The **dural sinus** is an opening the superior portion of the dura mater. This opening collects the venous blood from the brain and drains it down the posterior skull until it enters the jugular veins that exit the skull.

The **vertebral arteries** travel through the transverse foramen of the cervical vertebrae and enter the skull through the foramen magnum where they join the **basilar artery**. The **Internal carotid arteries** come off the carotid arteries of the anterior neck and enter the skull through the carotid canals. The **arterial circle or circle of Willis** is a rare complete circle. Arteries branch off the

circle and feed the brain. This circular structure allows for blood to get to both sides of the brain even if a vertebral or internal carotid artery blood supply is compromised on one side.

Ventricles of the Brain

- Lateral Ventricles
- Third Ventricle
- Fourth Ventricle
- Cerebral Aqueduct
- Choroid Plexus
- Septum Pellucidum

The **ventricles** of the brain are basically hollow areas deep in the brain tissue that contain cerebral spinal fluid, often called CSF. CSF is made by a tissue called the **choroid plexus** and the CSF helps “float” the brain. CSF is found in the ventricles and it also leaves the **fourth ventricle** to make its way around the brain between the pia and arachnoid membranes. The **third ventricle** is found in the diencephalon.

The **septum pellucidum** is a membrane that separates the lateral ventricles. It is most easily viewed in a medial view of the brain that has been separated in two parts via a sagittal section.

Structures of the Cerebrum and Cerebellum

- Cerebrum
 - Cerebral Hemispheres
 - Gyrus
 - Sulcus
 - Gray Matter
 - White Matter
 - Longitudinal Fissure
 - Lateral Sulcus (or Fissure)
 - Parietooccipital Sulcus
 - Frontal Lobe
 - Precentral Gyrus
 - Central Sulcus
 - Postcentral Gyrus
 - Parietal Lobe
 - Temporal Lobe
 - Occipital Lobe
- Cerebellum
 - Vermis
 - Cerebellar Hemisphere
 - Arbor Vitae
- Corpus Callosum
 - Genu
 - Splenium

The **cerebrum** refers to the part of the brain that contains the cerebral cortex. The cerebral cortex is the outermost layer of brain neural tissue. The cerebral cortex is made up of gyri and sulci. A **sulcus** is a more shallow kind of “valley” in the cerebral cortex. A **gyrus** is the opposite of a “valley” and refers to a “ridge” on the cerebral cortex. A **fissure** is a deep division that separates different lobes or hemispheres. The cerebrum has two **hemispheres** that are connected at the **corpus callosum**. The **cerebellum** has two hemispheres that are joined together and not separated. The neural structure that is found at the point of union for the cerebellar hemispheres is called the **vermis**. The cerebrum has one **frontal lobe**, two **parietal lobes**, two **temporal lobes** and one **occipital lobe**. Again, gray matter is found in areas of cell bodies and white matter is where the axons of nerves travel. The **arbor vitae** is the white matter of the cerebellum.

Diencephalon

- Thalamus
 - Intermediate Mass
- Hypothalamus
 - Mamillary Body
- Fornix
- Pineal Body
- Pituitary Gland
 - Infundibulum

Diencephalon means “between brains”. This region is an area that lies between the cerebrum and the brain stem. This area contains the **thalamus** which is an oval structure of gray matter on both sides and connected to each other by a small band of white matter called the **intermediate mass**. The **hypothalamus** is located below the thalamus and contains several regions of gray matter, one of which protrudes and is named the **mammillary body**. The **fornix** is a band of white matter that carries axons to the hypothalamus from other areas of the brain. The **pineal body** is a neural tissue that secretes the hormone

melatonin. The **pituitary gland** “hangs” by and **infundibulum** below the hypothalamus and communicates with the hypothalamus. These communications are crucial for regulation of the production and release of several different hormones.

Brain Stem

- **Medulla Oblongata**
- **Pons**
- **Midbrain**
 - **Corpora Quadrigemina**
 - **Superior Colliculi**
 - **Inferior Colliculi**

The **brain stem** is below the diencephalon but is still found within the skull. Below the foramen magnum, we call the descending neural tissue “spinal cord”. The brain stem looks much like a spinal cord at its most inferior end, but has some thickenings superiorly. The **medulla oblongata** is a thickening in the middle of the brain stem that contains nuclei “gray matter” important for control of vital body functions. The **pons** is another thickening on the brain stem that protrudes anteriorly. The pons contains nuclei important for motor control. The very superior end of the brain stem contains an area called the midbrain. The **midbrain** contains some nuclei called the corpora quadrigemina. The density of cell bodies in this area causes some protrusions that can be identified on the posterior mid brain. There are four protrusions called the inferior and superior colliculi, but all together we call these the corpora quadrigemina.

Cranial Nerves

- **I. Olfactory Nerves**
 - **Olfactory Bulb**
 - **Olfactory Tract**
- **II. Optic Nerve**
 - **Optic Chiasma**
 - **Optic Tract**
- **III. Oculomotor Nerve**
- **IV. Trochlear Nerve**
- **V. Trigeminal Nerve**
- **VI. Abducens Nerve**
- **VII. Facial Nerve**
- **VIII. Vestibulocochlear Nerve**
- **IX. Glossopharyngeal Nerve**
- **X. Vagus Nerve**
- **XI. Accessory Nerve**
- **XII. Hypoglossal Nerve**

Even though **cranial nerves** come off of the brain stem which is in the skull, they are actually peripheral nerves and part of the peripheral nervous system. Students should know the name and the roman numeral for each cranial nerve.

The **olfactory nerve** has two parts, the **bulb** which is the very end and is more swollen than the **tract** which is a band of axons that connect the bulb to the brain.

The **optic nerve** is the band of axons that connect the chiasma to the eyes. If the eyes have been removed from the specimen or model, the optic nerve will often show up as only small residual nerves coming off of the chiasma. The **chiasma** is where the optic nerves join and allow some axons to cross to the other side of the brain. The **optic tract** is the band of axons that carry axons into the brain “after” the chiasma. Chiasma means to cross.

The rest of the cranial nerves are seen arising from the brain stem along its entire length.

Some students have used the Mnemonic device below to memorize the cranial nerves.

Helpful mnemonic for remembering the order or the cranial nerves:

On On On They Traveled And Found Voldemort Guarding Very Ancient Horcruxes

Or for those who like animals:

Oh, Oh, Oh, To Touch And Feel Very Grateful Very Appreciative Horses

Review of the Spinal Cord

- Gray Matter
- White Matter
- Gray Commissure
- Horns
 - Ventral Horn
 - Lateral Horn
 - Dorsal Horn
- Columns
 - Ventral Column
 - Lateral Column
 - Dorsal Column
- Central Canal
- Anterior Median Fissure
- Posterior Median Sulcus
- Dorsal Root Ganglion

The spinal cord is still part of the central nervous system along with all the structures discussed so far in the brain. However, there is one structure in this list that is actually near the spinal cord but is not part of the spinal cord. The dorsal root ganglion is a collection of cell bodies that is part of the peripheral nervous system. Generally, gray matter is an area of cell bodies in the central nervous system and a ganglion is an area of cell bodies in the peripheral nervous system. The columns in the spinal cord are areas of nerve cell axons and can also be referred to collectively as white matter. The central canal is continuous with the fourth ventricle in the brain and it contains CSF. The fissure is an actual division of the spinal cord while the sulcus does not actually divide the spinal cord in half.

Anatomy of a Neuron

- Soma
- Axon
- Axon Hillock
- Dendrites
- Nucleus
- Myelin Sheath and Schwann Cell
- Node of Ranvier
- Endoneurium

Soma means “body” and refers to the part of a neuron that contains the nucleus of the cell. The **axon** protrudes from the soma and can travel for considerable distance before synapsing with another neuron. The **axon hillock** is the area of narrowing as the soma gives rise to an axon. Axons may be covered with a **myelin** sheath which is the cylindrical wrapping of a cell membrane belonging to yet another cell. In the peripheral nervous system myelin originates from a cell called a schwann cell (*in the central nervous system the cell that makes myelin is called an oligodendrocyte*).

A **node of ranvier** is the bare axon region that exists between schwann cells.

Peripheral neurons are surrounded by a connective tissue sheath called the **endoneurium**.