Human Anatomy and Physiology I
Lab 10 The nervous system

**Learning Outcomes**

- Break the nervous system into its main subdivisions.
  **Assessment:** Exercise 10.1

- Visually locate and identify the major structures of the brain
  **Assessment:** Exercise 10.1

**Overview of the nervous system**

**Information**

The nervous system is the collection of cells and tissues that form the structures and organs involved in collecting and processing sensory information and then triggering reactions.

The nervous system is broken down into the **central nervous system** and the **peripheral nervous system**. The central nervous system is just the brain and the spinal cord. The peripheral nervous system is the rest of the nervous tissue in the body and the sensory organs that the nervous tissue attaches to. The peripheral nervous tissue includes the **cranial nerves** that branch out from the brain and the **spinal nerves** that branch out from the spinal cord, as well as all the sensory organs in the head and body.

*Figure 10-1. A typical diagram of the nervous system, showing the central nervous system in yellow, and the nervous tissue of the peripheral nervous system in blue, but leaving out all the sensory organs that are also part of the peripheral nervous system.*
The four major regions of the brain

As is the case with many other human organs, understanding the structures and anatomy of the brain has proven far easier than understanding its functioning and physiology. As a result, different neuroanatomists have organized and labelled the different parts of the brain in different ways, based on different criteria. You can organize the brain by specific locations and structures, by related functions, by similar cytological features, etc. Often, the same region of the brain can have various names, depending on what system of organization you are using at the time.

We will mainly organize the brain by its gross anatomy – its large structures that are visible to the eye.

The human brain can be divided into four major parts, illustrated in Figure 10-2 and Figure 10-3.

1. The cerebrum, which is the part with the folds and crevices that we most associate with a mental image of the brain. It consists of two cerebral hemispheres which are divided by the longitudinal fissure down the center of the cerebrum.

2. The cerebellum, which is also known as the hindbrain. It is in the posterior region of the brain and inferior to the back of the cerebrum. In cross-section, it has an almost-cauliflower appearance, while its exterior consists of thin parallel folds.

3. The brain stem connects directly to the spinal cord but is noticeably thicker than the spinal cord below it.

4. The diencephalon is in the interior of the brain and can only be seen in its entirety if the brain is cut open. In intact brains, only the floor of the diencephalon can be seen directly superior to the brain stem.
The cerebrum, the cerebellum, and the brain stem are the three major regions of the brain visible from the exterior.
Figure 10-3. Two views of the diencephalon, the fourth major region of the brain, in orange on the left and in orange and green on the right.

**The cerebrum**

Information

The folds or ridges that dominate the exterior view are called gyri (singular: gyrus). The gyri are separated from one another by indentations or grooves called sulci (singular: sulcus) when they are relatively shallow, and called fissures (singular: fissure) when they are deeper.

There is a longitudinal fissure that divides the cerebrum into two hemispheres, the left hemisphere on the anatomical left, and the right hemisphere on the anatomical right. The longitudinal fissure is deep, but the two hemispheres are eventually connected to each other at the base of the longitudinal fissure by a thick wide structure called the corpus callosum. See Figure 10-4.
The various sulci and fissures in the cerebrum divide each hemisphere in four lobes, the frontal lobe, the parietal lobe, the occipital lobe, and the temporal lobe. Notice that each lobe has the same name as the cranial bone that is directly over it. See Figure 10-5.
There are a number of fluid-filled cavities in the cerebrum. The cavities are called the ventricles. The cells that line the ventricles produce the cerebrospinal fluid, which is the fluid contained within them. The cerebrospinal fluid is not confined to the ventricles. It surrounds the entire brain and the entire spinal cord.

Figure 10-6. The ventricles of the cerebrum.
The brain stem and the cerebellum

**Information**

The brain stem has many basic vital functions, including regulation of heart rate, breathing, sleeping, and eating. It is divided into three parts, the midbrain, the pons, and the medulla oblongata. The medulla oblongata (sometimes just called the medulla) connects to the spinal cord and is only slightly wider than the spinal cord.

![The brain stem](image)

**Figure 10-7.** The brain stem.

The cerebellum (“little brain”) is the small structure that appears to be a separate structure under the brain, but is actually integrated with the rest. The cerebellum receives information from the sensory systems, the spinal cord, and other parts of the brain and then regulates motor movements.

When dissected sagittally, there is branched white matter in the middle of the cerebellum. This white matter is called the arbor vitae, because it looks tree-like.
Figure 10-8. A sagittal view of the brain, illustrating the cerebellum and the parts of the brain stem.
The **diencephalon**

**Information**

The diencephalon is divided into the thalamus, the hypothalamus, and the epithalamus. There are two egg-like thalami in the diencephalon, but only one hypothalamus below them. The pituitary gland (part of the endocrine system as well as the nervous system) is the small pea-like structure that hangs down from the hypothalamus. The epithalamus is mainly made up of the small pinecone-shaped pineal gland, which is located in the center posterior of the diencephalon. Like the pituitary gland, the pineal gland is part of both the endocrine system and the nervous system.

The two thalami serve as a junction and relay system that receives and filters afferent (incoming) sensory information, then relays it on to other parts of the brain, mainly the cerebral cortex, but also to the cerebellum and brainstem.

The hypothalamus regulates body temperature, food intake, and thirst.

The pituitary gland regulates the secretions of other glands in the endocrine system. It receives signals from the hypothalamus to do so.

The pineal gland secretes melatonin which helps regulate sleep patterns.

**Figure 10-9. The major structures within the diencephalon.**
The meninges

Information

The brain and spinal cord are both wrapped with three layers of connective tissue membranes, collectively called the meninges. The three layers around the brain and the spinal cord have the same names in both locations, although the composition of the individual layers show a few slight differences depending on which location they are found in.

The outer layer is the toughest and thickest. It is called the dura mater (“DUR-ah MAY-ter”). The middle layer is the arachnoid mater (“ah-RACK-noid MAY-ter”). The inner-most layer lays directly on the nervous tissue of the brain or spinal cord, and is called the pia mater (“PIE-ah MAY-ter”). There is space between the inner-most pia mater and the arachnoid mater. The space is filled with cerebrospinal fluid.

Figure 10-10. The three meninges layers covering the brain.
Sheep brain dissection
Lab Exercises 10-1

The sheep brain is quite similar to the human brain except for proportion. The sheep has a smaller cerebrum. Also, the sheep brain is oriented anterior to posterior (more horizontally), while the human brain is oriented superior to interior (more vertically.)

Materials
Dissection tools and tray, lab gloves, preserved sheep brain.

Examining the external sheep brain.
1. The tough outer covering of the sheep brain is the dura mater, the outermost meninges membrane covering the brain. Remove the dura mater to see most of the structures of the brain, but remove it carefully, so as to leave all the other structures beneath it intact. Removing the dura mater from the cerebellum at the back of the brain can be tricky. Look for areas on the side of the brain that you can snip to peel the dura mater off.

2. Note the second meninges membrane, the arachnoid mater, below the dura mater.

3. The cerebrum half is missing the longitudinal fissure – which divides the brain into nearly symmetrical left and right hemispheres. But the transverse fissure is clearly visible.
4. The surface of the cerebrum is covered with large folds of tissue called gyri. The grooves between the gyri are sulci. The deeper sulci are often called fissures. The fissures are used as landmarks to divide the surface of the cerebrum into the four lobes.

5. Locate each lobe of the brain: the frontal lobe, the parietal lobe, the occipital lobe, and the temporal lobe.

6. The smaller, rounded structure at the back of the brain is the cerebellum. The cerebellum has smaller gyri that are roughly parallel to one another. Compare the gyri of the cerebellum to those of the cerebrum.

7. Carefully bend the cerebellum to get an inside glimpse of the brain. The bumps you see are the super colliculi. The smaller bumps underneath are the inferior colliculi.

8. If you gently push the colliculi down, you can see the tiny nub of the pineal gland. Find the pineal gland.

9. Turn the brain over so that the cerebrum is down. With the half brains you may need to prop it up with pins. The most prominent structure visible on the ventral side of the sheep brain is half of the optic chiasma, which is where the two optic nerves cross over each other and form an “X” shape. You will only see half the structure. Find the optic chiasma half on your brain. You may have removed the optic removed the chiasma with the dura mater. If you can’t find it, replace the dura mater to see it is there.

10. The pituitary gland is a large round structure under the optic chiasma, attached by the infundibulum (also known as the pituitary stalk.) Find the pituitary gland. If you removed this area with the dura mater, you may need to replace the dura mater to see it.

11. Toward the front of the brain are two prominent round structures, the olfactory bulbs. Find them.

12. Toward the posterior of the brain, in order moving away from the optic chiasma are the three bulges that indicate the three components of the brain stem, the midbrain, the pons, and the medulla oblongata. Find all three.

13. The oculomotor nerves may be visible to each side of the pituitary gland and stalk. This is another part that by have been removed with the dura mater. Find the oculomotor nerves.
Examining the internal sheep brain

Materials

Dissection tools and tray, lab gloves, preserved sheep brain with the dura mater removed.

1. Use a knife or a scalpel to cut the specimen along the longitudinal fissure. This will allow you to separate the brain into the left and right hemispheres. Lay one side of the brain on your tray to locate the structures visible on the inside. You should also cut through the cerebellum.

2. The corpus callosum had been connecting the two cerebral hemispheres and can now be clearly seen in the brain section. Find the corpus callosum.

3. The tiny space within the corpus callosum (which holds cerebrospinal fluid) is called the lateral ventricle. Underneath it, you can find another space called the third ventricle. There are other ventricles in the brain, but those are the easiest to located in a preserved specimen. Find the lateral ventricle and the third ventricle.

4. The white area between the lateral ventricle and the third ventricle is called the formix. The fourth ventricle is the space under the cerebellum.

5. Inferior to the corpus callosum is the thalamus. It is round and almost perfectly centered. Find the thalamus.

6. Just behind the thalamus is the pineal gland. Find it.
7. The hypothalamus is toward the ventral side of the brain. It is round but lower than the pineal gland. Find it.

8. Find the pons, medulla oblongata, and the spinal cord.

9. If you haven’t already, use your knife or scalpel to cut a sagittal section of the cerebellum and find the arbor vitae, so named because its white matter form a pattern that resembles a tree.

10. Use a scalpel to cut a cross section of the cerebrum in the occipital lobe area. You should be able to see the color and texture differences of the gray matter (at the cerebral cortex making up the outer edge of the cross-section) and the white matter (the interior portions of the cerebrum.)

11. Dispose of your brain as per your instructor’s directions.
**The spinal cord**

**Information**

The spinal cord in cross-section has a central region of darker gray matter and the rest is lighter white matter. The gray matter is made up of neuroglia cells and neuron cell bodies. The white matter is made up of neuron axons, mostly but not all myelinated.

The dorsal horns are the thinner projections of dark matter that jut out from the rest towards the dorsal/back side of the spinal cord. The ventral horns are the wider projections of dark matter towards the ventral/front side of the spinal cord.

The branches coming off on the back/dorsal sides of the spinal cord are called the dorsal roots. They contain the axons of sensory neurons returning to the spinal cord from sensory receptors. Near the spinal cord, there are bulges called dorsal root ganglia. They contain the cell bodies of the neurons heading back to the spinal cord.

The branches coming off on the front/ventral sides are called the ventral roots. They contain the axons of motor neurons heading off to muscles.

The central canal is a narrow hollow center to the spinal cord that is filled with cerebrospinal fluid (CSF).

![Cross Section of Spinal Cord](image)

**Figure 10-12. Cross-section of the spinal cord.**
Lab exercises 10.4
1. Fill in the names of the indicated structures in Figure 10-13.

Figure 10-13. A cross-section of the human spinal cord. Fill in the names of the structures indicated by the letters.

A. ________________________________
B. ________________________________
C. ________________________________
D. ________________________________
E. ________________________________
F. ________________________________
G. ________________________________
H. ________________________________