# **Exercise 10: Brain Anatomy and Reflexes**

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Figure 10.1 : The image above is a colored line engraving by W.H. Lizars of a posterior brain and spinal cord dissection.

https://commons.wikimedia.org/wiki/File:Brain\_and\_spinal\_cord;\_dissection,\_back\_view.\_Coloured\_line\_Wellcome\_V0008396.jpg

# **Exercise 10 Learning Goals**

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

* Describe the structure and function of the major lobes of the brain
* Identify specific surface and medial brain structures
* Identify and describe the function of the cranial nerves
* Be able to describe a reflex circuit
* Understand reflexes

# Pre-Lab Activity 10.1: Brain Anatomy

Below is a medial view of a sheep brain. Circle and label the following structures**: brainstem (midbrain, pons and medulla oblongata)**, **cerebellum**, **diencephalon** and **cerebrum**.

A picture containing sitting, ground, indoor

Description automatically generated

Figure 10.2 :Photo Credit: Heather Cathcart

What is the basic function of the:

-Brainstem?

Cerebellum?

Diencephalon?

Cerebrum?

# Pre-Lab Activity 10.2: Structure of the Cerebrum

The cerebrum is composed of gray and white matter structures of the right and left hemispheres which are separated by a deep longitudinal fissure. Each hemisphere is divided into **lobes** of the brain which have distinct functions and increase the surface area which equates to higher order complex thinking because of increased surface area shaped by gyri and sulci. A **gyrus** is a fold and a **sulcus** is a groove between nearby gyri. Gyri and sulci form the four main lobes of the brain. Describe the function and location of the four main lobes of the brain in the table below.

|  |  |  |
| --- | --- | --- |
| **Major lobes** | **Function** | **Location** |
| **Frontal** |  |  |
| **Parietal** |  |  |
| **Temporal** |  |  |
| **Occipital** |  |  |

# Pre-Lab Activity 10.3: Lateral Structures of the Brain

The lobes of the brain are separated by sulci. In the image below find the **central sulcus** and **Sylvian or lateral sulcus** (fissure), then answer the questions that follow.

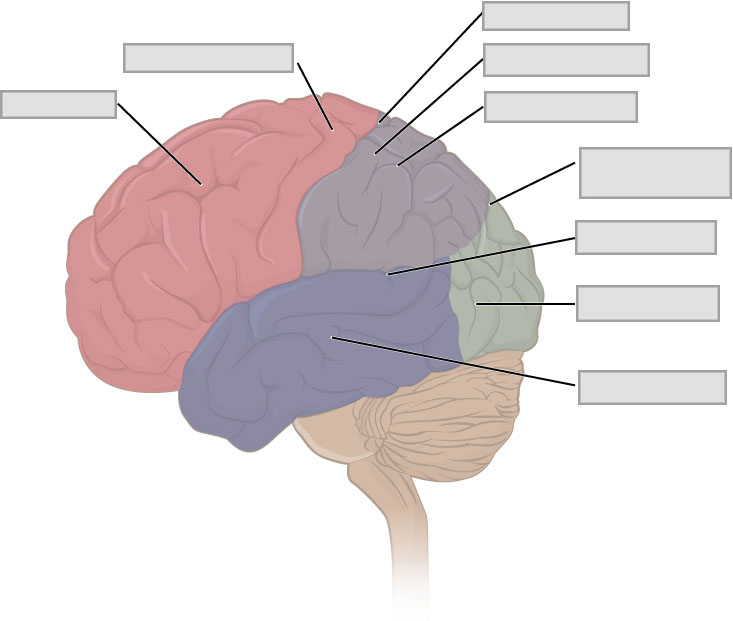


Fig. 10.3 Lobes of the cerebrum & major sulci

Which parts of the brain are separated by the longitudinal fissure?

Which lobes of the brain are separated by the central sulcus?

Which lobes of the brain are separated by the Sylvian fissure?

Circle the anterior part of the brain.

Circle the posterior part of the brain.

# Pre-Lab Activity 10.4: Medial Structures of the Brain

Below is a medial view of the human brain. Circle and label the following structures**: frontal lobe, parietal lobe, temporal lobe, occipital lobe, corpus callosum, cerebellum, midbrain, pons, medulla oblongata, thalamus, pineal gland (body)**.

Fig.10.4 Sagittal cut of brain; left half shown.

|  |  |
| --- | --- |
| **Structure** | **Function** |
| **Midbrain (brainstem)** |  |
| **Pons (brainstem)** |  |
| **Medulla (brainstem)** |  |
| **Corpus callosum** |  |
| **Thalamus** |  |
| **Pineal gland** |  |

Explore the function of the structures identified above using the table below.

# Pre-Lab Activity 10.5: Cranial Nerves

The brainstem connects the cerebral hemispheres to the spinal cord. Most of the cranial nerves arise from the midbrain, pons or medulla except for the olfactory nerve which connects directly to the olfactory bulb. Similar to spinal nerves the paired cranial nerves are part of the peripheral nervous system and have a name and roman numeral designation. Explore the functions and location of the 12 cranial nerves by completing the table below.

|  |  |  |
| --- | --- | --- |
| **Cranial Nerves** | **Function** | **Location** |
| **I Olfactory** |  |  |
| **II Optic** |  |  |
| **III Oculomotor** |  |  |
| **IV Trochlear** |  |  |
| **V Trigeminal** |  |  |
| **VI Abducens** |  |  |
| **VII Facial** |  |  |
| **VIII Vestibulocochlear** |  |  |
| **IX Glossopharyngeal** |  |  |
| **X Vagus** |  |  |
| **XI Accessory** |  |  |
| **XII Hypoglossal** |  |  |

Which of the cranial nerves carry special sensory information?

Which of the cranial nerves carry motor information only?

Which of the cranial nerves carry both sensory and motor information?

# Pre-Lab Activity 10.6: Reflexes

A reflex is a fast, involuntary, unplanned sequence of events that occurs in response to a specific stimulus. This is one way the spinal cord assists in maintenance of homeostasis in the body, because it serves as an integrating center for various reflexes. A reflex is initiated by a nerve impulse stimulated by sensory receptors in the periphery and that impulse is carried to the spinal cord, integrating the information and responding through the transmission of the nerve impulse to motor neurons and muscle cells in the periphery. There are five components to this reflex circuit, the **sensory receptor**, **sensory neuron**, **integrating center**, **motor neuron** and **effector cell**.

## Label the reflex circuit below.

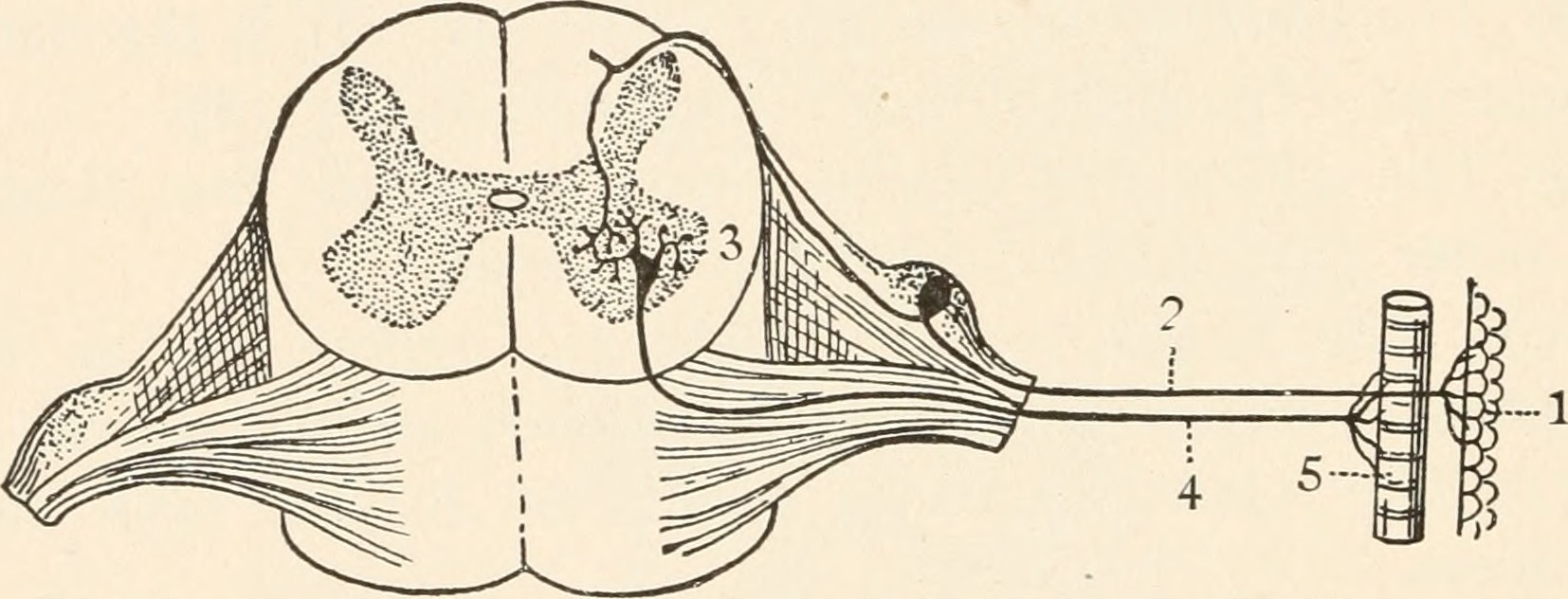


Fig.10.5:https://upload.wikimedia.org/wikipedia/commons/2/2a/The\_animans\_and\_man%3B\_an\_elementary\_textbook\_of\_zoology\_and\_human\_physiology\_%281911%29\_%2814598244299%29.jpg

1.

2.

3.

4.

5.

# **Lab Activity 10.1: Sheep Brain Dissection**

**Important Safety Information:**

**Most of our dissection specimens were preserved in formalin, an aqueous colorless solution that is a suspected carcinogen. Normally, the formalin will be 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 KEEP 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.

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

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

**3) Obtain a preserved sheep brain**

The sheep brain and human brain show many similarities. They both possess a protective membrane called the **meninges**, which you should observe prior to beginning your dissection. The outermost layer is the **dura** mater, the toughest layer. The middle layer is known at the **arachnoid** mater because it resembles a spider web, and the innermost **pia** mater contains the blood vessels and is attached to the surface of the brain. Using forceps and scissors gently remove the dura. Notice the **falx cerebri** which separates the right and left hemispheres and the **tentorium cerebelli** which separates the cerebrum from the cerebellum. When removing the dura mater, falx cerebri and tentorium cerebelli, take care not to remove the brain stem, cerebellum or optic chiasm.

## Identify the following structures on the whole brain:

|  |  |
| --- | --- |
| * **Gray matter** * **White matter** * **Gyri** * **Sulci**   **Meninges**   * **Dura mater** * **Arachnoid mater** * **Pia mater** * **Cerebrum** * **Frontal lobe** * **Parietal lobe** * **Occipital lobe** * **Temporal lobe** * **Longitudinal fissure** * **Central sulcus** * **Lateral sulcus** * **Corpus callosum** * **Septum pellucidum** * **Lateral ventricles** | * **Diencephalon** * **Epithalamus 🡪 Pineal gland** * **Thalamus** * **Hypothalamus** * **Pituitary gland** * **Brainstem** * **Midbrain** * **Pons** * **Medulla oblongata** * **Cerebellum** * **Folia** * **Arbor vitae** * **Olfactory bulbs (CN I)** * **Optic nerve (CN II)** * **Optic chiasm** * **Trigeminal nerve (CN V)** |

## Dissection Procedure:

1. Gently spread the cerebral hemispheres apart, deep in the longitudinal fissure you will see a thick bundle of white fibers that form the **corpus callosum** and connects the right and left hemispheres.
2. Cut your whole brain along the longitudinal fissure completely through the corpus callosum, midline of the brainstem and cerebellum.
3. Separate the hemispheres completely and examine the medial structures
4. Below the corpus callosum you will see a thin membrane the **septum pellucidum** and if you pierce this membrane with a sharp tool, you will see part of the **lateral ventricle**.
5. Each hemisphere has one lateral ventricle, c-shaped structures normally filled with cerebrospinal fluid.
6. Below the septum pellucidum is a round egg-shaped structure the **thalamus** which serves as a relay center for sensory information. There are two thalami, one in each hemisphere and they are connected by a bridge of fibers.
7. Gently spread the cerebral hemispheres and the cerebellum apart to reveal the midbrain, seen as two pairs of round swellings collectively called the corpora quadrigemina. The larger pair are known as the **superior colliculi** and the smaller pair are the **inferior colliculi**. The **pineal body** is seen directly between the superior colliculi and looks like a little bean. This structure is important in maintain a daily sleep-wake cycle.
8. The **cerebellum** is connected to the brainstem by three prominent fiber tracts called peduncles. The **superior cerebellar peduncle** connects the cerebellum with **midbrain**, the **middle cerebellar peduncle** connects the cerebellum with the pons and the **inferior cerebellar peduncle** connects the cerebellum with the **medulla**.
9. The following structures can be located on the ventral surface of the dissected brain. Beneath the frontal lobe of the cerebral hemispheres is where the **olfactory bulb** is located. The olfactory bulb continues posteriorly as the **olfactory tract**. Posterior to this tract, the optic nerves undergo a crossing (decussation) known as the **optic chiasm**.
10. Locate the **pituitary gland** just posterior to the optic chiasm. This gland is connected to the **hypothalamus** of the diencephalon by a stalk called the infundibulum. The hypothalamus is an important link between the endocrine system and the nervous system.
11. The **midbrain** is inferior to the hypothalamus, the **pons** is inferior to the midbrain and the **medulla oblongata** is a posterior extension of the pons. The structures are most important for regulating autonomic functions such as consciousness, breathing and blood pressure.
12. Identify the frontal lobe, parietal lobe and occipital lobe, while examining the medial view of the sheep brain.
13. Make a coronal section through the cerebral hemisphere just anterior to the thalamus. Examine the section which should reveal **gray matter** near the surface of the cerebral cortex and **white matter** beneath this layer. Gray matter represents cell bodies and dendrites of neurons, while the white matter is composed of myelinated axons.
14. Lastly examine the midsagittal section of the cerebellum. This cut reveals a treelike arrangement of gray matter called **folia** and white matter called the **arbor vitae**. The cerebellum is crucial for comparing and coordinating complex muscle movements.

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.**

# Activity 10.2: Label the Cranial Nerves

Identify by name and number the 12 pairs of cranial nerves using the diagram below.

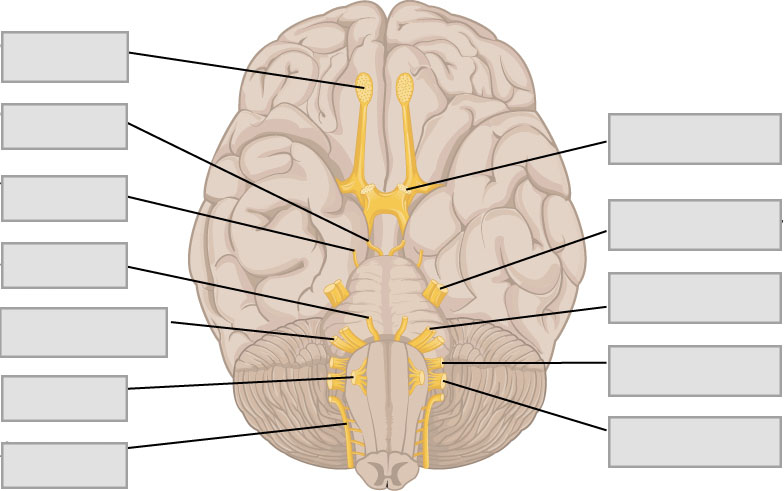


Fig.10.6:

Activity 10.3: Reflexes

Consider the various components of the reflex circuit, while testing the following and do not forget about the importance of anatomical position.

10.3.1 **Biceps reflex**. With your subject seated on a chair (you should be standing), support their right forearm with your right forearm. Your subjects’s forearm should be slightly bent at the elbow. Place your thumb over their biceps tendon while applying some pressure to the tendon. Strike your thumbnail with the end of the reflex hammer.

Describe the responses observed.

Repeat the procedure on the left arm. What is the response?

10.3.2 **Patellar reflex.** Have your subject sit on the lab bench or a chair so that the legs hang freely. Strike the patellar tendon just inferior to the kneecap with the reflex hammer.

Describe the responses observed.

Test the subject again while they interlock their fingers and pull one hand against the other. Is there a change in the level of activity of the reflex?

10.3.3 **Achilles reflex.** Have the subject kneel on a chair and let the foot hang freely over the edge of the chair. Bend one foot to increase the tension on the gastrocnemius muscle. Tap the calcaneal (achilles) tendon with the reflex hammer. What is the result?

10.3.4. **Plantar reflex.** Scratch the sole of your subjects’s foot by moving a blunt object (capped pen or metal end of the reflex hammer) along the sole from the toes to the heel. Describe the movement of the toes.

In children under two-years old it is normal for the hallux to move upward and outward while the other toes fan out. This is known as the Babinski reflex. Would you expect an adult to exhibit the Babinski reflex? Why or why not?

Which type of sensory receptors are you activating to cause these reflexes?

Activity 10.4: Draw a Simple Reflex Circuit

Draw a horizontal section of the spinal cord and include the **sensory receptor**, **sensory neuron**, **integrating center**, **motor neuron** and **effector cell**. Include arrows to show the flow of the nerve impulse.