BIOLOGY 211: HUMAN ANATOMY & PHYSIOLOGY

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**GROSS ANATOMY OF THE BRAIN**

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Reference: Saladin, KS: Anatomy and Physiology, The Unity of Form and Function. 8th ed. (2018)

**Be sure you have read and understand Chapters 12 and 14 before beginning this lab.**

**INTRODUCTION:**

The human brain is extremely complex. It has to simultaneously deal with such diverse functions as receiving input from peripheral sensors, sending output to muscle and glands, memory, reasoning, emotions, coordinating movement, and others. Many of the brain’s functions, in fact most of them, are concerned with the routine things we do every day without being aware of them: breathing, digesting food, adjusting blood pressure, maintaining body temperature, coordinating eyeball movements etc. Others, such as hunger, thirst, or emotions we are aware of but have little control over. Obviously, these are just as important as the functions which we have control over such as voluntary movement.

Different functions are carried out in specific regions of the brain which we will identify in this lab exercise, but you will find that few of these regions can be sharply differentiated from surrounding areas. Because the brain must integrate all of its various functions, there are many areas where two or more functions overlap.

**DEVELOPMENT OF THE BRAIN:**

In the developing embryo, the central nervous system first appears as a specialized, flattened region of cells called the **neural plate**, which invaginates and folds over to form a hollow **neural tube.** All of the structures in the adult brain and spinal cord develop from this. By the fourth week of development, anterior regions of the neural tube begin to expand and fold to form parts of the brain, while the posterior part of the neural tube retains its shape to form the spinal cord. The hollow space within the neural tube develops into the hollow spaces within the brain called **ventricles,** which are filled with cerebrospinal fluid.

*- Based on your reading of Chapters 12 and 14 in the Saladin text before lab:*

*a Explain to other members of your lab group what the “central nervous system” and*

*“peripheral nervous system” are. Why is the brain considered part of the former?*

*b) Explain to other members of your lab group the difference between “gray matter”*

*and “white matter” in the brain.*

*c) Explain to other members of your lab group what “sensory neurons”, “motor neurons”,*

*and “interneurons” are. Which of these would you expect to find in the human brain?*

**EXTERNAL ANATOMY OF THE BRAIN:**

**1. Examine models of the human brain**. Using Figures 14.1. 14.2, 14.13, 14.21, and 14.24 as well as the written descriptions in your Saladin textbook, identify each of its following parts while the two halfs are held together.

Cerebrum

Pons

Cerebellum

Medulla Oblongata

**On the models, identify the following parts of the Cerebrum:**

Right and left hemispheres

Gyrus (general structure)

Sulcus (general structure)

Frontal lobe

Parietal lobe

Occipital lobe

Temporal lobe

Lateral sulcus or fissure

Precentral gyrus

Central sulcus

Postcentral gyrus

Longitudinal fissure

Parieto-occipital sulcus

Olfactory tract

Realize that on the cerebrum and cerebellum, the external surface you can see is a highly developed region of gray matter called the **cortex**.

*- Which part of the brain connects directly to the spinal cord? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

**2.**  **Obtain a human skull and identify the anterior, middle, and posterior cranial fossae** using Figure 8.9 of your Saladin text.

*- Which part of the brain rests in the anterior cranial fossa?*

*- Which part of the brain rests in the middle cranial fossa?*

*- Which part of the brain rests in the posterior cranial fossa?*

**3.** **Identify the optic chiasm (chiasma) on the inferior surface of the model of the brain** using Figures 14.26 and 14.28 of your Saladin text. This is an “X”-shaped structure formed by the right and left **optic nerves** (the anterior legs of the “X”) and the right and left **optic** **tracts** (the posterior legs of the “X”).

Although it does not show well on all of the models, you may find a small midline projection just posterior to the optic chiasm called the **infundibulum**. This connects the brain to the pituitary gland (hypophysis) which lies just inferior to it, in the sella turcica of sphenoid bone. Identify the sella turcica on a skull and relate the location of the optic chiasm and infundibulum to it.

*- Based on the size of the sella turcica, the pituitary gland must be about the size and shape of a*

*(circle one): grain of sand / apple seed / grape / grapefruit / basketball / Buick*

*- The optic nerves pass through which foramina*

*(holes) between the cranial cavity and the orbits?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

*- The optic chiasm is superior to which bone of the skull? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

**INTERNAL ANATOMY OF THE BRAIN:**

**4:** **Examine a model of the brain.** Using Figures 14.1, 14.2, 14.6, 14.7, and 14.11 of your textbook; identify each of the following structures and regions in the midsagittal plane of view

Cerebrum

Cerebellum

Corpus callosum

Thalamus

Hypothalamus

Midbrain

Pons

Medulla oblongata

Third ventricle

Mesencephalic (Cerebral) aqueduct

Fourth ventricle

Arbor vitae (part of cerebellum)

*- With other members of your lab group, discuss the following:*

*a) Is any cortex of the cerebrum visible in midsagittal section?*

*b) Which lobes of the cerebrum are visible in this section?*

*c) Which regions of the brain border the third ventricle?*

*d) Which regions of the brain border the fourth ventricle?*

*e) Through which region does the mesencephalic (cerebral) aqueduct pass?*

**FUNCTIONAL AREAS OF THE CEREBRAL CORTEX:**

As noted earlier, certain regions of the cerebral cortex are specialized to carry out specific functions. Although there are some differences in the size of these areas between the two sides (hemispheres) of the cerebrum, these are the same on the two sides.

**5.** **Using Figures 14.20, 14.21, 14.22, & 14.24, and the related written information, identify each of the following regions on models of the brain and briefly describe its function:**

**Primary motor area**  Lobe: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Function:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Also called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gyrus

**Motor association area**  Lobe: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Function:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Primary somatosensory area**  Lobe: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Function:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Also called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gyrus

**Somatosensory association area**  Lobe: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Function:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Primary visual area**  Lobe: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Function:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Visual association area**  Lobe: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Function:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Primary auditory area**  Lobe: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Function:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Auditory association area** Lobe: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Function:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**THE MENINGES:**

If you were able to open up your lab partner’s skull (please do not do this), you would not see the brain. Instead, you would see three concentric layers of connective tissue which surround the brain and separate it from the skull, protecting it and holding it in place during normal movements of the head. These three layers are the **meninges**. You may know of someone who had an infection or inflammation of these membranes, called **meningitis**. These membranes surround both the brain and the spinal cord (remember how the brain and spinal cord developed together).

The outermost of the meninges is the ***dura mater*** (literally: “tough mother”). This is a very strong membrane - you can pull on it with quite a bit of force without tearing it - which is firmly attached to the inside of the skull and contains blood vessels which nourish the bone. A midsagittal fold of the dura mater, the ***falx cerebri***, extends into the longitudinal fissure of the cerebrum and prevents lateral or side-to-side movement of the cerebral hemispheres within the skull. A horizontal fold of the dura mater, the ***tentorium cerebelli*,** extends into the horizontal fissure which separates the occipital lobes of the cerebrum from the cerebellum, supporting the weight of the occipital lobes and limiting the vertical or up-and-down movement of the brain.

The middle layer of the meninges, much more delicate and deep to the dura mater, is the ***arachnoid mater*** (‘spiderweb-like mother”). This bridges over sulci of the cerebral cortex but follows the surface of the brain into larger fissures.

The deepest of the three layers of the meninges is the ***pia mater***(“delicate mother”). This is firmly attached to the nervous tissue of the brain and follows all of its convolutions into and out of sulci and fissures.

The spaces between these layers are also important. The **epidural space** lies between the bone of the skull and the dura mater. The **subdural space** lies between the dura mater and the arachnoid mater. The **subarachnoid space** lies between the arachnoid mater and the pia mater. In life, the subarachnoid space contains cerebrospinal fluid in which the brain is floating, while the other two spaces contain no fluid. However, different types of head injury can cause bleeding into any one of these three spaces, leading to **epidural, subdural, or subarachnoid hemorrhages.**

**6.**  Examine Figure 14.5 of your Saladin text and identify the three layers or membranes of meninges and the three related spaces (note: the epidural space is not labeled, but you should understand its location between the bones of the skull and the dura mater). While this diagram only shows the layers of the meninges near a small region of the brain, you should be able to visualize how each of the three layers completely surrounds the entire brain. Be sure you understand the relationship among these membranes and spaces.

***-*** *List the three layers of the meninges and the three related spaces in the correct order,*

*starting with the bone of the skull and moving toward the brain.*

***-*** *The meninges are composed of which one of the four basic tissue types?*

*- Which part of the brain is superior to and rests on the tentorium cerebellum?*

*- Which part of the brain is inferior to the tentorium cerebellum?*

*- Which parts of the brain are separated by the falx cerebri?*

**PRESERVED HUMAN SPECIMENS:**

**7:** **While wearing gloves, examine a preserved human brain**. Identify the

Cerebrum and its

Right and left hemispheres

Gyrus (general structure)

Sulcus (general structure)

Corpus callosum

Frontal lobe

Parietal lobe

Occipital lobe

Temporal lobe

Lateral sulcus or fissure

Longitudinal fissure

Thalamus

Hypothalamus

Midbrain

Pons

Cerebellum and its arbor vitae

Medulla Oblongata

**8**. One of the preserved human brains is still surrounded by the dura mater and other meninges. Wearing gloves, examine this specimen and identify the three **layers of meninges** and the three **related spaces** described above. Be sure you understand the relationship among these membranes and spaces.

On this specimen, identify the **falx cerebri** and **tentorium cerebelli**, both of which are folds of the dura mater.

**Be very careful in handing this specimen**. While the dura mater is strong, the arachnoid mater and pia mater are very fragile membranes and can be easily damaged. Dont touch them with anything rigid or sharp.

**VENTRICLES AND CIRCULATION OF CEREBROSPINAL FLUID:**

The hollow spaces that existed inside the embryonic brain still exist in the adult - they form the ventricles which are filled with cerebrospinal fluid. This fluid, which is a filtrate of the blood, is constantly being produced/secreted in the ventricles by a specialized tissue called the **choroid plexus,** and eventually leaves the fourth ventricle to enter the spaces outside the brain.

**9.** **Identify the following structures on Figures 14.6 and 14.7 of your Saladin text**

Lateral ventricle

Third ventricle

Fourth ventricle

Cerebral aqueduct

Interventricular foramen

Choroid plexus within each ventricle

Median aperture

Lateral apertures

Subarachnoid space

Arachnoid villi (also called “arachnoid granulations”)

**10. Identify the following structures on the gray model cast from the ventricles:**

Lateral ventricle

Third ventricle

Fourth ventricle

Cerebral aqueduct

Interventricular foramen

You should be able to trace the flow of cerebrospinal fluid from the other ventricles to the fourth ventricle, from where it can leave the ventricles to enter the subarachnoid space surrounding the brain. This is a one-way flow since additional cerebrospinal fluid is constantly being produced within each of the ventricles but can only be reabsorbed through the arachnoid granulations from the subarachnoid space back into the blood..

*- With other members of your lab group, discuss the following:*

*a) Starting with the lateral ventricle, describe the flow of cerebral spinal fluid through*

*all of the ventricles and spaces until it is reabsorbed into the blood:*

*b) What would happen if the choroid plexus in the ventricles stopped producing*

*cerebrospinal fluid but the arachnoid villi continued to reabsorb it into the blood?*

*c) What would happen if the choroid plexus in the ventricles continued to produce*

*cerebrospinal fluid but the arachnoid villi were unable to reabsorb it into the blood?*

*d) What type of cell lines the inside of the ventricles*?

**EMBEDDED CORONAL SECTIONS:**

**11**. Examine the coronal sections of a human brain which have been embedded in clear plastic. Identify the following:

Right and left cerebral hemispheres

Cortex (gray matter)

Longitudinal fissue

Lateral fissure

Corpus callosum

Lateral ventricles

Third ventricle

**CRANIAL NERVES:**

There are twelve nerves on each side that extend from the brain to muscles and skin of scalp, face, and neck; to the orbital, nasal, and oral cavities; and in one case to organs of the thorax and abdomen. These carry both motor and sensory information between these structures and the brain.

**12.** They are identified by Roman numerals from I to XII, but each of them also has a name. Using table 14.1 and Figures 14.27 through 14.39, you will be expected to know:

a) The name and number of each cranial nerve

b) Which foramen in the skull the nerve passes through, including all three branches of the

trigeminal nerve

c) The motor and sensory functions of at least three of these cranial nerves

You will not be expected to identify cranial nerves on diagrams, models, or preserved specimens of the brain.