BSMS MODULE: 202, NEUROSCIENCE AND BEHAVIOUR

DR SESSION: 3. TOPOGRAPHY OF THE HUMAN BRAIN

In the previous DR session you removed the brain from your cadaver, identified the various lobes, and began to examine the gyri and sulci of the cerebral hemispheres. In this session you will continue your examination of the surface features of the brain, and also the internal structures.

The brains from your cadavers have been sliced into mid-sagittal, horizontal and coronal sections. Today you will examine these sections and identify the major structures of the brain. Three workstations have been set up. You will spend approximately 25 minutes at each workstation.

Workstation 1

In this workstation you will examine the superior, lateral and inferior surfaces of the brain and the anterior surface of the brainstem.

A. On the whole brain, examine the *superior and lateral surfaces*. Use figure 1 to help locate the structures.

i. Identify the ***gyri*** (elevations) and ***sulci*** (grooves) of the ***cerebral hemispheres***. Remind yourselves that the outer gray matter of the cerebral cortex has an underlying layer of white matter that connects the different regions of the brain.

ii. Locate the ***longitudinal fissure***, which divides the two hemispheres.

iii. Identify the ***frontal*** and **occipital poles** of the brain and the ***frontal, parietal, occipital*** and ***temporal lobes***. Much of the frontal lobe is concerned with motor function, and includes Broca's "motor speech area". The parietal lobe is mainly concerned with somatosensory processing, such as touch, pain and limb position. The occipital lobe is involved with visual processing and the temporal lobe with auditory processing as well as speech, vision and memory.

iv. Identify the ***central sulcus***, which separates the frontal and parietal lobes.

Q1. Why is the central sulcus so important?

v. Identify the ***lateral sulcus***. Note that an area of cortex called the ***insula*** lies deep to the sulcus and cannot be seen unless the lips of the sulcus are parted. Many functions have been attributed to the insula, including visceral control, taste and olfaction. The ***primary auditory area*** of the brain is situated within the inferior wall of the lateral sulcus.

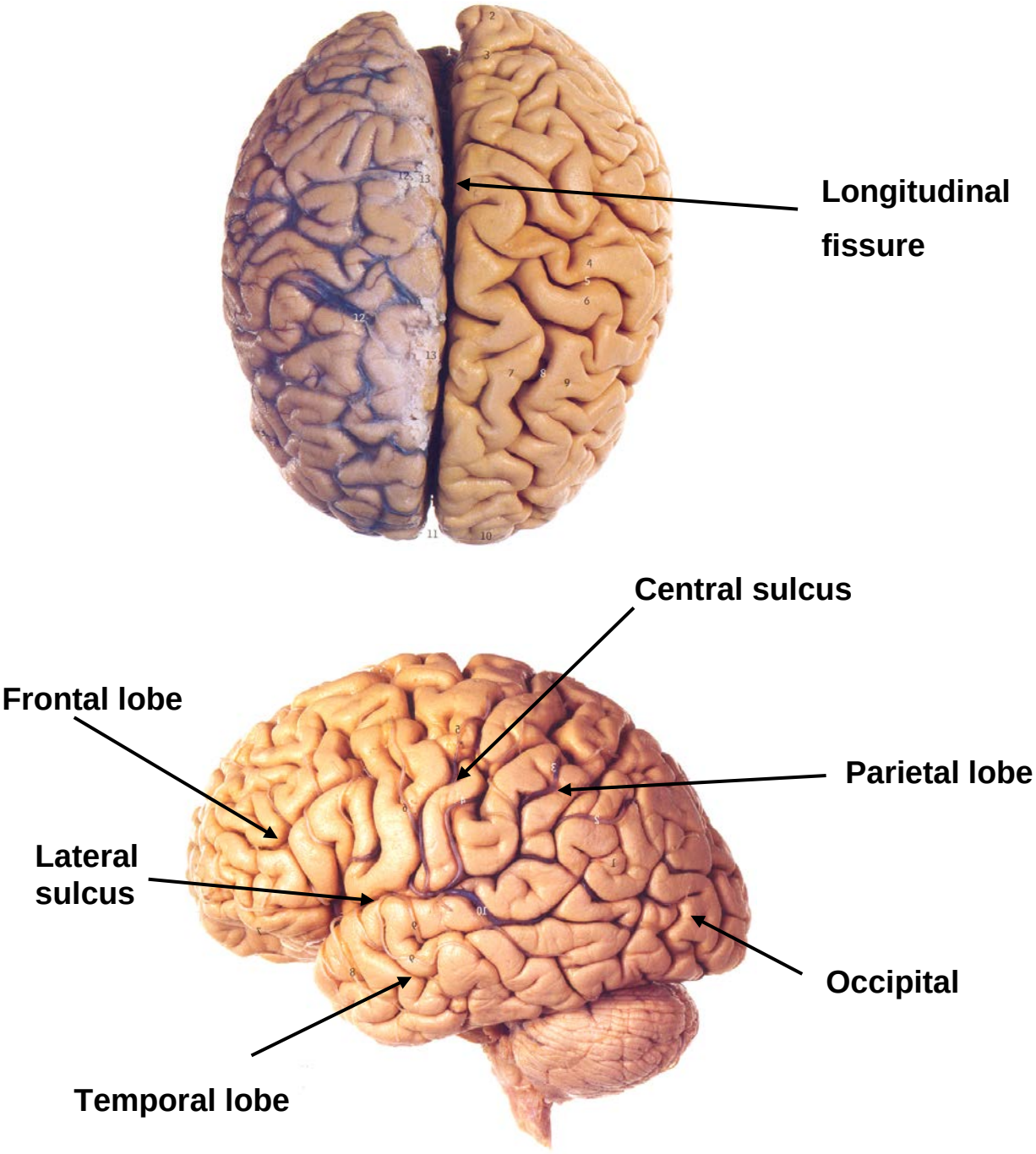

Figure 1. Superior and lateral surfaces of the brain

B. Now turn the brain over and examine the *inferior surface*. Use figure 2 to help locate the structures.

i. Identify the ***olfactory tract*** and ***bulb***. The ***olfactory bulb*** is a narrow oval body that lies on the dura mater. The olfactory bulb is the main relay station in olfactory pathways.

ii. Locate the ***optic chiasma***, which is a flattened bundle of nerve fibres at the junction of the anterior wall and floor of the ***third ventricle***. The anterolateral corners of the

chiasma are continuous with the ***optic nerves***, which will have been severed in removal of the brain. The ***optic tracts*** are found at the posterolateral corners of the chiasma. The optic tracts divide and pass to the thalamus and superior colliculus of the midbrain. Axons project from the thalamus to the primary visual cortex.

iii. Locate the ***pituitary stalk***, also known as the ***infundibulum***, which connects the ***hypothalamus*** to the ***pituitary gland***. This endocrine gland is about the size of a pea.

iv. Locate the ***mammillary bodies***, which lie posterior to the pituitary stalk. They are part of the limbic system. They are connected via the fornix to the hippocampus.

v. Examine the ***cerebellum***, which is covered superiorly by the ***tentorium cerebelli***, an extension of dura. It is the largest part of the hindbrain and consists of two lateral ***hemispheres*** connected by the ***vermis*** in the midline. The cerebellum is divided into three ***lobes***. The cerebellum is connected to the posterior aspect of the brainstem by three symmetrical bundles of fibres: the ***superior, middle*** and ***inferior cerebellar peduncles***. The main functions of the cerebellum are the control of posture, coordinating and planning limb movements, and the control of eye movements.

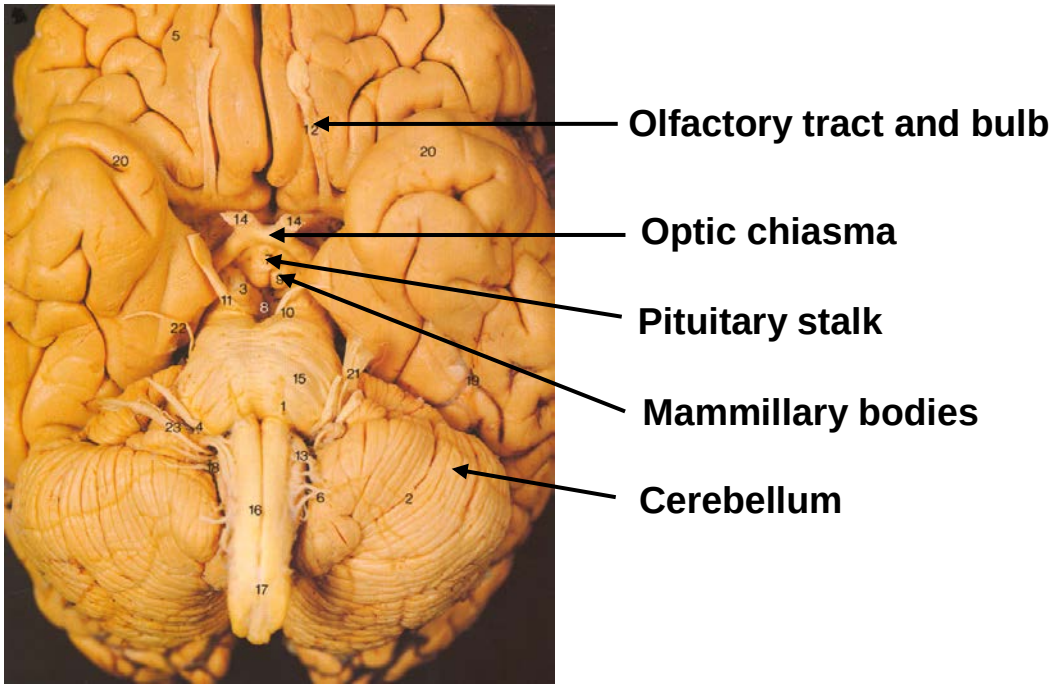

Figure 2. Inferior surface of the brain

C. Now examine the *anterior surface of the brainstem*. Use figure 3 to help locate the structures.

i. Locate the ***midbrain***. The two ***cerebral peduncles*** should be visible on the anterior surface of the midbrain. These contain fibres travelling from the cortex to the pons and spinal cord.

ii. Locate the ***pons***. The anterior surface shows many ***transverse fibres*** that converge on each side as the ***middle cerebellar peduncle***. The cerebellar peduncles connect

the brainstem to the cerebellum. The **basilar artery** sits in the shallow groove along the midline of the anterior surface of the pons. Note the ***trigeminal (V) nerve*** emerging from the side of the pons.

iii. Locate the ***medulla oblongata***. The two ***pyramids*** should be visible, medially on the anterior surface of the medulla. The pyramids are composed of bundles of nerve fibres, the ***corticospinal tracts***, which originate in the cerebral cortex and pass into the spinal cord. The corticospinal tract is the voluntary motor pathway.

Q2. In which part of the cerebral cortex do you think these fibres originate?

Lateral to the pyramids are the ***olives***, elevations produced by the underlying ***inferior olivary nucleus.*** The olives are closely associated with the cerebellum and are involved in the control and coordination of fine movements. Posterior to the olives are the ***inferior cerebellar peduncles***.

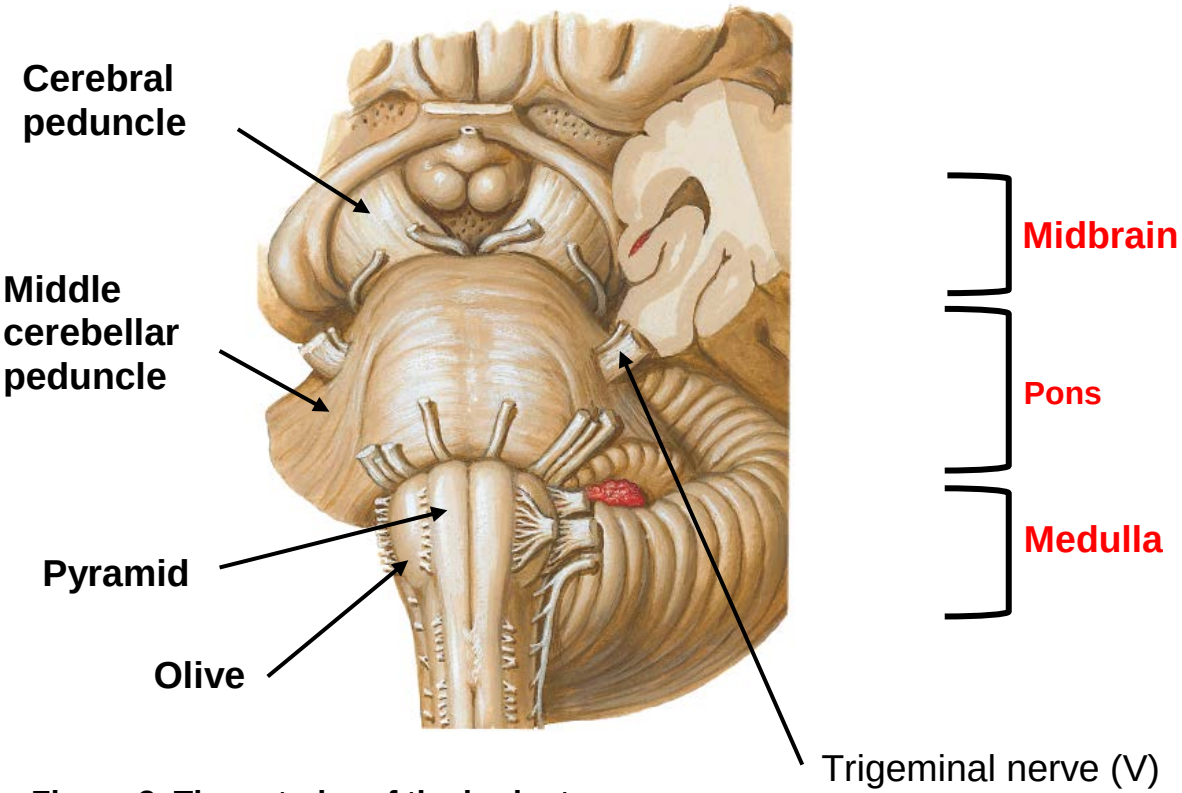

Figure 3. The anterior of the brainstem

Workstation 2

In this workstation you will examine the medial structures of the brain, the ventricles, and the posterior surface of the brainstem.

A. On the mid-sagittal section of the brain, examine the medial structures. **Use figure 4 to help locate these structures.**

i. Locate the **corpus callosum**, a large white matter tract. The posterior part of this tract is called the ***splenium***.

Q3. What is the function of the corpus callosum?

ii. Locate the ***cingulate gyrus/cortex***, which lies superior to the corpus callosum. The cingulate gyrus forms part of the limbic system.

iii. Locate the ***septum pellucidum***, which stretches between the ***corpus callosum*** and ***fornix***. The septum pellucidum is a thin sheet of nervous tissue that contains both white and gray matter.

iv. Locate the ***fornix***, which is a semi-circular white matter tract that extends between the hippocampus and the mammillary bodies on the inferior surface of the brain. It is one of the connecting pathways associated with the limbic system.

v. Locate the ***thalamus***, which is a large mass of gray matter in the centre of the brain. It is functionally very important, serving as a relay station for all the main sensory systems (apart from the olfactory pathway). The interthalamic adhesion can be seen, which links the two thalami.

vi. Locate the ***hypothalamus***, which extends from the optic chiasma to the mammillary bodies and lies below the thalamus. Anatomically speaking, the hypothalamus appears as a small area of the brain. However, it is functionally very important. It plays a major role in homeostasis, endocrine and autonomic functions, as well as in sleep, sexual and emotional behaviour.

vii. Examine the ***arbor vitae*** of the cerebellum. This has arisen because the cerebellum, like the cerebral cortex, consists of an outer covering of gray matter (the cerebellar cortex) and the inner white matter. Embedded in the white matter are important nuclei.

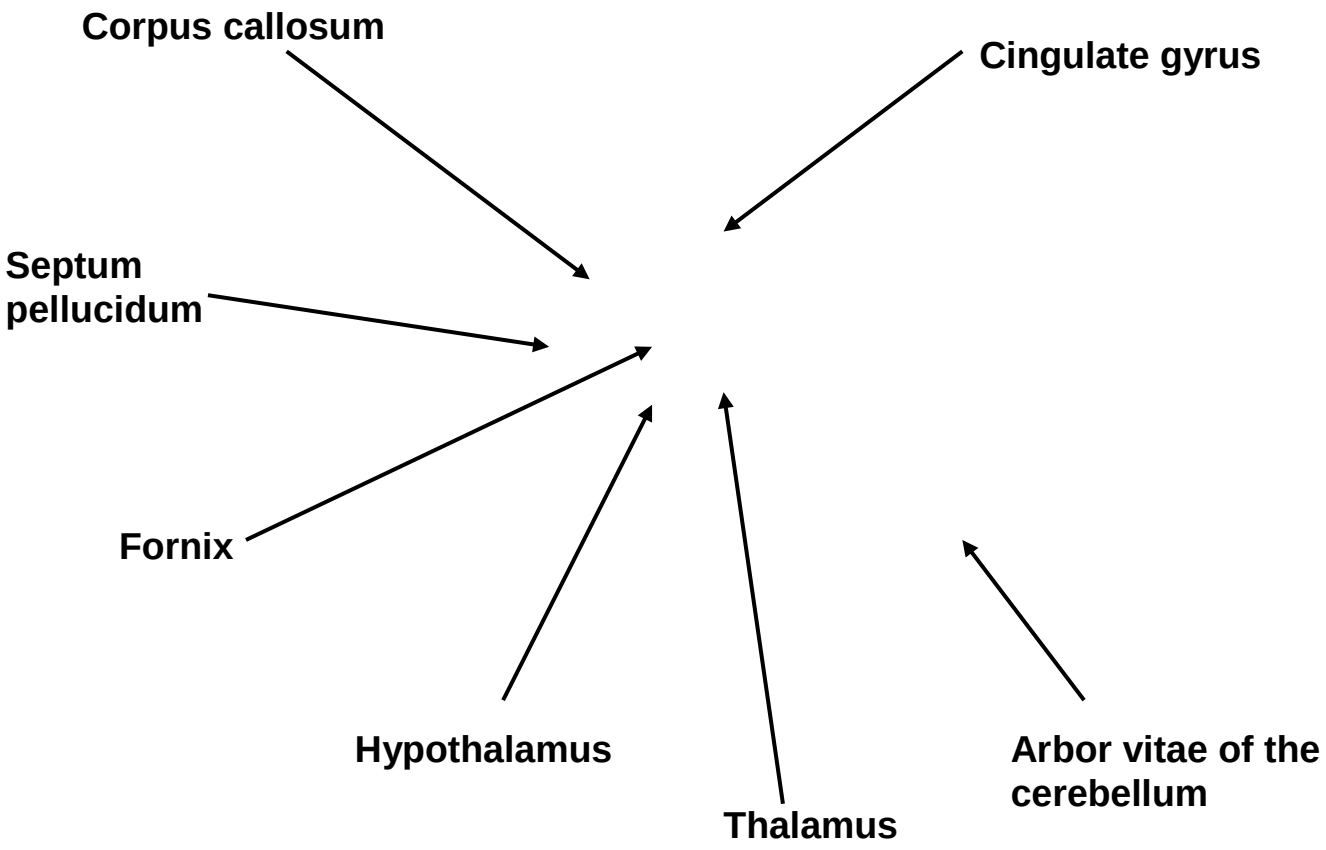

Figure 4. Mid sagittal section through brain.

B. Now examine the posterior surface of the brainstem. **Use figure 5 to help locate the structures.**

i. Locate the ***midbrain***. Observe the ***four colliculi*** (2 paired protrusions) on the posterior surface. The paired ***superior colliculi*** are part of the visual system and are involved in the regulation of eye movements. They receive information from the optic tracts and output to the cranial nerves that control the muscles that move the eye. The paired ***inferior colliculi*** are part of the auditory system. They receive inputs from the vestibulocochlear (CNVIII) nerve and output to the ***medial geniculate nuclei***.

ii. Locate the ***pineal gland*** sitting superior to the midbrain. This gland secretes melatonin and is involved in sleep cycles.

iii. Locate ***pons***. The ***middle cerebellar peduncles*** can be seen extending posteriorly. These form a link between the brainstem and cerebellum.

iv. Locate the ***medulla***. Observe the ***cuneate*** (lateral) and ***gracile*** (more medial) ***tubercles*** on the posterior surface of the medulla. These tubercles are formed from the underlying cuneate and gracile nuclei, which are where sensory fibres synapse from the upper and lower body respectively. They form part of the dorsal column-medial lemniscus pathway, which is involved in fine touch and proprioception.

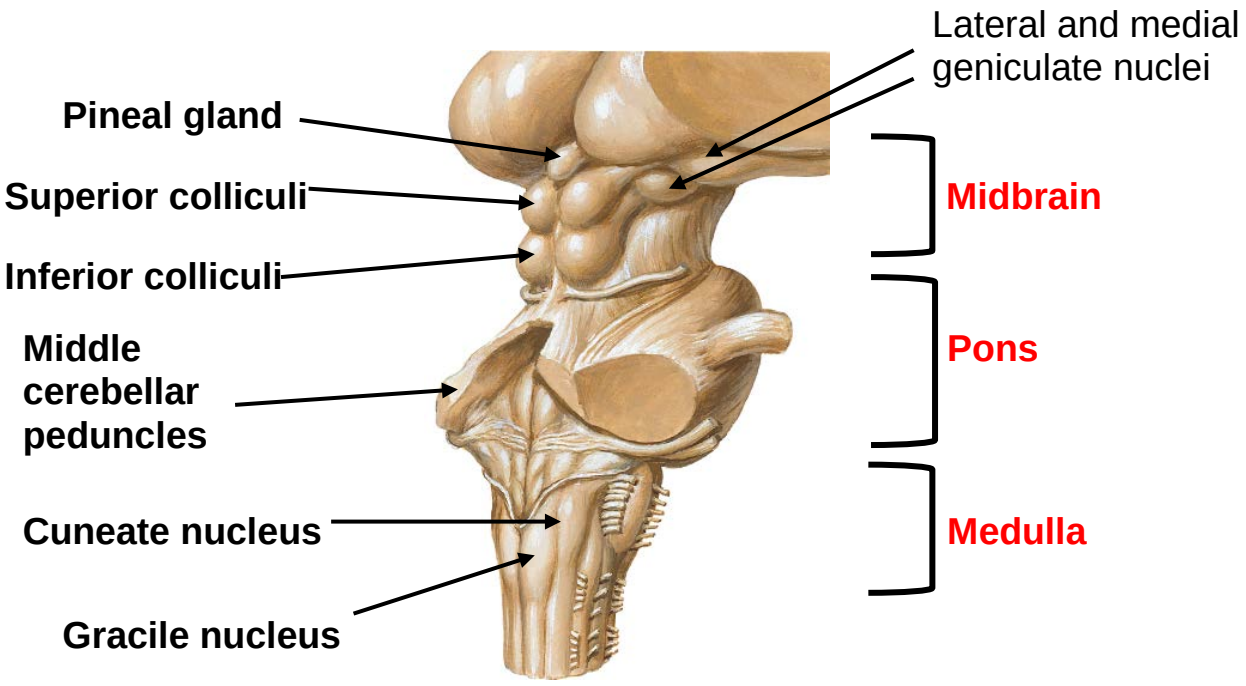

Figure 5. Posterior surface of brainstem

C. Use both prosections to examine the ventricular system. Use figure 6 to help locate the structures.

i. Locate the ***lateral ventricles***, which are separated by the septum pellucidum. Identify the anterior and posterior horns. Observe the corpus callosum in the roof of the lateral ventricles.

ii. Identify the ***interventricular foramen*** (***foramen of Monro***), which provides a communication between the lateral and third ventricle.

Q4. What would be the consequence of a blockage of the interventricular foramen?

iii. Examine the narrow ***third ventricle***, which is surrounded by the two thalami. Observe the fornix in the roof of the third ventricle.

iv. Locate the ***cerebral aqueduct*** (***aqueduct of Silvius***) in the centre of the midbrain, which provides a communication between the third and fourth ventricle.

v. Locate the diamond-shaped ***fourth ventricle***, which is found between the pons and cerebellum. It communicates with the subarachnoid space of the spinal cord through the ***foramina of Luschka and Magendie***.

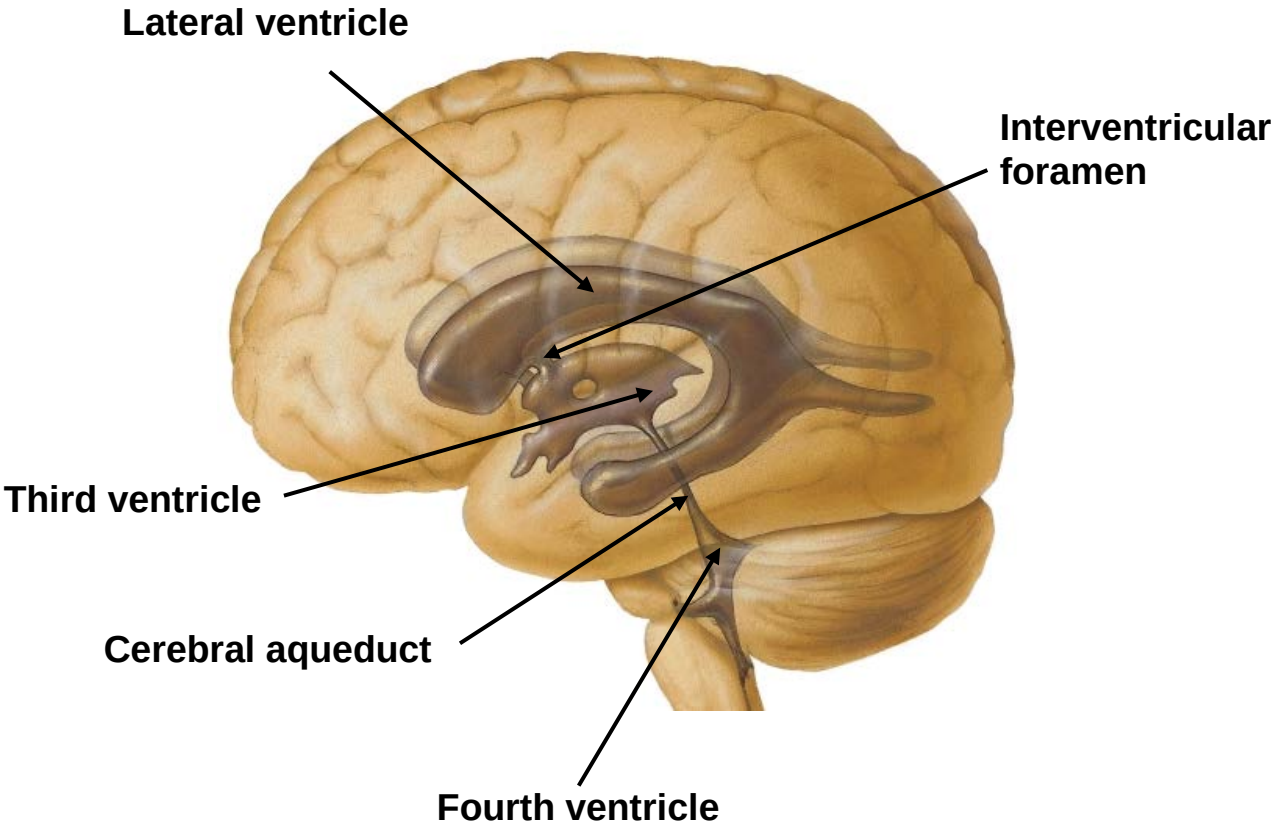

Figure 6. The ventricular system

Workstation 3

In this workstation you will examine components of the basal ganglia and limbic system.

The ***basal ganglia*** refer to a group of nuclei at the base of the cerebral hemispheres. Anatomically, the basal ganglia include the ***caudate nucleus*** and the ***lentiform nucleus***. Collectively, these interconnected structures are referred to as the ***corpus striatum***. They play an important part in the control of posture and movement.

The **limbic system** is important in the control of emotion, memory, behaviour and drive. The limbic system is formed of many components that span the telencephalon and diencephalon. In this session, we will inspect some of the main components, which include the ***hippocampal formation***, ***fornix***, ***mammillary bodies***, ***thalamus***, ***cingulate gyrus*** and ***hypothalamus***.

Horizontal and coronal sections have been cut through the brain. Identify a horizontal and coronal section towards the middle of the brain that can be used to examine each of the structures in these tasks.

A. On both the horizontal and coronal sections, examine the components of the basal ganglia. Use figures 7 and 8 to help locate the structures.

i. Start by locating the two ***thalami*** in the centre of the brain. Observe the ***third ventricle*** sitting between the thalami.

ii. Locate the ***lateral ventricles***, which have a characteristic C-shape. They have an anterior horn, body, posterior horn and inferior horn. On each of the other sections, trace the shape of the lateral ventricles.

iii. In the lateral wall of the lateral ventricle, locate the ***caudate nucleus***. This nucleus is a large C-shaped mass of gray matter that follows the contours of the lateral ventricle. It has a ***head***, ***body*** and ***tail***. The head forms the lateral wall of the anterior horn of the lateral ventricle. The tail terminates in the roof of the inferior horn of the lateral ventricle as the ***amygdala***. On each of the other sections, trace the shape of the caudate nucleus.

iv. Immediately lateral to the thalamus, observe the ***internal capsule***, a large white matter tract that links the cortex with the thalamus and brainstem.

v. Lateral to the internal capsule, the ***lentiform nucleus*** can be seen. This lens-shaped nucleus is divided into two regions: the ***putamen*** (outer region) and the ***globus pallidus*** (inner region). Identify both of these regions.

vi. Lateral to the putamen, a thin sheet of gray matter called the ***claustrum*** can be examined. This is separated from the putamen by fibres of the ***external capsule***.

vii. Lateral to the claustrum, the ***insula*** and ***lateral sulcus*** can be seen.

viii. On the coronal slices, it may be possible to identify a black region within the midbrain. This is the ***substantia nigra***, which also forms part of the basal ganglia.

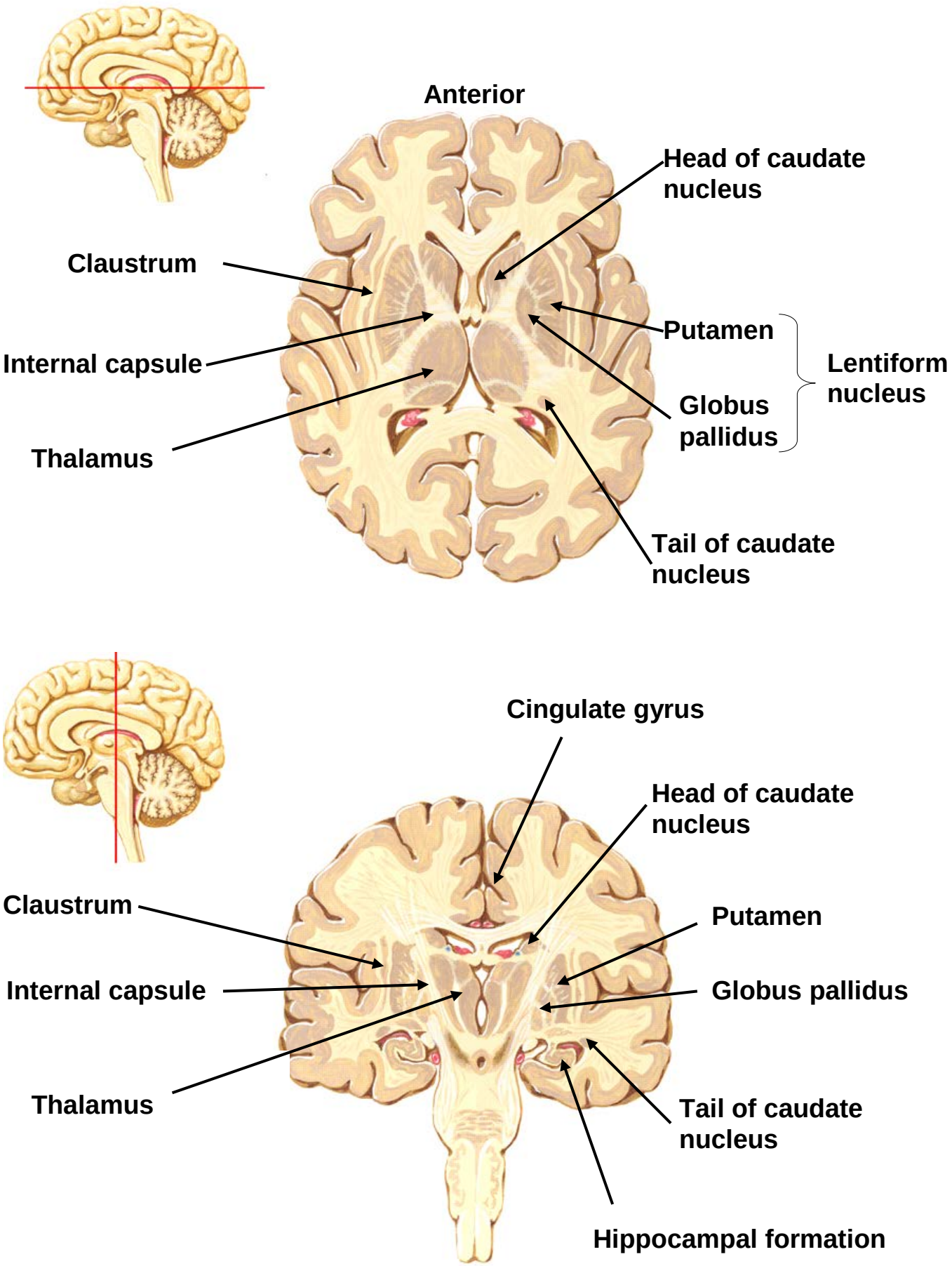

Figure 7. Horizontal (top) and coronal (bottom) section through the brain

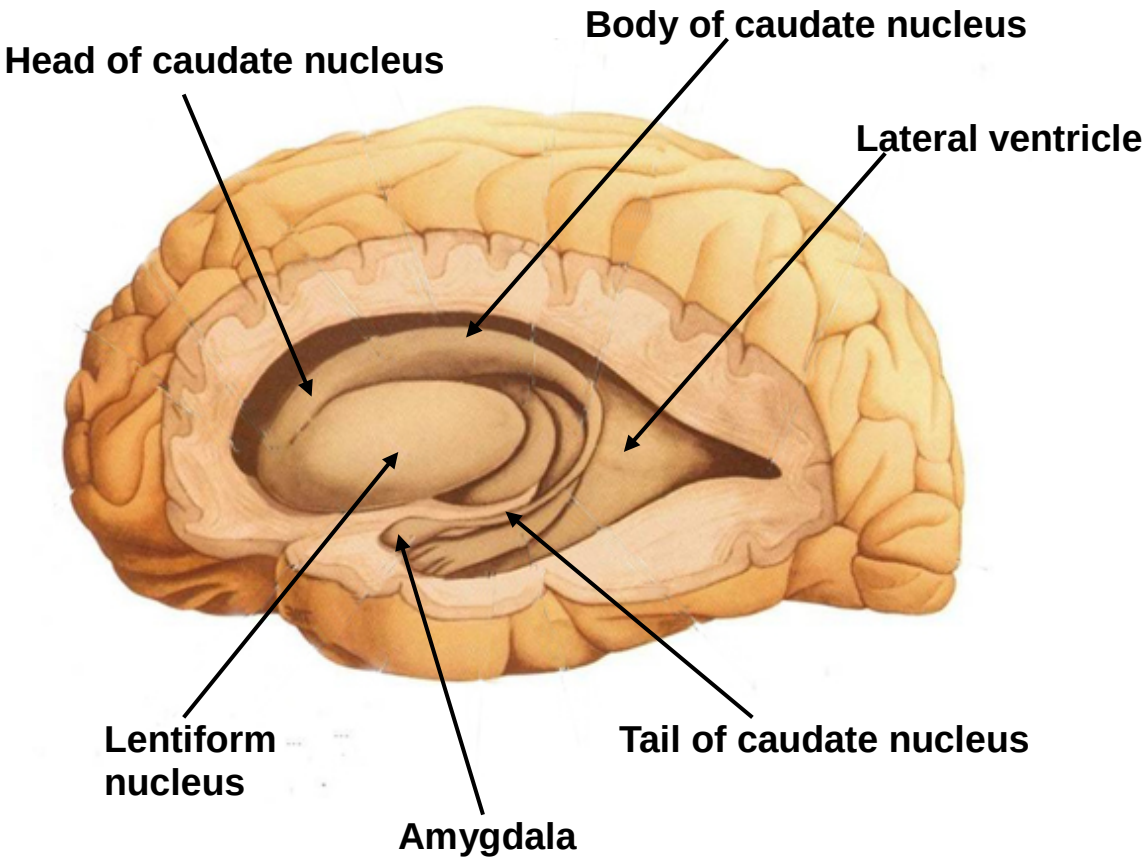

Figure 8. The corpus striatum

B. On the prosection of the lateral ventricle and a coronal slice, examine the main components of the limbic system. Use figure 7 to help locate structures.

i. On the prosection, examine the ***inferior horn of the lateral ventricle***. On the floor of this horn, identify the ***hippocampus***. This part of the hippocampus has a foot-like appearance (called the pes hippocampus).

ii. Continuous with the hippocampus, the ***fornix*** can be identified. This white-matter tract has a semi-circular shape, extending from the hippocampus to the mammillary bodies. It curves posteriorly, medially and superiorly over the thalamus. At this point it sits in the roof of the ***third ventricle*** as the ***columns of the fornix***. It then descends inferiorly over the thalamus to terminate on the ***mammillary bodies***, which can be observed on the inferior surface.

iii. On a coronal slice, identify the inferior horn of the lateral ventricle. In the floor, the ***hippocampal formation*** can be observed. Locate the hippocampus. The S-shaped gyri inferior to the hippocampus constitutes the dentate gyrus and subiculum.

iv. On the same section, locate the ***thalami*** and third ventricle. In the roof of the third ventricle, the ***columns of the fornix*** can be seen.
v. Now locate the ***corpus callosum***, which is the large white matter tract that connects the cerebral hemispheres. Superior to this structure, the ***cingulate gyri*** can be inspected on the medial side of each hemisphere.

vi. The ***amygdaloid nucleus*** is difficult to identify. It may be visible on a horizontal section in the temporal lobe, immediately anterior to the tail of the caudate nucleus.

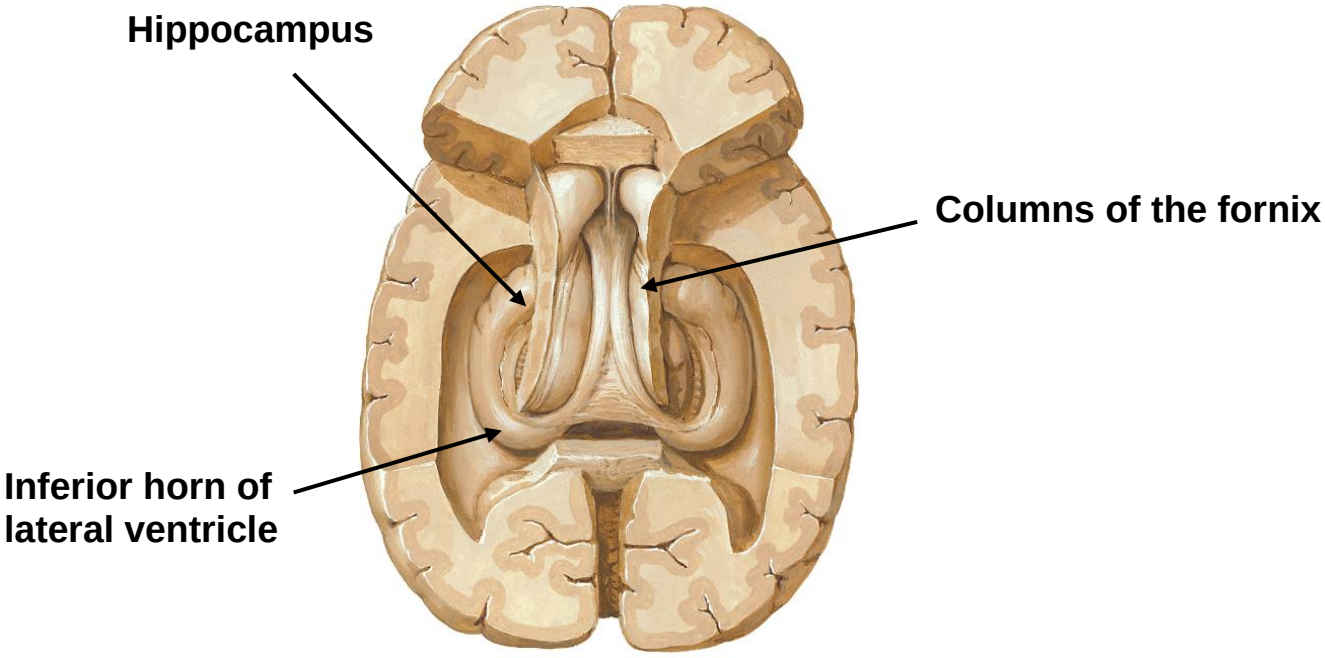

Figure 9. The hippocampus and fornix

Checklist

Review all the structures you have dissected today and ensure that your demonstrator is satisfied that you have completed the check list below before you leave the dissecting room:

Identified the surface features of the cerebral hemispheres
Identified the named structures visible on the inferior surface of the brain and have gained a preliminary knowledge of their functions
Identified the named structures visible on the medial aspect of a cerebral hemisphere and have gained a preliminary knowledge of their functions
Identified the named structures visible on the brainstem and have gained a preliminary knowledge of their functions
Have studied horizontal and coronal sections of the brain to enable a basic understanding of the topography of the basal nuclei and limbic system