brighton and sussex medical school

BSMS MODULE: 202, NEUROSCIENCE AND BEHAVIOUR
THEME: BRAIN, SPINAL CORD AND NERVE CELLS

DR SESSION: 1. EXAMINATION OF THE INTERIOR OF THE CRANIUM, MENINGES AND SPINAL CORD

By the end of the module students should be able to:

1. identify the location and extent of the dura mater and elements of the dural venous sinuses
2. understand the divisions and subdivisions of the brain
3. discriminate the main arterial and venous branches of the brain
4. distinguish the components of the spinal cord and its meningeal coverings
5. identify the location of the cranial nerves

Welcome back to the Anatomy Laboratory. In this module we will focus on elements of head and neck anatomy with a particular focus on the relations of the brain and cranial nerves. The head and neck is a demanding but interesting region in which you will find many important structures crowded into a relatively small space. In addition to the brain and the special sense organs, this region also houses the upper parts of the digestive and respiratory tracts. In the first dissection session we will focus on the cranial cavity

Task 1. Skull

On examination of your cadaver you will notice that some dissection has already been carried out. The skullcap (***calvaria***) has been cut to facilitate its removed to reveal the brain and its coverings. You may have to carry out a suboccipital dissection to expose the posterior parts of the brain to facilitate removal of the brain – ask your demonstrator for advice. A number of skull bones have either been removed or cut through during this part of the dissection. Using the plastic skulls and the diagram given below, work out which bones have been affected and name each of them.

Question 1. Do you know what the word scalp stands for?

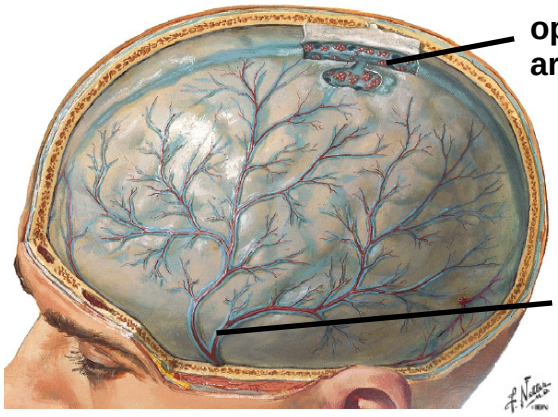
Task 2. Dura Mater

During the removal of the skullcap parts of ***scalp*** had to be removed. Take a moment to examine the cut edge of the detached skullcap and see if you can make out some of the layers that make up the scalp. Underlying the skullcap is the ***dura mater***, the protective layer of the meninges covering the brain. This layer adheres strongly to the internal surface of the skull and as you will notice it is a tough dense fibrous membrane. Upon initial examination, there may well be a shallow groove along the midline of the dura mater (running anterior to posterior). This is due to the presence of the ***superior***

sagittal sinus, one of the dural venous sinuses that collect blood from the veins of the brain before transferring it to the internal jugular veins.

Using a sharp scalpel make a medial sagittal incision through the dura to expose a small portion of the superior sagittal sinus. You may notice small granulations within the sinus; these are the ***arachnoid granulations*** that protrude through the dura and effect transfer of CSF to the venous system. In addition to the superior sagittal sinus you should also observe a network of blood vessels running from the lateral edges of the skull; these are the branches of the ***middle meningeal arteries*** and veins.

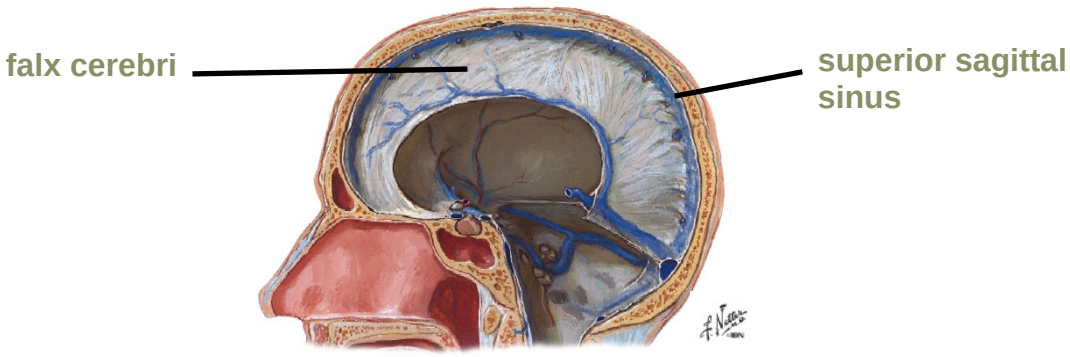
Question 2. What do the middle meningeal arteries supply?



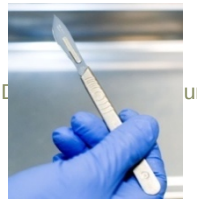
Task 3. Removal of the brain

In order to remove the brain we must make some incisions through the dura mater. First

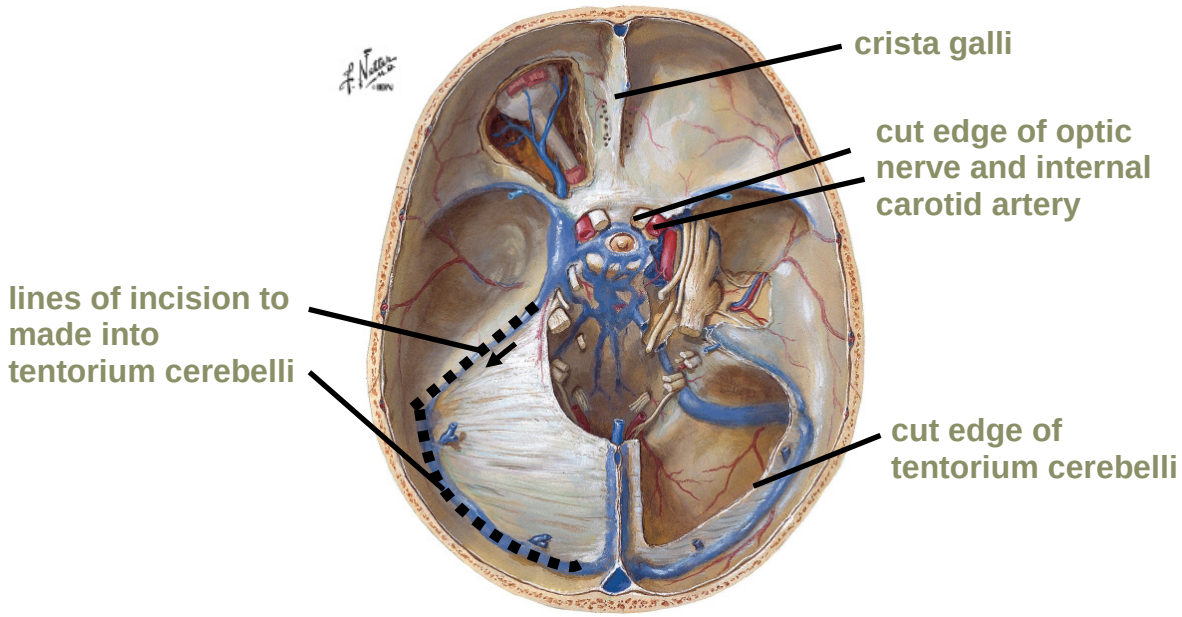
make two parallel sagittal incisions (about 3 cm apart) through the dura along the entire lateral border of the superior sagittal sinus. The portion of the dura that enters the longitudinal fissure between the two cerebral hemispheres is called the ***falx cerebri***, a sickle-shaped structure that is one of the dural infoldings. At the most anterior point detach the falx cerebri from its bony attachment – the ***frontal crest*** and the ***crista galli***, and pull the falx posteriorly so that it emerges from the longitudinal fissure.



Make sure that one of the team supports the brain by hand so that its own weight does not rupture the brainstem.



Gently ease the frontal and temporal lobes backwards and carefully cut the nerves and blood vessels (optic and oculomotor nerves and internal carotid arteries) running between the skull and the brain. Try and divide the structures midway to leave both part of the structure attached to the brain and part within the skull. Continue easing the brain backwards until you see the second dural infolding, the ***tentorium cerebelli***, which separates the cerebral hemispheres from the cerebellum, and which is attached to the ridges of the ***petrous***, ***temporal*** and ***clinoid processes***. Carefully sever these attachments with a sharp scalpel blade starting at the free edge and passing laterally and posteriorly as far as you can go. **The cavity will be quite dark and dissection space is quite limited, so make sure care is taken.**



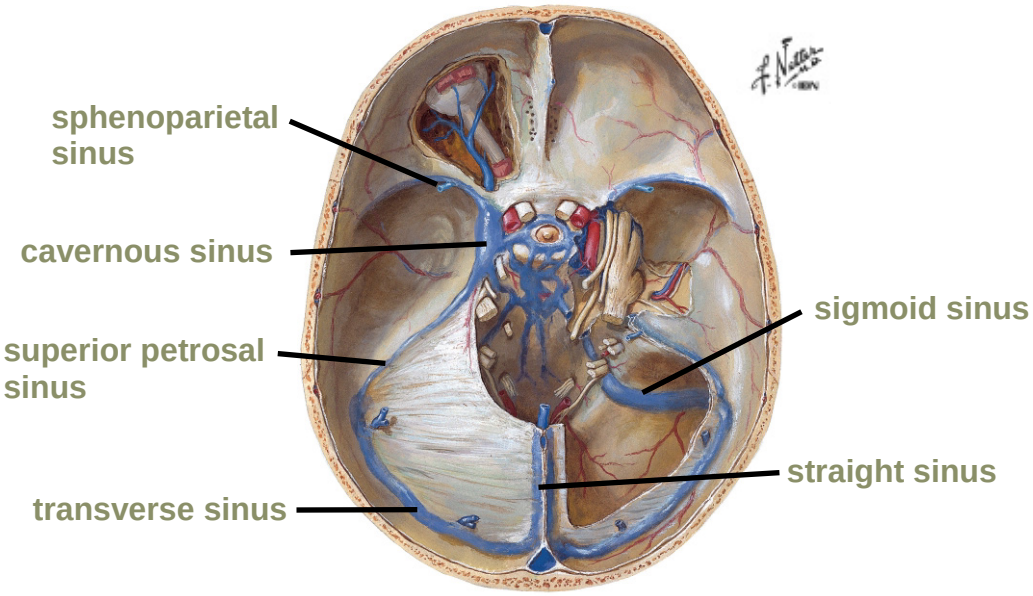
Cut the remaining cranial nerves midway between their cranial attachments and the dura. Finally **use the long handled scalpel** to cut through the ***medulla oblongata*** and ***vertebral arteries*** as close to the ***foramen magnum*** as possible (this is essential to ensure that as much of the medulla remains attached to the brain as this will be required in the brain topography practical session). Gently ease the cerebellum from its base and remove the brain in one piece using a 'forward, up and out' movement.

Question 3. Where is the diaphragma sellae?

Task 4. Dural venous sinuses

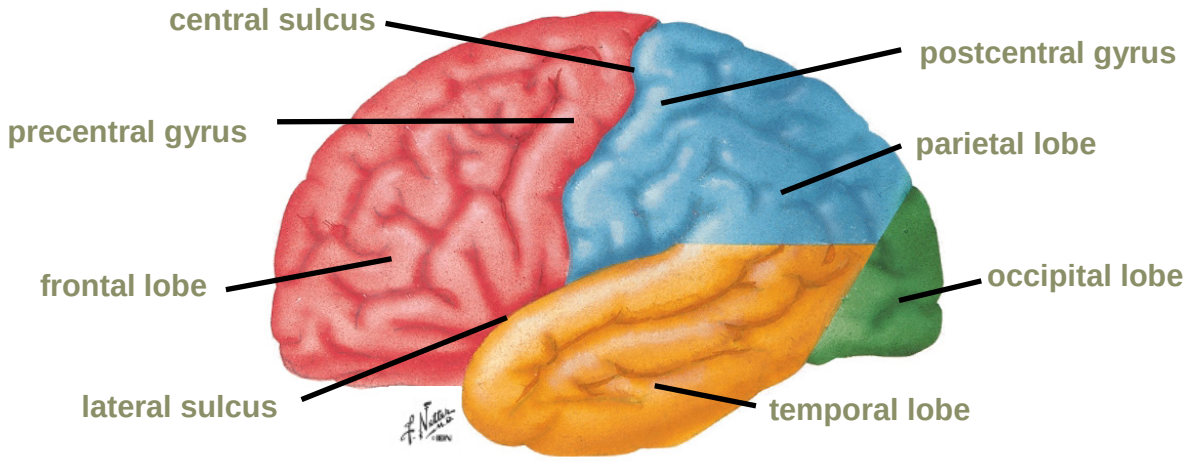
You have already identified the superior sagittal sinus; it is now time to locate some of the other main dural venous sinuses. In order to see the structures clearly you may need to make small incisions into each sinus – residual blood may be present. On one side start with the ***sphenoparietal sinus*** and the ***cavernous sinus*** before running to the ***superior petrosal sinus*** along the petrous ridge and moving on to the ***transverse sinus*** to the ***sigmoid sinus*** and finally terminating at the ***jugular foramen***. Also note the ***straight sinus*** and the ***inferior sagittal sinus***. Ask a demonstrator if you are having difficulty.

Question 4. How do you think the main sinuses all link up?



Task 5. Superficial surfaces of the brain

The cerebral hemispheres make up much of the outer brain and are dominated by a system of ***sulci*** (grooves) and ***fissures,*** which subdivide the cerebrum into smaller areas the ***lobes*** and the ***gyri*** (folds). You should now carefully examine the brain and identify the following features. Start by locating the ***longitudinal fissure*** separating each cerebral hemisphere then note the position of the ***central sulcus,*** which runs coronally dividing the ***frontal*** and ***parietal lobes***. The central sulcus is often difficult to find, but it is especially important as it separates the main motor and sensory areas of the cerebral cortex. The ***lateral sulcus*** separates the ***temporal lobe*** from the parietal and frontal lobes, whilst the parieto-occipital sulcus as the name suggests divides the ***occipital*** and parietal lobes. The boundaries between the parietal and temporal lobes and the occipital lobe are rather indistinct on the lateral surface and can be more clearly seen on the medial surface.



Two of the main folds visible on the surface of the brain are the ***pre-*** and ***post-central gyri***. The precentral gyrus, which lies immediately anterior to the central sulcus,

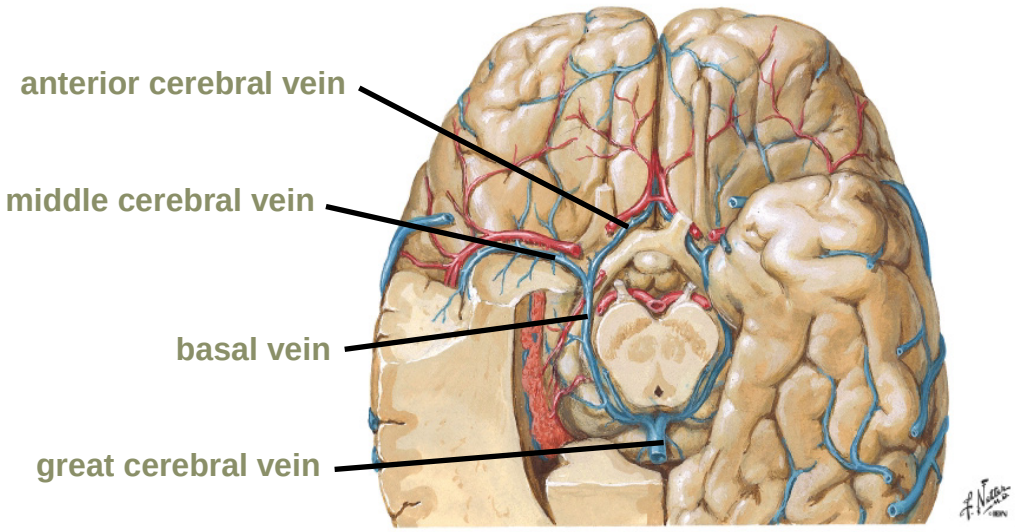
contains the primary motor cortex that controls movement. The postcentral gyrus, lying posterior to the central sulcus is the primary somatosensory cortex.

Question 5. what do you think might be consciously perceived in the somatosensory cortex?

Task 6. Blood vessels of the brain

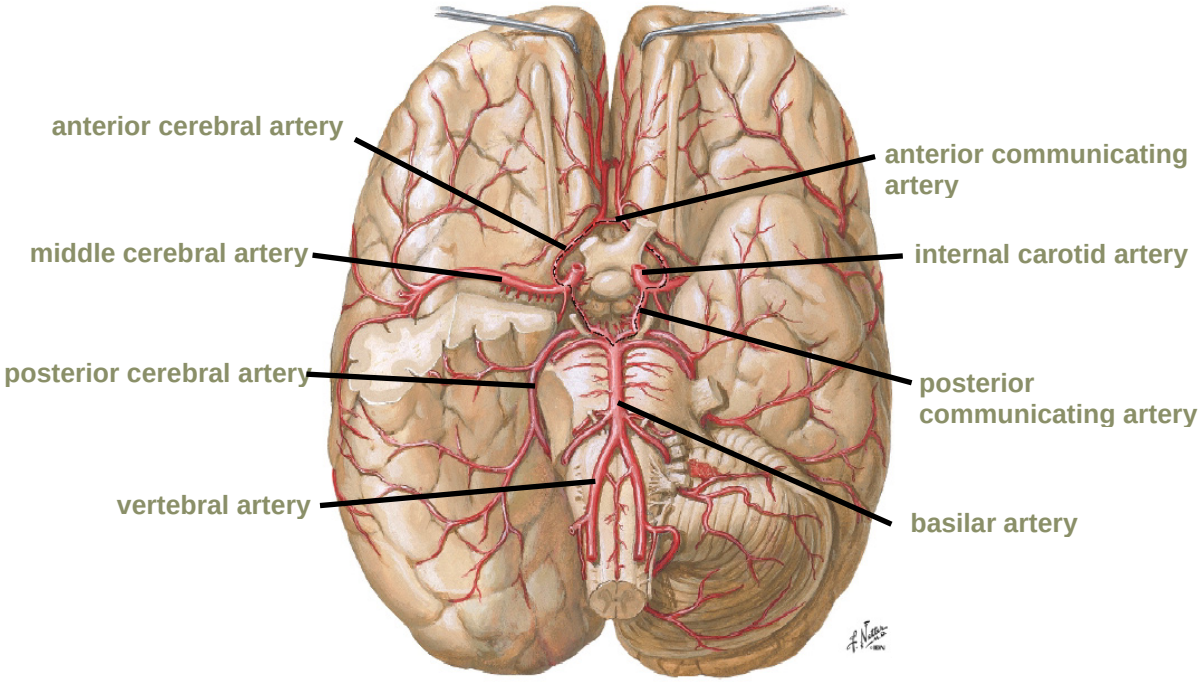
You will already have seen a number of blood vessels during this session including the dural sinuses that make up part of the drainage system. You will now focus on the other elements of the arterial and venous systems including cerebral veins and the branches of the internal carotid arteries and the vertebral arteries. Use the cadaveric brain and also the available models / posters to help you identify some of the main structures.

The main veins draining blood from the brain are the cerebral veins of which there are a number based on their location and territory of drainage. You should try and identify the ***anterior*** and ***middle cerebral veins,*** which drain into the ***basal veins*** before reaching the ***great cerebral vein***. Other veins such as inferior cerebral veins may also be visible. Venous drainage from the brain enters the dural venous sinuses, which eventually drain into the internal jugular vein at the jugular foramen in the base of the skull.



The arterial supply of the brain derives from the internal carotid and vertebral arteries. The internal carotid arteries arise from the common carotids and give rise to a number of terminal branches, which you should try and identify. The ***ophthalmic arteries*** run anteriorly and supply the orbit. The ***anterior cerebral arteries*** supply the medial and superior surface and the frontal pole, whilst the ***middle cerebral arteries*** supply the lateral surface and temporal pole.

The vertebral arteries arise from the subclavian arteries and unite in the vicinity of the pons to form the single ***basilar artery***. The basilar artery subsequently divides at the level of the superior border of the pons into the ***posterior cerebral arteries***, which supply the inferior surface and occipital pole. The main arterial vessels form an anastomosis at the base of the brain, which is known as the ***Circle of Willis*** or the ***cerebral arterial circle***. The circle is formed by the posterior cerebral, posterior communicating, internal carotid, anterior cerebral and anterior communicating arteries.

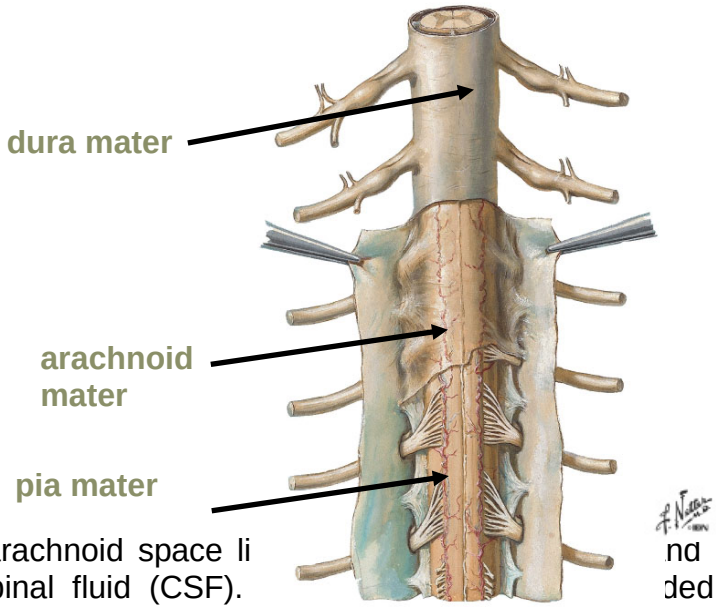


Examine pot ED 14 showing an aneurysm on the anterior communicating artery

Question 6. What is the result of a sudden occlusion in one of the main arteries of the brain?

Task 7. Spinal meninges

On some of the prosections a full or hemi laminectomy (removal of the laminae of the vertebrae) has been performed to reveal the spinal cord and its meningeal coverings. Like the brain, the ***spinal meninges*** are divided into three layers, two of which can be clearly distinguished. The ***dura mater*** is the tough fibrous outer cover protecting the spinal cord. The dura mater is separated from the vertebrae by the ***extradural or epidural space*** (often filled by fat) and adheres to the margin of the foramen magnum at its most cranial end and is anchored to the coccyx by the ***terminal filum***. The dura mater extends into the intervertebral foramina and along the nerve roots but is pierced by the spinal nerves. The ***arachnoid mater*** is a delicate avascular membrane lining (but not attached to) the dura mater and encloses the ***subarachnoid space*** (containing the spinal cord, nerve roots and ganglia). The inner ***pia mater*** intimately covers the spinal cord and all of its surface features and as such cannot be easily distinguished from the spinal cord. Inferiorly the pia mater continues as the terminal filum.



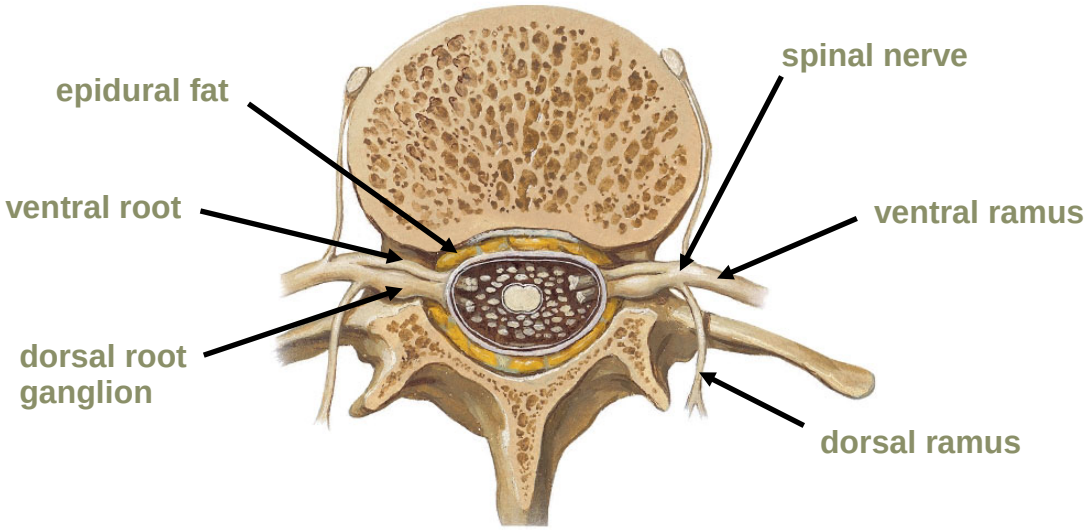
The subarachnoid space li nd pia mater and is filled with cerebrospinal fluid (CSF). ded within the dura mater by denticulate ligaments, lateral extensions of the pia mater.

Question 7. In meningitis the layers of the meninges become inflammed. Why is this condition painful?

Task 8. Spinal cord

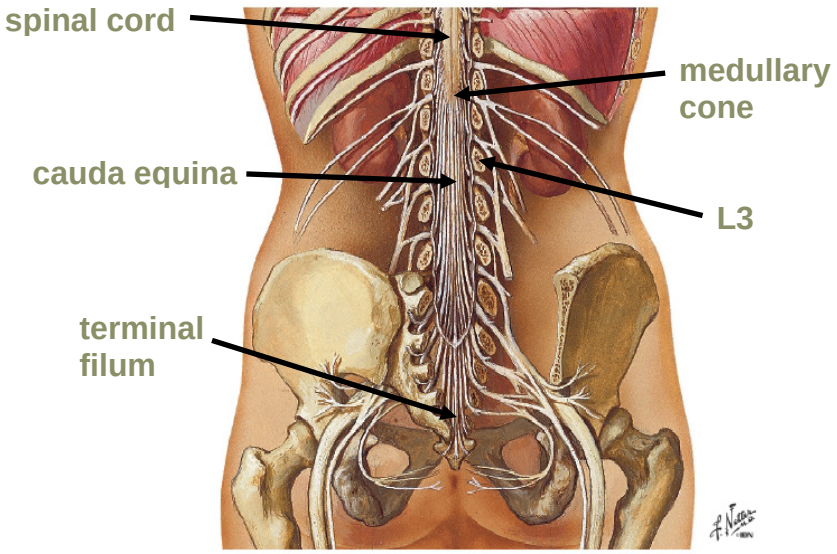
Upon examination, you will notice that the spinal cord is a cylindrical structure that is slightly flattened on anterior and posterior surfaces and is nestled within the vertebral canal. The spinal cord is the main conduction pathway between the body and the brain and is divided up into a number of regions, beginning as a continuation of the ***medulla oblongata***. The spinal cord only occupies about two-thirds of the vertebral canal and is enlarged in two regions, which allows for the exit of nerve bundles innervating the limbs. The ***cervical enlargement*** extends from the level of C4 to T1 and most of the anterior rami arising from this region form the brachial plexus that innervates the upper limb. The ***lumbrosacral enlargement*** extends from the level of L1 to S3, with the anterior rami contributing to the lumbar and sacral plexuses innervating the lower limb.

Multiple rootlets emerge from segments of the spinal cord on both the anterior and posterior surfaces and coalesce to form the ventral (anterior) and dorsal (posterior) roots of the spinal nerves. The dorsal roots can be followed within the epidural space as they enlarge into the spinal ganglia. The dorsal and ventral roots then unite as they exit from the vertebral foramen to form the spinal nerve. Each spinal nerve immediately divides into a dorsal primary ramus and a ventral primary ramus.



Thirty one pairs of spinal nerves exit the spinal cord in a segmented fashion. For each of the spinal cord segments, examine the position and direction of the spinal nerve roots as they leave the spinal cord and enter their respective interverterbral foramen.

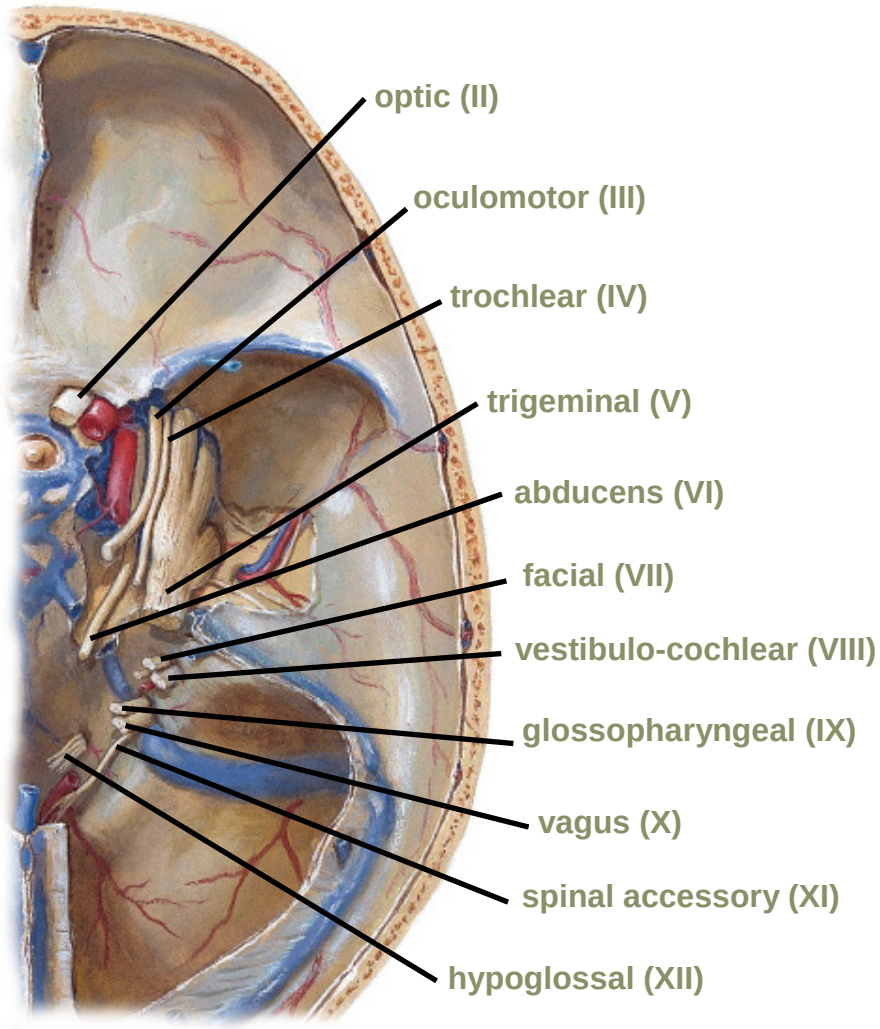
The spinal nerve roots arising from the inferior termination of the spinal cord resemble a horse's tail and are therefore referred to as the ***cauda equina***. This bundle of nerve roots lies within the ***lumbar cistern*** and enlargement of the subarachnoid space containing CSF. You will notice how the inferior end of the spinal cord tapers into a conical shape, known as the ***medullary cone***. The terminal filum (vestigial remnant of the spinal cord) descends from the cone and anchors to the dorsum of the coccyx.



Question 8. When a sample of CSF is required a lumbar puncture is performed, with a needle passed into the subarachnoid space at the level of L3/L4, a level limiting the chance of spinal cord damage. In children, a lumbar puncture is usually performed at the level of L5. Why do you think different levels are used?

Task 9. Cranial nerves

Return your attention to the cranial cavity once again and identify the cut ends of the twelve pairs of cranial nerves plus the internal carotid, vertebral and middle meningeal arteries. Focus your attention on following information: number, name, type (e.g. motor / sensory) and function. Try constructing your own summary table.



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 location and extent of dura mater and elements of the dural venous sinuses
- Understood the divisions and subdivisions of the brain
- Discriminated the main arterial and venous branches of the brain
- Distinguished the components of the spinal cord and its meningeal coverings
- Identified the location of the cranial nerves