BSMS MODULE: 202, NEUROSCIENCE AND BEHAVIOUR

DR SESSION:

1. **EXAMINATION OF THE INTERIOR OF THE CRANIUM, MENINGES AND SPINAL CORD**

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

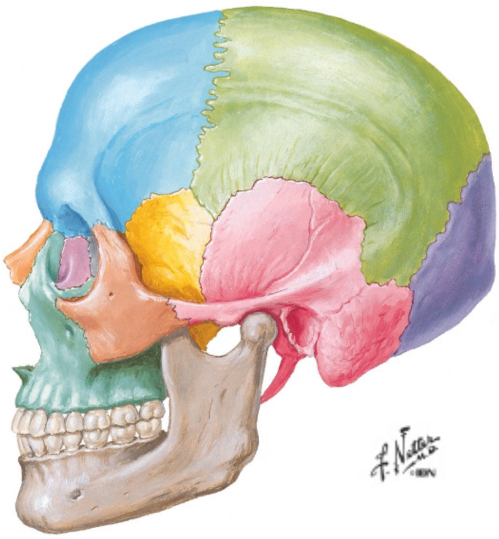
DR SESSION: **1. EXAMINATION OF THE INTERIOR OF THE CRANIUM, MENINGES AND SPINAL CORD**

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

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.



Examination of the scalp and dura mater

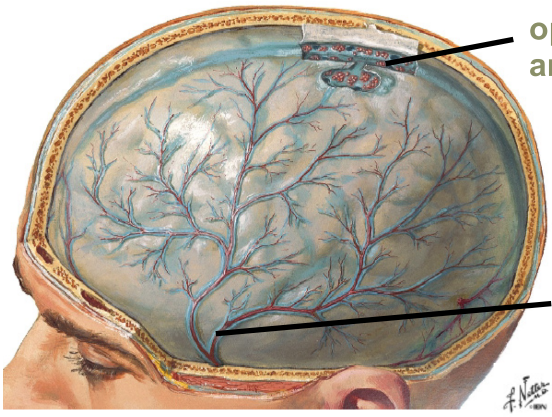
During the removal of the skullcap parts of ***scalp*** had to be removed. Take a moment to examine the cut edge of the detached skullcap and see if you can make out some of the layers that make up the scalp.

Do you know what the word scalp stands for?

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.

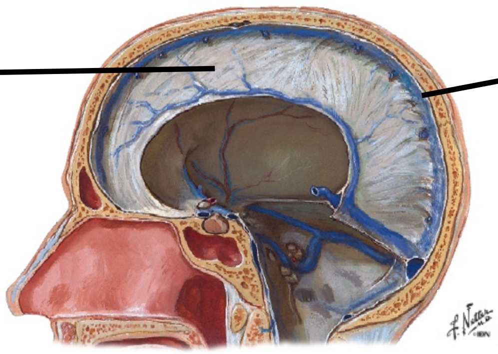
Using a sharp scalpel make a medial sagittal incision through the dura to expose a small portion of the superior sagittal sinus. You may notice small granulations within the sinus; these are the ***arachnoid granulations*** that protrude through the dura and effect transfer of CSF to the venous system. 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.

What do the middle meningeal arteries supply?



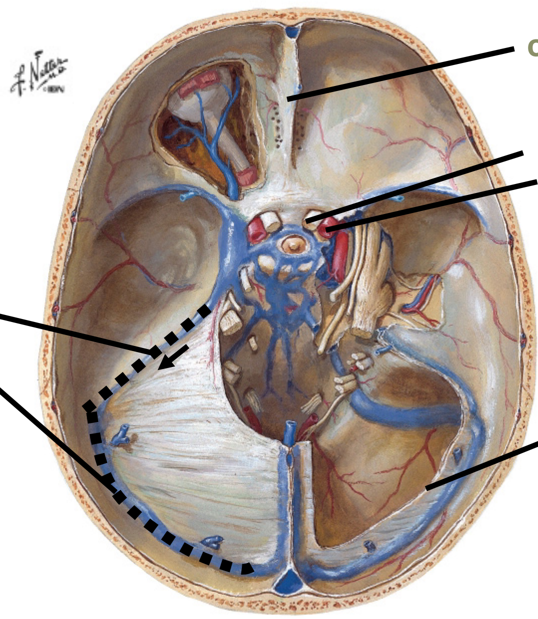
Removal of the brain

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.**

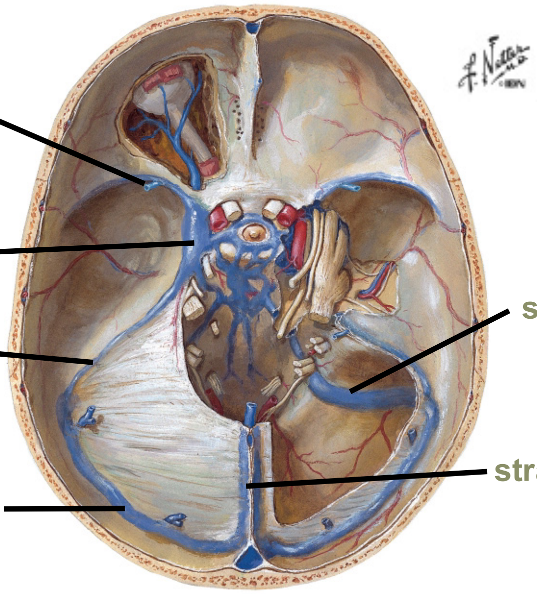


Cut the remaining cranial nerves midway between their cranial attachments and the dura. Finally **use the long handled scalpel** to cut through the ***medulla oblongata*** and ***vertebral arteries*** as close to the ***foramen magnum*** as possible (this is essential to ensure that as much of the medulla 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.

Examination of the dural venous sinuses

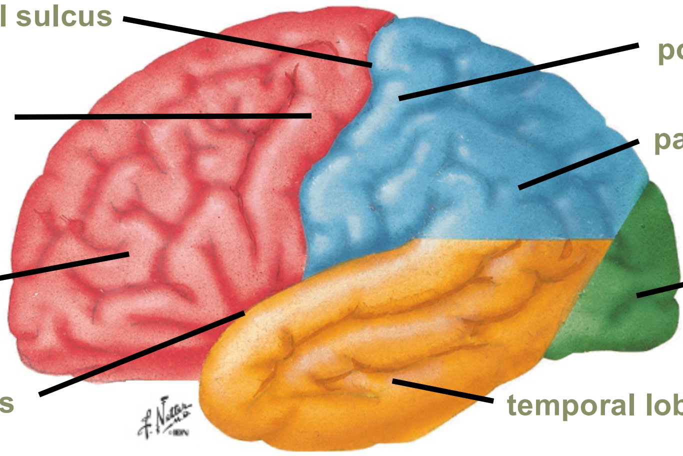
You have already identified the superior sagittal sinus; it is now time to locate some of the other main dural venous sinuses. In order to see the structures clearly you may need to make small incisions into each sinus – residual blood may be present. On one side start with the ***sphenoparietal sinus*** 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.

How do you think the main sinuses all link up?



Examination of superficial surface 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.



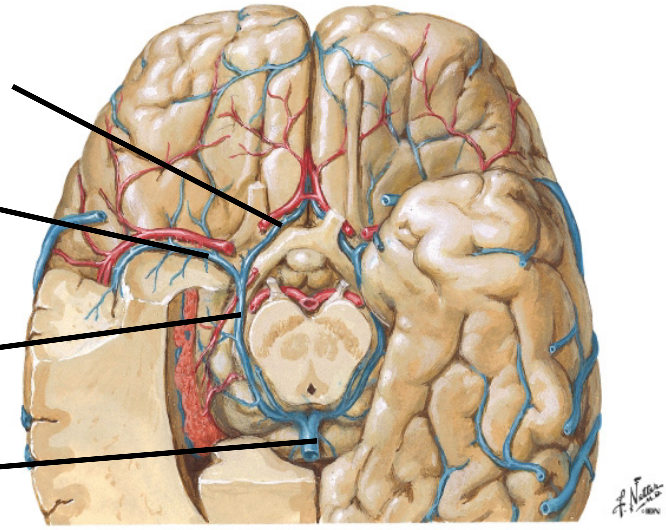
Two of the main folds visible on the surface of the brain are the ***pre-*** and ***post-central gyri***. The precentral gyrus, which lies immediately anterior to the central sulcus, contains the primary motor cortex that controls movement. The postcentral gyrus, lying posterior to the central sulcus is the primary somatosensory cortex.

What do you think might be consciously perceived in the somatosensory cortex?

Examination of the blood vessels of the brain

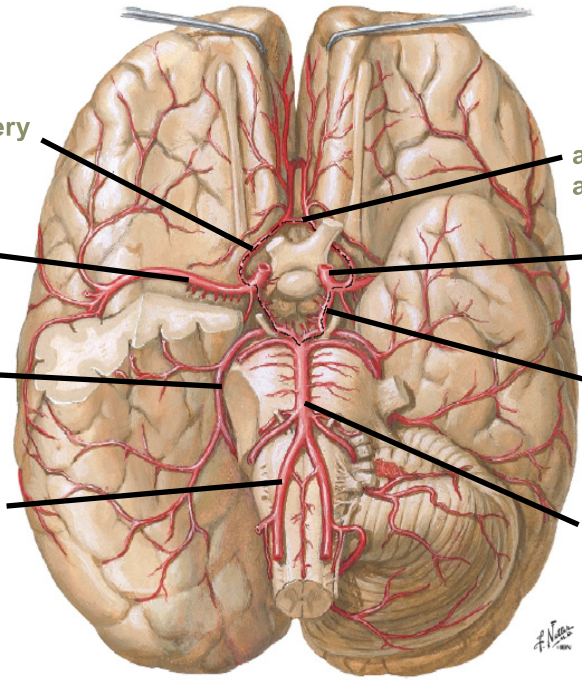
You will already have seen a number of blood vessels during this session including the dural sinuses that make up part of the drainage system. You will now focus on the other elements of the arterial and venous systems including cerebral veins and the branches of the internal carotid arteries and the 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.

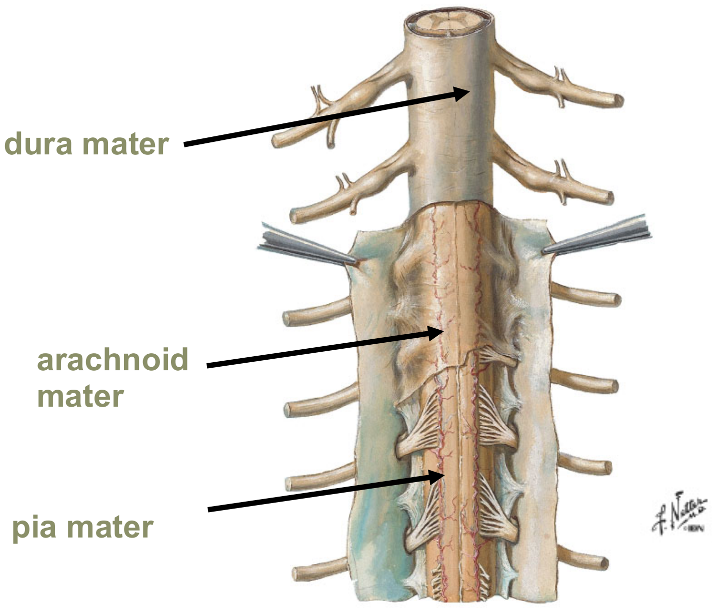


What is the result of a sudden occlusion in one of the main arteries of the brain?

Examination of the 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.

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



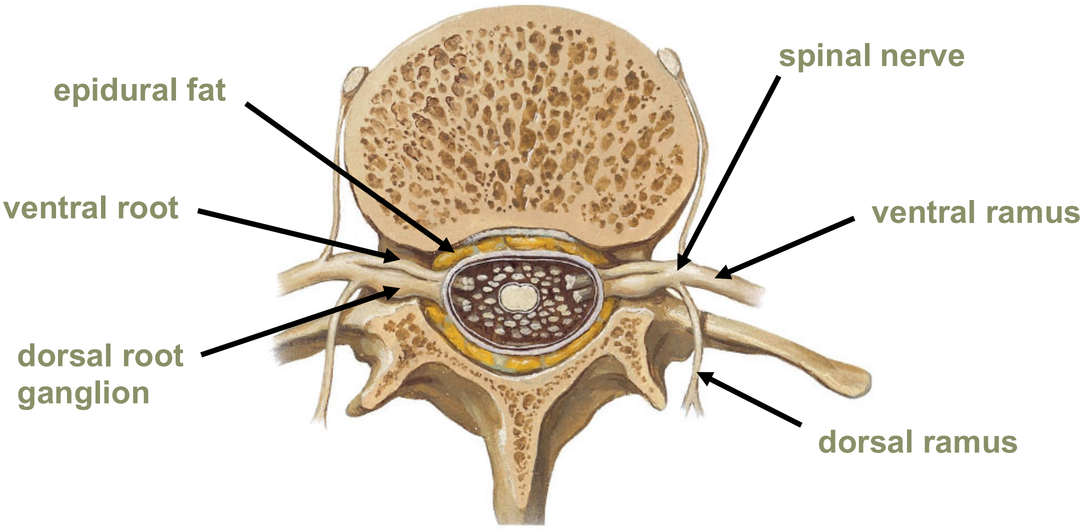
The subarachnoid space lies between the arachnoid and pia mater and is filled with cerebrospinal fluid (CSF). The spinal cord is suspended within the dura mater by denticulate ligaments, lateral extensions of the pia mater.

Examination of the 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.

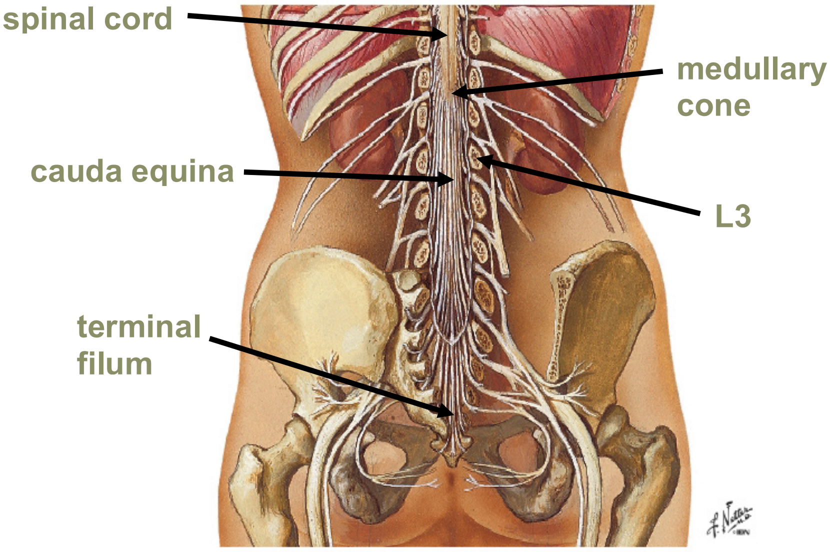
Multiple rootlets emerge from segments of the spinal cord on both the anterior and posterior surfaces and coalesce to form the ventral (anterior) and dorsal (posterior) roots of the spinal nerves. The dorsal roots can be followed within the epidural space as they enlarge into the spinal ganglia. The 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.

Using the knowledge gained from previous modules, how does the dorsal primary ramus of a spinal nerve differ from its dorsal root?



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.

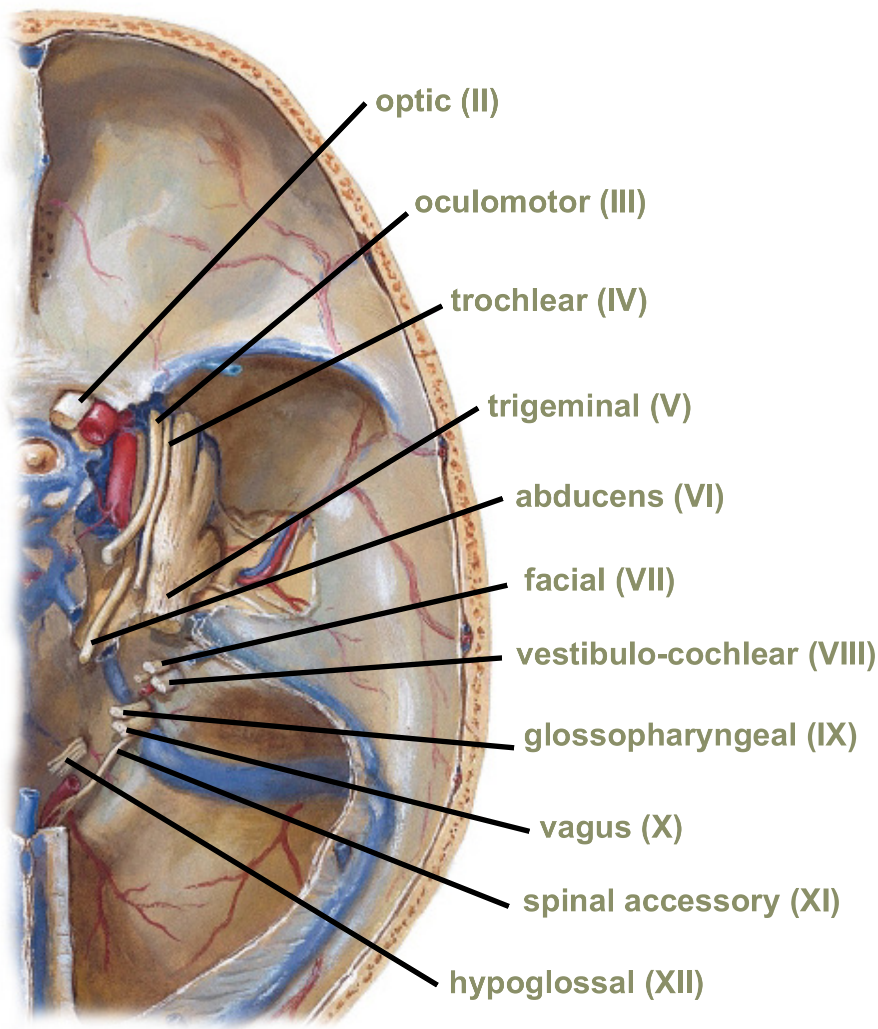
The spinal nerve roots arising from the inferior termination of the spinal cord resemble a horse's tail and are therefore referred to as the ***cauda equina***. This bundle of nerve roots lies within the ***lumbar cistern*** and enlargement of the subarachnoid space containing CSF. You will notice how 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.



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?

The 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. Following this session you **MUST** study the cranial nerves ready for the module tutorial looking at the skull and foramina. 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

BSMS MODULE: 202, NEUROSCIENCE AND BEHAVIOUR

DR SESSION:

2. EXAMINATION OF THE ORBIT AND GLOBE OF EYE

brighton and sussex medical school

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

DR SESSION: 2. EXAMINATION OF THE ORBIT AND GLOBE OF EYE

LEARNING OUTCOMES

By the end of the practical session students should be able to:

1. Identify the bones of the orbit and understand the clinical relevance.
2. Identify the nervous supply to the orbit including motor, somatic sensory and special sensory (vision) supply.
3. Identify the extraocular muscles and explain their innervation, function and clinical testing.
4. Identify the ophthalmic artery and understand the structures that it supplies.
5. Appreciate the venous drainage of the orbit.
6. Appreciate the autonomic nerve supply to the lacrimal gland, pupil, and ciliary muscle.
7. Apply this anatomy knowledge to a range of clinical scenarios.

In this practical session you will study the anatomy of the **orbit** and the exterior of the globe of the eye including the **extraocular muscles**. You will be focussing on a number of different cranial nerves. For this session you will be performing much of the dissection and will start by making an opening in the superior aspect of the frontal bone to expose the orbit from a superior view. In addition you will be able to examine a prosected specimen as well as the anatomical models available within the dissecting room. As with all your other practical sessions in the dissecting room make sure you work through this handout, answer the questions and complete the checklist.

Examination of the orbit

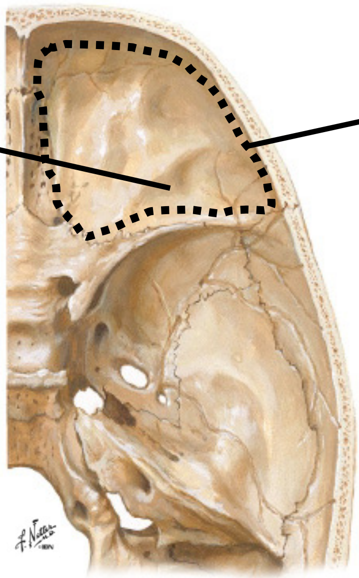
Your first task is to examine the bones that make up the orbit using the available skulls. The orbit is a pyramidal-shaped cavity in the facial skeleton, with the apex lying medio-posteriorly and the base of the pyramid (orbital aperture) lying anteriorly. Pay particular attention to the roof, floor and walls of the orbit and the differences in their thickness. Now observe the foramina and fissures of the orbit: the **optic canal**, **superior orbital fissure**, **inferior orbital fissure**, **inferior orbital canal** and the **supraorbital foramen**.

Which bones make up each wall of the orbital cavity?

Exposing the contents of the orbit

Working on both the right and left sides of your cadaver in two sub groups.

To expose the orbit you will need to remove the thin orbital plate of the frontal bone by careful use of the chisel and forceps (you should seek the advice of your demonstrator at this point). The wider (laterally) you make the exposure the easier it will be to identify the various orbital contents. As your dissection moves towards the midline you may reveal part of the mucous membrane of the **ethmoidal air sinuses** lateral to the cribriform plate, which you should NOT remove or damage. In most cases the contents of the orbit are embedded in lobular fat bounded by a connective tissue membrane. You should gently remove this layer and the fat using forceps. This procedure should be repeated for the other orbit thereby allowing for both a superficial and deep dissection of the orbit. Both dissections can be carried out simultaneously.



Examination of the superficial contents of the orbit

The **trigeminal nerve** (CNV) has three branches that divide intracranially. The first branch is the **ophthalmic nerve**. This nerve provides somatic sensory (touch, pain, temperature e) innervation to the eye, lacrimal gland, orbit and the skin around the orbit and forehead. It enters the orbit via the superior orbital fissure and has three main branches – **frontal, lacrimal and nasociliary**.

The first two of these can be found in the superficial dissection, by carefully removing the lobular fat. The **frontal nerve** runs just under the roof of the orbit and is easily visible. Remove as much of the lobular fat around this nerve and identify its two terminal branches. The larger more lateral branch is the **supraorbital nerve** that will exit the orbit through the supraorbital foramen that you should have previously observed.

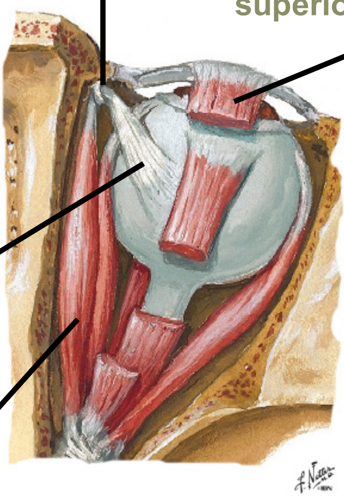
What innervation do you think these branches provide?

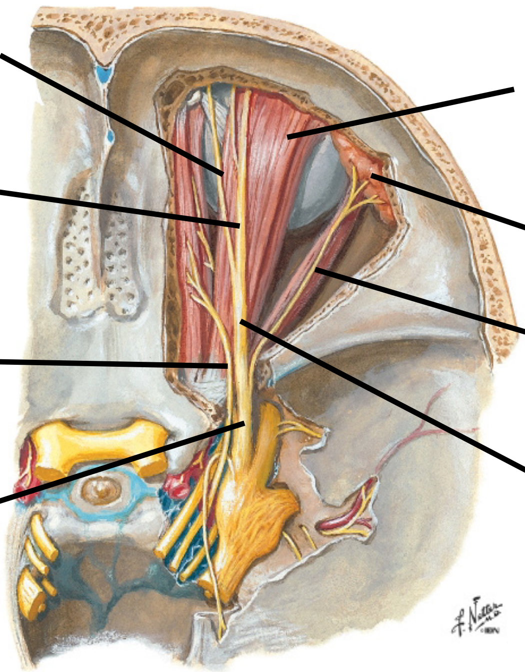
Now by removing as much of the lobular fat as you can, locate the **lacrimal gland** in the supero-lateral aspect of the orbital aperture. Carefully locate the **lacrimal branch** of the ophthalmic nerve as it runs from the apex of the orbit to this gland. This nerve carries <u>somatic sensory</u> information from the lacrimal gland, lateral conjunctiva, and also from a small area of skin over the lateral portion of the eyelids. Parasympathetic nerve innervation to the lacrimal gland (for tear production) will be discussed later.

The third branch of the ophthalmic nerve is the nasociliary nerve. This supplies the structures of the eye itself (as well as the ethmoid sinus and the skin over the nose) and so will be encountered shortly as part of the deep dissection.

Before completing the superficial dissection, you should move your attention to the medial aspect of the orbit and find the **superior oblique eye muscle**. This muscle extends forward from its origin at the apex, becomes tendinous and passes through a fibrous ring of tissue called the **trochlea** (which acts as a pulley). Here it changes direction and inserts into the sclera in the posterior part of the globe.

Carefully remove the fat around this muscle in its posterior third in order to find the **trochlear nerve** (CNIV) entering this muscle. Ocular movements will be covered in more depth later.





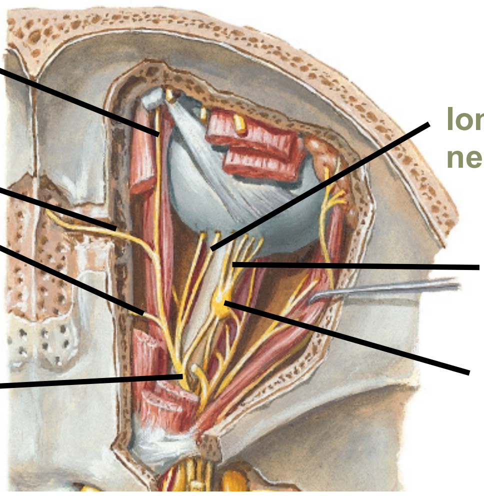
Examination of the deep contents of the orbit

Following the removal of the fat, observe the **levator palpebrae superioris muscle**. As its name suggests, this lifts the upper eyelid. Cut this muscle, along with the frontal nerve midway along their length and reflect to expose the first of the recti muscles of the eye, the **superior rectus**. Following a brief examination of the course of the muscle, cut and reflect it in the mid-belly region. As you reflect both muscles you should look for branches of the **oculomotor nerve** (CNIII) entering both of these muscles.

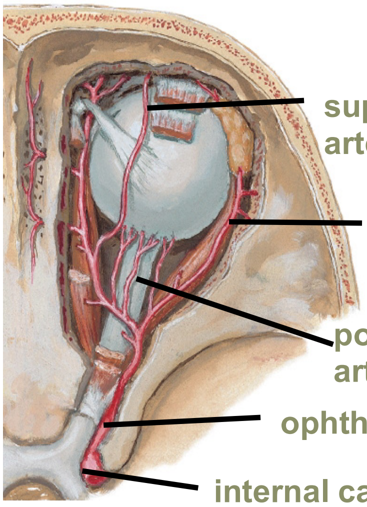
The four recti muscles will be covered in depth later but you should appreciate that along with their surrounding fat and fascia, they form a ‘cone’ extending from the apex to the eye. Carefully remove as much fat as you can from this ‘intraconal space’. There are a number of delicate structures to be found.

The largest structure is the **optic nerve** (3-4mm diameter) and will be the easiest to find. This carries nerve axons from the retina all the way to the thalamus of the brain and this pathway will be covered in more depth later.

Recall the two branches of the ophthalmic nerve (CNV_1) seen in the superficial dissection. The final branch (**nasociliary nerve**) should now be found crossing the optic nerve from lateral to medial along with the ophthalmic artery. The nasociliary nerve carries pain and touch sensation from the cornea via its long posterior ciliary branches. Its other branches are the anterior and posterior ethmoidal nerves that supply the mucous membranes of the paranasal sinuses and nasal cavity, and the terminal branch, the **infratrochlear nerve**, which supplies the medial portion of the eyelids and conjunctiva, as well as the skin of the nose. Carefully try to remove as much fat as you can and identify these branches.



The main artery supplying the orbit is the **ophthalmic artery**, the first branch of the internal carotid artery. As it branches from the internal carotid, it travels through the optic canal along with the optic nerve. After entering the orbit it gives a variety of branches that you should attempt to locate. These branches will supply the lacrimal gland, extraocular muscles, the ethmoid and sphenoid sinuses, eyelids, as well as the skin over the forehead and nose. Blood supply to the globe of the eye itself is two-fold: the central retinal artery and the ciliary arteries. The former is the first branch of the ophthalmic artery and enters the optic nerve sheath to supply this nerve as well as the retina. This artery and its 4 terminal branches are what can be visualised by ophthalmoscopy (see image below). The long and short posterior ciliary arteries enter the back of the eye along with the ciliary nerves to supply the other structures within the eye.



Using an ophthalmoscope, the optic ne
can be seen entering the eye as the op
disc, along with the central retinal arter
it's four main branches.

The orbit blood supply drains via the **superior** and **inferior ophthalmic veins**. You may have already come across the former. If not you should try to find it now. This vein passes through the superior orbital fissure into the cavernous sinus (part of the intracranial dural venous sinus network). The inferior vein may drain into the cavernous sinus or may pass through the inferior orbital fissure into the sphenopalatine fossa. Both of these have communications with veins of the face and sinuses, and so are important potential routes of entry for pathogens causing intracranial infections eg cavernous sinus thrombosis, meningitis, encephalitis.

What would be the result of a blockage of the central retinal artery? (think back to your first year notes from Module 102!)

The Extraocular Muscles and Cranial Nerves III, IV, VI

You need to appreciate the six muscles that act on the eye in addition to the levator palpebrae superioris that lifts the upper eyelid. In particular, it is essential that you fully understand their innervation and function as this is the basis for identifying intracranial pathology as part of the neurological examination. This is life-saving anatomy!

The six muscles that act to move on the eye include the four recti (superior, inferior, medial and lateral) and the two oblique muscles.

The Rectus Muscles
Each of the rectus muscles arise from the apex of the orbit, and insert in the anterior hemisphere of the eye. Identify each of these on the prosections.

When considering the movements that these muscles make, you need to examine the prosections. Looking at the superior orbital prosection, observe how the rectus muscles are directed at an angle of about 20° antero-laterally. However, the visual axis is directed anteriorly in the primary gaze (looking straight ahead).

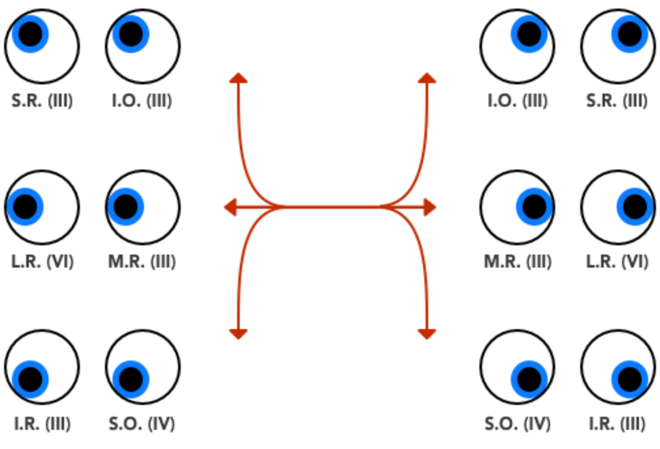
To test these muscles clinically you need to *isolate* the muscle. To isolate the superior or inferior recti muscles you must first <u>align the muscle directions with the visual axis</u> i.e. <u>ask the patient to look laterally, and then to look up or down</u>.

The medial and lateral rectus muscles will move the eyes in the medial and lateral direction as expected.

The Oblique Muscles
The superior oblique was observed as part of the superficial orbital dissection. It runs from the apex along the supero-medial aspect of the orbit to the trochlea, where it turns backwards and medially to insert on the postero-lateral aspect of the globe.

Now examine the inferior oblique. This is the only muscle not to originate from the apex. It arises from the maxillary bone in the infero-medial orbital margin. The muscle passes under the eye to insert into the postero-lateral aspect of the globe.

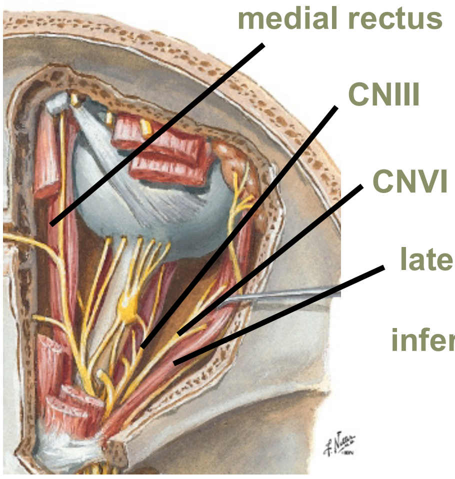
To test the function of these muscles clinically you must again test them in isolation. To do this, <u>always align the visual axis</u> with the direction of the muscle by asking the patient to turn the eye in question <u>medially</u> first. Then, if they are asked to look up or down, the oblique muscles will work in isolation to <u>elevate (inf. oblique)</u> or <u>depress (sup. oblique)</u> the eye.

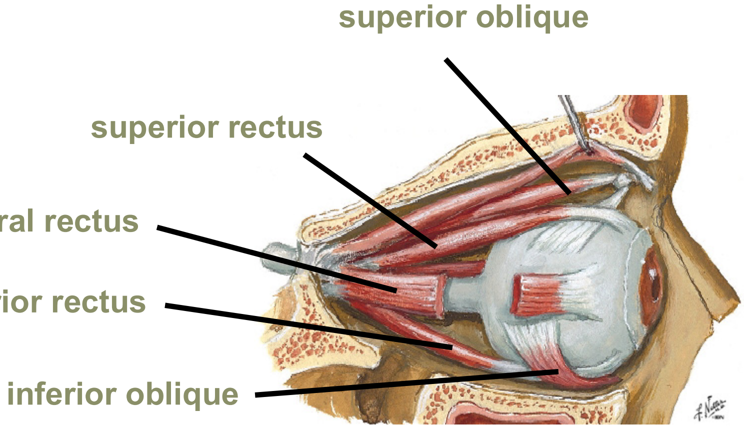


Nerve supply to the extraocular muscles
The oculomotor nerve (CNIII) carries motor innervation to the levator palpebrae superioris and inferior oblique as well as the superior, medial and inferior recti muscles.

It also carries parasympathetic supply to the ciliary muscle to adjust the lens for near vision (accommodation) and to the sphincter pupillae for pupil constriction. The trochlear nerve (CNIV) supplies the superior oblique muscle. The abducent nerve (CNVI) supplies the lateral rectus muscle.

Although you do not need to describe the precise course of these nerves, you should be aware that these nerves exit the brainstem in close proximity to a number of arterial branches, where they may be compressed by an aneurysm. Before entering the orbit through the superior orbital fissure, all three of these nerves pass through the cavernous sinus, along with the ophthalmic branch of the trigeminal nerve. Use the prosections to appreciate these points.





It is important to note that all the extraocular muscles are continuously involved in the movement of the eye and as such actions made by individual muscles are not tested clinically.

The action of which muscles of the left eye would you therefore be testing if you asked a patient to look up and to the right?

How would you test for a suspected lesion to the right abducens nerve and what would you expect to find?

Autonomic Supply

The autonomic nervous system is concerned with innervation to smooth muscles under involuntary control. In the eye and orbit this system acts predominantly on the pupil, the ciliary muscle (for lens adaptation) and the lacrimal gland.

The sympathetic nervous system is associated with "fight or flight responses" and the parasympathetic nervous system is associated with "rest and digest". These systems will be discussed separately.

Sympathetic nervous system
Sympathetic innervation of the eye stimulates the dilator muscle of the pupil and also opens the eyelid to allow more light in and enable better vision in dark, scary situations (fight or flight). It also inhibits the parasympathetic supply to the ciliary muscle, relaxing this muscle and allowing the lens to focus in the distance.

The sympathetic nervous system exits the central nervous system in the spinal cord levels T1-L2 (thoracolumbar). In order to innervate the structures in the head, nerve fibres from these levels will travel up the sympathetic chain (recall your notes from your first year dissection) to the superior cervical ganglion where they synapse. This ganglion lies in the neck (C2-C3) and is closely related to the internal carotid artery. Postganglionic fibres travel as a plexus (network) of nerves that travel with the arteries of the head and neck. To reach the eye they will travel with the branches of the nasociliary nerve (branch of CNVI) along with the sensory fibres.

Parasympathetic nervous system
When considering the parasympathetic supply, “rest and digest” is commonly used to remember the actions eg. in the gut.

In order to “rest” your eyes, your pupil constricts to let less light in, and when “digesting” your anatomy textbook, you need to stimulate the ciliary muscle to focus the lens on short distances (*accommodation*).

Parasympathetic nerves to these structures travel within the oculomotor nerve and synapse in the ciliary ganglion located within the orbit. Postganglionic fibres are carried in the short ciliary nerves into the eye.

On your dissection, you should locate the oculomotor nerve, the long and short ciliary nerves, and the small ciliary ganglion.

Additionally, as is the case in the gut and salivary glands, the parasympathetic nerve system promotes lacrimal gland secretion. Tears are secreted by this gland (you will recall is in the supero-lateral orbital margin) and wash across the eye as you blink. They nourish and protect the front of the eye. As they wash across, tears are drained into the lacrimal sac in the infero-medial orbital margin, and then drain into the nasal cavity via the nasolacrimal duct (When you cry lots, you sniff lots).

The parasympathetic nerve supply to the lacrimal gland is complex. You need to appreciate that preganglionic fibres originate from the lacrimal nucleus which is part of the facial (CNVII) nucleus in the brainstem and that they synapse in the sphenopalatine ganglion.

You should locate the sphenopalatine fossa and its communication with the orbit through the inferior orbital fissure. The postganglionic fibres “hitch-hike” with branches from the maxillary nerve (CNV_2) to reach the terminal part of the lacrimal nerve (branch of CNV_1). Although you do not need to know any more detail than this, you may find it useful to discuss this with one of the demonstrators.

Checklist

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

Identified the skeleton that makes up the orbit
Distinguished the components of lacrimal apparatus and understood their function
Discriminated the branches of the ophthalmic division of CNV
Understood the structure, function and innervation of the extraocular muscles
Identified the main blood vessels of the orbit

BSMS MODULE: 202, NEUROSCIENCE AND BEHAVIOUR

DR SESSION:

3. TOPOGRAPHY OF THE HUMAN BRAIN

BSMS MODULE: 202, NEUROSCIENCE AND BEHAVIOUR
THEME: FUNDAMENTAL NEUROSCIENCE AND THE BRAIN

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 surface markings of the brain, including the inferior surface.

Superior and lateral surfaces of the brain

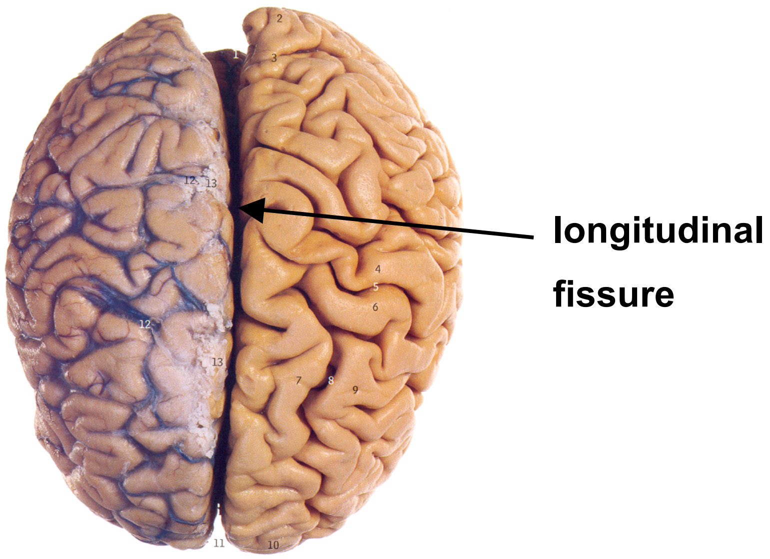
Identify the ***gyri*** (elevations) and ***sulci*** (grooves) of the cerebral hemispheres. Remind yourselves that the outer gray matter of the cerebral cortex has an underlying layer of white matter that connects the different regions of the brain.

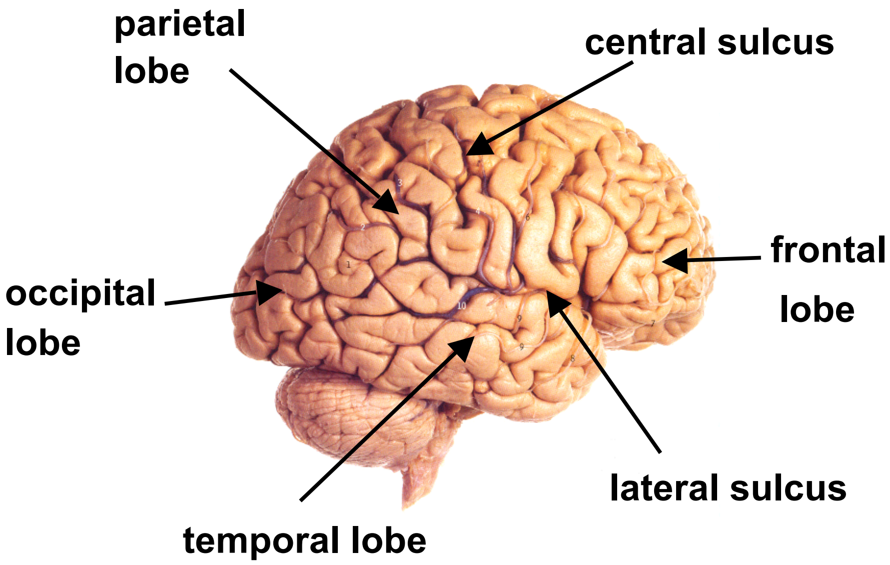
Using the figures below, locate the ***longitudinal fissure*** dividing the two hemispheres. Identify the ***frontal*** and **occipital poles** of the brain and the ***frontal, parietal, occipital*** and ***temporal lobes***. Much of the frontal lobe is concerned with motor function, and includes Broca's "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.

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

Why is the central sulcus so important?

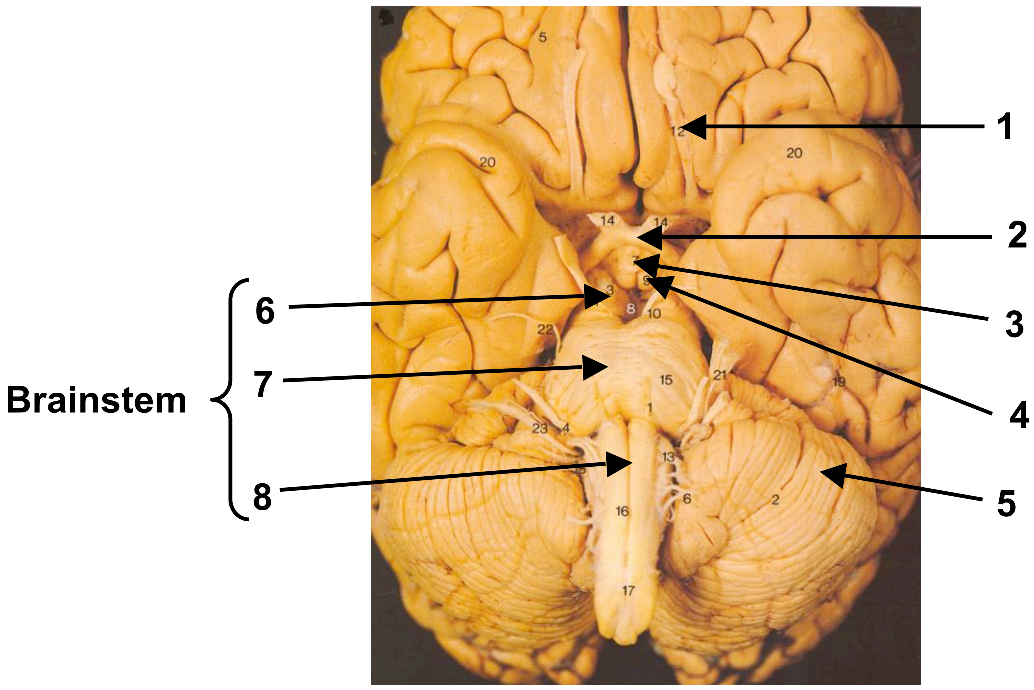
Identify the ***lateral sulcus***. Examine the lateral sulcus and note that an area of cortex called the ***insula*** lies deep to the sulcus and cannot be seen unless the lips of the sulcus are parted. Many functions have been attributed to the insula, including visceral control, taste and olfaction.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





Inferior surface of the brain

Once you have acquainted yourself with the superior and lateral aspects of the brain, turn the brain over and concentrate on the inferior surface. Using the figure below, identify each of the listed features:



1 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.

2 Optic chiasma
The ***optic chiasma*** 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.

3 Pituitary stalk
This is also known as the ***infundibulum*** and is continuous with the ***pituitary gland***. This endocrine gland is about the size of a pea.

4 Mammillary bodies
These are two small bodies lying posterior to the pituitary stalk. The ***mammillary bodies*** are part of the limbic system of the brain, which is involved with the control of emotion, behaviour and drive. They are also important in memory.

5 Cerebellum
The cerebellum is covered superiorly by the ***tentorium cerebelli***, an extension of dura. It is the largest part of the hindbrain and sits posterior to the ***IVth ventricle, pons*** and ***medulla***. It consists of two lateral ***hemispheres*** connected by the ***vermis*** in the midline. The cerebellum is divided into three ***lobes***. It is composed of an outer covering of gray matter, the cortex, and inner white matter. Embedded in the white matter are four paired nuclei. 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 to regulate coordination and motor control, including eye movements.

Brainstem

The brainstem comprises the ***midbrain***, ***pons*** and ***medulla***. The nuclei of many of the cranial nerves are situated within the brainstem. There are also important nuclei concerned with autonomic, motor, sensory and behavioural functions. All of the descending and ascending tracts between the brain and spinal cord pass through the brainstem.

6 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. Note the ***oculomotor (III) nerve*** arising from the superior border of the anterior midbrain. The ***trochlear (IV) nerve***, which exits from the posterior surface of the pons, and can be seen passing anteriorly over the midbrain.

7 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, medial to the middle cerebellar peduncles. Between the pons and medulla, emerge the ***abducens (VI), facial (VII)*** and ***vestibulocochlear (VIII) nerves***.

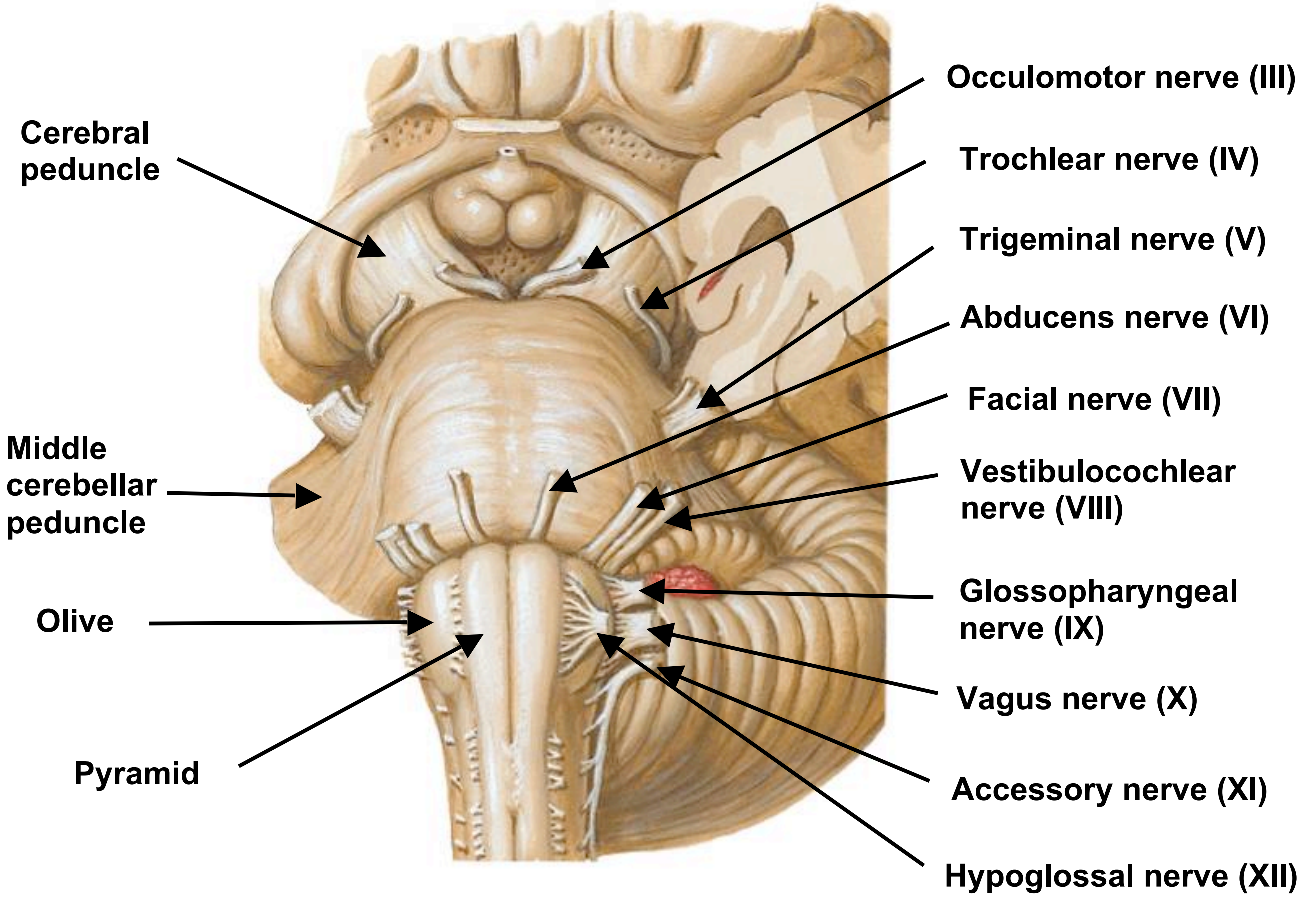
8 Medulla

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.

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***. Between the olives and these peduncles, emerge the ***glossopharyngeal (IX), vagus (X)*** and the cranial root of the ***accessory (XI) nerve***. The ***hypoglossal (XII) nerve*** emerges between the pyramid and olive on either side.

The following figure should be used to locate some of the cranial nerves as they exit from the brainstem:



Workstation 2

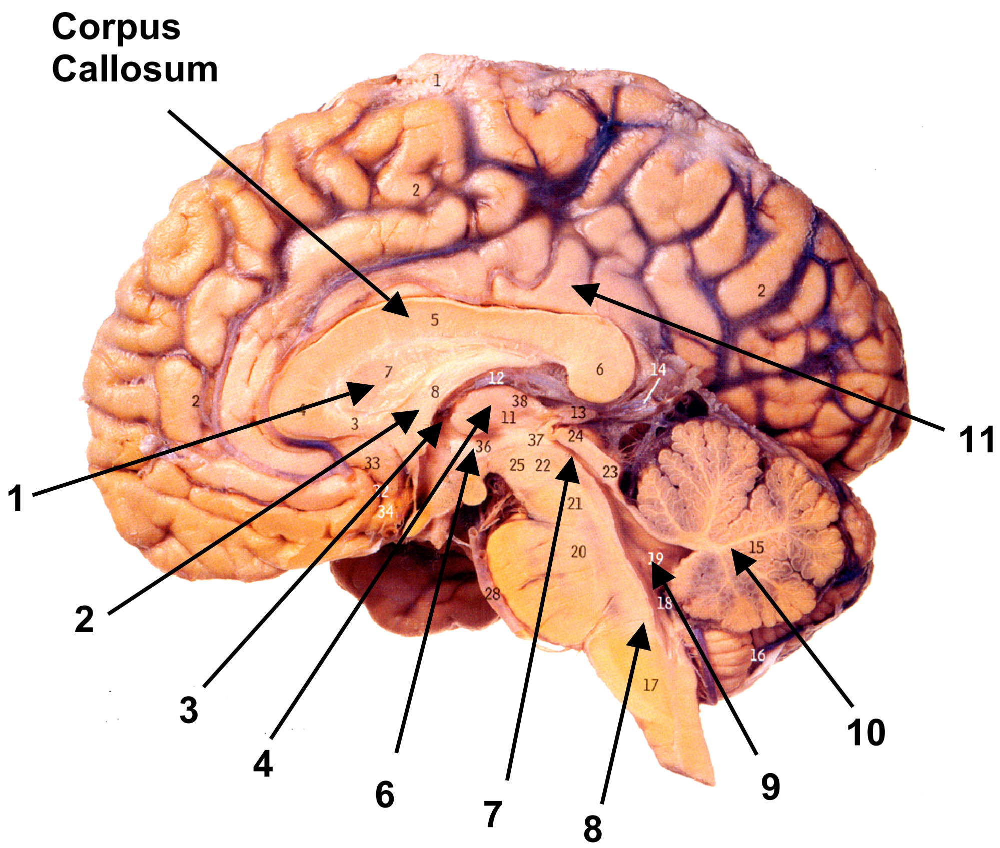
In this workstation you will examine the medial structures of the brain.

Mid-sagittal section

A mid-sagittal incision has been performed, separating the two cerebral hemispheres. A prominent feature is the mass of white matter, the ***corpus callosum***. The posterior part of the corpus callosum is called the splenium.

What is the function of the corpus callosum?

Using the diagram below, examine the main structures on the medial surface of the brain.



1 Septum pellucidum
This is a thin sheet of nervous tissue that contains both white and gray matter stretching between the ***fornix*** and the ***corpus callosum***. It forms a partition between the ***anterior horns of the lateral ventricles***.

2 Fornix
This structure is related to the roof of the third ventricle and consists of myelinated fibres, many of which terminate in the mammillary bodies. It is one of the connecting pathways associated with the limbic system.

3 Interventricular foramen
The communication between the ***lateral*** and ***third ventricles***.

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

4 Thalamus
This large mass of gray matter is functionally very important, serving as a relay station for all the main sensory systems (apart from the olfactory pathway). The lateral surface of the thalamus is separated from the ***lentiform nucleus*** (part of the basal ganglia) by the very important ***internal capsule***. The internal capsule consists of fibres passing between the cortex, thalamus and brainstem.

5 Third ventricle (not marked on figure)
This ventricle is very narrow and is found between the two thalami. It communicates with the lateral ventricles through the interventricular foramen and posteriorly with the fourth ventricle via the ***cerebral aqueduct***.

6 Hypothalamus
This region extends from the optic chiasma to the mammillary bodies and lies below the thalamus. It forms the floor of the third ventricle. 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.

7 Midbrain
Look at the posterior surface of the midbrain and observe the **four colliculi** (2 small protrusions on each side). The paired ***superior colliculi*** belong to the visual system and are linked to the regulation of eye movements, whereas the paired ***inferior colliculi*** are part of the auditory system. Below the inferior colliculi, the **trochlear (IV) nerve** can be seen. Through the centre of the midbrain is the ***cerebral aqueduct***, which connects the third and fourth ventricles.

8 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. These fibres are involved in proprioception.

9 The fourth ventricle
This ventricle is diamond-shaped and is found between the pons and cerebellum. It communicates with the third ventricle through the cerebral aqueduct and is continuous with the subarachnoid space of the spinal cord.

10 The arbor vitae of the cerebellar hemispheres
Note 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.

11 Cingulate gyrus
The ***cingulate gyrus*** forms part of the limbic system (see Workstation 3 notes).

Workstation 3

In this workstation you will examine both horizontal and coronal sections through the brain. This will involve an examination of the basal ganglia.

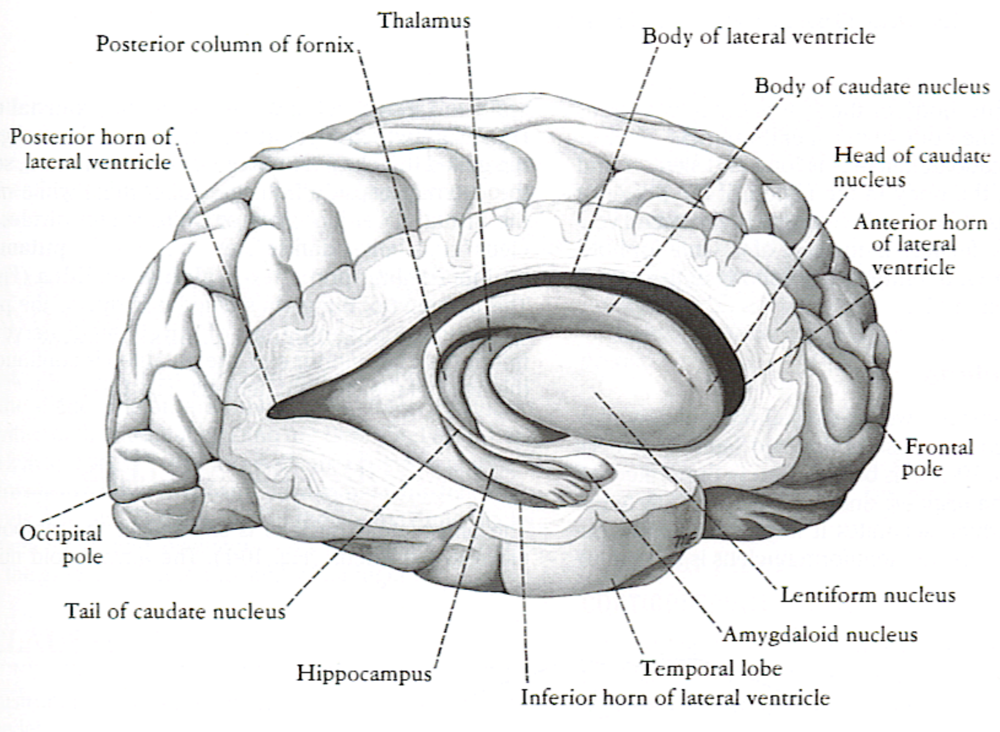
Examination of the basal ganglia

The ***basal ganglia*** refers to a group of interconnected nuclei at the base of the cerebral hemispheres. Anatomically, the basal ganglia includes the ***caudate nucleus*** and the ***lentiform nucleus***. Collectively, these interconnected structures are referred to as the ***corpus striatum***, and are located lateral to the thalamus. The basal ganglia play a very important part in the control of posture and voluntary movement. The interconnections of the basal ganglia are very complex – the account given here represents the basic structures involved in the system.

The ***caudate nucleus*** is a large C-shaped mass of gray matter that follows the contours of the lateral ventricle. It is said to have 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 ***amygdaloid nucleus***.

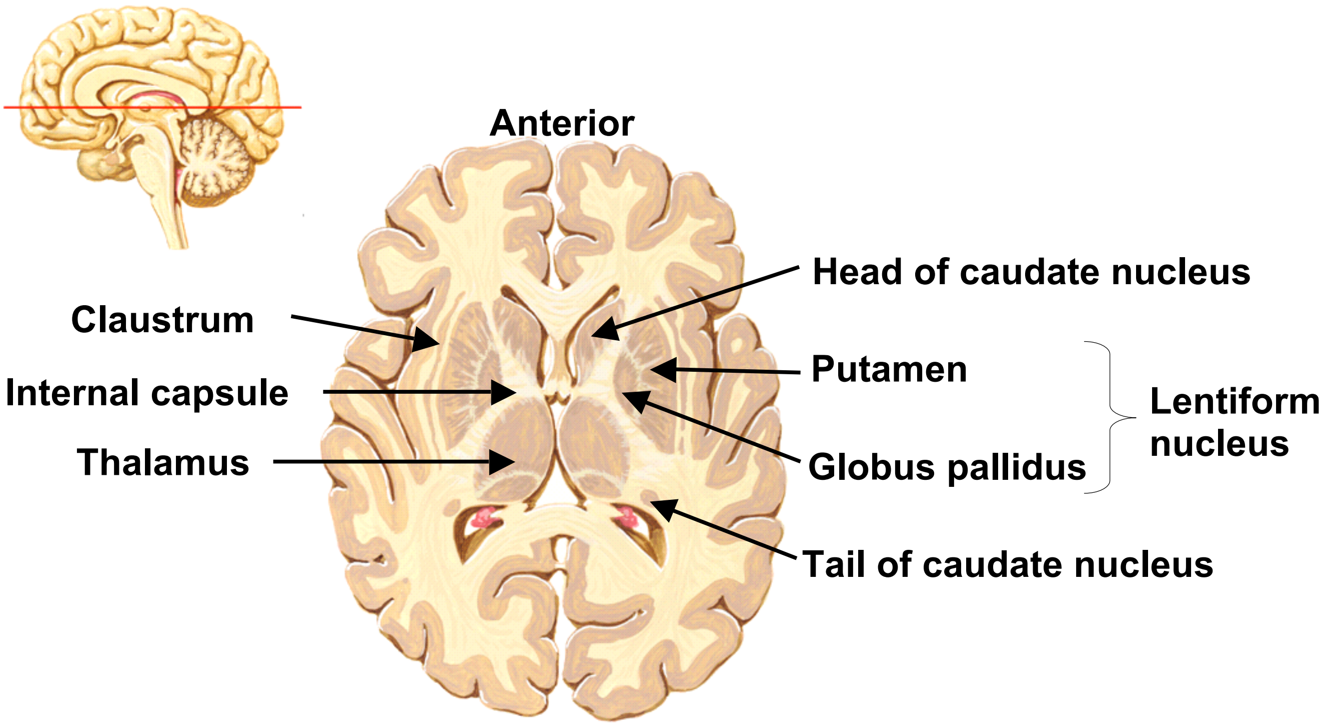
The lens-shaped ***lentiform nucleus*** lies lateral to the caudate nucleus. It is separated from the thalamus and caudate nucleus by fibres of the ***internal capsule***, which link the cortex with the thalamus and brainstem. The lentiform nucleus is divided into two regions – the ***putamen*** (outer region) and the ***globus pallidus*** (inner region).

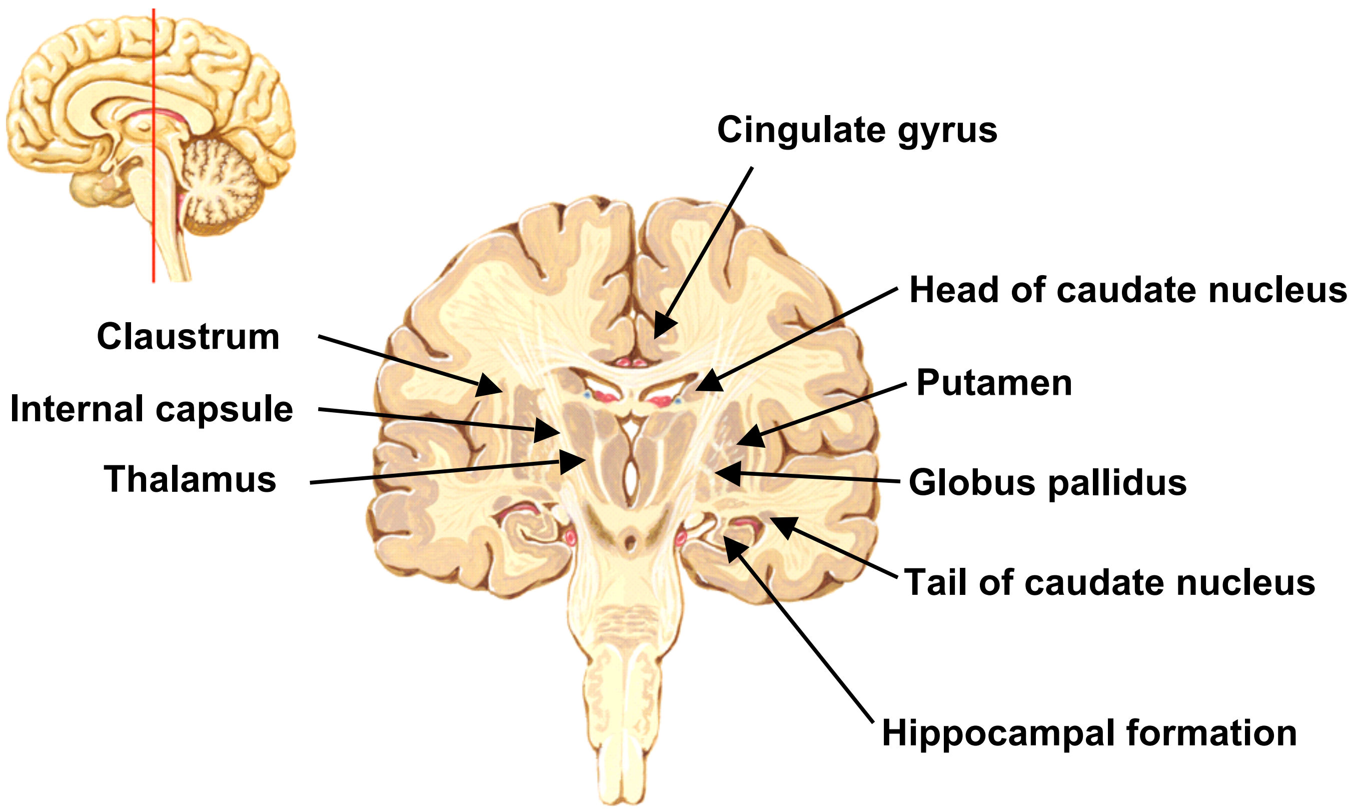
The corpus striatum is shown in the figure below:



Lateral to the putamen is a thin sheet of gray matter called the ***claustrum***. This is separated from the putamen by fibres of the ***external capsule***. Lateral to the claustrum is the insula.

Using the figures below, try to identify the main components of the corpus striatum. Make sure that you can also locate the ***anterior***, ***posterior*** and ***inferior horn*** of the ***lateral ventricle***.





Examination of the Limbic System

The **limbic system** is important in the control of emotion, drive and behaviour, and also the control of memory. The main components of the limbic system are the ***hippocampal formation*** (includes the hippocampus), the ***amygdala*** and the ***cingulate gyrus***. From the figures above, try to identify some of these structures.

THIS COMPLETES THE SESSION ON EXAMINATION OF THE BRAIN AND BRAIN SLICES. BE AWARE THAT IN THIS PRACTICAL WE HAVE MERELY INTRODUCED YOU TO MANY OF THE COMPLEX STRUCTURES OF THE BRAIN. OVER THE NEXT FEW WEEKS YOU WILL UTILISE THE KNOWLEDGE YOU HAVE GAINED HERE TO BEGIN TO UNDERSTAND HOW ALL THESE STRUCTURES ACT AND INTERACT FUNCTIONALLY AND THE CONSEQUENCE OF MALFUNCTION OF THE VARIOUS STRUCTURES TO THE PATIENT.

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 central and lateral sulci of the brain and understood their significance

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

BSMS MODULE: 202, NEUROSCIENCE AND BEHAVIOUR

DR SESSION:

4. EXAMINATION OF THE MUSCLES OF MASTICATION AND THE TRIGEMINAL NERVE

brighton and sussex
medical school

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

DR SESSION: **4. EXAMINATION OF THE MUSCLES OF MASTICATION AND THE TRIGEMINAL NERVE**

LEARNING OUTCOMES

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

1. Identify the muscles of mastication
2. Discriminate the boundaries of the temporal and infratemporal fossa
3. Identify the major contents of infratemporal fossa
4. Understand the spatial and functional relationship of the structures within the infratemporal fossa

In this practical session you will study the anatomy of the **muscles of mastication** and the contents of the **infratemporal fossa** including relations with the trigeminal nerve. For this session you will be performing much of the dissection and will work on a cadaveric head that has already been bisected for you by the demonstrators. In addition you will be able to examine a number of prosected specimens as well as the anatomical models available within the dissecting room. As with all your other practical sessions in the dissecting room make sure you work through this handout, answer the questions and complete the checklist.

Removal of the skin and parotid gland

In order to examine the muscles of mastication and the infratemporal fossa it will be necessary to remove much of the facial skin and also at least part of the **parotid gland**.

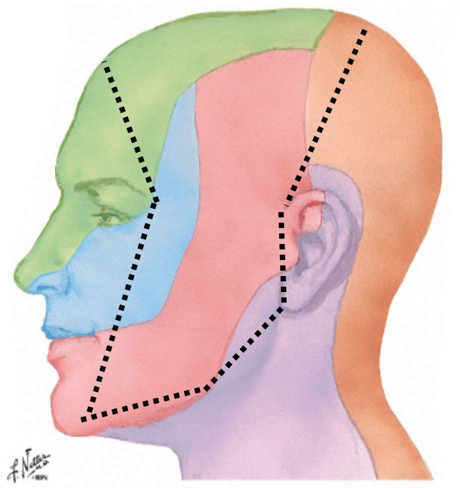
Follow the lines of incision shown in the figure below and make sure that in each case the cuts are made **superficially**. Where possible try to avoid damaging major vessels e.g. the **facial artery** (visible at the margin of the mandible) and main nerve branches. As you remove the skin you should reveal the superficial and delicate **muscles of facial expression**, which are innervated by the facial nerve. We will not concentrate on these muscles at this stage, but have a think about why they are referred to as muscles of facial expression. Removal of the skin from the parotid region may prove a little trickier due to the tough nature of the fascial covering of the parotid gland. As you uncover the gland you should be able to make out some of the main branches of the facial nerve – there are five. Next you should remove the parotid gland to allow access to the deeper structures. If possible retain some of the branches of the facial nerve.

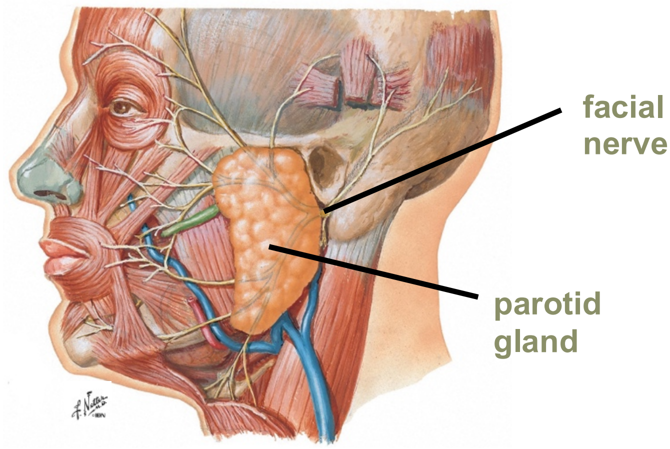
Facial Nerve

The facial nerve has two roots, a large motor root and a smaller nervus intermedius that consists of both sensory and parasympathetic fibres. Both roots arise at the cerebellopontine angle and pass with the vestibulocochlear (CN VIII) nerve and the labyrinthine artery into the internal acoustic meatus. Both roots of the nerve traverse the petrous temporal bone in the facial canal. Within the temporal bone a number of small branches arise from the facial nerve. Some of these pass anteriorly to supply the pteryopalatine ganglion; postganglionic fibres are distributed to the lacrimal gland (through the lacrimal branch of the ophtalmic nerve) and to the glands and mucous membranes of the nasal cavity and palate. The sensory root is finally distributed as the chorda tympani nerve which supplies taste to the anterior 2/3rds of the tongue and conveys parasympathetic fibres to the submandibular ganglion (see DR Session 5).

The motor root of the facial nerve gives a branch to the stapedius muscle before passing out of the skull via the stylomastoid foramen. It sweeps laterally and forward, gives branches to the posterior belly of digastric and to the stylohyoid muscle before entering the parotid gland. Within the gland the nerve divides into five terminal branches to supply the muscles of the face and scalp. From superior to inferior the branches are, **temporal, zygomatic, buccal, mandibular and cervical**. Locate these on your cadaver.

Because of its long and complex course through the temporal bone, the facial nerve is susceptible to damage by infections and surgical procedures in the middle ear. A facial palsy of unknown origin is usually termed Bell's palsy. Such a palsy can occur in neonates if they are delivered by forceps which compress the nerve. In the newborn the mastoid is undeveloped and the facial nerve is especially superficial and vulnerable.





Skin sensation of the face is supplied entirely by the three divisions of the trigeminal nerve (excepting the angle of the jaw). Using your knowledge of the skull foramina, where would you expect to see the following nerves emerging on to the face: the infra-orbital nerve, the zygomaticofacial nerve and the mental nerve.

From which trigeminal division do these branches arise?

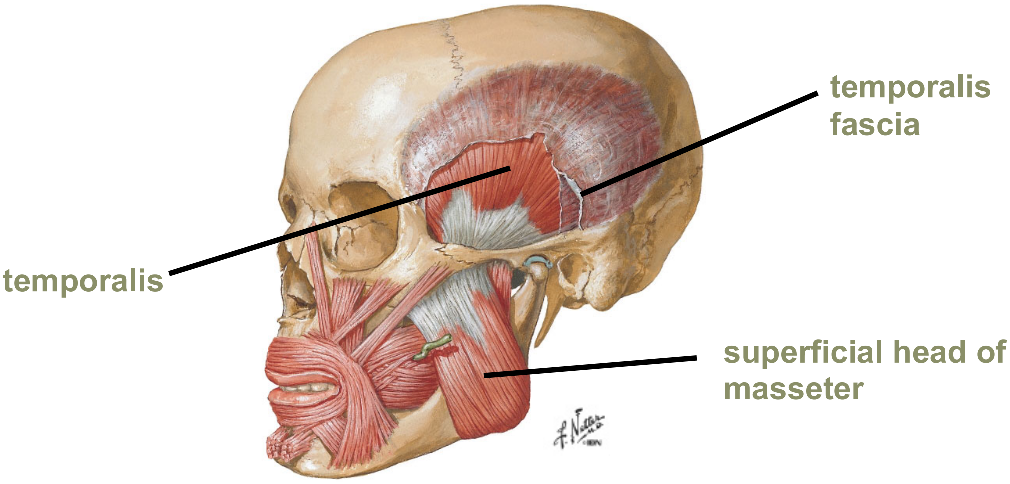
Examination of the temporalis and masseter muscles

Examine the region containing the **temporalis muscle**. Carefully remove the strong fascia that covers the muscle to expose the full extent of the muscle. In most cases as the calvaria was removed for an earlier dissection some of the muscle will be missing. The temporalis muscle is a fan shaped muscle that fills the **temporal fossa** and contains fibres that run in different orientations accounting for its different actions. Follow the temporalis muscle from its origin on the temporal bone to its insertion on the edge and medial surface of the **coronoid process** of the mandible and along the edge of the **ramus** of the mandible. Note that the insertion is very tendonous. Whilst in this region, observe the course and distribution of the superficial temporal vessels.

From which artery is the superficial temporal artery a branch?

The **masseter muscle**, like the temporalis is a muscle of mastication. Note the origin of the masseter on the zygomatic bone (superficial part) and **zygomatic arch** (deep part) and its multiple insertions onto the lateral surface of the ramus. Make a cut along the superior aspect of masseter to reflect it.

What is the innervation and action of temporalis and masseter?



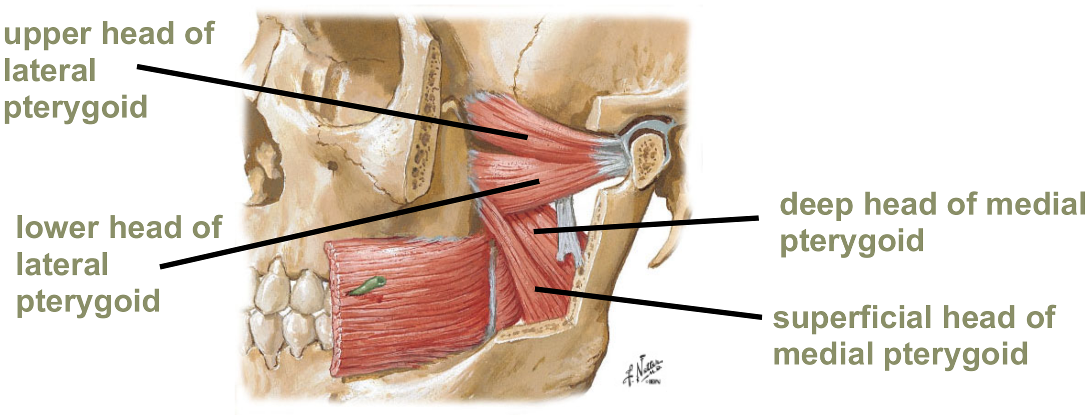
Examination of the Infratemporal fossa and the pterygoid muscles

In order to continue the examination of the muscles of mastication it is necessary to expose the **infratemporal fossa**. This is a difficult and time consuming dissection. Hence the next section requires detailed examination of the instructor body and the prosections.

The infratemporal fossa is a wedge-shaped cavity that lies inferior to the temporal fossa and between the ramus of the mandible and the wall of the pharynx. The fossa contains many structures and features and it is impossible to cover these all in part of one session, therefore this handout directs you to some of the most important aspects. The infratemporal fossa contains three muscles of mastication - the lower part of temporalis, and the lateral and medial pterygoid muscles, the maxillary artery and its branches, the pterygoid venous plexus, the mandibular and chorda tympani nerves and the otic ganglion. To demonstrate the infratemporal fossa a section through the zygomatic arch has been removed. A section of the mandible has also been removed. Begin by examining where the zygomatic arch was and where the remaining parts of the mandible are.

The **medial** and **lateral pterygoid** muscles are the other muscles of mastication. The medial pterygoid has two heads with the deep head taking origin at the medial surface of the **lateral pterygoid plate** of the sphenoid bone and the superficial head arising from the maxilla. Both heads insert at the angle of the mandible (try using a skull as an aid to understanding these attachments) and enable elevation and side-to-side movement of the mandible. The lateral pterygoid also has two heads. The upper head is not easy to see and arises on in the roof of the fossa, whilst the lower head is more visible and you should find it originating from the lateral surface of the lateral pterygoid plate. Both heads insert into the neck of the mandible and the capsule of the **temporomandibular joint.**

What makes the lateral pterygoid muscle different from the other muscles of mastication?



Examination of the mandibular branch of trigeminal and maxillary artery

The mandibular (branch of trigeminal) nerve has a large sensory and a small motor root. It supplies the skin in the temporal region, part of the auricle (including the external auditory meatus and the tympanic membrane), the lower lip, the lower part of the face, the lower teeth and gums, the mucosa of the anterior two thirds of the tongue and the mucosa of the floor of the mouth. One of the sensory branches (auriculotemporal nerve) conveys postganglionic parasympathetic fibres from the otic ganglion to the parotid gland. The motor root of the mandibular nerve passes with the sensory root out of the posterior cranial fossa via the foramen ovale. The motor root supplies the muscles of the first pharyngeal arch, extensively concerned with mastication. The mandibular nerve and its branches are intimately related to the structures found within the infratemporal fossa.

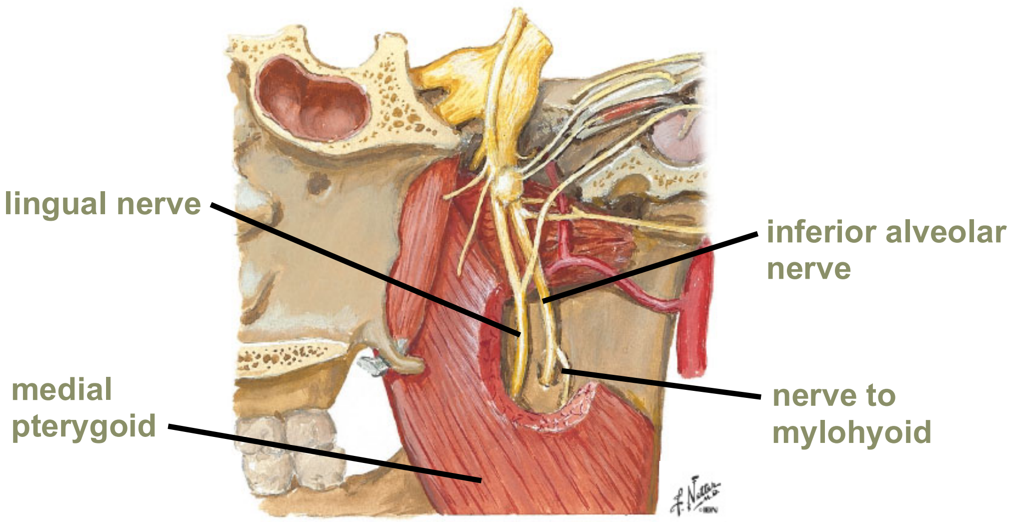
As the mandibular nerve enters the infratemporal fossa through the foramen ovale, it is attached to the **otic ganglion**. The nerve supplies the medial and lateral pterygoids, tensor palatini, temporalis and masseter. It has a sensory branch the buccal nerve which supplies the cheek not the buccanator muscle.

From the **mandibular nerve** the **auriculotemporal** branch passes around the middle meningeal artery to supply the external acoustic meatus, tympanic membrane and skin over the temple; it also carries parasympathetic fibres. The remainder of the posterior division of the mandibular nerve divides into the **lingual and inferior alveolar nerves**.

The **lingual nerve** is joined by the **chorda tympani** (branch of facial nerve) as it crosses the medial pterygoid and passes into the floor of the mouth. The **inferior alveolar nerve** gives off a small motor branch to the mylohyoid muscle and continues as a sensory nerve. It enters the mandibular foramen on the medial aspect of the mandible and runs in the mandibular canal to supply the lower teeth. The terminal portion emerges at the mental foramen to supply the lower lip and chin.

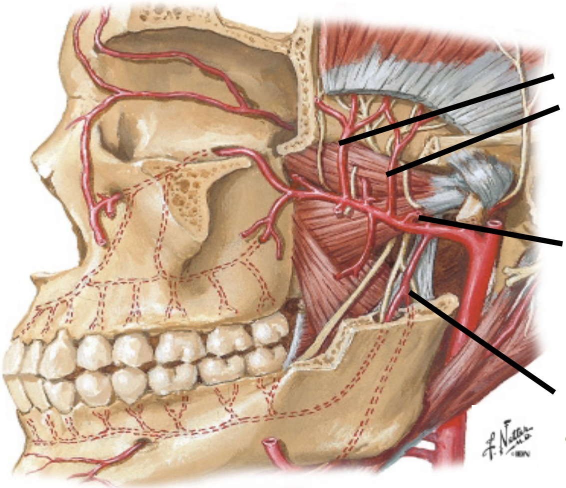
Examine some of the main branches of the the **mandibular nerve** (CNV_3) as it descends from the location of the foramen ovale.

Why does the inferior alveolar nerve enter the mandibular foramen?



The **maxillary artery** is the largest branch of the **external carotid artery** and should be clearly evident within the infratemporal fossa. The maxillary artery originates in the substance of the parotid gland (which you have largely dissected away) and passes deep to the neck of the mandible and gives off a number of branches in the fossa. One of the most important branches of the maxillary artery clinically is the **middle meningeal artery**. This passes deep to the lateral pterygoid, between the roots of the auriculotemporal nerve to enter the skull via the foramen spinosum. Identify the middle meningeal artery. In the specimens see if you can also identify the **inferior alveolar artery**, which runs inferiorly along with its nerve to the mandibular canal. Like the nerve the inferior alveolar artery also gives off a small mylohyoid branch.

The venous drainage of this area is through a dense pterygoid plexus around the pterygoid muscles. Veins corresponding to the branches of the maxillary artery open into this plexus which is drained by a maxillary vein. The pterygoid plexus communicates with the cavernous sinus and with the facial vein. The communications between intra and extra cranial veins can allow infections to spread into the cranial cavity.



What four main movements can the mandible make?

Checklist

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

Identified the muscles of mastication

Discriminated the boundaries of the infratemporal fossa

Identified the major contents of the infratemporal fossa

Understood the spatial and functional relationship of structures within the infratemporal fossa

BSMS MODULE: 202, NEUROSCIENCE AND BEHAVIOUR

DR SESSION:

5. EXAMINATION OF THE PARANASAL SINUSES, FLOOR OF THE MOUTH AND NECK.

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

DR SESSION: 5. EXAMINATION OF THE PARANASAL SINUSES, FLOOR OF THE MOUTH AND NECK.

LEARNING OUTCOMES

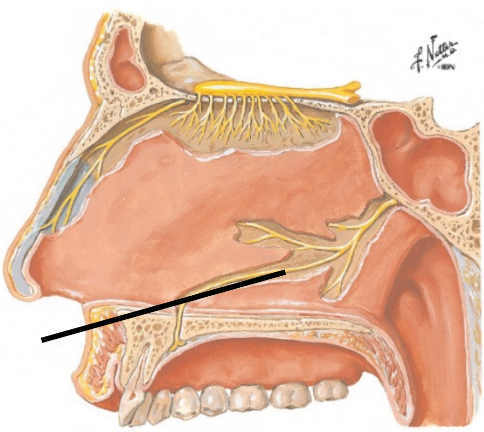
By the end of the module students should be able to

1. Distinguish the skeletal and nervous components of the nasal septum
2. Discriminate the structural and functional components of the lateral wall of the nose
3. Identify the location and structure of the paranasal sinuses
4. Understand the concept of the pterygopalatine ganglion
5. Identify the musculature of the floor of the mouth
6. Distinguish the components of the tongue and associated innervation and blood supply
7. Identify the strap muscles of the neck and understand their innervation
8. Locate the main neurovascular structures that traverse the neck
9. Locate the main structures of the larynx and pharynx.

In this practical session you will study the anatomy of the paranasal sinuses and the floor of the mouth. You will come across a number of different cranial nerves in this sessions, some of which we have not seen before. For this session you will be performing much of the dissection and will work on a cadaveric head that has already been bisected for you by the demonstrators and you used in the last session. In addition you will be able to examine a number of prosected specimens as well as the anatomical models available within the dissecting room. As with all your other practical sessions in the dissecting room make sure you work through this handout, answer the questions and complete the checklist.

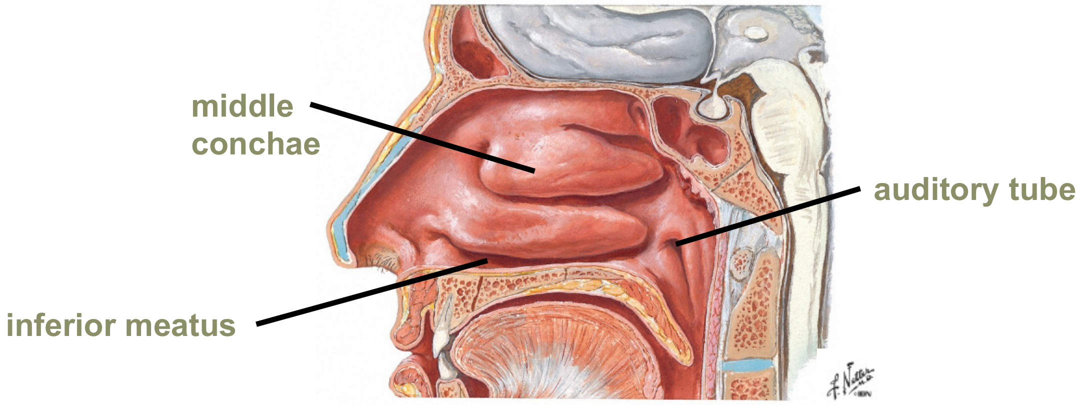
Examination of the nasal septum and lateral wall of the nose

Bisection of the cadaveric heads allows for an examination of the nasal septum and the lateral wall of the nose to be made. The sawcut has been made approximately 2-3 mm off the midline so that one side should have the **nasal septum** intact. If your head does not have the nasal septum in place, work with a neighbouring group or examine the prosections. Remove the mucous membrane covering the nasal septum and search for the **nasopalatine nerve,** which runs anteriorly and inferiorly. The septum itself consists of cartilage anteriorly and mainly the **vomer and ethmoid** bones posteriorly, although the **maxilla, nasal and palatine** bones also make small contributions.



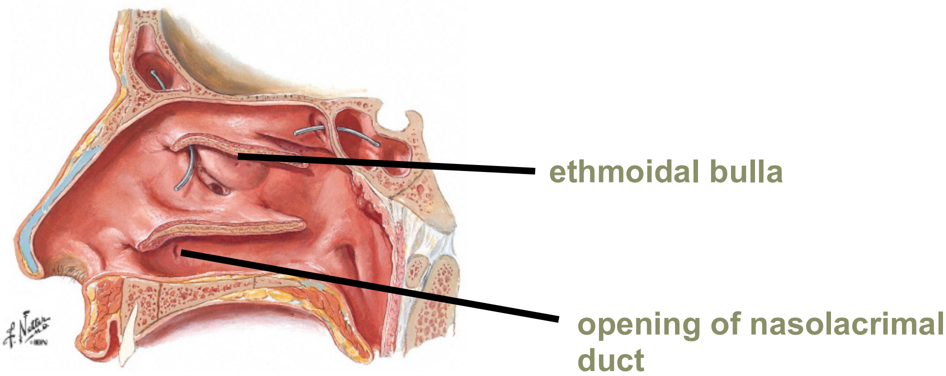
From which cranial nerve is the nasopalatine nerve a branch and what does it supply?

Next remove the nasal septum by making cuts along the superior and inferior attachments using a sharp scalpel blade and examine the lateral wall of the nose. Start by identifying the **vestibule** of the nose immediately above the nostril. The vestibule leads posteriorly into the larger **atrium** of the nose. Posterior to the atrium are three longitudinally running bony shelves – the **conchae** or **turbinate** bones. Identify the superior, middle and inferior conchae and the spaces that lie inferior to each one. These spaces or grooves are known as the **meatus**.



What purpose do the conchae serve?

Underlying the anterior lip of the inferior conchae is the opening to the nasolacrimal duct, which drains lacrimal fluid from the conjunctival sac of the eye into the nasal cavity (you met this in an earlier session). Carefully cut off the inferior concha to expose the opening and insert a probe into the opening (see diagram below) so that you can note the direction that the duct takes as it passes towards the orbit. Next remove the middle concha, under which is the opening to a number of the **paranasal sinuses**, which we will examine shortly. Immediately inferior to the attachment of the middle conchae the lateral wall elevates to form the dome-like **ethmoidal bulla** (see diagram). The 'bulging' of the underlying middle ethmoidal air cells creates the bulla. Inferior to the bulla is a curved groove known as the **hiatus semilunaris**, which forms a channel towards the frontal sinus and aids in mucus drainage. By removing the overlying mucous membrane from the posterior parts of the inferior and middle meatus you may be able to see the palatine nerves running within the **greater palatine canal**.



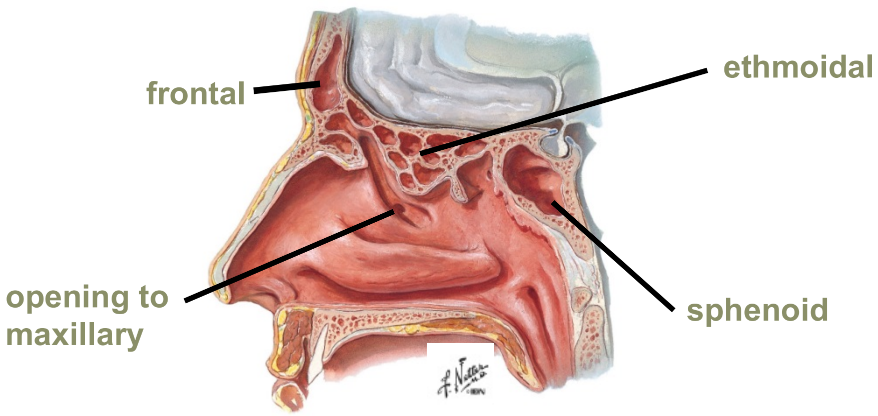
Examination of the paranasal sinuses

The **paranasal sinuses** are made up of the **frontal**, **sphenoidal** and **maxillary** sinuses and the **ethmoidal air cells**. Each sinus is lined by mucus secreting mucosa, has an opening into the nasal cavities and is innervated by branches of trigeminal. Firstly identify the frontal sinus, which lies within the frontal bone and drains onto the lateral wall of the middle meatus via the **frontonasal duct**.

Next examine the ethmoidal air cells, which are a cluster of small sinuses separated from each other and the also the orbit and nasal cavity by thin plates of bone. The individual chambers are divided into anterior, middle and posterior based on the aperture location. The sphenoid sinus lies within the body of the sphenoid bone with apertures on the anterior walls.

At the posterior end of the hiatus semilunaris you should identify the opening of the maxillary sinus. Insert a probe through this opening and you should be able to determine whether the opening lies in the superior or inferior part of the medial wall of the sinus.

Why might this be important clinically?



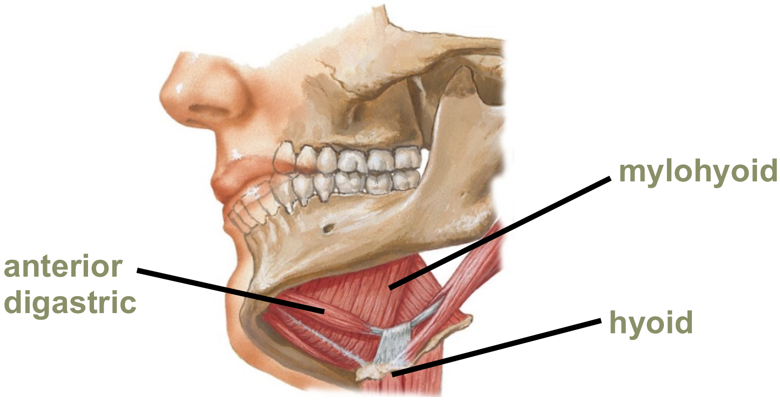
By breaking away the lateral wall of the nasal cavity from just in front of the **palatine canal** to the opening of the nasolacrimal duct you can expose the extent of the maxillary sinus, which fills the body of the maxilla. Despite the cavity being rather dark, you may be able to make out the infra-orbital nerve running within the **infraorbital groove** of the lateral wall of the sinus. The nerve also communicates with the pterygopalatine ganglion, one of the four main parasympathetic ganglia in the head.

Based on their location, which branch(es) of trigeminal do you think innervates the various paranasal sinuses?

Can you speculate as to the role(s) of the paranasal sinuses?

Examination of the floor of the mouth

If you haven't already removed the skin inferior to the mandible, do so now in order to expose the anterior belly of the **digastric muscle** (innervated by CN V3), which is attached to the mandible in the **digastric fossa** and has a fascial sling attachment to the **hyoid bone** (identify the hyoid bone on a skeleton). Cut the anterior digastric muscle at its mandibular attachment and reflect to examine the **mylohyoid muscle**. Two mylohyoid muscles form a muscular diaphragm that defines the inferior limit of the floor of the oral cavity. The mylohyoid muscles are attached to medial side of the mandible body, and run inferiorly to the midline where fibres join with those of the contralateral side in a **raphe**. The raphe extends posteriorly to the body of the hyoid.



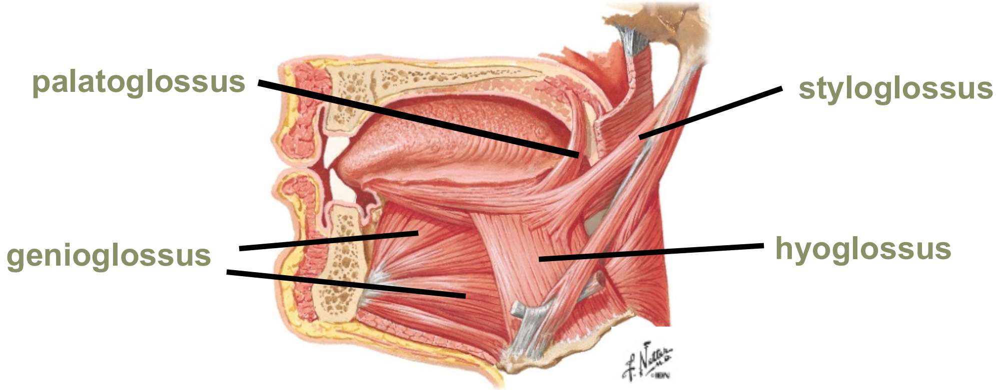
What is the innervation of the mylohyoid muscles and what is their action?

Reflect the mylohyoid towards the mandible and examine one of the paired **geniohyoid muscles** that lie on either side of the midline and run from the **mandibular symphysis** to the body of the hyoid (try using a skull to see these attachment sites). The geniohyoid muscles main role is to pull the hyoid and larynx superiorly and anteriorly during swallowing.

What is the innervation of the geniohyoid muscles?

Examination of the tongue

The tongue is a muscular structure that sits in the floor of the mouth. The tongue is divided in the midline by a septum, which means all the muscles of the tongue are paired. The extrinsic muscles have origins outside the tongue and insert into it. The four extrinsic muscles are the **genioglossus**, **hyoglossus**, **styloglossus** and **palatoglossus**. You will easily be able to identify genioglossus on the medial surface of your bisected head as it is the large fan shaped muscle that makes up a great deal of the bulk of the muscle. Genioglossus muscle fibres originate immediately superior to the origin of geniohyoid and run into the tongue where they blend with the intrinsic muscles. Genioglossus is innervated by the hypoglossal nerve.



It may be rather difficult to find hyoglossus, a thin quadrangular muscle, but try and locate it by reflecting the mylohyoid muscle and submandibular gland. This hypoglossal innervated muscle originates from the hyoid bone, blends into the tongue and is involved with depression of the tongue. Hyoglossus is a key landmark in the floor of the mouth as the lingual artery enters the tongue deep to hyoglossus and the hypoglossal and lingual nerves enter the tongue on the external surface of the hyoglossus. Styloglossus may be difficult to see clearly in your dissection. It takes its origin on the styloid process (use a skull to identify this structure and examine the prosections) and runs inferiorly and medially between the constrictor muscles of the pharynx to enter the lateral surface of the tongue.

How would you test for hypoglossal nerve damage?

The palatoglossus originates from the aponeurosis of the soft palate and passes anteriorly and inferiorly to the tongue. It is innervated by cranial accessory nerve (CN XI) fibres carried on the vagus nerve (CN X). It is really a muscle of the soft palate!

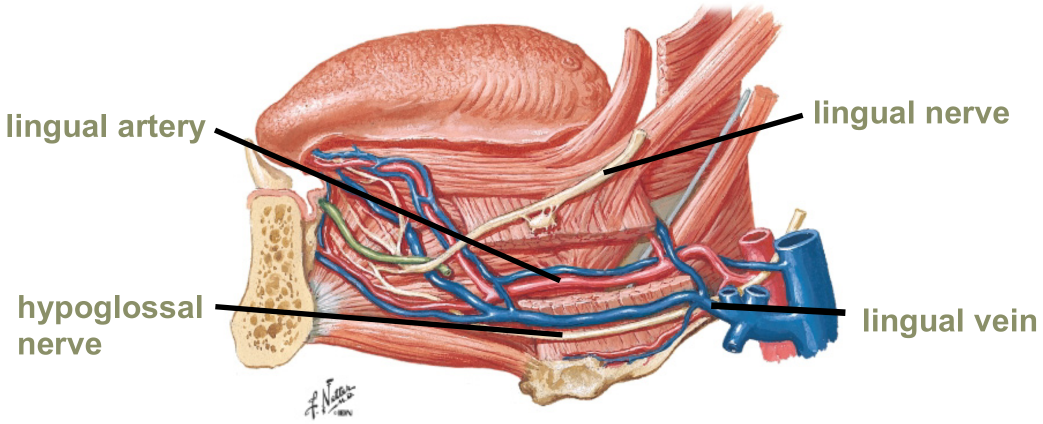
What is action of the styloglossus and palatoglossus muscles?

Unlike the extrinsic muscles of the tongue, the intrinsic muscles are less visible mainly because they originate and insert in the substance of the tongue. The muscles are the **superior** and **inferior longitudinal** muscles and the **transverse** and **vertical** muscles. These muscles act together to alter the shape of the tongue by changing the length, curling the edges and rounding and flattening the surface.

Apart from eating and swallowing, why are precision movements of the tongue required?

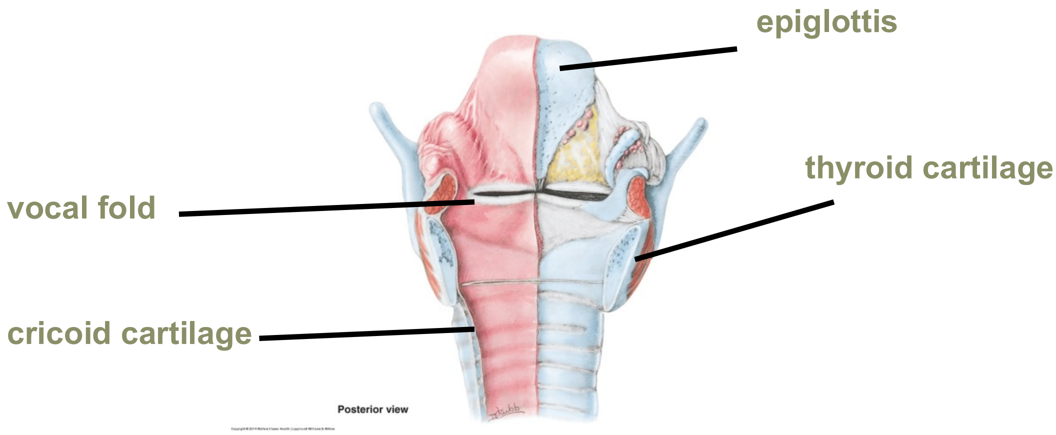
In addition to the musculature of the tongue you should examine some of the major vessels and nerves that are present within this region. Some of these structures are situated deep within the tongue and may not be readily visible and may require further dissection. The major artery of the tongue is the **lingual artery**, which originates from the external carotid artery. It travels anteriorly from an inferior position between the hyoglossus and genioglossus muscles to the apex of the tongue. Drainage of blood from the tongue is achieved via the **lingual vein** and its tributaries.

The innervation of the tongue is quite complex and involves five cranial nerves. Apart from the hypoglossal and accessory (using the vagus nerve) nerves there is the **lingual nerve** (CV V3). If you are able to reflect the mandible away from the lateral surface of the oral region you will notice how the lingual nerve loops under the submandibular duct and ascends into the tongue. The lingual nerve is responsible for general sensation in the oral part of the tongue. Other innervation of the tongue is provided by the **glossopharyngeal** and **facial** nerves, with general and special (taste) sensation of the pharyngeal tongue provided by the glossopharyngeal nerve and taste in the oral tongue carried by the facial nerve (via the **chorda tympani**).



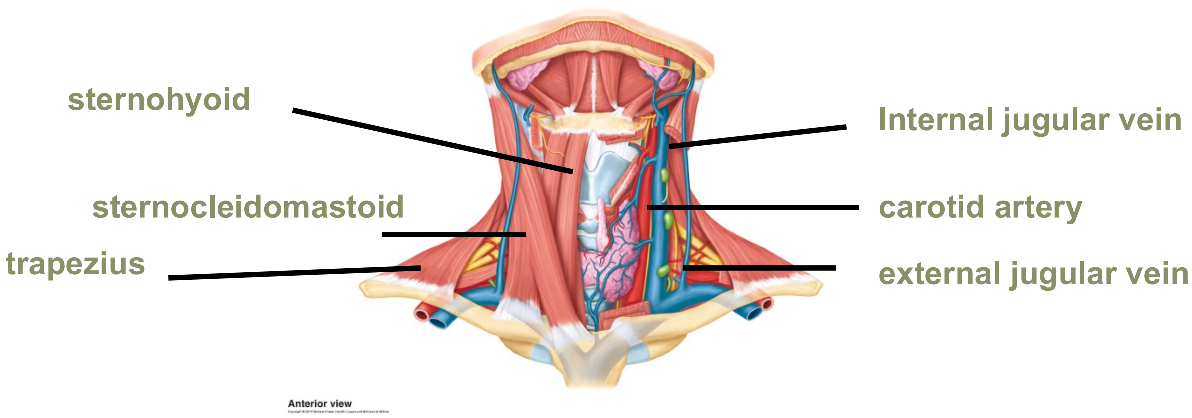
Examination of the Neck

The larynx is the organ responsible for voice production. It is located in the neck inferior to the hyoid bone and superior to the trachea. The larynx is located at the vertebral level C3-C6. Using the bisected head locate the larynx and trace its boundaries back to the vertebrae. The larynx is responsible for producing phonation and acts to guard the air passages. The larynx is comprised of a series of cartilages including a single **thyroid cartilage**, **epiglottis**, and **cricoid cartilage** and paired arytenoid, corniculate and cuneiform cartilages. Identify these on the prosection and the models. The interior of the larynx is comprised of a cavity and the **vocal folds**. You will be able to see the vocal fold on the bisected head. You will also note there is another fold this is the vestibular fold or false vocal fold. The vocal fold attaches to the arytenoid cartilages and muscles surround the larynx create change in the tone and the pitch of the sound emitted. These muscles are controlled by the inferior and superior laryngeal nerves which are branches of the **vagus** nerve.



What happens to the vocal fold during a Valsalva manoeuvre?

Using the prosected specimens. When peeling back the skin on the neck the first muscle that one encounters is **platymsa**, a thin broad sheet. Underneath the platysma on the anterior aspect is a series of 'strap' muscles of the neck. The muscles are described as being suprahyoid (above the hyoid bone) and include: mylohyoid, geniohyoid, stylohyoid and digastric, which you have already studied in the previous sections. Muscles which are 'infrahyoid' (below the hyoid) are the: **sternohyoid, omohyoid, sternothyroid and thyrohyoid. Using the prosections**of the neck examine the infrahyoid muscles. Moving laterally some of the larger muscles involved in movement of the neck can be examined. Locate each of the following: **sternocleidomastoid, omoyhoid**, **trapezius** and the **scalene muscle group**. Ensure you can locate the following vessels: internal jugular vein, external jugular vein, common carotid artery, internal and external carotid arteries.



Checklist

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

Distinguished the skeletal and nervous components of the nasal septum
Discriminated the structural and functional components of the lateral wall of the nose
Identified the location and structure of the paranasal sinuses
Understood the concept of the pterygopalatine ganglion
Identified the musculature of the floor of the mouth
Identified the main components of the larynx
Identified the main musculature and vasculature of the neck
Distinguished the components of the tongue and associated innervation