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MIDLANDS SURGICAL  
ANATOMY TEACHING  
SERIES



**MSATS**  
**HANDOUT**  
**2021/22**

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High Yield | Surgical Relevance | CPD Accredited

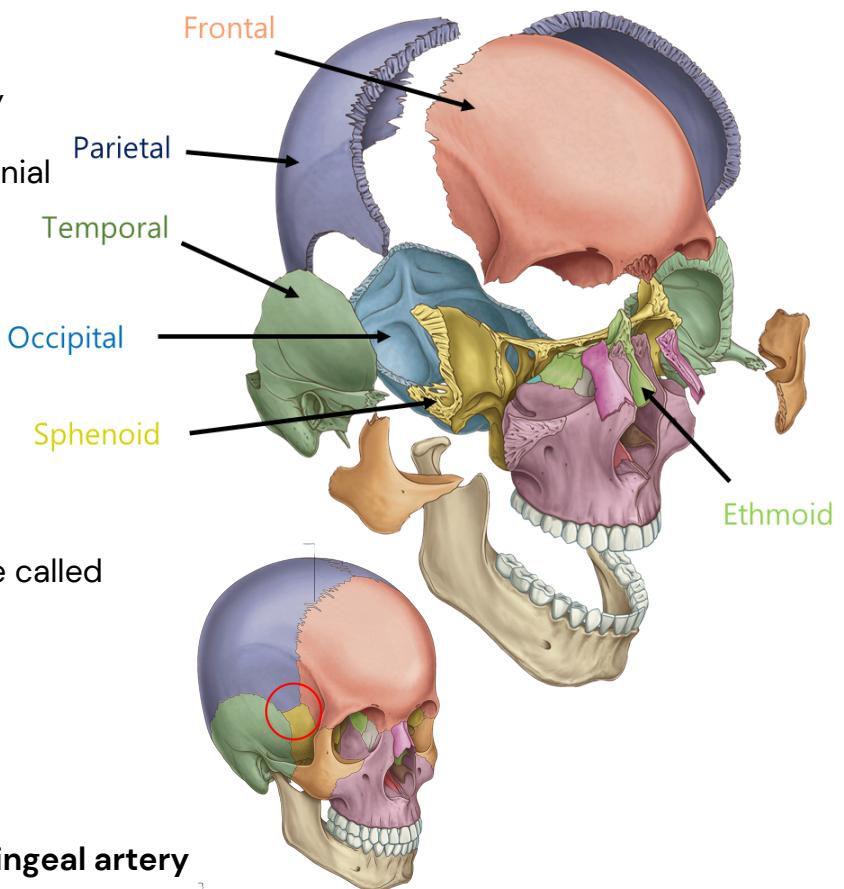
# BRAIN ANATOMY

**Objectives:** Appreciate the fundamental anatomy of the brain and its surroundings, including the skull, cranial base and meninges. Detail the vascular supply to the brain and the ultrastructure of the ventricles. Apply anatomical knowledge to the setting of common neurosurgical procedures.

## Bony Anatomy

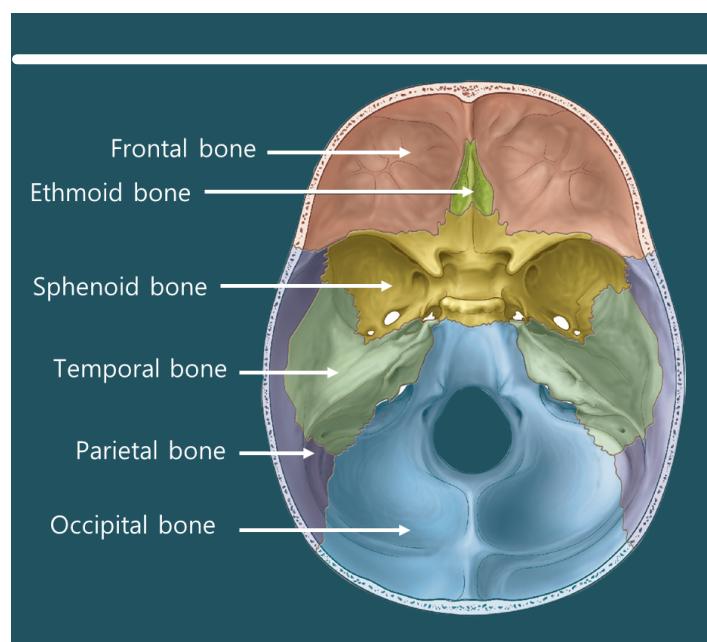
### Bones of the Skull

- The skull is a highly complex bony structure
  - Neurocranium** (calvaria & cranial base)
  - Viscerocranium
- The Neurocranium is made up of:
  - Frontal
  - Parietal
  - Temporal
  - Occipital
  - Sphenoid
  - Ethmoid
- The joints between each bone are called **sutures**
  - Sagittal suture
  - Coronal suture
  - Lambdoid suture
- Pterion**
  - Weakest point of the skull
  - Close relation to **middle meningeal artery**



### Cranial Base

- The cranial base is relevant in neurosurgery, ENT, plastics and maxillofacial surgery
- Can be split into 3 fossae
  - Anterior cranial fossa**
    - Houses frontal lobes
    - Cribriform plate for olfactory nerve (CNI)
  - Middle cranial fossa**
    - Houses temporal lobes & pituitary
    - Foramina for cranial nerves
      - CNII-VI
  - Posterior cranial fossa**
    - Houses cerebellum, pons & medulla
    - Foramina for cranial nerves
      - CNVII-XII



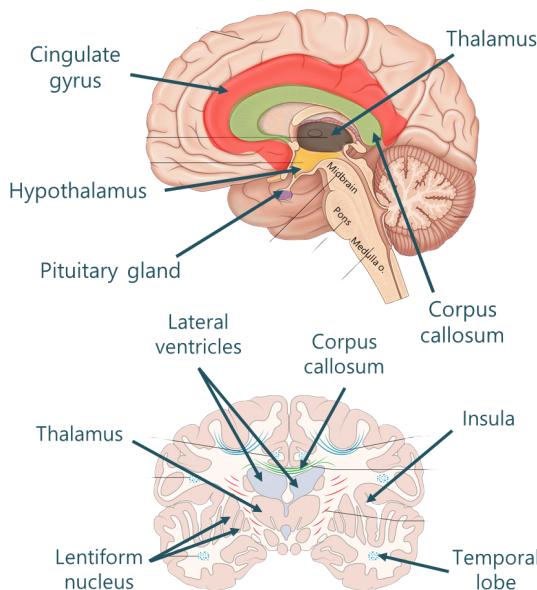
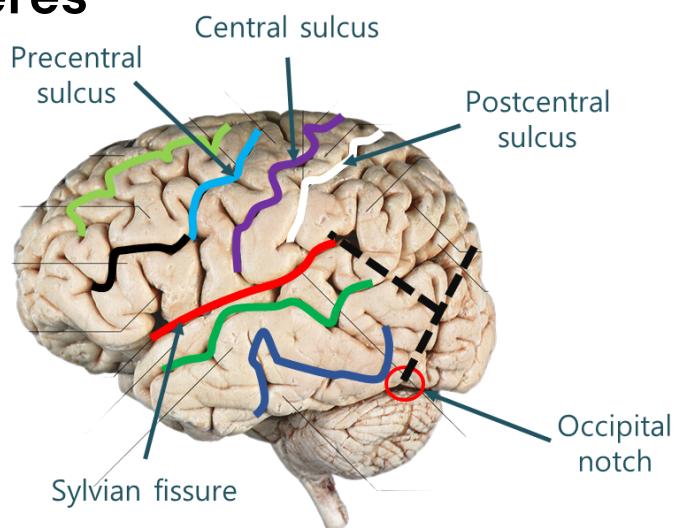
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## Topography of the Hemispheres

### Lateral View

- **Gyrus** = bump
- **Sulcus** = groove / infolding
- Primary sulci are anatomically maintained in most individuals and divide the lobes
- **Sylvian fissure** (lateral sulcus)
  - Frontal & parietal from temporal
- **Central sulcus**
  - Frontal from parietal

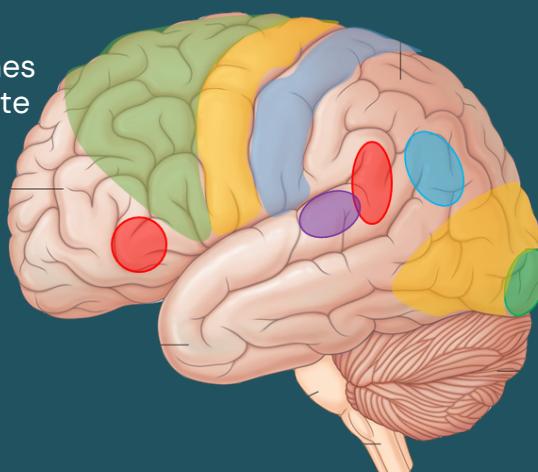
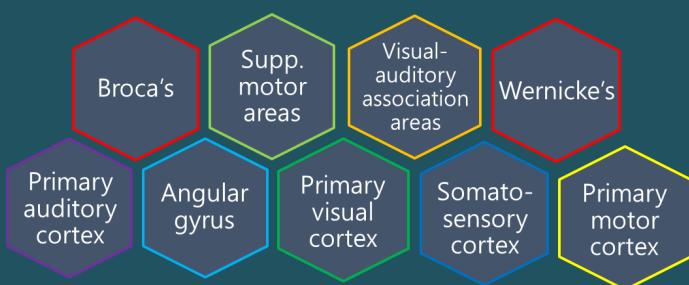


### Medial and Coronal Views

- To truly understand neuroanatomy you need **multiple views**
- **Medial view**
  - Brainstem
  - Deep brain grey
  - Grey matter within sagittal sulcus
- **Coronal view**
  - Ventricles
  - Insula
  - True anatomy of temporal lobe
  - Basal ganglia

## Eloquent Topography

- **Eloquent areas** = localised hubs of specialised functional neurones
- The highest cognitive function requires the whole cortex and white matter to **function** and **integrate**
- Eloquent topography is helpful for **surgery**



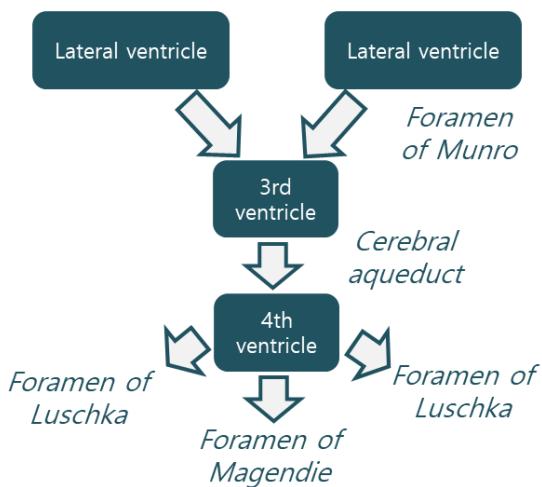
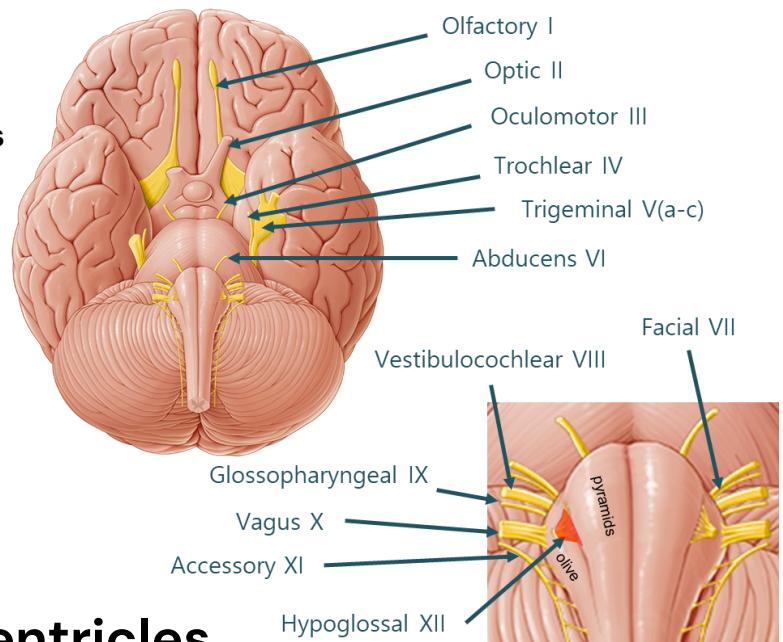
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## Cranial nerves

### Tips to remember:

- The first 2 cranial nerves emerge directly from the **cerebral hemispheres**
- Remaining 10 from the **brainstem**
- CNIII** – oculomotor is sensitive to herniation
- CNIV** – trochlear exits at posterior brainstem
- CNVIII** – vestibulocochlear is 2 nerves
- CNXI** – accessory has spinal routes
- CNXII** – hypoglossal is the only one between medullary pyramids and the olives

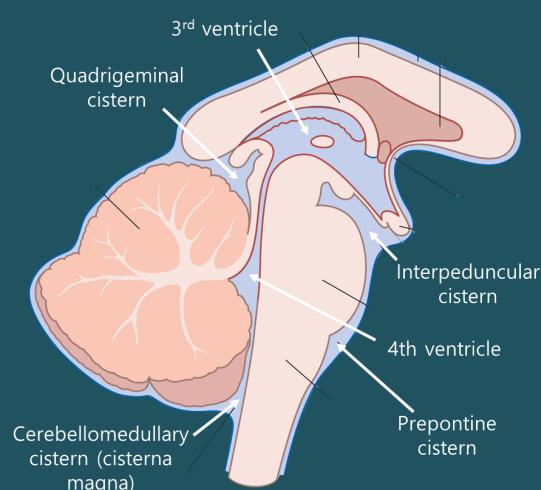


## Ventricles

- Function:** storage & production (choroid plexus) of CSF, protection and buoyance of the brain
- Hold **25ml** of the 150ml of CSF
- Foramen of Munro = **interventricular** foramen
- 3rd to 4th via: **Cerebral aqueduct**
- Foramen of Magendie = **median** aperture
- Foramen of Luschka = **lateral** apertures
- The ventricles drain CSF into the **subarachnoid cisterns**

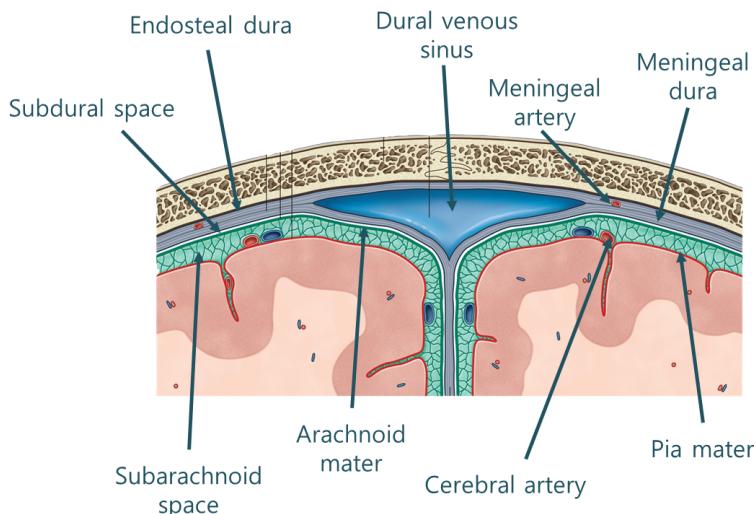
## Subarachnoid Cisterns

- Some key **cisterns**
  - Cerebellomedullary
  - Quadrigenital
  - Interpeduncular
  - Prepontine
  - Sylvian
  - Cerebellopontine (angle)
- Each subarachnoid cistern has important **neurovascular contents** that should be remembered
  - They provide a road map of the brain for surgery



# BRAIN ANATOMY

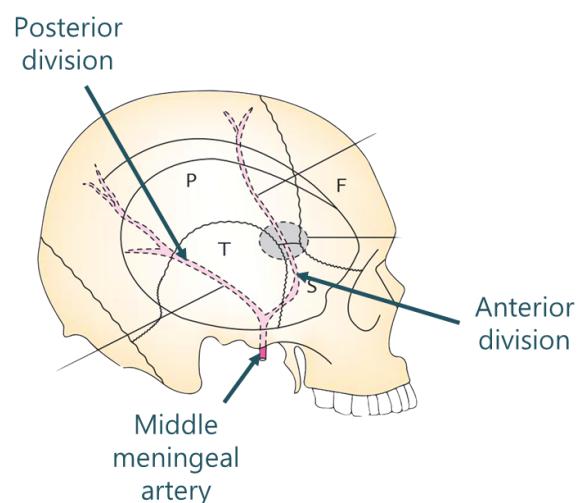
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## Meninges

### Layers

- **Dura mater** – thick fibrous, split into endosteal layer and meningeal layer
  - Subdural space – potential
- **Arachnoid mater** – thinner and looser, bridges over sulci
  - Subarachnoid space – actual
- **Pia mater** – microscopic layer, adheres closely to the brain

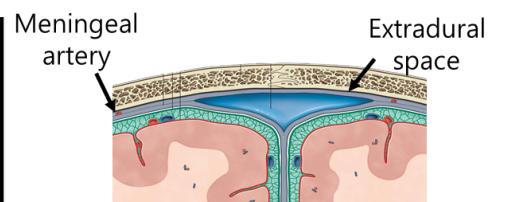
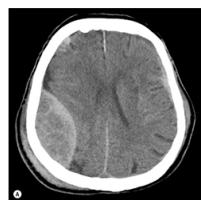


## Blood Supply

- Meningeal arteries supply the dura mater and bones of the calvaria
- The most prominent of these is the **middle meningeal artery** (branch of maxillary artery)
  - The **anterior branch** runs close to the pterion of the skull
- Meningeal vessels can be found in the **endosteal dura**
- Cerebral vessels can be found in the **subarachnoid space**
- Emissary veins cross all levels – subdural shear plane

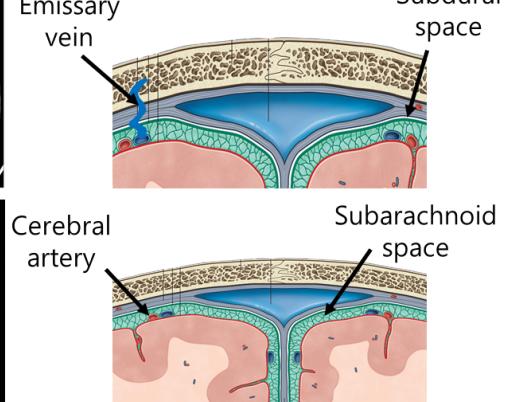
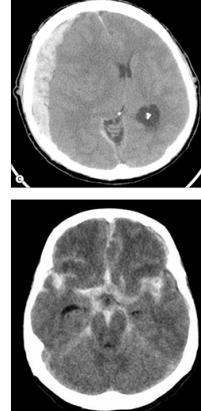
## Extradural haematoma

- Most commonly pterional fractures
- Do not cross sutures – endosteal dura fixed
- Opening this space requires lots of force
- Biconvex/lentiform appearance



## Subdural haematoma

- Emissary veins
- Shear plane between dura mater and arachnoid
- Brain atrophies with age
- Cross suture lines – crescent sign



## Subarachnoid haemorrhage

- Cerebral arteries burst (commonly aneurysm)
- Blood fills the subarachnoid space
- Cisterns can be seen filling with blood on brain CT

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## Arterial Supply to the Brain

### Circle of Willis

- The **Circle of Willis** is an in-built mechanism to allow for **collateral** supply to the brain
  - If there is restricted blood flow in one area, total ischaemia can be avoided
  - Terminal branches do not have this luxury
- The supply can be divided into **anterior** and **posterior** circulation
  - Each route has distinct **signs** and **symptoms** when obstructed

2x Internal Carotid arteries (ICA)

- Anterior circulation

ICA branches

- Anterior cerebral artery (ACA)
- Middle cerebral artery (MCA)
- Posterior communicating artery (Pcomm)

2x Vertebral arteries

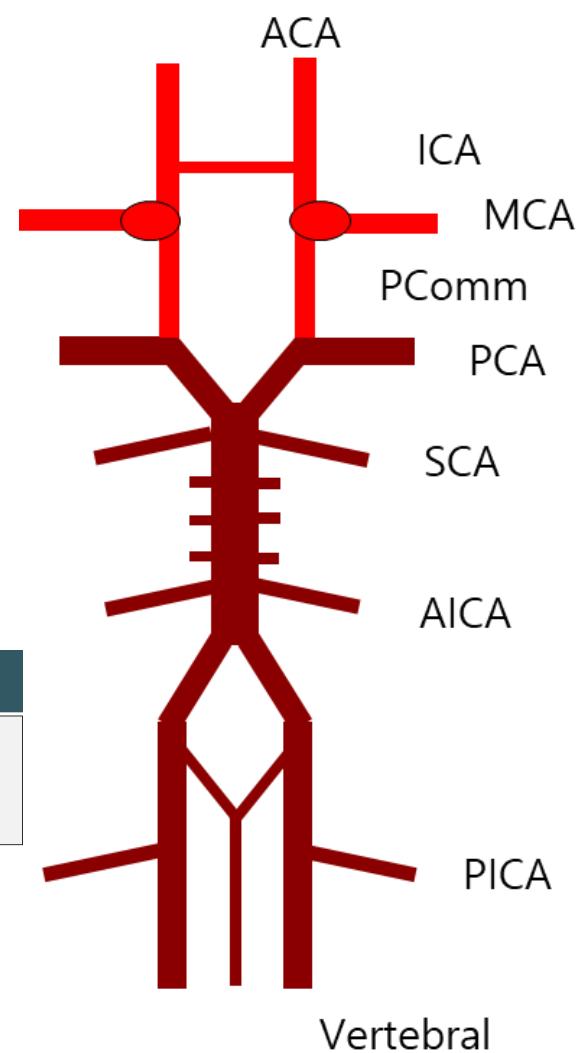
- Posterior circulation

Vertebral artery branches

- Posterior inferior cerebellar artery (PICA)
- Anterior spinal artery
- Join to make: Basilar artery

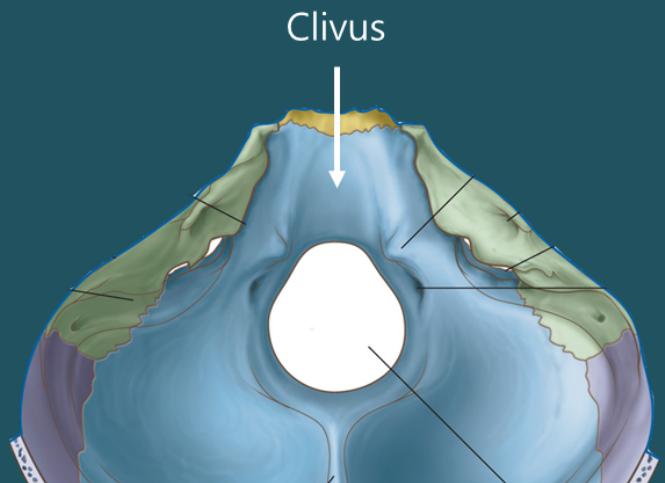
Basilar artery branches

- Anterior inferior cerebellar artery (AICA)
- Pontine branches
- Superior cerebellar artery (SCA)
- Posterior cerebral artery (PCA)



### Circle of Willis

- The basilar artery is formed by the two vertebral arteries
  - Sits ventral to the pons on the clivus of occipital bone
  - Gives off pontine branches
- The internal carotid arteries enter the middle cranial fossa
  - Just above the foramen lacerum (not through it)

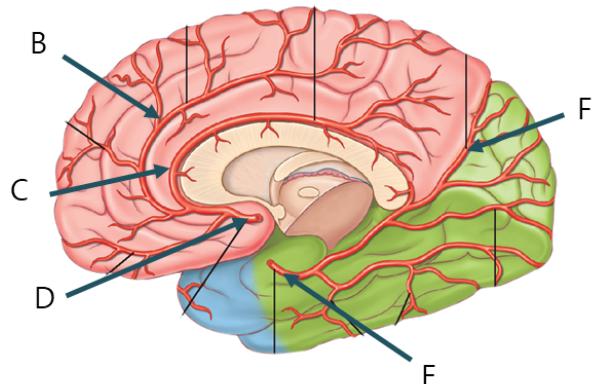
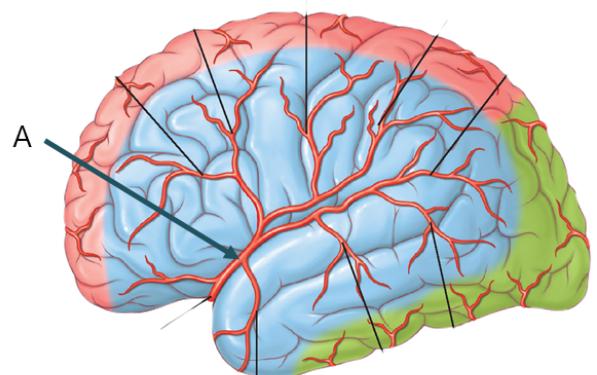


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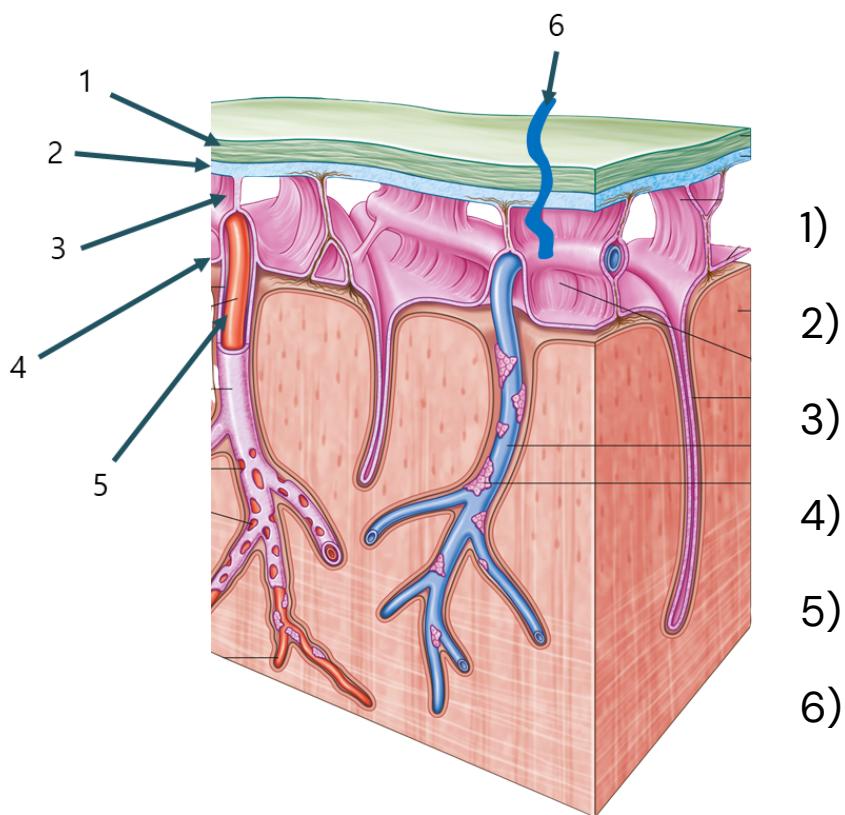
*Test yourself...*

**1) Label the structures...**

- A)
- B)
- C)
- D)
- E)
- F)



**2) Label:**



- 1)
- 2)
- 3)
- 4)
- 5)
- 6)

# BRAIN ANATOMY

*Test yourself...*

**MCQ 1:**

**A subarachnoid haemorrhage is usually...**

- A. Found in-between the endosteal and meningeal layers of dura
- B. Due to spontaneous rupture of a cerebral aneurysm
- C. Unable to cross the lines of the skull suture
- D. Due to an venous bleed
- E. Only found in comatose patients

**MCQ 2:**

**Which structure passes through the foramen ovale?**

- A. Optic nerve (CNII)
- B. Abducens nerve (CNVI)
- C. Maxillary nerve (CNVb)
- D. Middle meningeal artery
- E. Mandibular nerve (CNVc)

**MCQ 3:**

**Cortical regions that represent the motor supply to the leg are supplied by which artery?**

- A. Callosomarginal branch of anterior cerebral artery
- B. Pericallosal branch of anterior cerebral artery
- C. Frontoparietal branches of middle cerebral artery
- D. Temporal branches of middle cerebral artery
- E. Calcarine branch of the posterior cerebral artery

**MCQ 4:**

**The central sulcus delineates which lobes of the brain?**

- A. Frontal and temporal
- B. Parietal and occipital
- C. Temporal and occipital
- D. Frontal and insula
- E. Frontal and parietal

**MCQ 5:**

**If a patient fractures their pterion, which artery might be damaged and what is the sequelae?**

- A. Posterior branch of middle meningeal artery – subdural haematoma
- B. Anterior branch of middle meningeal artery – extradural haematoma
- C. Posterior branch of middle meningeal artery – extradural haematoma
- D. Anterior branch of middle meningeal artery – subdural haematoma
- E. Accessory meningeal artery – extradural haematoma

**MCQ 6:**

**Which cranial nerve can be found emerging between the medullary olives and pyramids?**

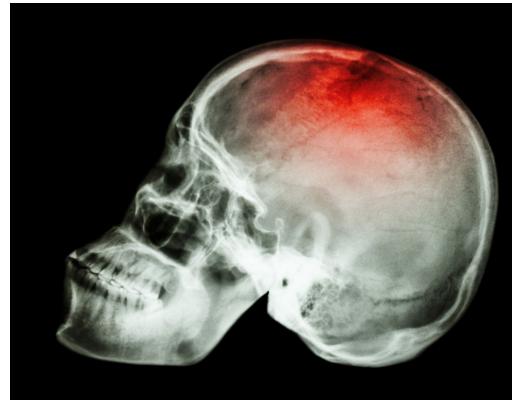
- A. Accessory nerve (CNXI)
- B. Vagus nerve (CNX)
- C. Hypoglossal nerve (CNXII)
- D. Glossopharyngeal nerve (CNIX)
- E. Vestibulocochlear nerve (CNVIII)

# BRAIN ANATOMY

## *Test yourself...*

# OSCE Station – Case Based Discussion

A 26 year old hockey player is accidentally struck in the side of their head during a game causing them to lose consciousness. They rapidly recover showing some signs of concussion but are not taken to hospital. 5 hours later, they are found unconscious at home. They cannot be woken and are breathing in an irregular pattern. By the time they arrive at the hospital, the junior doctor on call notices an unusual orientation of their right eye. Radiology report suggests this is an extradural haematoma.



**Q1. What imaging study is vital for this patient for diagnosis? Describe the image you would see?**

**Q2. Explain the anatomy of this pathology with specific reference to the meningeal layers**

**Q3. Give one simple manoeuvre you could do to help this patient and give one surgical option**

**Q4. Why was this patient initially fine but then progress to unconsciousness?**

**Q5. Briefly explain the orientation of their right eye**

**Q6. Aside from routine observations, what other continuous monitoring does this patient need and how will this be done?**

3) Sit the patient up above 30 degrees. Decompressive craniectomy  
4) Extradural haematomas often have a latent phase up to a few hours. Mass effect grows and causes raised intracranial pressure  
5) Down and out eye orientation due to oculomotor nerve palsy - unopposed action of lateral rectus & superior oblique  
6) ICP monitoring. Can be placed as an extra-ventricular drain (into the ventricles) or a subarachnoid bolt (into subarachnoid space)

1) CT head: Bi-concave / lensiform opacification representing an extradural haematoma  
 2) Fracture likely occurred at the petrion damaging the anterior branch of the middle meningeal artery (branch of maxillary artery). This artery when damaged will bleed between the endosteal dura and the bone opening the extradural space (usually a potential space).

MCQs (1) B, (2) E, (3) A, (4) E, (5) B, (6) C

Labels: (A) Middle cerebral artery (B) Callosomarginal branch of ACA (C) Pericallosal artery (D) Anterior cerebral artery (E) Posterior cerebral artery (F) Parietooccipital branch (G) Dura mater (H) Tracheobronchial artery (I) Dura mater (J) Cerebral artery (K) Epineurial artery (L) Epineurial vein