

Gross Anatomy of the Nervous System (Brain & Spinal Cord), Skull & Meninges

Dr. Nidal Abuahdrous

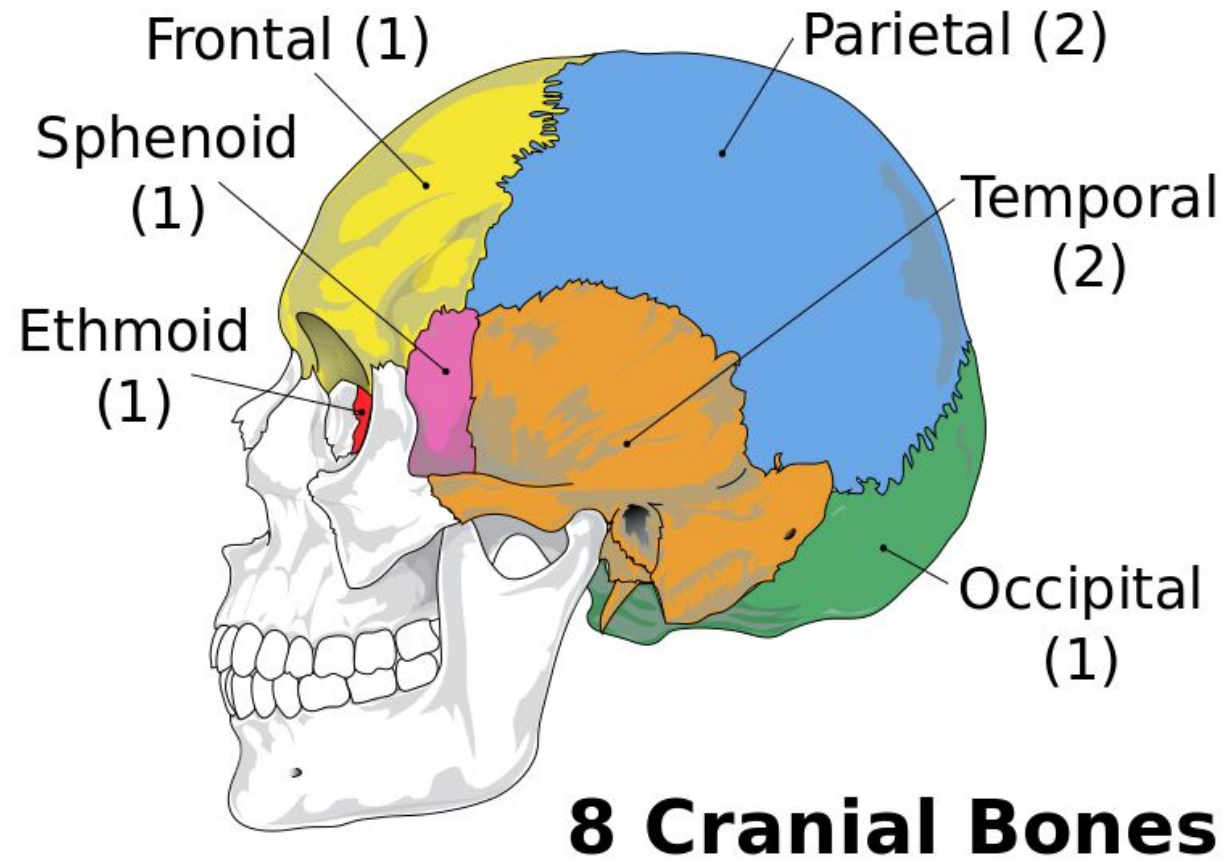
Consultant Neurosurgeon

Certificate of Arab Board of Neurosurgery

Director of Surgical Hospital – Shifa Medical Complex

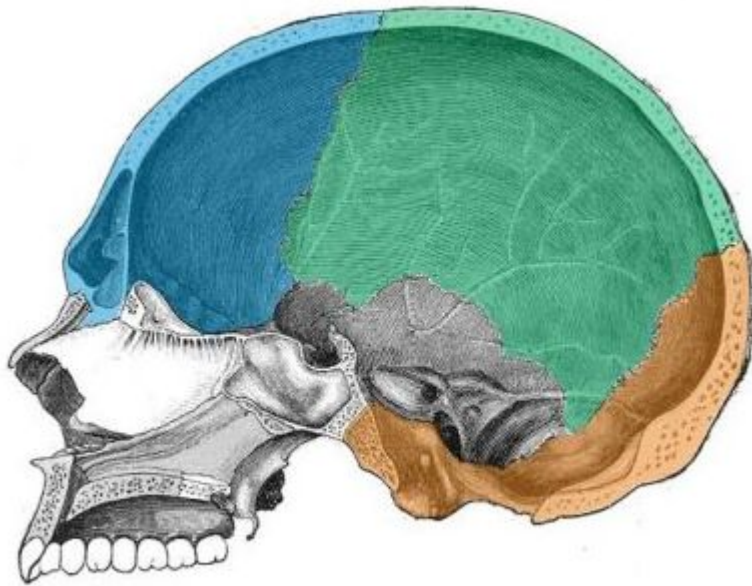
June 2023

Skull

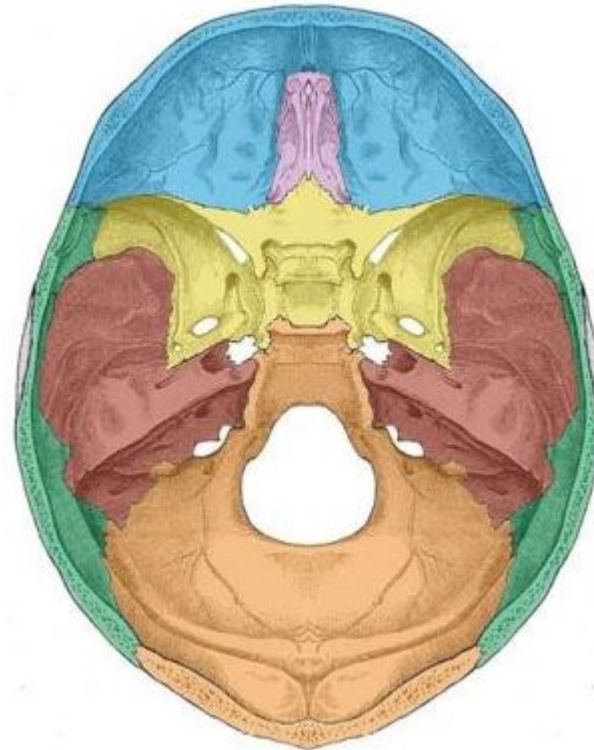


Skull

The Calvarium (Vault)

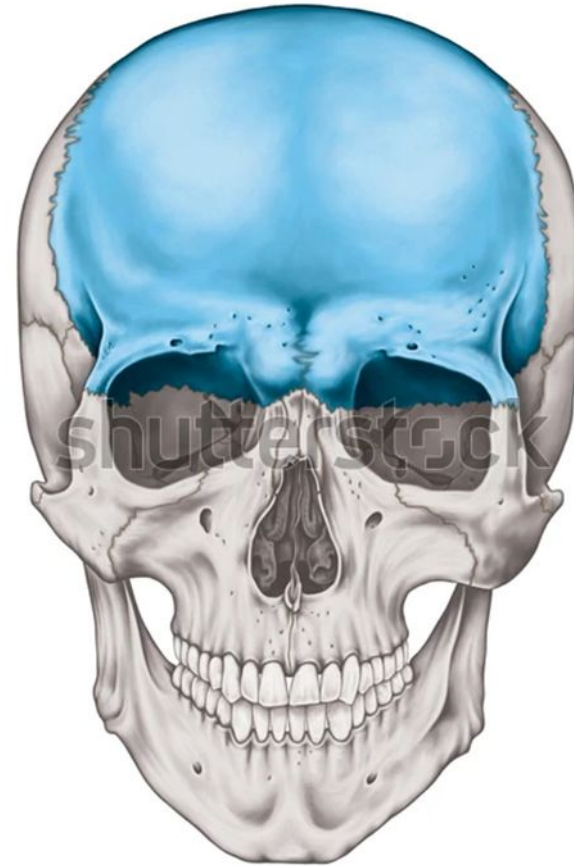
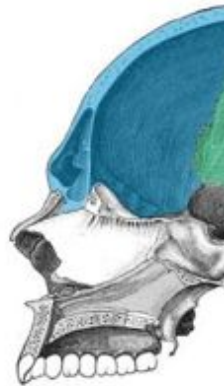


The skull base



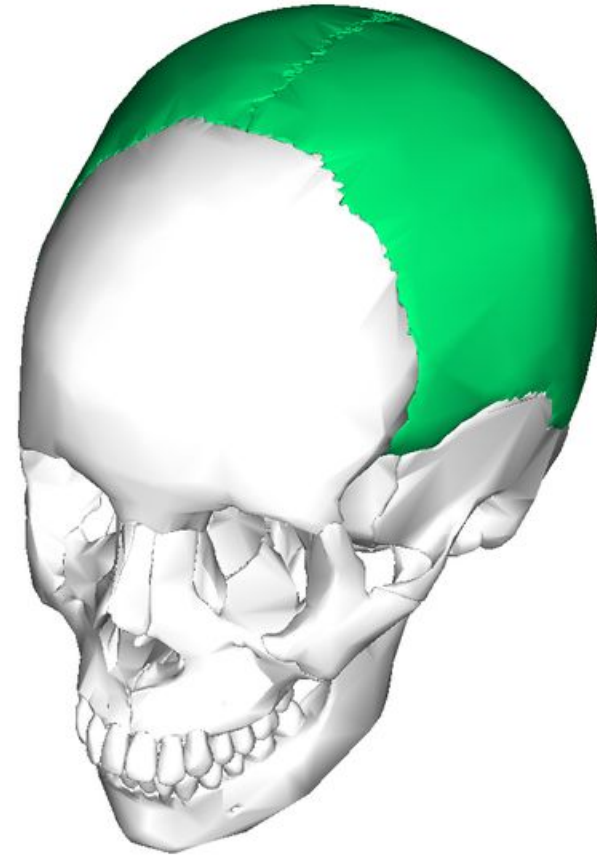
Frontal bone

- Unpaired bone
- Parts:
 - Squamous part
 - Nasal part
 - 2 orbital plates
 - 2 zygomatic processes
- Contains 2 frontal air sinuses
Rt & Lt above each eye

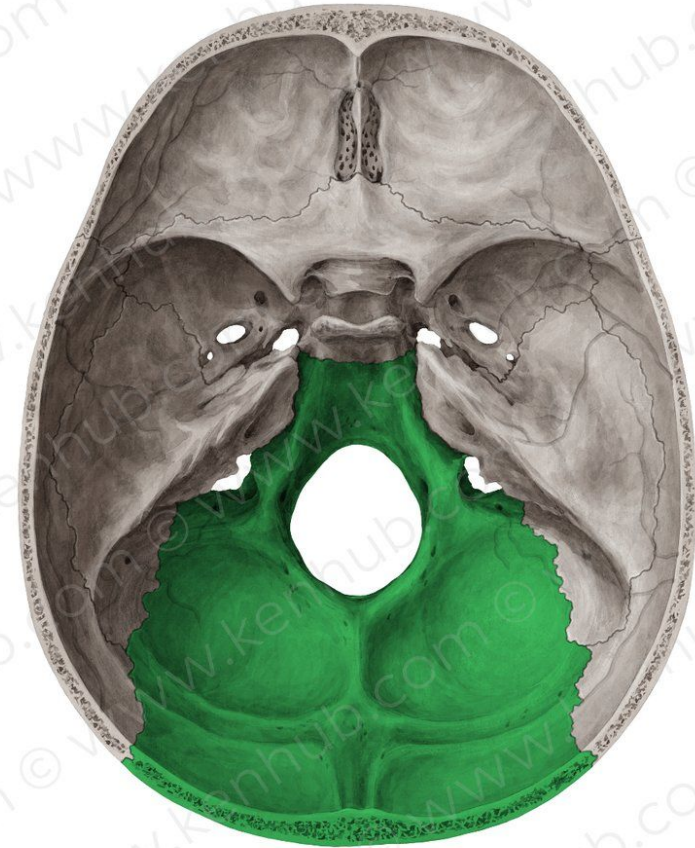
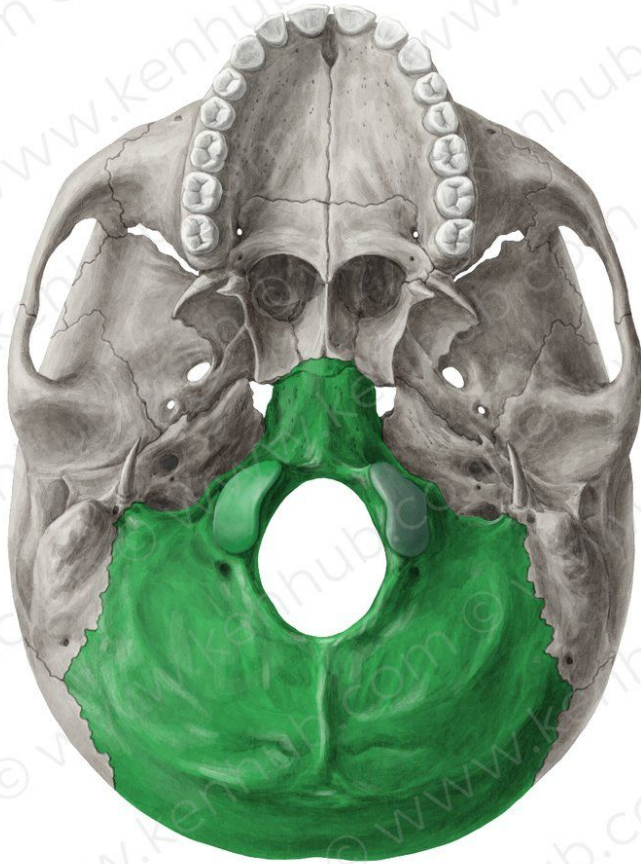


Parietal bones

- Paired
- Connects with each other in the midline (sagittal suture)
- Both connects anteriorly with frontal bone (coronal suture)
- Both connects posteriorly with occipital bone (lambdoid suture)
- Each connects down with temporal (squamous suture) & sphenoid bones.



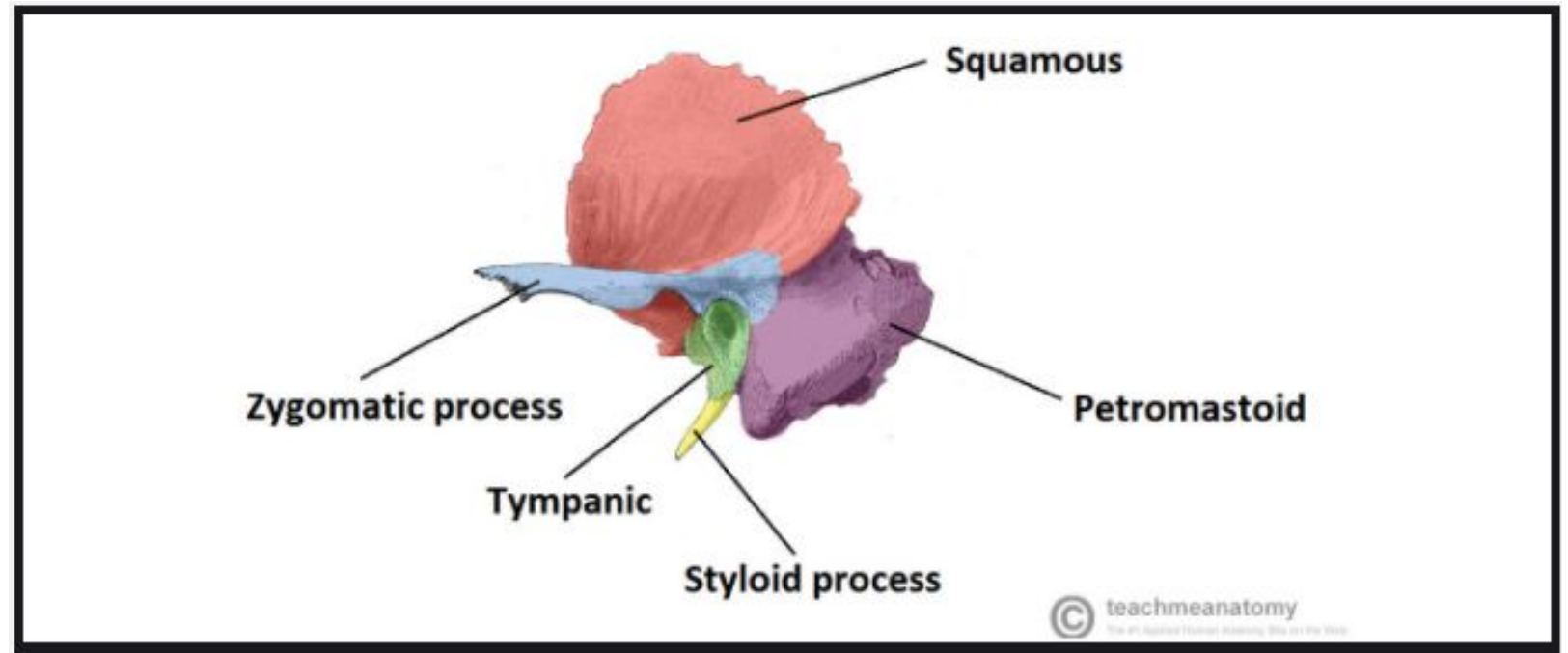
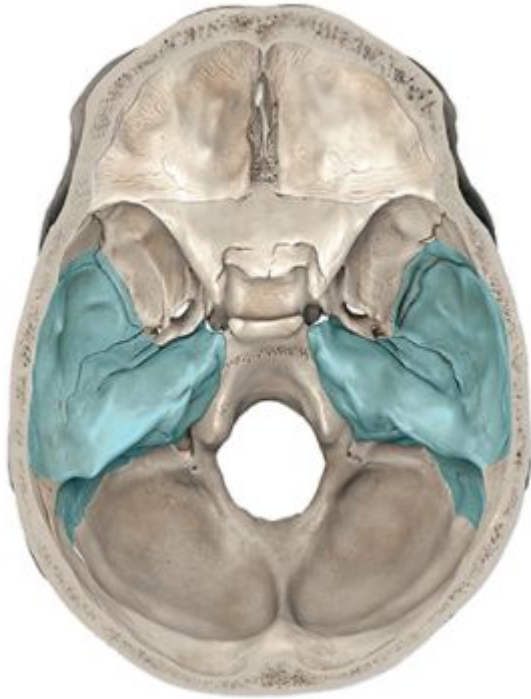
Occipital bone



Occipital bone

- Unpaired
- Squamous part
- Basilar part
- Occipital condyles
- Foramen magnum (sp. Cord, VAs, ant. & post. sp. art., XI n., meninges)
- Jugular foramen (Int. jugular V., IX, X, XI nerves)
- Hypoglossal canal (XII n.)

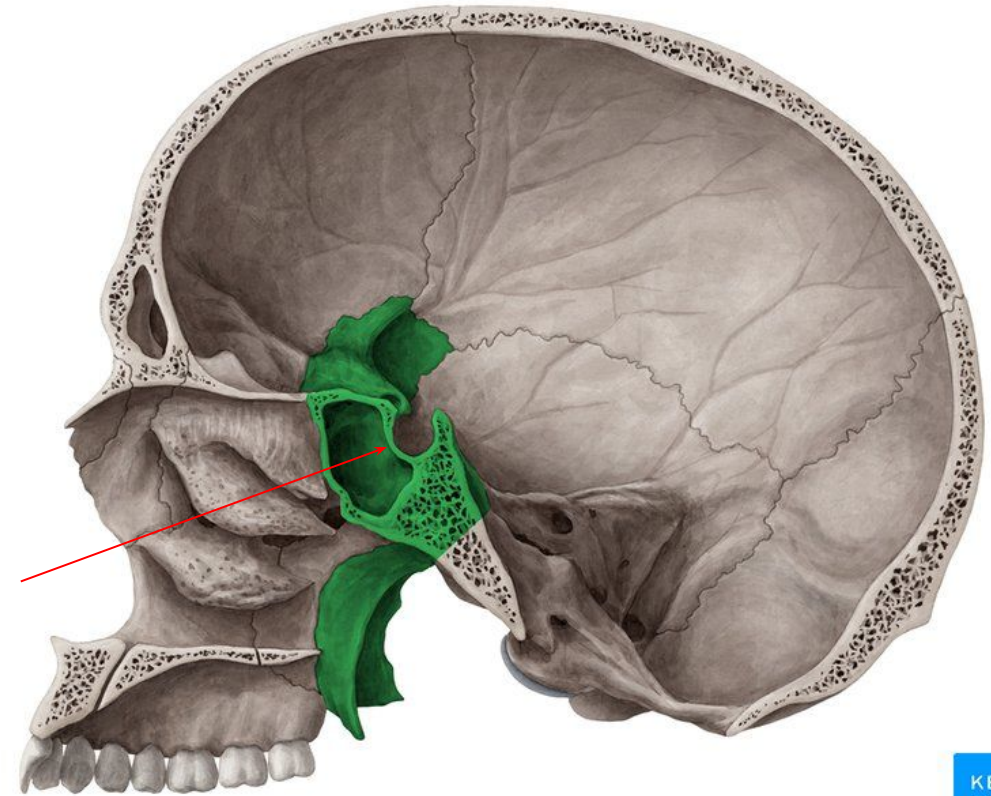
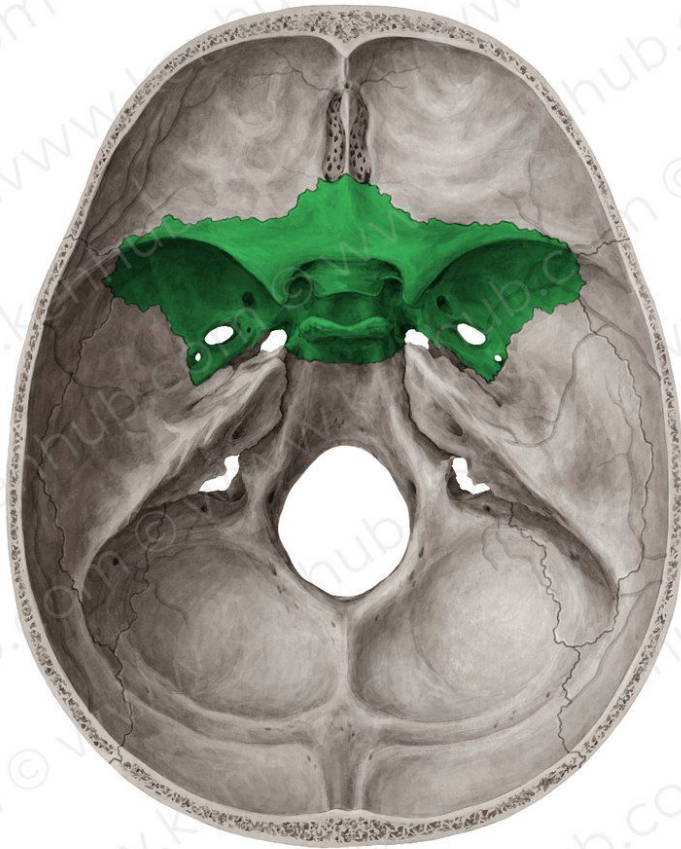
Temporal bone



Temporal bone

- External acoustic opening/ meatus
- Internal acoustic meatus (VII, VIII n., labyrinthine art.)
- Carotid canal (ICA)
- Foramen lacerum
- Stylomastoid foramen (VII n.)
- Skull fracturs → Otorrhea, VII n. palsy

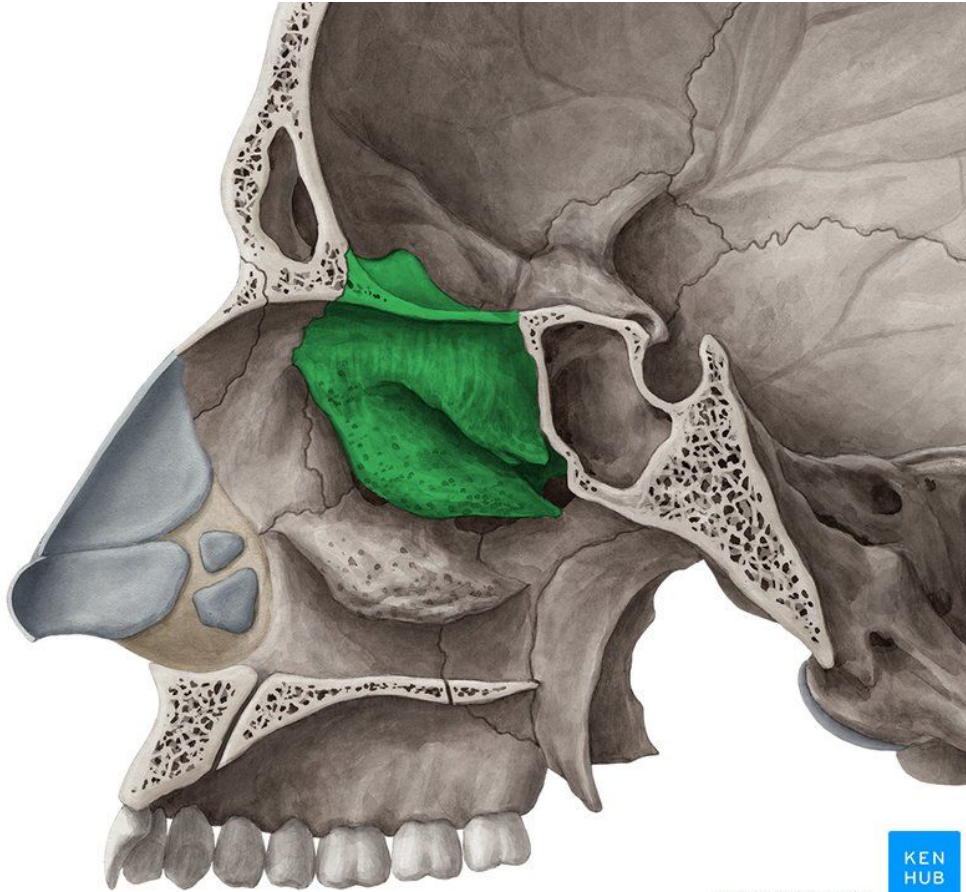
Sphenoid bone



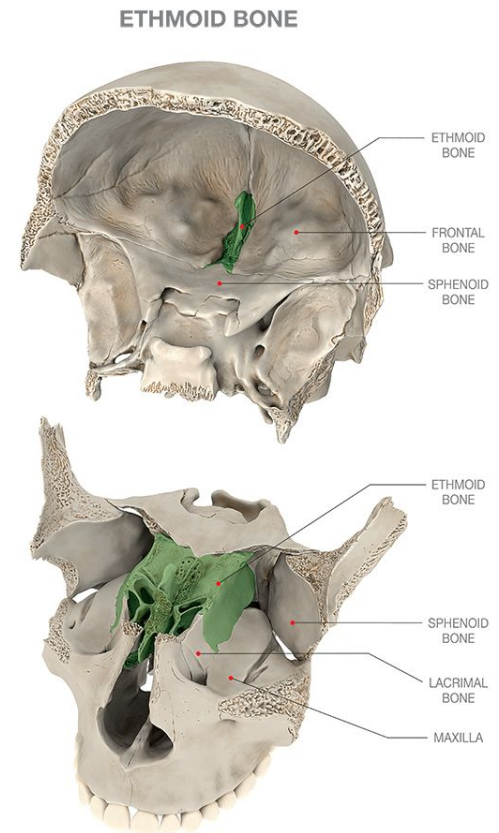
Sphenoid bone

- Sella turcica (Pituitary gland)
- Sphenoid sinus
- Optic canal (II n.)
- Superior orbital fissure (between greater & lesser wings, connects middle fossa & orbit. Transmits III, IV, V-1, VI n)
- Foramen rotundum (V-2)
- Foramen ovale (V-3)
- Foramen spinosum (Middle meningeal artery)

Ethmoid bone



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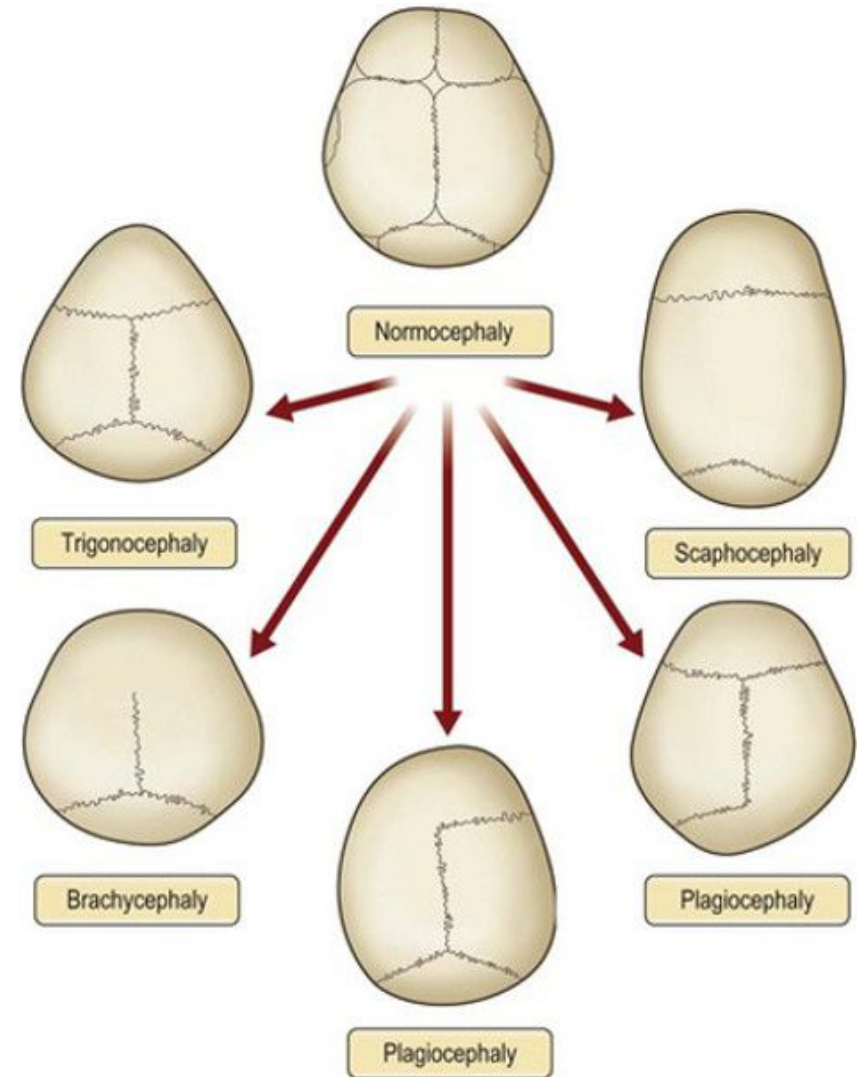
Ethmoid bone

- Unpaired bone, located in the midline of the anterior cranium base
- Separates the anterior cranial fossa & the nasal cavity
- Forms the medial orbital walls
- Cribriform plate (CN I). Fracture → Rhinorrhea, Anosmia
- Crista galli (attachment point for the falx cerebri)

Clinical scenarios

Craniosynostosis

- Premature closure of one or more cranial sutures in newborns
- Irregular head shape
- Sometimes high ICP
- Surgical correction is indicated in certain cases

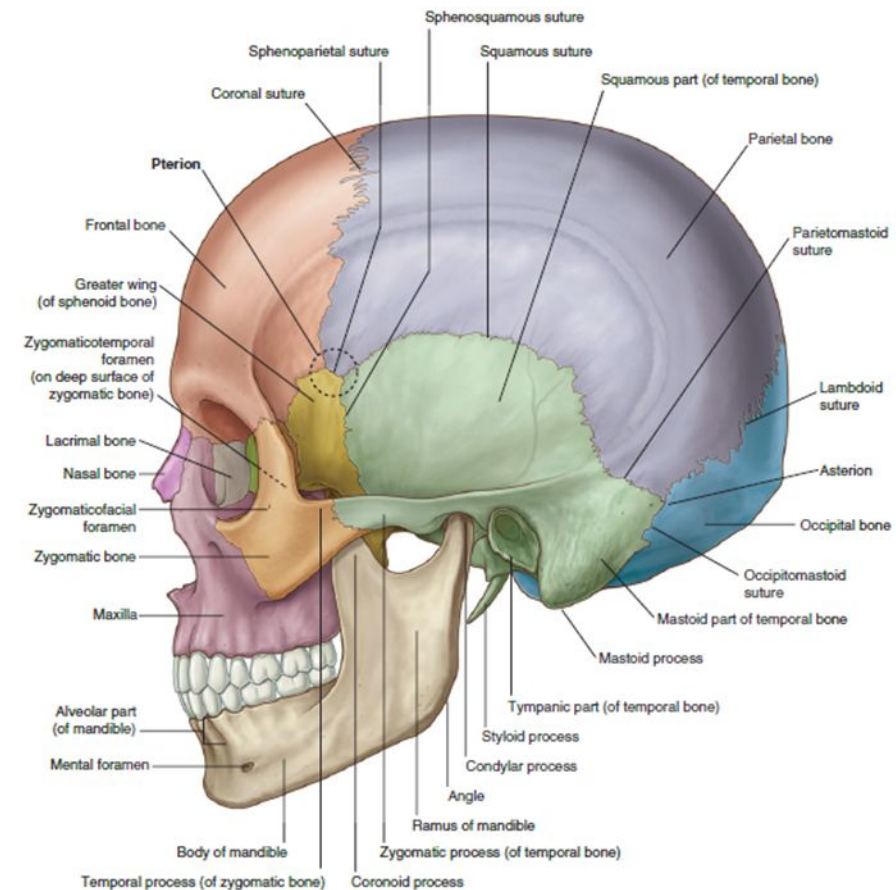


Skull fractures

- The fracture itself is usually of little consequence
- More important: brain injury and secondary complications
- Classification:
 - Closed (simple) or open (compound)
 - Linear (fissure) or depressed
 - Vault or base fractures

Pterion

- Skull fracture → Injury to anterior branch of middle meningeal artery → EDH
- Pterional craniotomy (Common access to several intracranial pathologies)

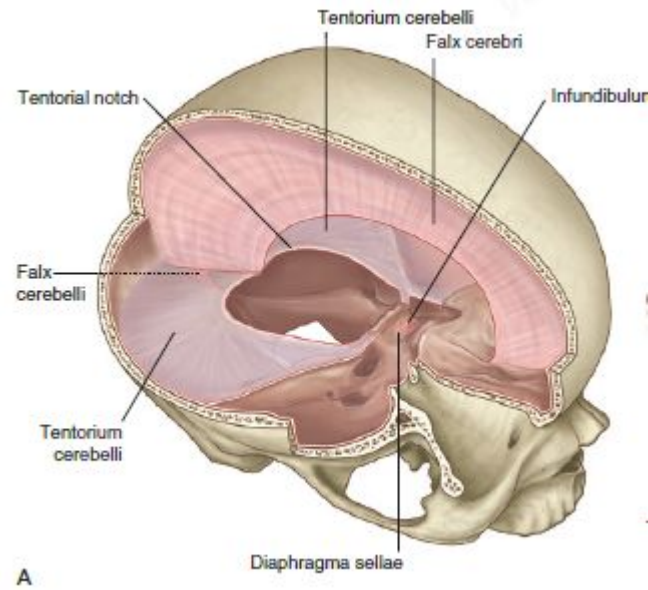


Meninges

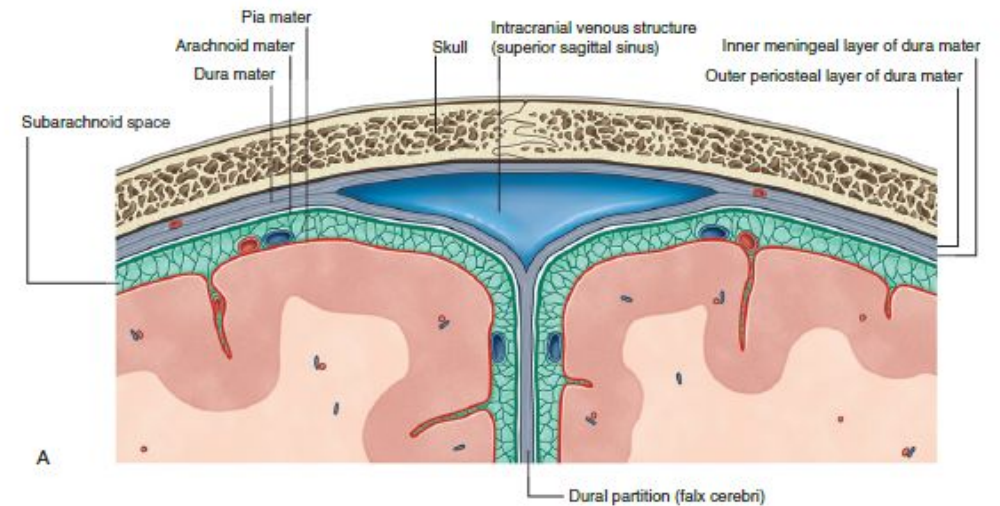
- Surround the brain & the spinal cord
- 3 layers
 - The dura: tough, outer layer
 - The arachnoid: a delicate avascular, middle layer
 - The pia: an inner layer firmly attached to the surface of the brain
- The cranial dura consists of two layers: periosteal & meningeal
- The spinal dural: one layer only (meningeal)

The Cranial Dura

Dural partitions



Venous sinuses



Blood supply of the cranial dura

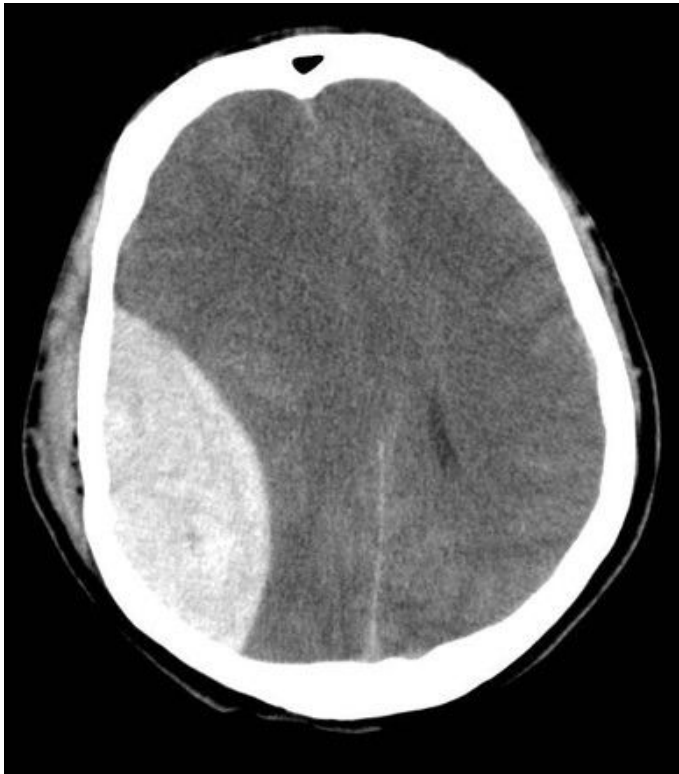
- Anterior cranial fossa: anterior meningeal arteries from ophthalmic artery from ICA
- The middle cranial fossa: middle meningeal arteries from maxillary artery from ECA
- The posterior cranial fossa: posterior meningeal artery from ascending pharyngeal artery from ECA

Clinical scenarios

- Extradural (Epidural hematoma)
- Subdural hematoma
- Subarachnoid hemorrhage (traumatic or aneurysmal)
- CSF leak (posttraumatic, spontaneous, iatrogenic)
- Meningitis (infection of the leptomeninges)
- Meningioma (extra-axial tumor, originate from arachnoid cap cells)

Extradural & Subdural hematoma

Extradural



Subdural



Subarachnoid hemorrhage

Spontaneous (aneurysmal)



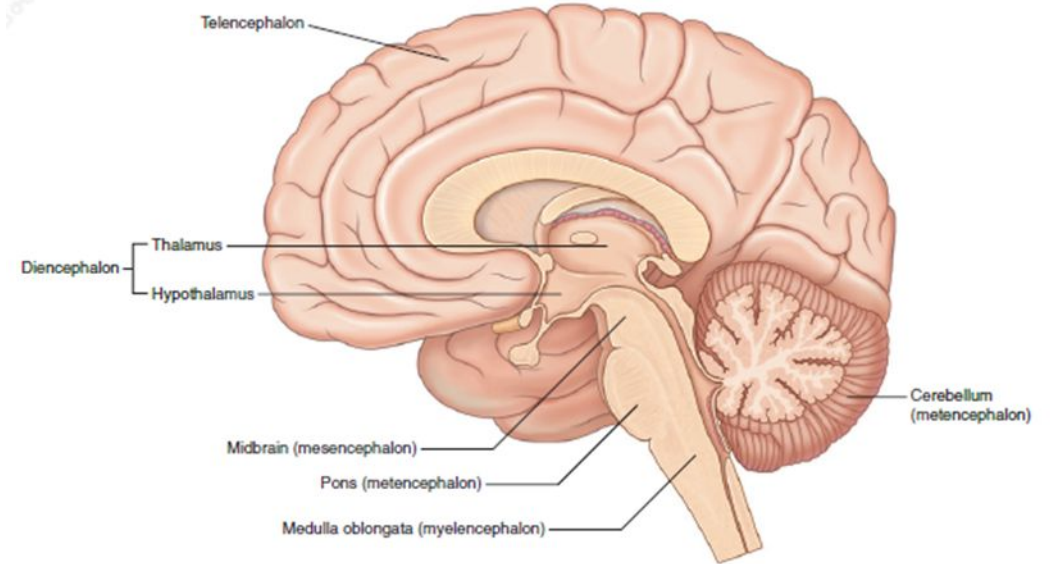
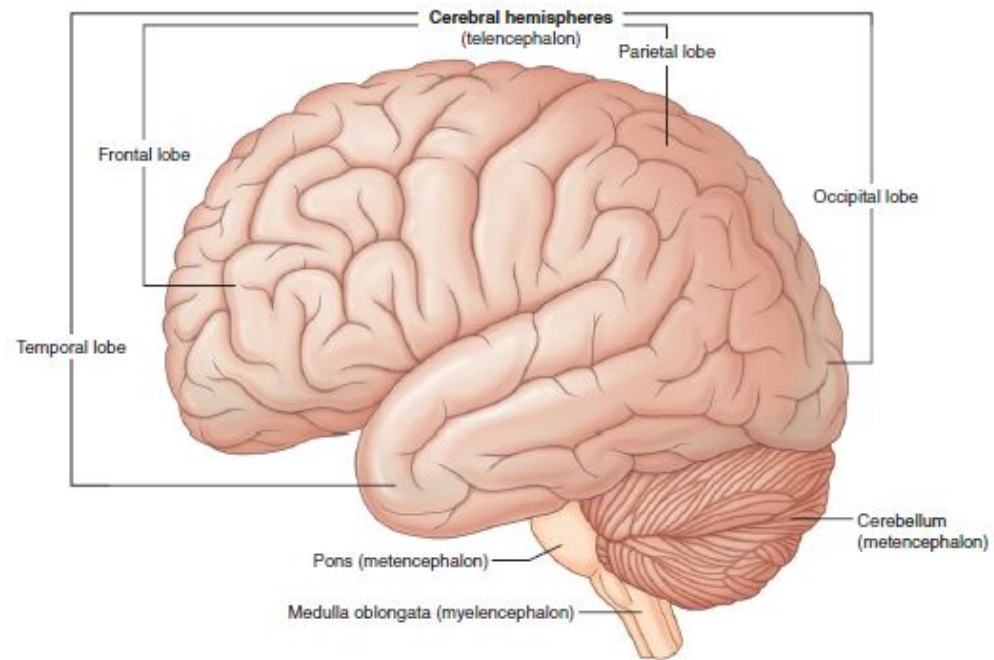
Traumatic



Brain

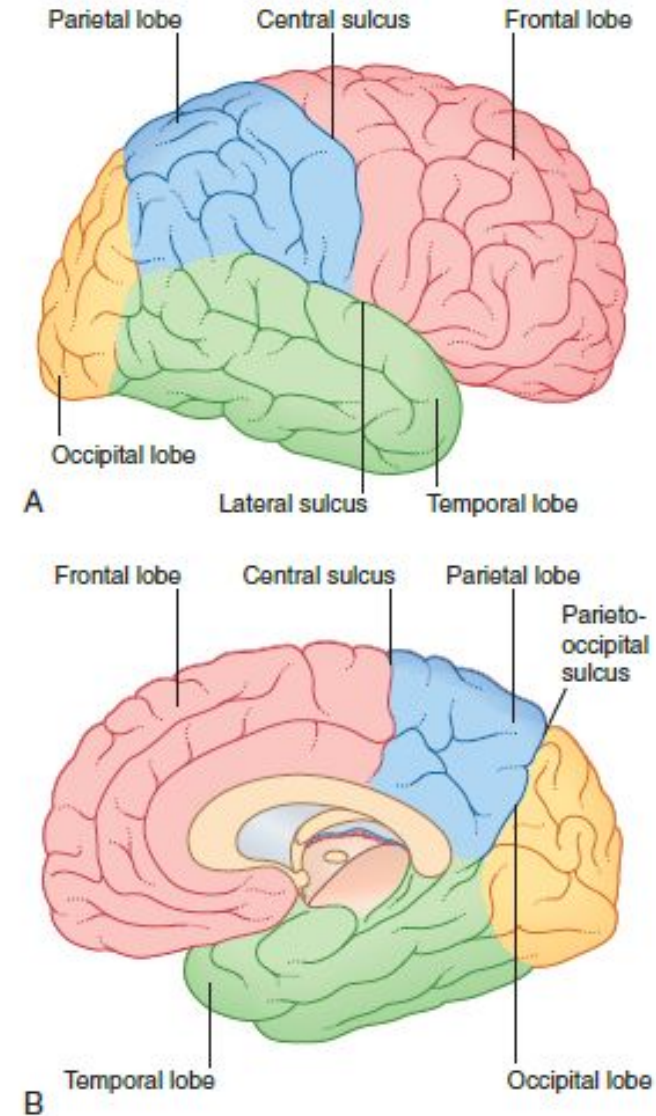
- Telencephalon (cerebrum)
- Diencephalon (thalamus, hypothalamus)
- Mesencephalon (midbrain)
- Metencephalon (Pons & Cerebellum)
- Myelencephalon (medulla oblongata)

Brain



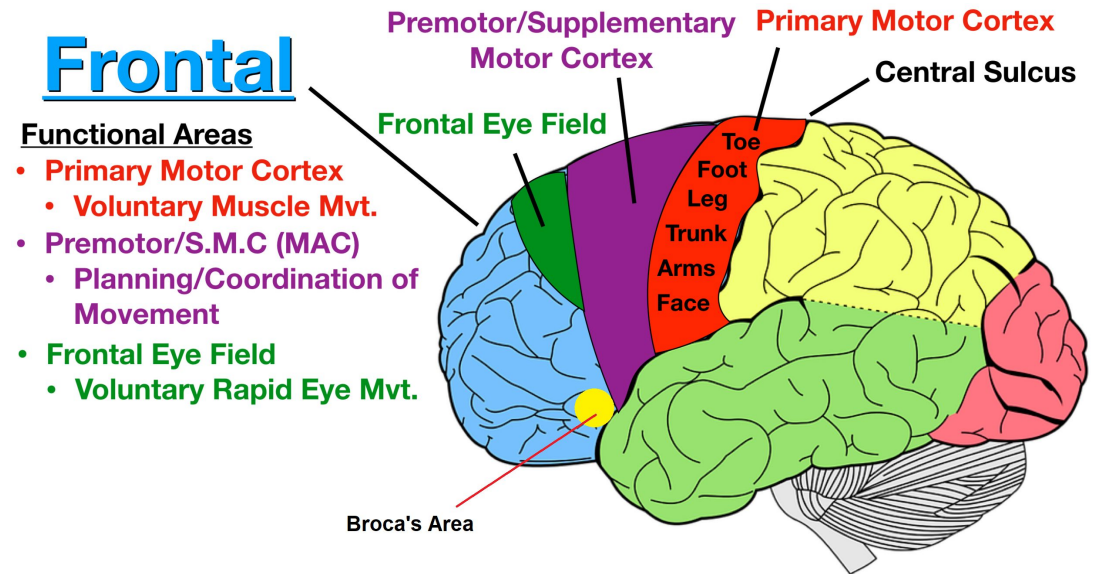
Cerebrum

- 2 hemispheres
- 4 lobes in each hemisphere
 - Frontal
 - Parietal
 - Temporal
 - Occipital



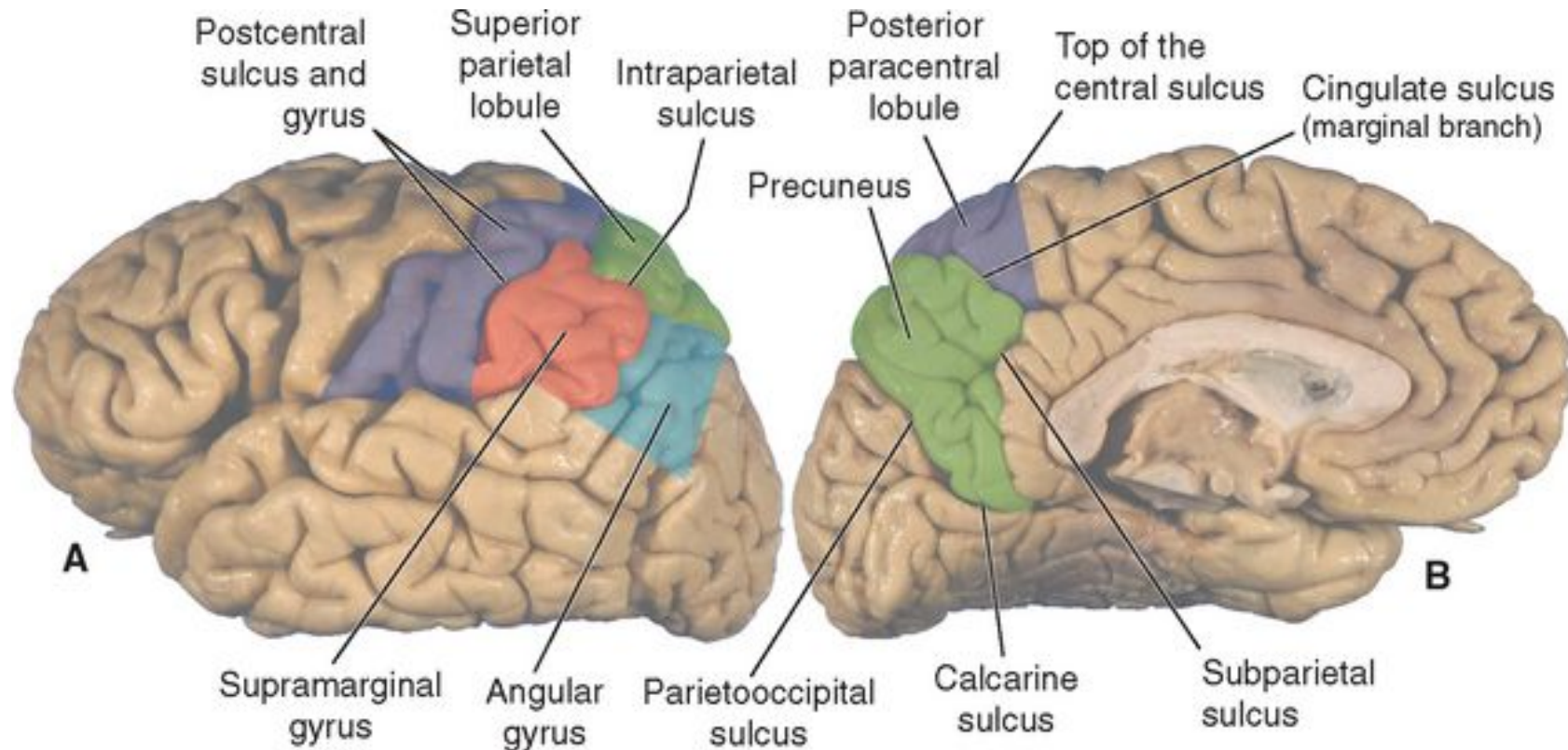
Frontal lobe

- Contralateral weakness
- Motor “Broca’s” dysphasia (in dominant side damage)
- Behavior changes
- Gaze paralysis to contralateral side



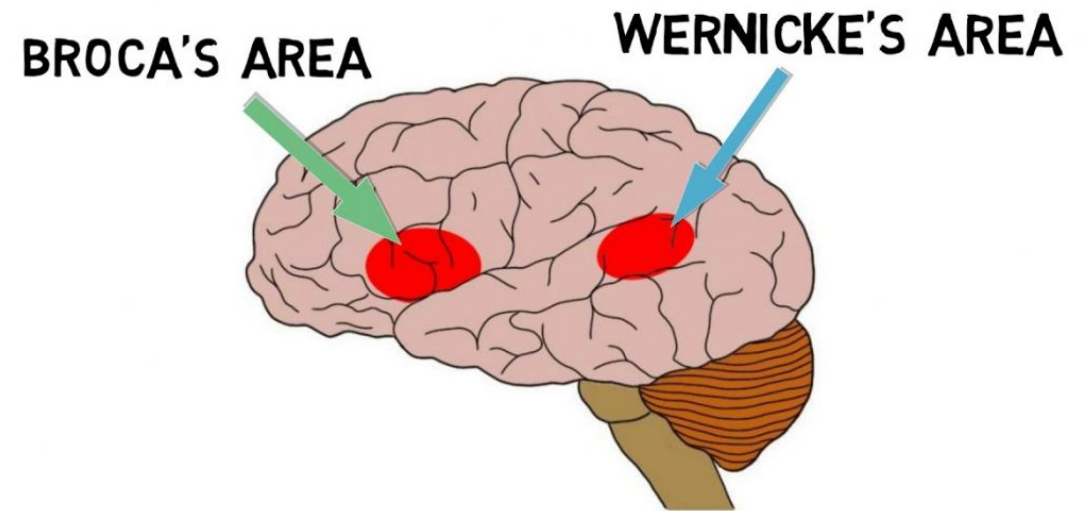
Parietal lobe

- Sensory cortex in the postcentral gyrus

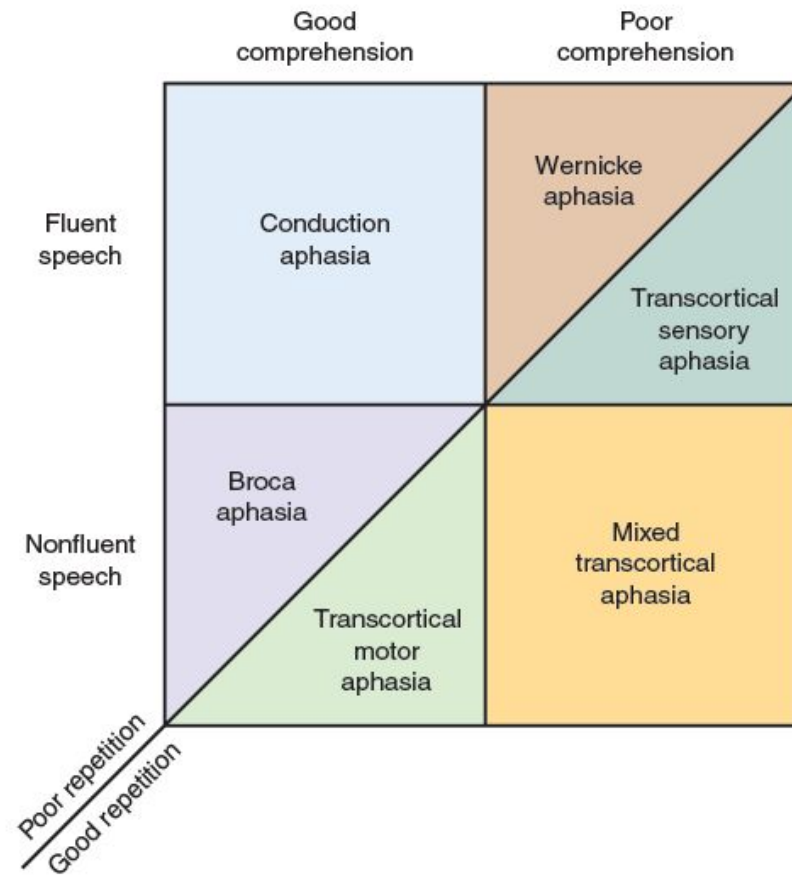


Temporal lobe

- Sensory dysphasia (Wernicke's)
- Auditory cortex
- Olfactory cortex

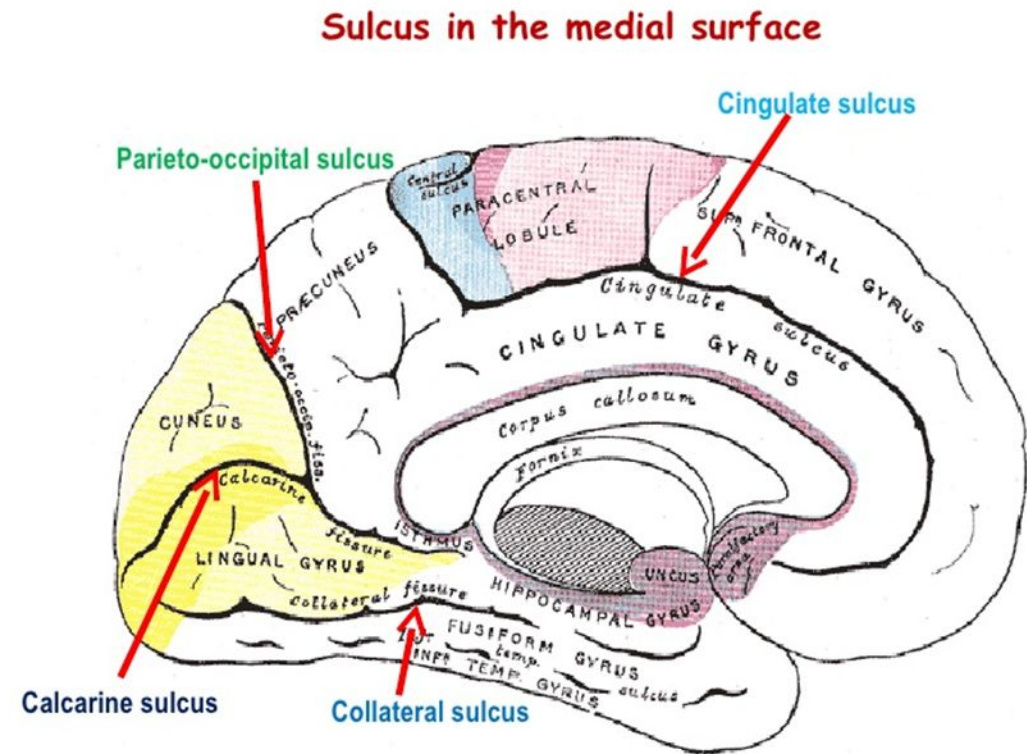


The Aphasia square

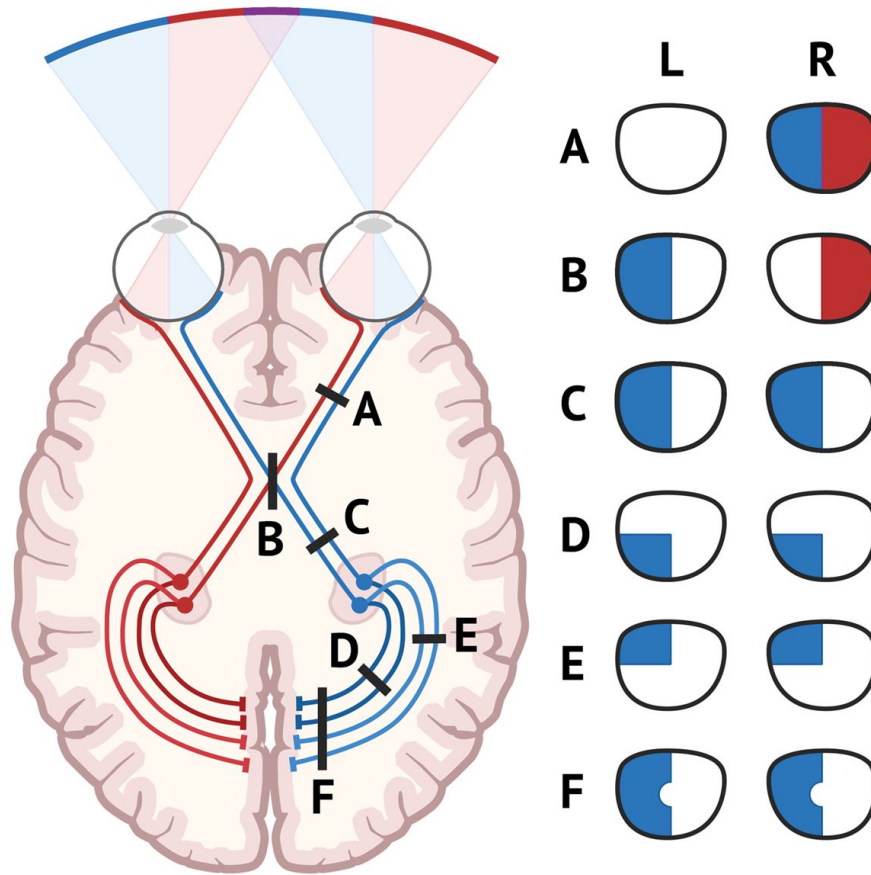


Occipital lobe

- Visual cortex, controlling contralateral visual field (contralateral hemianopia)
- Cuneus: lower quadrant (contralateral lower quadrantanopia)
- Lingual: upper quadrant (contralateral upper quadrantanopia)

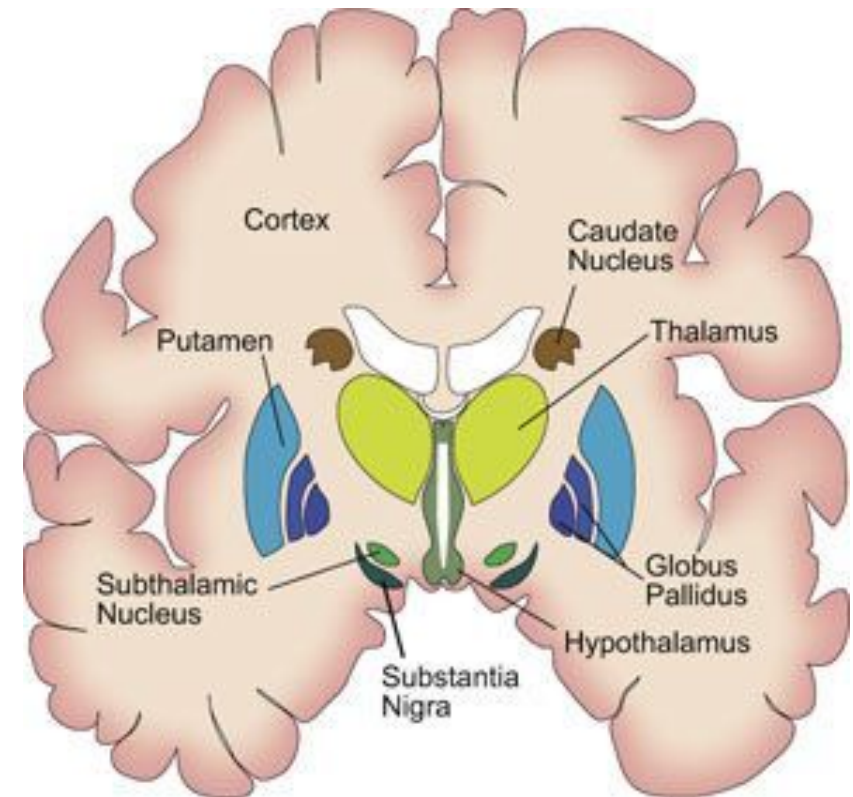


Visual pathway field defects



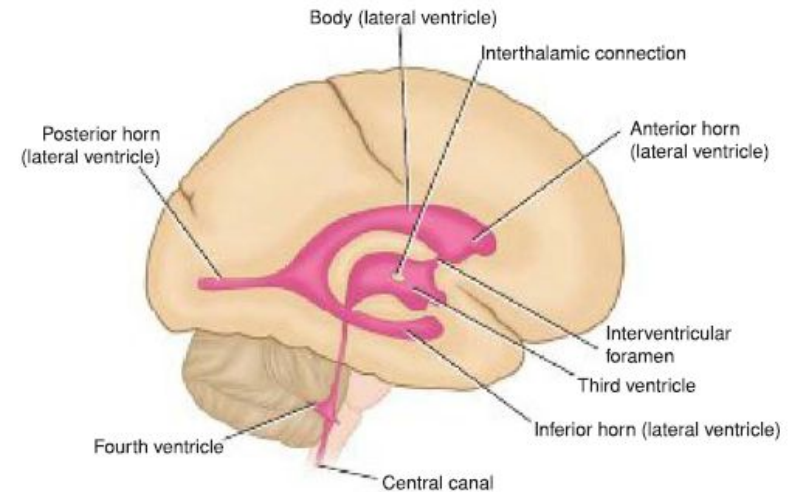
Basal Ganglia

- A group of subcortical nuclei responsible primarily for motor control
- Caudate nucleus, putamen, and globus pallidus in the cerebrum
- Subthalamic nucleus in the diencephalon
- Substantia nigra in the midbrain

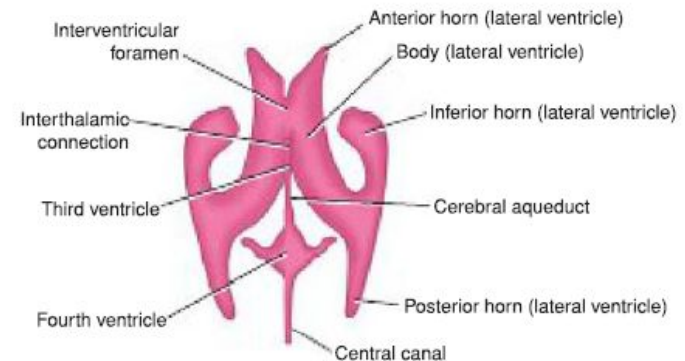


Ventricular System

- 2 lateral ventricles
 - Interventricular foramina (of Monro)
- 3^d ventricle
 - Cerebral aqueduct (aqueduct of Sylvius)
- 4th ventricle
 - Central canal of the spinal cord
 - 3 foramina in its roof, with the subarachnoid space (2 Luschka, 1 Magendie)



A



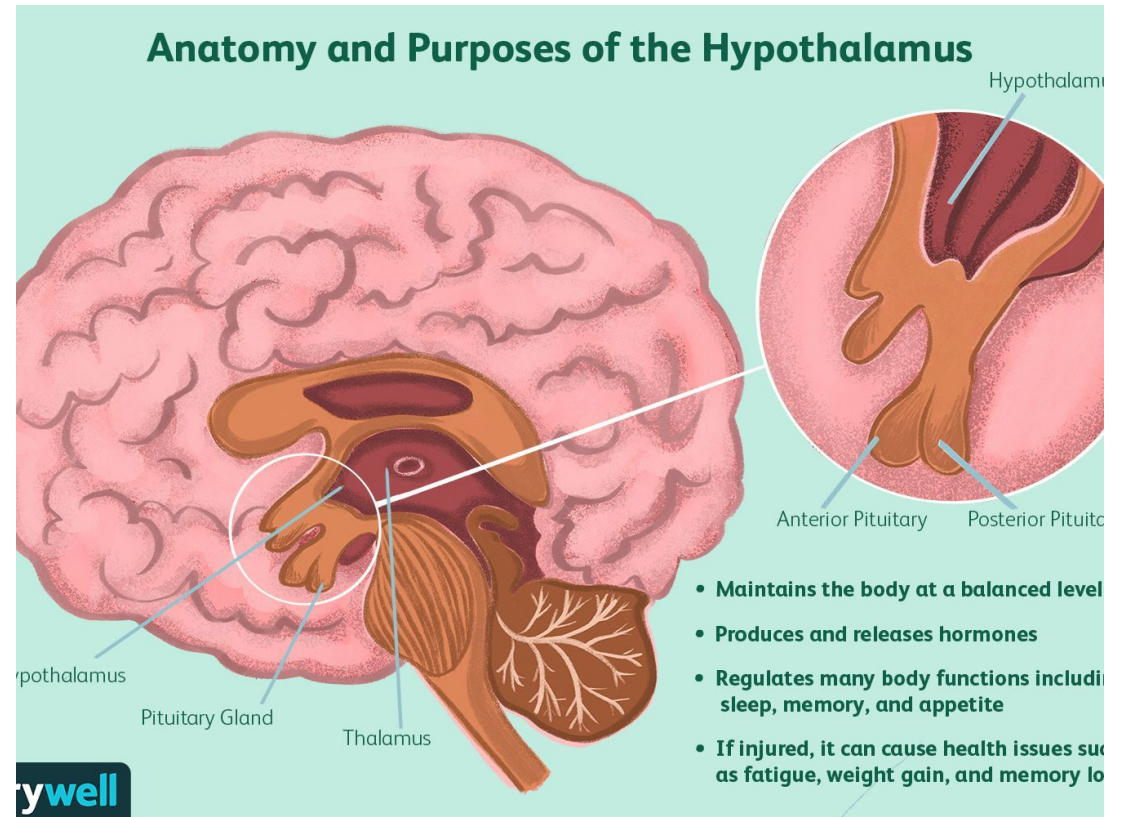
Thalamus

- Paired gray matter structure located near the center of the brain
- It is above the midbrain, allowing for nerve fiber connections to the cerebral cortex in all directions (relay motor and sensory signals to the cerebral cortex)



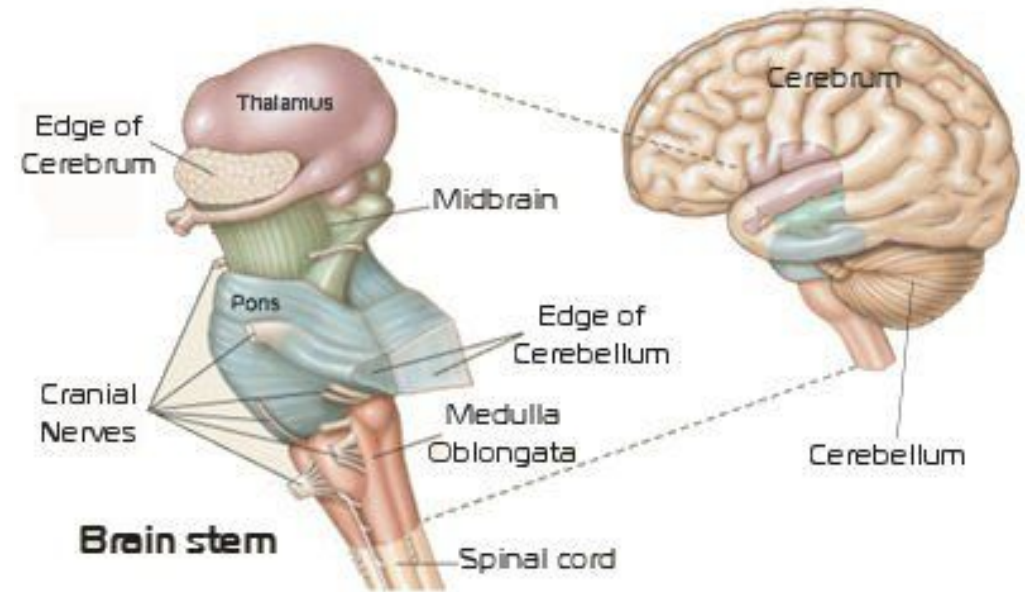
Hypothalamus

- Small area located above the pituitary gland and below the thalamus & attached to the pituitary gland by a small stalk
- Releasing & controlling hormones
- Controlling appetite
- Managing sexual behavior
- Regulating body temperature
- Fluid and electrolyte balance, including thirst

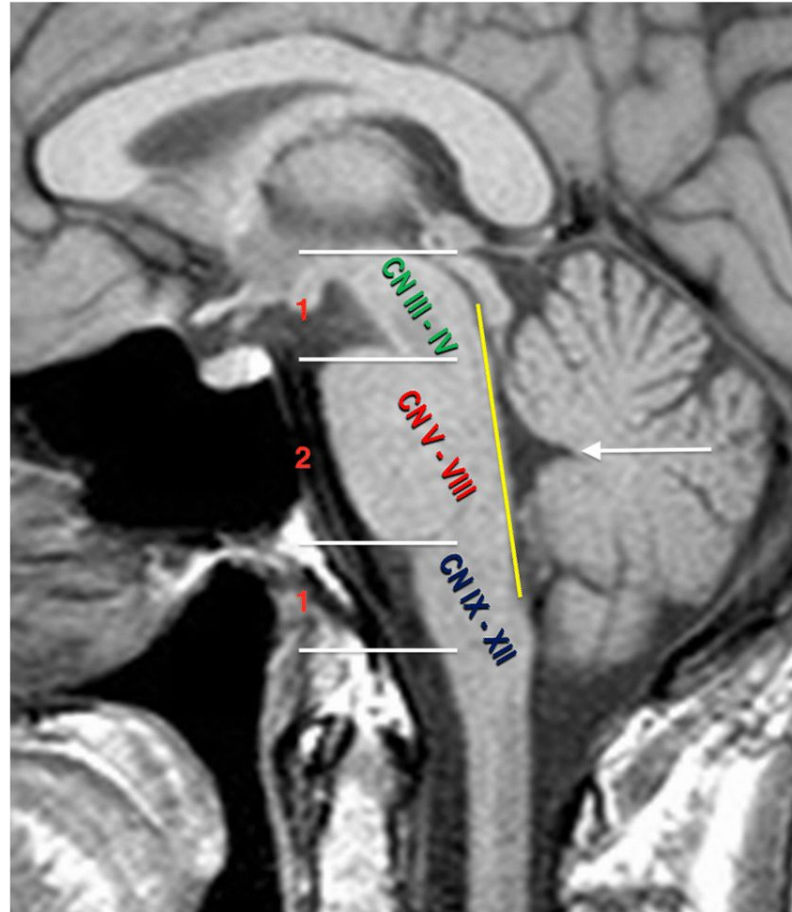


Brainstem

- Connects brain to spinal cord
 - Contains cranial nerve nuclei III to XII
 - Regulates respiration, cardiovascular function & consciousness
- Midbrain
 - Pons
 - Medulla Oblongata

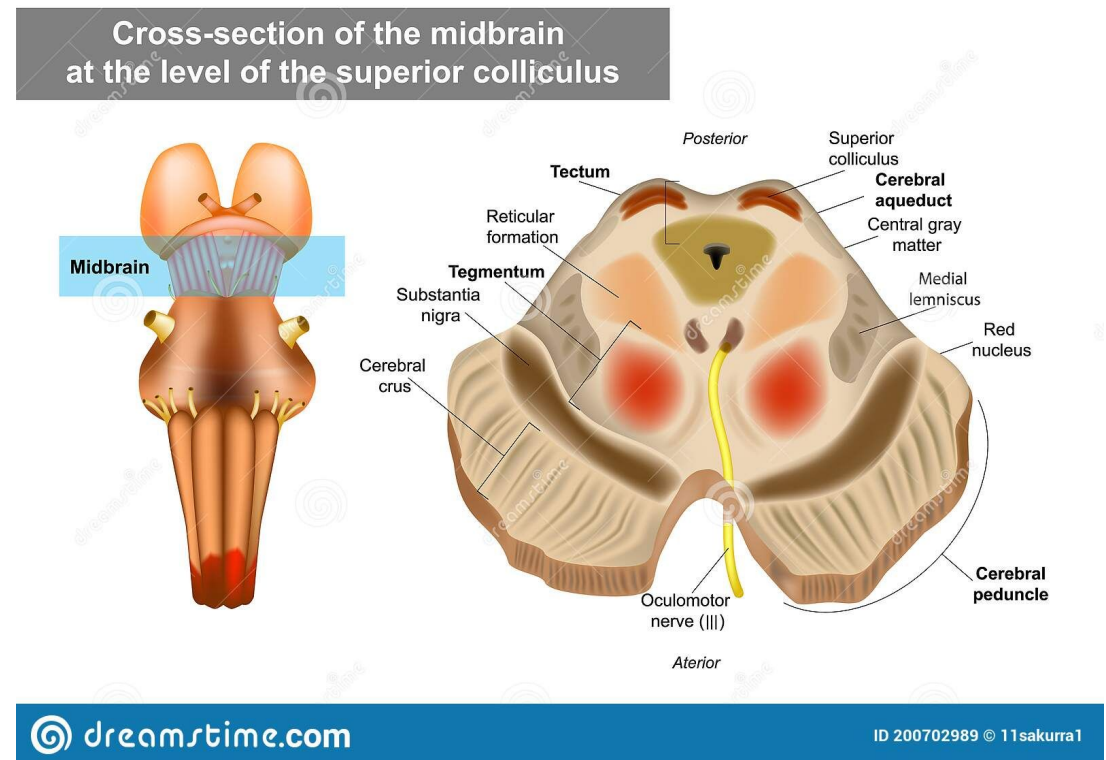


Brainstem



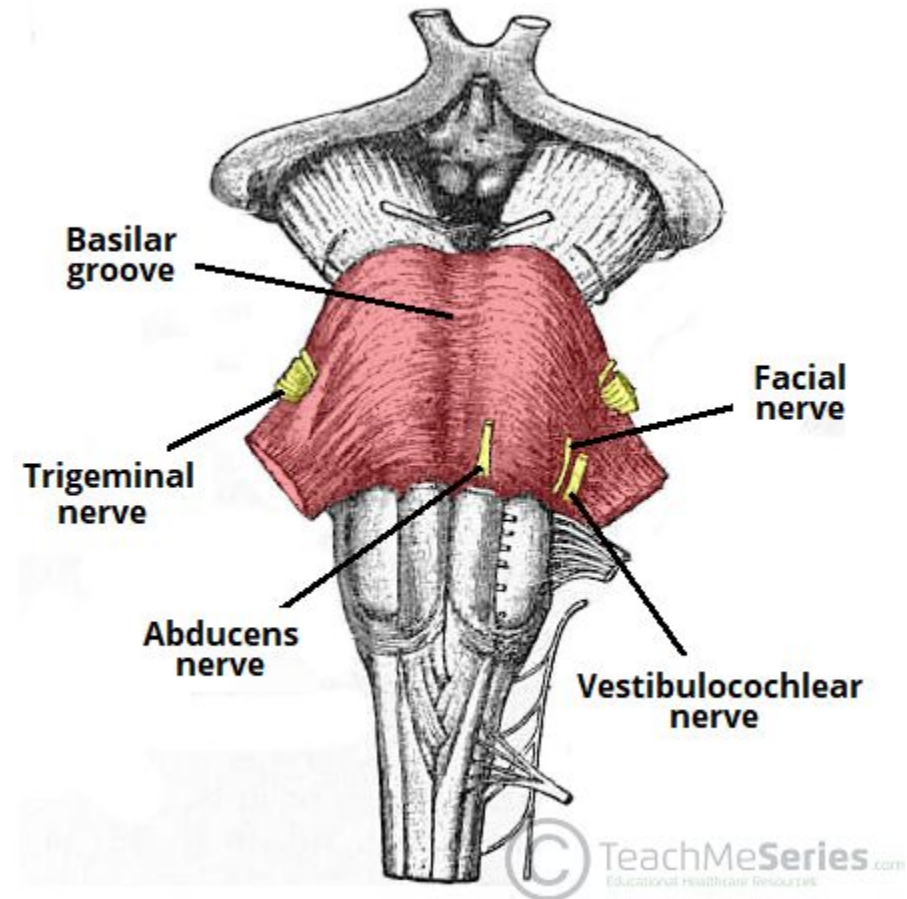
Midbrain

- III & IV CN
- 2 crus cerebri (pyramidal tracts)
- Quadrigeminal plate (superior colliculi & inferior colliculi)
- Cerebral aqueduct



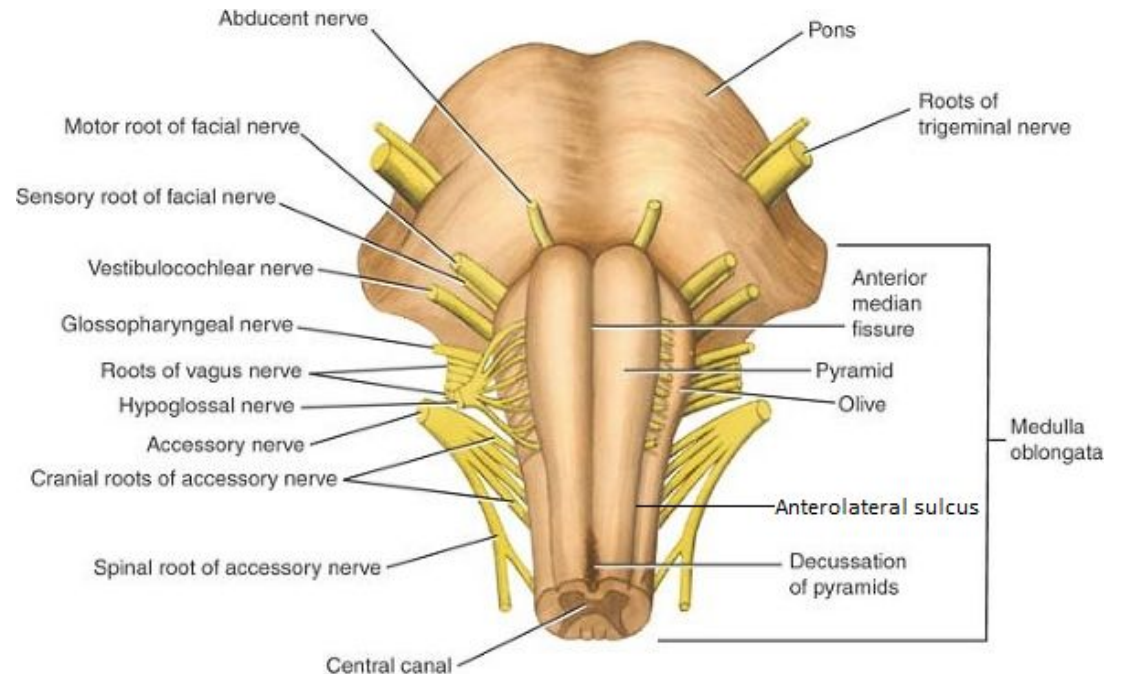
Pons

- V, VI, VII, VIII CN
- The posterior surface of the pons faces the cerebellum and forms the upper part of the floor of the fourth ventricle

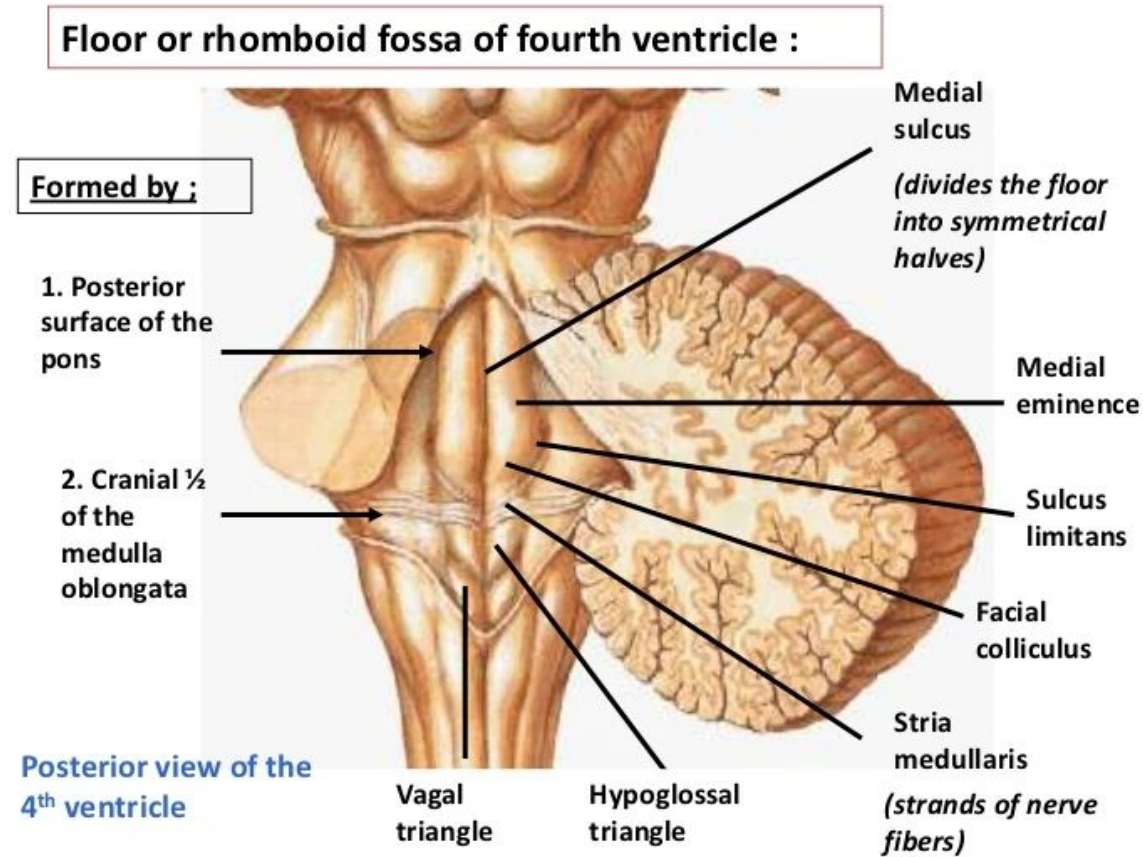


Medulla oblongata

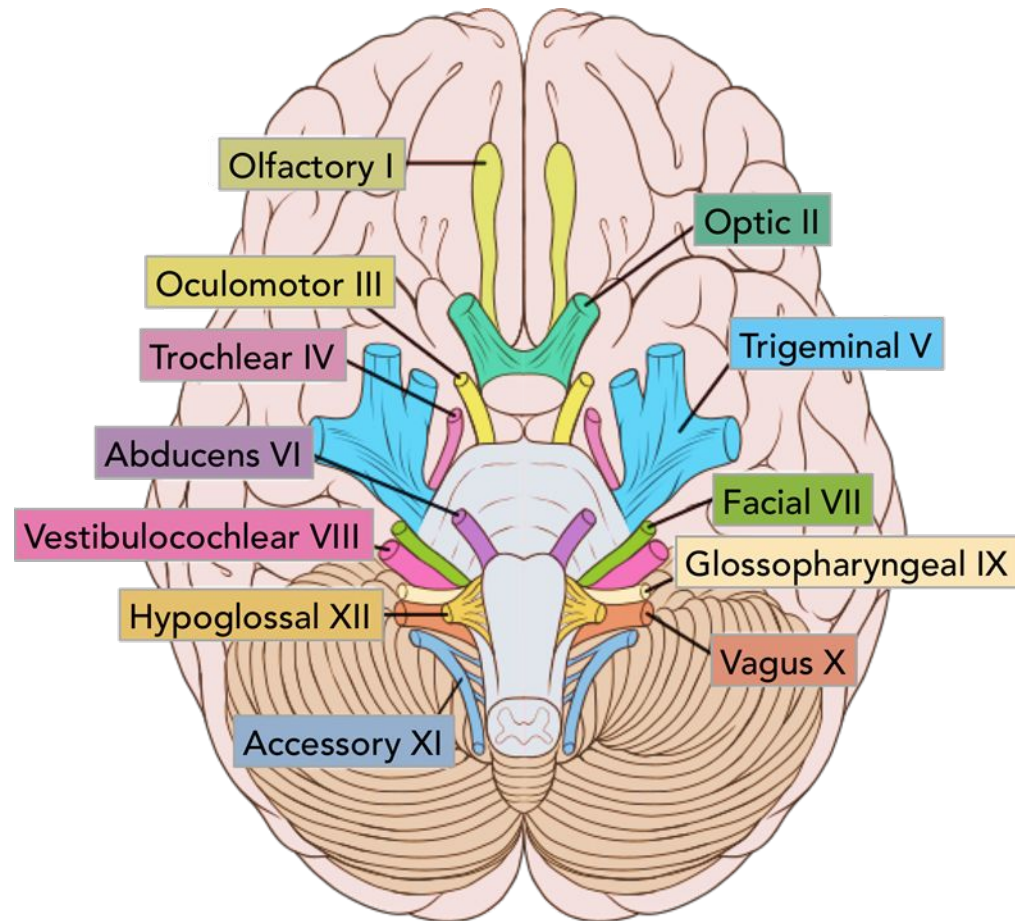
- Connects with the spinal cord at the level of the foramen magnum
- IX, X, XI, XII CN
- The posterior surface of the medulla faces the cerebellum and forms the lower part of the floor of the fourth ventricle



Floor of the 4th ventricle

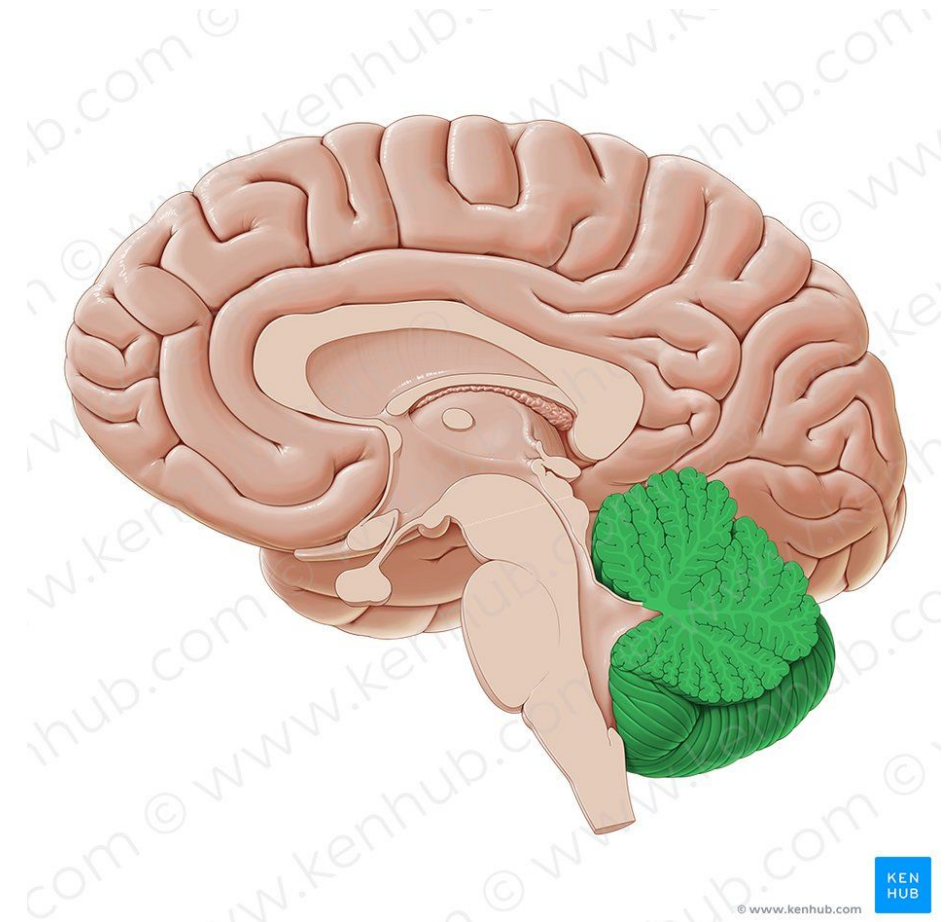
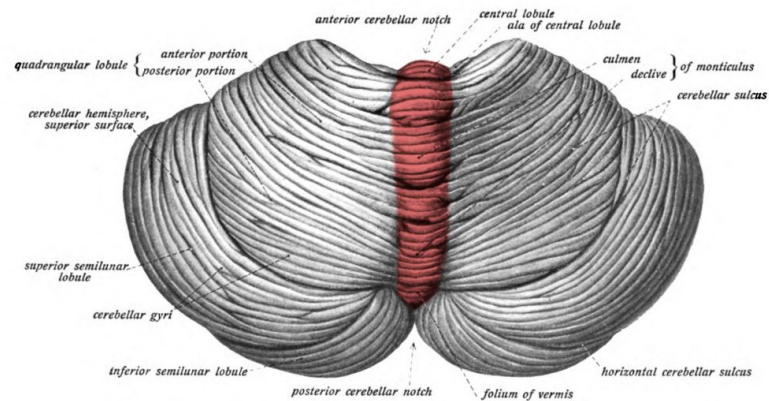


Cranial Nerves



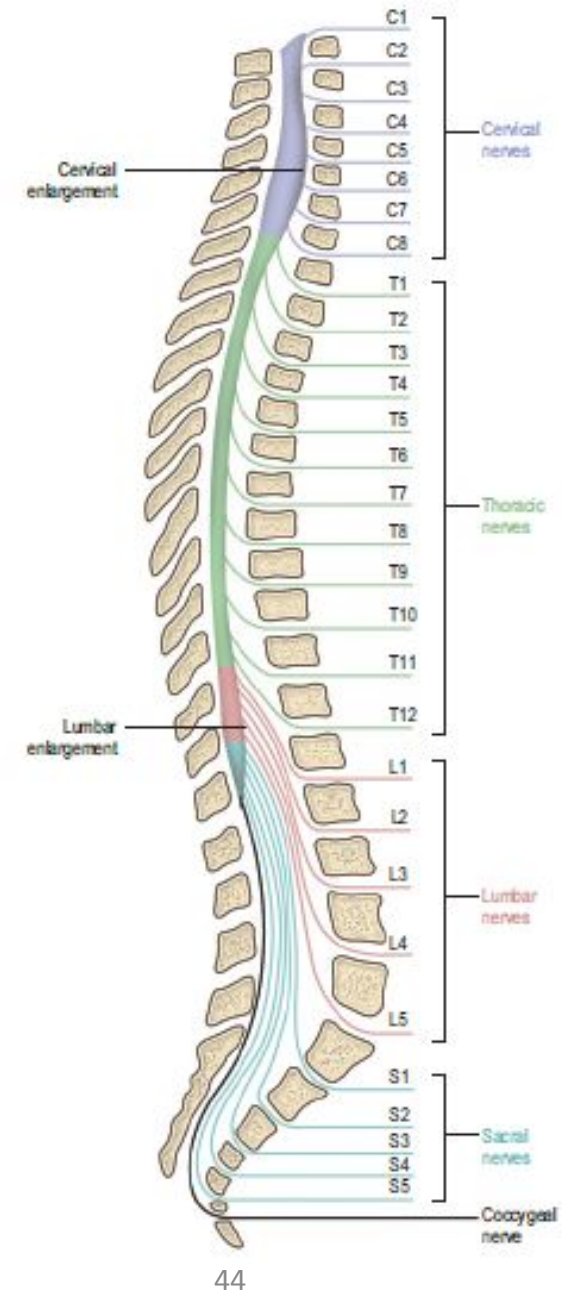
Cerebellum

- Located in the posterior fossa, infratentorial
- Main function: coordination of motor movement



Spinal cord

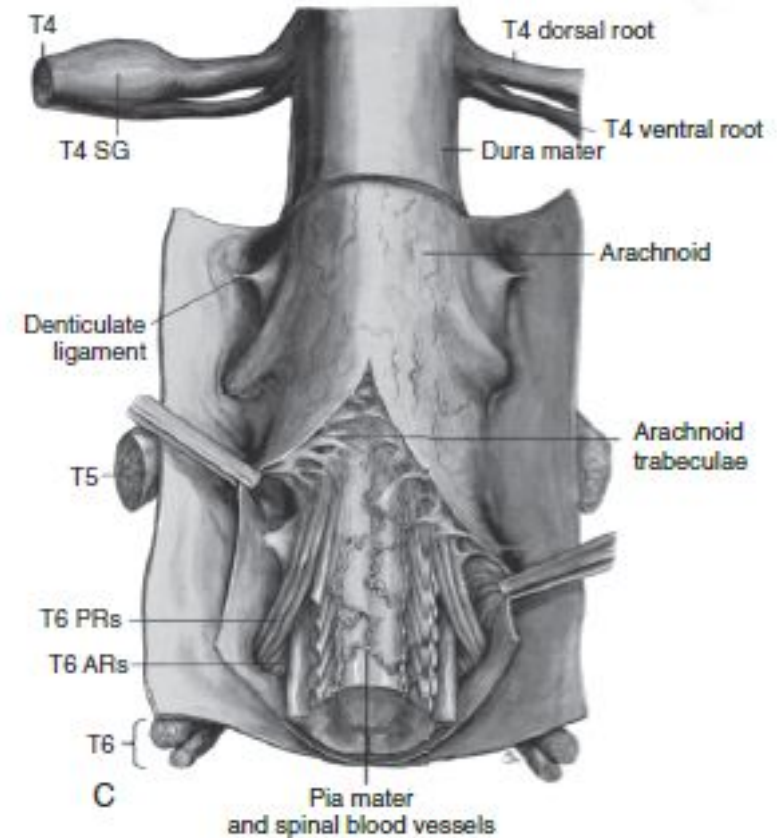
- Occupies the vertebral canal
- Extends from foramen magnum to L1-L2 level
- Cylindrical in shape
- Numerous ascending and descending axonal tracts
- Like the brain, it is surrounded by 3 concentric meninges (ending at S2)



Spinal cord

Denticulate ligaments

- A pia mater sheet
- Extends between the anterior and posterior roots
- Extend out through the arachnoid mater to attach onto the dura
- Anchor and position the spinal cord within the central area of the subarachnoid space.

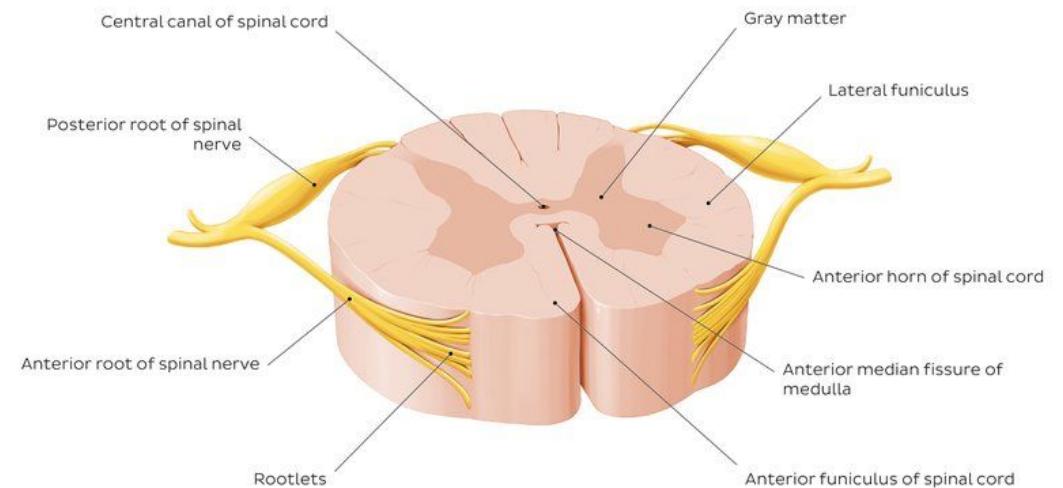


Spinal cord

Cross section

- Anterior median fissure
- Posterior median sulcus
- Posterolateral sulcus
- Posterior intermediate sulcus
- Outer white matter columns
- Inner H-shaped gray matter (horns)

Rootlets → Roots from each segment (anterior & posterior) → Spinal nerves (No. 31)

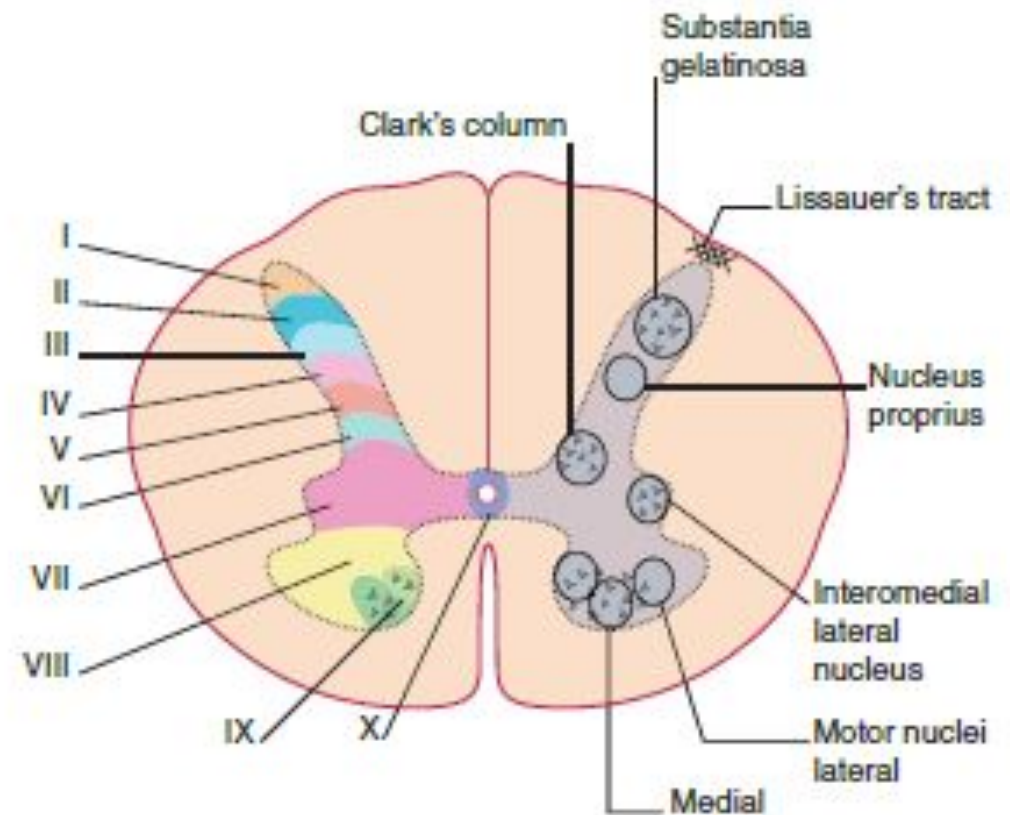


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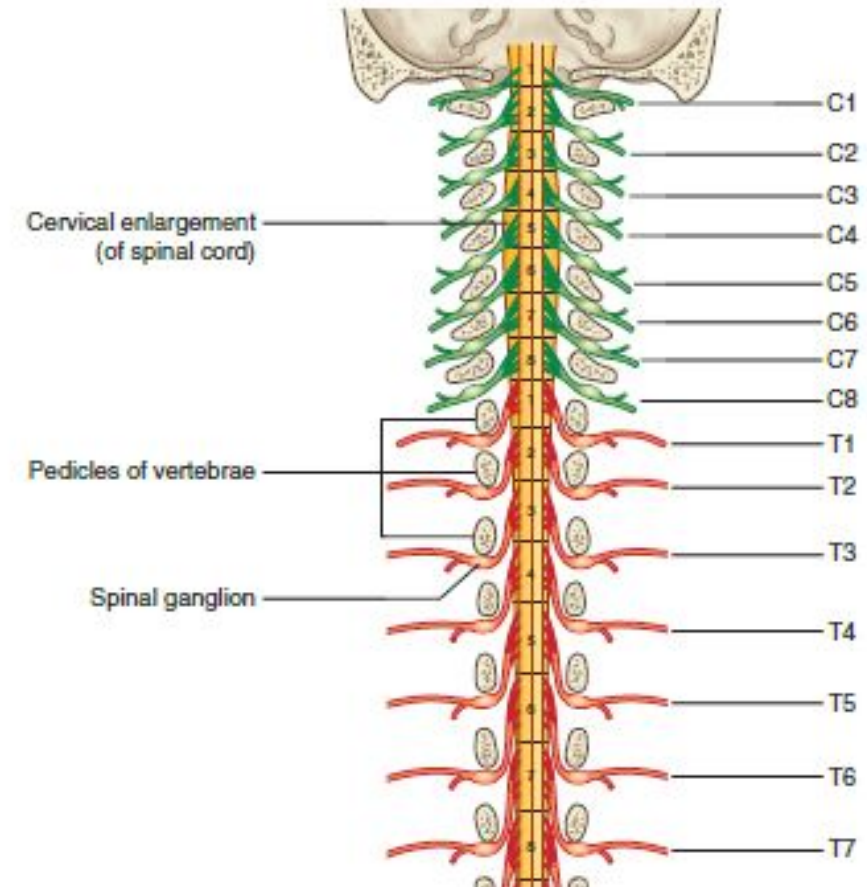
Spinal cord

- The grey matter is divided into 10 zones known as Rexed's laminae. The anterior horn contains motor neuron. The posterior horns, sensory.
- The white matter: The anterior funiculus (column) consists of motor axons, the posterior consists of sensory.



Spinal cord

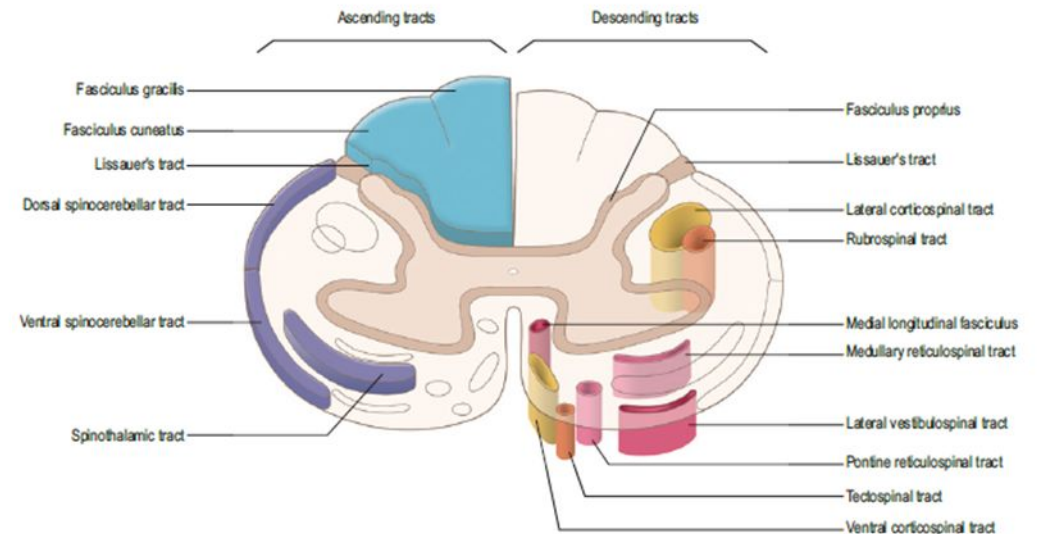
- Spinal nerves exit above the corresponding vertebra in Cervical spine, but below it in thoracic & lower spine
- This is because we have 7 cervical vertebrae but 8 cervical cord segments



Spinal cord

Important tracts:

- Lateral corticospinal (Pyramidal) tract (↓ motor)
- Anterolateral/spinothalamic tract (↑ pain & t^0)
- Posterior column–medial lemniscal pathway (↑ conscious proprioception, vibration, and discriminative touch)





For you!