THOMAS ADEWUMI UNIVERSITY

ANA 212: ANATOMY OF THE CEREBELLUM, CEREBRUM AND CRANIAL NERVE

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B.Sc; M.Sc; Ph.D In view (Unilorin)

Cerebellum

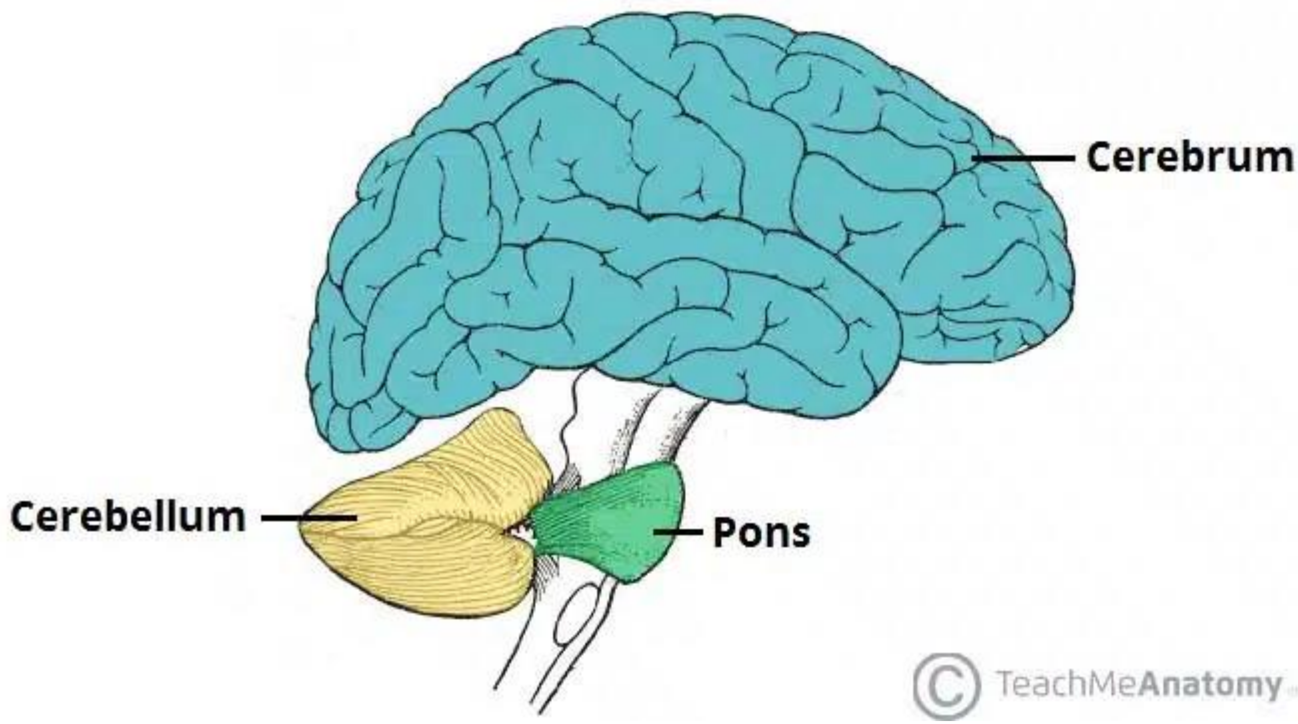
- ❖ The cerebellum, which stands for “little brain”, is a structure of the central nervous system.
- ❖ It has an important role in motor control, with cerebellar dysfunction often presenting with motor signs.
- ❖ In particular, it is active in the coordination, precision and timing of movements, as well as in motor learning.
- ❖ During embryonic development, the anterior portion of the neural tube forms three parts that give rise to the brain and associated structures:
- Forebrain (prosencephalon)
- Midbrain (mesencephalon)
- Hindbrain (rhombencephalon)

Cerebellum

- The hindbrain subsequently divides into the metencephalon (superior) and the myelencephalon (inferior).
- The cerebellum develops from the metencephalon division.

Anatomical Location

- The cerebellum is located at the back of the brain, immediately inferior to the occipital and temporal lobes, and within the posterior cranial fossa.
- It is separated from these lobes by the tentorium cerebelli, a tough layer of dura mater.
- It lies at the same level of and posterior to the pons, from which it is separated by the fourth ventricle.
- Anatomical position of the cerebellum. It is inferior to the cerebrum, and posterior to the pons.


Cerebrum
Cerebellum
Pons
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Anatomical Structure and Divisions

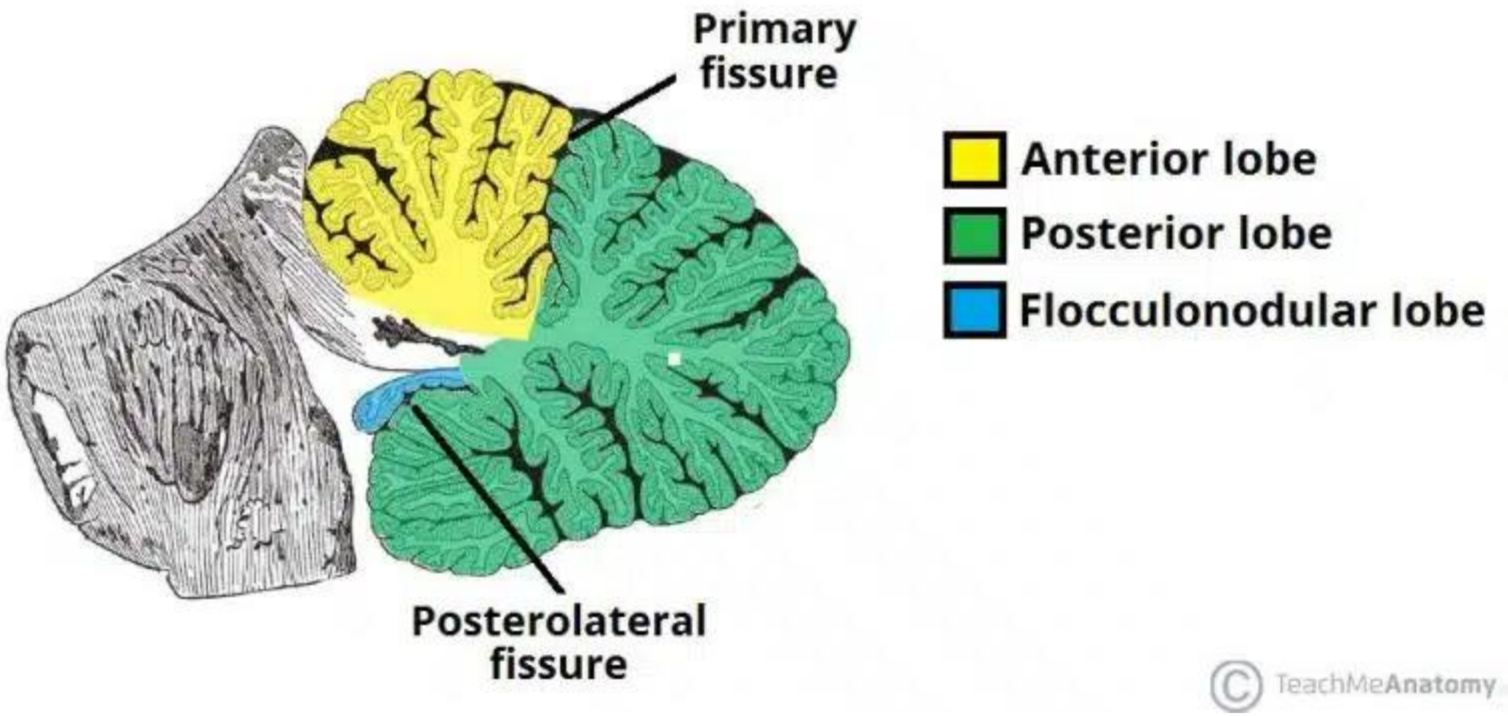
- ❖ The cerebellum consists of two hemispheres which are connected by the vermis, a narrow midline area.
- ❖ Like other structures in the central nervous system, the cerebellum consists of grey matter and white matter:
- Grey matter – located on the surface of the cerebellum. It is tightly folded, forming the cerebellar cortex.
- White matter – located underneath the cerebellar cortex. Embedded in the white matter are the four cerebellar nuclei (the dentate, emboliform, globose, and fastigi nuclei).
- ❖ There are three ways that the cerebellum can be subdivided – anatomical lobes, zones and functional divisions

Anatomical Lobes

- There are three anatomical lobes that can be distinguished in the cerebellum; the anterior lobe, the posterior lobe and the flocculonodular lobe.
- These lobes are divided by two fissures – the primary fissure and posterolateral fissure.

- **Zones**

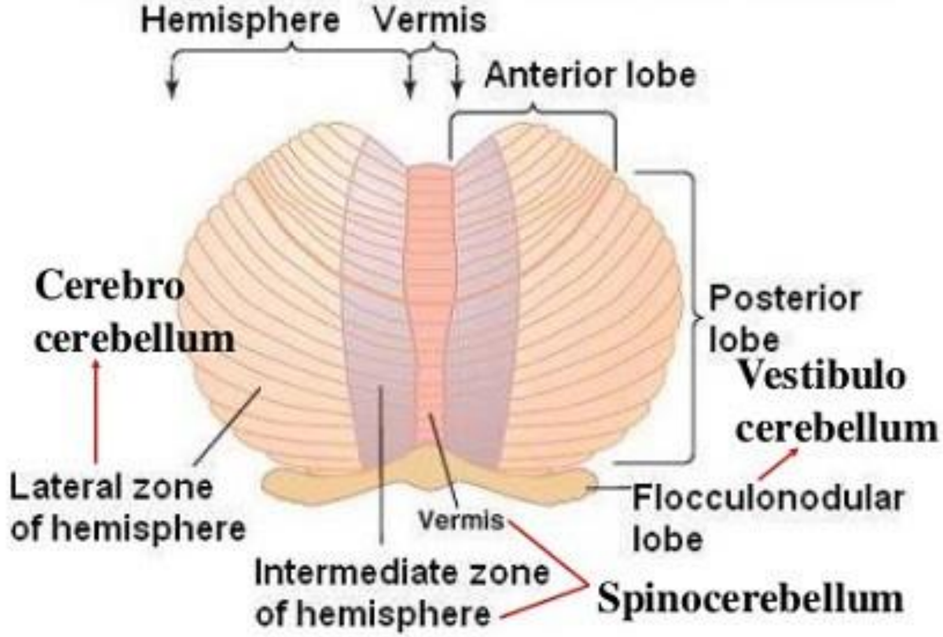
- There are three cerebellar zones. In the midline of the cerebellum is the vermis.
- Either side of the vermis is the intermediate zone.
- Lateral to the intermediate zone are the lateral hemispheres.
- There is no difference in gross structure between the lateral hemispheres and intermediate zones


Primary
fissure
Anterior lobe
Posterior lobe
Flocculonodular lobe
Posterolateral
fissure
TeachMeAnatomy

Functional Divisions

- ❖ The cerebellum can also be divided by function.
- ❑ Cerebrocerebellum – the largest division, formed by the lateral hemispheres.
- It is involved in planning movements and motor learning.
- It receives inputs from the cerebral cortex and pontine nuclei, and sends outputs to the thalamus and red nucleus.
- This area also regulates coordination of muscle activation and is important in visually guided movements.

Longitudinal functional divisions

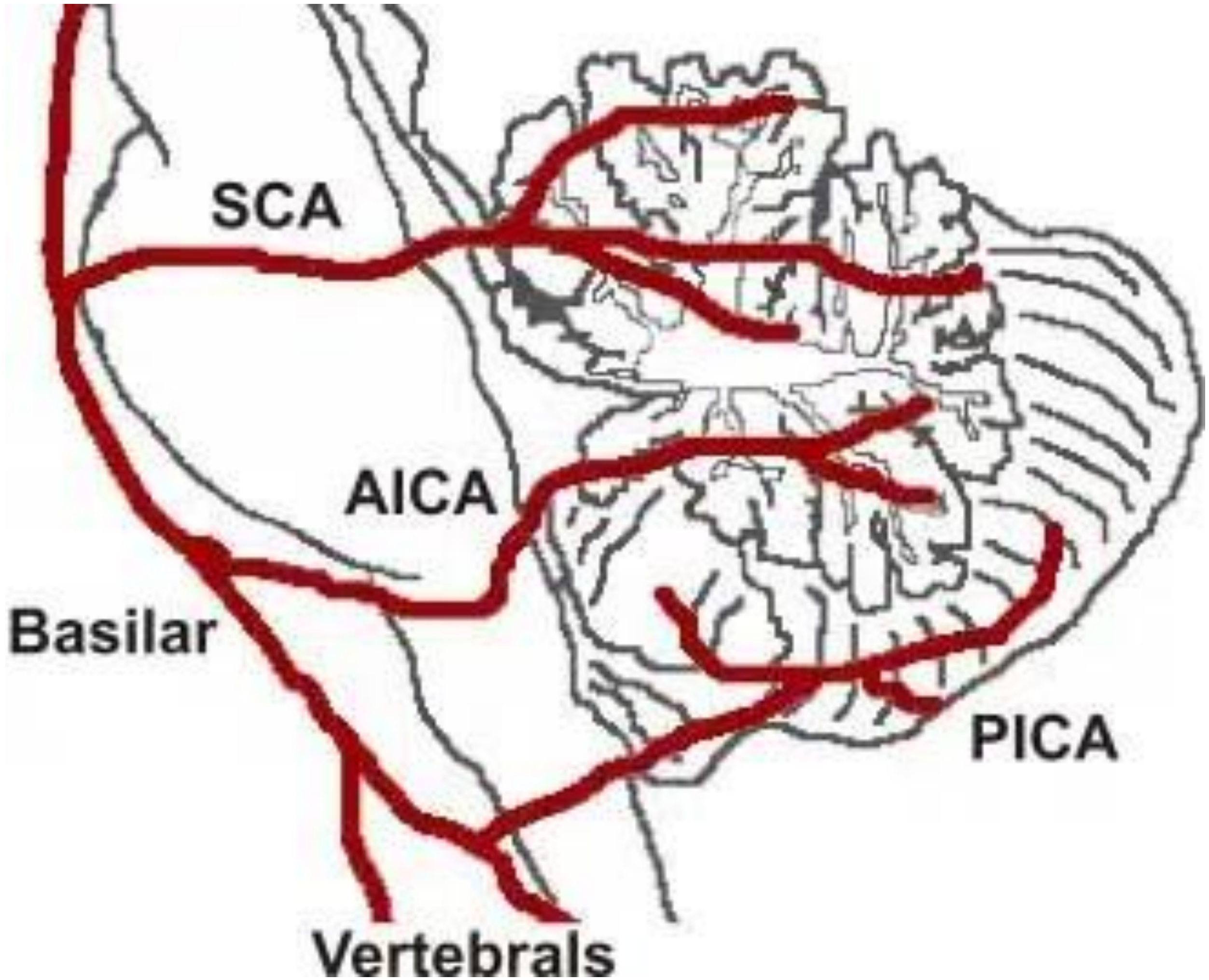


Functional Divisions

- Spinocerebellum – comprised of the vermis and intermediate zone of the cerebellar hemispheres.
- It is involved in regulating body movements by allowing for error correction.
- It also receives proprioceptive information.
- Vestibulocerebellum – the functional equivalent to the flocculonodular lobe.
- It is involved in controlling balance and ocular reflexes, mainly fixation on a target.
- It receives inputs from the vestibular system, and sends outputs back to the vestibular nuclei.

Vasculature

- ❖ The cerebellum receives its blood supply from three paired arteries:
- Superior cerebellar artery (SCA)
- Anterior inferior cerebellar artery (AICA)
- Posterior inferior cerebellar artery (PICA)
- The SCA and AICA are branches of the basilar artery, which wraps around the anterior aspect of the pons before reaching the cerebellum.
- The PICA is a branch of the vertebral artery.
- ❖ **Venous** drainage of the cerebellum is by the superior and inferior cerebellar veins. They drain into the superior petrosal, transverse and straight dural venous sinuses.


SCA
AICA
Basilar
PICA
Vertebrals

CLINICAL RELEVANCE

❖ Cerebellar Dysfunction

- Dysfunction of the cerebellum can produce a wide range of symptoms and signs.
- The aetiology is varied; causes include stroke, physical trauma, tumours and chronic alcohol excess.
- The clinical picture is dependent on the functional area of the cerebellum that is affected.
- Damage to the cerebrocerebellum and spinocerebellum presents with problems in carrying out skilled and planned movements and in motor learning.

CLINICAL RELEVANCE

- ❖ Dysdiadochokinesia is a neurological disorder that affects the cerebellum, leading to difficulties with rapid, alternating movements.
- ❖ Ataxia is a neurological sysmptom characterized by a lack of coordination balance, and precision in movement. It can affect various parts of the body, including:

- Arms and leg (limb ataxia)
- Trunk and torso (truncal ataxia)
- Eyes and vision (ocular ataxia)
- Speech and language (ataxia dysarthria).

CEREBRUM

- The cerebrum is the largest part of the brain, located superiorly and anteriorly in relation to the brainstem.
- It consists of two cerebral hemispheres (left and right), separated by the falx cerebri of the dura mater.
- Embryologically, the cerebrum is derived from the prosencephalon.
- We will look at the anatomy of the cerebrum – its structure, function, blood supply and the clinical implications of cerebral lesions.

Anatomical Position and Structure

- ❖ The cerebrum is located within the bony cranium. It extends from the frontal bone anteriorly to the occipital bone posteriorly.
- ❖ Within the skull, the cerebrum fills the anterior and middle cranial fossae, and is located above the tentorium cerebelli inferoposteriorly.

❑ **Internal Structure**

- The cerebrum is comprised of two different types of tissue – grey matter and white matter:
- Grey matter forms the surface of each cerebral hemisphere (known as the cerebral cortex), and is associated with processing and cognition.
- White matter forms the bulk of the deeper parts of the brain. It consists of glial cells and myelinated axons that connect the various grey matter areas.

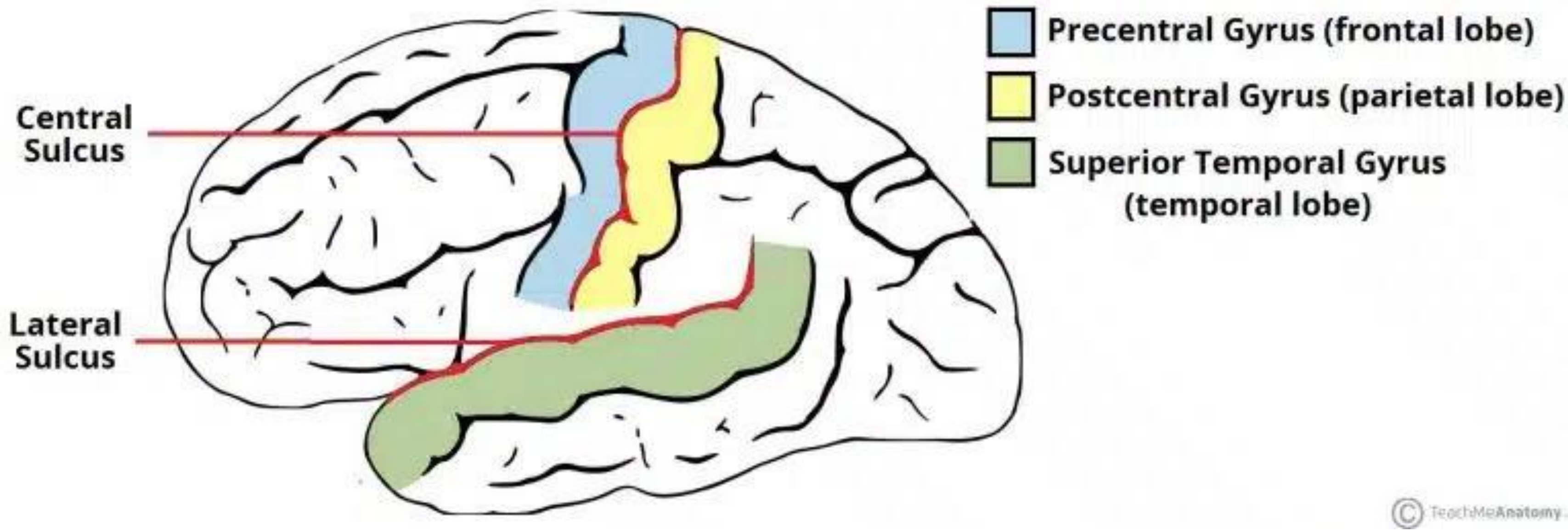
Anatomical Position and Structure

❑ External Structure

- Externally, the cerebrum has a highly convoluted appearance, consisting of sulci (grooves or depressions) and gyri (ridges or elevations).
- It is divided into two anatomically symmetrical hemispheres by the longitudinal fissure – a major sulcus that runs in the median sagittal plane.
- The falx cerebri (a fold of dura mater) descends vertically to fill this fissure.
- The two cerebral hemispheres are connected by a white matter structure, called the corpus callosum.

Anatomical Position and Structure

- **The main sulci are**:
  - Central sulcus – groove separating the frontal and parietal lobes.
  - Lateral sulcus – groove separating the frontal and parietal lobes from the temporal lobe.
  - Lunate sulcus – groove located in the occipital cortex.
- **The main gyri are**:
  - Precentral gyrus – ridge directly anterior to central sulcus, location of primary motor cortex.
  - Postcentral gyrus – ridge directly posterior to central sulcus, location of primary somatosensory cortex.
  - Superior temporal gyrus – ridge located inferior to lateral sulcus, responsible for the reception and processing of sound.


Central
Sulcus
Lateral
Sulcus
Precentral Gyrus (frontal lobe)
Postcentral Gyrus (parietal lobe)
Superior Temporal Gyrus
(temporal lobe)
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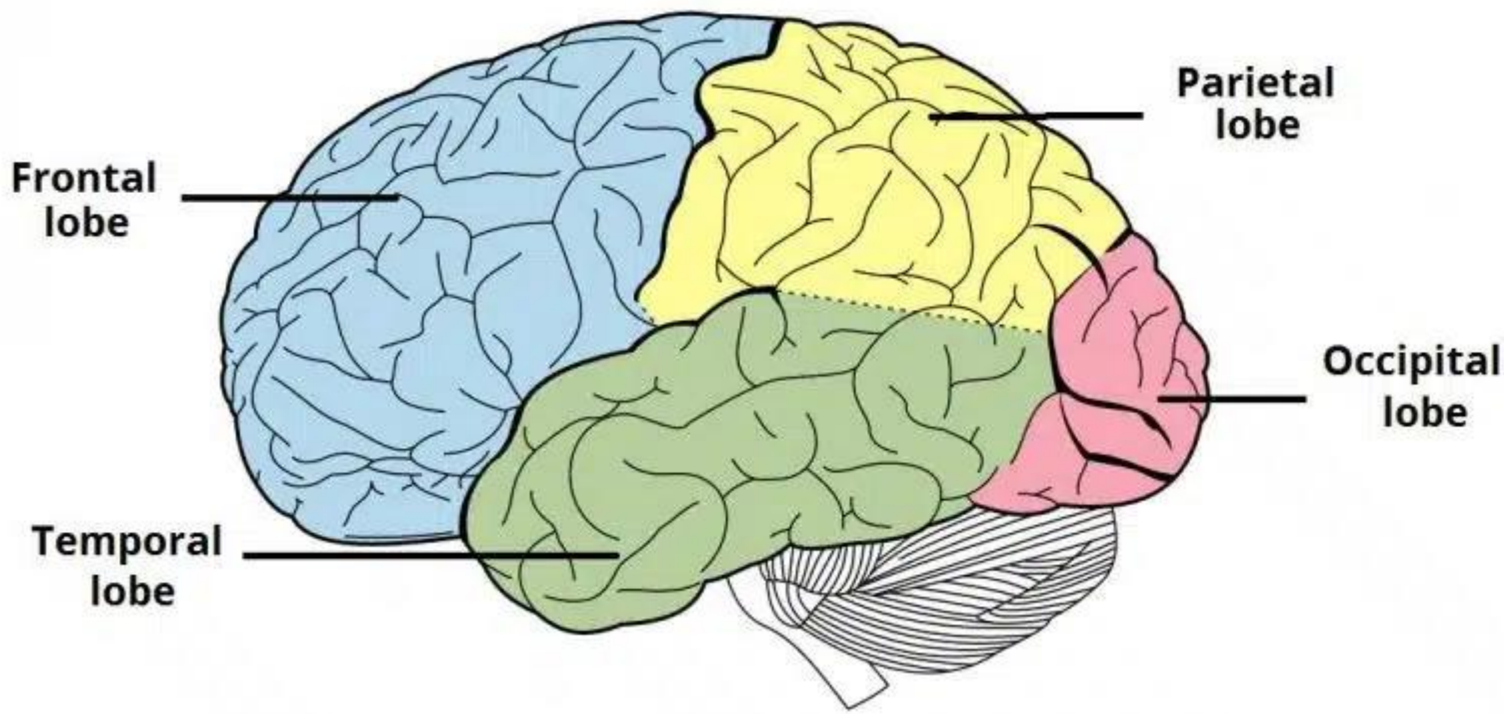
Lobes of the Cerebrum

- The cerebral cortex is classified into four lobes, according to the name of the corresponding cranial bone that approximately overlies each part.
- Each lobe contains various cortical association areas – where information from different modalities are collated for processing.

- Frontal Lobe

- The frontal lobe is located beneath the frontal bone of the calvaria and is the most anterior region of the cerebrum.
- It is separated from the parietal lobe posteriorly by the central sulcus and from the temporal lobe inferoposteriorly by the lateral sulcus.


Parietal lobe
Frontal lobe
Occipital lobe
Temporal lobe

Lobes of the Cerebrum

- The association areas of the frontal lobe are responsible for: higher intellect, personality, mood, social conduct and language (dominant hemisphere side only).

❑ Parietal Lobe

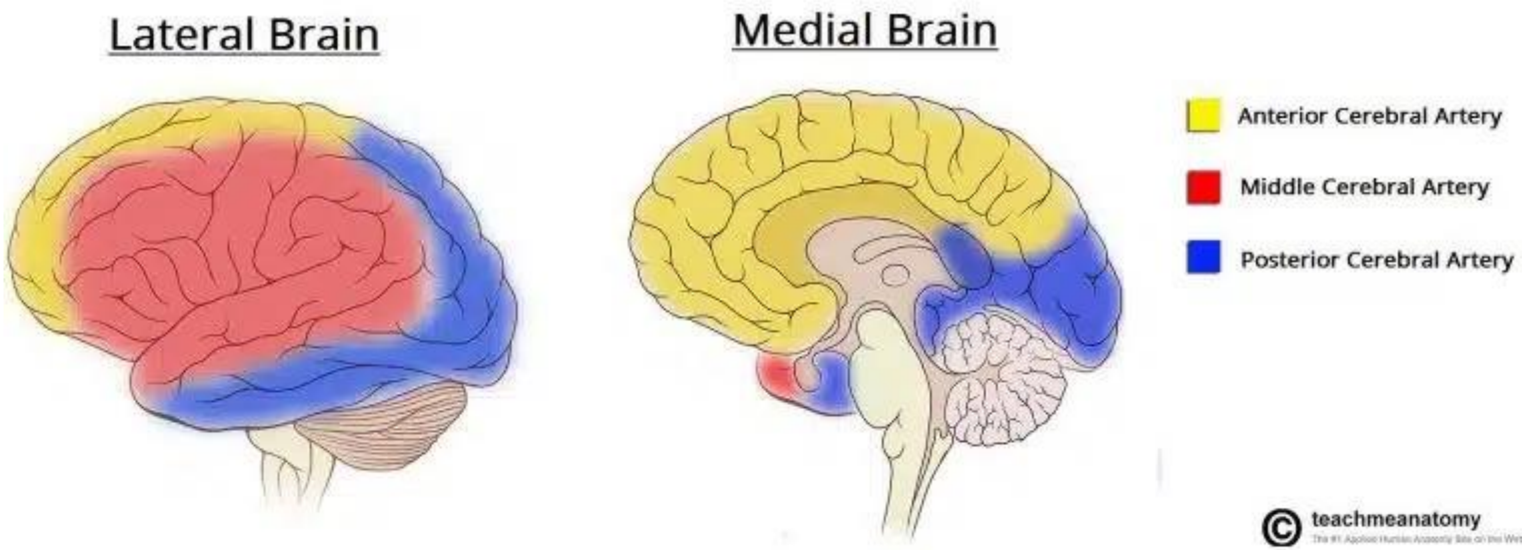
- The parietal lobe is found below the parietal bone of the calvaria, between the frontal lobe anteriorly and the occipital lobe posteriorly, from which it is separated by the central sulcus and parieto-occipital sulcus, respectively.
- It sits superiorly in relation to the temporal lobe, being separated by the lateral sulcus.
- Its cortical association areas contribute to the control of: language and calculation on the dominant hemisphere side, and visuospatial functions (e.g. 2-point discrimination) on the non-dominant hemisphere side.

Lobes of the Cerebrum

- ❑ Temporal Lobe
- The temporal lobe sits beneath the temporal bone of the calvaria, inferior to the frontal and parietal lobes, from which it is separated by the lateral sulcus.
- The cortical association areas of the temporal lobe are accountable for memory and language – this includes hearing as it is the location of the primary auditory cortex.
- ❑ Occipital Lobe
- The occipital lobe is the most posterior part of the cerebrum situated below the occipital bone of the calvaria.
- Its inferior aspect rests upon the tentorium cerebelli, which segregates the cerebrum from the cerebellum.
- The parieto-occipital sulcus separates the occipital lobe from the parietal and temporal lobes anteriorly.
- The primary visual cortex (V1) is located within the occipital lobe and hence its cortical association area is responsible for vision.

Vasculature

- ❖ The blood supply to the cerebrum can be simply classified into 3 distinct paired arterial branches:
- Anterior Cerebral Arteries – branches of internal carotid arteries, supplying the anteromedial aspect of the cerebrum.
- Middle Cerebral Arteries – continuation of internal carotid arteries, supplying most of the lateral portions of the cerebrum.
- Posterior Cerebral Arteries – branches of the basilar arteries, supplying both the medial and lateral sides of the cerebrum posteriorly.
- ❖ Venous drainage of the cerebrum is via a network of small cerebral veins. These vessels empty into the dural venous sinuses – endothelial lined spaces between the outer and inner layers of dura mater.



Lateral Brain
Medial Brain
Anterior Cerebral Artery
Middle Cerebral Artery
Posterior Cerebral Artery
teachmeanatomy

CLINICAL RELEVANCE

❖ Cerebrovascular Accident

- A cerebrovascular accident (also known as a stroke) is defined clinically as "an abrupt loss of focal brain function lasting more than 24 hours due to either spontaneous haemorrhage into brain substance or inadequate blood supply to part of the brain i.e. ischaemia (thrombosis, embolism)".
- Damage to the cerebrum in this matter can give rise to a range of clinical signs.
- The exact nature of the functional deficit that arises depends on the specific lobe that has been affected:

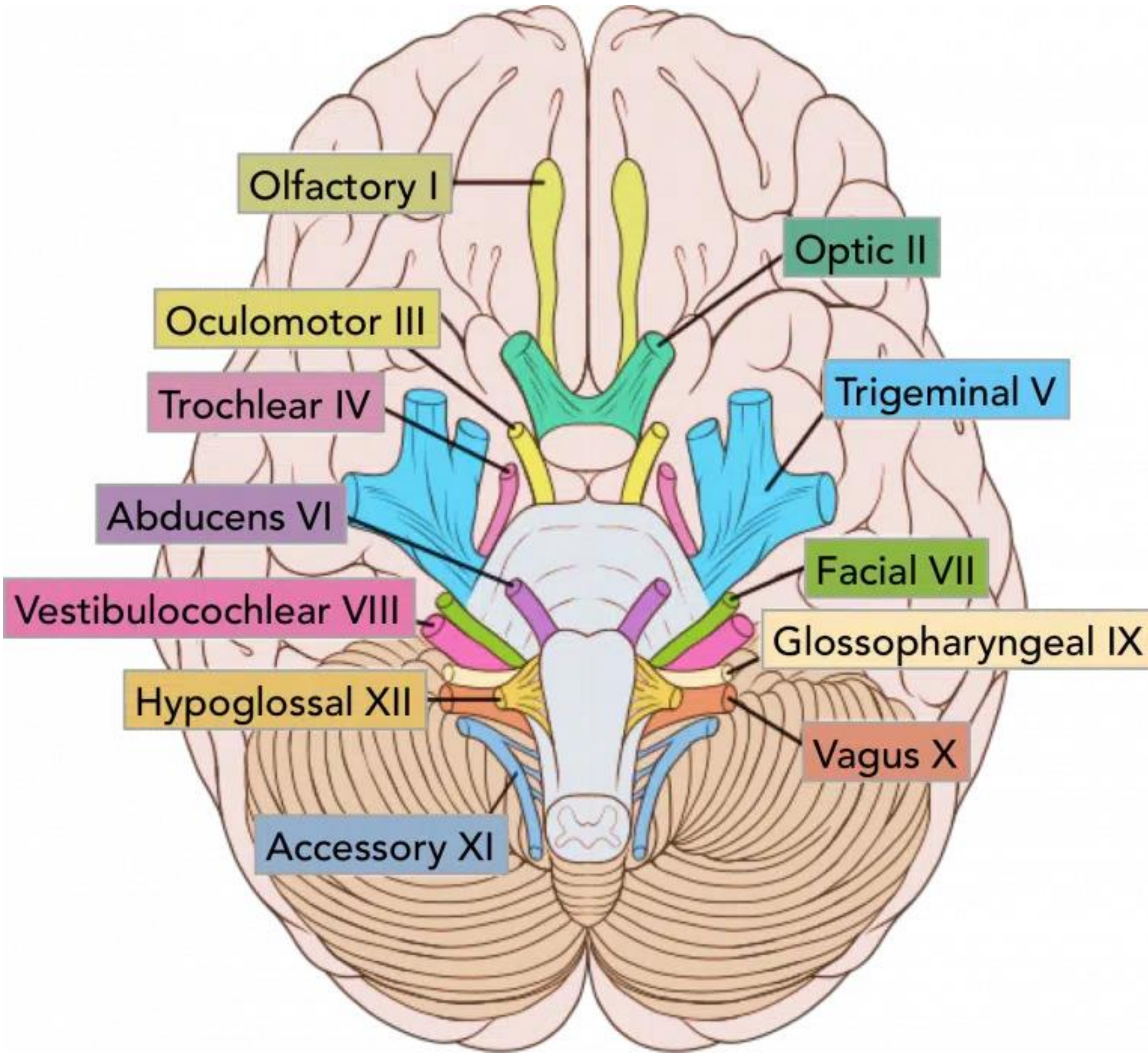
➢ Frontal lobe – a diverse range of presentations, often personality and behavioural changes occur and an inability to solve problems develops.

CLINICAL RELEVANCE

- Parietal lobe – typically presents with attention deficits e.g. contralateral hemispatial neglect syndrome: where the patient does not pay attention to the side of the body opposite to the lesion.
- Temporal lobe – presents with recognition deficits (agnosias) e.g. auditory agnosia: patient cannot recognise basic sounds, prosopagnosia: failure to recognise faces.
- Occipital lobe – visual field defects: contralateral hemianopia or quadrantanopia with macular sparing.
- Global lesions – severe cognitive deficits (dementia), patients cannot answer simple questions such as their name, today's date, where they are etc.

Cranial Nerves

- The cranial nerves are a set of 12 paired nerves that arise directly from the brain.
- The first two nerves (olfactory and optic) arise from the cerebrum, whereas the remaining ten emerge from the brainstem.
- The names of the cranial nerves relate to their function and they are numerically identified in roman numerals (I-XII).


Olfactory I
Optic II
Oculomotor III
Trochlear IV
Trigeminal V
Abducens VI
Facial VII
Vestibulocochlear VIII
Glossopharyngeal IX
Hypoglossal XII
Vagus X
Accessory XI

Origin Cranial Nerves

- The olfactory nerve (CN I) and optic nerve (CN II) originate from the cerebrum.
- Midbrain – the trochlear nerve (IV)
- Midbrain-pontine junction – oculomotor (III).
- Pons – trigeminal (V).
- Pontine-medulla junction – abducens, facial, vestibulocochlear (VI-VIII).
- Medulla oblongataPosterior to the olive: glossopharyngeal, vagus, accessory (IX-XI).Anterior to the olive: hypoglossal (XII).
- The cranial nerves are numbered by their location on the brainstem (superior to inferior, then medial to lateral) and the order of their exit from the cranium (anterior to posterior).

Modalities

❖ **Sensory (afferent) modalities**:
- General somatic sensory (GSS) – general sensation from skin.
- General visceral sensory (GVS) – general sensation from viscera.
- Special somatic sensory (SSS) – senses derived from ectoderm (e.g. sight, sound, balance).
- Special visceral sensory (SVS) – senses derived from endoderm (e.g. taste, smell).

❖ **Motor (efferent) modalities**:
- General somatic motor (GSM) – skeletal muscles.
- General visceral motor (GVM) – smooth muscles of gut and autonomic motor.
- Special visceral motor (SVM) – muscles derived from pharyngeal arches.

FUNCTION

Number	Name	Exit	Modality	Function
1	(CN I) Olfactory	Cribriform plate	Sensory (SVS)	Smell
2	(CN II) Optic	Optic canal	Sensory (SSS)	Vision
3	(CN III) Oculomotor	Superior orbital fissure	Motor (GSM & GVM)	GSM: 4 extrinsic eye muscles and levator palpebrae superioris. GVM: pupillary sphincter

FUNCTION

Number	Name	Exit	Modality	Function
4	(CN IV) Trochlear	Superior orbital fissure	Motor (GSM)	Superior oblique
5	(CN V) Trigeminal: Ophthalmic Maxillary Mandibular	Superior orbital fissure. F. rotundum. F. Ovale	GSS GSS GSS,SVM	Scalp, forehead and nose Cheeks, lower eye lid, nasal mucosa, upper lip, upper teeth and palate. Anterior 2/3 tongue, skin over mandible and lower teeth. Muscles of mastication.

FUNCTION

Number	Name	Exit	Modality	Function
6	(CN VI) Abducens	Superior orbital fissure	Motor (GSM)	Lateral rectus
7	(CN VII) Facial	Internal acoustic meatus > stylomastoid f.	GSS SVS SVM GVM	GSS: sensation to part of ext. ear. SVS: taste from ant. 2/3 tongue, hard and soft palate. SVM: muscles of facial expression. GVM: lacrimal, submandibular, sublingual glands and mucous glands of mouth and nose.
8	(CN VIII) Vestibulocochlear	Internal acoustic meatus	Sensory (SSS)	Hearing and balance.

FUNCTION

Number	Name	Exit	Modality	Function
9	(CN IX) Glossopharyngeal	Jugular f.	GSS GVS SVS GVM SVM	GSS: post. 1/3 tongue, ext. ear, and middle ear cavity. GVS: carotid body and sinus. SVS: taste from post. 1/3 tongue. GVM: parotid gland. SVM: stylopharyngeus.
10	(CN X) Vagus	Jugular f.	GSS GVS SVS GVM SVM	GSS: ext. ear, larynx and pharynx. GVS: larynx, pharynx and, thoracic & abdominal viscera. SVS: taste from epiglottis region of tongue GVM: smooth muscles of pharynx, larynx and most of the GIT. SVM: most muscles of pharynx and larynx.

FUNCTION

Number	Name	Exit	Modality	Function
11	(CN XI) Spinal accessory	Jugular f.	Motor (GSM & SVM)	GSM: trapezius and sternocleidomastoid. SVM: a few fibres run with CNX to viscera.
12	(CN XII) Hypoglossal	Hypoglossal canal	Motor (GSM)	Intrinsic and extrinsic tongue muscles (except the palatoglossus).


Thank You
For Listening
It's not bye bye, but see you again!
Ajiboye A.A