



Blood Supply of The Brain and Spinal Cord

By:

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M N U



Intended Learning Outcomes (ILOs)

1. **Identify the blood supply** of the different parts of the brain.
2. **Recognize the different sources** of blood supply of brain .
3. **List the branches of the arteries** of the brain and spinal cord.
4. **Enumerate venous drainage** of brain and spinal cord.
5. **Explain the different lesions** results from disturbances of blood supply to brain and spinal cord.



Agenda

1. **The vasculature of the brain**
2. **The vasculature of the spinal cord**



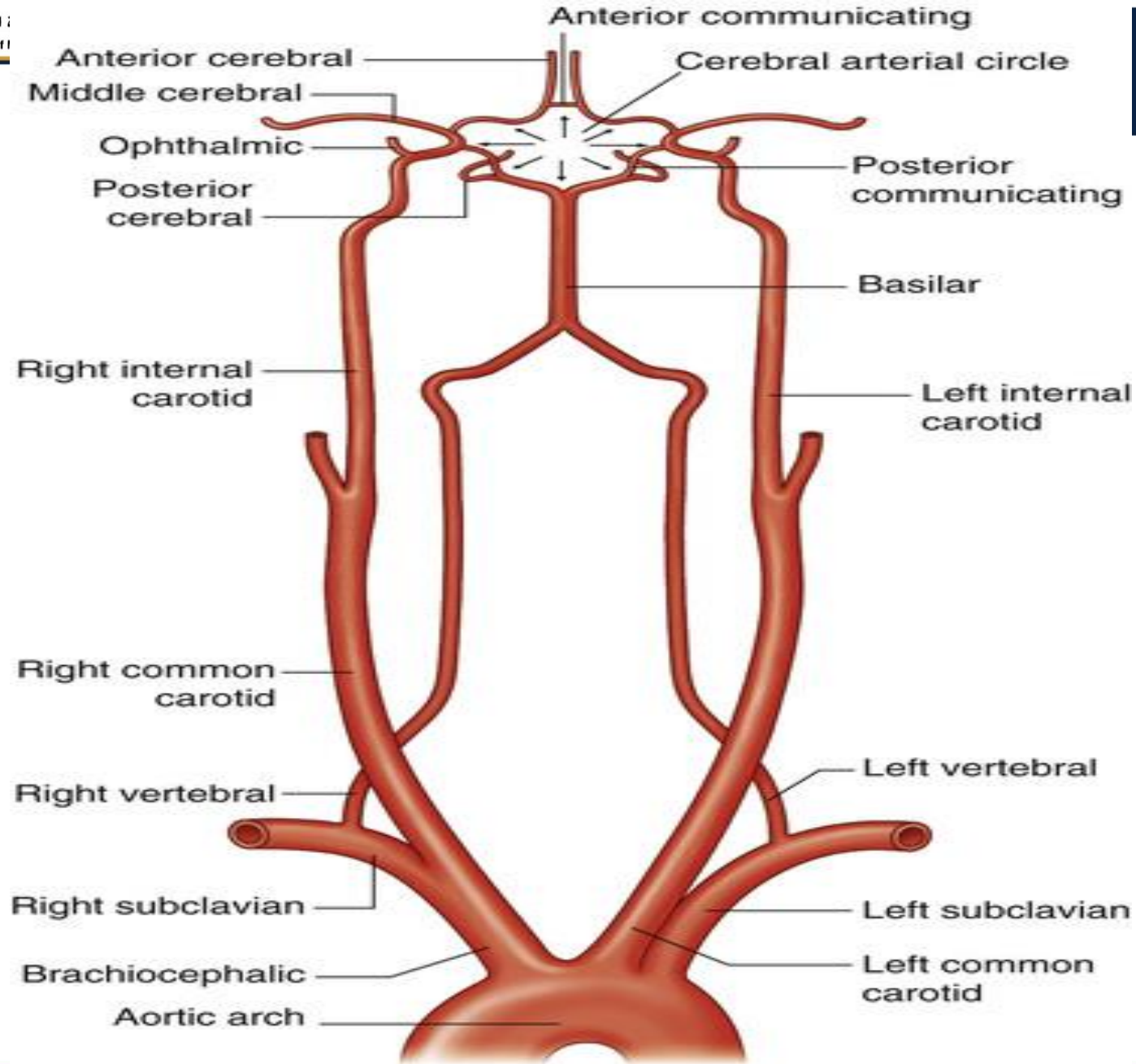
Blood supply of the brain Arterial supply

The brain is supplied by two systems:

1. Vertebrobasilar system:

the two vertebral arteries and the basilar artery.

2. Internal carotid system: the two internal carotid arteries.



Internal Carotid Artery:

Origin: one of the two terminal branches of the common carotid artery at the upper border of the thyroid cartilage (disc between C3 and C4).

Course: the course of the internal carotid artery is divided into 4 parts:

1. Cervical part: inside the carotid sheath with the internal jugular vein & the vagus nerve.

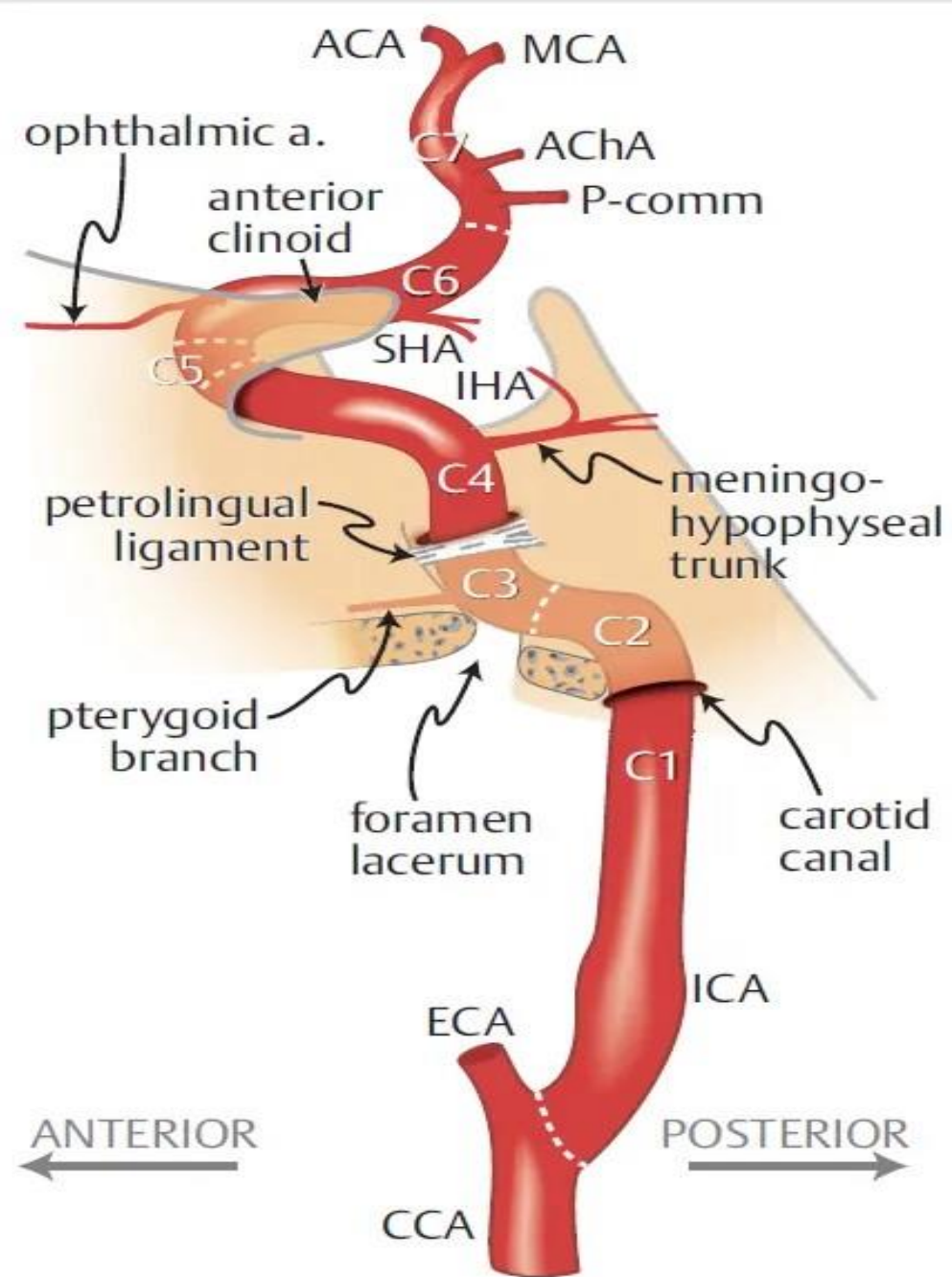
2. Petrous part: in the carotid canal in the petrous part of the temporal bone.

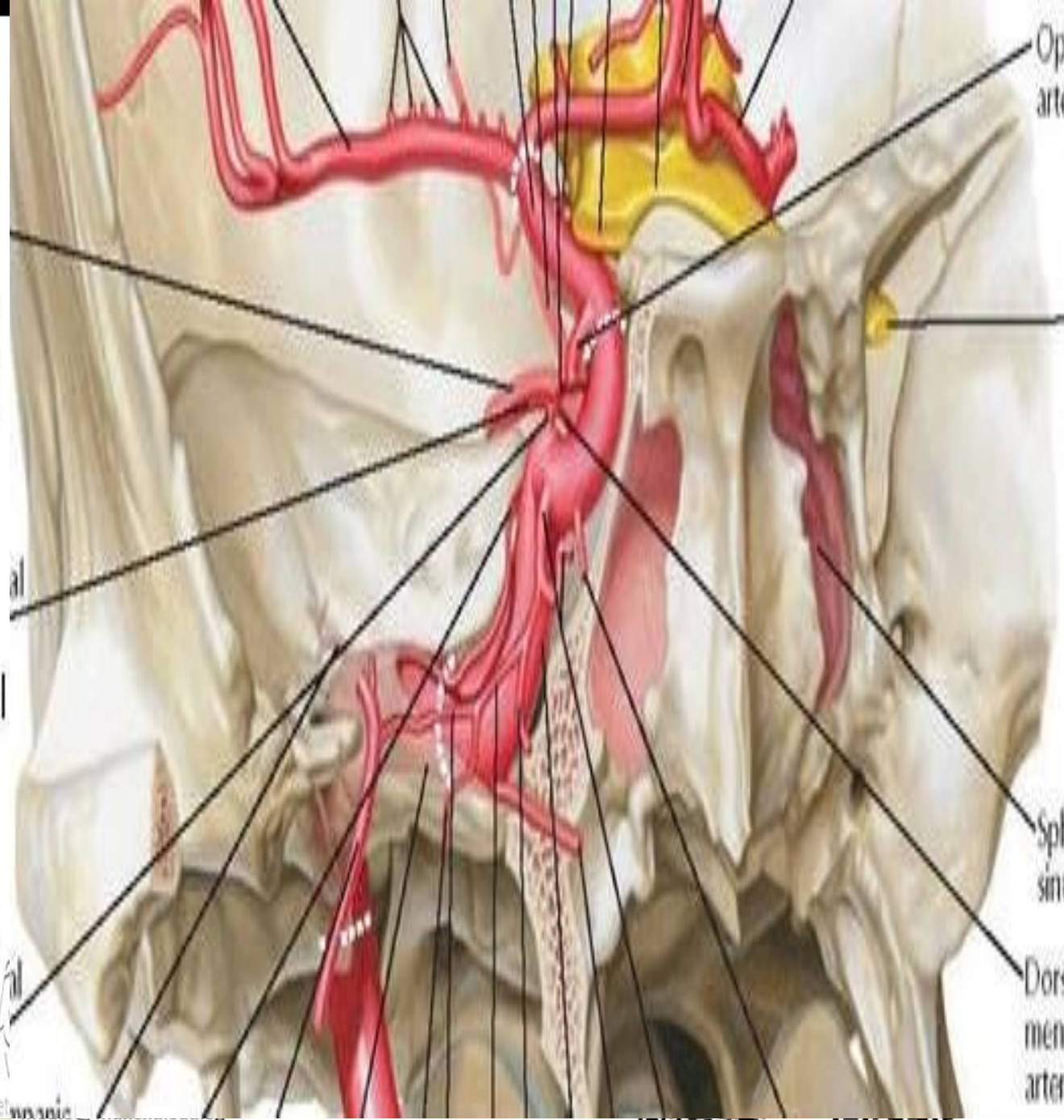
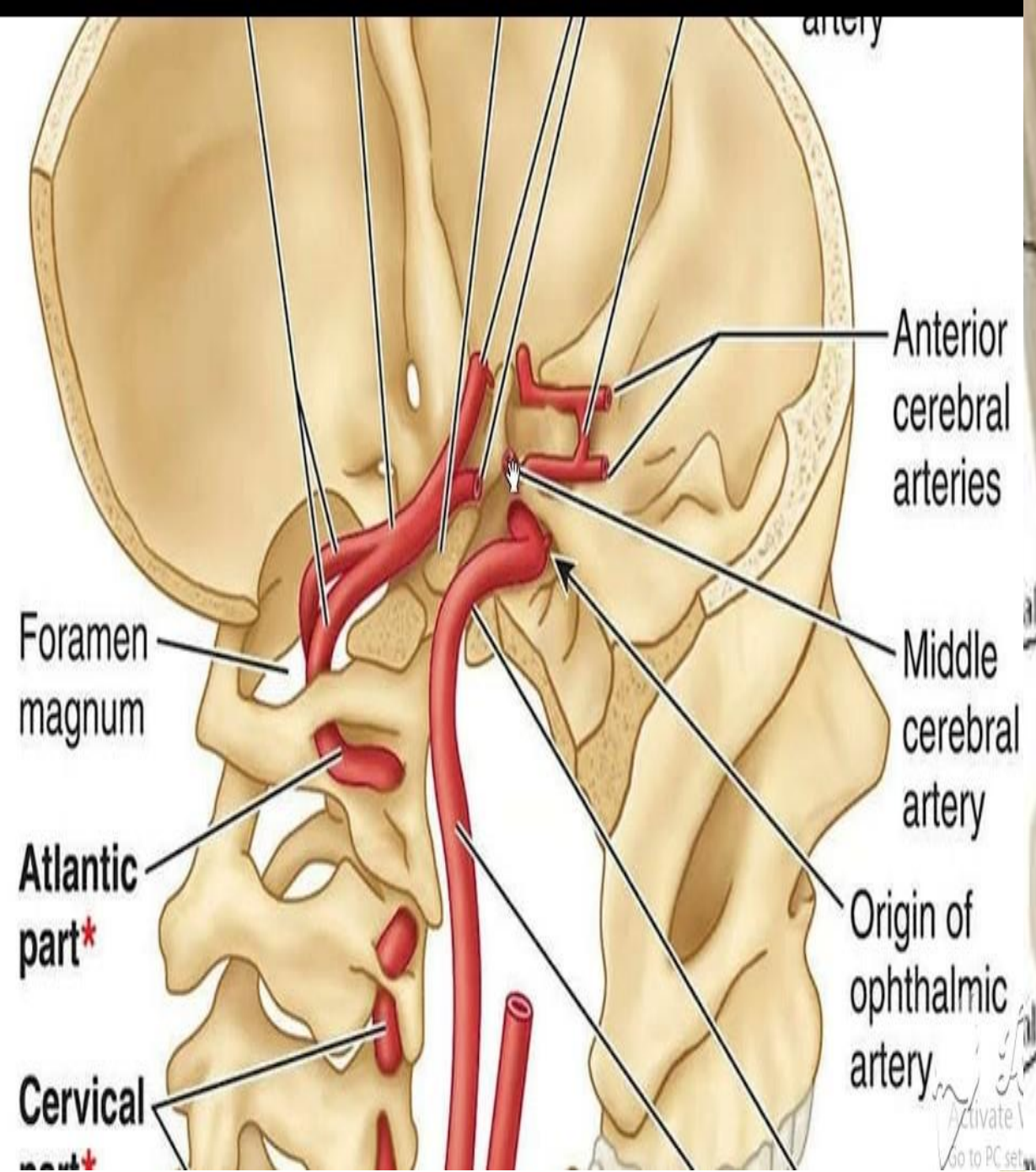
3. Cavernous part: passes forward inside the cavernous sinus, then pierces its roof to form the supracavernous part.

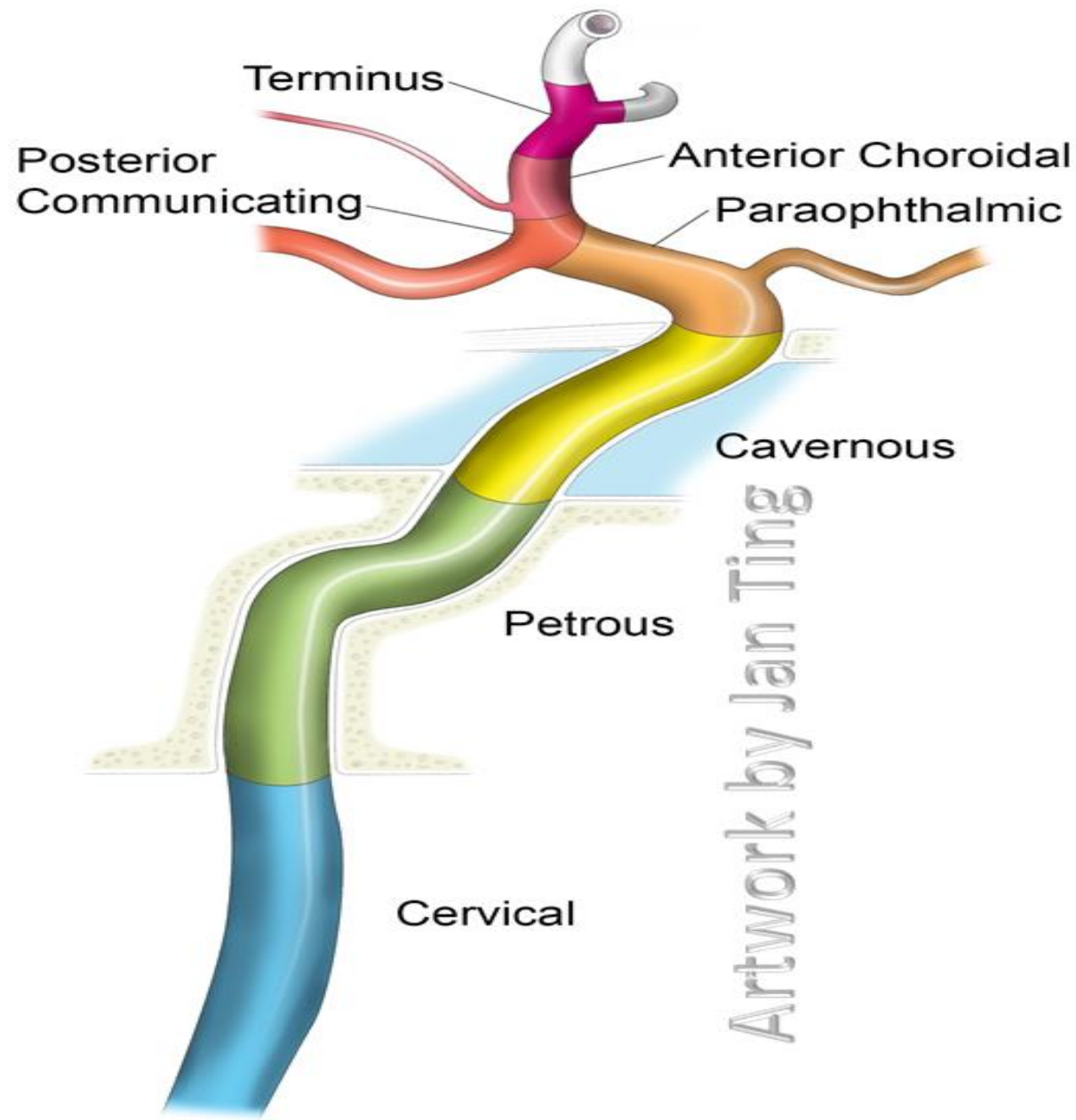
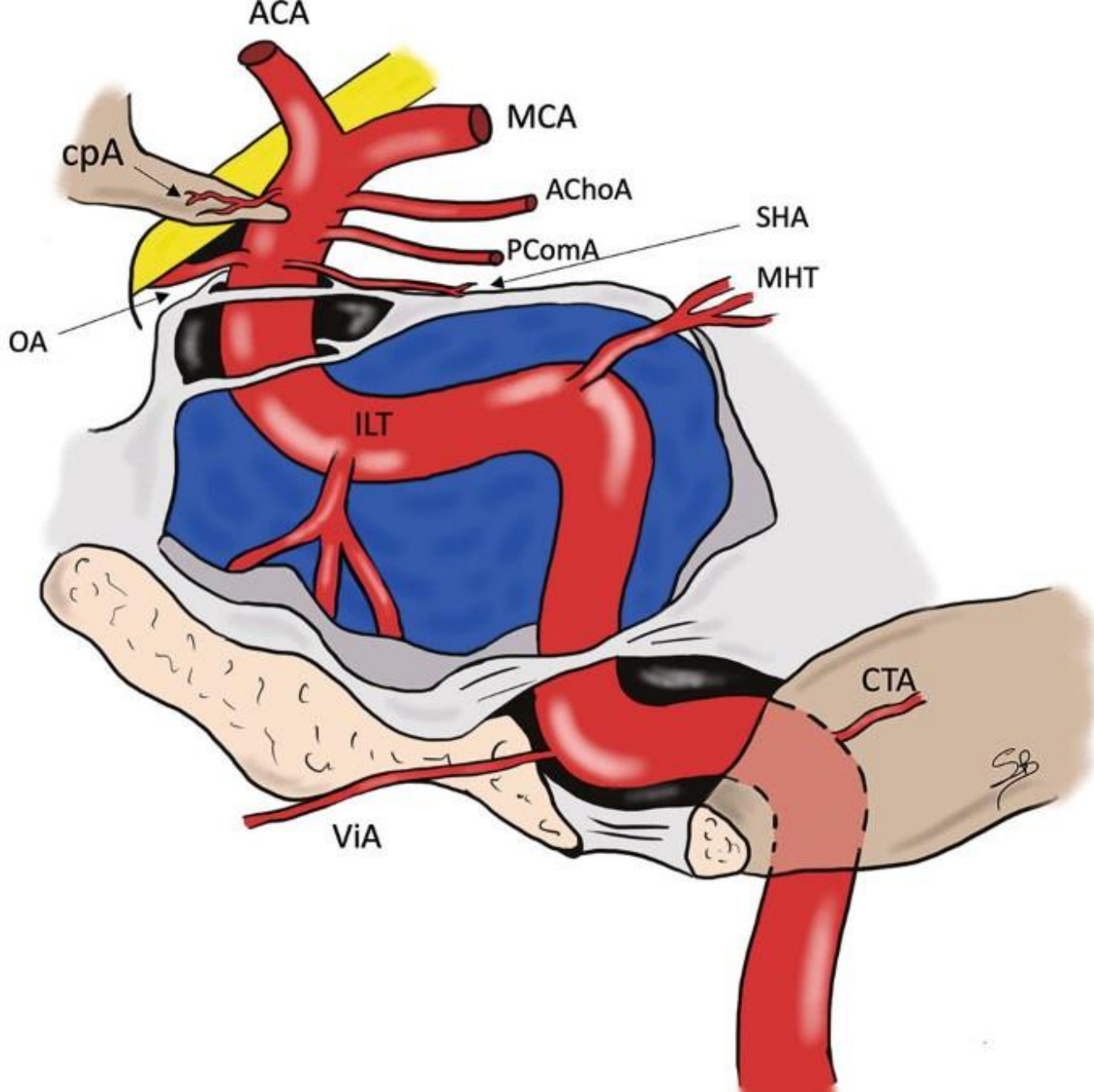
4. Supracavernous part: passes backward above the cavernous sinus.

The cavernous and supracavernous parts form the carotid siphon (U-shaped in the angiogram)

Termination: lateral to optic chiasma by dividing into anterior & middle cerebral arteries.

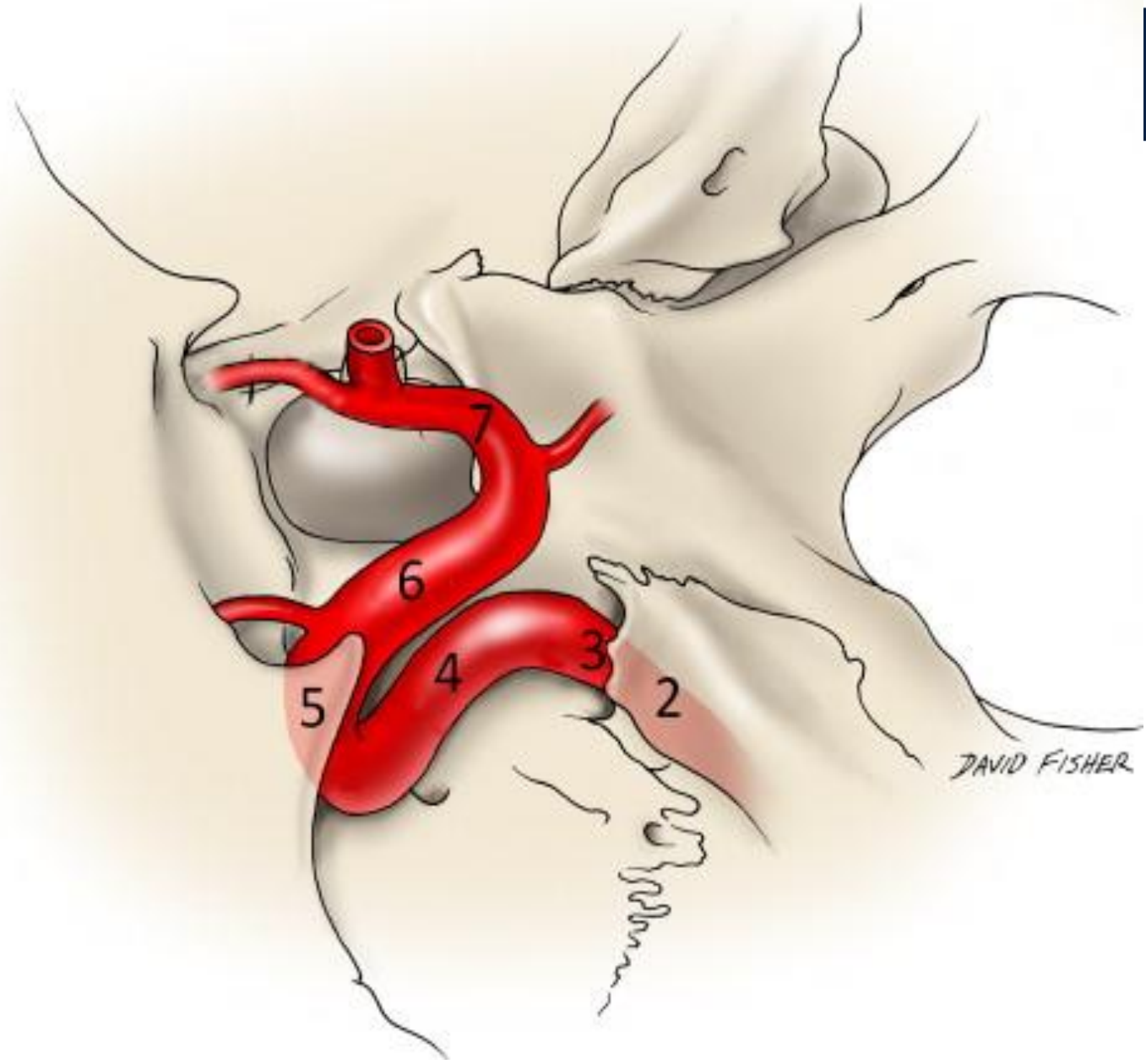






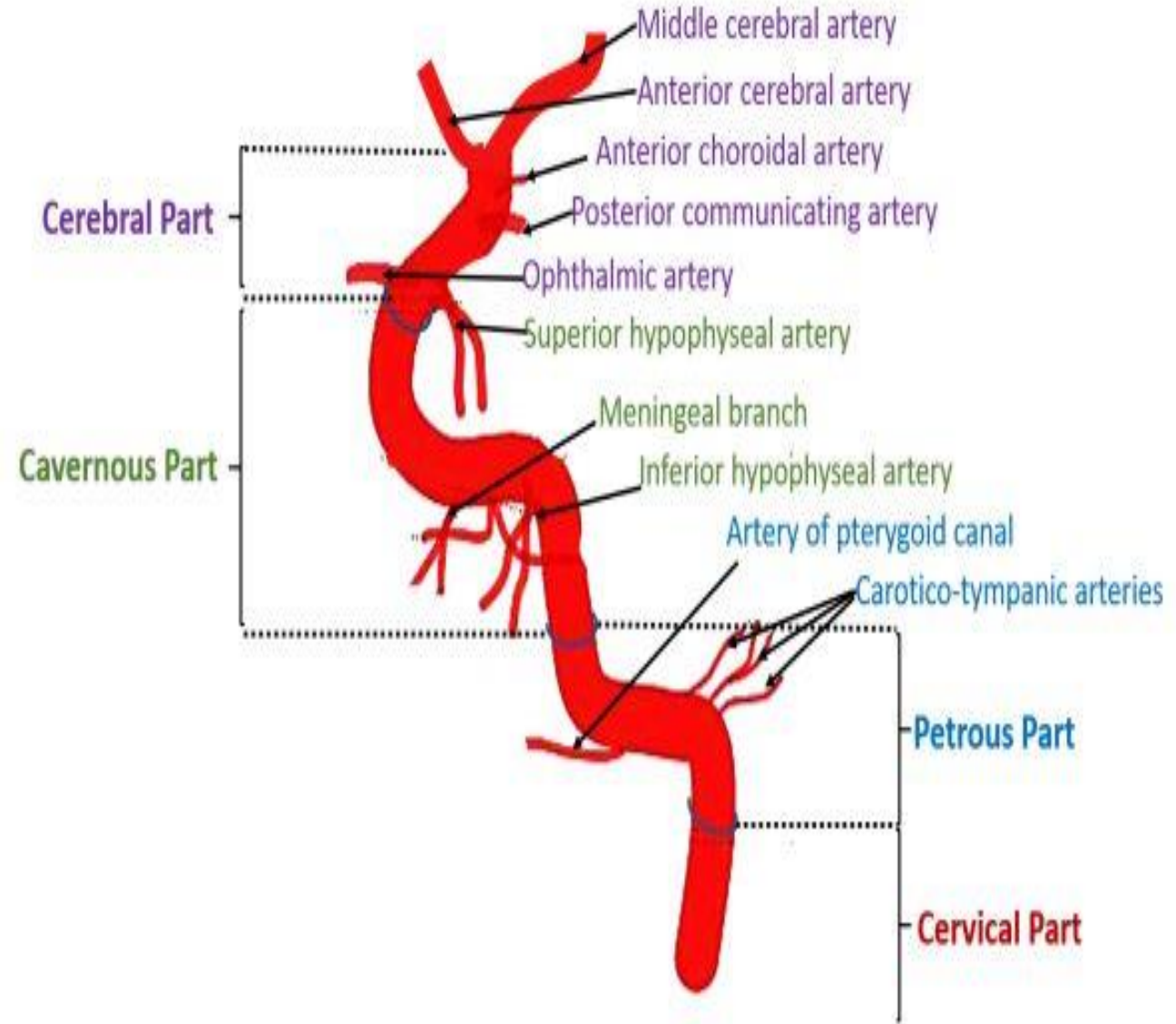
Artwork by Jan Ting





Branches of internal carotid artery:

1. **Hypophyseal branches:** superior and inferior. They supply the pituitary gland.
2. **Ophthalmic artery:** enters the orbit through the optic canal.
3. **Posterior communicating artery:** joins the posterior cerebral artery and supplies the: **Midbrain, thalamus and hypothalamus.**
4. **Internal capsule:** posterior part of the genu & anterior third of the posterior limb.
5. **Anterior choroidal artery** supplies the:
 - 6. **Posterior two-thirds** of the posterior limb of the internal capsule.
 - 7. **Choroid plexus** of the **inferior horn** of the lateral ventricle.
 - 8. Optic tract and lateral geniculate body.
 - 9. Tail of the caudate nucleus and amygdaloid nucleus.
5. **Two terminal branches:** anterior cerebral artery and middle cerebral artery.

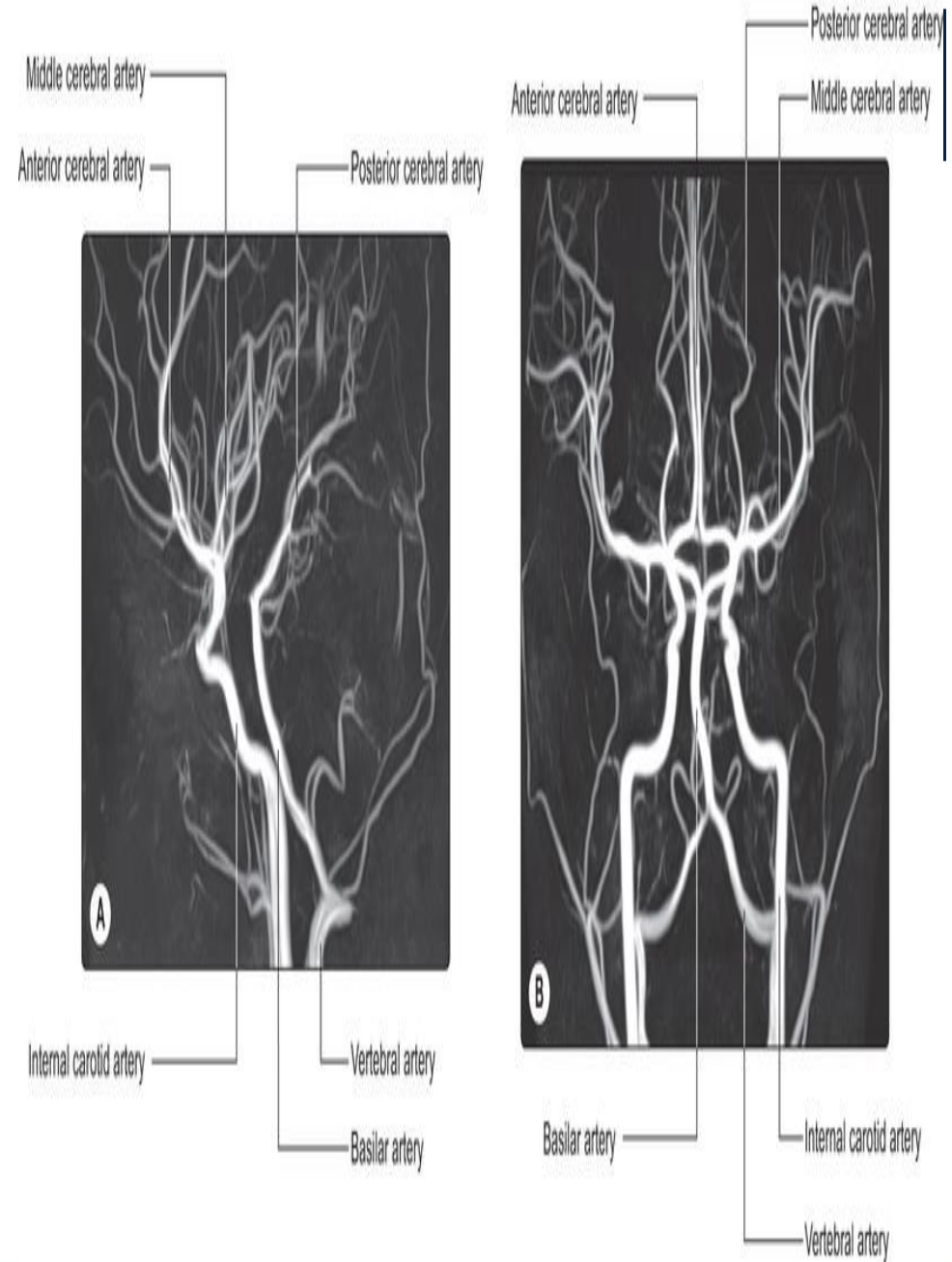
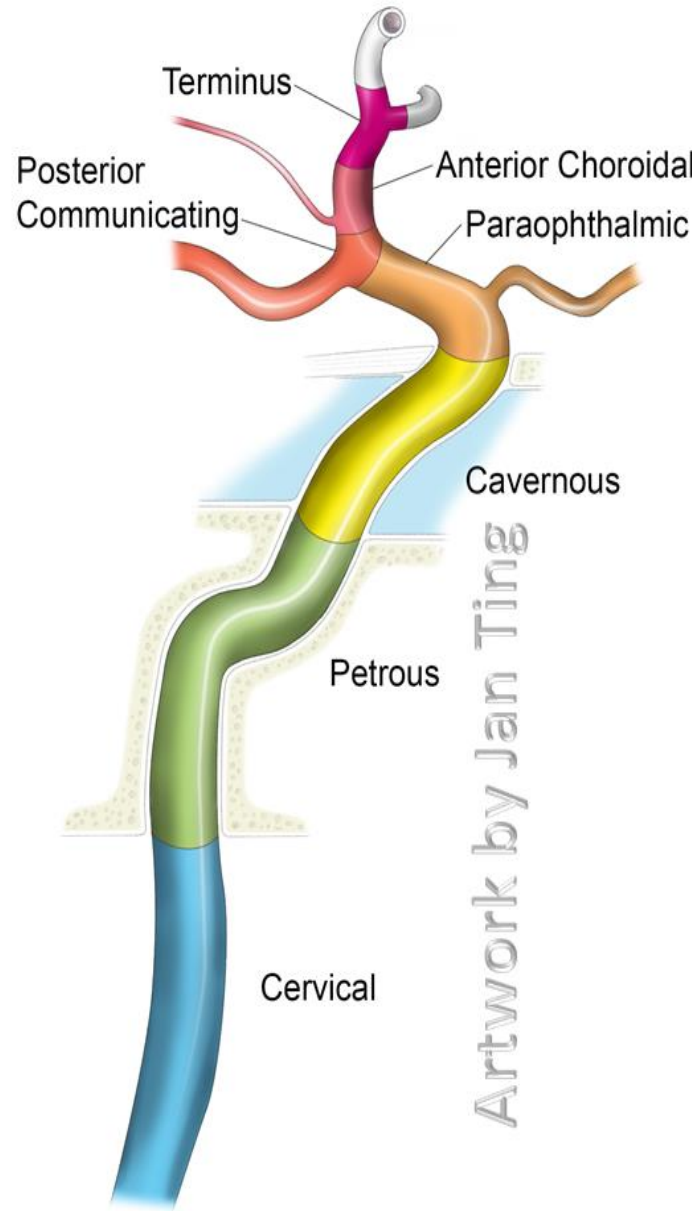




Once the carotid artery enters the carotid canal it has **a very tortuous course** – **six bends** in all before its terminal division.

The reason for **this tortuosity is unknown** but it may have a role **in reducing the pulsating force of the blood** supply to the brain.

The cavernous and supraglenoid portions of the internal carotid artery are referred to as **the carotid siphon**.



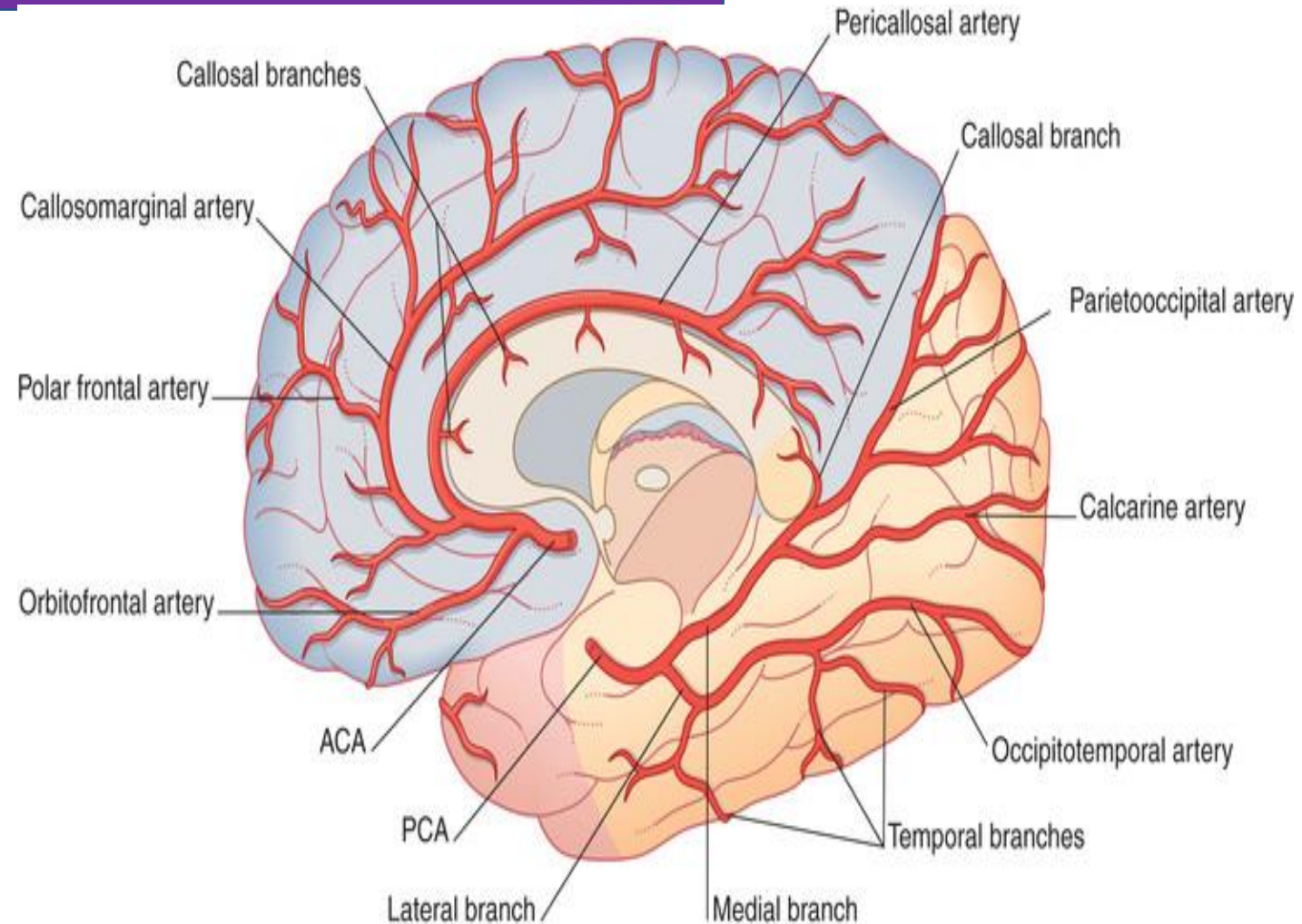
Anterior cerebral artery (ACA)

ORIGIN: one of the two terminal branches of the internal carotid artery (it is the **smaller one**).

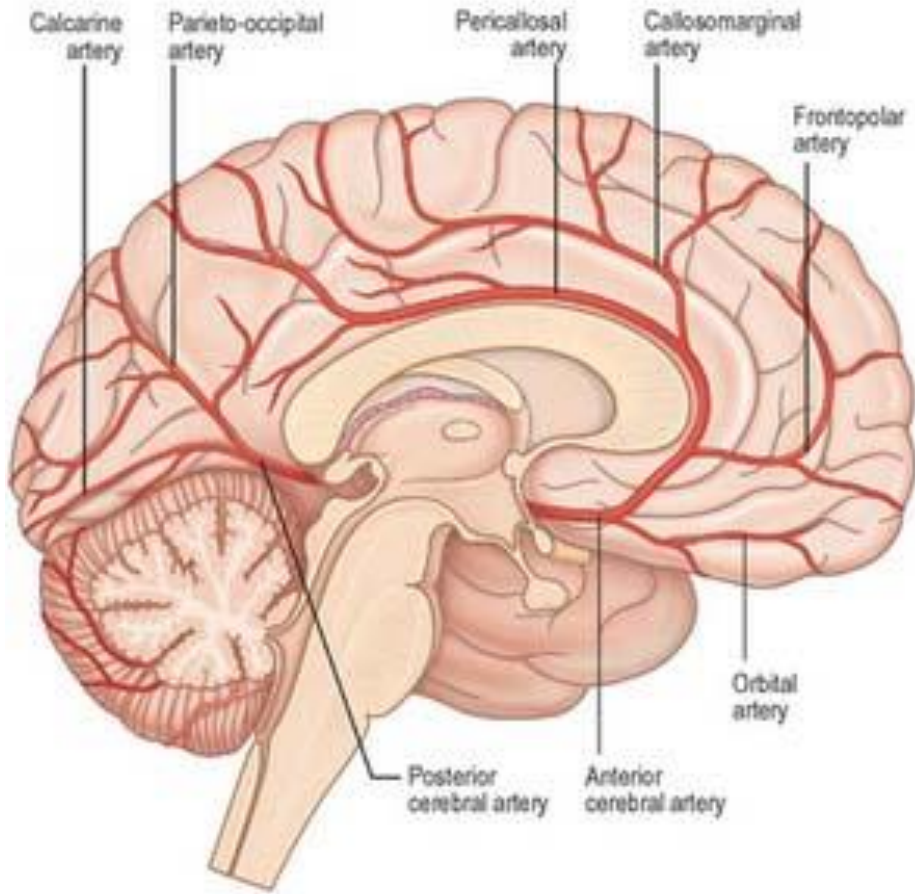
Course: It is joined with the opposite one by the **anterior communicating artery**.

It passes around the **genu** of the corpus callosum and continues backward on the upper surface of the corpus callosum in the **callosal sulcus**.

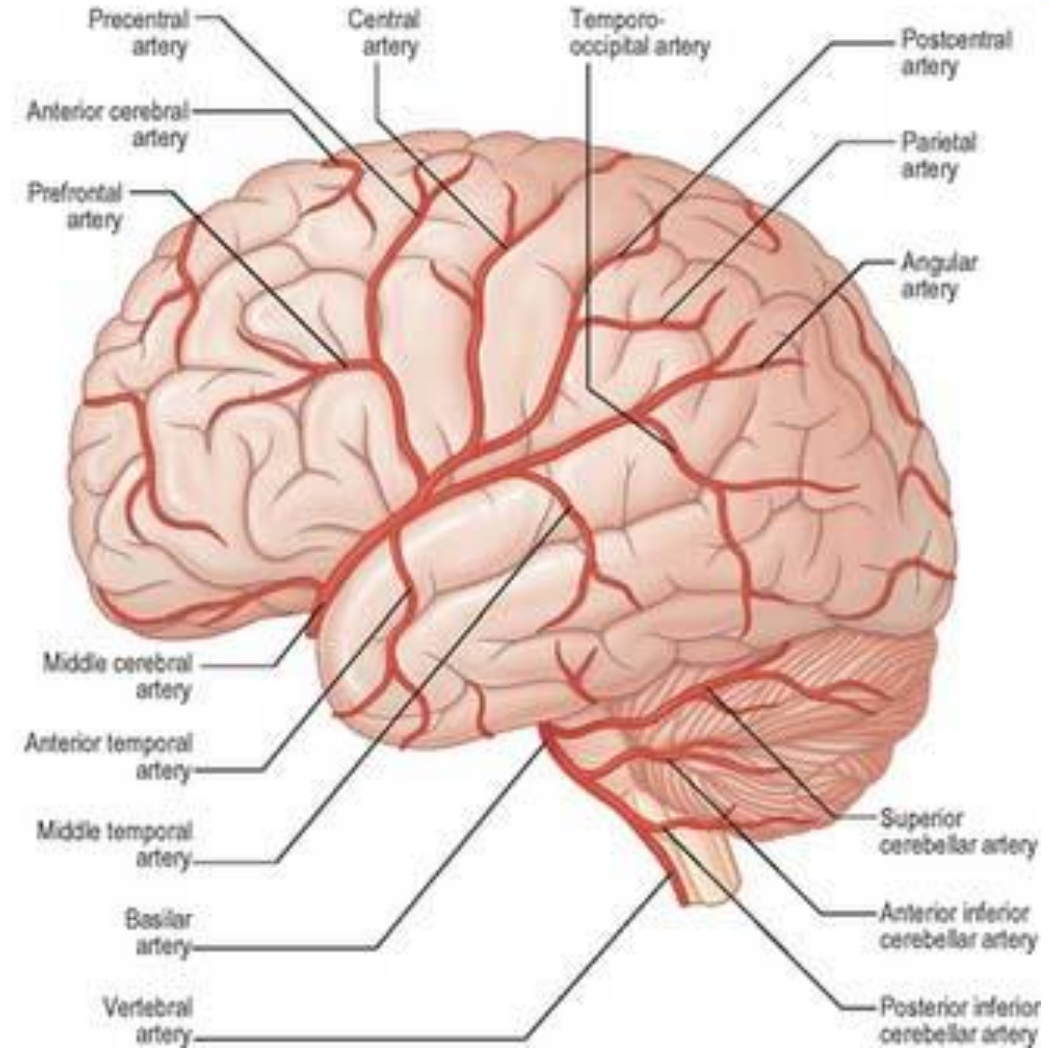
It ends at the **splenium** by anastomosing with branches of the **posterior cerebral artery**.



A



B



Anterior cerebral artery (ACA)

Branches:

1. Cortical branches: supply:

Upper **one inch** of the **lateral surface** of the frontal and parietal lobes. It supplies the **leg area** of the motor and sensory cortical areas.

Medial surface of the frontal and parietal lobes.

Medial half of the orbital surface.

2. Central branches: supply: (4 anterior)

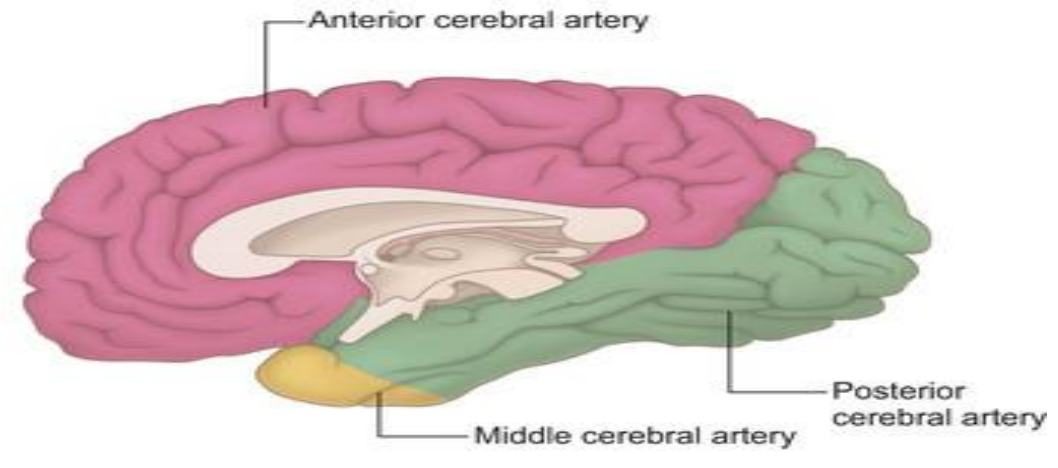
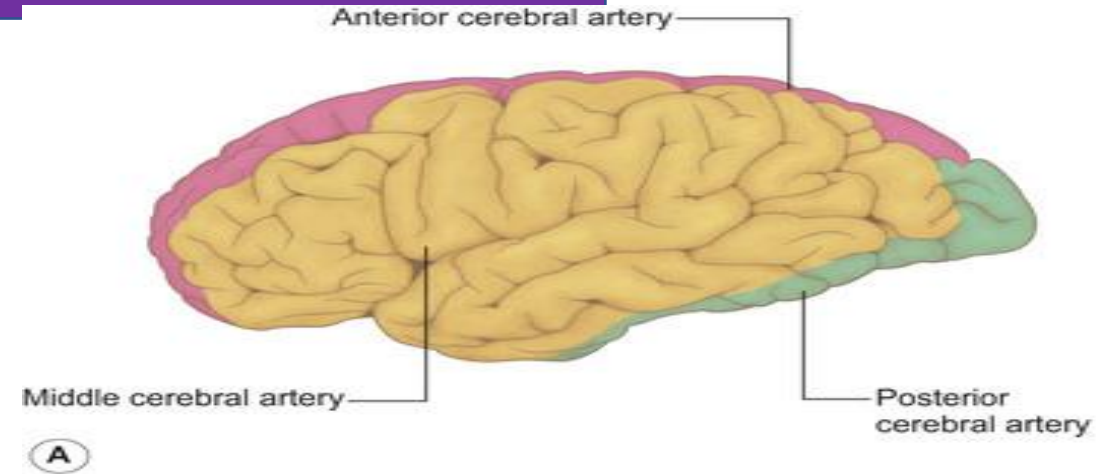
Anterior limb of the internal capsule.

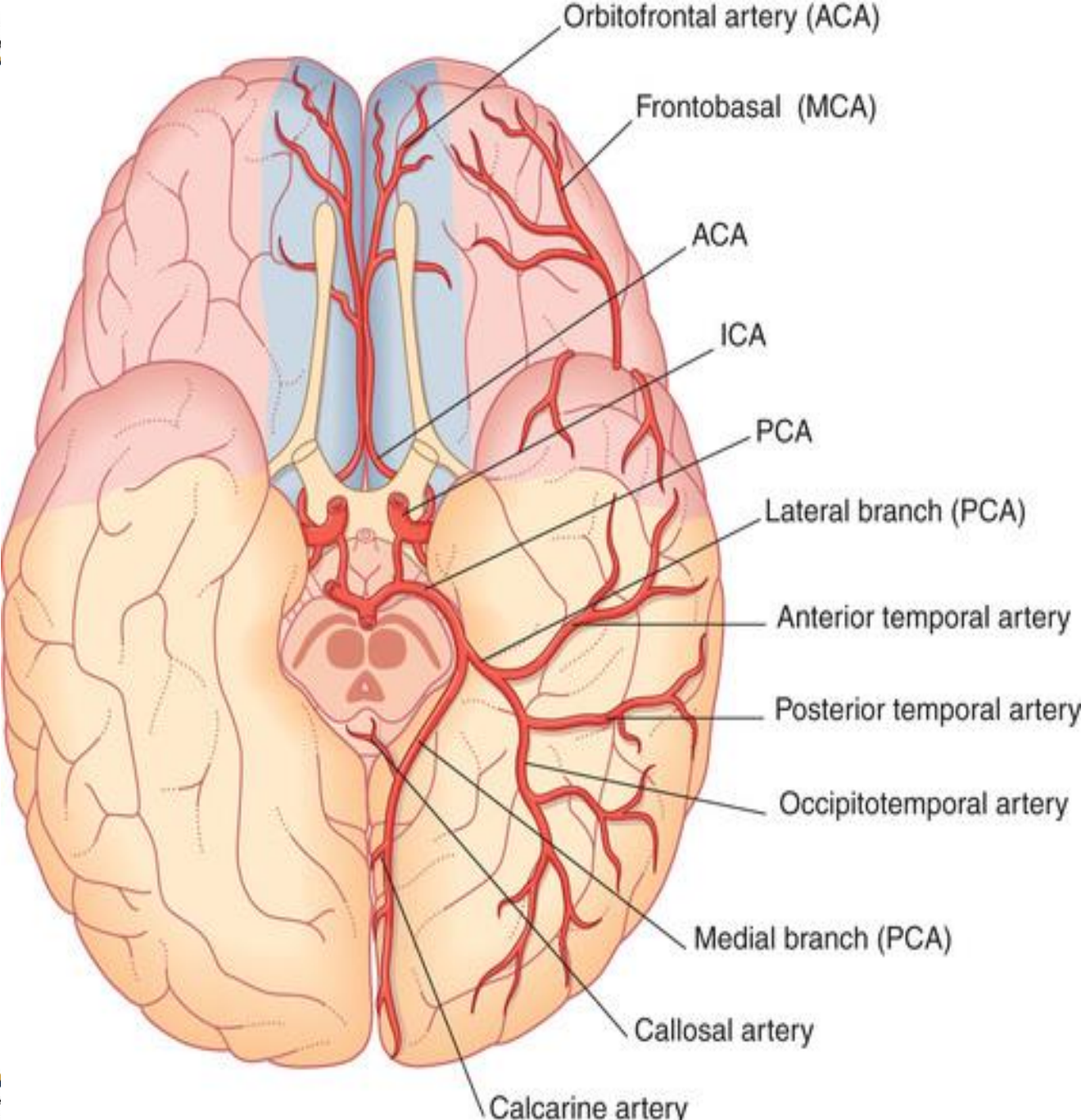
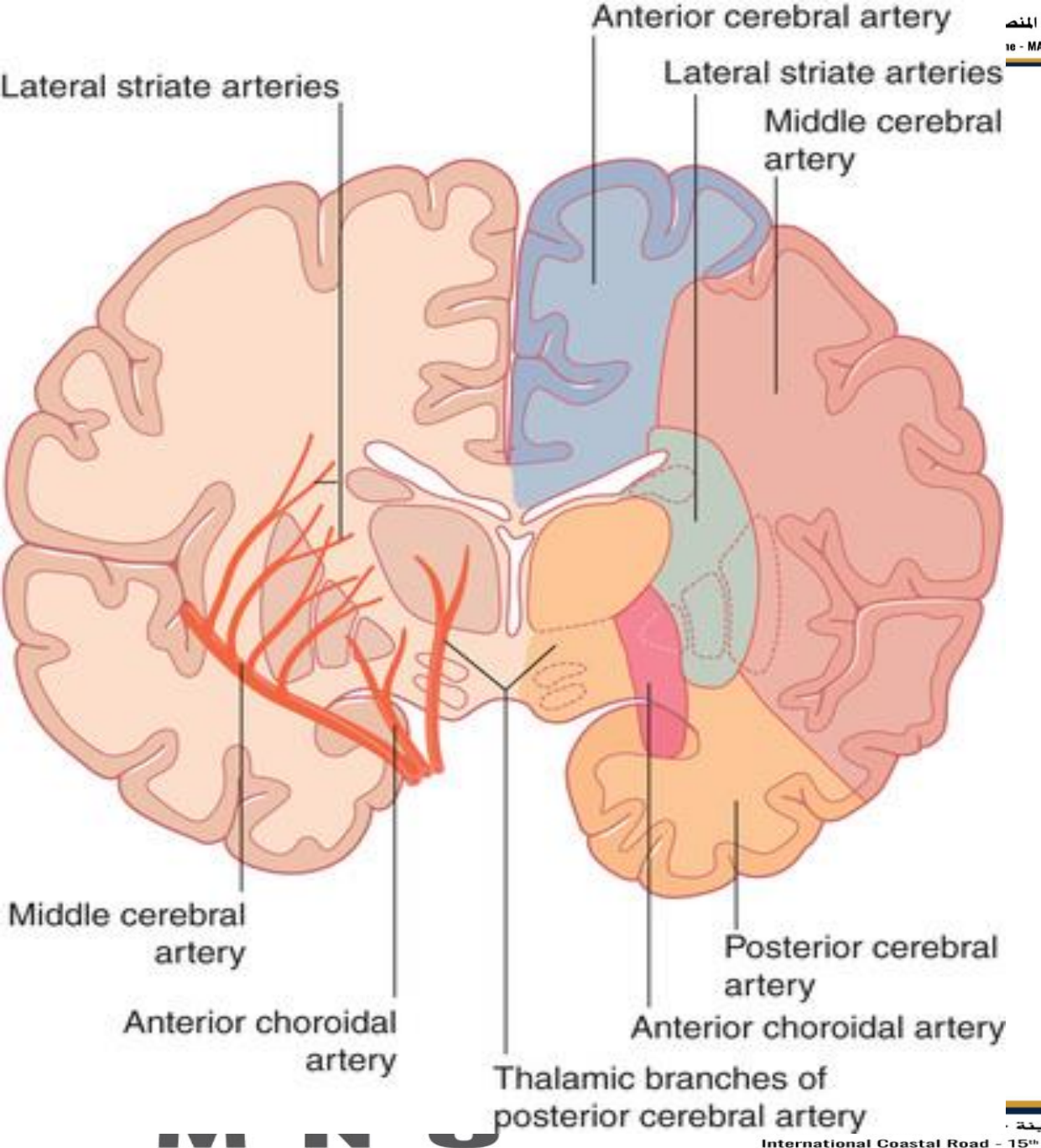
Anterior part of the genu of the internal capsule.

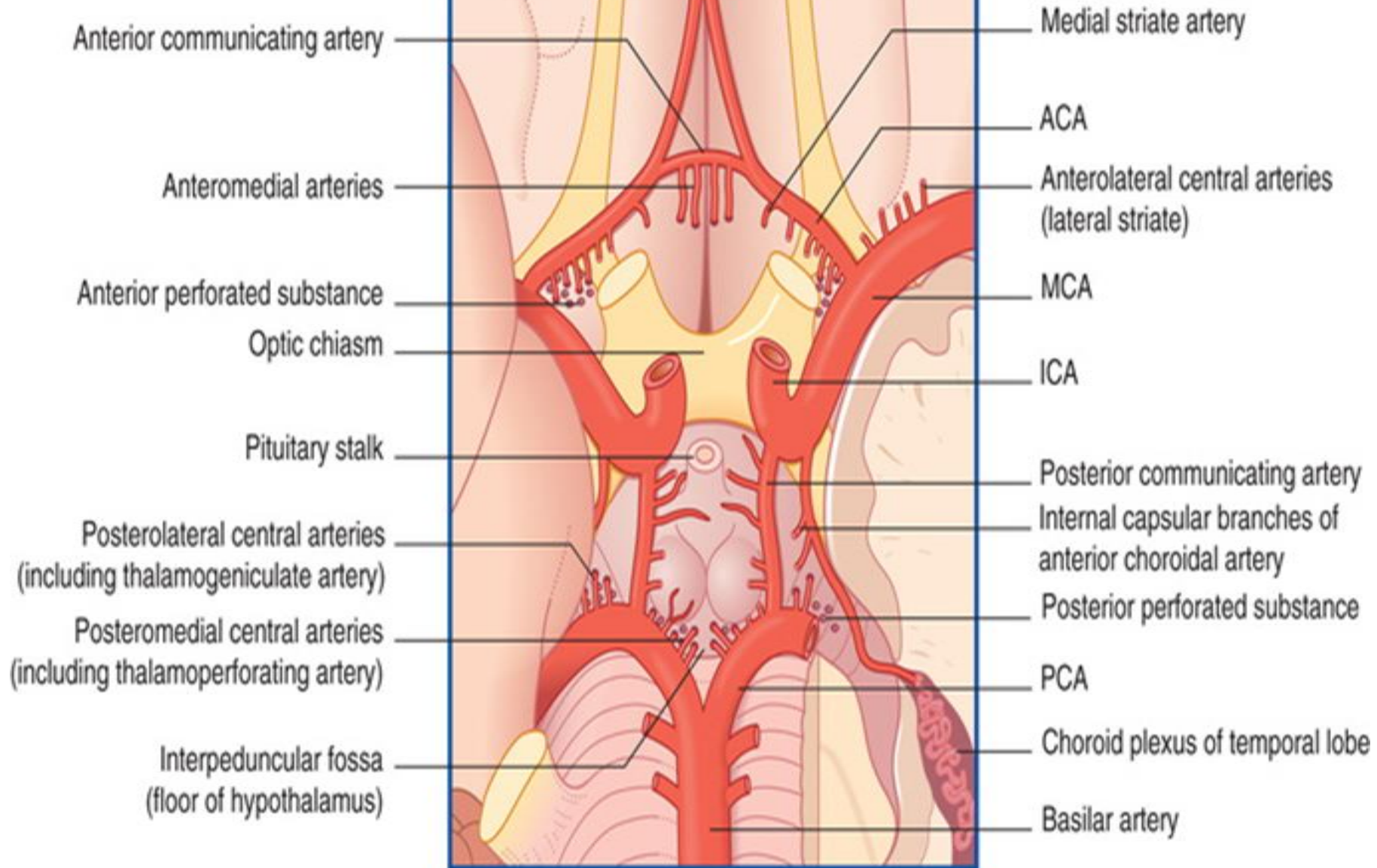
Anterior part of corpus striatum: lentiform nucleus & head of caudate nucleus.

Anterior part of the hypothalamus.

3. Callosal branches: to the entire corpus callosum.







Anterior cerebral artery (ACA)

Clinical Note:

Occlusion of the anterior cerebral artery causes:

1. **Affection** of the paracentral lobule:

- Contralateral paralysis** of the leg muscles.
- Contralateral somatosensory loss** in the leg.

2. Affection of the corpus callosum: **callosal apraxia.**

Posterior cerebral artery (PCA)

Origin: by the bifurcation of the basilar artery at the upper border of the pons.

Course:

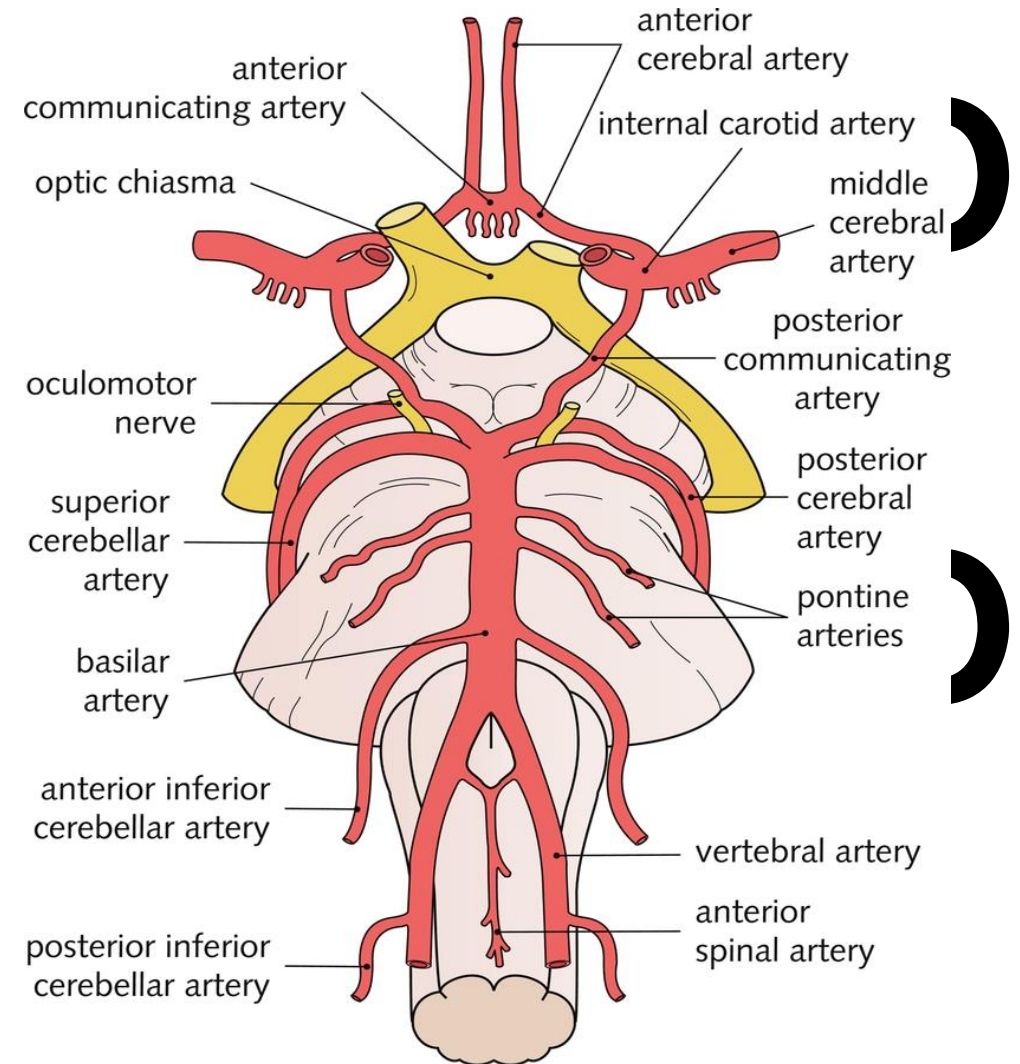
It passes backward around the **lateral side of the midbrain** to reach the **splenium** of the corpus callosum where it divides into temporal, calcarine and parieto-occipital branches.

The **temporal branches** are distributed over the inferior surface of the temporal lobe.

The **other branches** run in the corresponding sulci and anastomose with branches of the **anterior cerebral artery**.

It is joined with the internal carotid artery by the **posterior communicating artery**.

It is separated from the superior cerebellar artery by the **oculomotor and trochlear nerves**.



Posterior cerebral artery (PCA)

Branches:

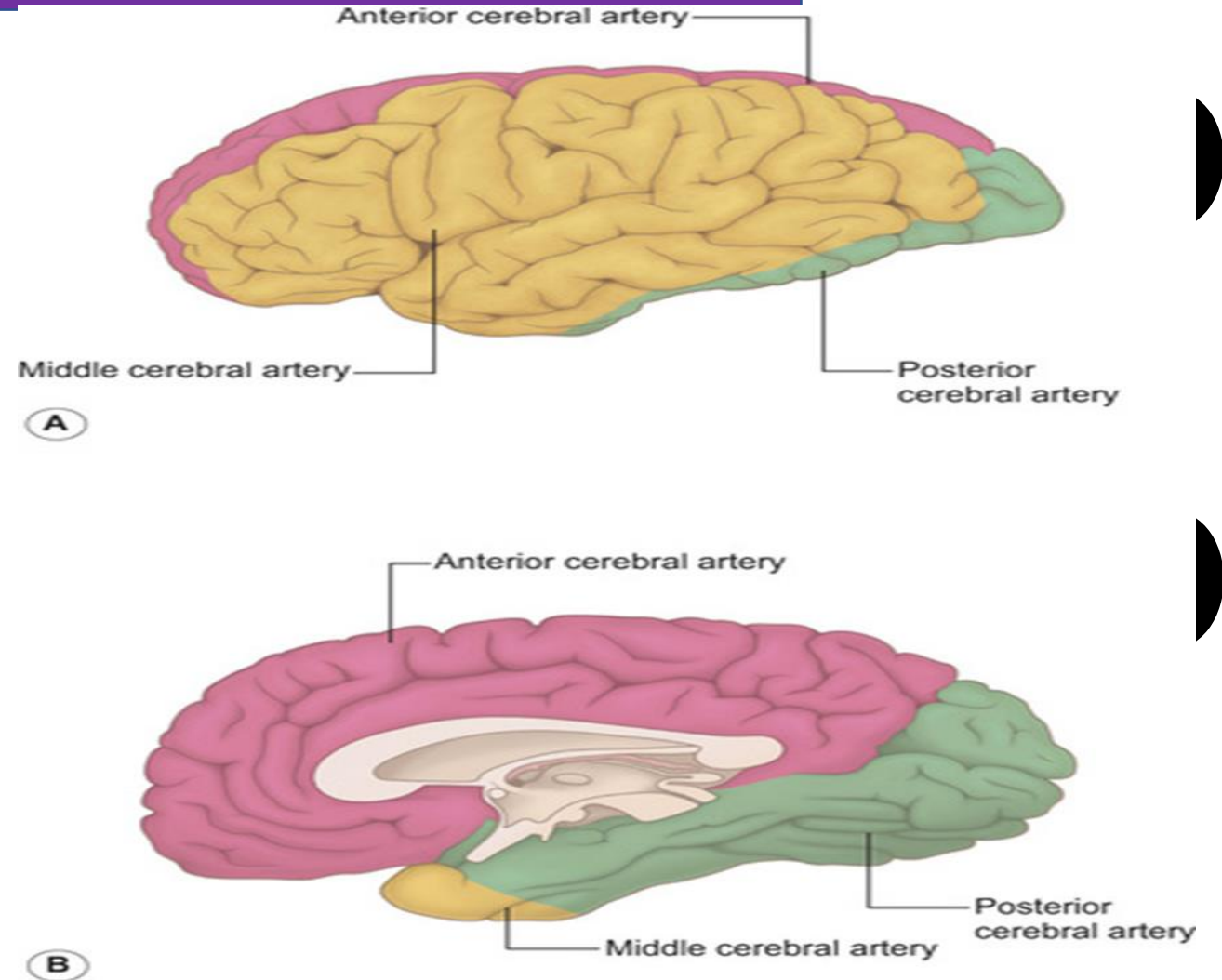
1. Cortical branches: supply:

☐ Lower inch of the lateral surface (inferior temporal gyrus).

☐ All aspects of the occipital lobe. It supplies the primary visual area (area 17) and the visual association areas (areas 18 & 19).

☐ Medial and inferior surfaces of the temporal lobe except the temporal pole.

2. Central branches: enter through the posterior perforated substance and supply: ☐ Thalamus and the hypothalamus. ☐ Midbrain.



Posterior cerebral artery (PCA)

Posterior choroidal artery: supplies:

☐ Choroid plexus of the **third and lateral ventricles.**

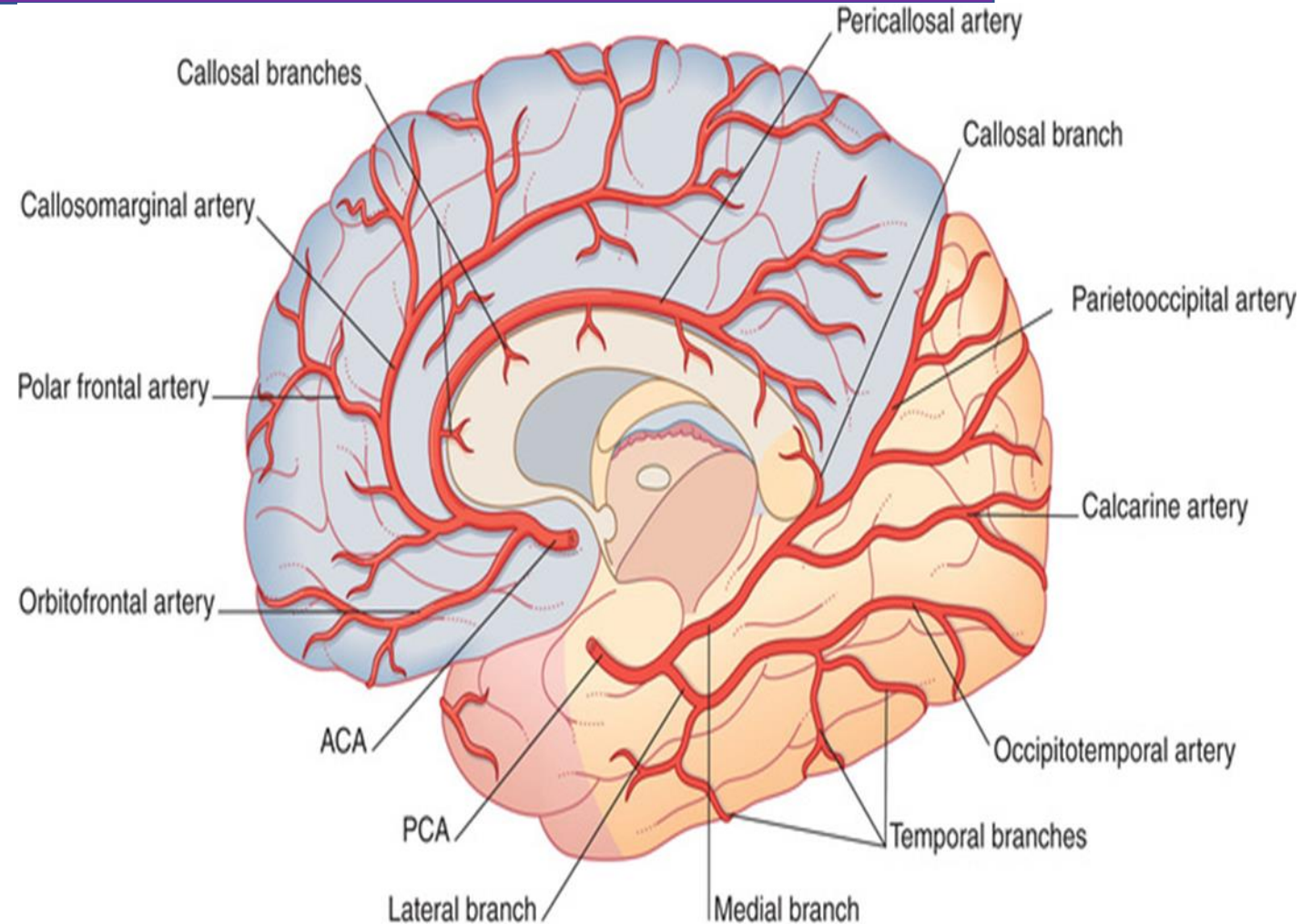
☐ Thalamus

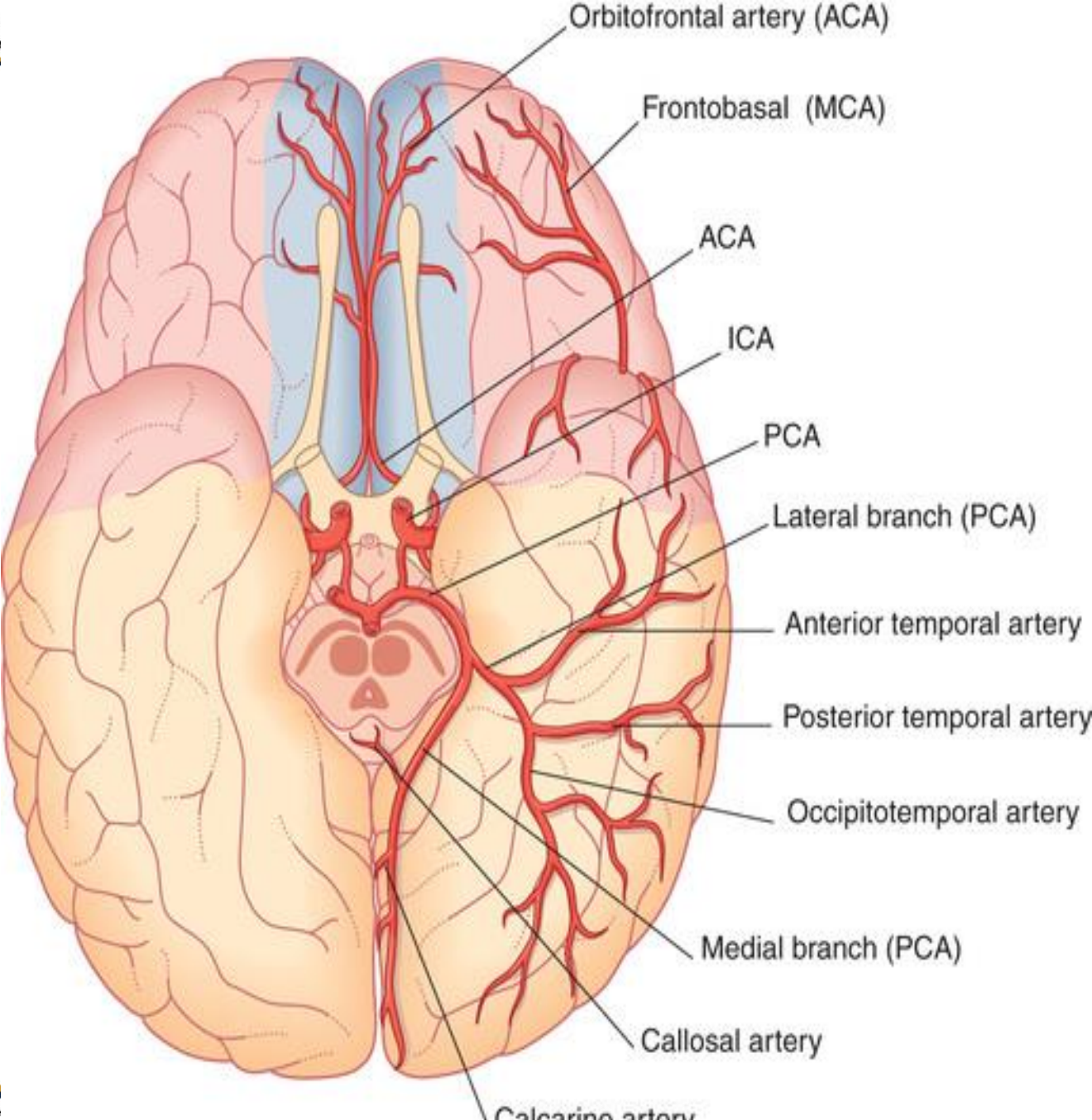
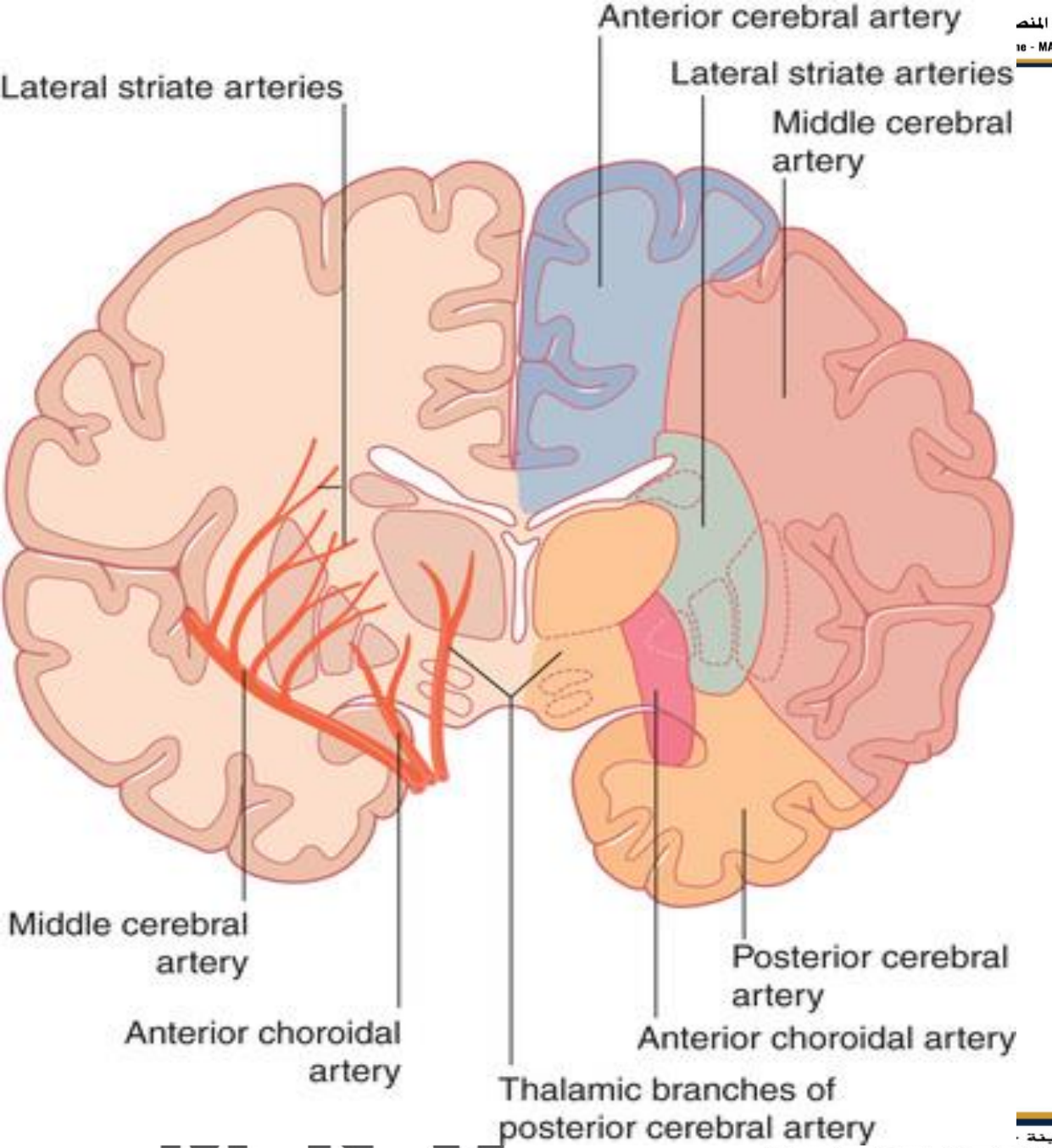
☐ Midbrain.

4. Splenial artery: it may be present and supplies the splenium of the corpus callosum.

Clinical Note:

☐ Occlusion of the posterior cerebral artery causes **contralateral homonymous hemianopia** with macular sparing.





Middle cerebral artery (MCA)

Origin: one of the two terminal branches of the internal carotid artery (it is **the larger one**). This is the largest and most direct of the branches of the internal carotid artery and is therefore the most prone to embolism.

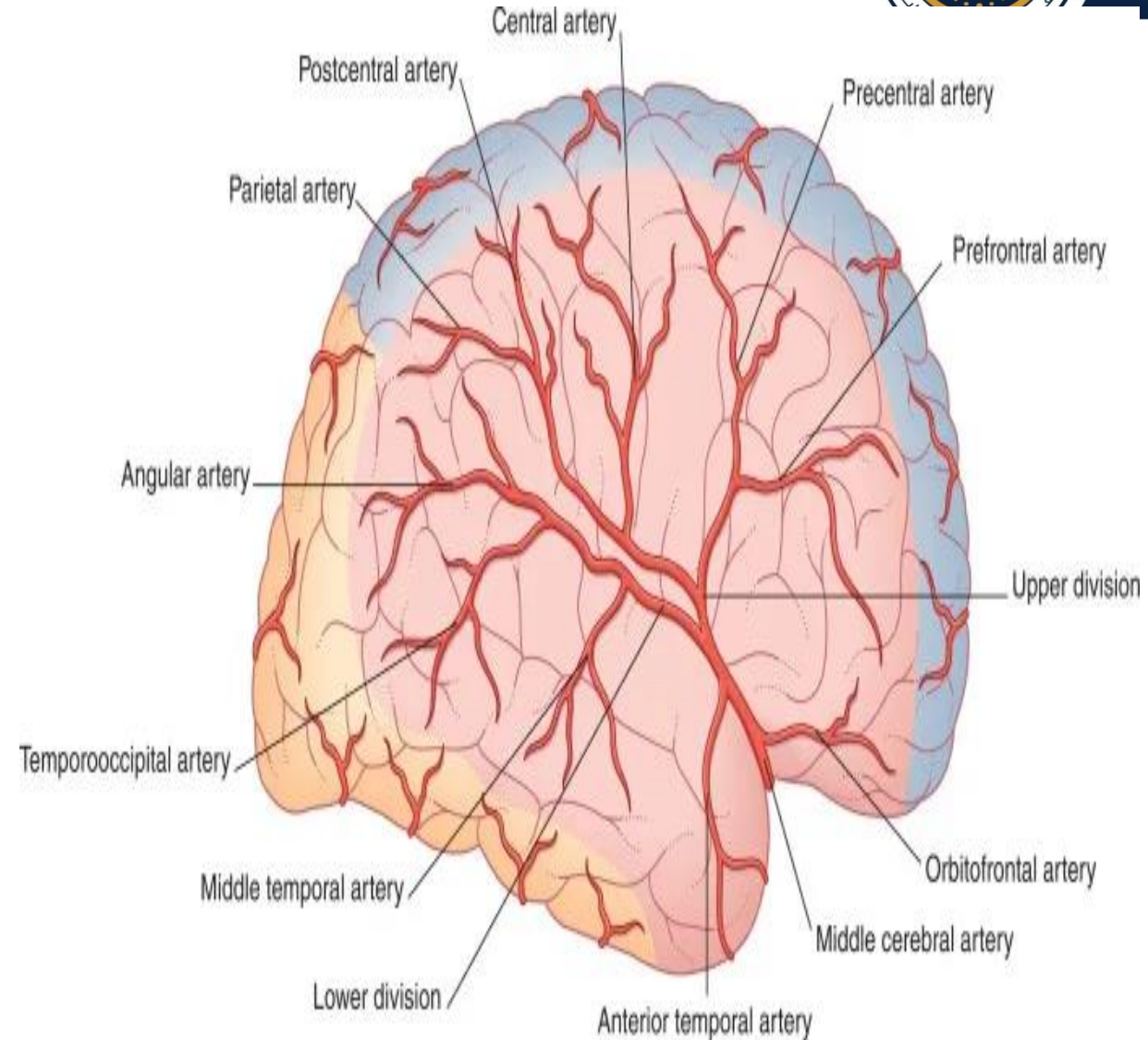
Course:

☐ Passes in the lateral sulcus ☐ Ends on the surface of the insula by dividing into terminal branches.

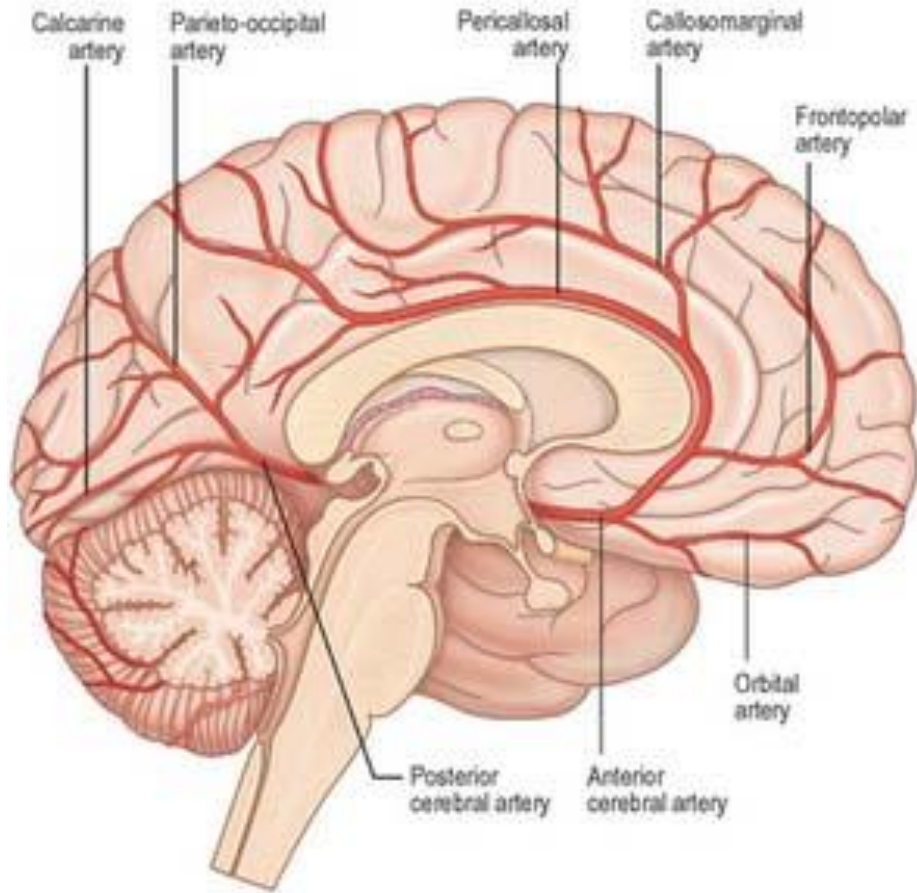
Branches:

1. Cortical branches: supply:

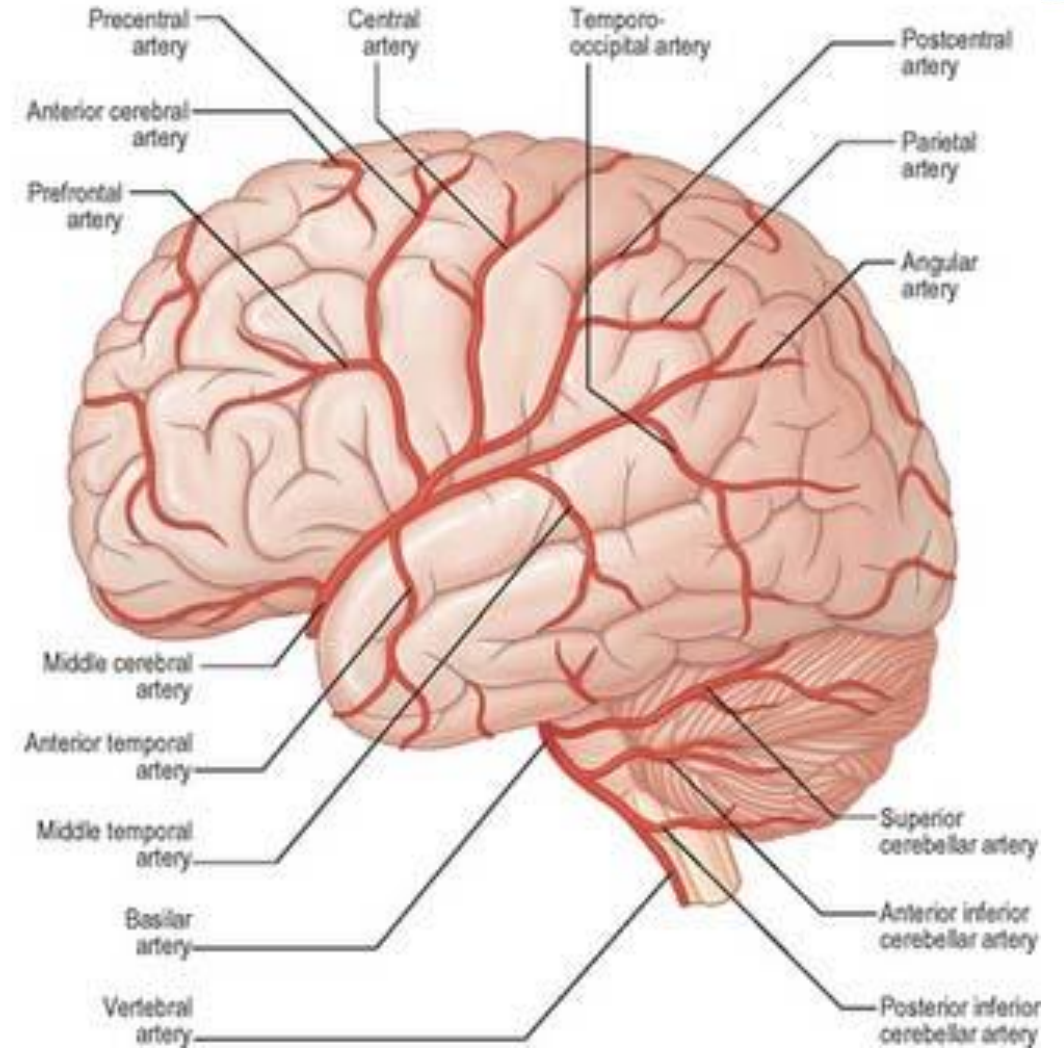
- ☐ **Lateral half** of the orbital surface.
- ☐ **All aspects of the temporal pole.**
- ☐ **Lateral surface** of the hemisphere except:
 - a. **Upper one inch** (by anterior cerebral).
 - b. **Lower one inch** (inferior temporal gyrus) (by the posterior cerebral).
 - c. **Occipital lobe** (supplied by the posterior cerebral).



A



B



Central branches (lateral striate arteries):

One of these arteries is large, liable to rupture and called **artery of cerebral hemorrhage**

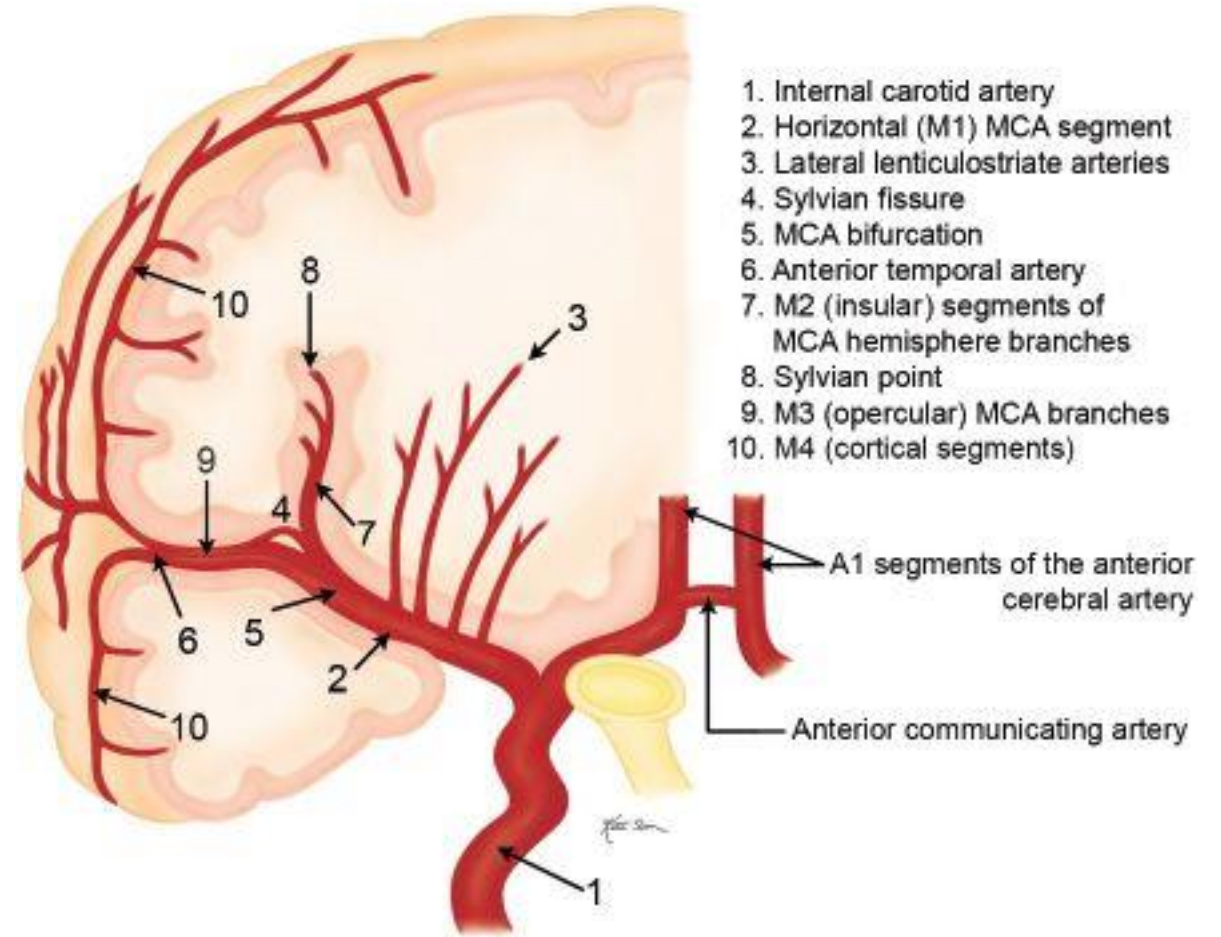
The central branches pierce the **anterior perforated substance** and supply the:

- Anterior and posterior limbs of the internal capsule.
- Posterior part of the corpus striatum except the tail of the caudate nucleus.

Important Cortical Areas Supplied by the MCA:

- Motor, premotor and general sensory areas except the **leg area (upper inch)**.
- Auditory and auditory association areas.
- Motor speech area (Broca's area) and sensory speech areas.

Middle Cerebral Artery
Coronal View

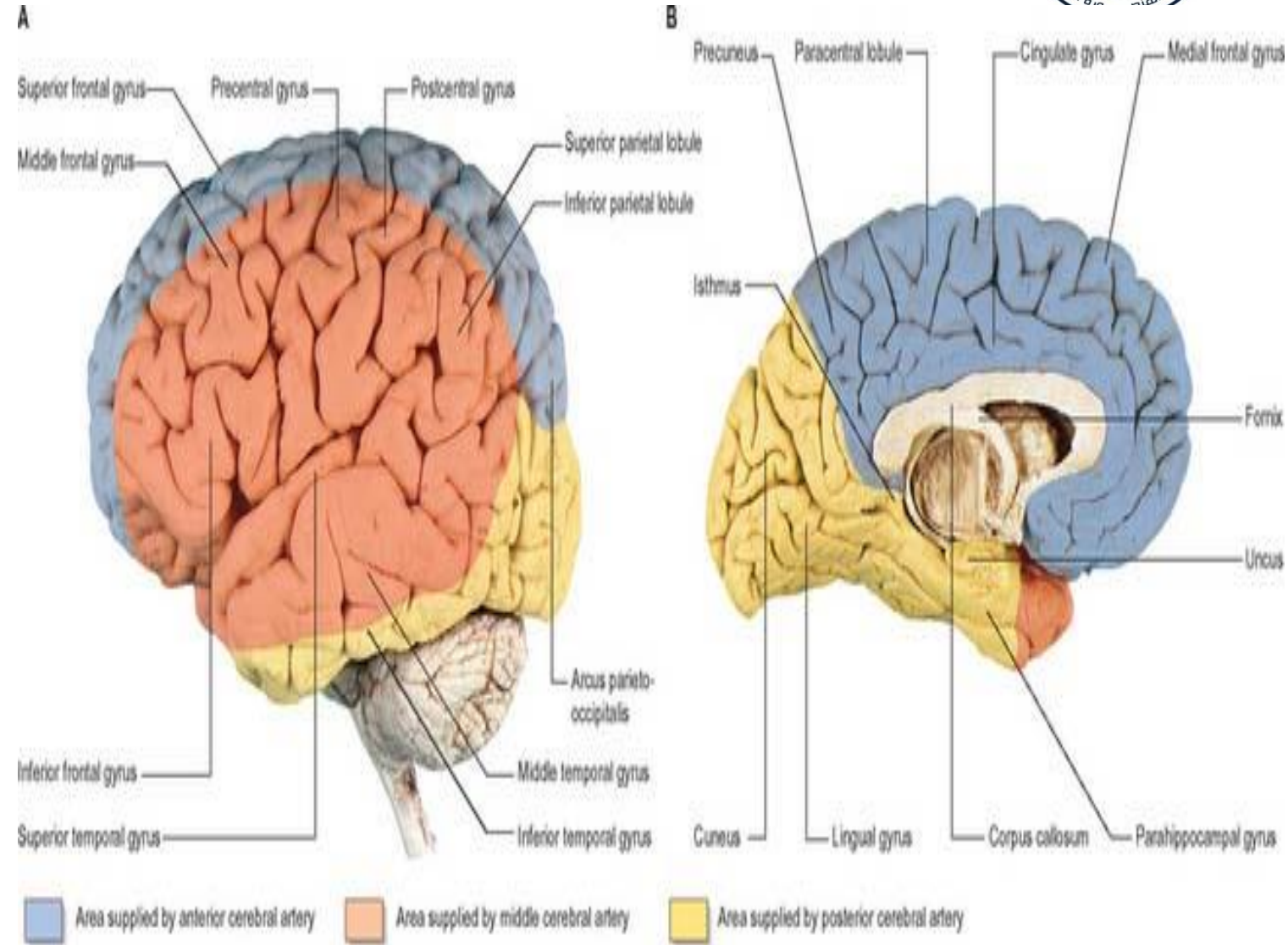


Middle cerebral artery (MCA)

Clinical Note:

occlusion of the middle cerebral artery causes:

- 1. Contralateral hemiplegia**, most marked in the upper limb and face.
- 2. Contralateral sensory loss** of proprioception and discriminative touch.
- 3. Bilateral diminution** of hearing but mainly on **the opposite side**.
- 4. Aphasia (paralysis of the speech)** if the dominant hemisphere is affected.



Arterial supply of the cerebral cortex

Lateral surface:

1. **Upper inch** of the frontal and parietal lobes: by the anterior cerebral artery.
2. **Occipital lobe and lower inch** (inferior temporal gyrus): by the posterior cerebral artery.
3. The rest of the lateral surface: by the middle cerebral artery.

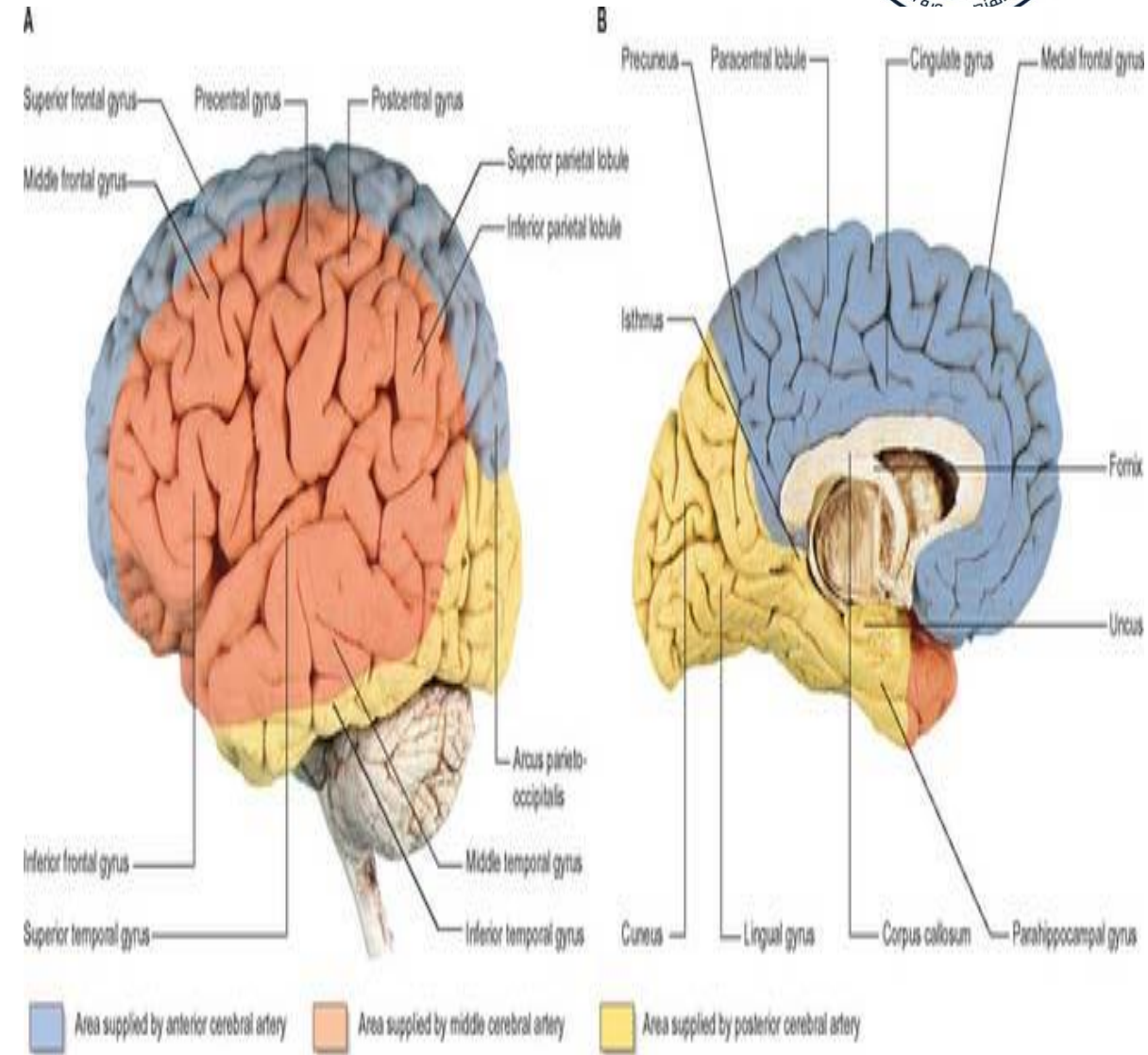
Medial surface:

1. **Frontal and parietal lobes:** by the anterior cerebral artery.
2. **Occipital and temporal lobes** except the temporal pole: by the posterior cerebral artery.

3. **Temporal pole:** by the middle cerebral artery.

Inferior surface:

1. **Medial half** of the orbital surface: by the anterior cerebral artery.
2. **Lateral half** of the orbital surface and the temporal pole: by the middle cerebral artery.
3. **Tentorial surface** except the temporal pole: by the posterior cerebral artery.



Arterial supply of the internal capsule

Anterior Limb:

☐ **Dorsal 1/2:** middle cerebral artery.

☐ **Ventral 1/2:** anterior cerebral artery.

Genu:

☐ **Anterior part:** anterior cerebral artery.

☐ **Posterior part:** post communicating artery.

Posterior Limb:

☐ **Dorsal half:** middle cerebral artery.

☐ **Ventral half:**

1. **Anterior 1/3:** posterior communicating artery.

2. **Posterior 2/3:** Anterior choroidal artery.

Venous drainage of the brain

The brain is drained by two venous systems:

1. Superficial cerebral veins.
2. Deep cerebral veins.

Superficial cerebral veins

They drain the superficial structures into the dural venous sinuses.

They are divided into superior, middle and inferior cerebral veins.

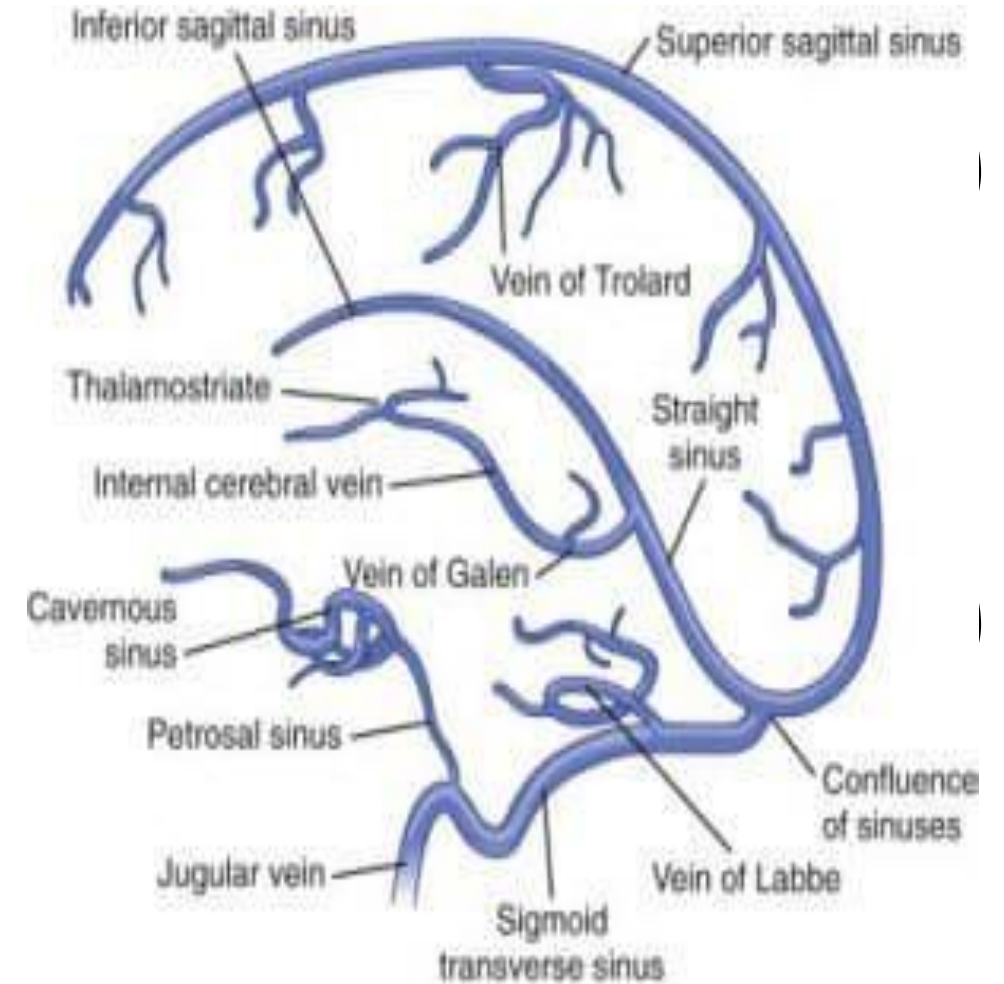
1. Superior cerebral veins (8-12): they drain into the superior sagittal sinus.

2. Middle cerebral veins: are divided into:

a. Superficial middle cerebral vein: in the lateral sulcus. Drains into cavernous sinus.

b. Deep middle cerebral vein: in the bottom of the lateral sulcus and drains the insula. It unites with the anterior cerebral vein to form the basal vein.

3. Inferior cerebral veins: they drain into the cavernous and transverse sinuses.



Deep cerebral veins:

They drain the **deep subcortical structures** and form three **large veins**:

1. Two internal cerebral veins:

Each is formed at the interventricular foramen of Monro by the union **of the thalamostriate vein and the choroidal vein**.

The two internal cerebral veins unite below the splenium of the corpus callosum to form the **great cerebral vein**.

2. Great cerebral vein:

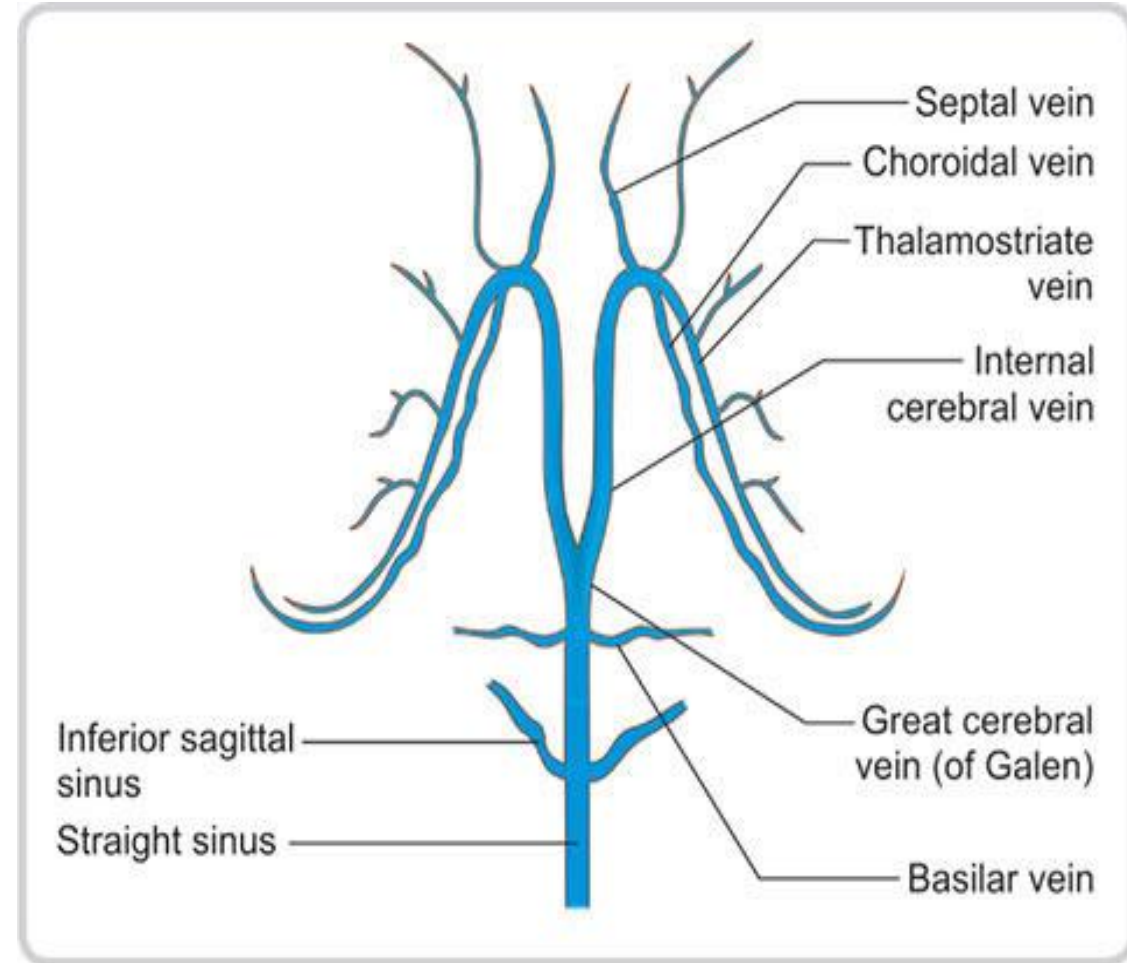
Formed by the union of the two internal cerebral veins.

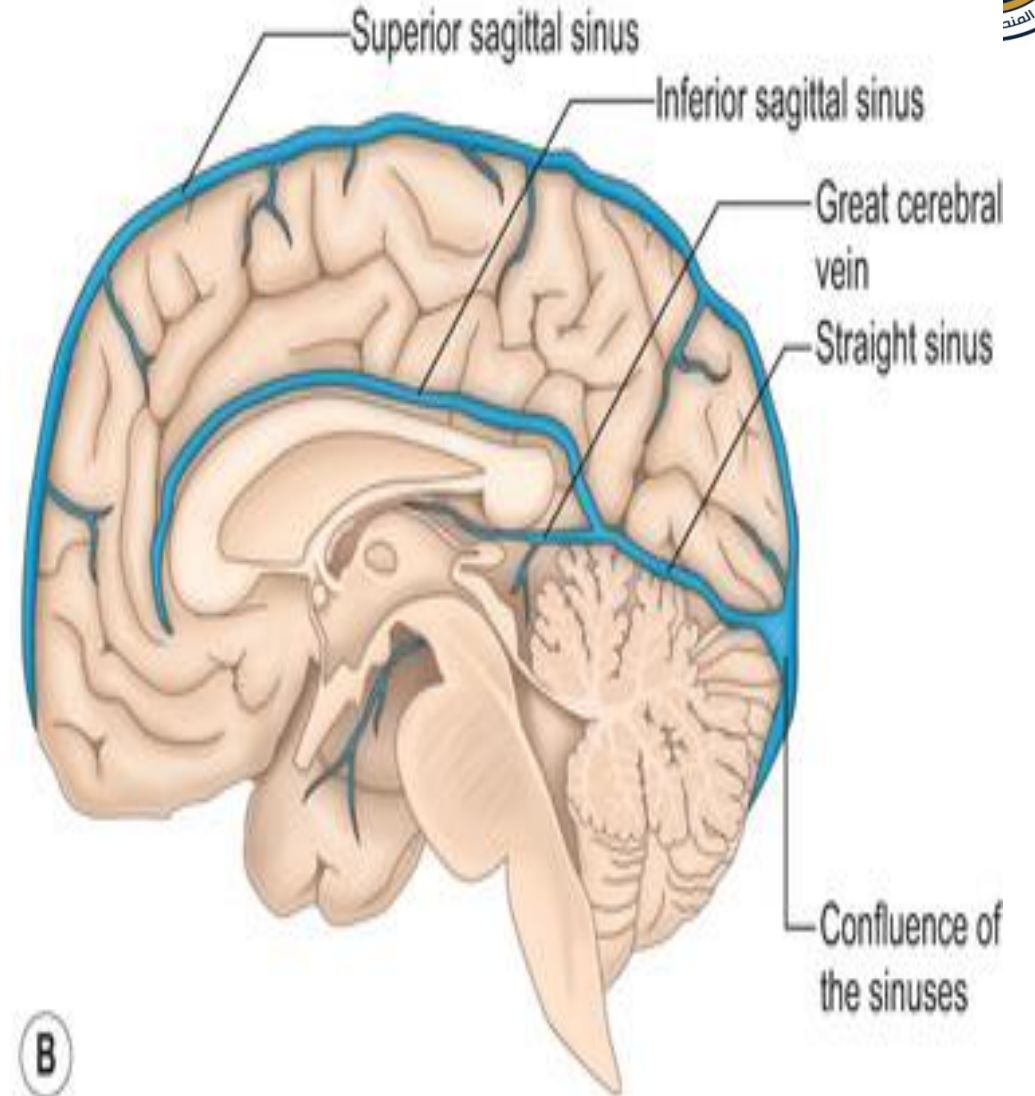
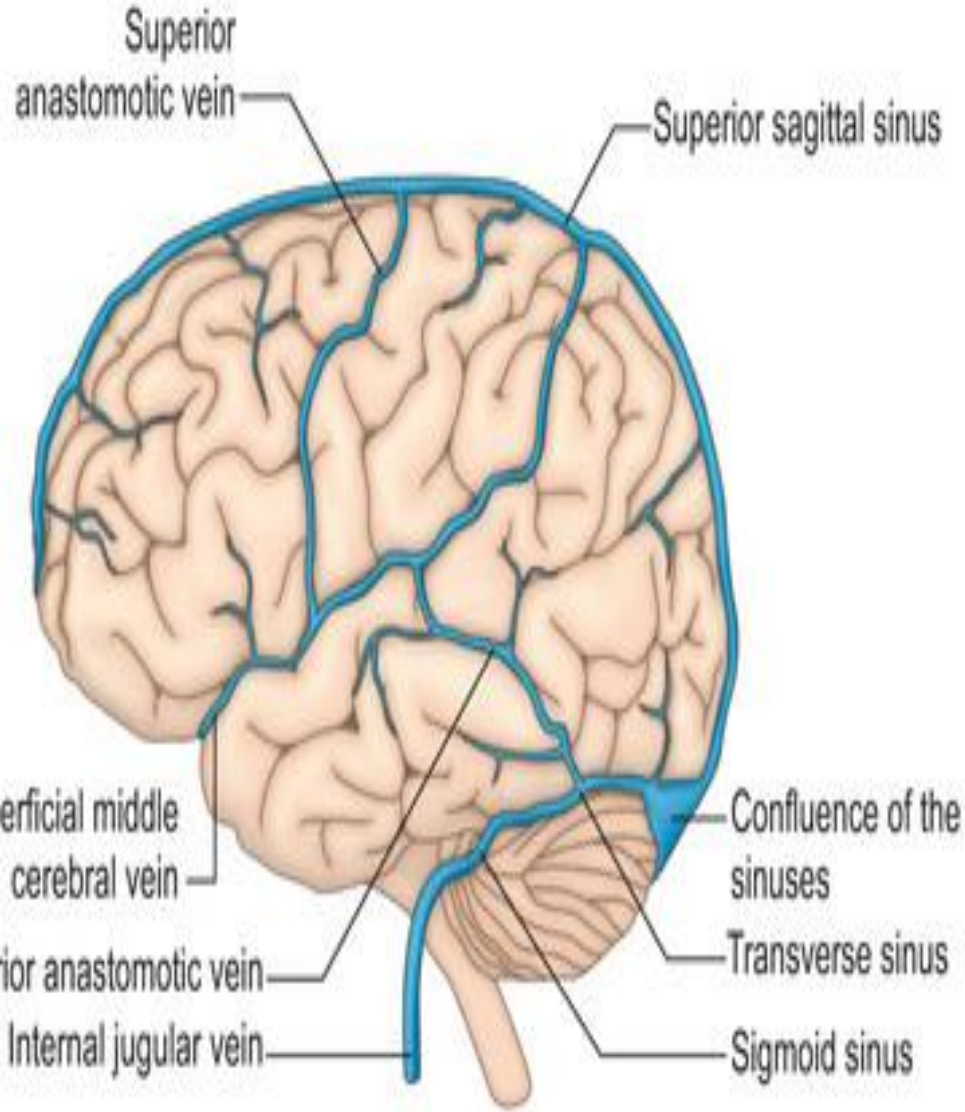
It unites with the **inferior sagittal sinus** to form the **straight sinus**.

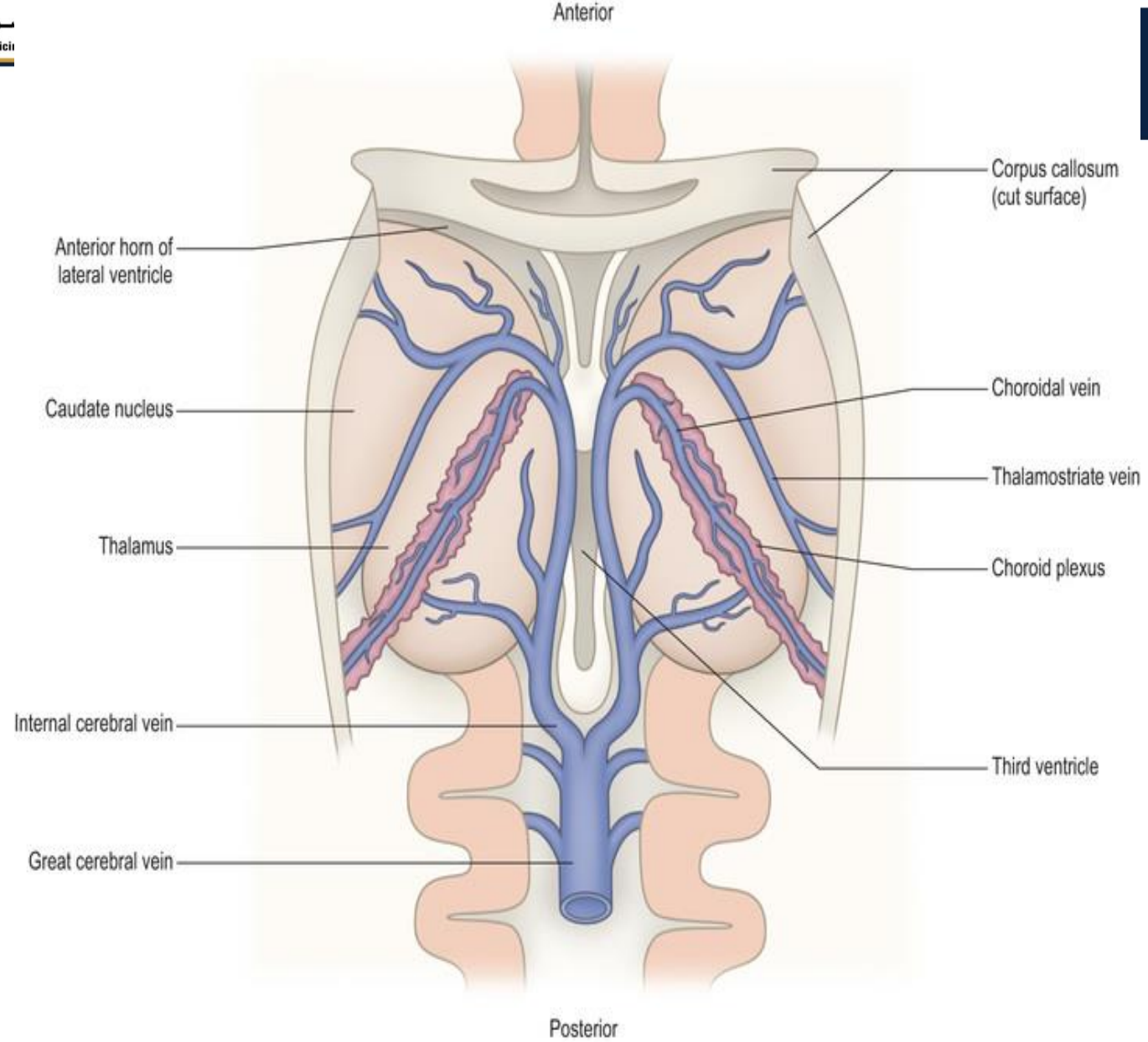
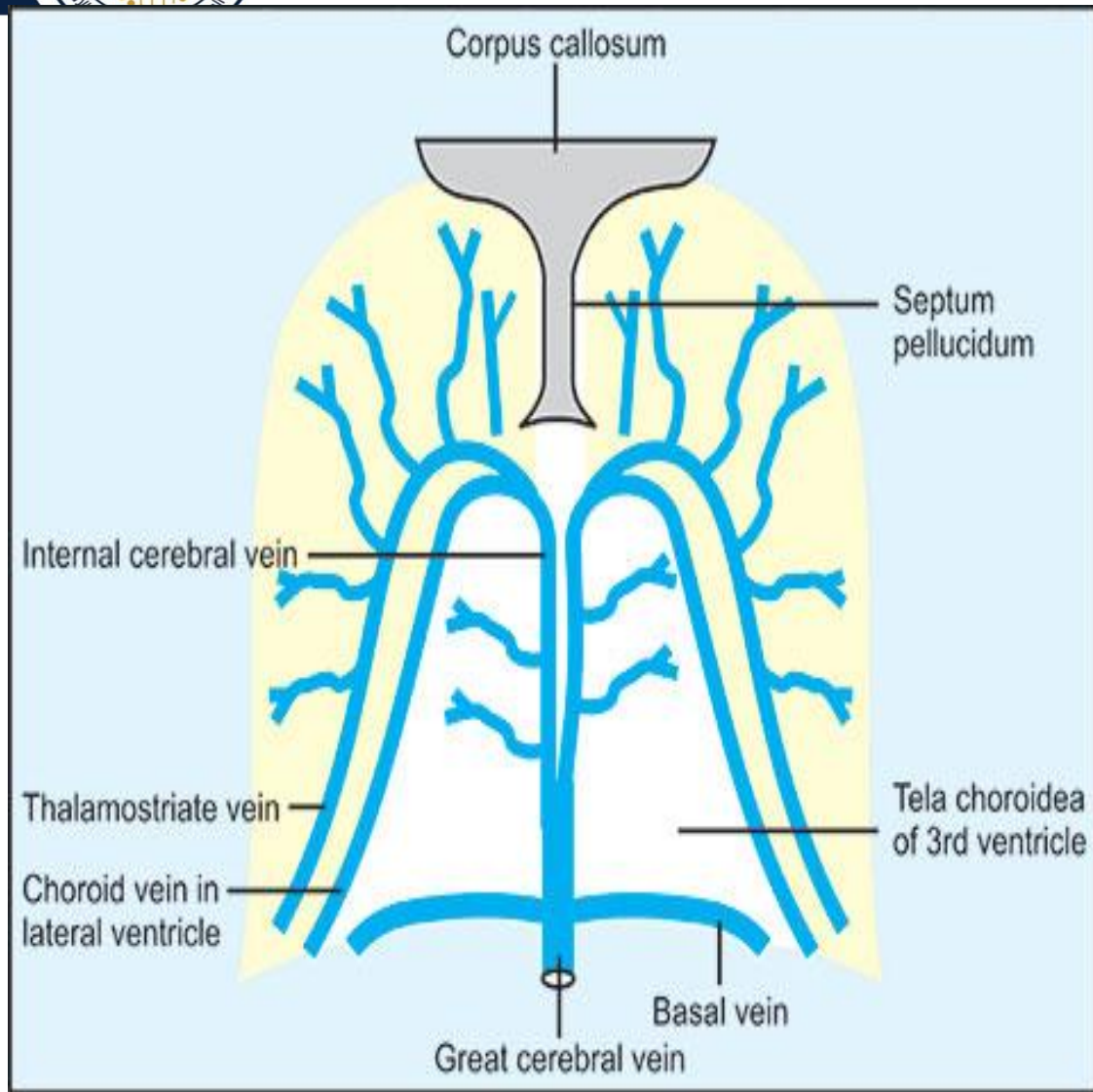
3. Two basal veins:

Formed by the union of the **deep middle cerebral vein** and **anterior cerebral vein** at the anterior perforated substance.

It ends in **the great cerebral vein**







Vertebral artery

Origin: it is a branch of the first part of the subclavian artery.

Course: 4 parts

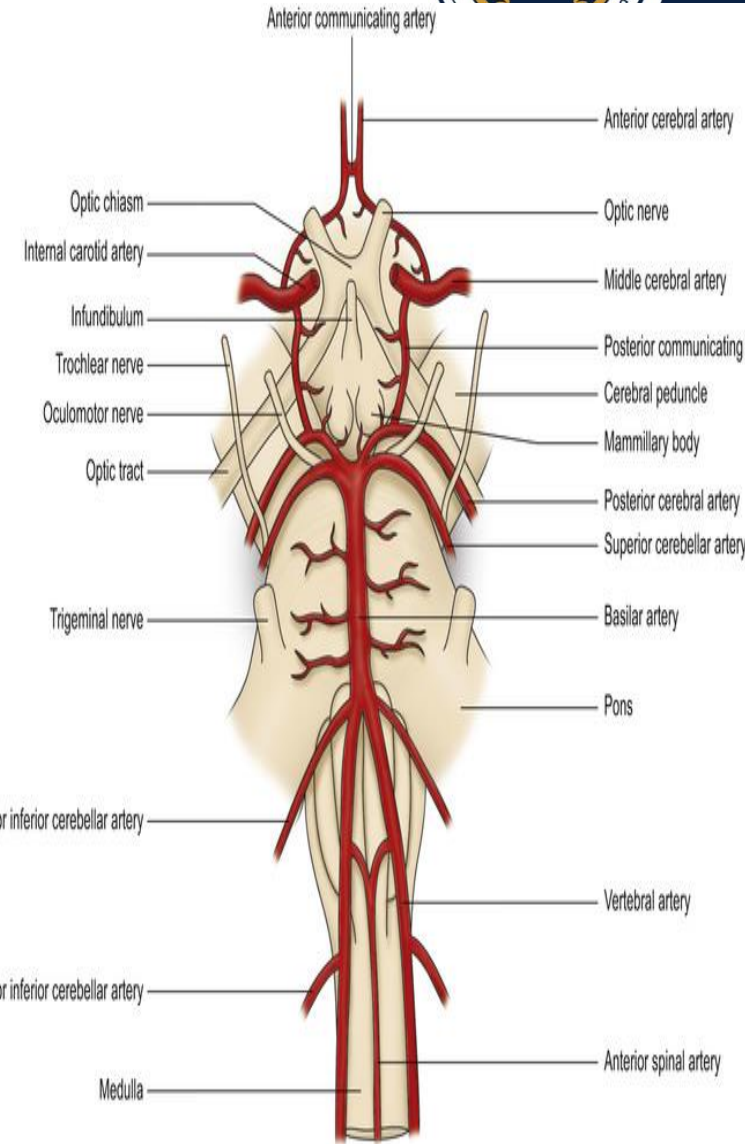
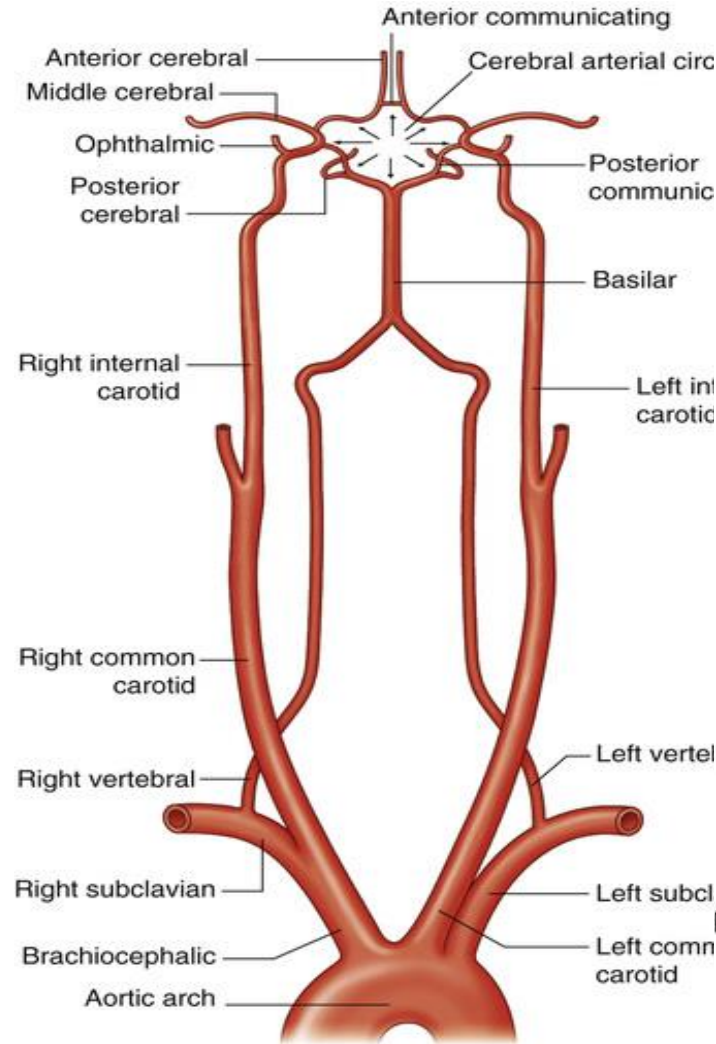
A. First part: from the origin to foramen transversarium of c6.

B. Second part: ascends through foramina transversaria of the upper six cervical vertebrae.

C. Third part: on the posterior arch of atlas.

D. Forth part enters the cranial cavity through foramen magnum. Ascends upward on the medulla to reach the lower border of the pons.

Termination: at the lower border of the pons where the **2 vertebral arteries** unite to form **the basilar artery**.



Vertebral artery

Branches in the cranial cavity:

1. Anterior spinal artery: ? It unites with the opposite one to form a single anterior spinal artery. It supplies:

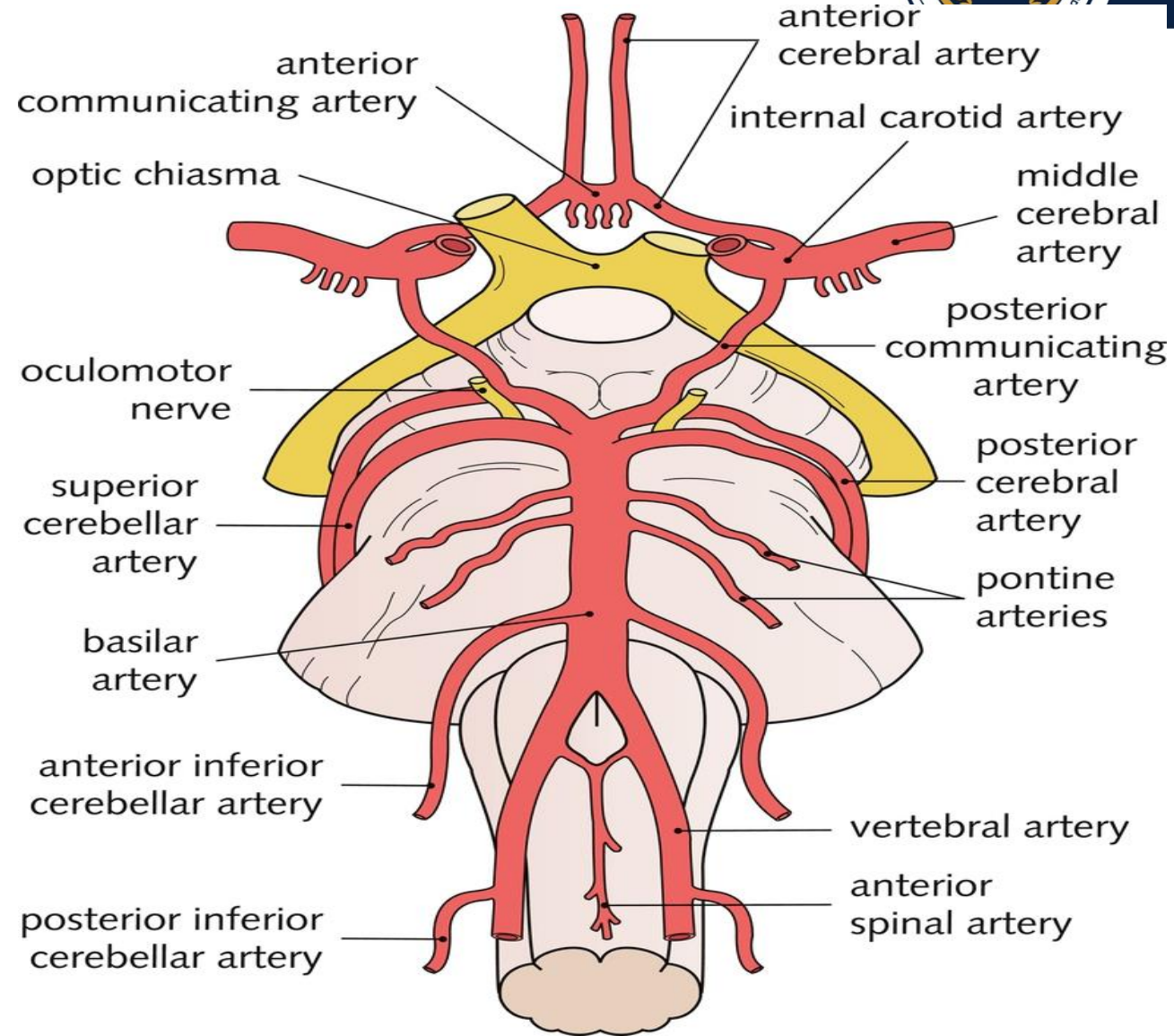
- o Anterior two-thirds of the spinal cord.
- o Medial zone of the medulla.

? **Occlusion of the anterior spinal artery** causes medial medullary syndrome.

2. Posterior spinal artery: Usually arises from the PICA. It supplies:

- ? Posterior third of the spinal cord.
- ? Gracile and cuneate tracts and nuclei.

3. Medullary branches: supply the middle zone of the medulla including the olive.



4. Posterior inferior cerebellar artery

(PICA): it supplies:

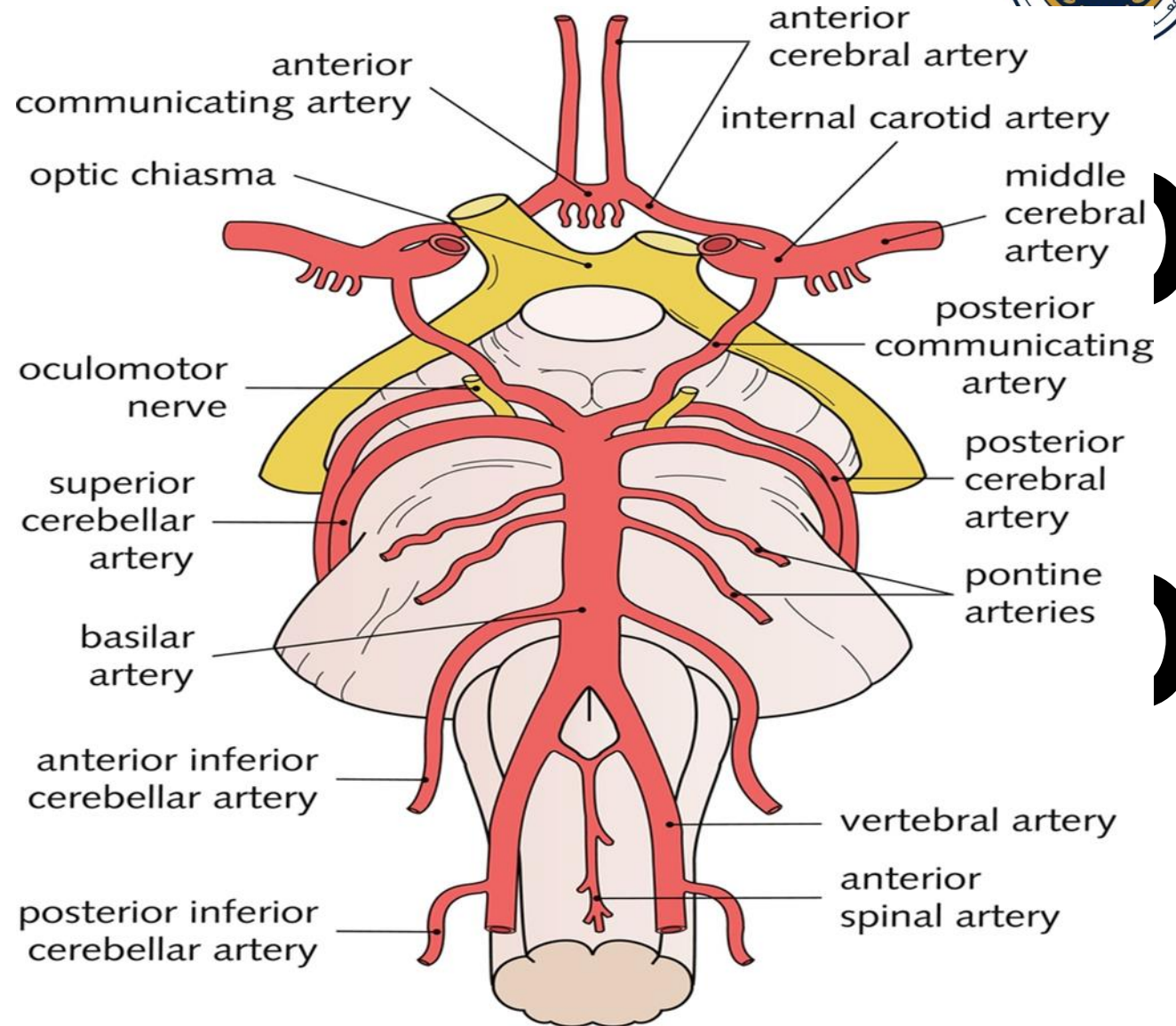
- Postolateral zone of the medulla.
- Inferior cerebellar peduncle.
- Posterior part of the inferior surface of the cerebellum.
- Choroid plexus of the 4th ventricle.

It usually gives the posterior spinal artery.

Occlusion of the pica causes lateral medullary syndrome.

5. Posterior meningeal artery:

supplies the meninges of the posterior cranial fossa.



Origin: at the **lower border of the pons** by the union of the two vertebral arteries.

Course: ascends in the basilar groove of the pons.

Termination: at **the upper border** of the pons by dividing into **2 posterior cerebral arteries**.

Branches: 1. **Pontine branches:** 3 groups

❑ **Paramedian branches:** to the medial zone of basis pontis.

❑ **Short circumferential branches:** to the lateral zone of basis pontis.

Long circumferential branches: to the pontine tegmentum.

2. **Anterior inferior cerebellar artery (AICA):** supplies:

❑ Anterior part of the inferior surface of the cerebellum.

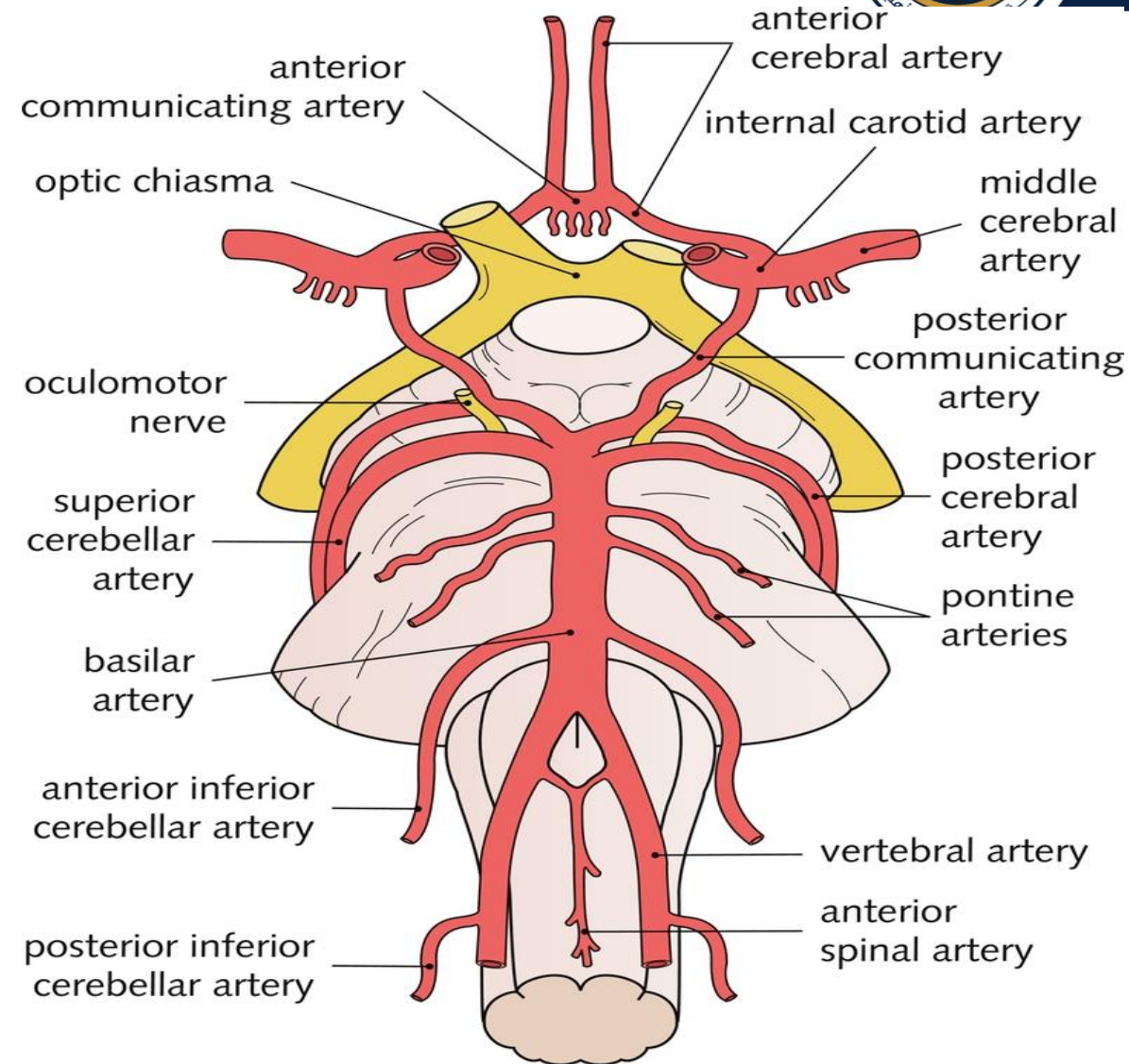
❑ Middle cerebellar peduncle.

❑ It gives the labyrinthine artery in 85%.

3. **Labyrinthine (internal auditory) artery (in 15%):**

❑ It accompanies the vestibulocochlear nerve and the facial nerve in the internal acoustic meatus

❑ **It supplies the internal ear.**



Basilar artery

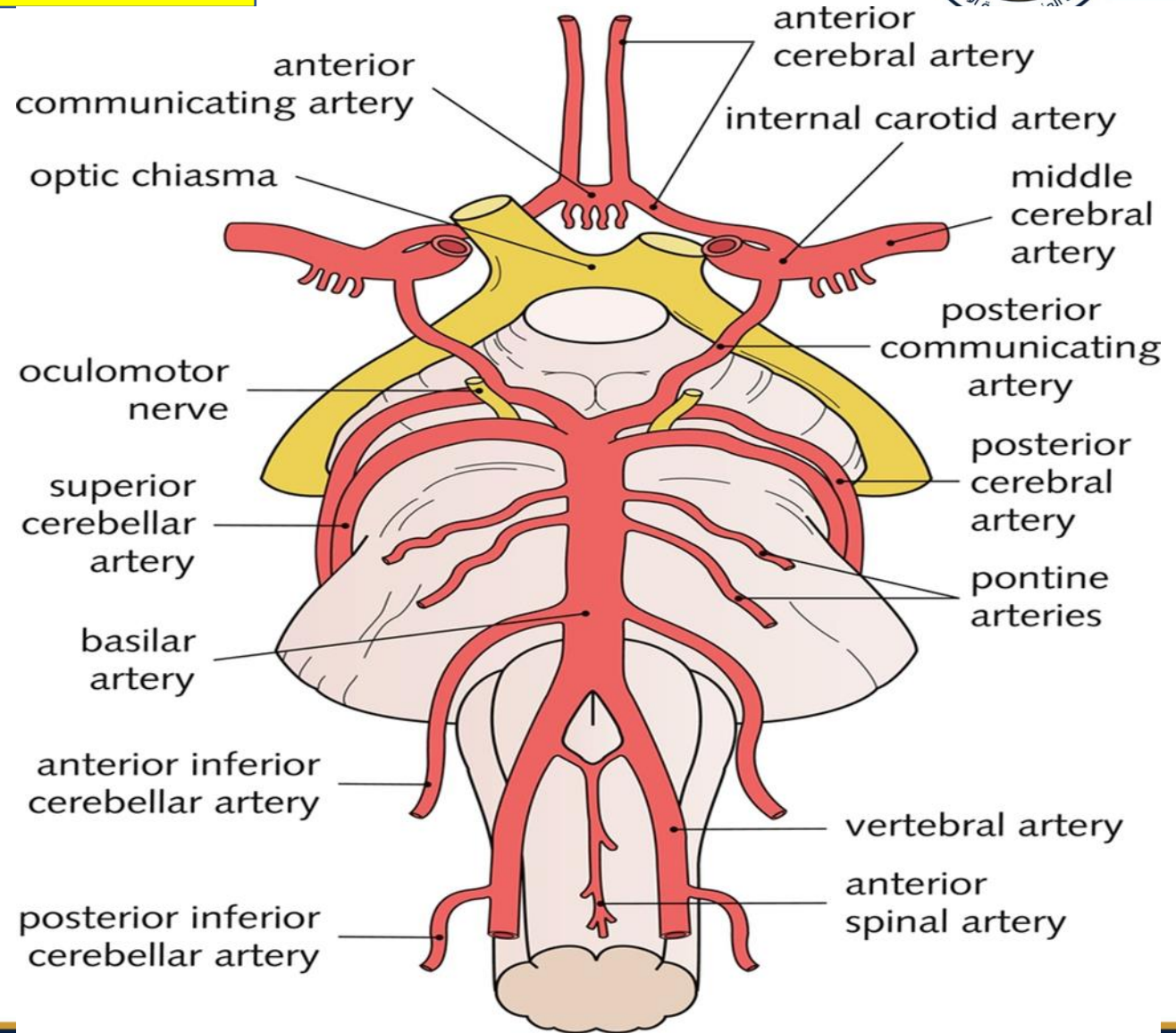
4. Superior cerebellar artery (SCA):

It winds around the midbrain and supplies:

- ☐ Superior surface of the cerebellum.
- ☐ Superior cerebellar peduncle and the superior medullary velum.
- ☐ Inferior colliculus of the midbrain.

5. Two terminal branches (posterior cerebral arteries):

- ☐ They wind around the midbrain.
- ☐ It is connected with the internal carotid artery by the posterior communicating artery.
- ☐ It supplies the midbrain, thalamus, hypothalamus and occipital lobe.
- ☐ It is separated from the superior cerebellar artery by the oculomotor & trochlear nerves.



Blood supply of the brain

Arterial supply

Circulus arteriosus (circle of Willis)

Location: in the interpeduncular fossa at the base of the brain.

Formation: it is formed by the following arteries:

A. Anteriorly: anterior communicating artery connecting the two anterior cerebral arteries.

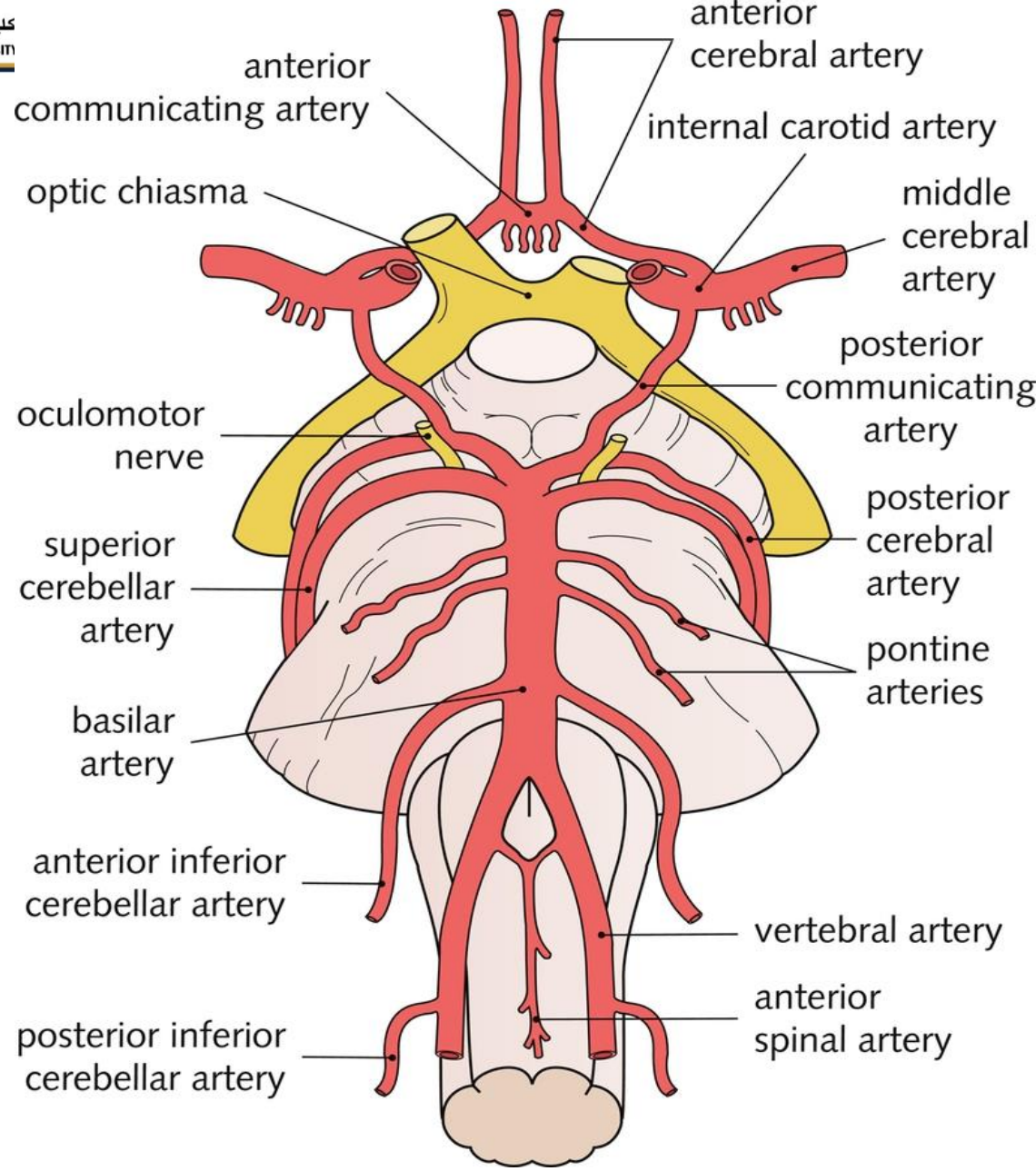
B. Posteriorly: two posterior cerebral arteries.

C. On each side: from before backward:

❑ **Anterior cerebral artery:** the smaller terminal branch of the internal carotid artery.

❑ **Internal carotid artery.**

❑ **Posterior communicating artery** connecting the internal carotid artery with the posterior cerebral artery.



Disorders of the blood supply of the brain

One of the most common causes of neurological disability is stroke, resulting from **blockage or rupture of vessels** in the cerebral circulation.

The **sudden occlusion** of a cerebral artery leads to death of brain tissue (infarction).

Rupture of a blood vessel causes bleeding into the brain (cerebral hemorrhage). These events lead to the rapid development of a focal neurological syndrome.

Strokes related to the **carotid artery** and its cerebral branches are associated with focal epilepsy, a contralateral sensory/motor deficit and a psychological deficit (e.g. aphasia).

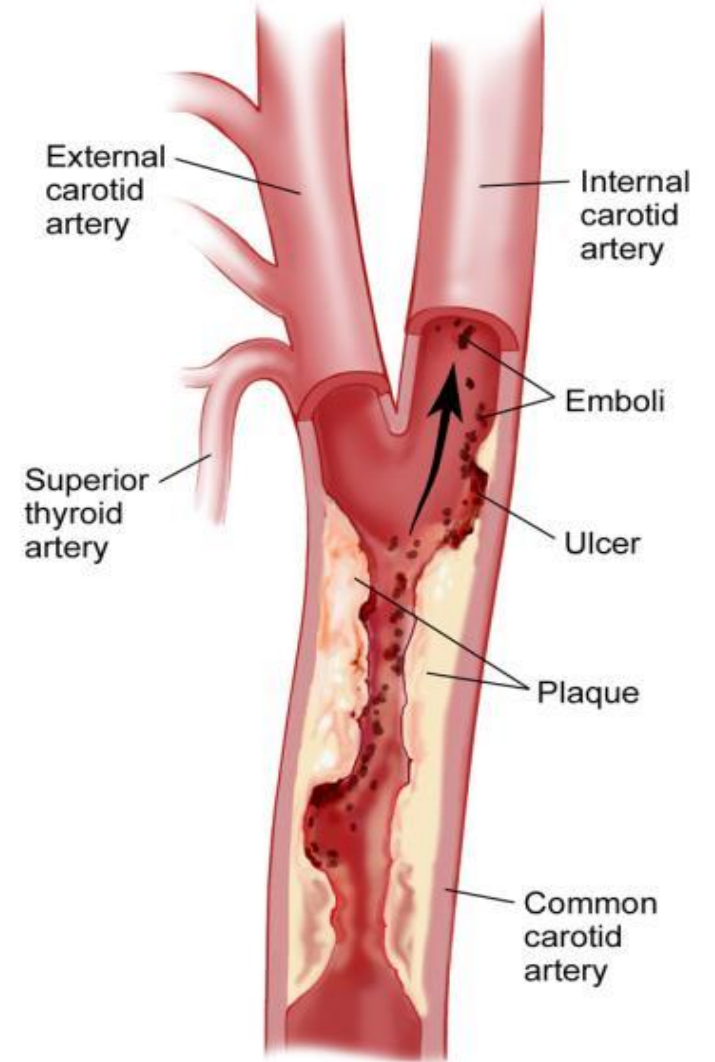
Strokes involving the **vertebrobasilar circulation** lead to a **focal brainstem syndrome**.

An **aneurysm** is an abnormal, balloon-like swelling of an artery.

A **surgical emergency** arises when an aneurysm ruptures and blood projects around the brain in the subarachnoid space (**subarachnoid haemorrhage**) and into the brain (intracerebral haemorrhage).

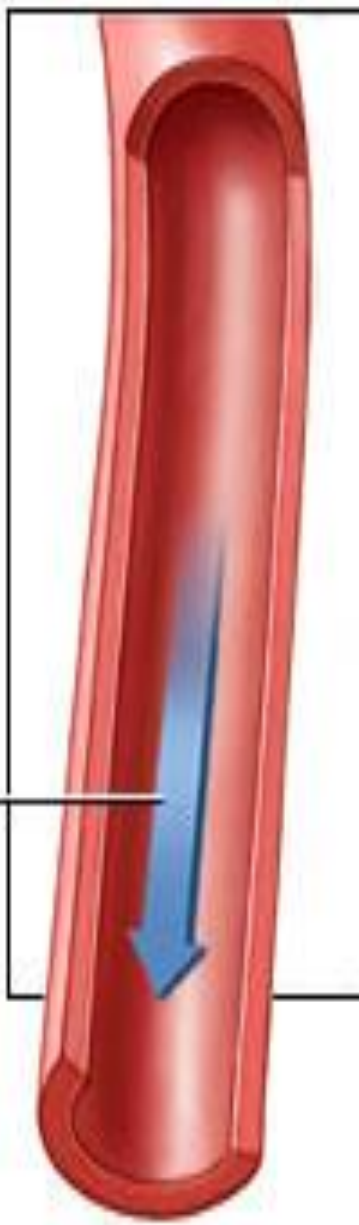
A sudden severe headache and neck stiffness are followed by coma and neurological deficits.

Neurosurgery or intra-arterial 'coiling' are required to seal the aneurysm to prevent further bleeding and allow recovery.

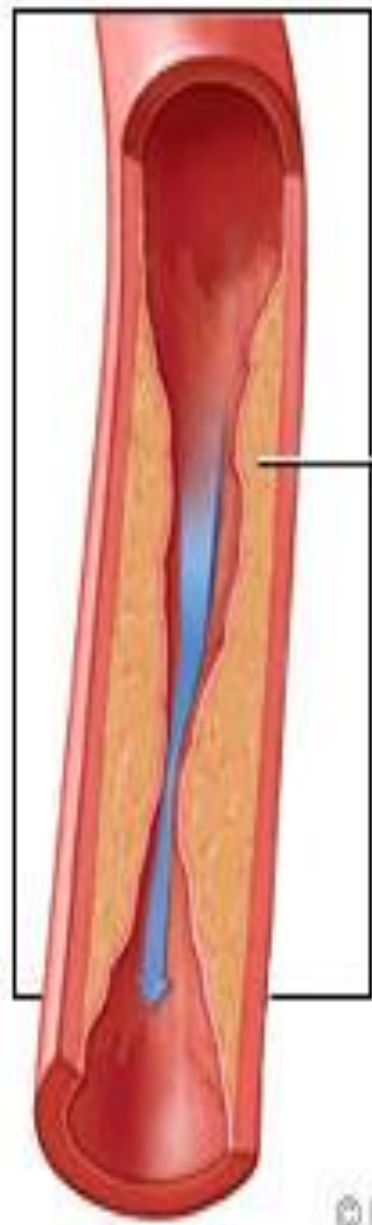




Normal artery



Artery narrowed by atherosclerosis



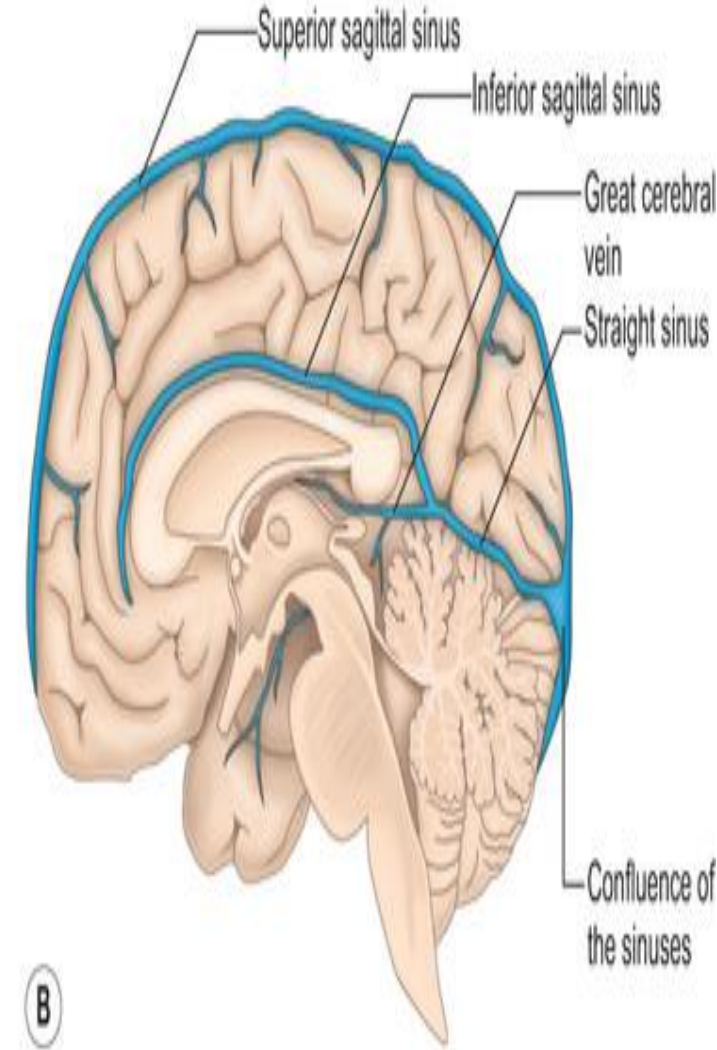
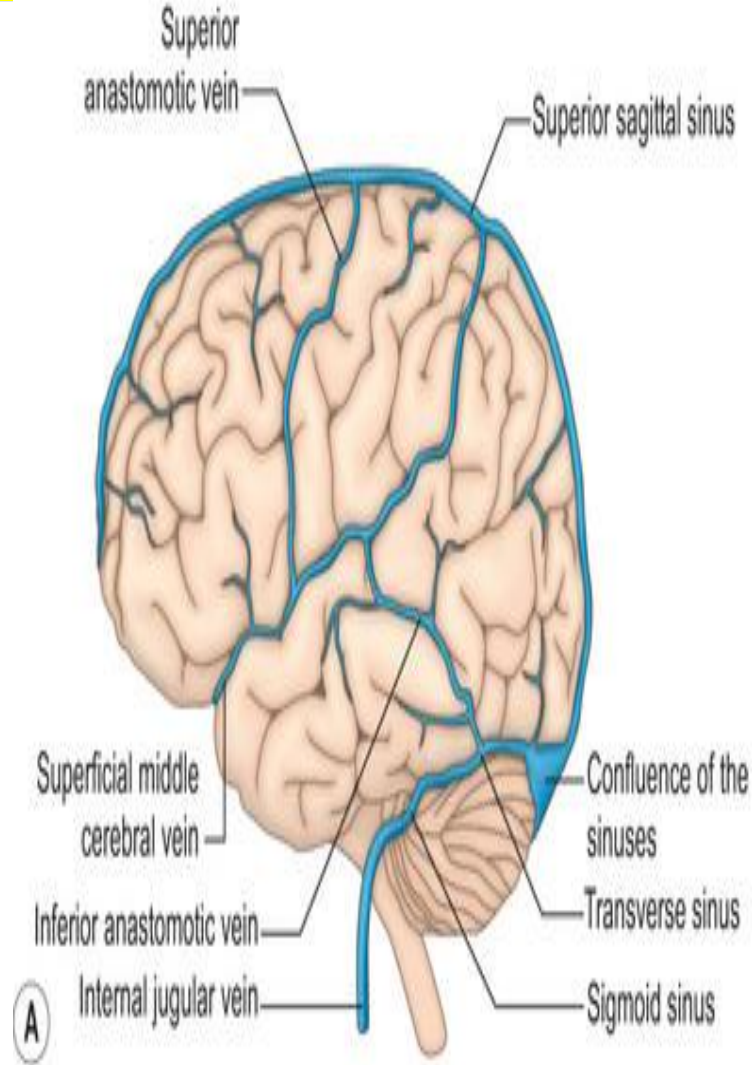
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ARTERIAL SUPPLY OF THE BRAIN

- **The brain** is supplied by **paired internal carotid and vertebral arteries**.
 - **The internal carotid artery** terminates **lateral to** the optic chiasm, giving rise to the **anterior and middle cerebral arteries**.
 - **The anterior cerebral artery** passes into the great longitudinal fissure and supplies the **medial aspect** of the cerebral hemisphere.
 - **The middle cerebral artery** passes into the **lateral fissure** and supplies **the lateral aspect** of the cerebral hemisphere.
 - **The vertebral arteries** ascend on the ventrolateral aspect of the medulla, uniting to form the **midline basilar artery**, which extends the length of the pons.
- Along their course the vertebral and basilar arteries give rise to branches that supply the **cerebellum and brainstem**.
- **The principal terminal branch of the basilar artery** is **the posterior cerebral artery**, which supplies the **occipital lobe** of the cerebral hemisphere.
 - **The anterior communicating artery** links together the two anterior cerebral arteries.
 - **Posterior communicating arteries** pass between the internal carotid artery and the posterior cerebral artery, on each side.
- This anastomosis of vessels constitutes the circle of Willis.**
- **Small perforating arteries** arise from the circle of Willis to supply the **hypothalamic area, the basal ganglia and the internal capsule**.

Venous Drainage of The Brain

- **Venous drainage** of the brain involves deep veins, superficial veins and dural venous sinuses.
- **Deep cerebral veins** drain into the great cerebral vein, which is continuous with the straight sinus.
- **Superficial veins** empty principally into the superior sagittal sinus and the cavernous sinus.
- **The superior sagittal sinus** and straight sinuses meet at the confluence of the sinuses.
- From the confluence of the sinuses, venous blood flows, via the transverse sinus and sigmoid sinus, **into the internal jugular vein.**

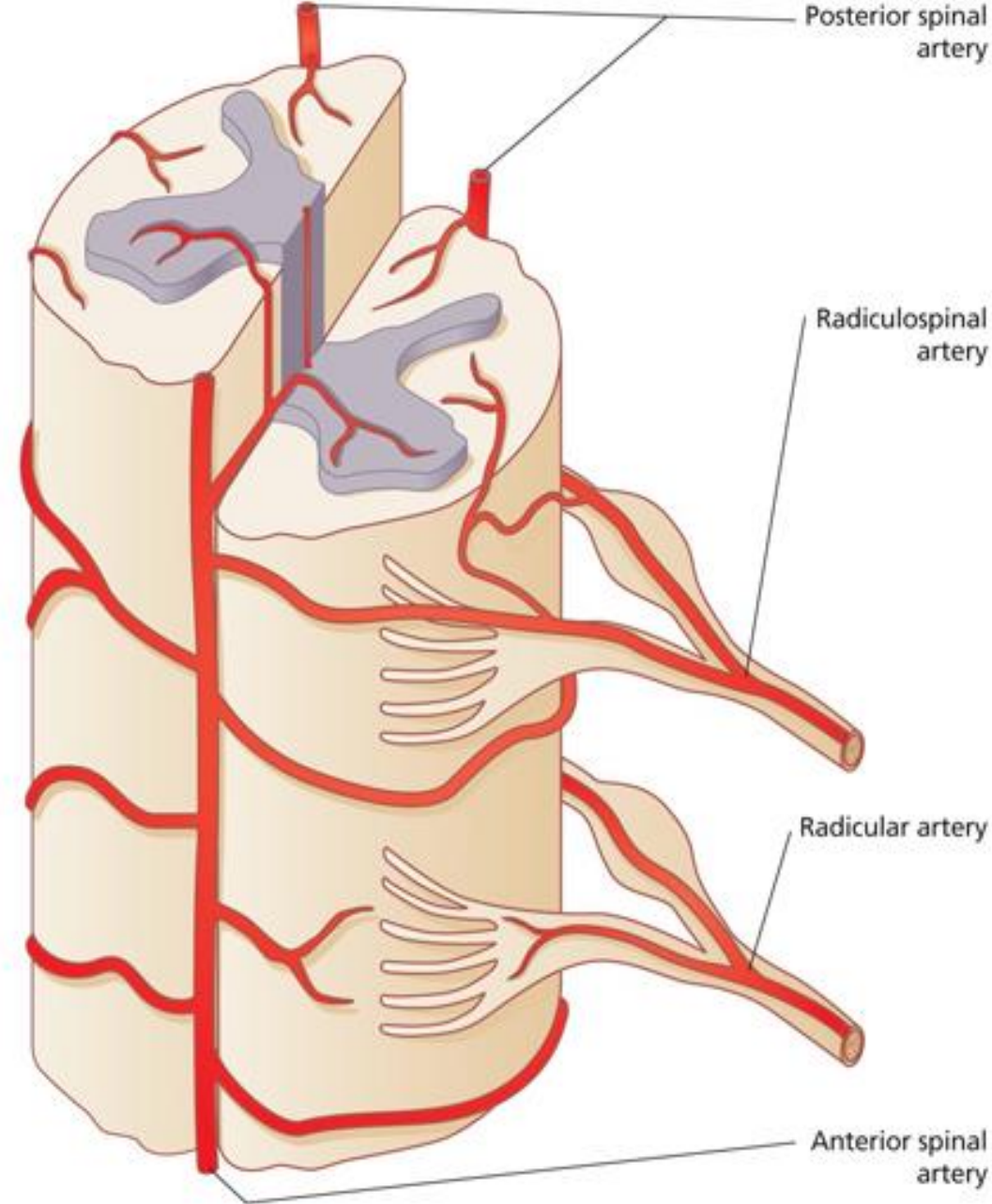


1. Anterior Spinal Artery:

- Is a single artery formed by the union of the two anterior spinal branches of the vertebral arteries. It descends in the anterior median fissure of the spinal cord.
- It supplies the **anterior 2/3 of the spinal cord**.
- It becomes very small below the cervical region & reinforced by **radicular arteries**

2. Two Posterior Spinal Arteries:

- Each is a branch of the vertebral artery or usually from the PICA.
- They descend along the dorsal nerve roots (posterolateral fissure).
- They supply the **posterior 1/3 of the spinal cord** (dorsal funiculus and horn).

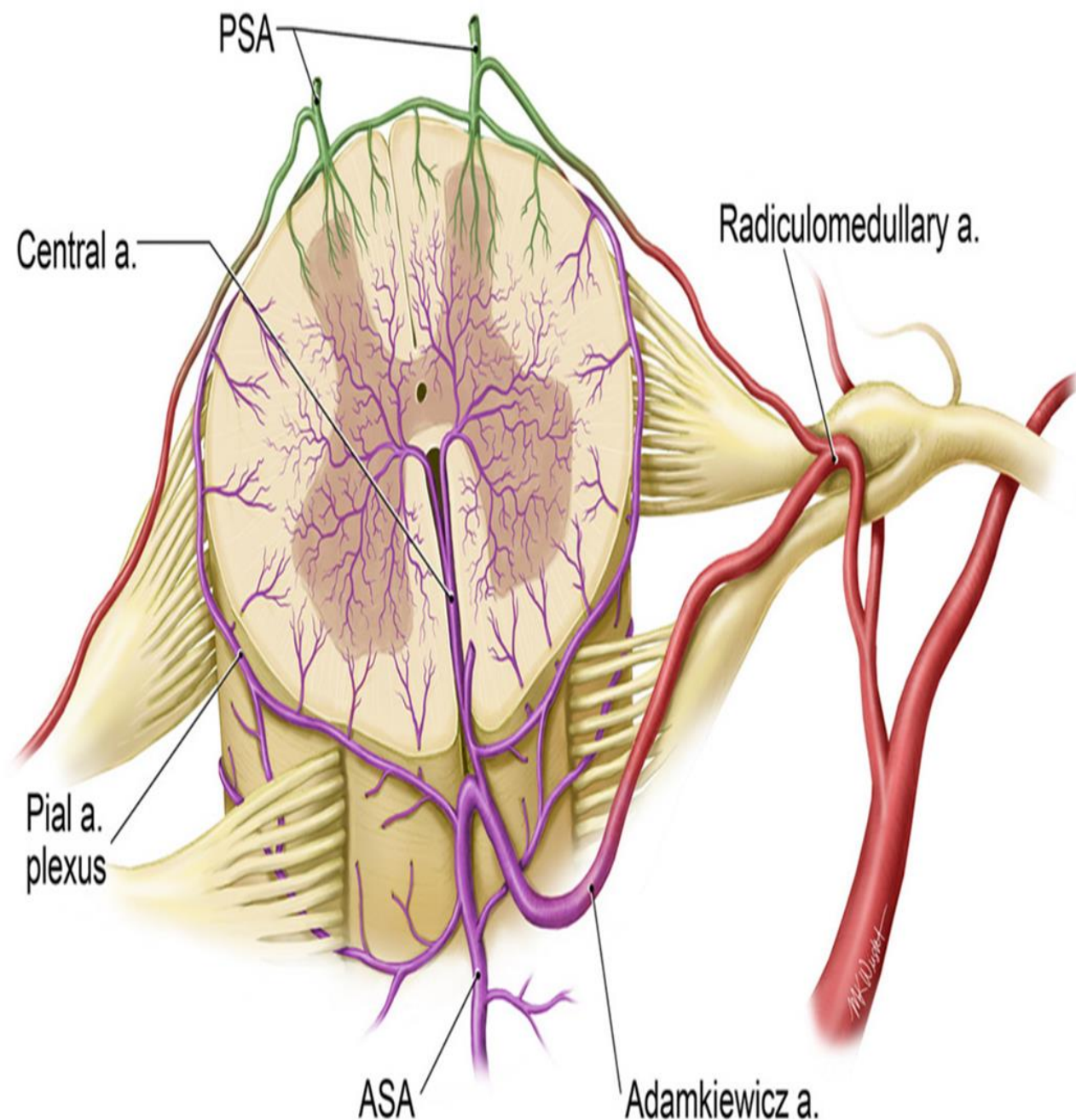


3. Radicular Arteries:

- They are the major source of blood to the lower two-thirds of the spinal cord.
- They enter the vertebral canal through the intervertebral foramina and divide into anterior and posterior branches which join the anterior & posterior spinal arteries.
- They are branches from:
 - ❓ In the neck: from the vertebral & ascending cervical arteries.
 - ❓ In the thorax: from the intercostal arteries.
 - ❓ In the abdomen: from the lumbar arteries.
 - ❓ In the pelvis: from the lateral sacral arteries.

Venous drainage of the spinal cord:

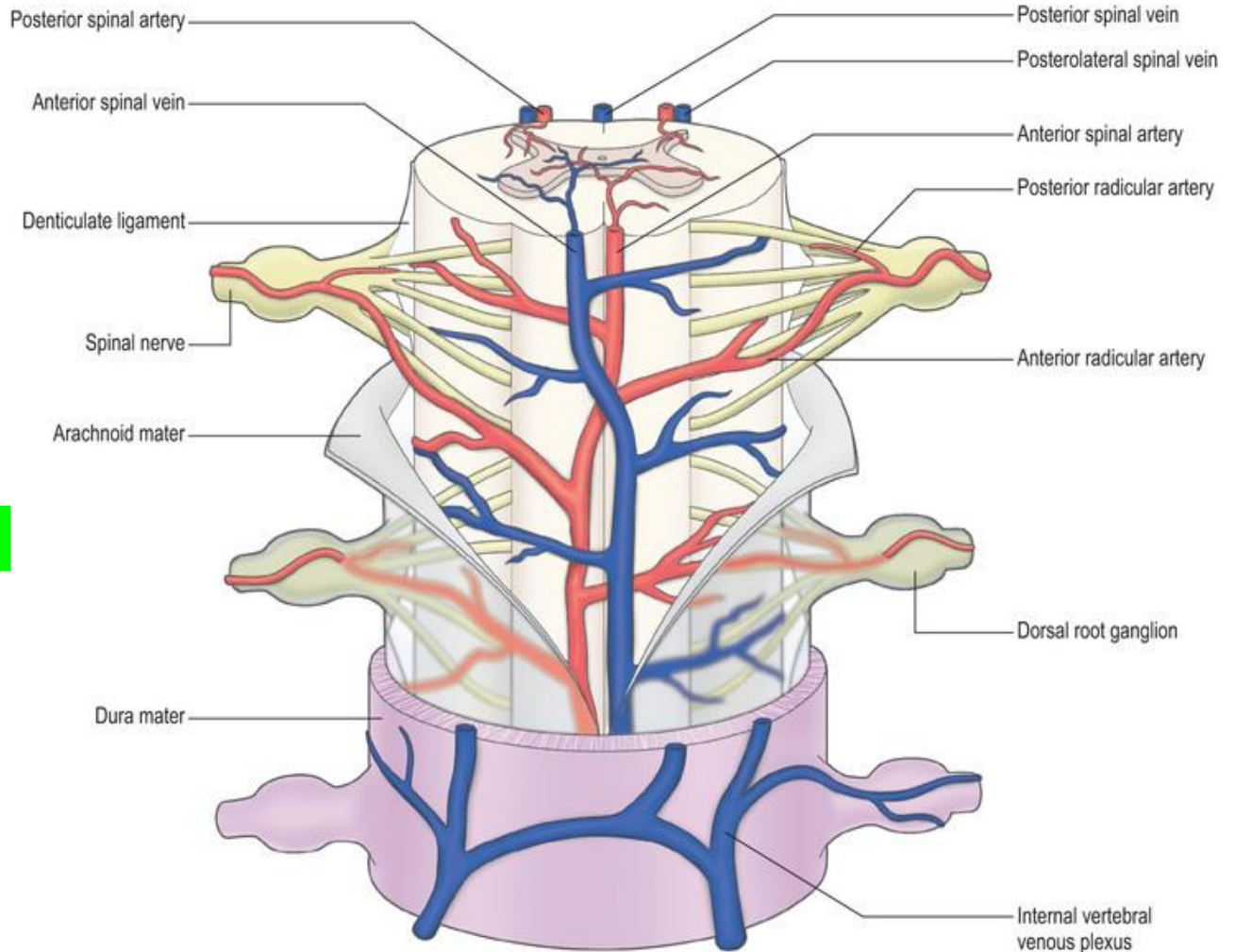
- The veins correspond to the arteries and drain into the internal vertebral venous plexus present in the epidural space.

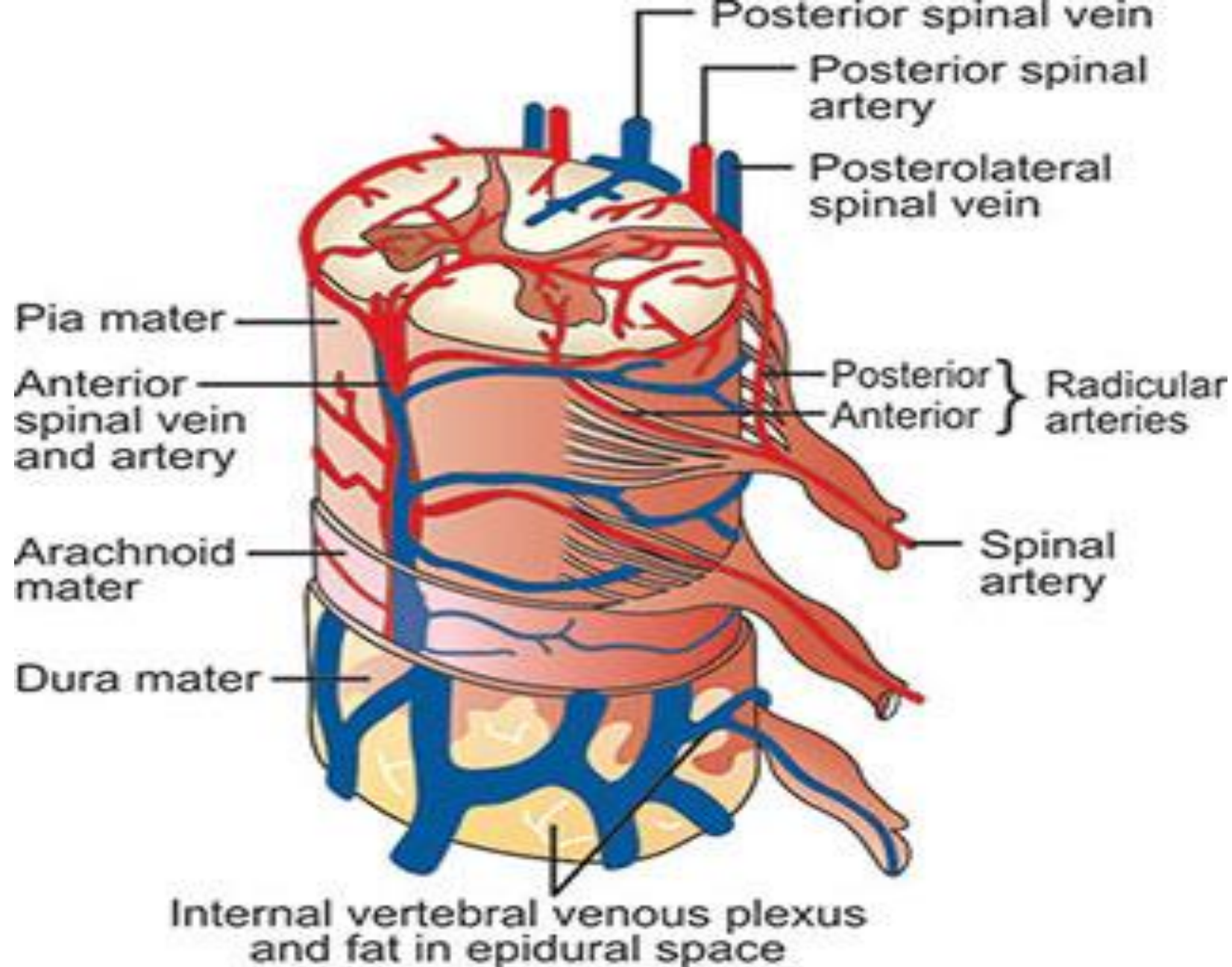


Arterial supply of the spinal cord

Vasculature of the spinal cord

- **The spinal cord** is supplied by the anterior and posterior spinal arteries, supplemented by radicular arteries.
- **Venous drainage** is by anterior and posterior spinal veins, which drain, via radicular veins, into the **internal vertebral venous plexus**.
- **Occlusion of the anterior spinal artery**, usually secondary to **dissection of the descending thoracic aorta**, leads to **an acute thoracic cord syndrome** with **paraplegia and incontinence**.
- The spinothalamic modalities of pain and temperature **are preferentially lost**, whereas the proprioceptive functions of the dorsal columns are **relatively preserved**.





Quiz

Which of the following best describes the internal carotid artery?

- A. One of two terminal branches of external carotid artery
- B. It supplies the occipital lobes and the brain stem
- C. It connects with the posterior cerebral artery through anterior communicating artery
- D. It connects with the posterior cerebral artery through posterior communicating artery
- E. It has a straight course along its length

Answer:

M N U



Thank You!