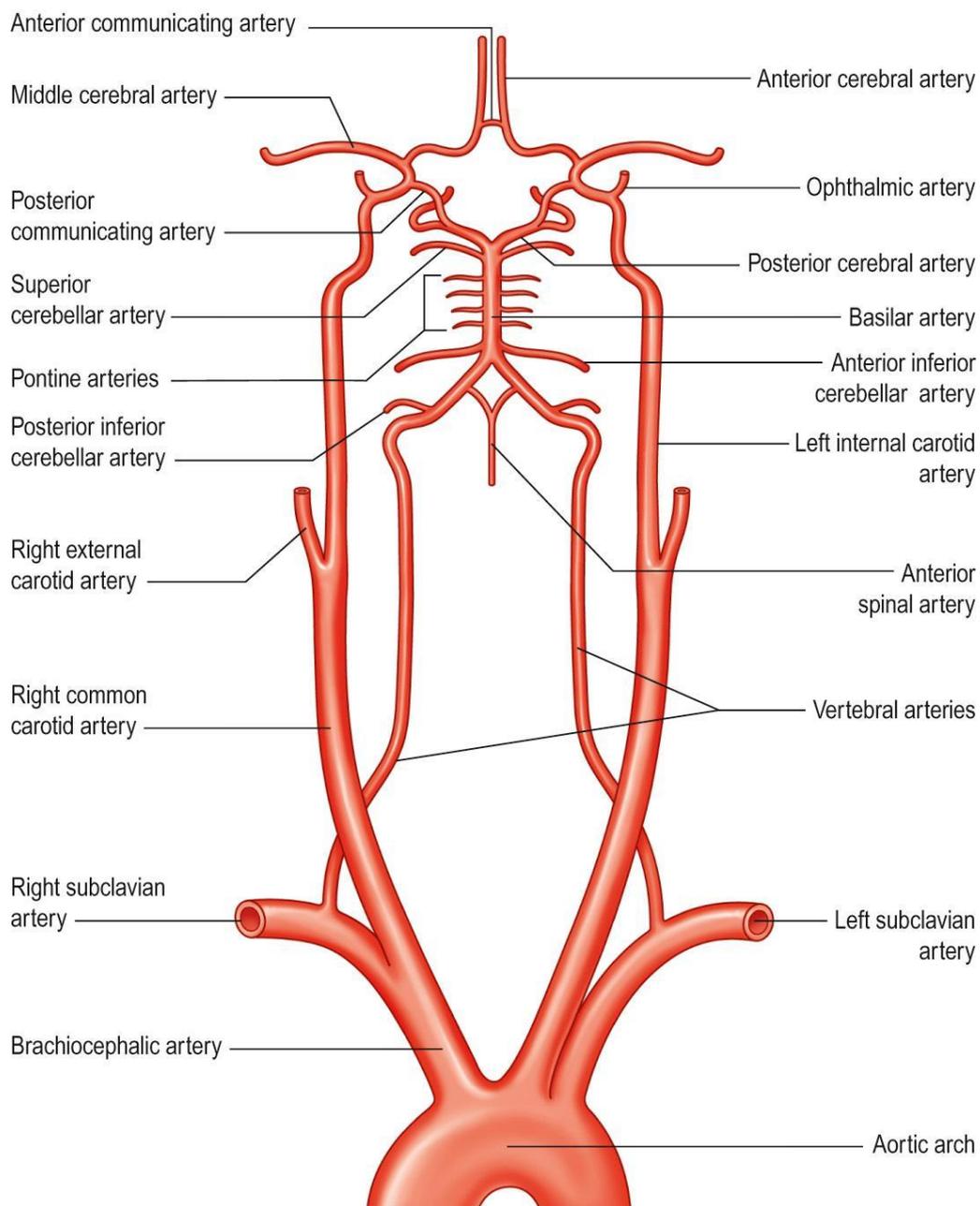


Blood supply of the brain and the spinal cord

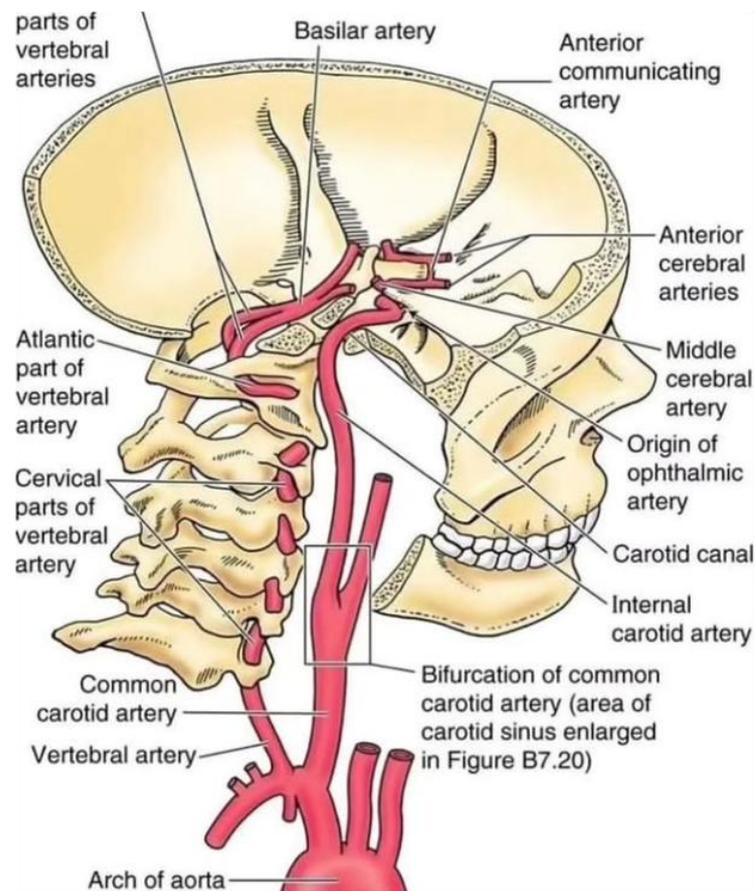
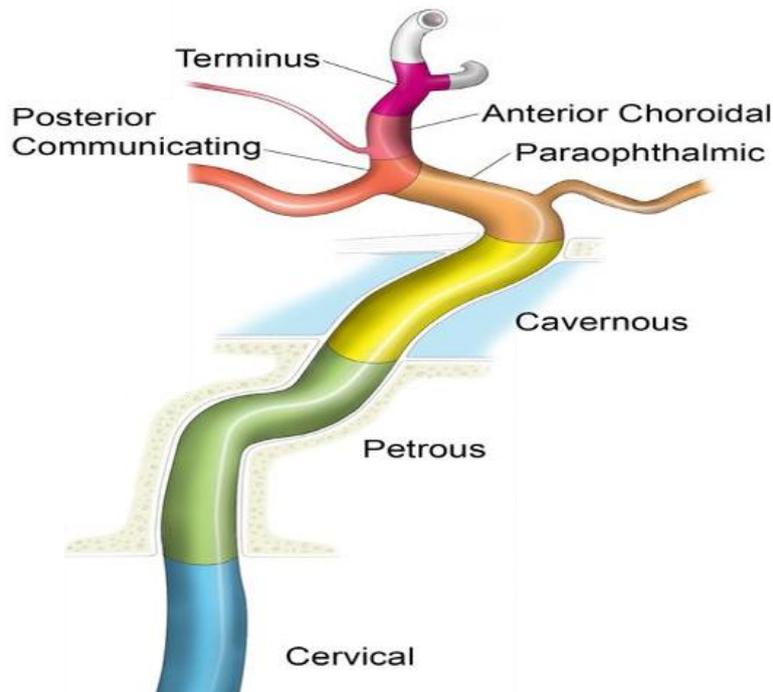
Arterial supply of the Brain

- The brain is supplied by two systems:
 - **Vertebrobasilar system:**
 - The two vertebral arteries and the basilar artery.
 - **Internal carotid system:**
 - The two internal carotid arteries.



Internal Carotid Artery (ICA)

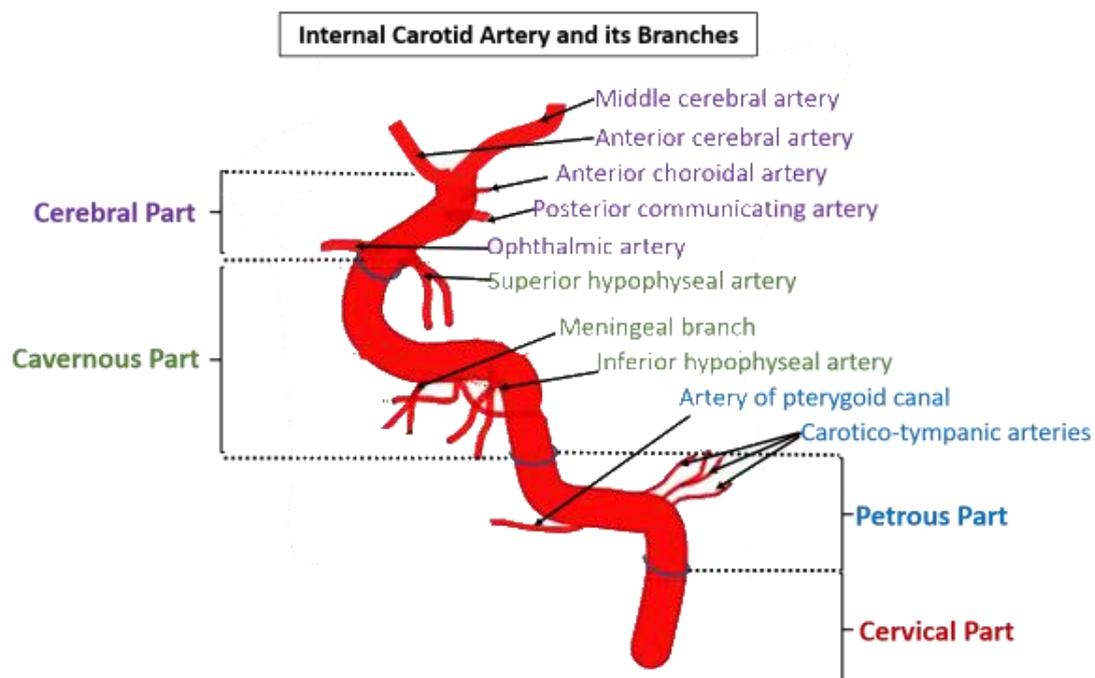
Origin	One of the two terminal branches of the common carotid artery at the upper border of the thyroid cartilage (disc between C3 and C4).	
Course	Cervical part	Inside the carotid sheath with the internal jugular vein & the vagus nerve.
	Petrous part	In the carotid canal in the petrous part of the temporal bone .
	Cavernous part	Passes forward inside cavernous sinus , then pierces its roof to form supra-cavernous part.
	Supra-cavernous part	Passes backward above the cavernous sinus .
Termination	Lateral to optic chiasma by dividing into anterior & middle cerebral arteries .	
N.B.	The <u>cavernous</u> and <u>supra-cavernous</u> parts form the carotid siphon (U-shaped in the angiogram).	



Branches of the ICA

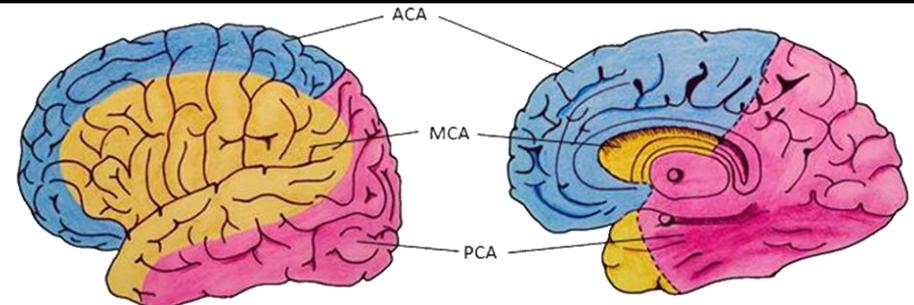
Hypophyseal branches	Superior and inferior branches supplying the pituitary gland .
Ophthalmic artery	Enters the orbit through the optic canal .
Posterior communicating artery	- Joins the posterior cerebral artery and supplies the midbrain, thalamus, and hypothalamus . - Supplies the posterior part of the genu and anterior 1/3 of the posterior limb of the internal capsule.
Anterior choroidal artery	Supplies: - Posterior 2/3 of the posterior limb of the internal capsule. - Choroid plexus of the inferior horn of the lateral ventricle. - Optic tract and lateral geniculate body . - Tail of the caudate nucleus and amygdaloid nucleus.
Two terminal branches	- Anterior Cerebral Artery. - Middle Cerebral Artery.

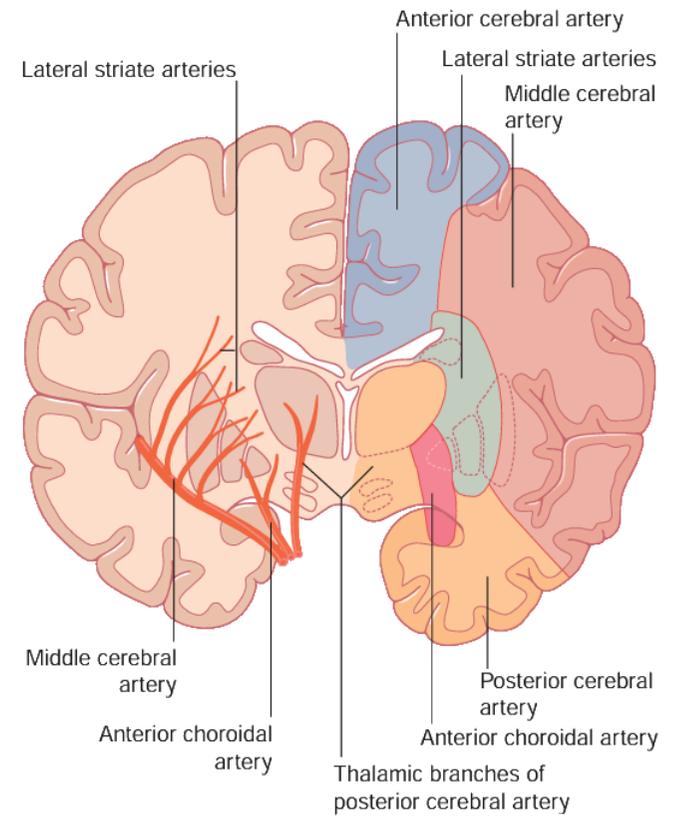
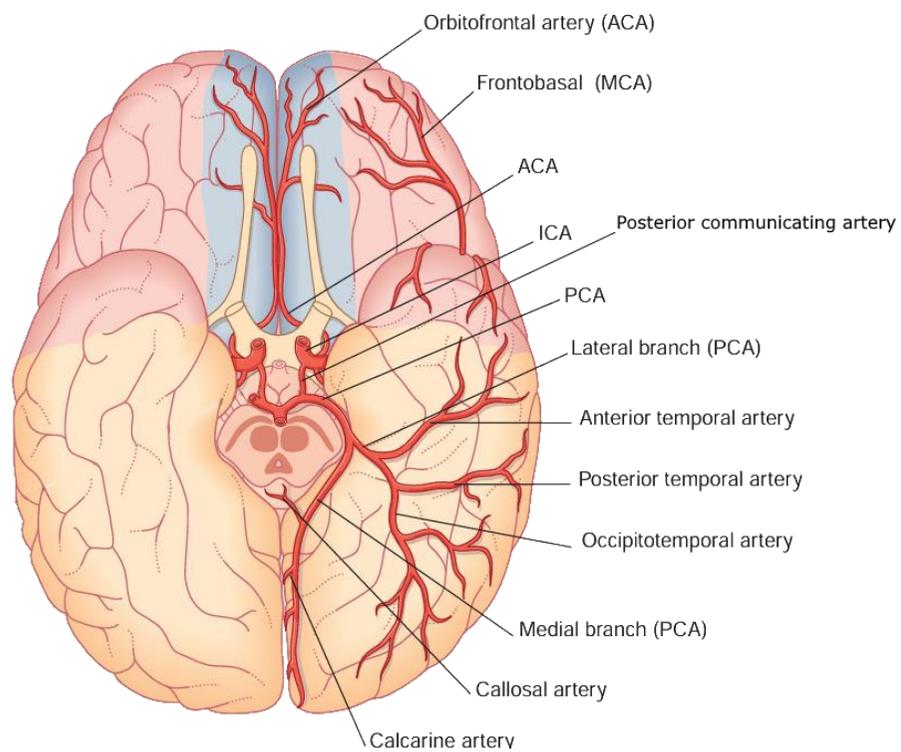
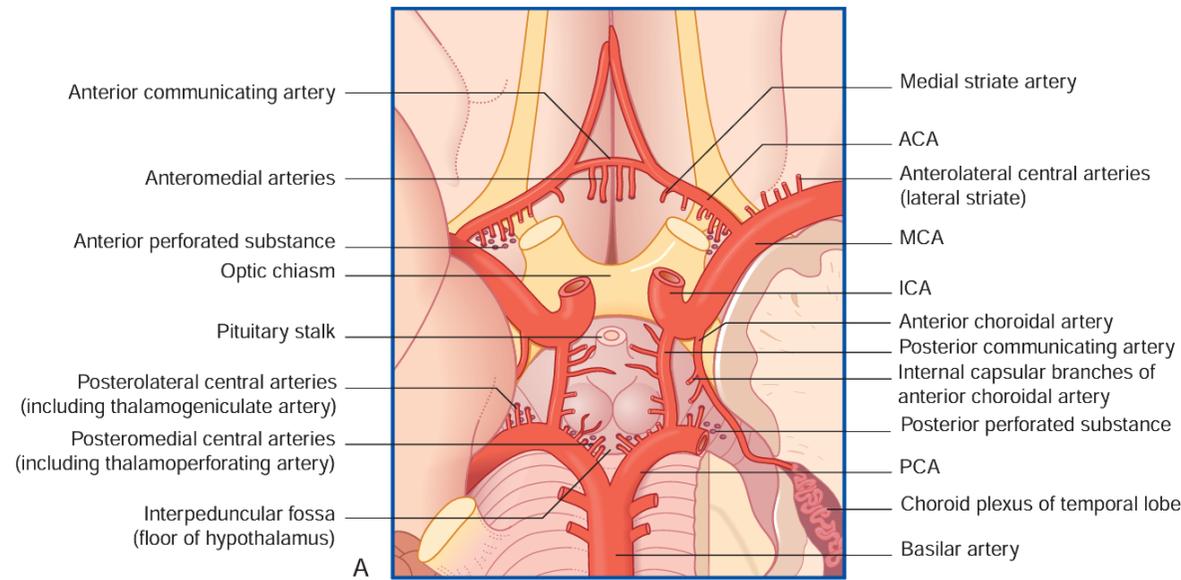
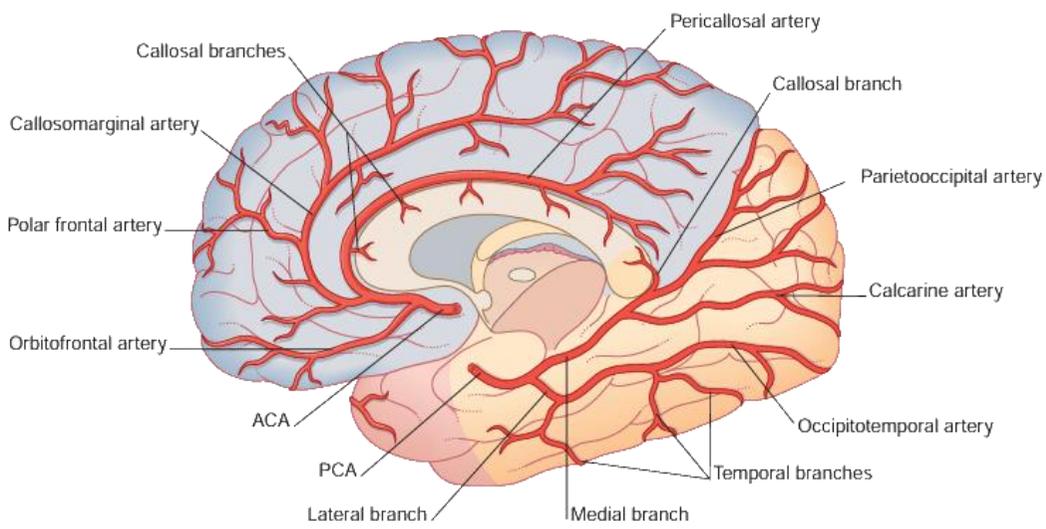
- Once the carotid artery enters the **carotid canal** it has a very **tortuous** course (6 bends before its terminal division).
- The reason for this tortuosity is unknown but it may have a **role in reducing the pulsating force** of the blood supply to the brain.
- The cavernous and supraglenoid portions of the internal carotid artery are referred to as the **carotid siphon**.



a) Anterior Cerebral artery (ACA):

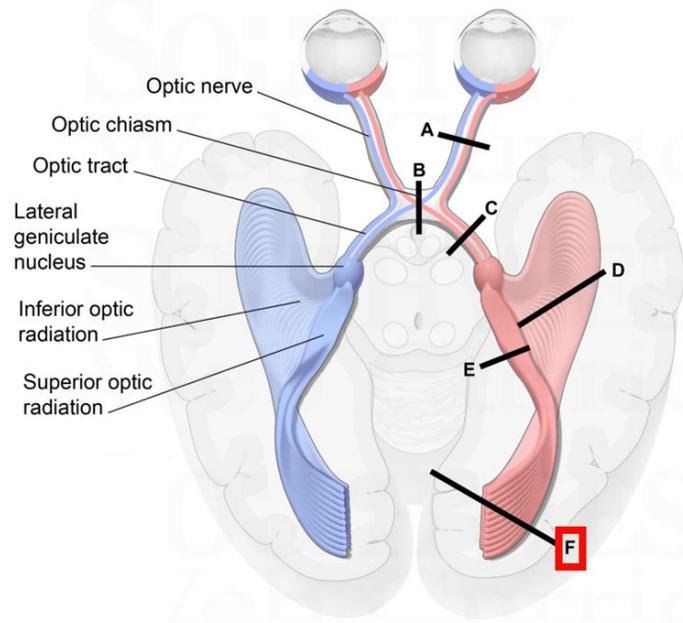
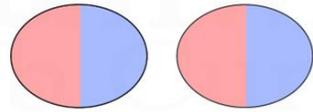
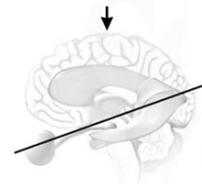
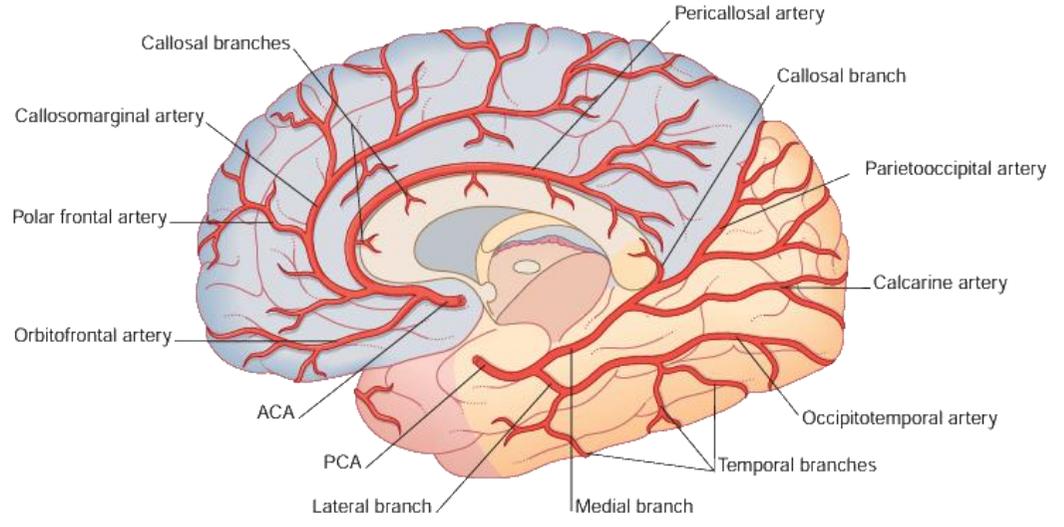
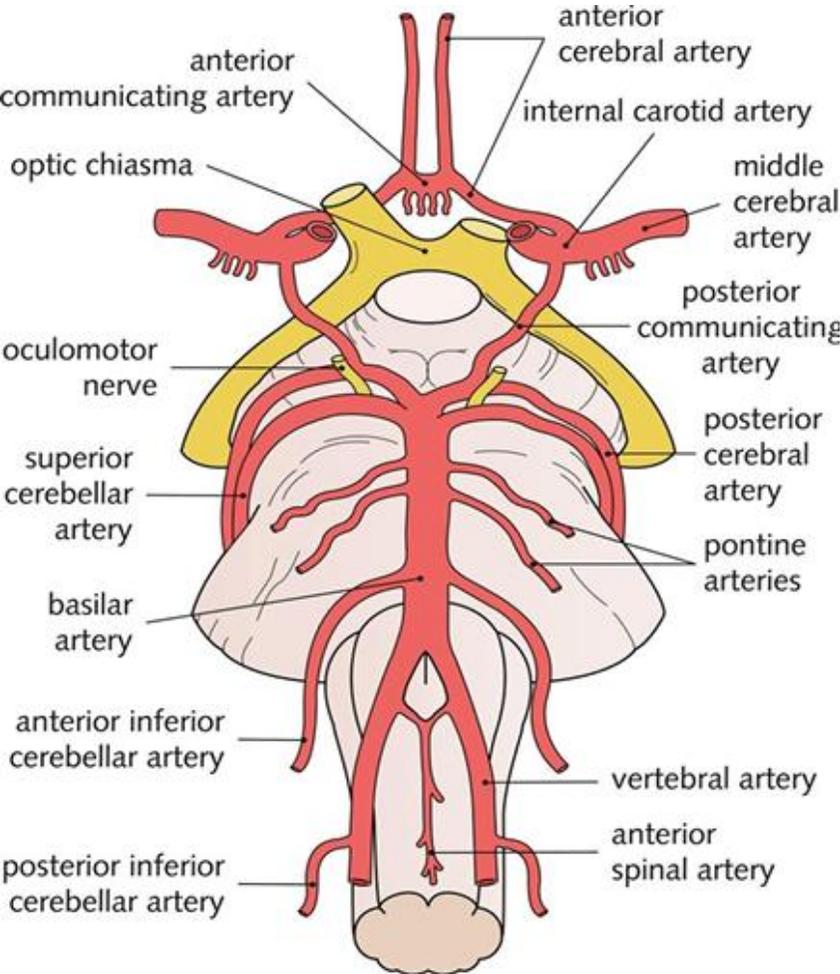
Origin	One of the two terminal branches of the internal carotid artery (it is the smaller one).	
Course	<ul style="list-style-type: none"> - It is joined with the opposite one by the anterior communicating artery. - It passes around the genu of the corpus callosum and continues backward on the upper surface of the corpus callosum in the callosal sulcus. - It ends at the splenium by anastomosing with branches of the posterior cerebral artery. 	
Branches	Cortical branches supplies	<ul style="list-style-type: none"> - 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.
	Central branches supplies	<ul style="list-style-type: none"> - <u>Anterior</u> limb of the internal capsule - <u>Anterior</u> part of the genu of the internal capsule. - <u>Anterior</u> part of corpus striatum: lentiform nucleus & head of caudate nucleus. - <u>Anterior</u> part of the hypothalamus.
	Callosal branches supplies	To the entire corpus callosum .
Clinical Note	<p>Occlusion of the anterior cerebral artery causes:</p> <ol style="list-style-type: none"> 1. Affection of the paracentral lobule → <ul style="list-style-type: none"> Contralateral paralysis of the leg muscles. Contralateral somatosensory loss in the leg. 2. Affection of the corpus callosum → callosal apraxia. 	





b) Posterior Cerebral artery (PCA):

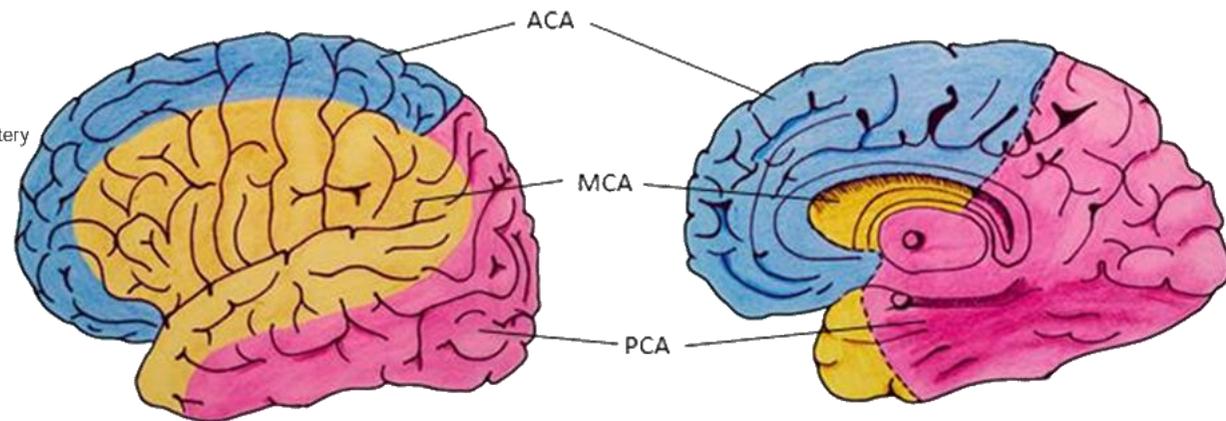
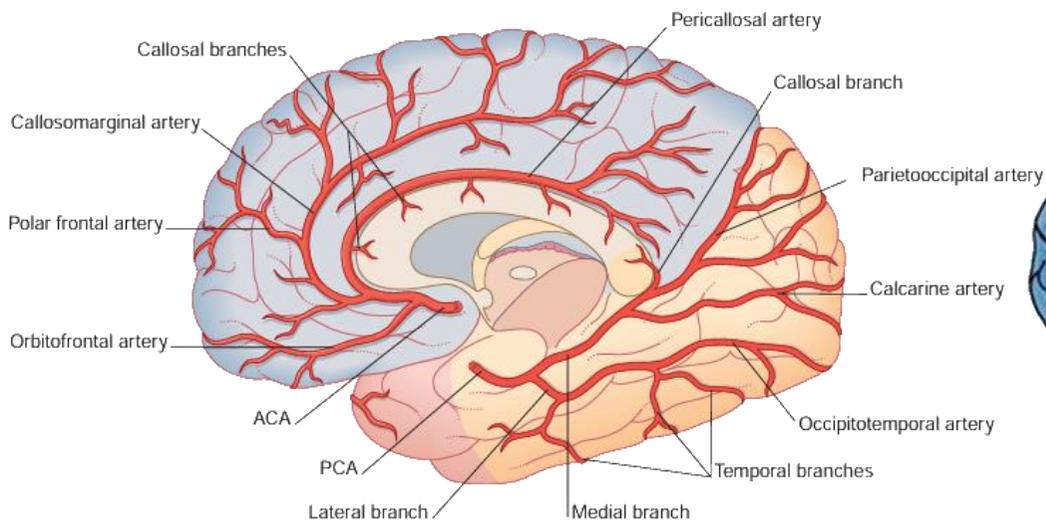
Origin	By the bifurcation of the basilar artery at the upper border of the pons.	
Course	<ul style="list-style-type: none"> - It passes backward around the lateral side of the midbrain to reach the splenium of the corpus callosum where it divides into temporal, calcarine and parieto-occipital branches. - 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. 	
Branches	Cortical branches supplies	<ul style="list-style-type: none"> - Lower 1 inch of the lateral surface (inferior temporal gyrus). - All aspects of the occipital lobe (including areas 17, 18, 19). - Medial and inferior surfaces of the temporal lobe (except temporal pole).
	Central branches	- Enter through the posterior perforated substance and supply the thalamus, hypothalamus, and midbrain .
	Posterior choroidal artery	Choroid plexus of the third and lateral ventricles, thalamus and midbrain .
	Splenial artery (if present)	Supplies the splenium of the corpus callosum .
Clinical Note	Occlusion of the Posterior cerebral artery causes: Contralateral homonymous hemianopia with macular sparing.	



- A. Ipsilateral monocular blindness
 -
- B. Bitemporal (heteronymous) hemianopsia
 -
- C. Contralateral homonymous hemianopsia
 -
- D. Contralateral superior homonymous quadrantanopsia
 -
- E. Contralateral inferior homonymous quadrantanopsia
 -
- F. Contralateral homonymous hemianopsia with macular sparing
 -

c) Middle Cerebral artery (MCA):

Origin	<ul style="list-style-type: none"> - The larger terminal branch of the two branches of the ICA. - Most direct ICA branch, making it prone to embolism. 	
Course	Passes in the lateral sulcus → Ends on the surface of the insula by dividing into terminal branches.	
Branches	Cortical branches	<ul style="list-style-type: none"> - Lateral half of the orbital surface. - All aspects of the temporal pole. - Lateral surface of the hemisphere <u>except</u>: <ol style="list-style-type: none"> <u>Upper one inch</u> (by anterior cerebral). <u>Lower one inch</u> (inferior temporal gyrus by the posterior cerebral). <u>Occipital lobe</u> (supplied by the posterior cerebral).
	Central Branches (Lateral Striate Arteries)	<ul style="list-style-type: none"> - One of these arteries is large, liable to rupture and called artery of cerebral hemorrhage. - The central branches <u>pierce the anterior perforated substance</u> and supply the: <ol style="list-style-type: none"> Anterior and posterior limbs of the internal capsule. Posterior part of the corpus striatum (<u>except</u> → <u>tail</u> of the caudate nucleus).



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.

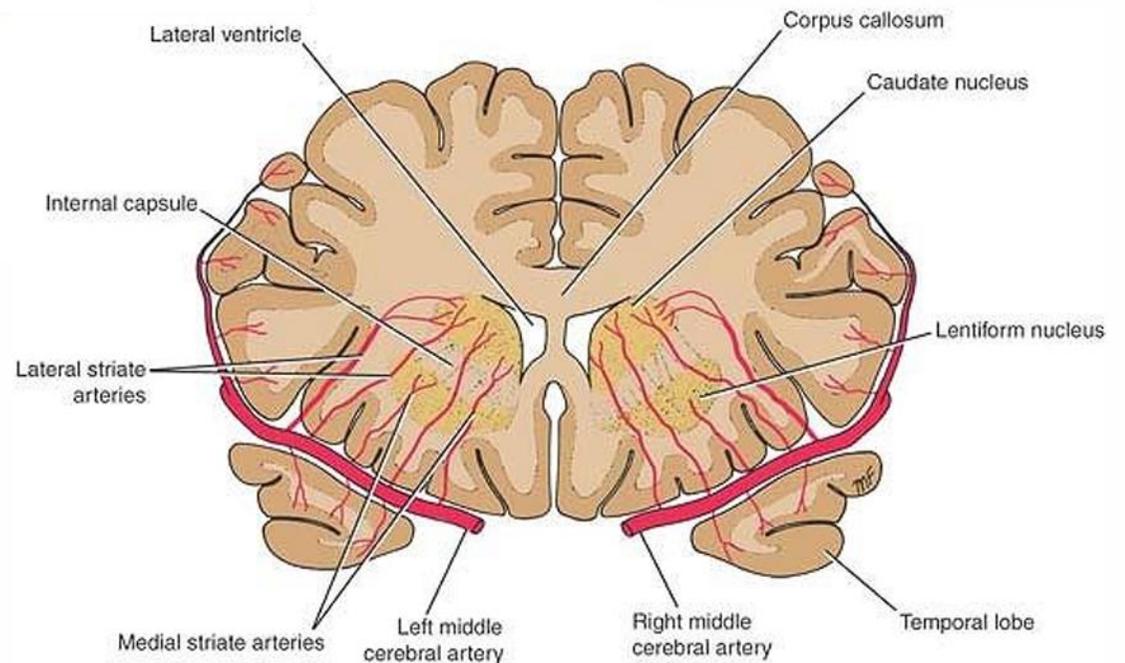
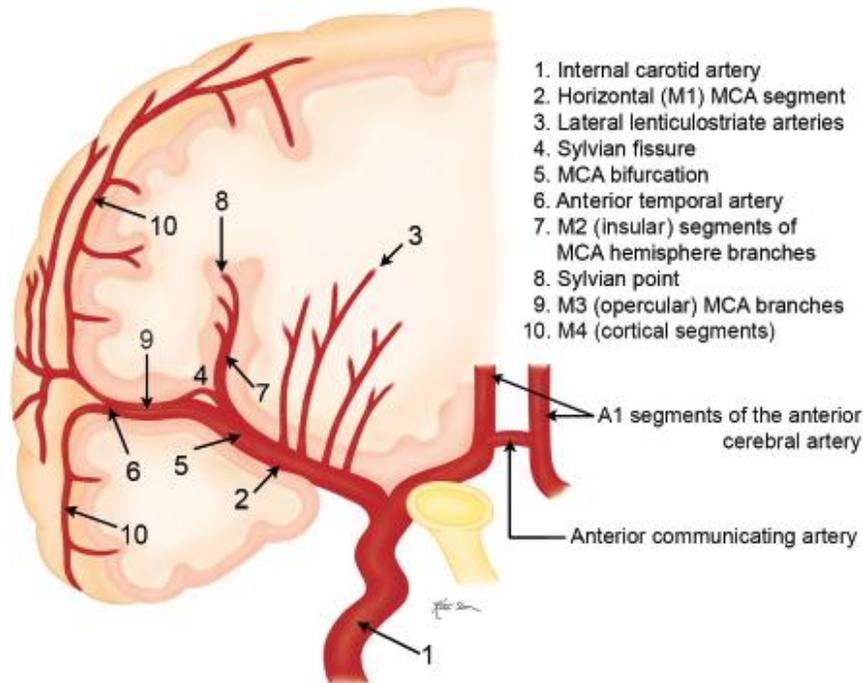
Clinical Note

Important cortical areas supplied by MCA:

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

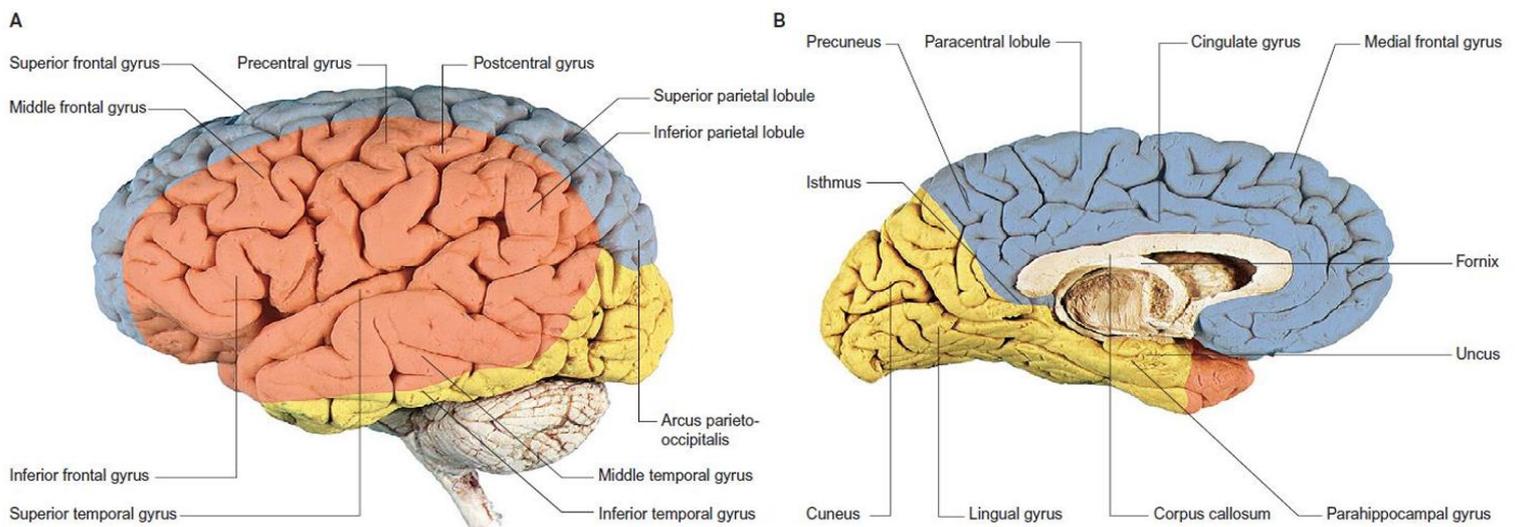
N.B.

Middle Cerebral Artery
Coronal View



Arterial supply of the cerebral cortex

Lateral surface	<ol style="list-style-type: none"> 1. Upper inch of the frontal and parietal lobes → ACA 2. Occipital lobe + lower inch (inferior temporal gyrus) → PCA. 3. Rest of lateral surface → MCA.
Medial surface	<ol style="list-style-type: none"> 1. Frontal and parietal lobes → ACA. 2. Occipital and temporal lobes (except temporal pole) → PCA. 3. Temporal pole → MCA.
Inferior surface	<ol style="list-style-type: none"> 1. Medial half of orbital surface → ACA. 2. Tentorial surface (except the temporal pole) → PCA 3. Lateral half of orbital surface and the temporal pole → MCA.



Arterial supply of the Internal capsule

Anterior Limb	<ul style="list-style-type: none"> - Dorsal $1/2$: MCA. - Ventral $1/2$: ACA.
Genu	<ul style="list-style-type: none"> - Anterior part: ACA. - Posterior part: Posterior communicating artery.
Posterior Limb	<ul style="list-style-type: none"> - Dorsal half: MCA. - Ventral half: <ol style="list-style-type: none"> 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 systems:

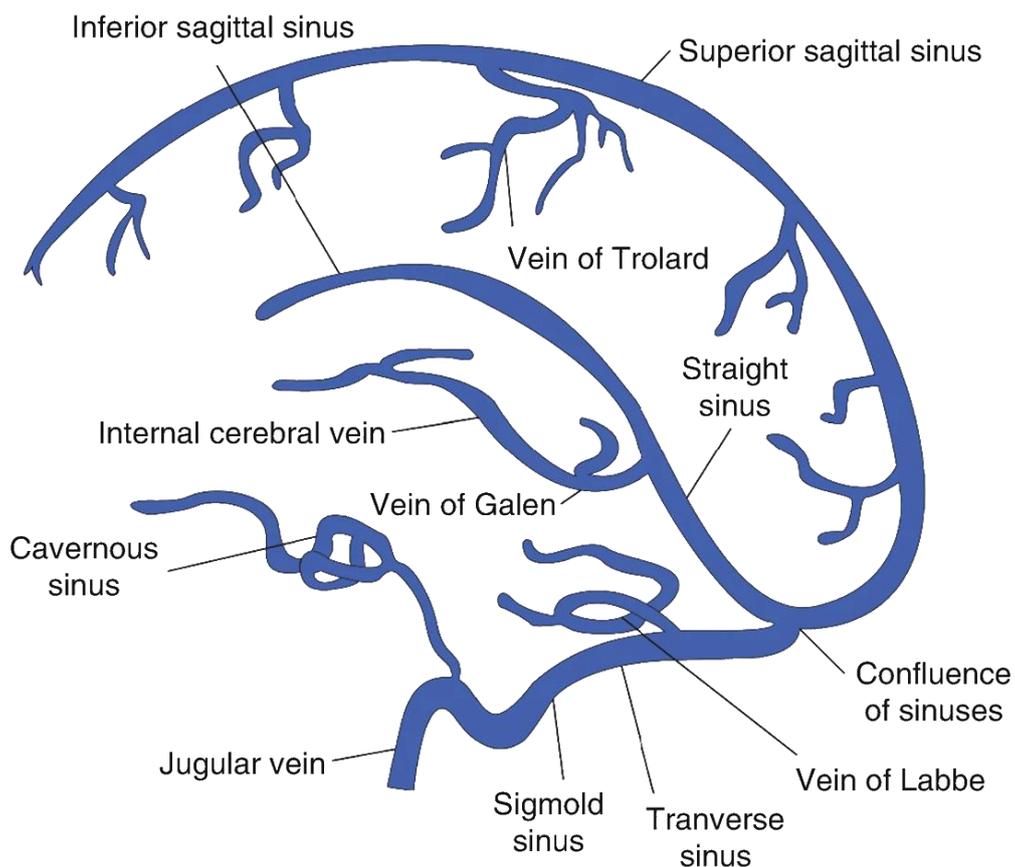
1) **Superficial cerebral veins**

2) **Deep cerebral veins.**

1) Superficial cerebral veins

- They drain the superficial structures into the **dural venous sinuses**.
- They are divided into superior, middle and inferior cerebral veins.

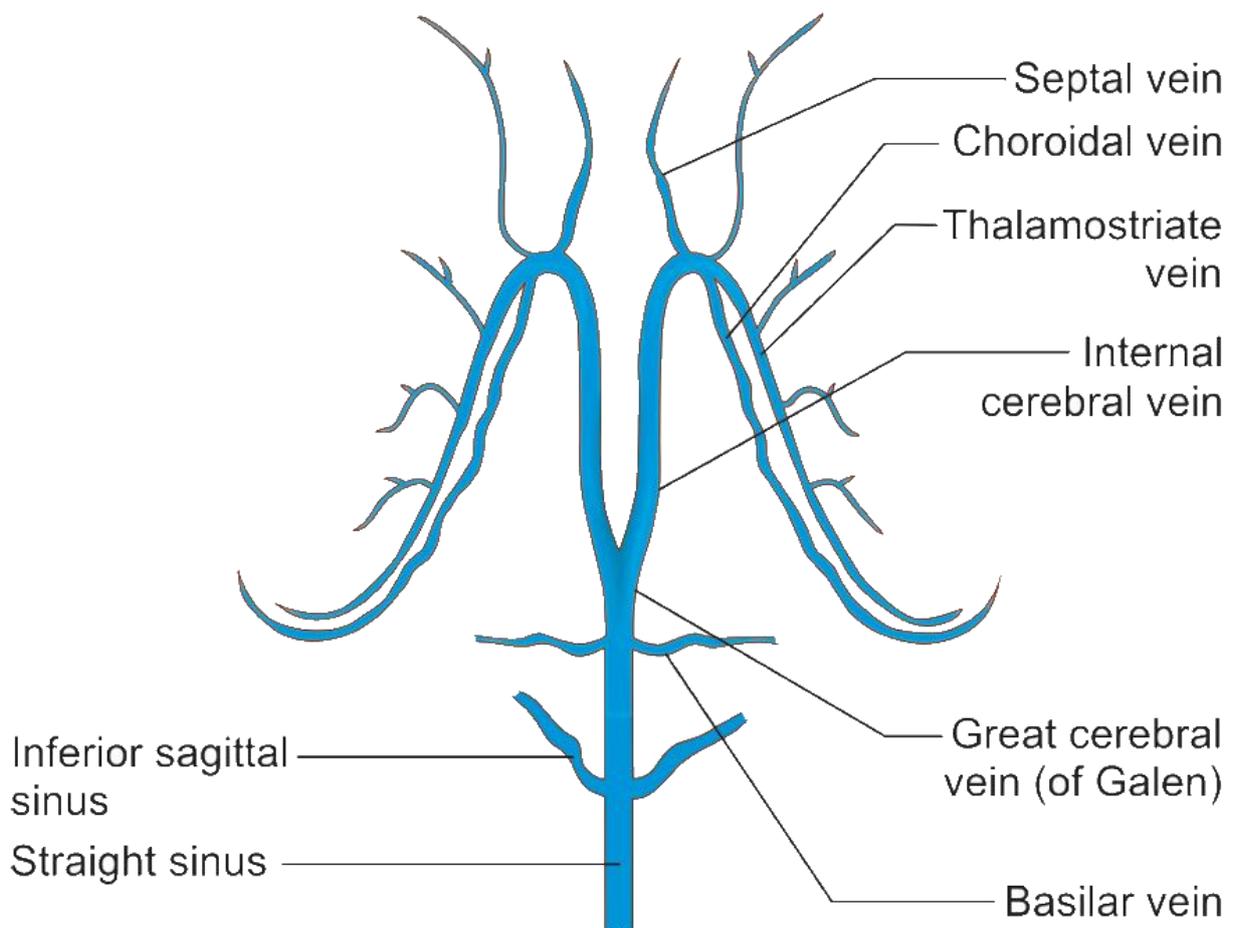
Superior cerebral vein (8-12)	They drain into the superior sagittal sinus .	
Middle cerebral vein	Superficial middle cerebral vein	- In the lateral sulcus . - Drains into cavernous sinus .
	Deep middle cerebral vein	- In the bottom of the lateral sulcus and drains the insula . - It unites with the <u>anterior cerebral vein</u> to form the basal vein .
Inferior cerebral vein	They drain into the cavernous and transverse sinuses .	



2) Deep cerebral veins

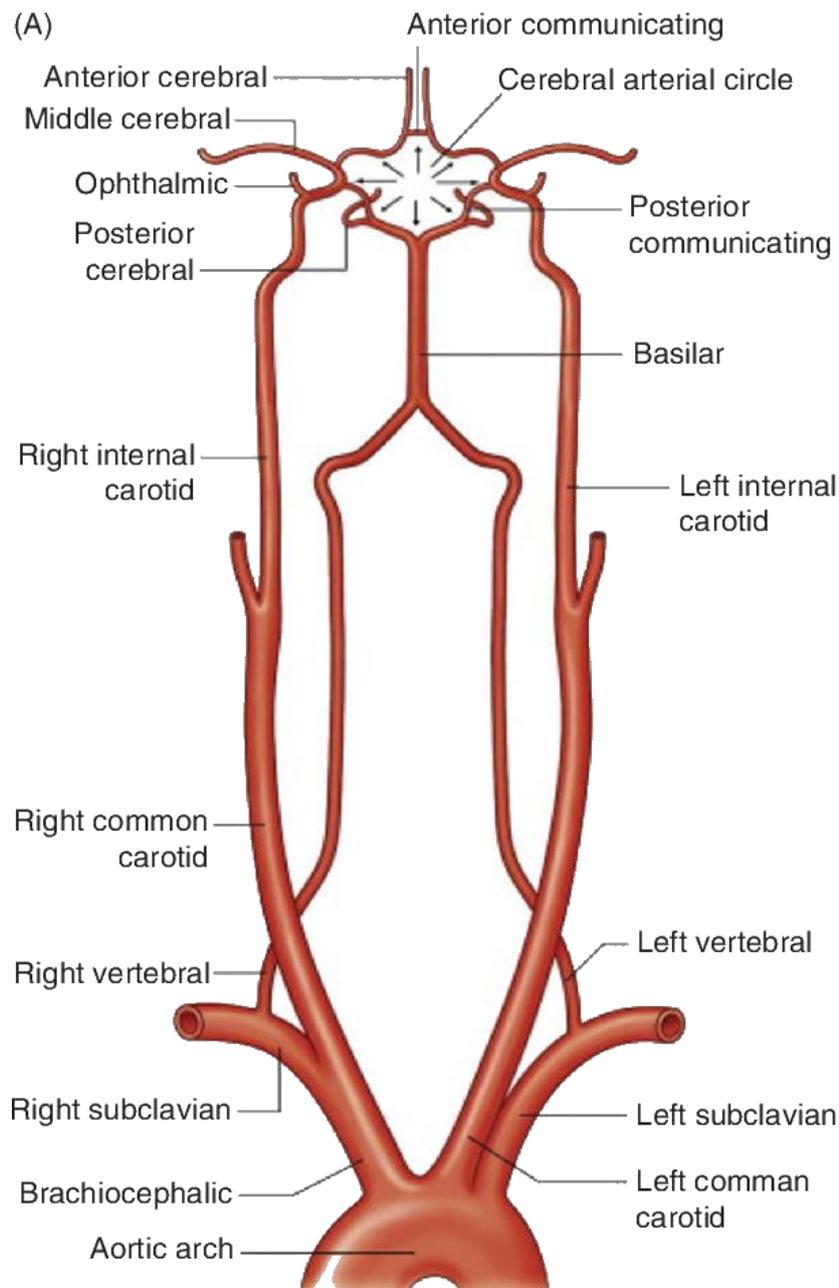
- They drain the **deep subcortical structures** and form three large veins:

Two internal cerebral veins	<ul style="list-style-type: none"> 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.
Great cerebral vein	<ul style="list-style-type: none"> Formed by the union of the two internal cerebral veins. It unites with the inferior sagittal sinus forming → straight sinus.
Two basal veins	<ul style="list-style-type: none"> 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.



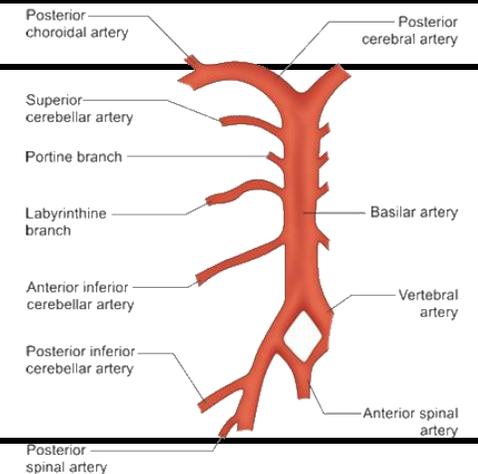
Vertebral artery

Origin	it is a branch of the first part of the subclavian artery .	
Course	1st part	from the origin to foramen transversarium of c6.
	2nd part	ascends through foramina transversaria of the upper six cervical vertebrae.
	3rd part	on the posterior arch of atlas .
	4th 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 .	



Branches of the vertebral artery in the cranial cavity:

<p>Anterior spinal artery</p>	<ul style="list-style-type: none"> - Unites with the opposite one to form a single anterior spinal artery. - Supplies: <ol style="list-style-type: none"> 1) Anterior 2/3 of the spinal cord 2) Medial zone of the medulla. - Occlusion → Medial medullary syndrome.
<p>Posterior spinal artery</p>	<ul style="list-style-type: none"> - Usually arises from the PICA. - Supplies: <ol style="list-style-type: none"> 1) Posterior 1/3 of the spinal cord 2) Gracile and cuneate tracts and nuclei.
<p>Medullary branches</p>	<p>supply the middle zone of the medulla, including the olive.</p>
<p>Posterior inferior cerebellar artery (PICA)</p>	<ul style="list-style-type: none"> - Supplies: <ol style="list-style-type: none"> 1) Posterolateral zone of the medulla. 2) Inferior cerebellar peduncle. 3) Posterior part of the inferior surface of the cerebellum. 4) Choroid plexus of the 4th ventricle. - Occlusion → Lateral medullary syndrome.
<p>Posterior meningeal artery</p>	<p>supplies the meninges of the posterior cranial fossa.</p>

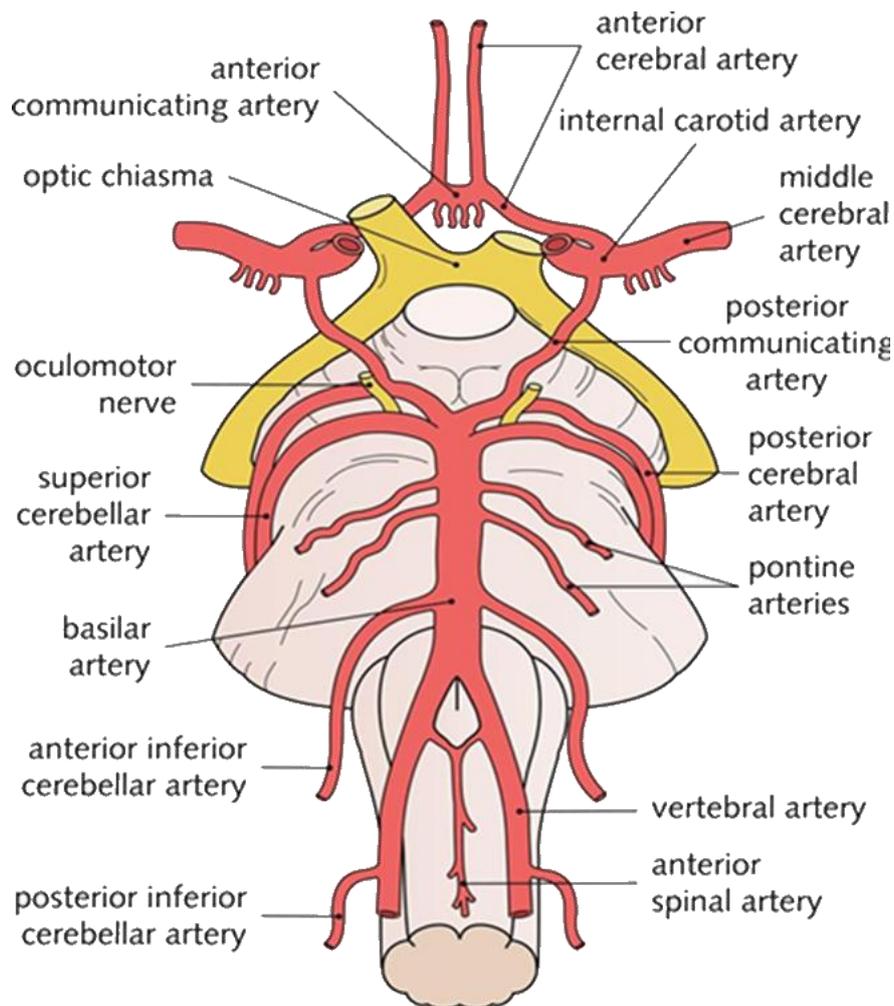


Basilar Artery

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	Pontine branches (3 groups)	Paramedian branches supply the medial zone of basis pontis.
		Short circumferential branches supply the lateral zone of basis pontis
		Long circumferential branches supply the pontine tegmentum .
	Anterior inferior cerebellar artery (AICA)	- <u>Supplies</u> : 1) Anterior part of the inferior surface of the cerebellum. 2) Middle cerebellar peduncle . - Gives the labyrinthine artery in 85% of cases.
	Labyrinthine (internal auditory) artery (in 15% of cases)	- Accompanies the vestibulocochlear and facial nerves in the internal acoustic meatus. - <u>Supplies</u> : the internal ear .
	Superior cerebellar artery (SCA)	<u>Supplies</u> : 1) Superior surface of the cerebellum. 2) Superior cerebellar peduncle and superior medullary velum . 3) Inferior colliculus of the midbrain.
Two terminal branches (posterior cerebral arteries)	- Wind around the midbrain . - Connected to the internal carotid artery by the posterior communicating artery . - <u>Supplies</u> : midbrain, thalamus, hypothalamus, and occipital lobe. - Separated from the superior cerebellar artery by the oculomotor and trochlear nerves .	

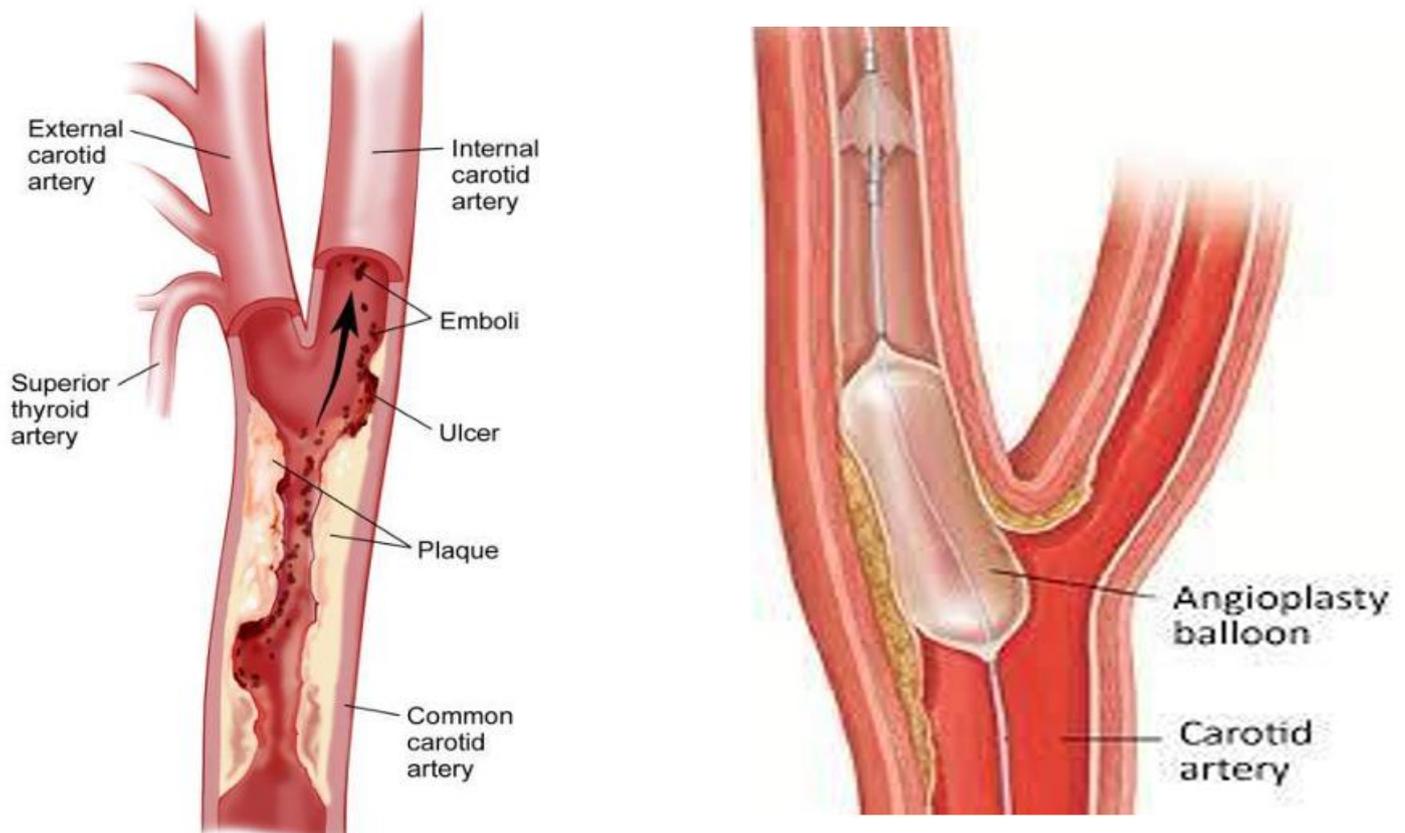
Circulus arteriosus (circle of Willis)

Location	in the interpeduncular fossa at the base of the brain.			
Formation	Anteriorly	anterior communicating artery connecting the two anterior cerebral arteries.		
	Posteriorly	two posterior cerebral arteries.		
	On each side (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 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 → **death** of brain tissue (infarction).
- **Rupture of a blood vessel** → **bleeding** into the brain (cerebral hemorrhage).
- These events lead to the rapid development of a **focal neurological syndrome**.
- **Strokes related to the carotid artery** are associated with → **focal epilepsy**, a **contralateral sensory/motor deficit** and a **psychological deficit** (e.g. aphasia).
- **Strokes involving the vertebrobasilar** → **focal brainstem syndrome**.
- **Aneurysm** → 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 hemorrhage**) and into the brain (**intracerebral hemorrhage**).
- A **sudden severe headache** + **neck stiffness** followed by **coma** and neurological deficits.
- **Neurosurgery** or intra-arterial 'coiling' are required to seal the aneurysm to prevent further bleeding and allow recovery.

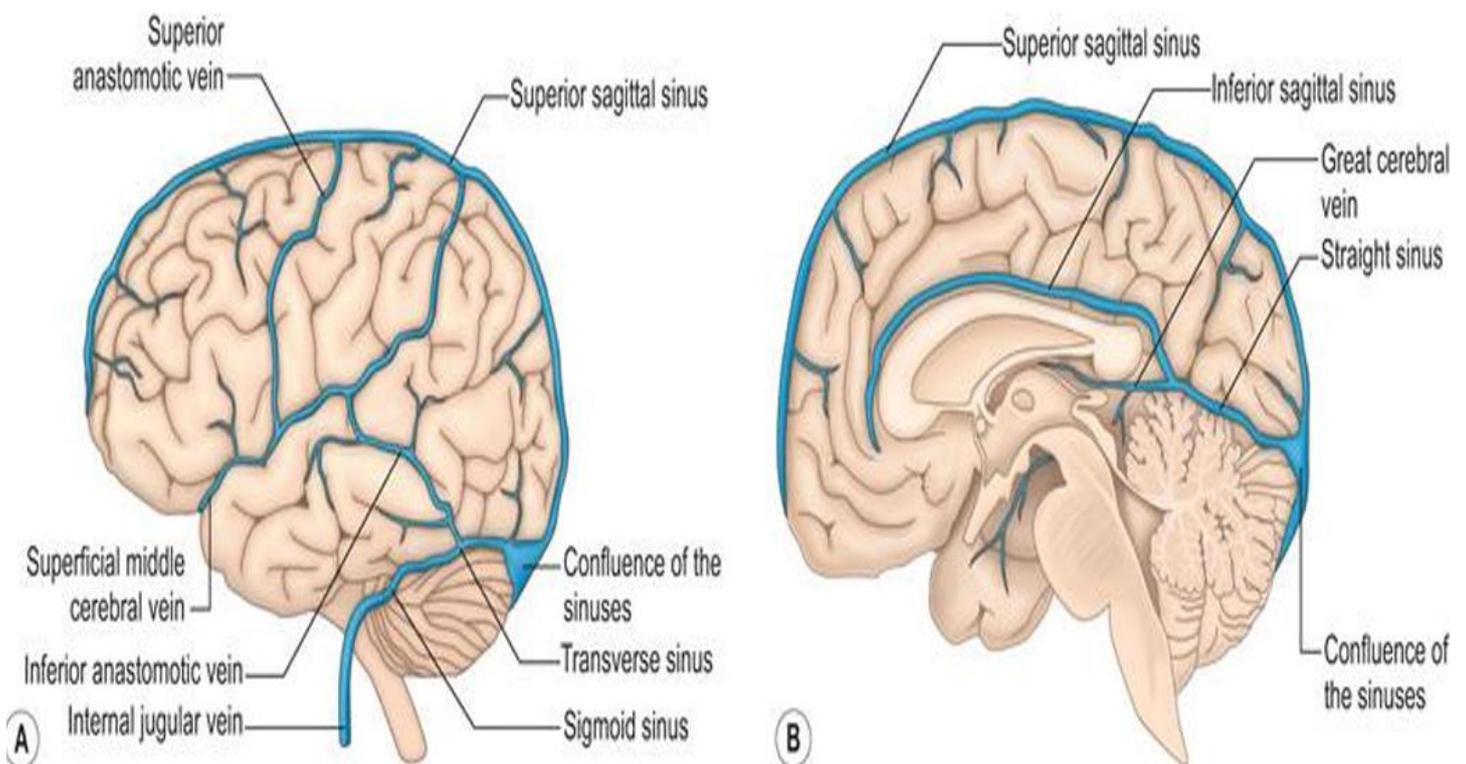


Arterial supply of the brain

- The brain is supplied by paired **internal carotid (ICA)** and **vertebral arteries**.
- The **ICA terminates lateral to the optic chiasm**, giving rise to **ACA & MCA**.
- The **ACA passes into the great longitudinal fissure** and supplies the **medial aspect** of the cerebral hemisphere.
- The **MCA 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** → **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 ICA 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**.



Arterial supply of the spinal cord

a) Anterior spinal artery

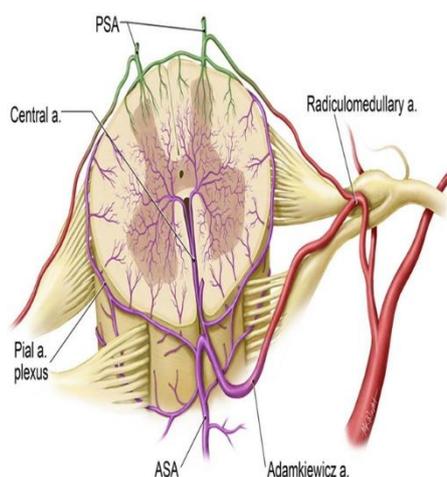
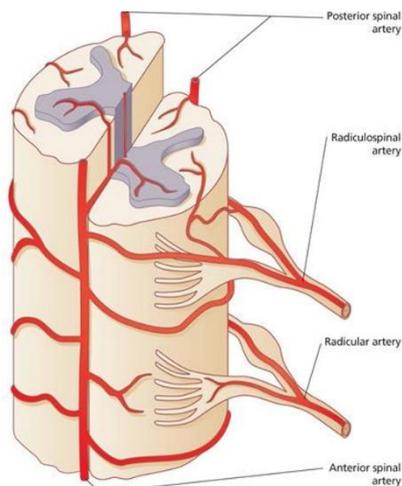
Origin	A single artery formed by the union of the two anterior spinal branches of the vertebral arteries.
Course	Descends in the anterior median fissure of the spinal cord.
Supplies	- The anterior 2/3 of the spinal cord. - It becomes very small below the cervical region and is reinforced by radicular arteries .

b) Two posterior spinal arteries

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

c) Radicular arteries

Def	Major source of blood to the lower 2/3 of the spinal cord.	
Course	They enter the vertebral canal through the intervertebral foramina and divide into anterior and posterior branches , which join the anterior and posterior spinal arteries.	
Branches from	Neck	Vertebral and ascending cervical arteries.
	Thorax	Intercostal arteries.
	Abdomen	Lumbar arteries.
	Pelvis	Lateral sacral arteries.



Venous Drainage of the Spinal cord

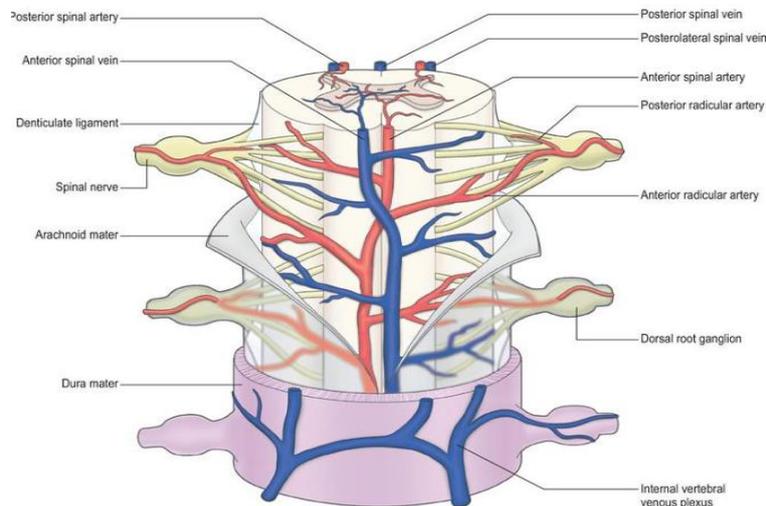
- The veins correspond to the arteries and **drain into the internal vertebral venous plexus**, which is present in the epidural space.

Vasculature of the Spinal cord

- The spinal cord is supplied by the **anterior and posterior spinal arteries**, supplemented by **radicular arteries**.

- Venous drainage:

By **anterior and posterior spinal veins**, which drain via **radicular veins** into the **internal vertebral venous plexus**.



Clinical correlation

- 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**.

Q: Which of the following best describes the internal carotid artery?

A) One of two terminal branches of ECA

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