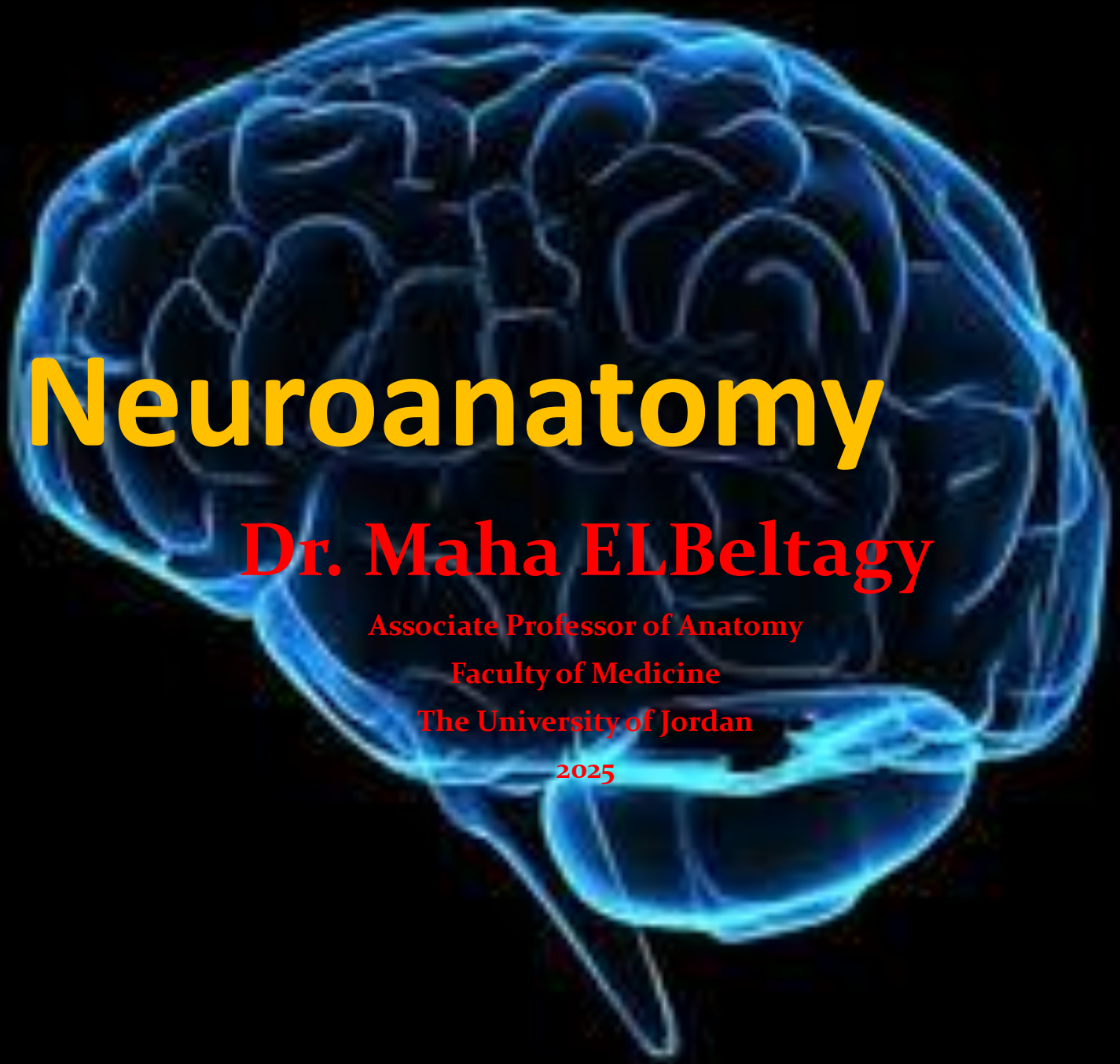


Neuroanatomy

Dr. Maha ELBeltagy

Associate Professor of Anatomy

Faculty of Medicine

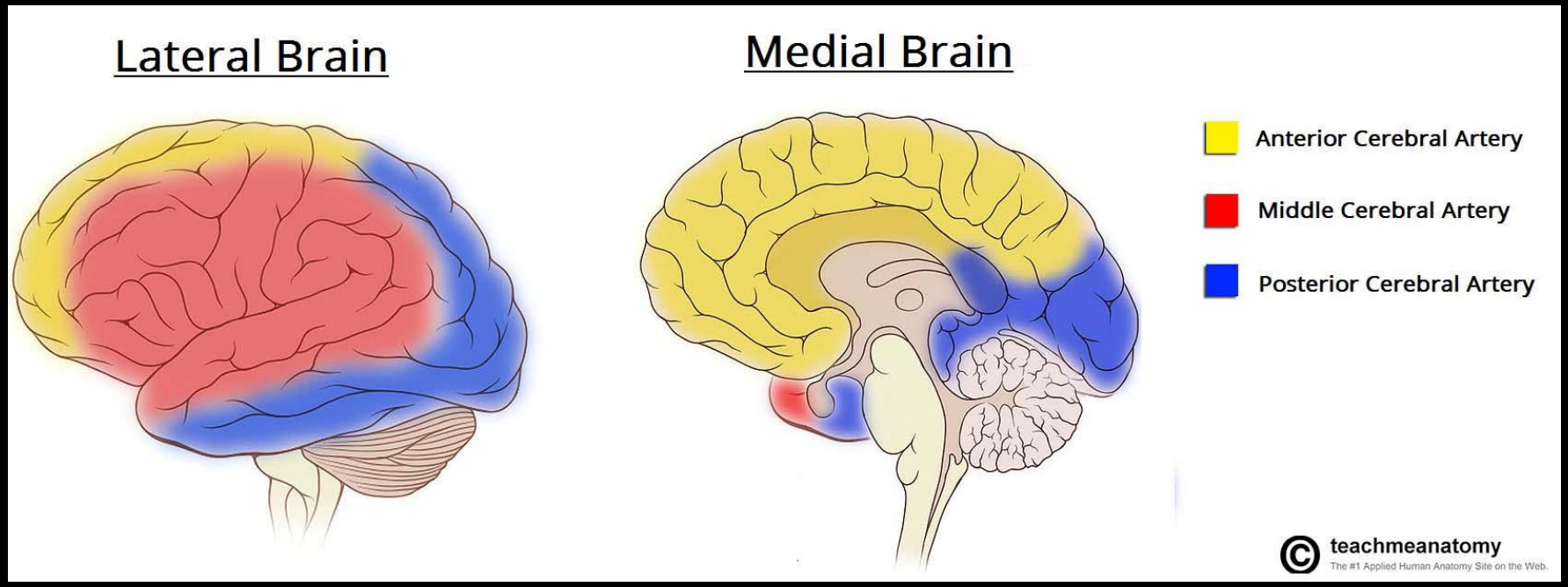
The University of Jordan

2025

objectives

- Differentiate between the vertebrobasilar and carotid systems (Anatomical location, formation, distribution, branches and physiological significance).
- Describe detailed anatomy of the circle of willis and its physiological importance.
- Describe detailed blood supply of the cerebral cortex and subcortical structures including (septum lucidum, white matter, basal nuclei, internal capsule, diencephalon, ventricular system, cerebellum, brain stem and spinal cord).
- Enumerate veins that drain the brain and differentiate between external and internal venous circulation.
- Differentiate anatomically and by MRI between the 4 types of cranial haemorrage and the cause of each.
- Differntiate between cerebral arteries syndromes and the effect of their ischemia or occlusion on different cortical and subcortical structures and describe the clinical picture of each.

Blood Supply of Brain and Spinal Cord



Arterial Supply of Brain

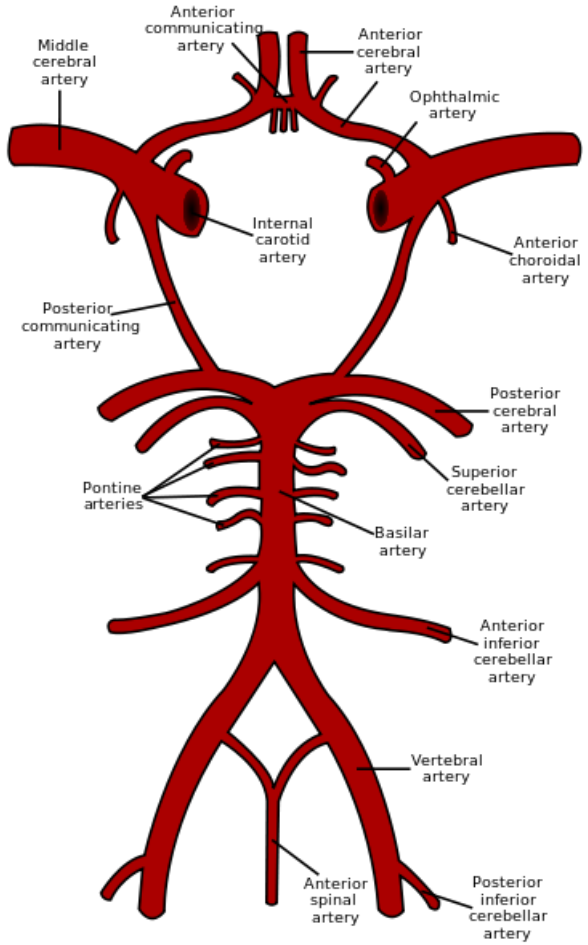
- The brain receives blood from two sources: the **internal carotid arteries**, which arise at the point in the neck where the common carotid arteries bifurcate, and the **vertebral arteries**
- The internal carotid arteries branch to form, the **anterior** and **middle cerebral arteries**
- 70% blood is delivered to ICA

- The right and left vertebral arteries come together at the level of the pons on the ventral surface of the brainstem to form the midline **basilar artery**
- The basilar artery joins the blood supply from the internal carotids in an arterial ring at the base of the brain (in the vicinity of the hypothalamus and cerebral peduncles) called the **circle of Willis**
- The **posterior cerebral arteries** arise at this confluence, as do two small bridging arteries, the **anterior and posterior communicating arteries**

Physiological Significance
Circle of Willis

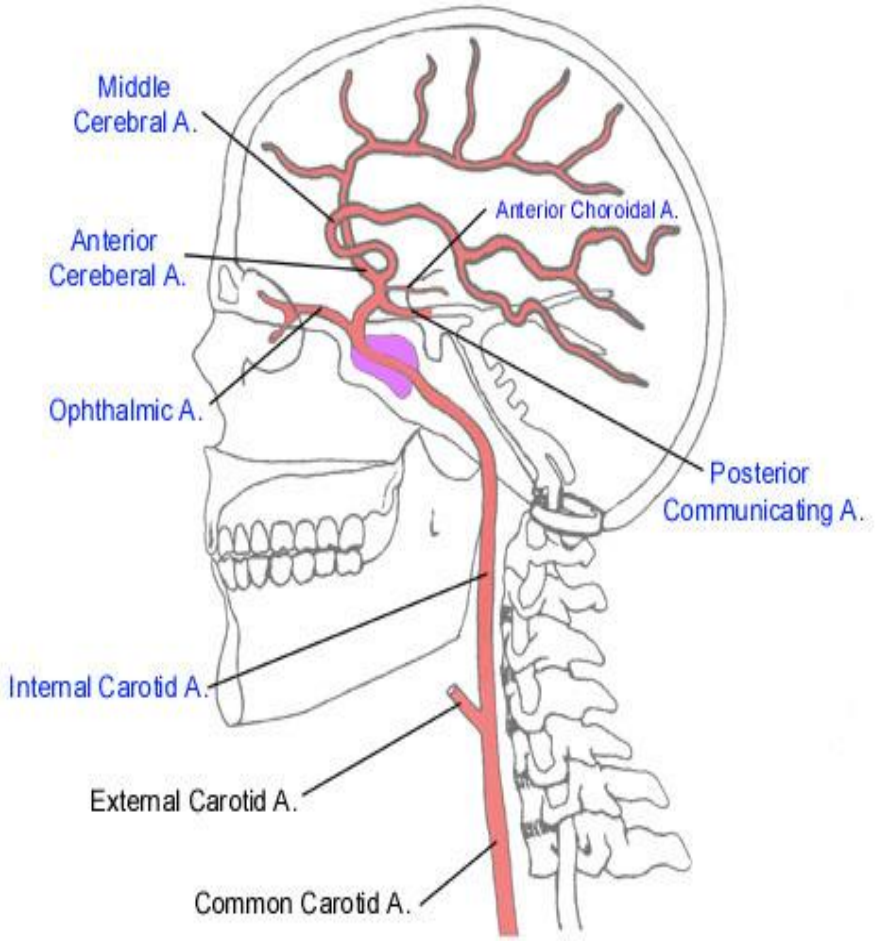
The arrangement of the brain's arteries into the **Circle of Willis** creates collaterals in the cerebral circulation

If one part of the circle becomes blocked or narrowed (stenosed) or one of the arteries supplying the circle is blocked or narrowed, blood flow from the other blood vessels can often preserve the cerebral perfusion well enough to avoid the symptoms of ischemia



Internal Carotid Artery

- Arises from common carotid artery in the neck, entering head at skull base via the carotid canal, and terminates at bifurcation into the anterior cerebral artery and middle cerebral artery
- The extracranial segment of the ICA is from the origin of the ICA to the skull base
- The intracranial segment of the ICA is divided into petrous, cavernous, supraclinoid portions



Internal Carotid Artery

•Upon exiting the cavernous sinus, the ICA extends through the meninges to become the supraclinoid segment

•The supraclinoid or cerebral ICA bends posteriorly and laterally between the oculomotor (III) and optic (II) nerves

•Branches:

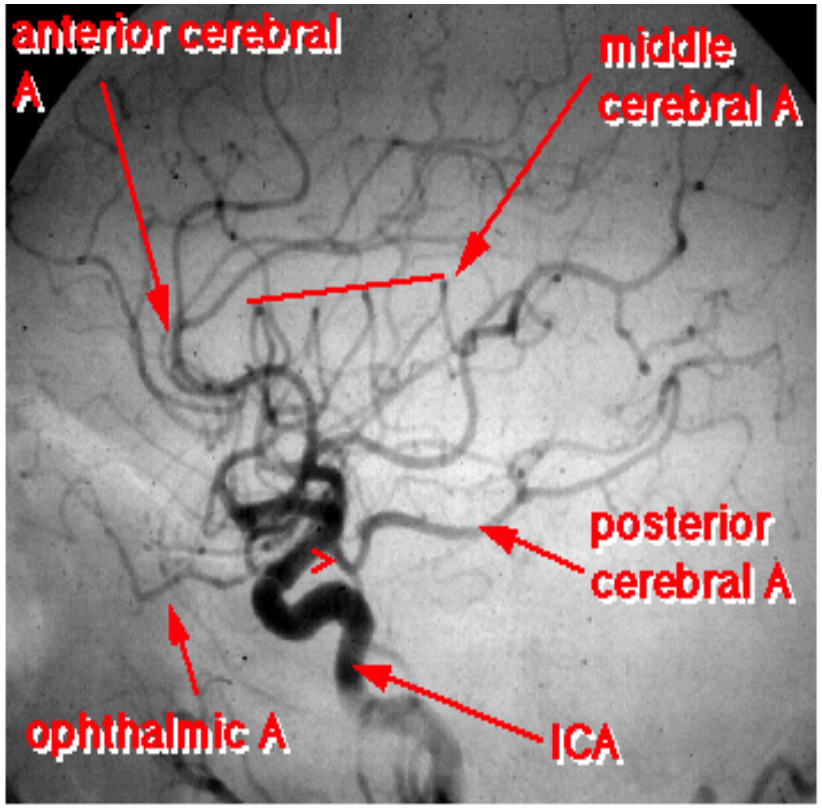
•Ophthalmic A

• A to the anterior pituitary and stalk

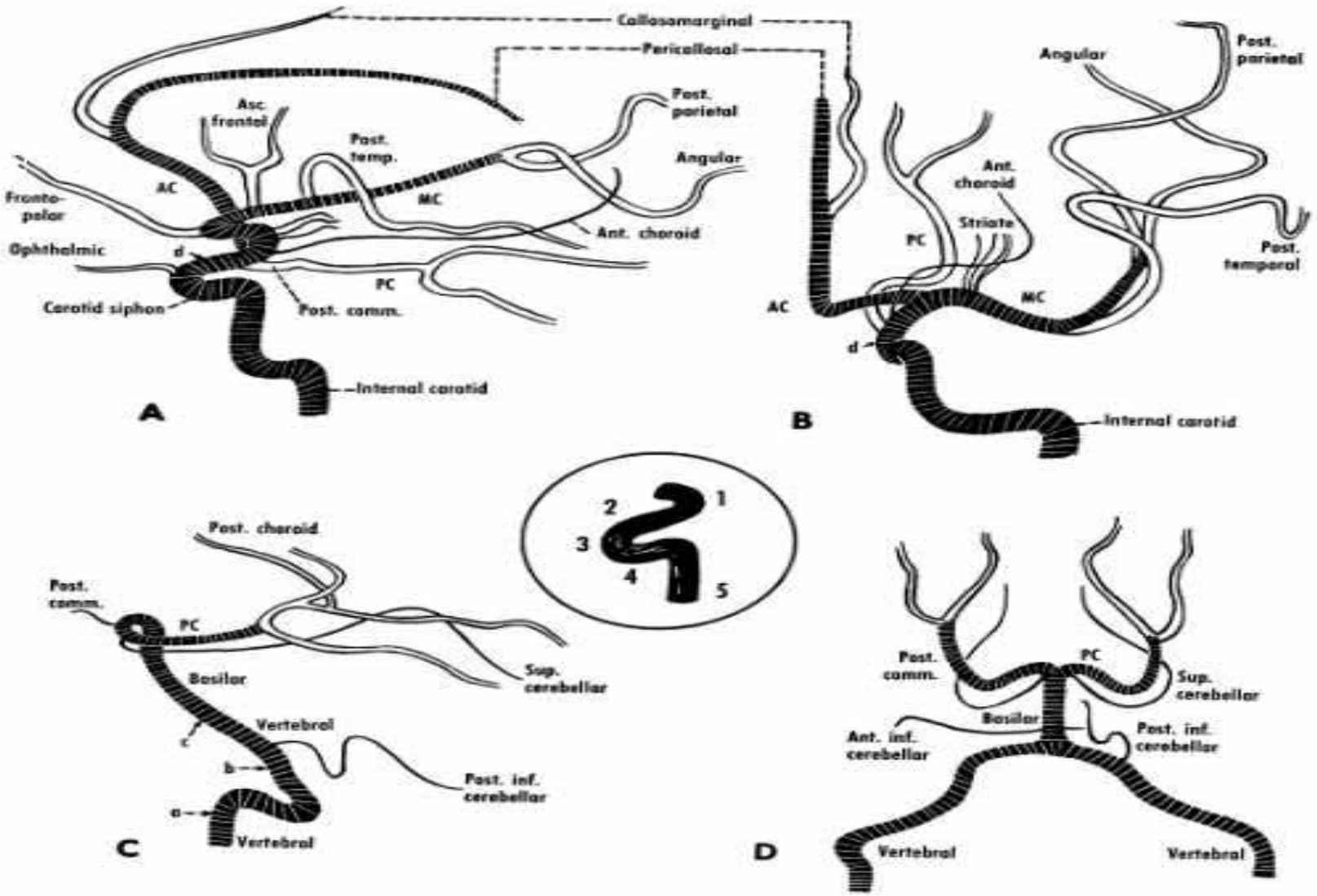
•posterior communicating artery (PCoA).

•anterior choroidal artery (AChA)

•bifurcating into the ACA and MCA



Branches of Internal Carotid Artery

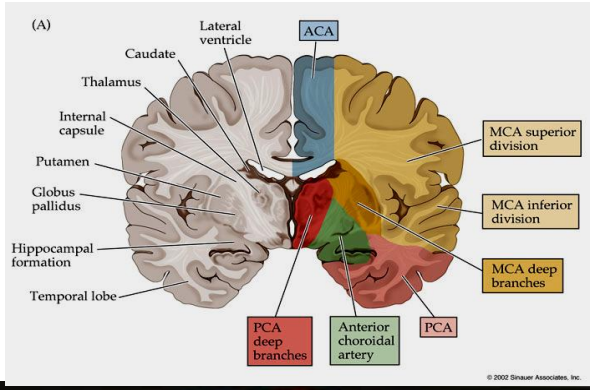


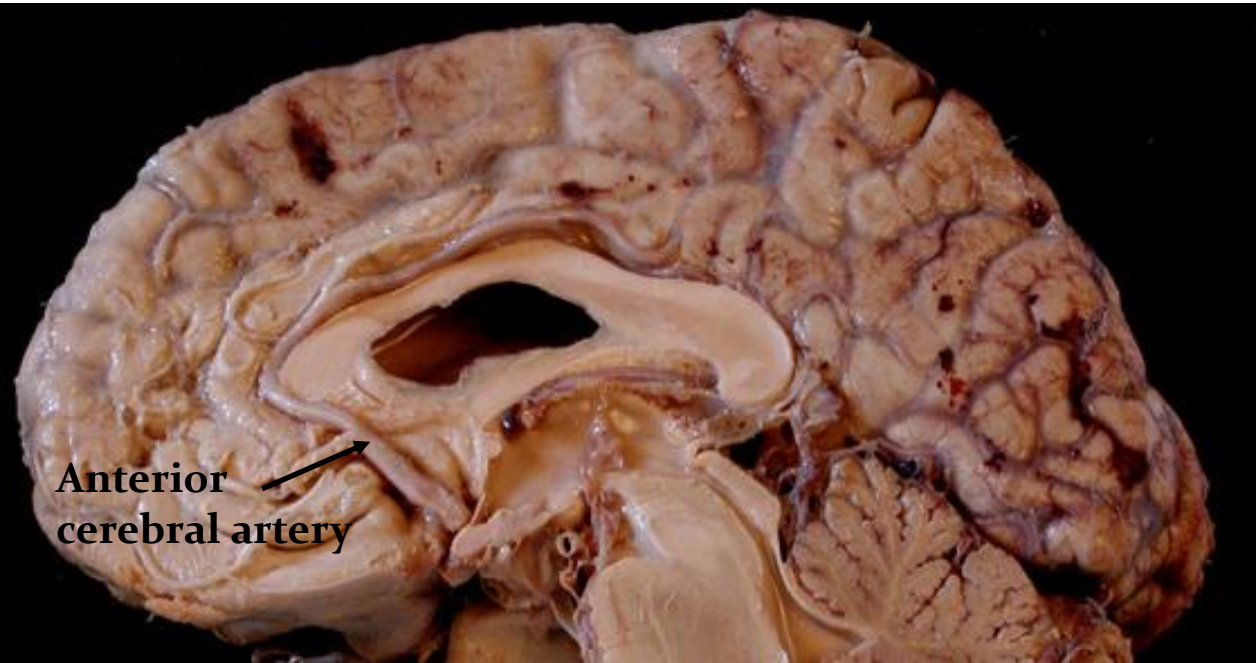
The anterior cerebral artery(ACA):

Runs medially & forwards in the longitudinal fissure along corpus callosum & ends by passing upwards near the parieto-occipital fissure.

Branches:

- **Cortical branches**: For the **medial surface** back to the parieto-occipital fissure. To a strip one inch below the superomedial border on the **lateral surface** back to the parieto-occipital fissure & to the medial ½ of the **orbital surface**.
- **Central branches**: to the anterior part of corpus striatum & part of anterior limb of internal capsule.
- **Septal branches** for septum lucidum.
- **Callosal branches** for corpus callosum except the splenium.



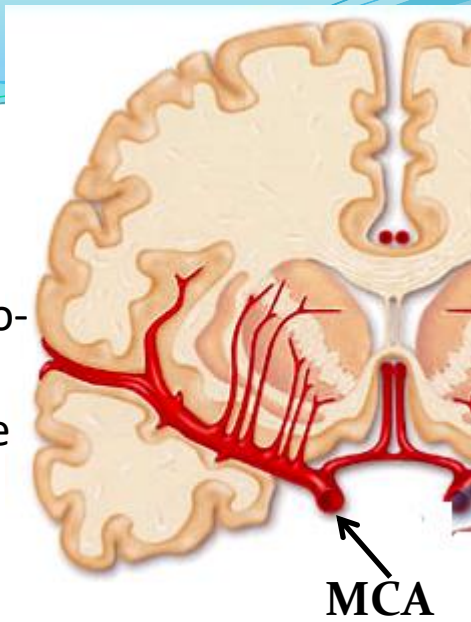


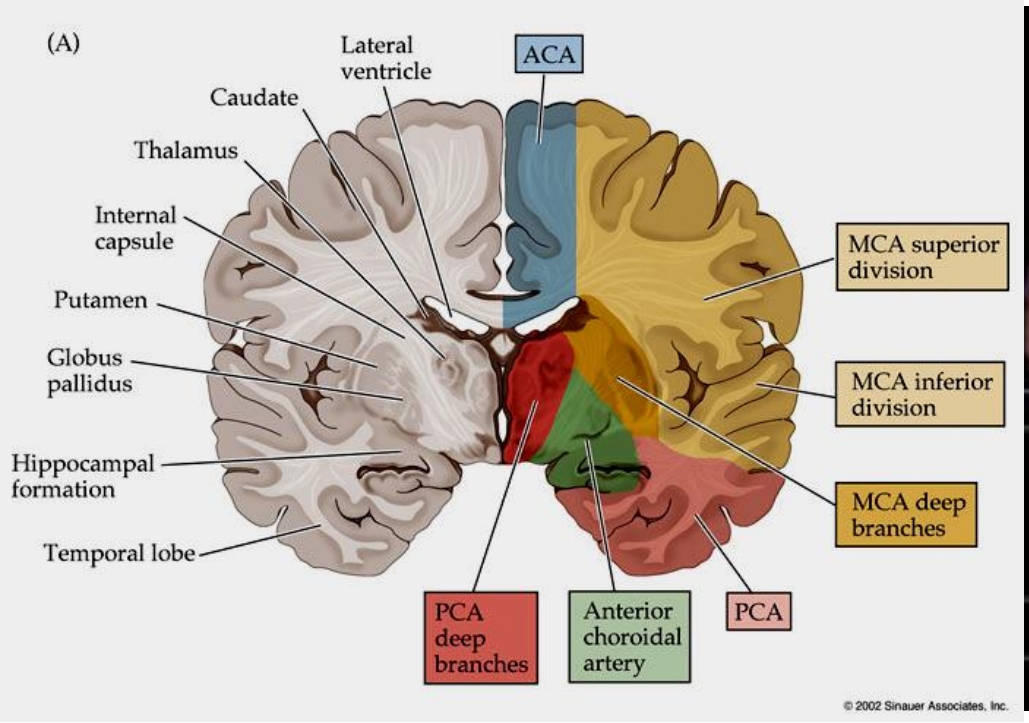
The middle cerebral artery (MCA):

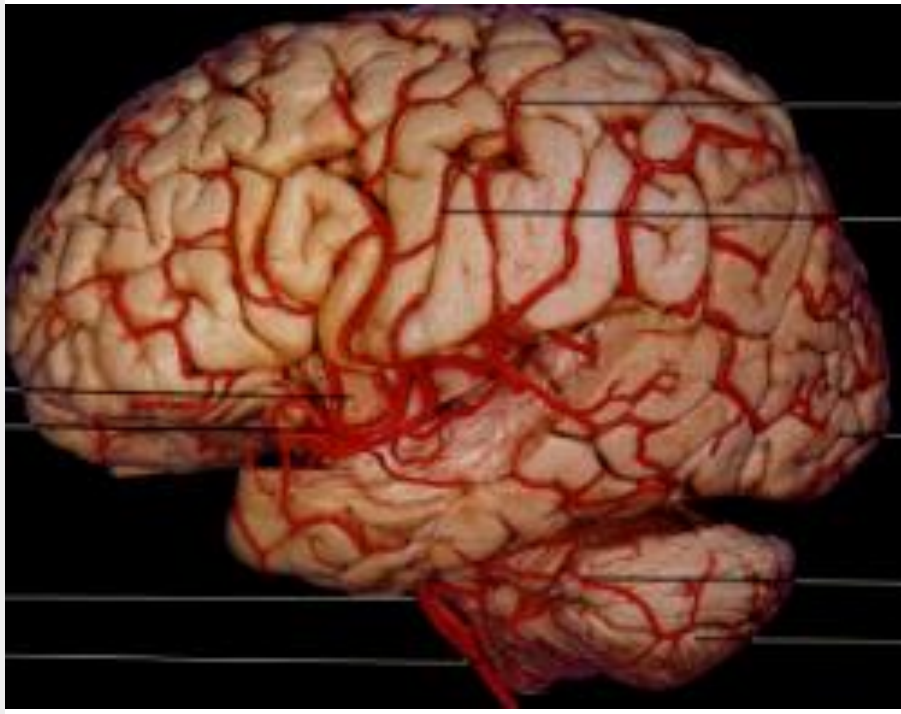
Runs laterally in the lateral fissure to the insula where it divides into terminal branches which appear on the lateral surface.

Branches:

- **Cortical branches**: supply the superolateral surface back to the parieto-occipital fissure (except the upper one inch below the superomedial border which is supplied by ACA), the lateral ½ of orbital surface & the temporal pole.
- **Central branches**: Supply posterior part corpus striatum & internal capsule.





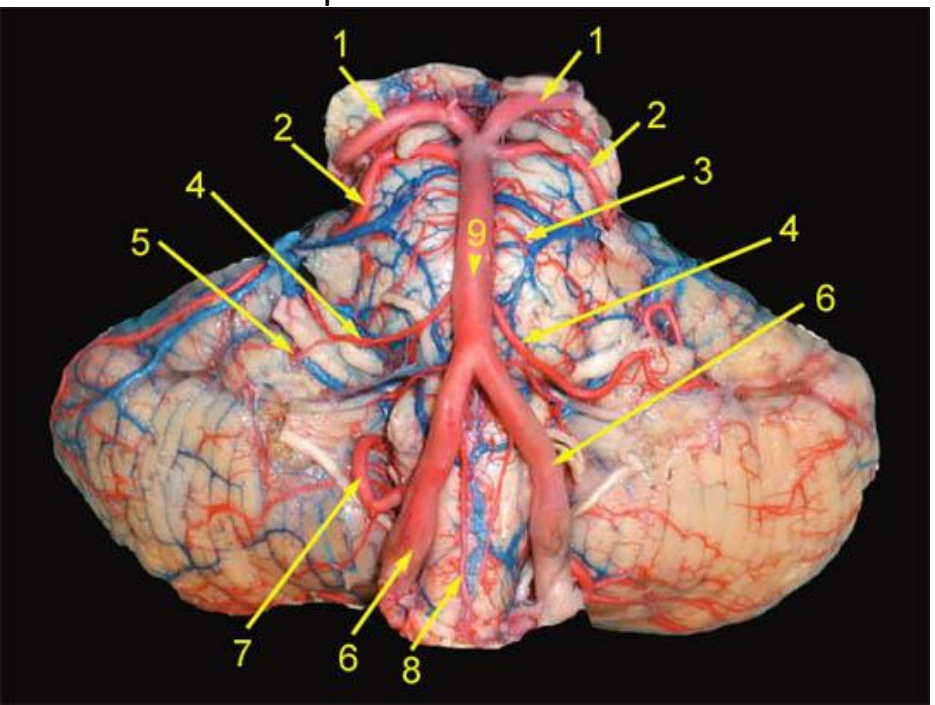


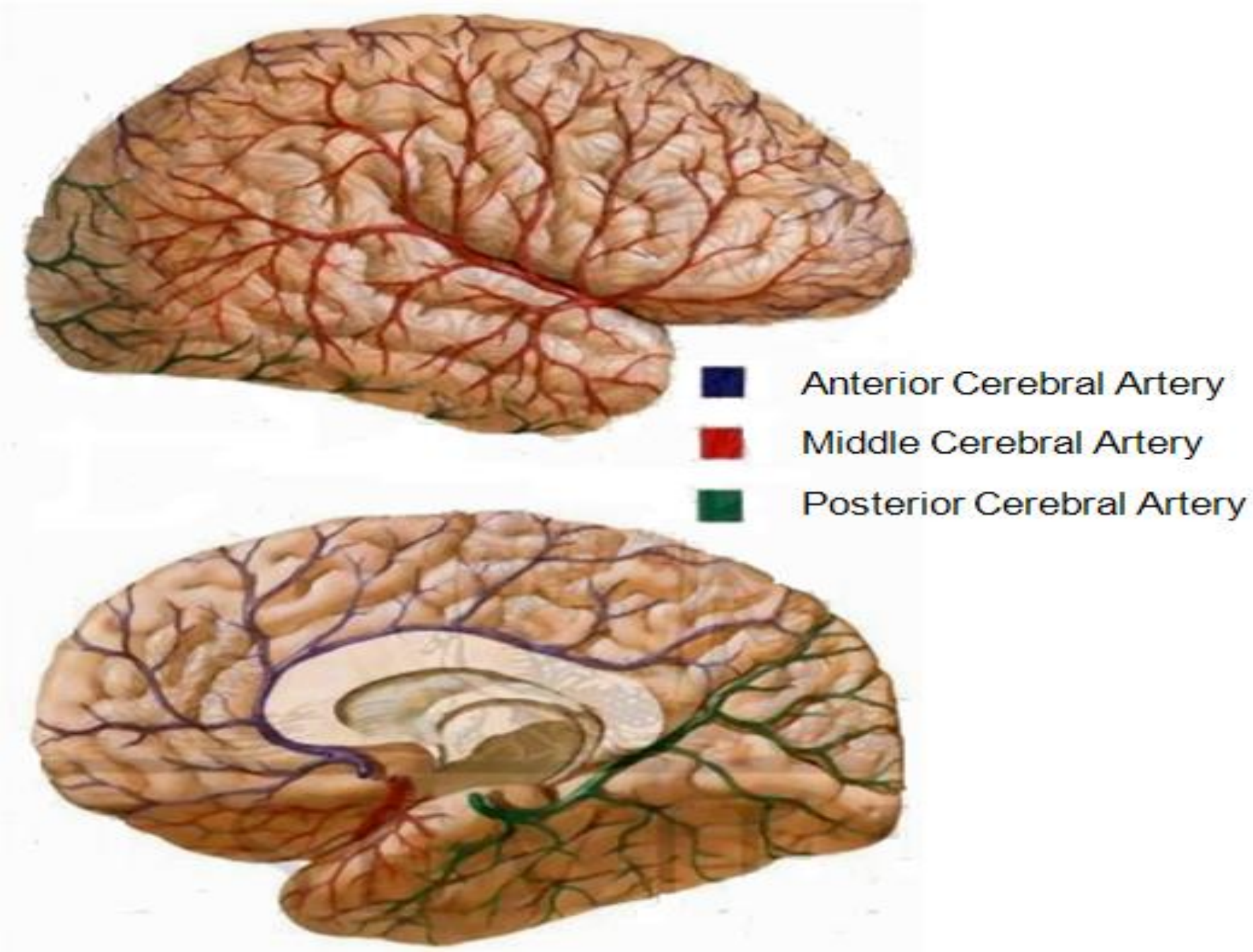
The posterior cerebral artery (PCA):

Curves backwards around the midbrain & comes below the splenium of corpus callosum where it divides into branches which run in the calcrine & parieto-occipital fissure.

Branches:

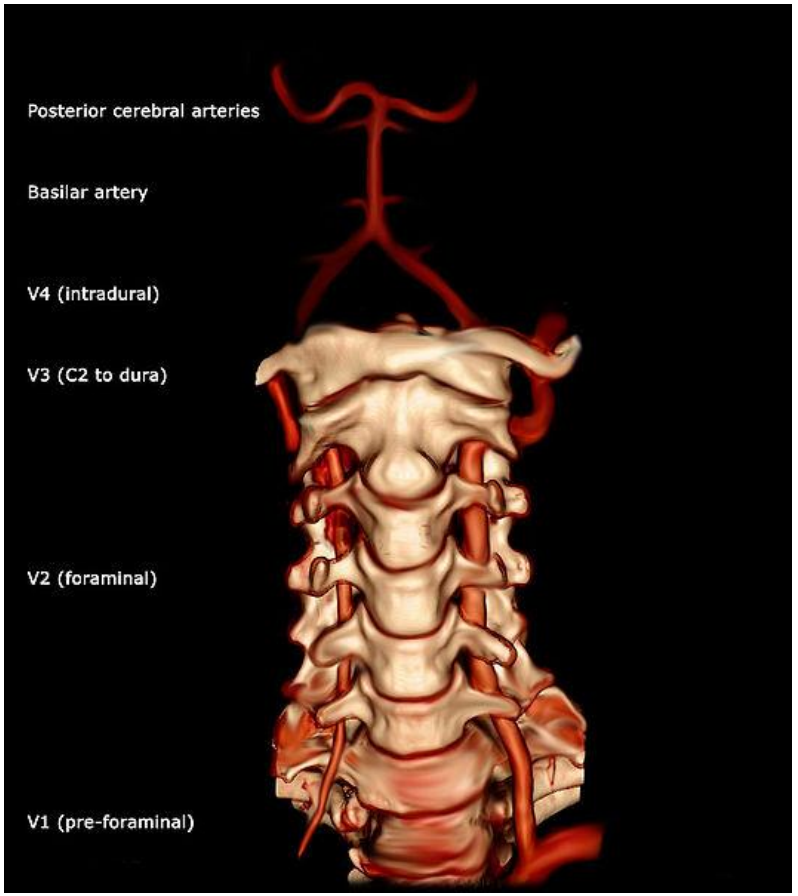
- **Cortical branches**: to the **lateral & medial** surface behind the parieto-occipital fissure & to the **tentorial** surface except the temporal pole.
- **Short medial central branches**: pierce the posterior perforated substance & supply the cerbral peduncles, mammillary bodies & anterior part of thalamus.
- **Long lateral central branches**: Curve around the midbrain to supply the midbrain, geniculate bodies & back of thalamus.
- **Posterior choroidal artery**: arises from the PCA below the splenium of cc & supplies the choroid plexuses of the 3rd & lateral ventricles & the dorsum of thalamus.




Anterior Cerebral Artery
Middle Cerebral Artery
Posterior Cerebral Artery

Vertebral arteries

- Arises from the 1st part of the subclavian artey.
- Inside the skull, the two vertebral arteries join up to form the basilar artery at the base of the medulla oblongata
- The basilar artery is the main blood supply to the brainstem and connects to the Circle of Willis to potentially supply the rest of the brain if there is compromise to one of the carotids



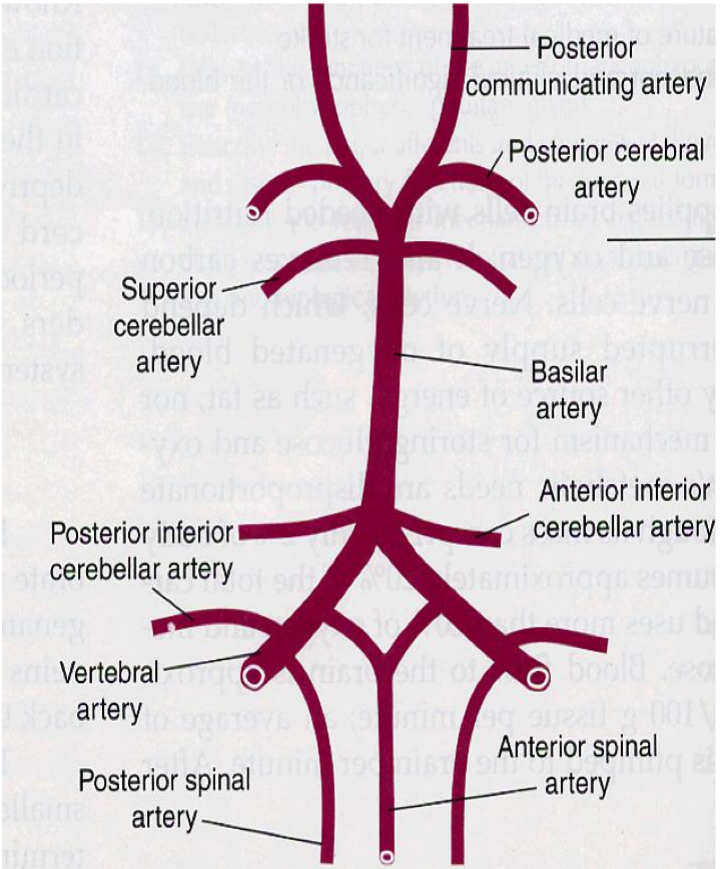
VERTEBRAL ARTERY

BRANCHES:

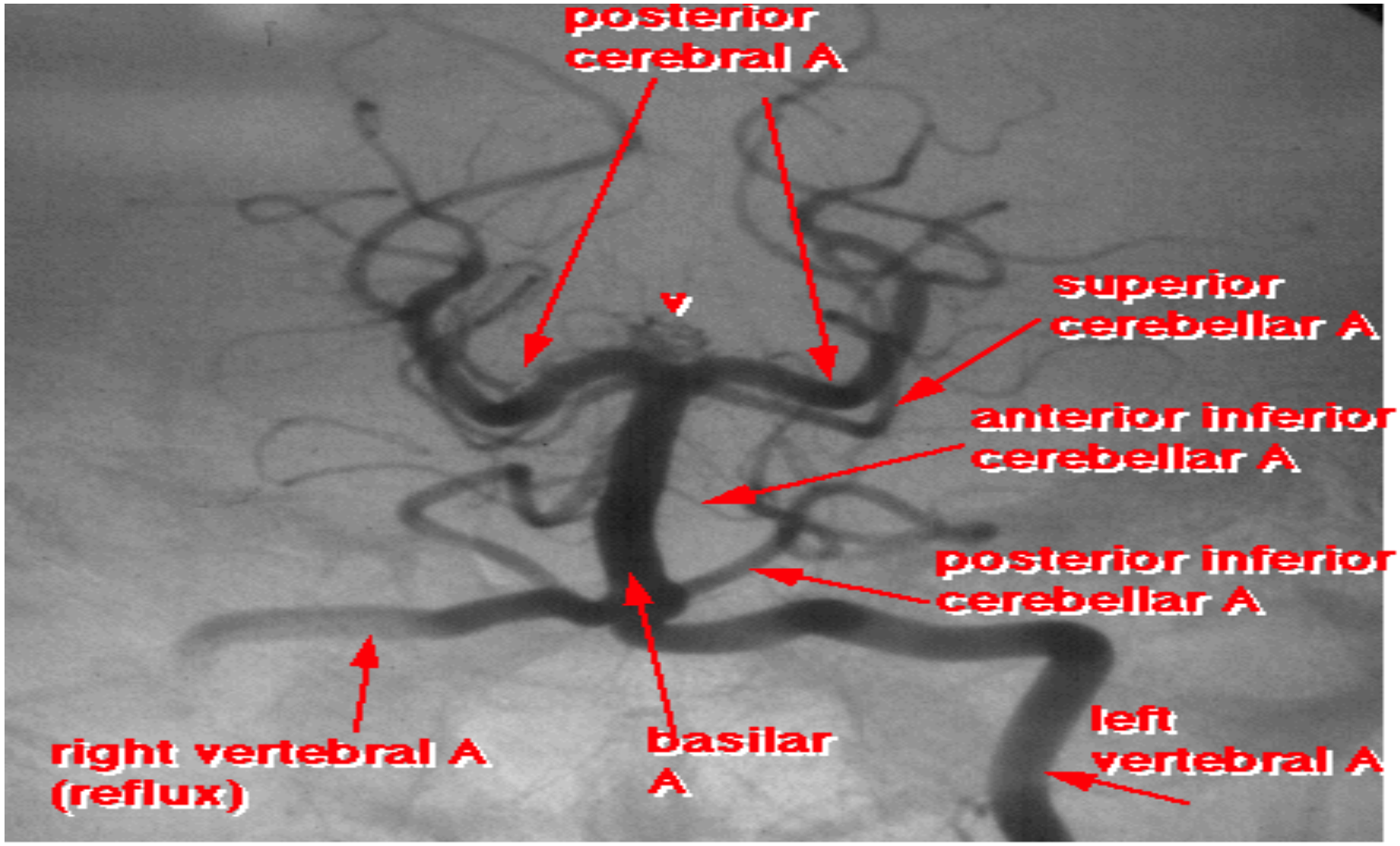
1. ANTERIOR + POSTERIOR SPINAL A.
2. PICA (posterior inferior cerebellar artery)
3. Medullary branches

BASILAR ARTERY BRANCHES:

1. AICA (Anterior inferior cerebellar artery)
2. INTERNAL AUDITORY A.
3. SUPERIOR CEREBELLAR A.
4. POSTERIOR CEREBRAL A.
5. MEDULLARY AND PONTINE PERFORATING ARTERIES



Vertebrobasilar arteries angiogram

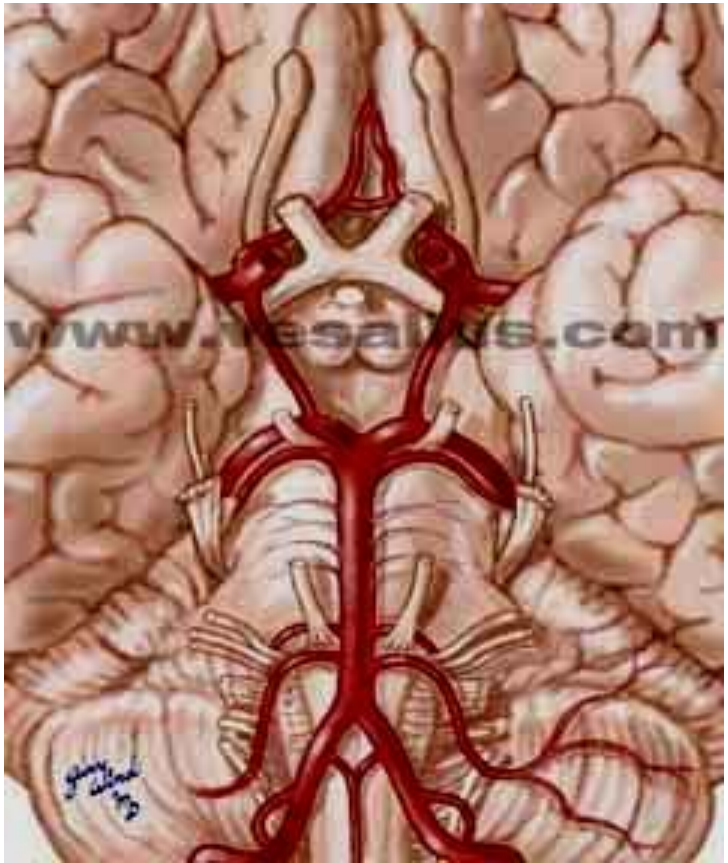


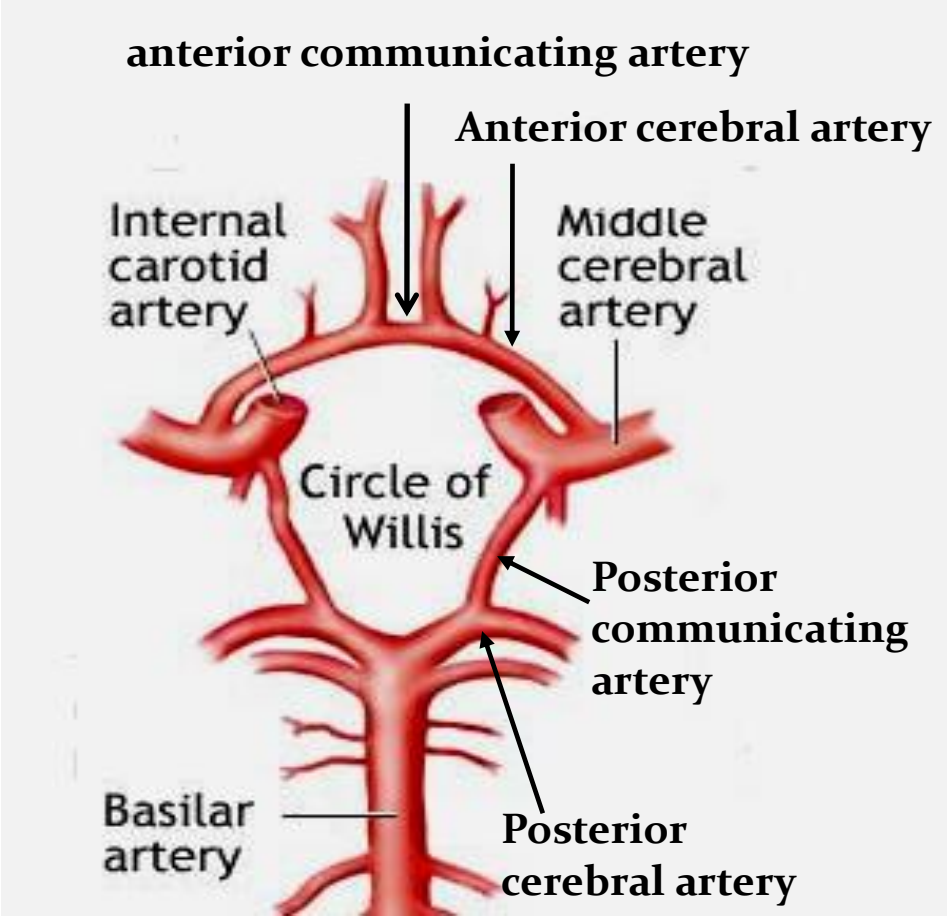
v =perforators off the top of the basilar

Circulus Arteriosus (Circle of Willis)

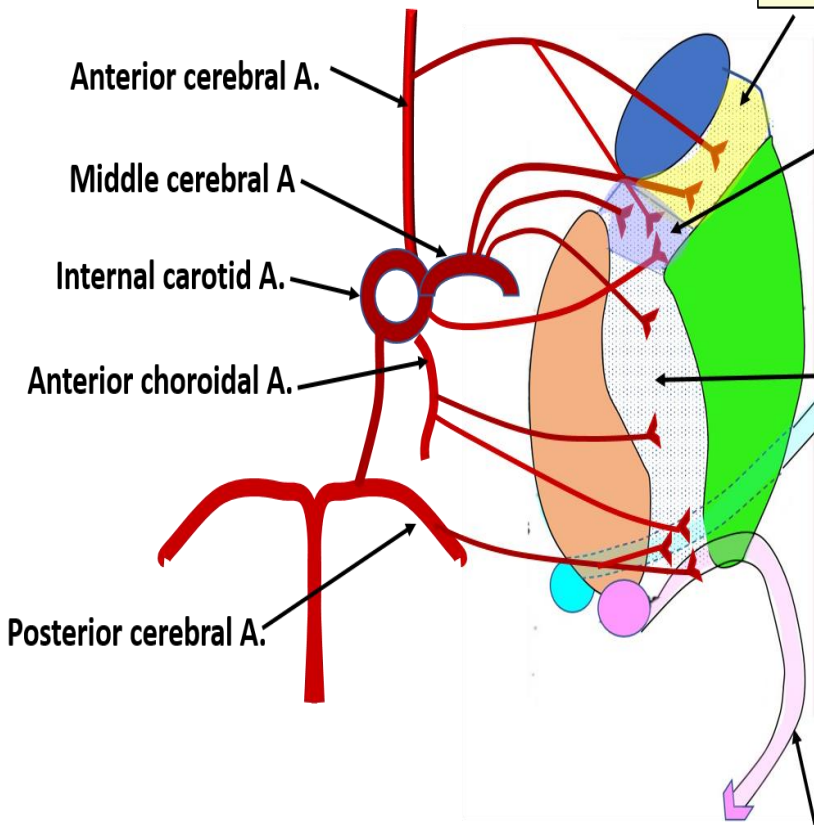
It is found around the interpeduncular fossa & is formed by the following arteries:

- Right & left **anterior cerebral** arteries which are connected by **anterior communicating** artery.
- Right & left **internal carotid** arteries .
- Right & left **posterior cerebral** arteries.
- Right & left **posterior communicating** arteries which connect the internal carotid arteries with the posterior cerebral arteries.





Blood supply of the internal capsule



Anterior limb

Striate branches of **Anterior cerebral** (including the longest branch - **recurrent artery of Heubner and Middle cerebral**

Genu

Striate branches of **Anterior cerebral, Middle cerebral** and direct branches from **Internal carotid**

Posterior limb

Striate branches from **Middle cerebral** (including large **Charcot artery of cerebral haemorrhage) and Anterior Choroidal.**

Sublentiform Part

Striate Branches from **Posterior cerebral and anterior choroidal**

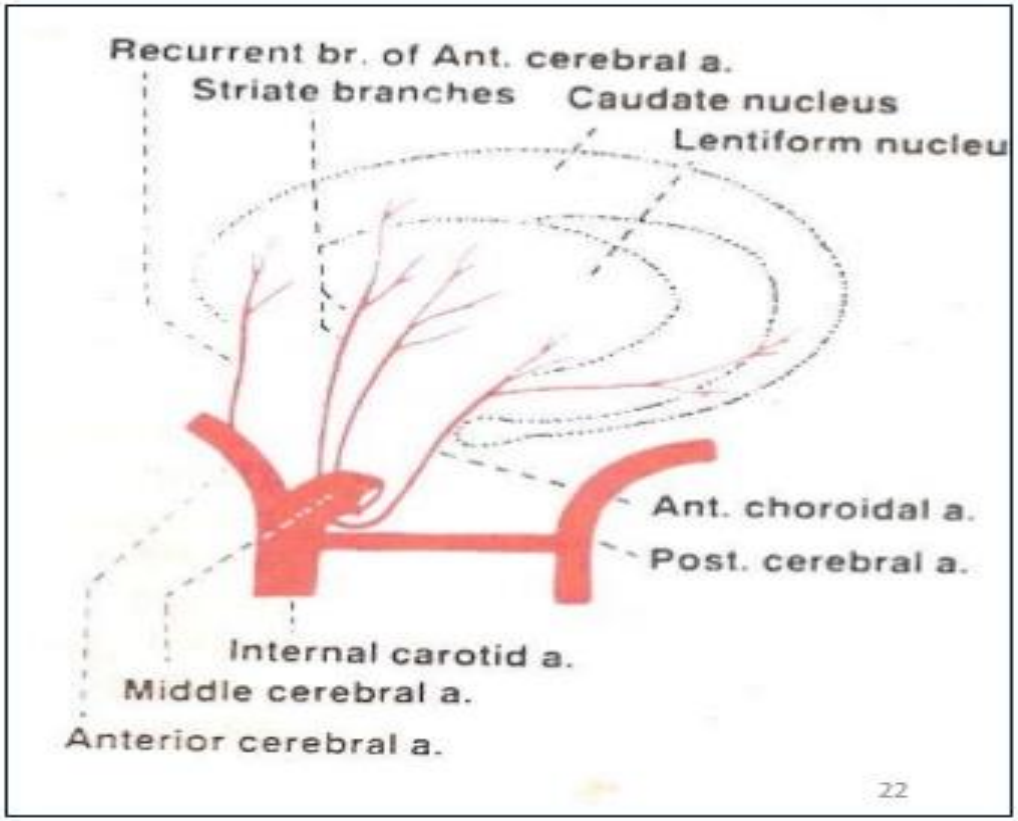
Retrolentiform Part

Striate Branches from **Posterior cerebral**

Blood supply of the basal ganglia

Blood Supply

- **Arterial**
  - Medial Striate Brs. - MCA
  - Lat. Striate Brs. – MCA
  - Recurrent Br – ACA
  - Ant. Choroidal Br - MCA
- **Venous**
  - Striate veins
  - Int. cerebral vein
  - Basal Vein



Venous drainge of the brain

External Cerebral Veins

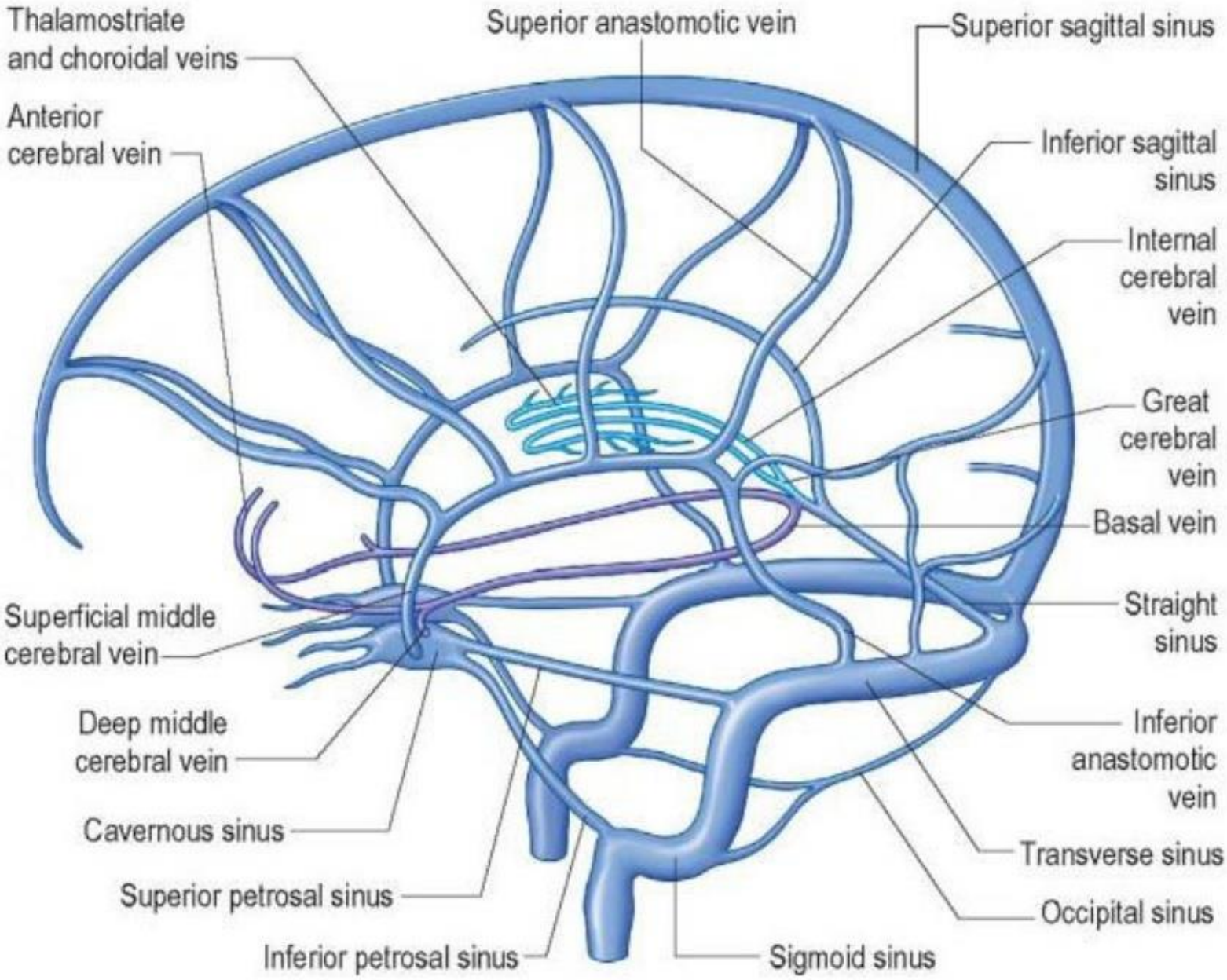
The **superior cerebral veins** **pass upward over the lateral surface** of the cerebral hemisphere and empty into the superior sagittal sinus.

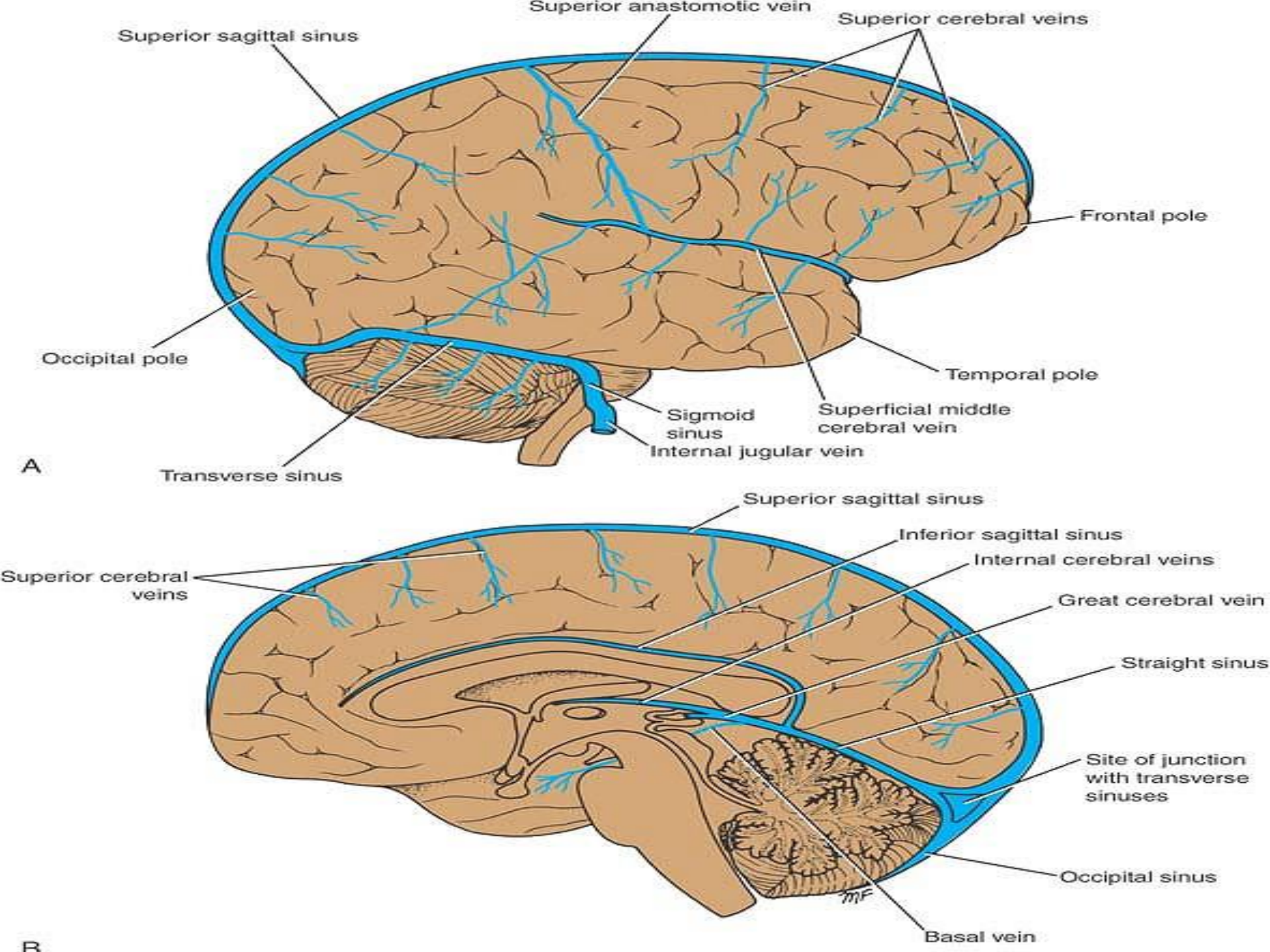
The **superficial middle cerebral vein** **drains the lateral surface** of the cerebra**l** hemisphere. It runs in the lateral sulcus and empties into the cavernous sinus.

The **deep middle cerebral vein** **drains the insula and is joined by the anterior cerebral** and **striate veins to form the basal vein. The basal vein ultimately joins the great** cerebral vein, which in turn drains into the straight sinus.

Internal Cerebral Veins

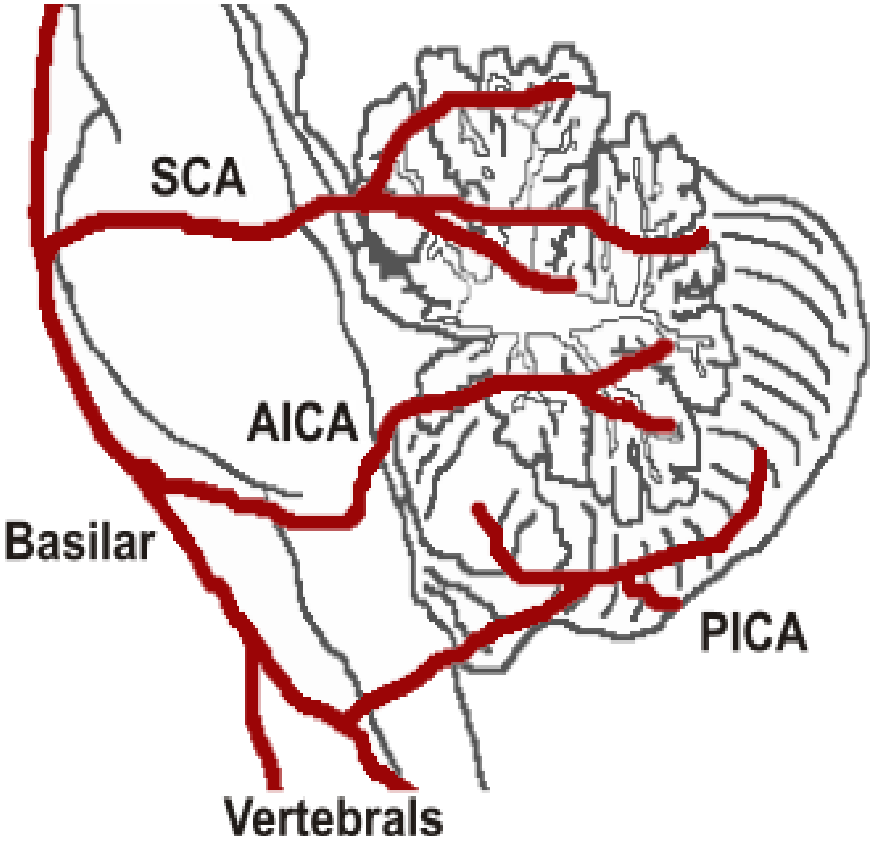
There are two internal cerebral veins, and they are formed by the union of the **thalamostriate vein and the choroid vein at the interventricular foramen. The two** veins run posteriorly in the tela choroidea of the third ventricle and unite beneath the splenium of the corpus callosum to form the great cerebral vein, which empties into the straight sinus.


Thalamostriate and choroidal veins
Superior anastomotic vein
Superior sagittal sinus
Anterior cerebral vein
Inferior sagittal sinus
Internal cerebral vein
Great cerebral vein
Basal vein
Straight sinus
Superficial middle cerebral vein
Deep middle cerebral vein
Inferior anastomotic vein
Cavernous sinus
Transverse sinus
Superior petrosal sinus
Occipital sinus
Inferior petrosal sinus
Sigmoid sinus


Superior anastomotic vein
Superior sagittal sinus
Superior cerebral veins
Frontal pole
Occipital pole
Temporal pole
Sigmoid sinus
Superficial middle cerebral vein
Internal jugular vein
Transverse sinus
A
Superior sagittal sinus
Inferior sagittal sinus
Internal cerebral veins
Superior cerebral veins
Great cerebral vein
Straight sinus
Site of junction with transverse sinuses
Occipital sinus
Basal vein
B

Blood Supply to Cerebellum

- Superior cerebellar artery (SCA) from basilar artery
- Anterior inferior cerebellar artery (AICA) from basilar artery
- Posterior inferior cerebellar artery (PICA) from vertebral artery



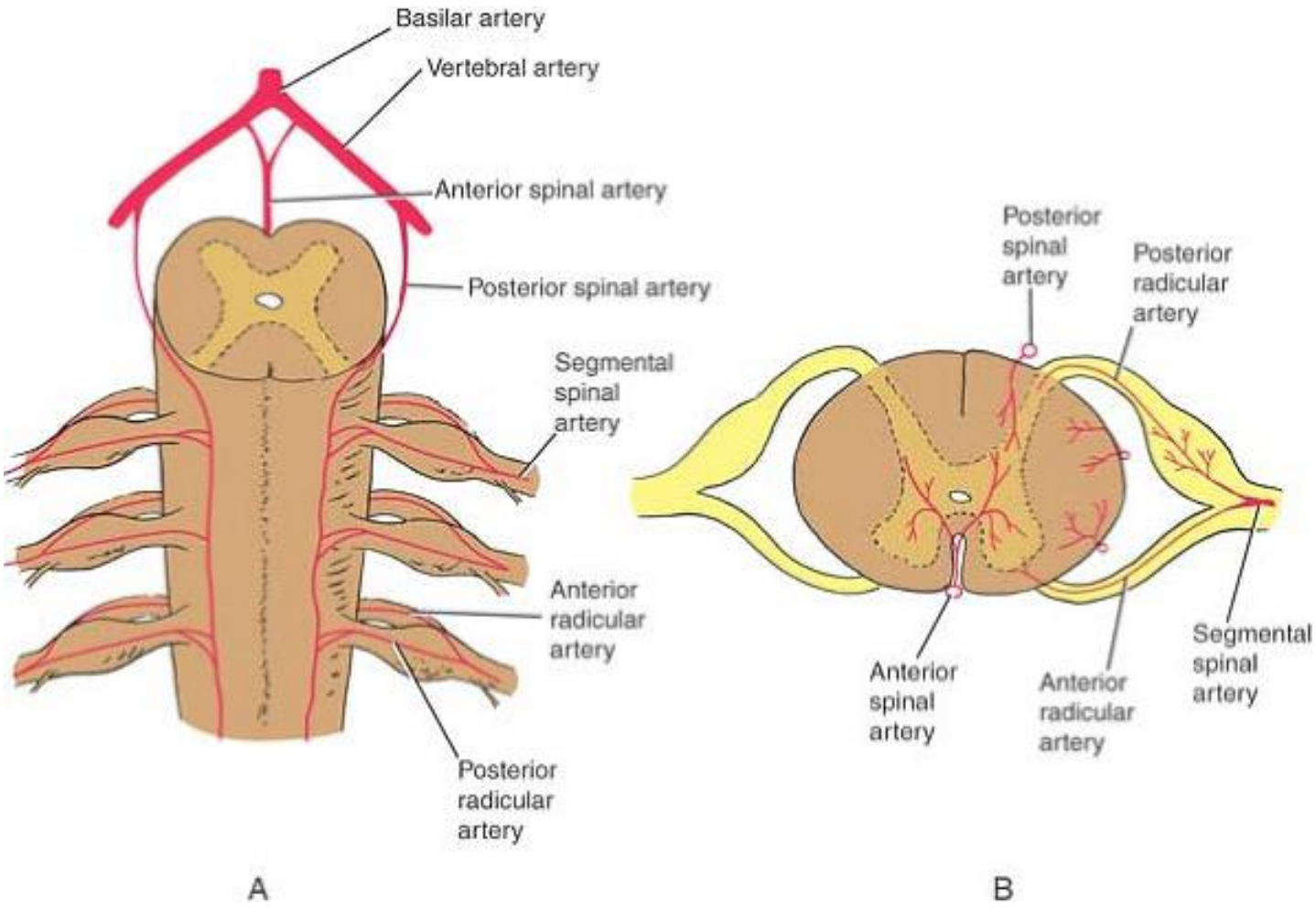
Blood Supply to Spinal Cord

- The spinal cord is supplied with blood by three arteries that run along its length starting in the brain, and many arteries that approach it through the sides of the spinal column
- The three longitudinal arteries are called the **anterior spinal artery, and the right and left posterior spinal arteries**
- These travel in the **subarachnoid space** and send branches into the spinal cord
- They form anastomoses via the **anterior and posterior segmental medullary arteries**, which enter the spinal cord at various points along its length
- Supply blood up to **cervical segments**

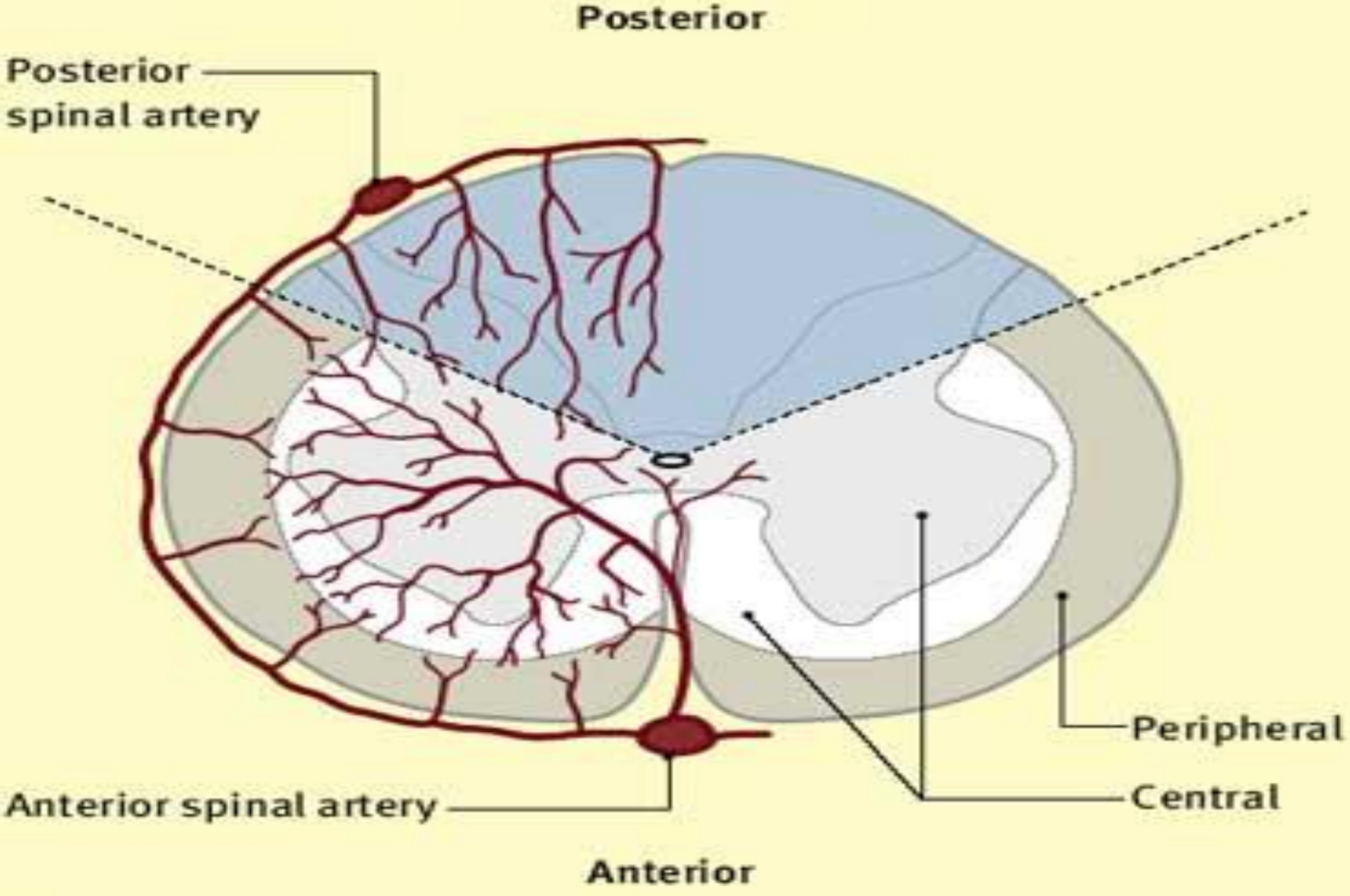
Blood Supply to Spinal Cord

- Arterial blood supply below the cervical region comes from the radially arranged posterior and anterior radicular arteries, which run into spinal cord alongside the dorsal and ventral nerve roots
- These intercostal and lumbar radicular arteries arise from the aorta, provide major anastomoses and supplement the blood flow to the spinal cord.
- Largest of the anterior radicular arteries is known as the artery of Adamkiewicz (abodomial aorta) which usually arises between L1 and L2
- Impaired blood flow through these critical radicular arteries, especially during surgical procedures that involve abrupt disruption of blood flow through the aorta for example during aortic aneursym repair, can result in spinal cord infarction and paraplegia

Arterial Supply to Spinal Cord

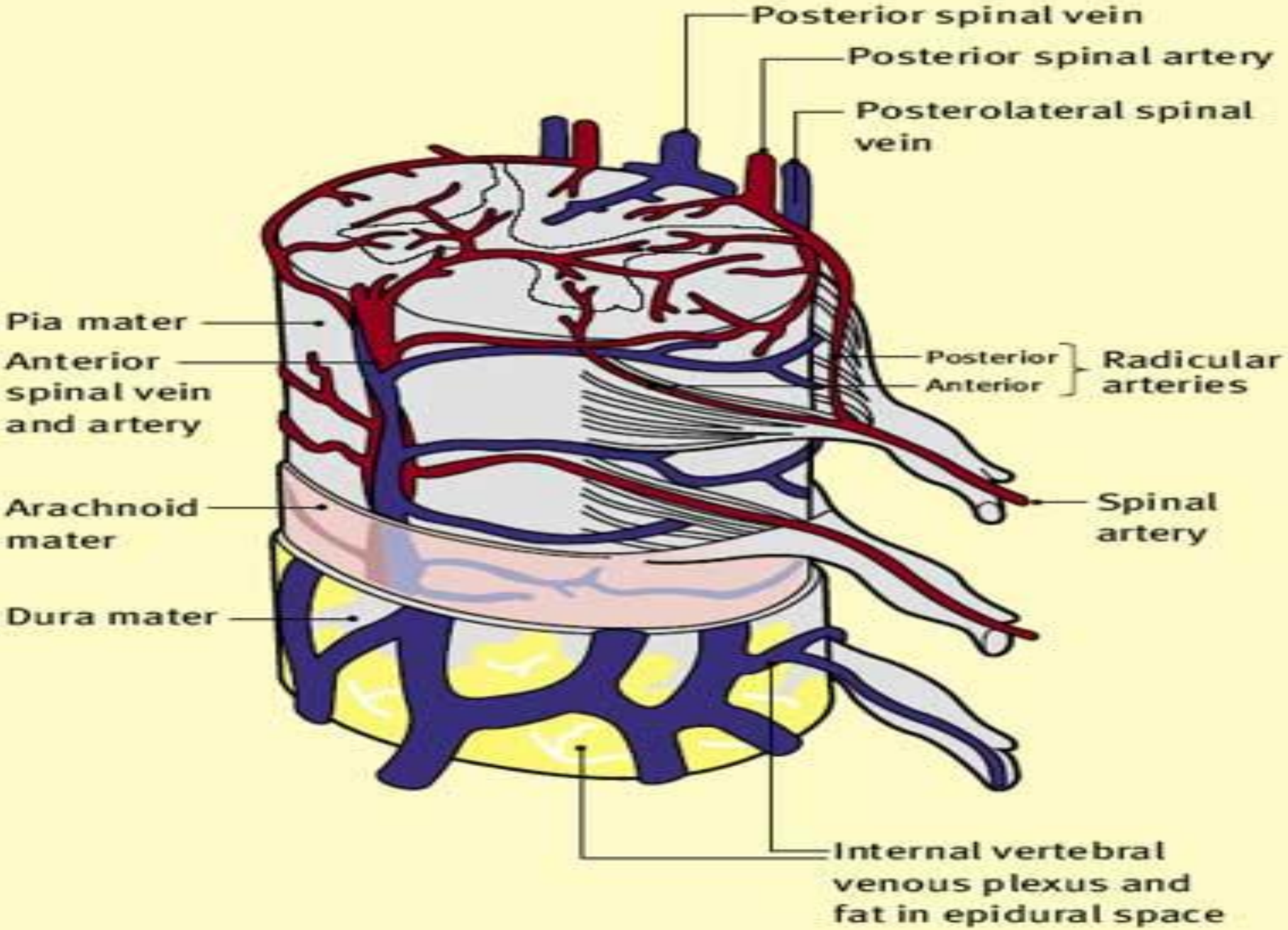


Blood supply to the spinal cord: horizontal distribution



The central area supplied only by the anterior spinal artery is predominantly a motor area

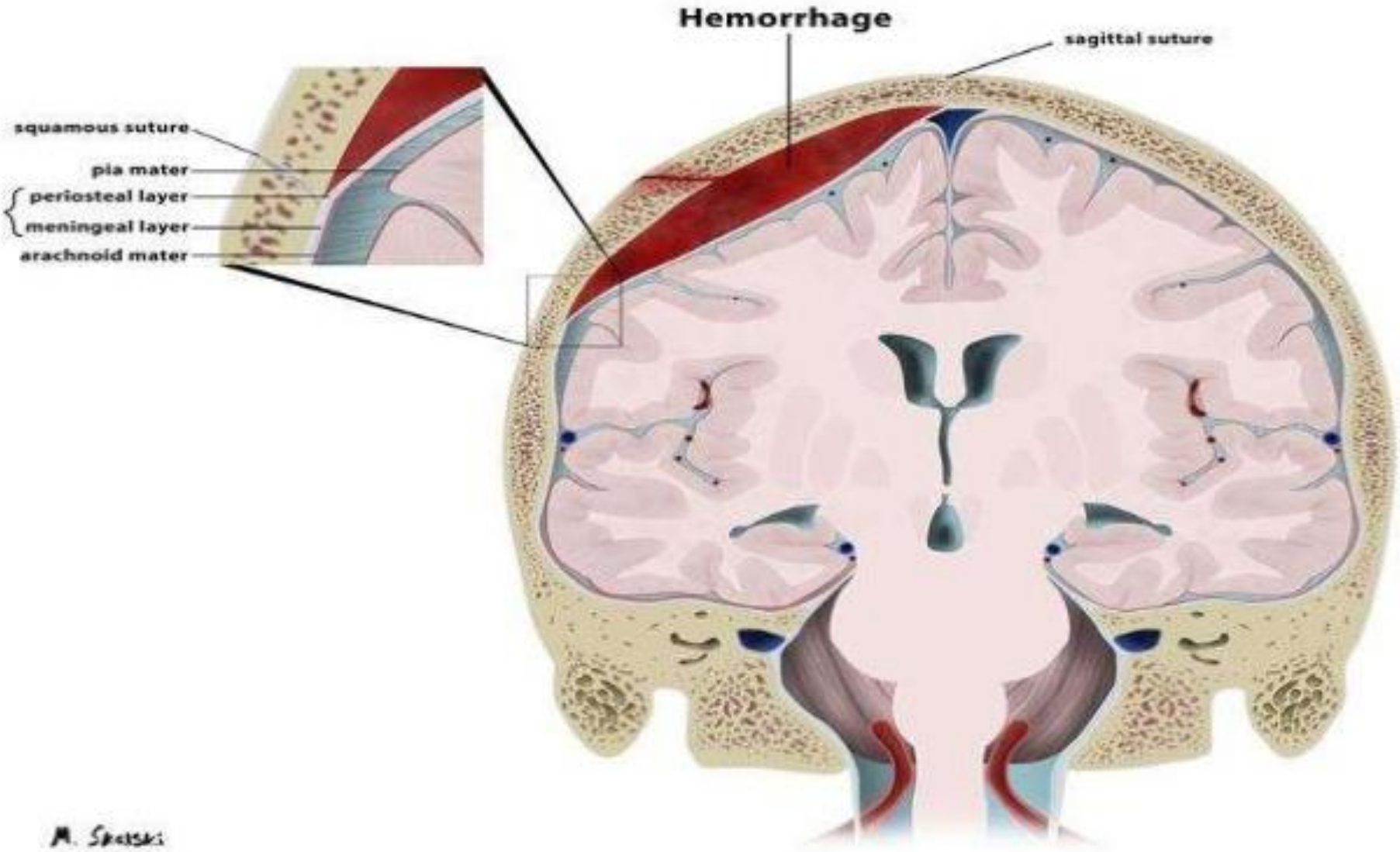
Arterial supply and venous drainage of the spinal cord



Extra-dural Hemorrhage

- It results from injuries of the meningeal arteries or veins
- The most common is the anterior branch of the middle meningeal artery.
- A minor blow to the side of the head result in fracture of the anteroinferior portion of the parietal bone (pterion)
- The intracranial pressure rises. The blood clot exerts local pressure on the underlying motor area in the **precentral gyrus**.
- Blood may pass out through the fracture line to form a soft swelling under the temporalis muscle
- The burr hole through the skull wall should be placed 2.5 to 4 cm above the midpoint of the zygomatic arch to ligate or plug the torn artery or vein

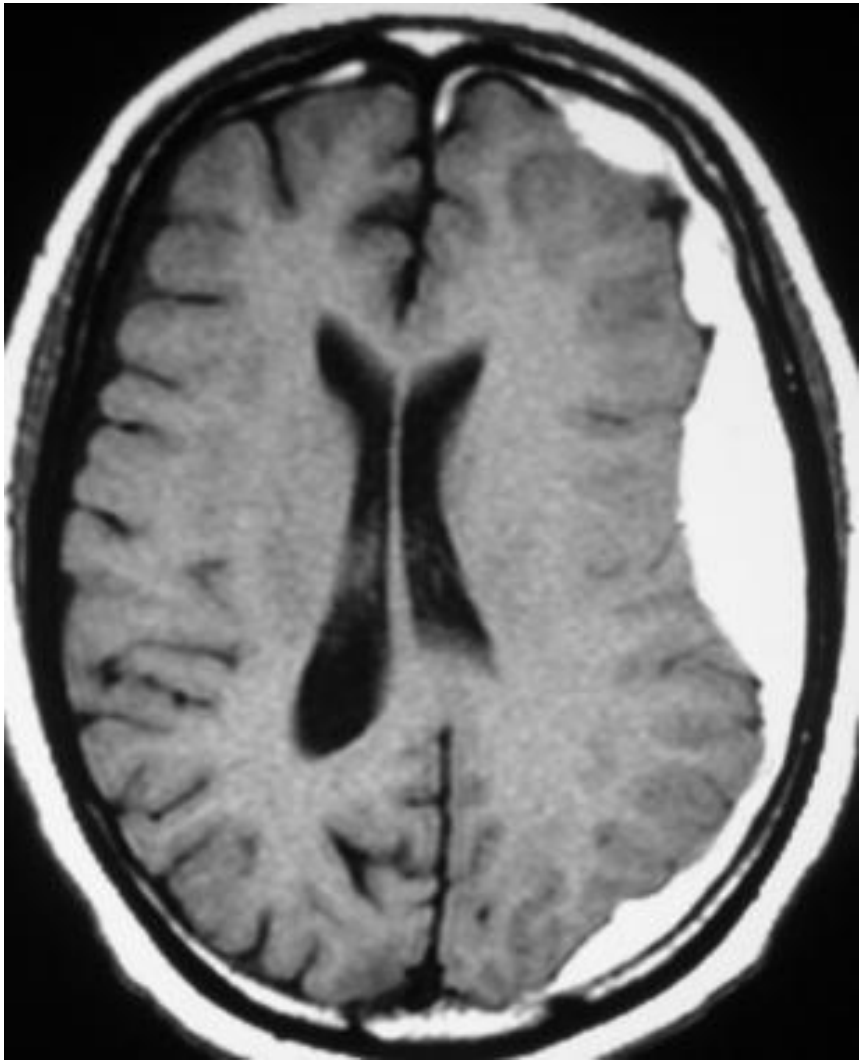
Extradural Hemorrhage



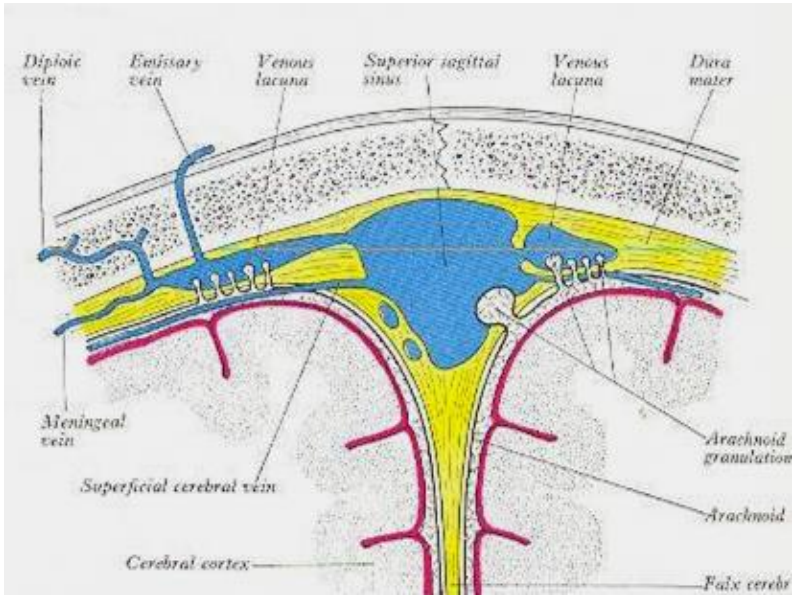
Sub-dural Hemorrhage

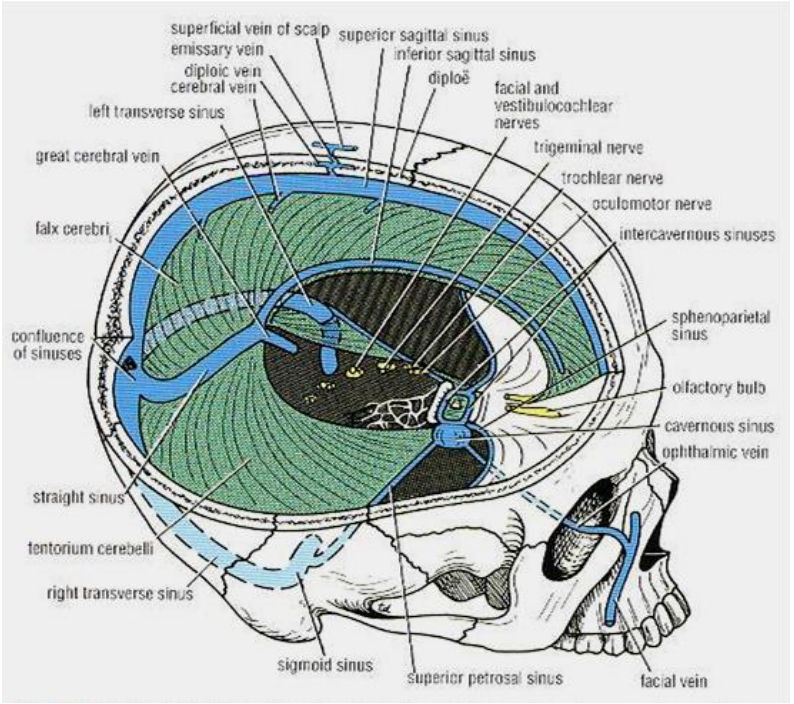
- It results from tearing of the superior cerebral veins at their entrance into the superior sagittal sinus.
- Cause is a blow on the front or back of the head causing anteroposterior displacement of the brain within the skull.
- Blood under low pressure begins to accumulate in the space between the dura and arachnoid.
- Acute symptoms in the form of vomiting due to rise in the venous pressure may be present. In the chronic form, over a several months, the small blood clot will attract fluid by osmosis so a hemorrhagic cyst is formed and gradually expands produces pressure.

MRI showing fronto temporal Subdural haemorrage



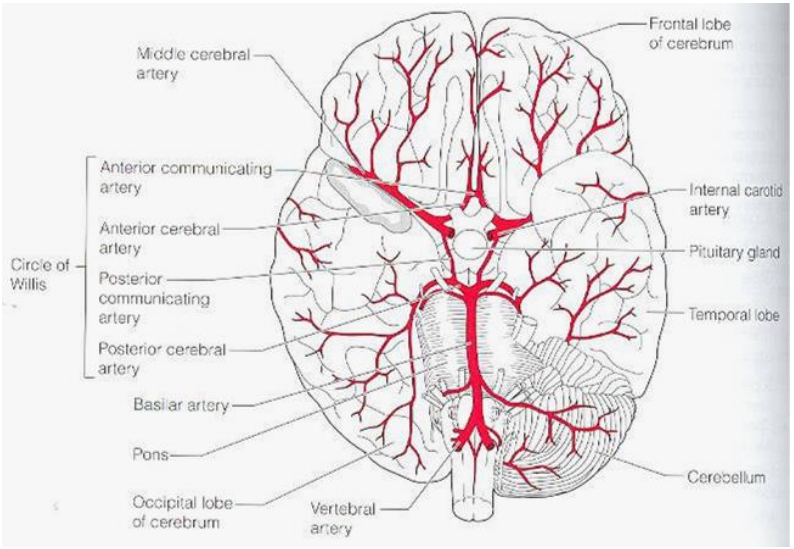
Sub-dural Hemorrhage



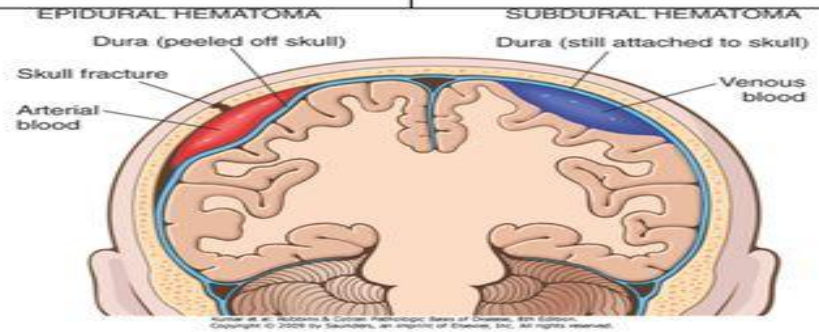
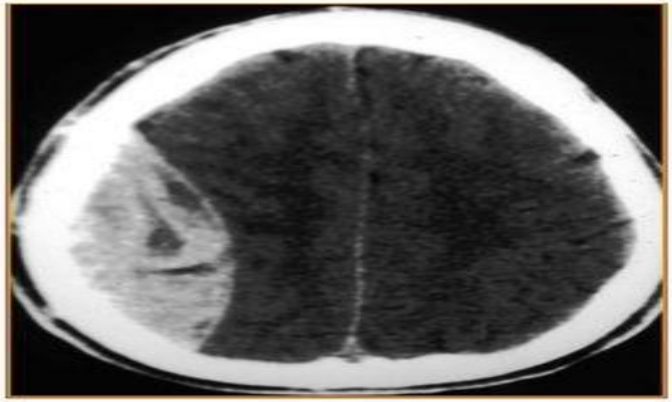


Subarachnoid Hemorrhage

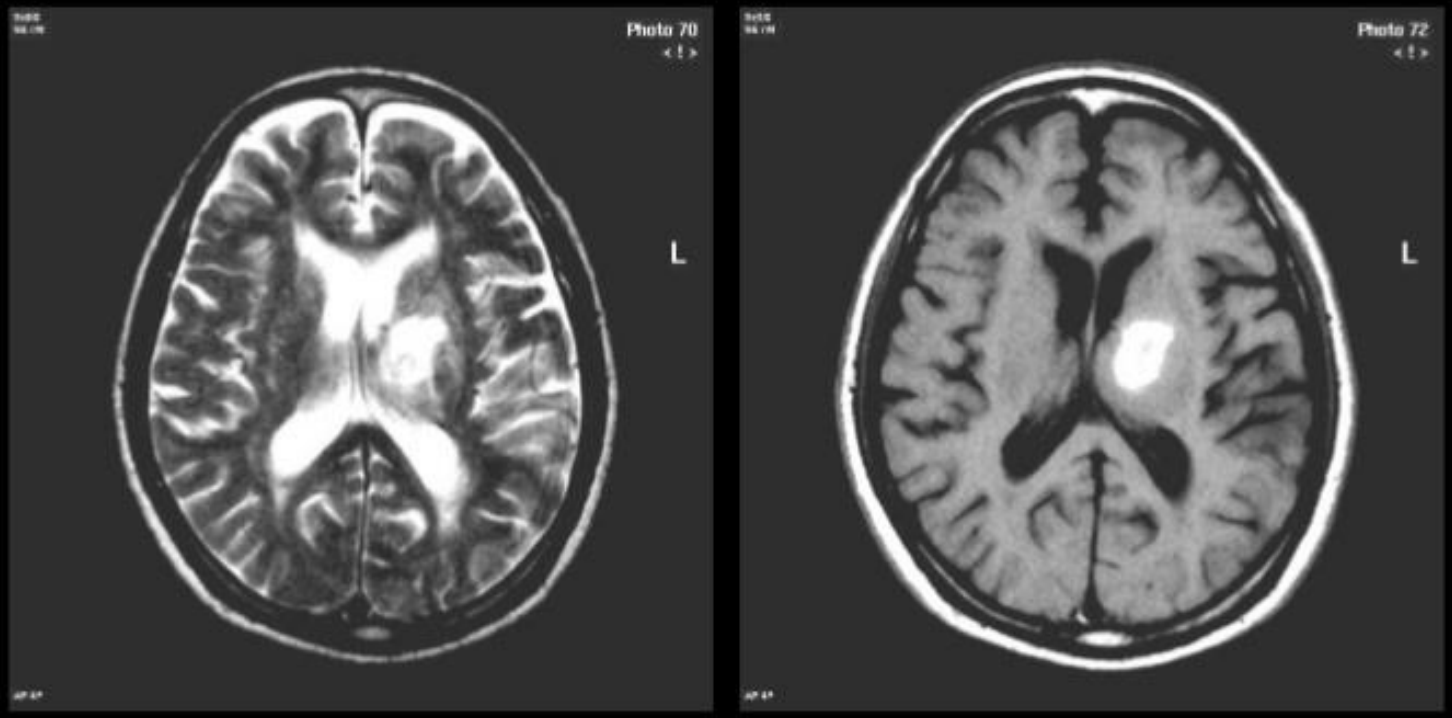
- It results from leakage or rupture of a congenital aneurysm on the circle of Willis
- The sudden symptoms include severe headache; stiffness of the neck and loss of consciousness
- The diagnosis is established by withdrawing heavily blood- stained CSF fluid through a lumbar puncture (spinal tap)



Difference between subdural and epidural haemorrages

Hematoma type	Epidural	Subdural
Location	Between the skull and the outer endosteal layer of the dura mater	Between the *dura* and the arachnoid
		
Involved vessel	• Temperoparietal locus (most likely) - **Middle Meningeal Artery** • Frontal locus - anterior ethmoidal artery • Occipital locus - transverse or sigmoid sinuses • Vertex locus - superior sagittal sinus	**Bridging veins** (drain brain to dural sinuses)
Symptoms	Lucid interval followed by unconsciousness → "talk & die" sd	Gradually increasing headache and confusion
CT appearance	Biconvex lens 	Crescent-shaped 

Chronic intracranial hemorrhage



Cerebral artery syndromes

Anterior Cerebral Artery Occlusion

Occlusion distal to the communicating artery may produce the following signs and symptoms:

1. **Contralateral hemiparesis and hemisensory loss** involving mainly the leg and foot (paracentral lobule of cortex).
2. **Inability to identify objects correctly, apathy, and personality changes** (frontal and parietal lobes).

Middle Cerebral Artery Occlusion

1. **Contralateral hemiparesis and hemisensory loss** involving mainly the face and arm (precentral and postcentral gyri)
2. **Aphasia if the left hemisphere** is affected (rarely if the right hemisphere is affected)
3. **Contralateral homonymous hemianopia** (damage to the optic radiation)
4. **Agnosia** if the right hemisphere is affected (rarely if the left hemisphere is affected)

Posterior Cerebral Artery Occlusion

1. Contralateral homonymous hemianopia with some degree of macular sparing (damage to the calcarine cortex, macular sparing due to the occipital pole receiving collateral blood supply from the middle cerebral artery).
2. **Visual agnosia** (ischemia of the left occipital lobe)
3. Impairment of memory (the medial aspect of the temporal lobe)

Internal Carotid Artery Occlusion

1. The symptoms and signs are those of middle cerebral artery occlusion, including **contralateral hemiparesis and hemianesthesia.**

2. There is **partial or complete loss of sight on the same side**, but permanent loss is rare (emboli dislodged from the internal carotid artery reach the retina through the ophthalmic artery).

Vertebrobasilar Artery Occlusion

1- Ipsilateral pain and temperature sensory loss of the face and **contralateral pain and temperature sensory loss** of the body.

2. Attacks of hemianopia or complete cortical blindness.

3. Ipsilateral loss of the gag reflex, dysphagia, and hoarseness as the result of lesions of the nuclei of the glossopharyngeal and vagus nerves.

4. Vertigo, nystagmus, nausea, and vomiting

5. Ipsilateral Horner syndrome

6. Ipsilateral ataxia and other cerebellar signs.

7. Unilateral or bilateral hemiparesis.

8- Comma

THANK YOU