



MED437
KING SAUD UNIVERSITY



Cerebral Blood Circulation

Lecture (16)

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هذا العمل مبني بشكل أساسي على عمل دفعة ٤٣٦ مع المراجعة والتدقيق وإضافة الملاحظات ولا يغني عن المصدر الأساسي للمذاكرة

- **Important**
- **Doctors Notes**
- Notes/Extra explanation

{وَمَنْ يَتَوَكَّلْ عَلَى اللَّهِ فَهُوَ حَسْبُهُ}

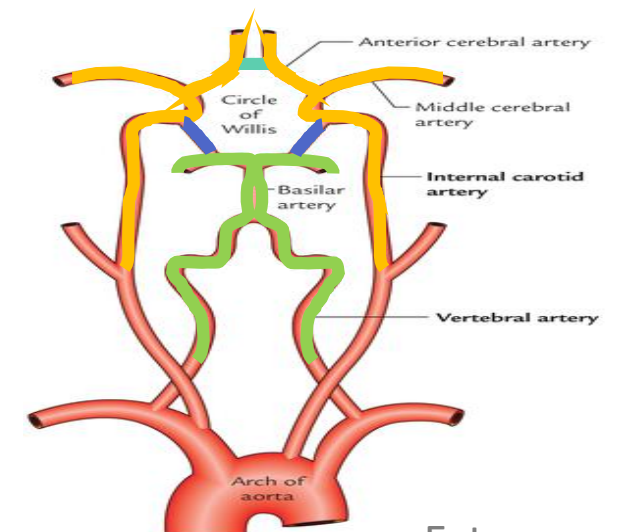
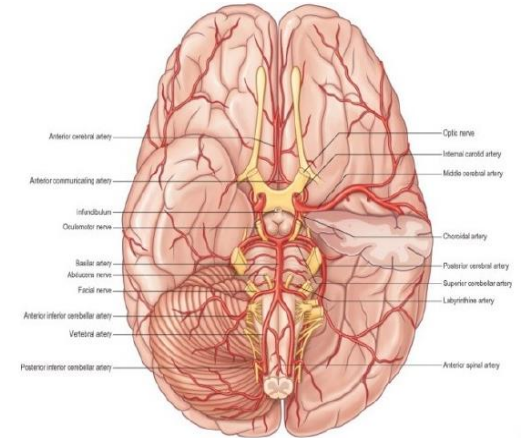
■ Objectives

At the end of the lecture, students should be able to:

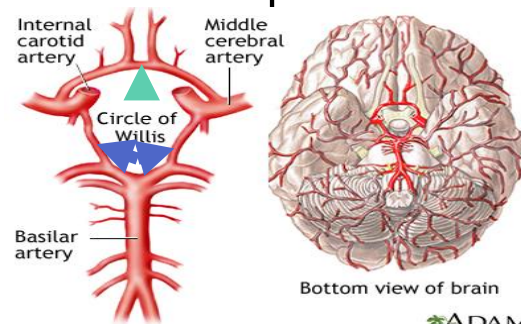
- ✓ List the cerebral arteries.
- ✓ Describe the cerebral arterial supply regarding the origin, distribution and branches.
- ✓ Describe the arterial Circle of Willis .
- ✓ Describe the cerebral venous drainage and its termination.
- ✓ Describe arterial & venous vascular disorders and their clinical manifestations.

Cerebral Circulation

- It is the movement of blood through the network of blood vessels to supply the brain.
- The movement of blood in the cerebral circulation is called **cerebral blood flow**.
- The arteries carry oxygenated blood and other nutrients to the brain.
- The veins carry deoxygenated blood back to the heart removing carbon dioxide and other metabolic products.
- The two anterior cerebral circulations (left and right) are connected to each other by ONE anterior communicating artery.
- The anterior circulation (carotid) is interconnected to the posterior circulation (basilar) via **bilateral TWO** posterior communicating arteries.
- Posterior communicating arteries are part of **Circle of Willis**.



Extra



Cerebral Arterial supply

The arterial supply of the cerebrum is composed of/provided by 2 arterial systems:

1) Carotid System (Anterior cerebral circulation)

Composed of:

- **Internal carotid** artery and its branches:
- **Anterior cerebral** artery* (smaller)
- **Middle cerebral** artery* (bigger)

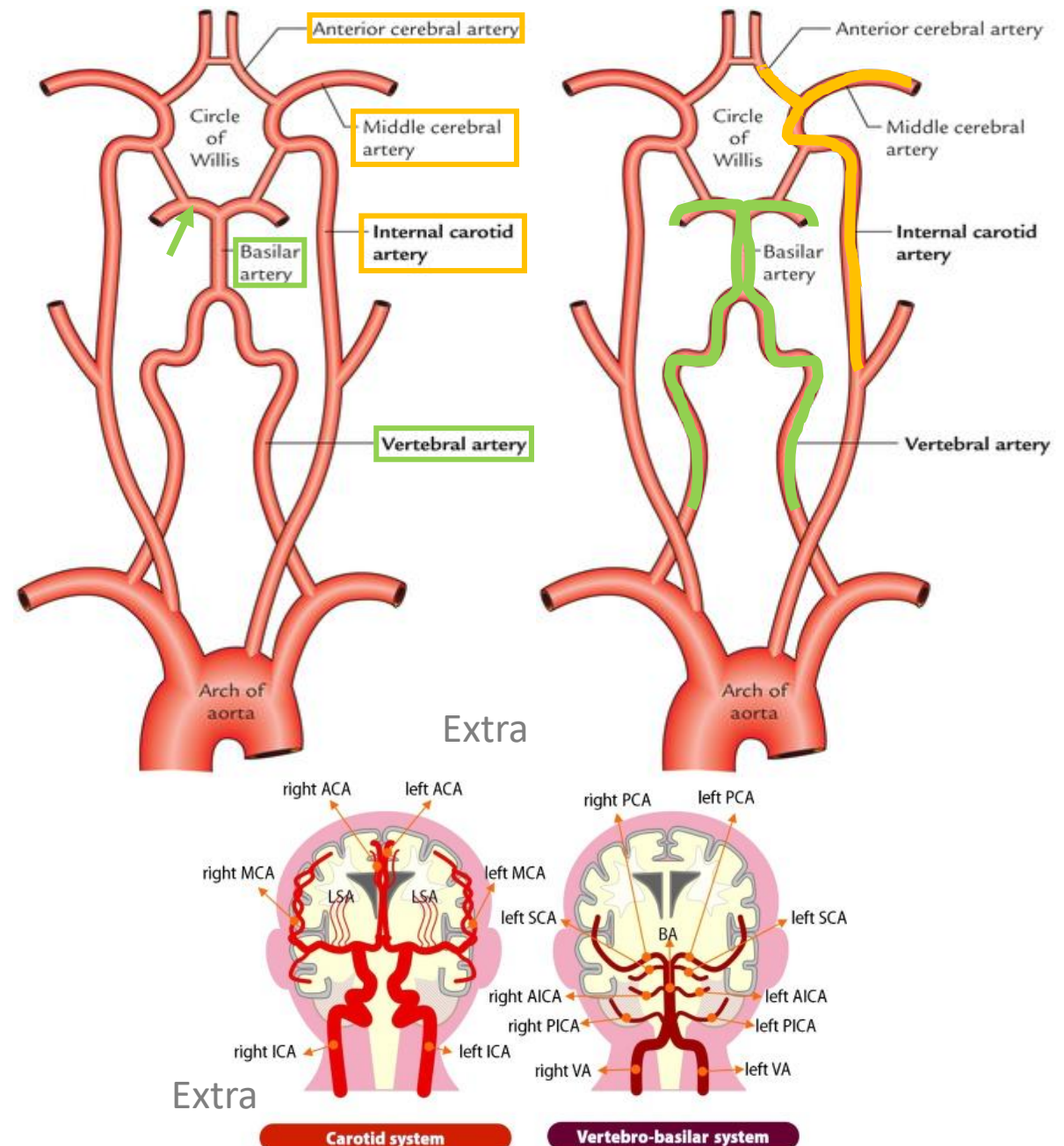
Supply **anterior** portion of brain

2) Vertebro-Basilar System (Posterior cerebral circulation)

The two **vertebral** arteries (from the **subclavian** artery) unite to form **basilar** artery*. It divides at the upper border of pons into **two posterior cerebral** arteries*

Supply **posterior** portion of brain

*We will talk about these in more detail later.

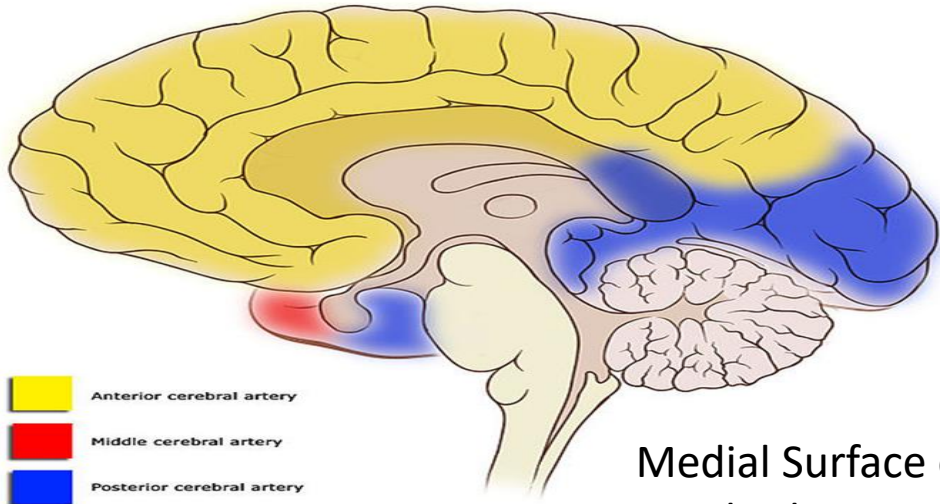


Cerebral Arterial supply

Origin	Internal carotid artery		Basilar artery
Branch	Anterior Cerebral Artery (ACA)	Middle Cerebral Artery (MCA)	Posterior Cerebral Artery (PCA)
Supplies	<ol style="list-style-type: none"> Orbital and medial surfaces of frontal and parietal lobes. A narrow part on the superolateral surface. 	<p>Entire Superolateral surface*:</p> <ol style="list-style-type: none"> Somatosensory Cortex Motor Cortex Language areas: <ul style="list-style-type: none"> Broca's Area: linked to <u>speech production</u>. Wernicke's Area: It is involved in the understanding of written and spoken language Auditory areas: <ul style="list-style-type: none"> Primary auditory area Heschl's Gyrus: to process incoming auditory information 	<ol style="list-style-type: none"> Anterior and inferior temporal lobes Uncus: <ul style="list-style-type: none"> Located on the tip end of the medial surface of the parahippocampal gyrus. Part of the olfactory cortex that processes information from the sense of smell. Inferior temporal gyri Inferior and Medial Occipital lobe (visual area)

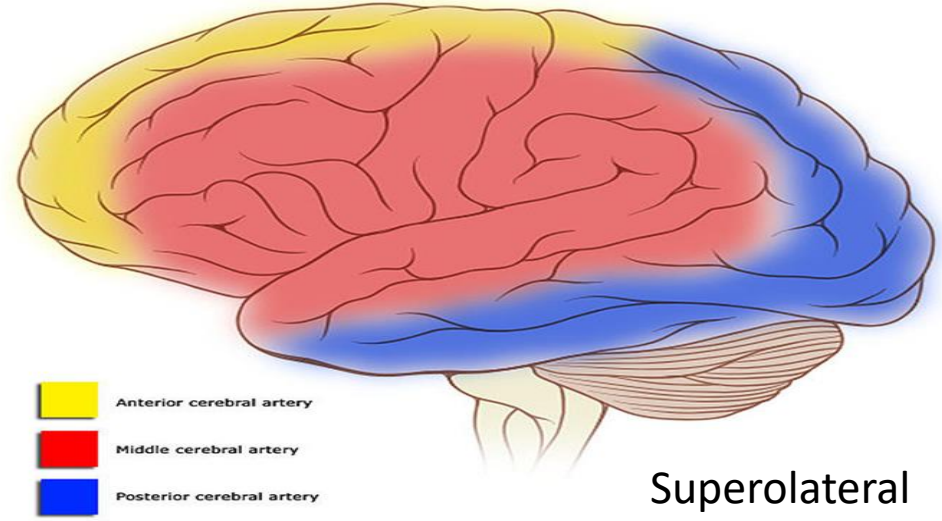
*Except for a narrow part by the ACA, MCA supplies all the motor area except the leg area. (Snell) **except foot and genitals**

Cortical vascular territories



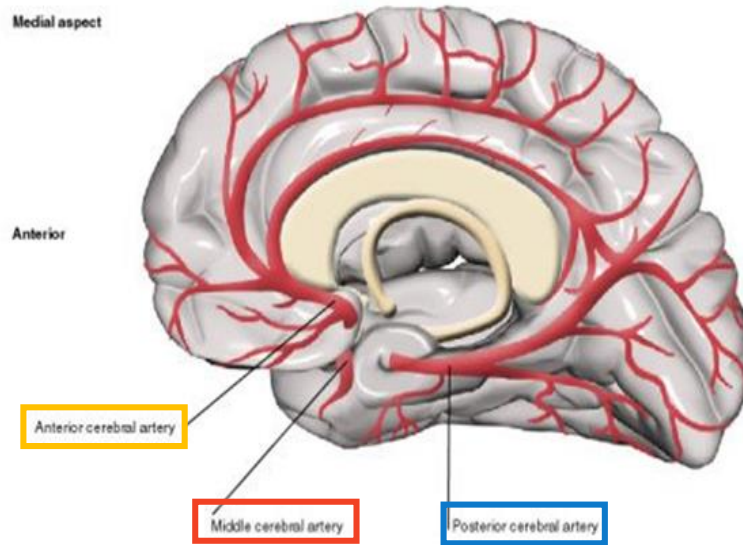
Medial Surface of Cerebral Hemisphere

Cortical vascular territories



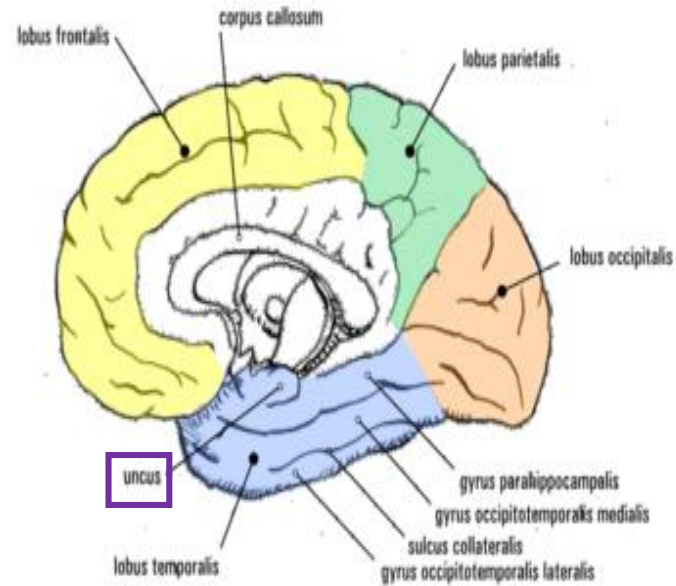
Superolateral Surface of Cerebral Hemisphere

Medial aspect



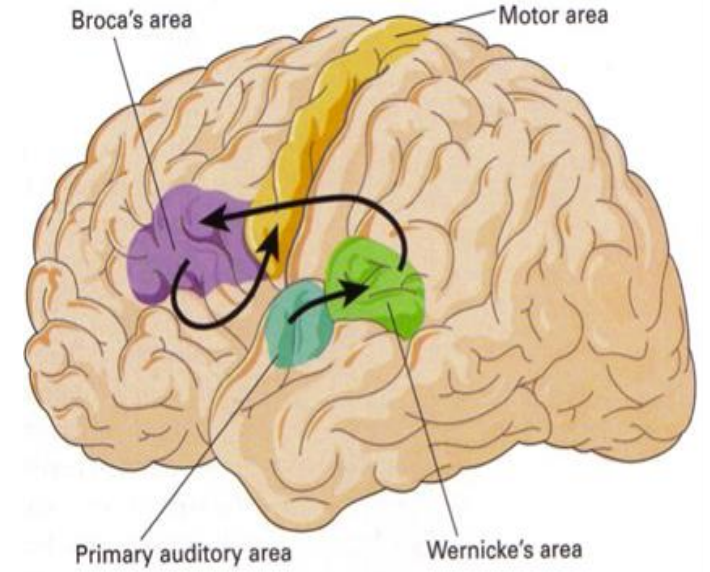
Anterior

Posterior



Broca's area

Motor area

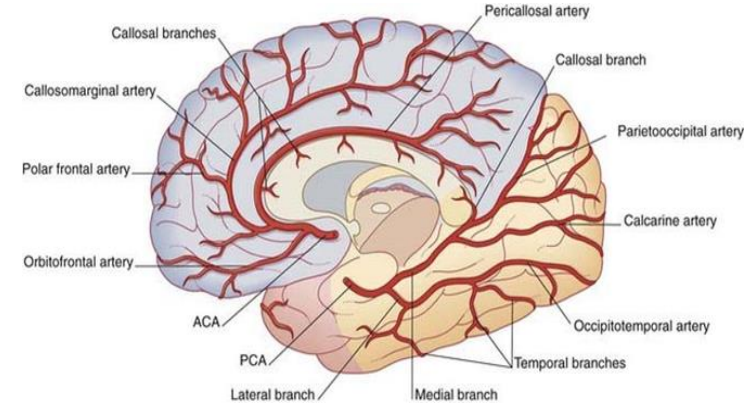


Primary auditory area

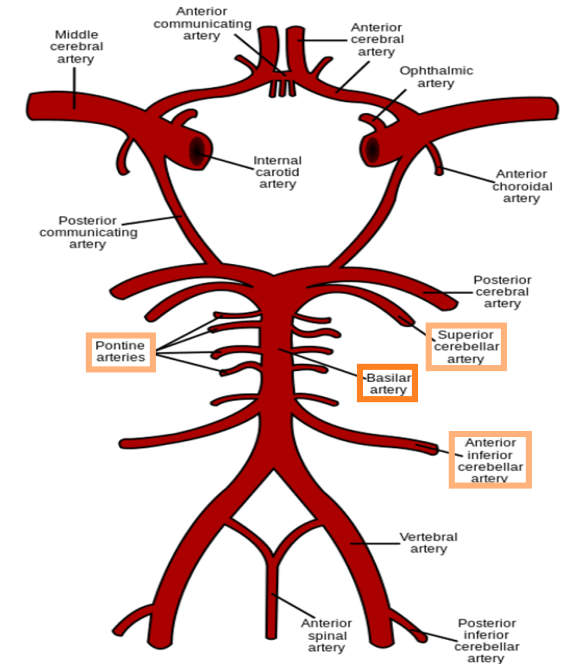
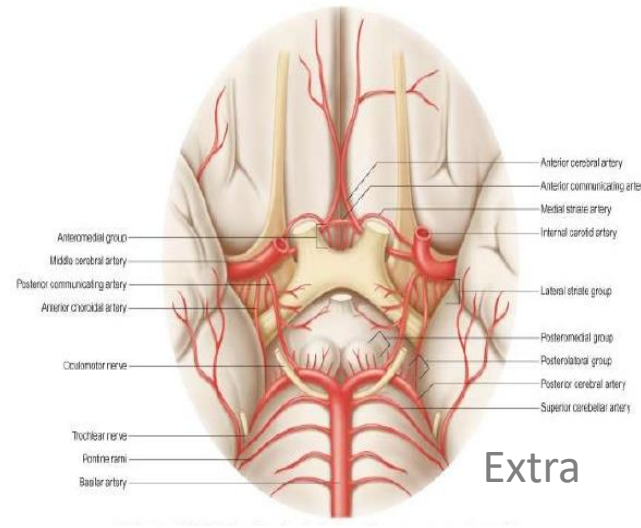
Wernicke's area

Basilar artery

Supplies:	Mid brain and cerebellum
Branches:	<ul style="list-style-type: none"> • Anterior inferior cerebellar artery. • Pontine branches. • Superior cerebellar artery.



- The vertebral arteries unite at the lower border of the pons to form the basilar artery.
- Pontine: related to the pons.
- Its formed by 2 vertebral artery



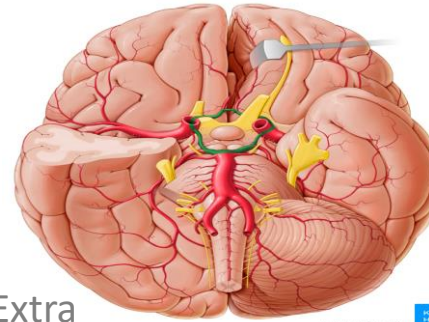
Circulus Arteriosus (Circle of wills*)



Playlist

IMPORTANT

- It **joins** the carotid and vertebrobasilar systems**.
- It is **located** on the base of the brain to supply deep structures
- It **encircles** (surrounds):
 1. Optic chiasma.
 2. Hypothalamus.
 3. Midbrain.
 4. Pituitary gland



Extra

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It is **formed** by:

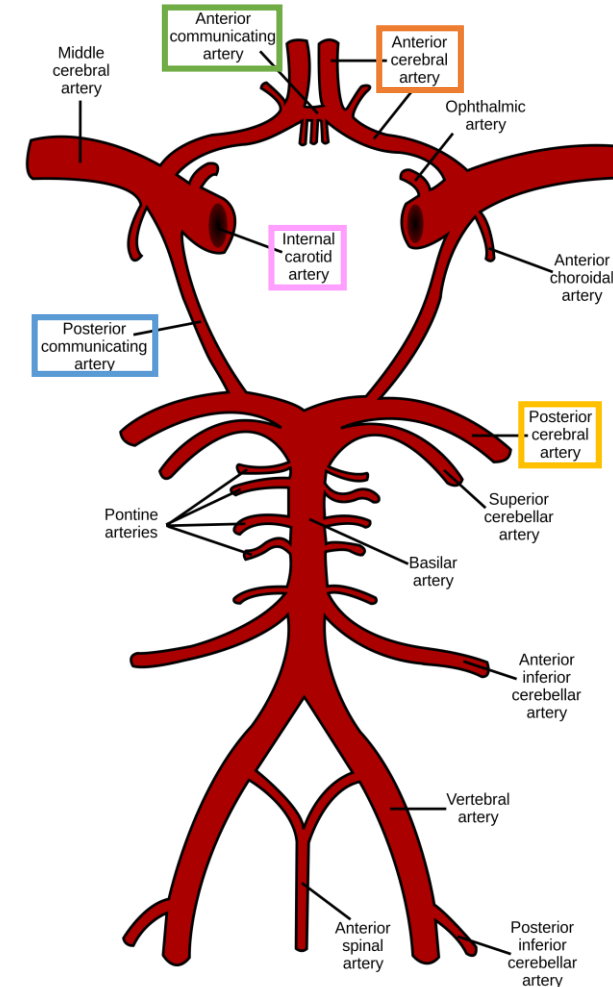
Two **internal** carotid arteries

Two anterior **cerebral** arteries

Two posterior **cerebral** arteries

Two posterior **communicating** arteries

One anterior **communicating** artery

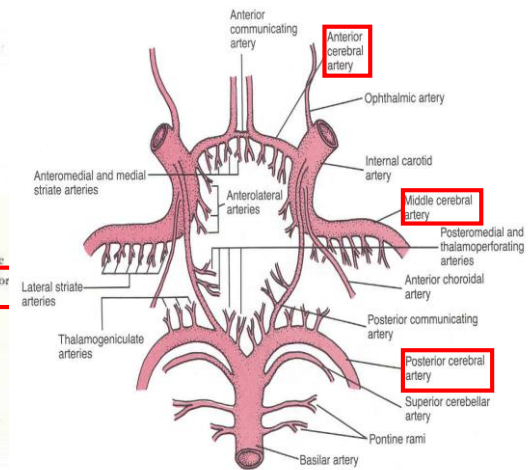
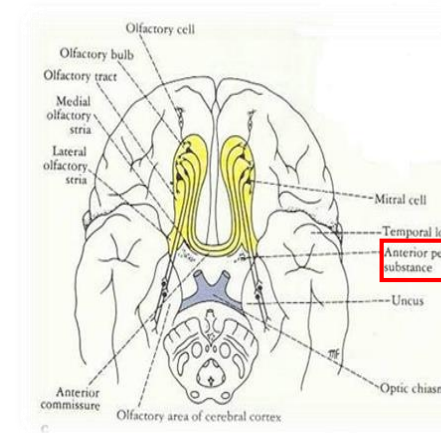


*Named after Thomas Willis (1621–1675), an English physician.

** the circle of Willis is Formed by the anastomosis between the two internal carotid arteries and the two vertebral arteries. (Snell)

Circulus Arteriosus (Circle of wills)

- **Branches:** Perforating arteries numerous small vessels that penetrate the surface of the brain through the anterior and posterior perforating substances.
- They are divided into:



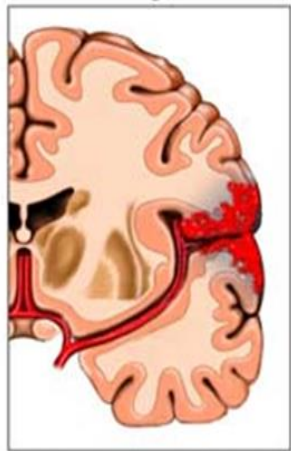
	Anterior Perforating Arteries	Posterior Perforating Arteries
Arise from:	<ul style="list-style-type: none"> • Anterior cerebral artery. • Anterior communicating artery. • Middle cerebral artery. 	<ul style="list-style-type: none"> • Posterior cerebral artery . • Posterior communicating artery.
Enter brain through:	<ul style="list-style-type: none"> • Anterior perforated substance (an irregularly quadrilateral (having 4 sides) area in front of the optic tract and behind the olfactory trigone). 	<ul style="list-style-type: none"> • Posterior Perforated substance. (perforated substance: a layer of grey matter, that is pierced to allow blood vessels to pass)
Supplies	<ol style="list-style-type: none"> 1. Large part of basal ganglia. 2. Optic chiasma. 3. Internal capsule (a white matter structure). 4. Hypothalamus . 	<ol style="list-style-type: none"> 1. Ventral portion of Midbrain. 2. Parts of Subthalamus and Hypothalamus.

Arterial Disorders

Stroke

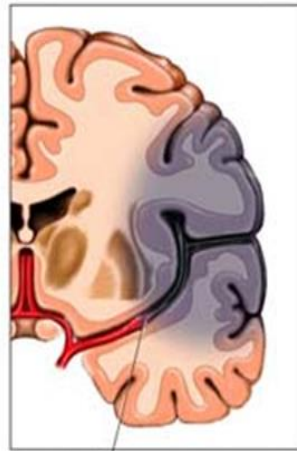
- It happens when blood supply to the brain is interrupted or reduced.
- **Sudden occlusion**
- It can be: **Ischemic** or **hemorrhagic**.

Hemorrhagic Stroke



Hemorrhage/blood leaks into brain tissue

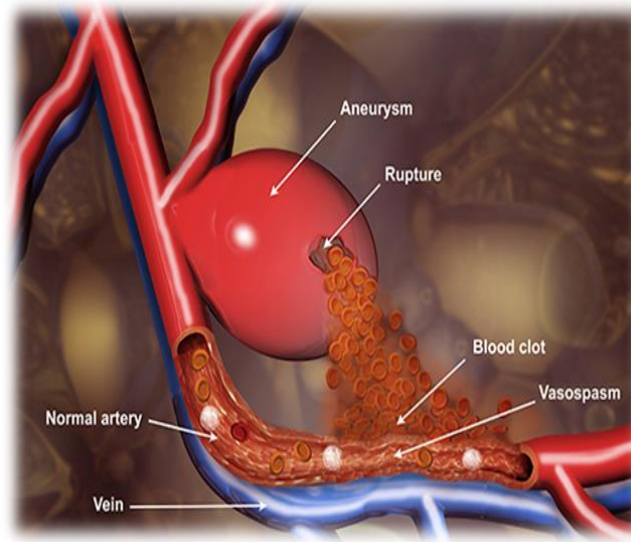
Ischemic Stroke



Clot stops blood supply to an area of the brain

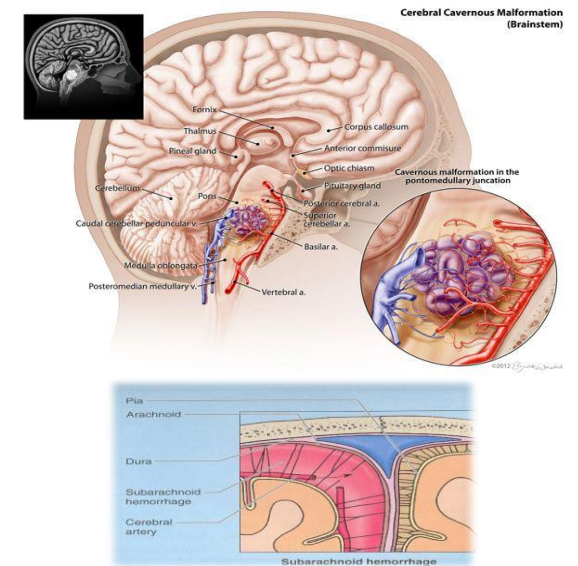
Aneurysm

- localized, blood-filled balloon-like bulge in the wall of a blood vessel.
- Dilation of the wall (may take years)

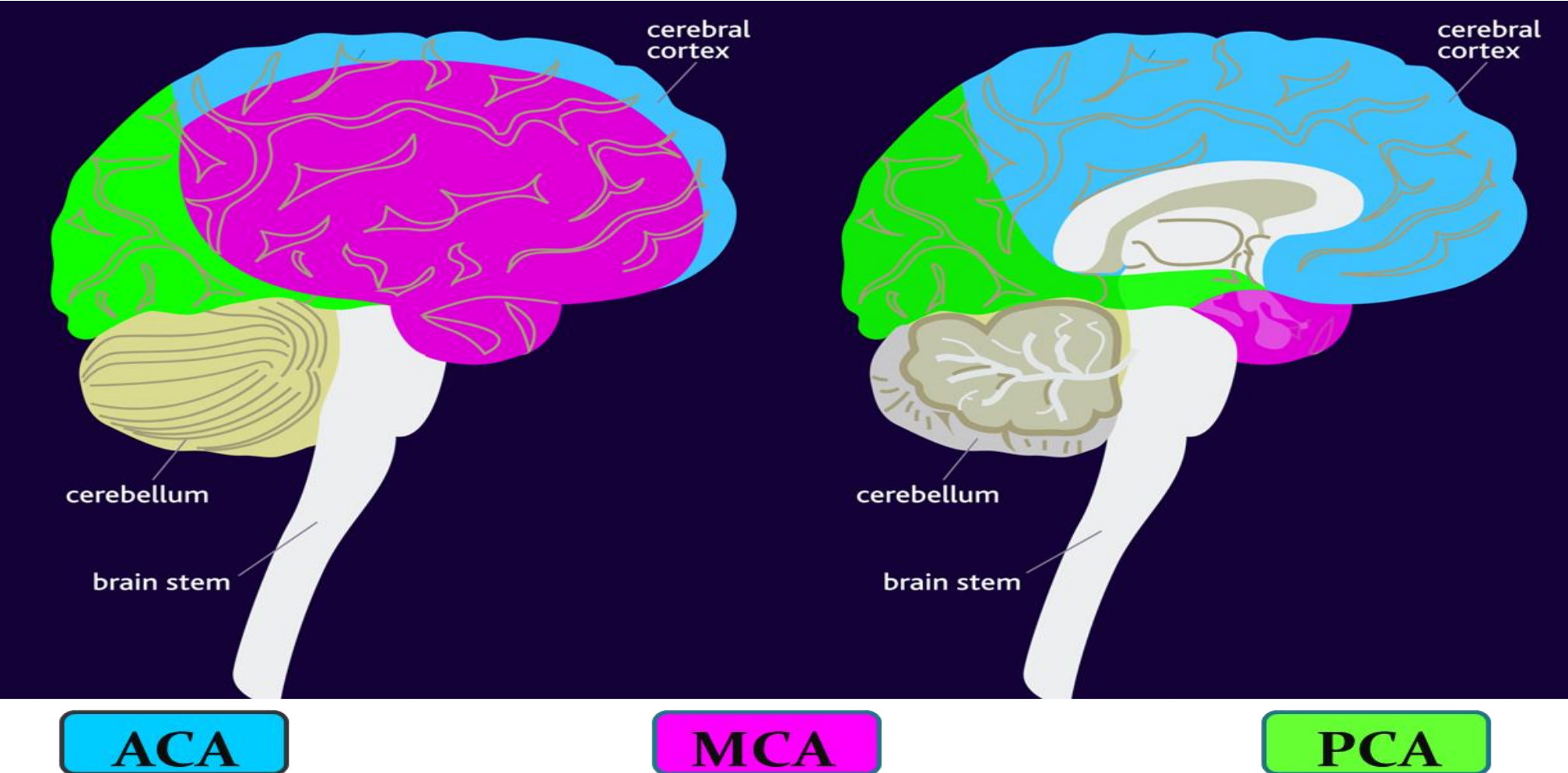


Angioma

- **benign tumors** derived from cells of the vascular or lymphatic vessel walls (epithelium) or derived from cells of the tissues surrounding these vessels.



Effects of Occlusion of Cerebral Arteries

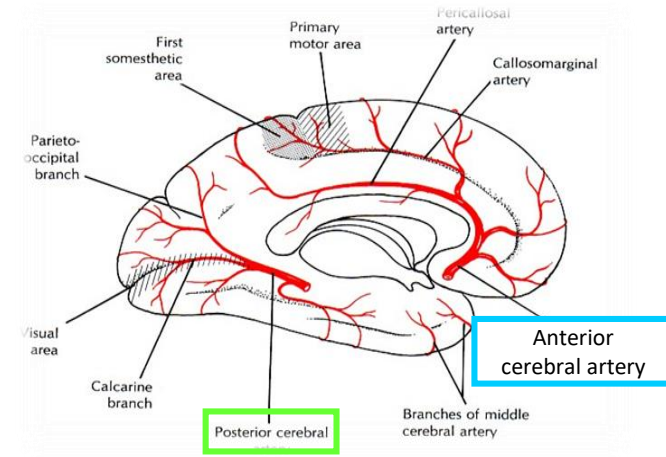
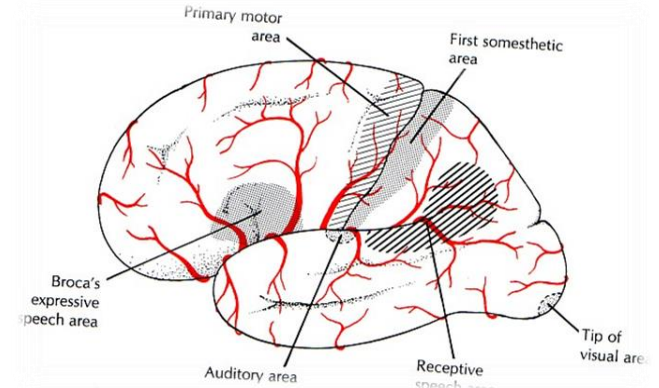


IMPORTANT

Effects of Occlusion of Cerebral Arteries (Manifestations)

(Important may come as scenario)

Artery	Anterior Cerebral Artery (ACA)	Middle Cerebral Artery (MCA)	Posterior Cerebral Artery (PCA)
Effect	1- <u>Motor disturbance</u> in contralateral distal leg 2- Difficulty in prefrontal lobe functions: <ul style="list-style-type: none"> • Cognitive thinking • Judgement • Motor initiation • Self monitoring 	1- Contralateral weakness of: face, arm & hands “more than legs” <ul style="list-style-type: none"> • 2- Contralateral sensory loss of: face, arm, and hands more than legs • Visual field cut (damage to optic radiation) 4- Aphasia (language disturbance): <ul style="list-style-type: none"> • In Broca’s area: production • In Wernicke’s area: comprehension 	1- <u>Visual disturbances</u> : <ul style="list-style-type: none"> • Unilateral lesion: contralateral homonymous hemianopsia • Bilateral lesions: cortical blindness, patients unaware they cannot see (Anton’s Syndrome) 2- Memory impairment : if temporal lobe is affected



Optic radiation: **axons** from the neurons in the lateral geniculate nucleus to the primary visual cortex.

Hemianopsia: decreased vision or blindness in half the visual field.

Homonymous hemianopsia: the loss of half of the visual field on the same side in both eyes (see picture on right).

Cortical blindness: total or partial vision loss because of damage to the occipital cortex.

Extra

Cerebral Venous Drainage

- The veins are thin walled and are devoid of (don't have) valves.
- The cerebral veins are:

I. Superficial cortical veins

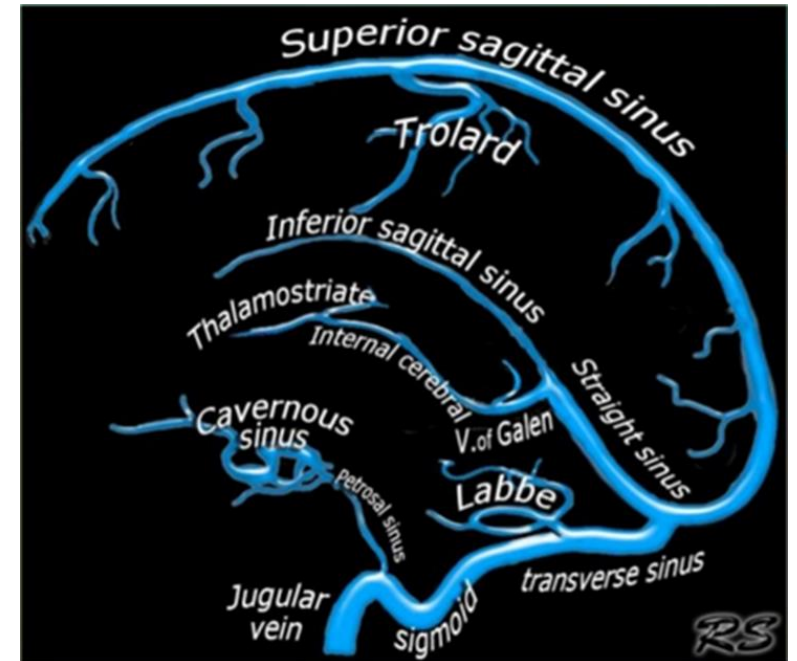
- Found in the subarachnoid space
- Drain the cortical surface

II. Deep veins

- Drain the deep structures

These veins ultimately drain into:

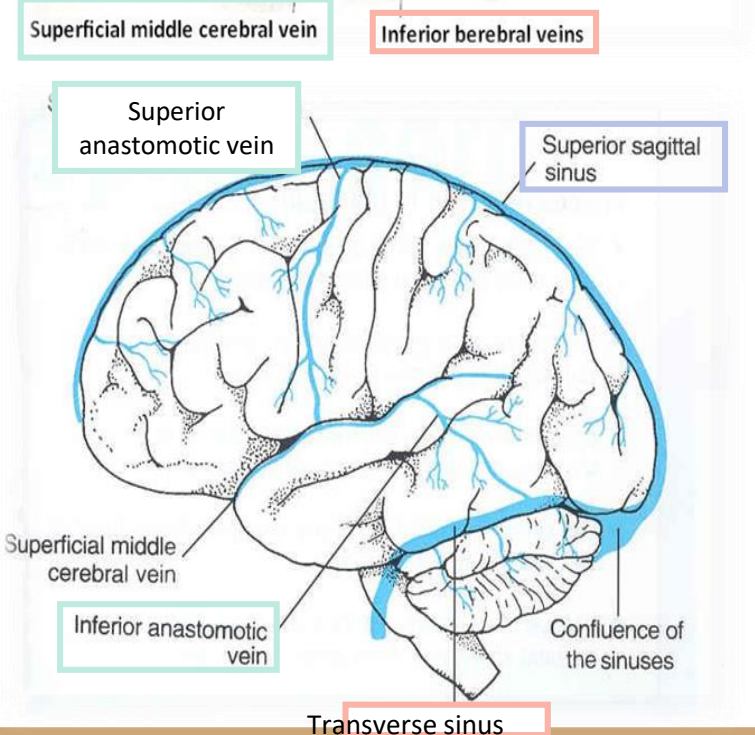
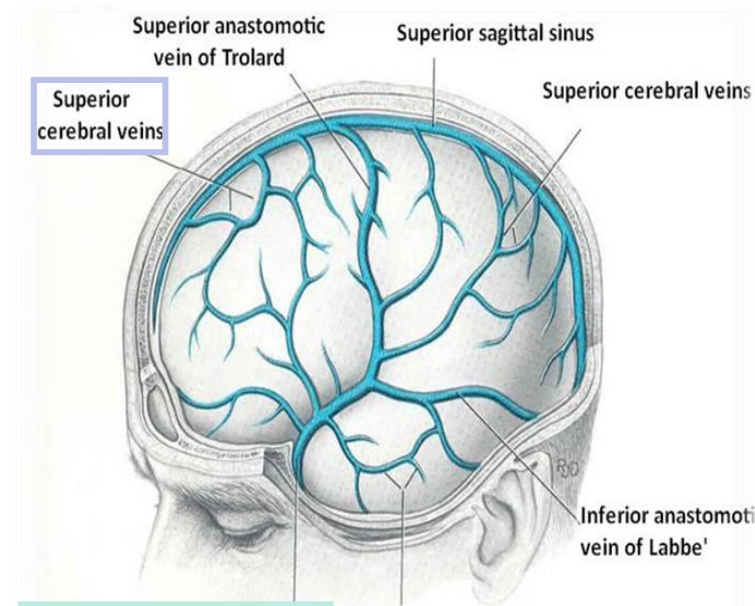
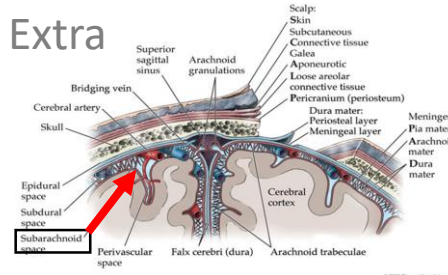
Dural venous sinuses



Cerebral Venous Drainage

I. Superficial Cortical Veins

They lie on the brain surface, in the **subarachnoid space**. They are divided into:



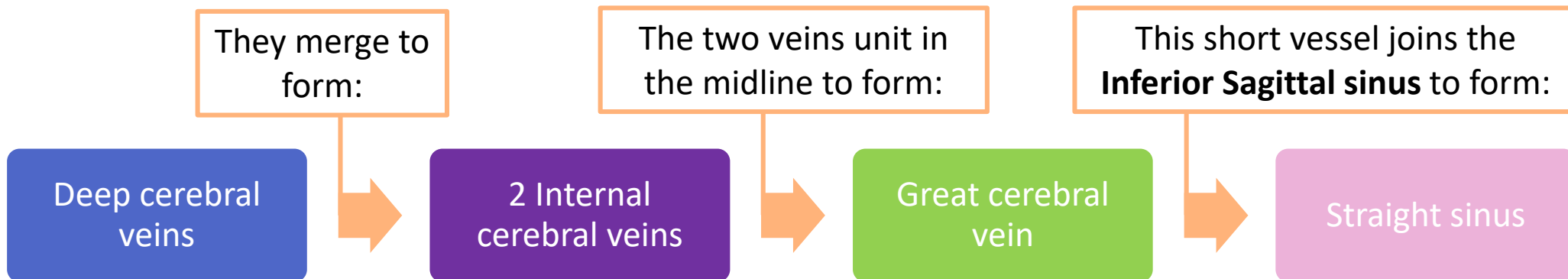
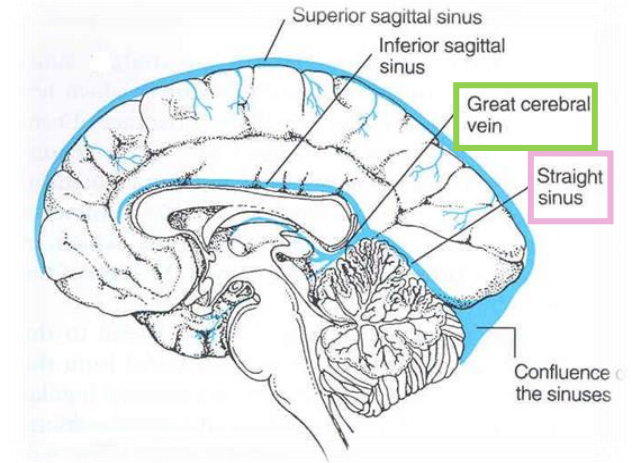
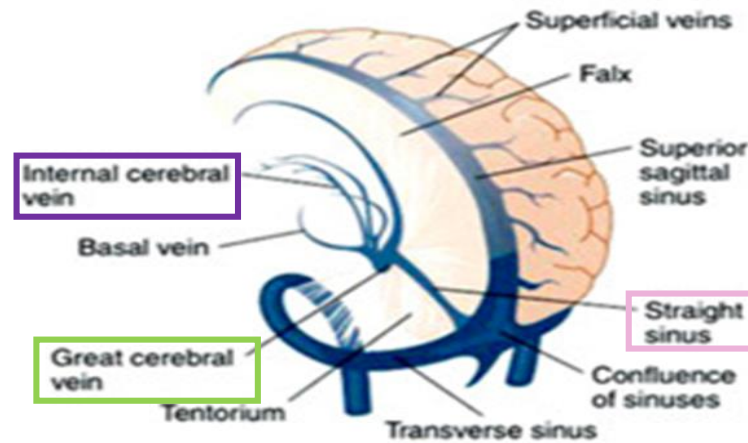
	Course	Termination	Notes
Superior cerebral veins	<ul style="list-style-type: none"> • Drain lateral surface of brain above the lateral sulcus 	<ul style="list-style-type: none"> • Terminate <u>mainly</u> into the Superior Sagittal sinus, and <u>partly</u> into superficial middle cerebral vein 	<ul style="list-style-type: none"> • 6 to 12 veins
Inferior cerebral veins	<ul style="list-style-type: none"> • Run below the lateral sulcus 	<ul style="list-style-type: none"> • Terminate <u>partly</u> into superficial middle cerebral vein & <u>partly</u> into Transverse sinus. 	<ul style="list-style-type: none"> • Drain the lateral surface of the temporal lobe
Superficial middle cerebral veins	<ul style="list-style-type: none"> • Runs along the lateral sulcus 	<ul style="list-style-type: none"> • Terminates into the Cavernous sinus 	<ul style="list-style-type: none"> • Connected posteriorly by Superior & Inferior anastomotic veins to Superior Sagittal & Transverse sinuses respectively

Cerebral Venous Drainage

II. Deep Veins

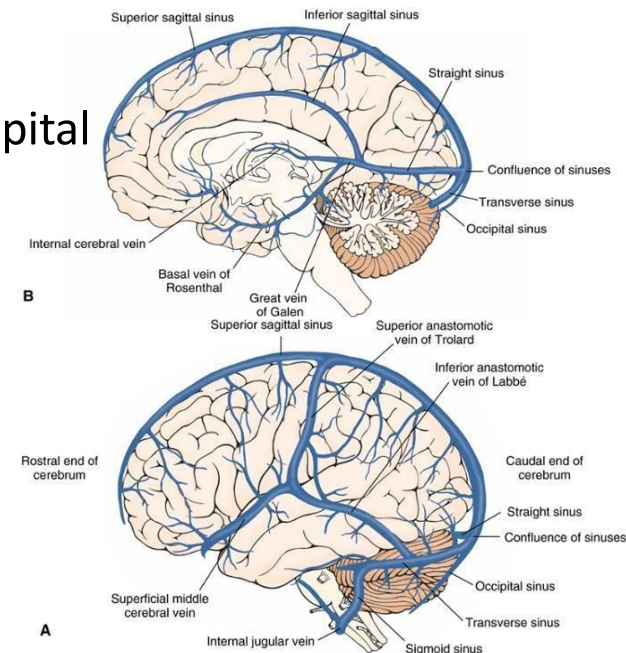
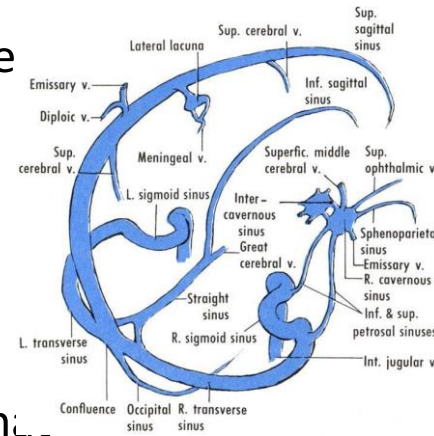
They drain the internal structures:

- Basal ganglia
- Internal capsule
- Thalamus



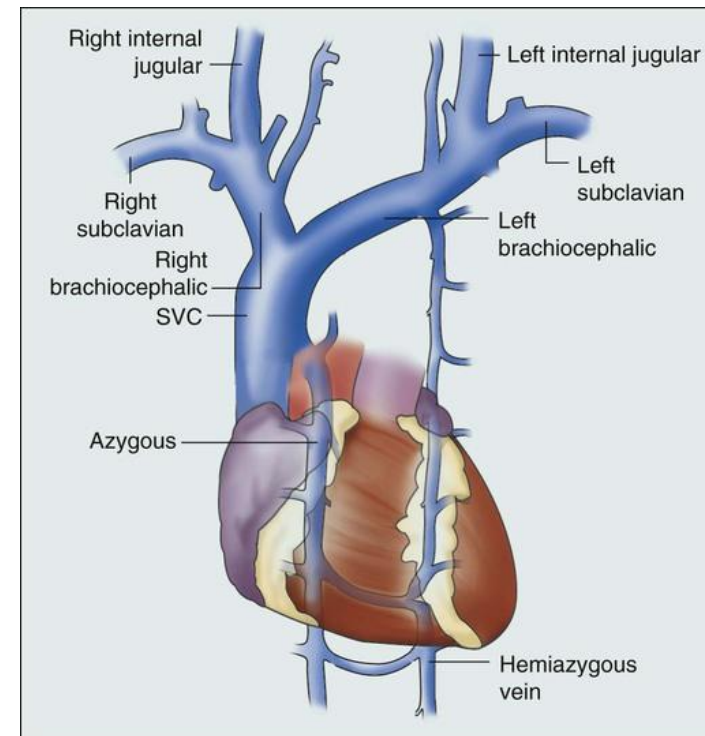
Cerebral sinuses

- **The Superior Sagittal Sinus**
 - Lies along the superior border of the falx cerebri and empties into the confluence of sinuses
- **The Inferior Sagittal Sinus**
 - Lies in the inferior border of the falx cerebri.
 - The great cerebral vein of Galen joins the inferior sagittal sinus to form the straight sinus.
- **The Transverse Sinuses**
 - Originate on each side of the confluence of sinuses.
 - Each transverse sinus travels laterally, and curves downward to form the sigmoid sinus that empties into the internal jugular vein on the same side.
- **The Confluence of Sinuses**
 - At the confluence of sinuses, the superior sagittal, straight, transverse, and occipital sinuses join.
- **The Cavernous Sinuses**
 - Located on each side of the sphenoid bone.
 - Ophthalmic and superficial middle cerebral veins drain into these sinuses.
- **The Sphenoparietal Sinuses**
 - Located below the sphenoid bone and drain into the cavernous sinus.
- **The Sigmoid Sinuses**
 - Receive blood from posterior dural venous sinus veins.



Superior vena cava

- **Formed by the union of the right and left brachiocephalic veins.**
- **Brachiocephalic veins are formed by the union**
- **Of internal jugular and subclavian veins.**
- **Drains venous blood Superior vena cava**
- **from:**
- **Head, neck, thoracic wall & upper limbs**
- **It passes downward and enter the right atrium.**

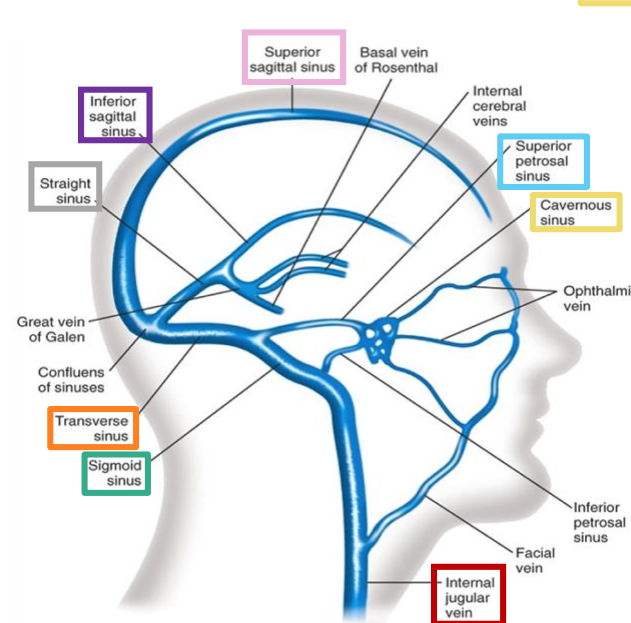
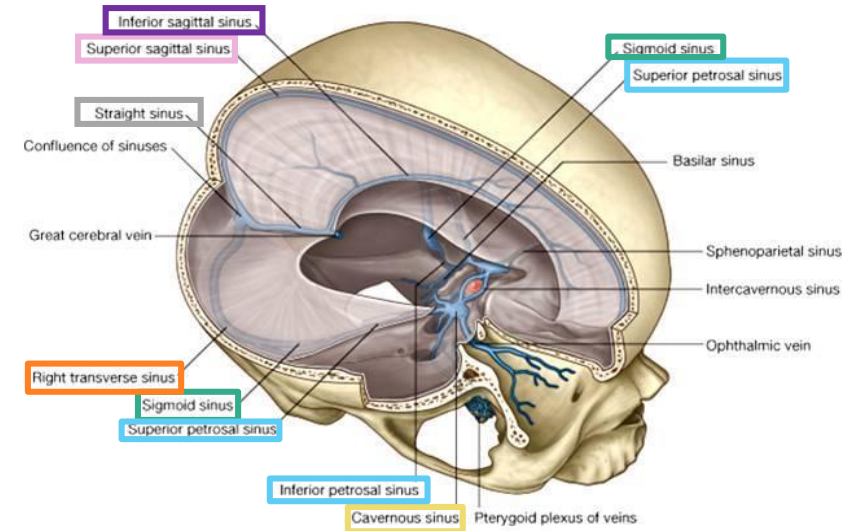


Dural venous sinuses

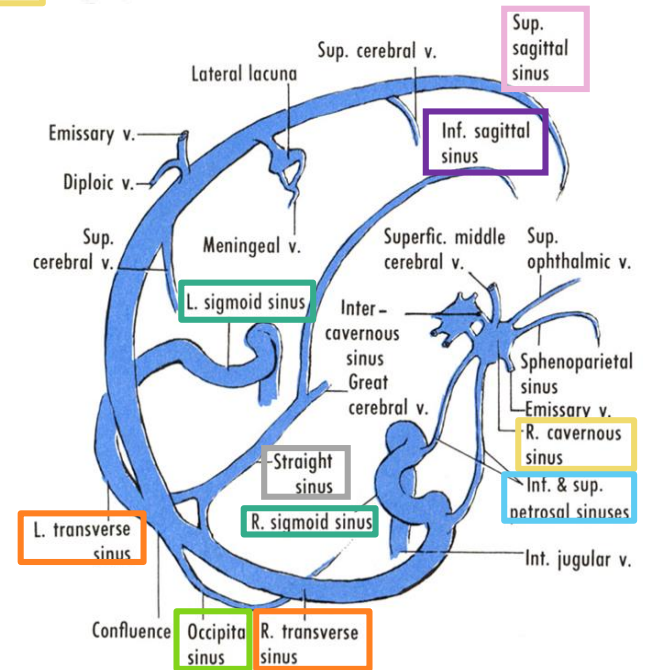
- The dural venous sinuses are grouped into:

Paired: (right & left)	Single:
Transverse	Superior sagittal
Sigmoid	Inferior sagittal
Cavernous	Straight
Petrosal (superior & inferior)	Occipital

- Blood flows from **transverse & sigmoid sinuses** into IJV **Internal Jugular Vein**.



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Venous Disorders

Infarction

- refers to tissue death (necrosis) that is caused by a local lack of oxygen due to obstruction of the tissue's blood supply

Sinus thrombosis

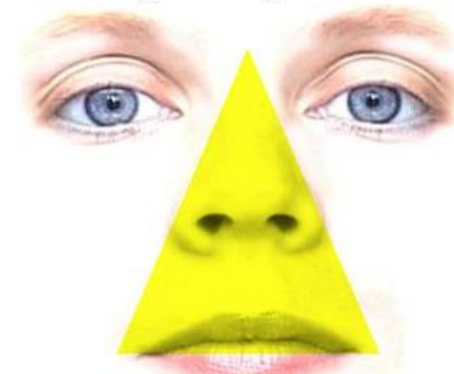
- SSS (superior sagittal sinus) thrombosis*: can complicate ear infection
- Cavernous sinus thrombosis: As a complication of infection in the dangerous area of the face**

- Obstruction of venous drainage of the brain leads to Cerebral swelling (**edema**) and **raised Intracranial Pressure**.

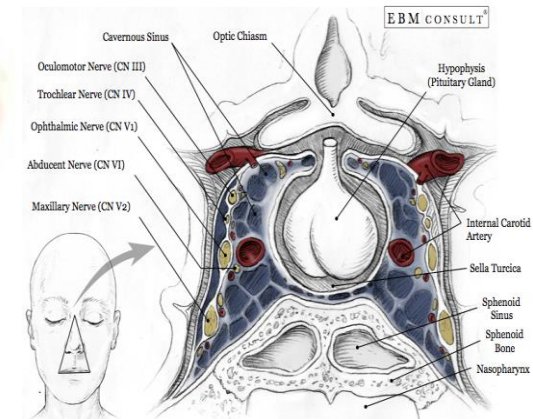
*Superior sagittal sinus thrombosis (SSST) is the most common type of dural venous sinus thrombosis and is potentially devastating



**
Danger Triangle of Face



<http://medchrome.com>



Extra

These 2 videos summarize the lecture:
(to view them download the ppt version)

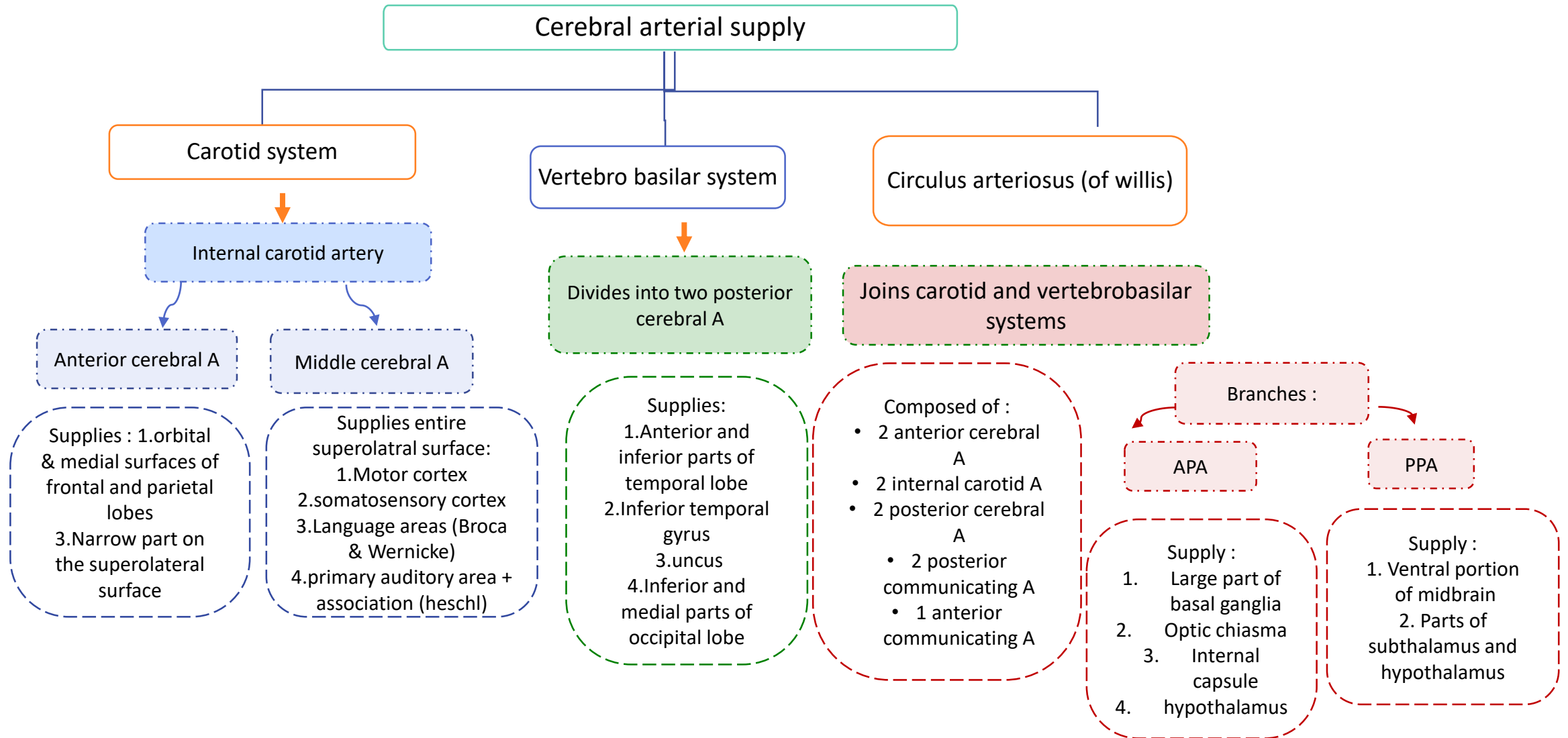


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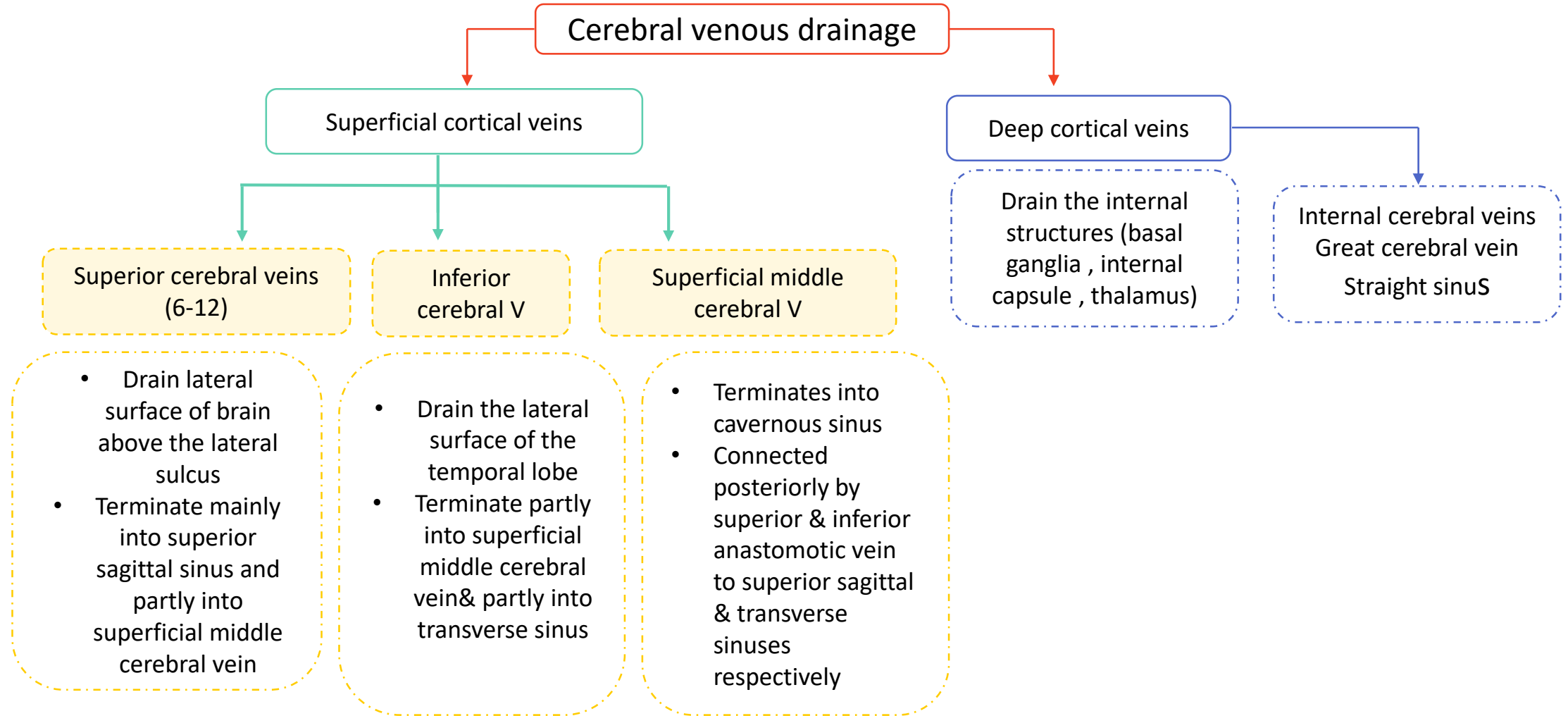


Duration: 01:18

Summary



Summary



MCQs

(1) What does the basilar artery supply?

- A) Mid brain
- B) Cerebellum
- C) A&B
- D) Motor cortex

(2) Which of the following are paired Dural sinuses?

- A) Inferior sagittal
- B) Straight
- C) Cavernous
- D) Occipital

(3) Which of the following is the one of the effects that occur when the posterior cerebral artery is occluded?

- A) Visual disturbances
- B) Language disturbances
- C) Motor disturbance in the contralateral distal leg
- D) Contralateral sensory loss of face

(4) Which of the following supplies the optic chiasma?

- A) Anterior perforating arteries
- B) Posterior perforating arteries
- C) Middle perforating arteries
- D) Anterior cerebral artery

(5) What does the the circle of willis not encircle?

- A) Optic chiasma
- B) Hypothalamus
- C) Midbrain
- D) Cerebellum

(6) Which of the following is not a branch of the basilar artery

- A) Anterior inferior cerebellar artery.
- B) Pontine branches
- C) Superior cerebellar artery
- D) Middle cerebral artery

(7) What do the cerebral veins NOT drain?

- A) Basal ganglia
- B) Internal capsule
- C) Thalamus
- D) Hypothalamus

(8) Which of the following runs below the lateral sulcus:

- A) Superficial cerebral veins
- B) Inferior cerebral veins
- C) Superficial cerebral artery
- D) Inferior cerebral artery


(9) A patient Came to the hospital and his family noticed difference in his personality and he cant make decisions, what is the most likely diagnosis?

- A) Middle cerebral artery occlusion
- B) Superior sagittal sinus
- C) Thrombosis anterior cerebral artery
- D) Right temporal and right nasal Fibers

(10) Blood filled bulge in the wall of a blood vessel?

- A) Stroke
- B) Aneurysm
- C) Angioma
- D) Sinus thrombosis

Answers



(1) C

(2) C

(3) A

(4) A

(5) D

(6) D

(7) D

(8) B

(9) C



(10) B

(1) From which arteries do the anterior perforating arteries arise from,

- Anterior cerebral artery
- Anterior communicating artery
- Middle cerebral artery

(2) Which parts do the posterior perforating arteries supply?

- Ventral portion of Midbrain
- Parts of Subthalamus and Hypothalamus

(3) A 35 year old man came to the hospital complaining of impaired memory and cortical blindness.

(A) Which cerebral artery is affected?

Posterior cerebral artery

(B) Which side is most likely affected?

Bilateral lesion (affecting both sides) which will lead to Anton's syndrome



Good luck
Special thank for team436 ❤️

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Abdulrahman Alduhayyim
Rinad Alghoraiby
Rawan Mishal**

- References:
 1. Girls' & Boys' Slides
 2. Greys Anatomy for Students
 3. TeachMeAnatomy.com

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