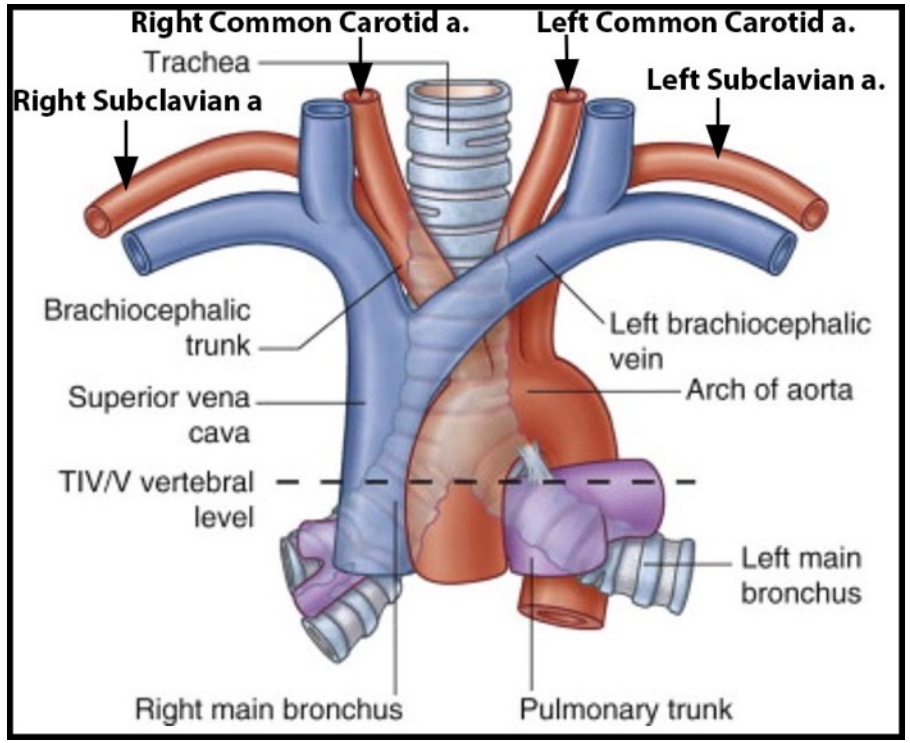
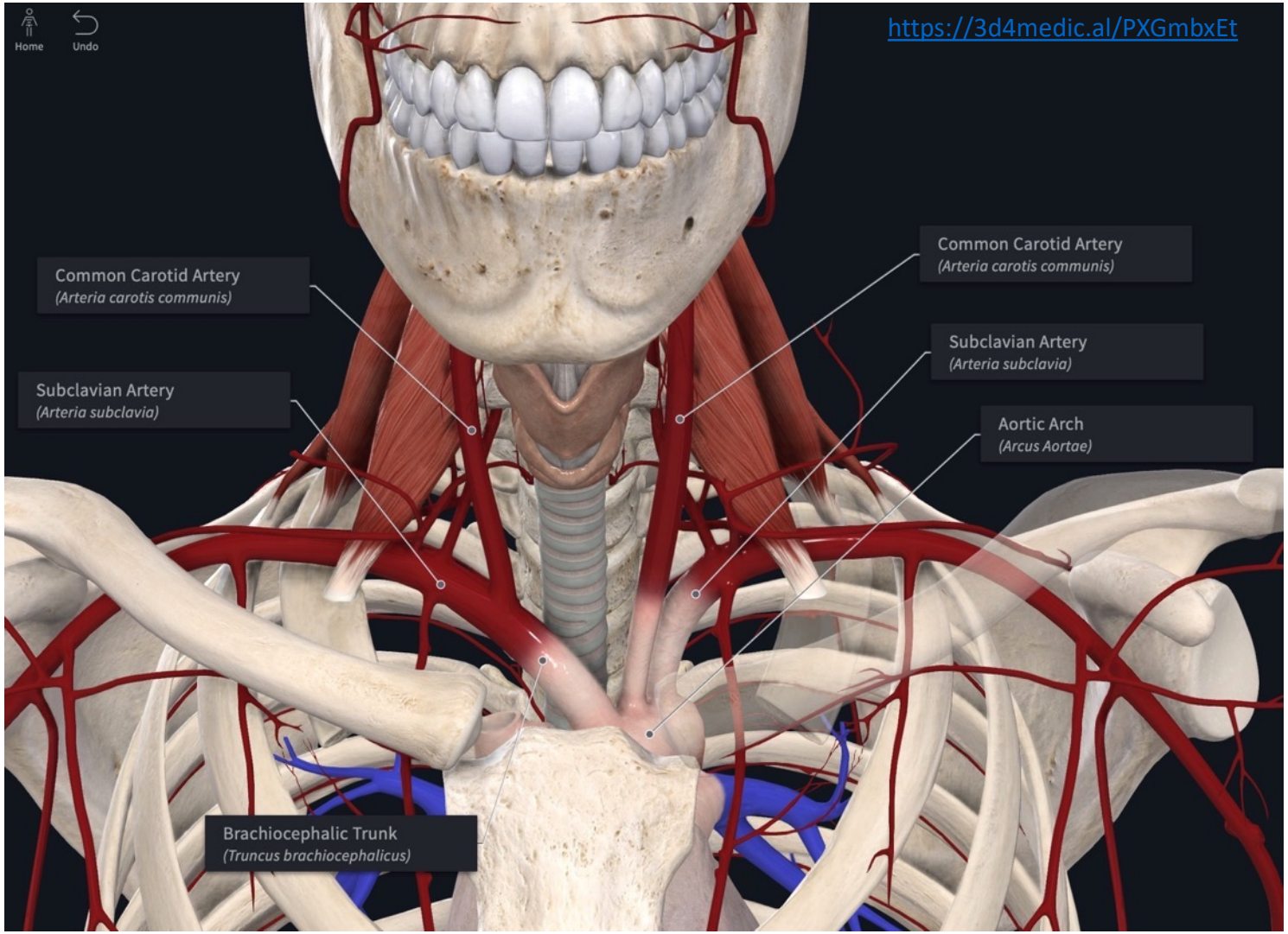
MBB Lab 2, Part B
Dural Folds, Dural Sinuses, and Arterial Supply to Head and Neck

Aortic Arch Branches Supplying Blood to Head and Neck (Review)

The head and neck receive their blood supply from branches of the **right and left common carotid** and **right and left subclavian arteries**.

- On the right side of the body, the subclavian and common carotid arteries are branches of the **brachiocephalic trunk**.
- On the left side of the body, each artery branches directly from the **arch of the aorta**.





Carotid Arteries (Review)

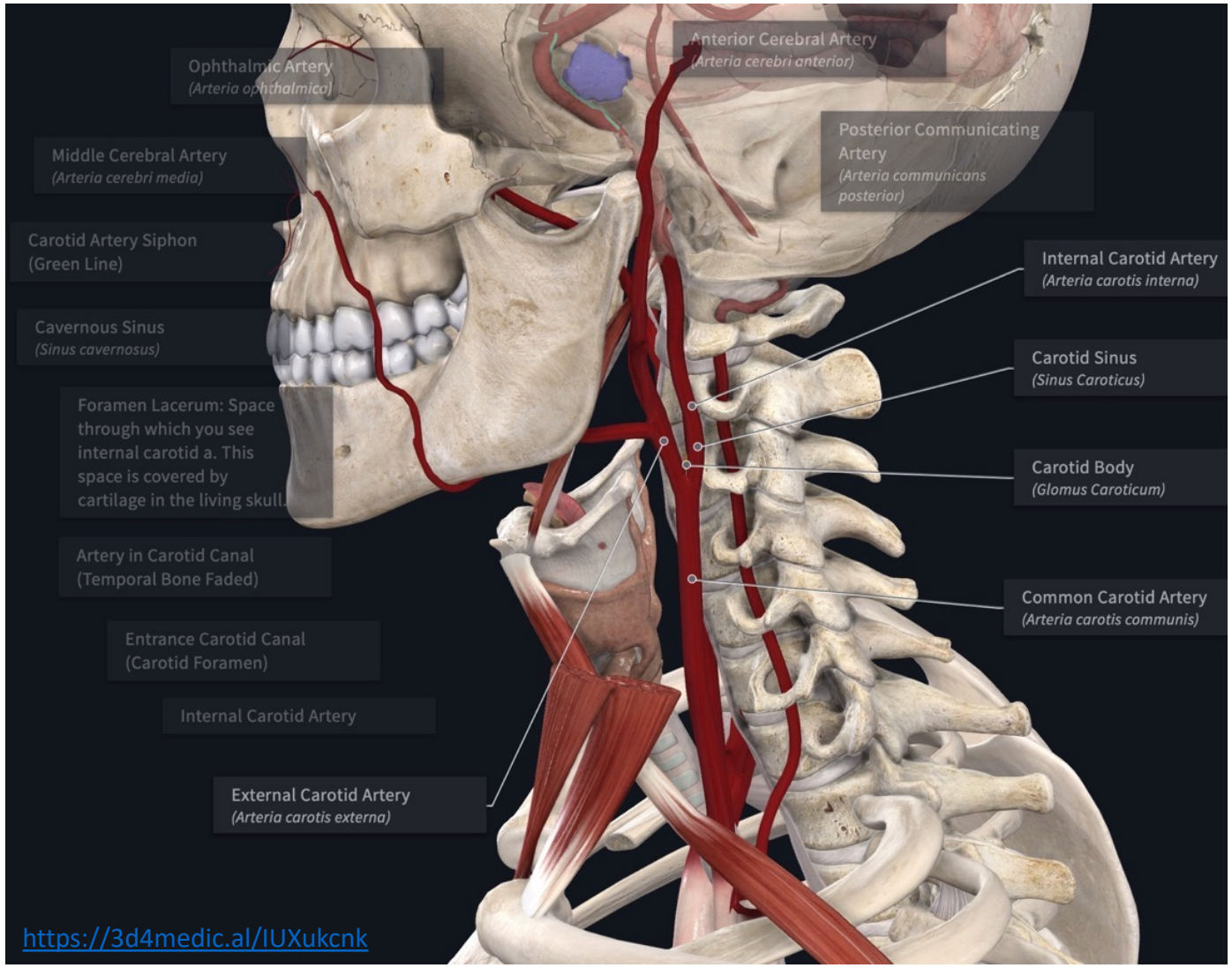
On each side of the neck, the **common carotid arteries** ascend in the neck where they divide into external and internal carotid arteries at the **carotid bifurcation**. The carotid bifurcation typically occurs slightly superior to the to the **upper border of the thyroid cartilage** (approximately at the vertebral level C3 or C4)

- The posterior aspect of the carotid bifurcation consists of an area known as the **carotid body.**
  - This small area is densely populated by chemoreceptors that are sensitive to the partial pressure of O_2 (primarily) and CO_2 in the blood.
  - The wall of the carotid body is innervated primarily by the glossopharyngeal nerve.

- The **external carotid artery** gives off 8 branches that supply the neck, face, and scalp. These branches will be detailed in an upcoming slide.

- **Internal carotid artery** (next slide)
  - The **carotid sinus** is a dilation at the beginning of the **internal carotid artery.**
    - It contains numerous receptors that are sensitive to changes in arterial blood pressure (*baroreceptors*).
    - The carotid body chemoreceptors are innervated primarily by the glossopharyngeal nerve

  - The internal carotid artery ascends in the neck to enter the cranial cavity. The path of the internal carotid artery into, and through the skull, is outlined is outlined on the next slide.

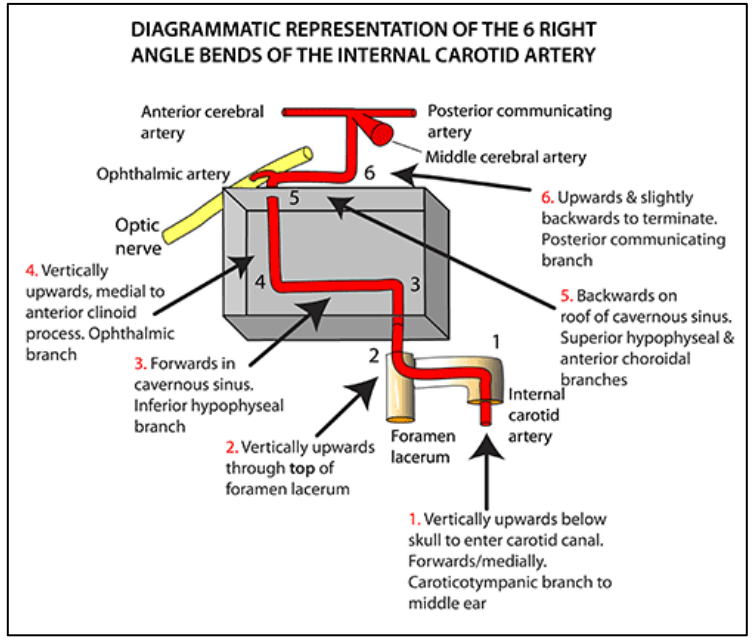


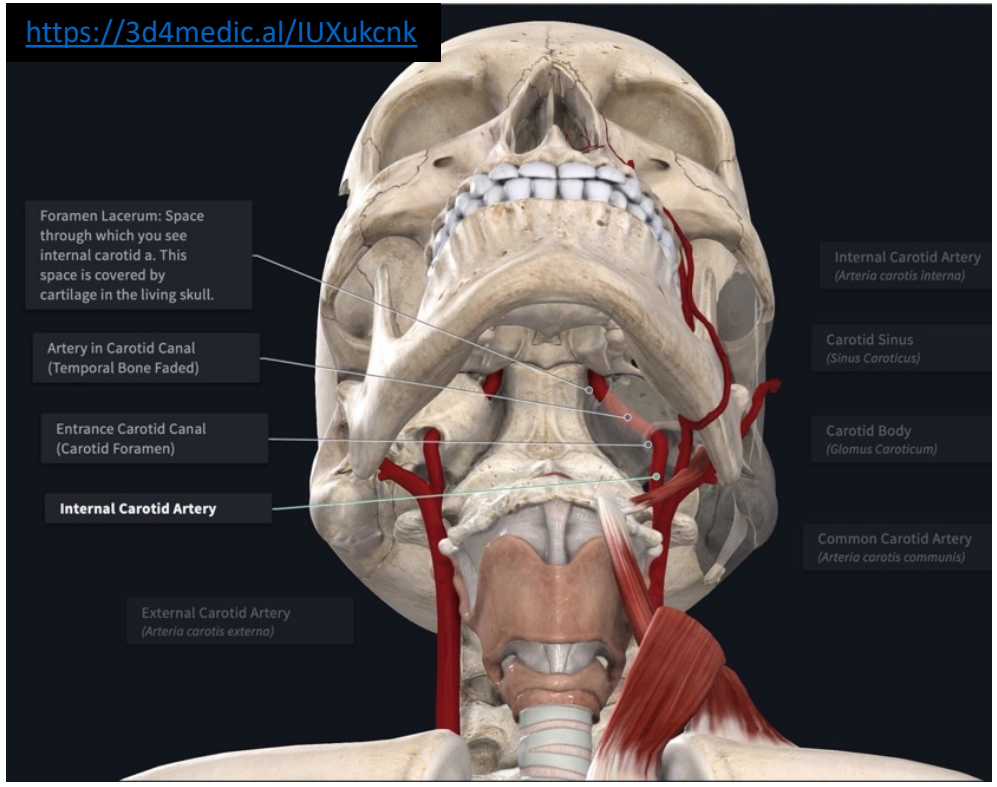
Internal Carotid Artery (Review)

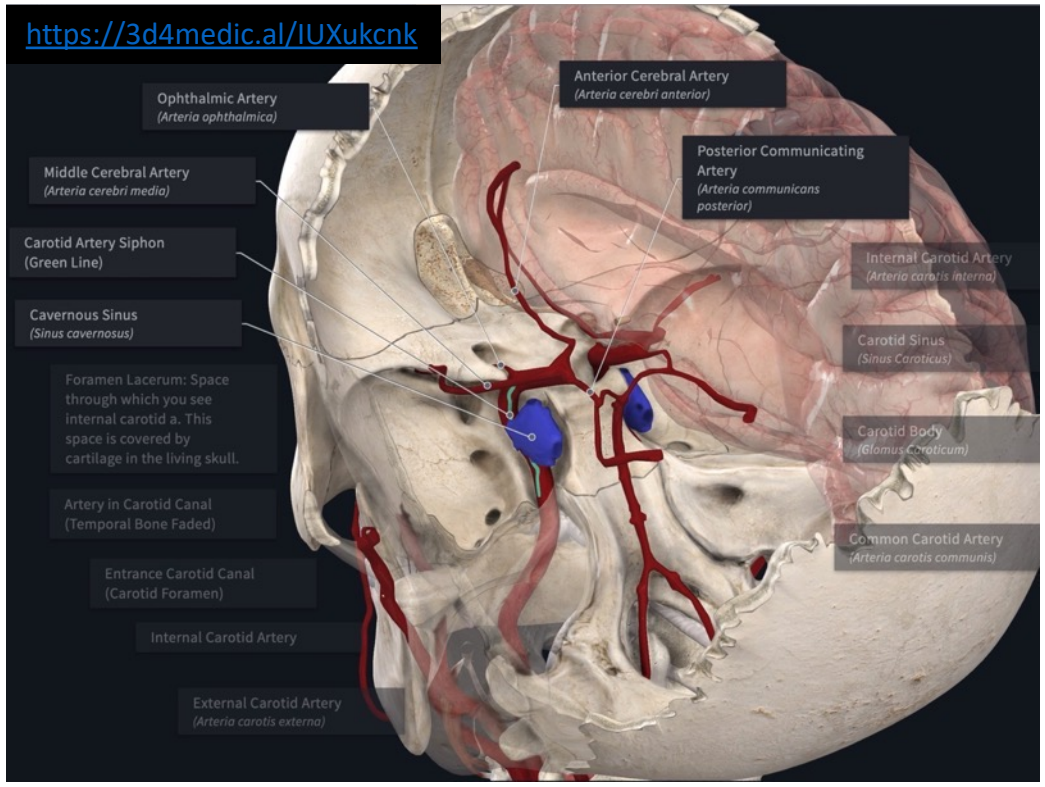
[Moyer PRL: Path of Internal Carotid Artery (Panopto)]

On the inferior side of the skull, the internal carotid artery enters the **carotid canal,** which is a passageway through the **temporal bone**. The opening into the carotid canal is sometimes referred to as the carotid foramen, but this isn't considered an accepted anatomical term.

- Intracranial path of **internal carotid artery** (The path of the internal carotid artery will be revisited in Lab 5.
  - The artery passes through the **carotid canal** in an anterior and medial direction.
  - After exiting the **carotid canal**, it crosses through the superior region of the **foramen lacerum**. (Note that the foramen lacerum isn't a foramen in the living skull because its inferior margin is covered by cartilage.) The internal carotid artery courses superior to the cartilage covering the **foramen lacerum's** inferior opening.
  - It then enters the **cavernous sinus** where it makes a characteristic S-shaped bend, which is referred to as the **siphon** of the internal carotid artery. The artery then emerges from the **cavernous sinus** near the optic nerve. It is now anterior relative to where it entered the **cavernous sinus**. After exiting the **cavernous sinus**, the **internal carotid artery** forms its fist intracranial branch, which is the **ophthalmic artery** that passes through the optic canal.



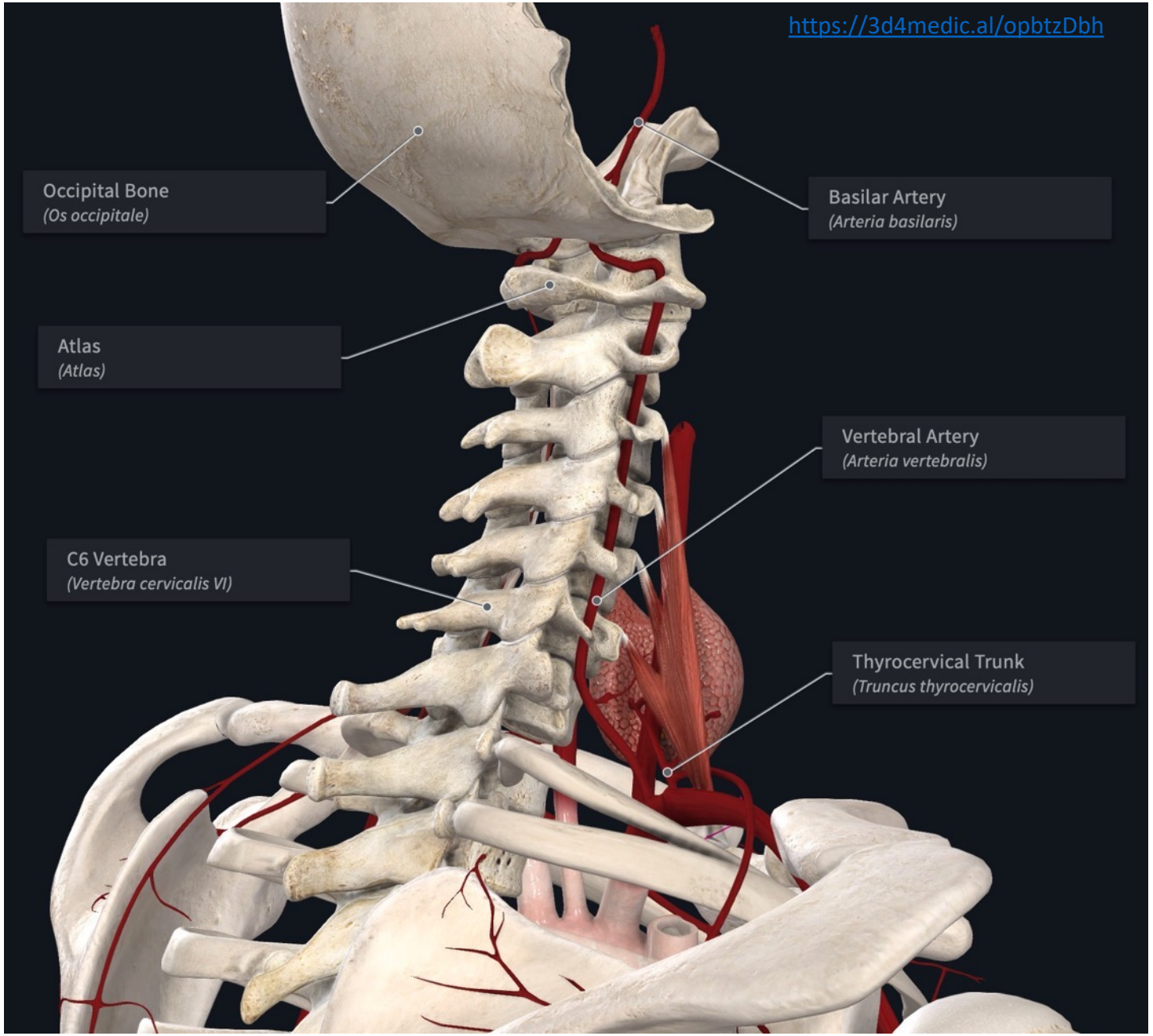




Vertebral Artery (Review)

The Vertebral Artery is the first branch of the **subclavian artery.**

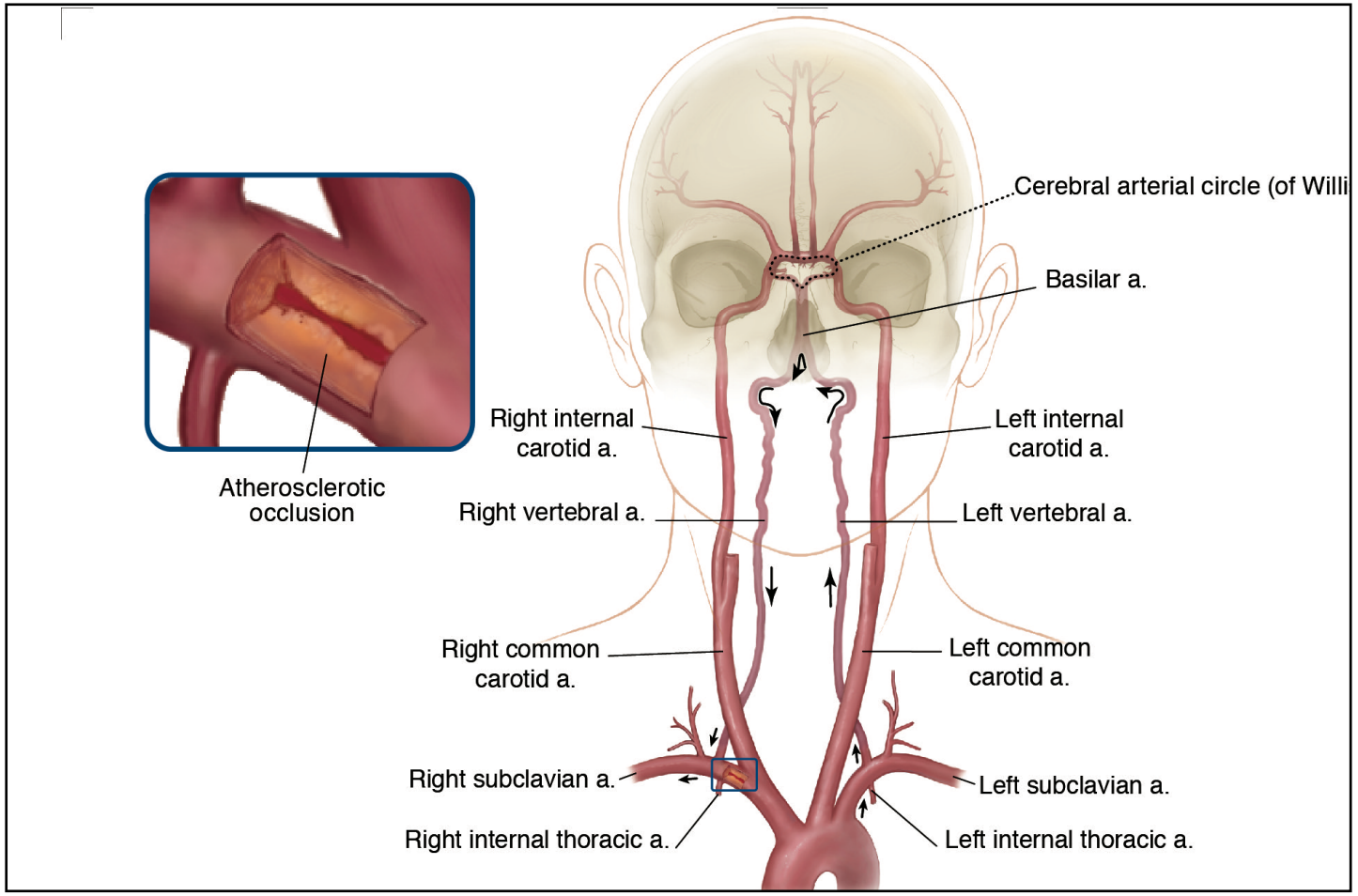
- It ascends in the root of the neck to enter the transverse foramen of the C6 vertebra.
- It continues to ascend the neck through the remaining transverse foramina (during which it gives off spinal and muscular branches).
- After exiting the transverse foramen of C1 (atlas), it curves medially to pass along the superior surface of atlas' posterior arch.
- It then turns superiorly to enters the cranium via the **foramen magnum**.
- Upon entering the **cranial cavity** it ascends on the brainstem where it gives off branches to supply the spinal cord, medulla and cerebellum. At the lower border of the pons, the right and left **vertebral arteries** join the form the **basilar artery**.



Subclavian Steal Syndrome

CLINICAL ANATOMY: Subclavian steal syndrome *may* occur when one subclavian artery is stenotic (narrowed) *proximal* to the origin of vertebral artery. To maintain blood flow into the areas distal to the stenosis, the following can occur.

- Blood in the vertebral artery on the opposite side of the stenosis flows in a retrograde direction upon entering the basilar artery.
- This retrograde flow allows blood to enter the vertebral artery on the side of the stenosis, which ultimately maintains perfusion distal to the site stenosis in the subclavian artery. As a result of this retrograde flow in the vertebral artery, the following occurs.
    - Blood flow is maintained to the upper extremity on the side of the stenosis, but blood pressure is reduced.
    - Blood flow to the brain is reduced, which induces brain ischemia and neurological symptoms.

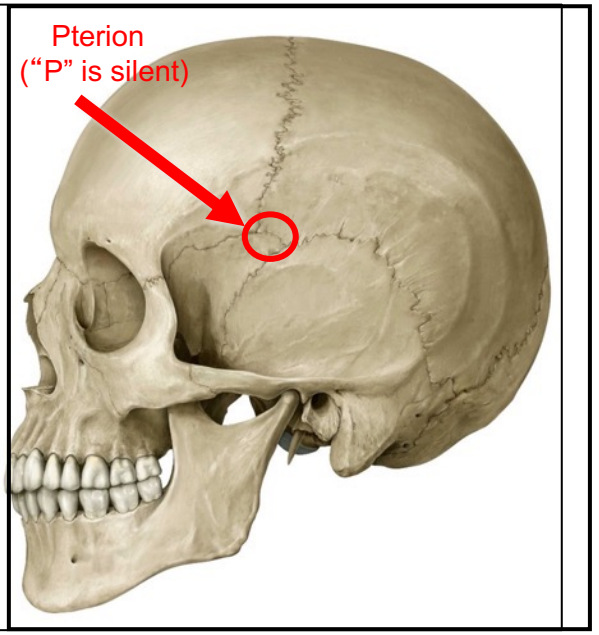


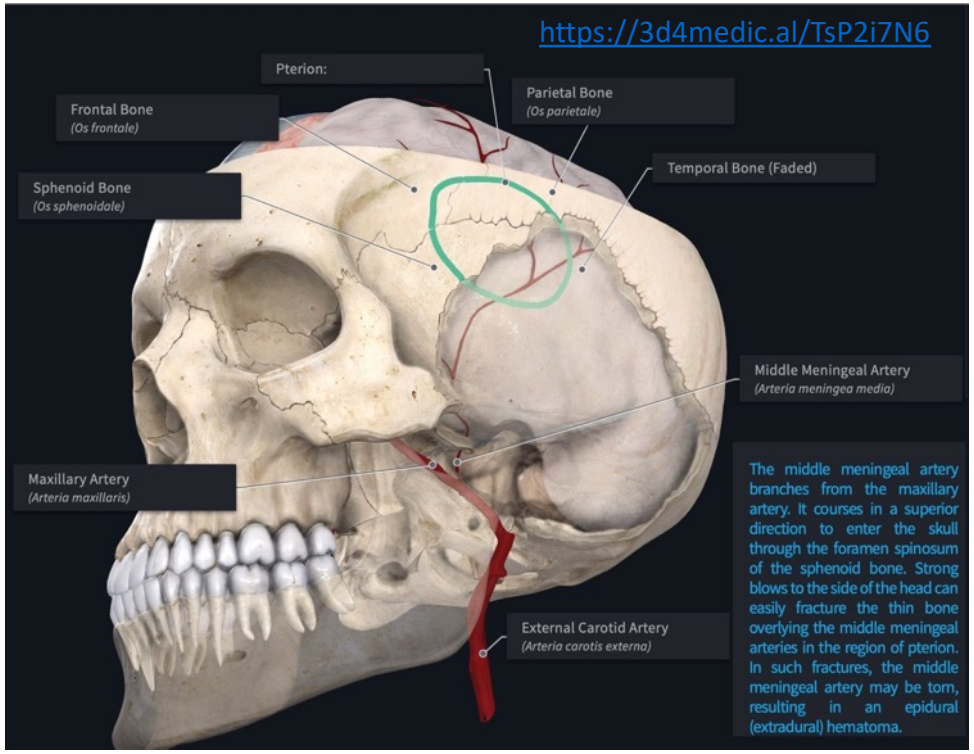
Middle Meningeal Artery

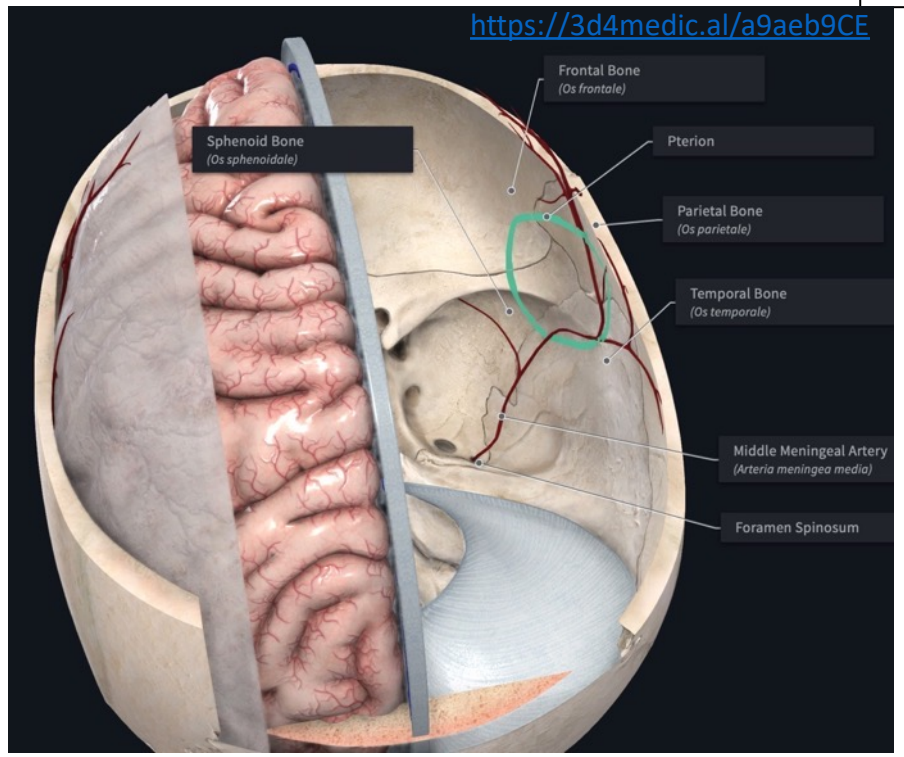
The **middle meningeal artery is the** largest vessel supplying blood to the dura.

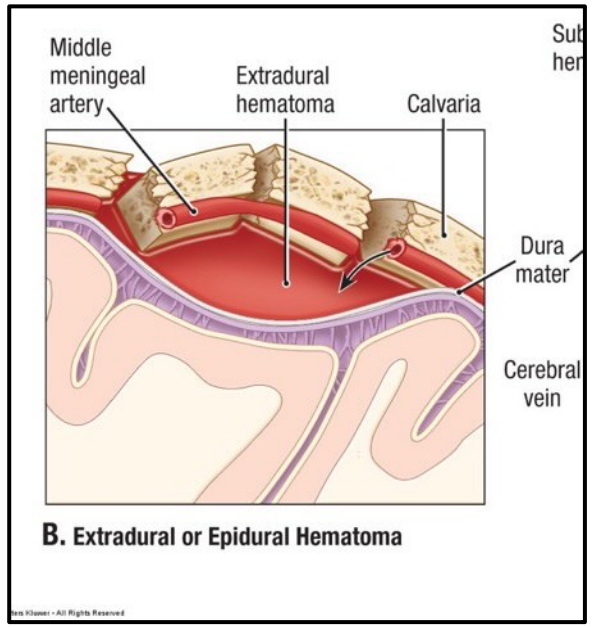
- It is a branch of the **maxillary artery** (branch of **external carotid artery).**
- It enters the middle cranial fossa of the cranial cavity through the **foramen spinosum** of the **sphenoid bone**.
- In the cranial cavity, it courses laterally within the dura and then turns in a supero-anterior direction to pass along the the greater wing of the sphenoid bone at the **pterion**. The pterion is the location where the sphenoid, frontal, parietal, and temporal bones all join to each other.

CLINICAL ANATOMY: The bone in the area of the pterion is particularly thin and overlies the anterior division of the middle meningeal artery. Strong blows to the side of the head can easily fracture the thin bone in the region of the pterion. In such fractures, the **middle meningeal artery** may be torn, resulting in arterial blood flowing into the **epidural space** causing an **epidural (extradural) hematoma.**



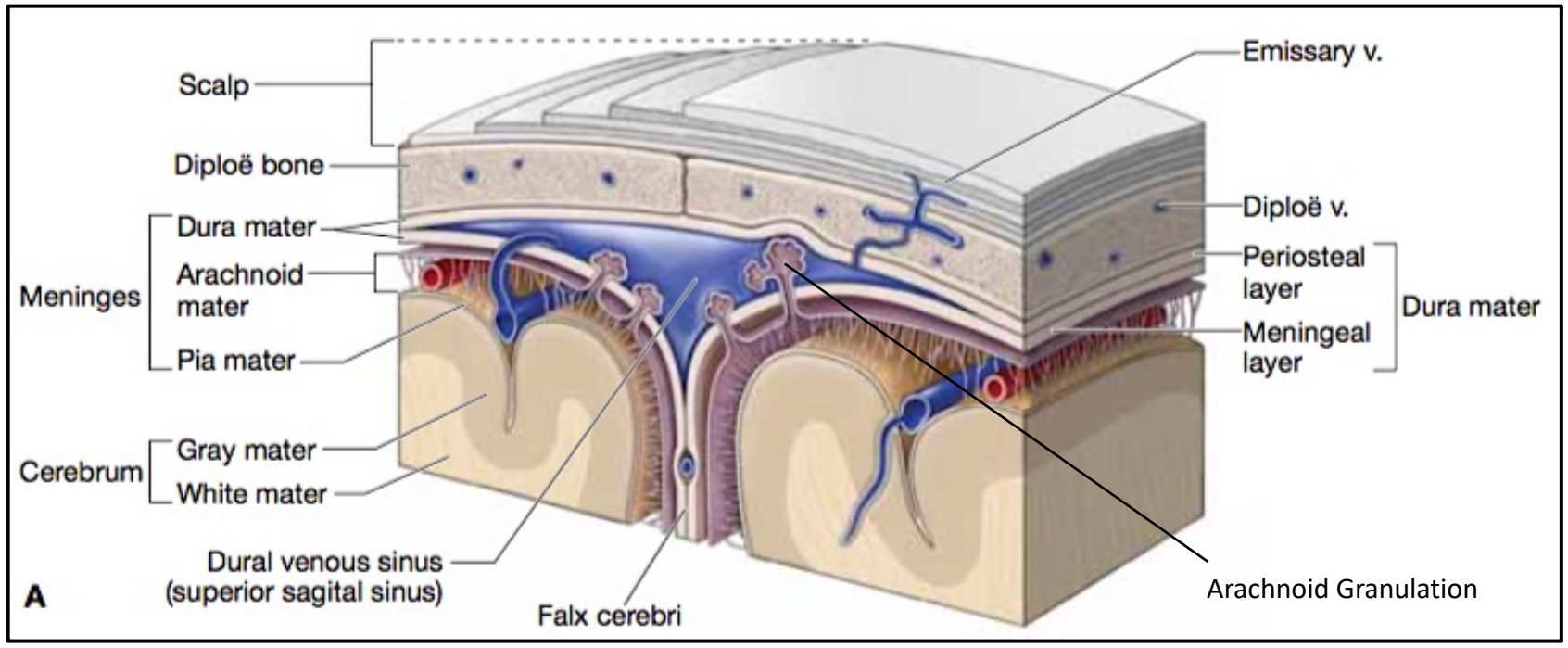






Meningeal Layers & Spaces

- The **dura mater** (from Latin meaning “tough mother”) is the thickest connective tissue layer surrounding the CNS. In the cranial cavity it consists of two layers: periosteal dura and meningeal dura (more details on the next slide).
- Since the periosteal layer is adhered to the bone of the cranial cavity as the bone’s periosteum, the **epidural space** within the cranial cavity is a potential space between the bone of the cranial cavity and the dura mater. This is in contrast to the epidural space of the vertebral canal, which is a real space. Since the middle meningeal artery courses through the epidural space, disruption of the vessel wall can lead to blood accumulation in the epidural space (epidural hematoma).
- The **subdural space** is a potential space between the dura mater and the arachnoid mater. Bleeding into this space results in a subdural hematoma.



- The **arachnoid mater** (from Latin meaning “spider mother”) is deep to the dura mater and is continuous with the arachnoid mater surrounding the spinal cord. Extensions that have the appearance of a spider web, called trabeculae, extend from the arachnoid layer to the pia mater.
  - Arachnoid granulations (villi) are protrusions of arachnoid mater that penetrate the dura mater to reside within the dural venous sinus. They function as one-way valves to allow the cerebrospinal fluid (CSF) within the subarachnoid space to enter the venous circulation. The largest granulations are associated with the superior sagittal sinus.
- The **subarachnoid space** is between the arachnoid and pia mater. In a living individual a filtrate of blood called cerebrospinal fluid (CSF) is contained within the space. The subarachnoid space is not obvious in a cadaver because the CSF in this space is maintained by sufficient blood pressure, which is lacking in a cadaver. Therefore, in the cadaver, the arachnoid mater lies directly superficial to the pia mater. Along with CSF, thin connective tissue projections, called trabeculae, are present in the subarachnoid space. They extend from the arachnoid layer to connect to the pia mater.
- **The pia mater** (from Latin meaning “tender mother”) is a thin, vascularized connective tissue layer that is tightly adhered to the brain and spinal cord.

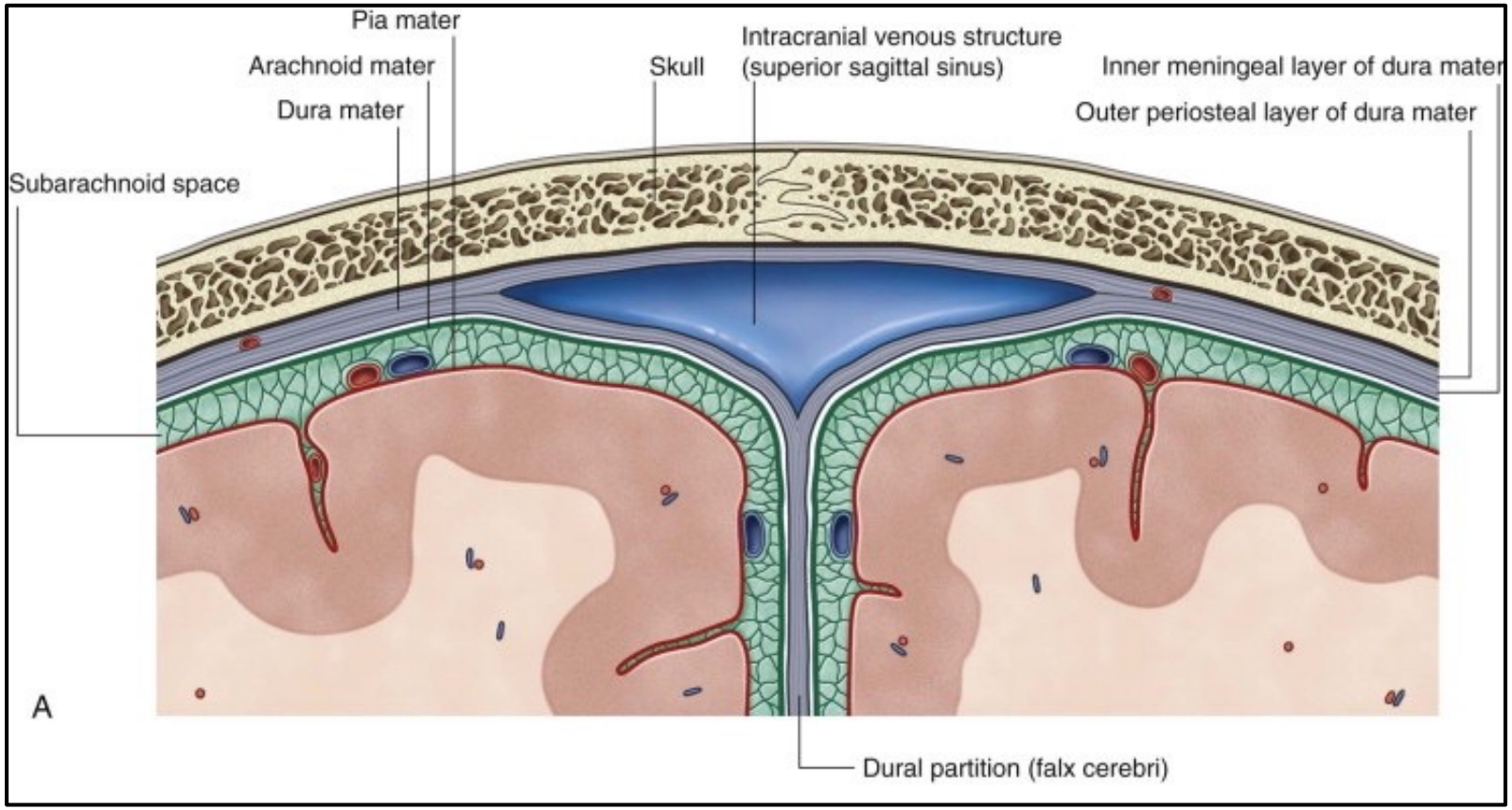
Cranial Dura, Dural Folds, & Dural Venous Sinuses

The dura mater in the cranial cavity consists of two layers. (Recall that the dura mater within the vertebral canal consists of only one layer.)

- The outer **periosteal dura** is adhered to the inner surfaces of the bones forming the cranial cavity . As its name implies, it is the periosteum along the surfaces of the bones that face the cranial cavity.
- The inner **meningeal layer** is adhered to the outer periosteal layer throughout most of the cranial cavity. However, in some places it separates from the outer periosteal layer to form **dural folds (reflections).**
    - **Dural folds (reflections)** create partial partitions between different areas of the brain and provide support for some brain structures.
    - When the meningeal dura separates from the periosteal dura, endothelial lined spaces called **dural venous sinuses**, are formed between the two layers.
        - Dural venous sinuses collect venous blood from the brain, scalp, and diploe (spongy bone of flat bones) of the calvaria.

FUNCTIONAL ANATOMY: Dural venous sinuses are venous channels that lack valves, which means venous blood may flow through them in either direction.

FUNCTIONAL ANATOMY: Most of the blood collected by the **dural venous sinuses** drains to the **internal jugular veins**. However, alternate routes out of the cranial cavity do exist and are clinically significant (e.g., internal vertebral venous plexus).



Innervation of Dura

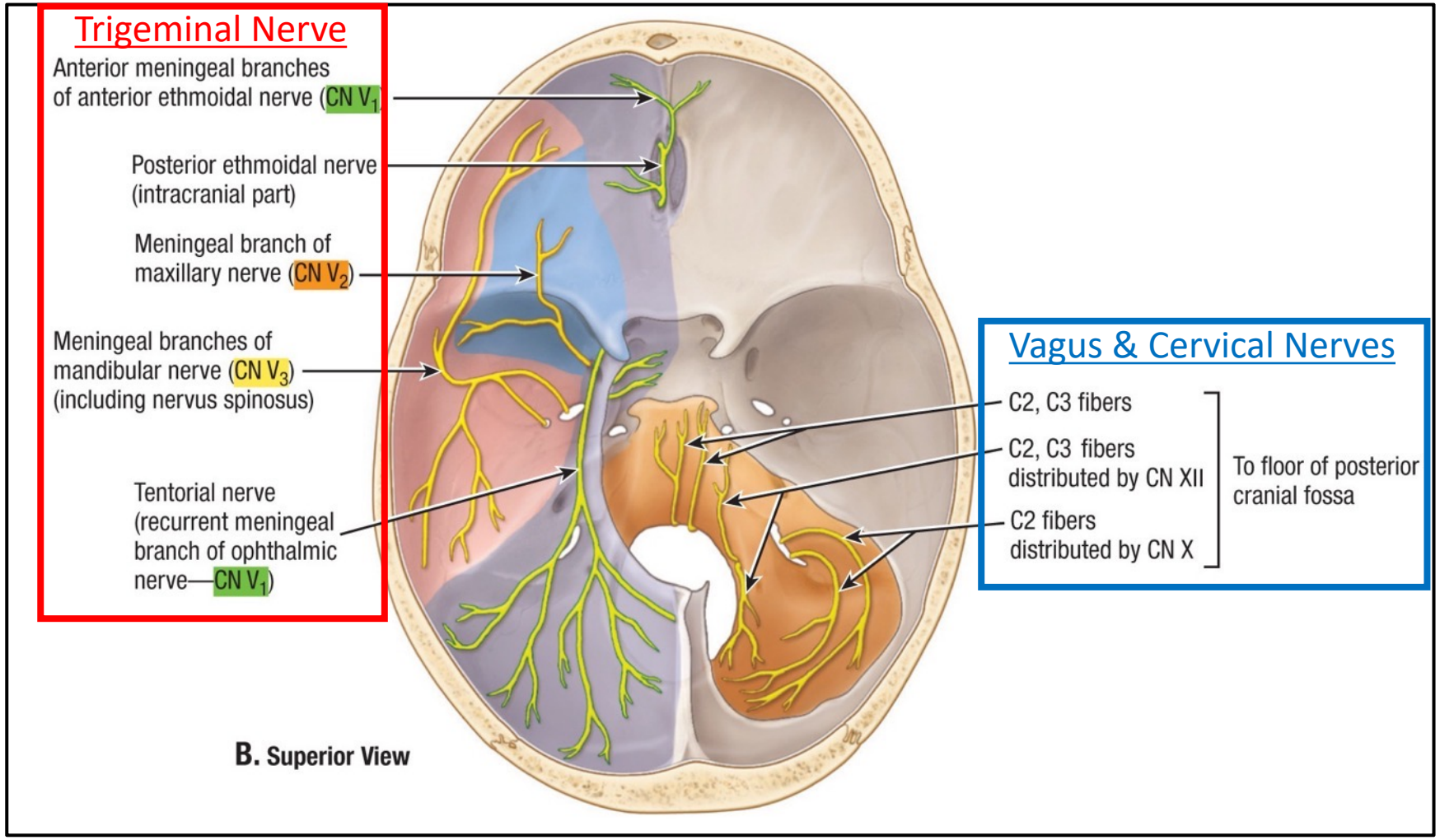
Sensory innervation to the dura is provided by branches of the following nerves.

- **Trigeminal nerve (CN V)**
- **Vagus nerves (CN X)**
- Branches of **cervical spinal nerves**.

Below is a simplification of what you need to know.

- The posterior cranial fossa below the tentorium cerebelli is innervated by the following nerves
  - **Vagus (CN X)**
  - **Cervical nerves**.

- The dura of the anterior cranial fossa, middle cranial fossa, and posterior cranial fossa superior to the tentorium cerebelli, are innervated by branches of the **trigeminal nerve**.



Emissary Veins & Diploic Veins

Emissary veins connect extracranial veins in the face and scalp to the intracranial venous system**.**

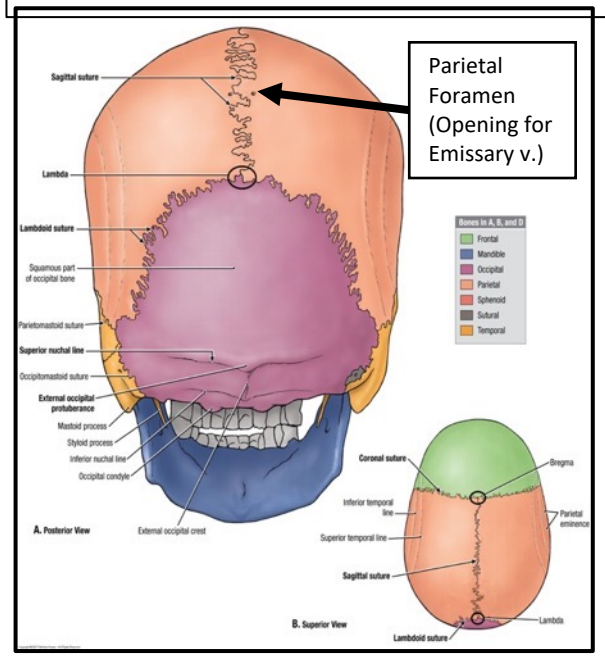
- They pass through cranial apertures, such as the orbits, nasal aperture, and foramina
- The parietal foramina, which are sometimes visible on a dried skull, contained **emissary veins in the** living person. Emissary veins passing through parietal foramina drain venous blood from the scalp into the superior sagittal sinus.

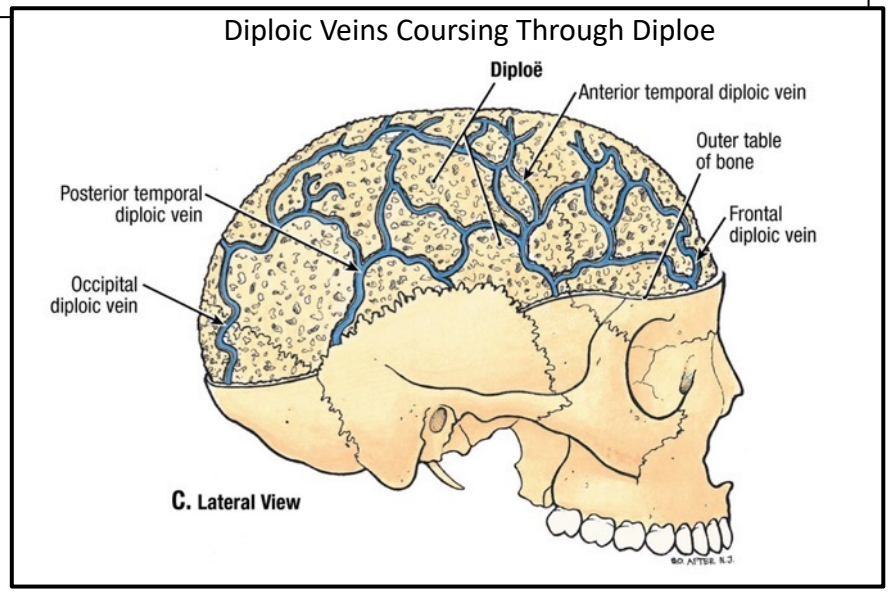
The **diploic venous system** consists of a network of veins coursing between the spongy bone trabeculae of the cranial cavity's flat bones. This spongy bone region, called **diploë**, is sandwiched on either side by compact bone.

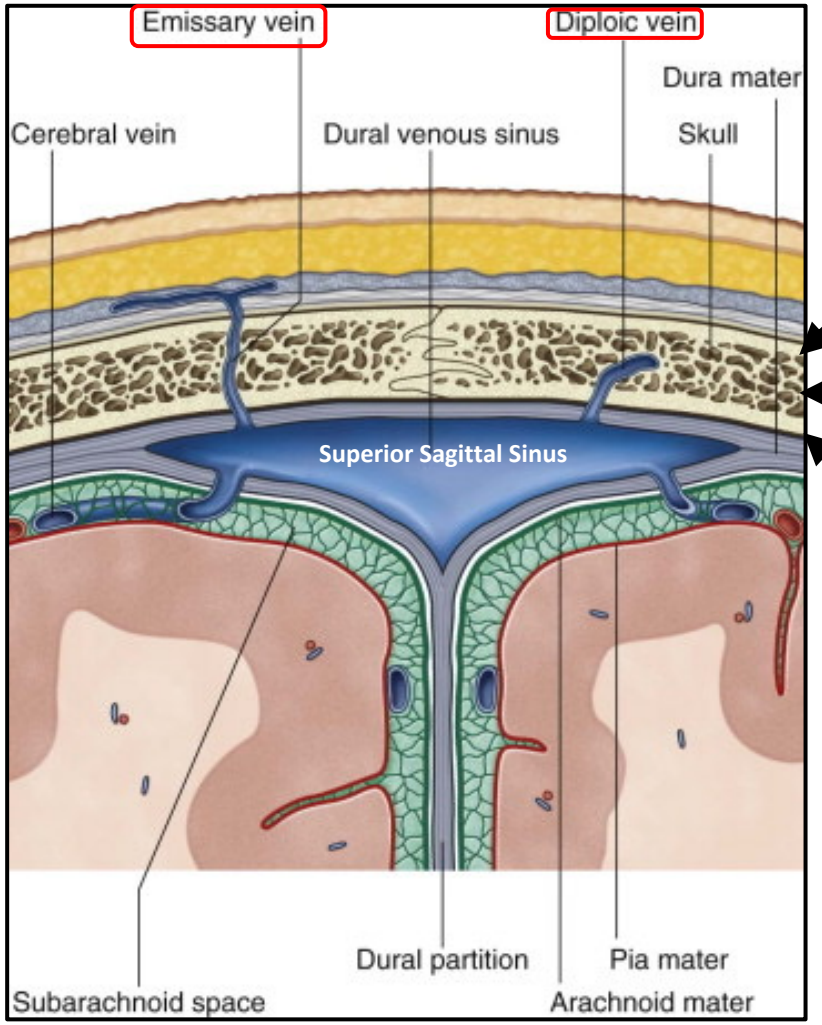
- Diploic veins drain into dural venous sinuses
- Although not common, emissary veins can drain into diploic veins.

FUNCTIONAL ANATOMY: Both emissary veins and dipoic veins lack valves, which means venous blood can flow through them in either direction.

CLINICAL ANATOMY: Emissary veins and diploic veins are clinically significant because they are a possible route for the spread of infection from extracranial foci to the cranial cavity, and *vice versa*.







Cerebral & Cerebellar Veins

Cerebral and cerebellar veins drain blood from brain tissue into the dural venous sinuses.

- These veins are often referred to as “bridging veins” because they must “bridge” the subarachnoid space in order to gain access to, and open into, the dural venous sinuses (Figure 1).

CLINICAL ANATOMY: Extravasated blood from a torn bridging vein collects between the dura and the arachnoid and results in a subdural (dural border) hemorrhage (Figure 2)

Figure 1

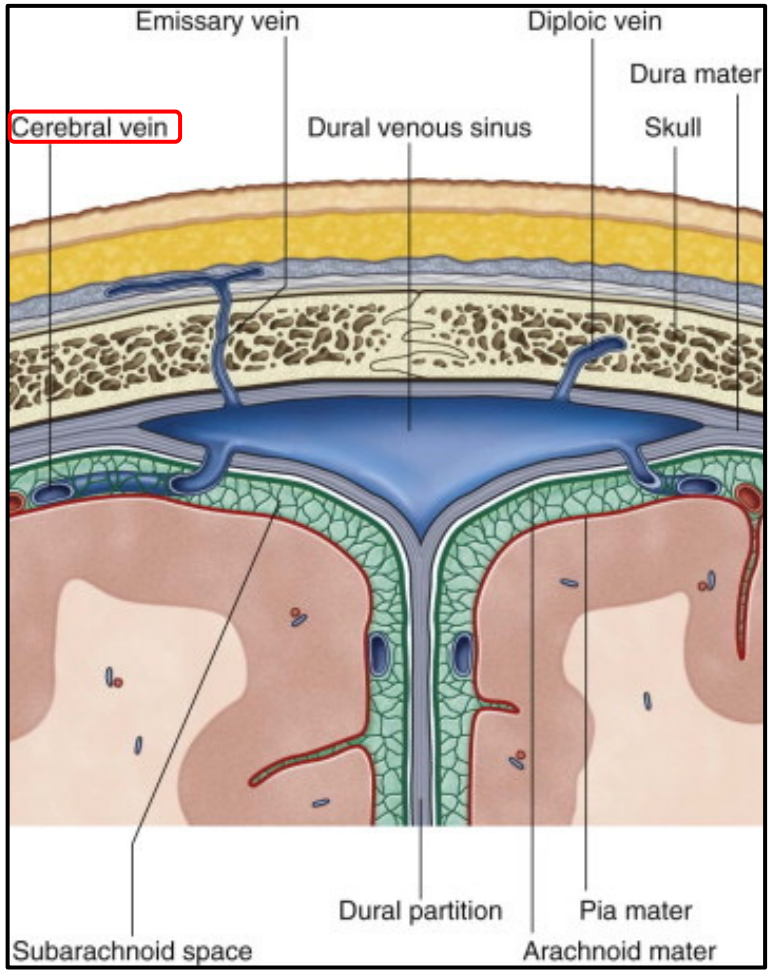
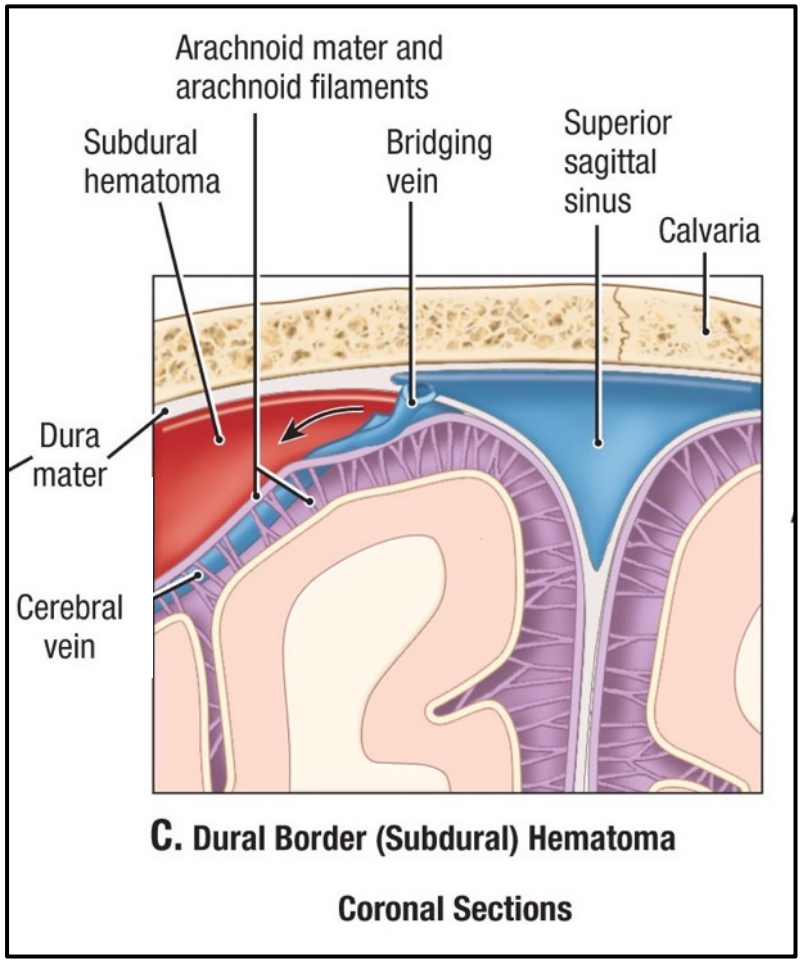


Figure 2

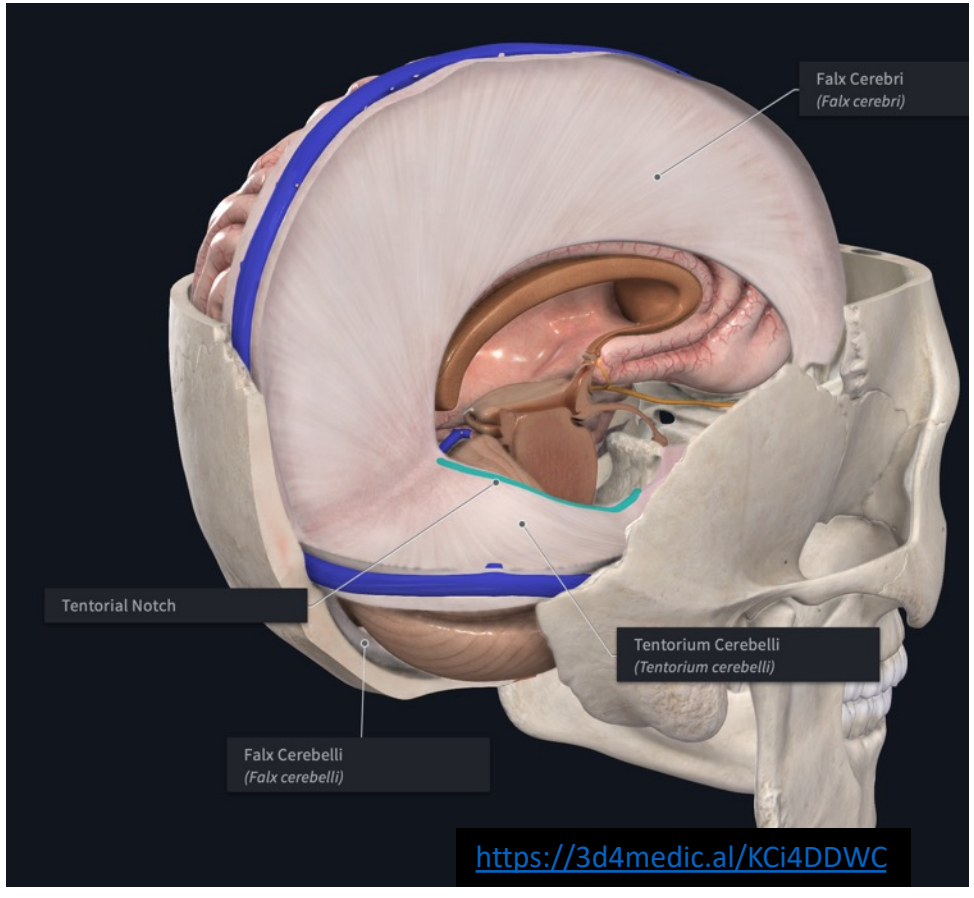


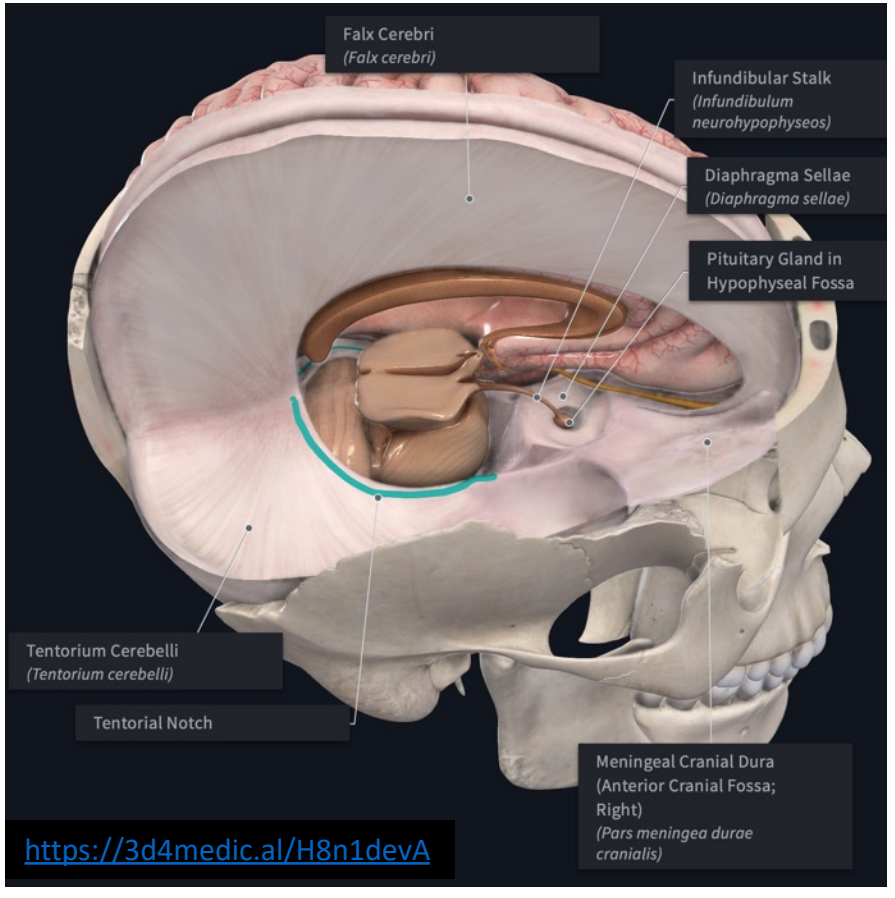
Named Dural Folds

Dural folds form the following named structures.

- The **cerebral falx** is a sickle-shaped fold of dura that extends into the longitudinal cerebral fissure of the brain.
- The **cerebellar tentorium (tentorium cerebelli)** is the transversely-oriented fold of dura within the transverse (horizontal) cerebral fissure that separates the cerebrum from the cerebellum.
    - The “U” shaped free edge of the tentorium cerebelli that creates an opening for the passage of the brainstem, which is called the **tentorial notch**. The **cerebellar falx** is a vertical fold located inferior to the tentorium cerebelli. It is attached to the occipital crest and separates the cerebellar hemispheres.
- The **diaphragm sellae** is the smallest dural fold. It forms a roof over the **hypophyseal fossa**, which houses the pituitary gland.

CLINICAL ANATOMY: In cases of increased intracranial pressure, the brain may be injured if it is pushed under or around the free “sharp” edges of the **cerebral falx** or the **cerebellar tentorium** at the **tentorial notch**.

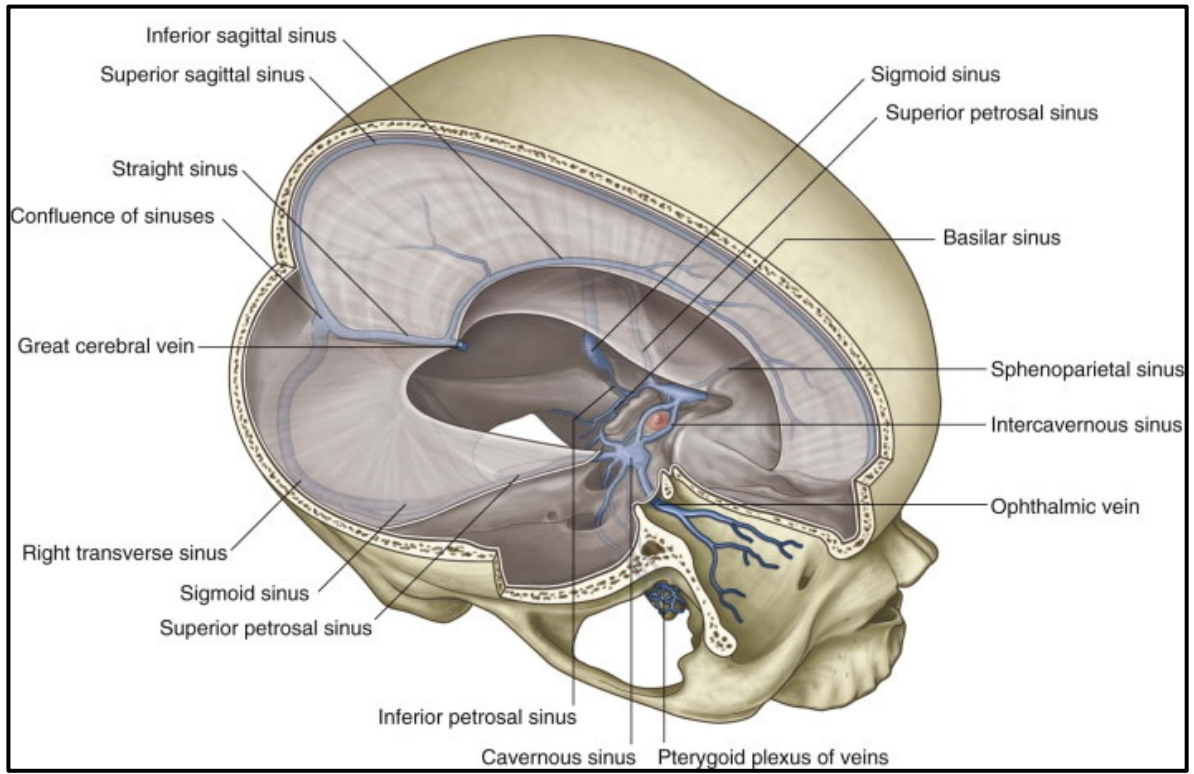


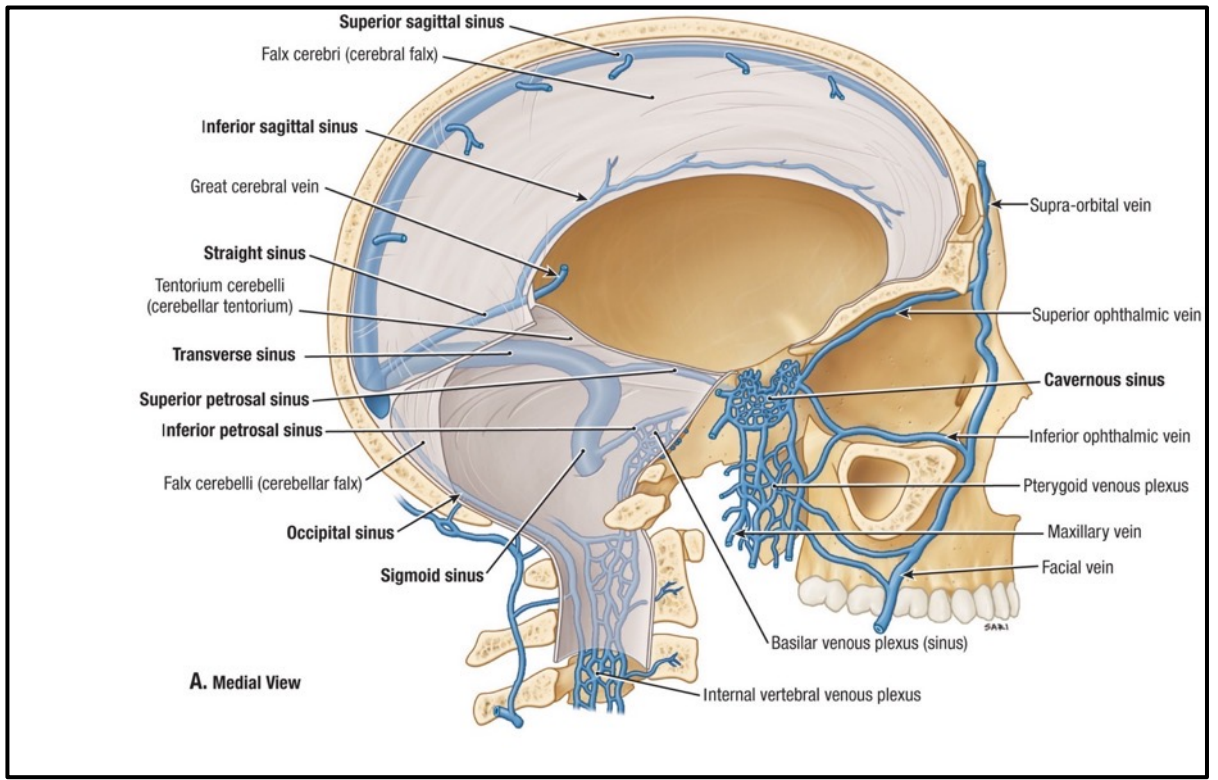


Dural Venous Sinuses

Dural Venous Sinus	Location	Receives Blood From	Drains Blood To
Superior sagittal sinus	• Along the attached border of the **falx cerebri** • Extends from its attachment at the **crista galli** to the **confluence of sinuses**	• Superior cerebral veins	**Confluence of sinuses**
Inferior sagittal sinus	• Within the unattached border of the **falx cerebri** • Ends at its junction with the **straight sinus**	• Deep & medial aspects of the cerebral hemispheres • **Falx cerebri**	**Straight sinus**
Straight sinus	Courses along the attachment of the **falx cerebri** to the **tentorium cerebelli**	• **Great cerebral vein (of Galen)** • **Inferior sagittal sinus**	**Confluence of sinuses**
Occipital sinus	Along attached border of the **falx cerebelli**	• **Confluence of sinuses**	**Internal vertebral venous plexus**

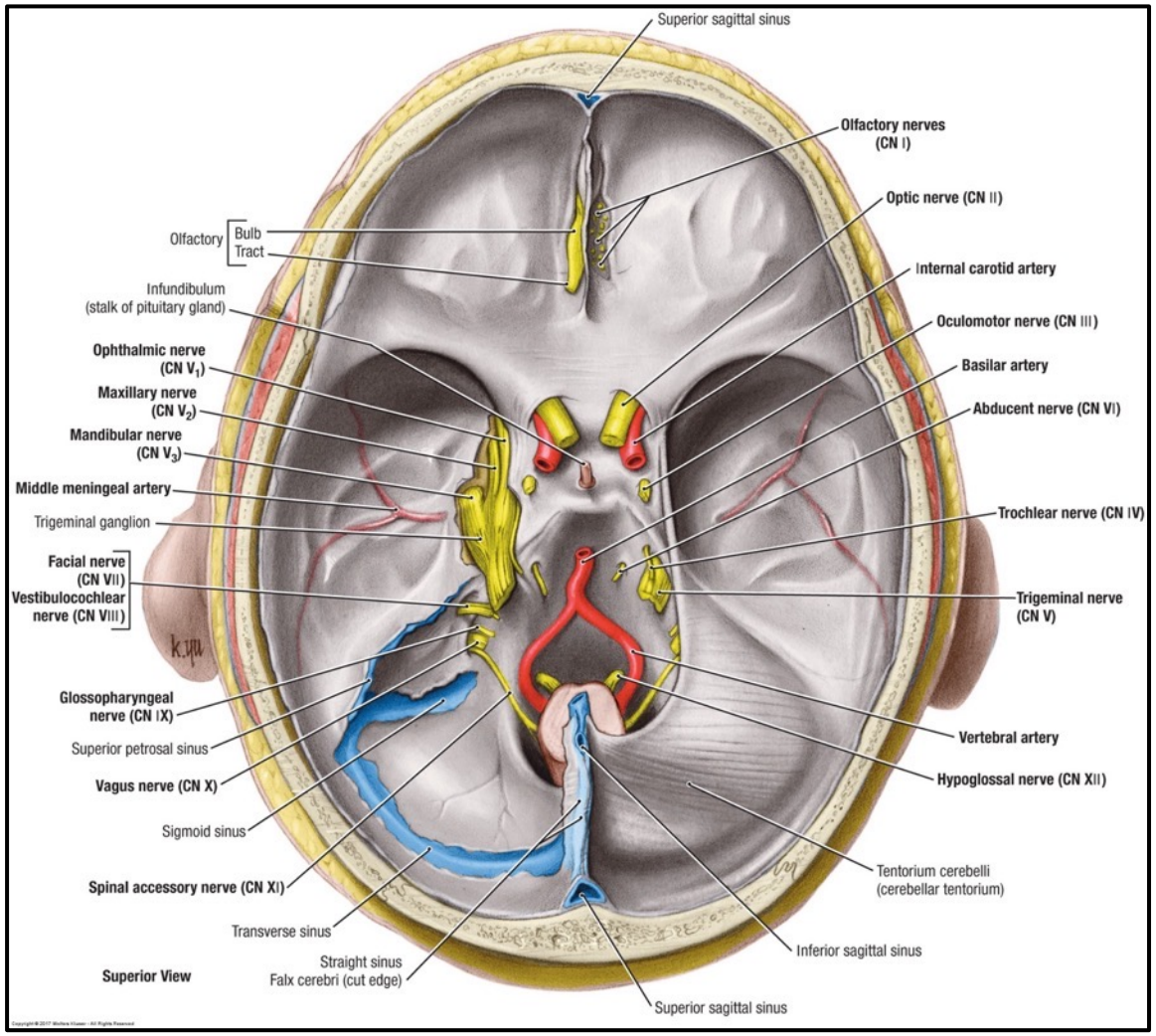
The **occipital sinus** and the **basilar plexus** of veins located on the clivus, communicate with the **internal vertebral venous plexus** through the foramen magnum. Because this venous system lacks valves, tumors originating in the prostate, colon, or breast can metastasize via this venous communication to the brain.

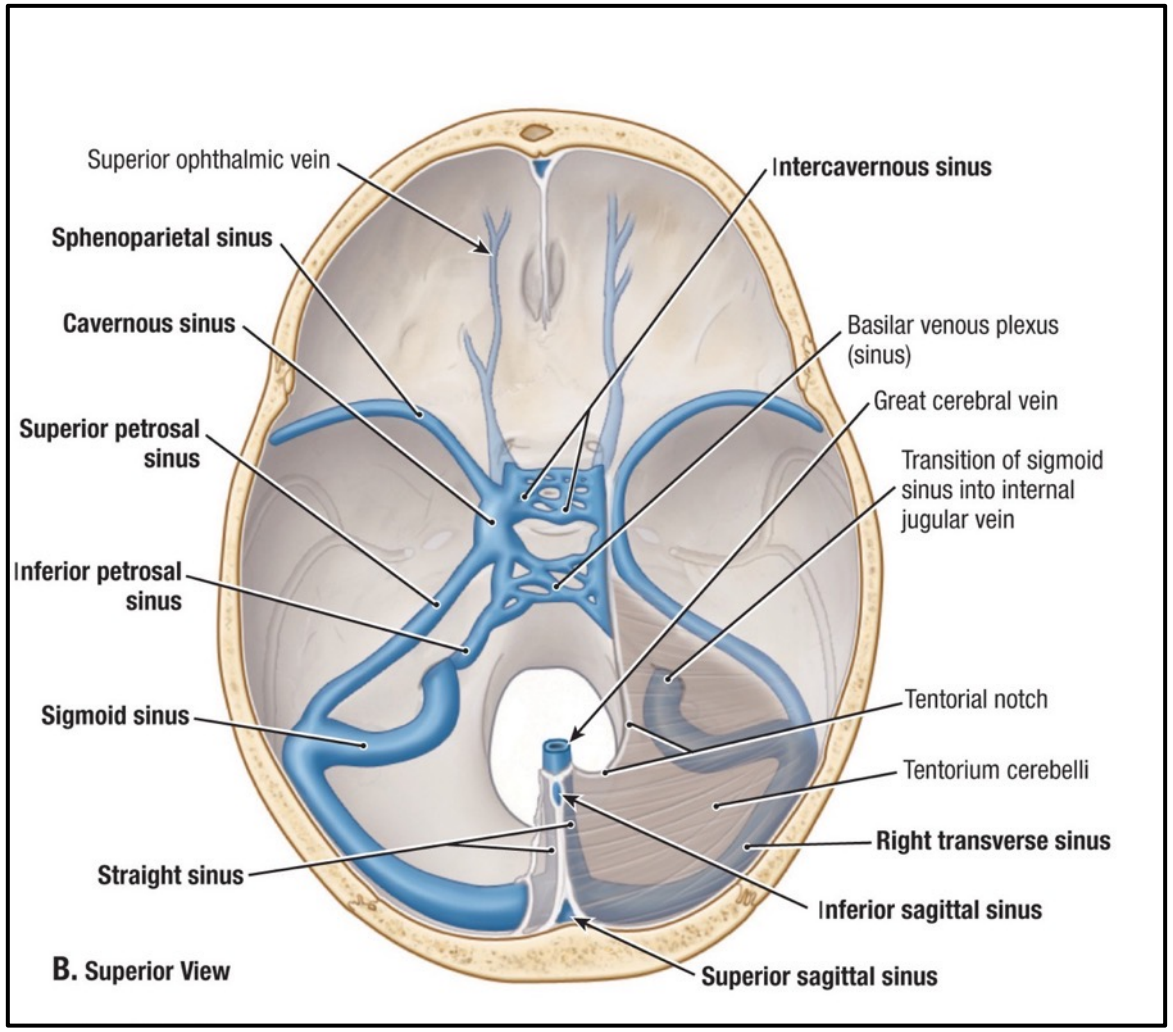




Dural Venous Sinuses (Continued)

Dural Venous Sinus	Location	Receives Blood From	Drains Blood To
Transverse sinuses	Course laterally from the **confluence of sinuses** within the attached border of the **tentorium cerebelli**	**Confluence of sinuses**	**Sigmoid sinuses**
Sigmoid sinuses	Continuation of the **transverse sinuses**	**Transverse sinuses**	**Internal jugular veins (jugular bulb) at jugular foramen**

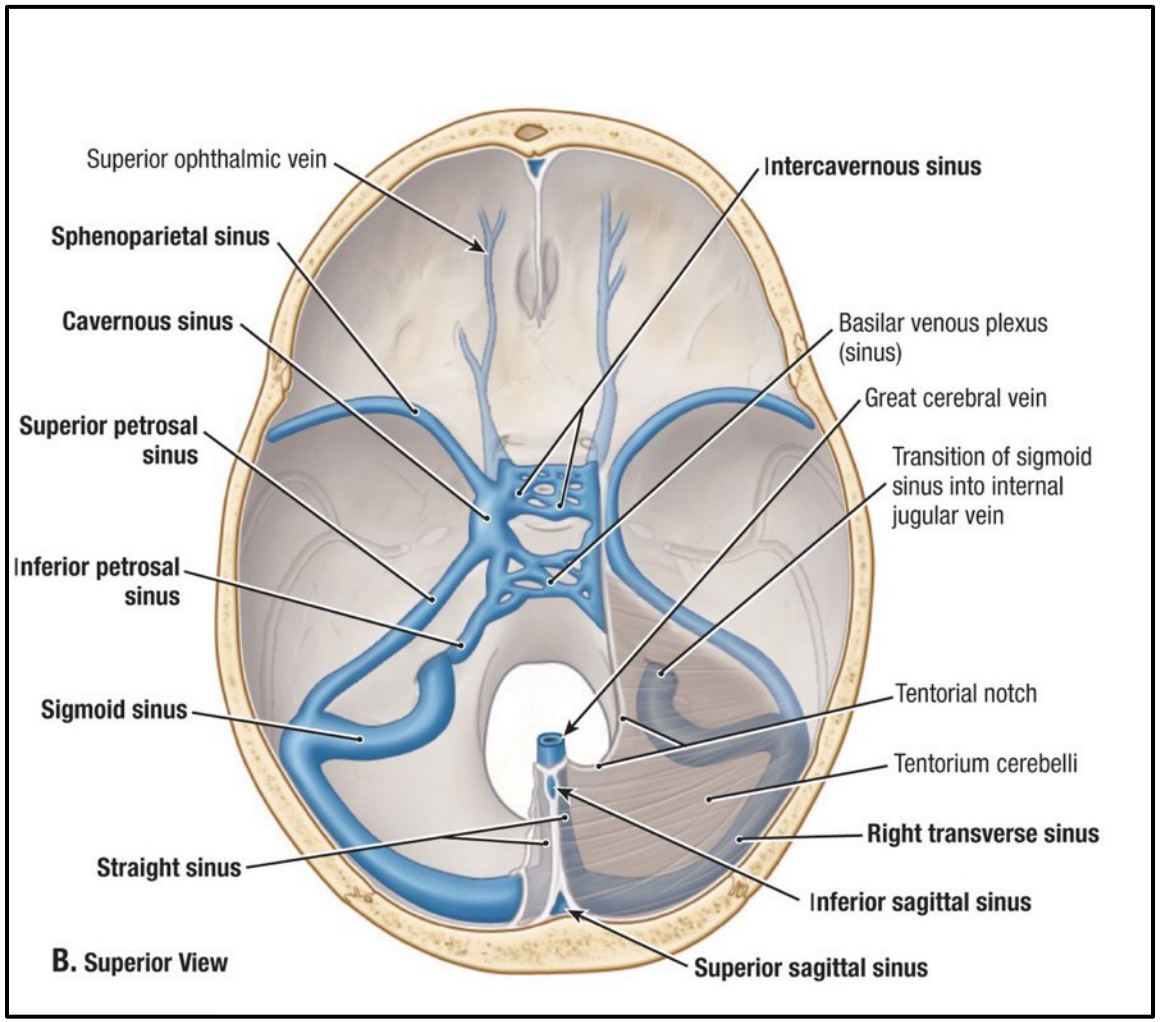


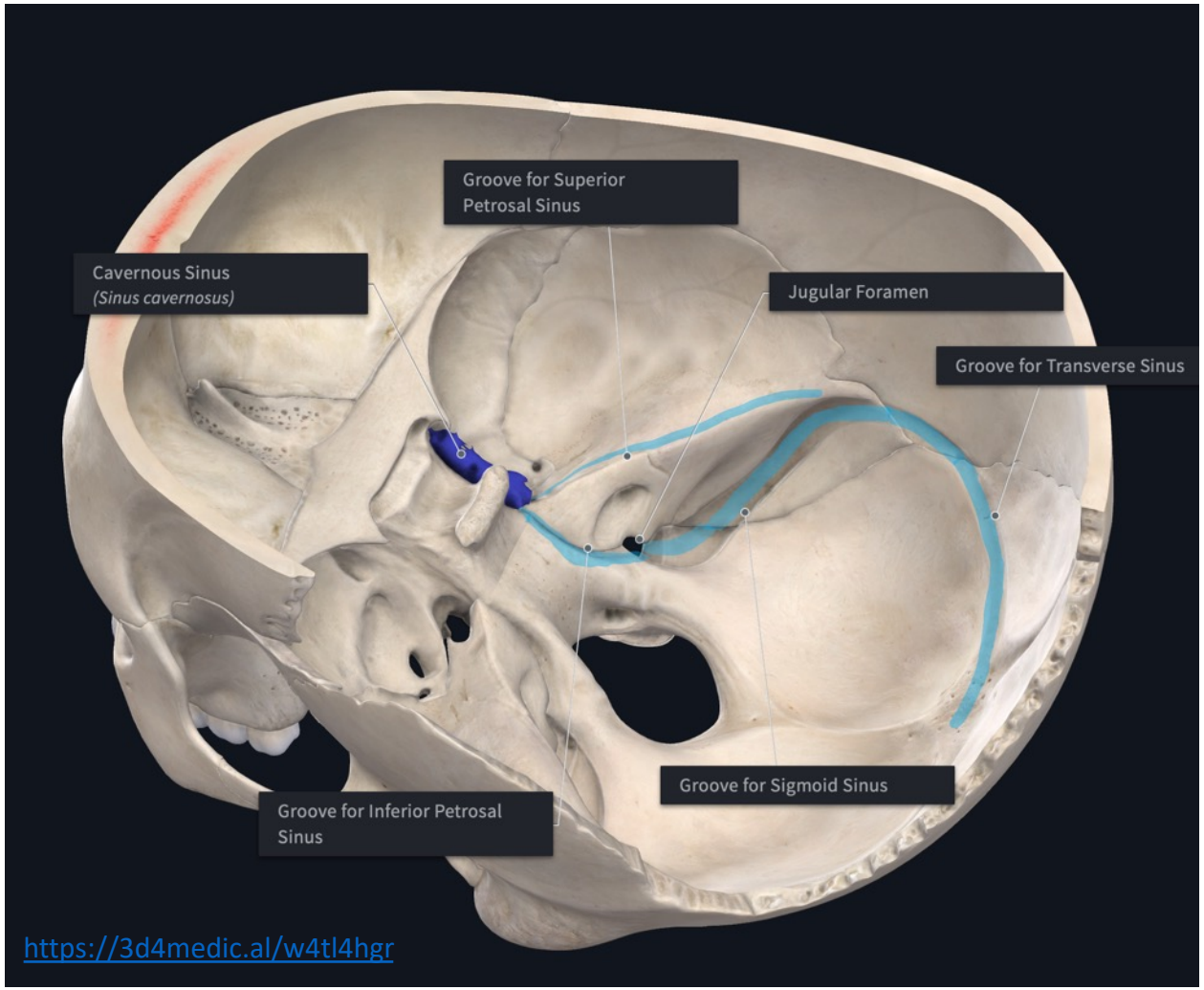


Osseous Grooves formed by Dural Sinuses

The **dural venous sinuses** create grooves in the bones of the cranial cavity that can be seen on a dry skull.

- **Groove for transverse sinus**
- **Groove for sigmoid sinus**
- **Groove for inferior petrosal sinus**
- **Groove for superior petrosal sinus**





Venous Drainage of Head: Cavernous Sinuses

The **cavernous sinuses** are large venous plexuses located on either side of the **sella turcica** that extend from the **superior orbital fissure** anteriorly to the apex of the **petrous part of the temporal bone** posteriorly. They are different than other sinuses because they don't consist of a single venous channel. Instead, each sinus consists of a large plexus of thin-walled veins.

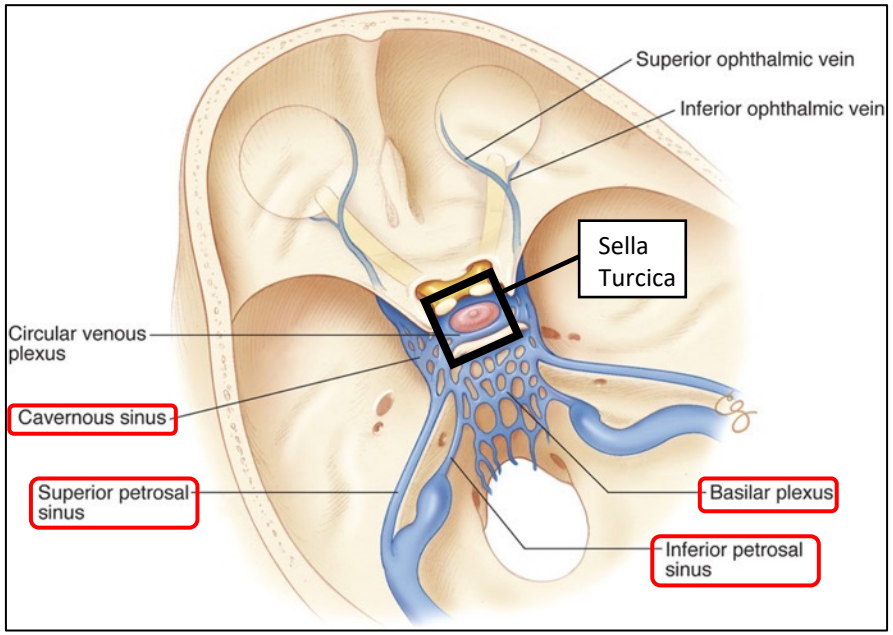
The **cavernous sinuses** receive blood from the following structures.

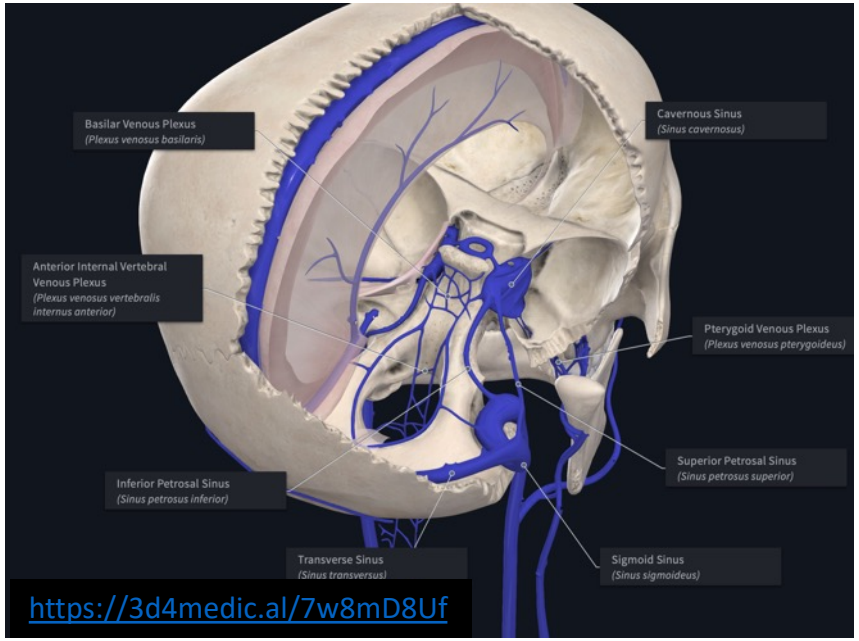
- Upper face and scalp
- Orbit
- Brain

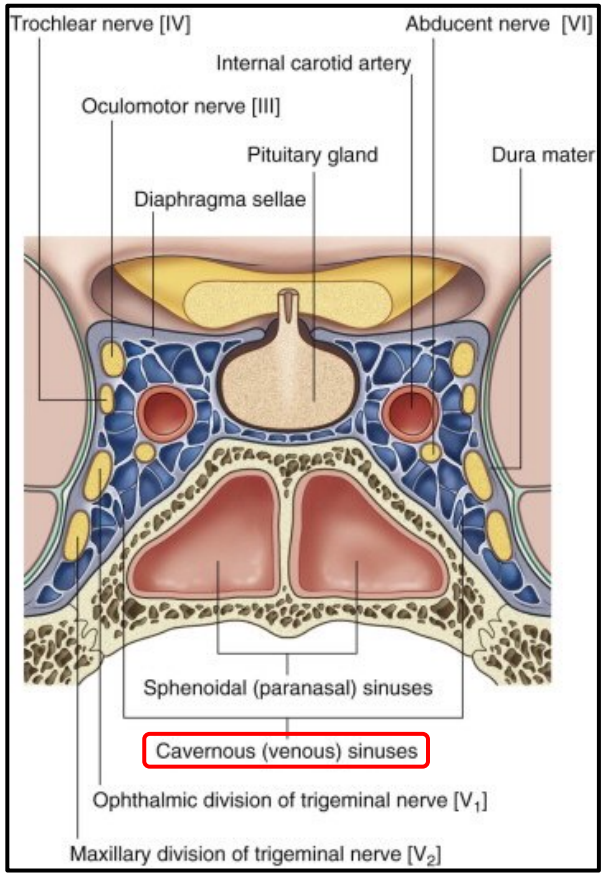
The **cavernous sinus** has the following drainage pathways.

- Posterolaterally: The **superior petrosal sinuses** drain into the junction of the **transverse** and **sigmoid sinuses**.
- Posteroinferiorly: The **inferior petrosal sinuses** drain into the distal ends of the **sigmoid sinuses** at the location where the sigmoid sinuses passes through the jugular foramina to become the **internal jugular veins.**
- Posterocentrally: The **basilar plexus** drains into the **internal vertebral venous plexus.**
- Inferiorly: Vessels passing through the foramen ovale drain into the **pterygoid venous plexus located** in the deep face.

Since the cavernous sinus ends anteriorly at the superior orbital fissure, all structures that pass into the orbit through the superior orbital fissure either pass through the sinus or are located within its lateral wall. In future labs, you will identify these structures and note their anatomical relationship to the **cavernous sinus**.





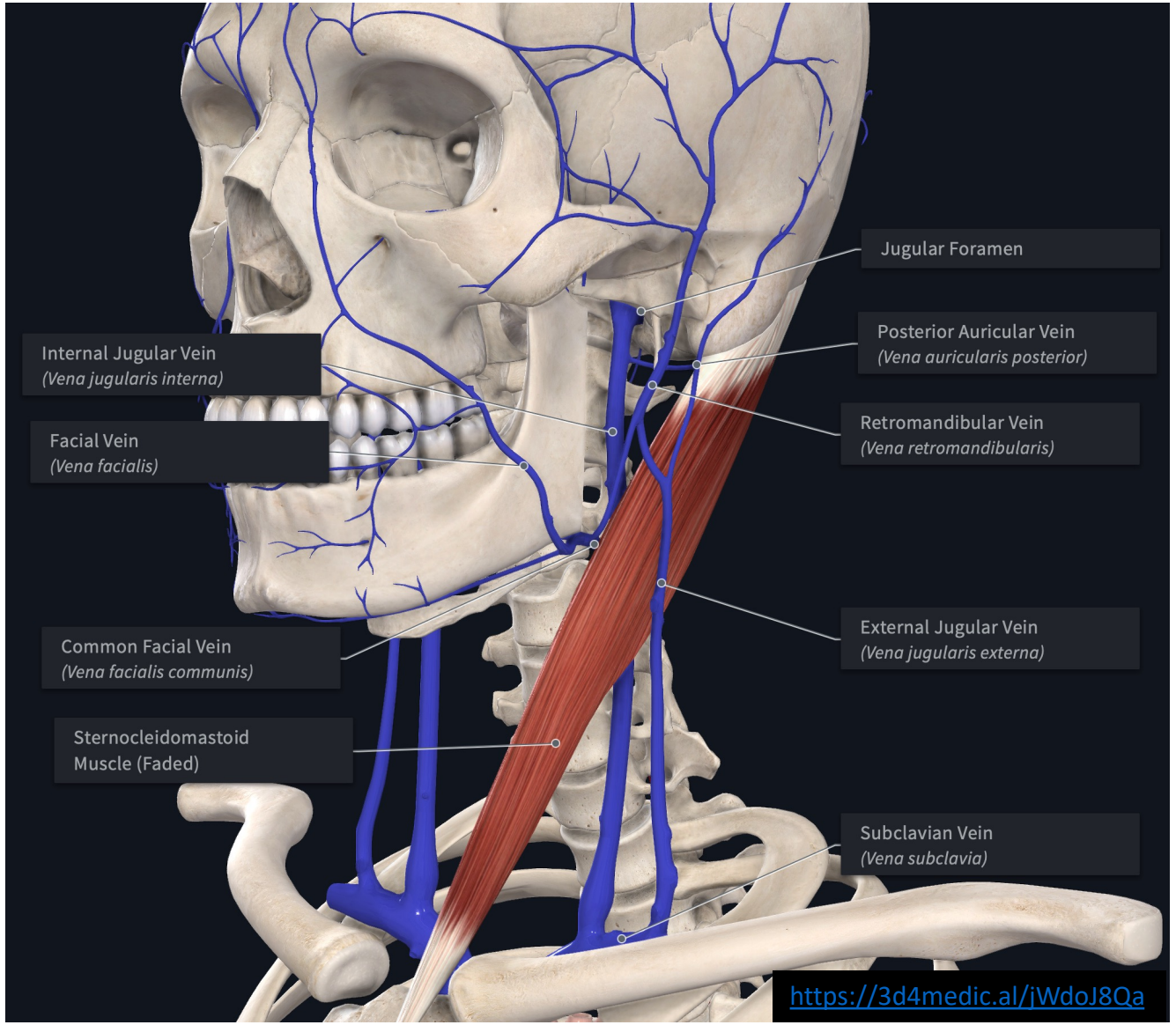


Intracranial and Extracranial Venous Drainage (Review)

Veins draining the head & neck can be subdivided into two primary groups.

1. Intracranial veins are located within the cranial cavity.
   - Intracranial venous blood is collected from cerebral, cerebellar, emissary, diploic veins, and other named veins into dural venous sinuses.
   - Most (not all) of the venous blood collected in the **dural venous sinuses** drains into the jugular bulb region of the internal jugular vein. The **internal jugular vein exits** the cranial cavity by passing through the **jugular foramen.**

2. Extracranial veins are located outside of the cranial cavity.
   - The **internal jugular vein** descends the neck within the carotid sheath along with the internal carotid artery and the vagus n. Along its descent, ithe internal jugular vein receives blood from tributaries that drain the face and neck. The internal jugular vein joins the subclavian vein to form the brachiocephalic vein.
   - The **external jugular vein** receives venous blood from the face and scalp and is initially formed by the union of the retromandibular vein (posterior division) and the posterior auricular vein. As it descends in the neck, it obliquely crosses the sternocleidomastoid's superficial surface. It terminates by draining into the subclavian vein.



Head & Neck Venous Drainage (Review)

Dural Venous Sinus	Receives Blood From	Drains Blood To
External jugular v. (L and R)	Scalp, pinna, and side of the face (union of posterior auricular vein and retromandibular vein)	**Subclavian vein**
Internal jugular v. (L and R)	Brain (dural venous sinuses), anterior face, and neck	Joins with subclavian v. to form **brachiocephalic vein**
Brachiocephalic v. (L and R)	Subclavian v. and internal jugular v.	**Superior vena cava**