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УНИВЕРСИТЕТ

The head

The cranial **region**

Department for operative surgery and
topographic anatomy

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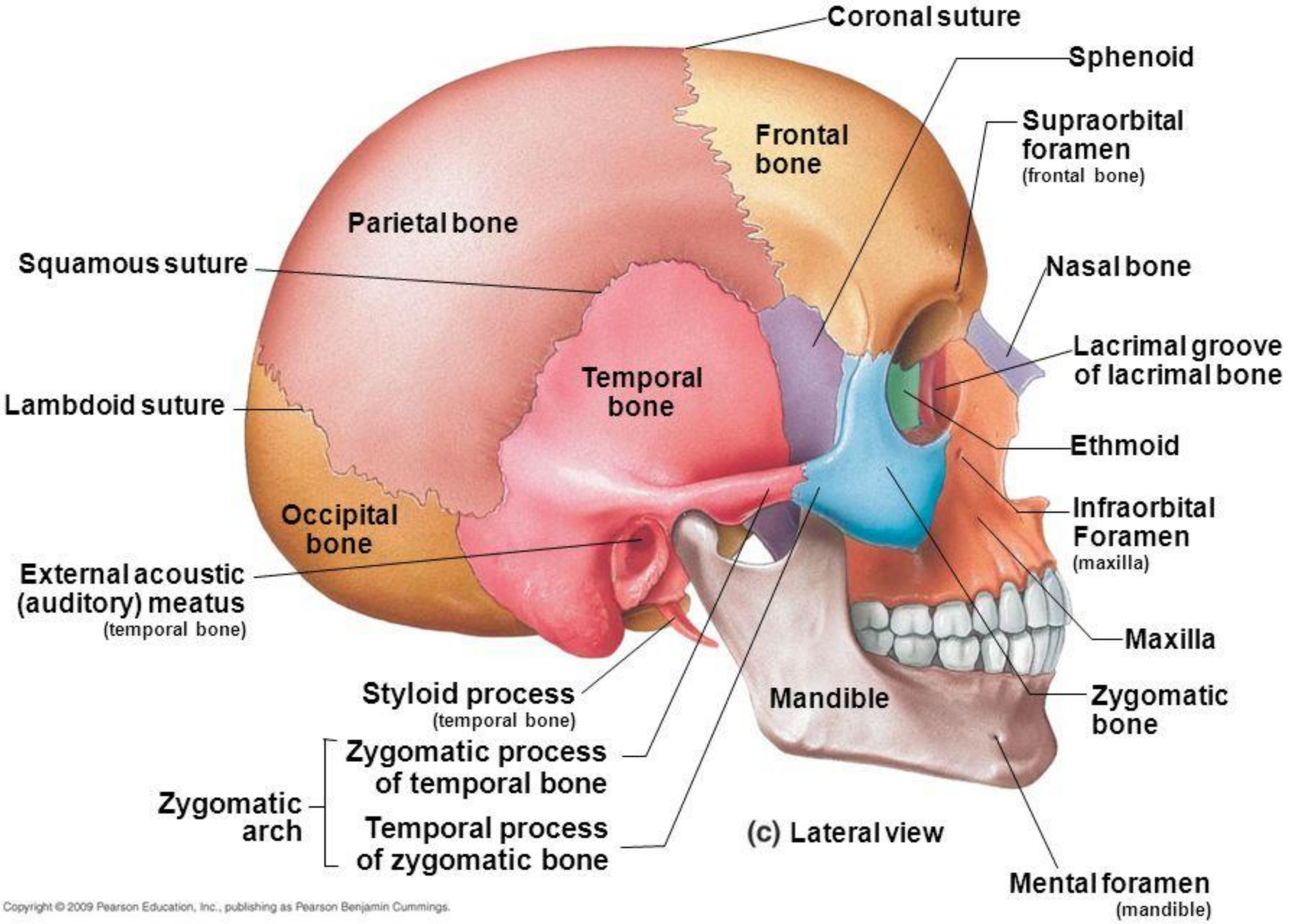
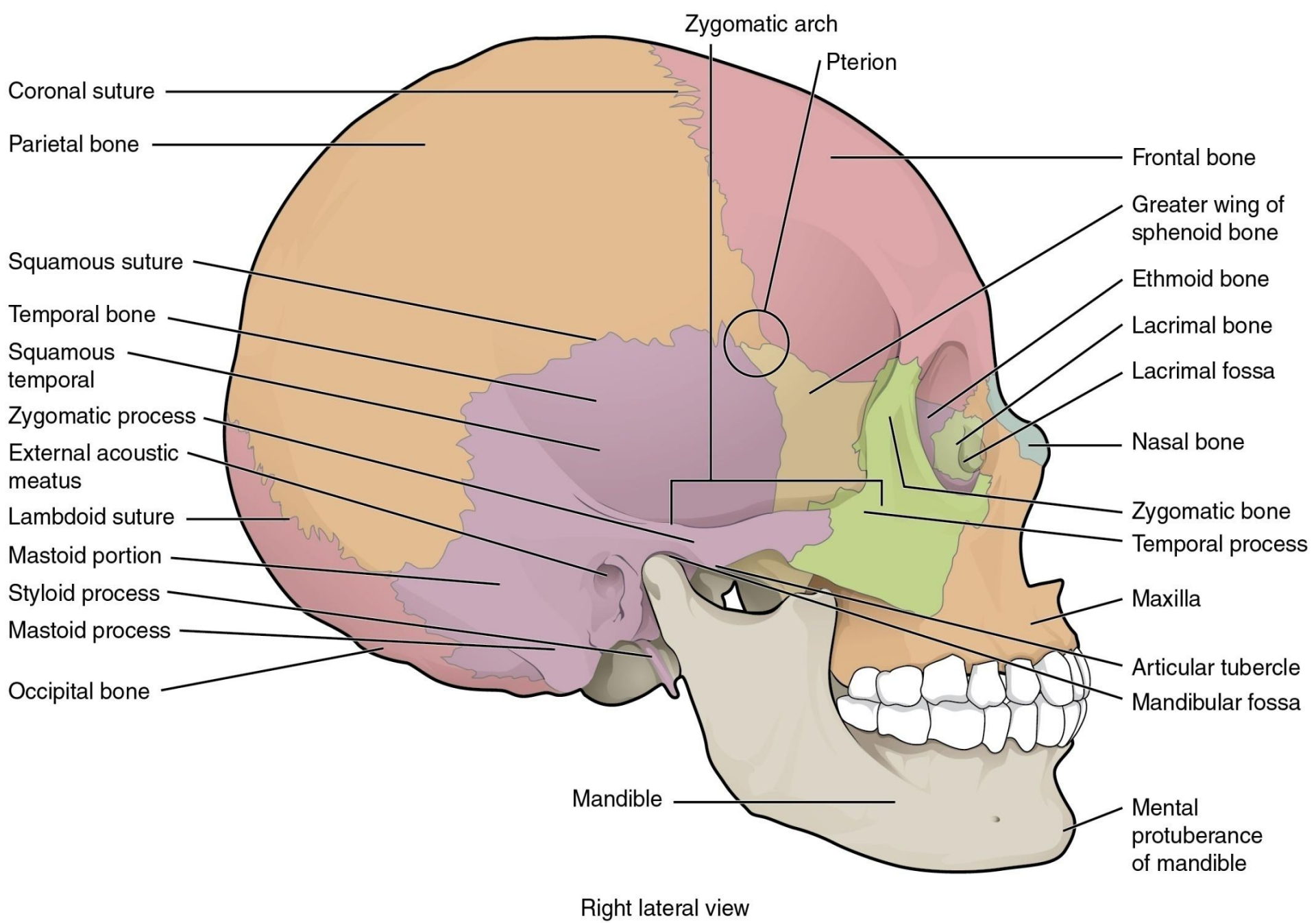
E.A. Barinova

- The head consists of the brain, its protective coverings, and the ears and face. The cranium (scull) is the skeleton of the head. Learning the features of the cranium serves as an important framework to facilitate the understanding of the head region.



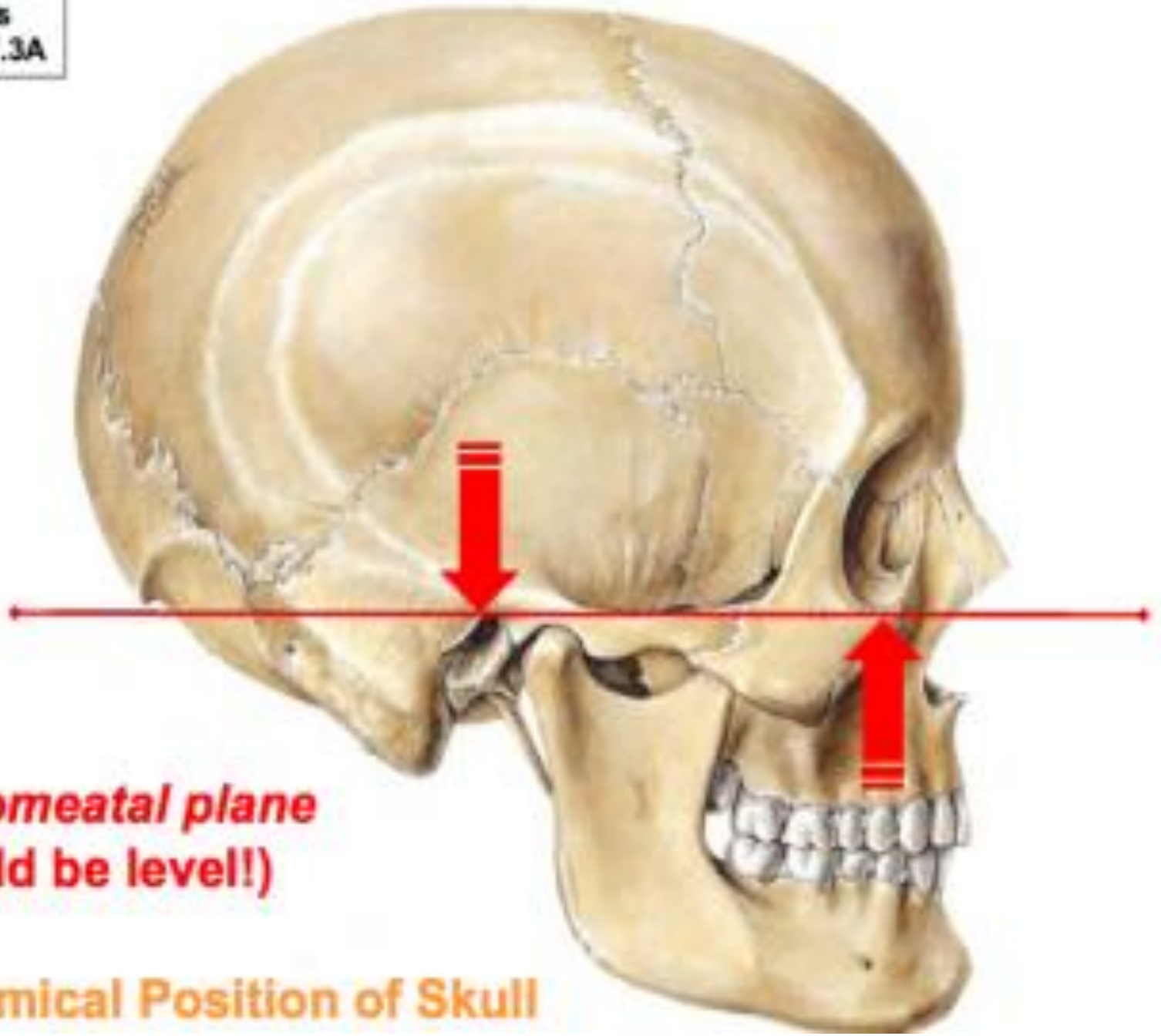


Right lateral view

Cranial vault

- In the anatomical position, the cranium is oriented so that the inferior margin of the orbit and the superior margin of the external acoustic meatus of both sides lie in the same horizontal plane. This standard craniometric reference is the **orbitomeatal plane (Frankfort horizontal plane).**

Agur & Dalley
Grants Atlas
13th ed., Fig. 7.3A



Orbitomeatal plane
(should be level!)

Anatomical Position of Skull

Cranial vault

- The cranium consists of two parts, structural and functional: the **neurocranium** and **viscerocranium**. The **neurocranium (cranial vault)** is the bony case of the brain and its membranous coverings, the cranial meninges. It also contains the proximal parts of the cranial nerves and the vasculature of the brain.

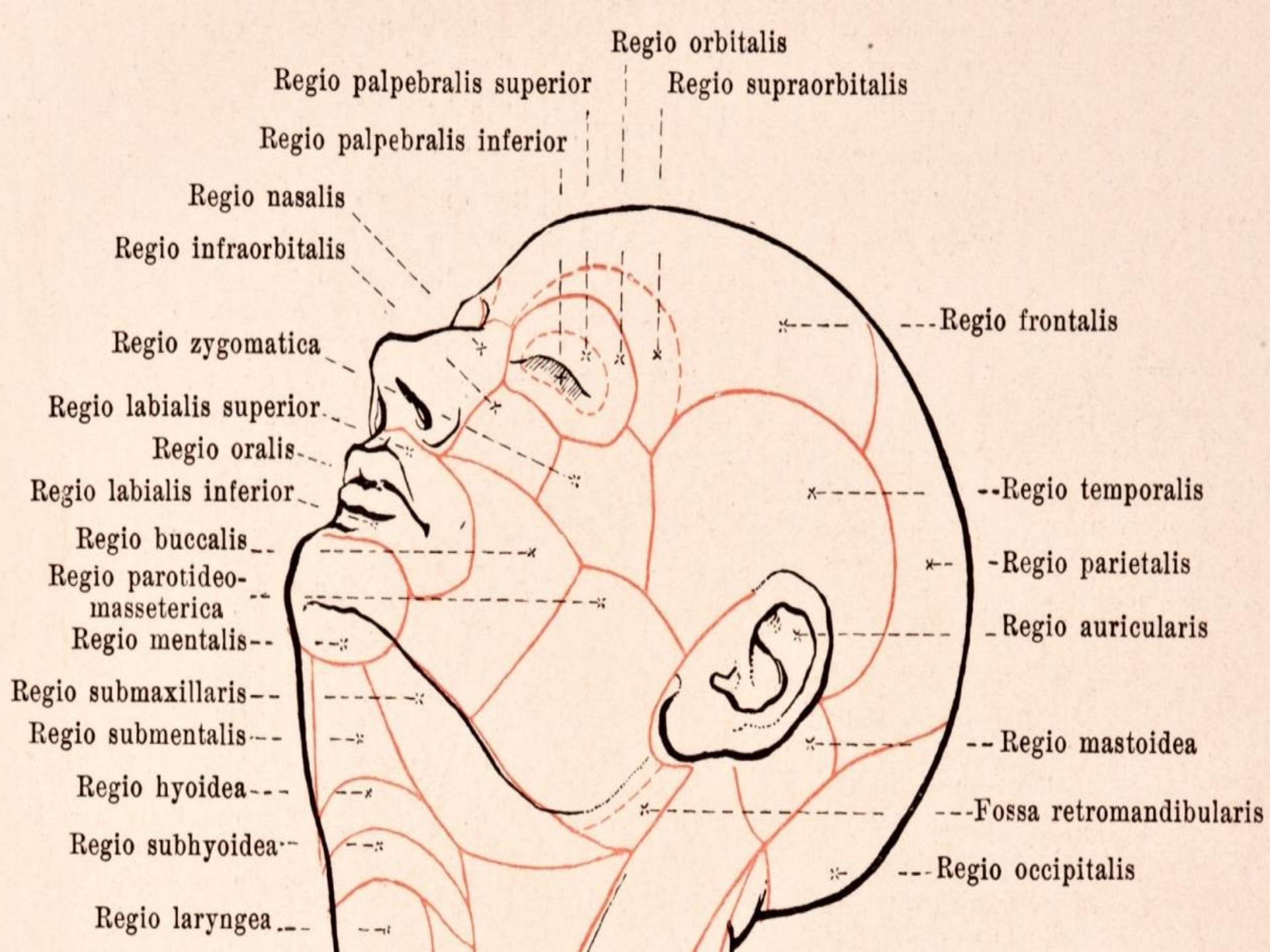
Cranial vault

- The neurocranium has a dome-like roof, the **calvaria (skullcap)**, and a floor or **cranial base (basicranium).**
- The neurocranium is formed by eight bones: four singular bones centered on the midline (frontal, occipital, sphenoid, ethmoid) and two sets of bones occurring as bilateral pairs (parietal and temporal).

The head regions

The head is divided into 14 regions, 8 of which belong to the face. These regions are:

- Frontal region
- Parietal region
- Occipital region
- Temporal region
- Auricular region
- Mastoid region
- Orbital region
- Infraorbital region
- Buccal region – comprising of the cheek
- Parotid (parotideomasseteric) region – housing the parotid gland, the largest of three paired salivary glands
- Zygomatic region
- Nasal region
- Oral region
- Mental region – named after the mental protuberance (chin)

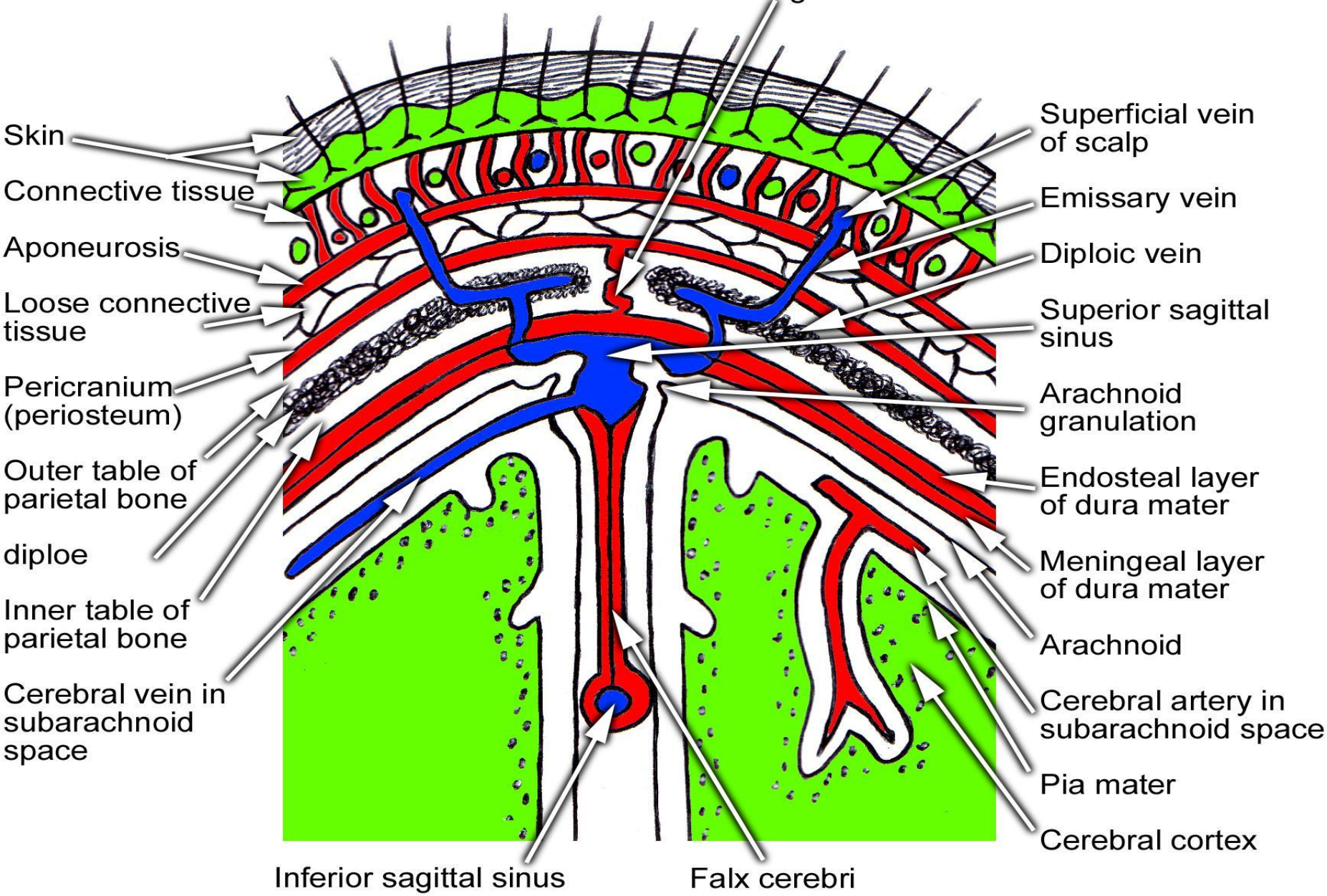

Regio orbitalis
Regio palpebralis superior
Regio supraorbitalis
Regio palpebralis inferior
Regio nasalis
Regio infraorbitalis
Regio zygomatica
Regio labialis superior
Regio oralis
Regio labialis inferior
Regio buccalis
Regio parotideo-masseterica
Regio mentalis
Regio submaxillaris
Regio submentalis
Regio hyoidea
Regio subhyoidea
Regio laryngea
Regio frontalis
Regio temporalis
Regio parietalis
Regio auricularis
Regio mastoidea
Fossa retromandibularis
Regio occipitalis

The head regions

- All of these 14 regions can be grouped into either a **neurocranial portion** or **viscerocranial portion**.
- With the exception of the auricular region, which includes the external ear, the names of the regions of the neurocranial portion of the head correspond to the underlying bones or bony features, and they are the **frontal, parietal, occipital, temporal and mastoid** regions.

Scalp anatomy

- The soft tissue envelope of the cranial vault is called the scalp. The scalp extends from the external occipital protuberance and superior nuchal lines to the supraorbital margins. The scalp consists of 5 layers (seen in the image below): the skin, connective tissue, epicranial aponeurosis, loose areolar tissue, and pericranium. The first 3 layers are bound together as a single unit. This single unit can move along the loose areolar tissue over the pericranium, which is adherent to the calvaria.



Coronal section of scalp that shows layers of the scalp (From Snell RS, Clinical Anatomy for Medical Students, 5th ed)

Layers of the scalp

S
C
A
L
P

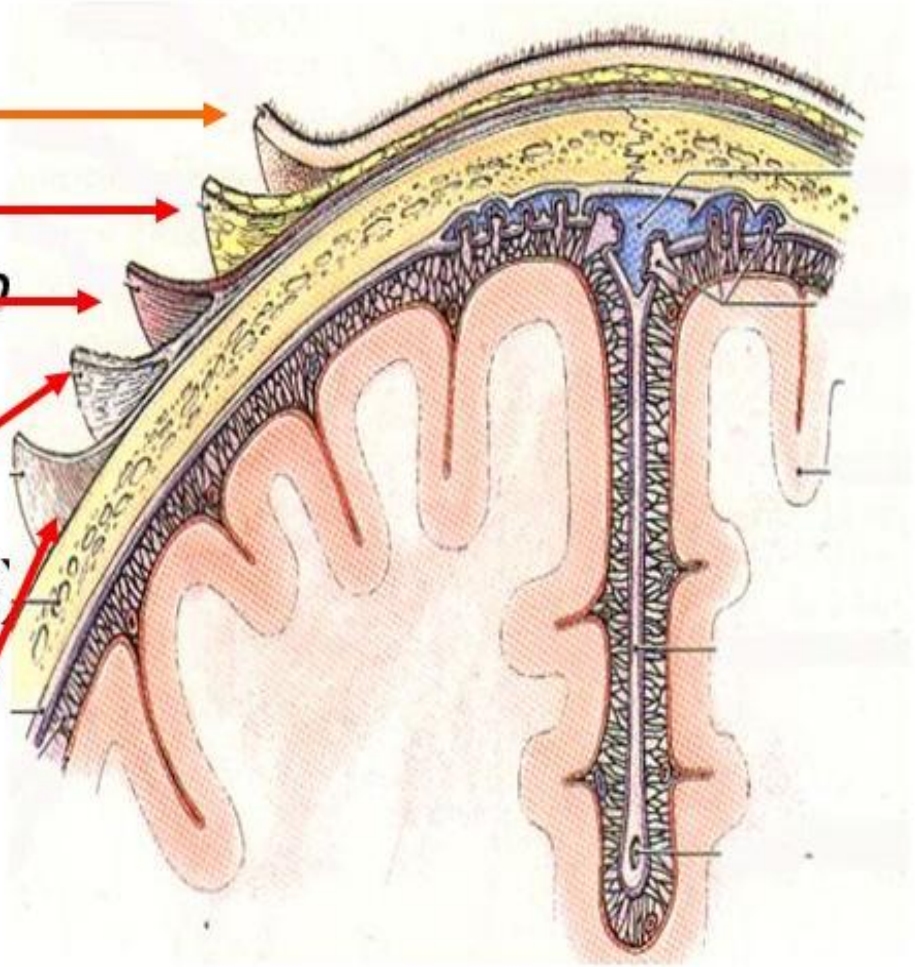
= *skin*

= *connective tissue*

= *aponeurosis of occipito Frontalis*

= *loose areolar C.T.* (subaponeurotic space)

= *pericranium (periosteum)*



Scalp anatomy
Skin

- The skin of the scalp is thick and hair bearing and contains numerous sebaceous glands. As a result, the scalp is a common site for sebaceous cysts.

Scalp anatomy
Connective tissue (superficial fascia)

- The superficial fascia is a fibrofatty layer that connects skin to the underlying aponeurosis of the occipitofrontalis muscle and provides a passageway for nerves and blood vessels. Blood vessels are attached to this fibrous connective tissue. If the vessels are cut, this attachment prevents vasospasm, which could lead to profuse bleeding after injury.

Superficial arteries of face and scalp

Moore_39_s_Essential_Clinical_Anatomy_5E.pdf - Adobe Acrobat Reader DC

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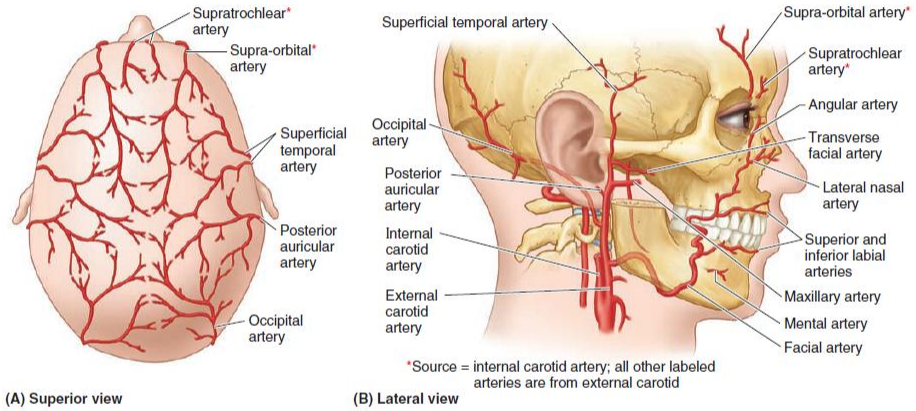

FIGURE 7.17. Superficial arteries of face and scalp.

TABLE 7.5 SUPERFICIAL ARTERIES OF FACE AND SCALP

Nerve	Origin	Course	Distribution
Facial	External carotid artery	Ascends deep to submandibular gland; winds around inferior border of mandible and enters face	Muscles of facial expression and face
Inferior labial	Facial artery near angle of mouth	Runs medially in lower lip	Lower lip
Superior labial		Runs medially in upper lip	Upper lip and ala (side) and septum of nose
Lateral nasal	Facial artery as it ascends alongside nose	Passes to ala of nose	Skin on ala and dorsum of nose

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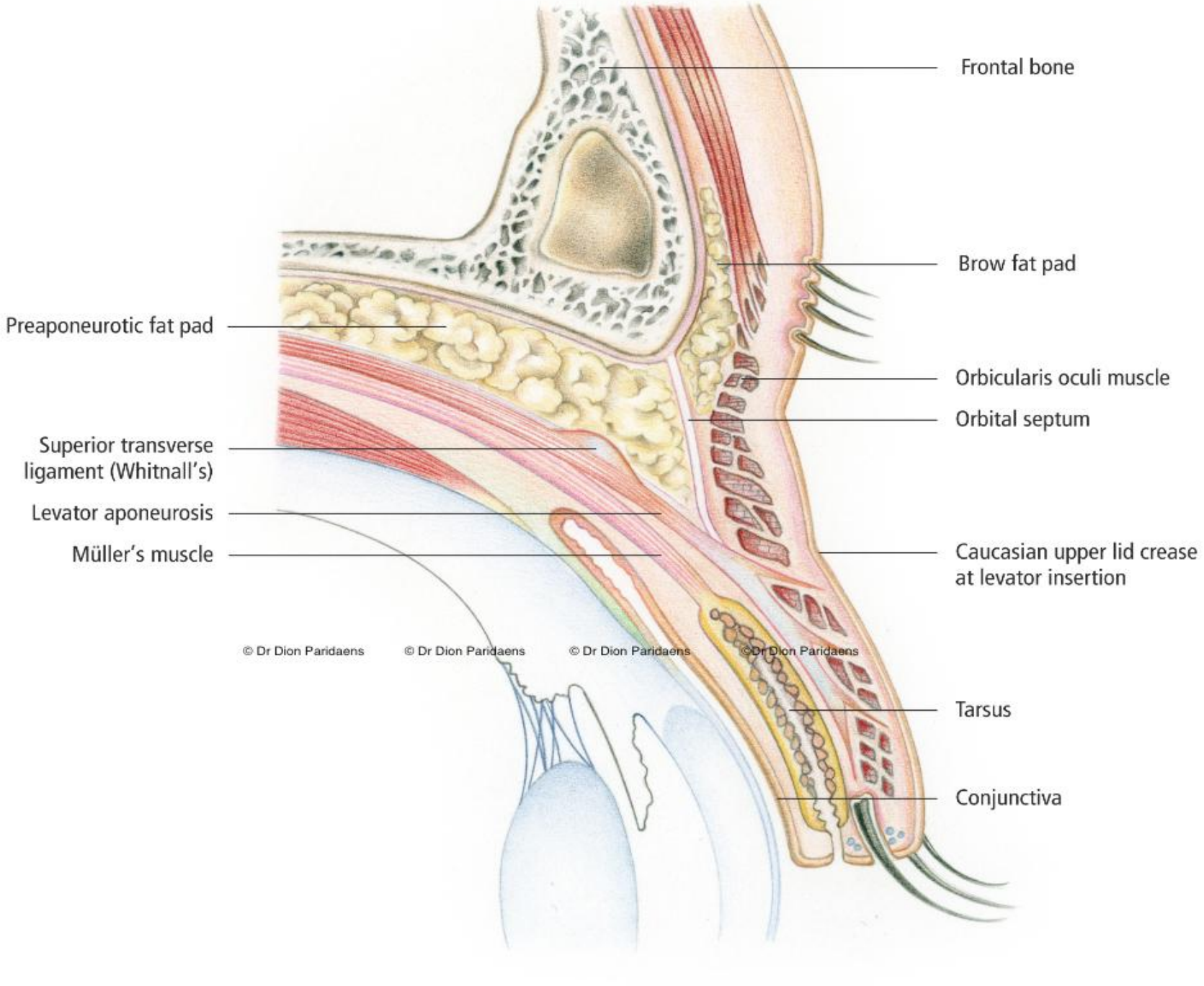
Scalp Anatomy
Epicranial aponeurosis (galea aponeurotica)

- The epicranial aponeurosis is a thin, tendinous structure that provides an insertion site for the occipitofrontalis muscle. Posterolaterally, the epicranial aponeurosis attachment extends from the superior nuchal line to the superior temporal line. Laterally, the epicranial aponeurosis continues as the temporal fascia. Anteriorly, the subaponeurotic space extends to the upper eyelids due to the lack of a bony insertion. This loose areolar tissue provides a potential subaponeurotic space that allows fluids and blood to pass from the scalp to the upper eyelids.


Frontal bone
Brow fat pad
Preaponeurotic fat pad
Orbicularis oculi muscle
Orbital septum
Superior transverse ligament (Whitnall's)
Levator aponeurosis
Müller's muscle
Caucasian upper lid crease at levator insertion
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Tarsus
Conjunctiva

Scalp anatomy
Loose areolar tissue

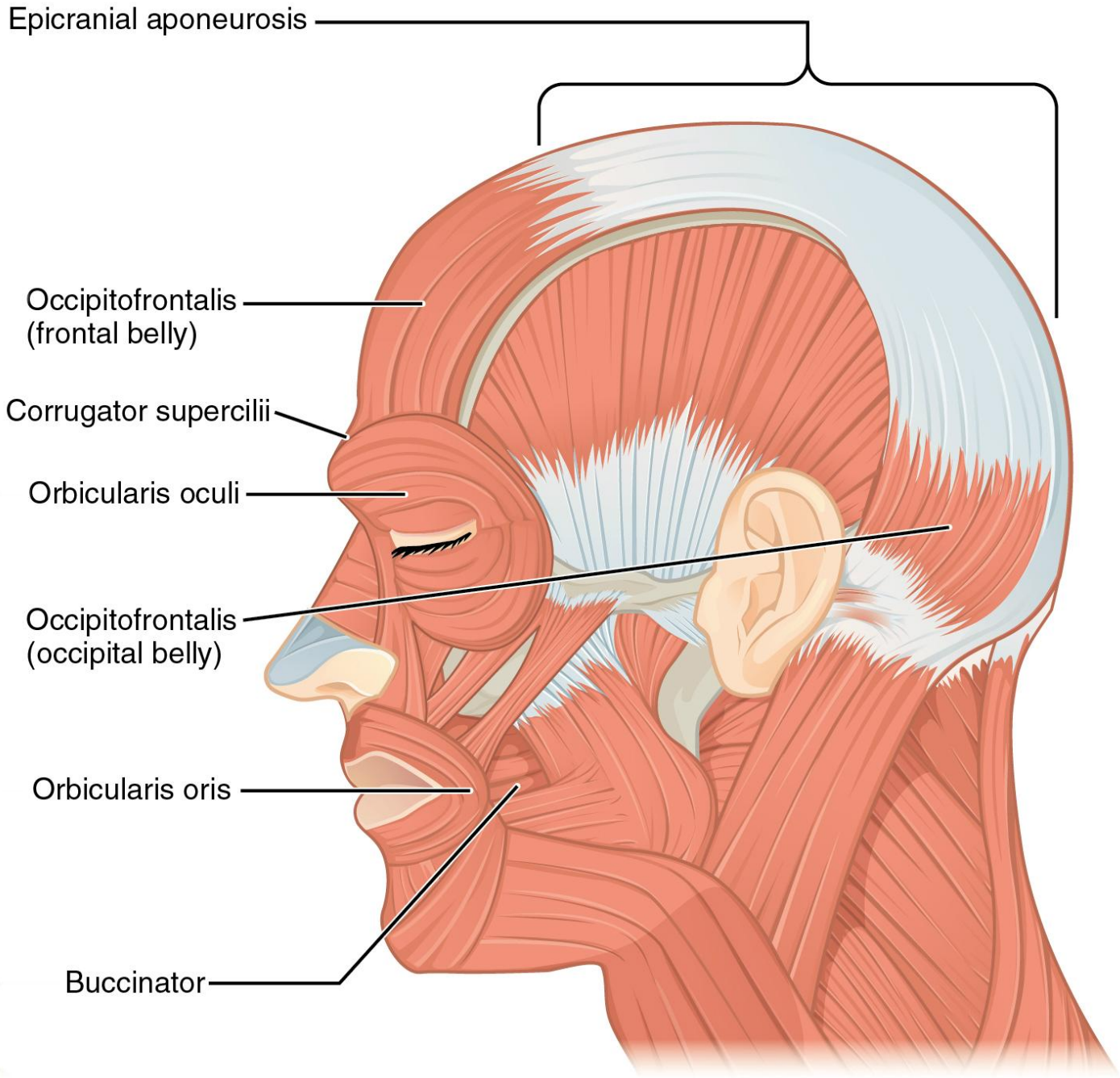
- Areolar tissue loosely connects the epicranial aponeurosis to the pericranium and allows the superficial 3 layers of the scalp to move over the pericranium. Scalp flaps are elevated along a relatively avascular plane in craniofacial and neurosurgical procedures. However, certain emissary veins traverse this layer, which connects the scalp veins to the diploic veins and intracranial venous sinuses.

Scalp anatomy
Pericranium

- The pericranium is the periosteum of the skull bones. Along the suture lines, the pericranium becomes continuous with the endosteum. A subperiosteal hematoma, therefore, forms in the shape of the skull bones.

Occipitofrontalis muscle

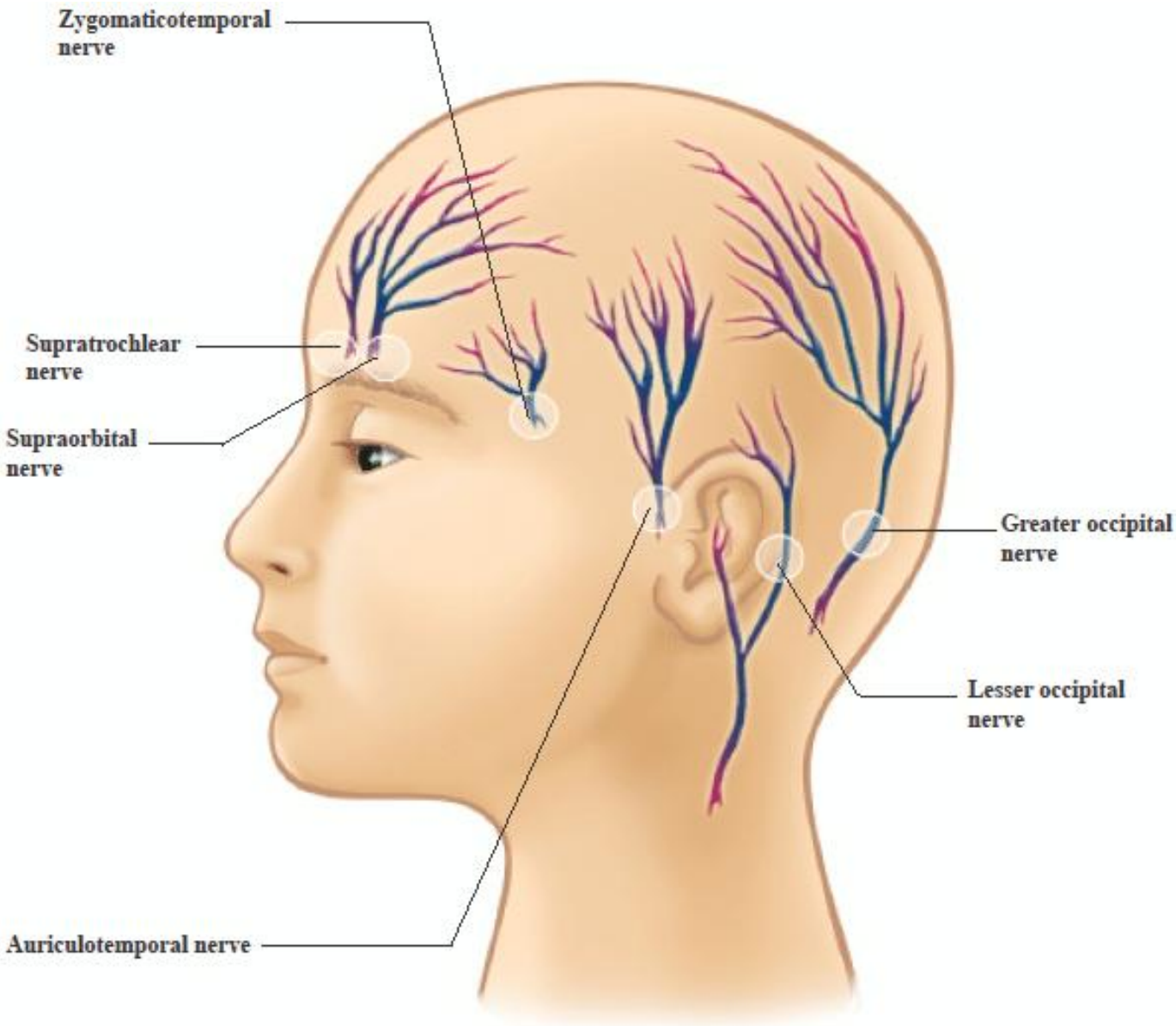
- The occipitofrontalis muscle consists of 2 occipital bellies and 2 frontal bellies. The occipital bellies arise from the superior nuchal lines on the occipital bone. The frontal bellies originate from the skin and superficial fascia of the upper eyelids. The occipital and frontal bellies insert into the epicranial aponeurosis.
- Each occipital belly is innervated by the posterior auricular branch of the facial nerve, and each frontal belly is innervated by the frontal branch of the facial nerve. The frontal bellies can raise the eyebrows.

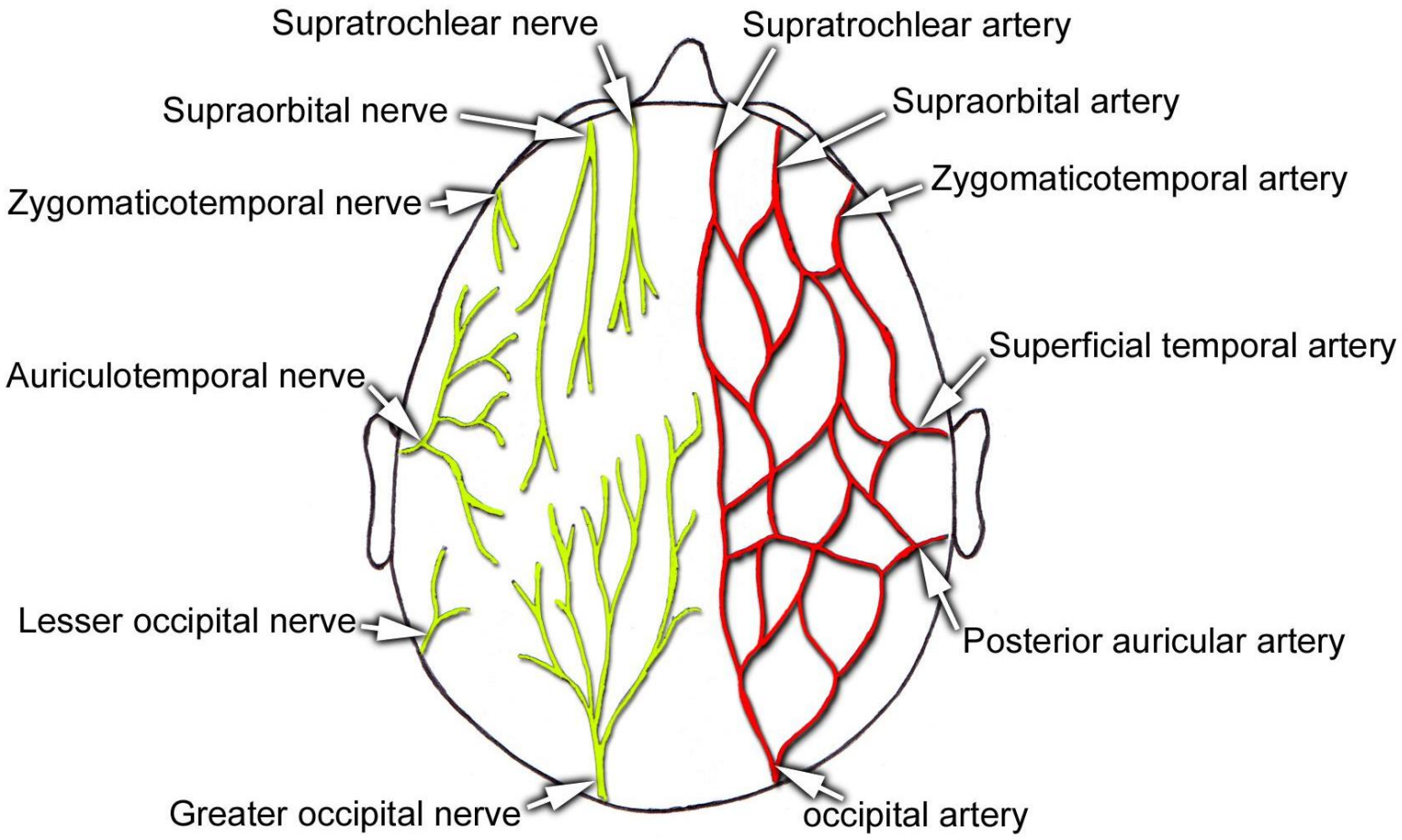


Facial muscles (lateral view)

Nerve Supply

The following 6 sensory nerve branches of either the trigeminal nerve or the cervical nerve supply the scalp (see the image and list below):



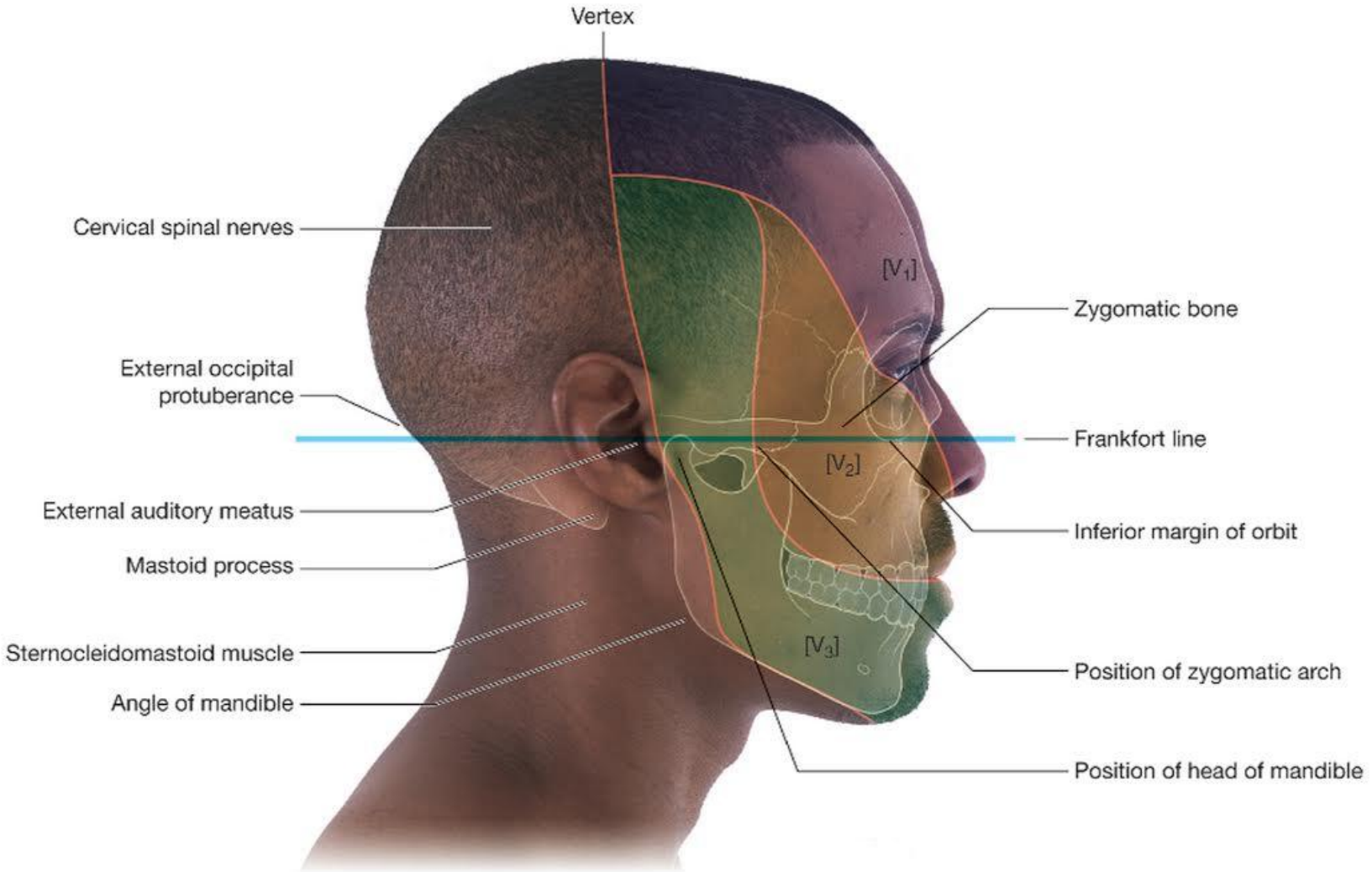


Sensory innervation and arterial supply of the scalp (From Snell RS, Clinical Anatomy for Medical Students, 5th ed)

Sensory supply

- Supratrochlear nerve - A branch of the ophthalmic division of the trigeminal nerve; this nerve supplies the scalp in the medial plane at the frontal region, up to the vertex
- Supraorbital nerve - Also a branch of the ophthalmic division of the trigeminal nerve; this nerve supplies the scalp at the front, lateral to the supratrochlear nerve distribution, up to the vertex
- Zygomaticotemporal nerve - A branch of the maxillary division of the trigeminal nerve; it supplies the scalp over the temple region
- Auriculotemporal nerve - A branch of the mandibular division of the trigeminal nerve; it supplies the skin over the temporal region of the scalp
- Lesser occipital nerve - A branch of the cervical plexus (C2); it supplies the scalp over the lateral occipital region
- Greater occipital nerve - A branch of the posterior ramus of the second cervical nerve; it supplies the scalp in the median plane at the occipital region, up to the vertex

Sensory supply



Motor supply

- The frontal branch of the facial nerve supplies the frontal bellies of the occipitofrontalis muscle, and the auricular branch of the facial nerve supplies the occipital bellies of the muscle.

Arterial supply

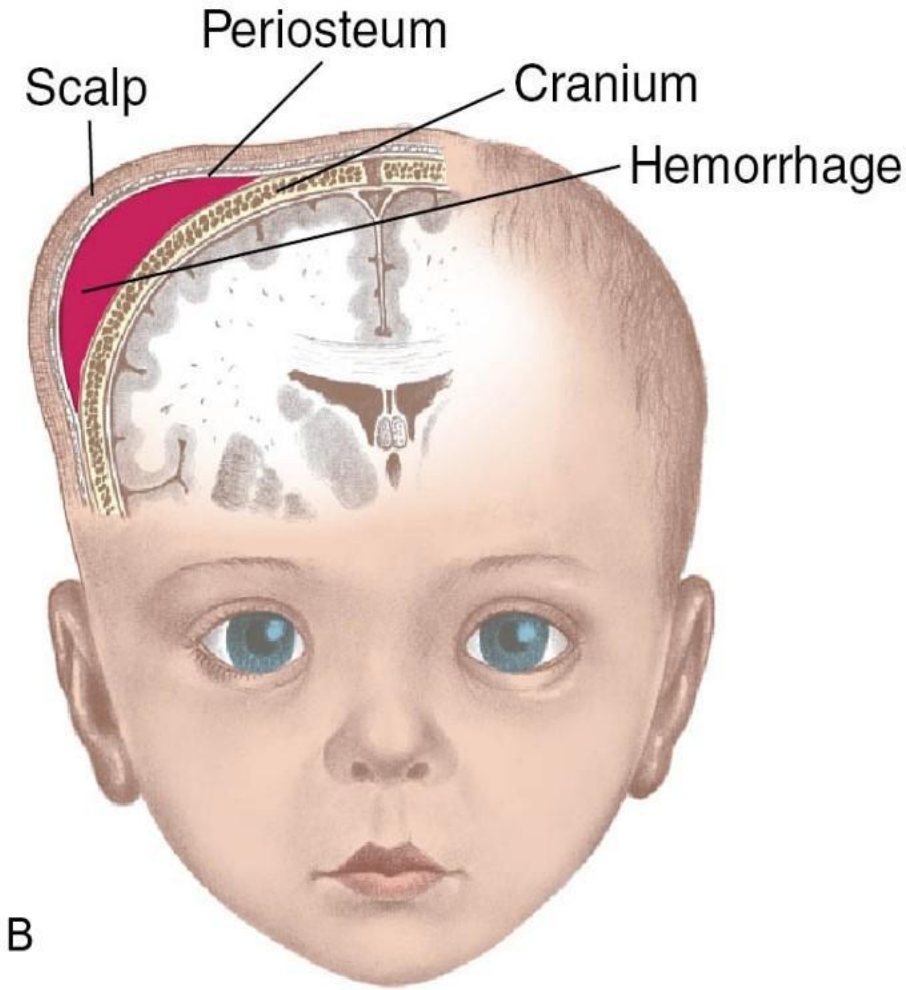
- The scalp has a rich vascular supply. The blood vessels traverse the connective tissue layer, which receives vascular contribution from the internal and external carotid arteries. The blood vessels anastomose freely in the scalp.

Arterial Supply

- Wounds in the scalp bleed profusely, because the fibrous fascia prevents vasoconstriction. However, wounds superficial to the aponeurosis gap much less than do wounds that cut through it, because aponeurosis holds the skin tight.

Arterial Supply

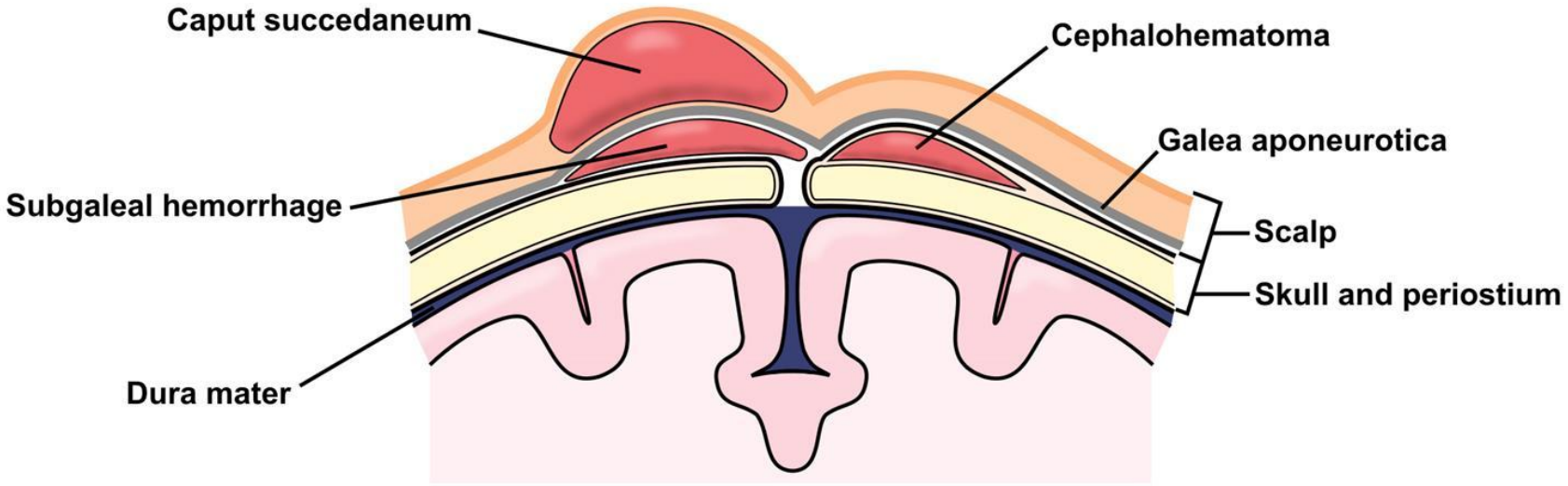
- During a difficult birth, bleeding may occur between the neonate's pericranium and calvaria, usually over 1 parietal bone, because of a rupture of multiple minute periosteal arteries. The resulting collection of blood several hours after birth is known as cephalohematoma.



(From Seidel, H., Ball, J., Dains, J., & Benedict, G. [2006]. *Mosby's guide to physical examination* [6th ed.]. St. Louis: Mosby.)

Arterial Supply (cephalohematoma)

Neonatal Extracranial Injuries



Moises Dominguez

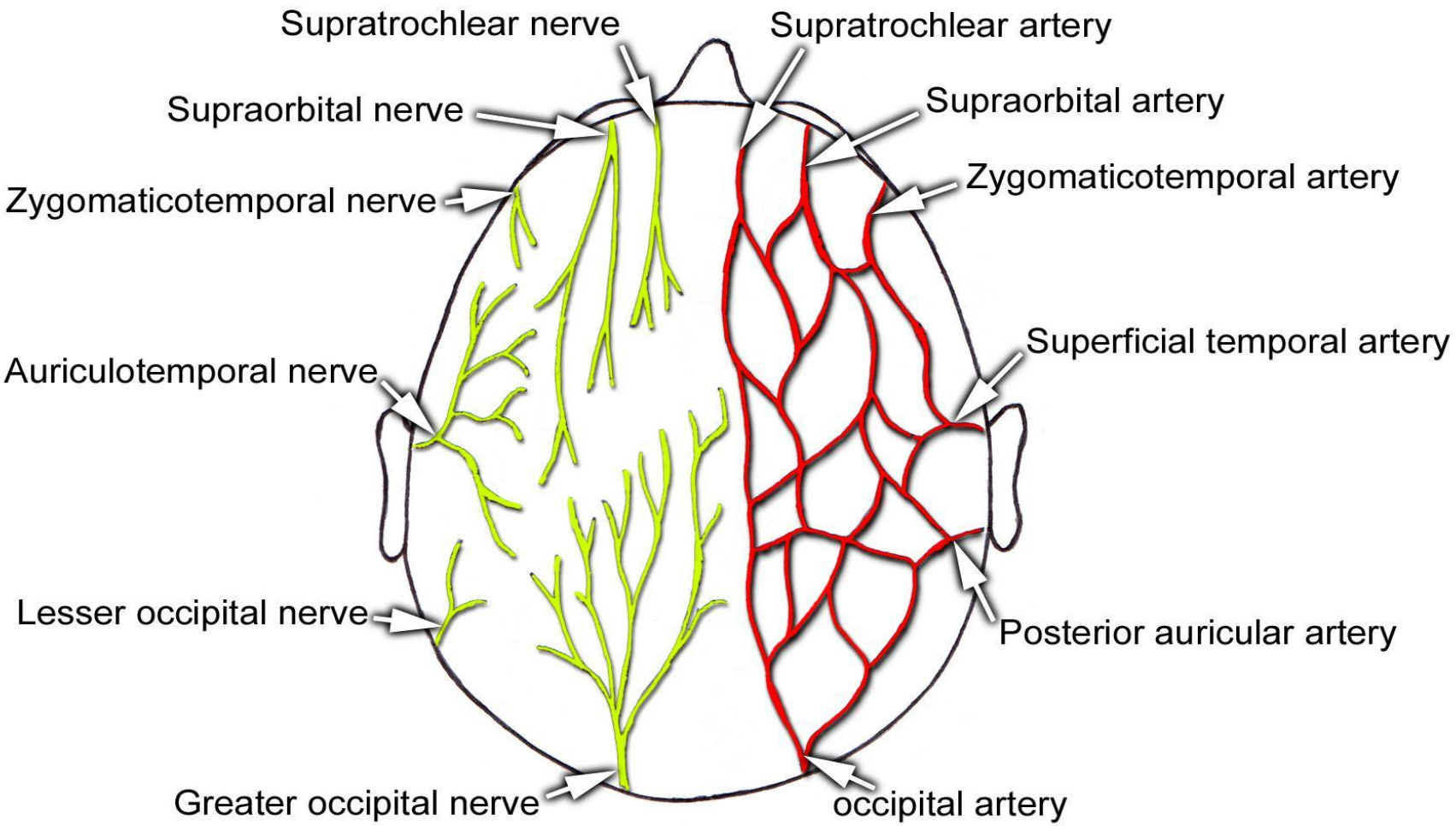
Arterial Supply

- Anastomosis exists at the medial angle of the eye, between the facial branch of the external carotid artery and the cutaneous branch of the internal carotid artery. During old age, if the internal carotid artery undergoes atherosclerotic changes, the intracranial structures can receive blood from the connection of the facial artery to the dorsal nasal branch of the ophthalmic artery.

Arterial supply

From the midline anteriorly, the arteries present as follows:

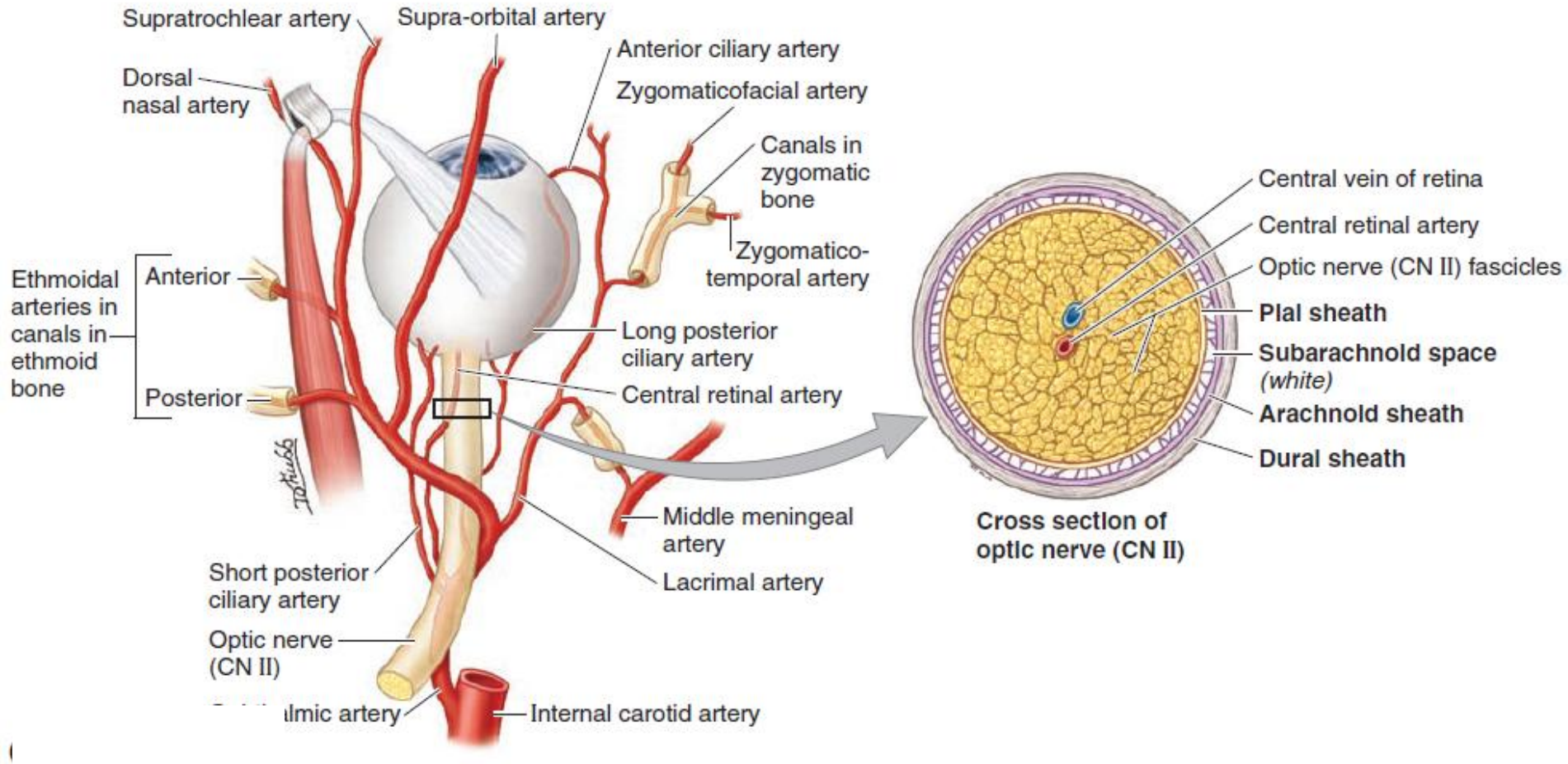
- Supratrochlear artery
- Supraorbital artery
- Superficial temporal artery
- Posterior auricular artery
- Occipital artery


Supratrochlear nerve
Supratrochlear artery
Supraorbital nerve
Supraorbital artery
Zygomaticotemporal nerve
Zygomaticotemporal artery
Auriculotemporal nerve
Superficial temporal artery
Lesser occipital nerve
Posterior auricular artery
Greater occipital nerve
occipital artery

Arterial supply

- The supratrochlear and supraorbital arteries are 2 branches of the ophthalmic artery, which, in turn, is a branch of the internal carotid artery. These arteries accompany the corresponding nerves.

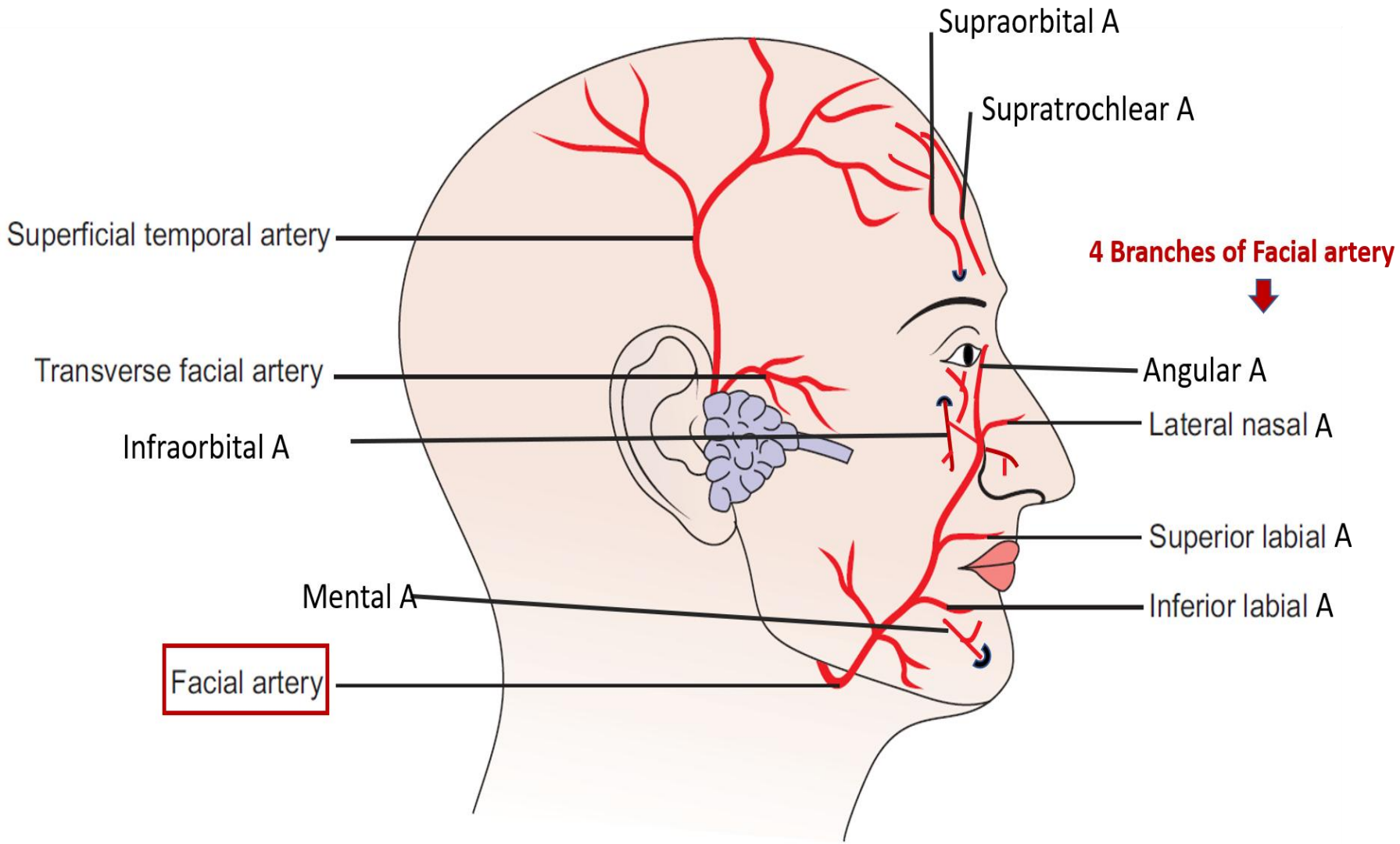
Branches of ophthalmic artery



Arterial supply

- The superficial temporal artery is a terminal branch of the external carotid artery that ascends in front of the auricle. This artery, which supplies the scalp over the temporal region, travels with the auriculotemporal nerve and divides into anterior and posterior branches.

Arterial supply



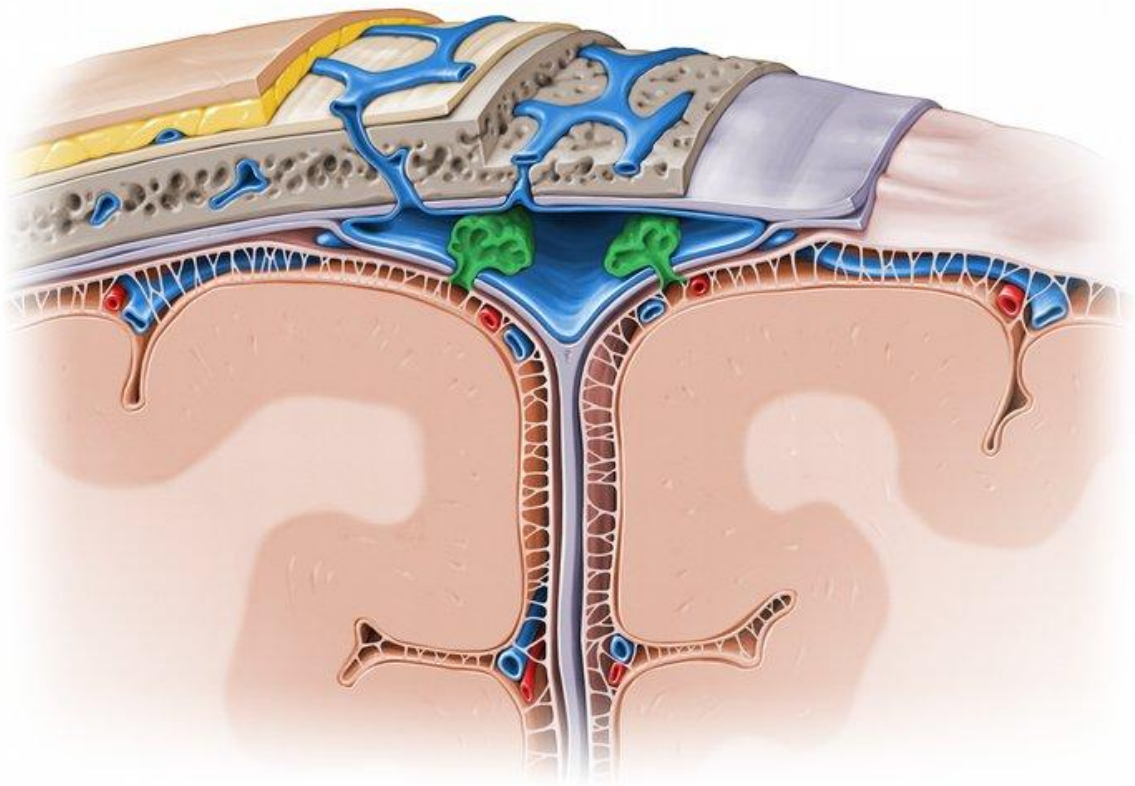
Arterial supply

- The posterior auricular artery is a branch of the external carotid artery that ascends posterior to the auricle. The occipital artery is a branch of the external carotid artery; it is accompanied by the greater occipital nerve.

Venous and Lymphatic Drainage

- The veins of the scalp freely anastomose with one another and are connected to the diploic veins of the skull bones and the intracranial dural sinuses through several emissary veins. The emissary veins are valveless.

Venous and Lymphatic Drainage



Venous and lymphatic drainage

- The emissary veins do not have valves and open in the loose areolar tissue; therefore, infection can be transmitted from the scalp to the cranial cavity. The layer of loose areolar tissue is known as the dangerous area of the scalp.

Venous and Lymphatic Drainage

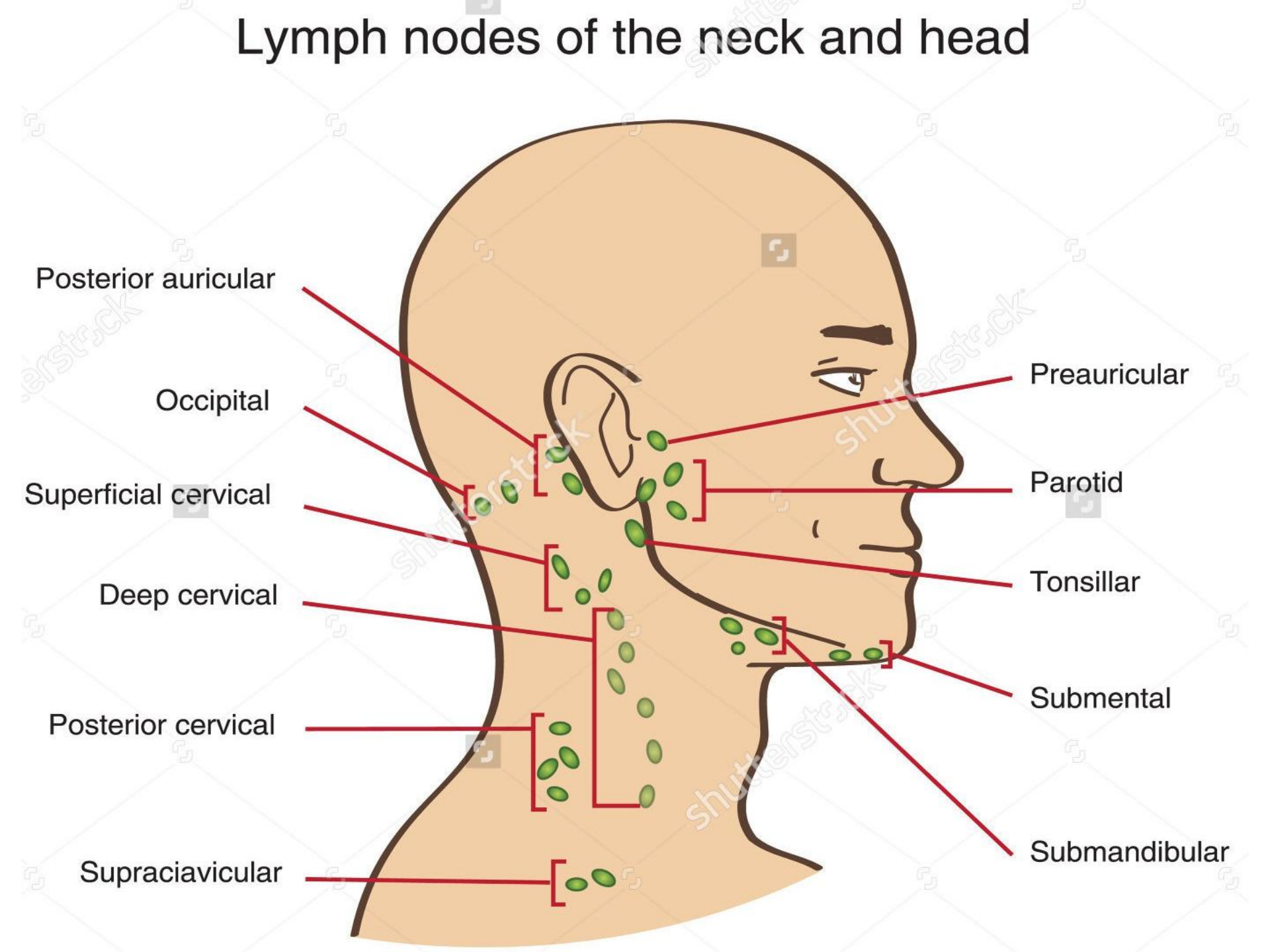
The scalp veins, which are as follows, accompany the arteries and have similar names (see the image below):

- Supratrochlear and supraorbital veins - Drain the anterior region of the scalp; these 2 veins unite to form the angular vein at the medial angle region of the eye and continue further as the facial vein
- Superficial temporal vein - Descends in front of the auricle and enters the parotid gland; it joins the maxillary vein to form the retromandibular vein, the anterior division of which unites with the facial vein to form the common facial vein, which then drains into the internal jugular vein
- Posterior auricular vein - Joins the posterior division of the retromandibular vein to form the external jugular vein
- The occipital vein - Terminates in the suboccipital venous plexus, which lies beneath the floor of the upper part of the posterior triangle

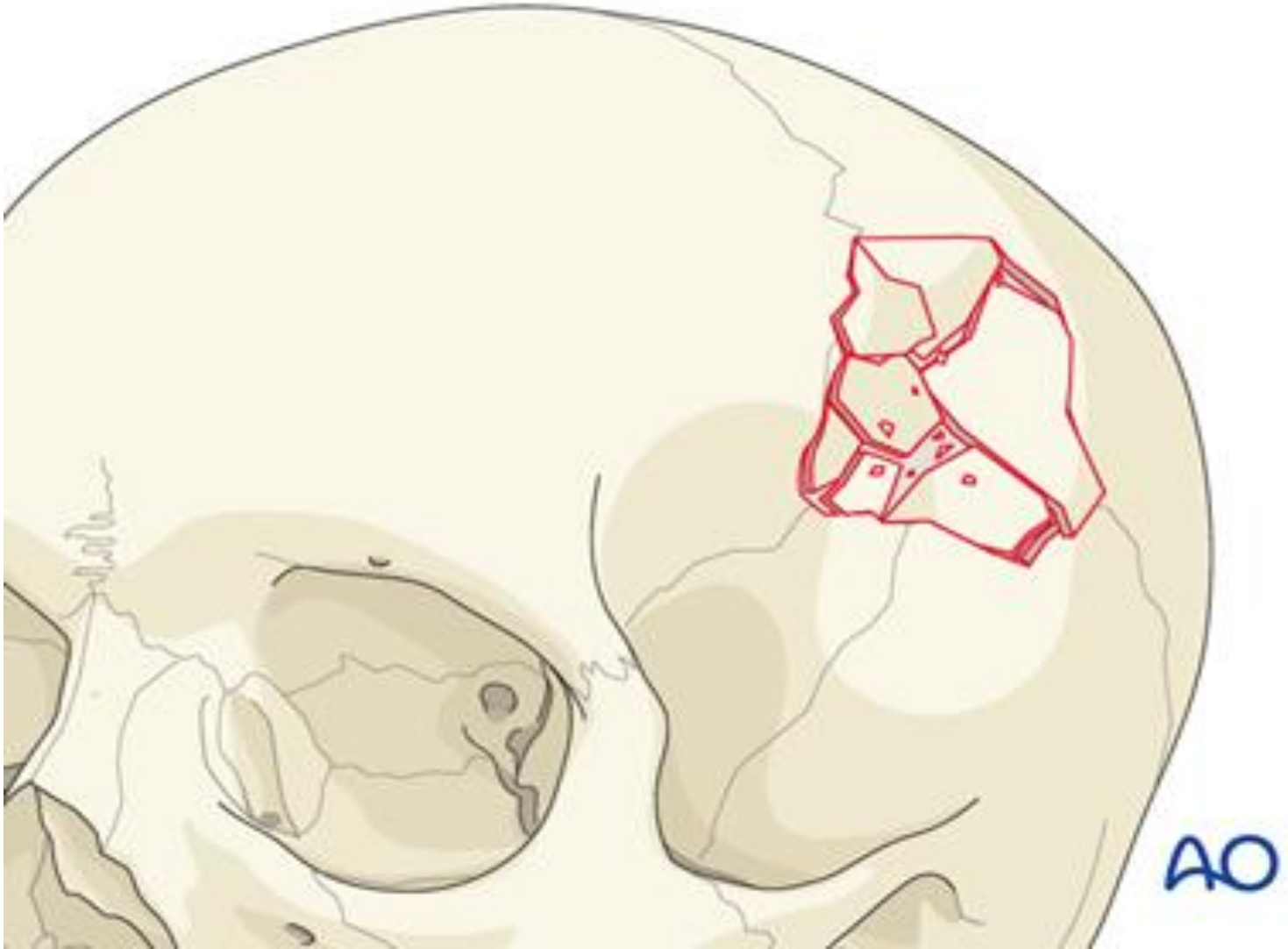
Lymphatic drainage

- The part of the scalp that is anterior to the auricles is drained to the parotid, submandibular, and deep cervical lymph nodes. The posterior part of the scalp is drained to the posterior auricular (mastoid) and occipital lymph nodes.

Lymph nodes of the neck and head



The fractures of the cranial vault



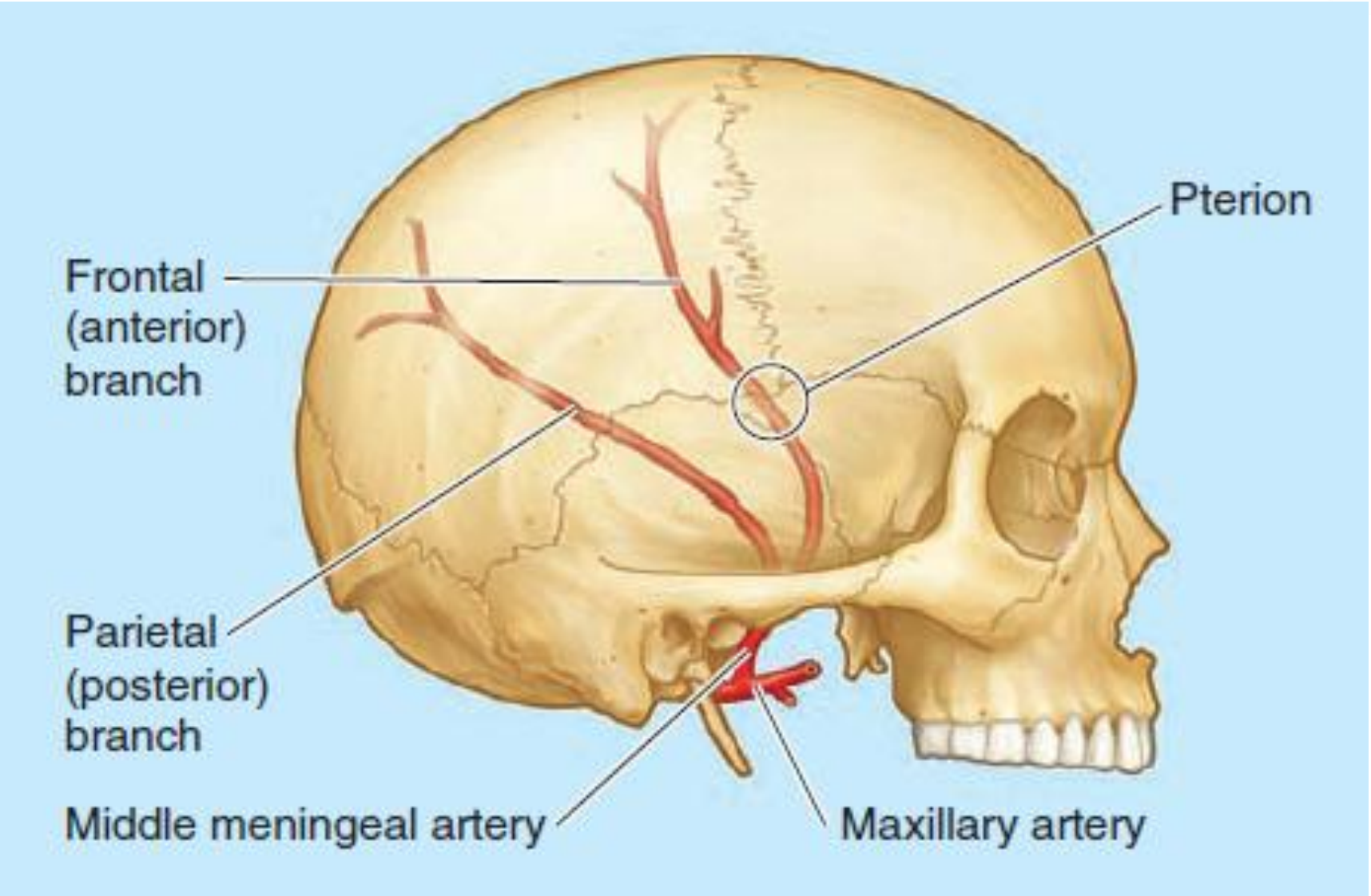
The fractures of the cranial vault

- The majority of head trauma involve the cranial vault.
- Fractures most often occur in the frontal or parietal bone. In case of frontal vault fractures, typically the frontal sinus is involved.
- Many fractures can start between cranial sutures and extend to contiguous bones (eg, frontal, parietal, and temporal bones as illustrated).
- The fractures of the cranial vault can be depressed, closed, or open with or without the involvement of the brain and meninges.

The fractures of the cranial vault

The convexity of the calvaria (skullcap) distributes and thereby minimizes the effects of a blow to it. However, hard blows to the head in thin areas are likely to produce depressed fractures in which a fragment of bone is depressed inward, compressing and/or injuring the brain.

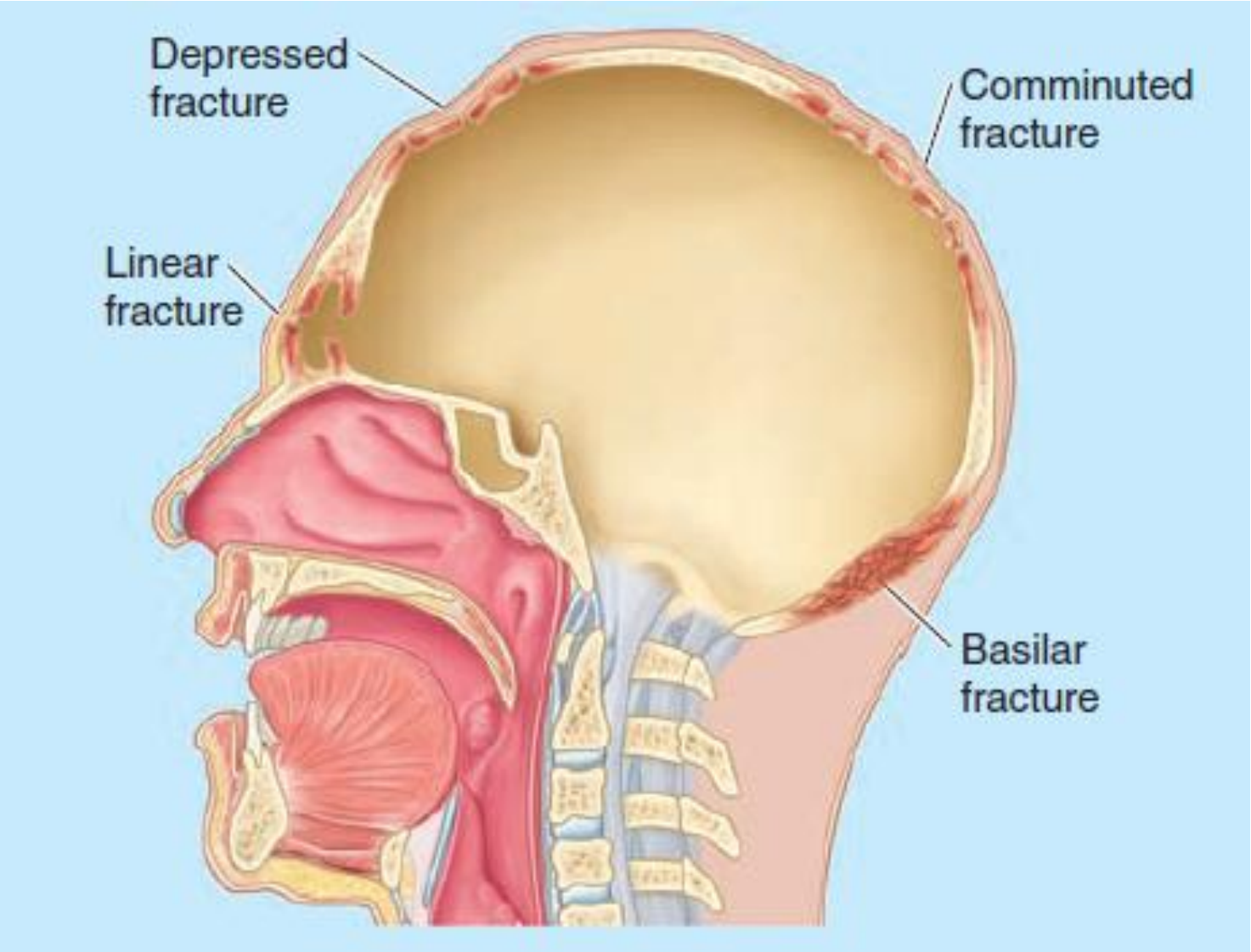
The fractures of the cranial vault



The fractures of the cranial vault

Fracture of the pterion can be life threatening because it overlies the frontal (anterior) branches of the middle meningeal vessels, which lie in grooves on the internal aspect of the lateral wall of the calvaria. A hard blow to the side of the head may fracture the thin bones forming the pterion, rupturing the frontal branches deep to the pterion. The resulting epidural hematoma exerts pressure on the underlying cerebral cortex. Untreated middle meningeal artery hemorrhage may cause death in a few hours.

The fractures of the cranial vault



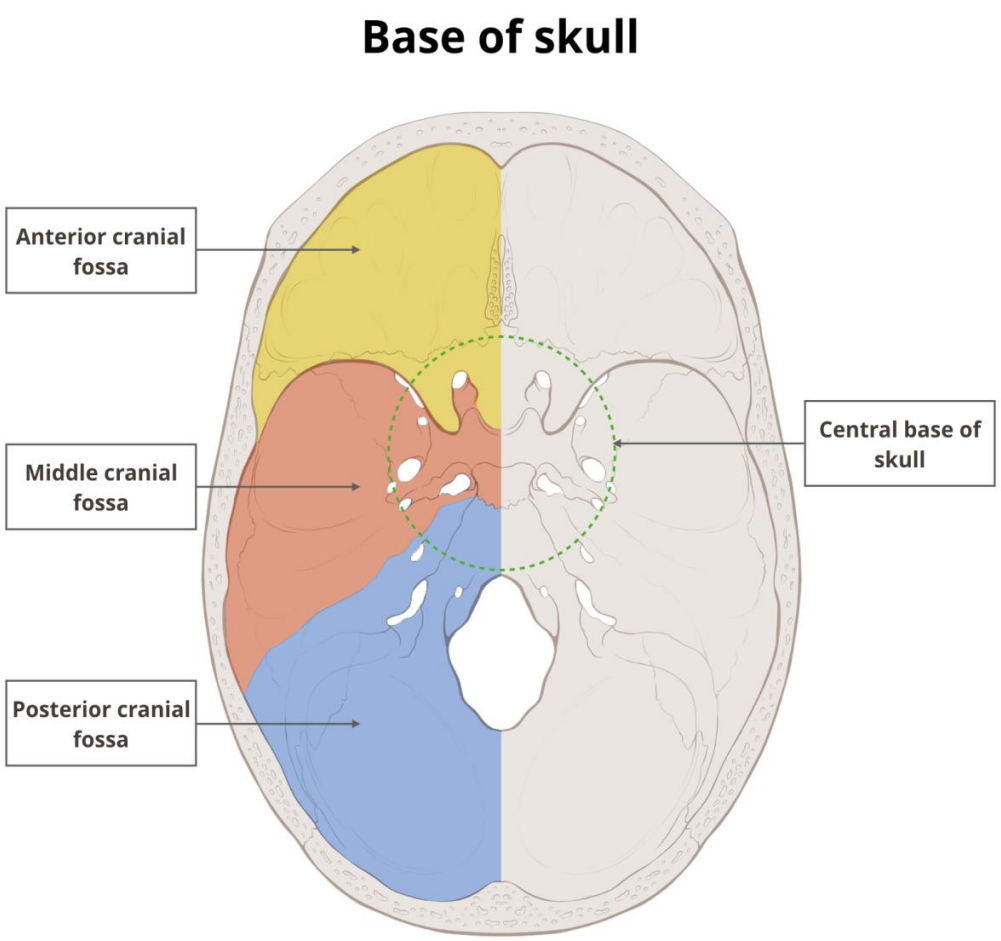
The fractures of the cranial vault

In **comminuted fractures**, the bone is broken into several pieces. **Linear calvarial fractures**, the most frequent type, usually occur at the point of impact, but fracture lines often radiate away from it in two or more directions. If the area of the calvaria is thick at the site of impact, the bone usually bends inward without fracturing; however, a fracture may occur some distance from the site of direct trauma where the calvaria is thinner. In a **contrecoup (counterblow) fracture**, the fracture occurs on the opposite side of the cranium rather than at the point of impact.

The skull base

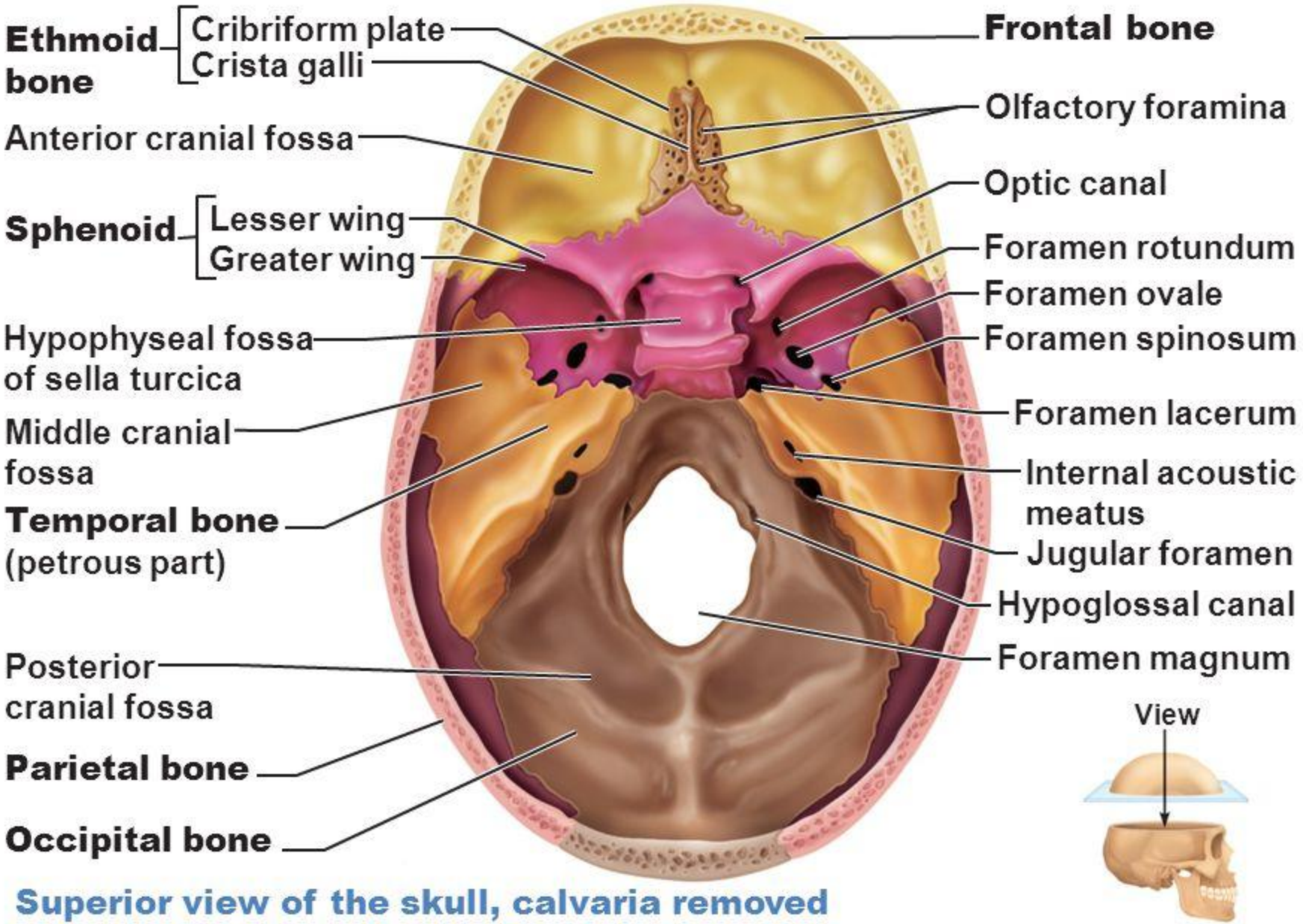
- The skull base forms the floor of the cranial cavity and separates the brain from other facial and neck structures. This anatomic region is complex and poses surgical challenges for otolaryngologists and neurosurgeons alike. Working knowledge of the normal and variant anatomy of the skull base is essential for effective surgical treatment of disease in this area.

The skull base



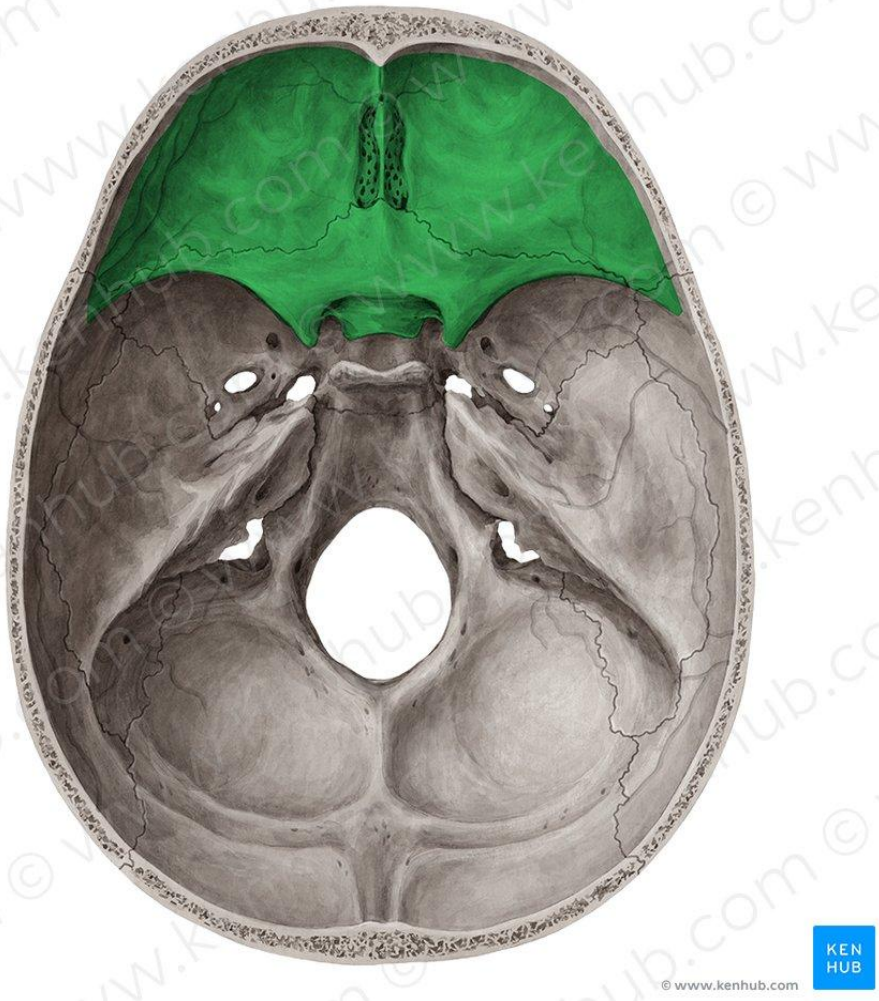
Adapted by Frank Gaillard based on the illustration of skull base by Patrick J. Lynch CC BY 2.5 commons.wikimedia.org File:Skull_brain_human_normal.svg

- The 5 bones that make up the skull base are the ethmoid, sphenoid, occipital, paired frontal, and paired temporal bones. The skull base can be subdivided into 3 regions, anterior-to-posterior depressions or fossae: the anterior, middle, and posterior cranial fossae.



Superior view of the skull, calvaria removed

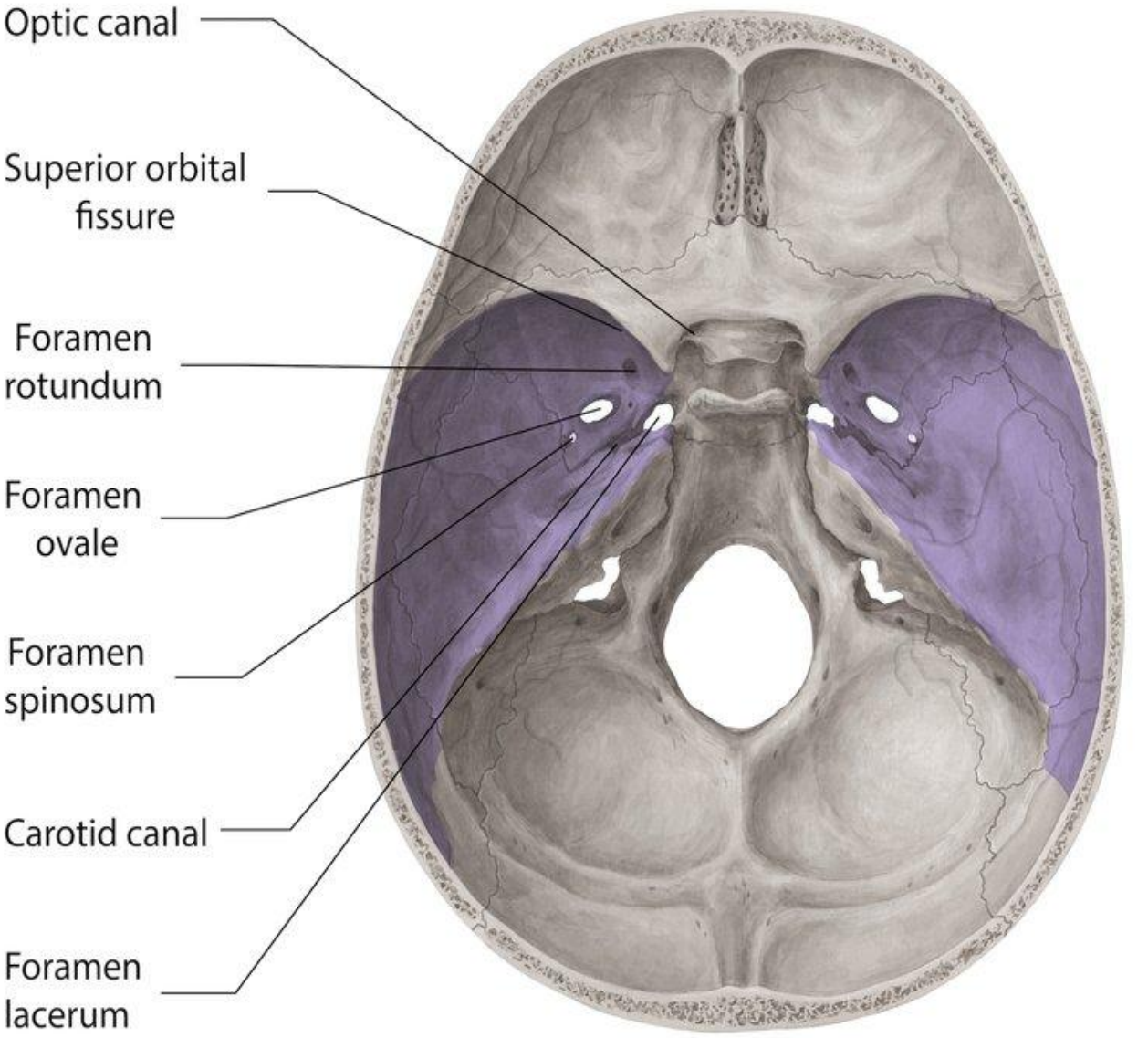
Anterior cranial fossa (Fossa cranii anterior)



- The anterior fossa is formed by the orbital plates of the frontal bone, cribriform plate of the ethmoid, and lesser wings of the sphenoid. It features the crista galli for attachment of the falx cerebri and the cribriform plate containing multiple foramina for the neurofilaments of the olfactory nerve.

The skull base

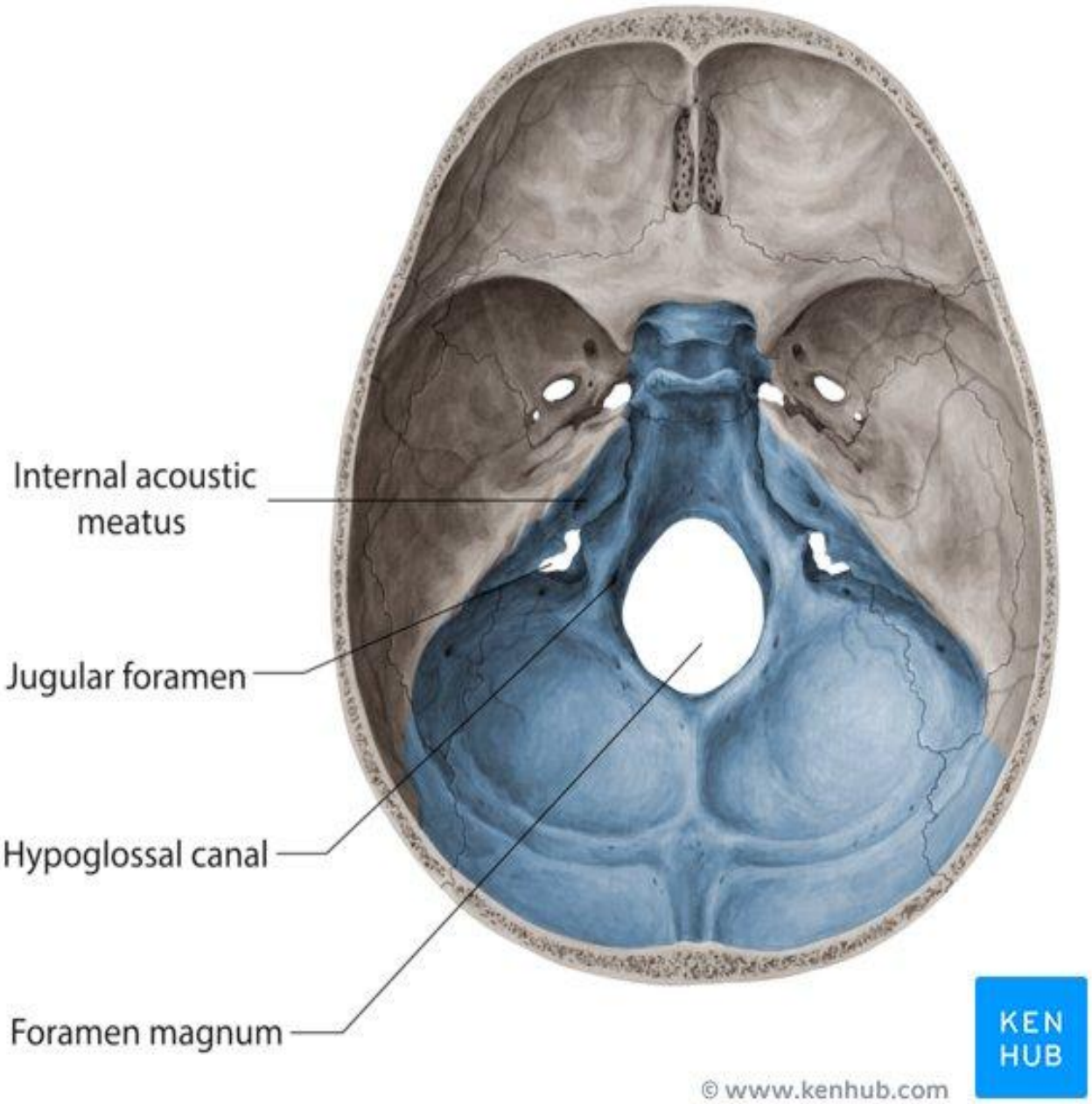
The middle fossa extends from the lesser wings of the sphenoid to the superior border of the petrous portion of temporal bone and includes the midline body of the sphenoid. Foramina of interest here include the optic canal, superior orbital fissure, foramen rotundum, foramen ovale, foramen spinosum, foramen lacerum, and intracranial opening of the carotid canal.



- **Openings (foramina and canals) of the middle cranial fossa**

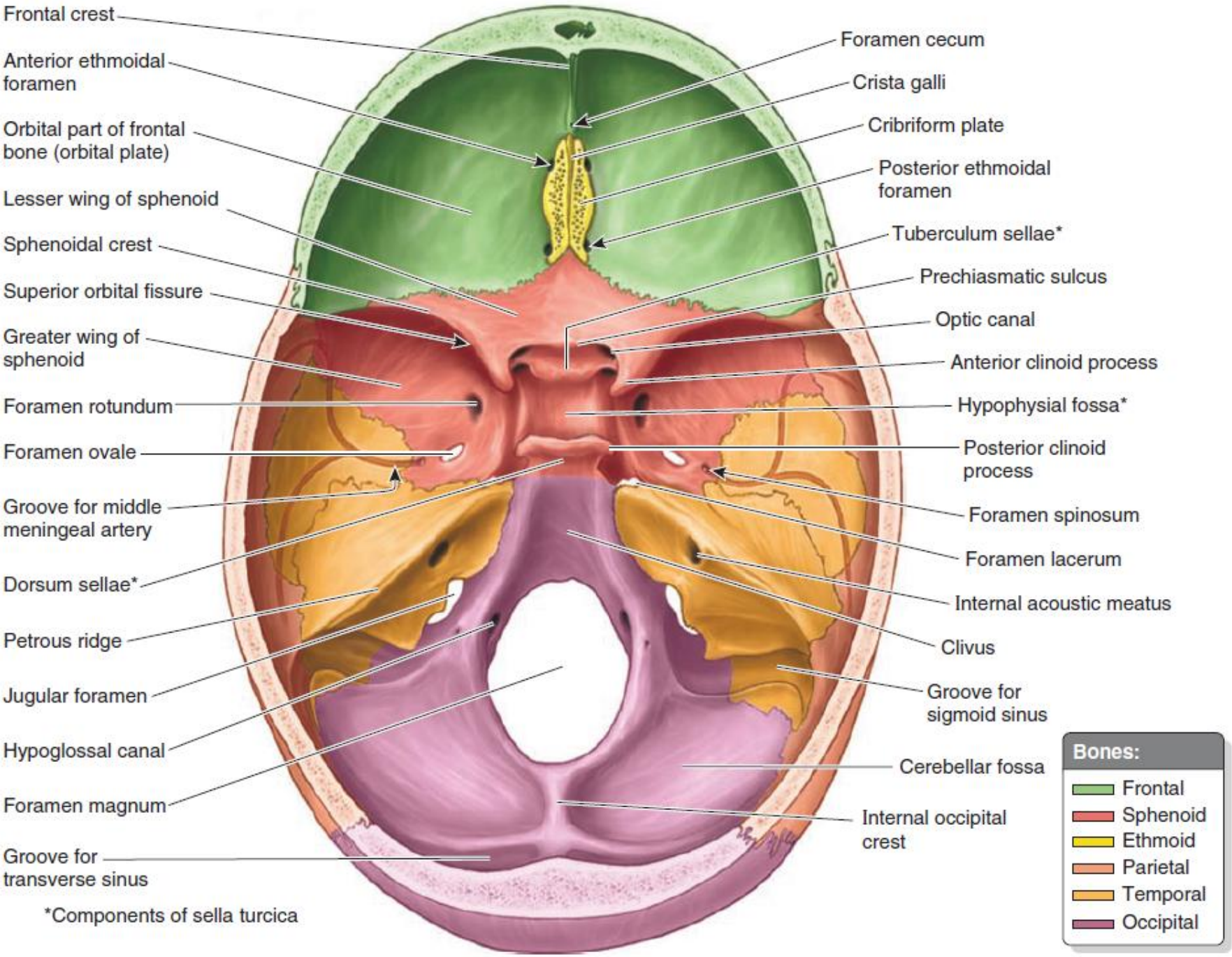
The skull base

The posterior fossa extends from the superior border of the petrous bone to the transverse groove of the occipital bone. These are the attachment sites of the tentorium cerebelli and contain, respectively, the superior petrosal sinus and transverse sinus. Foramina in the posterior fossa include the internal auditory meatus, jugular foramen, hypoglossal canal, and the foramen magnum.

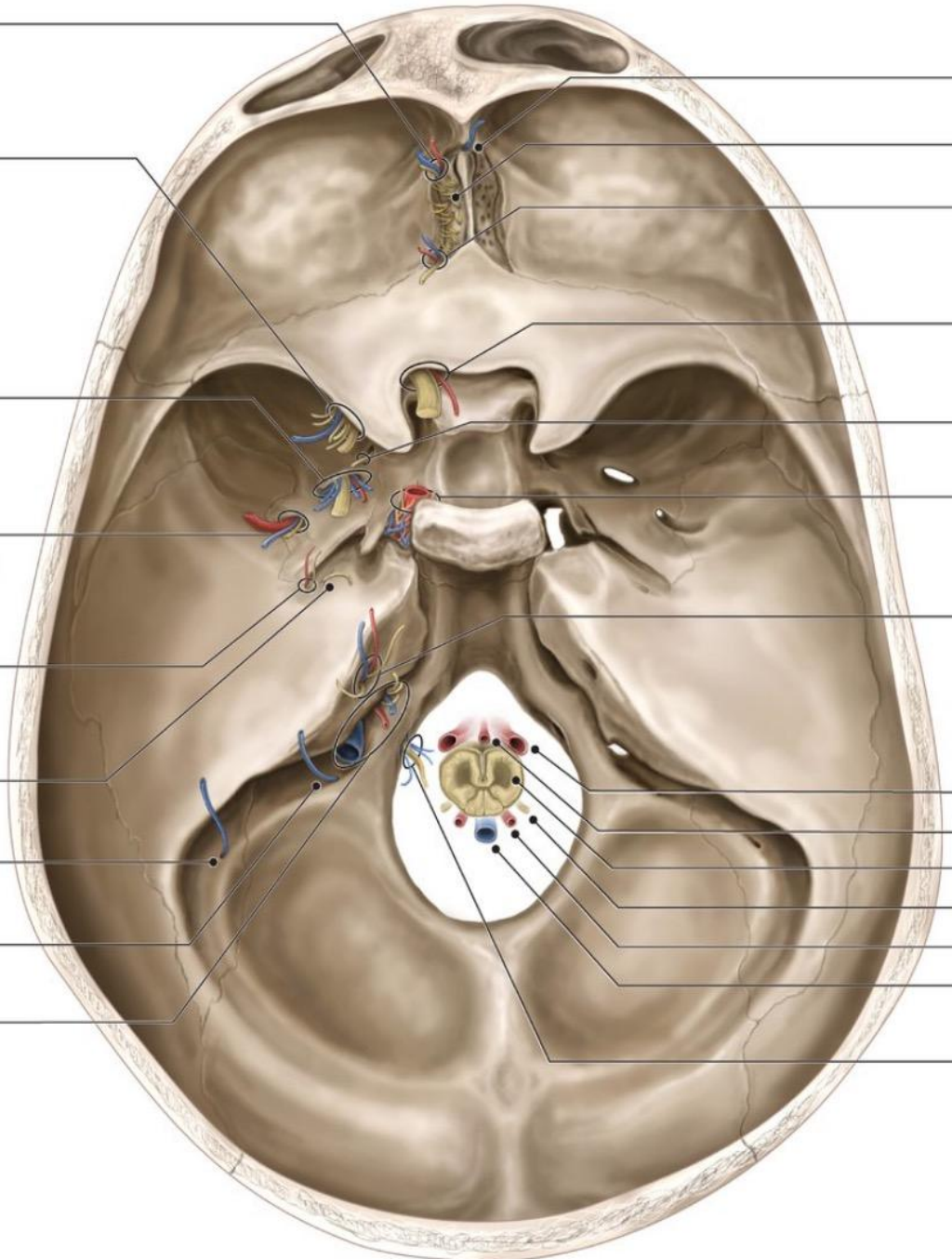


- **Openings of the posterior cranial fossa**

Anterior cranial fossa	**Content: frontal lobe of the brain, olfactory bulb, olfactory tract** **Bones: orbital surface of the frontal bone, lesser wing of the sphenoid bone** **Landmarks: anterior ethmoidal foramen, cribriform foramina, jugum sphenoidale, foramen caecum, frontal crest**
Middle cranial fossa	Content: temporal lobes of the brain, pituitary gland Bones: body and greater wings of the sphenoid bone, petrous and squamous parts of the temporal bones Landmarks: - middle part - chiasmatic groove, tuberculum sellae, anterior clinoid process, sella turcica, middle clinoid process, carotid groove, foramen lacerum - lateral parts - foramen spinosum, superior orbital fissure, foramen rotundum, foramen ovale, foramen spinosum, foramen lacerum, trigeminal depression, orifice of the carotid canal
Posterior cranial fossa	Content: brainstem and cerebellum Bones: occipital bone, mastoid part of the temporal bone Landmarks: clivus, foramen magnum, internal acoustic meatus, jugular foramen, hypoglossal canal


Frontal crest
Anterior ethmoidal foramen
Orbital part of frontal bone (orbital plate)
Lesser wing of sphenoid
Sphenoidal crest
Superior orbital fissure
Greater wing of sphenoid
Foramen rotundum
Foramen ovale
Groove for middle meningeal artery
Dorsum sellae*
Petrous ridge
Jugular foramen
Hypoglossal canal
Foramen magnum
Groove for transverse sinus
*Components of sella turcica
Foramen cecum
Crista galli
Cribriform plate
Posterior ethmoidal foramen
Tuberculum sellae*
Prechiasmatic sulcus
Optic canal
Anterior clinoid process
Hypophysial fossa*
Posterior clinoid process
Foramen spinosum
Foramen lacerum
Internal acoustic meatus
Clivus
Groove for sigmoid sinus
Cerebellar fossa
Internal occipital crest
Bones:
Frontal
Sphenoid
Ethmoid
Parietal
Temporal
Occipital

Superior view of the interior of the skull



Foramen ethmoidale anterius
- N. ethmoidalis anterior (aus V_1)
- A. ethmoidalis anterior
- V. ethmoidalis anterior

Fissura orbitalis superior
- N. oculomotorius (III)
- N. trochlearis (IV)
- N. lacrimalis (aus V_1)
- N. frontalis (aus V_1)
- N. nasociliaris (aus V_1)
- N. abducens (VI)
- V. ophthalmica superior

Foramen ovale
- N. mandibularis (V_3)
- A. meningea accessoria
- Plexus venosus foraminis ovalis

Foramen spinosum
- R. meningeus n. mandibularis (aus V_3)
- A. meningea media
- V. meningea media

Hiatus canalis n. petrosi minoris
- N. petrosus minor (aus IX)
- A. tympanica superior

Hiatus canalis n. petrosi majoris
- N. petrosus major (aus VII)

Foramen mastoideum
- V. emissaria mastoidea

Canalis condylaris
- V. emissaria condylaris

Foramen jugulare
- N. glossopharyngeus (IX)
- N. vagus (X)
- N. accessorius (XI)
- A. meningea posterior
- Sinus petrosus inferior
- V. jugularis interna (Fortsetzung des Sinus sigmoideus)

Foramen caecum
- V. emissaria

Lamina cribrosa
- Fila olfactoria (N. olfactorius, I)

Foramen ethmoidale posterius
- N. ethmoidalis posterior (aus V_1)
- A. ethmoidalis posterior
- V. ethmoidalis posterior

Canalis opticus
- N. opticus (II)
- A. ophthalmica

Foramen rotundum
- N. maxillaris (V_2)

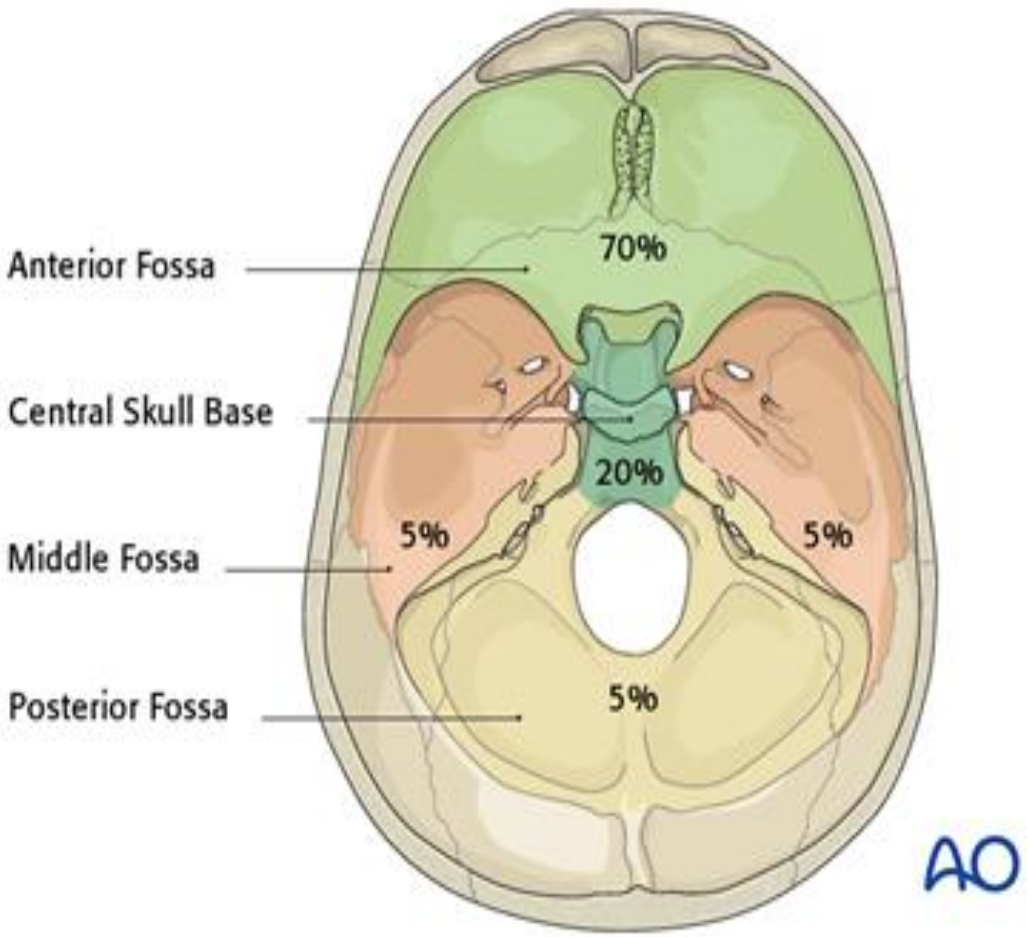
Canalis caroticus
- Plexus sympathicus caroticus internus
- A. carotis interna
- Plexus venosus caroticus internus

Porus acusticus internus
- N. facialis (VII)
- N. vestibulocochlearis (VIII)
- A. labyrinthi
- V. labyrinthi

Foramen magnum
- Aa. vertebrales
- A. spinalis anterior
- Medulla spinalis (Medulla oblongata)
- Radix spinalis n. accessorii (XI)
- Aa. spinales posteriores
- V. spinalis oder Plexus venosus vertebralis internus

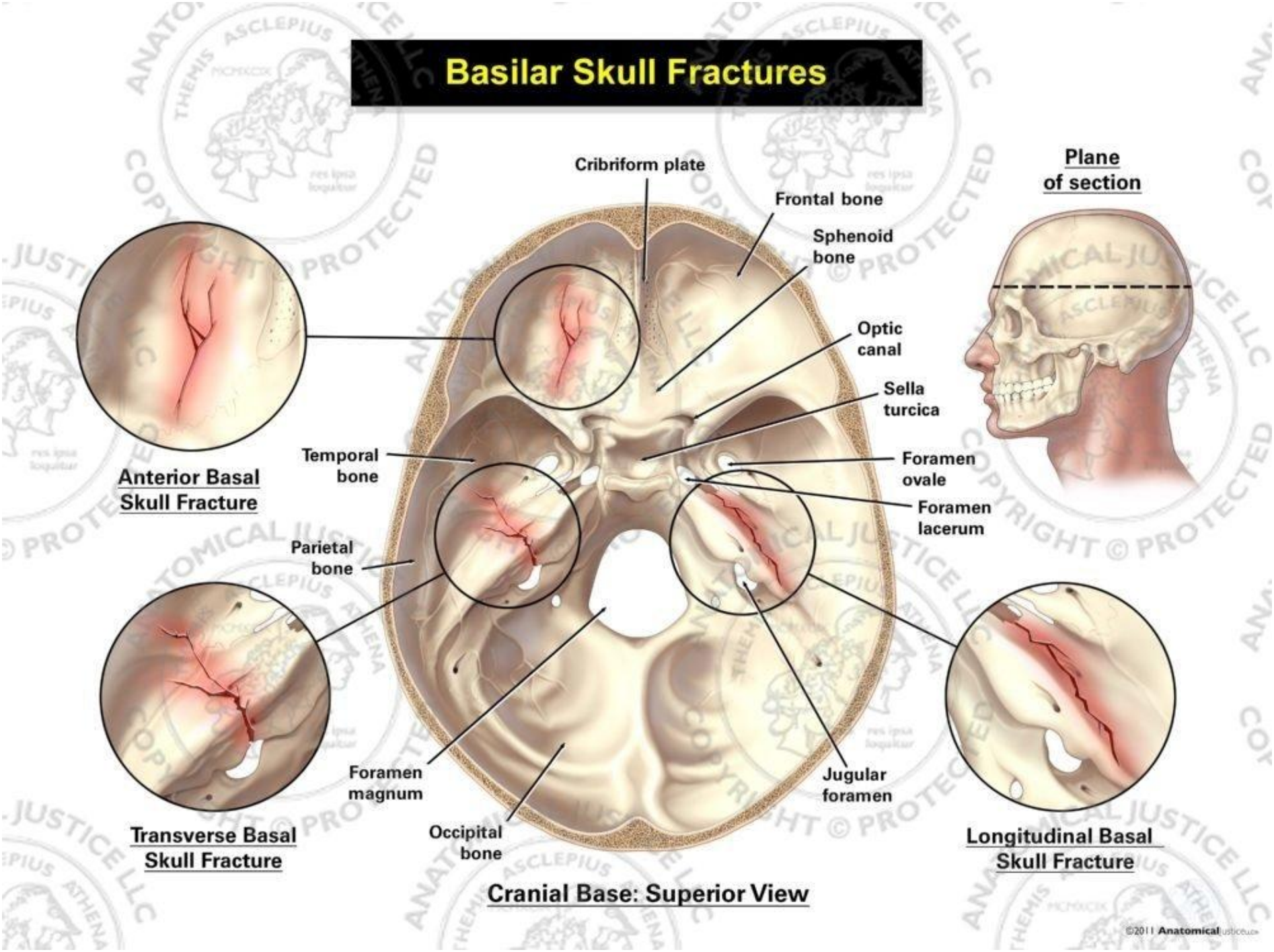
Canalis nervi hypoglossi
- N. hypoglossus (XII)
- Plexus venosus canalis n. hypoglossi

Skull base fractures

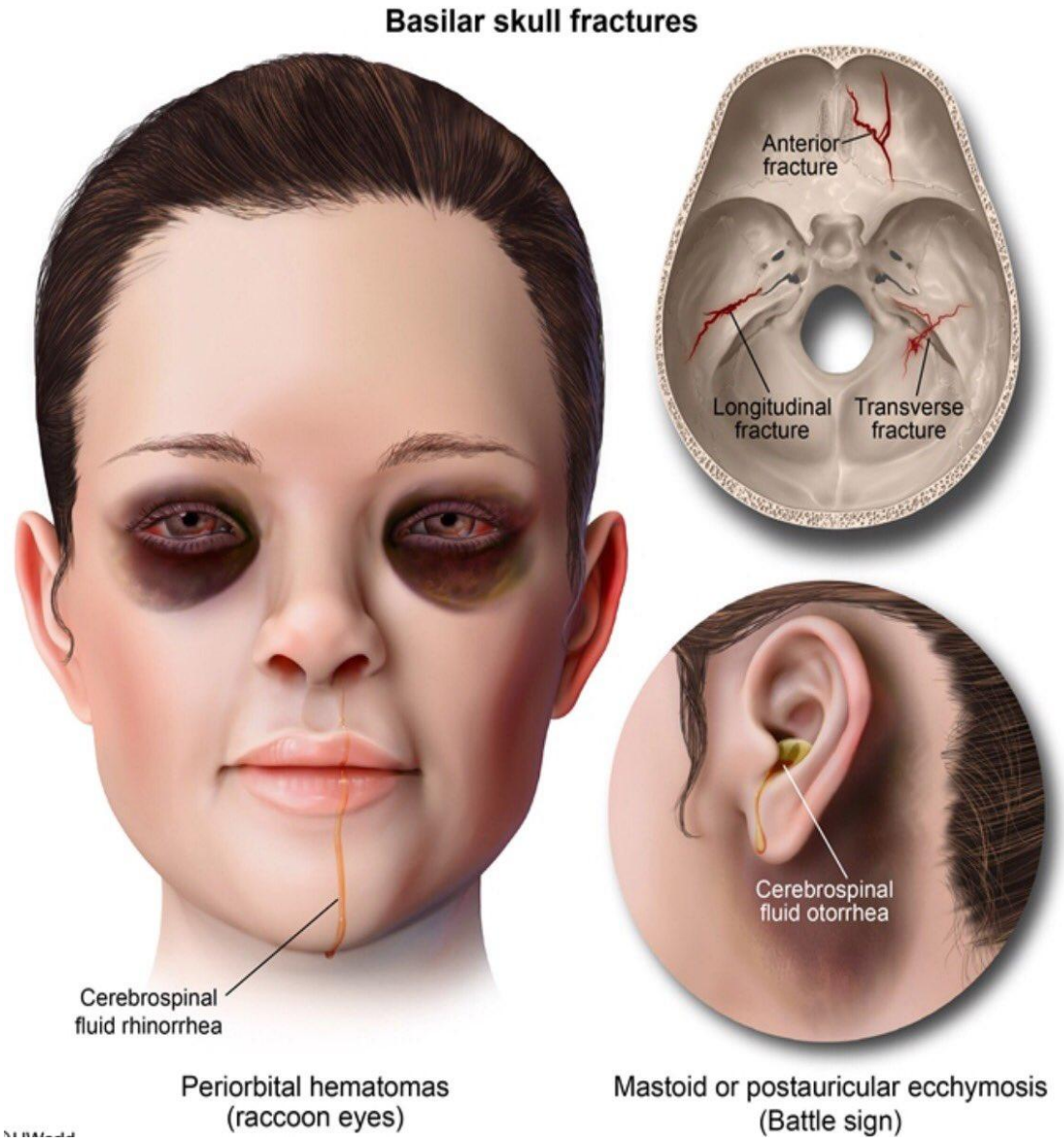


- Skull base fractures are of high importance in neurotrauma. They occur in 3.5 - 24% of head injuries and are often related to brain injury (in 50% of the cases).
- 70% of the skull base fractures occur in the anterior fossa, 20% in the middle central skull base and 5% in the middle and posterior fossa.

Basilar Skull Fractures

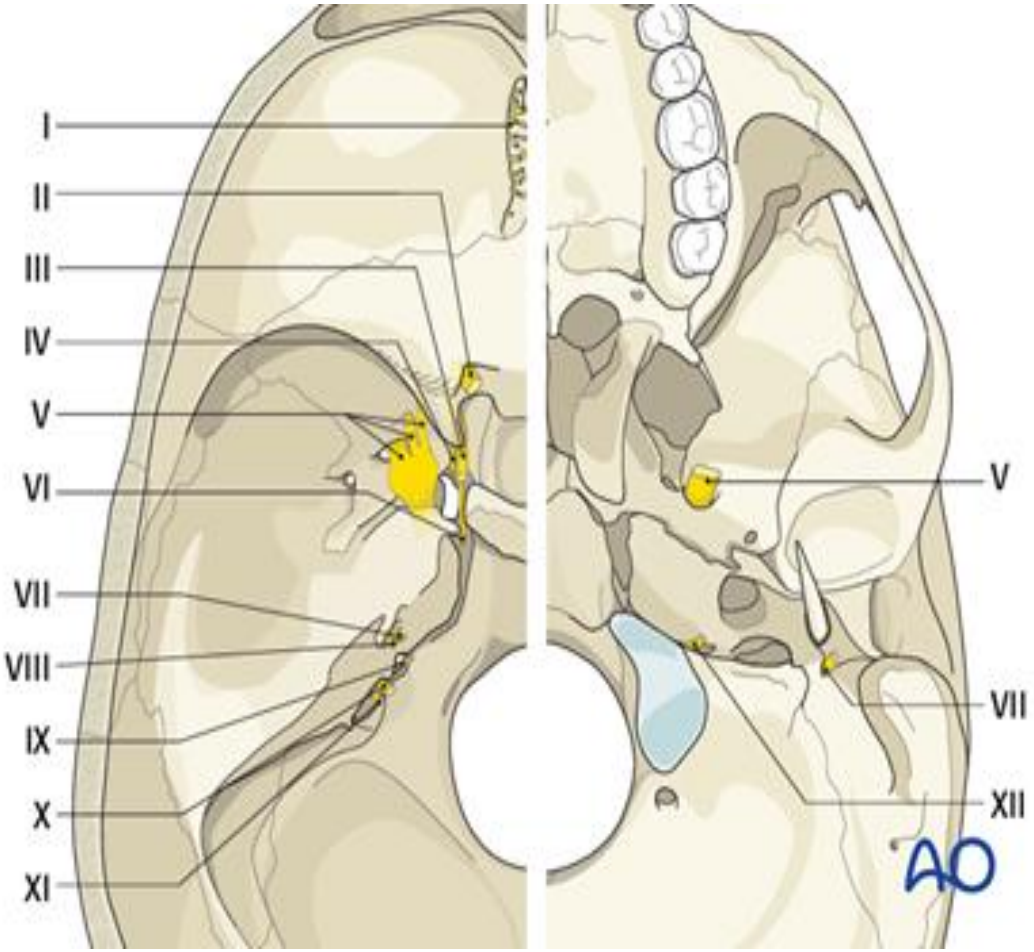


Skull base fractures



- **Signs of skull base fractures : - Rhinorrhea & Otorrhea -Raccoon eyes -Battle sign**

Cranial nerves and related skull base foramina



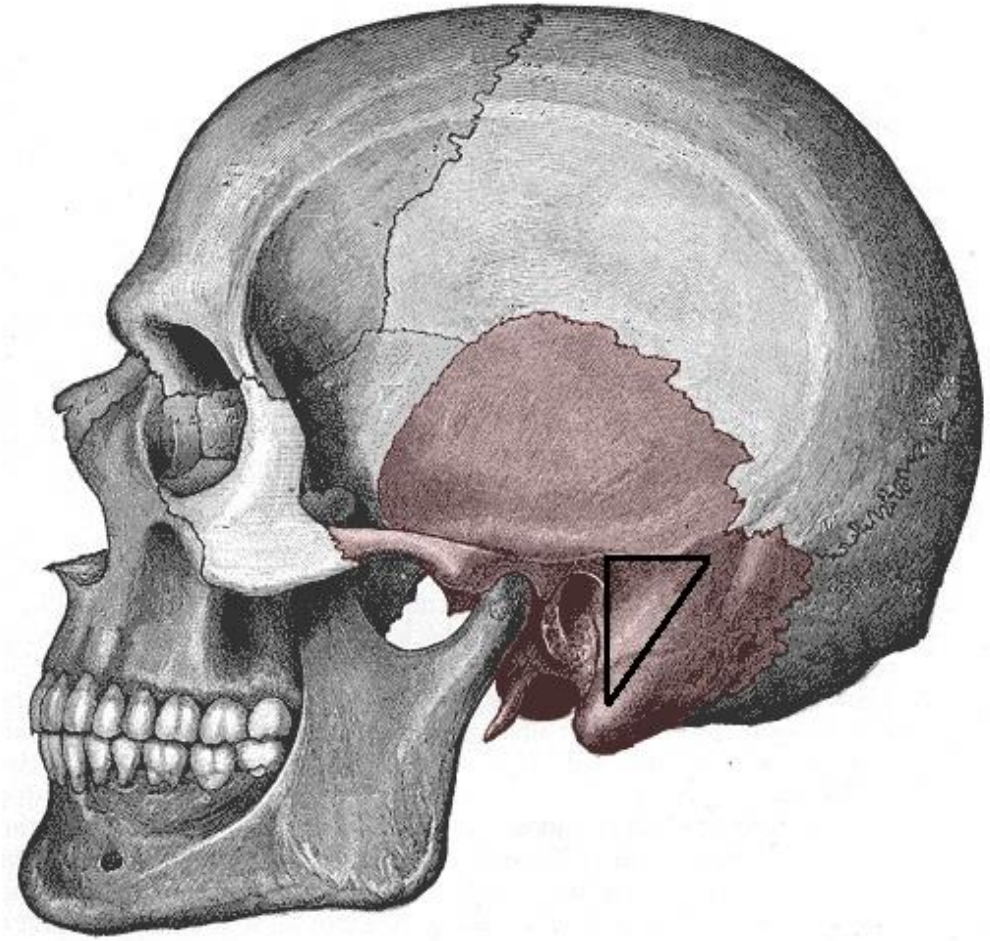
- When fractures involve some specific anatomical regions the involvement of nerves passing through a foramen in the respective region should be always considered.

Skull base fractures

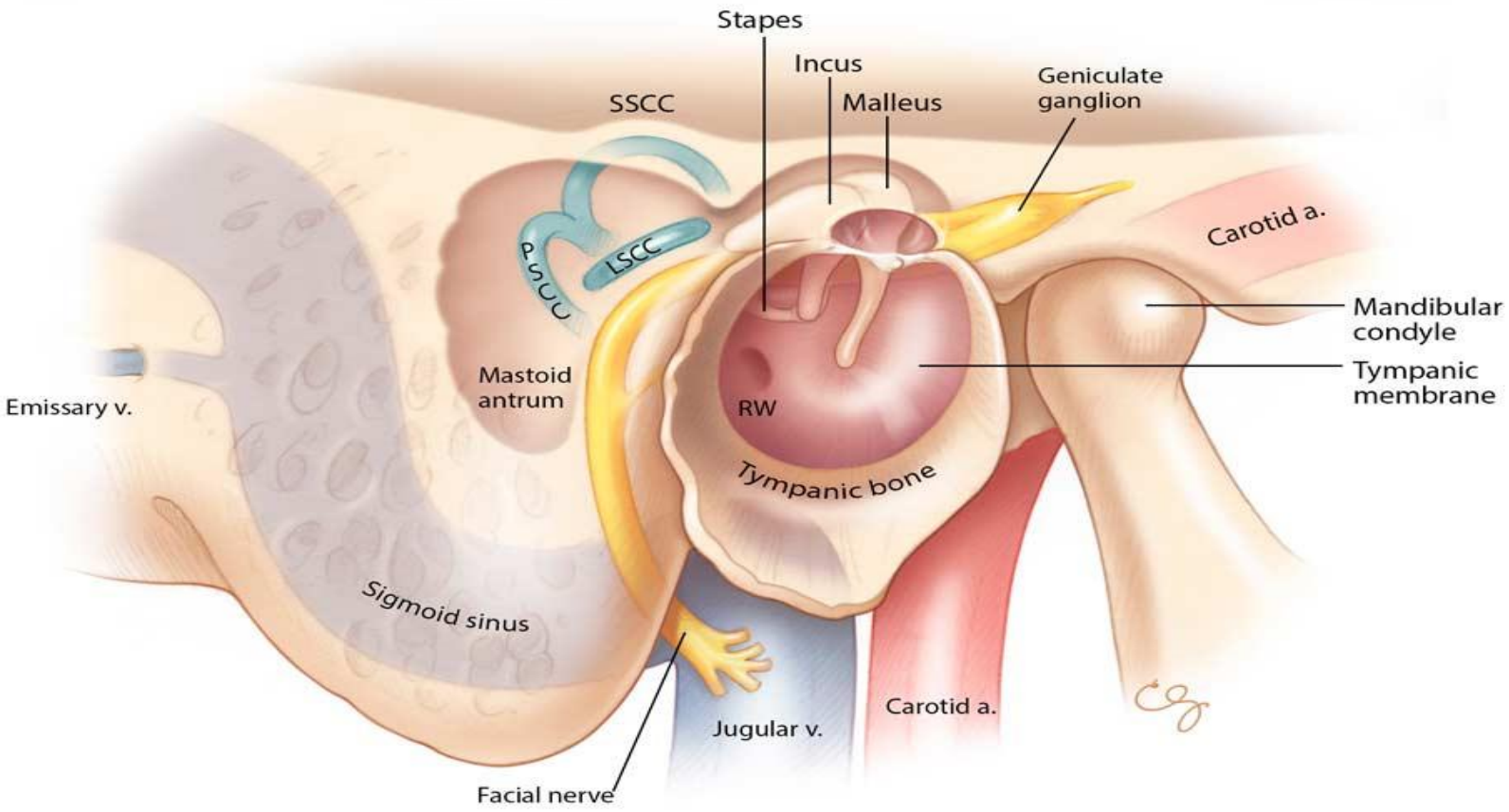
Traumatic (CSF) leakage.

The most relevant clinical sign related to skull base fractures is CSF leakage. It occurs in 2% of all head trauma and can reach 30% of all skull base fracture cases. 80% of th e traumatic CSF leakage occurs within 48 hours after injury. 16% of cases are “occult“, being found after recurrent meningitis.

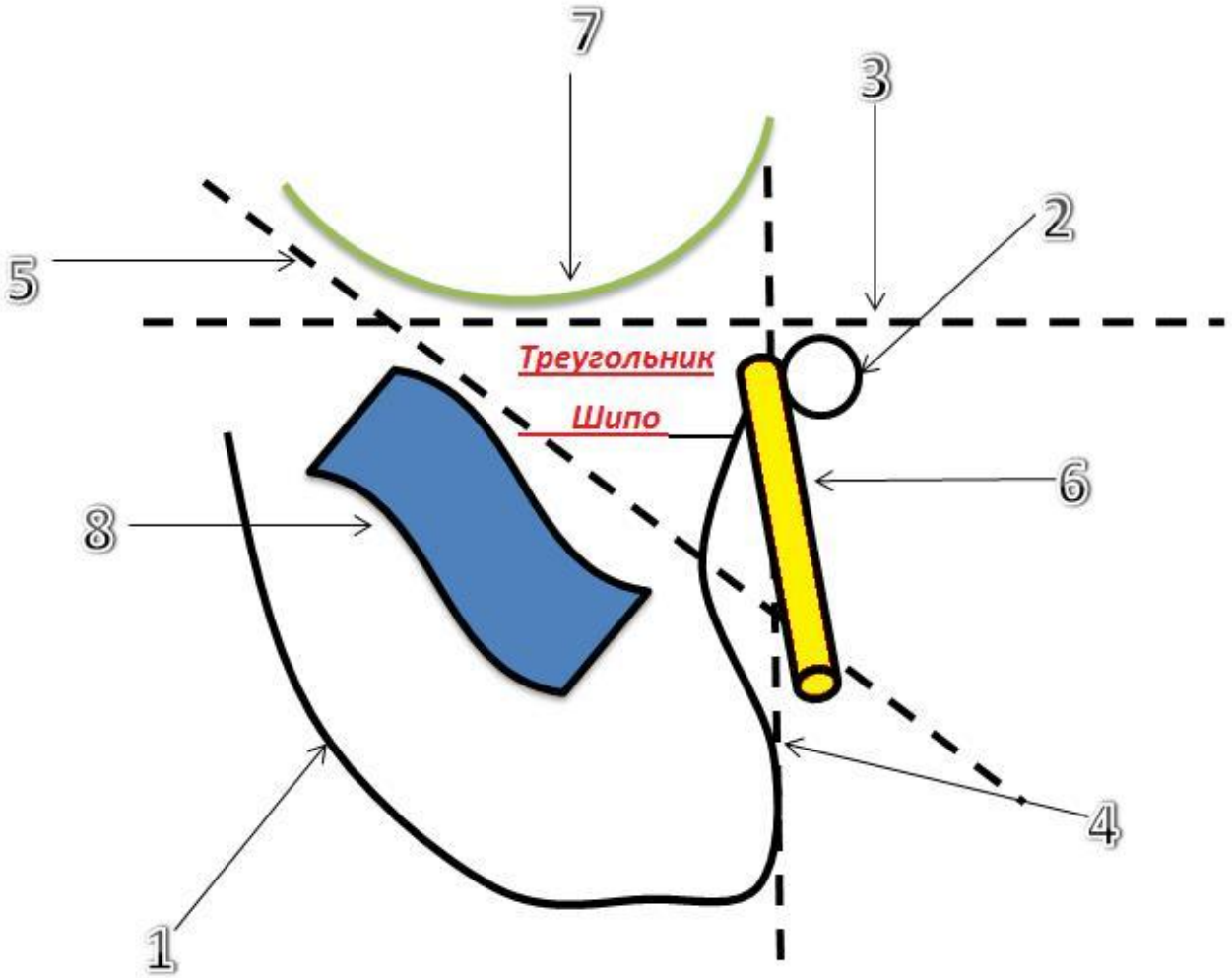
Triangle of Chipault



Triangle of Chipault



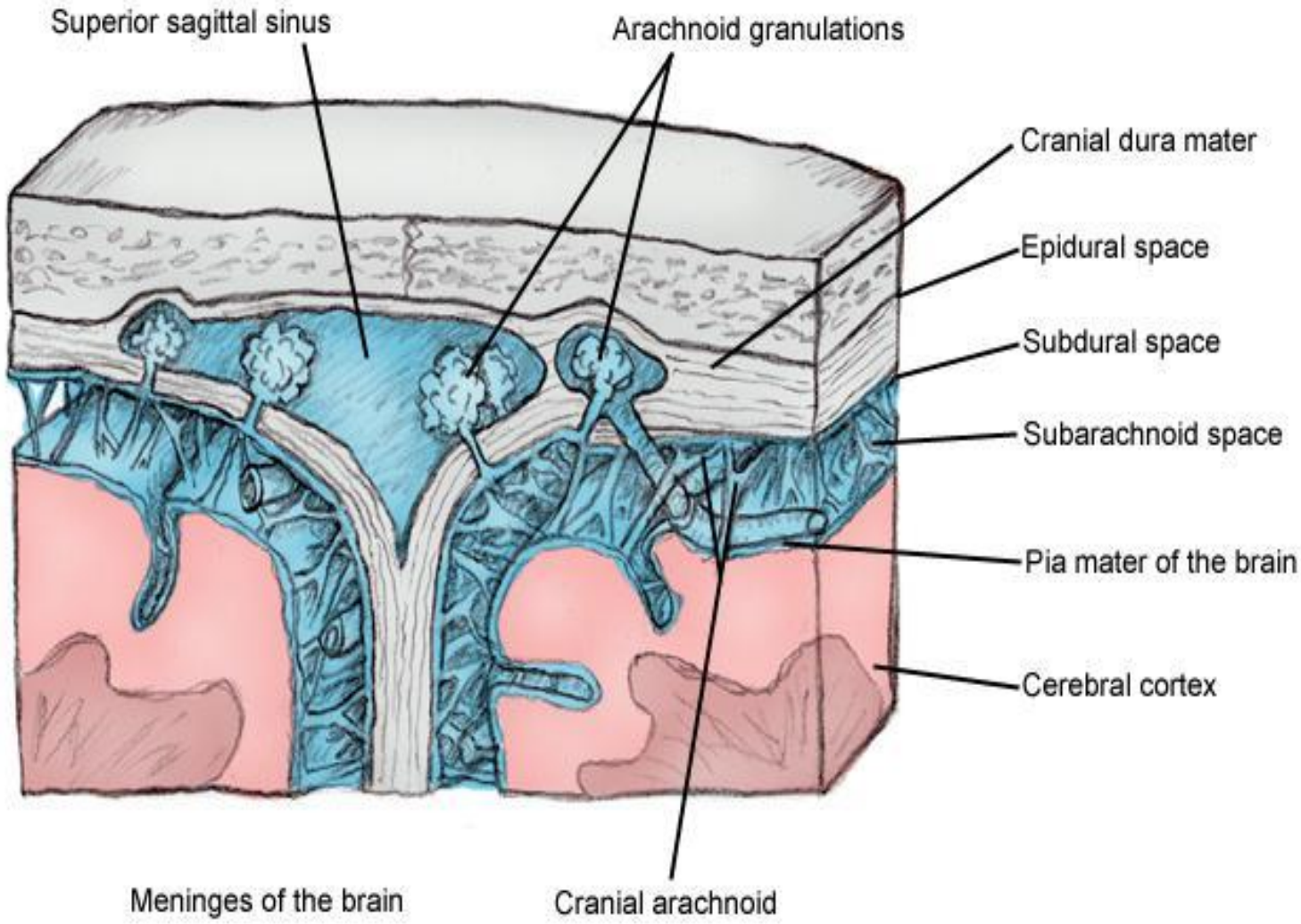
Triangle of Chipault



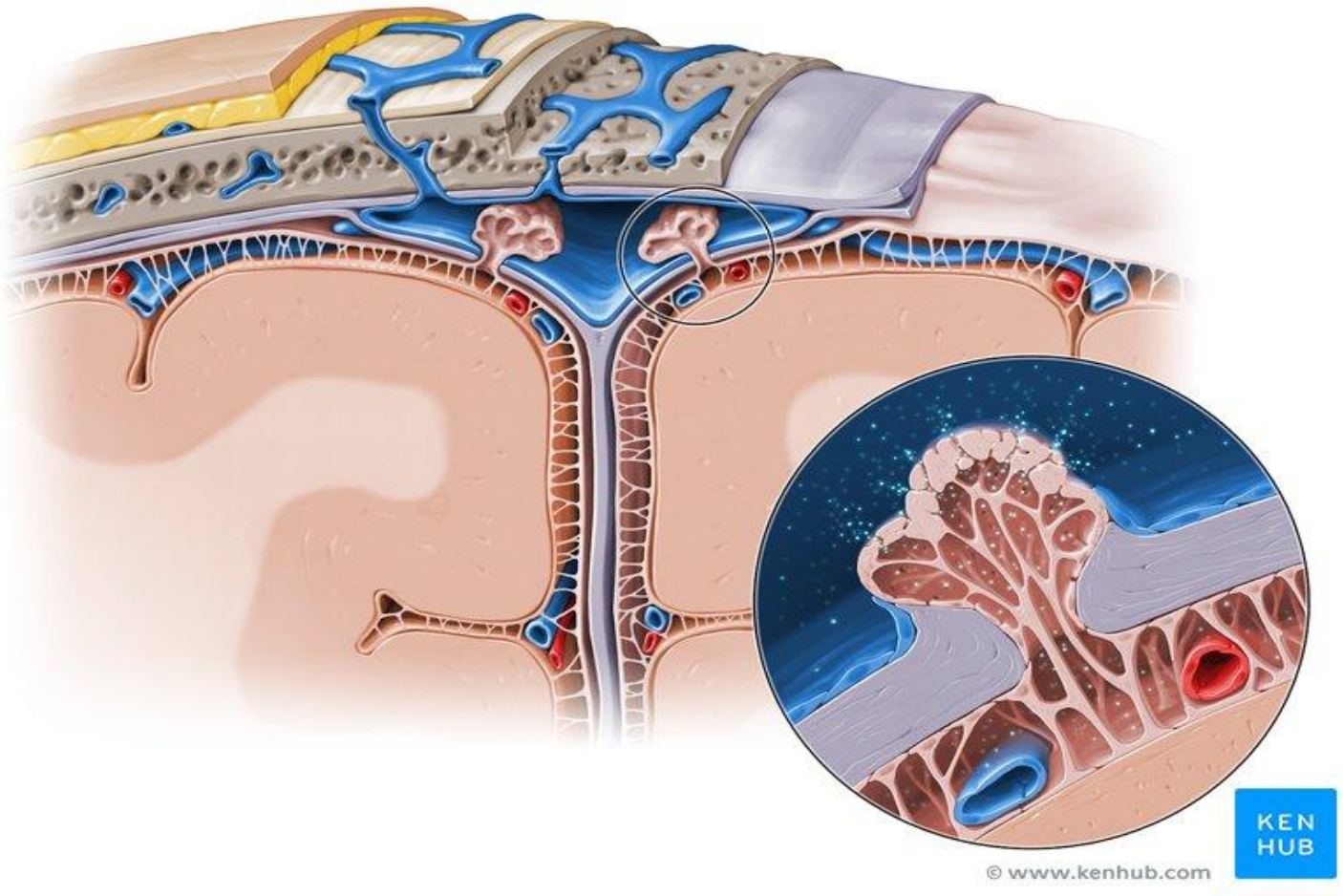
Meninges

- The meninges consist of 3 tissue layers that cover the brain and spinal cord: the pia, arachnoid, and the dura mater (see the image below). The pia along with the arachnoid are referred to as the leptomeninges, whereas the dura is referred to as the pachymeninx.

Meninges


Superior sagittal sinus
Arachnoid granulations
Cranial dura mater
Epidural space
Subdural space
Subarachnoid space
Pia mater of the brain
Cerebral cortex
Meninges of the brain
Cranial arachnoid

Meninges



Meninges

- The outermost meningeal layer is the dura mater, which lines the interior of the skull. The dura mater is composed of 2 individual layers, the meningeal dura and the periosteal dura. For the most part, these layers are fused; venous sinuses can be found in areas of separation. The tentorium cerebelli is a dura mater fold that separates the cerebellum from the cerebrum. The falx cerebri is a fold that separates the left and right cerebral hemispheres.

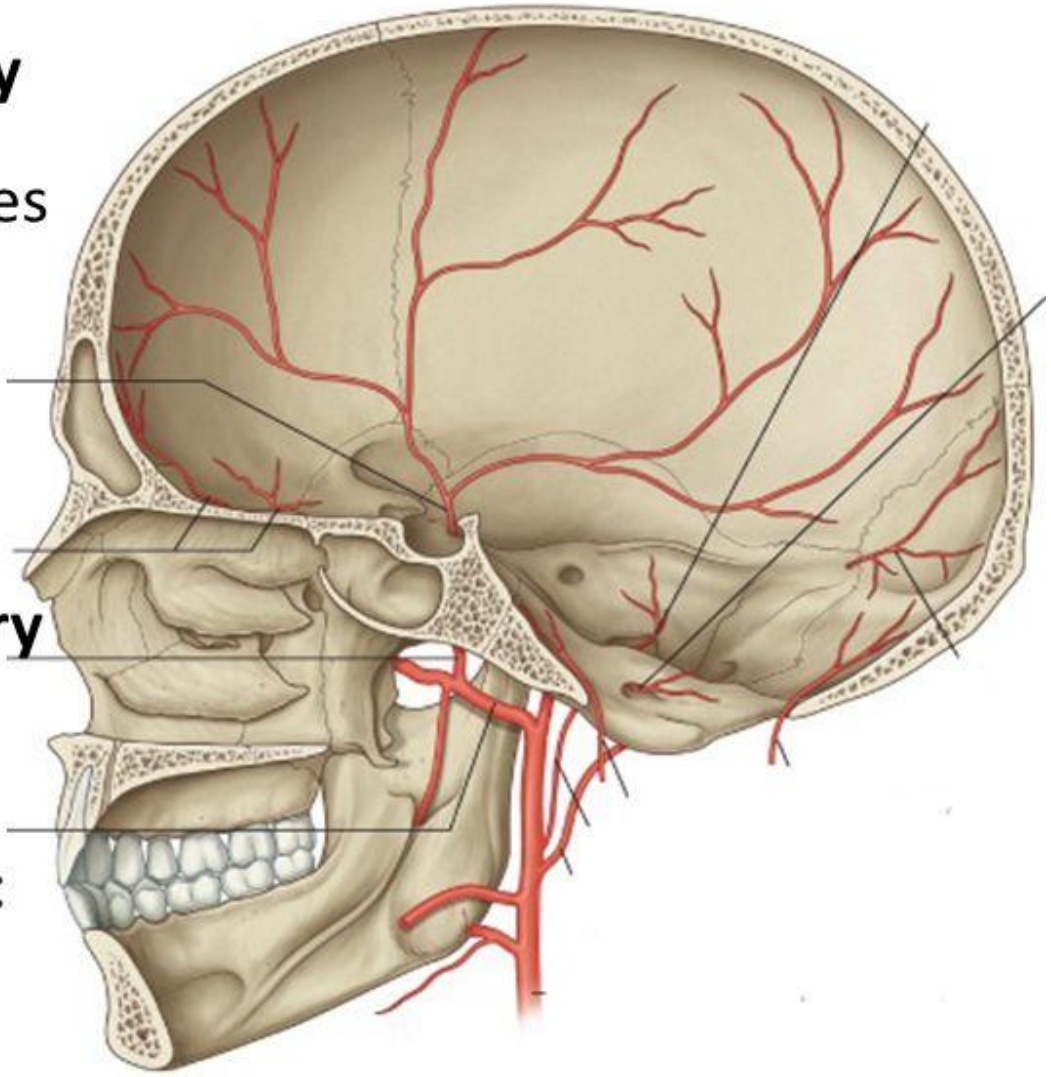
Arterial Supply of Dura

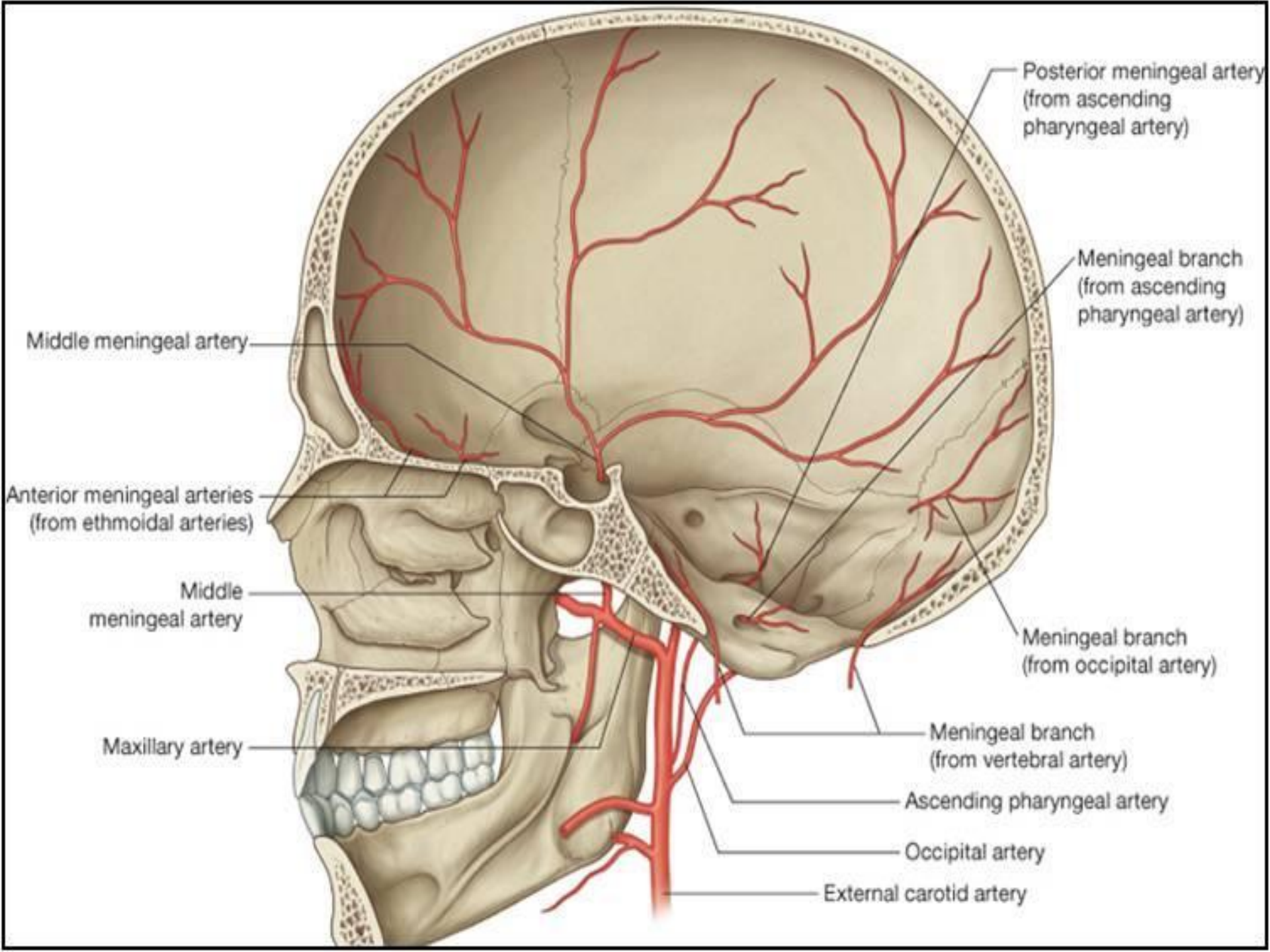
- **Anterior meningeal artery** (branches of ethmoidal arteries which are branches of maxillary artery (ECA).
- **Middle meningeal artery** and accessary meningeal artery: branches of Maxillary artery (ECA)
- **Posterior meningeal artery** (terminal branch of ascending pharyngeal artery (ECA) & other meningeal branches from:

1- Ascending pharyngeal artery

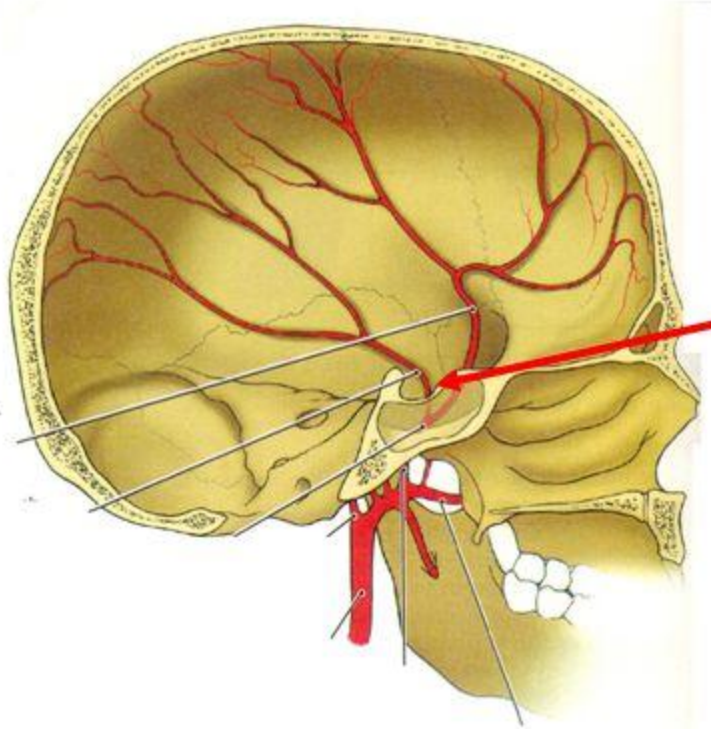
2- Occipital artery

3- Vertebral artery



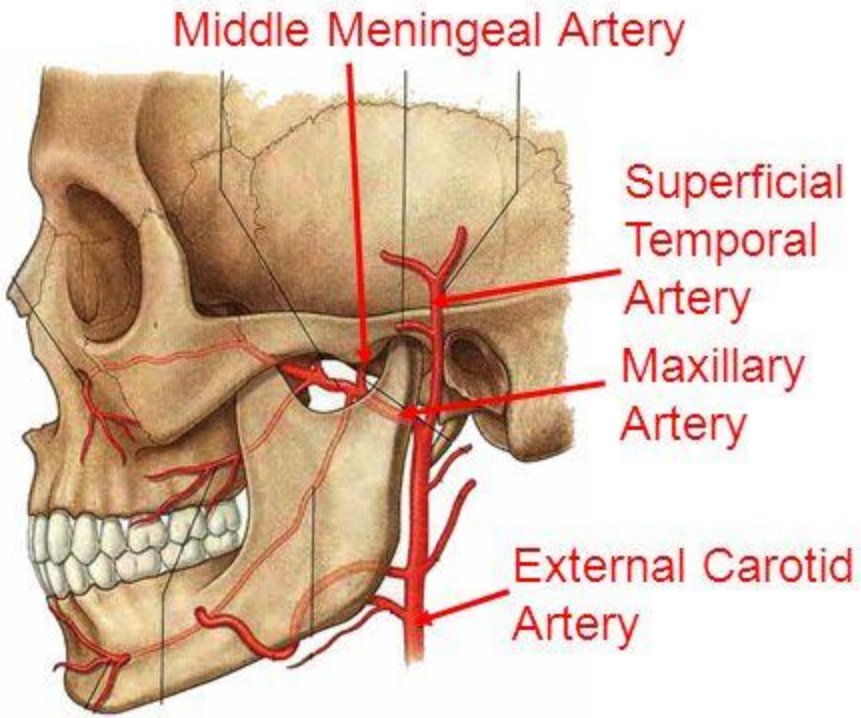

Posterior meningeal artery
(from ascending
pharyngeal artery)
Meningeal branch
(from ascending
pharyngeal artery)
Middle meningeal artery
Anterior meningeal arteries
(from ethmoidal arteries)
Middle
meningeal artery
Meningeal branch
(from occipital artery)
Maxillary artery
Meningeal branch
(from vertebral artery)
Ascending pharyngeal artery
Occipital artery
External carotid artery

INTRACRANIAL HEMATOMAS

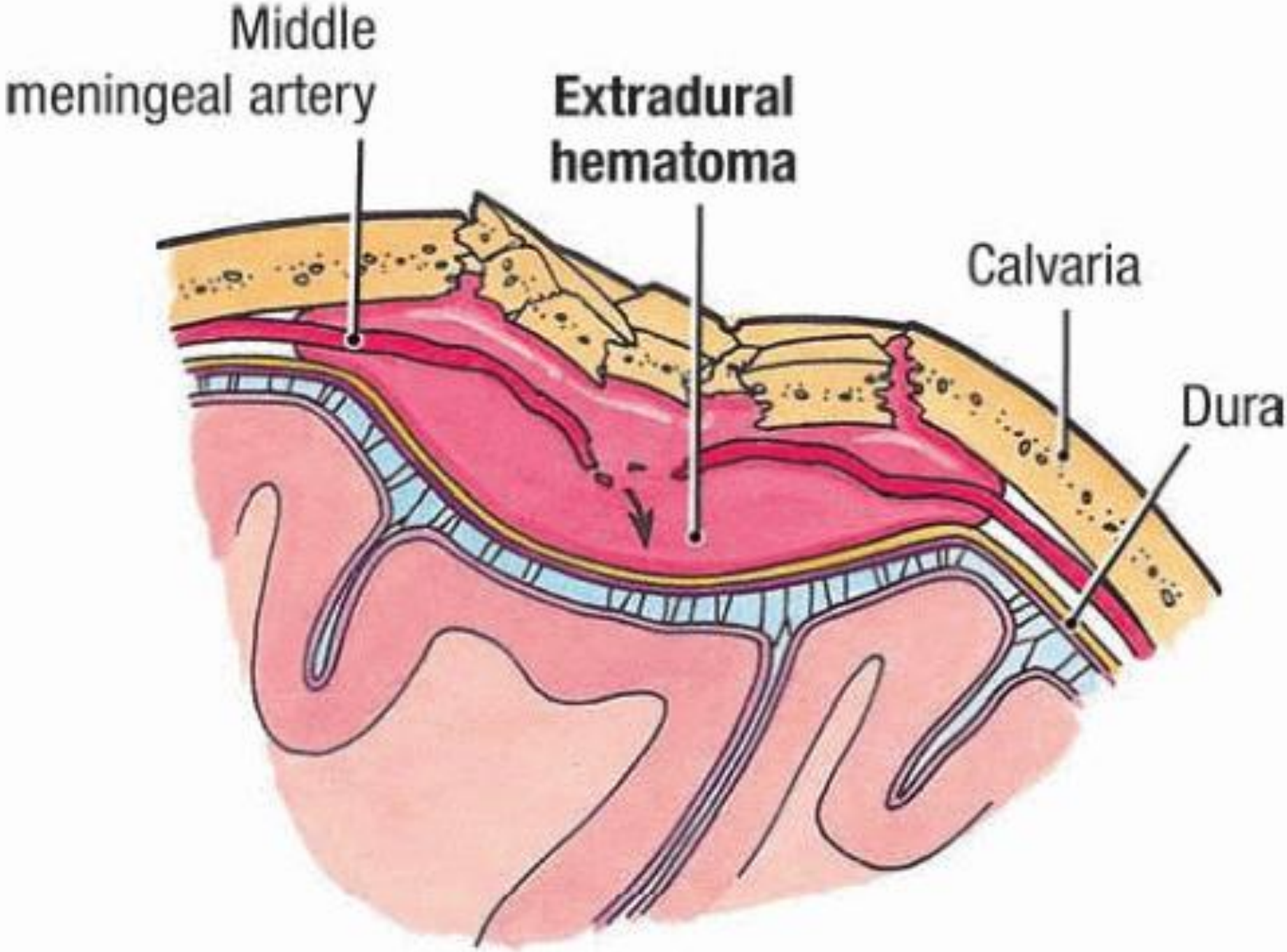


EPIDURAL HEMATOMA

– Middle meningeal artery - branch of Maxillary artery from External Carotid Artery



- provides blood supply to calvarium
- outside Dura


Middle
meningeal artery
Extradural
hematoma
Calvaria
Dura

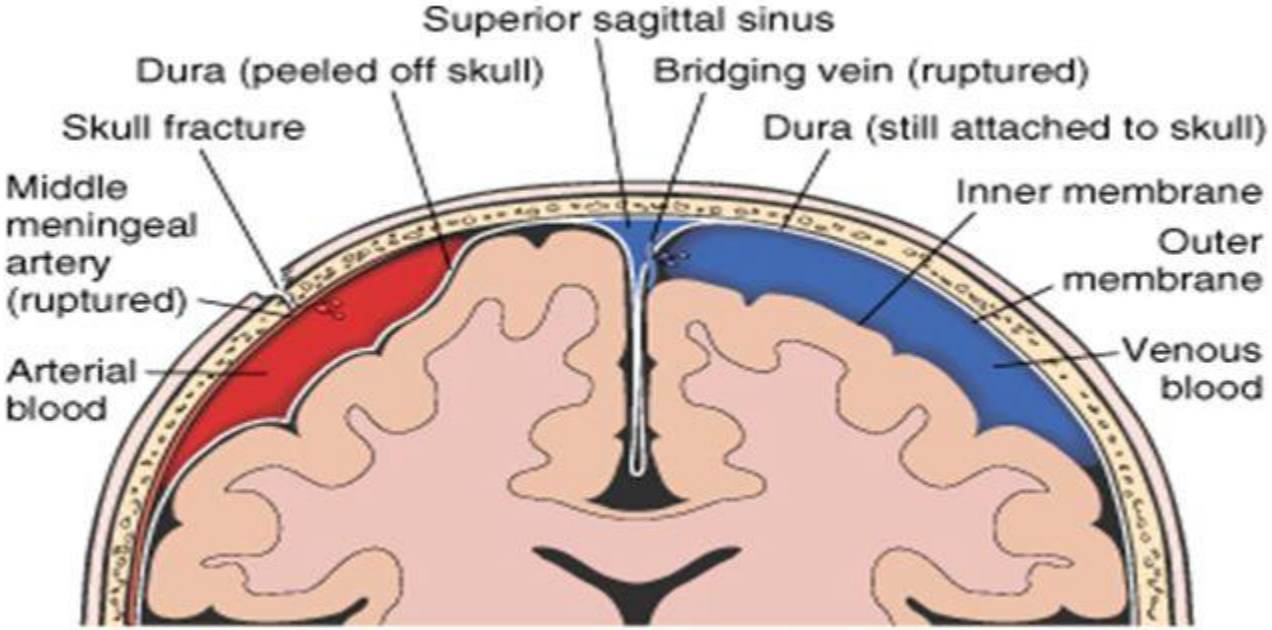
Haemorrhage of the brain

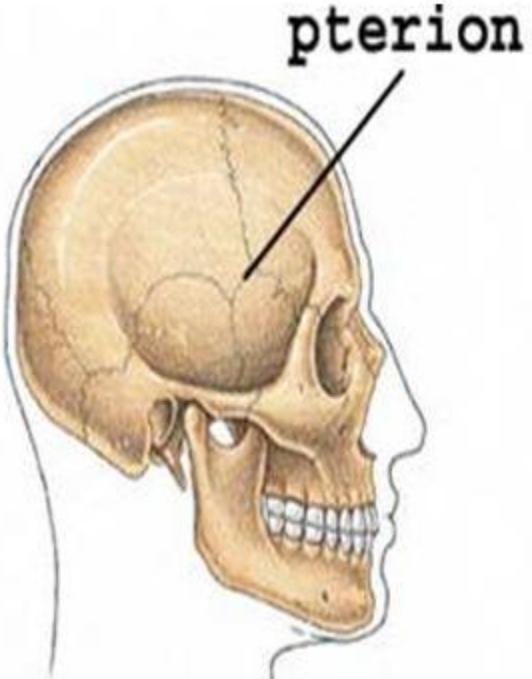
- Epidural hematoma (Artery) - middle meningeal artery rupture

  Usually due to blow to the side of the head at the pterion (area where skull is thinnest/easiest to fracture). Fracture may rupture the anterior branch of middle meningeal artery.

- Subdural hematomas (Veins) – tears in bridging veins that cross the subdural space.

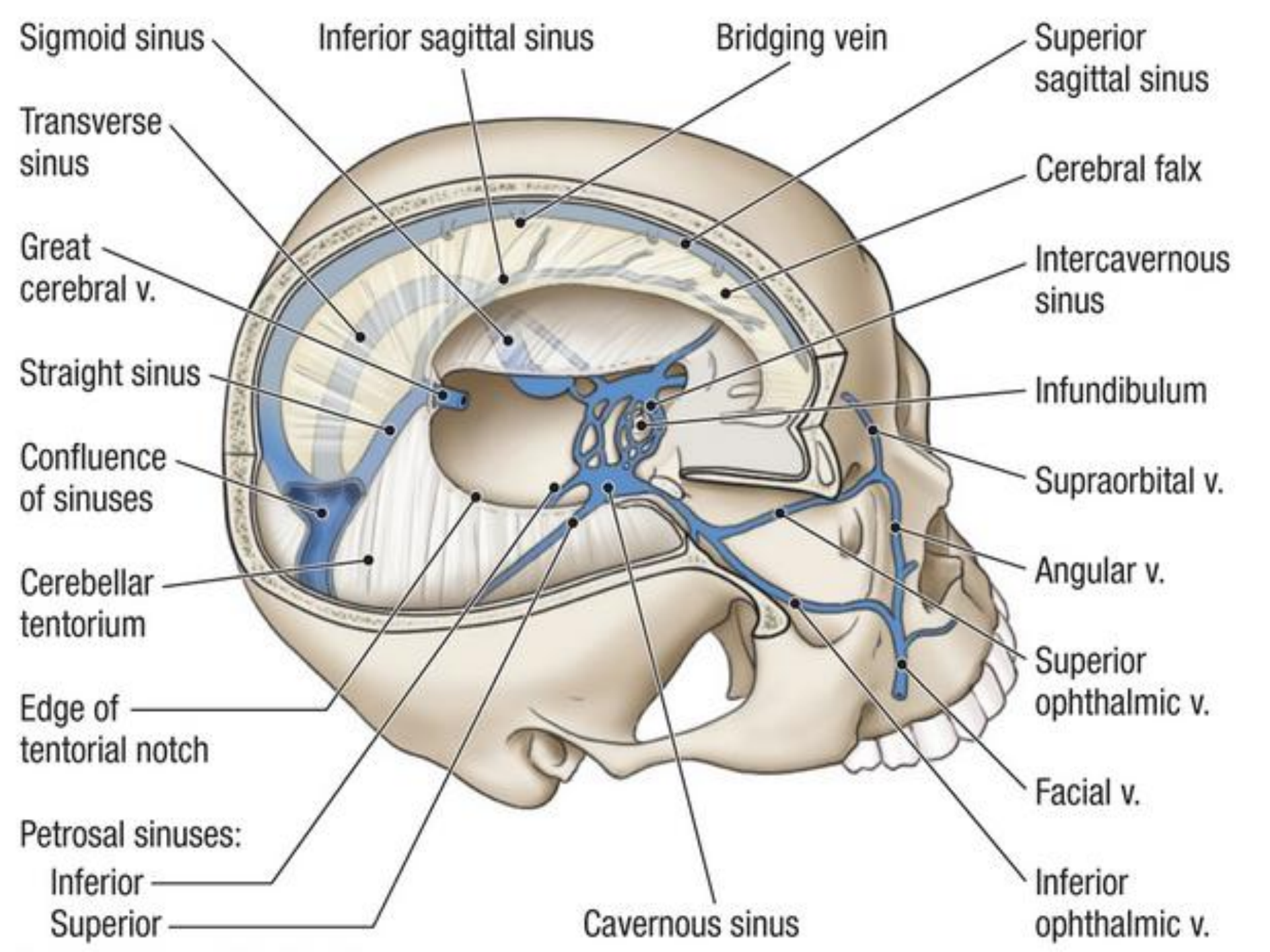
Meningitis- Inflammation of the (meninges) pia-arachnoid of the brain spinal cord or both.



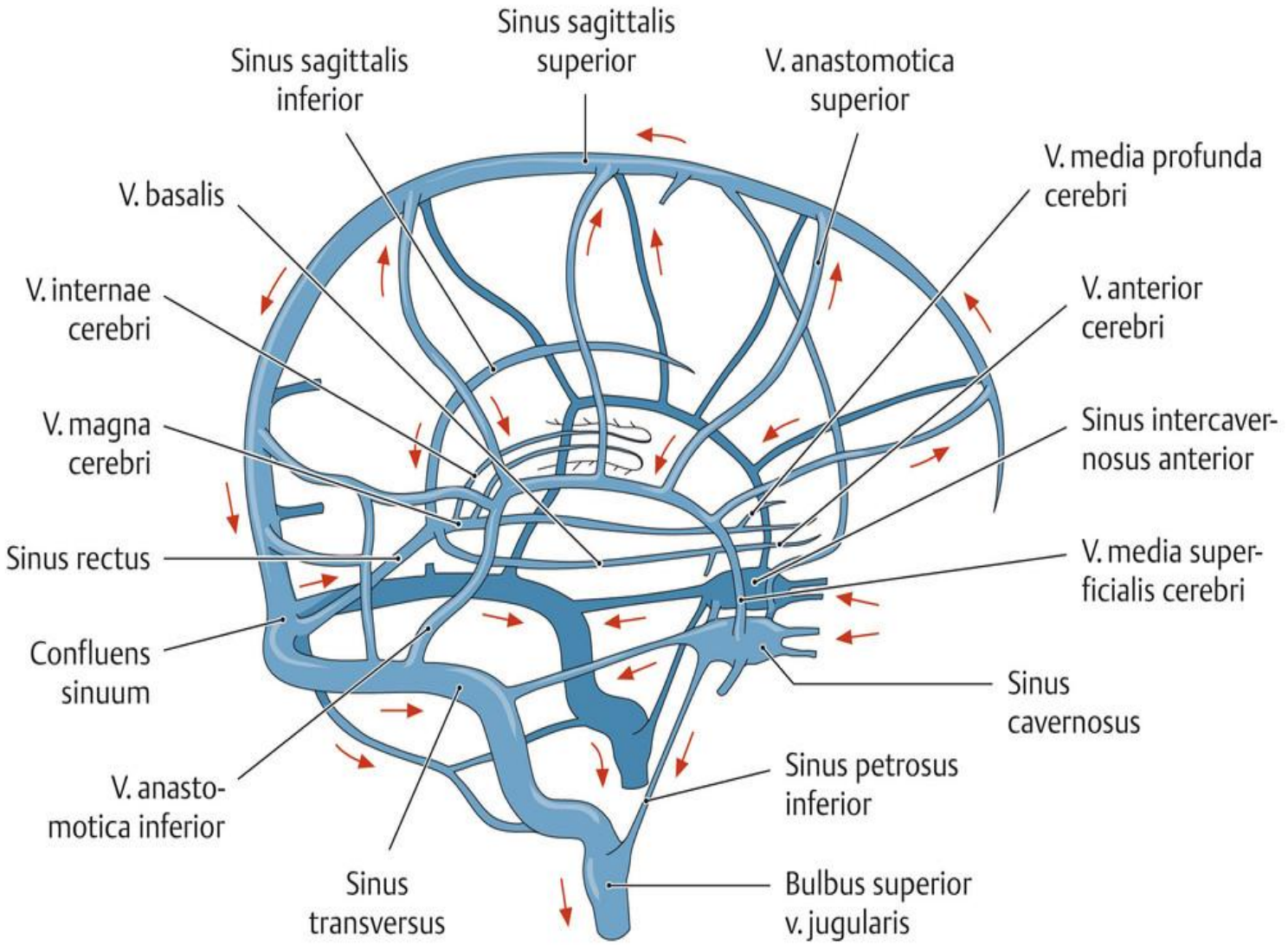


Meninges

Dural venous sinuses – endothelial-lined spaces between the outer periosteal and inner meningeal layers of the dura mater into which empty the cerebral veins, the cerebellar veins, and the veins draining the brainstem and that lead to the internal jugular veins.


Sigmoid sinus
Inferior sagittal sinus
Bridging vein
Superior sagittal sinus
Transverse sinus
Cerebral falx
Great cerebral v.
Intercavernous sinus
Straight sinus
Infundibulum
Confluence of sinuses
Supraorbital v.
Angular v.
Cerebellar tentorium
Superior ophthalmic v.
Edge of tentorial notch
Facial v.
Petrosal sinuses:
Inferior
Superior
Cavernous sinus
Inferior ophthalmic v.

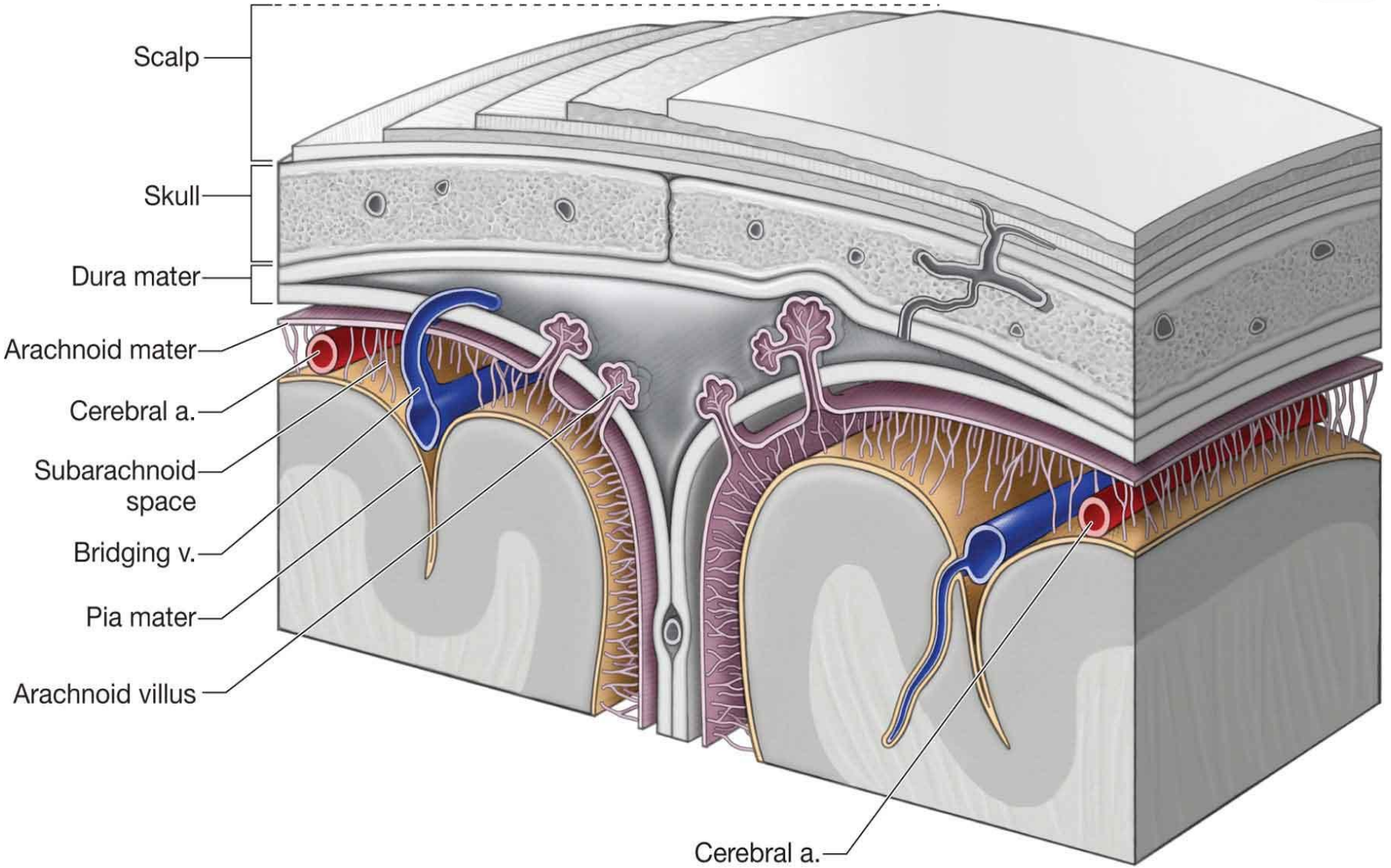
The sinuses of the dura mater



Meninges

- The innermost of the 3 layers is the pia mater, which tightly covers the brain itself, conforming to its grooves and folds. This layer is rich with blood vessels that descend into the brain.

Meninges


Scalp
Skull
Dura mater
Arachnoid mater
Cerebral a.
Subarachnoid space
Bridging v.
Pia mater
Arachnoid villus
Cerebral a.

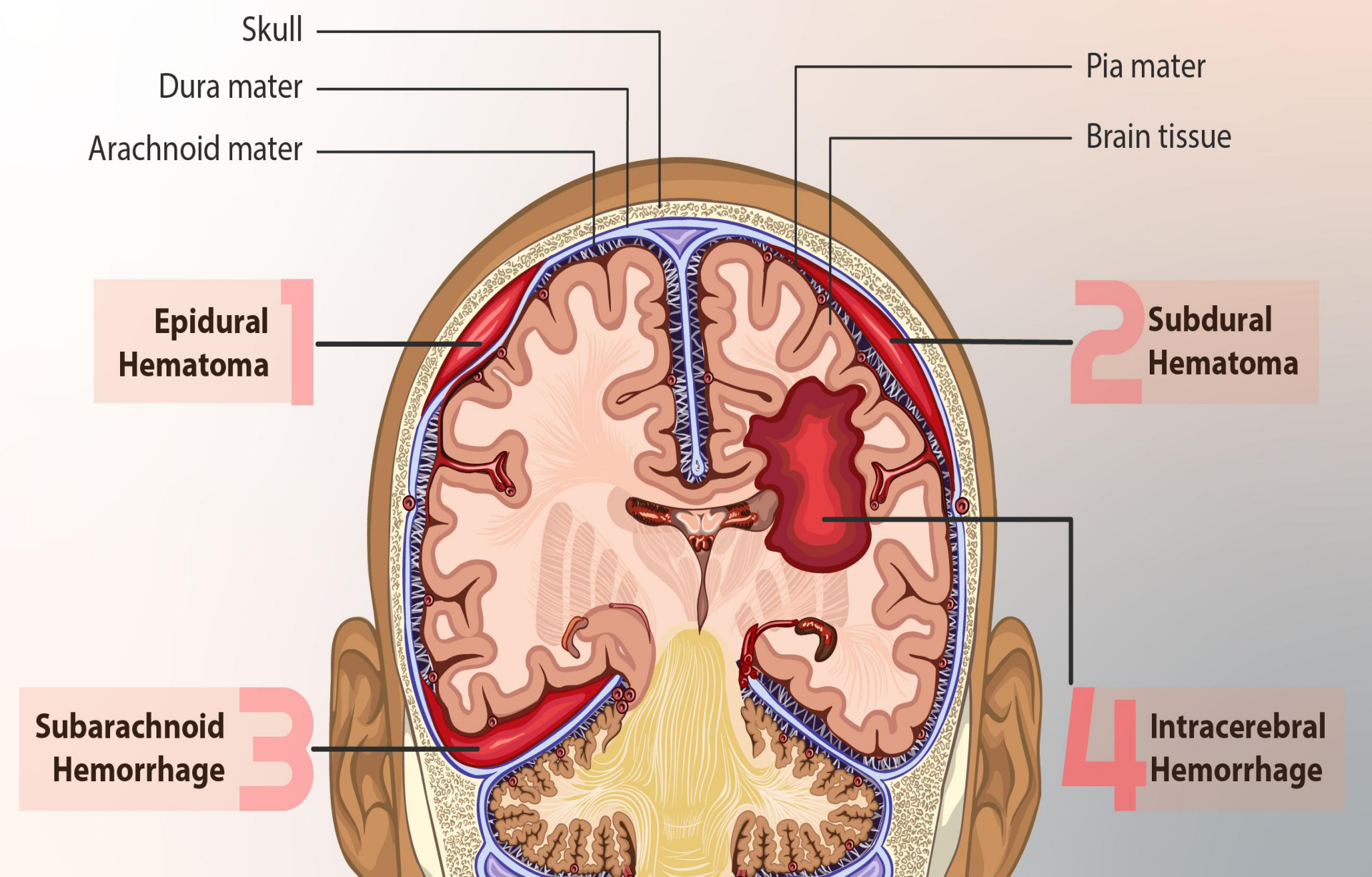
Meninges

- Outside the pia mater, which tightly contours the brain, is the arachnoid mater. The arachnoid mater is a thin weblike layer. Between the pia mater and the arachnoid mater is a space called the subarachnoid space, which contains cerebrospinal fluid (CSF). This space is where the major arteries supplying blood to the brain lie. If a blood vessel ruptures in this space, it can cause a subarachnoid hemorrhage.

Meninges

- Between the arachnoid mater and the dura mater is the subdural space. If bleeding occurs in the space underneath the dura mater, it is called a subdural hematoma. If bleeding occurs outside the dura but underneath the skull, this is called an epidural hematoma

Types of brain hemorrhage



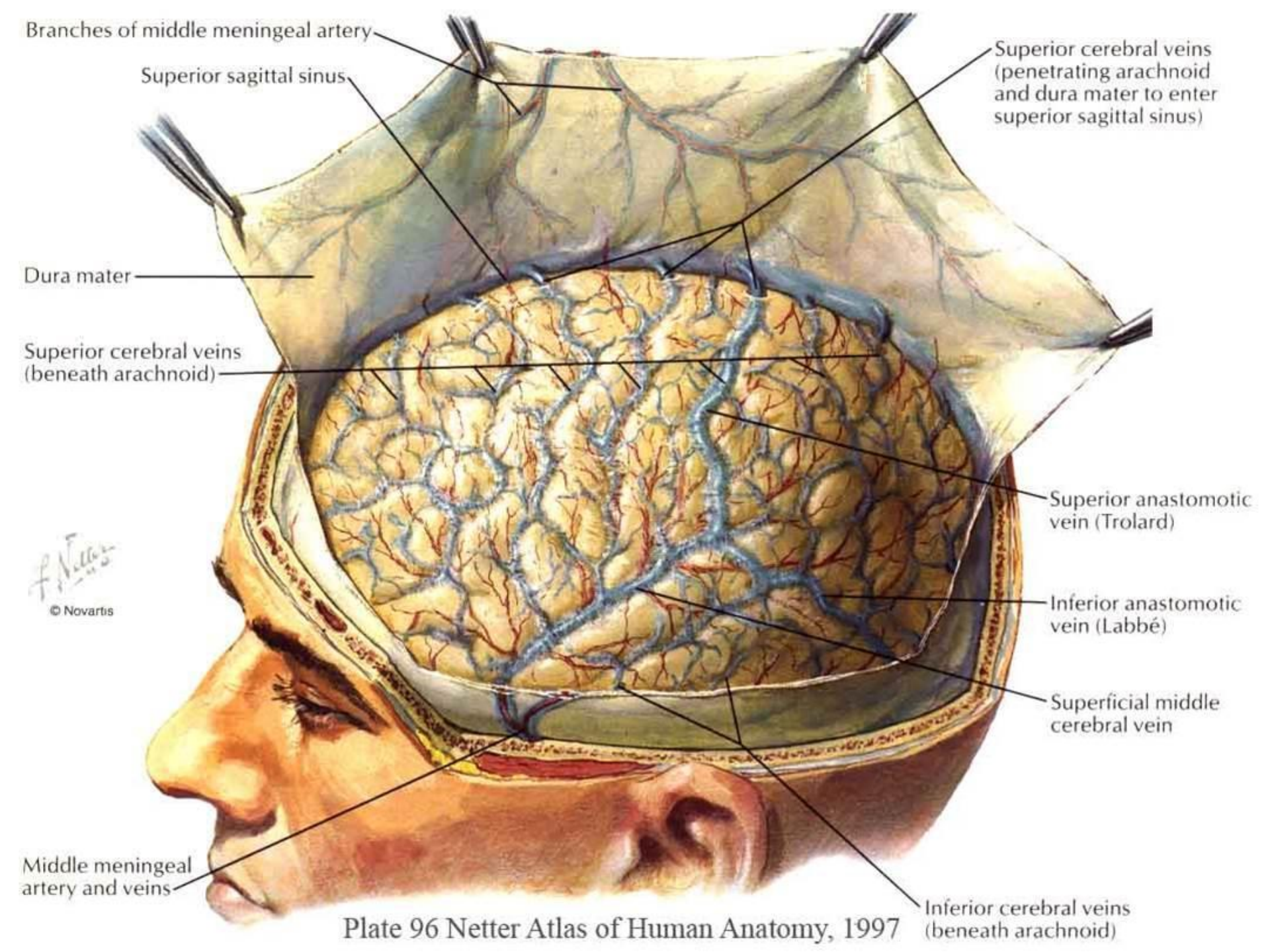
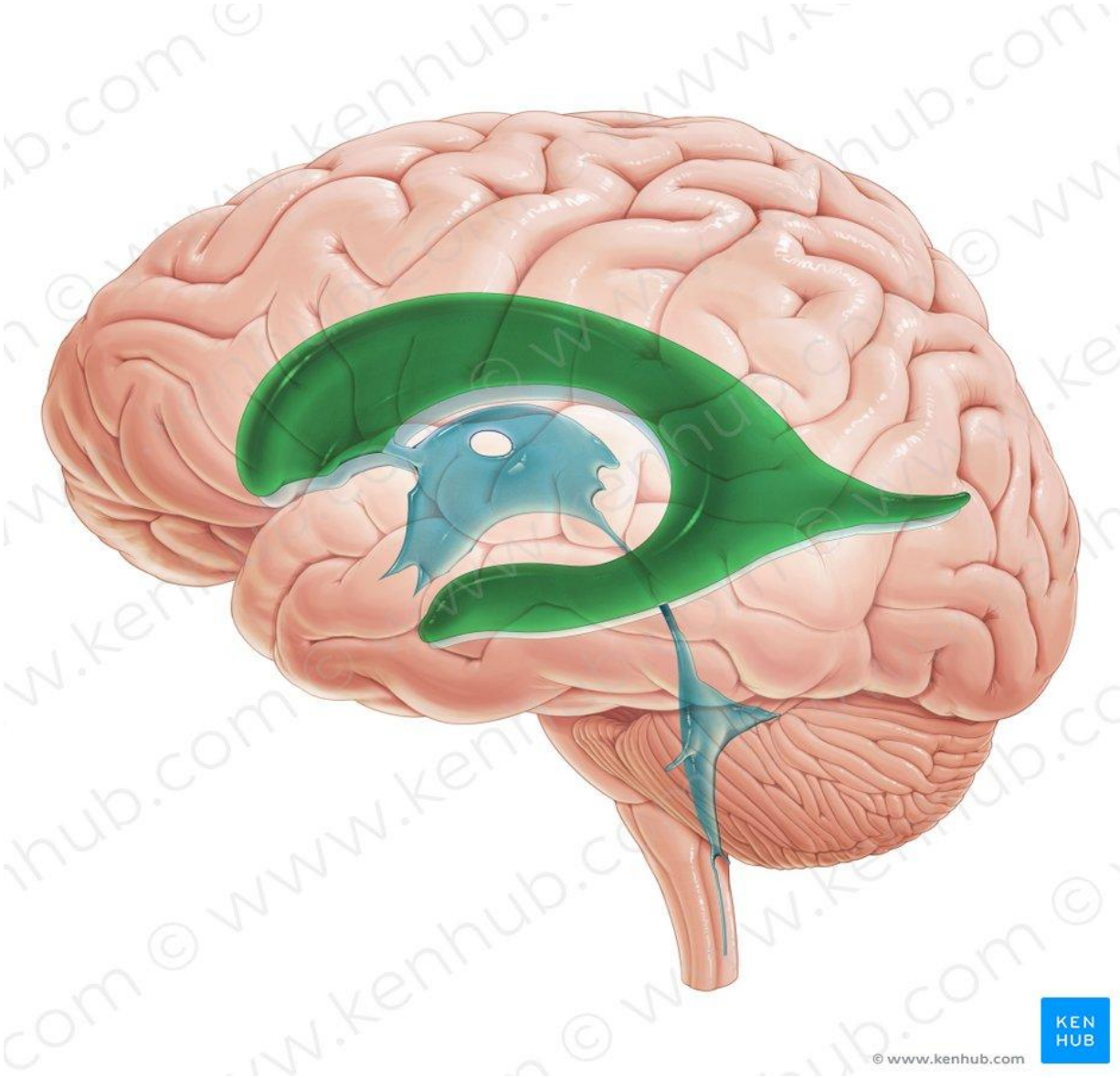


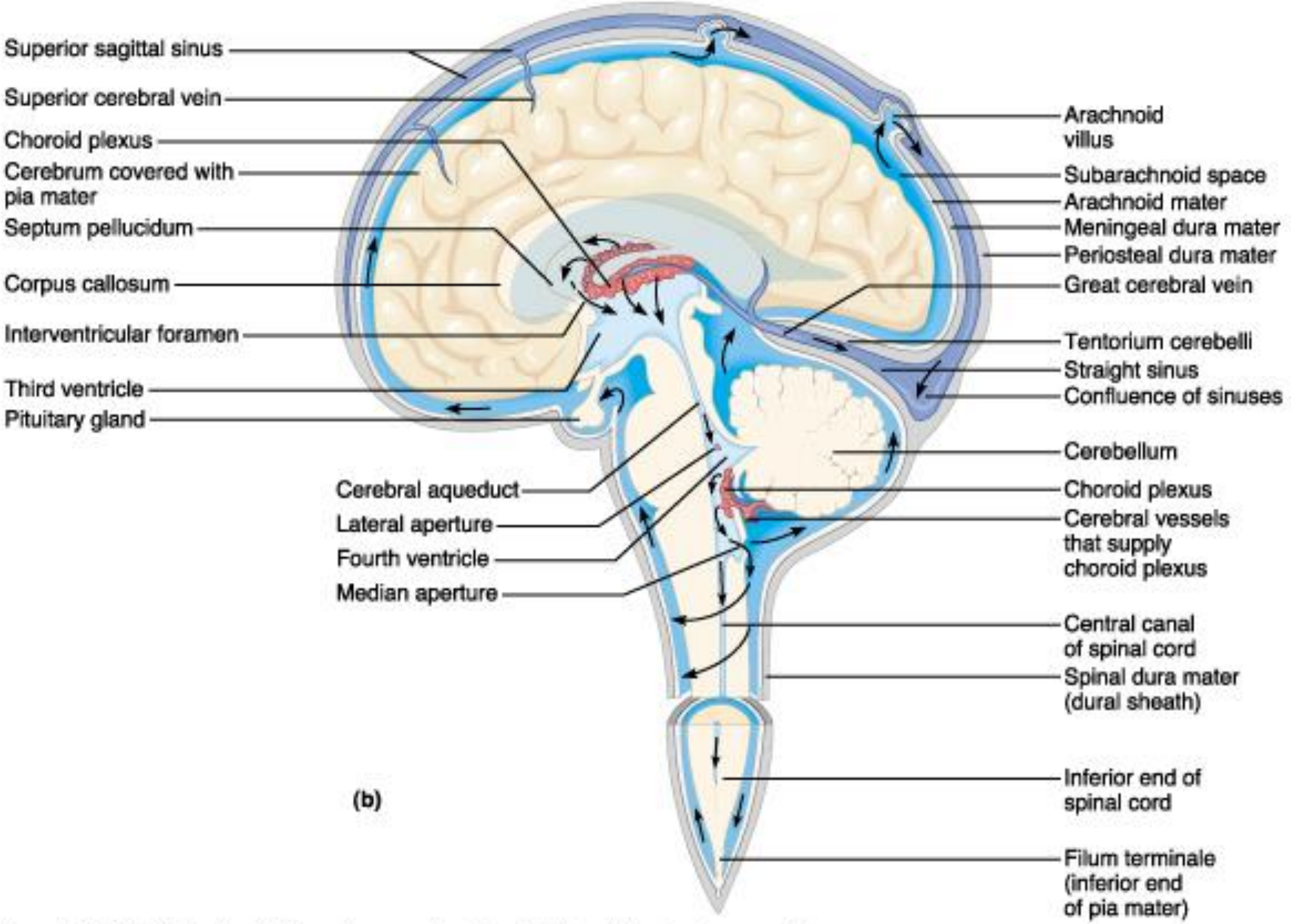
Plate 96 Netter Atlas of Human Anatomy, 1997

Ventricles and cerebrospinal fluid

- The brain is bathed in cerebrospinal fluid (CSF), which is continuously produced and absorbed. The ventricles are CSF-containing cavities within the brain. The structures that produce CSF are contained within the ventricles and are called the choroid plexuses.

Ventricles and cerebrospinal fluid





Ventricles and cerebrospinal fluid

- A network of capillaries called the choroid plexus projects into each ventricle. Ependymal cells (a type of neuroglial cell) surround these capillaries. Blood plasma entering the ependymal cells from the capillaries is filtered as it passes into the ventricle, forming CSF. CSF is produced at a rate of about 450 mL/day, although at any given time about 150 mL can be found within the CSF spaces. Thus, the volume of CSF in most adults is turned over about 3 times per day.

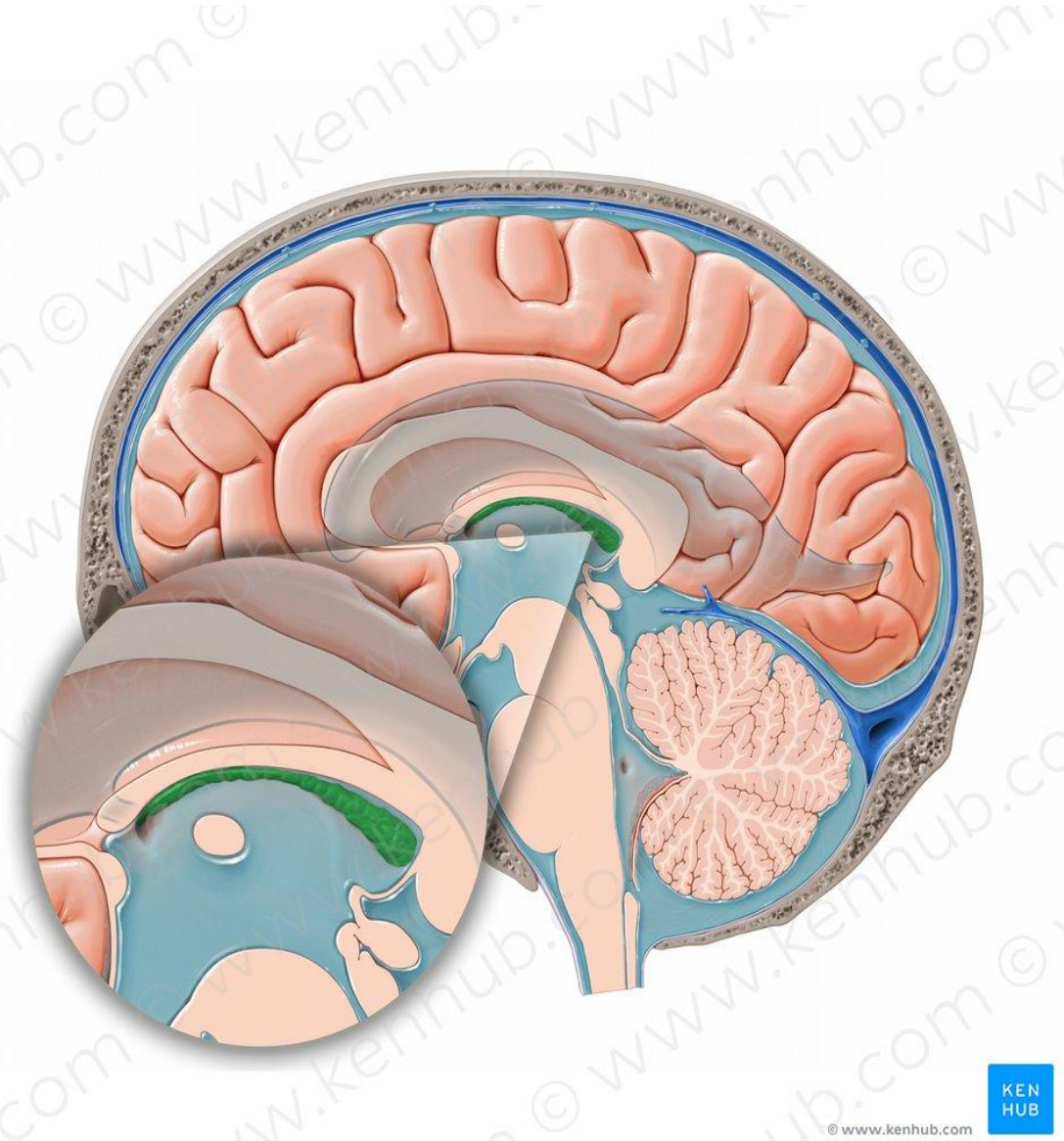
Ventricles and cerebrospinal fluid

- The brain has 4 ventricles (see the image below). Within the cerebral hemispheres are the lateral ventricles, which are connected to each other and to the third ventricle through a pathway called the interventricular foramen (of Monro). The third ventricle lies in the midline, separating deeper brain structures such as the left and right thalami. The third ventricle communicates with the fourth ventricle through the cerebral aqueduct (of Sylvius), which is a long narrow tube.

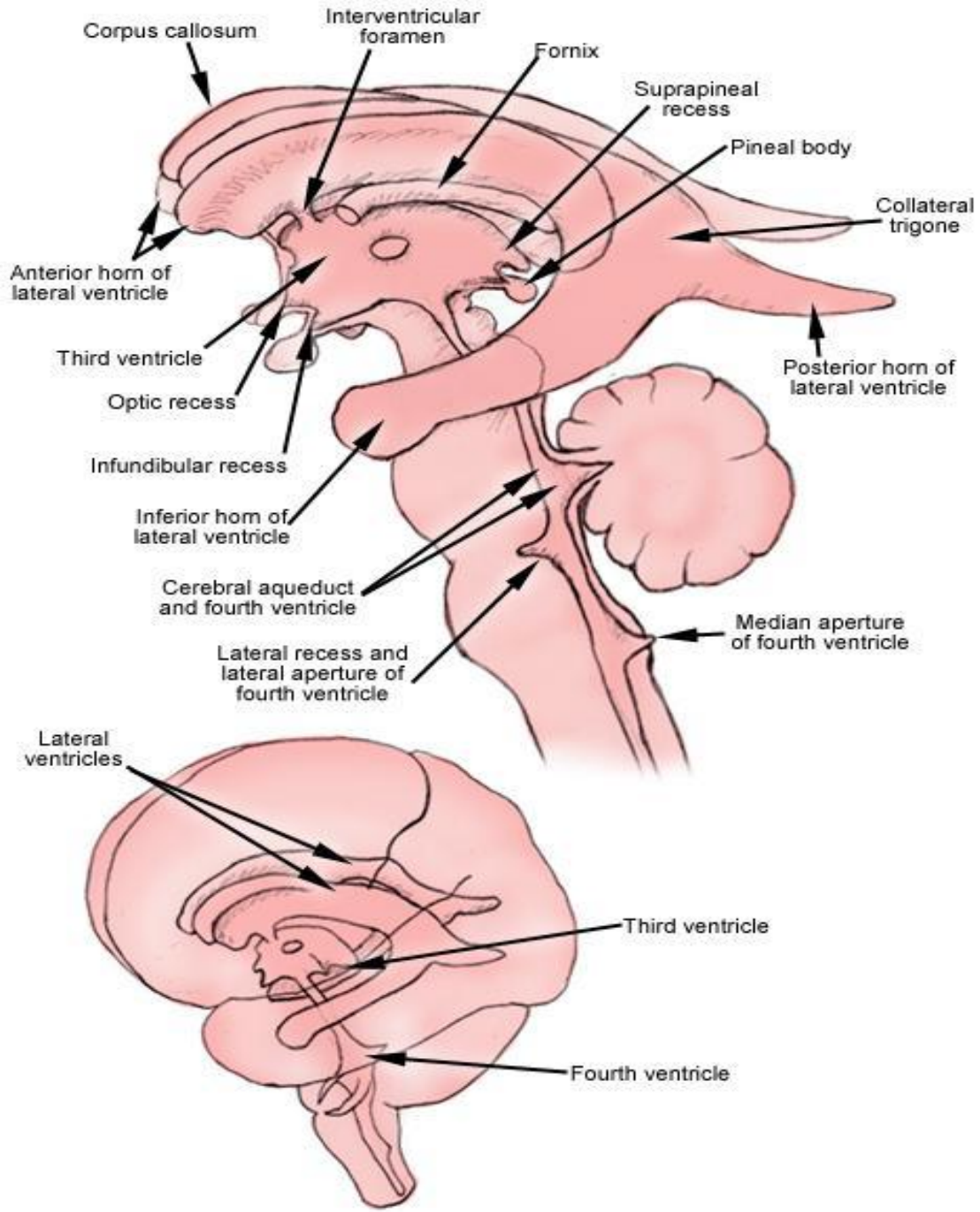
Ventricles and cerebrospinal fluid

- The third ventricle lies in the midline, separating deeper brain structures such as the left and right thalami. The third ventricle communicates with the fourth ventricle through the cerebral aqueduct (of Sylvius), which is a long narrow tube. Additional openings in the fourth ventricle allow CSF to flow into the subarachnoid space.

Ventricles and cerebrospinal fluid



- Choroid plexus of third ventricle
- (Plexus choroideus ventriculi tertii)



- **Ventricular system, which circulates cerebrospinal fluid through brain.**

Ventricles and cerebrospinal fluid

The pathway of the cerebrospinal fluid is as follows:

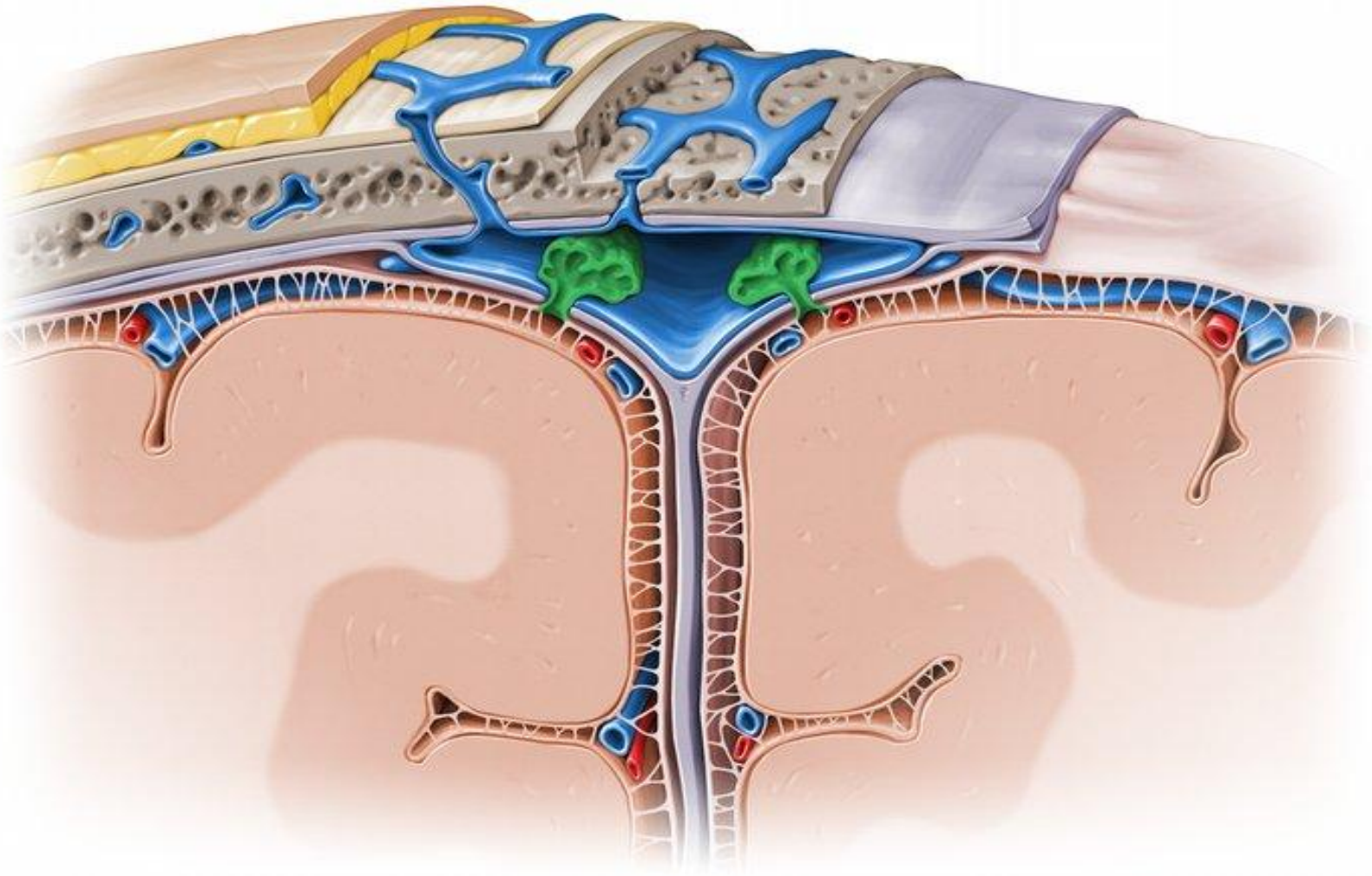
- The CSF passes from the lateral ventricles to the third ventricle through the interventricular foramen (of Monro).
- From the third ventricle, the CSF flows through the cerebral aqueduct (of Sylvius) to the fourth ventricle.

Ventricles and cerebrospinal fluid

- From the fourth ventricle, some CSF flows through a narrow passage called theobex and enters the central canal of the spinal cord. However, the majority of CSF passes through the apertures of the fourth ventricle; the median aperture (of Magendie) and two lateral apertures (of Luschka). Via these openings, the CSF enters the cisterna magna and cerebellopontine cisterns, respectively.

Ventricles and cerebrospinal fluid

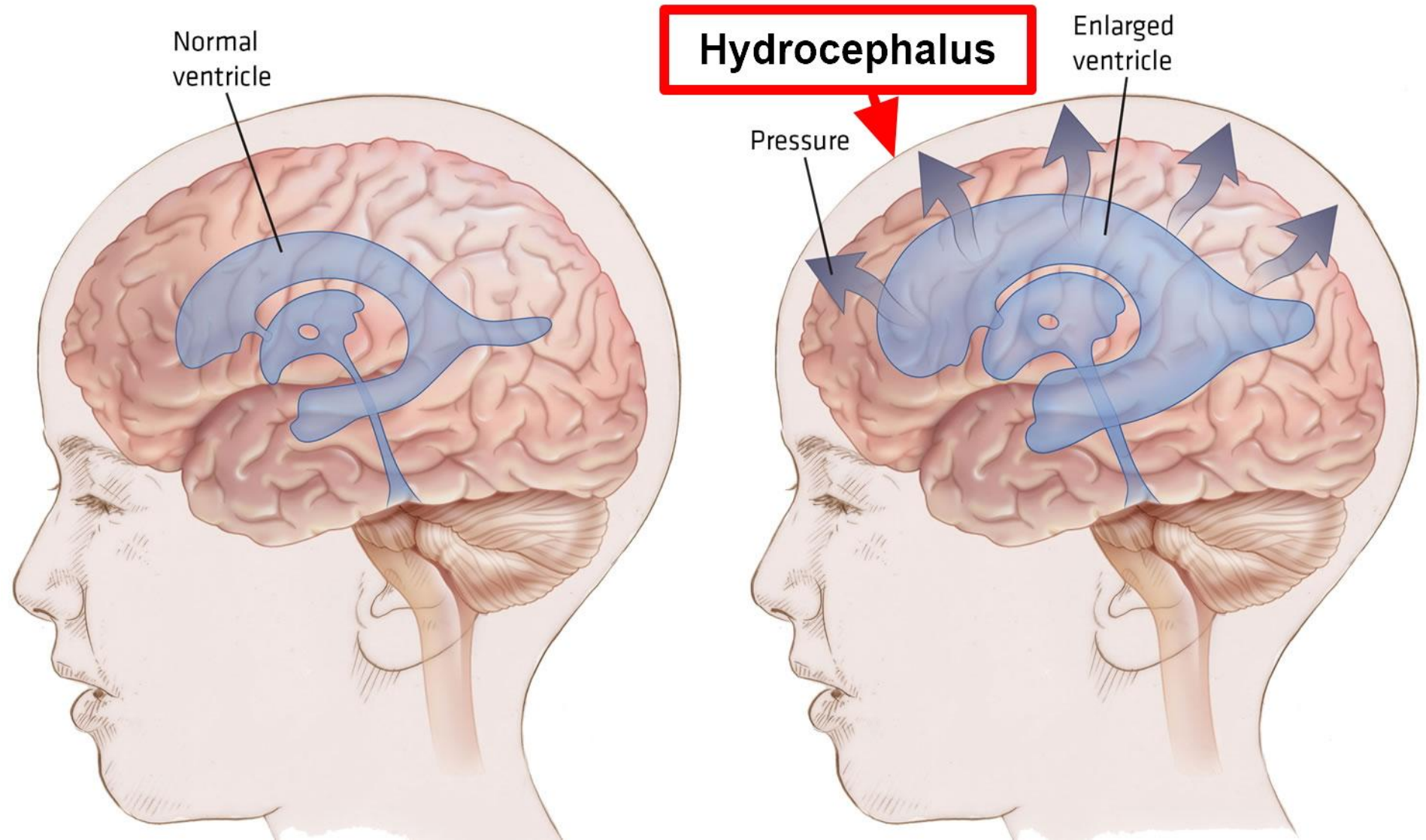
- From there, the CSF flows through the subarachnoid space of the brain and spinal cord.
- It is finally reabsorbed into the dural venous sinuses through arachnoid granulations. Arachnoid granulations or villi are structures projecting into the superior sagittal sinus that release CSF back into the venous system.



Ventricles and cerebrospinal fluid

- Hydrocephalus is a condition in which production of CSF is disproportionate to absorption. This is most commonly caused by impaired absorption resulting from obstruction of the CSF circulatory pathways, in which case it is termed obstructive hydrocephalus. This also occurs when the absorption of CSF is impaired, in which case it is termed communicating hydrocephalus. Rarely is hydrocephalus caused by increased CSF production.

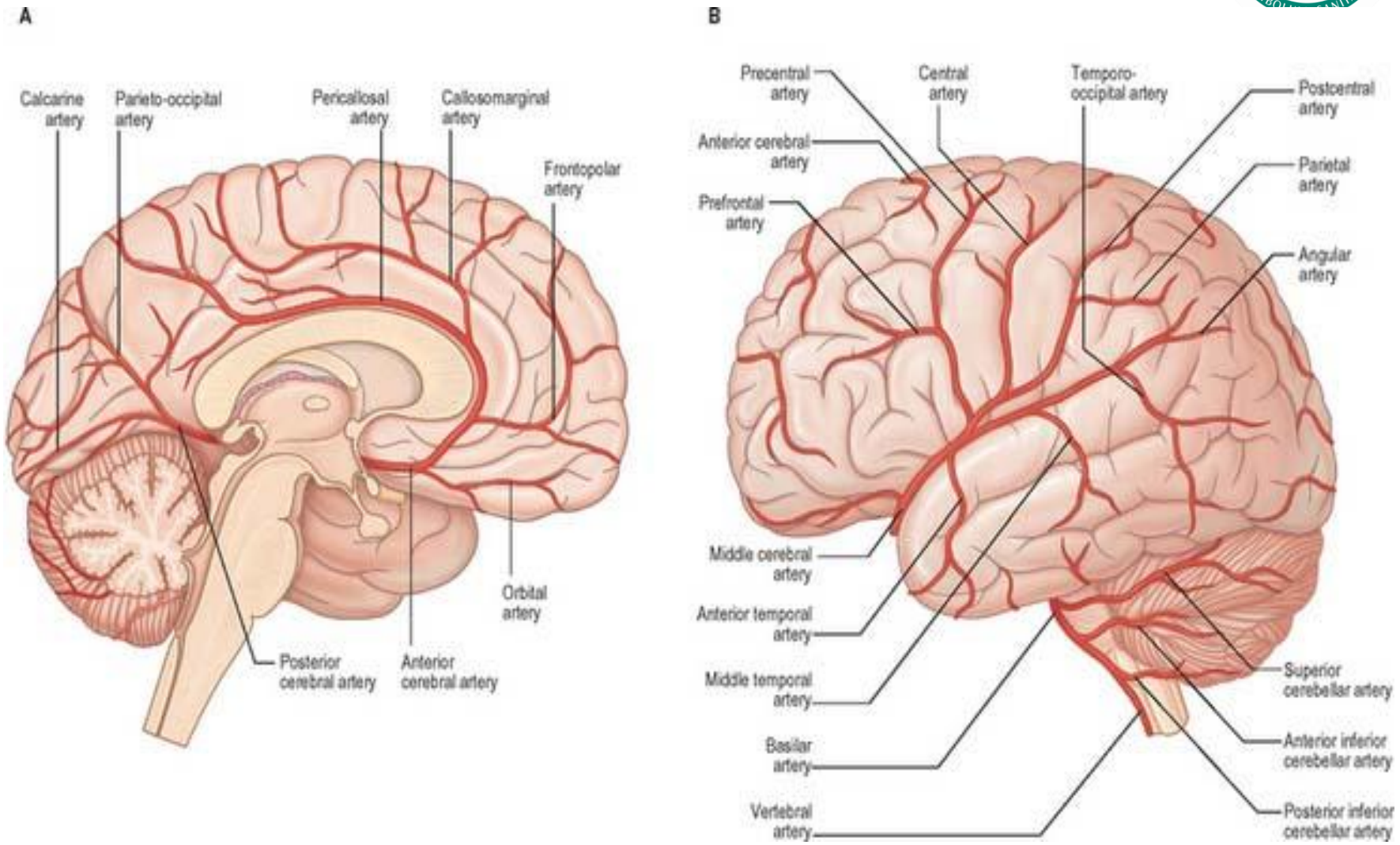
Ventricles and cerebrospinal fluid



Blood vessels

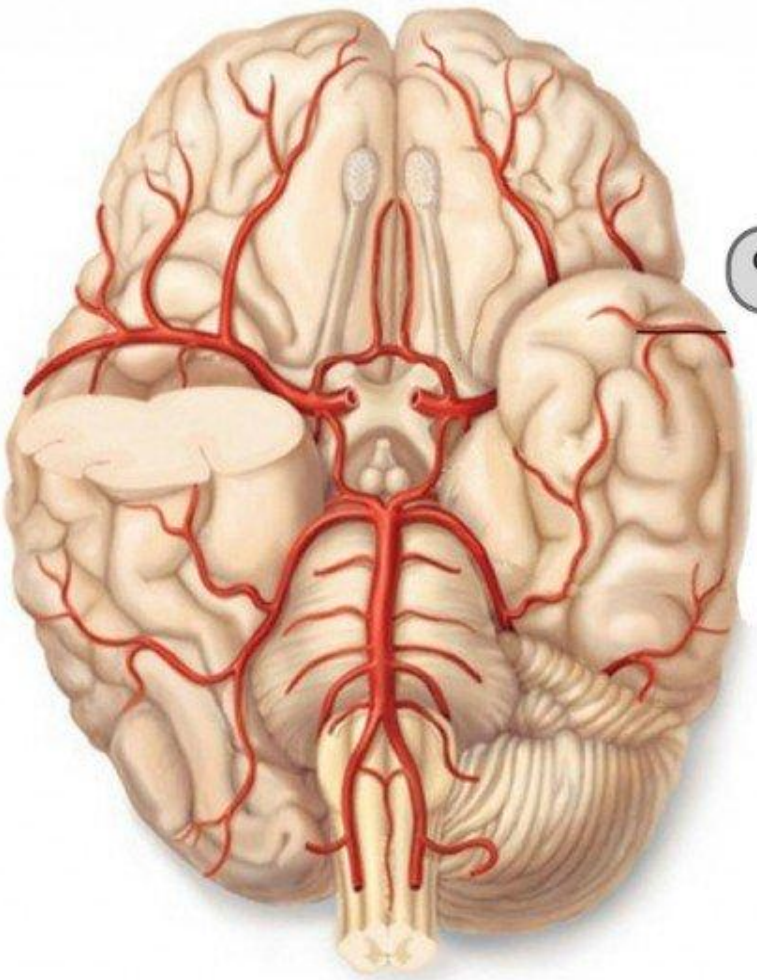
- Arteries supply blood to the brain via 2 main pairs of vessels: the internal carotid artery and the vertebral artery on each side. The internal carotid artery on each side terminates into the anterior cerebral artery, the middle cerebral artery, and the posterior communicating artery. The vertebral arteries on each side join to form the basilar artery. The basilar artery then gives rise to the posterior cerebral arteries and the superior cerebellar arteries.

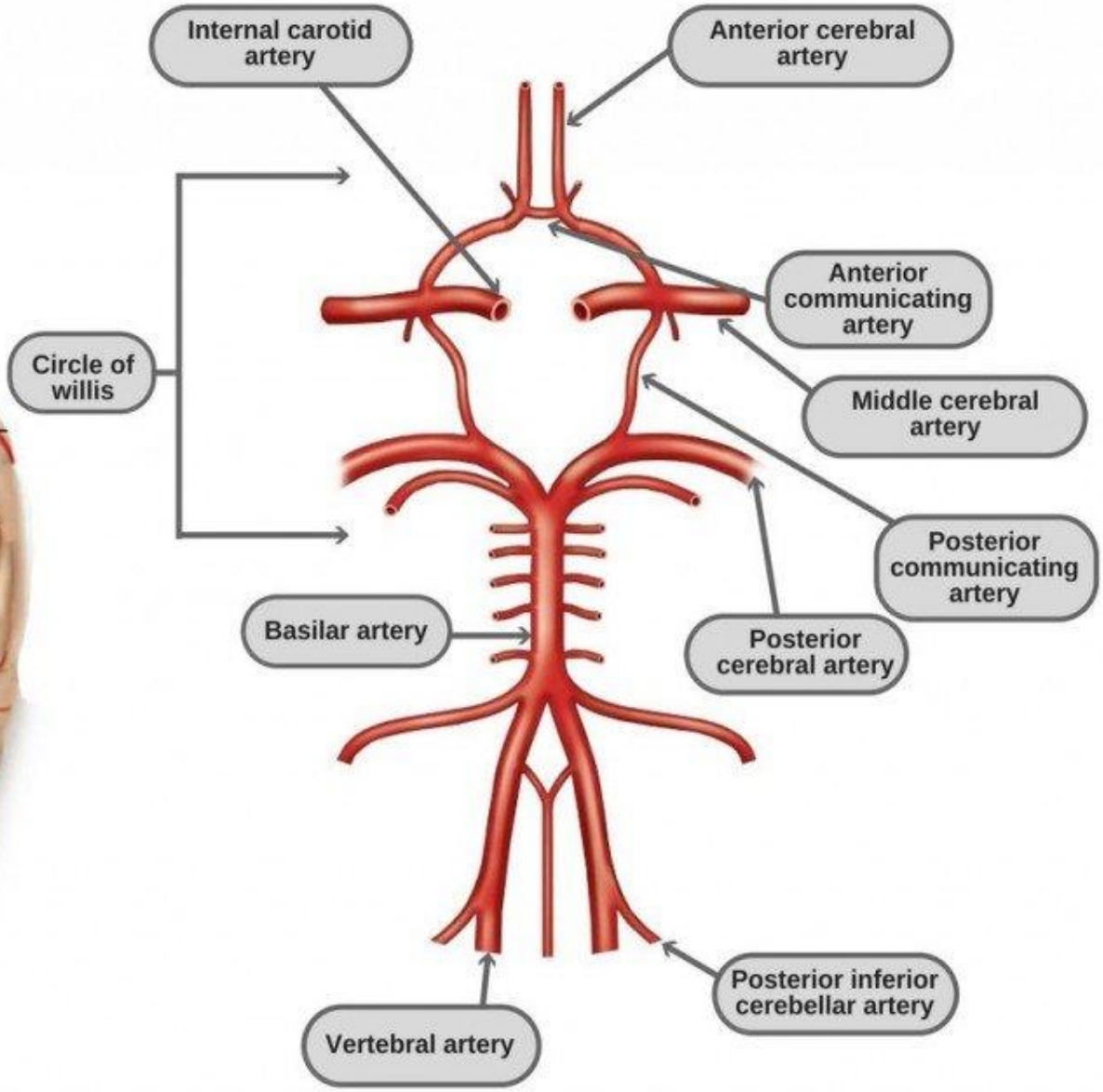
The major arteries supplying the medial, A, and lateral, B, aspects of the brain.



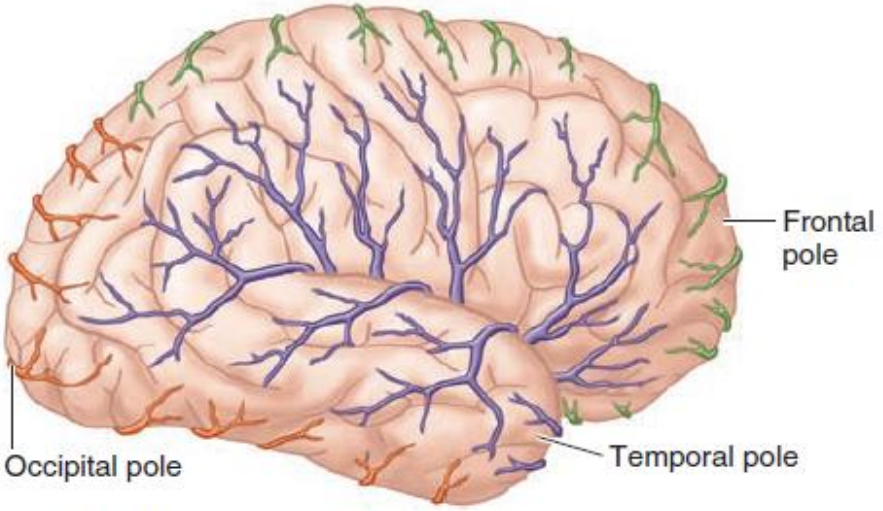
Blood vessels

- The basilar artery, the posterior cerebral arteries, the posterior communicating arteries, and the anterior cerebral arteries, along with the anterior artery, form an important collateral circulation at the base of the brain termed the cerebral arterial circle (of Willis).

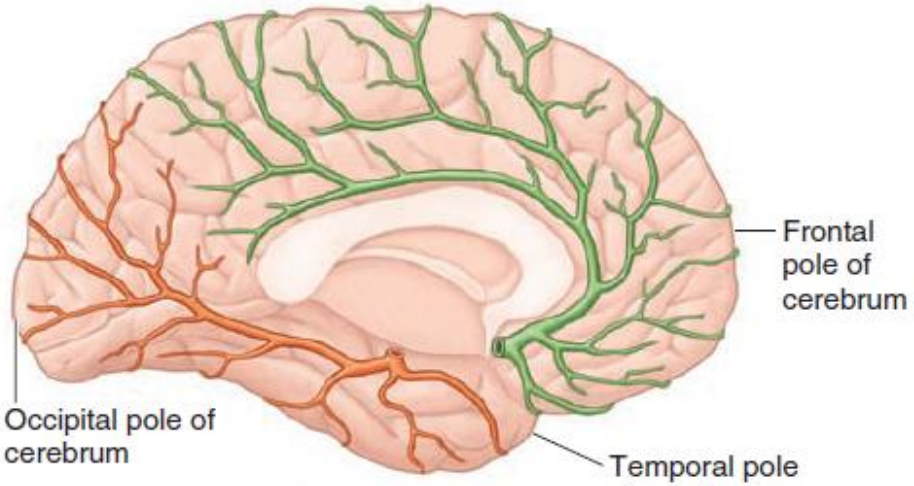



Internal carotid artery
Anterior cerebral artery
Circle of willis
Anterior communicating artery
Middle cerebral artery
Posterior communicating artery
Basilar artery
Posterior cerebral artery
Posterior inferior cerebellar artery
Vertebral artery

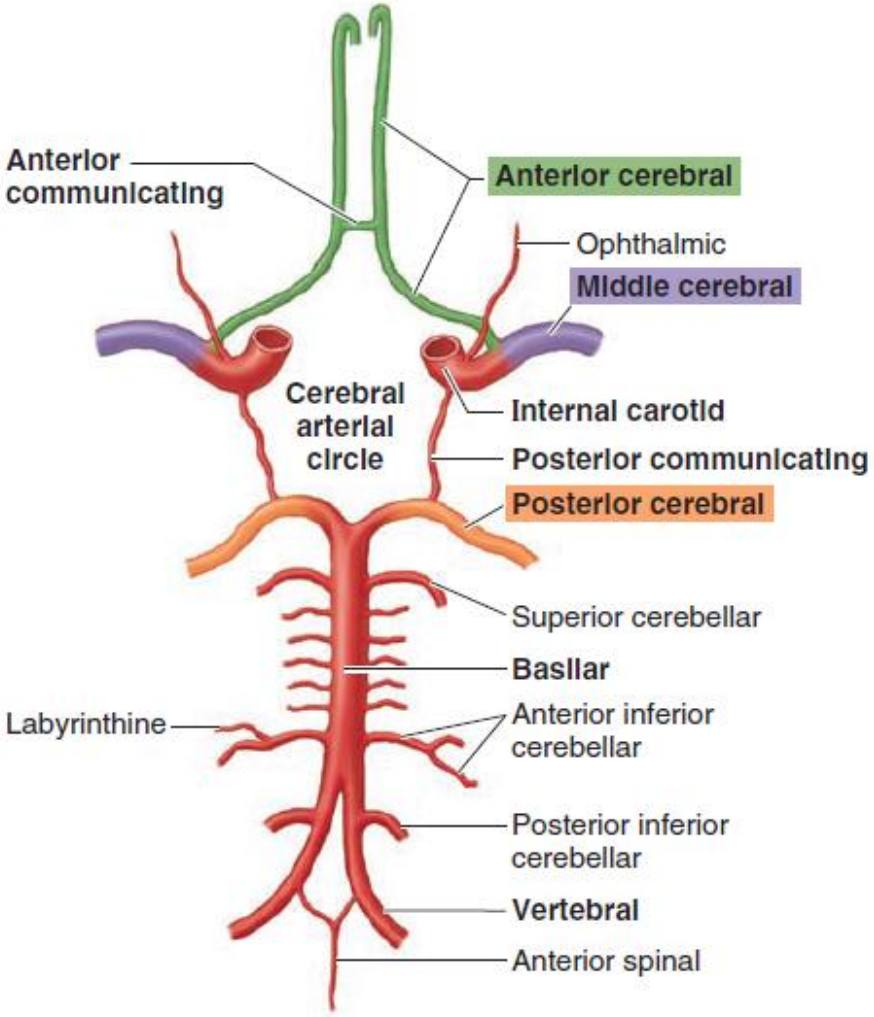
Arterial supply of cerebrum



(A) Right lateral view of right hemisphere

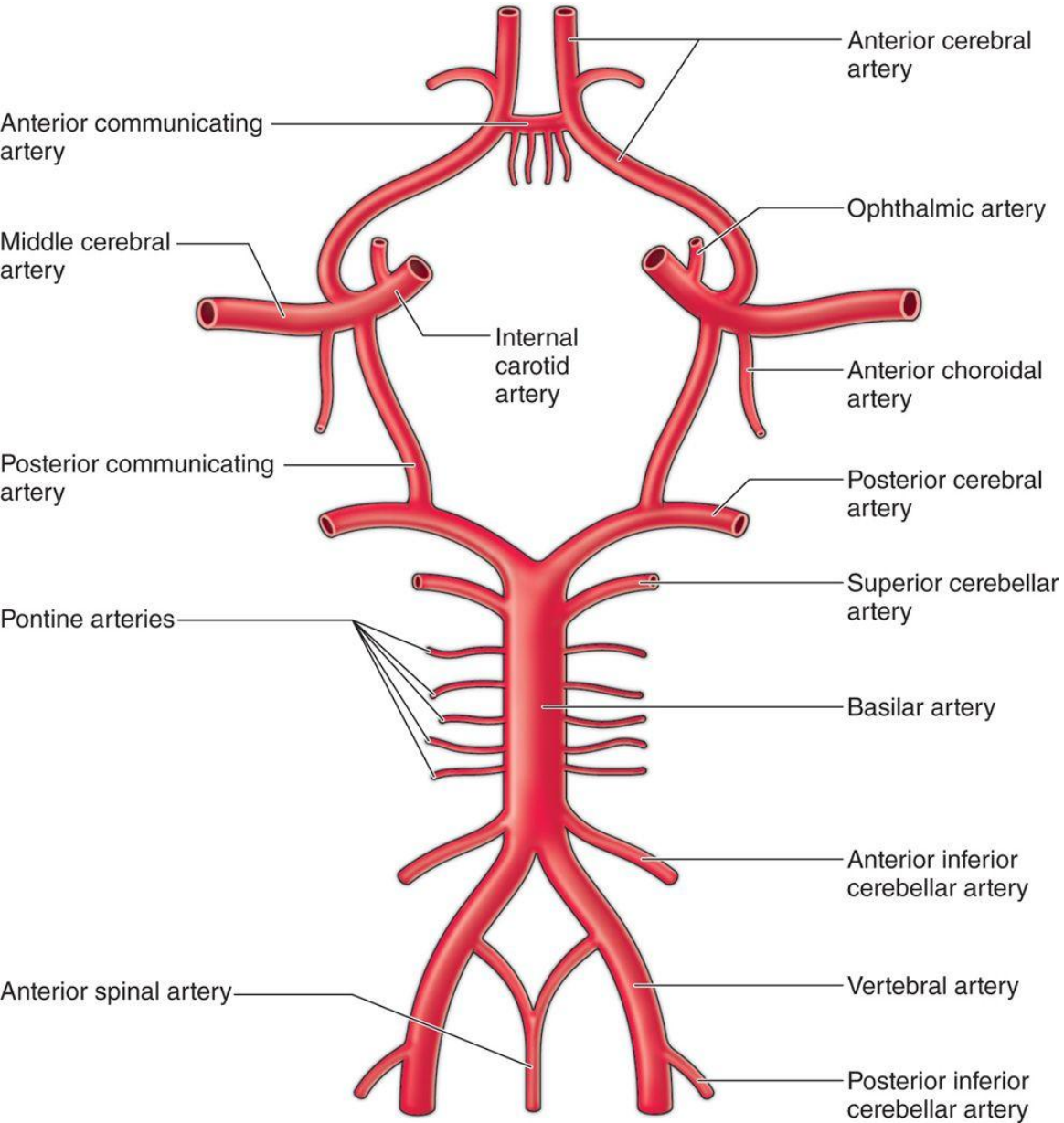


(B) Medial view of left hemisphere



(C) Inferior view

The cerebral arterial circle (of Willis)



- These vessels lie within the subarachnoid space and are a common location for cerebral aneurysms to form.

The cerebral arterial circle (of Willis)

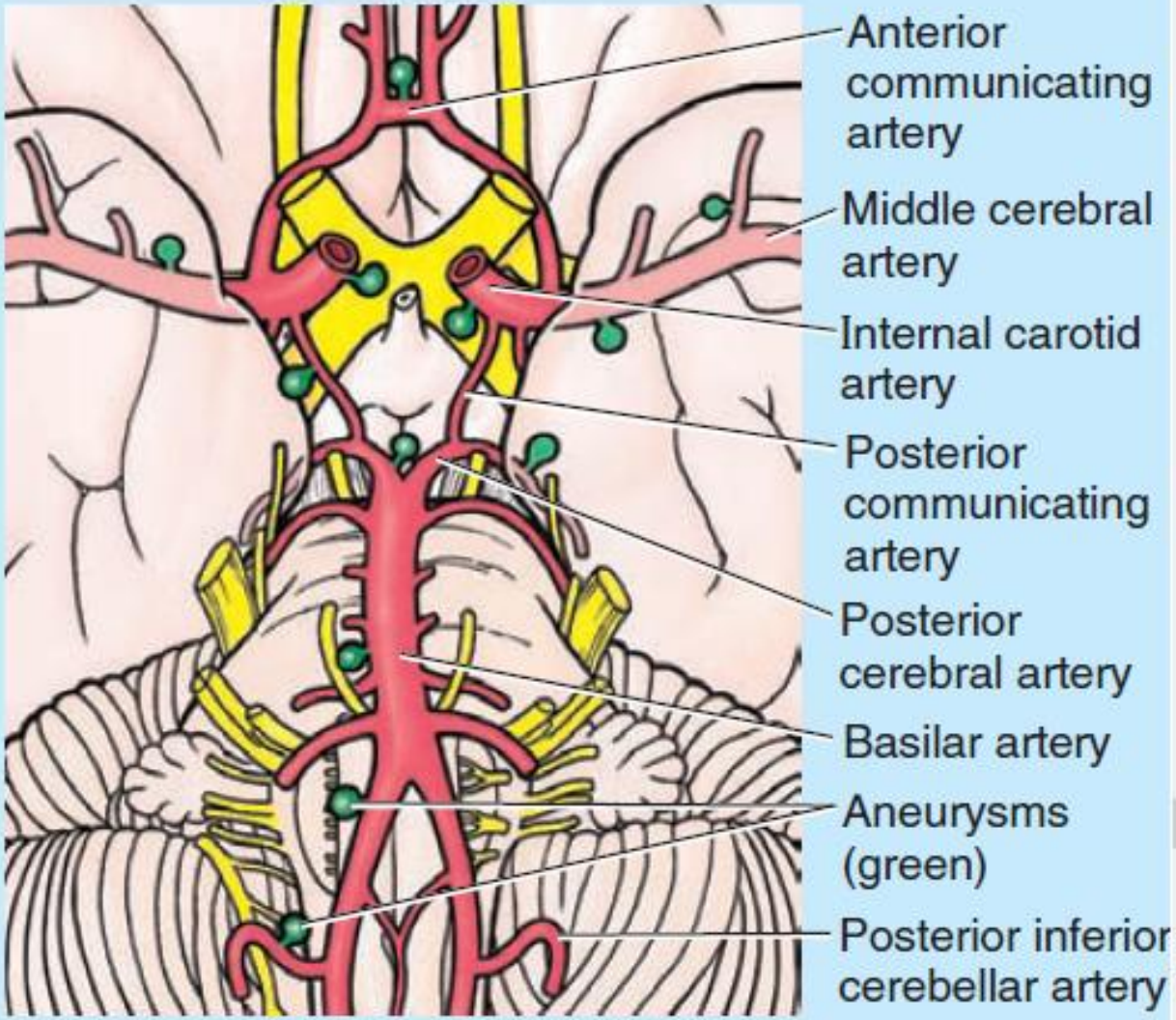
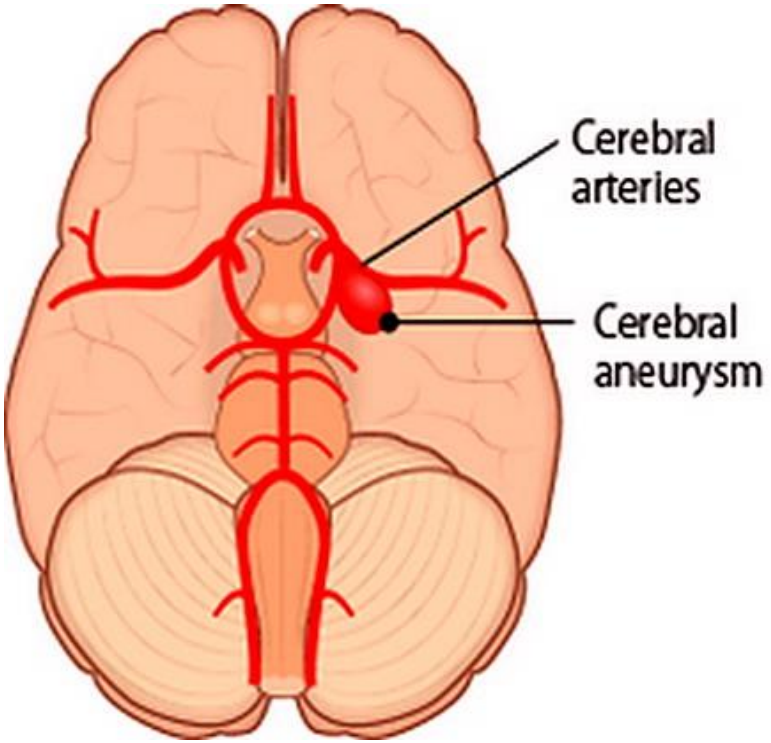
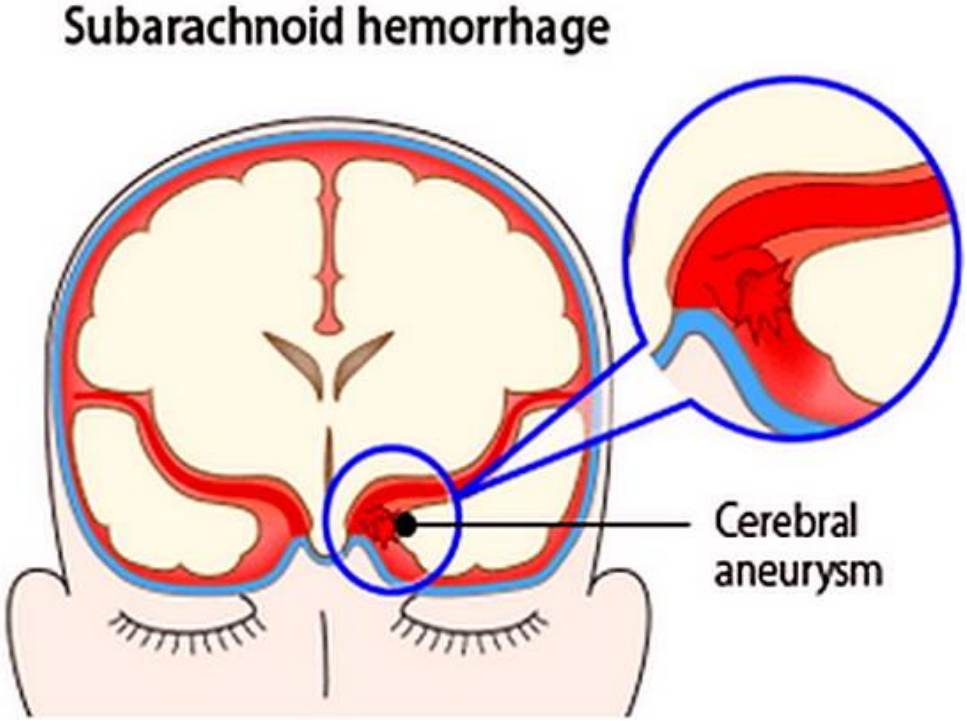


FIGURE B7.4. Berry aneurysm (BA).

These vessels lie within the subarachnoid space and are a common location for cerebral aneurysms to form.

Subarachnoid hemorrhage





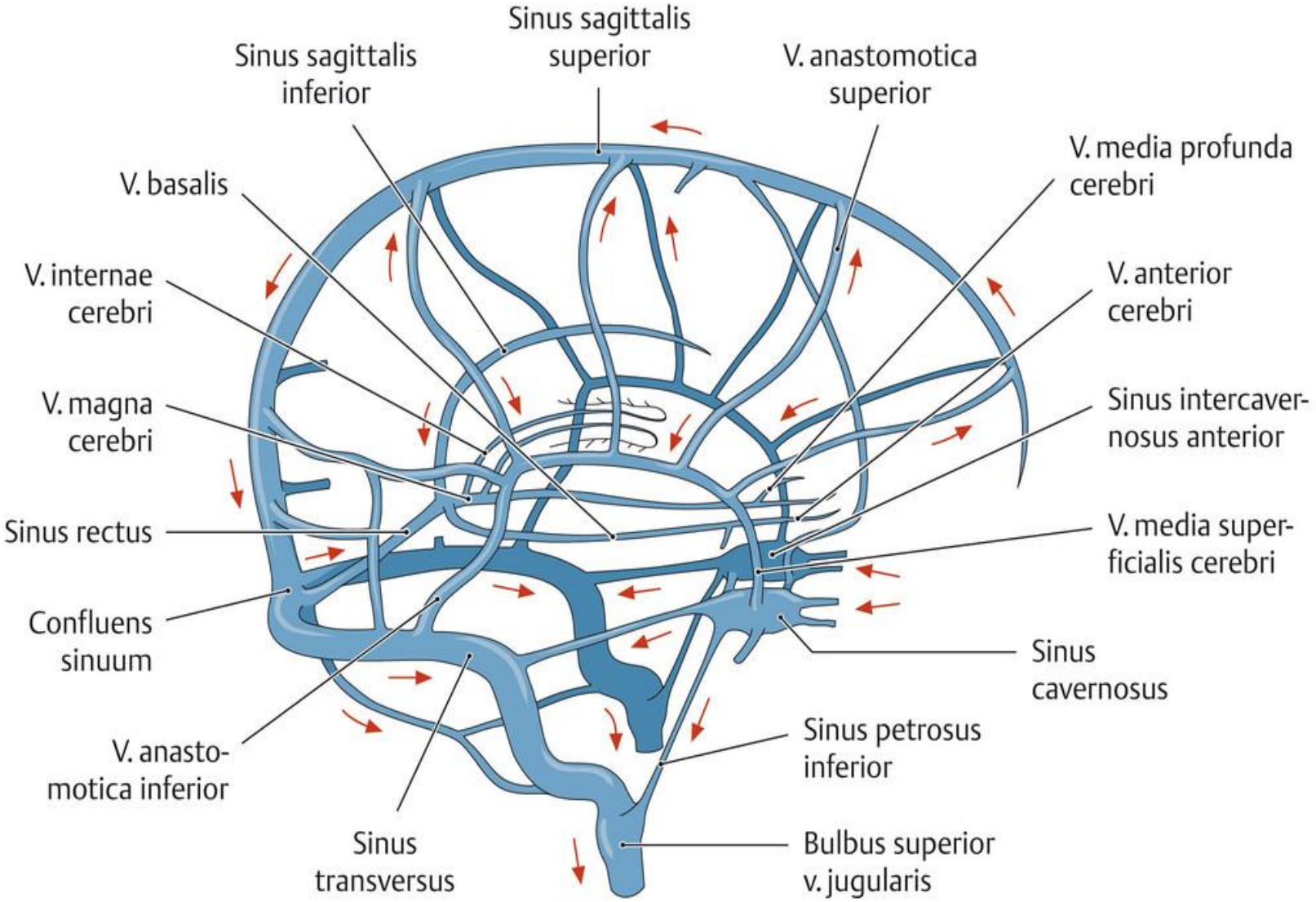
Blood vessels

- Venous return to the heart occurs through a combination of deep cerebral veins and superficial cortical veins. The veins then contribute to larger venous sinuses, which lie within the dura and ultimately drain through the internal jugular veins to the brachiocephalic veins and then into the superior vena cava.

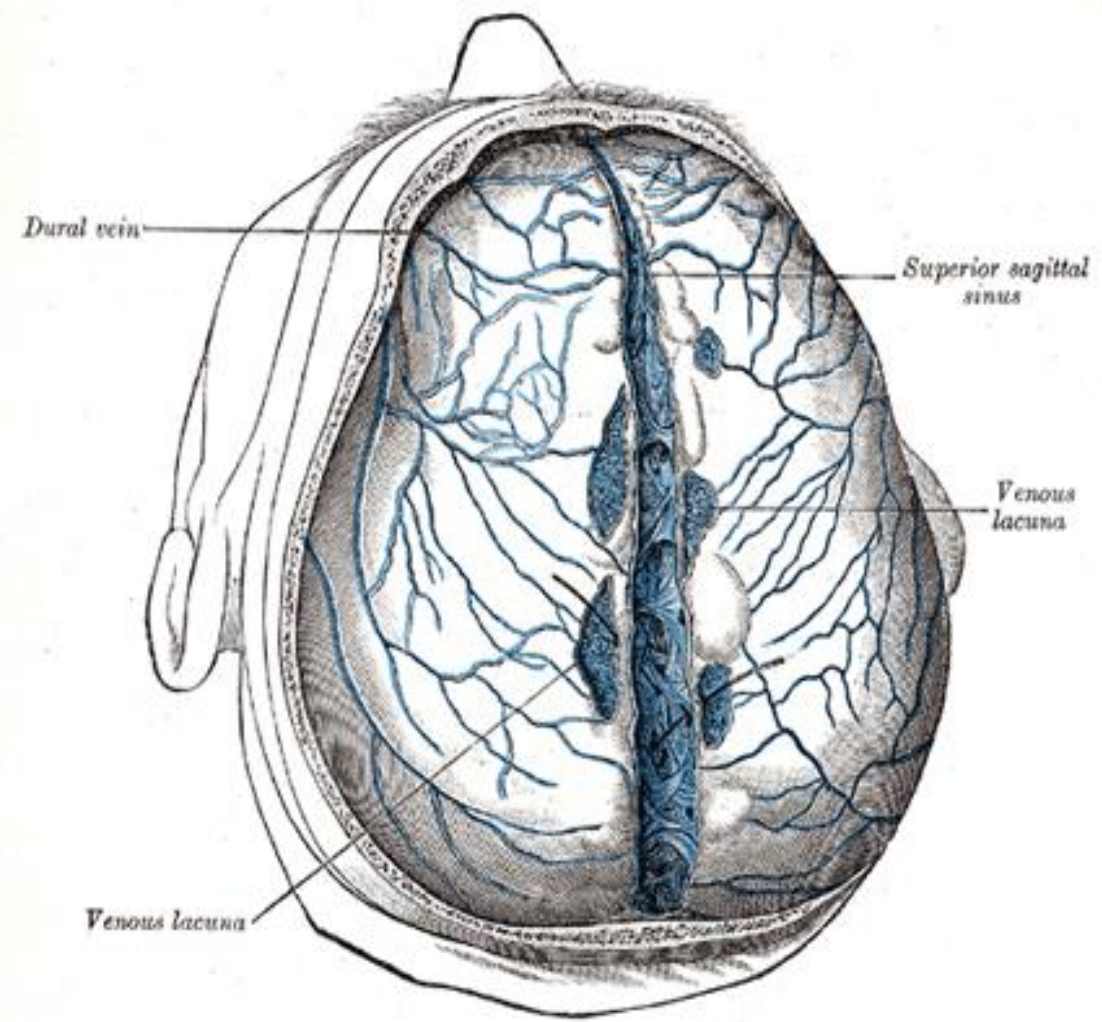
The sinuses of the dura mater

- The **sinuses of the dura mater** are venous channels which drain the blood from the brain; they are devoid of valves, and are situated between the two layers of the dura mater and lined by endothelium continuous with that which lines the veins. They may be divided into two groups: (1) a **postero-superior,** at the upper and back part of the skull, and (2) an **antero-inferior,** at the base of the skull.

The Sinuses of the Dura Mater



The Sinuses of the Dura Mater

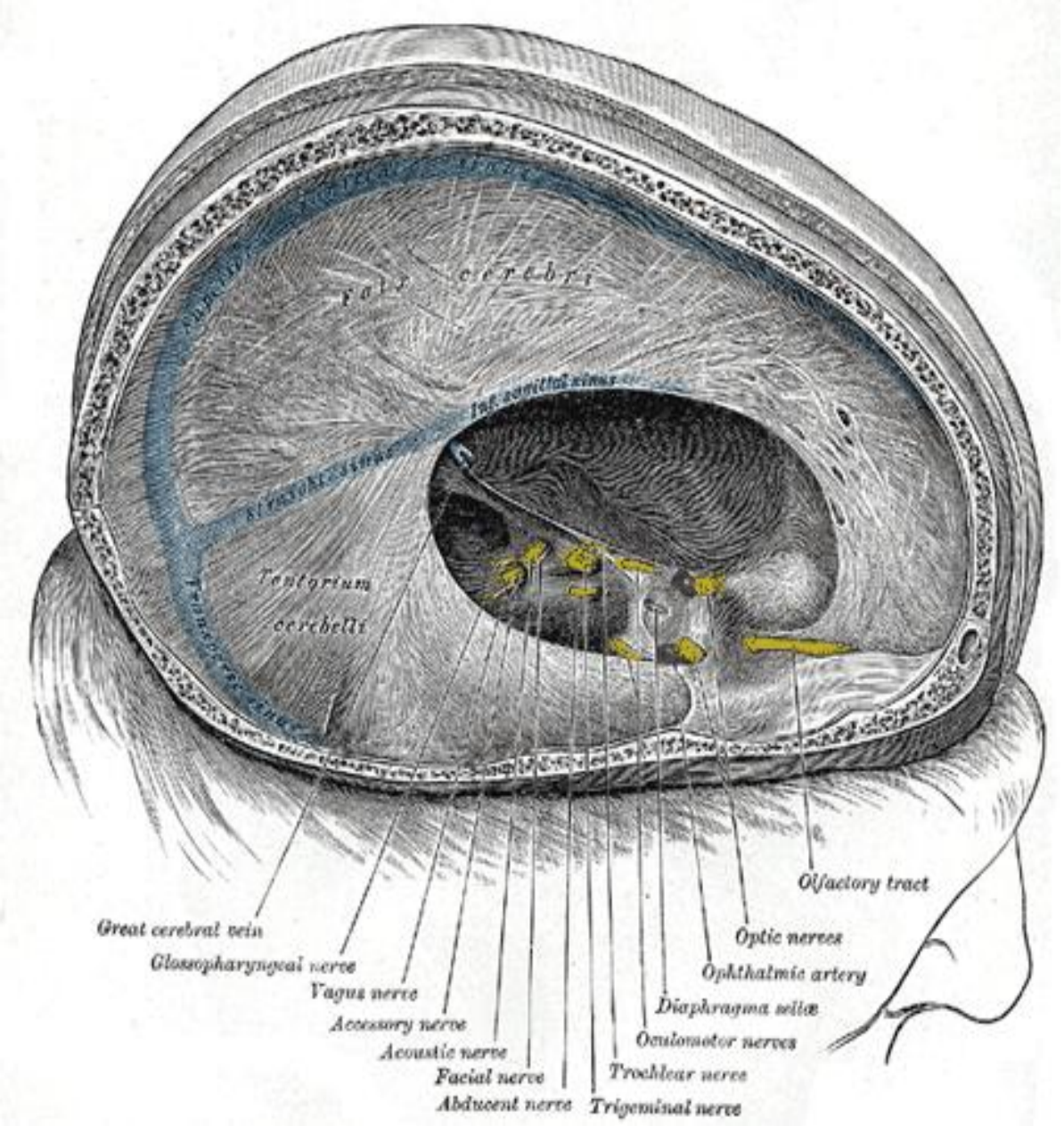


- Superior sagittal sinus laid open after remova of the skull cap. The chordæ Willisii are clearly seen. The venous lacunæ are also well shown; from two of them probes are passed into the superior sagittal sinus. (Poirier and Charpy.)

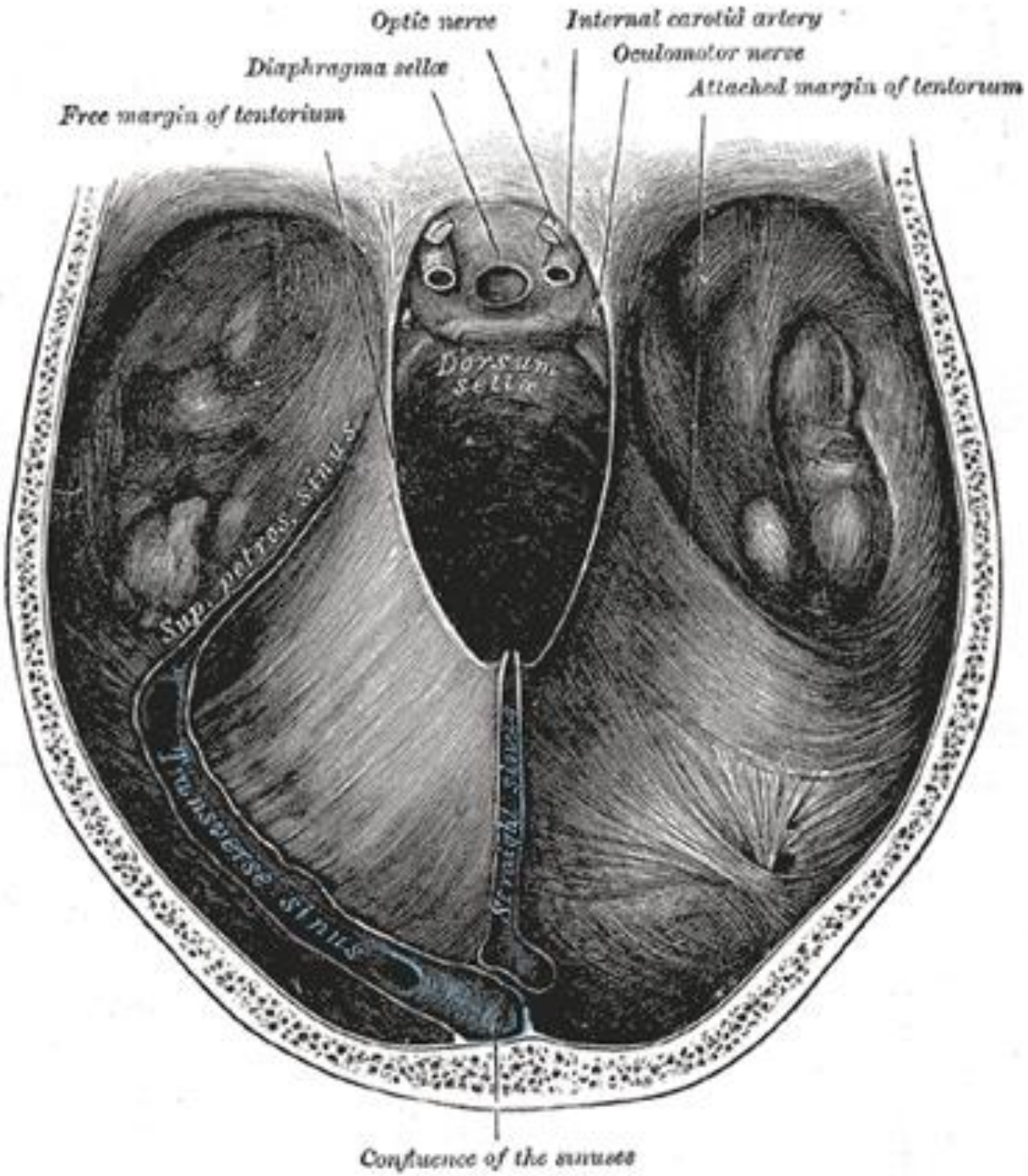
The Sinuses of the Dura Mater

The postero-superior group comprises the

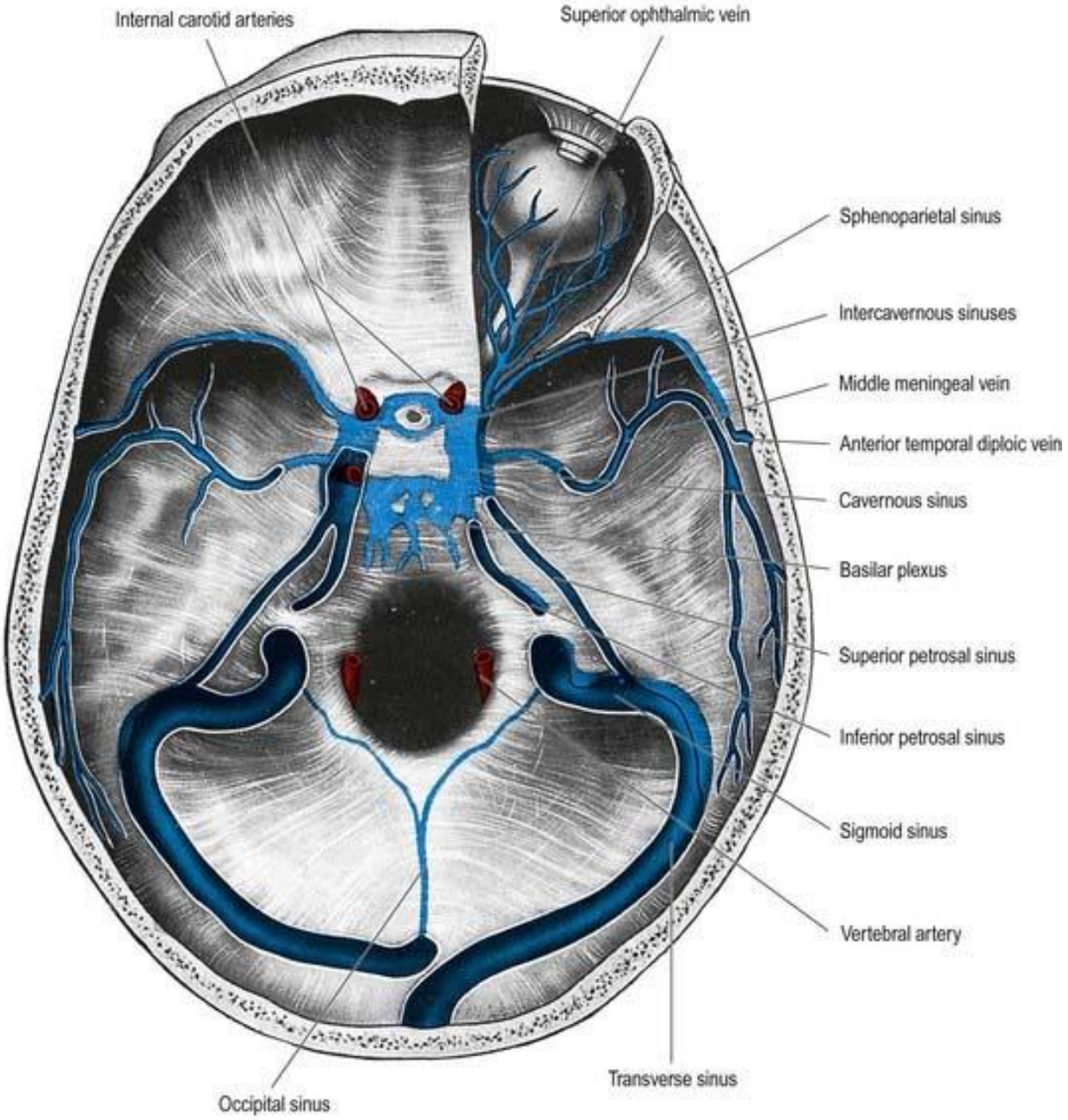
- Superior Sagittal.
- Straight.
- Inferior Sagittal.
- Two Transverse.
- Occipital.



Dura mater and its processes exposed by removing part of the right half of the skull, and the brain.



- Tentorium cerebelli from above.



- **The sinuses at the base of the skull.**

The sinuses at the base of the skull.

- The **Confluence of the Sinuses** (*confluens sinuum; torcular Herophili*) is the term applied to the dilated extremity of the superior sagittal sinus. It is of irregular form, and is lodged on one side (generally the right) of the internal occipital protuberance. From it the transverse sinus of the same side is derived. It receives also the blood from the occipital sinus, and is connected across the middle line with the commencement of the transverse sinus of the opposite side.

The sinuses at the base of the skull.

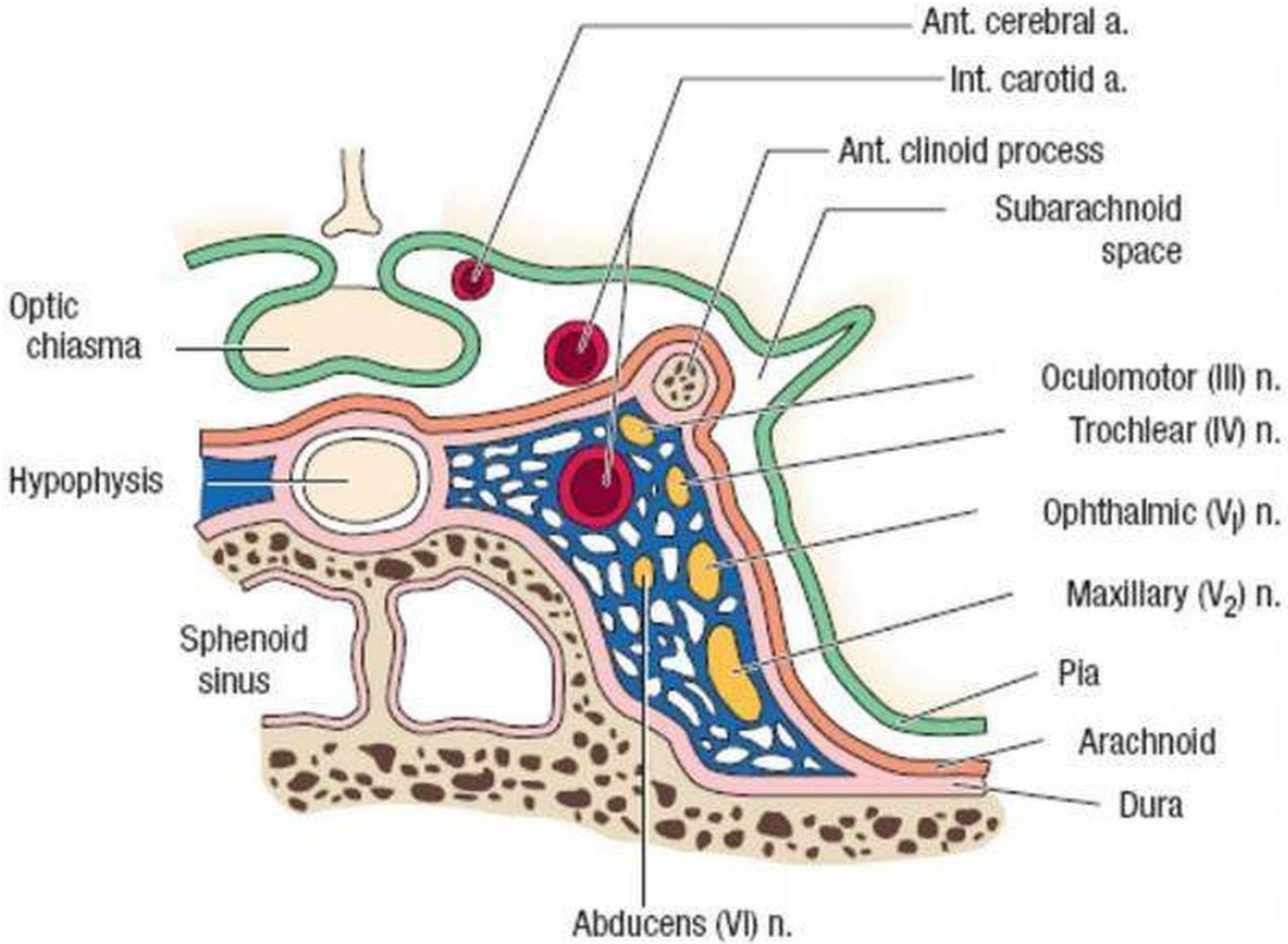
The antero-inferior group of sinuses comprises the

- Two Cavernous.
- Two Superior Petrosal.
- Two Intercavernous.
- Two Inferior Petrosal.
- Basilar Plexus.

The sinuses at the base of the skull.

- The **cavernous sinuses** (*sinus cavernosus*) are so named because they present a reticulated structure, due to their being traversed by numerous interlacing filaments. They are of irregular form, larger behind than in front, and are placed one on either side of the body of the sphenoid bone, extending from the superior orbital fissure to the apex of the petrous portion of the temporal bone. Each opens behind into the petrosal sinuses.

The cavernous sinus



The cavernous sinus

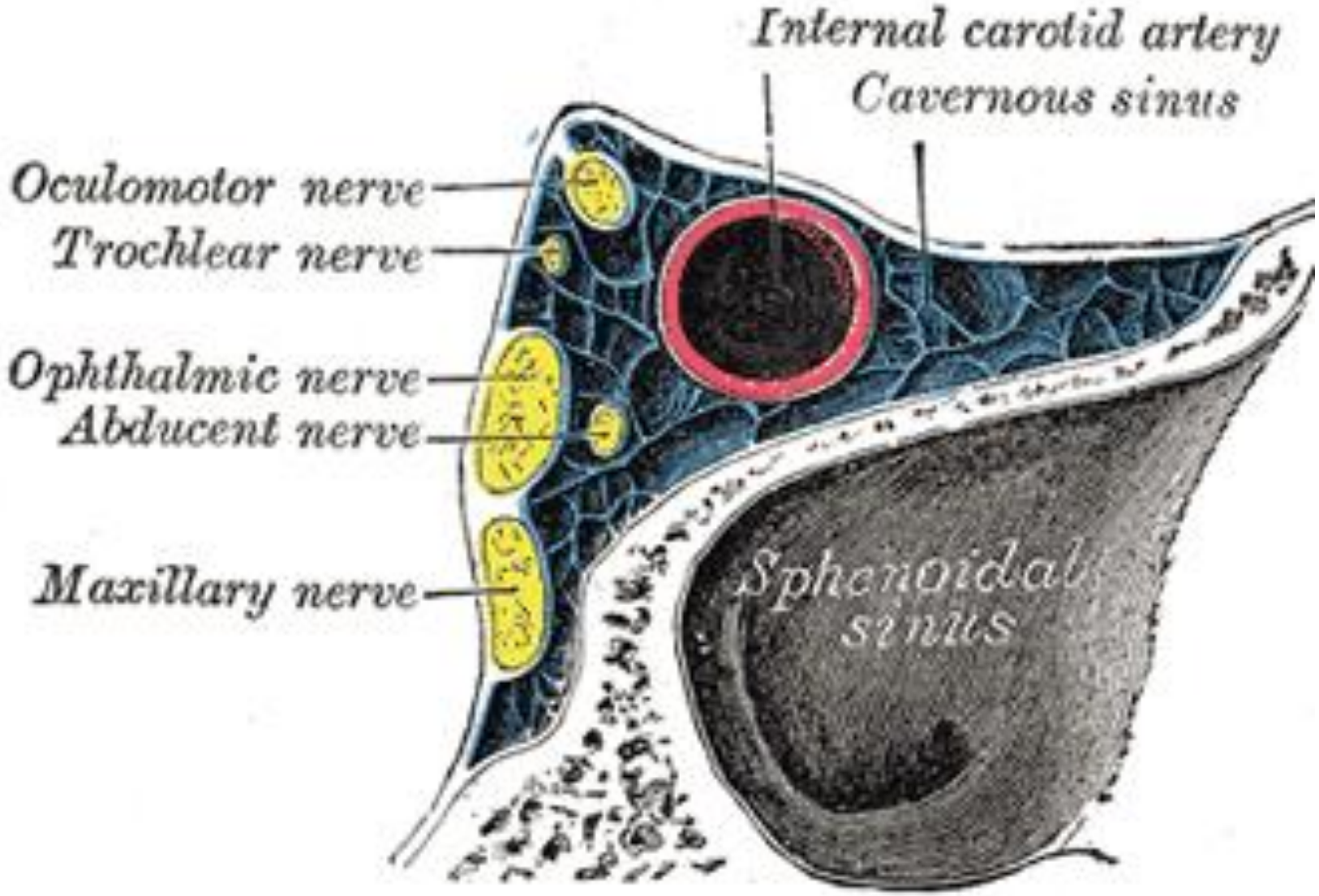
- On the medial wall of each sinus is the internal carotid artery, accompanied by filaments of the carotid plexus; near the artery is the abducent nerve; on the lateral wall are the oculomotor and trochlear nerves, and the ophthalmic and maxillary divisions of the trigeminal nerve. These structures are separated from the blood flowing along the sinus by the lining membrane of the sinus.

The sinuses at the base of the skull.

- The cavernous sinus receives the superior ophthalmic vein through the superior orbital fissure, some of the cerebral veins, and also the small **sphenoparietal sinus,** which courses along the under surface of the small wing of the sphenoid.

The sinuses at the base of the skull.

- It communicates with the transverse sinus by means of the superior petrosal sinus; with the internal jugular vein through the inferior petrosal sinus and a plexus of veins on the internal carotid artery; with the pterygoid venous plexus through the foramen Vesalii, foramen ovale, and foramen lacerum, and with the angular vein through the ophthalmic vein. The two sinuses also communicate with each other by means of the anterior and posterior intercavernous sinuses.



Oblique section through the cavernous sinus.

The sinuses at the base of the skull.

- The **basilar plexus** (*plexus basilaris; transverse or basilar sinus*) consists of several interlacing venous channels between the layers of the dura mater over the basilar part of the occipital bone, and serves to connect the two inferior petrosal sinuses. It communicates with the anterior vertebral venous plexus.

The sinuses at the base of the skull.

- **Emissary Veins (*emissaria*).**—The emissary veins pass through apertures in the cranial wall and establish communication between the sinuses inside the skull and the veins external to it. Some are always present, others only occasionally so.

The principal emissary veins

The principal emissary veins are the following:

- (1) A mastoid emissary vein, usually present, runs through the mastoid foramen and unites the transverse sinus with the posterior auricular or with the occipital vein.
- (2) A parietal emissary vein passes through the parietal foramen and connects the superior sagittal sinus with the veins of the scalp.
- (3) A net-work of minute veins (*rete canalis hypoglossi*) traverses the hypoglossal canal and joins the transverse sinus with the vertebral vein and deep veins of the neck.

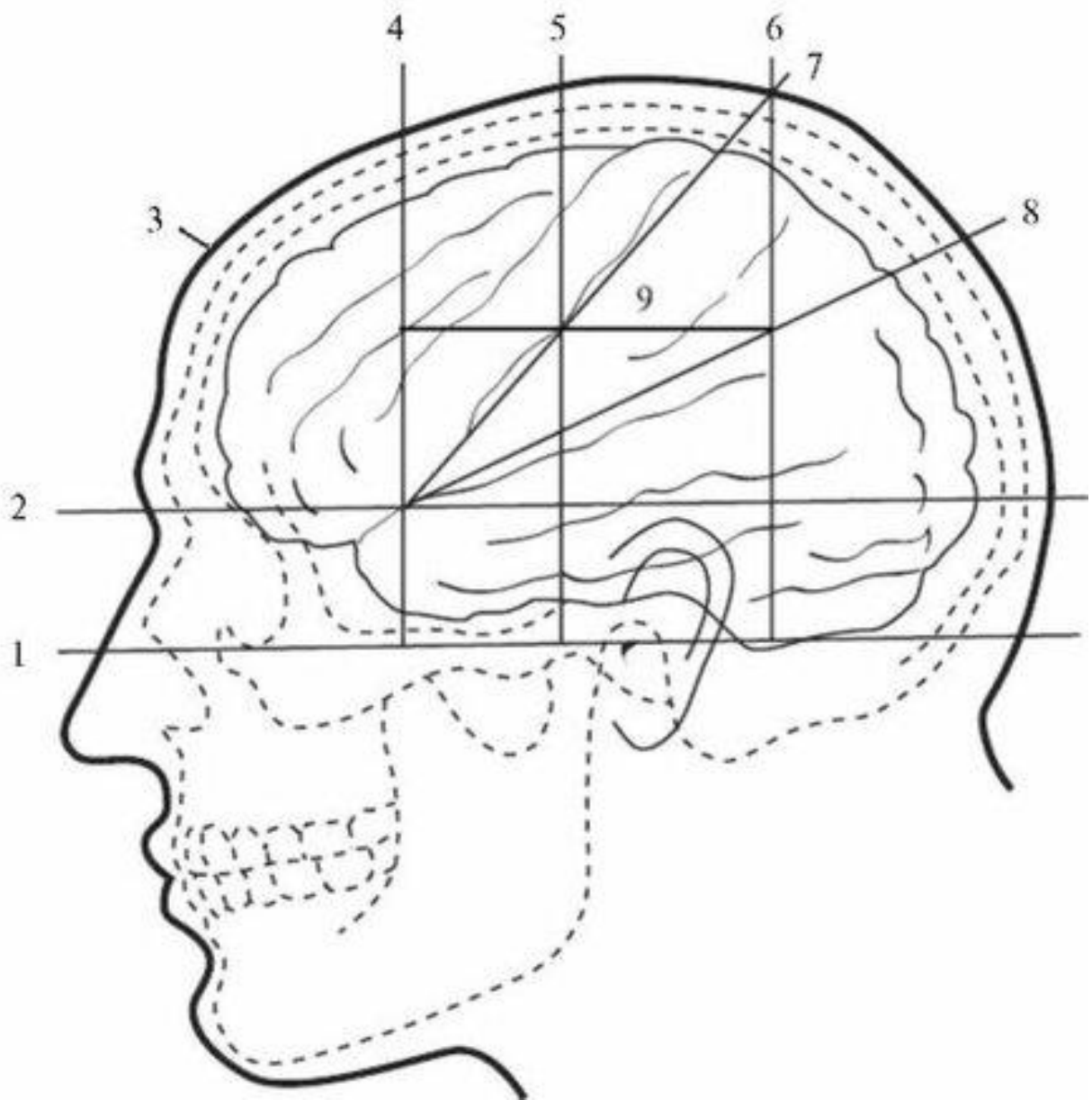
The principal emissary veins

- (4) An inconstant condyloid emissary vein passes through the condyloid canal and connects the transverse sinus with the deep veins of the neck.
- (5) A net-work of veins (*rete foraminis ovalis*) unites the cavernous sinus with the pterygoid plexus through the foramen ovale.
- (6) Two or three small veins run through the foramen lacerum and connect the cavernous sinus with the pterygoid plexus.

The principal emissary veins

- (7) The emissary vein of the foramen of Vesalius connects the same parts.
- (8) An internal carotid plexus of veins traverses the carotid canal and unites the cavernous sinus with the internal jugular vein.
- (9) A vein is transmitted through the foramen cecum and connects the superior sagittal sinus with the veins of the nasal cavity.

Cranial topography according Kronlein-Brusova



Cranial topography according Kronlein-Brusova

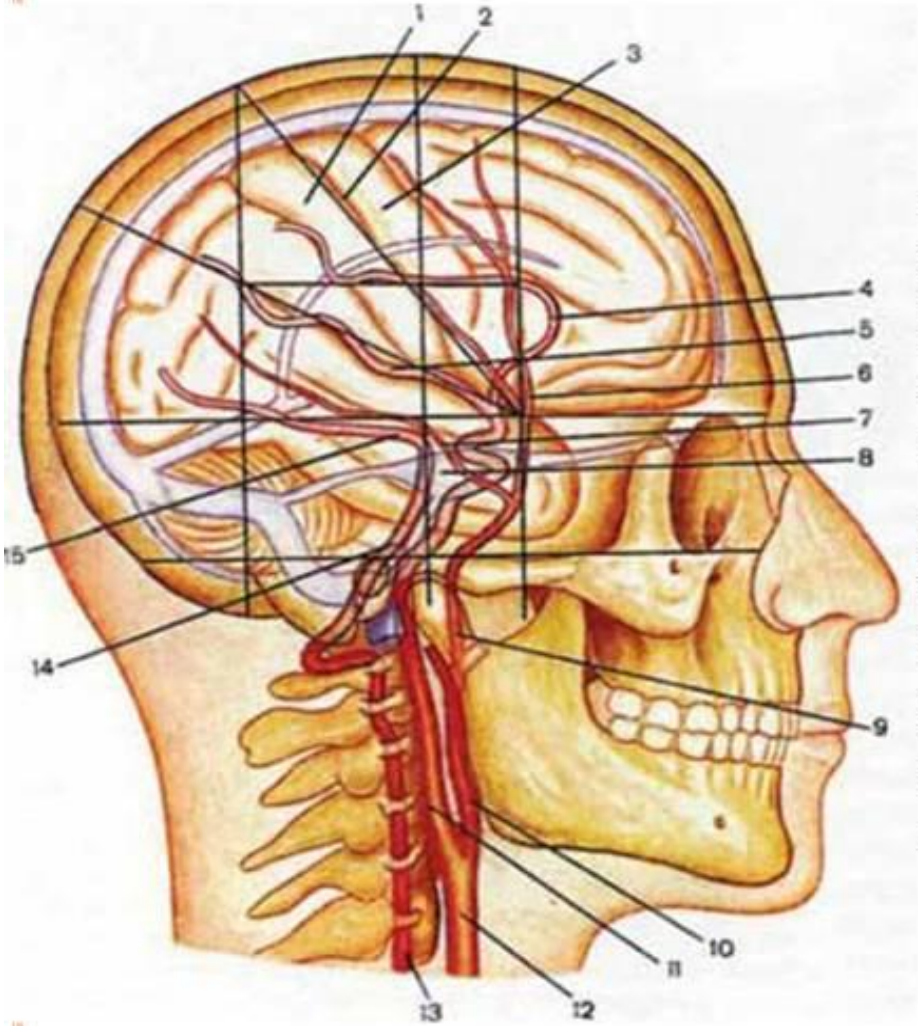


Схема черепно-мозговой топографии

1 — gyrus postcentralis;
2 — sulcus centralis;
3 — gyrus precentralis;
4 — a. cerebri anterior;
5 — a. Cerebri media;
6 — r. frontalis a. meningeae mediae;
7 — r. parietalis a. meningeae mediae;
8 — sinus cavernosus;
9 — a. meningea media;
10 — a. carotis externa;
11 — a. carotis interna;
12 — a. carotis communis;
13 — a. vertebralis;
14 — a. basilaris;
15 — a. Cerebri posterior.

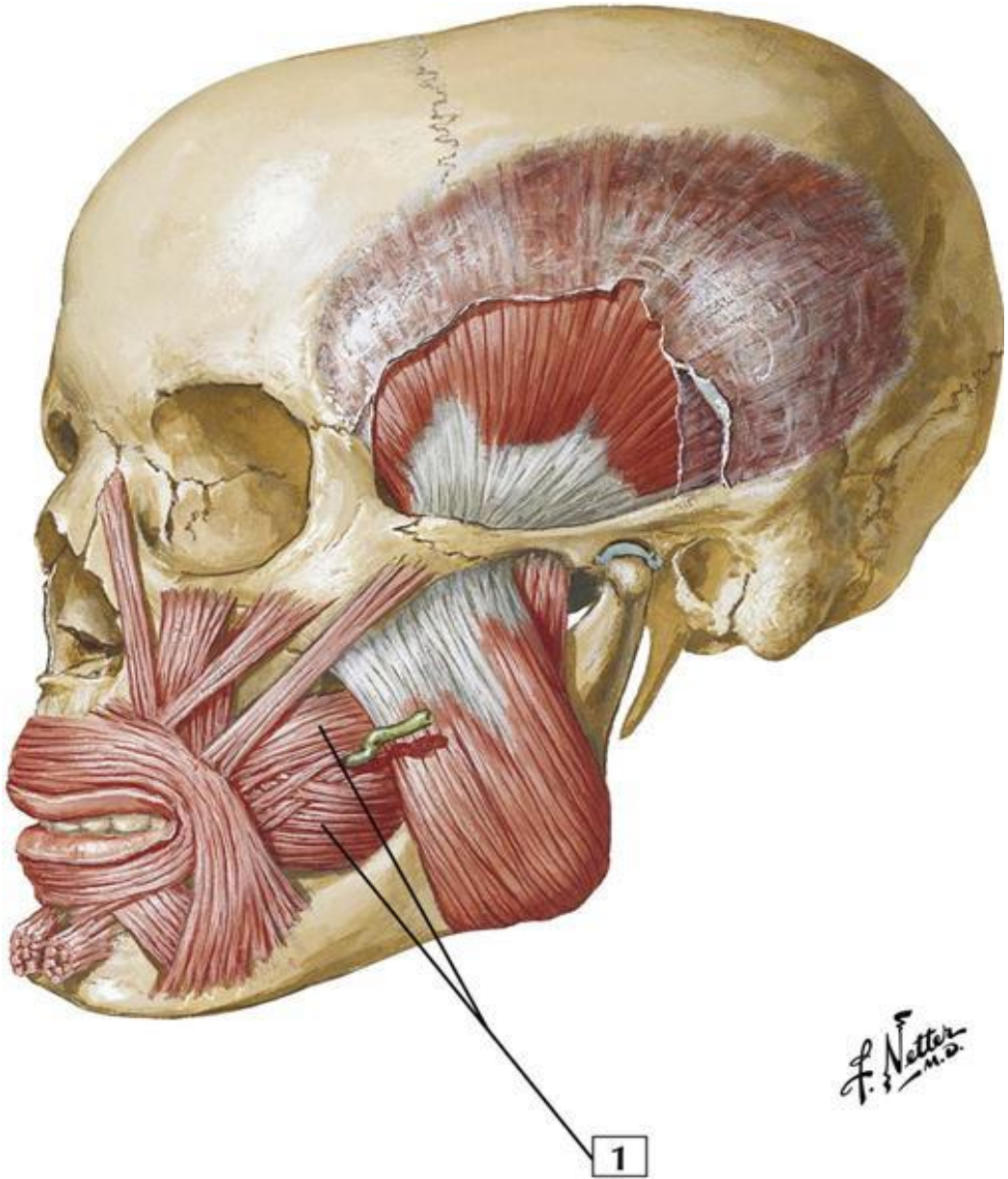
Cranial topography according Kronlein-Brusova

This scheme is used to determine the projections of intracranial structures on the surface of the shaved head of the patient when prepared for the cranial surgery; then these lines are drawn on the surface of the shaved head of the patient with sterile marker

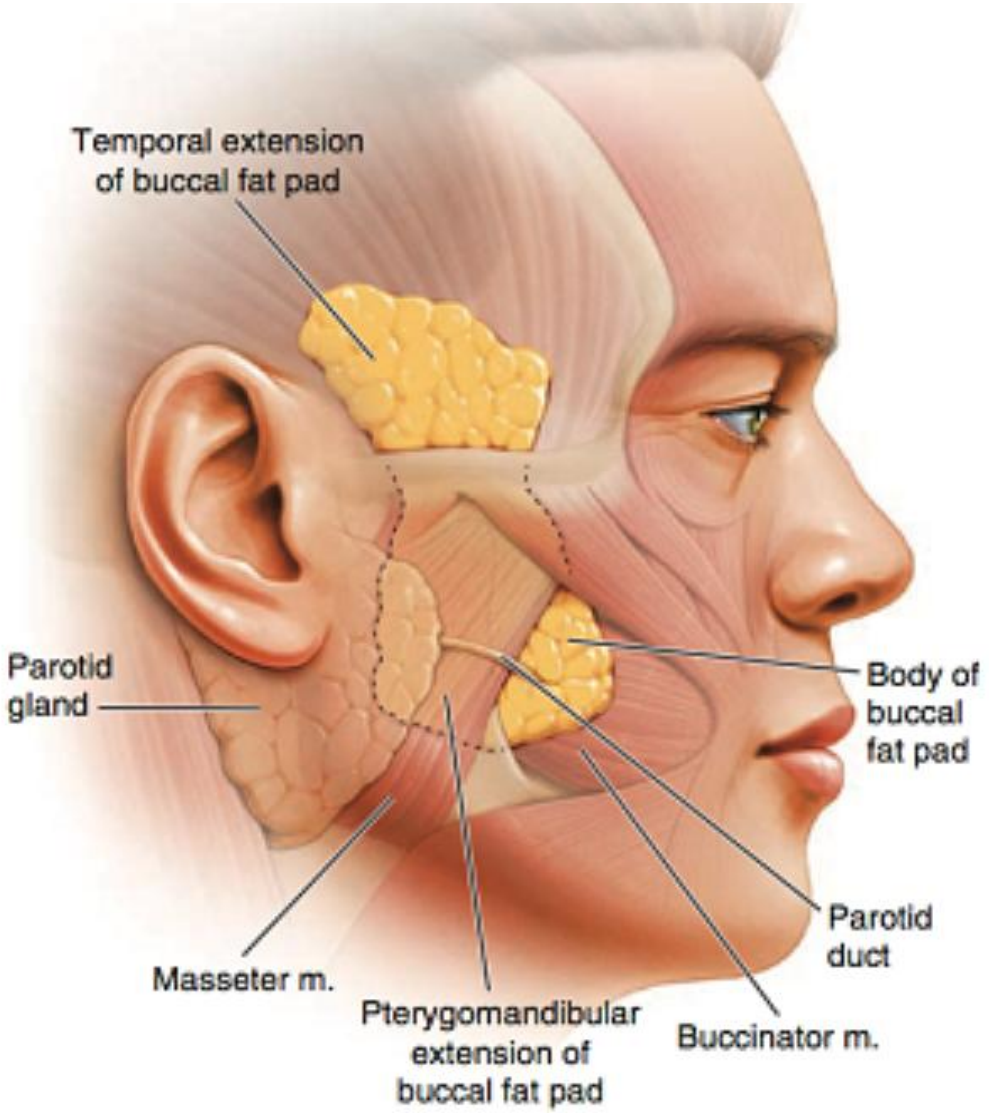
The temporal region

The region of the temple is on the side of the head as far forward as the eye and as low as the zygoma and infratemporal crest. The floor of the temporal fossa is formed by the posterior portion of the frontal and anterior portion of the parietal bones as high as the temporal ridge, the outer surface of the greater wing of the sphenoid, and the squamous portion of the temporal bone. These four bones meet to form the region of the pterion.

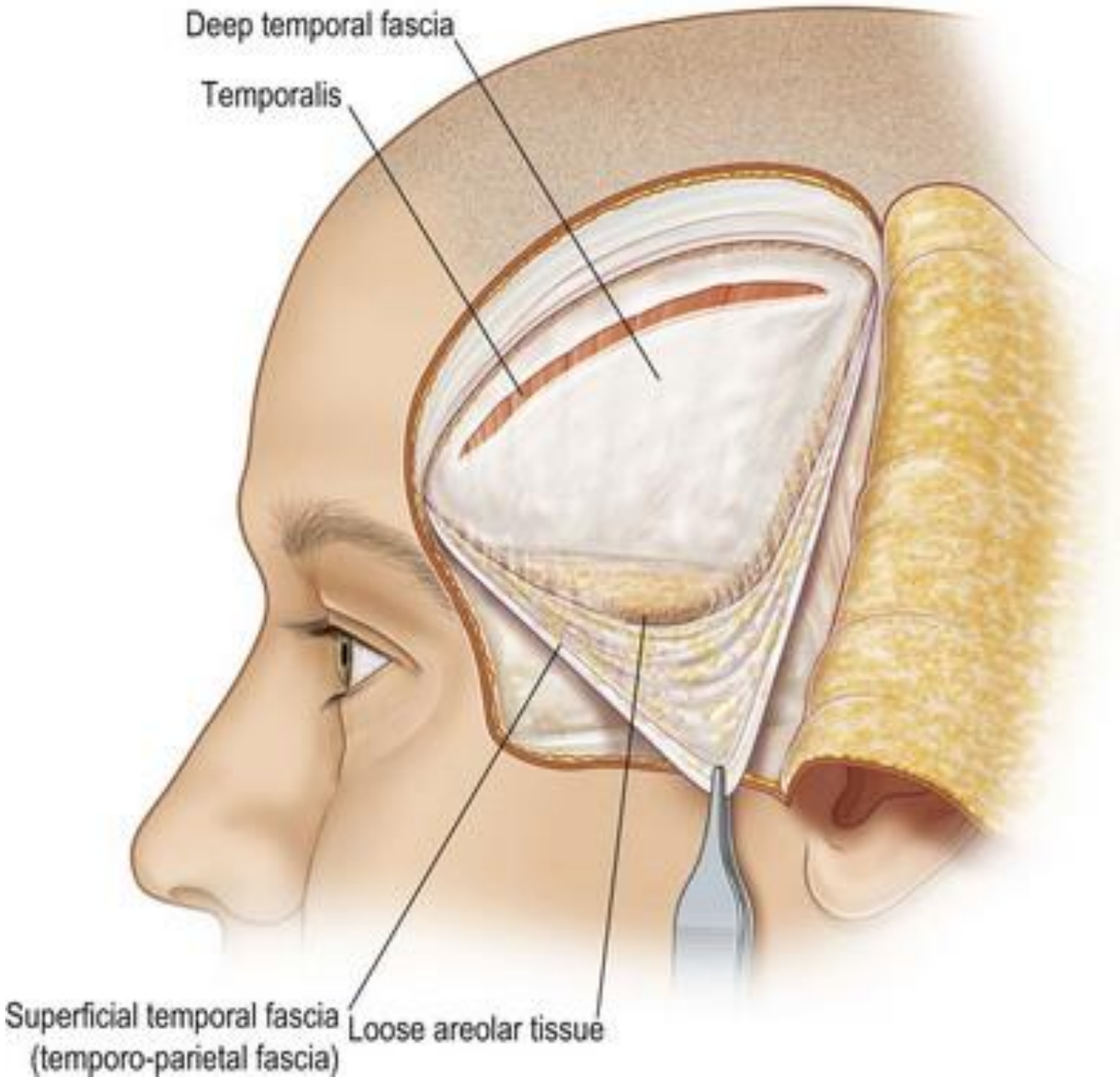
The temporal region



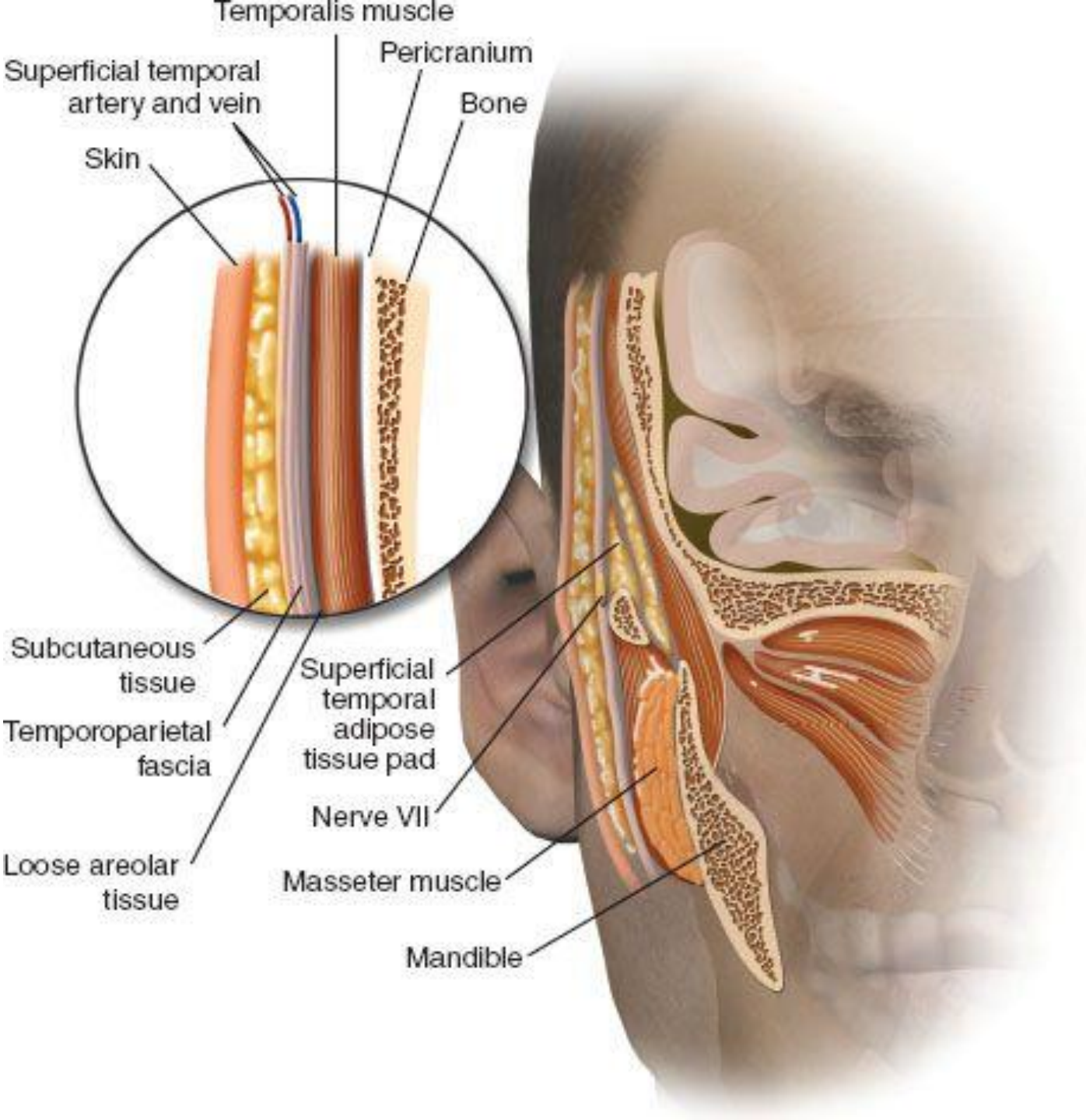
The temporal region



The temporal region



The temporal region



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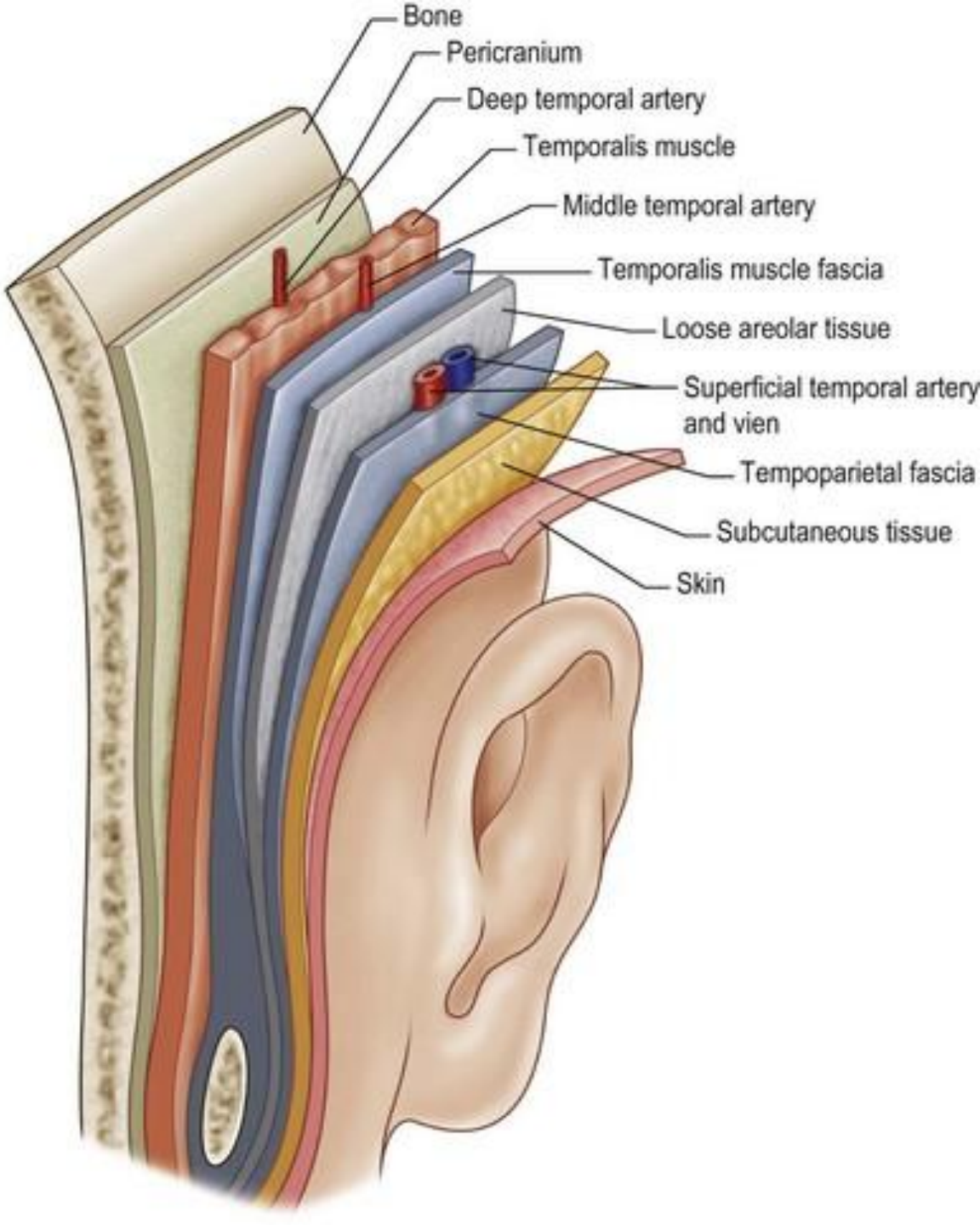

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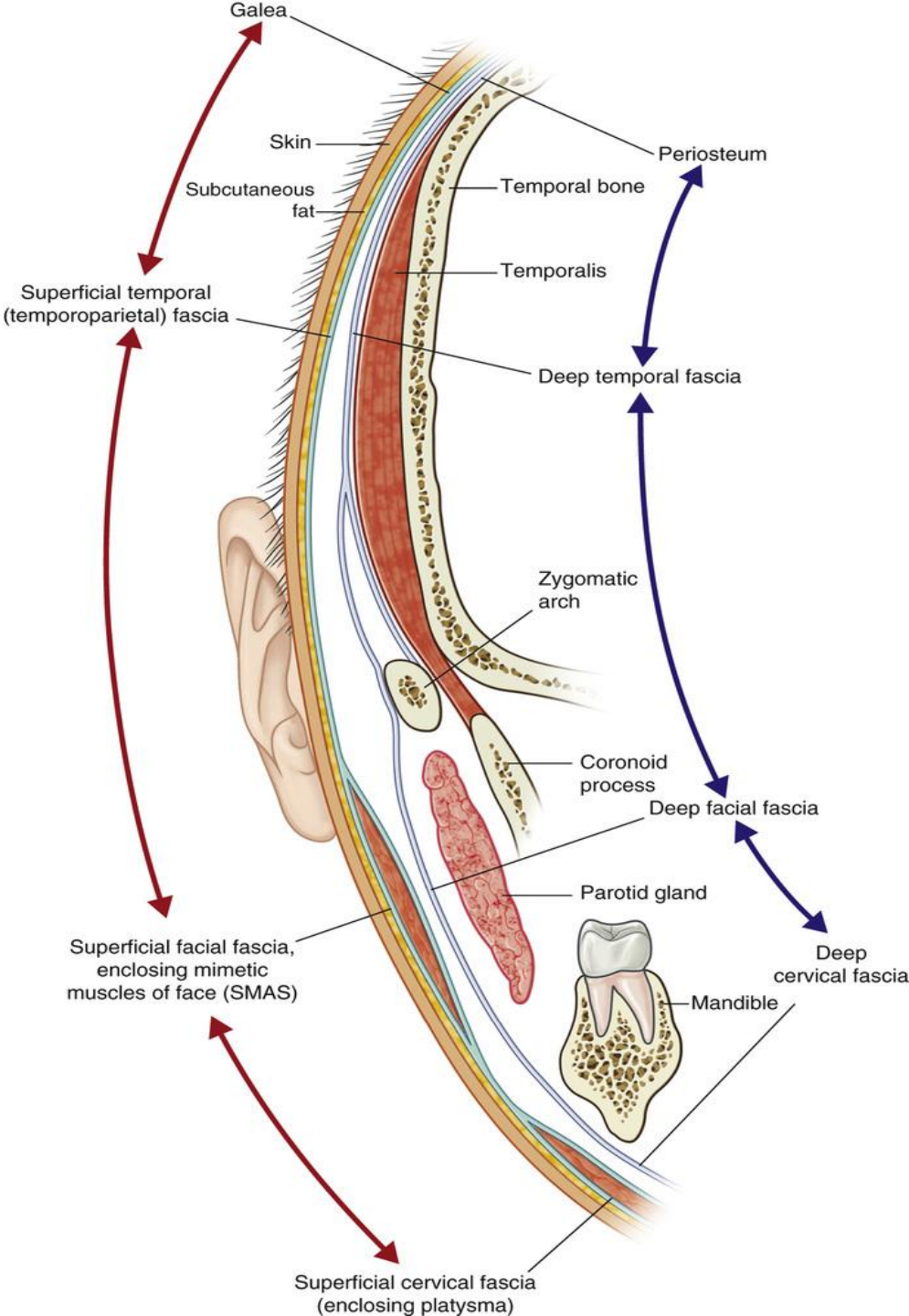

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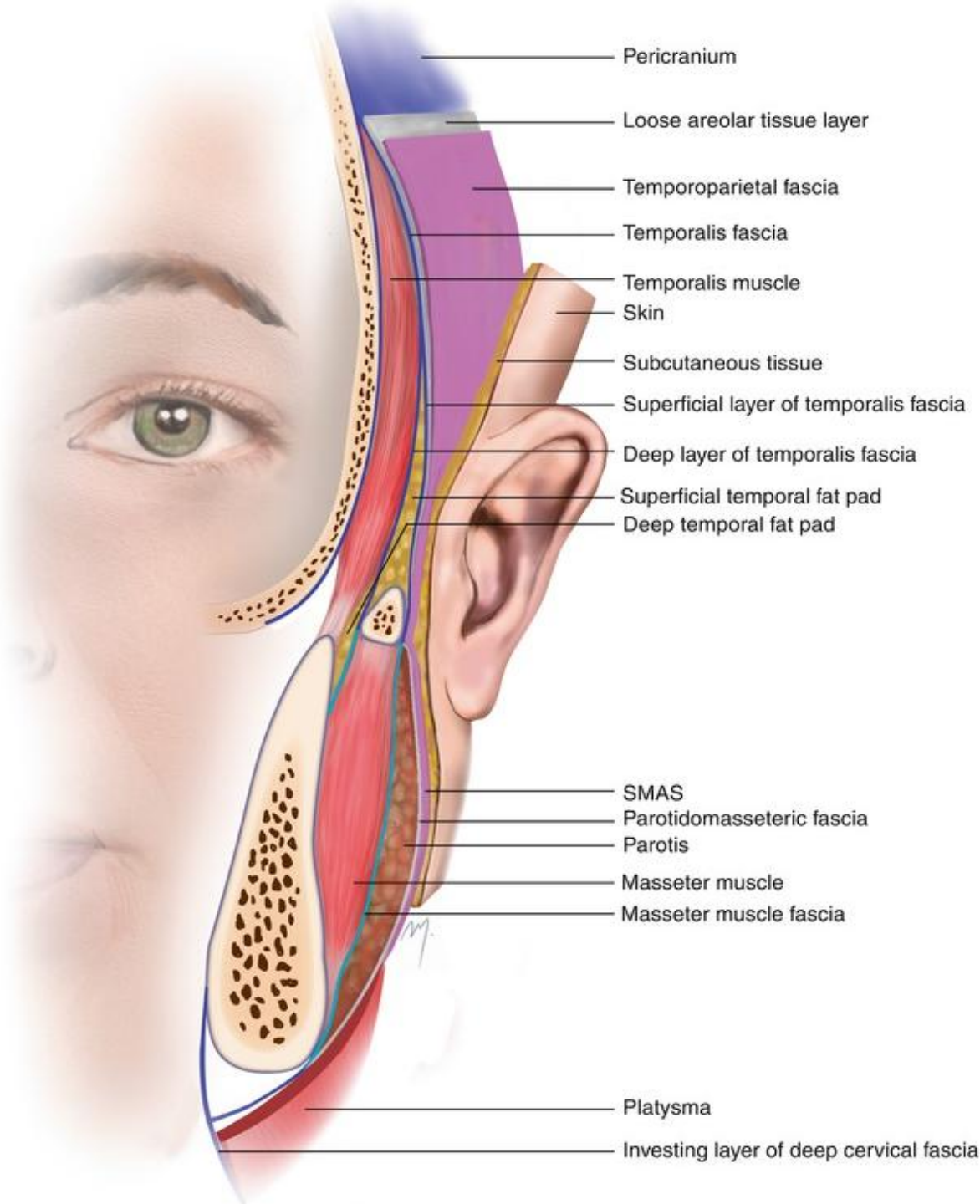

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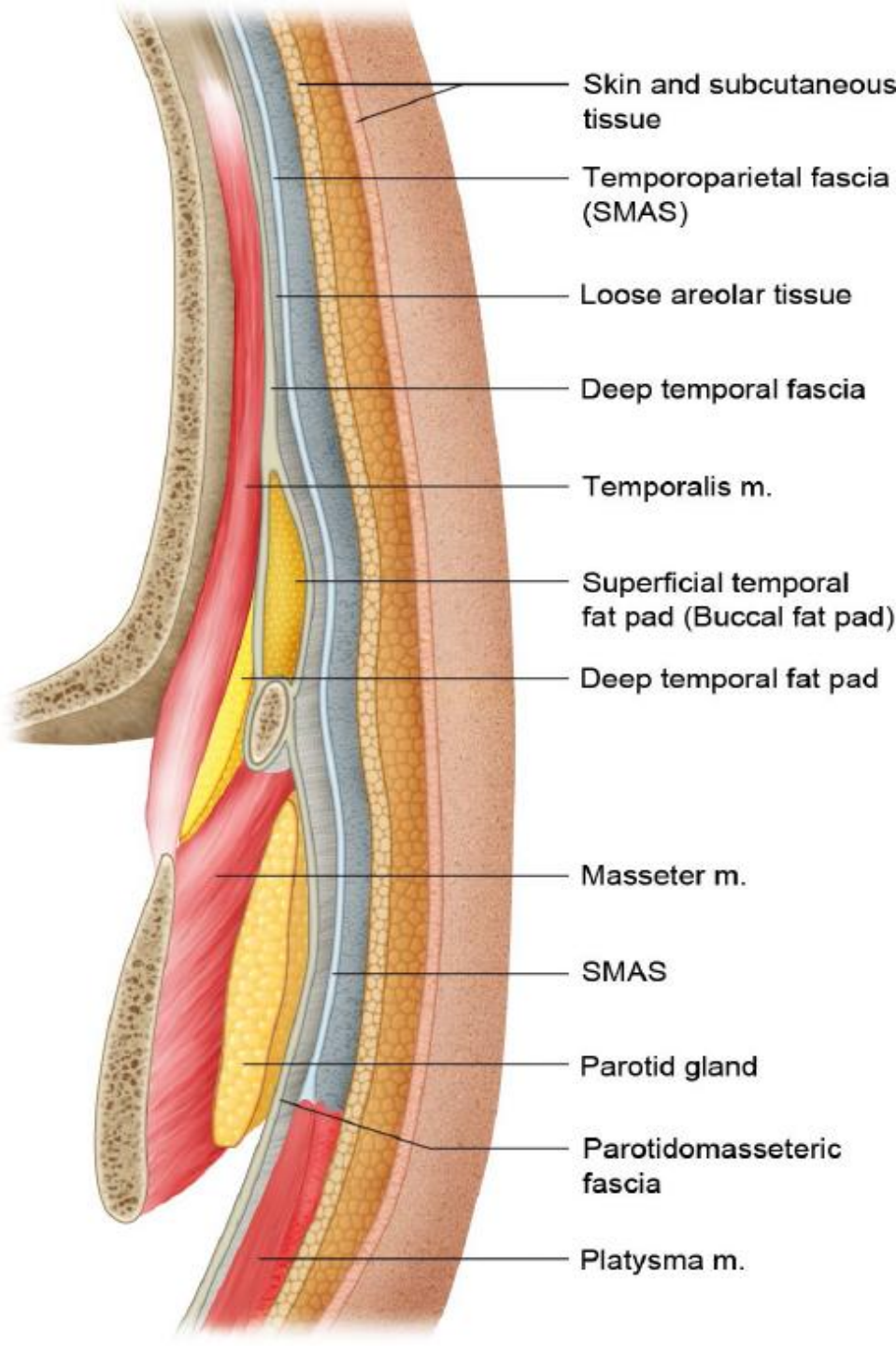


The Temporal Region

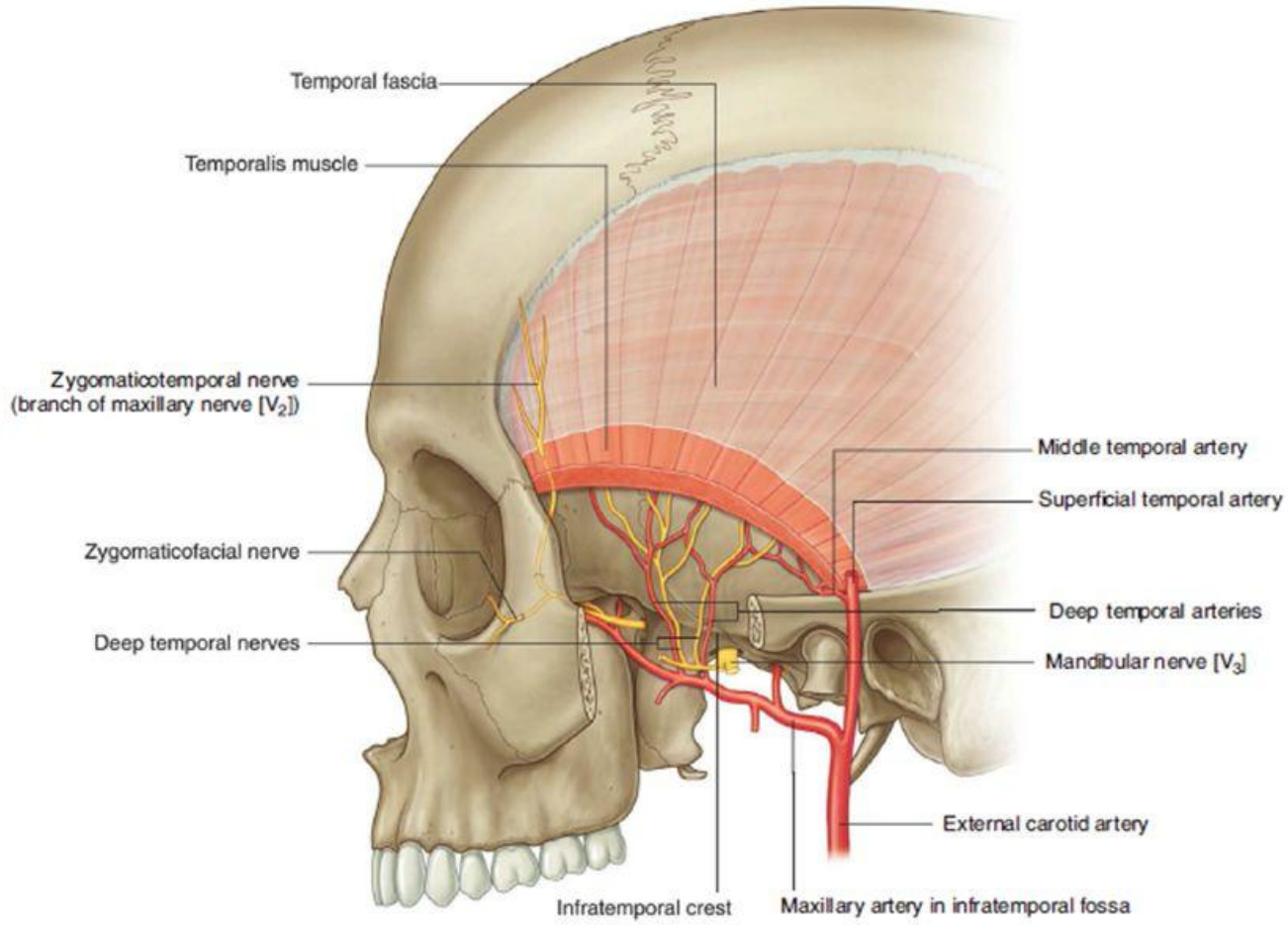
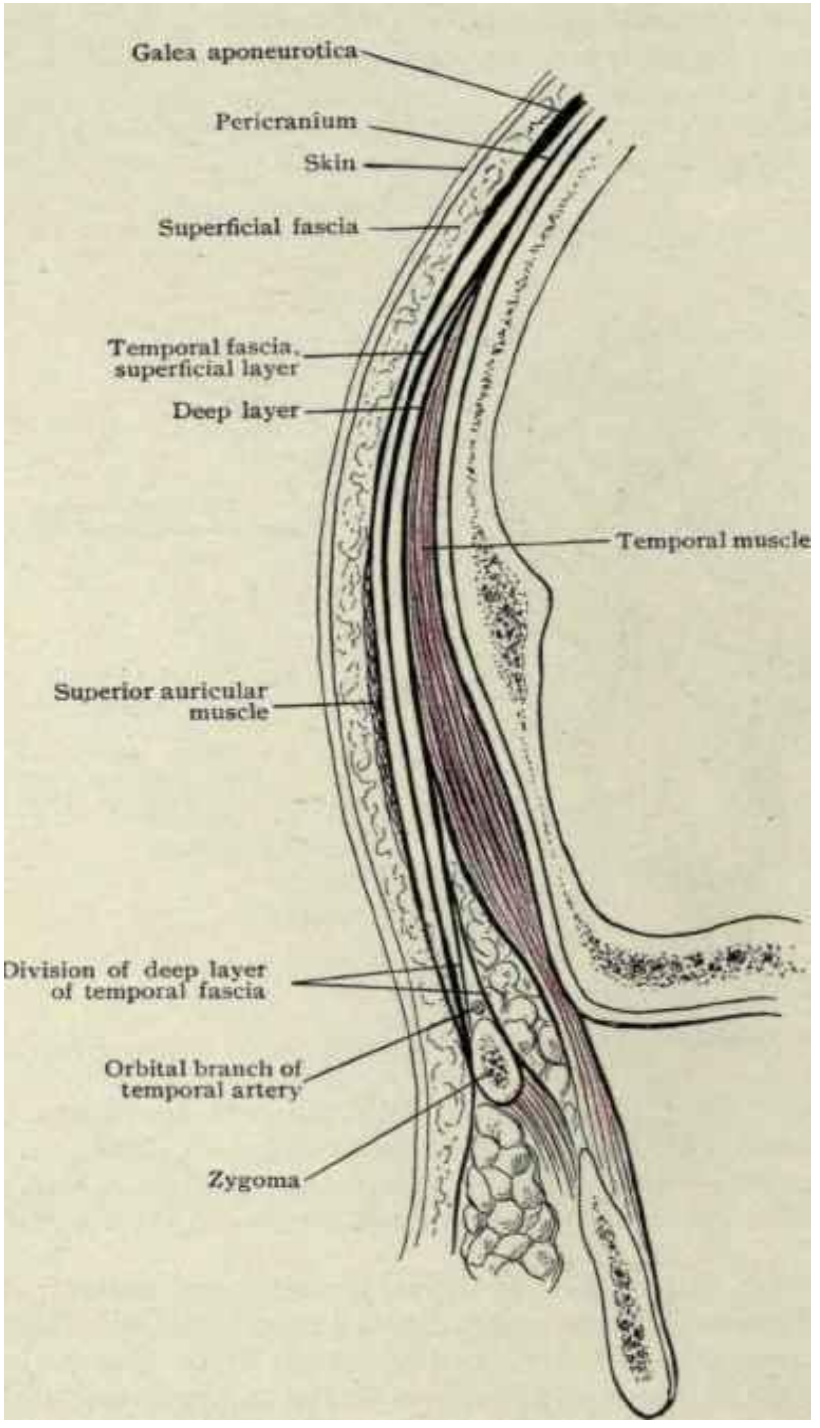
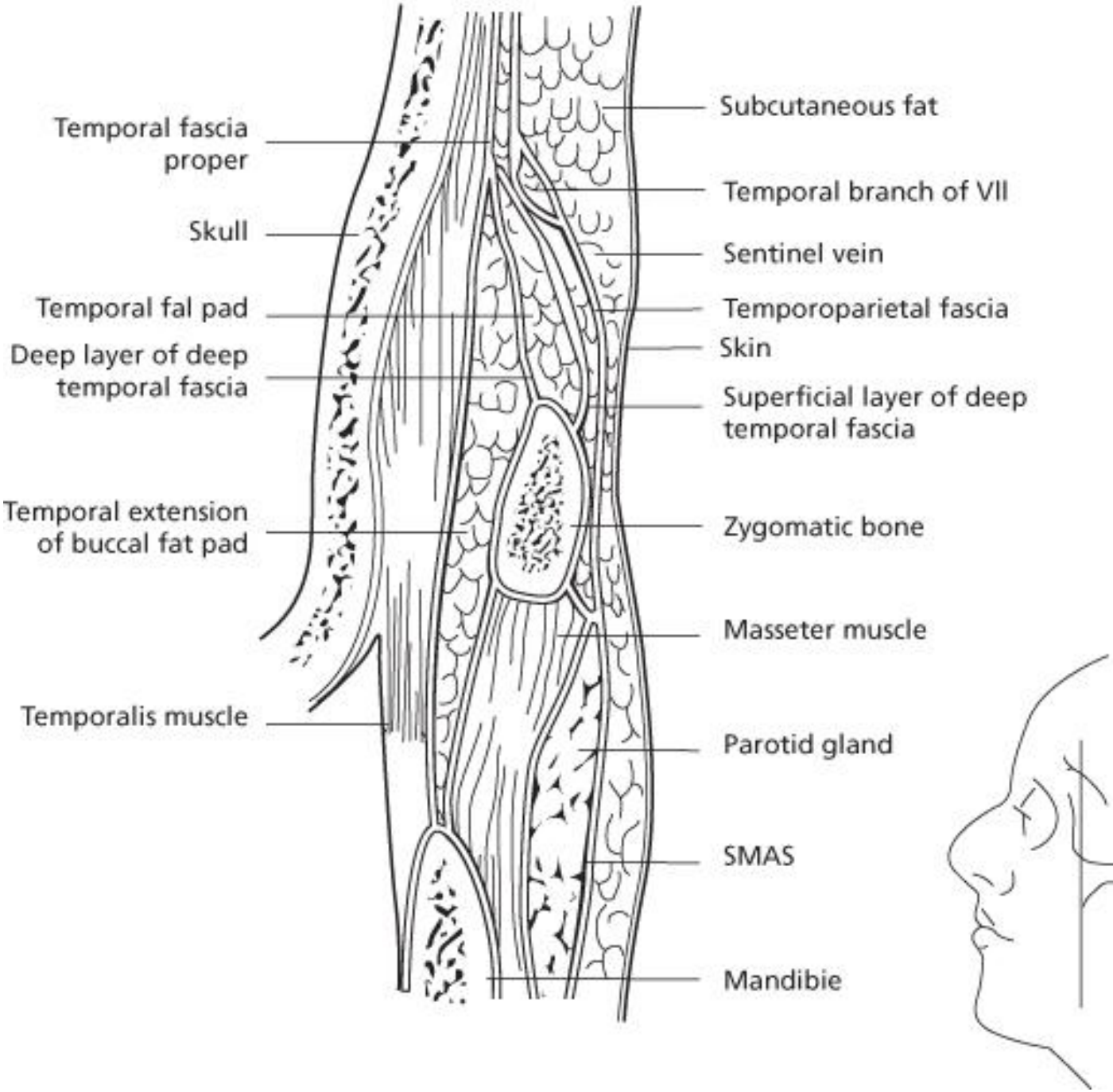


Fig. 8.140 Nerves and arteries of the temporal fossa.

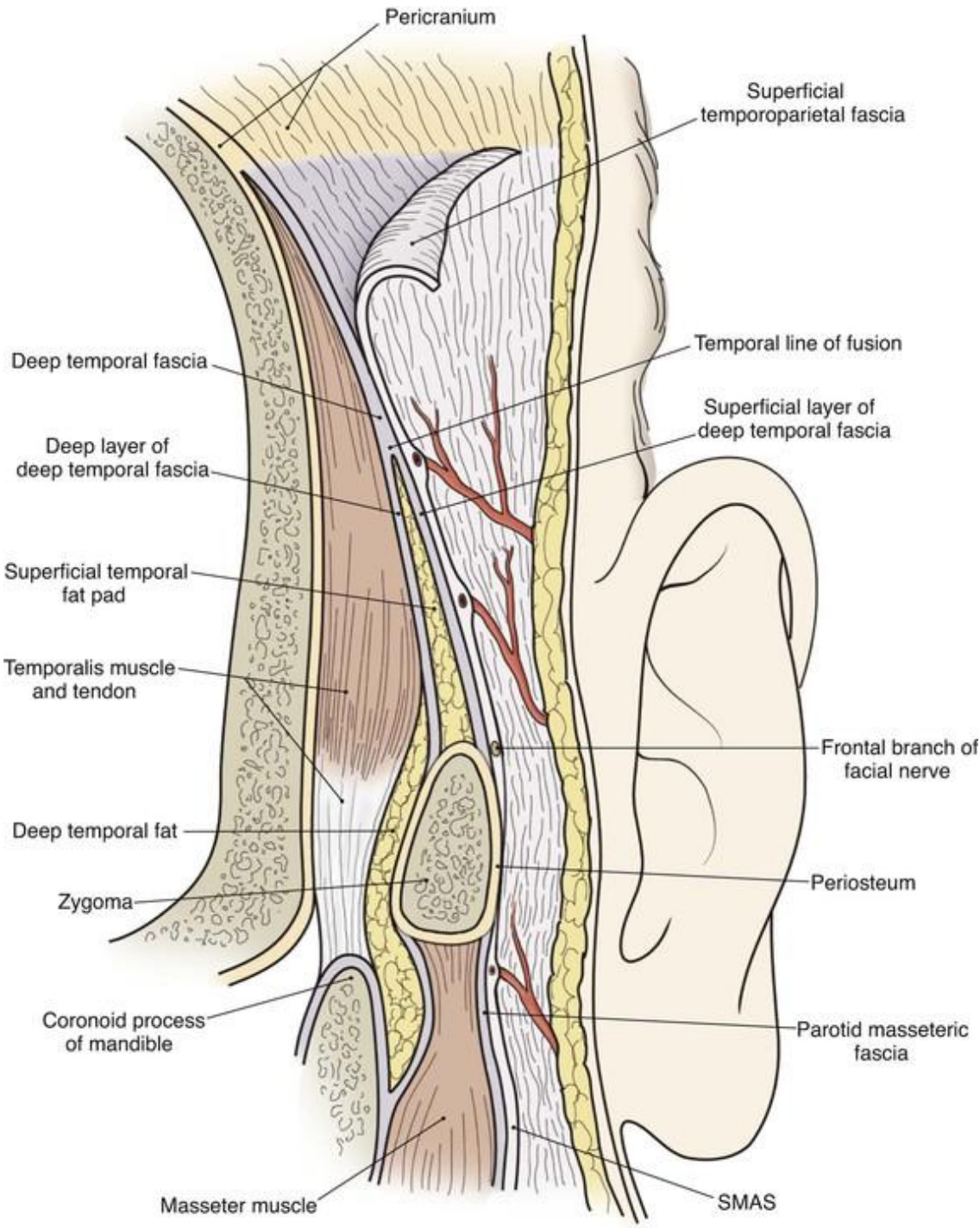
Transverse coronal section in the region of the temple, showing the various layers.



Transverse coronal section in the region of the temple, showing the various layers.



Transverse coronal section in the region of the temple, showing the various layers.



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4.