

# MENINGES AND VENOUS SINUSES OF BRAIN

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## I. ARTERIAL SUPPLY OF BRAIN - derived from two sources

A. Internal Carotid Artery – Common Carotid Artery arises from Brachiocephalic Artery on right, Arch of Aorta on left; bifurcates at level of upper border of thyroid cartilage (Adam's apple) into Internal and External Carotid Arteries; Internal Carotid ascends to enter skull via Carotid Canal to Middle Cranial Fossa.

B. Vertebral Artery – arises from Subclavian Artery; ascends through Foramina Transversaria of vertebrae C1-C6; enters skull via Foramen Magnum.

## II. MENINGES OF BRAIN - 3 layers, as in spinal cord; however, **dura mater is tightly attached to inner side of cranial cavity and has extensions (= reflections) into the cranial cavity. There is no epidural space in the cranial cavity.**

A. **Dura mater** (tough mother) - tough connective tissue layer said to be composed of two layers: inner meningeal (true dura) and outer endosteal (periosteum of inner side of calvarium); the two layers are fused in most places and tightly attached to inner surface of calvarium and cranial cavity (there is normally no epidural space) however, layers of dura separate to form inward folds called dural reflections. Dural reflections support and stabilize the brain and contain venous sinuses (see below):

1. **Falx cerebri** - sickle shaped fold between cerebral hemispheres; attached anteriorly to crista galli of ethmoid bone; posteriorly blends into tentorium cerebelli.

2. **Falx cerebelli** - small sickle-shaped fold that projects anteriorly from posterior wall of posterior cranial fossa between cerebellar hemispheres.

3. **Tentorium cerebelli** - crescent-shaped fold, forms roof over posterior cranial fossa; anteriorly has gap called tentorial notch for passage of brainstem.

4. **Diaphragma sella** - small circular fold of dura mater over sella turcica (has opening for stalk of pituitary).

B. **Arachnoid** (spider like) – similar to spinal cord; layer attached to inner surface of dura (separated from dura by potential space, subdural space); separated from pia mater by subarachnoid space which contains cerebrospinal fluid.

C. **Pia mater** (tender mother) - thin layer closely adherent to brain, surrounds arteries and veins that course on surface of brain.

## III. VENOUS SINUSES OF BRAIN - course between two layers of dura; receive blood from brain, orbit and emissary veins.

## A. Named sinuses

1. **Superior Sagittal sinus** - courses in upper fixed border of Falx Cerebri; begins anteriorly at foramen cecum and ends posteriorly by becoming continuous with transverse sinus; communicates laterally with outpocketings called venous lacunae; receives blood from Superior Cerebral veins which course on surface of hemispheres (via branches called **bridging veins**).

2. **Inferior Sagittal sinus** - courses in lower free border of Falx Cerebri; joins Great Cerebral vein to form Straight Sinus.

3. **Straight sinus** - courses between dural layers at junction of Falx Cerebri and Tentorium Cerebelli; posteriorly can join with Superior Sagittal sinus at Confluens of Sinuses or just turn left and be continuous with Transverse sinus.

4. **Transverse sinuses** - course posteriorly in fixed part of Tentorium Cerebelli; arise either at Confluens of Sinuses or as continuations of Superior Sagittal and Straight Sinuses.

5. **Sigmoid sinuses** - S-shaped continuations of Transverse sinuses; end at jugular foramen to drain into Internal Jugular veins.

6. **Occipital sinus** - courses in attached part of Falx Cerebelli; drains to confluens of sinuses.

7. **Cavernous sinuses** - situated in the middle cranial fossa on each side of the body of the sphenoid bone surrounding Pituitary gland (both Cavernous sinuses are connected by Intercavernous sinus); receive venous blood from Superior and Inferior Ophthalmic veins, cerebral veins; drains to Superior and Inferior Petrosal sinuses.

**Note: Cavernous sinus also has anastomoses with Pterygoid venous plexus; provides a pathway by which infection can spread from face to brain.**

**Note: Cavernous Sinus Thrombosis - Internal Carotid artery and a number of cranial nerves (III, IV, V1, V2, VI) pass through wall of the cavernous sinus; disease processes in sinus can produce neurological symptoms; (Carotid siphon = U shaped turn of Int. Carotid as it passes through Cav. Sinus)**

8. **Superior and Inferior Petrosal Sinuses** - situated on superior and inferior parts of petrous part of temporal bone; receive blood from cavernous sinus anteriorly; Superior Petrosal drains to Transverse sinus, Inferior Petrosal to Internal Jugular Vein.

IV. **CEREBROSPINAL FLUID** - made inside brain in choroid plexuses; flows out of brain into subarachnoid space; is re-absorb into venous sinuses at inpockets of subarachnoid

space called **arachnoid villi** (arachnoid granulations containing arachnoid villi are particularly prominent in walls of Superior Sagittal sinus); calcification of arachnoid villi common in elderly.

Note: **Communicating Hydrocephalus - Reduced re-absorption** of cerebrospinal fluid can result in **communicating hydrocephalus**; can damage brain by increased pressure.

V. **HEMATOMAS** - internal bleeds; in cranium can occur at a number of places; can damage brain by increasing intracranial pressure and by physically pressing brain.

A. **Epidural hematomas** - bleeding between dura mater and bone; often results from tearing of a **meningeal artery** (caused by skull fracture near pterion); bleeding can be quite profuse and **rapid** (arterial); lens shaped (biconvex) mass on CT; can displace brain and cause herniation (Uncal herniation = displacement of temporal lobe (uncus) through Tentorial Notch; Tonsillar herniation = displacement of cerebellum (tonsil) through Foramen magnum; patient often lucid at first (ex., following car accident) but bleeding can be fatal within hours.

B. **Subdural hematomas** - bleeding into potential space between dura and arachnoid; often results from tearing of branches of Superior Cerebral veins (**bridging veins**) or **venous sinus**; bleeding is often **slow** (venous blood) and chronic subdural hematomas can remain undetected; crescent shaped mass on CT; can cause herniation if untreated.

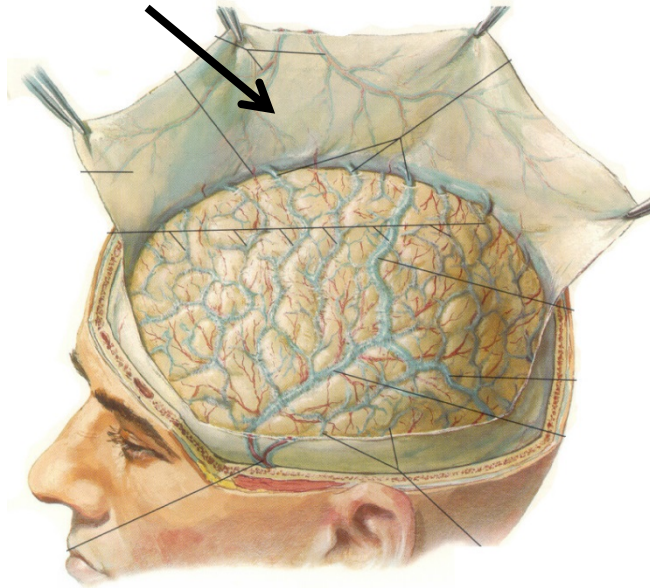
C. **Subarachnoid hematomas** - bleeding into subarachnoid space; can result from rupture of aneurysm (swelling on vessel wall) or physical tearing of **cerebral artery or vein**; bleeding can be **rapid (if arterial blood)** and fatal.

### SUMMARY: INTRACRANIAL HEMATOMAS

Clinical	Anatomy	Cause	Sign/Symptom
<b>Epidural Hematoma</b>	<b>Middle Meningeal artery</b> (90% of Epidural hematomas; branch of Maxillary artery that passes through foramen spinosum; supplies bone of calvarium;	<b>Blow to side of head (fracture skull in region of pterion)</b>	Patient conscious after accident; loses consciousness within hours; coma, death (Note: <b>hematoma is lens-shaped</b> on CT)
<b>Subdural Hematoma</b>	<b>Bridging veins</b> link Superficial cerebral veins on surface of brain and Superior Sagittal sinus (also other venous sinuses)	<b>Blow to head; in elderly can occur without distinct event</b>	<b>Slow onset</b> of neurological symptoms, headache (often hours to days) (Note: <b>hematoma is crescent-shaped</b> on CT)
<b>Subarachnoid hematoma</b>	Rupture of artery (ex. ' <b>berry aneurism'</b> ) or vein into subarachnoid space	<b>Many, Hypertension, Trauma, etc.</b>	<b>Berry Aneurysm: Headache (sudden onset); rapid loss of consciousness, 25-50 % die</b>

# MENINGES AND VENOUS SINUSES OF BRAIN

**DURA MATER**



## OUTLINE

- I. ARTERIAL SUPPLY
- II. MENINGES
- III. VENOUS SINUSES
- IV. CEREBROSPINAL FLUID
- V. HEMATOMAS

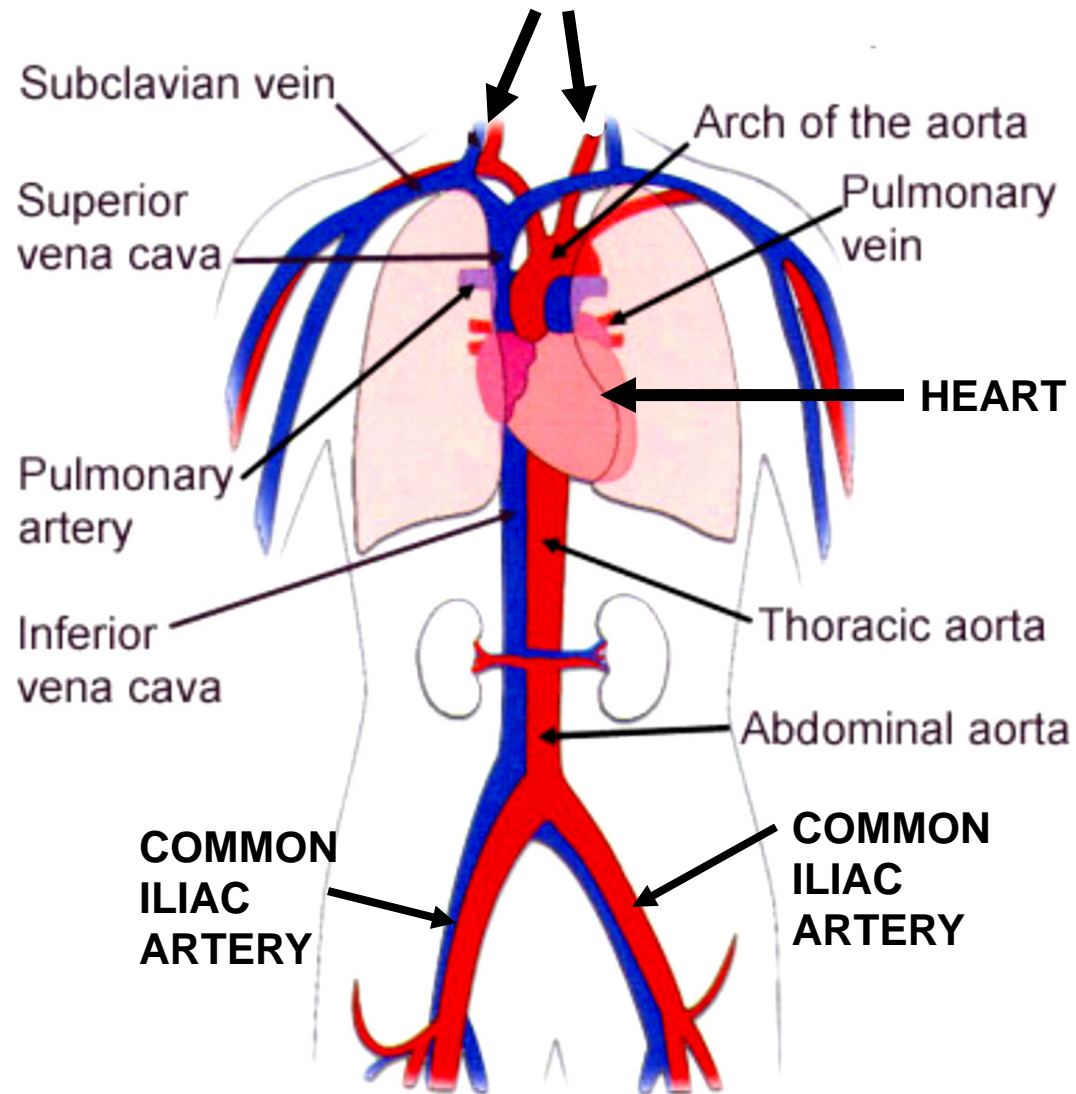
**FACT: CRANIAL CAVITY IS ENCLOSED BY BONE; THERE IS NO ROOM FOR EXPANSION INSIDE SKULL**

**WORD OF THE DAY: HEMATOMA = abnormal mass of blood outside blood vessel**

# ARTERIAL SUPPLY TO HEAD

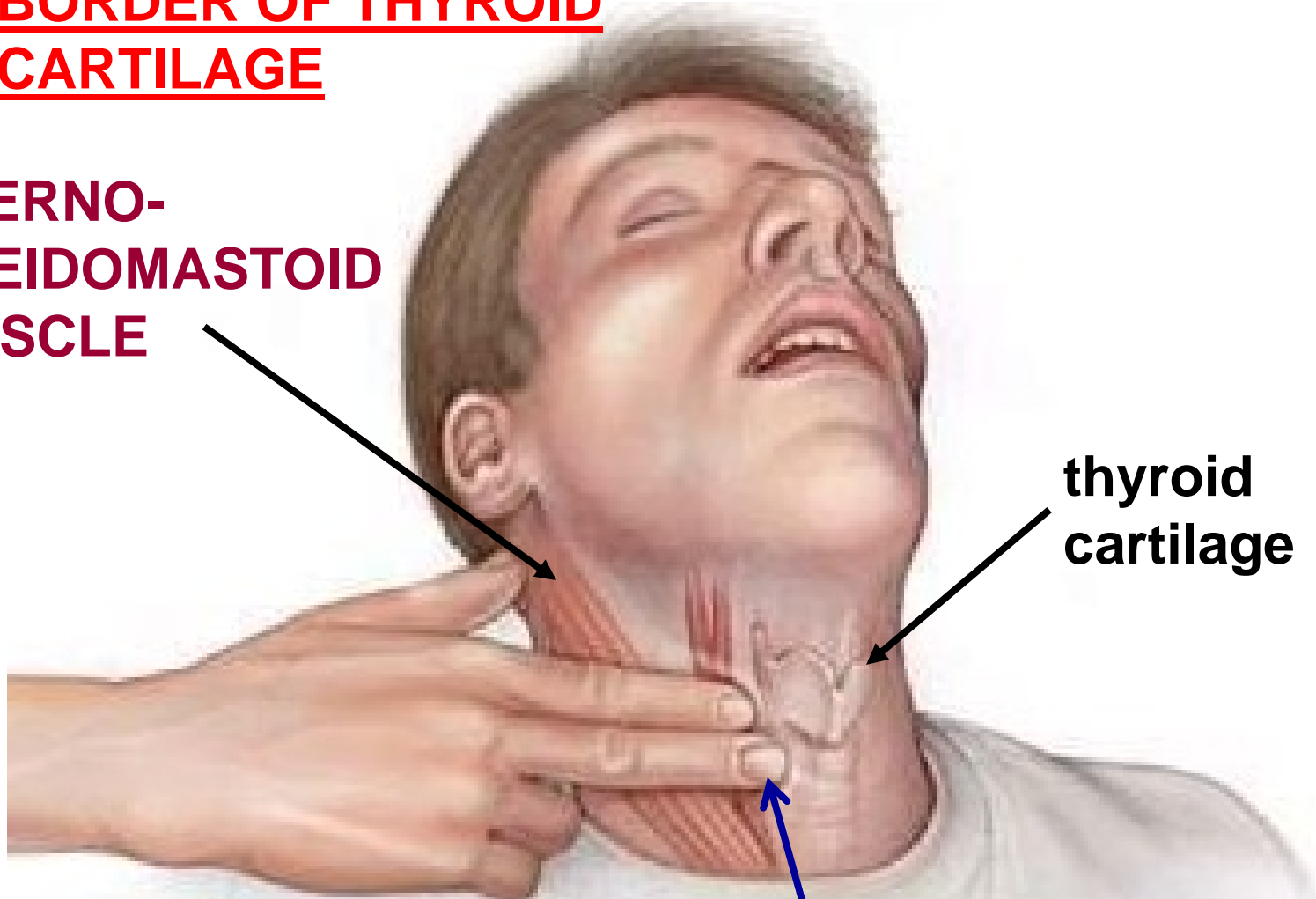
BLOOD FLOW  
TO HEAD:  
WHERE  
DOES IT  
COME  
FROM?

## COMMON CAROTID ARTERIES



**PALPATE CAROTID BIFURCATION AT UPPER  
BORDER OF THYROID  
CARTILAGE**

**STERNO-  
CLEIDOMASTOID  
MUSCLE**



**thyroid  
cartilage**

**CAROTID PULSE**

**\*\***

**VERTEBRAL LEVEL C4**

# VENOUS DRAINAGE FROM HEAD

RIGHT INTERNAL JUGULAR VEIN

LEFT INTERNAL JUGULAR VEIN

COMMON  
CAROTID A.

RIGHT SUBCLAVIAN VEIN

RIGHT BRACHIOCEPHALIC VEIN

VEINS ARE  
SYMMETRICAL

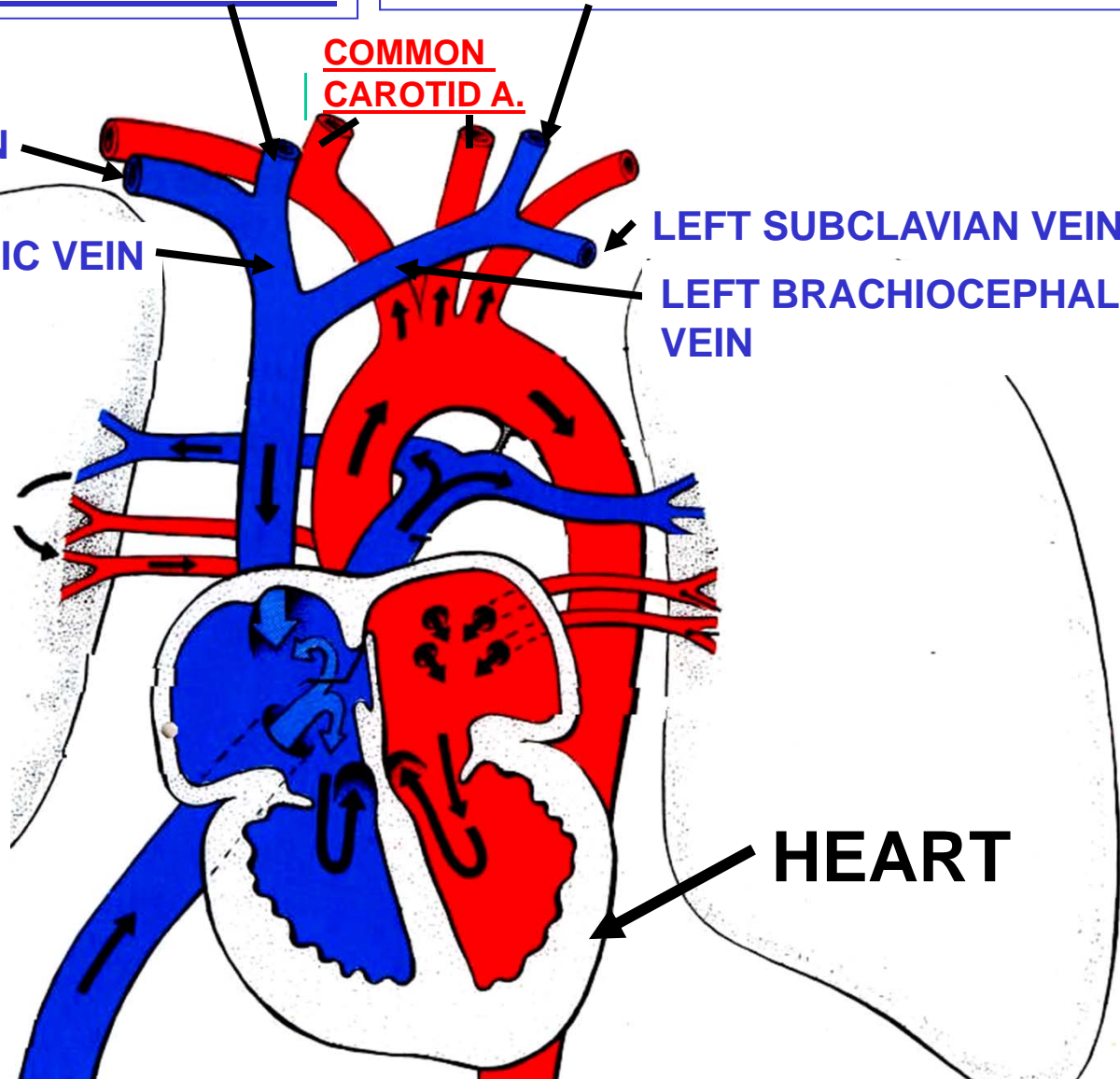
INTERNAL JUGULAR  
VEINS JOIN  
SUBCLAVIAN VEINS TO  
FORM  
BRACHIOCEPHALIC  
VEINS

RIGHT AND LEFT  
BRACHIOCEPHALIC  
VEINS FORM  
SUPERIOR VENA CAVA

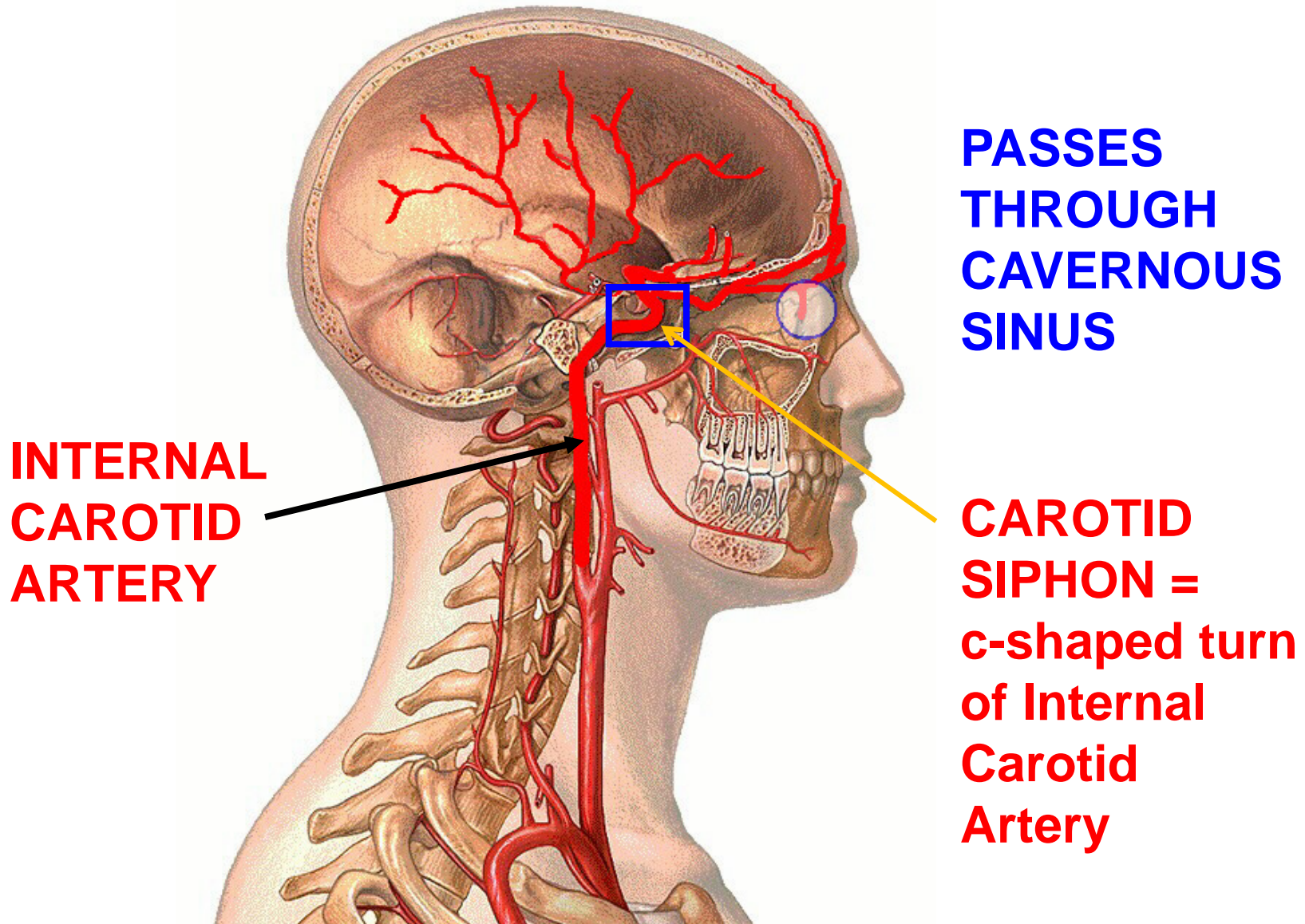
LEFT SUBCLAVIAN VEIN

LEFT BRACHIOCEPHALIC  
VEIN

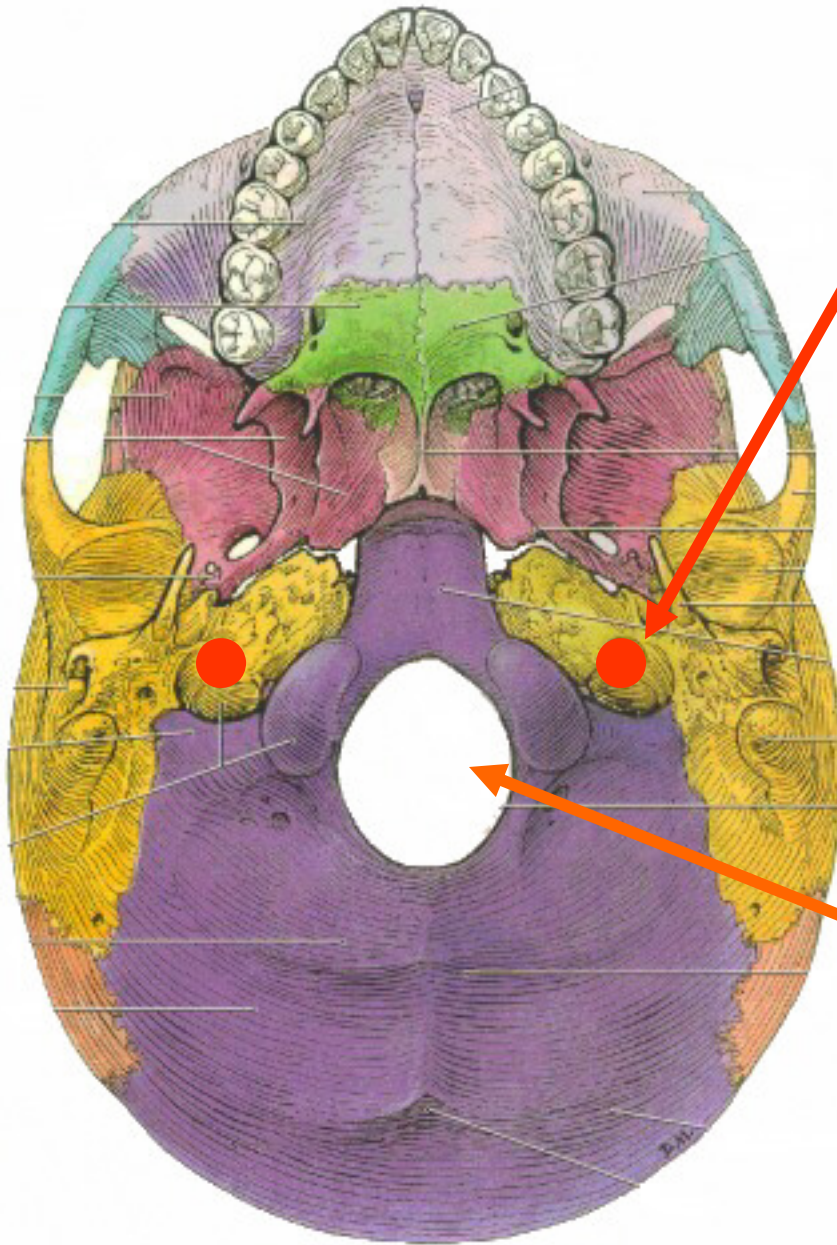
**HEART**



# INTERNAL CAROTID ARTERY: ENTERS SKULL





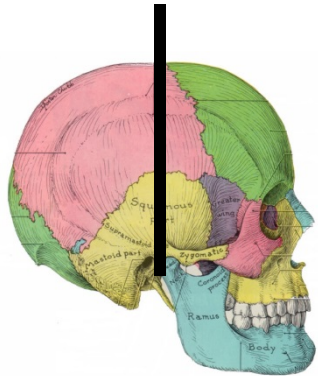


Internal Carotid Artery-  
enters skull  
via Carotid Canal  
And Foramen  
Lacerum

Vertebral Artery-  
enters skull  
via Foramen  
Magnum

**VIEW FORAMINA IN SKULL SESSION**

CORONAL PLANE



ORIENT



## II. MENINGES OF BRAIN

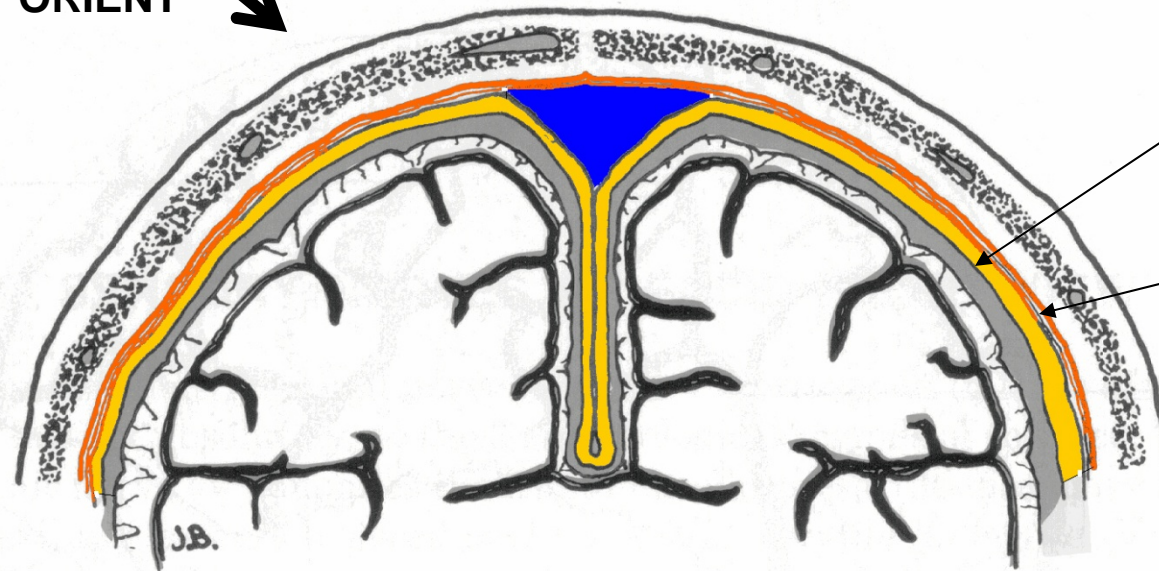
**3 layers, like spinal cord**; Dura Mater – tough mother; Arachnoid = spiderlike; Pia Mater = tender mother; arrangement different

**A. DURA MATER -**  
tough connective tissue layer, composed of two layers -

1) INNER MEMBRANE LAYER (true dura)

2) OUTER ENDOSTEAL LAYER - periosteum on inner side of calvarium

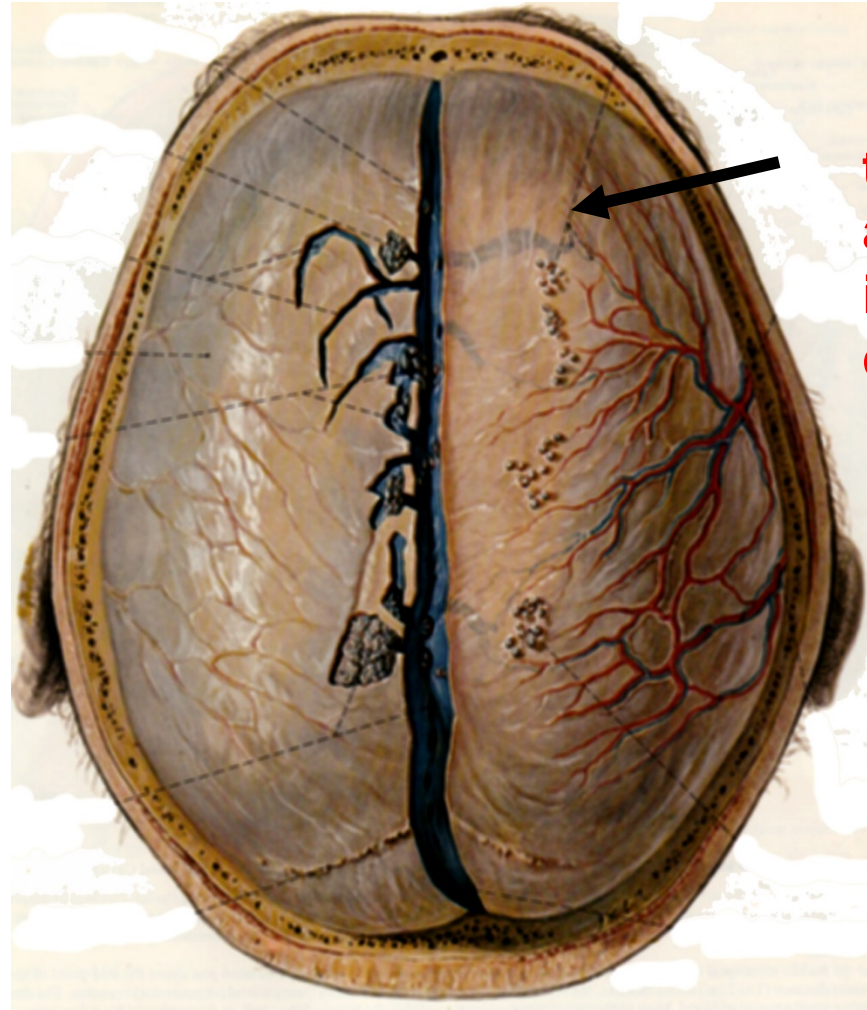
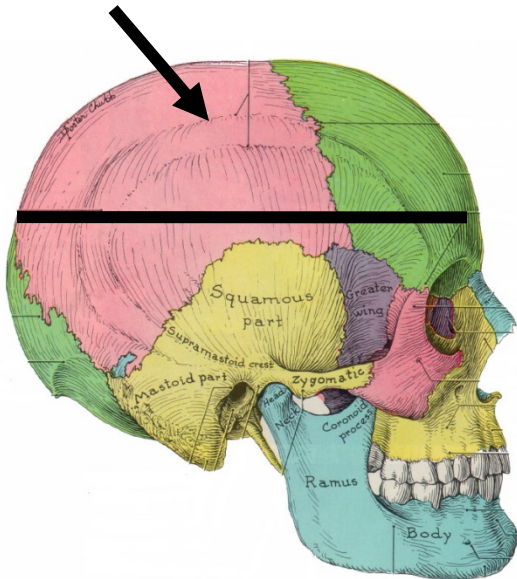
Two layers - fused in most places - separate to form DURAL REFLECTIONS



**Note: There is normally NO EPIDURAL SPACE IN SKULL as dura is fused to bone**

## DURA - 2 LAYERS ARE FUSED IN MOST PLACES

Orient - remove  
**CALVARIUM =  
SKULL  
CAP**

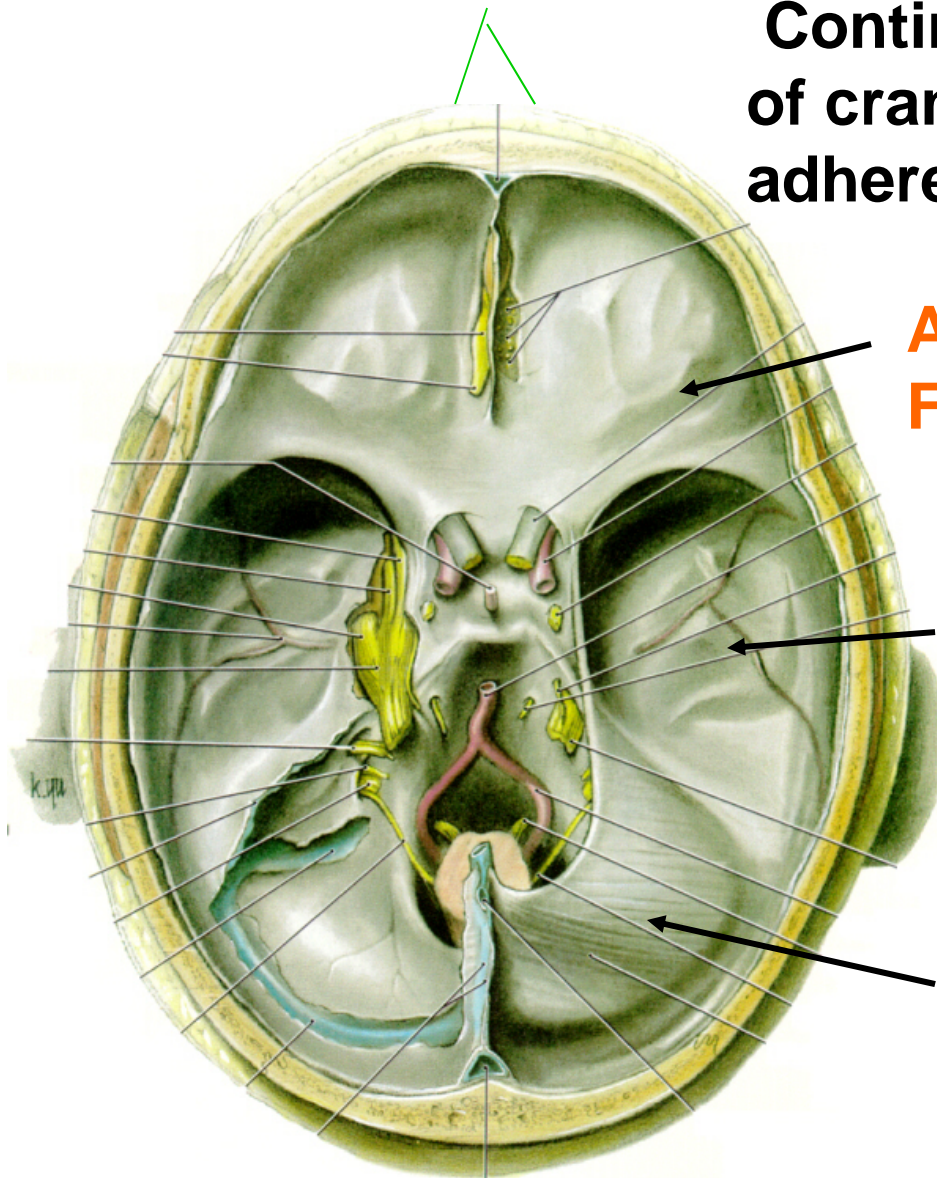


**DURA** is  
tightly  
attached to  
inner side of  
calvarium

**Normally No there is no Epidural Space  
(unlike spinal cord); calvarium removed  
by pulling away bone from dura**

# DURA MATER INSIDE SKULL

Continuous lining of interior of cranial cavity, closely adherent to bone.



**Anterior Cranial Fossa**

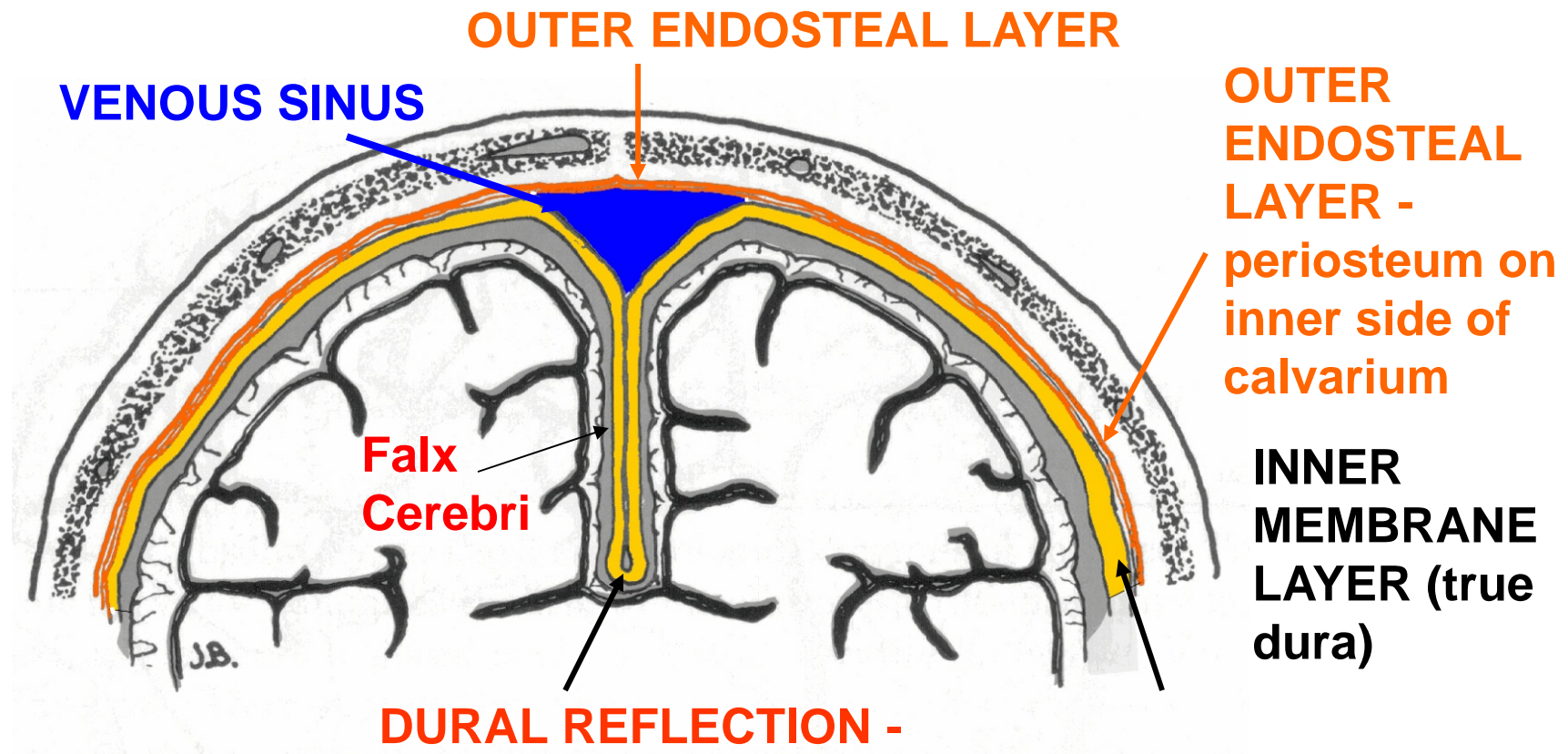
**Middle Cranial Fossa**

**Posterior Cranial Fossa**

**(fossa = depression)**

# DURAL REFLECTIONS

2 Layers of Dura separate form Inward Folds (Reflections)-  
Function to stabilize brain and contain **venous sinuses**



**DURAL REFLECTION -  
TWO LAYERS OF  
INNER MEMBRANE  
LAYER (true dura)**

**Reflection = dura  
projects out and turns  
back**

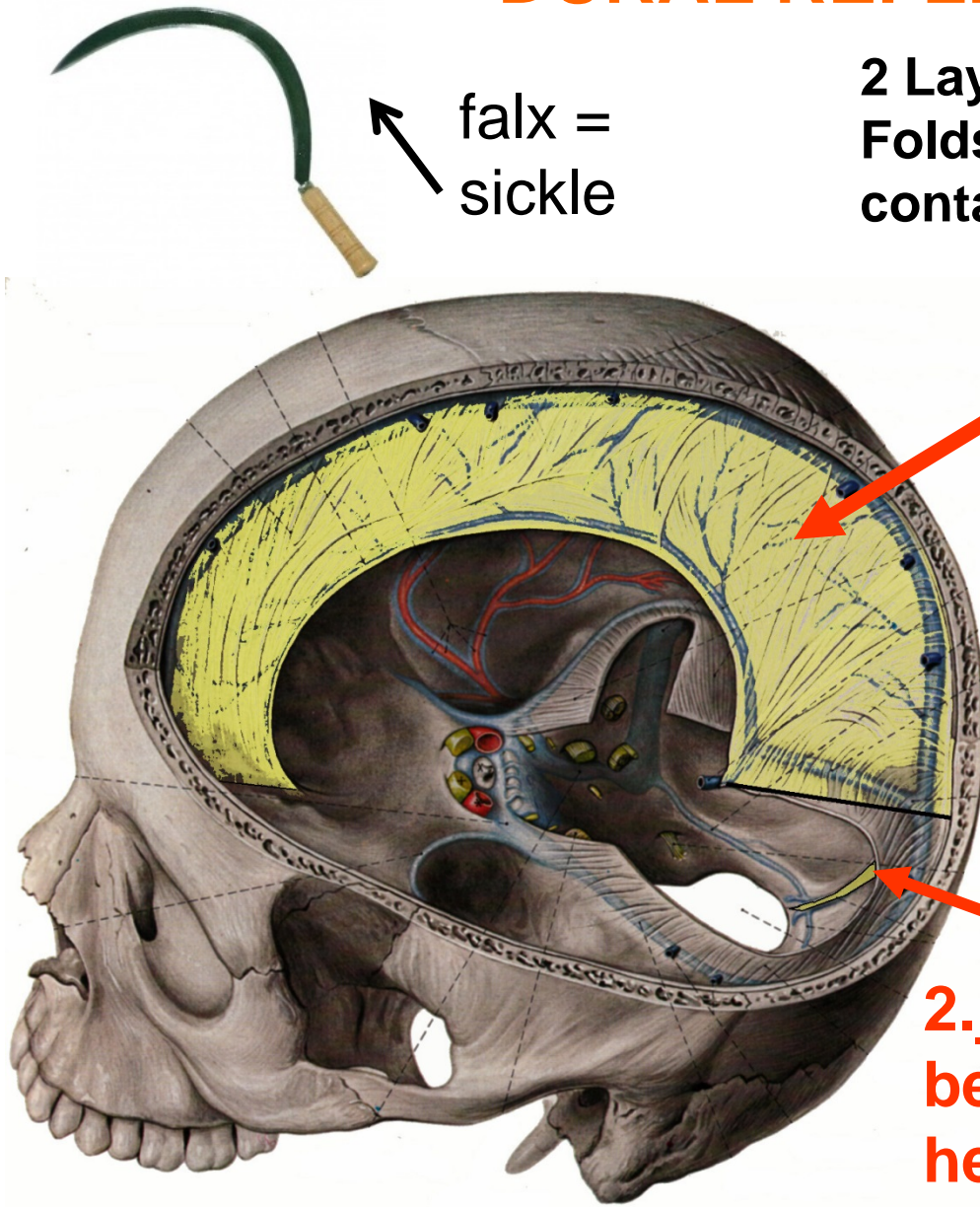
**OUTER  
ENDOSTEAL  
LAYER -  
periosteum on  
inner side of  
calvarium**

**INNER  
MEMBRANE  
LAYER (true  
dura)**

# DURAL REFLECTIONS

2 Layers of Dura separate form Inward Folds (Septa)- Stabilize brain and contain venous sinuses

falx = sickle

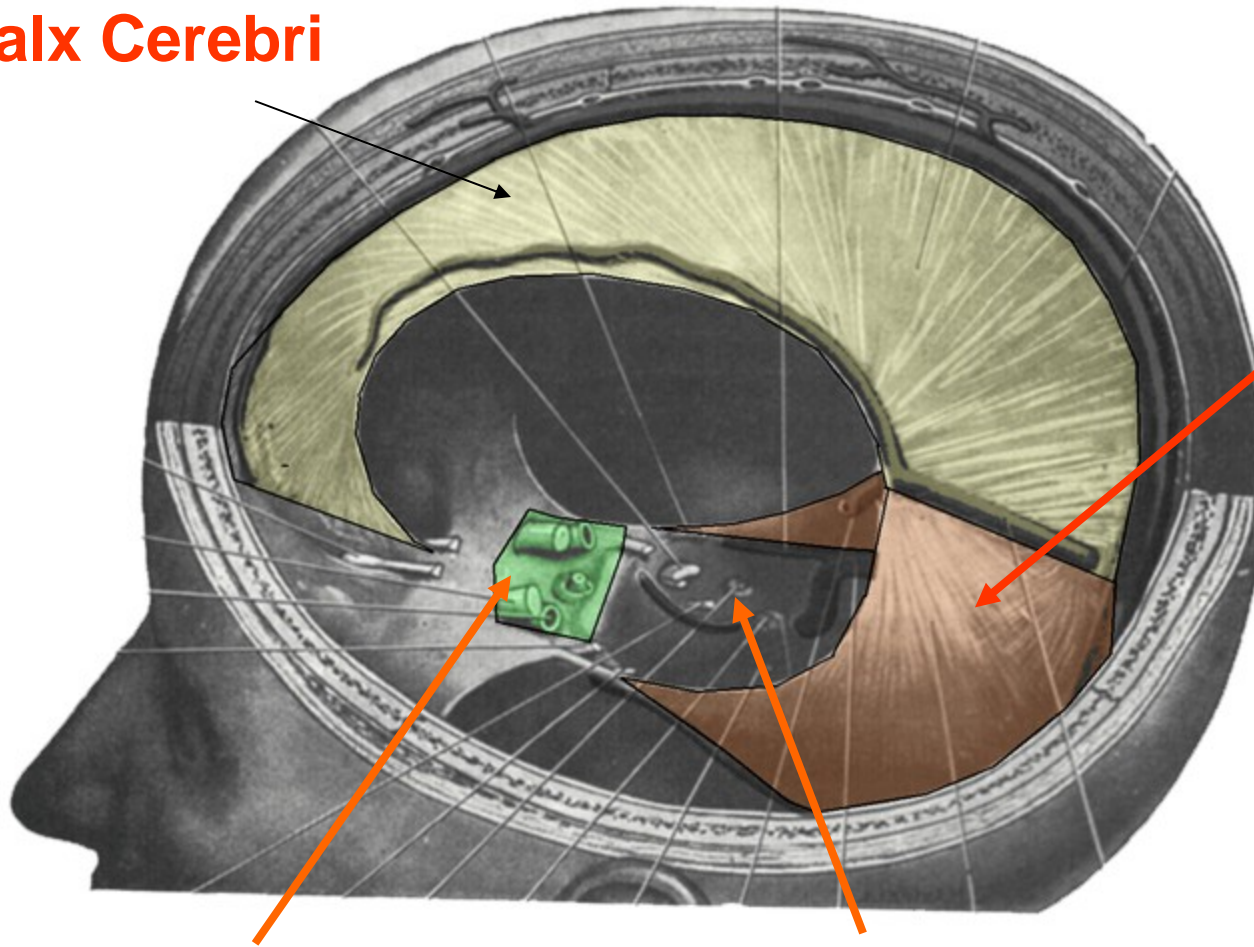


1. Falx Cerebri - sickle shaped - between cerebral hemispheres; attached ant. to crista galli of ethmoid; post. blends into tentorium cerebelli

2. Falx Cerebelli - smaller between cerebellar hemispheres along post. wall of Post. Cran. Fossa

# DURAL REFLECTIONS

**Falx Cerebri**



**3. Tentorium Cerebelli – forms **roof** of post. cran. fossa**

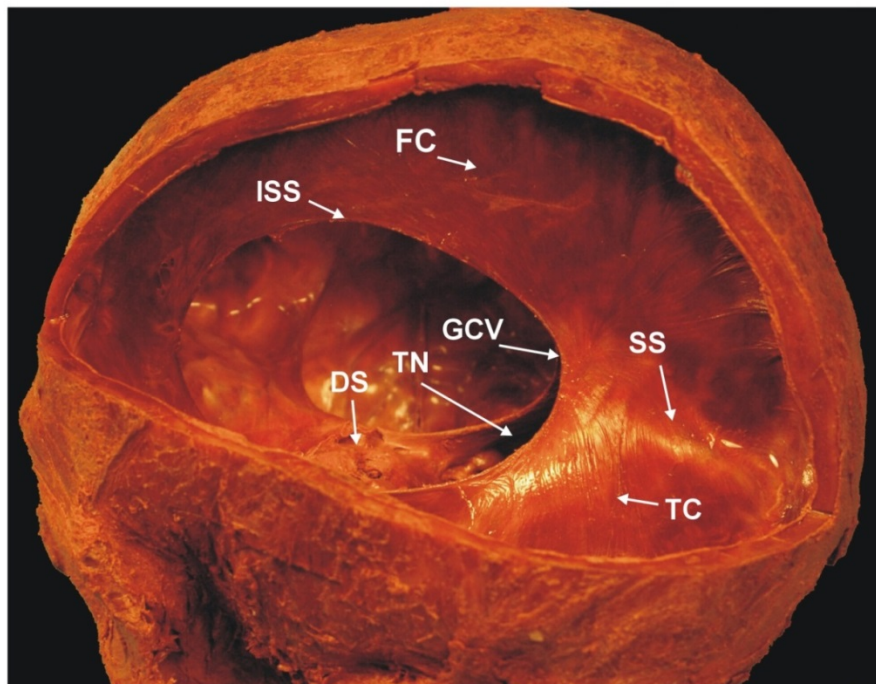
**4. Diaphragma Sella – fold over sella turcica**

**Tentorial Notch – opening for brainstem**

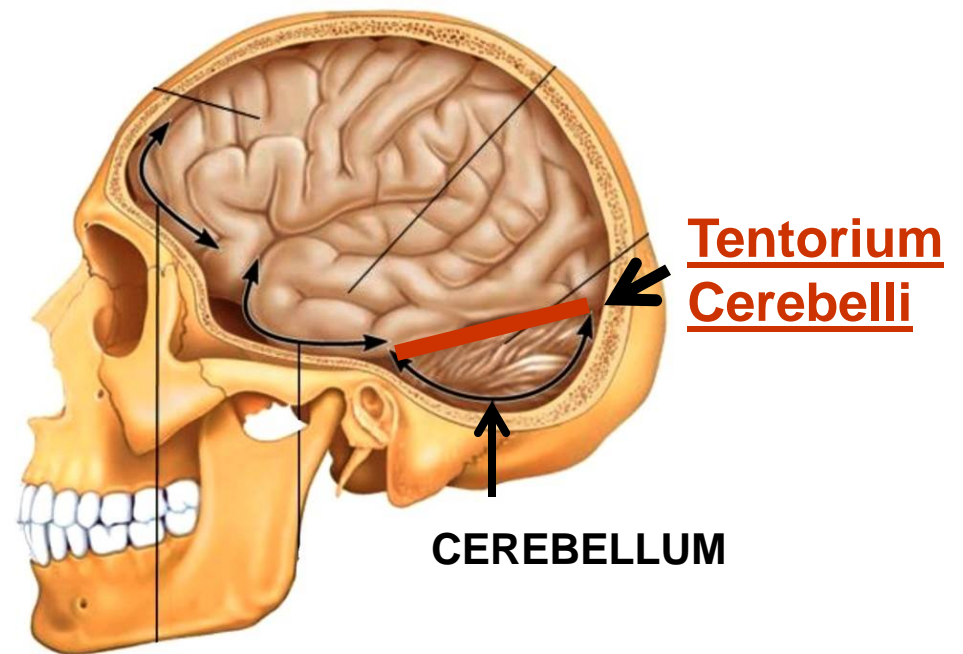
# LOOK AT PROSECTION 279 – 'RED HEAD'

279

## DURAL REFLECTIONS AND VENOUS SINUS



FC - FALX CEREBRI  
TC - TENTORIUM CEREBELLI  
ISS - LOCATION OF INFERIOR SAGITTAL SINUS  
SS - LOCATION OF STRAIGHT SINUS  
GCV - OPENING OF GREAT CEREBRAL VEIN OF GALEN  
DS - DIAPHRAGMA SELLA  
TN - TENTORIAL NOTCH

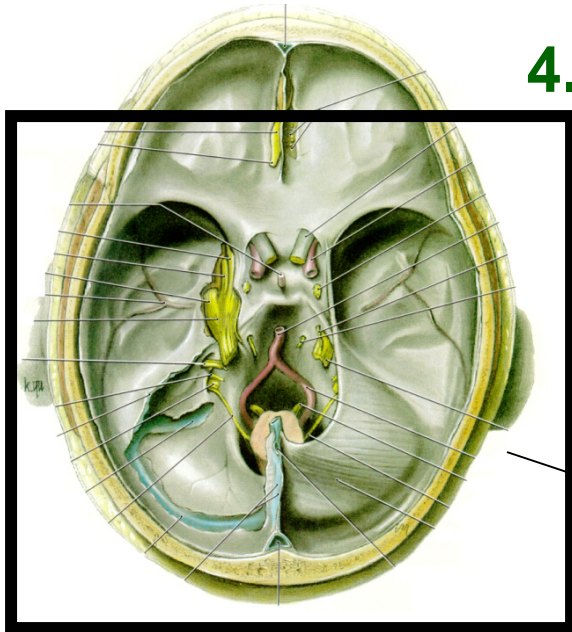


Tentorium Cerebelli =  
roof over Cerebellum



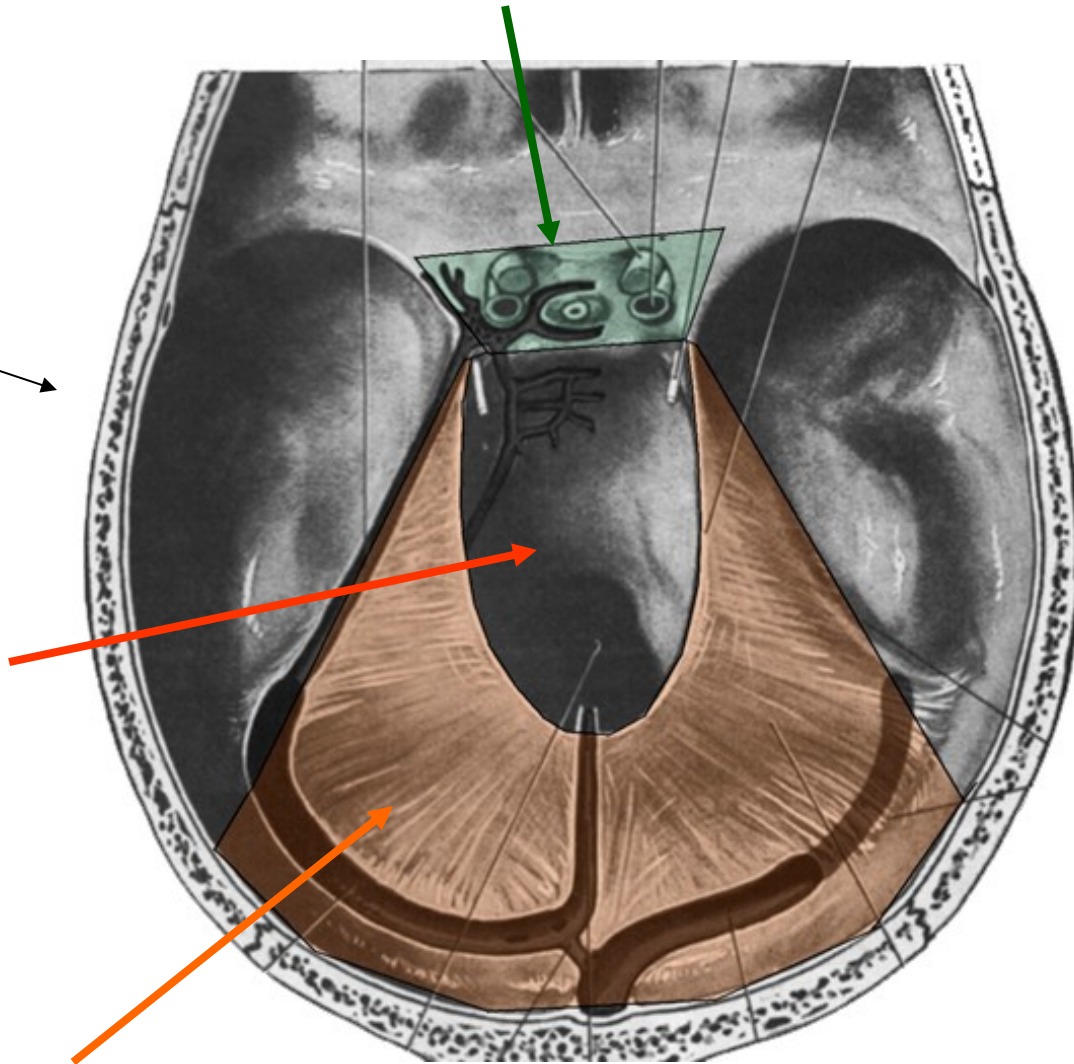
# DURAL REFLECTIONS

## 4. Diaphragma Sella – over sella turcica



view inside cranial cavity

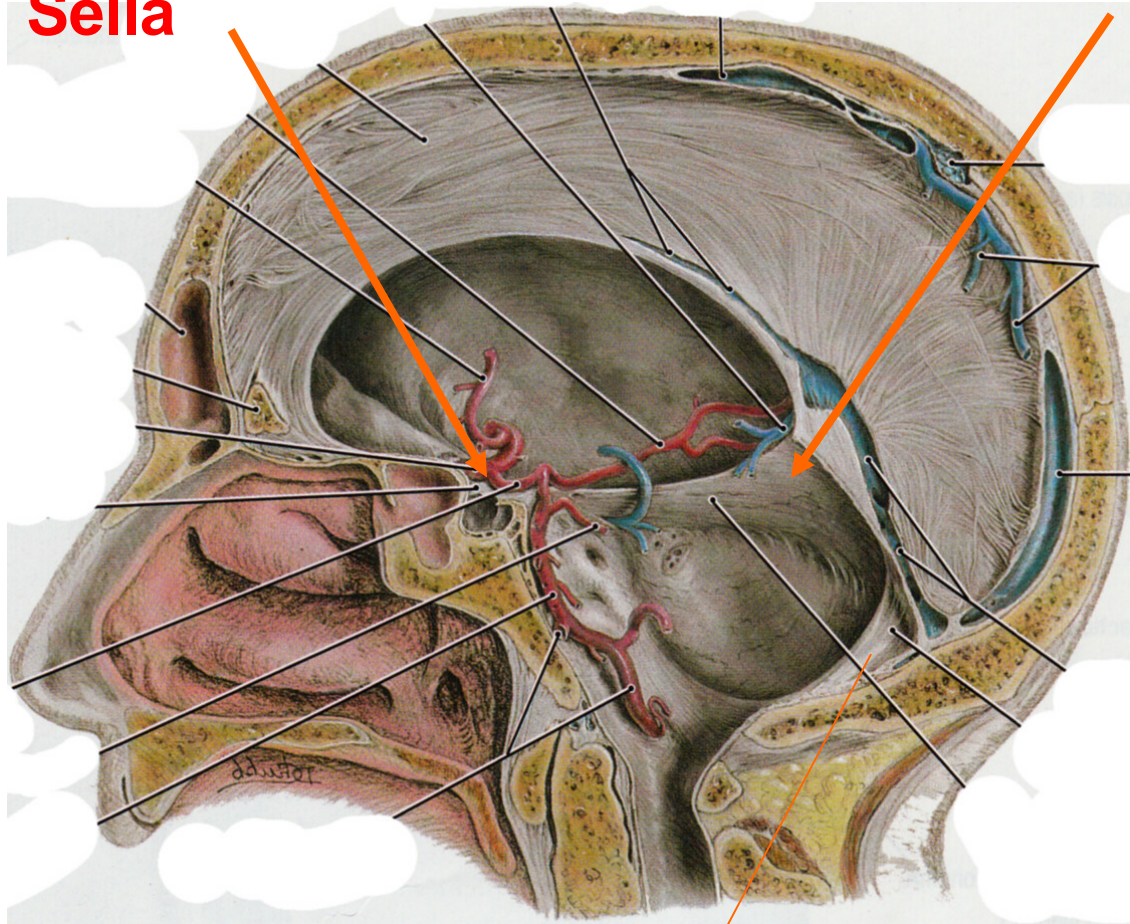
**Tentorial Notch –  
opening for  
brainstem**



3. Tentorium Cerebelli – forms roof of post. cran. fossa

# DURAL REFLECTIONS

**Diaphragma  
Sella**



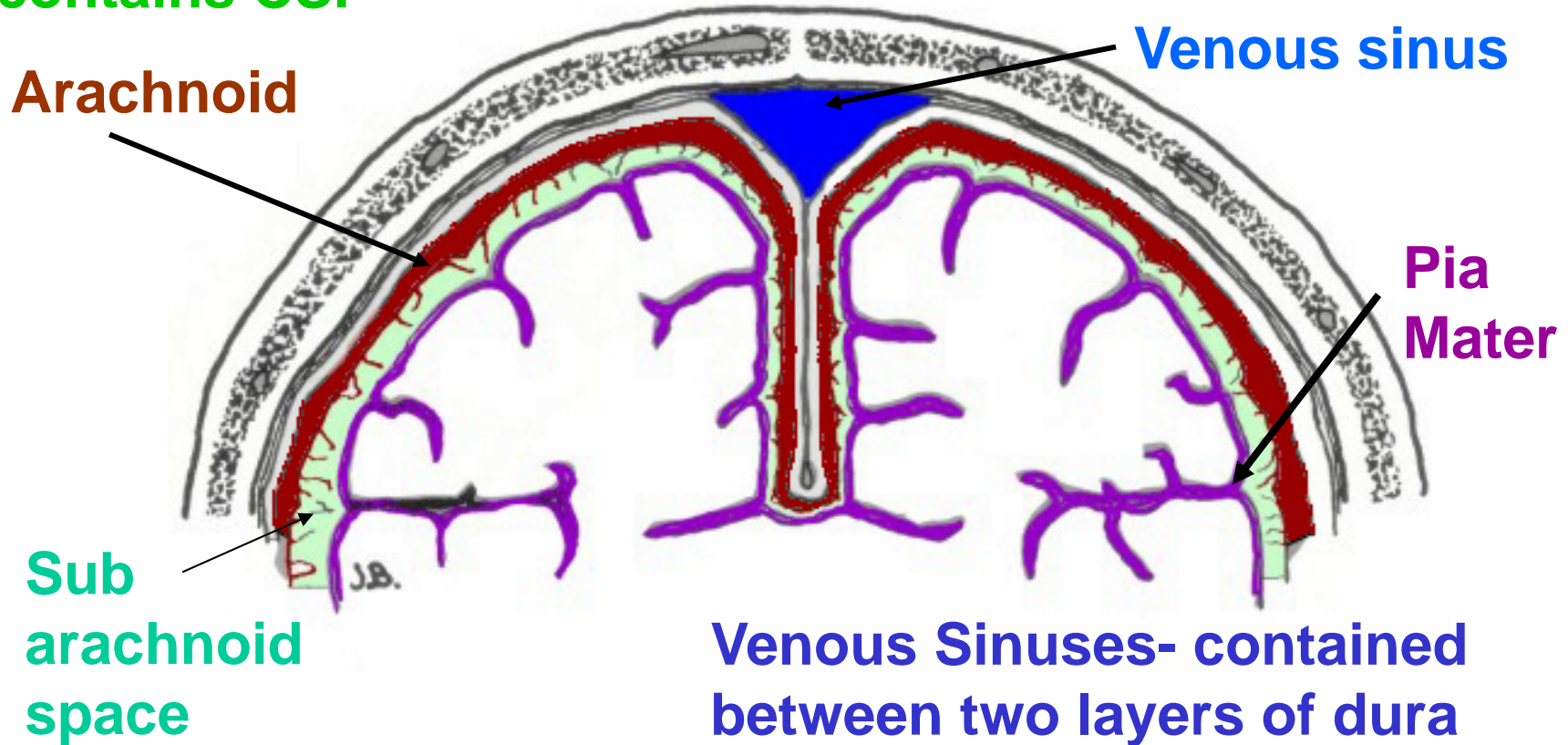
**Falx Cerebelli**

**3. Tentorium  
Cerebelli** – crescent  
shaped, forms roof of  
post. cranial fossa,  
has gap- tentorial  
notch for pass of  
brainstem

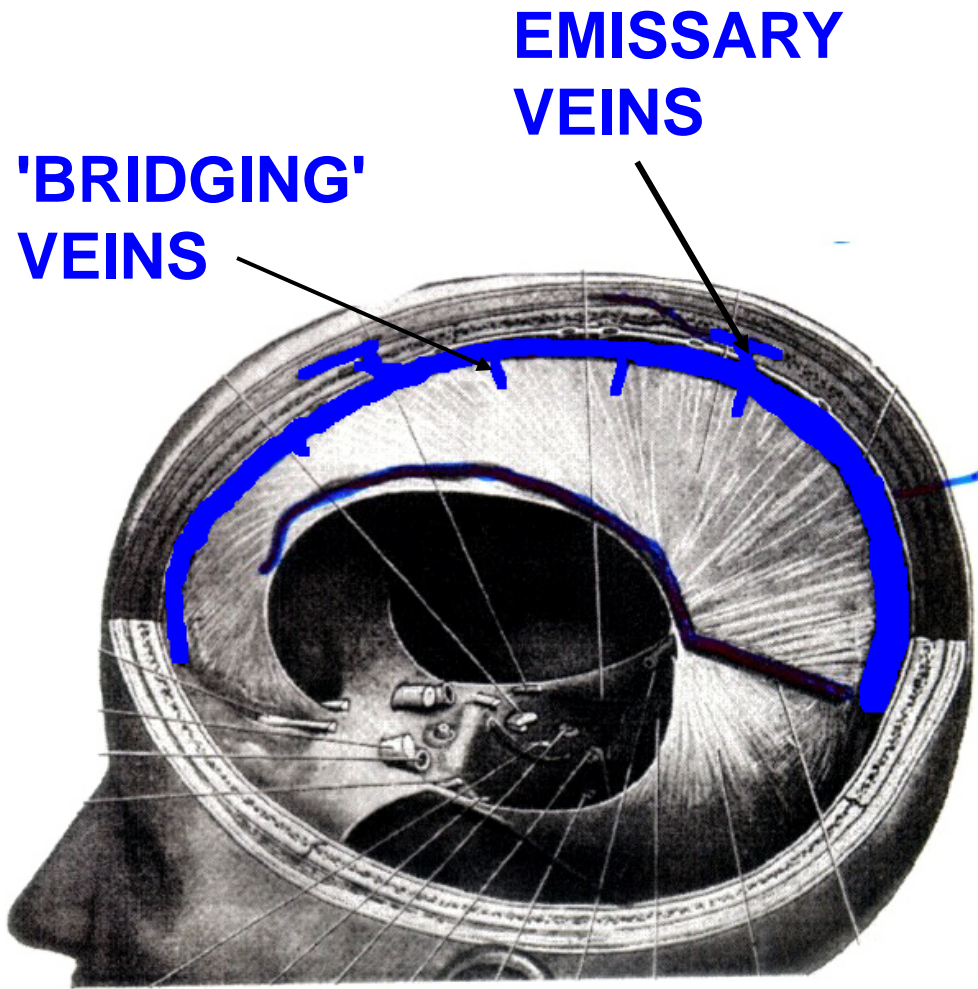
**4. Diaphragma  
Sella** – circular  
fold over sella  
turcica, has  
opening for stalk  
of pituitary

# MENINGES OF BRAIN

Other layers like spinal cord: **B. Arachnoid** - attached to inner side dura (potential space= Subdural Space); **C. Pia Mater** - adheres to brain; **Subarachnoid Space**- real space contains CSF



### III. VENOUS SINUSES – BETWEEN 2 LAYERS OF DURA



Brain removed

Receive blood from brain, orbit, emissary veins

1. VEINS from brain (inside) -  
a. 'BRIDGING' VEINS - inside cranial cavity - drain blood from surface of brain

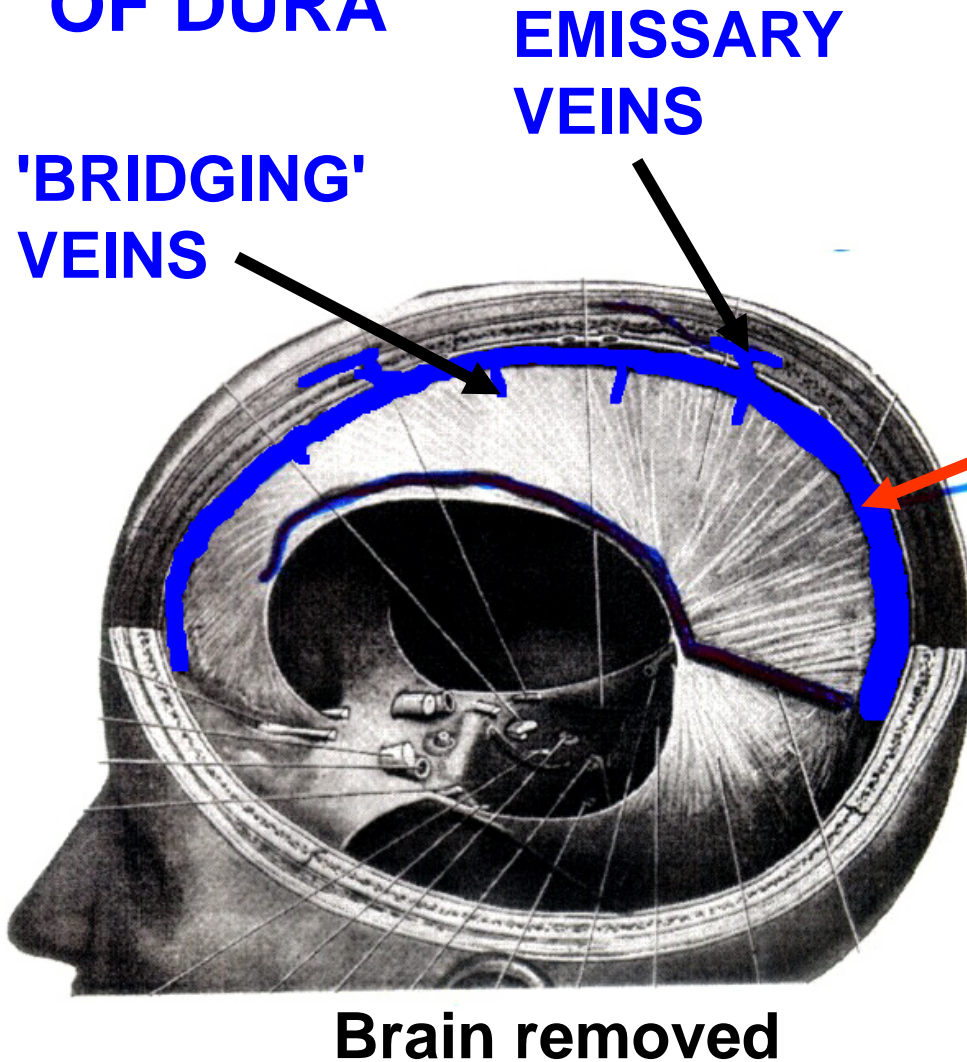
b. named veins - ex. GREAT CEREBRAL VEIN OF GALEN

2. VEINS from outside (ex. scalp)

a. EMISSARY VEINS - drain blood from scalp, to venous sinuses

b. named veins - OPTHALMIC VEINS from eye (orbit)

### III. VENOUS SINUSES – BETWEEN 2 LAYERS OF DURA



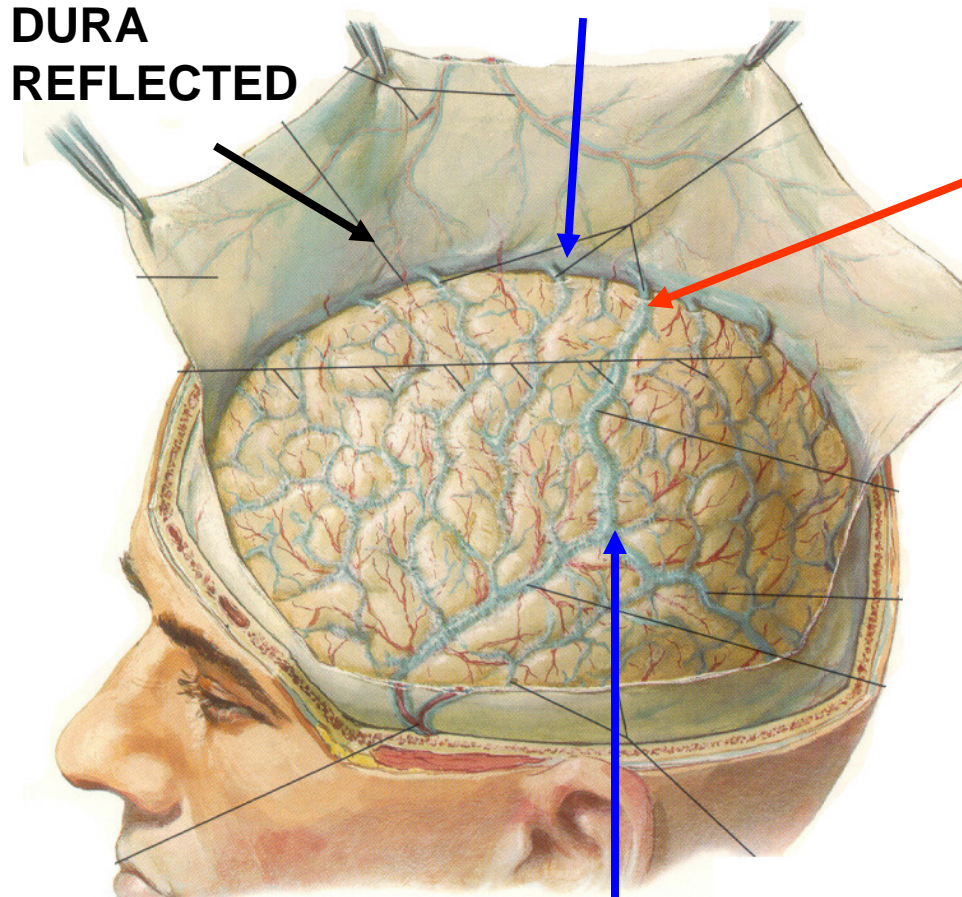
Receive blood from brain, orbit, emissary veins

1. Superior Sagittal Sinus – in upper border of falx cerebri; ant. - foramen cecum; post- transverse sinus; - communicates laterally with venous lacunae; blood from Superior Cerebral veins through 'bridging veins'; blood also from emissary veins

NOTE: Venous sinuses are like large veins – only have endothelial lining

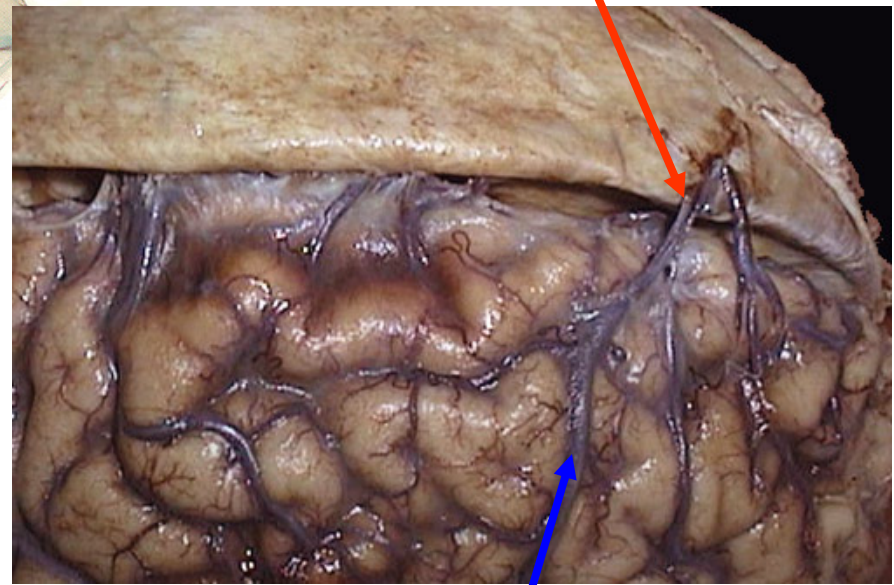
# SUPERIOR SAGITTAL SINUS receives blood from Superior Cerebral veins through 'BRIDGING' VEINS

## Superior Sagittal Sinus



Superior Cerebral veins

**'BRIDGING' VEINS**

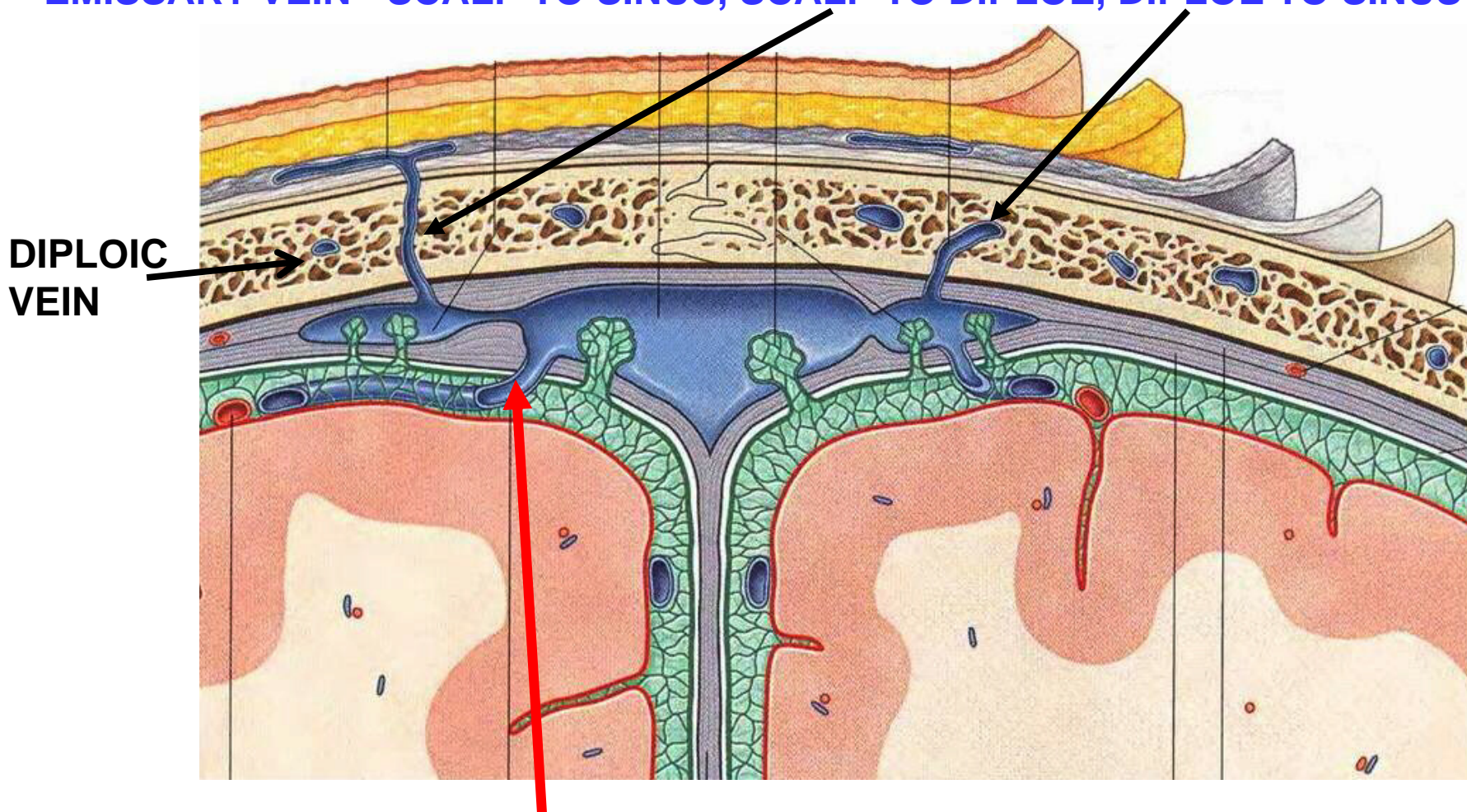


Superior Cerebral veins

Photo from lecture of Dr. Nancy Norton

## EMISSARY VEINS VS BRIDGING VEINS

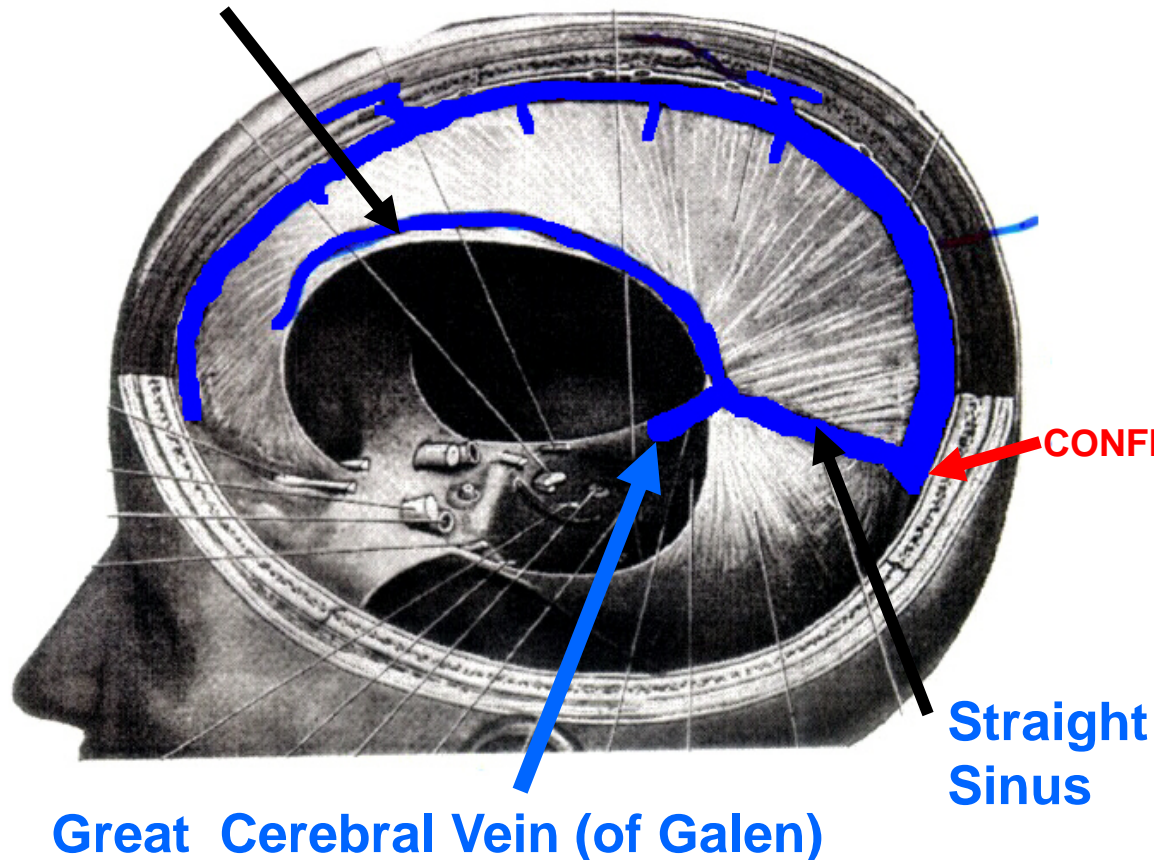
EMISSARY VEIN - SCALP TO SINUS, SCALP TO DIPLOE, DIPLOE TO SINUS



BRIDGING VEIN - CEREBRAL VEIN (BRAIN) TO SINUS

# VENOUS SINUSES

Inferior Sagittal Sinus



2. Inferior Sagittal Sinus - in lower (free) border of falx cerebri; - joins Great Cerebral V. form Straight Sinus

3. Straight sinus - at junction of falx cerebri and tentorium

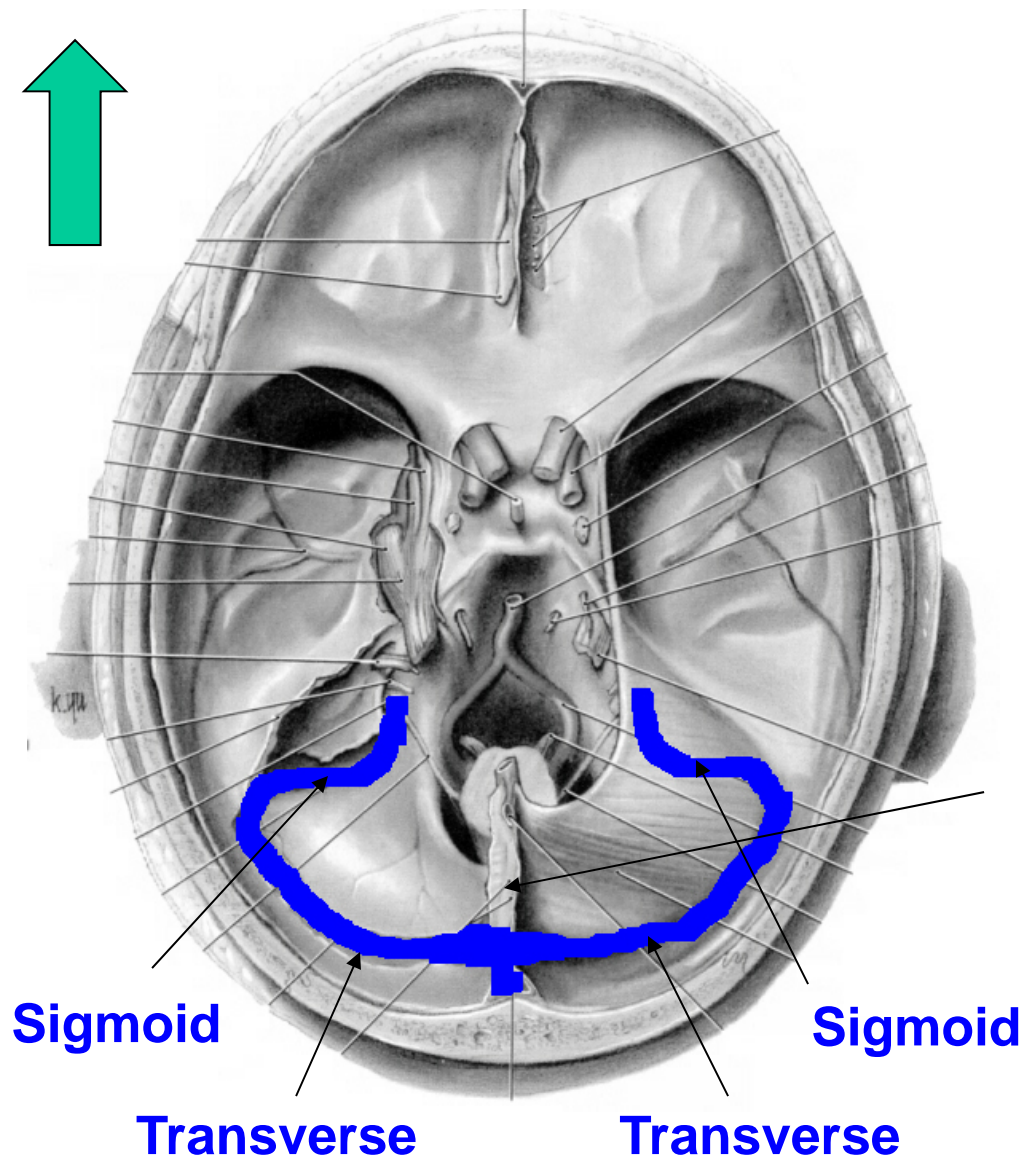
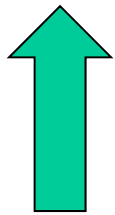
**NOTE: INFERIOR SAGITTAL SINUS DOES NOT DIRECTLY JOIN SUPERIOR SAGITTAL SINUS \*\***

Straight Sinus can join Superior Sagittal Sinus at Confluens of Sinuses or turn left



# VENOUS SINUSES

NOSE

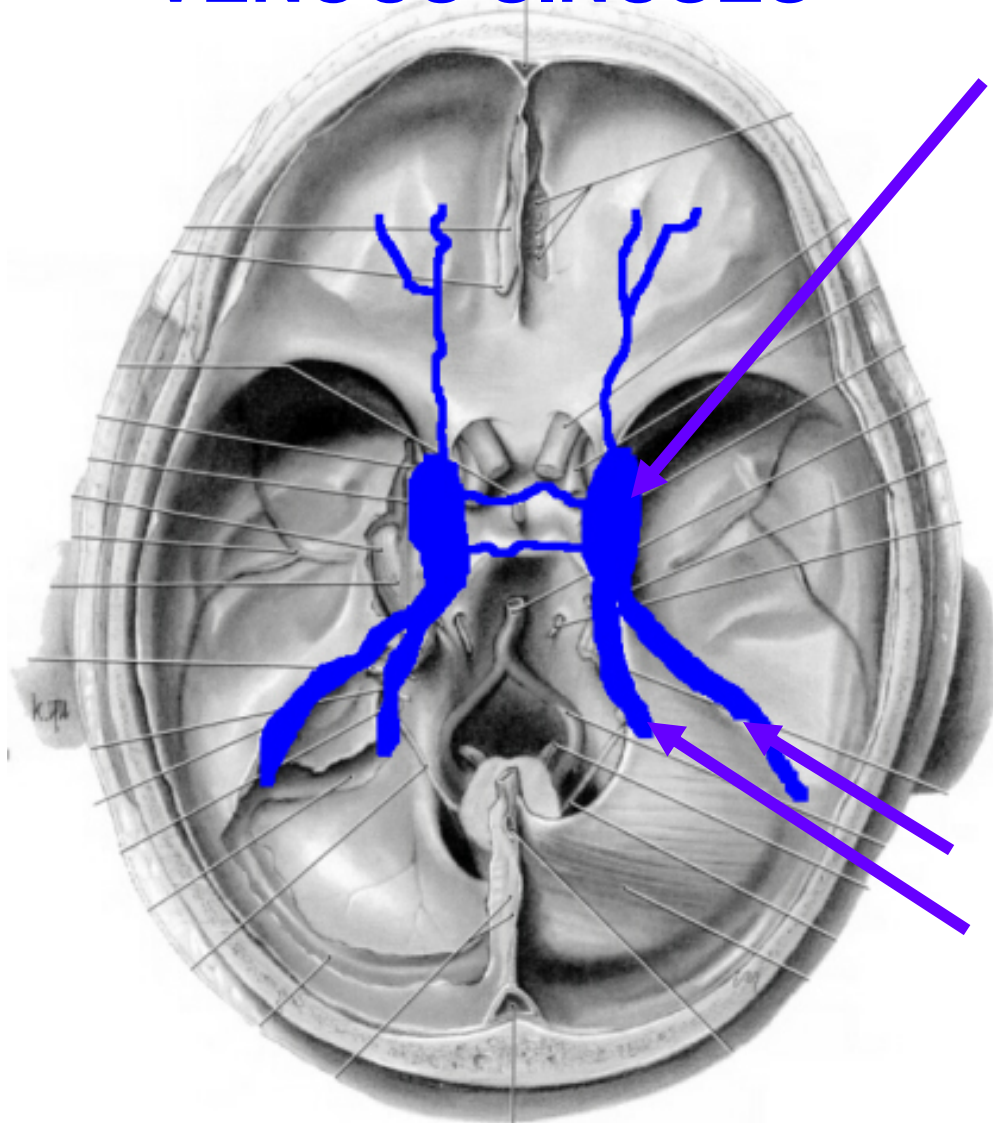


4. Transverse sinuses - in lateral fixed part of tentorium; receive blood from Sup. Sagittal or Confluens

5. Sigmoid sinuses - S-shaped continuation of Transverse; end in Jugular Foramen; form Internal Jugular Vein

6. Occipital Sinus - in Falx cerebelli; drain to Confluens

# VENOUS SINUSES

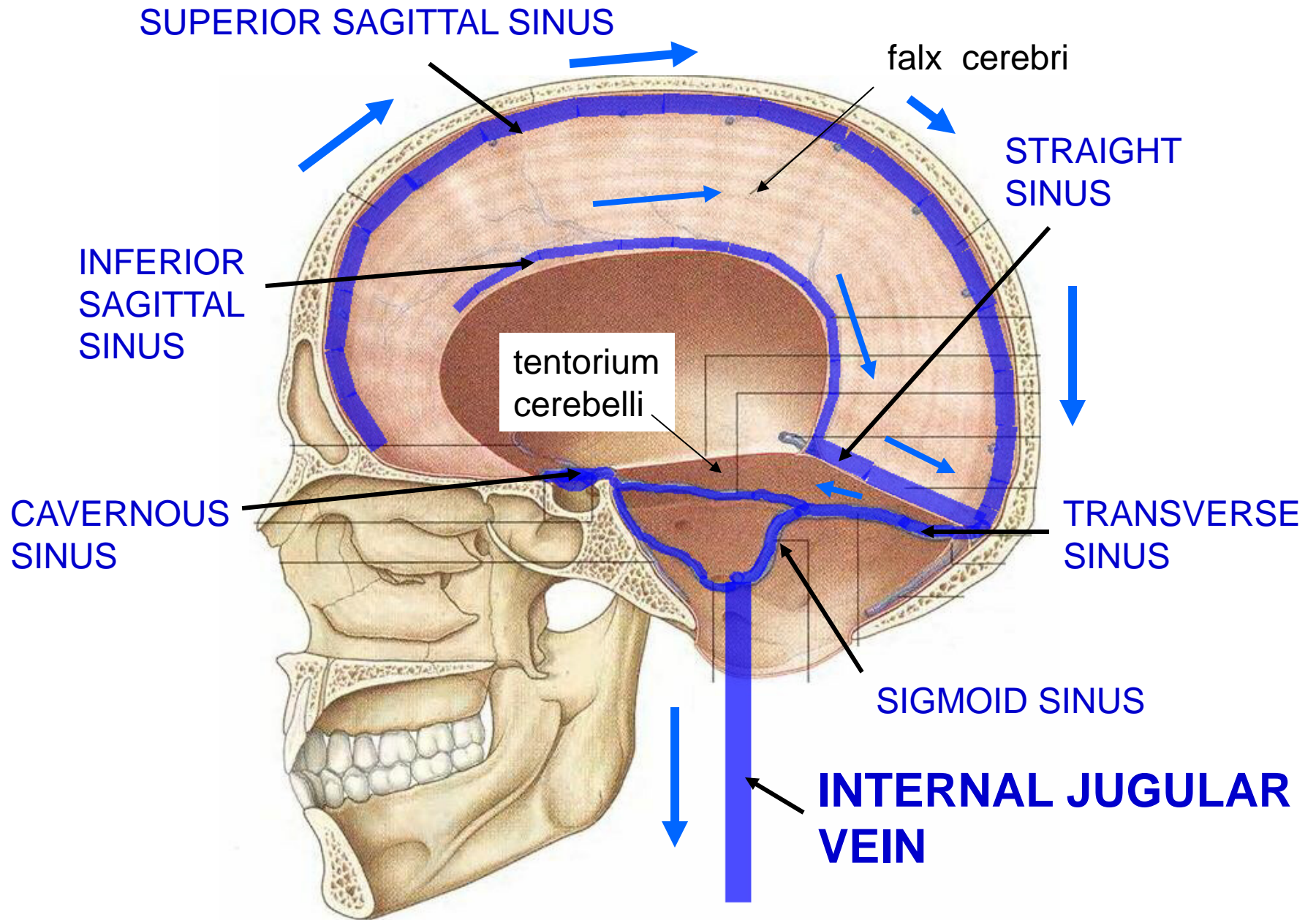


7. Cavernous sinuses - in middle cranial fossa; on side of the body of the sphenoid bone; connected by Intercavernous sinus; receive blood from Sup. and Inf. Ophthalmic veins, Cerebral veins; drain to Sup. and Inf. Petrosal sinuses

8. Sup. and Inf. Petrosal sinuses - on petrous part of temporal bone  
Sup. drains to Transverse  
Inf. Drains to Internal Jugular

Infection can spread from Face to Cavernous sinus via anastomoses of Ophthalmic veins and Facial veins

# VENOUS SINUSES OF BRAIN



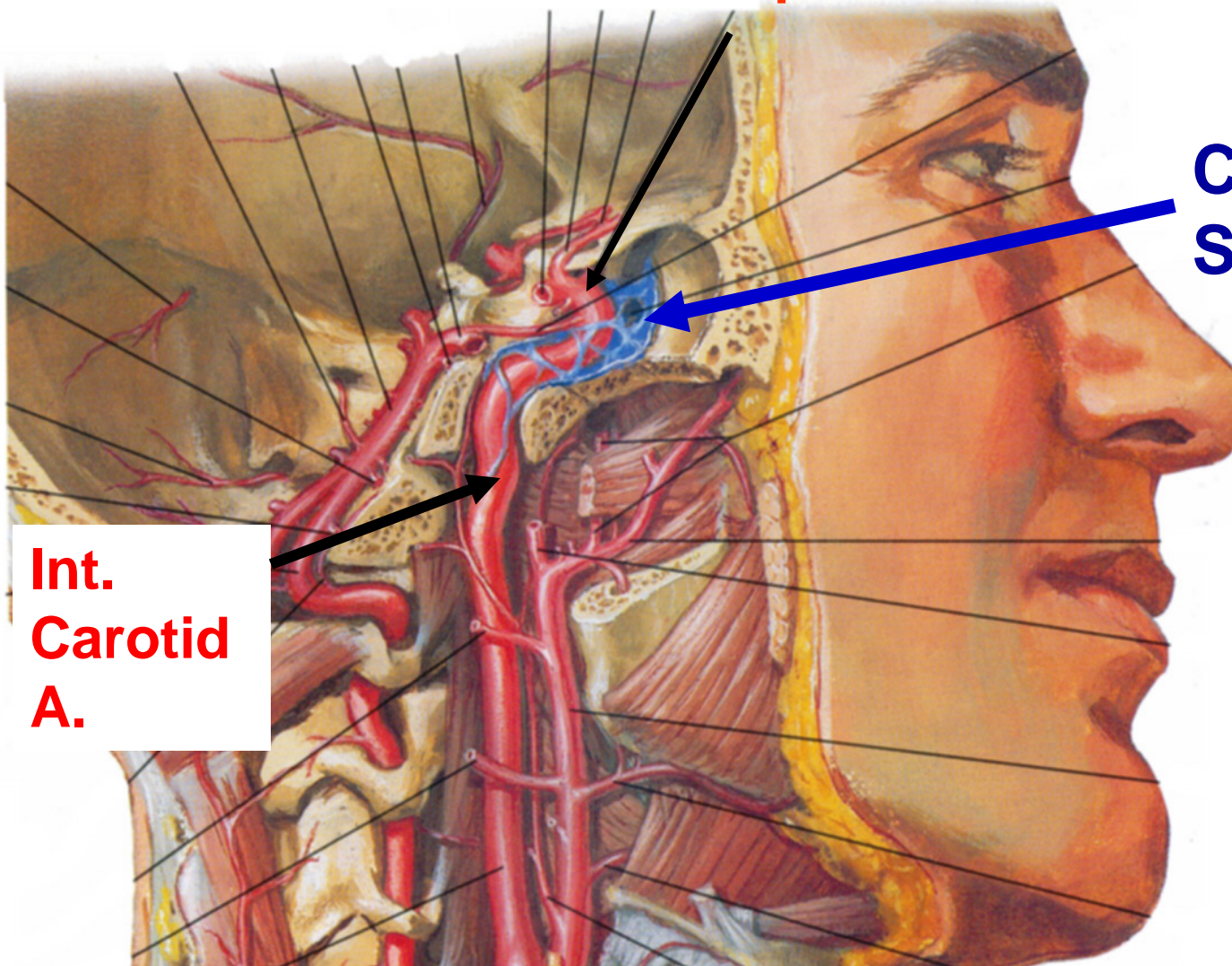
# Internal Carotid Artery – Passes Through Wall of Cavernous Sinus \*\*

Carotid Siphon

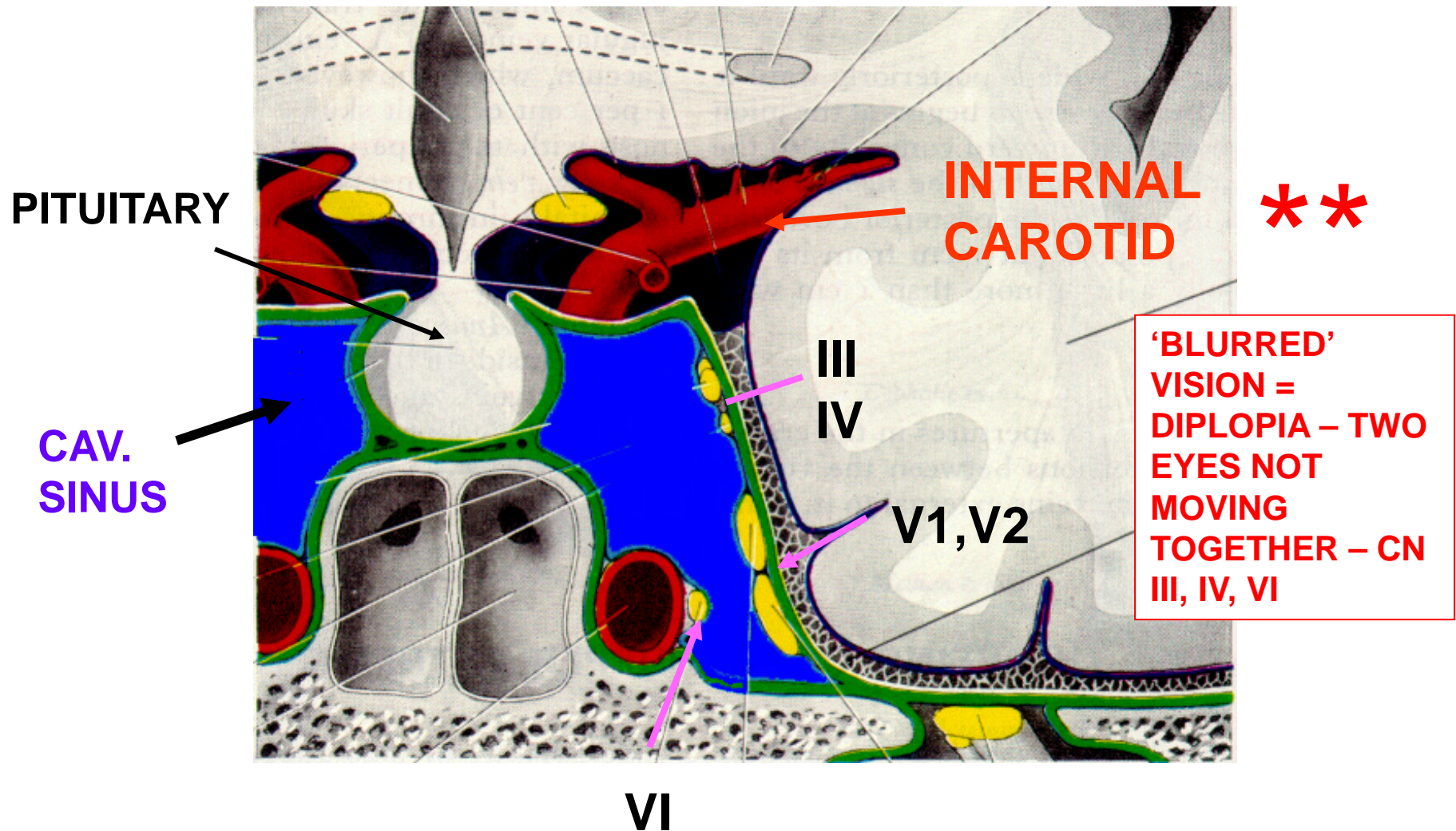
Cavernous Sinus \*\*

Int.  
Carotid  
A.

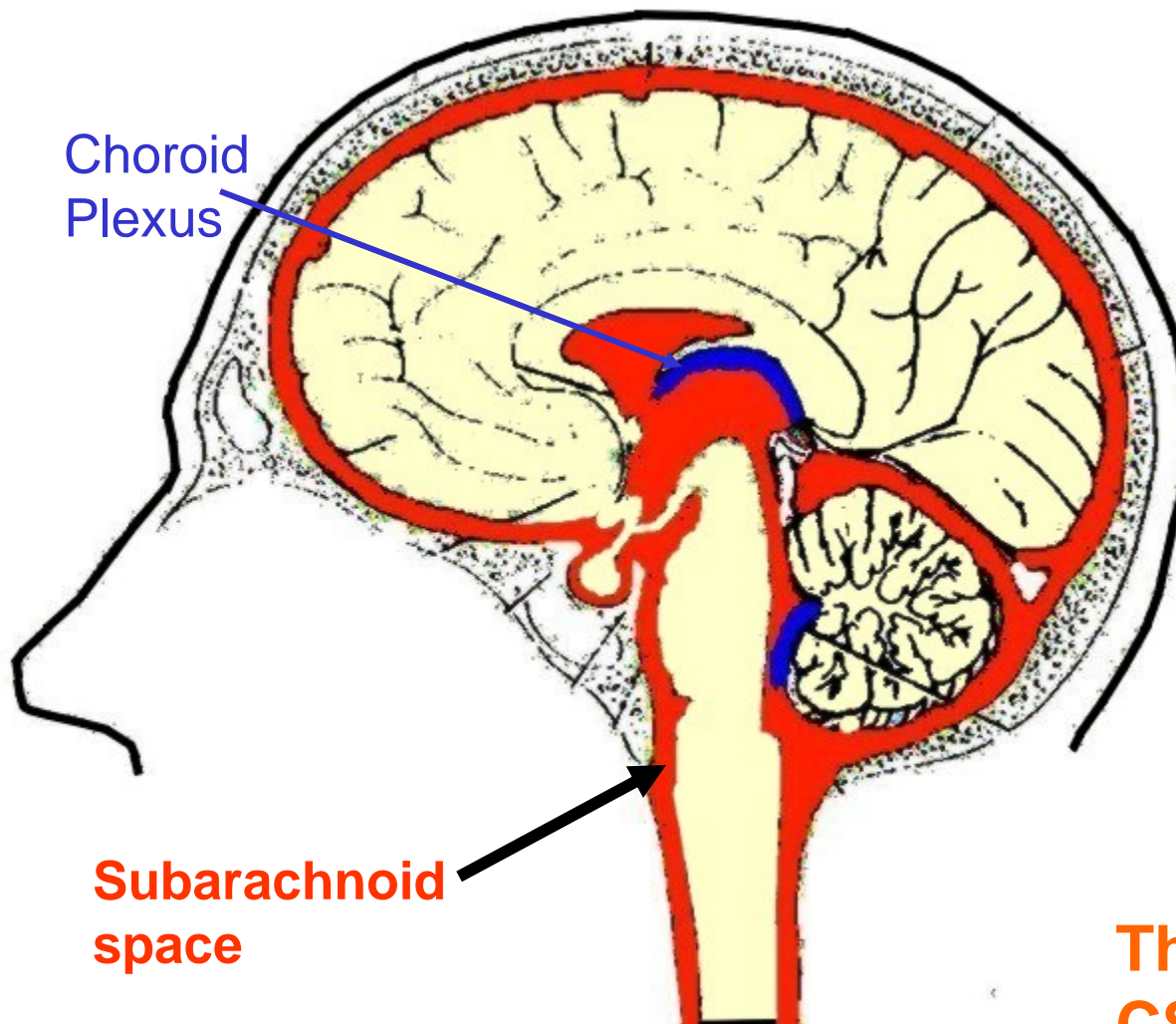
Carotid-  
Cavernous  
Fistula -  
Bleed of  
Internal  
Carotid  
Artery inside  
Cavernous  
Sinus



**STRUCTURES PASSING THROUGH WALL OF CAVERNOUS SINUS - Int. Carotid A., Cranial N.'s III, IV, V1, V2, VI;  
Clinical sign of Infection in Sinus – ‘BLURRED’ VISION**



## IV. CEREBRO-SPINAL FLUID (CSF)



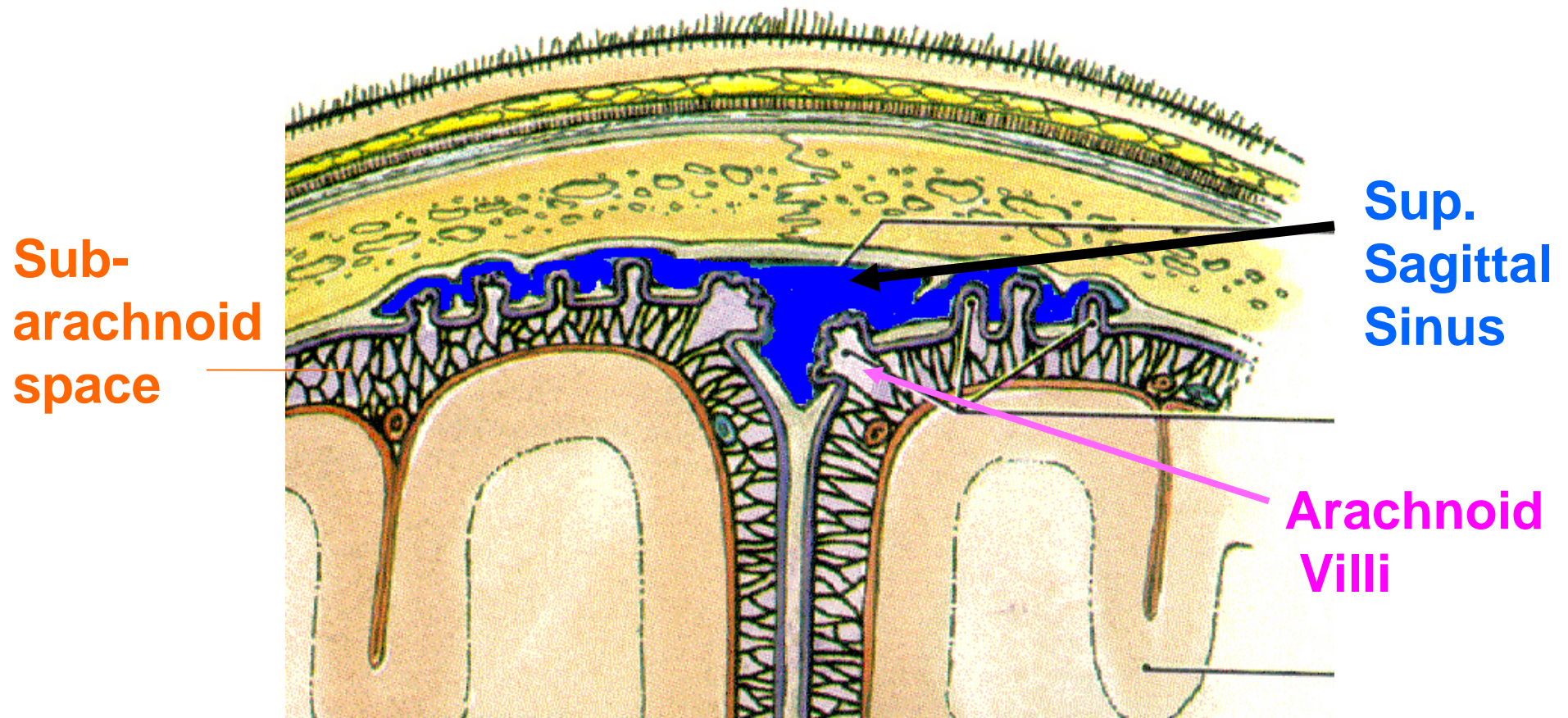
Choroid  
Plexus

Subarachnoid  
space

made inside  
brain in Choroid  
Plexus; flows  
out of brain to  
Subarachnoid  
Space

The brain floats in  
CSF - Shock  
Absorber

# CSF REABSORBED INTO VENOUS SINUSES



**CSF reabsorbs into venous sinuses at Arachnoid Villi; - In elderly arachnoid villi can become calcified- Arachnoid Granulations; Reduced Re-Absorption can produce Communicating Hydrocephalus \*\***

# CSF REABSORBED INTO VENOUS SINUSES

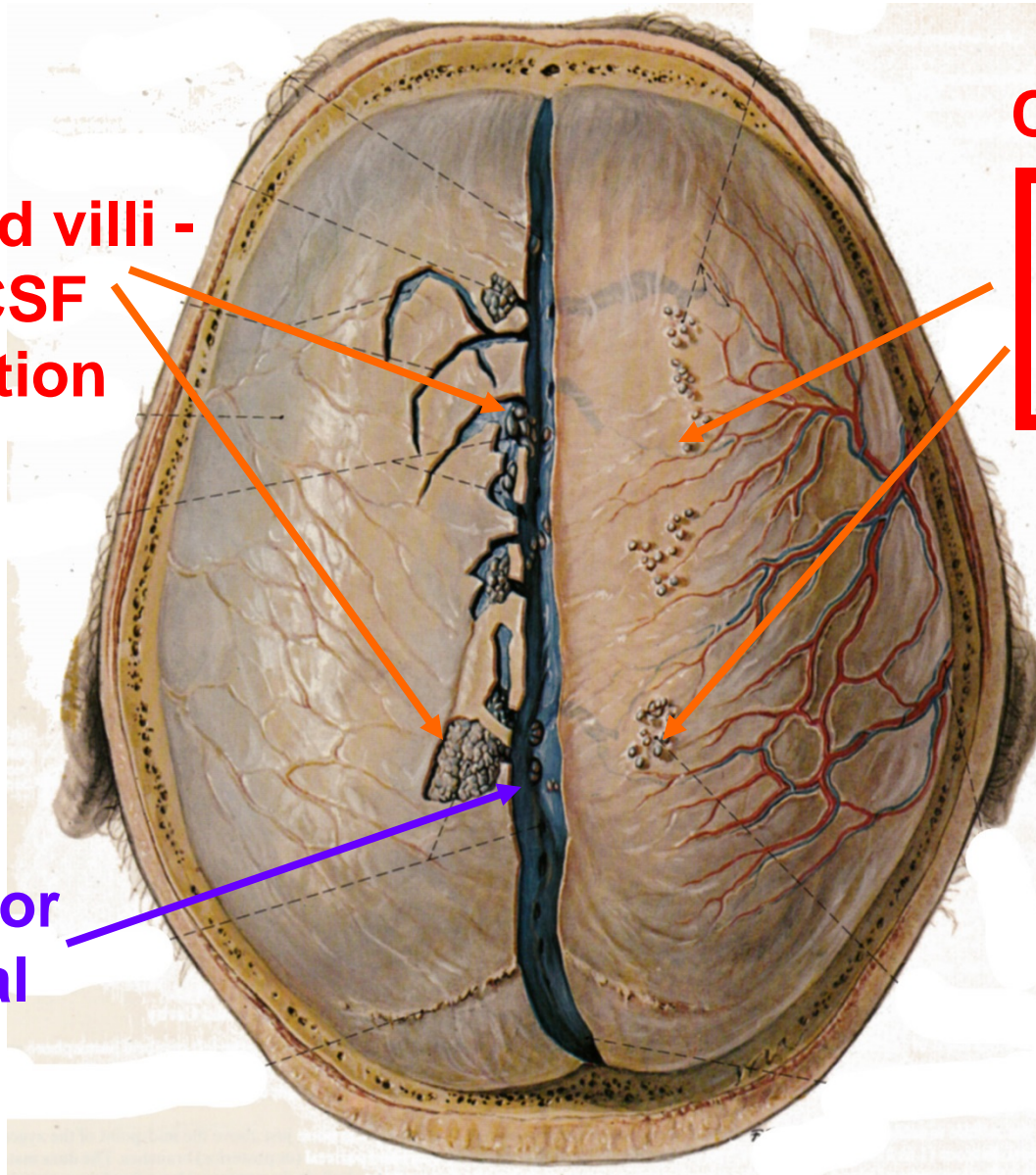
Arachnoid villi -  
sites of CSF  
reabsorption

CLINICAL \*\*

Arachnoid villi -  
sites of CSF  
reabsorption

Superior  
Sagittal  
Sinus

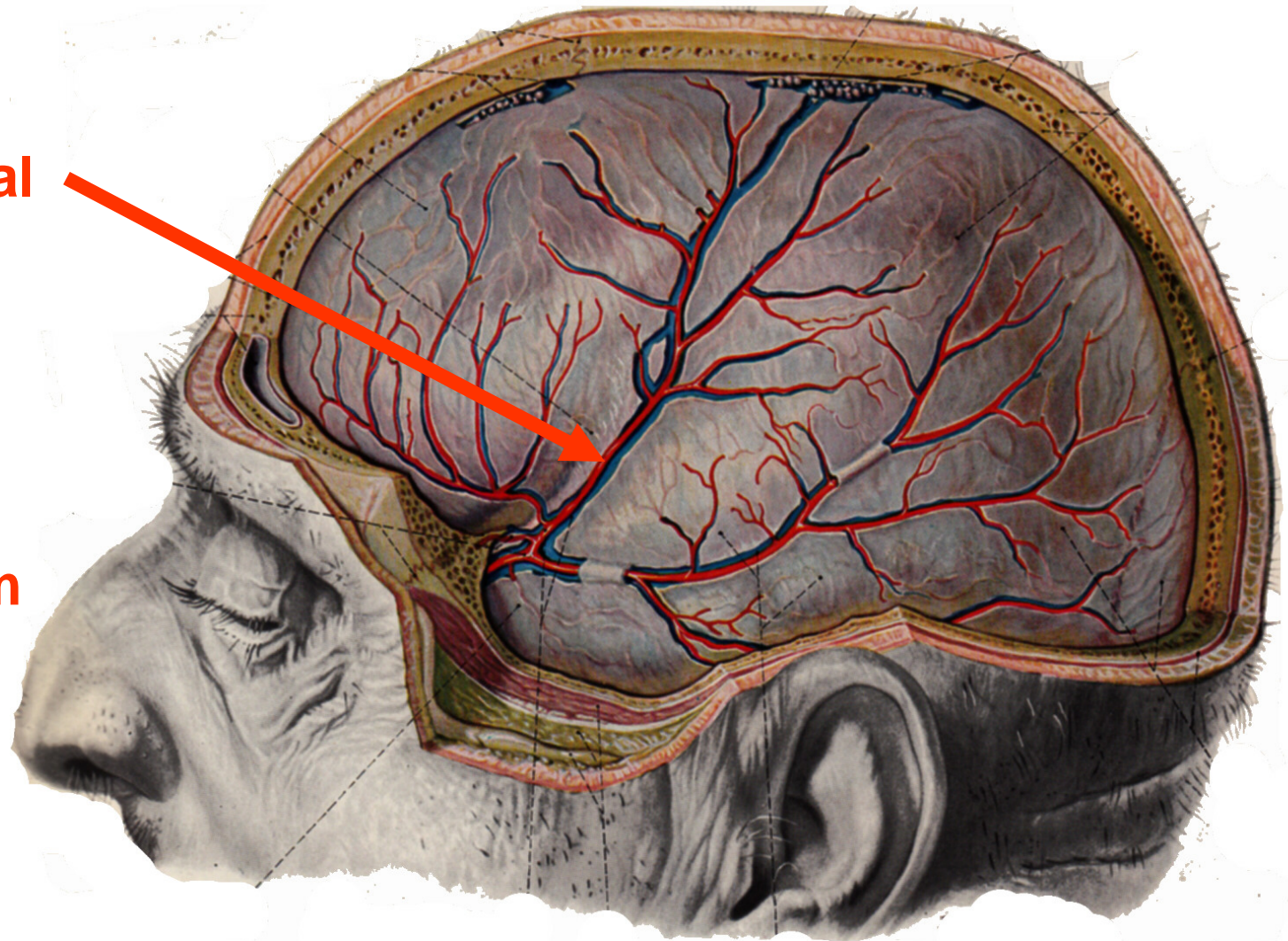
Calcification of  
Arachnoid Villi is  
common in  
elderly; can cause  
hydrocephalus  
due to decreased  
reabsorption of  
CSF



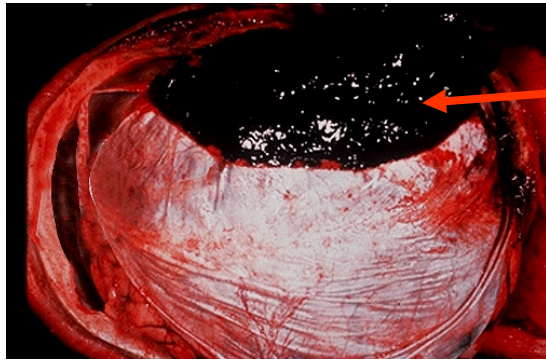


## V. HEMATOMAS - INTERNAL BLEEDS

**Middle  
Meningeal  
Artery –  
courses  
outside  
dura –  
supplies  
calvarium**



**A. EPIDURAL HEMATOMA - bleeding between dura  
and bone**



# EPIDURAL HEMATOMA

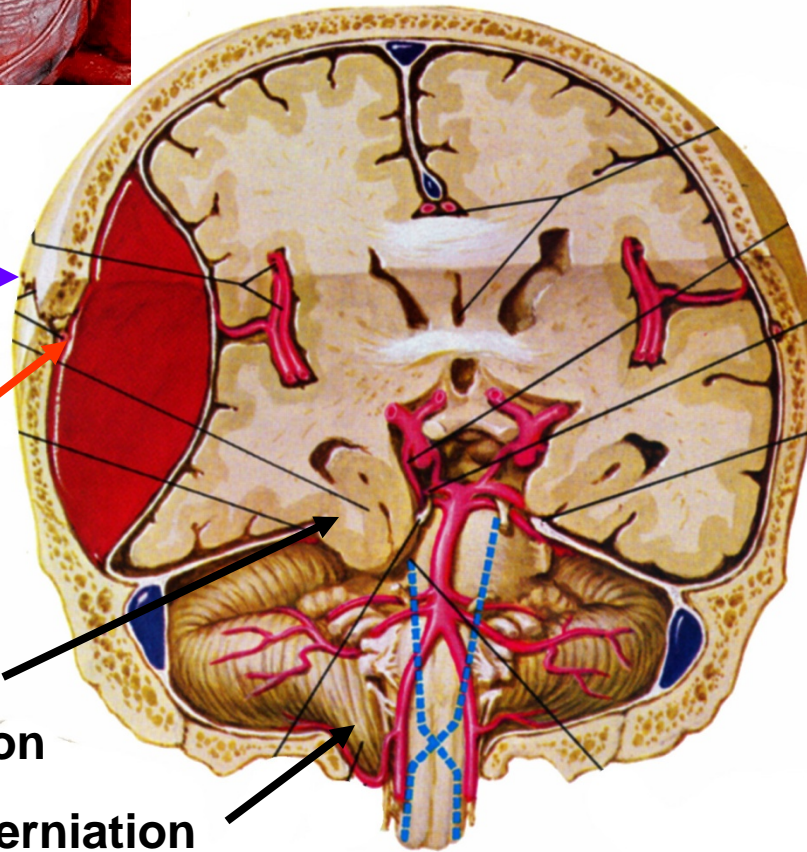
- 1) Skull fracture near Pterion
- 2) Tear Middle Meningeal Artery
- 3) Blood 'peels' dura from bone
- 4) Lens shaped (biconvex) mass on CT

Skull Fracture Near Pterion

Tear Middle Meningeal Artery

Uncal herniation

Tonsillar herniation

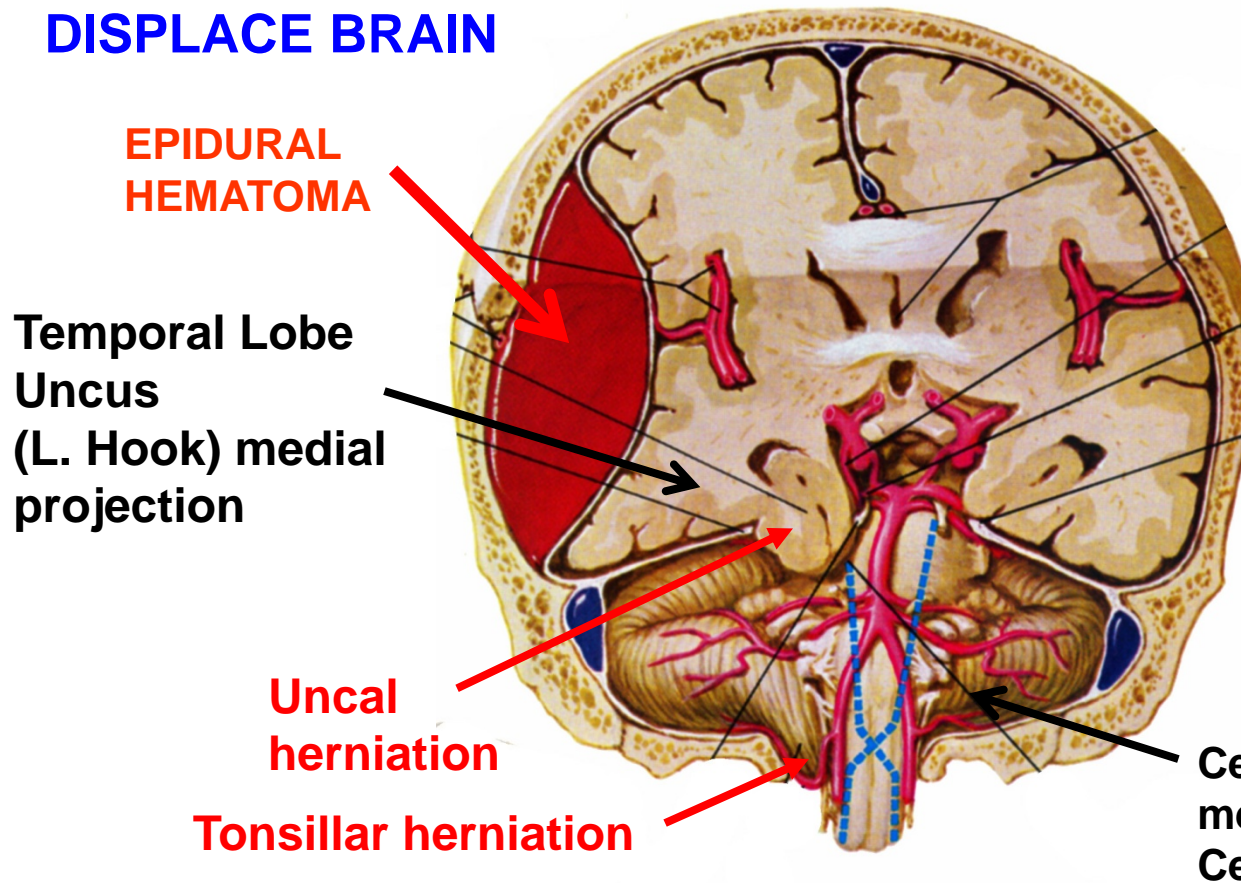


Clinical - bleeding is arterial; can be profuse and rapid (ex, car accident); patient lucid at first; can be fatal within hours if herniation occurs

**EPIDURAL HEMATOMA – \*\***  
1) **ARTERIAL – often MIDDLE MENINGEAL ARTERY**  
2) **'LENS' SHAPED MASS**  
3) **RAPID**

# EPIDURAL HEMATOMA

MASS OF BLOOD CAN  
DISPLACE BRAIN



6) Herniation -

i. Uncal herniation -  
push Temporal lobe  
(uncus) through  
Tentorial Notch

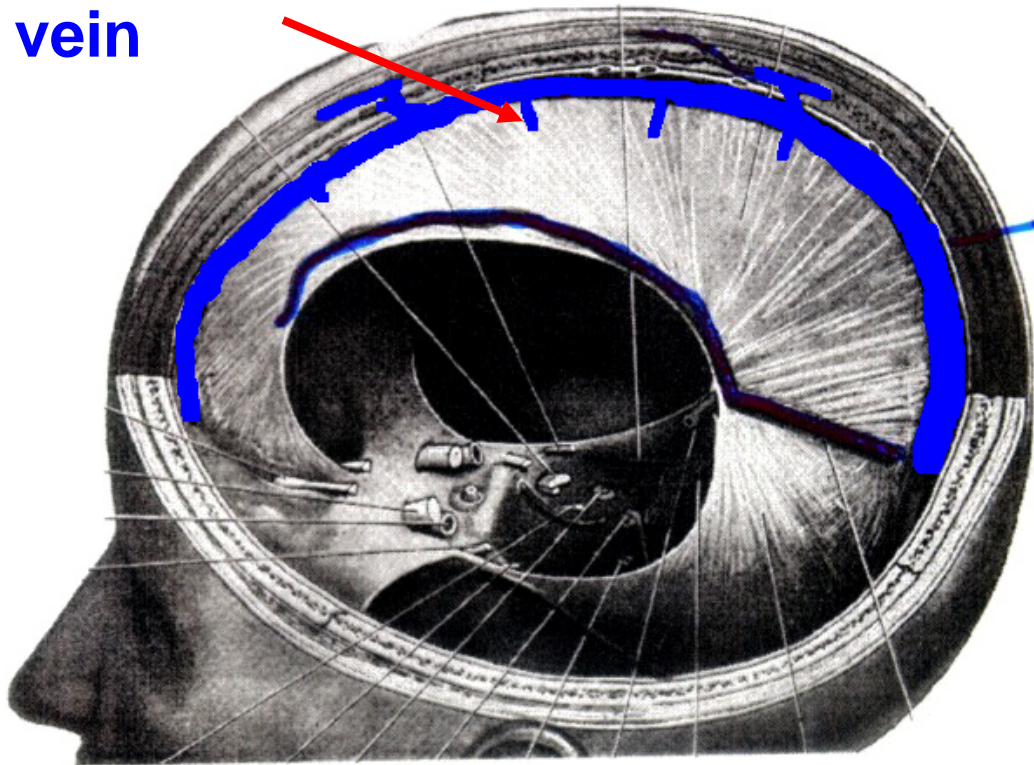
ii. Tonsillar  
herniation -  
push Cerebellum  
(tonsil) through  
Foramen Magnum

Cerebellar Tonsil -  
medial projection of  
Cerebellum

Clinical - bleeding is arterial; can be profuse and rapid (ex, car accident);  
patient lucid at first; can be fatal within hours if herniation occurs - actress  
Natasha Richardson 2009 \*\*

## B. SUBDURAL HEMATOMA

'Bridging'  
vein



- bleed into potential space between Dura and Arachnoid
- from **tear 'Bridging' vein or sinus \*\***
- bleeding often **slow**
- chronic subdural hematomas can remain undetected



'Bridging'  
vein

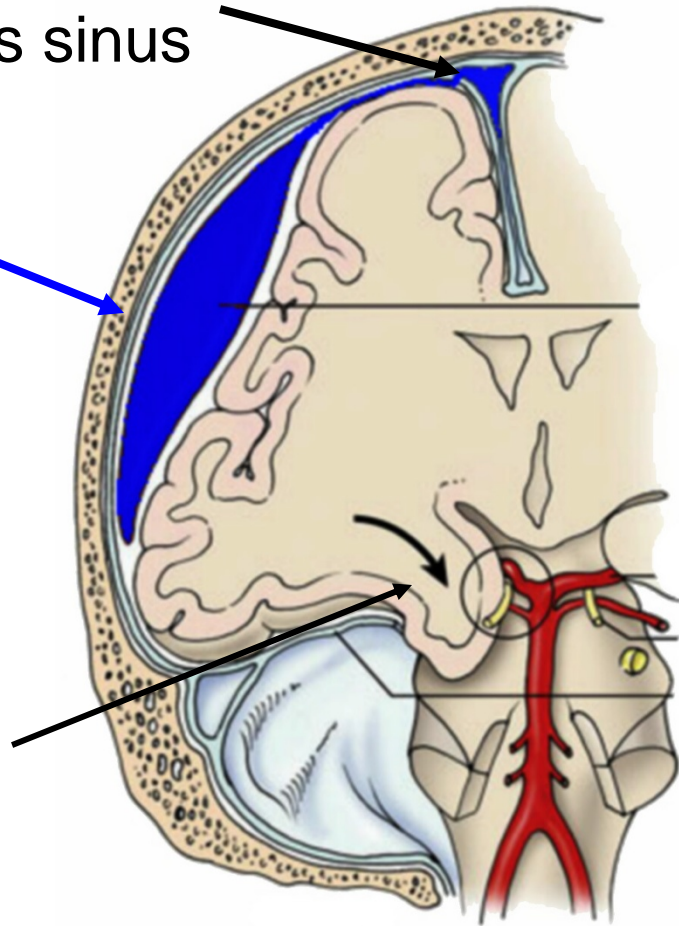
Photo from lecture of Dr. Nancy Norton

# SUBDURAL HEMATOMA

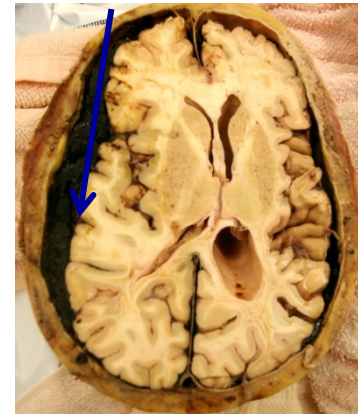
Tear 'bridging' vein  
or venous sinus

Crescent  
shaped  
hematoma  
on CT/MRI

Herniation  
of uncus (L.  
hook) of  
temporal  
lobe  
through  
Tentorial  
notch



SUBDURAL HEMATOMA  
BLOOD

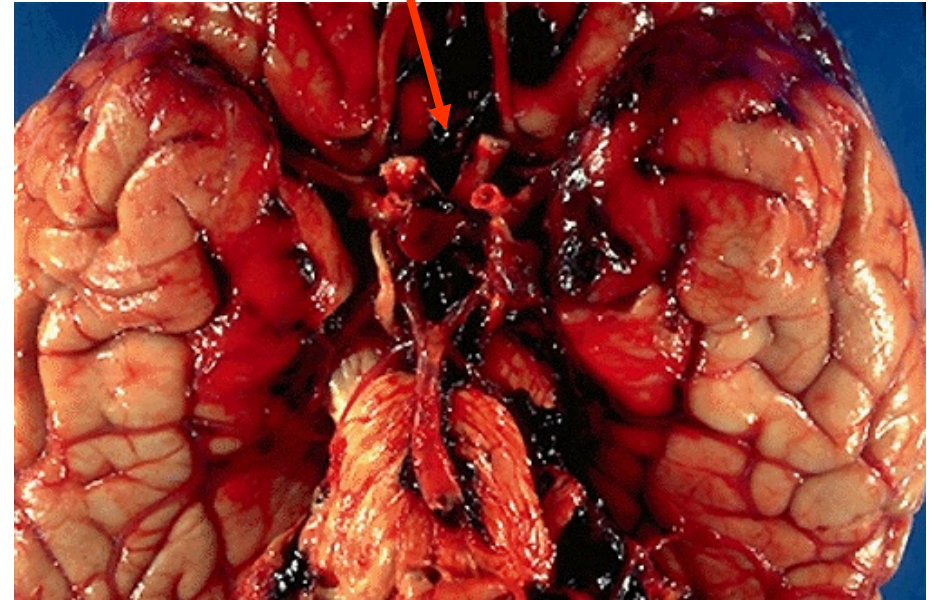
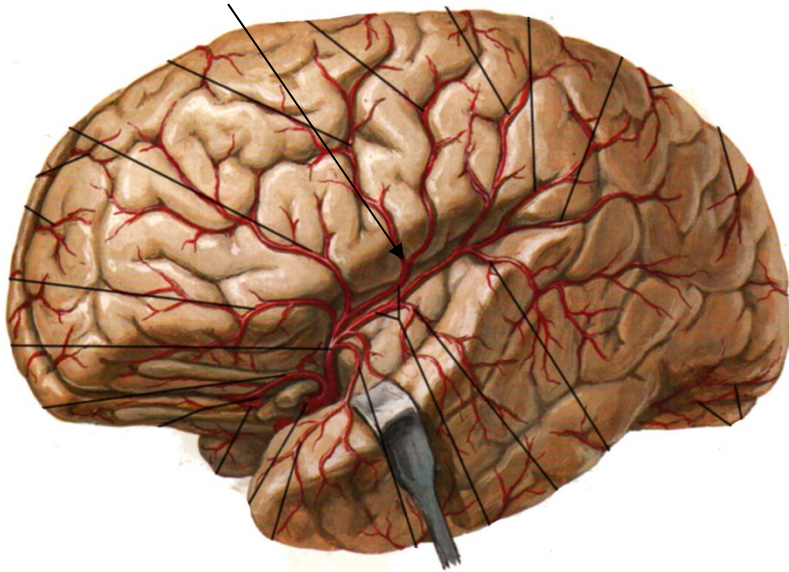


**SUBDURAL \*\*  
HEMATOMA –  
1) VENOUS – often  
BRIDGING VEIN  
2) CRESCENT  
SHAPED MASS  
3) SLOW**

**Clinical: bleeding slow (venous); Chronic Subdural Hematomas can remain undetected; can result in herniation if untreated**

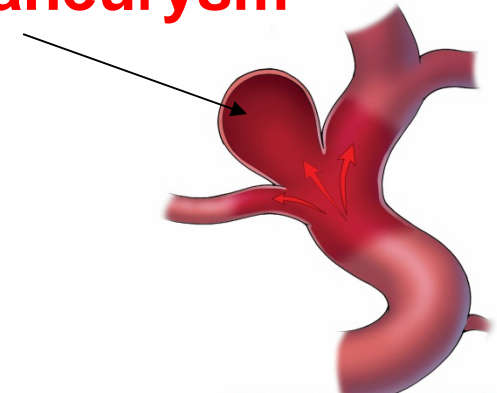
## C. SUBARACHNOID HEMATOMA

Cerebral artery

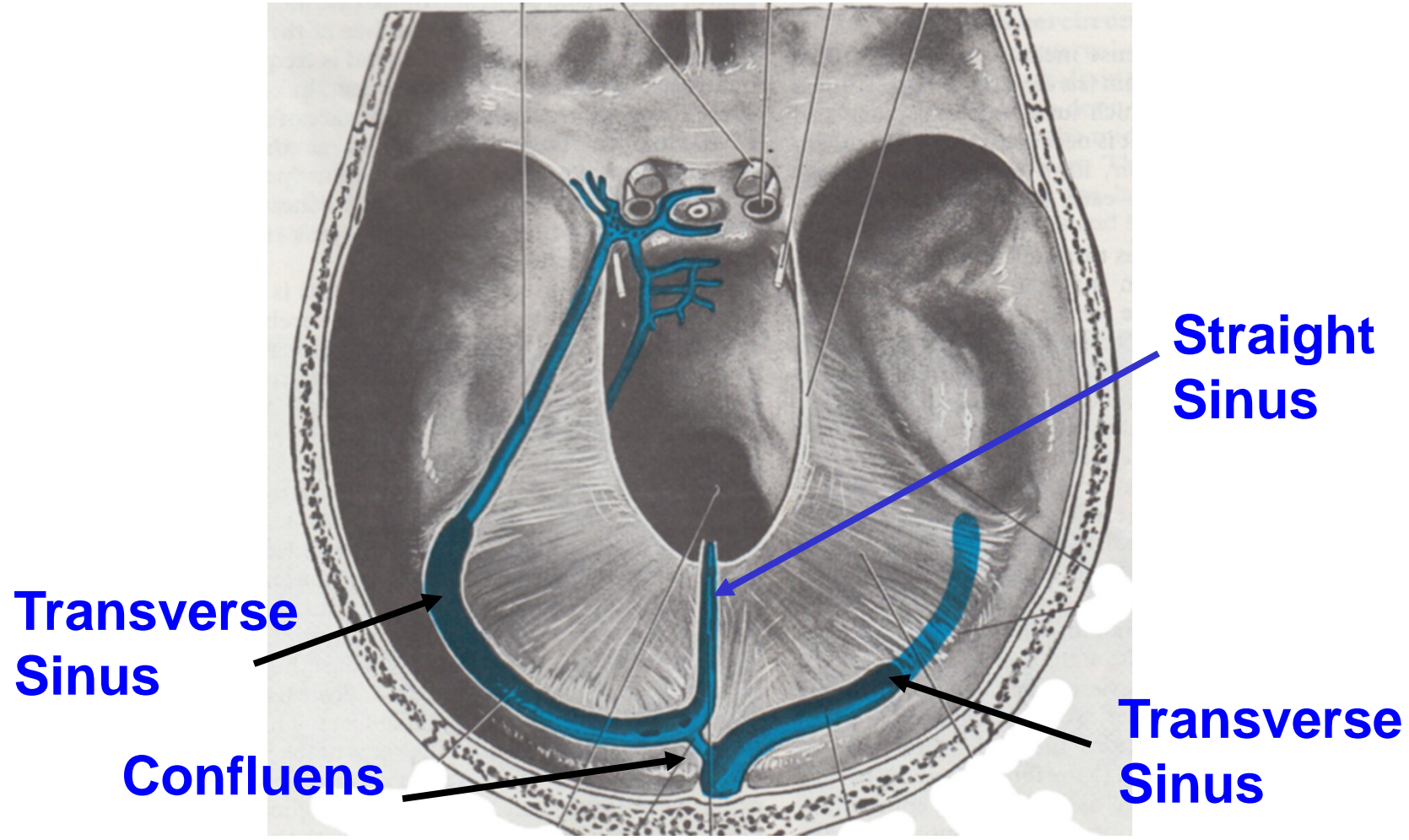


Tearing cerebral artery or aneurysm (ex, berry aneurysma = swelling of vessel wall) or cerebral vein; If arterial can be rapid and fatal

Berry aneurysm



# VARIANT: INCOMPLETE FORMATION OF CONFLUENS OF SINUSES



**Straight Sinus can join Superior Sagittal Sinus at Confluens of Sinuses or **turn left****

## ORBIT, EYE STRUCTURES AND EYE MUSCLES

© 2021zillmusom

I. **BONES OF ORBIT** - bones are rigidly linked together to form a stable socket to permit precise movements of eye.

### A. Boundaries

1. Roof - Frontal bone (anterior cranial fossa is superior to roof)
2. Floor - Maxillary bone (Maxillary sinus is inferior to floor).
3. Medial wall - Maxillary, Lacrimal, Ethmoid, Frontal and Sphenoid bones (nasal cavity is medial to medial wall of orbit).
4. Lateral wall - Zygomatic bone and sphenoid bone (greater wing).

B. Foramina - openings which transmit nerves and vessels to structures in orbit (eye, extraocular muscles and lacrimal gland (tears)); also **IMPORTANTLY**, orbit serves as passageway for nerves that are sensory to face, scalp and nasal cavity - see Foramina handout

C. Lining of orbit - periosteum of bones of orbit is called Periorbita.

II. **EYELIDS** - layered, moveable structures which protect eye, keep cornea (outermost layer) of eye moist.

### A. Layers

1. Skin - contains eyelashes (cilia), openings of sebaceous and sweat glands.
2. Subcutaneous layer - connective tissue containing sebaceous glands;

Clinical: **Obstruction of sebaceous glands in subcutaneous layer of eyelid called a stye (hordeolum).**

3. Orbicularis oculi muscle - skeletal muscle which surrounds eyelid; closes eyelids; innervated by Facial nerve (VII); damage to facial nerve paralyzes muscle; patient unable to close eyelids and spread tears over cornea; can result in corneal damage.

4. Orbital septum, tarsal plate and Levator Palpebrae Superioris muscle.

- a. Orbital septum - fascial layer inside eyelid, is continuous with connective tissue lining orbit (periorbita).

- b. Tarsal plate - dense fibrous connective tissue, located deep to orbital septum; forms 'skeleton' of eyelid; contains **tarsal glands**.



Clinical: Obstruction of **tarsal glands in eyelid called a chalazion.**

c. Levator palpebrae superioris muscle - muscle composed of both smooth and skeletal muscle components; origin - Tendinous ring (see below); insertion - skin and tarsal plate of upper lid; action - opens eyelids; **innervation - skeletal part by Oculomotor nerve (III), smooth part by Sympathetics.**

**Clinical – Ptosis = eyelid droop, important clinical sign; can result from damage to Oculomotor Nerve (III) or sympathetics.**

5. Conjunctiva - membrane covering inner side of eyelid; conjunctiva continues as a layer over sclera of eye and fuses to cornea; reflection of conjunctiva from eyelid to eye called Superior and Inferior fornices of conjunctiva; very sensitive.

III. **LACRIMAL APPARATUS** - tears are constantly produced in lacrimal gland, drain to nasal cavity via lacrimal duct.

A. Lacrimal gland - located in superolateral orbit; have numerous ducts (about 12) which open through conjunctiva; produce tears;

**Flow of tears:** circulate over conjunctiva and wash out dirt; drain through **lacrimal puncta** (openings) in medial part of upper and lower eyelids (you can see these on yourself in a mirror); puncta drain to **lacrimal sac** which drains via **Nasolacrimal duct** to **Inferior Meatus of nasal cavity** (this is why you blow your nose when you are crying)

B. Innervation of lacrimal gland - **Parasympathetics from Facial nerve (VII)** via a complicated pathway in which fibers hitch-hike with branches of the Trigeminal nerve (V) (more in future Cranial nerve lecture).

Clinical: **Obstructed Nasolacrimal Duct** - Nasolacrimal duct develops embryologically as a solid cord between maxillary and nasal processes; cord then becomes canalized; failure of canalization is Obstructed Nasolacrimal duct; tears flow onto face of neonate.

IV. **FASCIAL SHEATH OF EYEBALL** - thin fascial membrane surrounding eye (also called Tenon's capsule); thickenings of sheath attach to bones and form Medial and Lateral Check ligaments which prevent excess movement of eye.

## V. **LAYERS OF EYE**

A. Structure of eyeball - described as three layers

1. Fibrous layer

a. Sclera - tough, smooth fibroelastic layer surrounding eye (continuous anteriorly with cornea); functions to protect eye and maintain shape; provides attachment of extraocular muscles; pierced by nerves and vessels of eye.

b. Cornea - avascular, transparent layer covering anterior eye; important in focusing light; **Clinical: irregularities in cornea responsible for astigmatism.**

## 2. Vascular layer

Note: Blood supply to eye is derived from branches of **Ophthalmic artery** (from Internal Carotid Artery); major branches to eye: 1. Choroidal arteries (Anterior and Posterior) - to choroid; 2) Central Artery of Retina - to retina.

a. Choroid - highly vascular (Choroidal arteries and veins), pigmented membrane; provides nutrients and oxygen to other layers of eye.

b. Ciliary body - attaches to suspensory ligament of lens; hold lens taut; contains ciliary muscles.

i. Ciliary muscles - smooth muscles attached to suspensory ligaments of lens; **contraction of muscles produces relaxation of suspensory ligaments; causes lens to thicken for near vision (accommodation);** innervation - **Parasympathetics from Ciliary ganglion (nerve III)** cause contraction of ciliary muscles (parasympathetics travel in **Short Ciliary nerves**).

c. Iris - pigmented, contractile layer surround pupil (opening); controls amount of light entering eye; contains two muscles

i. Constrictor pupillae - circular smooth muscle which constricts iris, pupil; innervated by Parasympathetics (from Ciliary ganglion of III).

ii. Dilator pupillae - radial smooth muscle which dilates pupil; innervated by sympathetics.

3. Retina - contains photosensitive rods and cones and many neurons which process visual information; artery - **Central Artery of Retina** (branch of Ophthalmic artery), classically thought to have no anastomoses (occlusion results in blindness).

**New Anatomy:** imaging has shown that branches of Ciliary Arteries (**Cilioretinal arteries**) are present in about 20% of people; can provide partial sparing of retina in cases of **Central Retinal Artery Occlusion (CRAO)**.

Note: **Subarachnoid space** extends around optic nerve up to its junction with sclera in back of eyeball; optic nerve can be viewed in ophthalmoscope as optic disc; changes in

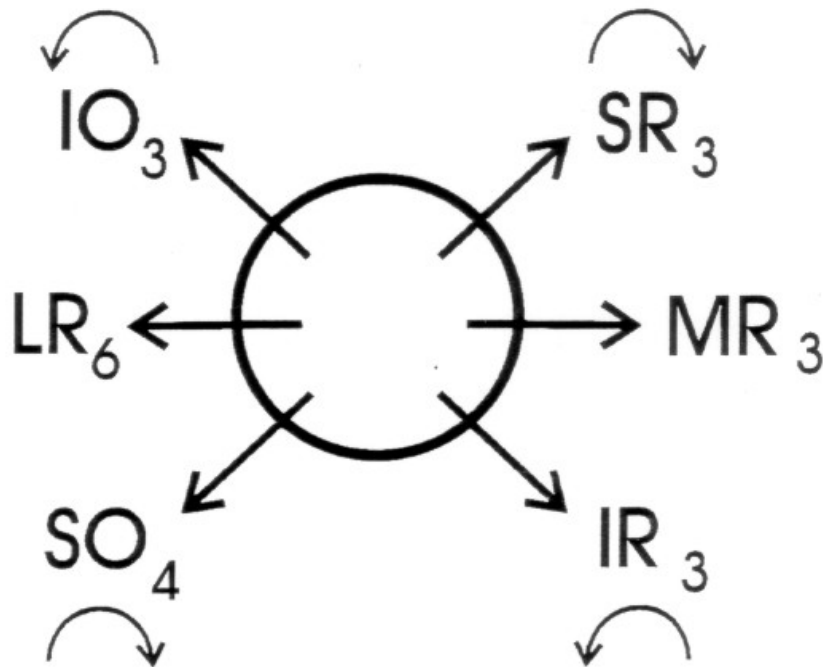
intracranial pressure (ex. hydrocephalus) can be diagnosed by viewing optic disc.

## VI. EXTRAOCULAR MUSCLES

A. Origins - all take origin from Tendinous ring (except Inferior Oblique which has origin on floor of orbit); Tendinous ring is ring of connective tissue surrounding opening of Optic canal and Superior Orbital Fissure.

### B. Actions and Innervation

Muscle	Nerve	Action
Medial rectus	III	Adduct eye
Lateral rectus	VI	Abduct eye
Inferior rectus	III	Adduct, lower and laterally rotate eye
Superior rectus	III	Adduct, raise and medially rotate eye
Superior oblique	IV	Abduct, lower and medially rotate eye
Inferior oblique	III	Abduct, raise and laterally rotate eye.



## VII. NERVE DAMAGE

A. **Abducens** nerve (VI) - damage causes **Medial Strabismus** (cross-eyed).

B. **Trochlear** nerve (IV) - damage results in **inability to turn eye down and out**;  
ALSO **Head Tilt**: at rest, **patient tilts head to opposite side (compensate for unilateral eye rotation)**

C. **Oculomotor** nerve (III) - damage causes **ptosis (drooping eyelid** from paralysis of skeletal component of Levator palpebrae superioris), **Lateral Strabismus** (wall-eyed, from damage to Medial rectus), **dilated pupil** (from paralysis of Constrictor pupillae) and **diplopia** (double vision)

## VIII. CILIARY GANGLION - parasympathetic ganglion of Oculomotor nerve (III)

A. Contains - parasympathetics for Ciliary muscles and Sphincter Pupillae; parasympathetics travel in Short Ciliary nerves.

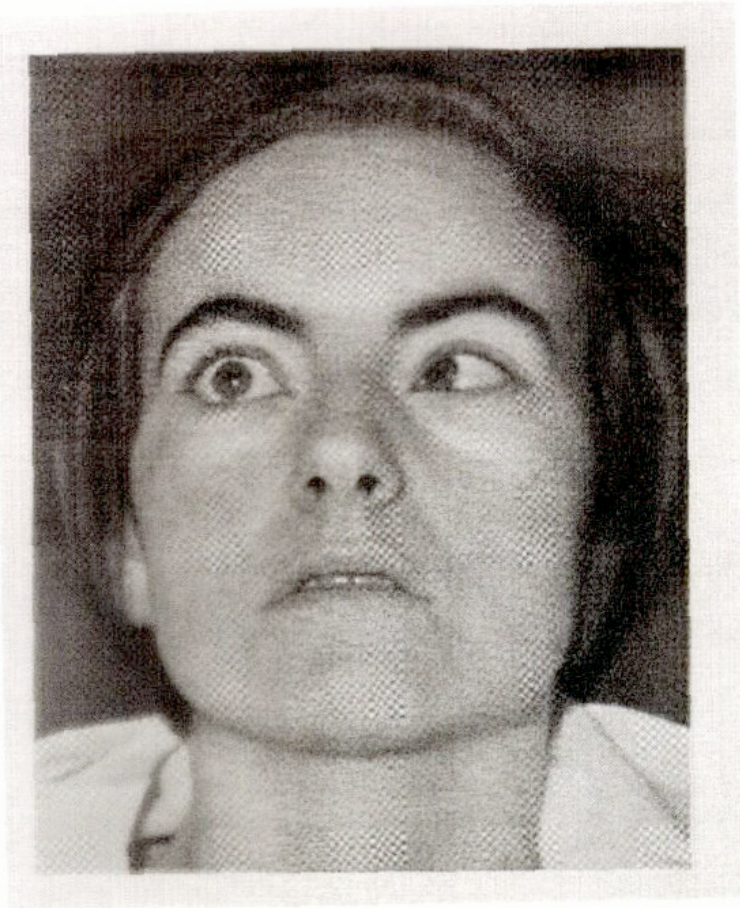
B. Nerves passing to back of eye (in addition to Optic Nerve)

1. Short Ciliary nerves - parasympathetics from III to Ciliary muscles and constrictor pupillae

2. Long ciliary nerves - sensory branches of Ophthalmic division (V1) of Trigeminal nerve which innervate cornea.

**Clinical: 'Blown' Pupil = Pupil Dilated (Mydriasis) - pupil unable to constrict in response to light; indicates catastrophe (stroke, herniation, etc.); Anisocoria – pupils of unequal size (can be normal or abnormal)**

# ORBIT



## OUTLINE

I. BONES OF ORBIT

II. EYELIDS

III. LACRIMAL APPARATUS

IV. FASCIAL SHEATH  
OF EYEBALL

V. STRUCTURE OF EYE

VI. EXTRAOCULAR MUSCLES/  
EYE MOVEMENTS

VII. CILIARY GANGLION

VIII. NERVE DAMAGE

- **VISION REQUIRES COORDINATED MOVEMENTS OF TWO EYES**

- **EYES/EYE MOVEMENTS USED DIAGNOSTICALLY**

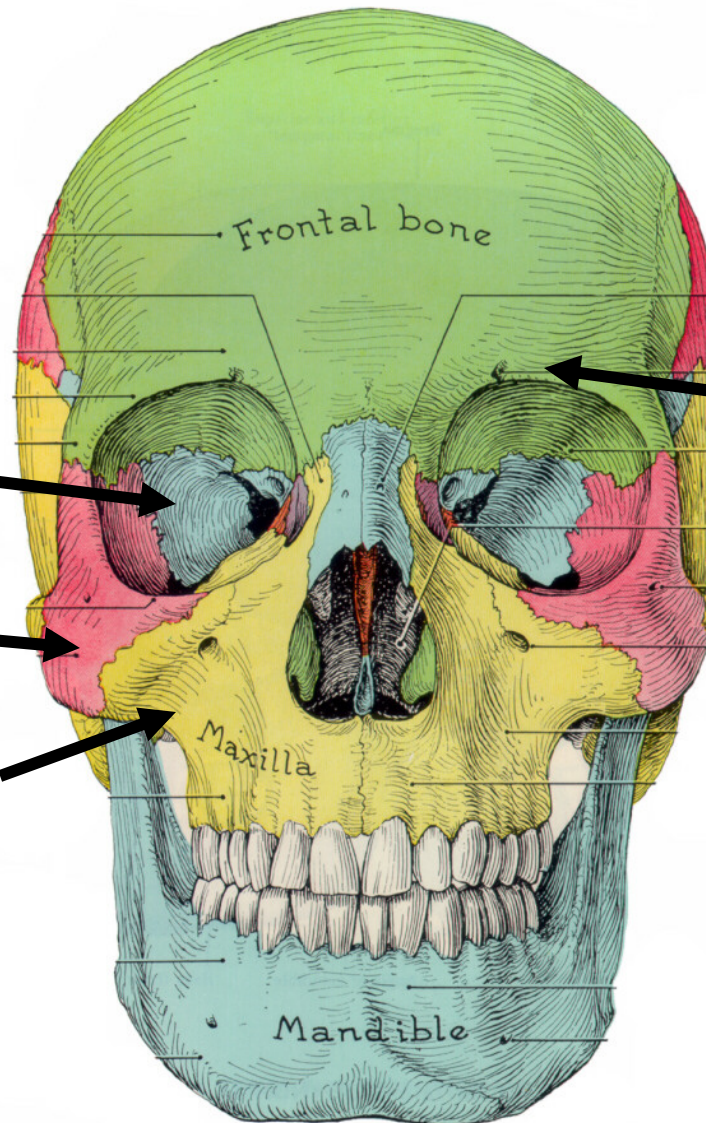
# I. BONES OF ORBIT

RIGIDLY LINKED  
FOR EYE  
MOVEMENTS

SPHENOID

ZYGOMATIC

MAXILLARY



## A. BOUNDARIES

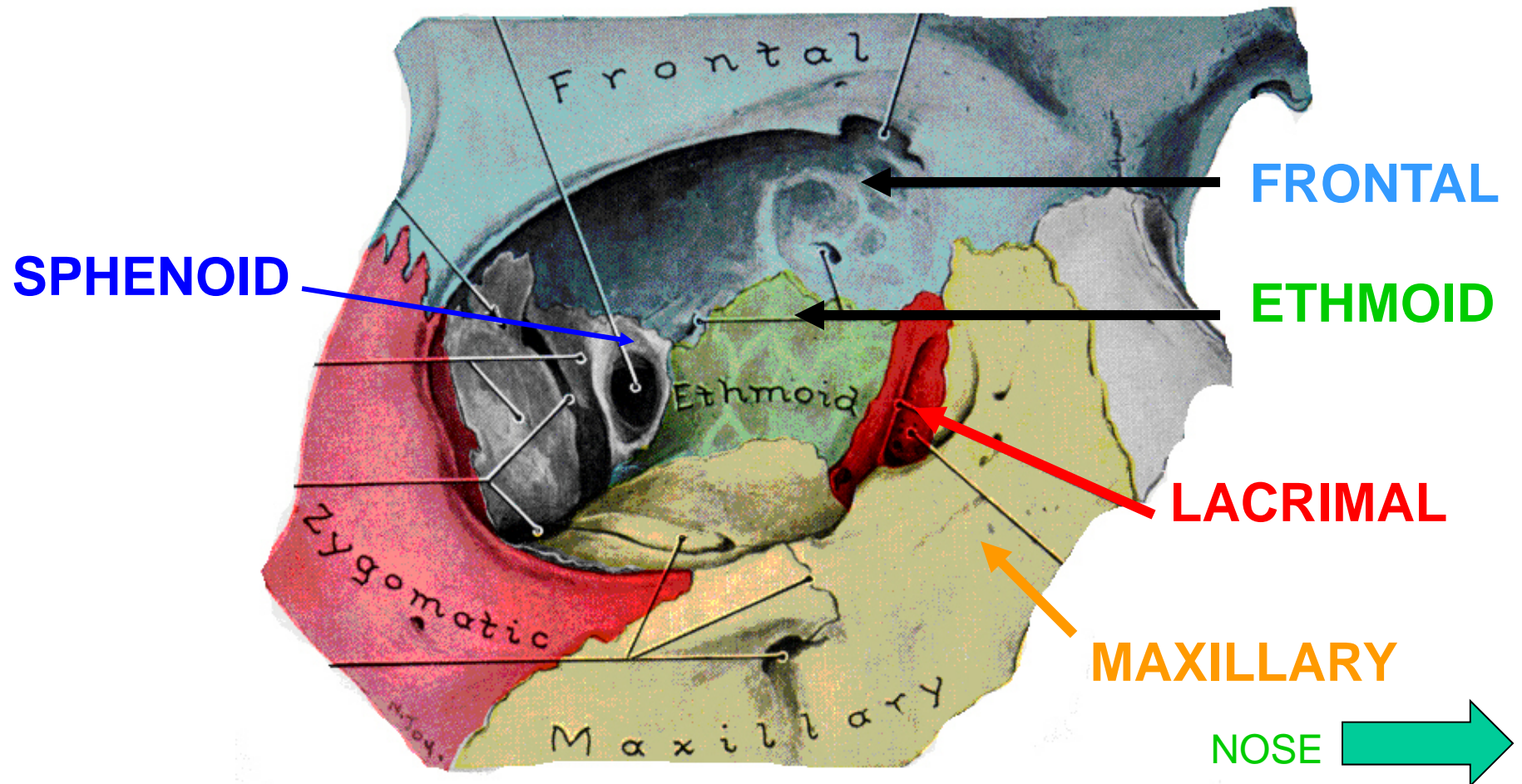
1. ROOF  
FRONTAL

4. LATERAL  
WALL  
ZYGOMATIC  
SPHENOID

2. FLOOR  
MAXILLARY

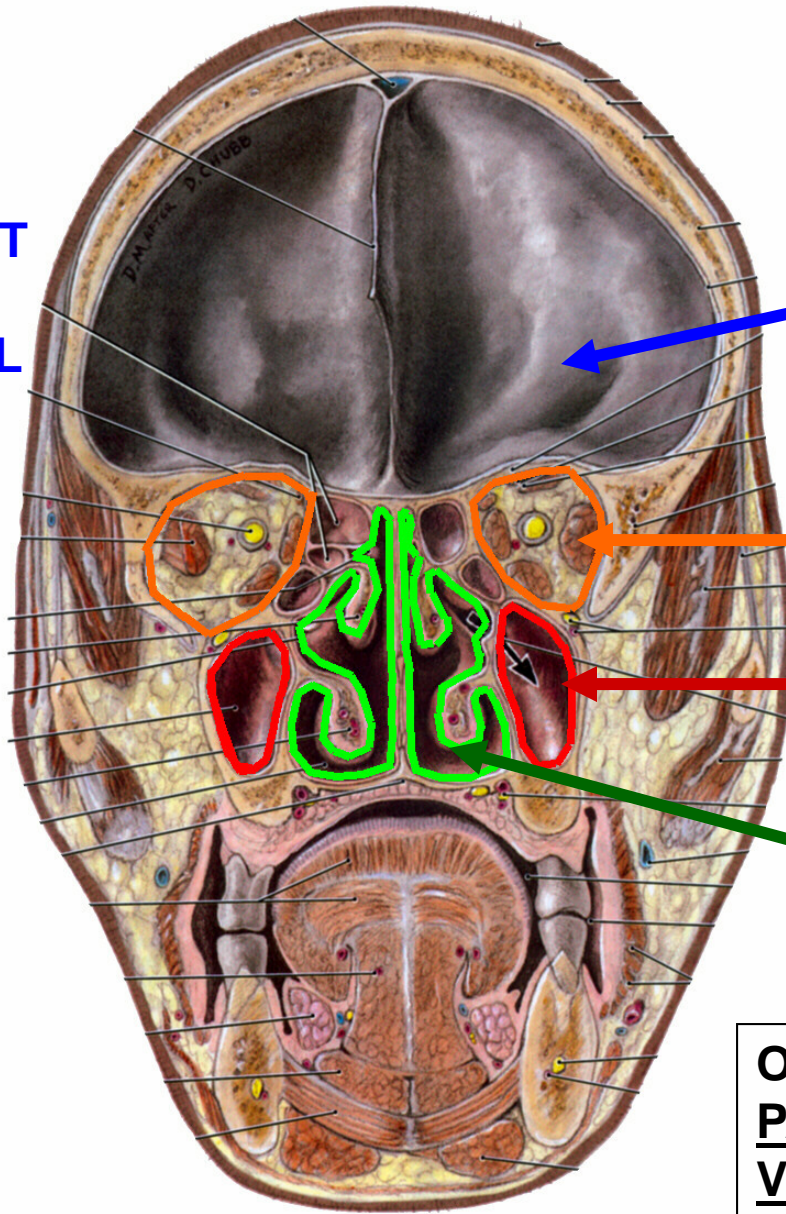
# BONES OF ORBIT

3. MEDIAL WALL - INCLUDES MAXILLARY, LACRIMAL, ETHMOID, FRONTAL AND SPHENOID BONES (NASAL CAVITY IS MEDIAL TO MEDIAL WALL OF ORBIT)



# BONES OF ORBIT

HEAD CUT  
IN  
CORONAL  
PLANE



## RELATIONS OF ORBIT

1) ANTERIOR CRANIAL FOSSA - SUPERIOR TO ROOF

ORBIT

2) MAXILLARY SINUS - INFERIOR TO FLOOR

3) NASAL CAVITY - MEDIAL TO MEDIAL WALL OF ORBIT

ORBIT - SERVES AS A PASSAGEWAY FOR NERVES, VESSELS TO FACE, SCALP AND NASAL CAVITY

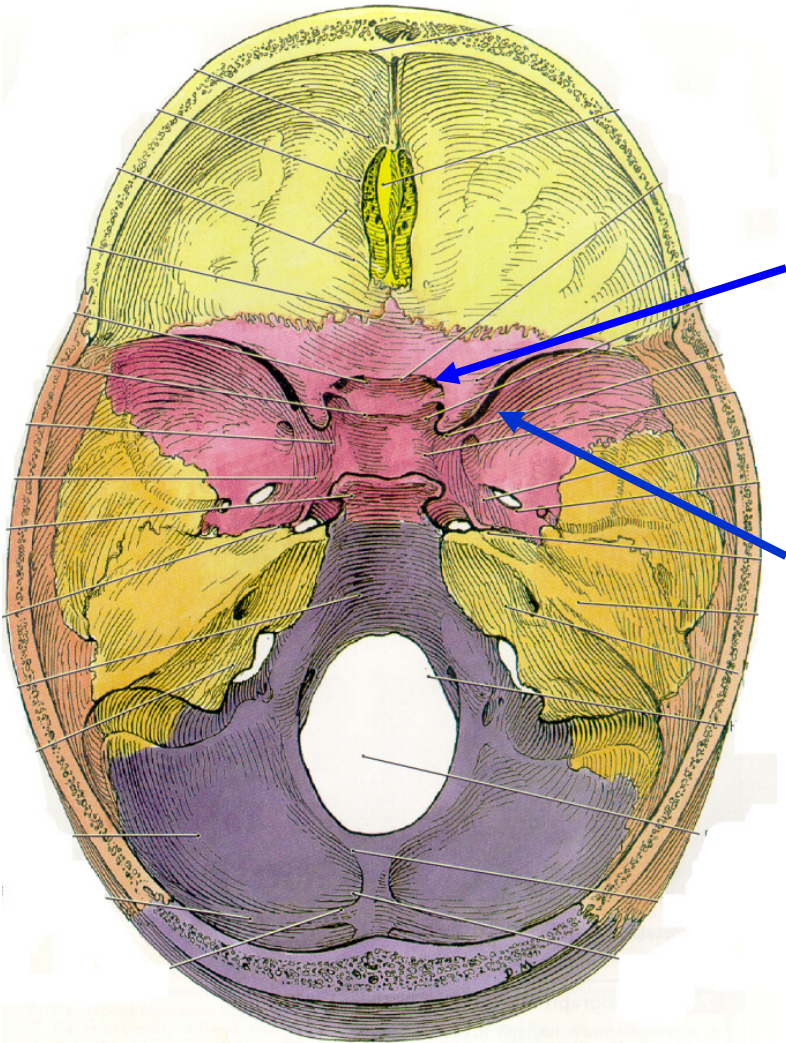


## B. FORAMINA OF ORBIT – structures entering orbit

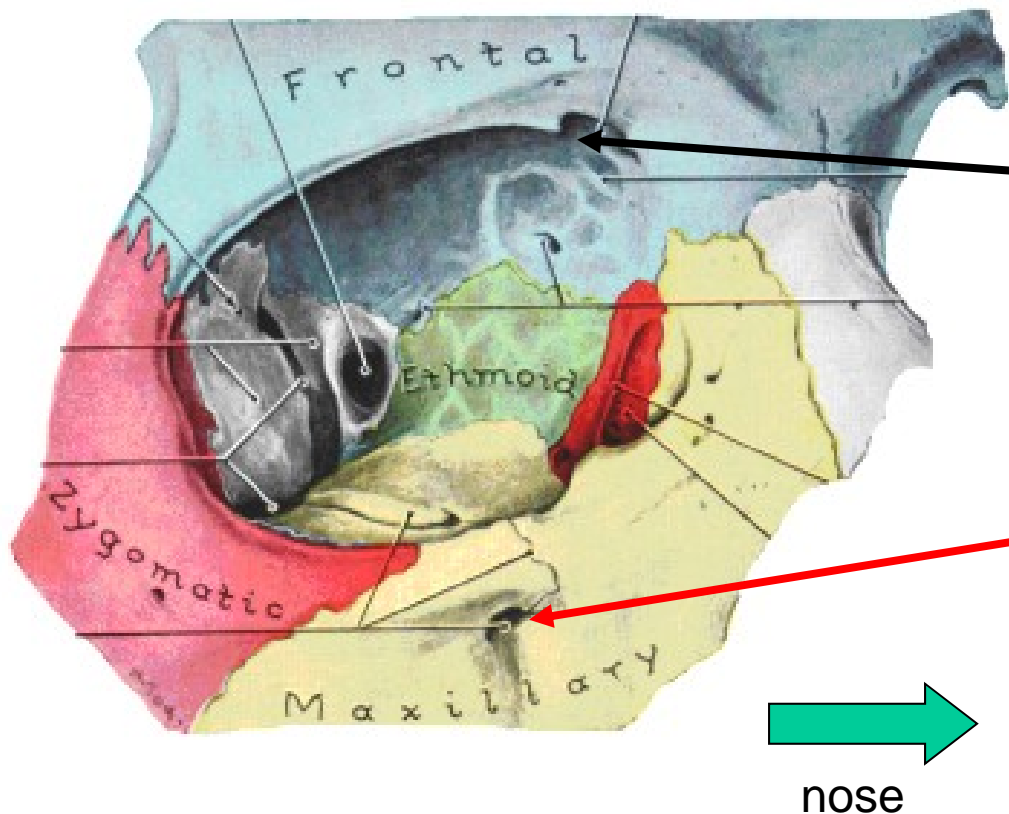
FORAMINA- MOST STRUCTURES ENTER ORBIT FROM MIDDLE CRANIAL FOSSA

1) OPTIC CANAL- IN BASE OF LESSER WING OF SPHENOID BONE, CONTAINS OPTIC NERVE (II) and OPTHALMIC ARTERY

2) SUPERIOR ORBITAL FISSURE - BETWEEN GREATER AND LESSER WINGS OF SPHENOID, CONTAINS III, IV, V1, VI, OPTHALMIC VEINS



## B. FORAMINA OF ORBIT – pathways leaving orbit

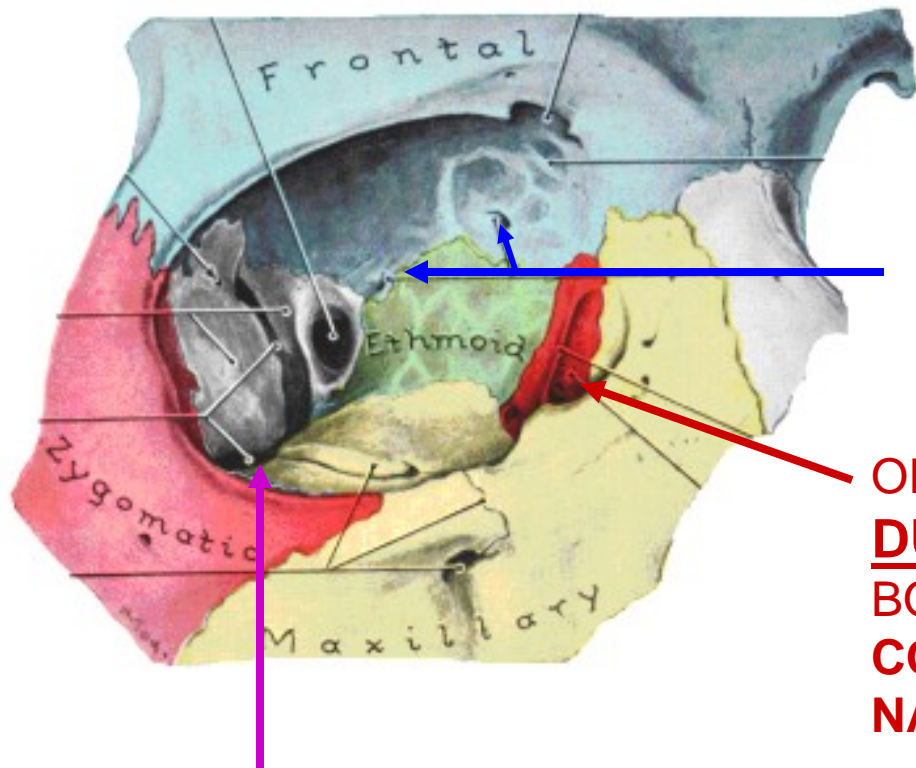


TO FACE, SCALP:

1) **SUPRAORBITAL NOTCH OR FORAMEN** - IN FRONTAL BONE CONTAINS SUPRAORBITAL N., A. and V. FROM V1, OPHTHALMIC artery and vein.

2) **INFRAORBITAL FORAMEN** - IN MAXILLARY BONE CONTAINS INFRAORBITAL N., A. and V. FROM V2 AND MAXILLARY artery.

## C. FORAMINA OF ORBIT - pathways to Nasal Cavity



**2) ANT. AND POST. ETHMOIDAL FORAMINA**- BETWEEN ETHMOID AND FRONTAL BONES; CONNECT ORBIT AND NASAL CAVITIES  
**CONTAINS: ANT. AND POST. ETHMOIDAL N., A. and V. (br. Of V1 and OPHTHALMIC artery, vein)**

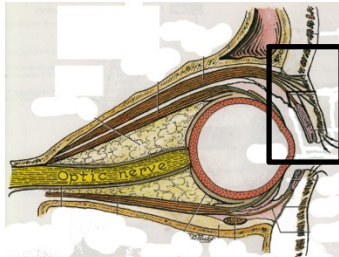
OPENING OF **3) NASOLACRIMAL DUCT**- IN MAXILLARY, LACRIMAL BONES AND INF. NASAL CONCHA;  
**CONTAINS: MEMBRANEOUS NASOLACRIMAL DUCT AND TEARS**

**NOTE: INFERIOR ORBITAL FISSURE** - KNOW FOR NEXT BLOCK IN JANUARY

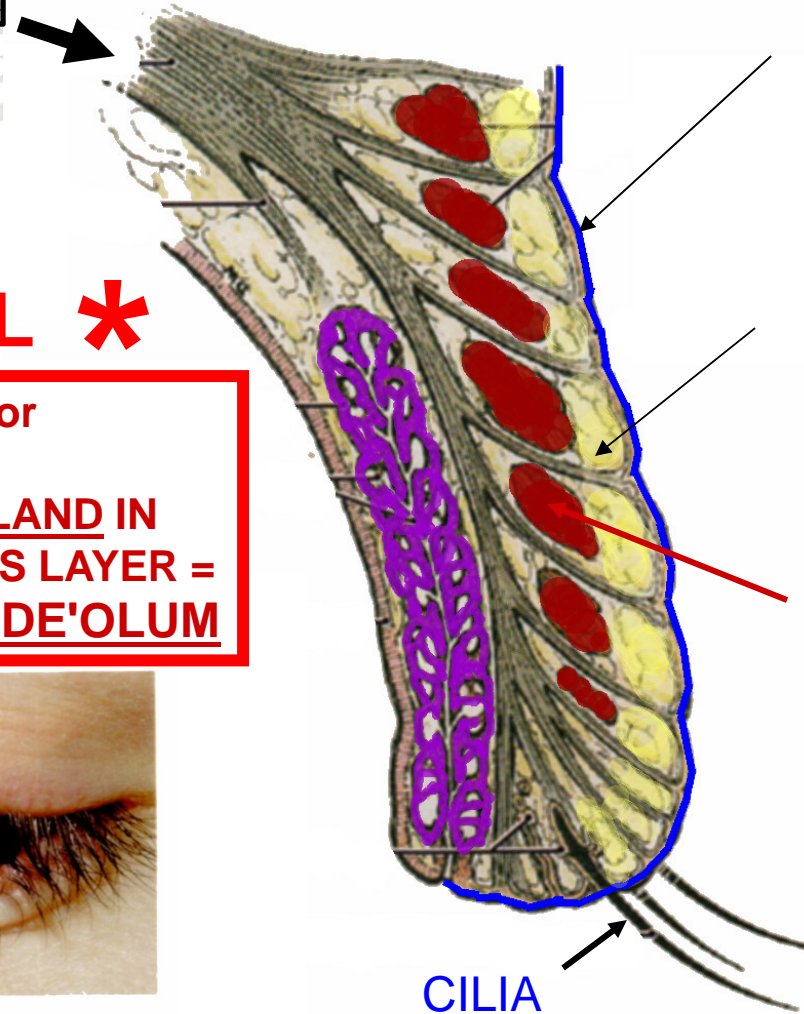


## II. EYELIDS = PALPEBRAE - LAYERED

EYELIDS PROTECT EYE, MOVEABLE, KEEP CORNEA MOIST



ORIENT - EYELID  
PARASAGITTAL  
SECTION



1. SKIN - CONTAINS EYELASHES (CILIA) AND OPENINGS OF SEBACEOUS, SWEAT GLANDS;

2. SUBCUTANEOUS LAYER - CONNECTIVE TISSUE CONTAINS SEBACEOUS GLANDS; OBSTRUCTION = STYE OR HORDE'OLUM

3. ORBICULARIS OCULI (PALPEBRAL PART) - SKELETAL MUSCLE CLOSES EYE, INNERVATED BY VII - PARALYZE ORBICULARIS OCULI - CAN DAMAGE CORNEA

### CLINICAL \*

OBSTRUCTION or INFECTION OF SEBACEOUS GLAND IN SUBCUTANEOUS LAYER = STYE OR HORDE'OLUM



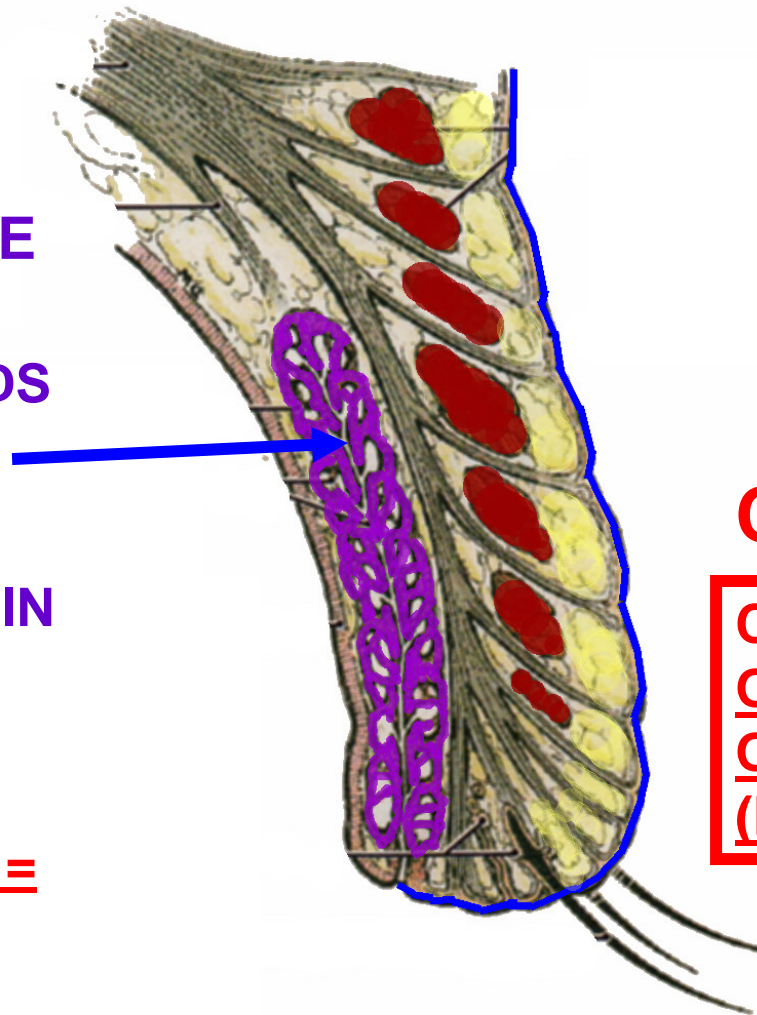
FIGURE 10-10  
Acute hordeolum of upper eyelid.  
From Palay, Krachmer, 1997.

# EYELIDS - LAYERS

4B. TARSAL PLATE - FIBROUS CT 'SKELETON' OF EYELID, DEEP TO ORBITAL SEPTUM

**TARSAL PLATE**  
- CONTAINS  
**TARSAL GLANDS**  
(Meibomian glands)

- KEEP TEARS IN EYE, PREVENT EVAPORATION OF TEARS -  
**OBSTRUCTION = CHALAZION**



**CHALAZION**

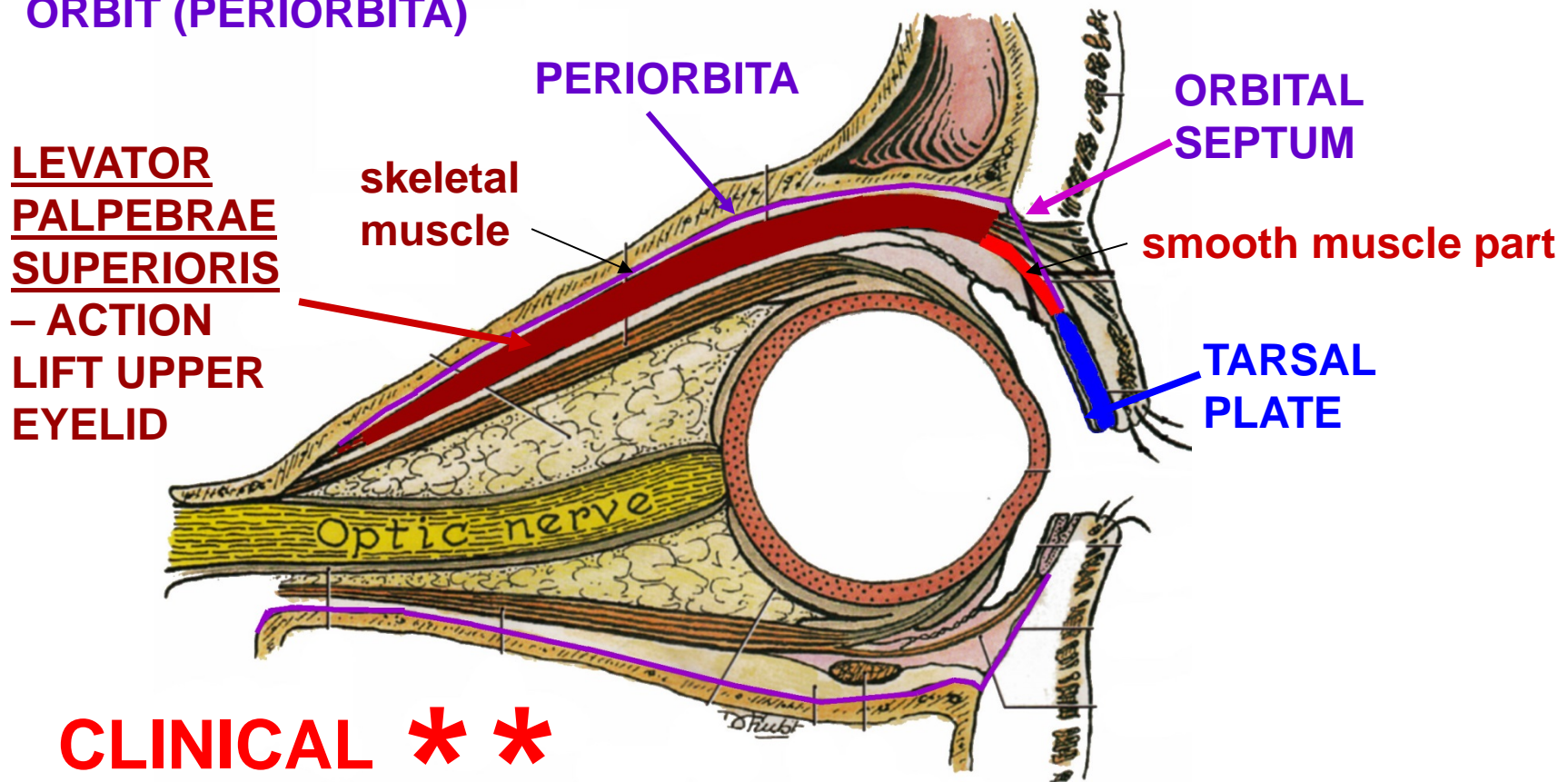


**CLINICAL \***

**CHALAZION:**  
**OBSTRUCTION**  
**OF TARSAL**  
**(MEIBOMIAN) GLAND**

# EYELIDS - LAYERS

4A. ORBITAL SEPTUM - CT LAYER CONTINUOUS WITH PERIOSTEUM OF ORBIT (PERIORBITA)

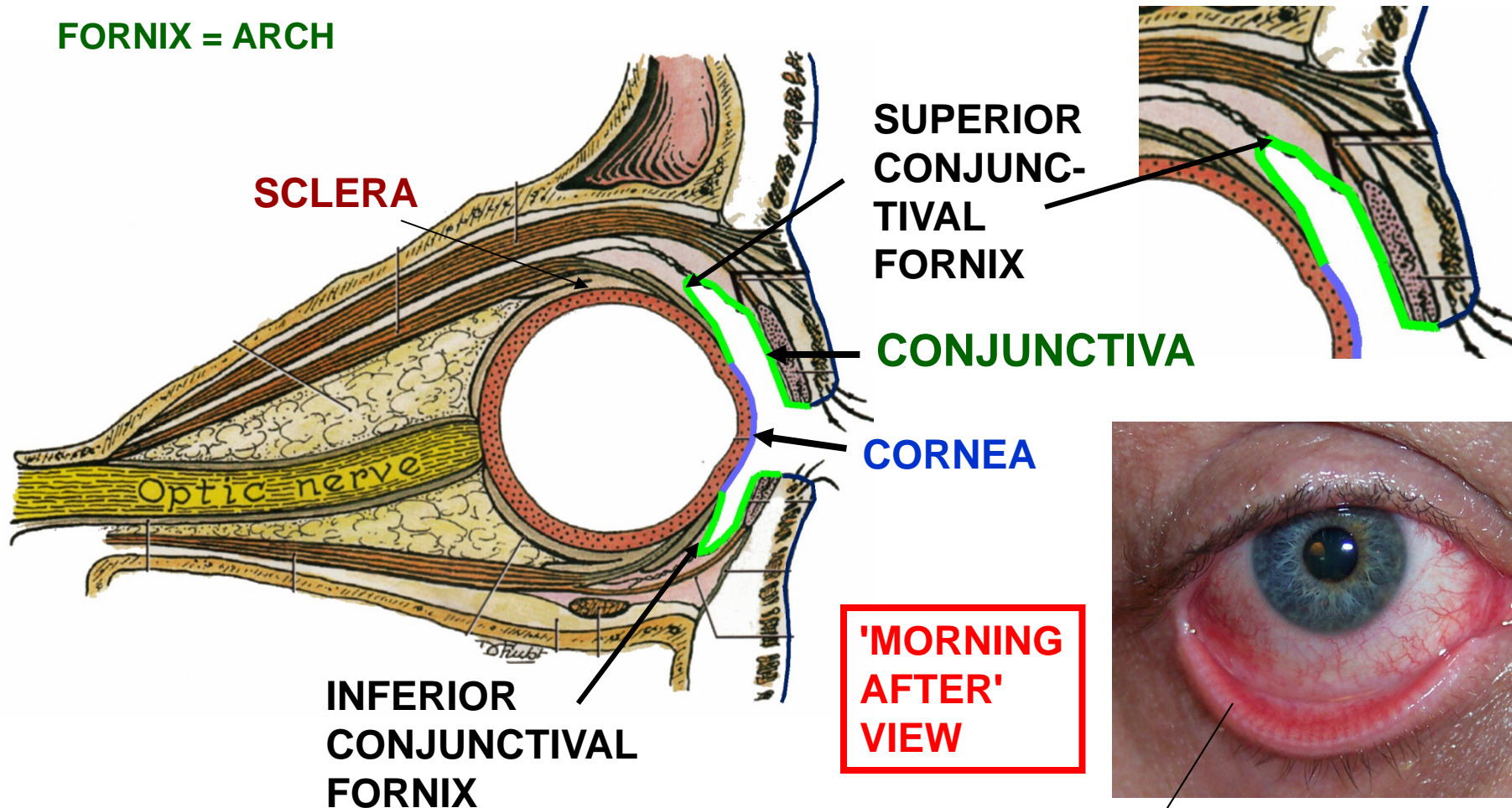


**CLINICAL \* \***

4C. LEVATOR PALPEBRAE SUPERIORIS MUSCLE - ORIGIN FROM TENDINOUS RING - COMPOSED OF SKELETAL (CN III) AND **SMOOTH (SYMPATHETICS)** MUSCLE PARTS - damage either part:  
**EYELID DROOP = PTOSIS- DAMAGE III OR SYMPATHETICS**

**5) CONJUNCTIVA - CLEAR MEMBRANE COVERING INSIDE OF LID - FUSES TO SCLERA - REFLECTED TO CORNEA OF EYE AT FORNICES**

**FORNIX = ARCH**



**'MORNING AFTER' VIEW**

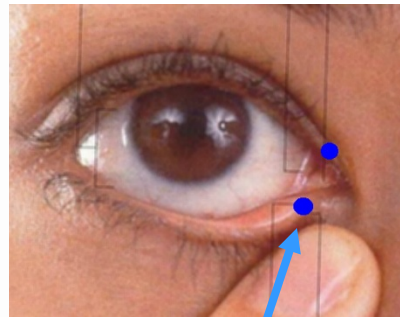
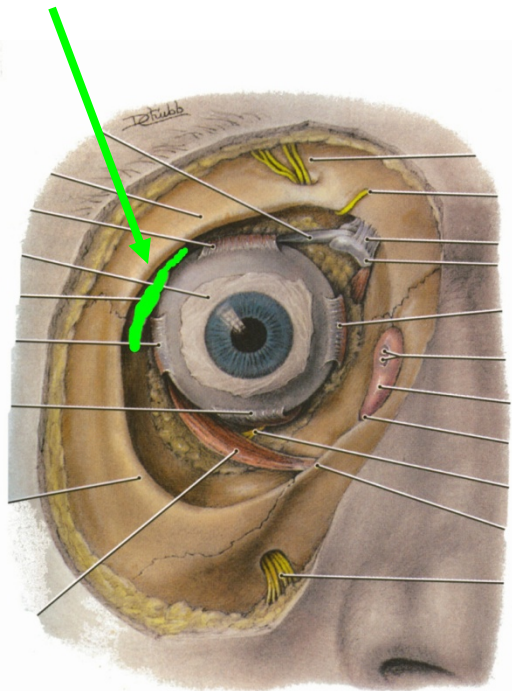


**FORNIX = LATIN FOR ARCH, VAULT**

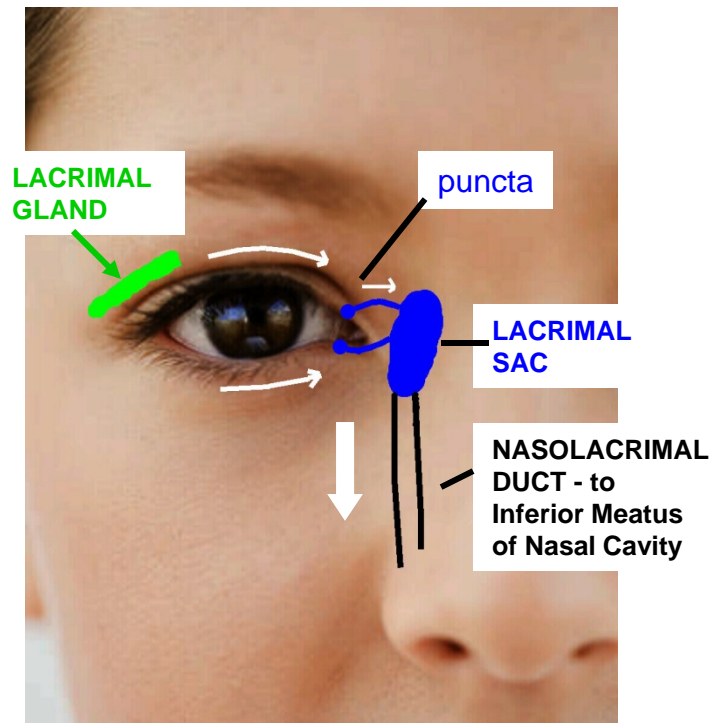
**Conjunctivitis (Pinkeye) - inflammation of conjunctiva**

### III. LACRIMAL APPARATUS

A. **LACRIMAL GLAND** - LOCATED IN SUPEROLATERAL ORBIT - OPENS BY DUCTS (~12) THROUGH CONJUNCTIVA TO SUPERIOR FORNIX - TEARS CONSTANTLY PRODUCED



LACRIMAL PUNCTA

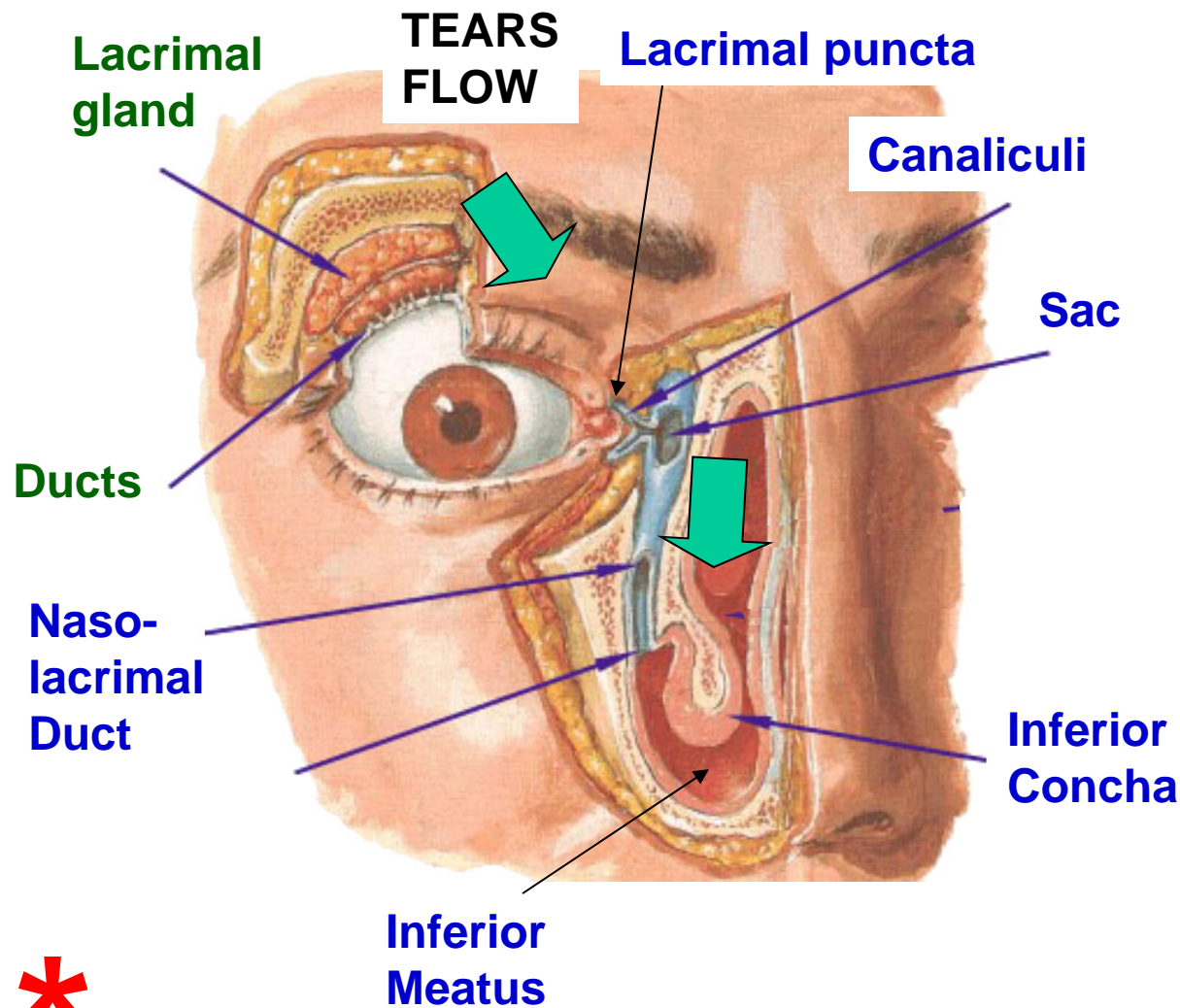


- TEARS DRAIN THROUGH LACRIMAL PUNCTA TO LACRIMAL SAC TO NASOLACRIMAL DUCT TO INFERIOR MEATUS OF NASAL CAVITY

B. LAC. GLAND INNERVATED BY VII - COMPLEX PATHWAY



# DRAINAGE OF TEARS

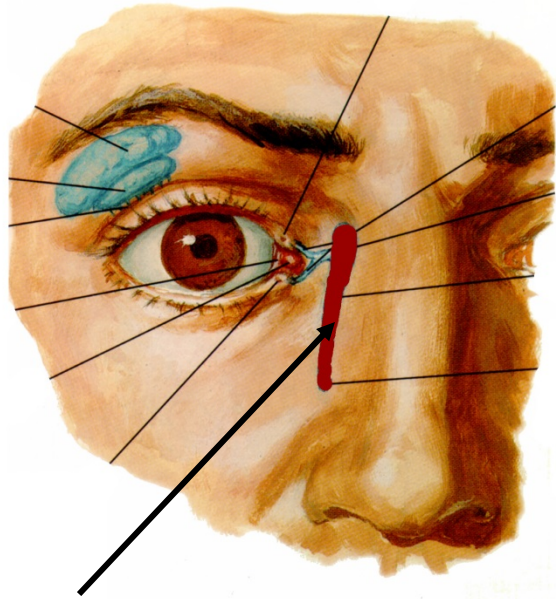


- TEARS FLOW ACROSS EYE TO LACRIMAL PUNCTA ON MEDIAL END OF EYELIDS (eyelids meet at MEDIAL CANTHUS);
- TEARS THEN PASS THROUGH LACRIMAL CANALICULI TO LACRIMAL SAC;
- SAC CONNECTS TO NASOLACRIMAL DUCT WHICH DRAINS TO INFERIOR MEATUS OF NASAL CAVITY



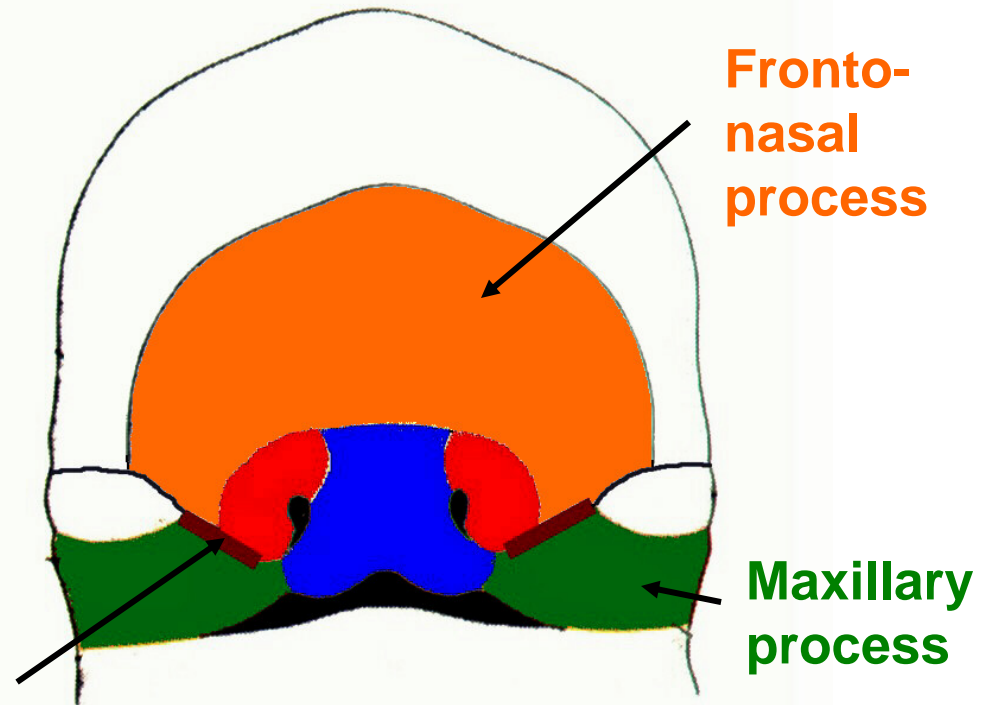
**LACRIMAL GLAND IS INNERVATED BY VII - FACIAL NERVE;**  
**BLOCK VII - DECREASE TEARS; PRESSURE/IRRITATION VII - EXCESSIVE TEARS**

## DEVELOPMENT: OBSTRUCTED NASOLACRIMAL DUCT



### NASOLACRIMAL DUCT

- extends from Medial Canthus of eye to Inferior Meatus of nasal cavity

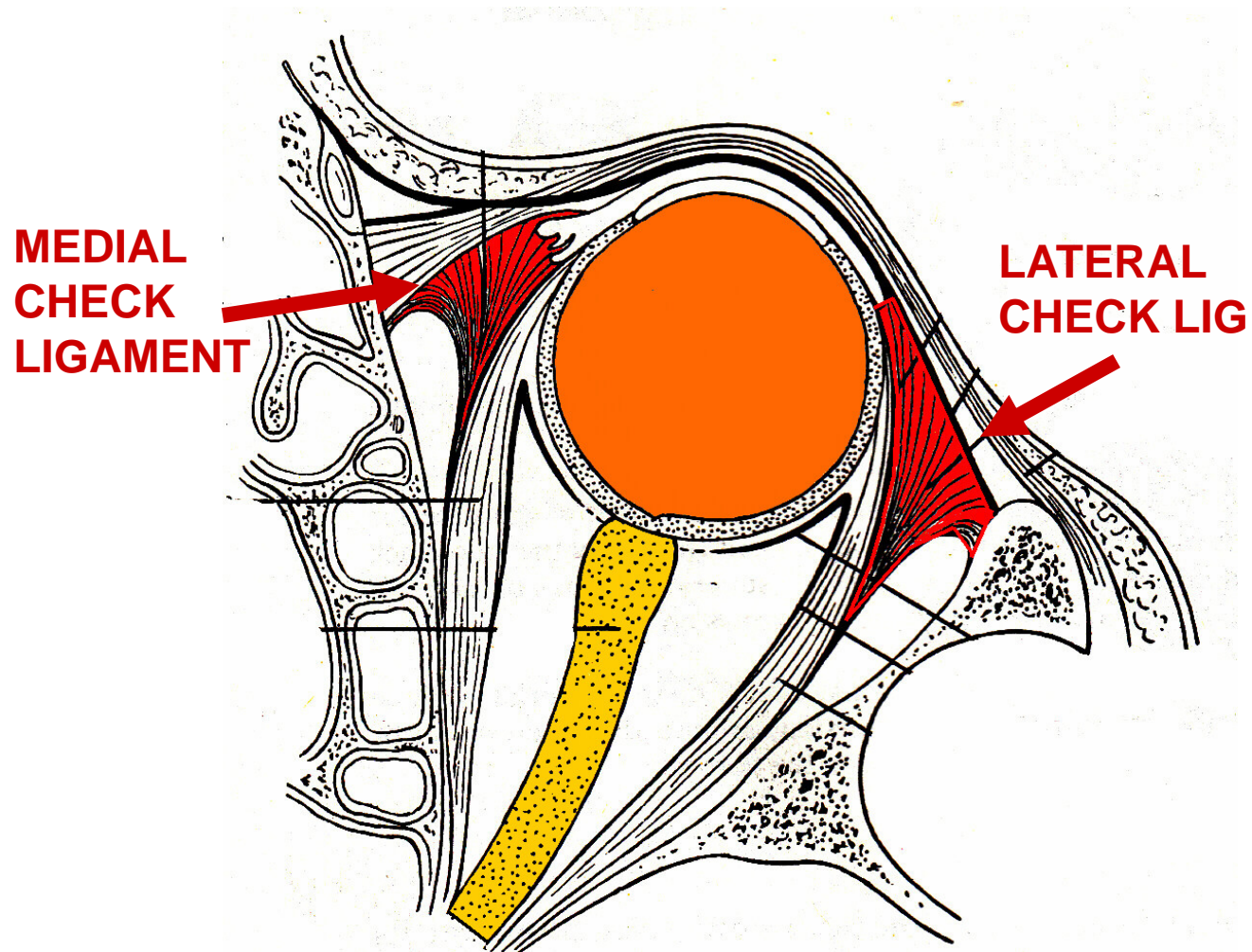


- Develops as a fold between maxillary process and frontonasal process  
- then forms a solid cord that becomes canalized.

**Obstructed Duct - failure of duct to canalize; tears drain over lower eyelid to face; opened surgically for tears to drain to nasal cavity**

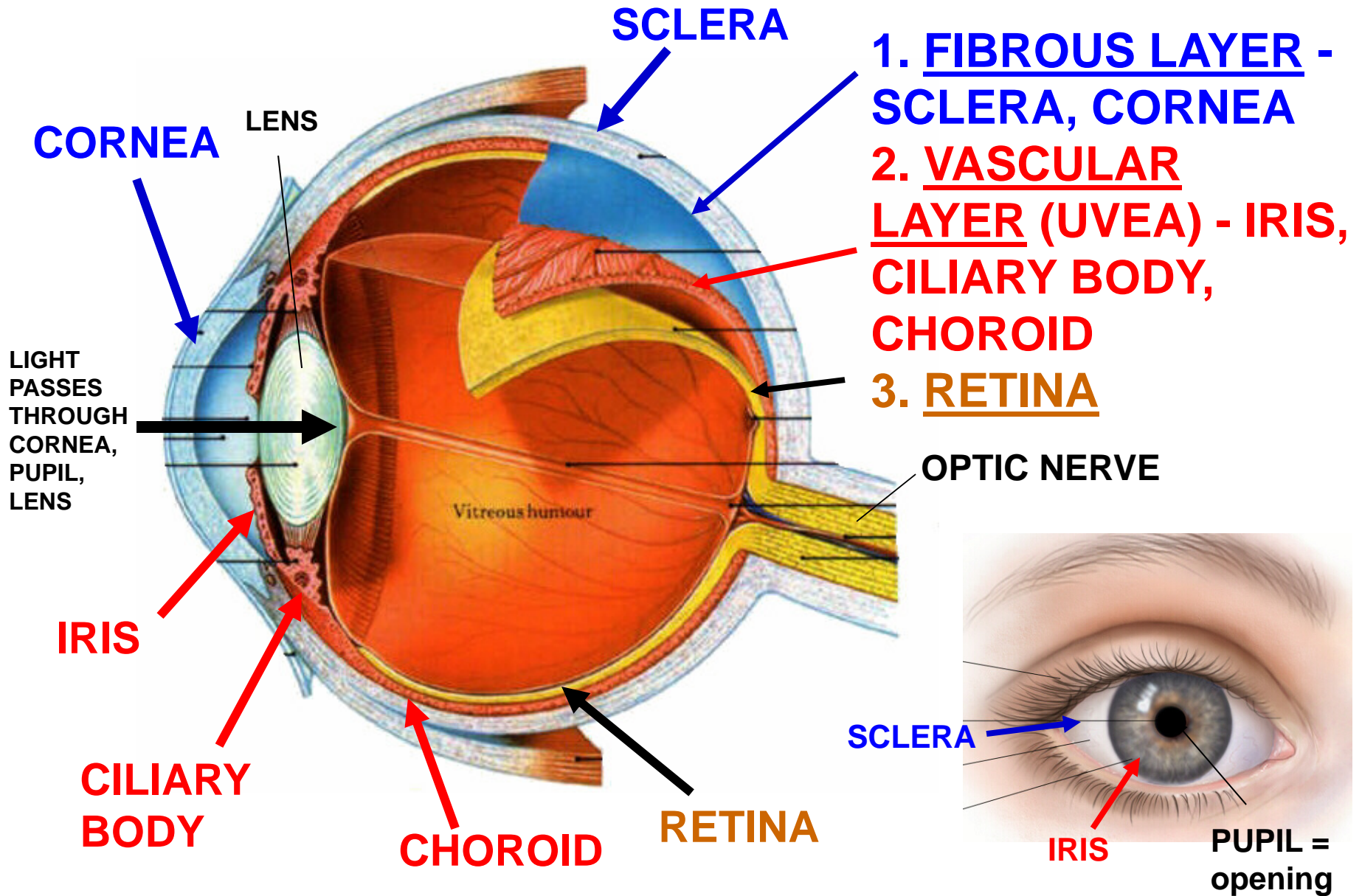
## IV. FASCIAL SHEATH OF EYE

NOSE



= TENON'S  
CAPSULE - THIN  
MEMBRANE  
SURROUNDS  
BACK OF EYE -  
THICKENINGS -  
MEDIAL AND  
LATERAL  
CHECK  
LIGAMENTS -  
PREVENT  
EXCESSIVE  
ROTATION

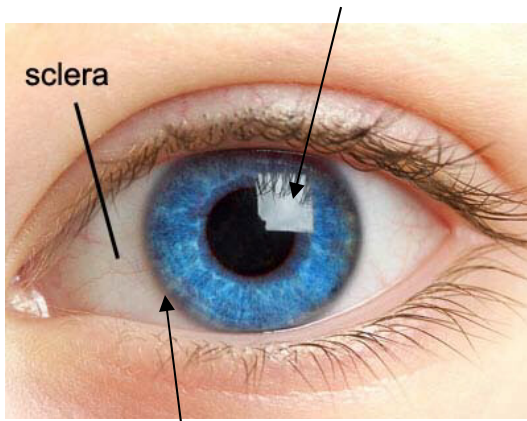
## V. STRUCTURE OF EYE - 3 LAYERS



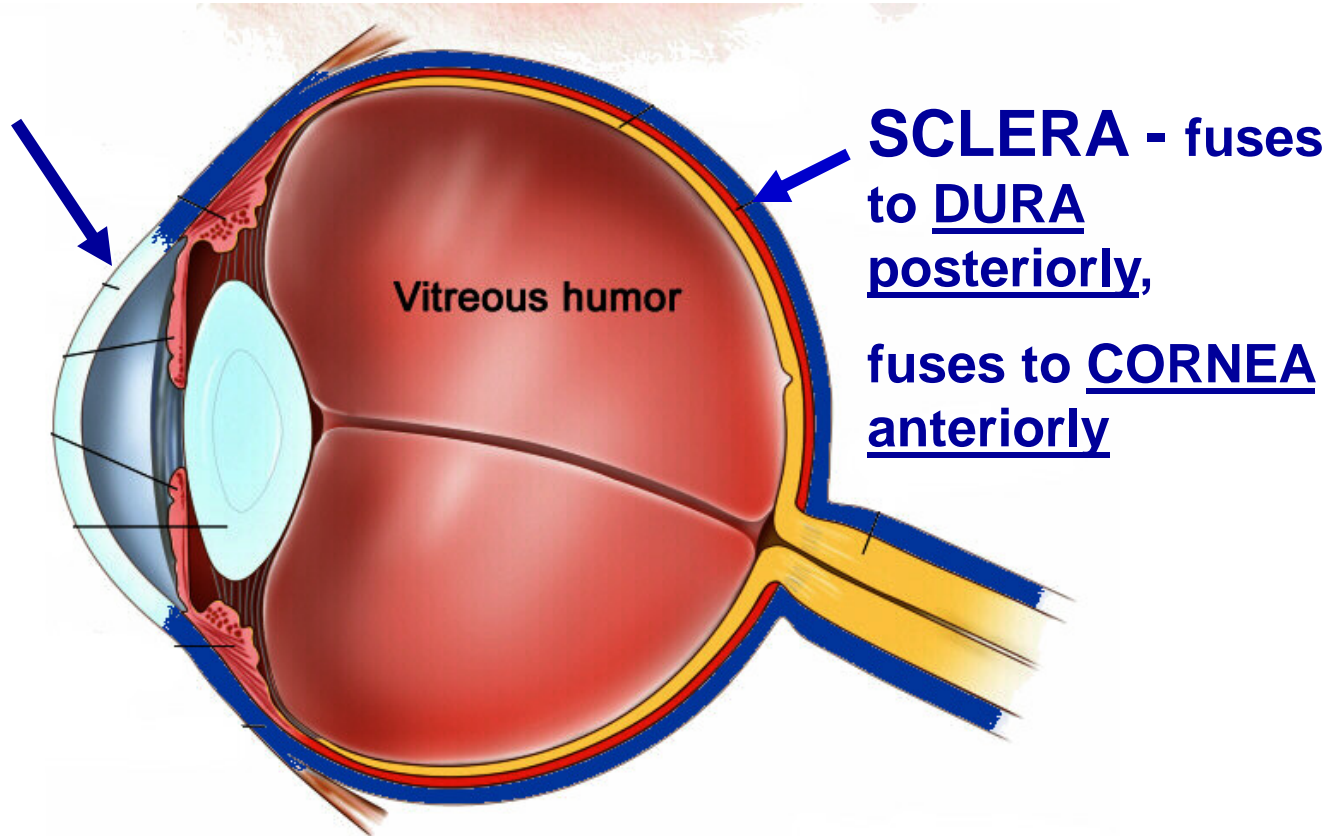
# EYE- STRUCTURE OF EYEBALL- FIBROUS LAYER

A) SCLERA - TOUGH, SMOOTH WHITE FIBROELASTIC CT LAYER;  
SURROUNDS EYE; PIERCED BY VESSELS AND NERVES;  
FUNCTIONS- MAINTAIN EYE SHAPE, ATTACHMENT OF MUSCLES

**CORNEA -  
clear layer**

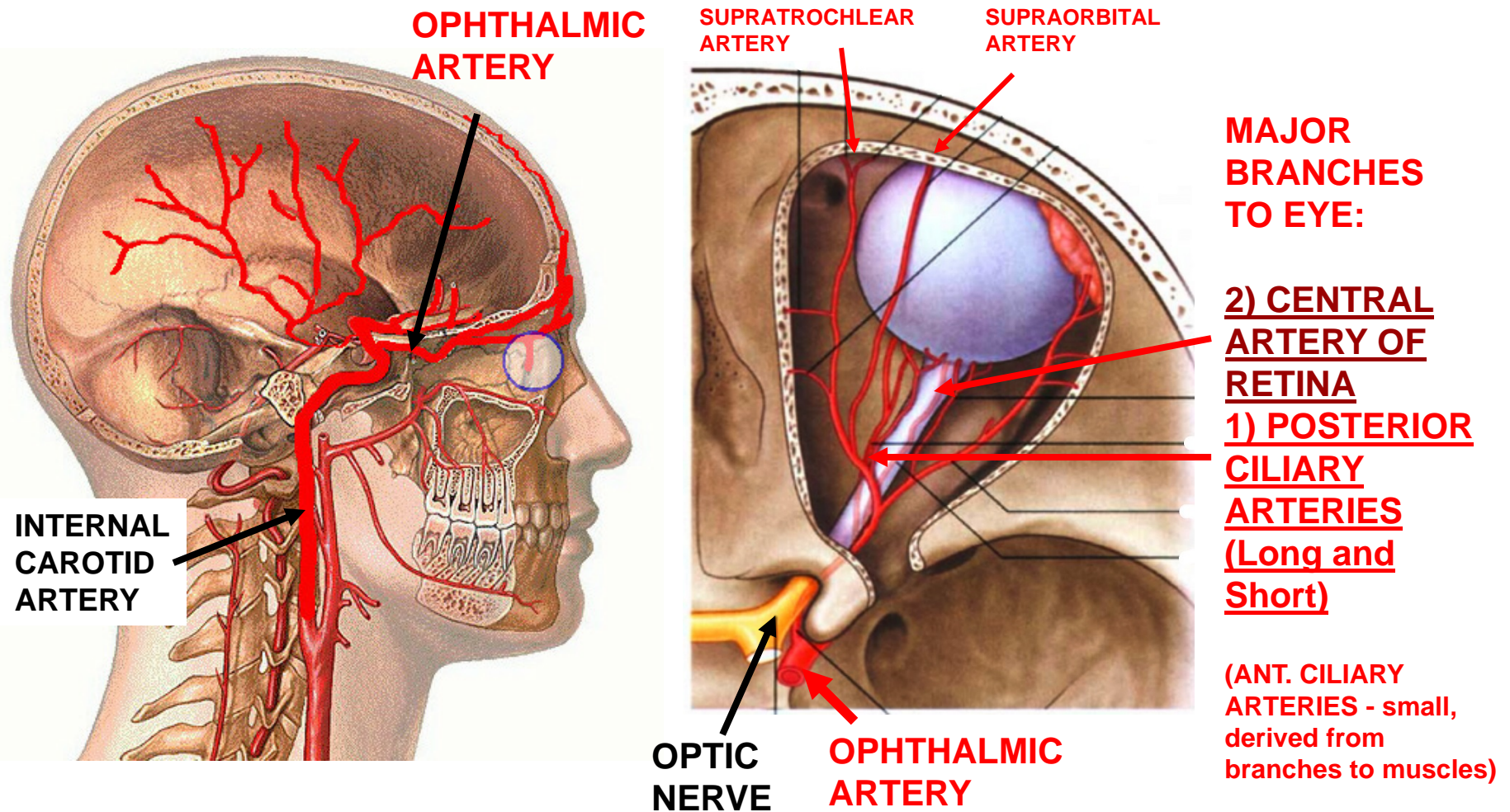


**LIMBUS - junction of  
sclera and cornea**



B) CORNEA - AVASCULAR, TRANSPARENT LAYER OVER ANTERIOR  
EYE - AIDS IN FOCUSSING LIGHT; **IRREGULARITIES - ASTIGMATISM**

# BLOOD SUPPLY TO ORBIT: OPHTHALMIC ARTERY



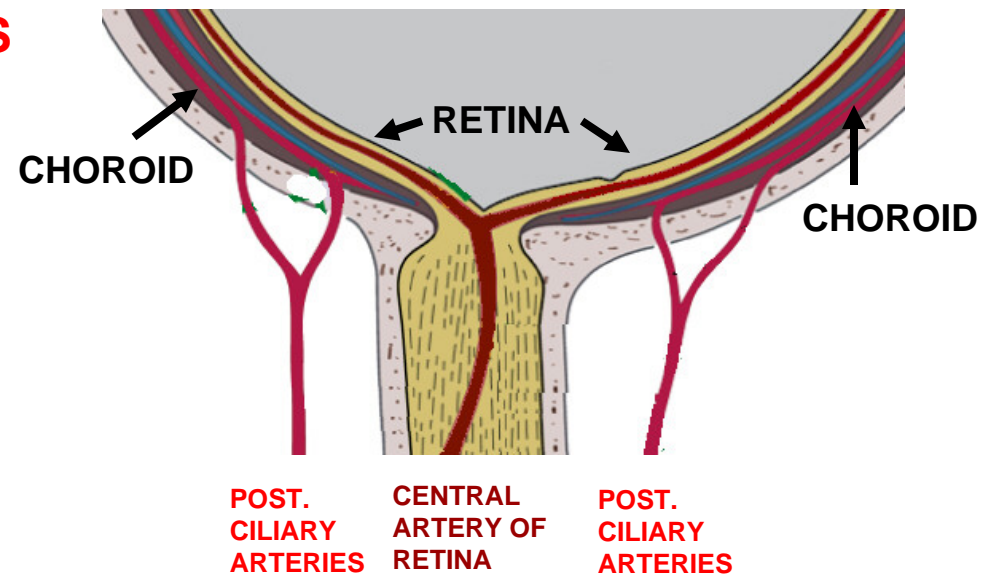
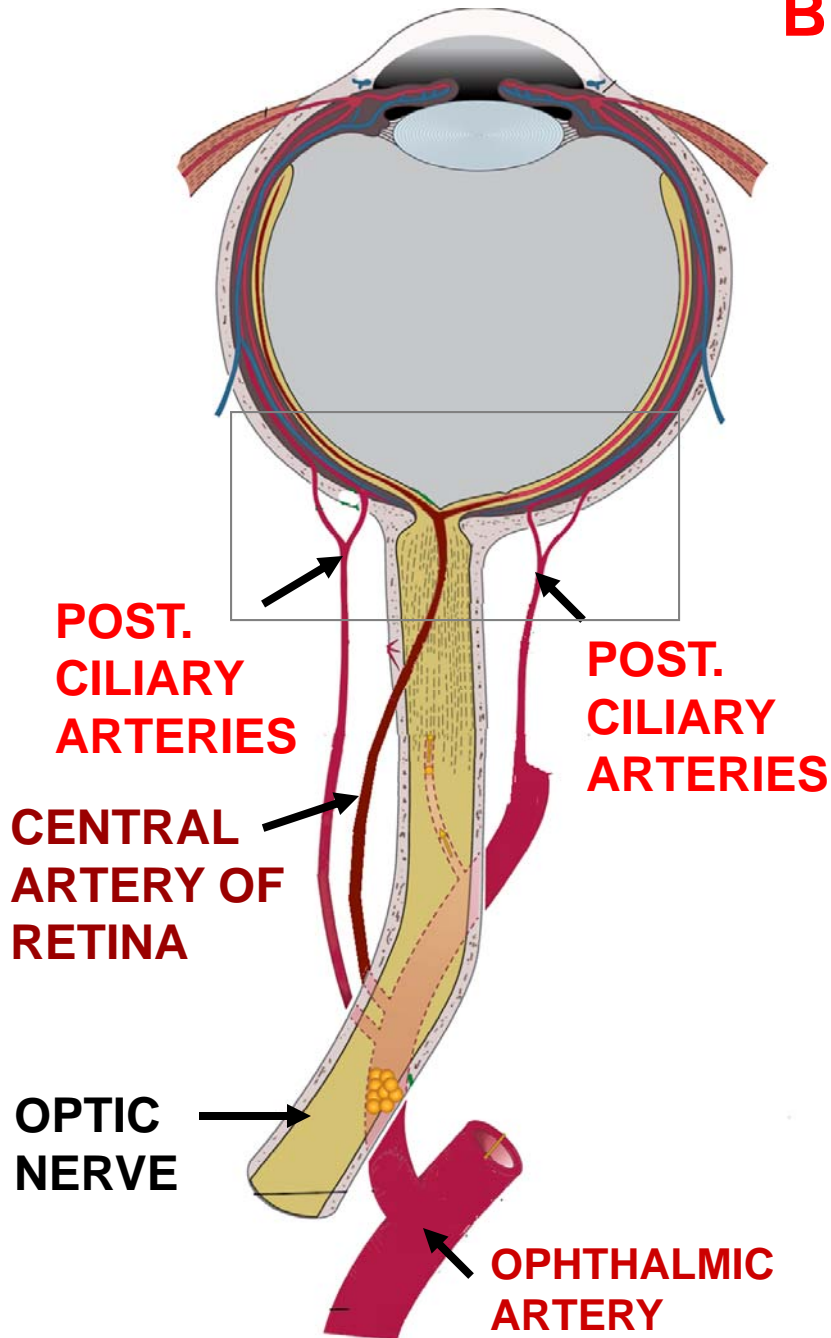
**Note: Branches of Ophthalmic Artery supply eye: Posterior Ciliary Arteries and Central Artery of Retina enter posterior side of Eyeball**

# BLOOD SUPPLY TO EYE

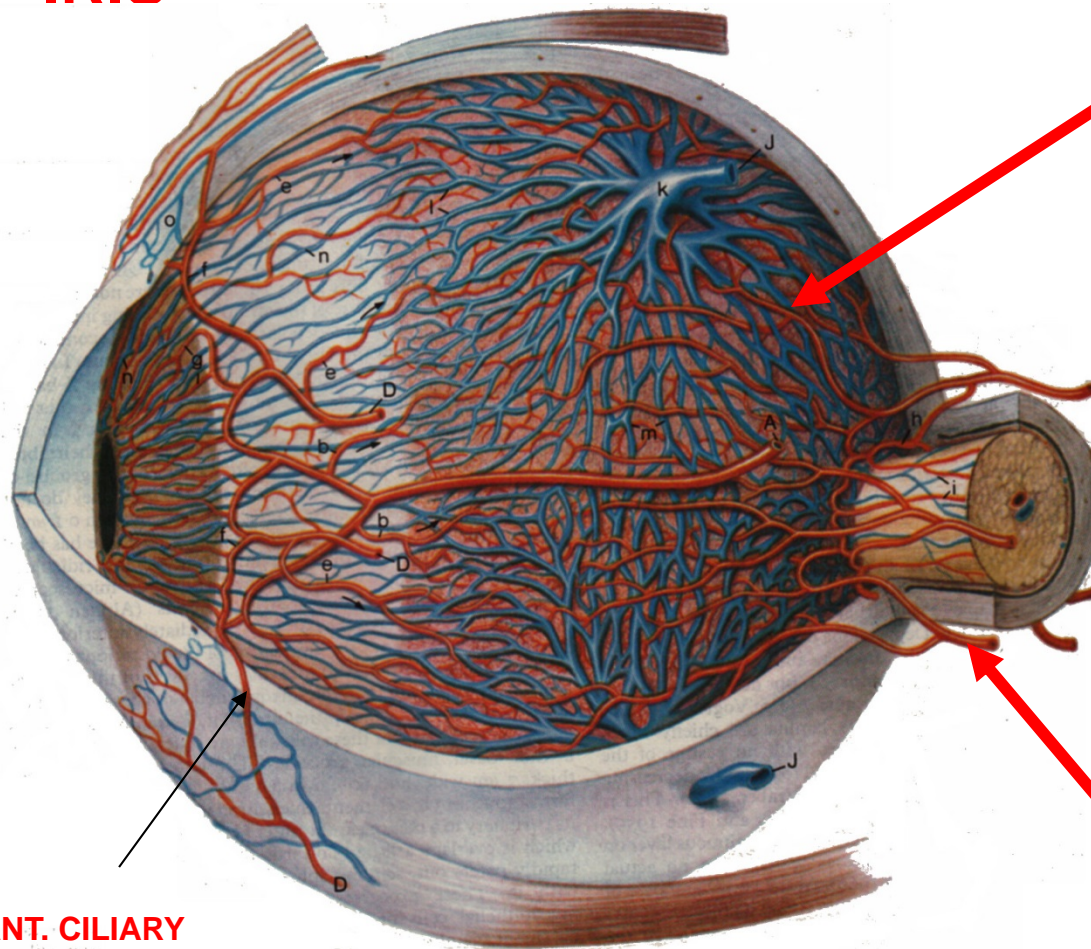
## BRANCHES TO EYE:

- 1) POSTERIOR CILIARY ARTERIES - pierce sclera; blood to choroid, photoreceptors
- 2) CENTRAL ARTERY OF RETINA - pierces Optic nerve; blood to neural retina

**CENTRAL ARTERY OF RETINA - end artery (no anastomosis)**



# EYE - STRUCTURE OF EYEBALL - VASCULAR LAYER = UVEAL TRACT (UVEA) = CHOROID, CILIARY BODY, IRIS



ANT. CILIARY ARTERIES - small

uva = L. grape

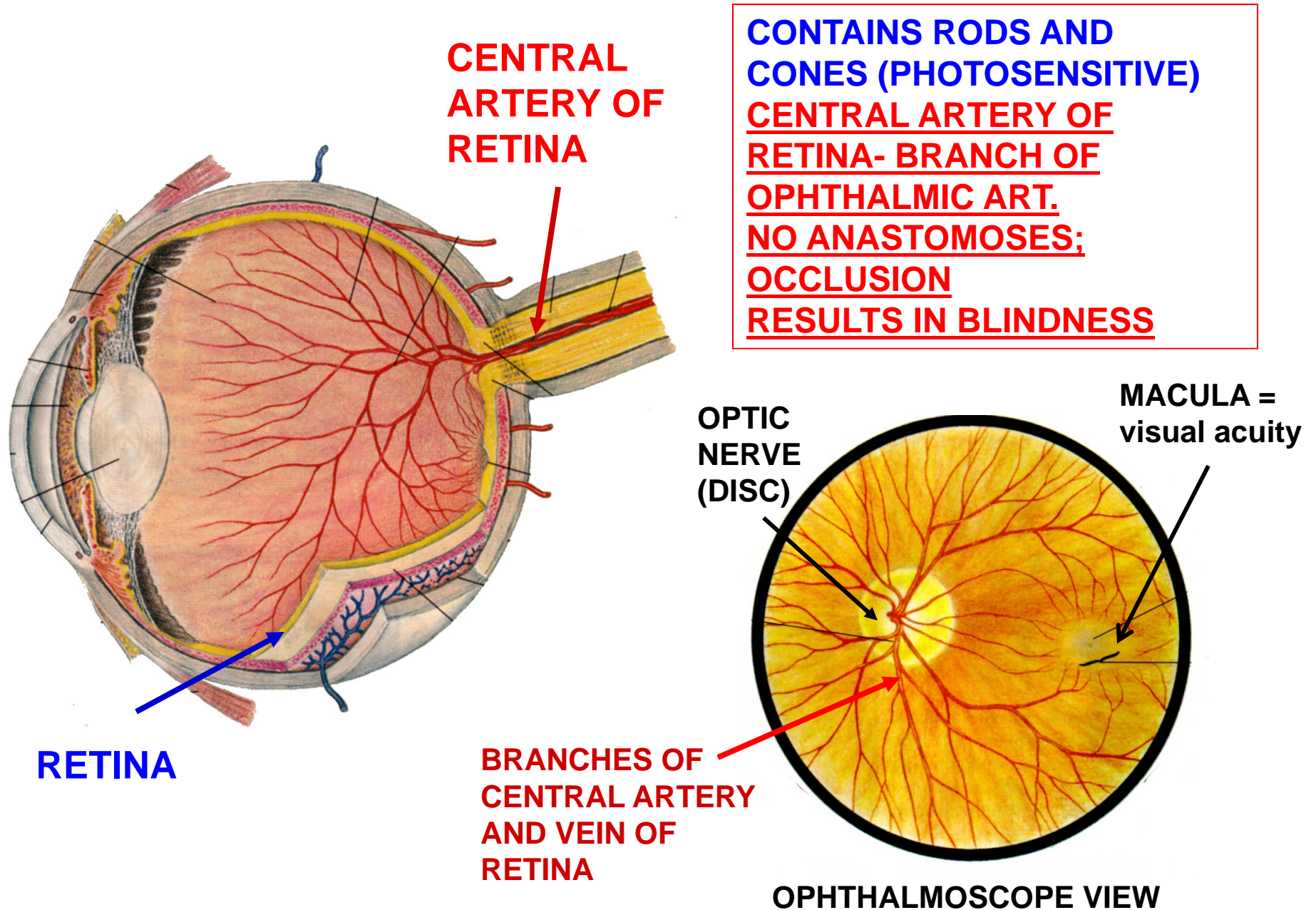
**A. CHOROID** -  
HIGHLY VASCULAR,  
PIGMENTED:  
FUNCTIONS:  
PROVIDE O<sub>2</sub>,  
NUTRIENTS TO  
PHOTORECEPTORS.

BUT NORMALLY  
DOES NOT SUPPLY  
GANGLION CELLS  
OF RETINA (THAT  
FORM OPTIC NERVE)

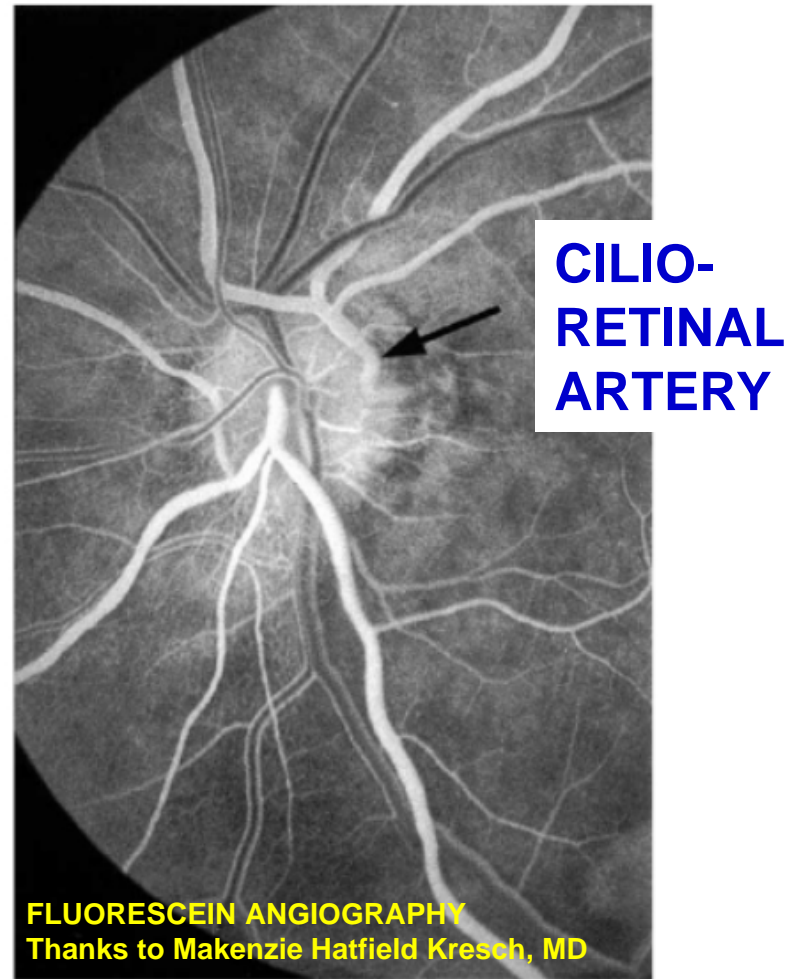
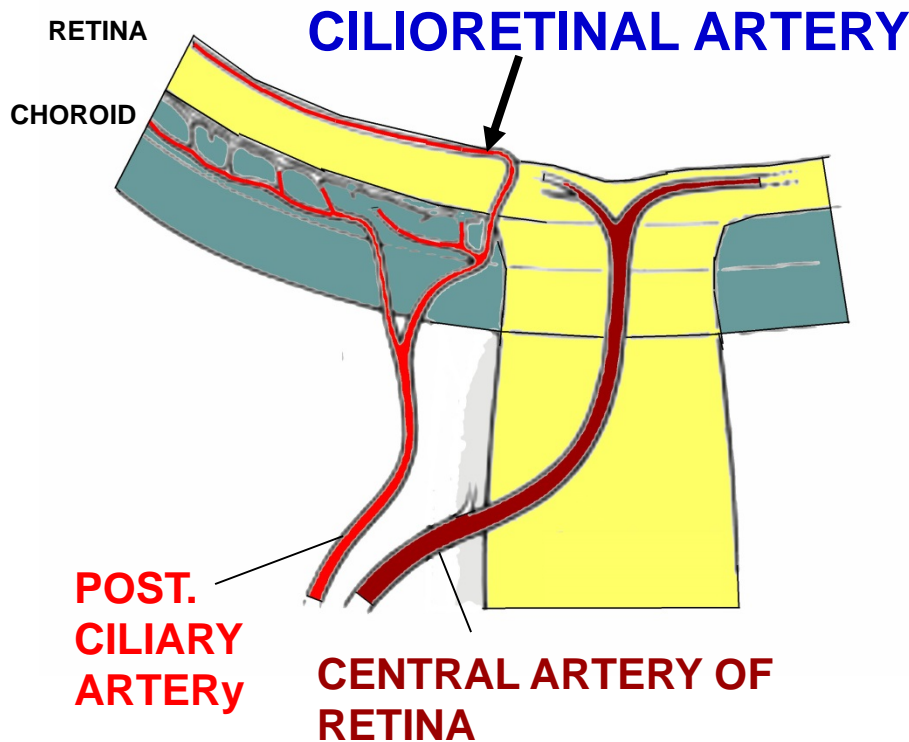
POSTERIOR CILIARY  
ARTERIES (LONG AND  
SHORT) -  
branches of  
Ophthalmic Artery



# EYE- STRUCTURE OF EYEBALL- RETINA

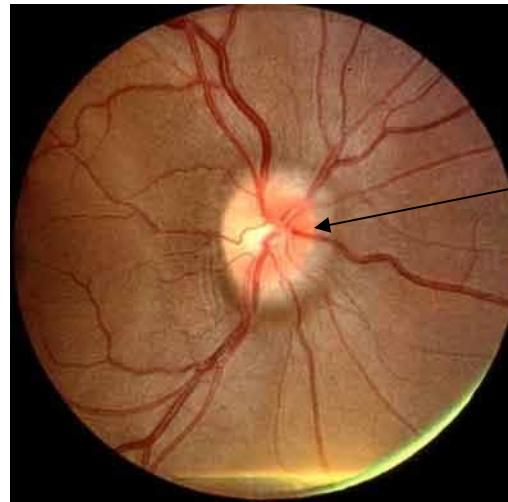
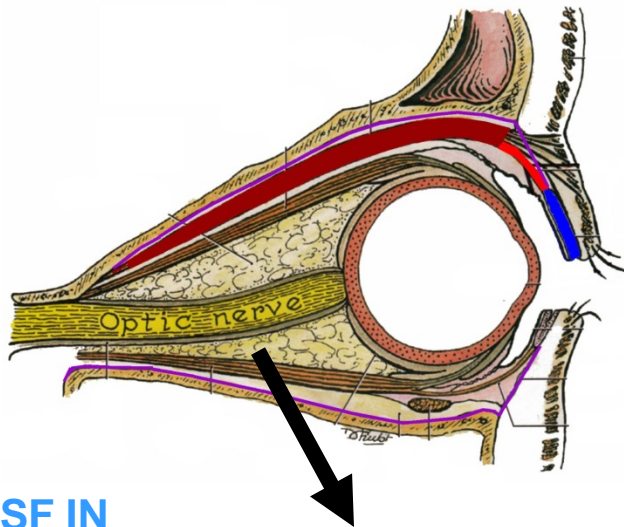


**CRAO - CENTRAL RETINAL ARTERY OCCLUSION -  
most common cause, Carotid Artery atherosclerosis;  
if complete: blind in one eye**



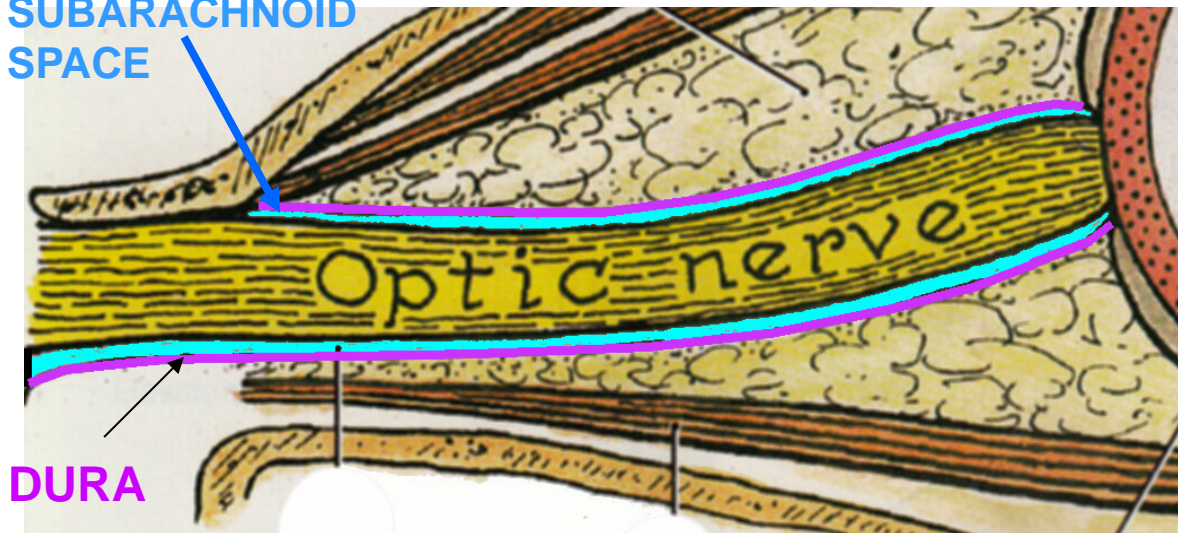
**New Anatomy: imaging has shown that branches of Ciliary Arteries (Cilioretinal arteries) can supply retina (20% of people); can provide partial sparing of retina in cases of Central Retinal Artery Occlusion**

# SUBARACHNOID SPACE EXTENDS TO BACK OF EYEBALL



**PAPILLEDEMA**  
- engorgement of retinal veins (correspond to branches of central artery)

CSF IN SUBARACHNOID SPACE



**CLINICAL\*\***

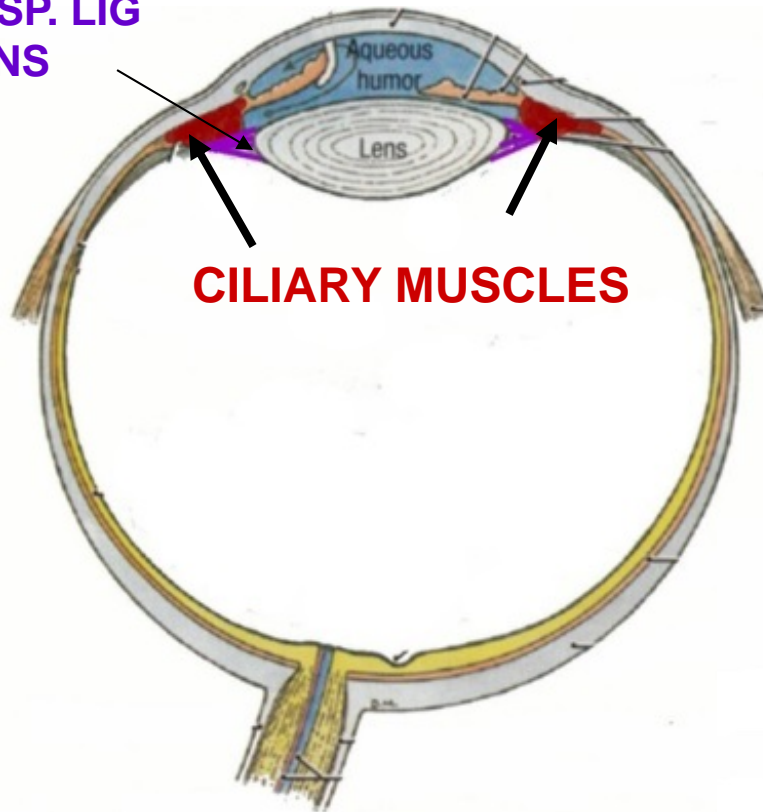
**DURA AND SUBARACHNOID SPACE (CSF) EXTEND AROUND OPTIC NERVE; INCREASE IN CSF (PRESSURE) CAN AFFECT VISION**

**PAPILLEDEMA = swelling of optic disc**

Clinical - slow onset; headaches

# EYE- STRUCTURE OF EYEBALL- VASCULAR LAYER

SUSP. LIG  
LENS

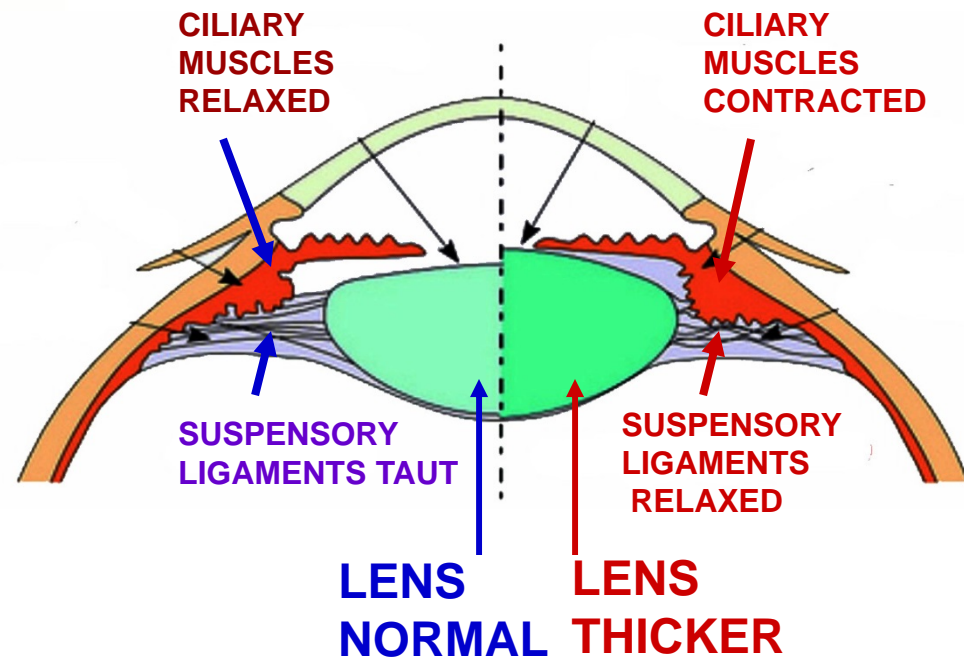


**CILIARY MUSCLES**

**B. CILIARY BODY- CILIARY MUSCLES- SMOOTH MUSCLES AT ATTACHMENTS OF SUSPENSORY LIGAMENTS OF LENS CONTROL THICKNESS OF LENS**

**NORMAL VISION**

**NEAR VISION**

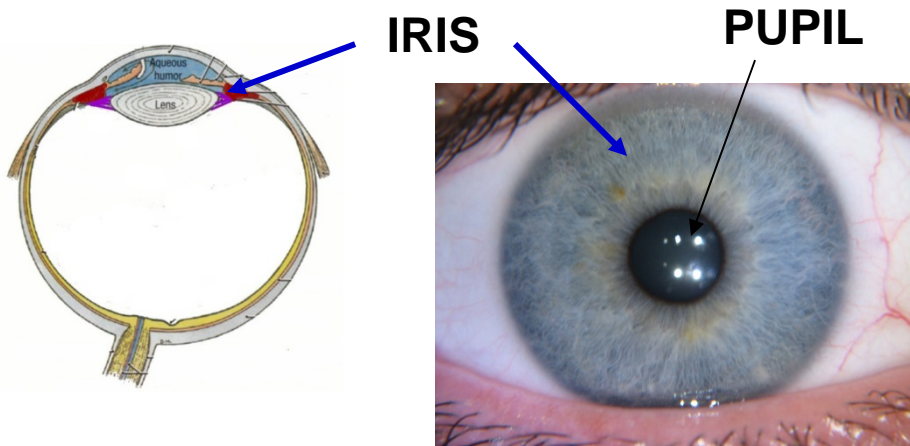


**ACCOMMODATION - THICKEN LENS FOR NEAR VISION (VIEWING OBJECTS CLOSE UP)**

**PARASYMPATHETIC CONTROL- III (Short ciliary nerves)**

**CILIARY MUSCLES CONTRACT - LENS THICKER**

# EYE - STRUCTURE OF EYEBALL- VASCULAR LAYER



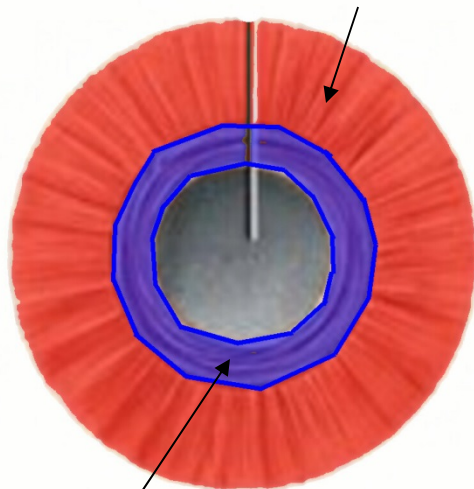
**C. IRIS - PIGMENTED, CONTRACTILE LAYER WITH SMOOTH MUSCLES SURROUNDING PUPIL**

**NORMAL**

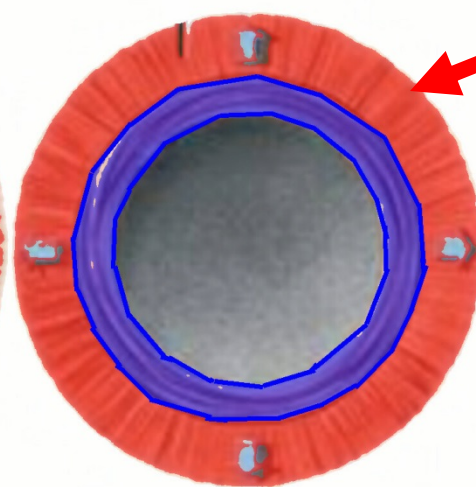
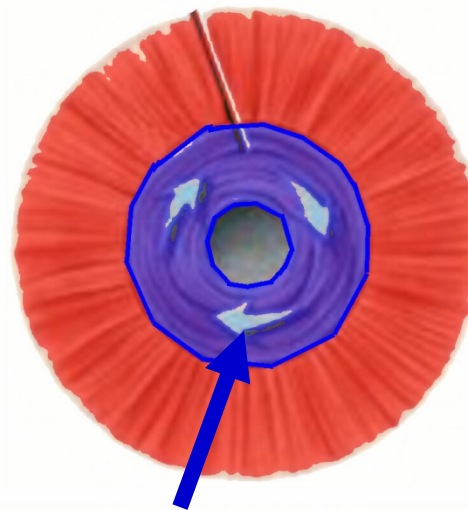
**DILATOR**

**BRIGHT LIGHT - PUPIL CONSTRICTED**

**DIM LIGHT - PUPIL DILATED**



**CONSTRUCTOR**



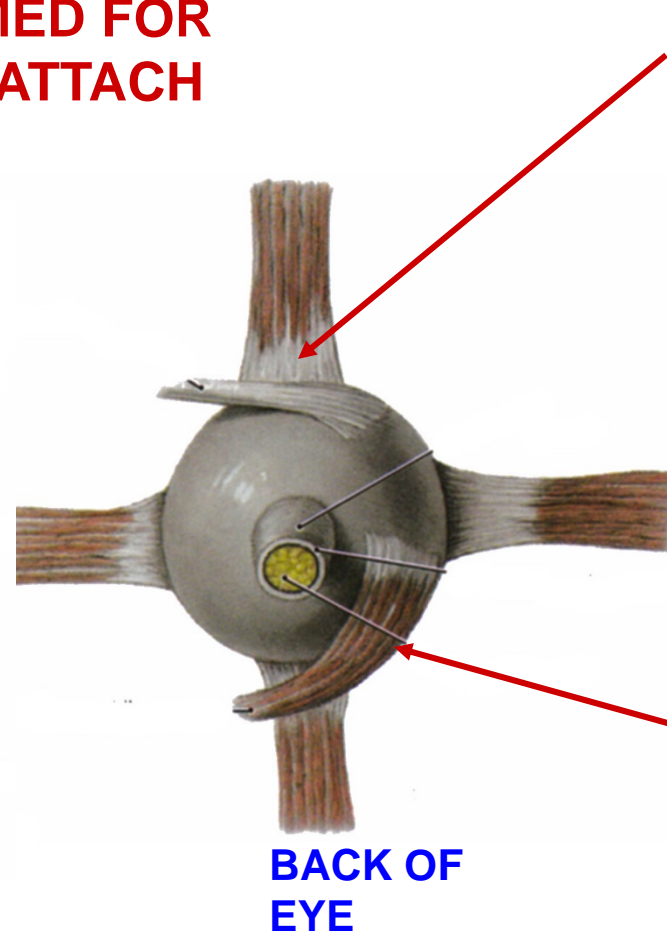
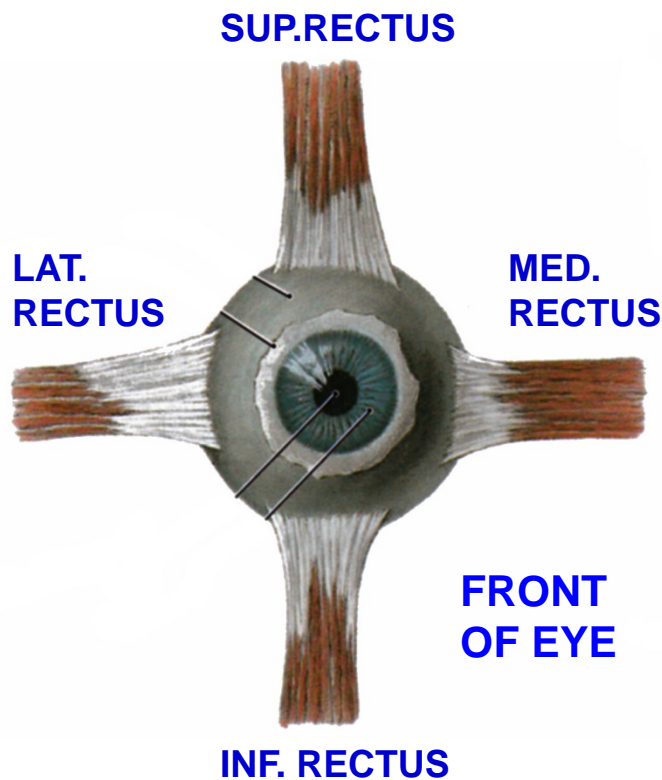
**DILATOR PUPIL- RADIAL SMOOTH MUSCLE; SYMPATHETICS**

**CONSTRUCTOR PUPIL- CIRCULAR SMOOTH MUSCLE; PARASYMPATHETICS (CN III)**

# V. EXTRAOCULAR MUSCLES

- VOLUNTARY SKELETAL MUSCLES WHICH MOVE EYEBALL

RECTI = STRAIGHT, NAMED FOR SIDES ON WHICH THEY ATTACH

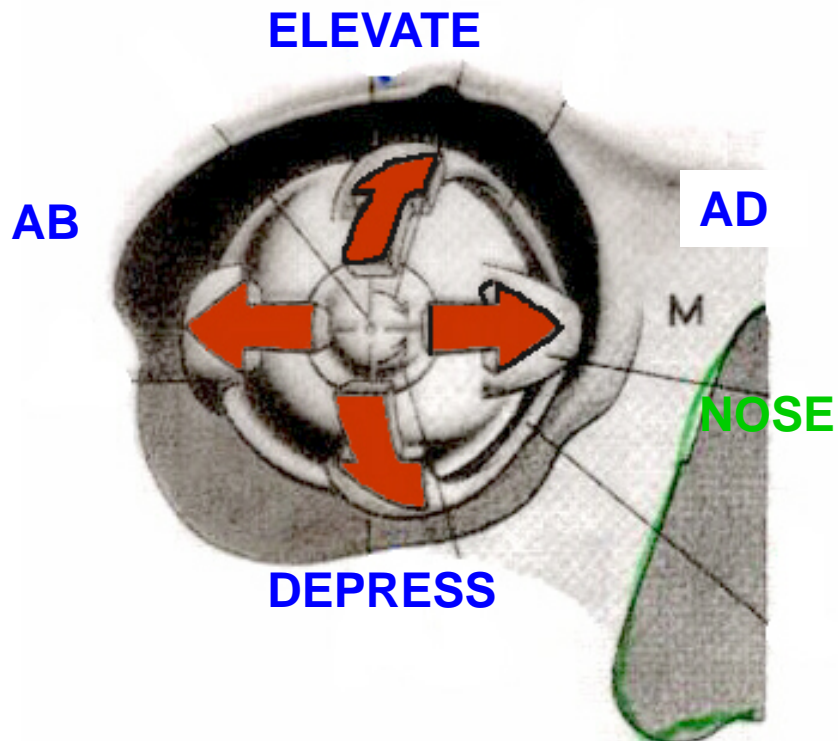


OBLIQUES - MORE COMPLICATED DEVIATED SUPERIOR OBLIQUE - ACTS THROUGH PULLEY (TROCHLEA); INFERIOR OBLIQUE - TO FLOOR OF ORBIT

# EYE MOVEMENTS

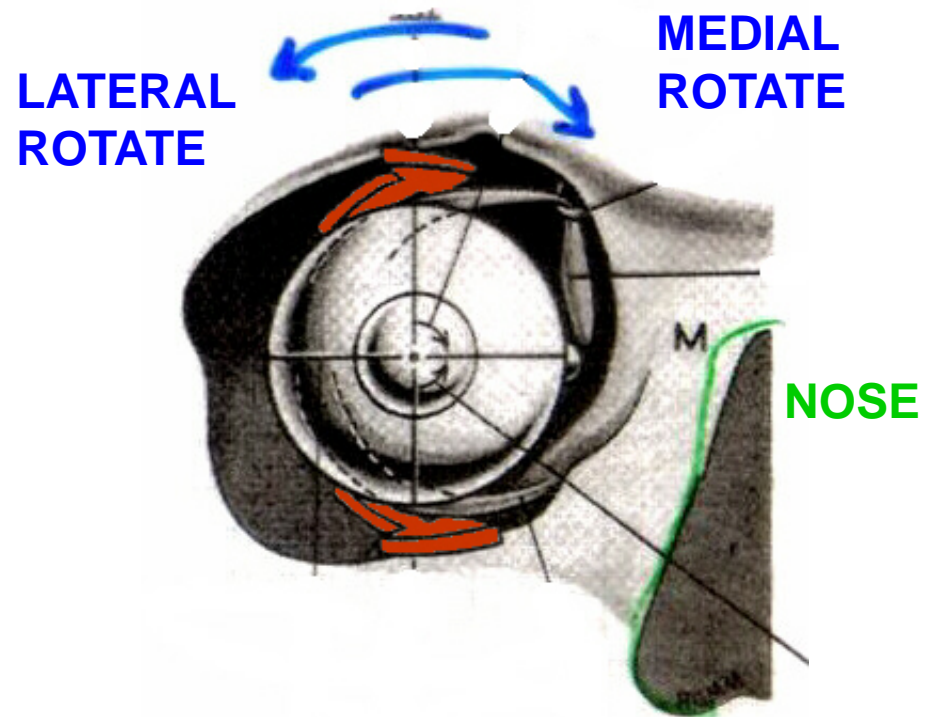
## VOLUNTARY

ADDUCT - MOVE MEDIANLY  
ABDUCT - LATERALLY  
ELEVATE OR RAISE - SUPERIORLY  
DEPRESS OR LOWER - INFERIORLY



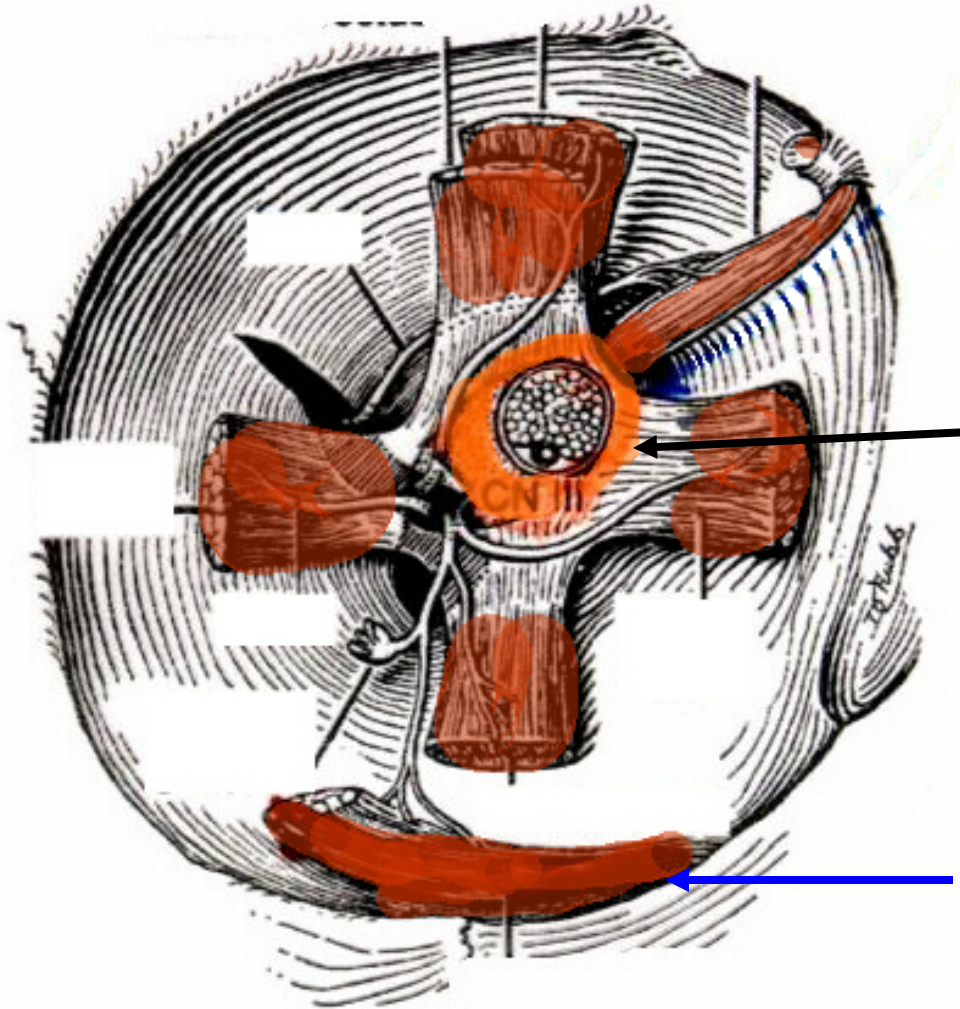
## ROTATE- INVOLUNTARY WHEN TILT

HEAD : MEDIAL ROTATE - INTORSION  
LATERAL ROTATE - EXTORSION



ROTATIONAL MOVEMENTS – COMPENSATE FOR HEAD TILT

## A. ORIGINS OF EXTRAOCULAR MUSCLES



VIEW OF ENUCLEATED  
ORBIT- EYEBALL  
REMOVED; MOST  
MUSCLES TAKE ORIGIN  
FROM

TENDINOUS RING- RING  
OF CT SURROUNDING  
OPTIC CANAL AND  
SUPERIOR ORBITAL  
FISSURE

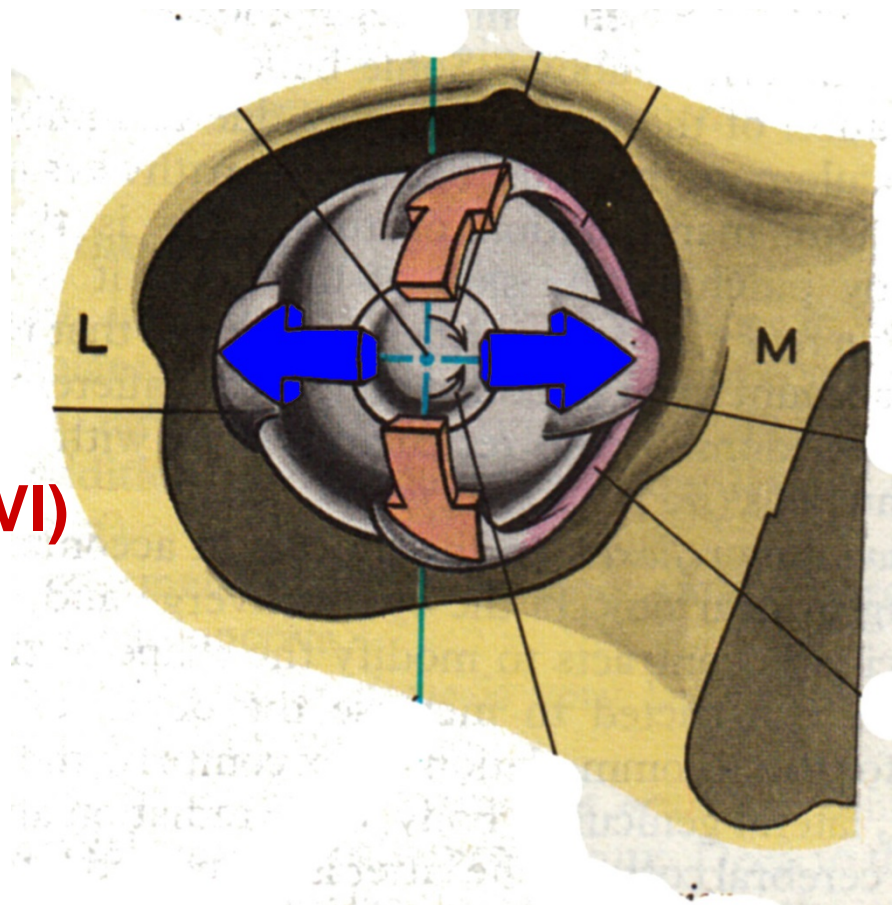
NOTE: NOT INFERIOR  
OBLIQUE - FROM FLOOR  
OF ORBIT



## B. ACTIONS - EYE MOVEMENTS

### ACTIONS - MEDIAL RECTUS AND LATERAL RECTUS STRAIGHTFORWARD

LATERAL  
RECTUS  
ABDUCT (VI)

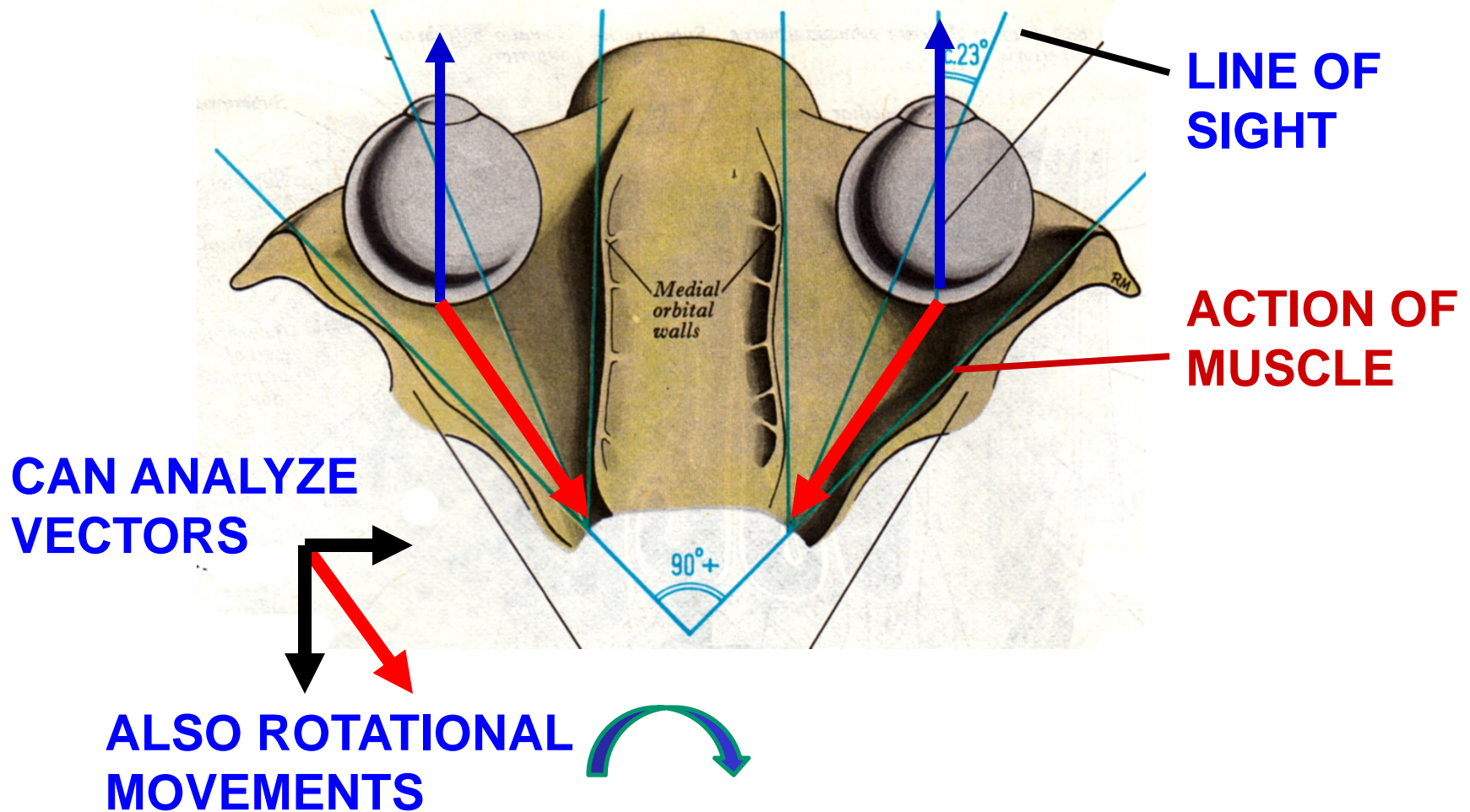


MEDIAL  
RECTUS-  
ADDUCT  
EYE (III)

# EYE MOVEMENTS

- ACTIONS OF OTHER MUSCLES COMPLEX

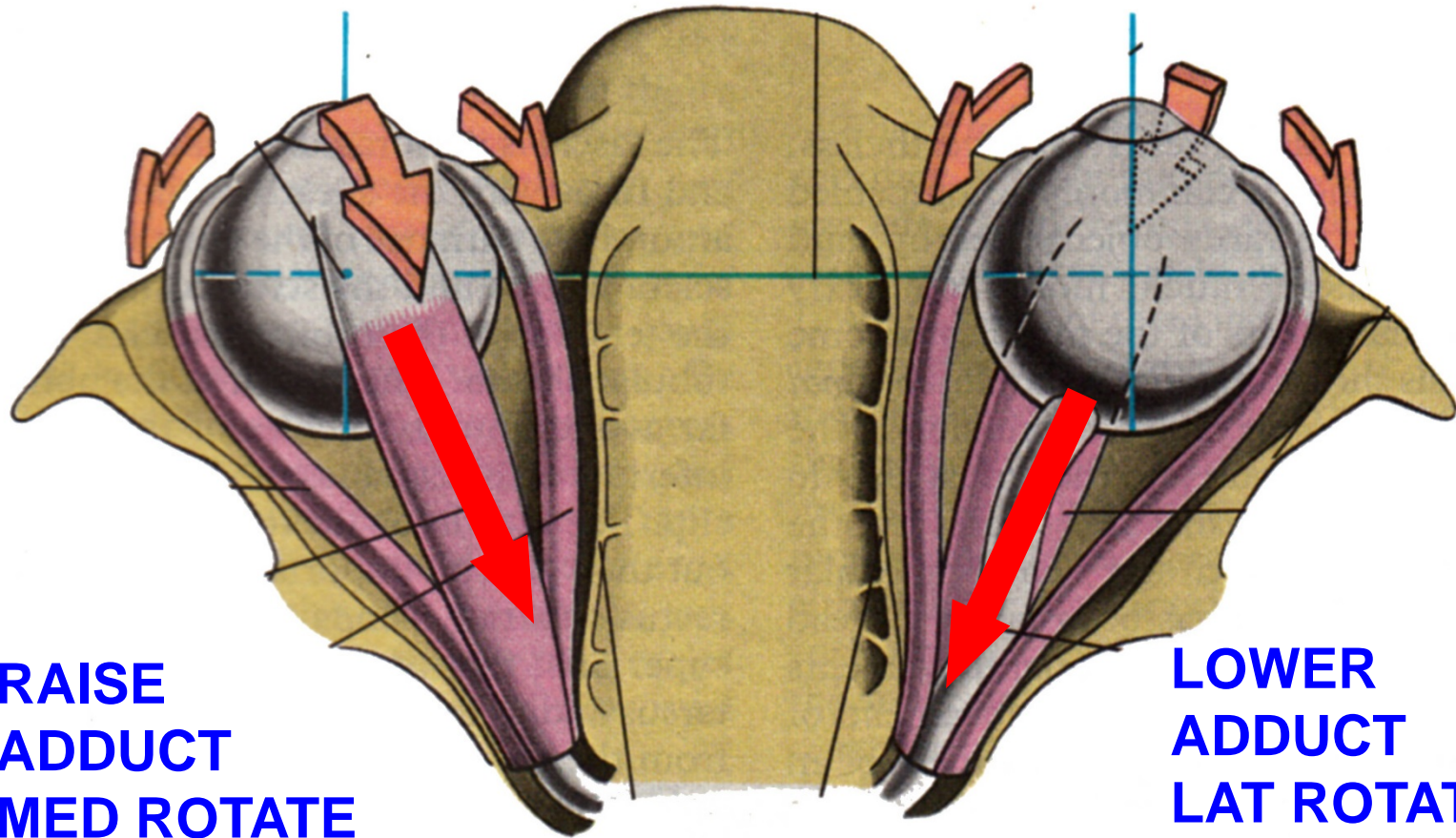
- PULL OF **SUP. AND INF. RECTUS** AT ANGLE WITH LINE OF SIGHT



# EYE MOVEMENTS

**SUP RECTUS (III)**

**INF RECTUS (III)**



**RAISE  
ADDUCT  
MED ROTATE**

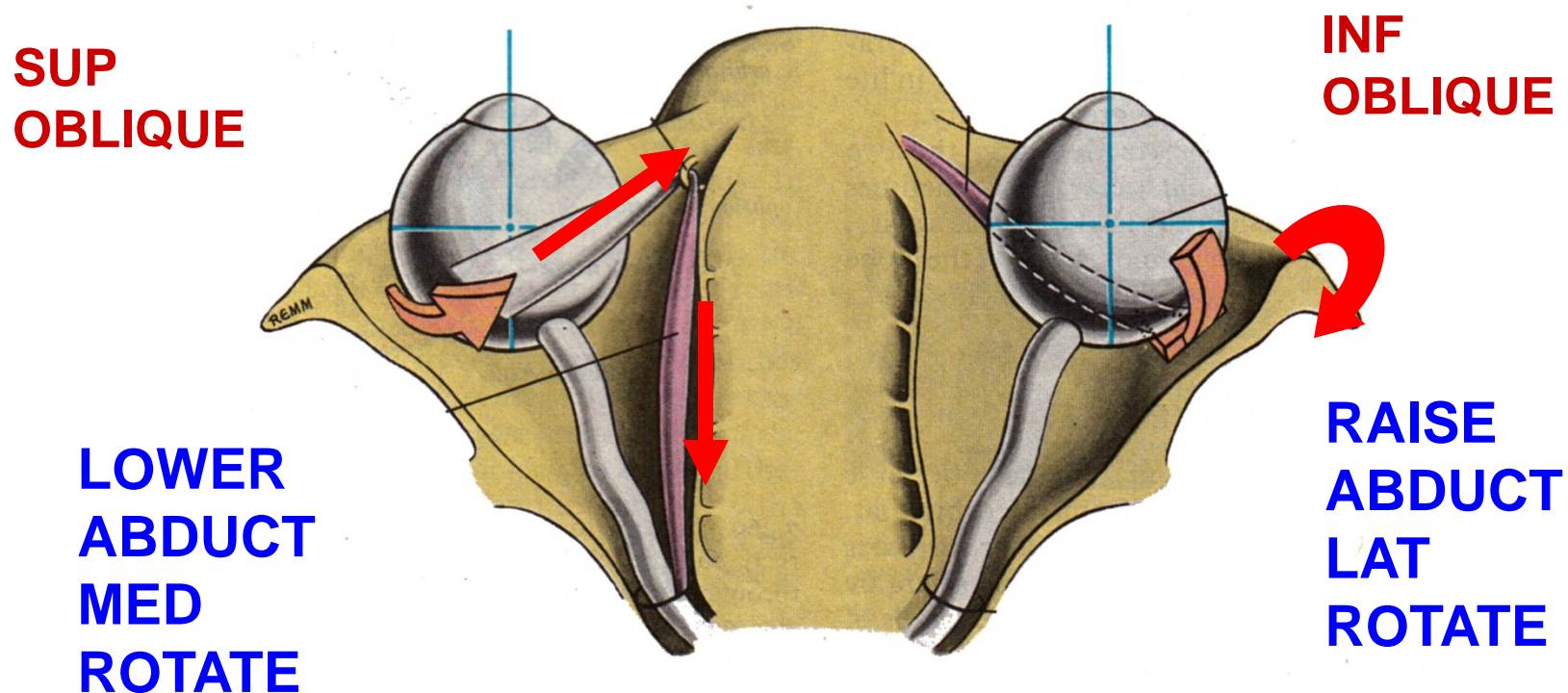
**LOWER  
ADDUCT  
LAT ROTATE**

# EYE MOVEMENTS

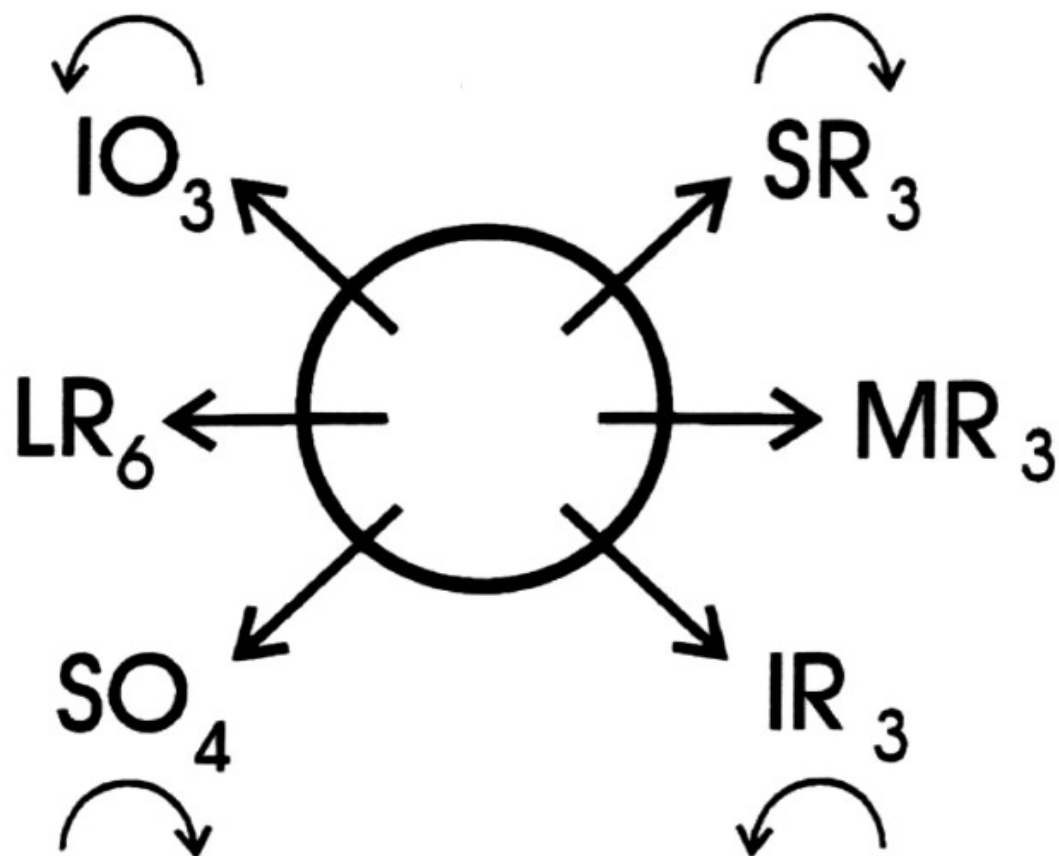
**ACTION OF OBLIQUE MUSCLES COMPLEX (COUNTERINTUITIVE)**

**SUP OBLIQUE (IV) - ACTS THROUGH PULLEY (TROCHLEA) LIKE MUSCLE ON NOSE**

**INF OBLIQUE (III) - ORIGIN FROM FLOOR OF ORBIT- LIKE MUSCLE ON EAR**



## EYE MOVEMENTS DIAGRAM

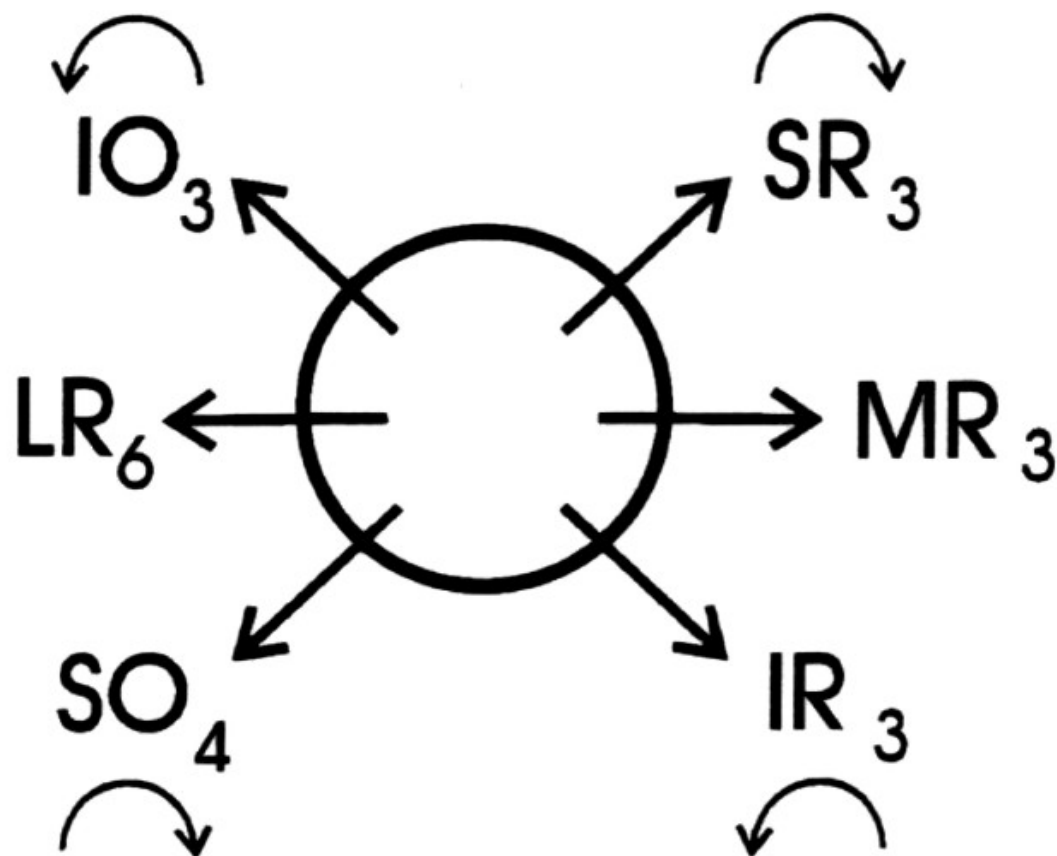


NOSE



- 1- Resting position of eye depends upon tonic activities in muscles.
- 2- Damage to any one muscle does not entirely eliminate abduction, adduction, elevation or depression; only get weakness.

## EYE MOVEMENTS DIAGRAM

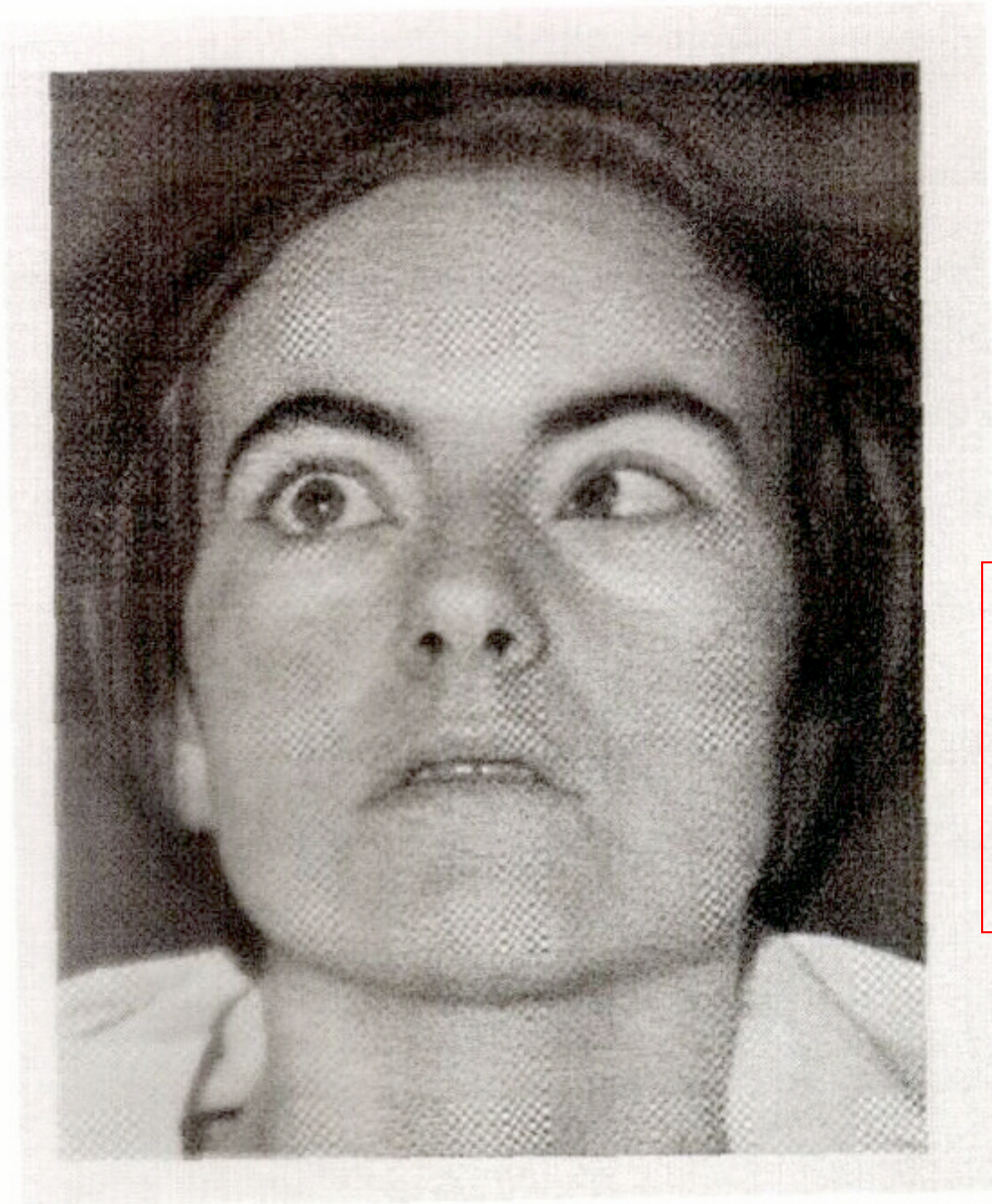


NOSE



**SAMPLE QUESTIONS: 1- WHAT ARE ACTIONS OF INFERIOR OBLIQUE?  
2- WHAT ARE ACTIONS OF SUPERIOR OBLIQUE?  
2- WHAT IS SYMPTOM OF DAMAGE TO ABDUCENS NERVE?**

## VIII. NERVE DAMAGE - all clinically important

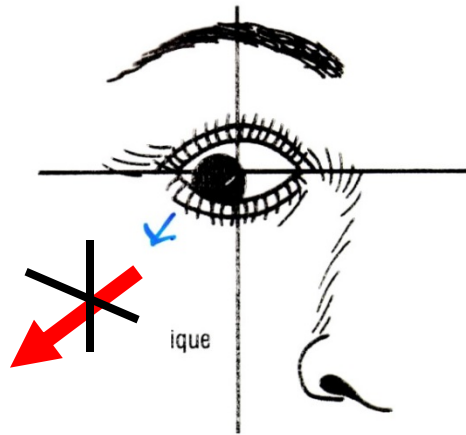


### A. ABDUCENS (VI) NERVE DAMAGE



**ABDUCENS (VI): AT REST 1)  
MEDIAL STRABISMUS  
(CROSS-EYED) DUE TO  
DAMAGE/PARALYZE  
LATERAL RECTUS**

# B. TROCHLEAR (IV) NERVE DAMAGE: INABILITY TO TURN EYE DOWN AND OUT; ALSO HEAD TILT



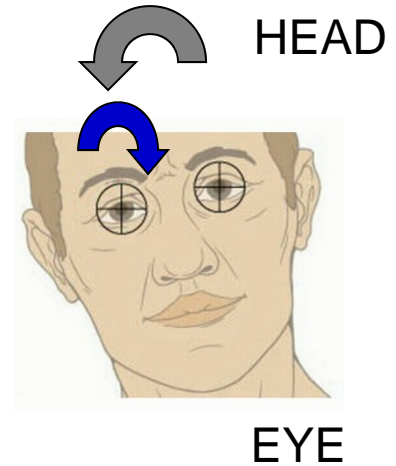
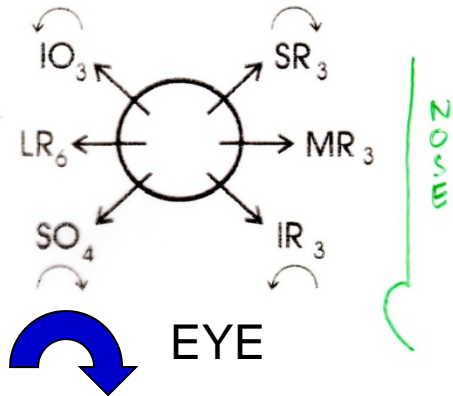
**PATIENT CANNOT LOOK DOWN AND OUT**

**Symptoms - Difficulty walking down stairs; HEAD TILTED**

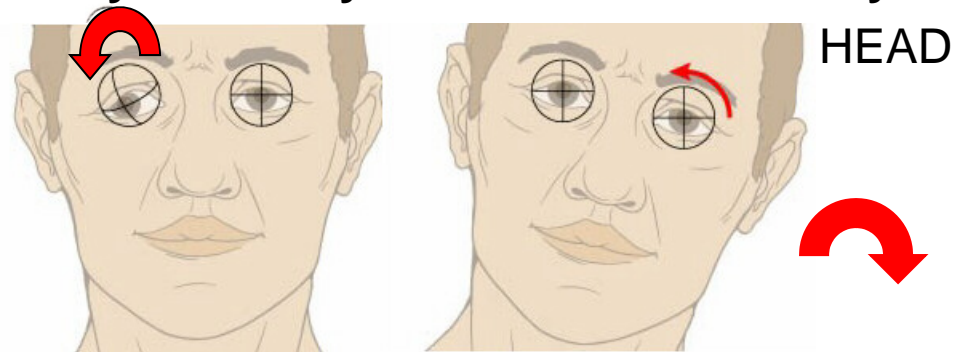
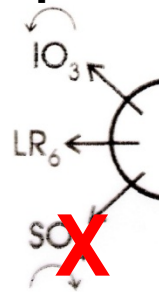
**\*\*\***

**AFTER IV DAMAGE - eye rotated laterally; PATIENT TILTS HEAD TO OPPOSITE SIDE so both eyes rotated**

NORMAL



**NORMAL Rotation** - occurs when tilt head; rotate ipsilateral eye medially when tilt head laterally





## C. OCULOMOTOR (III) NERVE DAMAGE



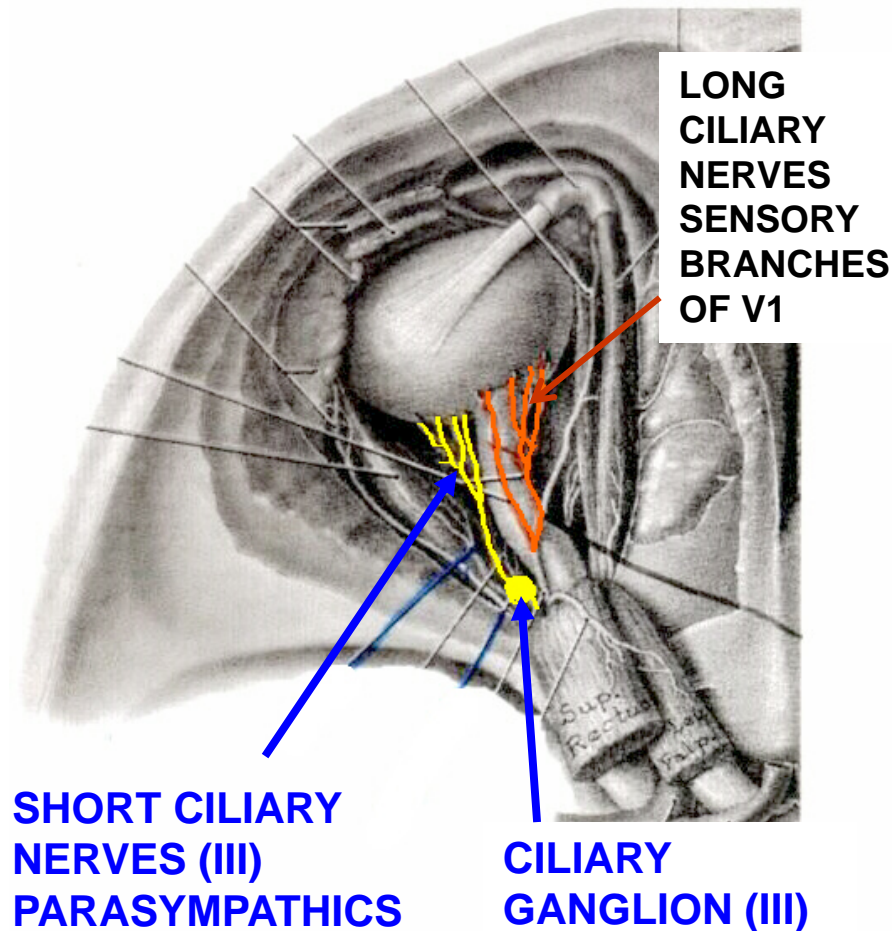
### AT REST

1) LATERAL STRABISMUS (WALL-EYED) DUE TO PARALYZE MEDIAL RECTUS

2) PTOSIS - DROOPING EYELID PARALYZE LEV. PALPEBRAE SUPERIORIS

3) DILATED PUPIL - (MYDRIASIS) PARALYZE PUPILLARY CONSTRICTOR

## VII. CILIARY GANGLION - PARASYMPATHETIC



CILIARY GANGLION-  
PARASYMPATHETICS OF  
OCULOMOTOR N (III); TRAVEL IN  
SHORT CILIARY NERVES - (FOUND  
LATERAL AND DORSAL TO OPTIC  
NERVE)

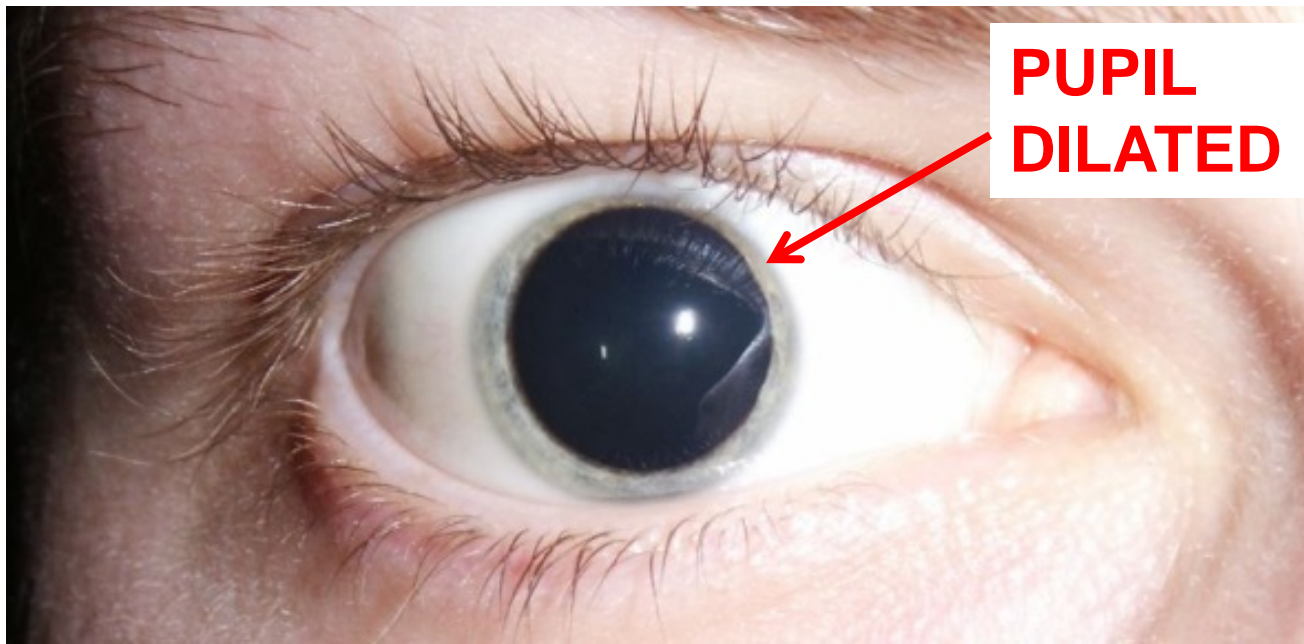
**INNERVATE:** 1) CILIARY MUSCLES  
2) SPHINCTER (CONSTRICTOR)  
PUPILLAE

**NOTE:** LONG CILIARY NERVES  
BRANCHES OF V1 (OPHTHALMIC) -  
SENSORY TO CORNEA - (FOUND  
MEDIAL AND DORSAL TO OPTIC  
NERVE)

**CLINICAL \*\***

**DAMAGE SHORT CILIARY NERVES (ONLY) - MAIN  
SYMPTOM: PUPIL IS DILATED = MYDRIASIS**

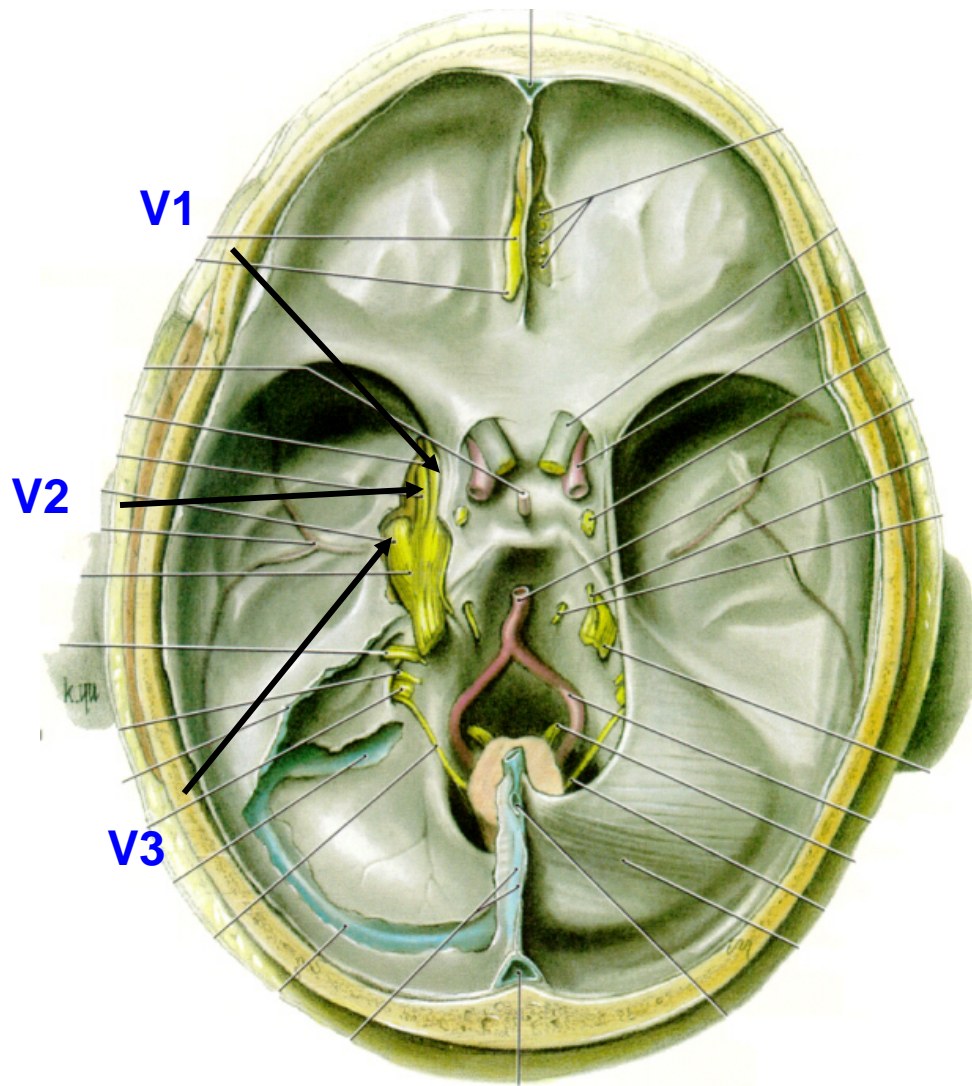
# 'BLOWN PUPIL' = MYDRIASIS (muh-dry'-a-sis)



**'BLOWN PUPIL' = MYDRIASIS - PUPIL DILATED, UNABLE TO CONSTRICT IN RESPONSE TO LIGHT - INDICATES CATASTROPHE - STROKE, HERNIATION, ETC.**

**Note; Anisocoria – pupils of unequal size (normal or abnormal)**

# TRIGEMINAL NERVE - V



**V1 – OPHTHALMIC -Sup.**  
**Orbital fissure – SOMATIC**  
**SENSORY**

**V2 - MAXILLARY - Foramen**  
**rotundum – SOMATIC**  
**SENSORY**

**V3 – MANDIBULAR - -**  
**Foramen ovale – SOMATIC**  
**SENSOR AND**  
**BRANCHIOMOTOR**

## DEVELOPMENT OF BRANCHIAL ARCHES

© 2021zillmusom

I. **DEVELOPMENT OF BRANCHIAL ARCHES** - structures which develop in an embryo that are comparable to gills of fish; reflect fact that ontogeny (development of individual) resembles phylogeny (evolution of species); are important in understanding the final structure and innervation of head and neck.

A. Week 4 - Neural crest cells invade future head and neck region of embryo; cells form ridges on side of head and neck located lateral to rostral part of the foregut; will form branchial arch components. Terminology is confusing. (Note: Branchial Arch = Pharyngeal Arch, Branchial Arch Artery = Aortic Arch, Cleft = Groove)

B. Branchial apparatus - Composed of 4 elements (including branchial arches):

1. **Branchial arch** - components - arches are covered by ectoderm externally; lined internally by endoderm; core of arch formed by mesenchyme; mesenchyme will form muscles, arteries, connective tissue, cartilage and parts of skeleton; each arch has a specific nerve that innervates the muscles that develop from that arch; some arteries will form adult vessels (considered as Aortic Arches).

2. **Branchial groove** (Pharyngeal cleft) - ectodermal (external) cleft between adjacent arches

3. **Branchial pouch** - endodermal outpocketing of rostral part of foregut; pouches are located between adjacent branchial arches.

4. **Branchial membrane** - site of contact of ectoderm of branchial groove with endoderm of pharyngeal pouch.

D. Branchial apparatus of embryo is reshaped into new structures; structures can disappear or form vestigial remnants by the end of the embryonic period.

II. **FATE OF BRANCHIAL ARCHES** - contribute to formation of face, neck, mouth, larynx, and pharynx – see chart

A. Branchial Arch Cartilages – form skeletal elements (bones, cartilages and ligaments)

B. Branchial Arch Nerves are cranial nerves (**Branchiomotor, SVE component**) - **First** arch = **Trigeminal** (V), **Second** arch = **Facial N.** (VII); **Third** arch = **Glossopharyngeal N.** (IX); **Fourth** arch = **Vagus** (X); **Sixth** arch (caudal) = **Accessory N.** (XI)

Note: Fifth arch forms no adult structures in humans; Sixth arch is small; descriptions of Fourth and Sixth Arches vary among authors.

C. Branchial arch muscles – many (see chart); each muscle migrates but continues to be innervated by the cranial nerve to the arch from which the muscle is derived.

**STRUCTURES DERIVED FROM BRANCHIAL ARCHES**

ARCH/NERVE	SKELETAL	LIGAMENTS	MUSCLES
First (V)	1) Malleus 2) Incus	1) Ant. ligament of malleus 2) Sphenomandibular ligament	1) Muscles of Mastication 2) Tensor tympani 3) Tensor palati 4) Mylohyoid 5) Ant. belly of Digastric
Second (VII)	1) Stapes 2) Styloid process 3) Hyoid bone - lesser horn, upper half of body	Stylohyoid ligament	1) Muscles of Facial Expression 2) Stapedius 3) Stylohyoid 4) Post. belly of Digastric
Third (IX)	Hyoid bone - greater horn, lower half of body	-----	Stylopharyngeus
Fourth (X)	Cartilages of Larynx	-----	1) All muscles of Larynx 2) All muscles of Pharynx (except Stylopharyngeus) 3) All muscles of Soft Palate (except Tensor palati)
Sixth (XI)	-----	-----	1) Sternocleidomastoid 2) Trapezius

Note: First Branchial Groove (Cleft) becomes External Auditory Meatus  
First Branchial Membrane becomes Tympanic Membrane

PLANE OF SECTION

### III. FATE OF BRANCHIAL POUCHES

A. **Pouch 1** - elongates into tubotympanic recess; forms **Auditory tube** and **Tympanic cavity (middle ear cavity)**.

B. **Pouch 2** - forms epithelial lining of **Crypts** (spaces) **of the Palatine tonsils**.

C. **Pouch 3** - Upper part forms **Inferior Parathyroid gland**; lower part forms **Thymus gland**

D. **Pouch 4** - forms **Superior Parathyroid gland** and **C cells of Thyroid gland** (produce hormone calcitonin).

NOTE: Superior parathyroid gland develops from Pouch 4 and Inferior parathyroid gland from Pouch 3; final position occurs because **elements from Pouch 3 migrate caudal to Pouch 4**.

### IV. FATE OF BRANCHIAL GROOVES AND MEMBRANES, ANOMALIES

A. Four branchial grooves separate the branchial arches externally on each side; only one pair of branchial grooves forms a structure in the adult; the **First Branchial Groove** forms the **External Auditory meatus** (outer ear canal), the **First Branchial Membrane** forms the **Tympanic Membrane**.

B. The other **branchial grooves** develop to lie in a larger depression called the **Cervical Sinus**; this sinus is **normally obliterated** during development

Note: **Cervical sinus can persist as a Branchial sinus** (blind pouch off pharynx) or a **Branchial Cyst Fistula** (channel connecting pharynx to skin); when present are found **anterior to Sternocleidomastoid**.

Note: **Branchial fistula (channel)** - when present often extends from 2nd pharyngeal pouch and passes between Internal and External Carotid arteries and exits to skin Anterior to the sternocleidomastoid muscle; can become infected.

## STRUCTURES DERIVED FROM BRANCHIAL POUCHES, CLEFT AND MEMBRANES

POUCH	FORMS	CLINICAL
First	1) Auditory tube 2) Tympanic cavity	First Branchial 'Cleft' cyst - tract linked to external auditory meatus
Second	Lining (crypts) of palatine tonsils	Second Branchial 'Cleft' cyst - tract linked to tonsillar fossa (palatine tonsils)
Third	1) Inferior parathyroid gland 2) Thymus	Third Branchial 'Cleft' cyst - tract at thyrohyoid membrane or piriform recess
Fourth	1) Superior parathyroid gland 2) C-cells of Thyroid	does not form
Sixth (XI)	-----	-----

Note: Cysts and fistuli - in lateral neck are **anterior to Sternocleidomastoid muscle**

Note: **Branchial Pouch structures are NOT innervated by the same nerves as the Branchial arches** (see lectures on Pharynx).

CLEFT	FORMS
First	External Auditory Meatus

MEMBRANE	FORMS
First	Tympanic membrane

## V. DEVELOPMENT OF THYROID GLAND

A. Initial stage - a median endodermal thickening forms in floor of primitive pharynx at site of **junction of future anterior 2/3's and posterior 1/3 of tongue**.

B. Later - thickening elongates into floor of pharynx as the **Thyroid diverticulum**; opening of diverticulum on surface of developing tongue called the Foramen Cecum.

C. Developing Thyroid diverticulum descends in the neck anterior to the hyoid bone and larynx; as diverticulum (developing gland) elongates into neck, a Thyroglossal duct connects diverticulum with foramen cecum.

D. Developing thyroid gland reaches final site in neck (anterior to upper rings of trachea); thyroglossal duct disintegrates; foramen cecum remains as a vestigial pit on the



tongue.

#### E. Congenital malformations

1. **Persistent thyroglossal duct remnants** - part of duct can remain and form thyroglossal cysts anywhere from foramen cecum of tongue to thyroid gland in neck; cysts found in midline of neck and can be located anterior to hyoid bone or larynx.

Clinical note: **Lingual Thyroid** – Developing Thyroid Gland can fail to migrate and remain in tongue as Lingual Thyroid; can produce difficulty in swallowing (but should not be inadvertently removed).

2. **Pyramidal lobe** - present in 50 percent of people; represents persistent part of thyroglossal duct, which can contain some thyroid tissue; lobe can be attached to hyoid bone by fibrous strand; usually no associated clinical problems.

# DEVELOPMENT OF BRANCHIAL ARCHES

FORM GILLS  
IN FISH



~4 weeks



~11 weeks



## OUTLINE

I. EARLY DEVELOPMENT/  
TERMINOLOGY

II. FATE OF ARCHES  
(CHART) - CARTILAGES,  
LIGAMENTS, NERVES,  
MUSCLES

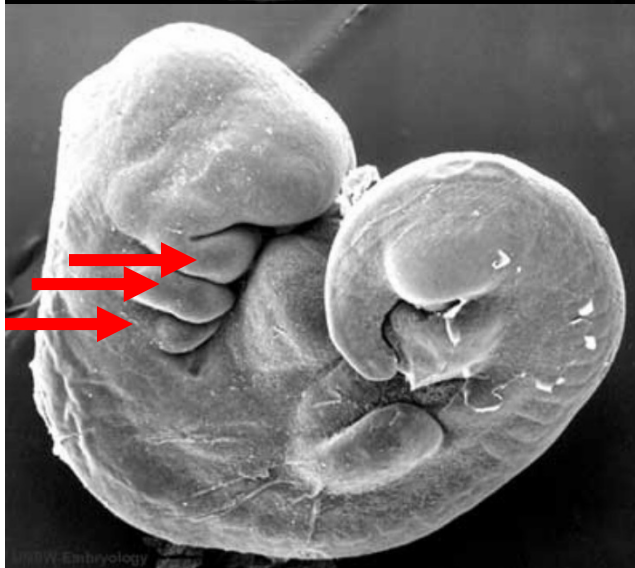
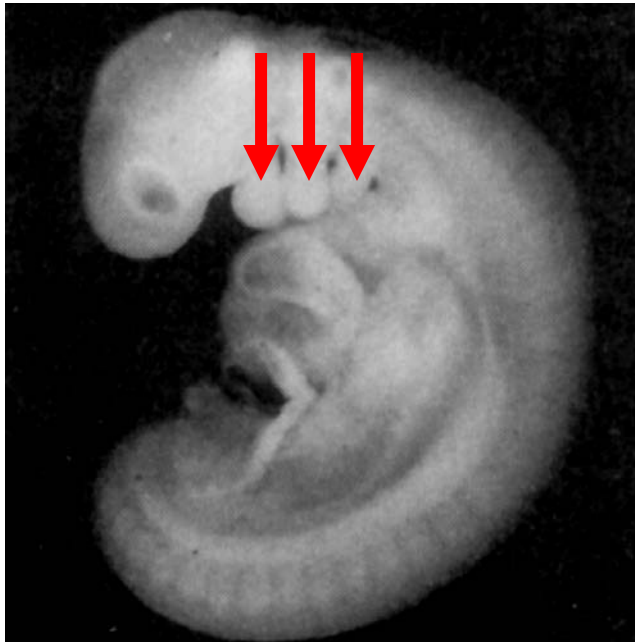
III. BRANCHIAL POUCHES,  
GROOVES, MEMBRANES

IV. DEVELOPMENT OF  
THYROID

- ADULT STRUCTURE IS RESULT OF TRANSFORMATION;
- SPECIFIC SYNDROMES OCCUR IF DEVELOPMENT IS ABNORMAL

# Photo of 4 Week Embryo

## BRANCHIAL ARCHES



## I. BRANCHIAL ARCHES

- Structures which develop that are similar in origin and structure to gills of fish

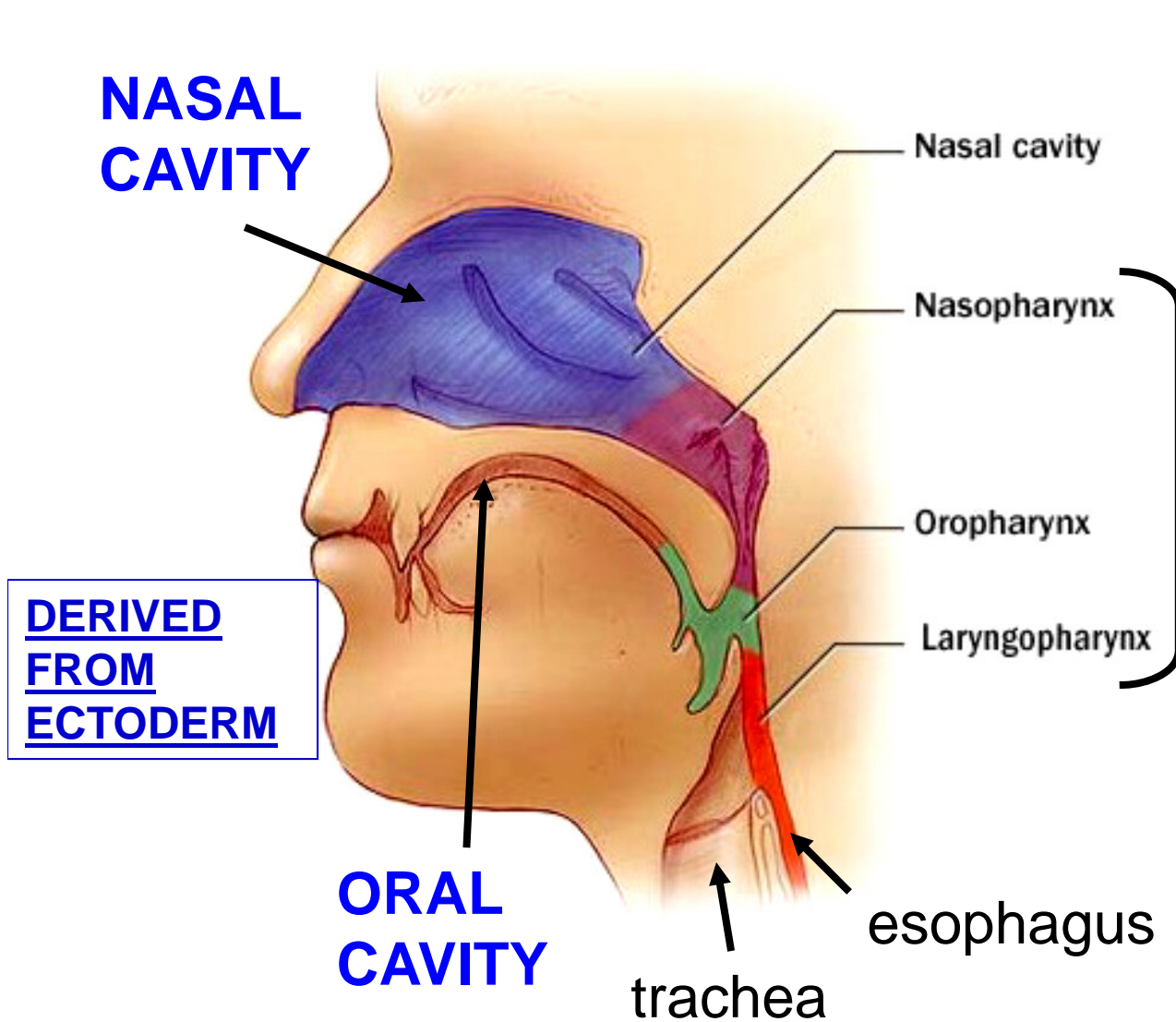
- **Gill = Branchial**

- Ontogeny resembles Phylogeny

- Reorganize to produce Adult structures

Note Terminology :  
Branchial Arch =  
Pharyngeal Arch

# WHERE/WHAT IS THE PHARYNX?

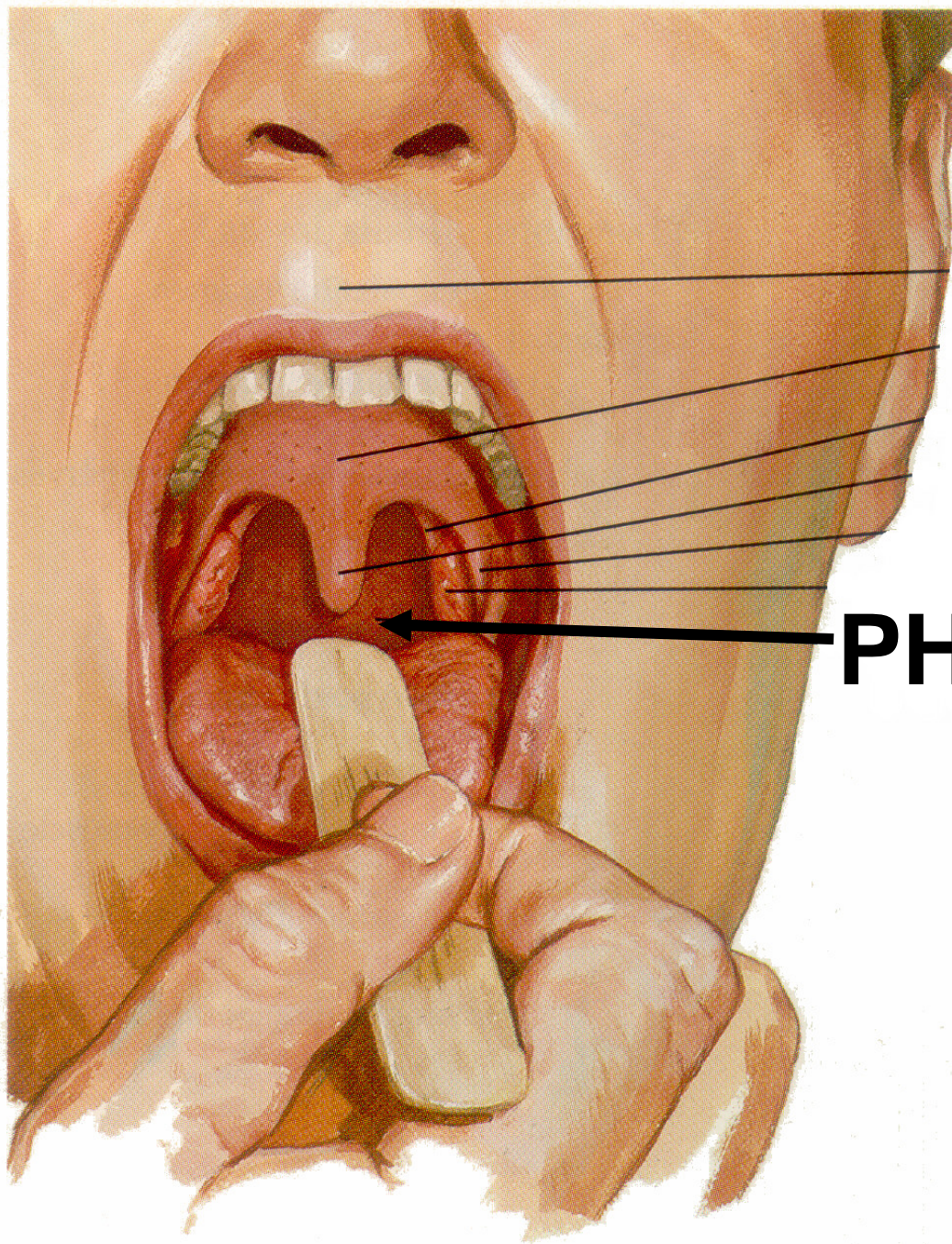


**DERIVED**  
**FROM**  
**ENDODERM**

**PHARYNX -**  
region behind  
Oral and Nasal  
Cavities

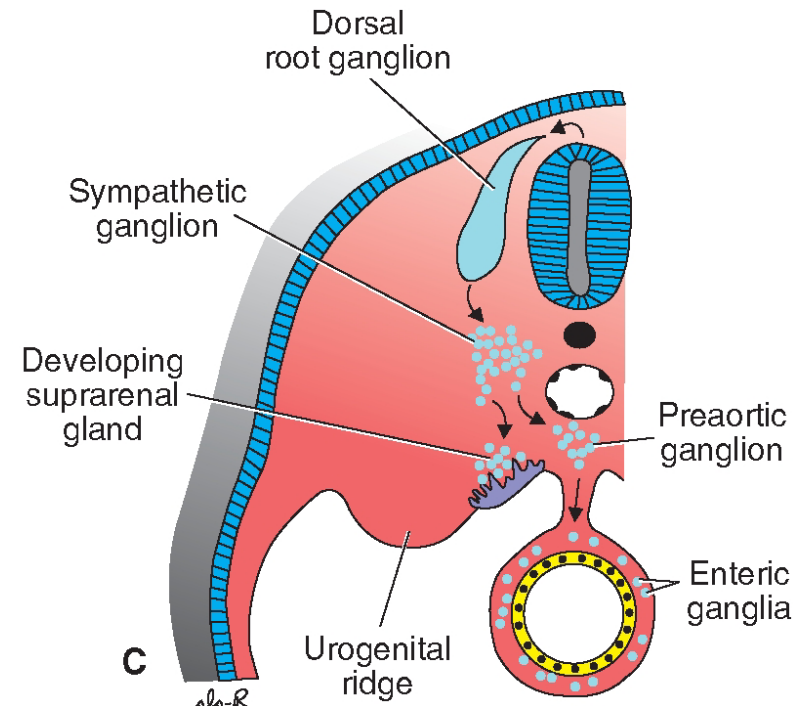
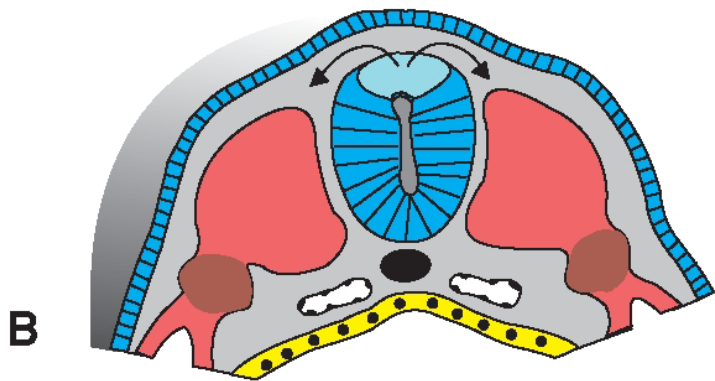
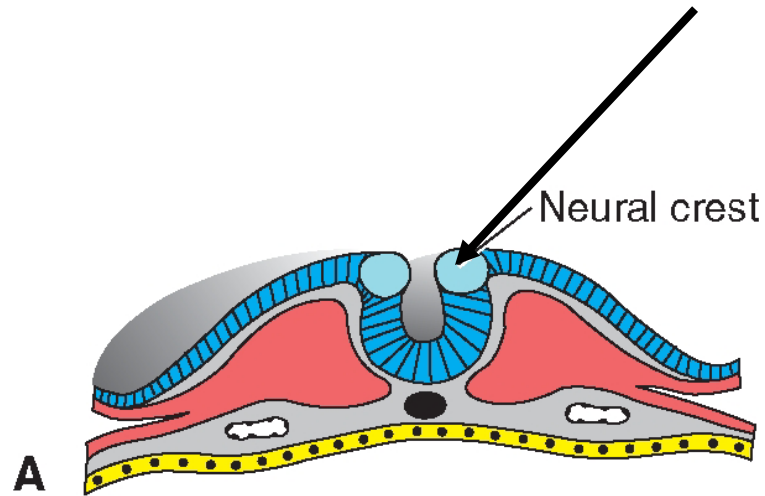
**PHARYNX IS**  
**CONNECTED TO**  
**TRACHEA**  
**(RESPIRATORY**  
**SYSTEM) AND**  
**ESOPHAGUS**  
**(GI) SYSTEM**

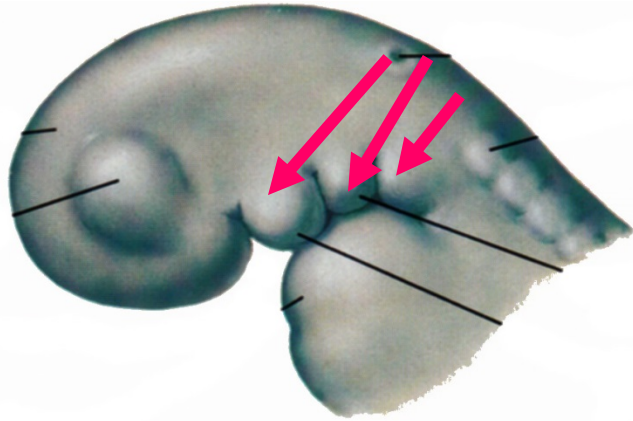
**SAY  
AAHH!**



**PHARYNX**

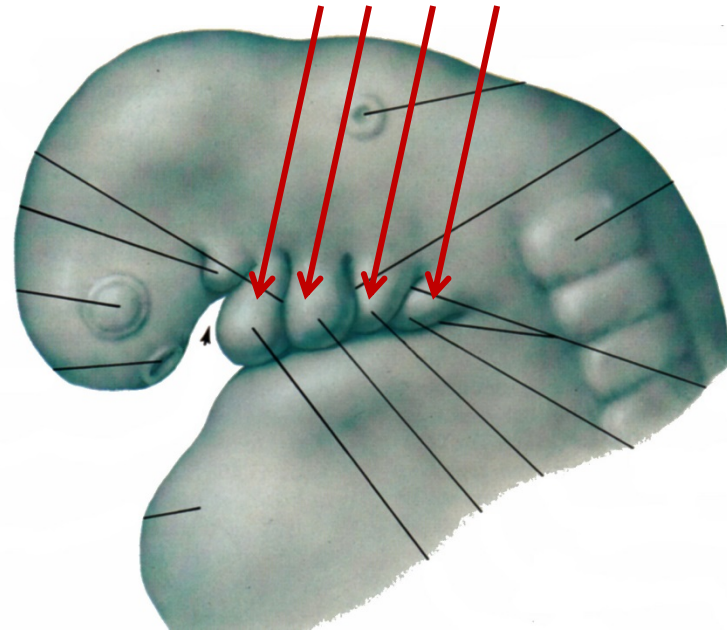
## A. Week 4 - Neural Crest Cells Migrate





**Neural Crest  
Cells  
Invade Head  
and Neck  
Lateral  
To Rostral Part  
of Foregut  
= PHARYNX**

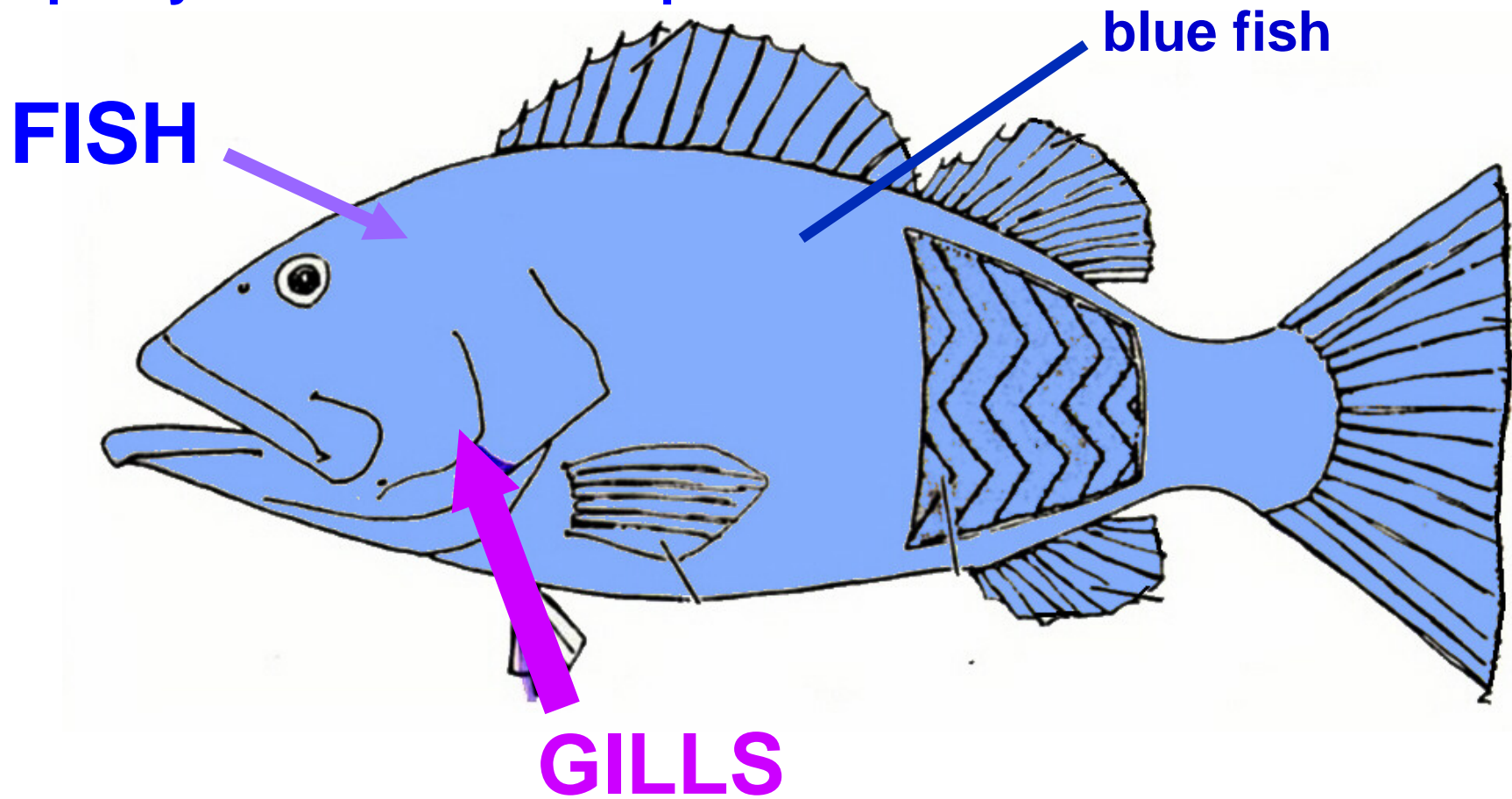
**Form Ridges = Branchial Arches**



**Branchia  
Means Gill  
In Greek;  
In fish, similar  
structures  
form Gills**

# GILLS OF FISH

Gills - located lateral to Rostral (proximal) end of pharynx - covered and protected





# GILLS HAVE ARTERIES, MUSCLES AND NERVES

Gills have filaments attached to cartilages

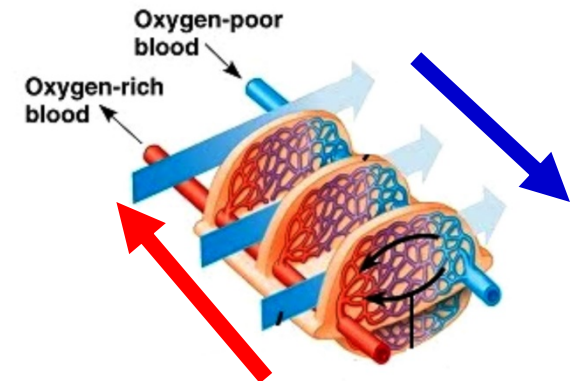
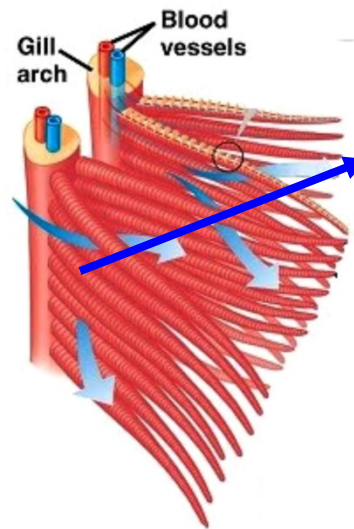
- arteries pass through filaments for gas exchange

- Gills moveable (filter feeding) - each has skeletal muscle and nerve  
(CRANIAL NERVE)



**water flow**

**blood flow**

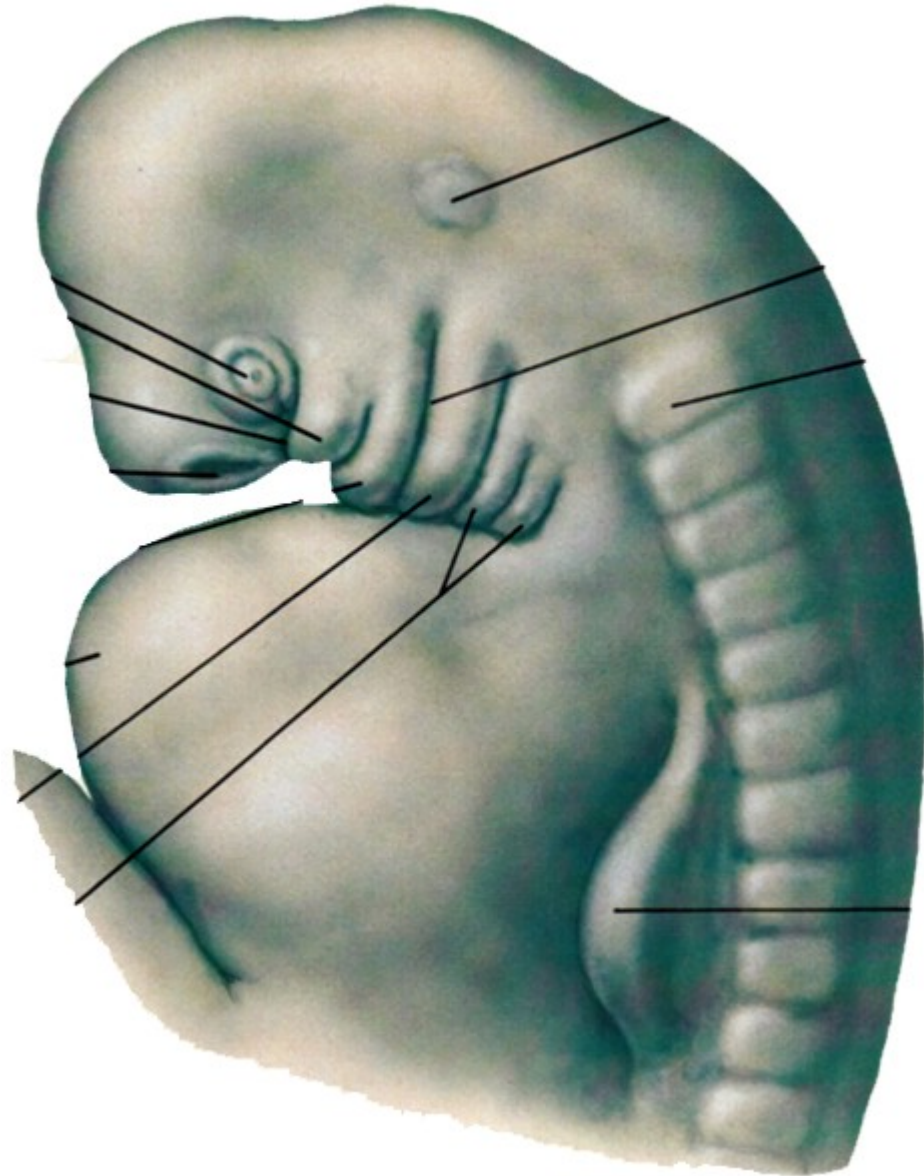


**Large surface area - Mackerel (swim a lot) - surface of gills 10 times surface area of body**

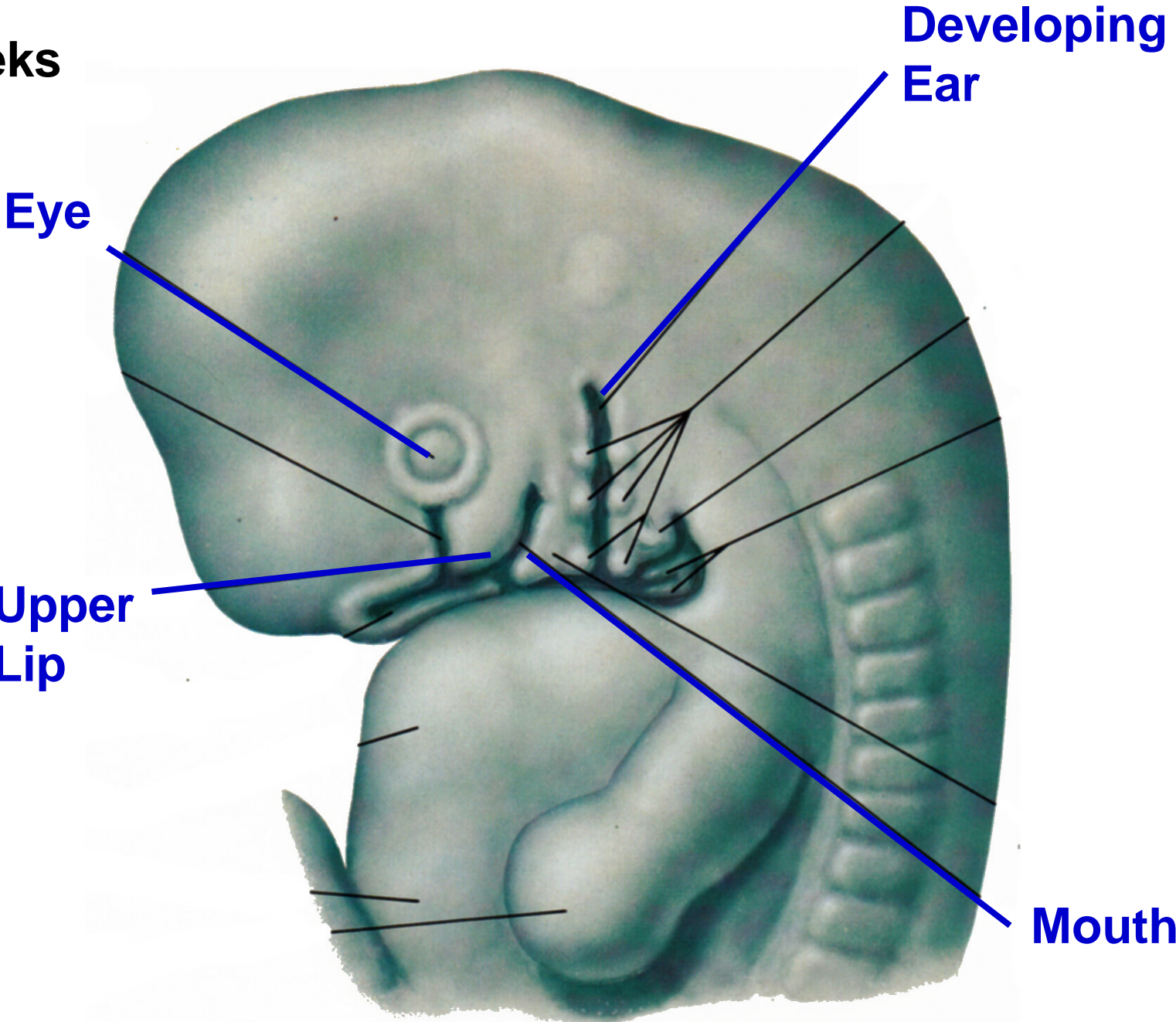
**Structures in Embryonic Branchial Arches Reorganize to form cartilages, nerve, muscles & arteries in fetus.**

**5- 6 weeks**

**Forms much of musculature of head some of neck**



**6-7 weeks**



**Developing  
Ear**

**Eye**

**Upper  
Lip**

**Mouth**

**8-10 weeks**



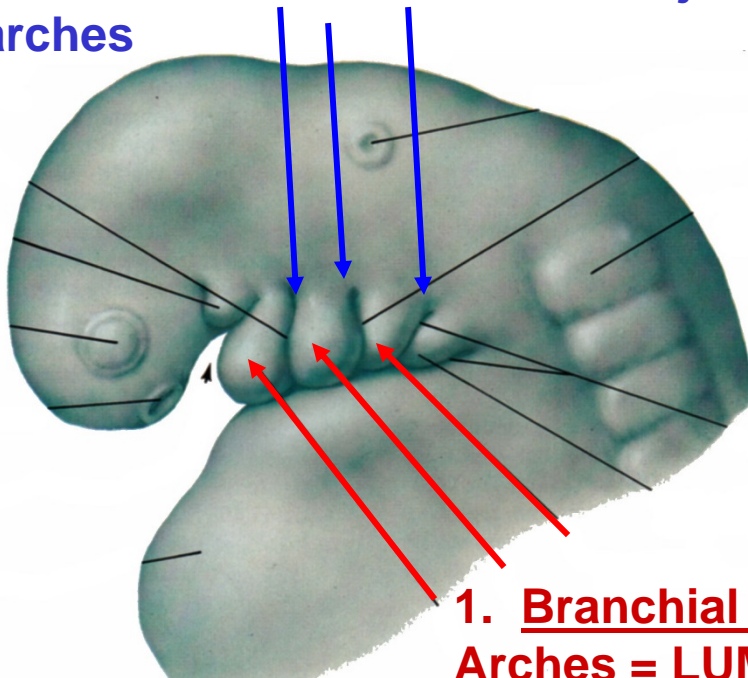
**Congenital Malformations of Head and Neck Result from incorrect Transformation of Branchial Apparatus to Adult Structures**

# TERMINOLOGY: ARCHES, GROOVES, POUCHES, MEMBRANES

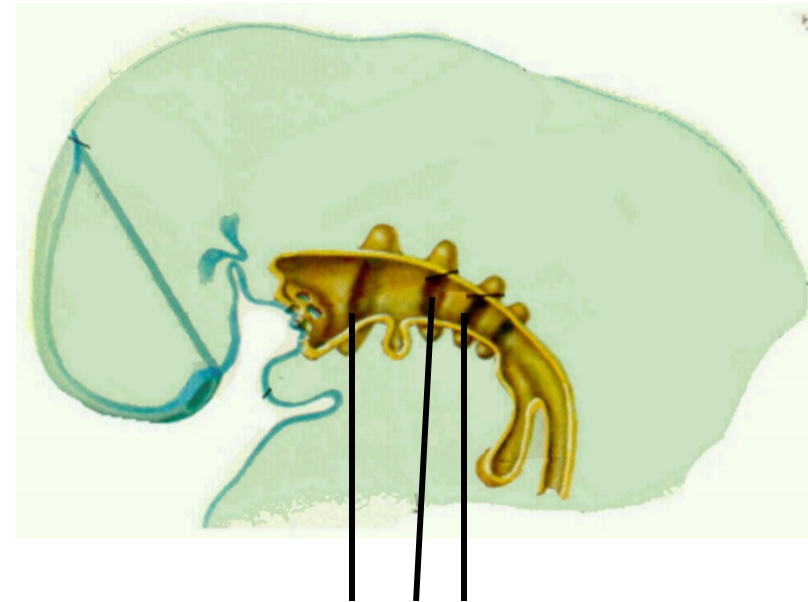
## VIEW OF EXTERIOR OF EMBRYO

### 2. Branchial Grooves (Clefts)

- ectodermal clefts between adjacent arches



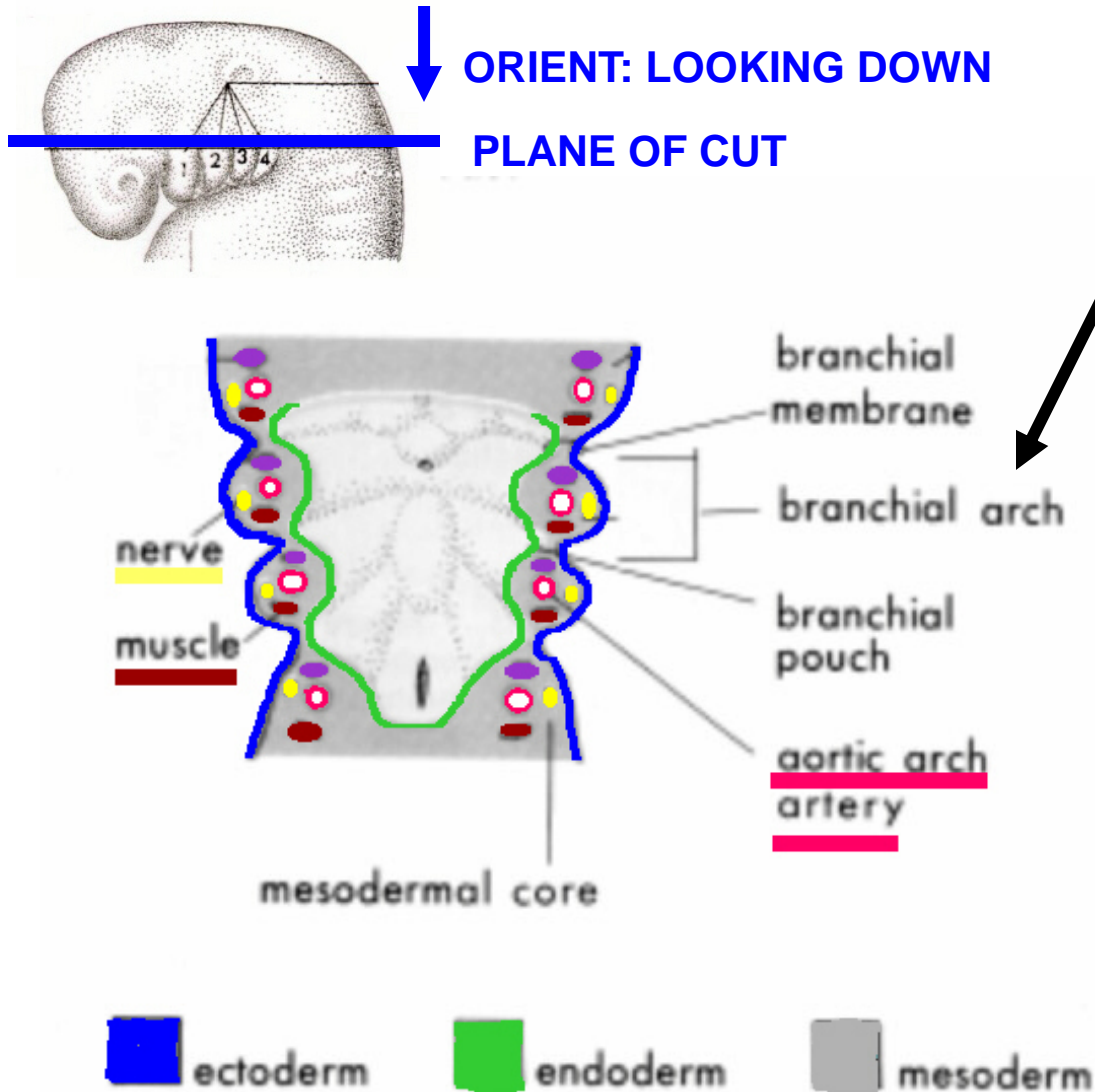
## VIEW OF EMBRYO BISECTED IN SAGITTAL PLANE



### 3. Branchial Pouch

- endodermal out pocketing from rostral foregut  
- between adjacent arches

## B. BRANCHIAL APPARATUS - 4 elements

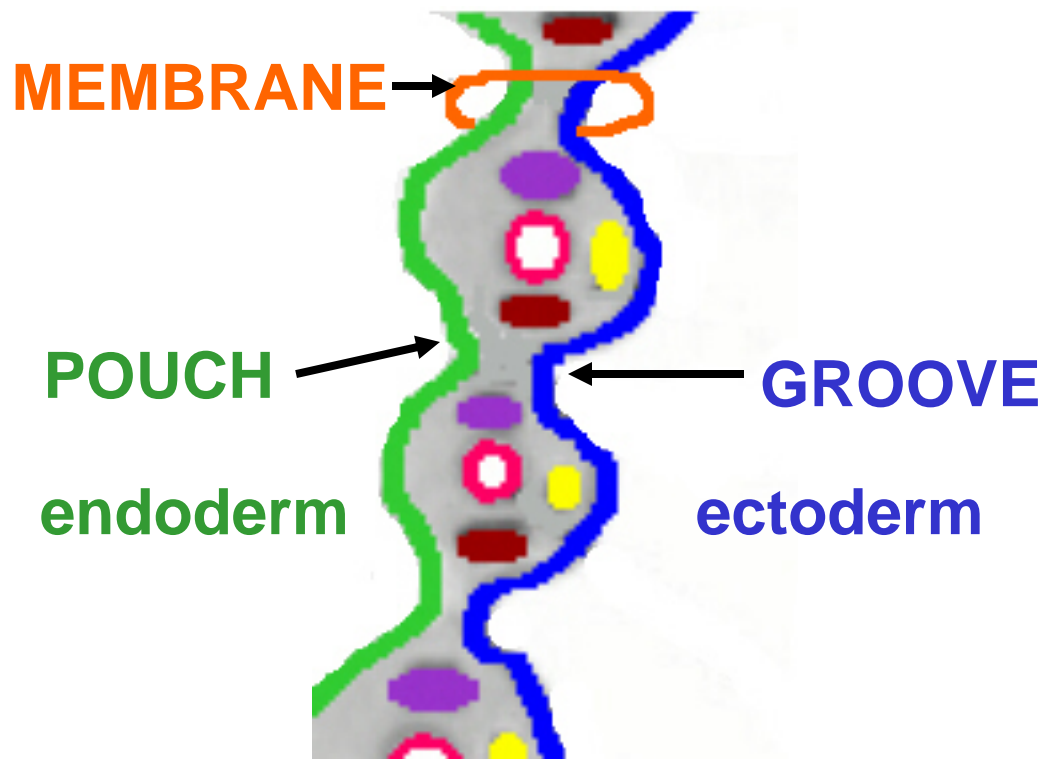
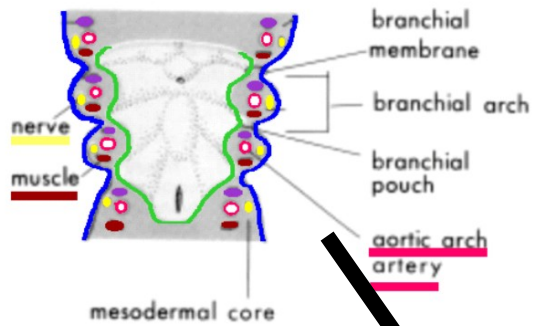


1. Branchial Arch  
covered by:  
Ectoderm - externally  
Endoderm - lined internally  
(Mesenchyme - core)

Each arch has own cartilage, nerve, muscle and artery (= aortic arch artery)

Each nerve innervates structures derived from its associated arch

# BRANCHIAL APPARATUS - 4 elements



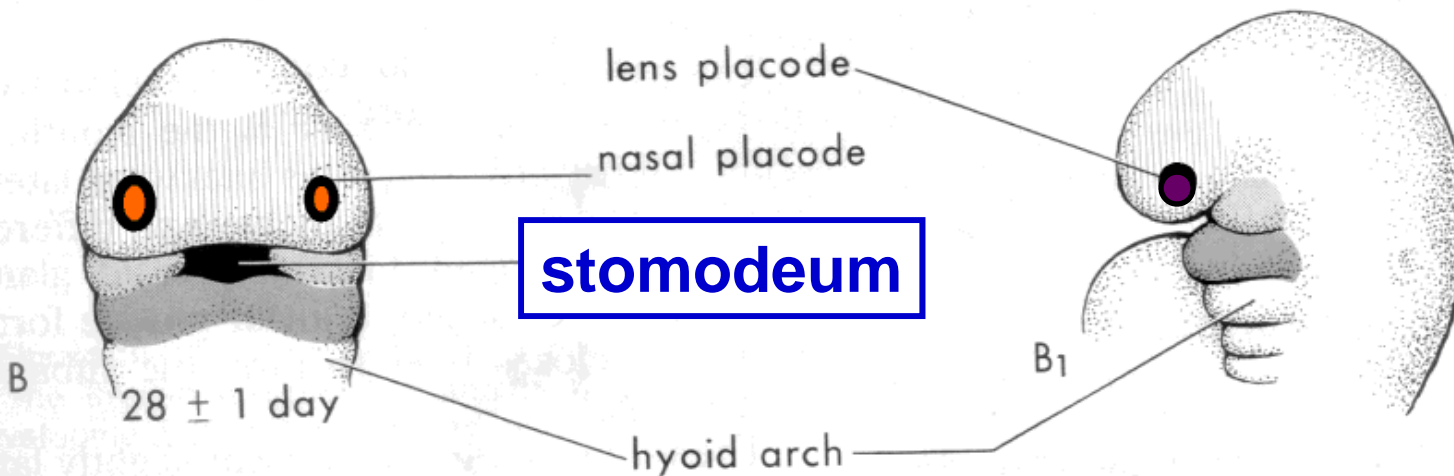
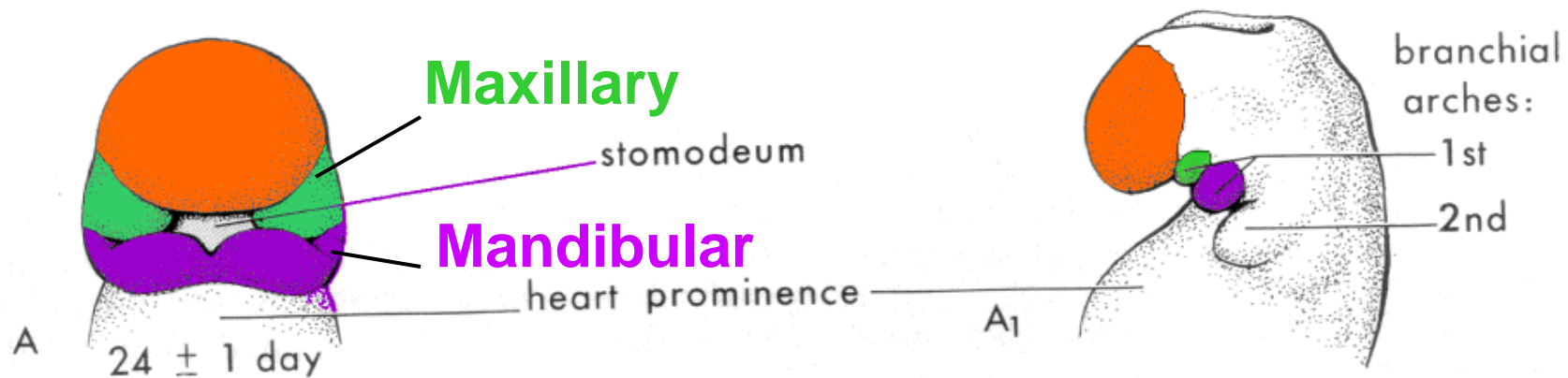
2. Branchial Groove  
(Pharyngeal Cleft)  
- ectodermal cleft  
between adjacent  
arches

3. Branchial Pouch -  
endodermal  
outpocketing from  
rostral foregut  
-between adjacent  
arches

4. Branchial Membrane  
- site of contact of  
Groove (ectoderm)  
Pouch (endoderm)

# First Arch - forms face, has maxillary and mandibular processes

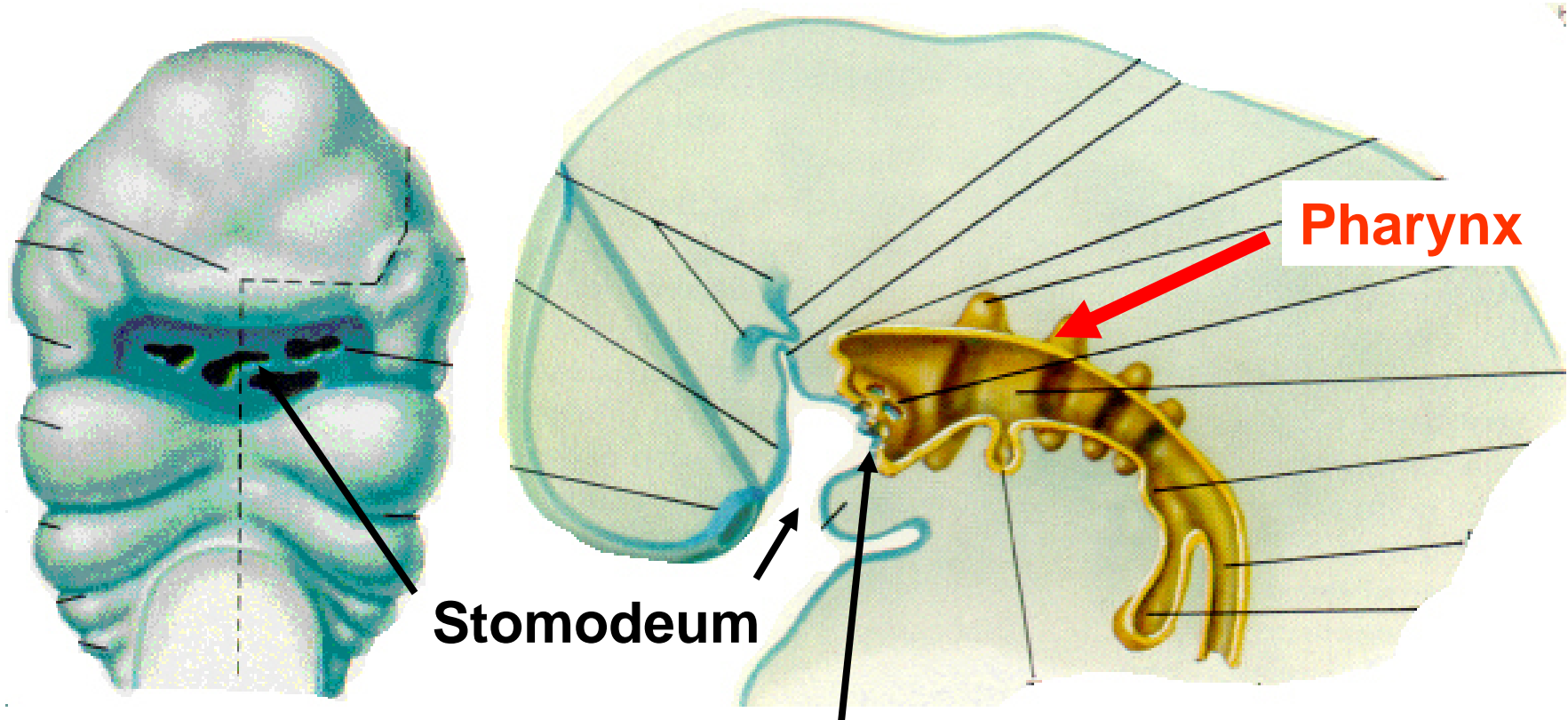
- surrounds stomodeum (primitive mouth)



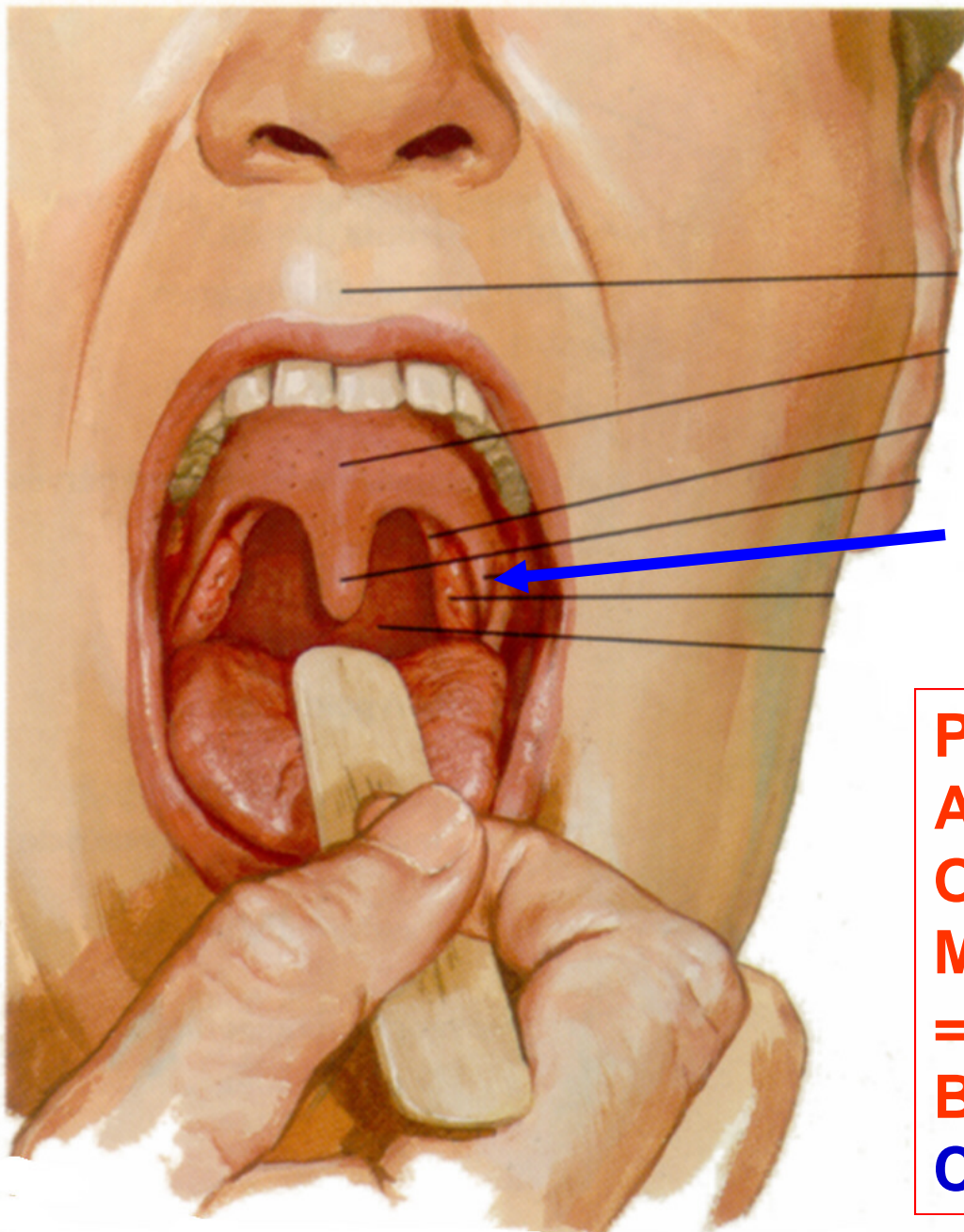
**NOTE: LENS PLACODE IS CORRECT**



- Stomodeum formed by Ectoderm; forms Oral Cavity and Nasal Cavity
- Contacts Endoderm at Oropharyngeal Membrane
- Pharynx – rostral foregut - formed by Endoderm



**Oropharyngeal Membrane = BOUNDARY**



**SAY  
AAHH!**

**PALATOGLOSSAL  
ARCH\*\***

**PALATOGLOSSAL  
ARCH = SITE OF  
OROPHARYNGEAL  
MEMBRANE  
= BOUNDARY,  
BETWEEN ORAL  
CAVITY AND PHARYNX**



ARCH/NERVE	SKELETAL	LIGAMENTS	MUSCLES
First (V)	1) Malleus 2) Incus	1) Ant. ligament of malleus 2) Sphenomandibular ligament	1) Muscles of Mastication 2) Tensor tympani 3) Tensor palati 4) Mylohyoid 5) Ant. belly of Digastric
Second (VI)	1) Stapes 2) Styloid process 3) Hyoid bone - lesser horn, upper half of body	Stylohyoid ligament	1) Muscles of Facial Expression 2) Stapedius 3) Stylohyoid 4) Post. belly of Digastric
Third (IX)	Hyoid bone - greater horn, lower half of body	-----	Stylopharyngeus
Fourth (X)	Cartilages of Larynx	-----	1) All muscles of Larynx 2) All muscles of Pharynx (except Stylopharyngeus) 3) All muscles of Soft Palate (except Tensor palati)
Sixth (XI)	-----	-----	1) Sternocleidomastoid 2) Trapezius

Note: First Branchial Groove (Cleft) becomes External Auditory Meatus  
First Branchial Membrane becomes Tympanic Membrane

**Note:**

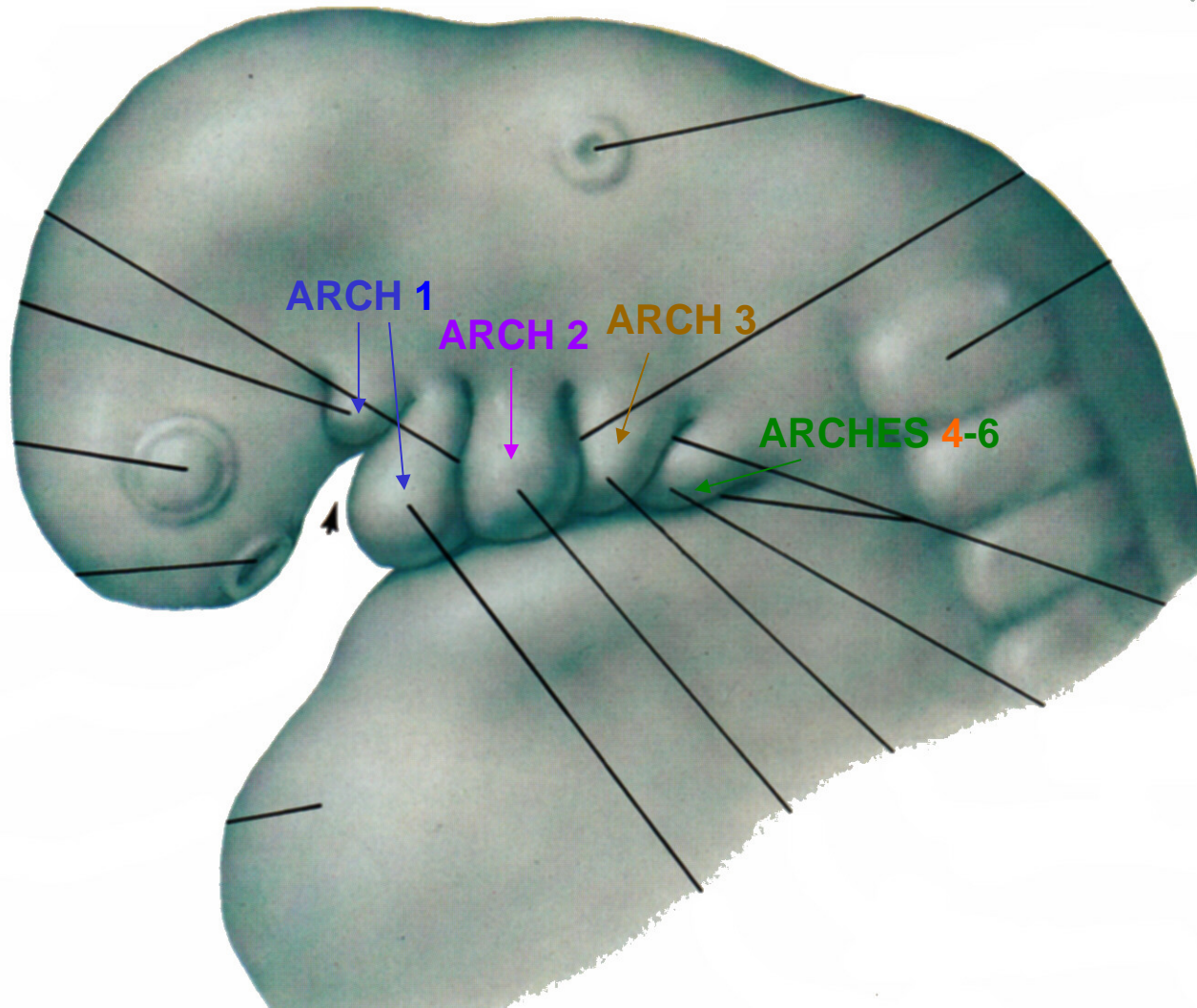
**All authors agree on:**

**1) Fate of Arches**

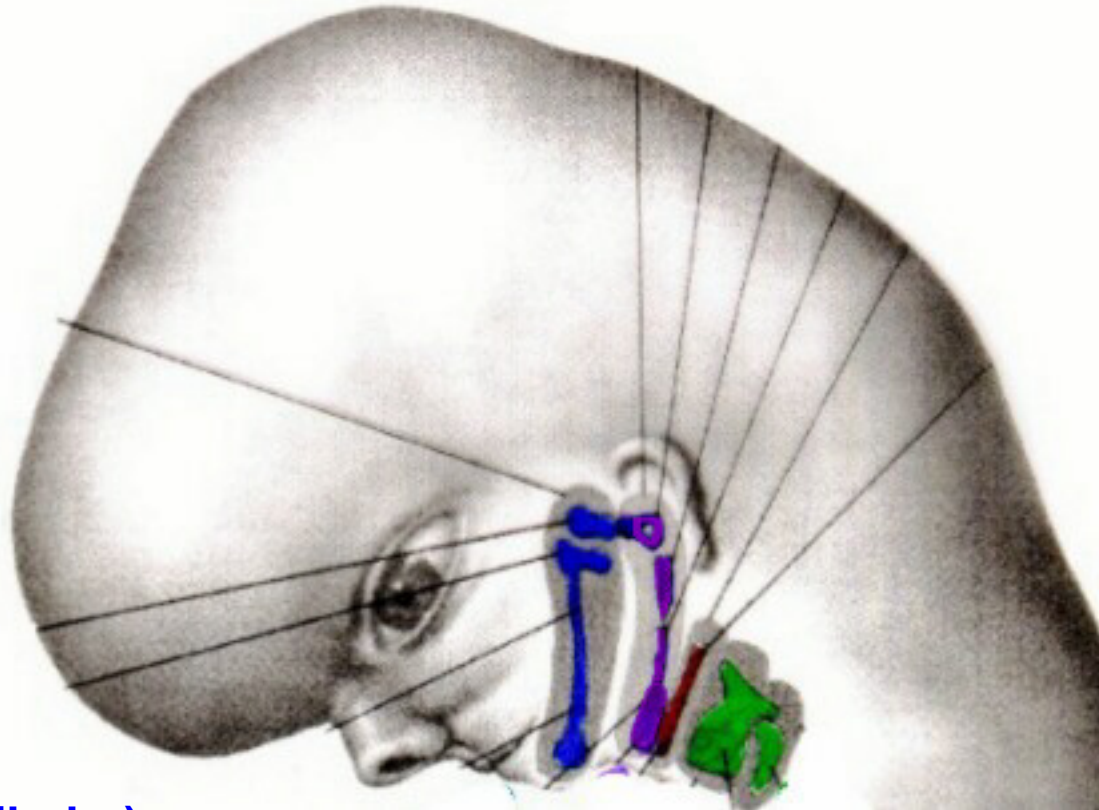
**1- 3;**

**2) Arch 5 does not form structures in humans**

**Accounts vary on Arches 4 and 6 (6 is small)**



# BRANCHIAL ARCH CARTILAGES



## I First (Mandibular)

### Arch -

1. Malleus
2. Incus
3. Ant. Ligament  
Of malleus
4. Sphenomandibular  
ligament

## II Second (Hyoid) Arch

1. Stapes
2. Styloid Process
3. Stylohyoid Ligament
4. Lesser horn, Upper  
 $\frac{1}{2}$  body Hyoid

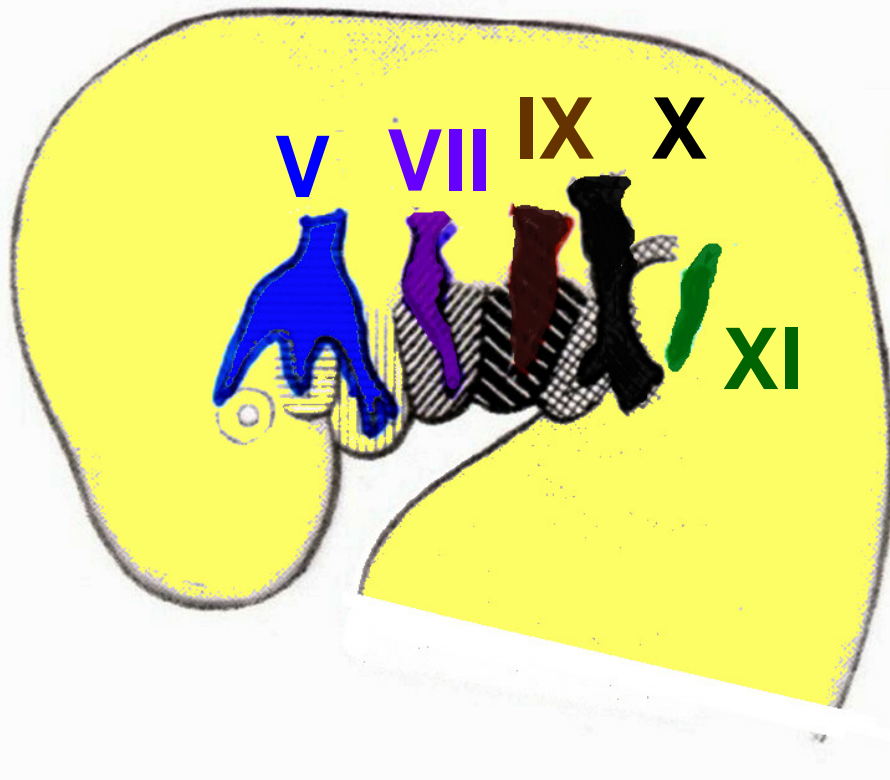
## III Third Arch -

- Lower  $\frac{1}{2}$   
Body, Greater  
Horn Of hyoid

## IV Fourth (Sixth) Arch - Cartilages Of larynx

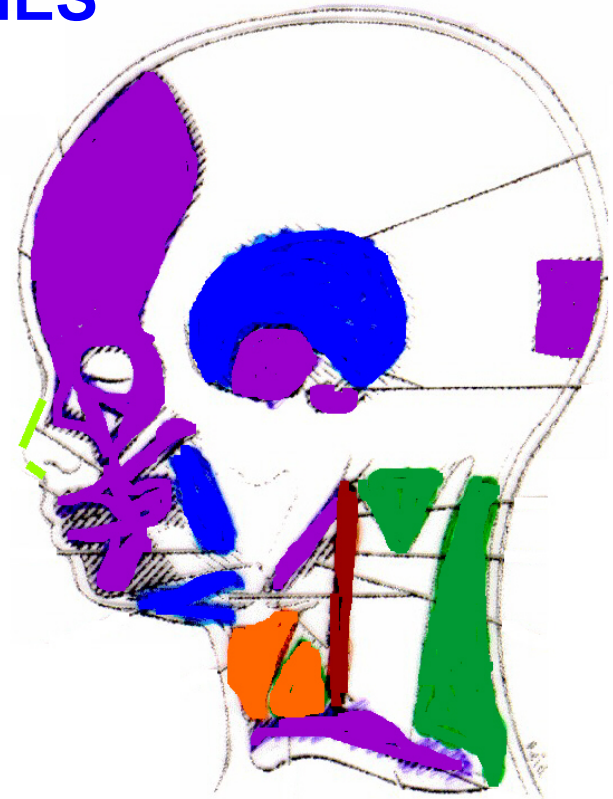
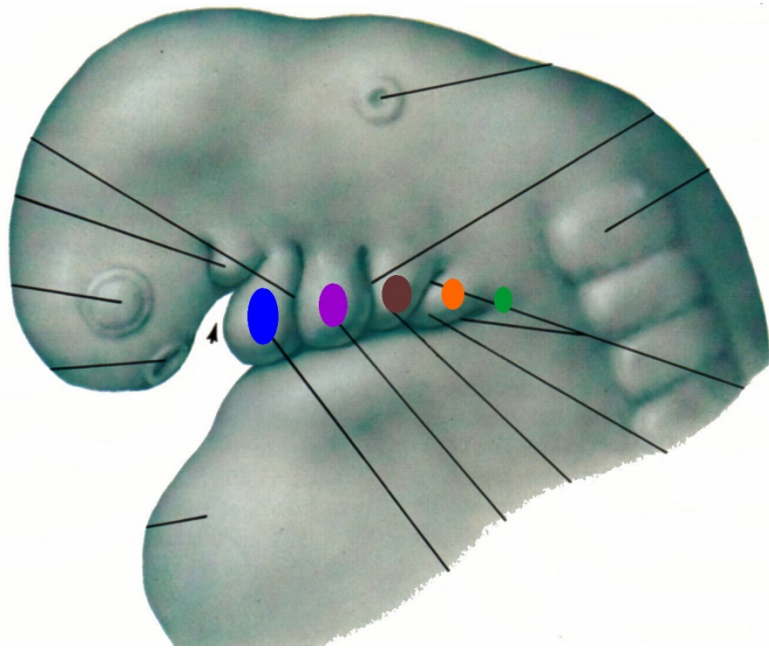
# BRANCHIAL ARCH NERVES

Muscles of Arches are innervated by Cranial Nerves



- 1) First Arch – Trigeminal (V)
- 2) Second Arch – Facial (VII)
- 3) Third Arch – Glossopharyngeal (IX)
- 4) Fourth Arch – Vagus (X)
- 5) Caudal Sixth – Accessory (XI)

# MUSCLES OF BRANCHIAL ARCHES



**Innervated by**

**First -  
Trigeminal  
V**

**Second -  
Facial  
VII**

**Third  
Glosso-  
pharyngeal  
IX**

**Fourth  
Vagus  
X**

**Sixth  
Accessory  
XI**

When muscles migrate, they carry the nerve branch with them.

**10) BRANCHIOMOTOR** - voluntary motor to skeletal muscles of face, ear, pharynx and neck that are derived from branchial arches.

	<u>Nerve</u>	<u>Innervates</u>	
<b>FIRST ARCH</b>	V (Trigeminal) (all in V3)	muscles of mastication mylohyoid tensor tympani tensor palati anterior belly of digastric	<b>KNOW THIS: QUESTIONS ON EXAM, BOARDS</b>
<b>SECOND ARCH</b>	VII (Facial)	muscles of facial expression stylohyoid posterior belly of digastric stapedius	
<b>THIRD ARCH</b>	IX (Glossopharyngeal)	stylopharyngeus	
<b>FOURTH ARCH</b>	X (Vagus)	all muscles of pharynx (except stylopharyngeus) muscles of larynx all muscles of palate (except tensor palati)	
<b>CAUDAL SIXTH ARCH</b>	XI (Accessory)	sternocleidomastoid trapezius	

**\* \* \***

**note: Innervation pattern of Cranial Nerves applies to muscles of BRANCHIAL ARCHES: DOES NOT APPLY TO POUCHES OR CLEFTS**

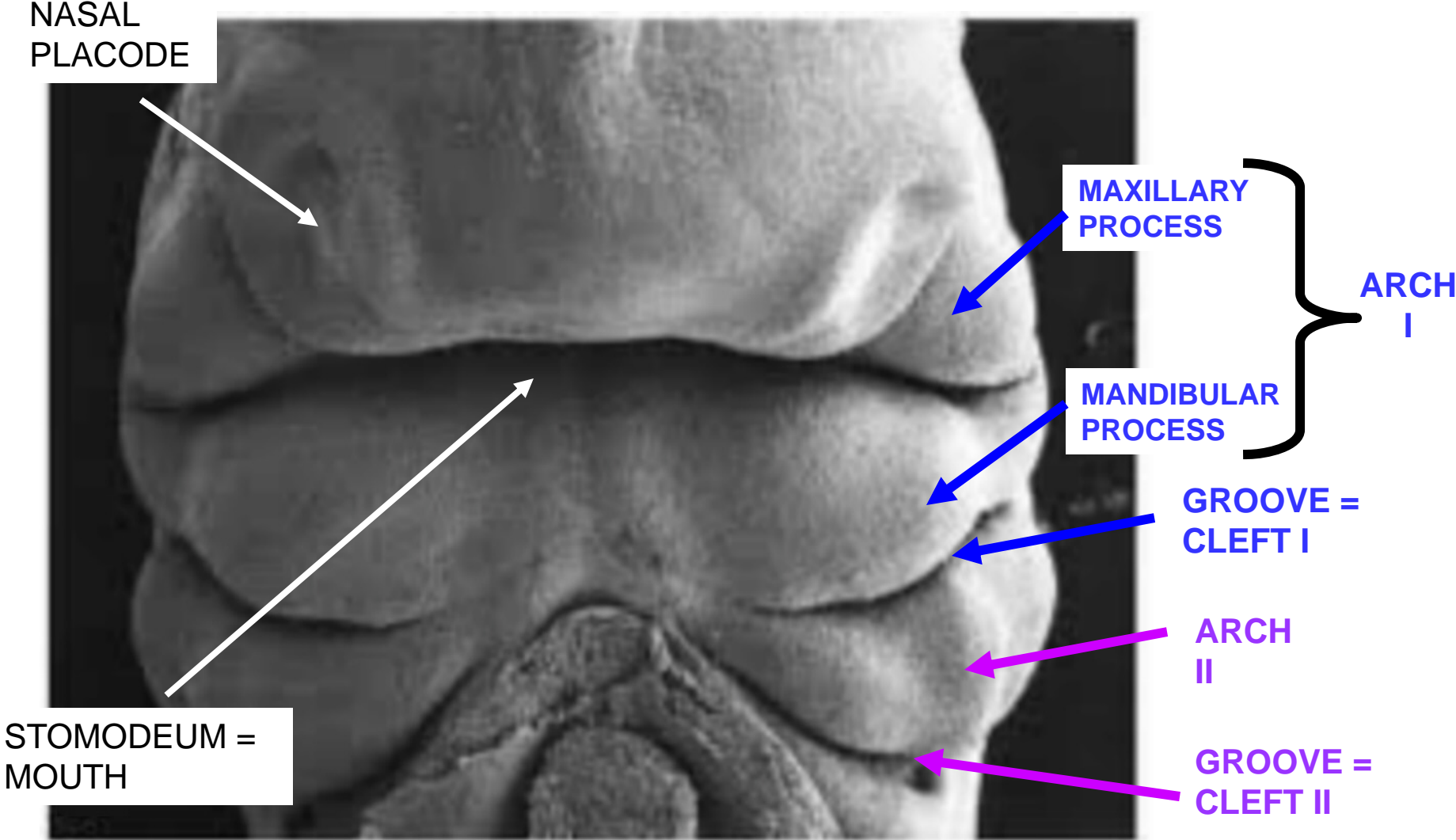


# BRANCHIOMOTOR (SVE) = SKELETAL MUSCLES DERIVED FROM BRANCHIAL ARCHES

ARCH/NERVE	SKELETAL	LIGAMENTS	MUSCLES
First (V)	1) Malleus 2) Incus	1) Ant. ligament of malleus 2) Sphenomandibular ligament	1) Muscles of Mastication 2) Tensor tympani 3) Tensor palati 4) Mylohyoid 5) Ant. belly of Digastric
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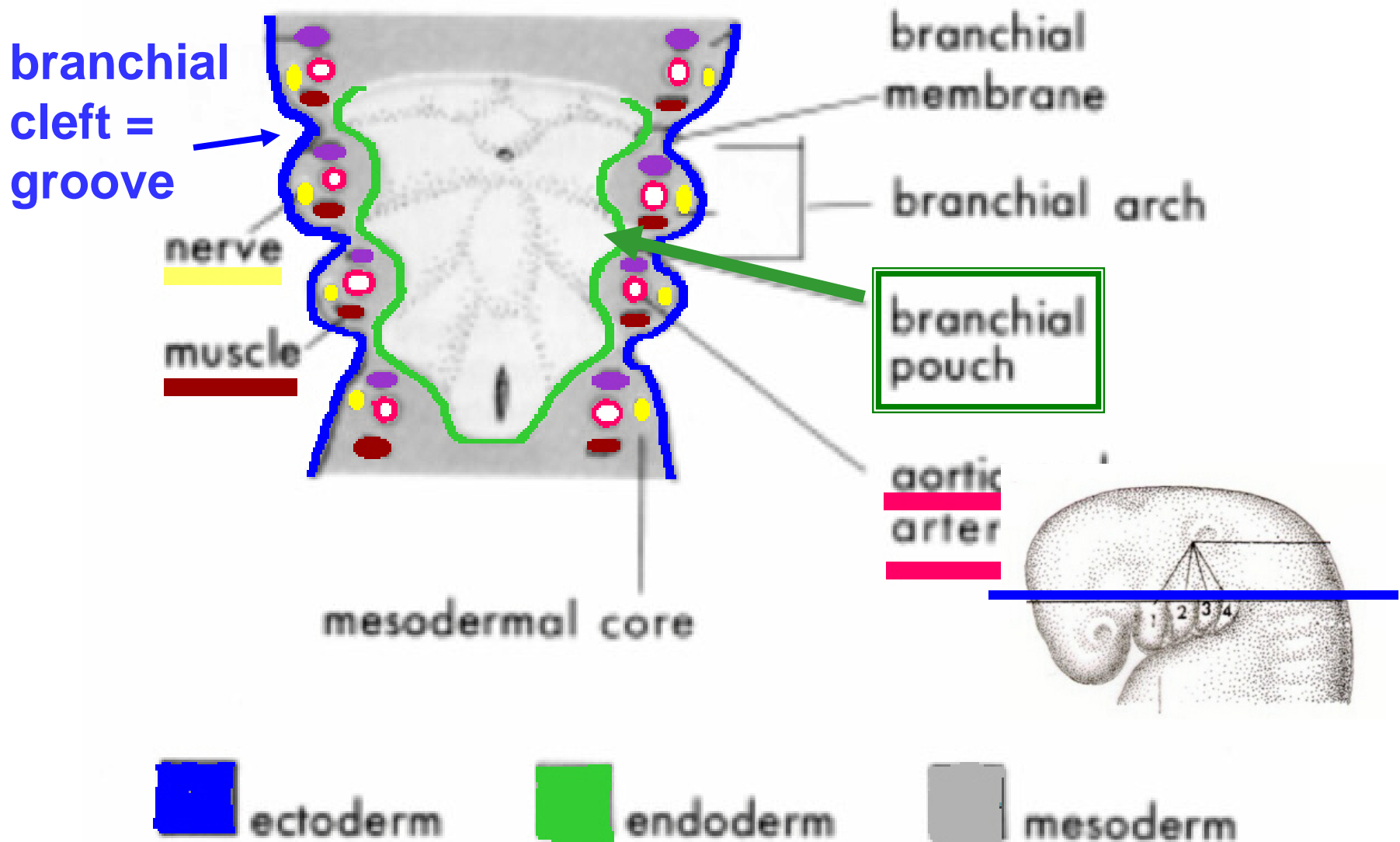
Note: First Branchial Groove (Cleft) becomes External Auditory Meatus  
First Branchial Membrane becomes Tympanic Membrane

# BRANCHIAL ARCHES AND CLEFTS

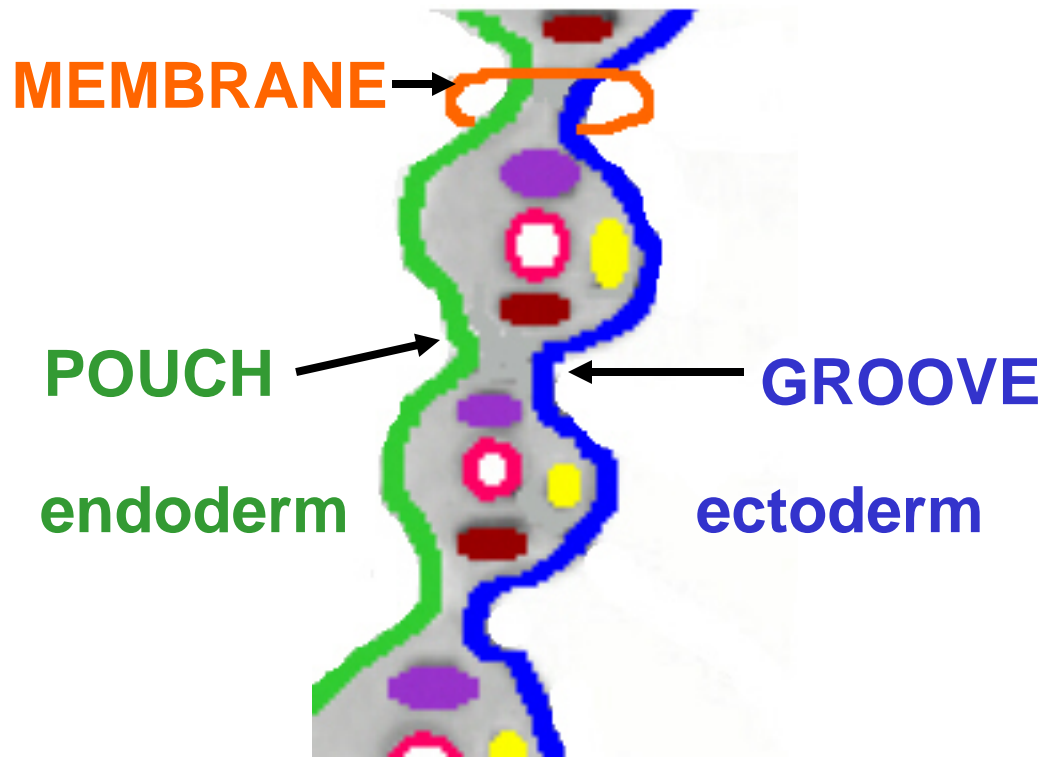
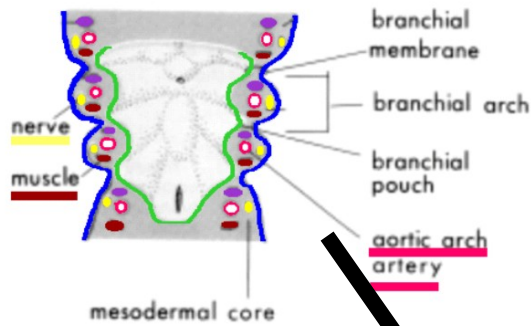


24 DAY HUMAN EMBRYO

# BRANCHIAL POUCHES, GROOVES, MEMBRANES



# BRANCHIAL APPARATUS - 4 elements



2. Branchial Groove  
(Pharyngeal Cleft)  
- ectodermal cleft  
between adjacent  
arches

3. Branchial Pouch -  
endodermal  
outpocketing from  
rostral foregut  
-between adjacent  
arches

4. Branchial Membrane  
- site of contact of  
Groove (ectoderm)  
Pouch (endoderm)

# BRANCHIAL POUCHES, GROOVES, MEMBRANES

**KNOW THIS:  
QUESTIONS ON  
EXAM, BOARDS**

\*\*\*

POUCH	FORMS	CLINICAL
First	1) Auditory tube 2) Tympanic cavity	First Branchial 'Cleft' cyst - tract linked to external auditory meatus
Second	Lining (crypts) of palatine tonsils	Second Branchial 'Cleft' cyst - tract linked to tonsillar fossa (palatine tonsils)
Third	1) Inferior parathyroid gland 2) Thymus	Third Branchial 'Cleft' cyst - tract at thyrohyoid membrane or piriform recess
Fourth	1) Superior parathyroid gland 2) C-cells of Thyroid	does not form
Sixth (XI)	-----	-----

Note: Cysts and fistuli - in lateral neck are **anterior to Sternocleidomastoid muscle**

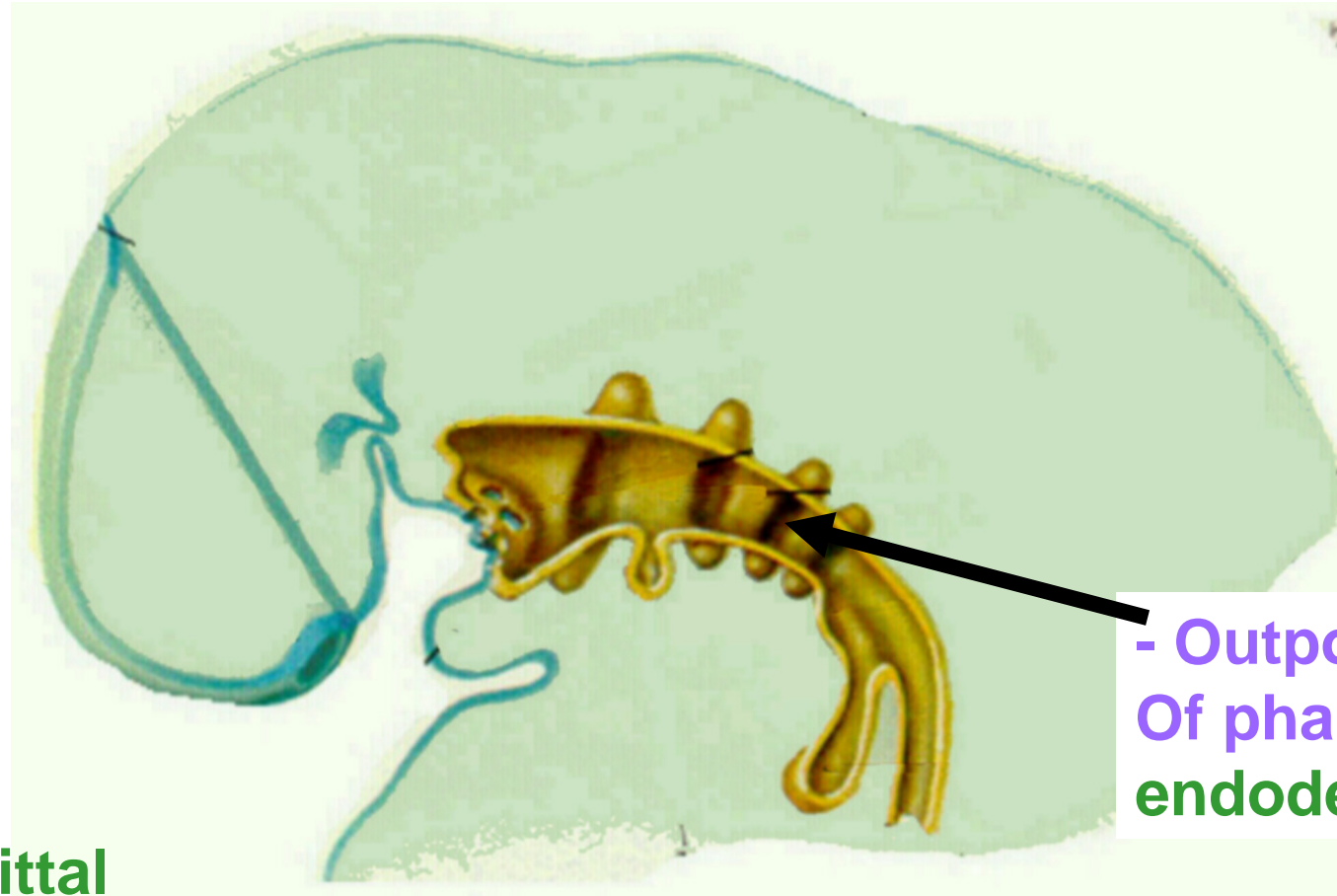
CLEFT	FORMS
First	External Auditory Meatus

\*\*\*

MEMBRANE	FORMS
First	Tympanic membrane

**NOTE: CLEFT = GROOVE**

## IV. BRANCHIAL POUCHES

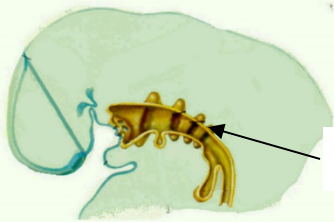


- Outpocketings  
Of pharynx  
endoderm

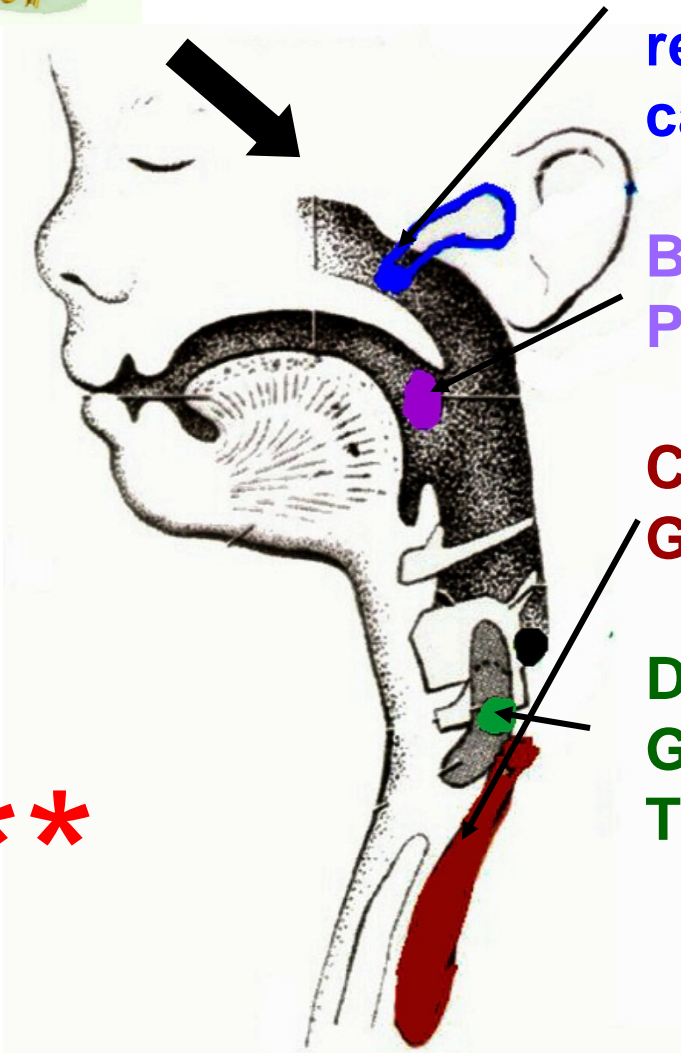
Sagittal  
View – embryo  
6-7 weeks

View  
Inside Pharynx  
Endoderm

# BRANCHIAL POUCH DERIVATIVES



Branchial Pouch



**A. Pouch 1 - forms Tubotympanic recess - Auditory Tube, Tympanic cavity**

**B. Pouch 2 - lining (crypts) of Palatine Tonsils**

**C. Pouch 3- Inferior Parathyroid Glands and Thymus Gland**

**D. Pouch 4 - Superior Parathyroid Glands and C-Cells (Calcitonin) of Thyroid**

**\*\*\***

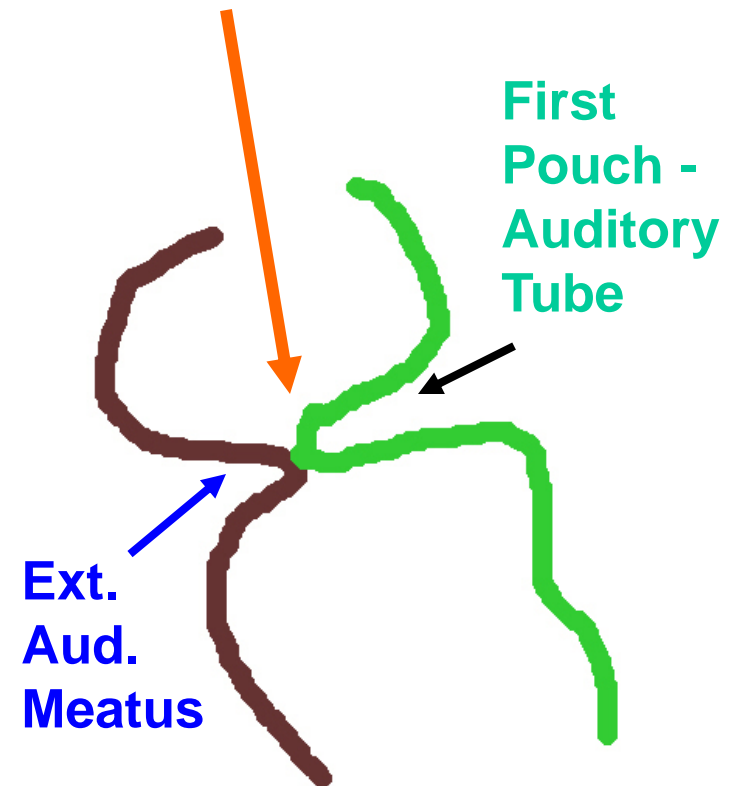
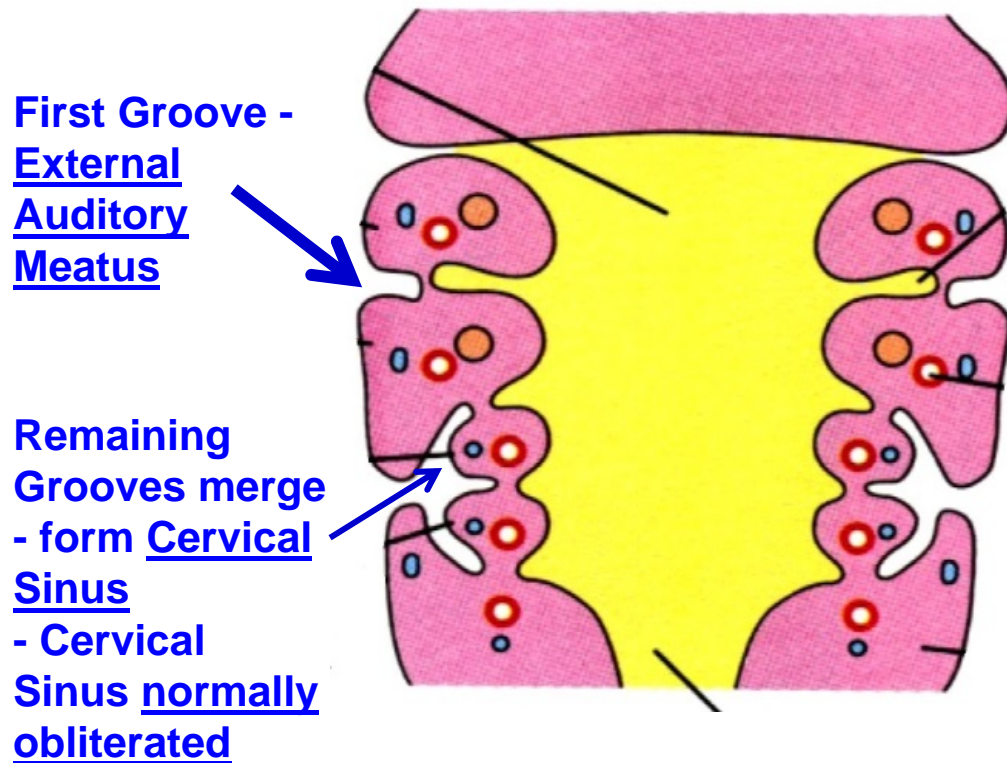
**Note: Pouch 3 derivatives migrate caudal to pouch 4**

### III. BRANCHIAL GROOVES (CLEFTS) AND MEMBRANES

Only First Branchial Groove and Membrane Normally form Structures in Adult

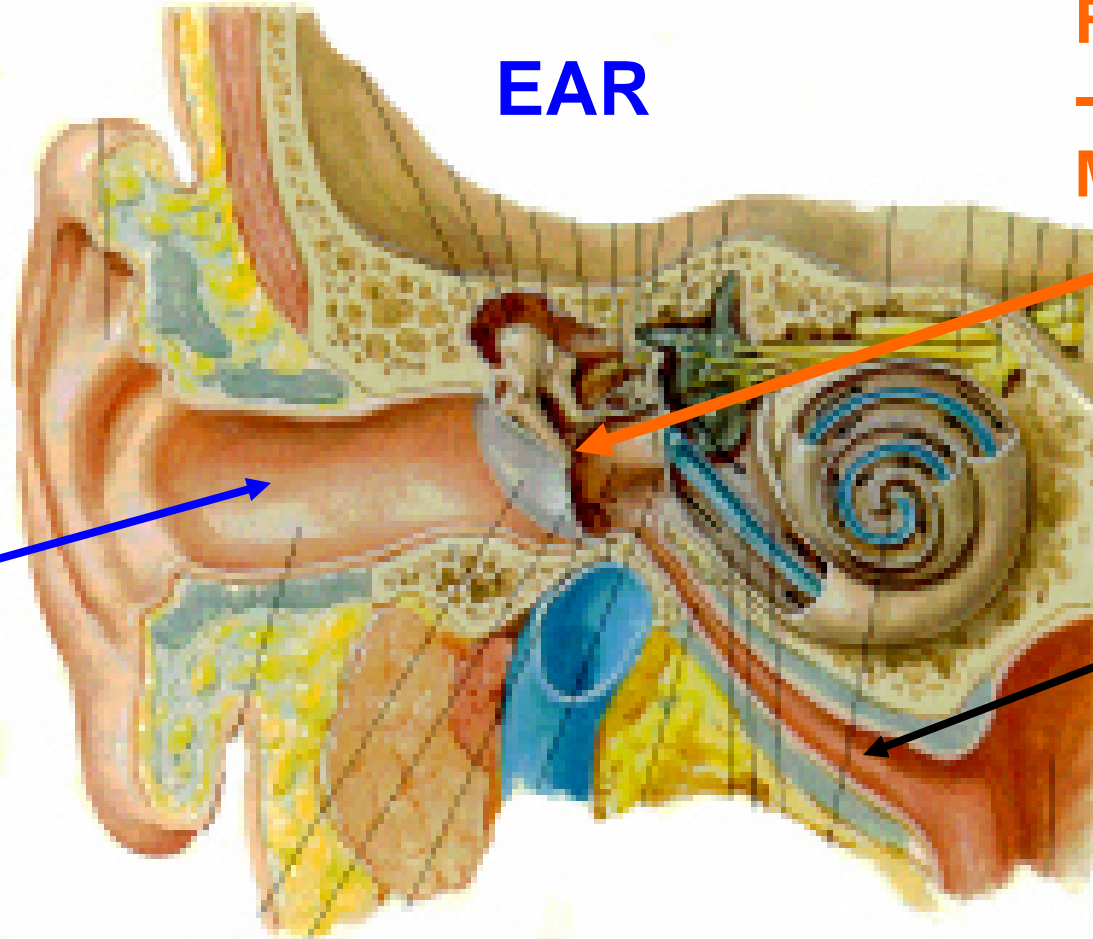
First Groove - External Auditory Meatus

First Membrane = Tympanic Membrane





# EAR



**FIRST GROOVE -**  
Ext. Aud.  
Meatus

**First Membrane - Tympanic Membrane**

**FIRST POUCH -**  
Auditory Tube,  
Tympanic Cavity

## Outer Ear

- 1) funnel shaped
- 2) directs sounds to tympanic membrane
- 3) binaural hearing

## Middle Ear

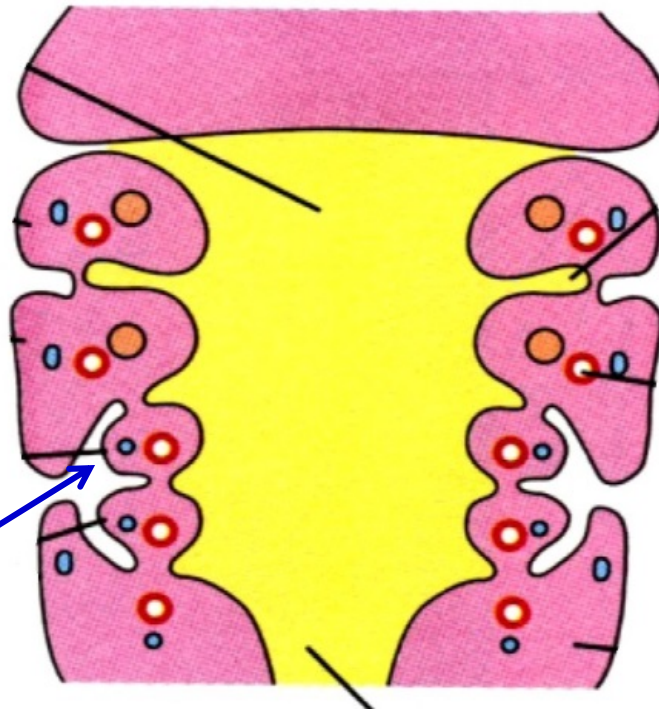
- 1) bones link tympanic membrane to cochlea amplify pressure
- 2) muscles can dampen loud sounds

## Inner Ear

- 1) cochlea-hearing  
vestibular apparatus-gravity

# BRANCHIAL GROOVES

Other Grooves develop in longer depression  
Cervical Sinus



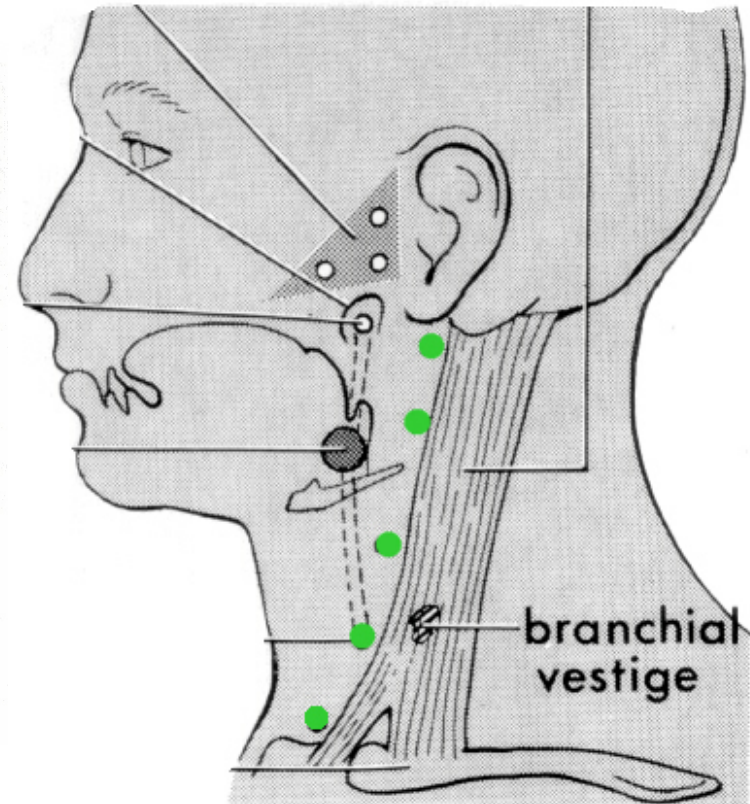
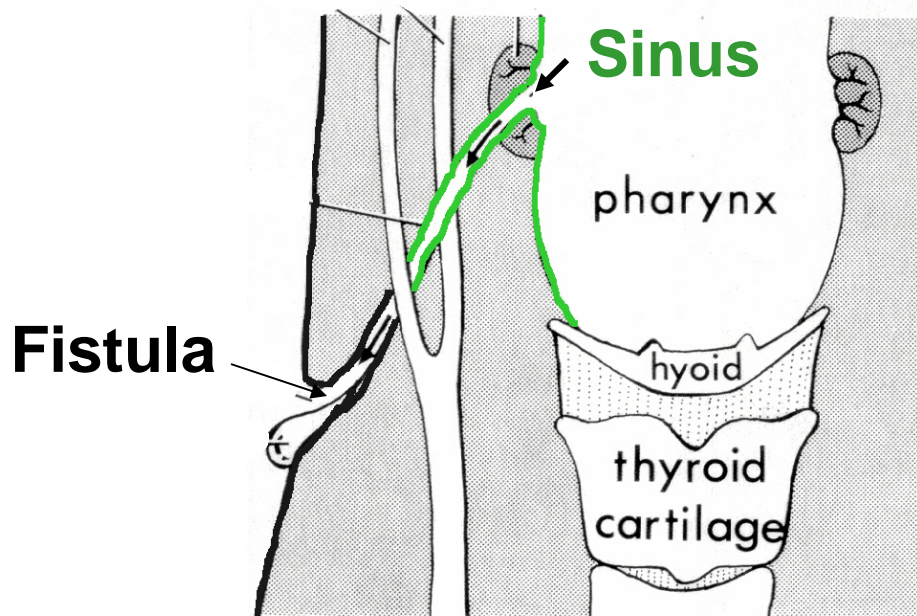
Remaining  
Grooves merge  
- form Cervical  
Sinus  
- Cervical  
Sinus normally  
obliterated

Note:  
Cervical  
sinus  
normally  
obliterated  
but  
can persist

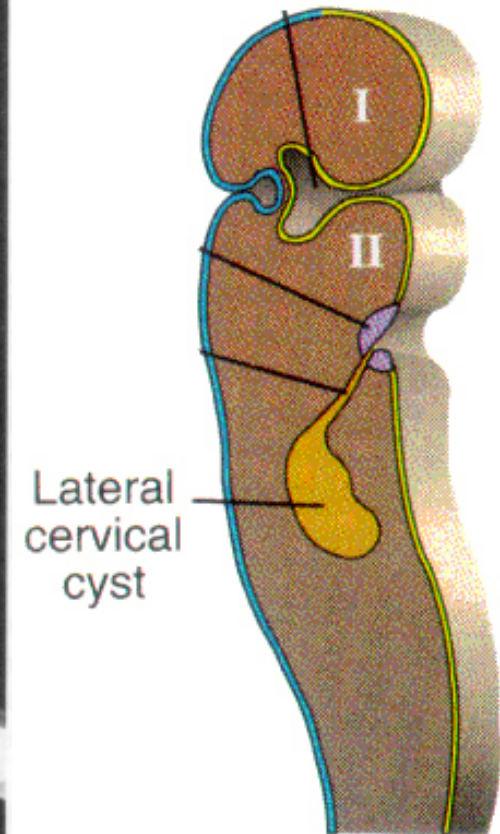
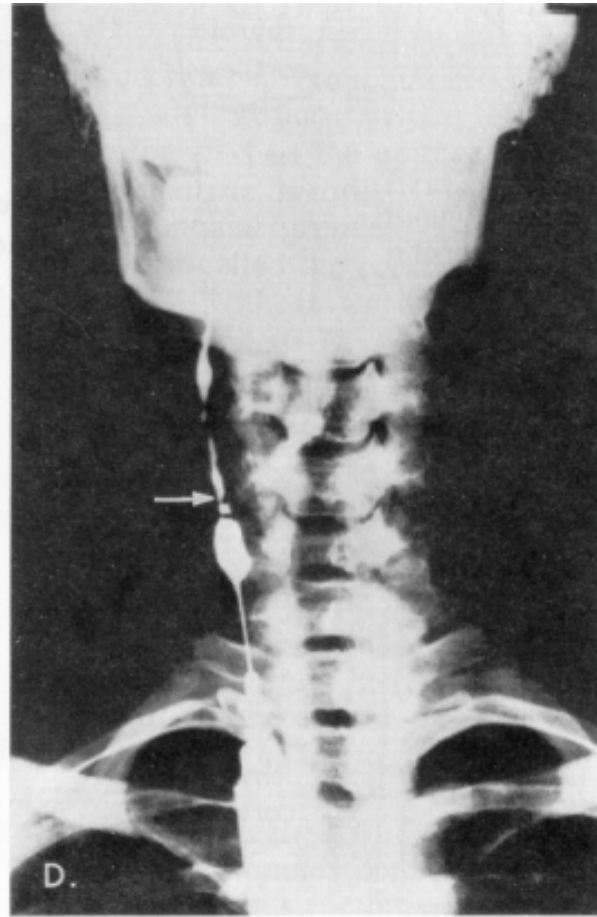
## BRANCHIAL ANOMALIES

Branchial Sinus = Blind pouch from Pharynx

Branchial Fistula = Channel, often connecting Pharynx to skin of neck; usually passes Anterior to Sternocleidomastoid, between Int. and Ext. Carotid A.



## BRANCHIAL ANOMALIES



**Branchial Fistula - drains to neck**

**Branchial Cyst  
often remnant  
of Cervical Sinus**

# BRANCHIAL POUCHES, GROOVES, MEMBRANES

POUCH	FORMS	CLINICAL
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Sixth (XI)	-----	-----

Note: Cysts and fistuli - in lateral neck are **anterior to Sternocleidomastoid muscle**

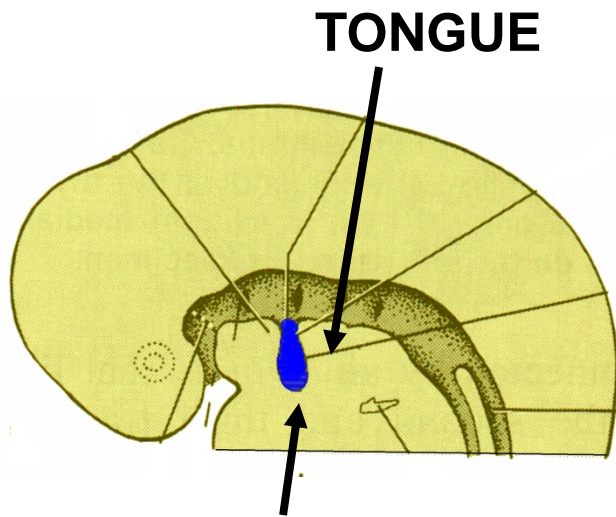
CLEFT	FORMS
First	External Auditory Meatus

MEMBRANE	FORMS
First	Tympanic membrane

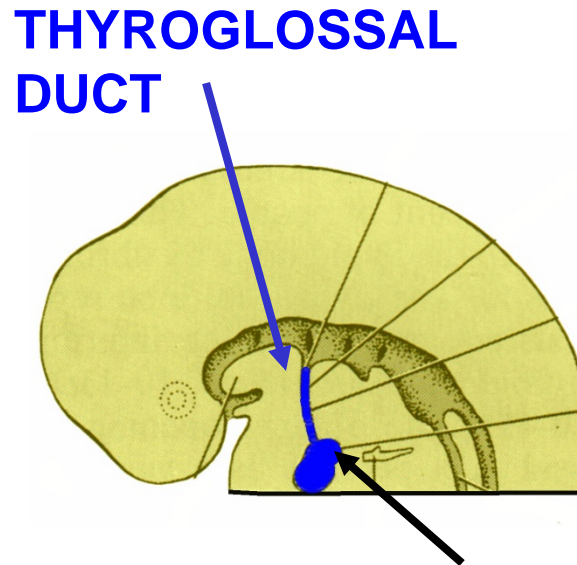
**KNOW THESE CHARTS QUESTIONS ON EXAM, BOARDS**

**NOTE: CLEFT = GROOVE**

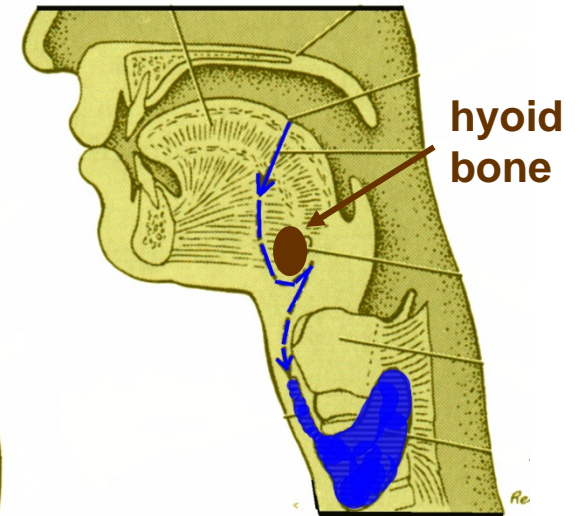
## V. DEVELOPMENT OF THYROID



1) Thyroid start as Median endodermal Thickening on floor of pharynx at **future junction of anterior 2/3 and posterior 1/3 of tongue (marked by Foramen Cecum)**

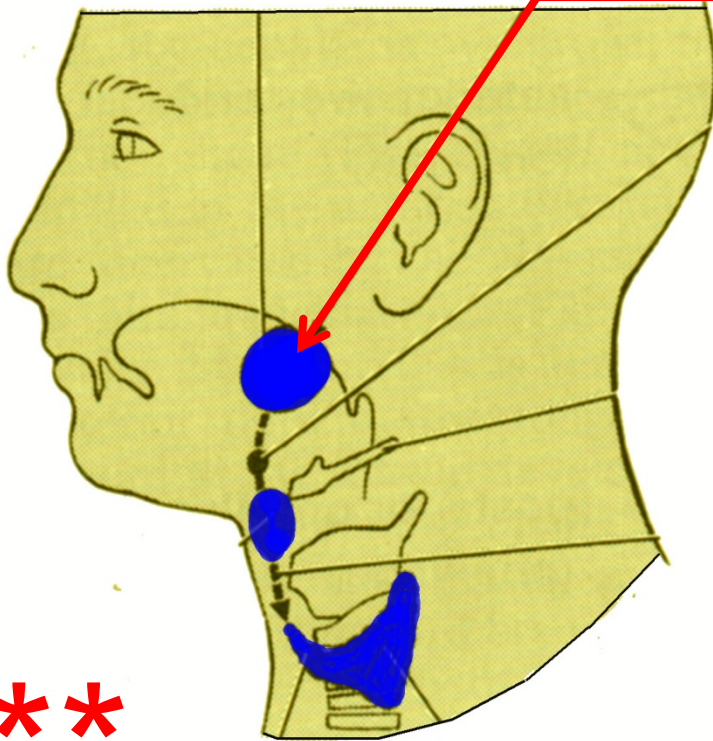


2) Elongates to form Thyroid Diverticulum; descends ant. to hyoid bone and larynx  
3) Thyroglossal duct connects Diverticulum to Foramen cecum



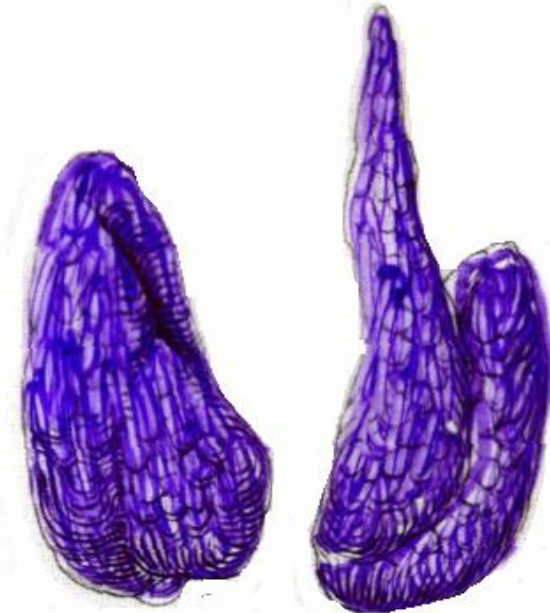
# CONGENITAL MALFORMATIONS

**LINGUAL THYROID\* - gland in tongue**



\*\*\*

**Thyroglossal Duct Remnants - can form thyroid tissue (cysts) along path (midline, ant. to hyoid, larynx)**



C. PYRAMIDAL LOBE. ABSENCE OF ISTHMUS

**Pyramidal Lobe - 50% of people; attached to hyoid by fibrous strand; no clinical problems**

**LINGUAL THYROID\* - Thyroid gland in tongue**



\*\*\*

**AT: Junction of anterior 2/3 and posterior 1/3 of tongue**



# NECK Part I

© 2021zillmusom

## I. OVERVIEW OF NECK

A. Neck is compartmentalized:

1. Posterior compartment - contains
  - a. Vertebrae of neck = cervical vertebrae
  - b. Muscles which surround and move cervical vertebrae and neck: i. posterior to vertebrae, muscles are continuations of Muscles of Back and Suboccipital region; ii. laterally, muscles are called Scalenes; iii. anteriorly, muscles located directly anterior to vertebrae are called Prevertebral muscles
2. Anterior compartment contains
  - a. Viscera - in lower part of neck: Trachea, Thyroid gland and Esophagus.
  - b. Pharynx - in upper part of neck: Pharynx. Pharynx is a tube composed of muscles and fascia that is continuous anteriorly with the Oral and Nasal cavities; the Esophagus and the Larynx open into the pharynx.
3. Lateral compartment (lateral and posterior to pharynx) - Carotid Sheath contains blood vessels (Carotid arteries and Internal Jugular veins) and Vagus nerve; Sympathetic Chain is posterior to Carotid Sheath.

II. **MUSCLES OF NECK** - see Table of Muscles of Neck for actions and innervation.

A. Muscles not attached to hyoid bone

1. Sternocleidomastoid muscle

Note: **Torticollis** (L. torti, twisted; collum, neck) - Rotational torticollis can be congenital or acquired; associated with contracture of Sternocleidomastoid; **head is rotated so face is directed to opposite side (contralateral to lesion)** (BOARD QUESTION).

**Note: Sternocleidomastoid is important landmark in diagnosis and procedures** in neck. **Internal Jugular vein** can be accessed and catheterized between Sternal and Clavicular heads of Sternocleidomastoid; Thyroid gland and Jugular chain of Lymphatics are located anterior to Sternocleidomastoid; Branchial cleft cysts are lateral masses anterior to Sternocleidomastoid.

2. Scalenus anterior and medius

**Note: Scalene muscles are important landmarks;** Brachial plexus and Subclavian artery pass between Scalenus Anterior and Scalenus Medius; **Phrenic nerve (nerve to Diaphragm) passes anterior to Scalenus Anterior, posterior to Sternocleidomastoid** (BOARD QUESTION).

B. Hyoid bone - located in anterior part of neck; 'free-floating', attached to skull and skeleton only by muscles and ligaments; Stylohyoid ligament links hyoid to styloid process of temporal bone; Thyrohyoid membrane link hyoid to Thyroid cartilage; Hyoid bone has parts: body (central part),

Greater and Lesser horns (cornu); all Infrahyoid and Suprahyoid muscles (except Sternothyroid) attach to body of hyoid; Greater horns can be palpated in neck above thyroid cartilage and used as landmarks to locate surrounding structures.

Functional Note: **Hyoid bone anchors tongue and floor of mouth; also supports larynx;** muscles which move hyoid bone produce movements of larynx and tongue (as occur during swallowing and talking)

C. Infrahyoid muscles - all muscles act to depress hyoid bone: Omohyoid, Sternohyoid, Sternothyroid, Thyrohyoid.

D. Suprahyoid muscles - all act to elevate the hyoid bone: Digastric - also opens mouth; Stylohyoid - note: splits to surround digastric tendon; Mylohyoid - forms muscular floor of mouth; Geniohyoid - pulls hyoid forward.

### III. NERVES OF NECK

A. Cervical plexus - formed from ventral primary rami of spinal nerves C2-C4, which emerge from posterior border of Sternocleidomastoid (near its mid-point); most branches are cutaneous:

1. Lesser Occipital nerve - innervates skin behind ear and skin of upper lateral neck
2. Great Auricular nerve - innervates skin over parotid gland and skin located inferior to ear.
3. Transverse Cervical nerve - innervates skin of anterior neck.
4. Supraclavicular nerves - innervate skin of lower lateral neck and shoulder
5. **Phrenic nerve** - (C3,4,5) provides motor innervation to the diaphragm, crosses anterior to Scalenus Anterior muscle, posterior to Sternocleidomastoid.

B. Ansa cervicalis – loop of fibers from **cervical spinal nerves that innervate neck muscles**; loop is attached to the Hypoglossal nerve; fibers from C1 travel with Hypoglossal nerve then leave and join fibers from C2 and C3 forming a loop; loop is located anterior to Carotid sheath and is attached to Hypoglossal nerve; however, **no fibers from the Hypoglossal nerve innervate neck muscles.**

### IV. ARTERIES OF HEAD AND NECK

A. Subclavian artery - at root of neck; artery passes laterally toward arm, posterior to Scalenus Anterior muscle; Scalenus Anterior muscle is used as a landmark to divide the artery into three parts:

1. Part I (medial to Scalenus Anterior) - **three branches:** (1) **Vertebral artery**, which ascends into neck and enters foramina transversaria of vertebra C1-C6; (2) **Internal Thoracic artery** which descends into thorax posterior to sternum; (3) **Thyrocervical trunk** - branches into **Inferior Thyroid, Transverse (or Superficial) Cervical, and Suprascapular arteries.**

2. Part II (post. to Scalenus Ant.) - one branch: **Costocervical trunk** - which

branches into a. Superior Intercostal artery to supply first two intercostal spaces with Posterior Intercostal arteries and b. Deep Cervical Artery to deep neck muscles.

3. Part III (lat. to Scalenus Ant.) - no branches.

B. Carotid arteries - Common carotid artery arises from aorta on left, brachiocephalic artery on right; it ascends into neck and divides at level of upper border of thyroid cartilage (vertebral level C4) into Internal and External Carotid arteries; Internal Carotid artery ascends to skull without branching; **External Carotid branches** supply face and scalp; branches are (from inferior to superior):

#### **Branches from Anterior side of External Carotid**

1. Superior Thyroid artery - descends to thyroid gland - gives off Superior Laryngeal artery which courses to larynx.
2. Ascending Pharyngeal artery - small branch which ascends to pharynx.
3. Lingual artery - ascends to supply tongue.
4. Facial artery - arises below mandible; first courses medial to mandible to supply tonsils and salivary glands; then crosses over surface of mandible to supply face, lips and nose.

#### **Branches from Posterior side of External Carotid**

5. Occipital artery - small branch which arises on posterior side of ext. carotid (opposite Facial artery) and supplies posterior scalp.
6. Posterior Auricular artery - small branch from posterior side of External Carotid which supplies posterior ear and adjacent scalp.

#### **Terminal branches of External Carotid - Ext. Carotid ends when it divides into:**

7. Superficial Temporal artery - large terminal branch of External Carotid; arises opposite External Auditory meatus; ascends to supply scalp and Temporalis muscle.
8. Maxillary artery - second large terminal branch of External Carotid; many branches (considered in lecture on Infratemporal region).

Clinical Note: **Carotid Artery Stenosis is a major cause of ischemic stroke of the brain.** MRI and CT angiography are the principal diagnostic tools for diagnoses and surgical intervention (Carotid Endarterectomy).

#### **V. VEINS OF HEAD AND NECK**

A. Overview - most arterial branches have accompanying veins (venae comitantes); branching pattern is variable; normally:

1. Superficial Temporal and Maxillary veins unite to form Retromandibular vein.
2. Retromandibular vein divides at angle of mandible into Anterior and Posterior divisions.
3. Anterior division joins Facial Vein to form Common Facial vein which drains into Internal Jugular vein.

4. Posterior division joins Posterior Auricular vein to form External Jugular vein.
5. External Jugular vein descends across Sternocleidomastoid muscle to drain into Subclavian vein.
6. Anterior Jugular vein forms from small veins below mandible; descends to join Ext. Jugular vein above clavicle.

## VI. FASCIA OF NECK

A. Superficial fascia - loose connective tissue below dermis; in neck generally thin and hard to demonstrate; contains platysma muscle and superficial veins.

B. Deep cervical fascia - layers of connective tissue; one layer completely surrounds neck; other layers form tubes contained within that layer; names of some layers are confusing

1. Investing layer of Deep cervical fascia - completely surrounds neck; splits into 2 layers to enclose Trapezius, Sternocleidomastoid, Suprahyoid and Infrahyoid muscles.
2. "Prevertebral" layer of deep cervical fascia - forms a tube which completely surrounds vertebral column, muscles of back of neck, prevertebral, lateral vertebral and suboccipital muscles (not Trapezius).
3. "Pretracheal" (visceral) layer of deep cervical fascia - actually completely surrounds cervical viscera, including thyroid gland, trachea, and esophagus; inferiorly it enters mediastinum.

Clinical Note: Retropharyngeal space - potential space between "prevertebral" and "pretracheal" layers; **infection (Retropharyngeal abscess)** can spread from head (as in tonsillitis) and neck via retropharyngeal space into mediastinum; George Washington may have died from this.

4. Carotid sheath - paired; on each side surrounds Common and Internal Carotid arteries, Internal Jugular vein, Vagus nerve, and Deep Cervical lymph nodes (sympathetic chain is posterior to carotid sheath); **infections tend to remain localized within the sheath.**

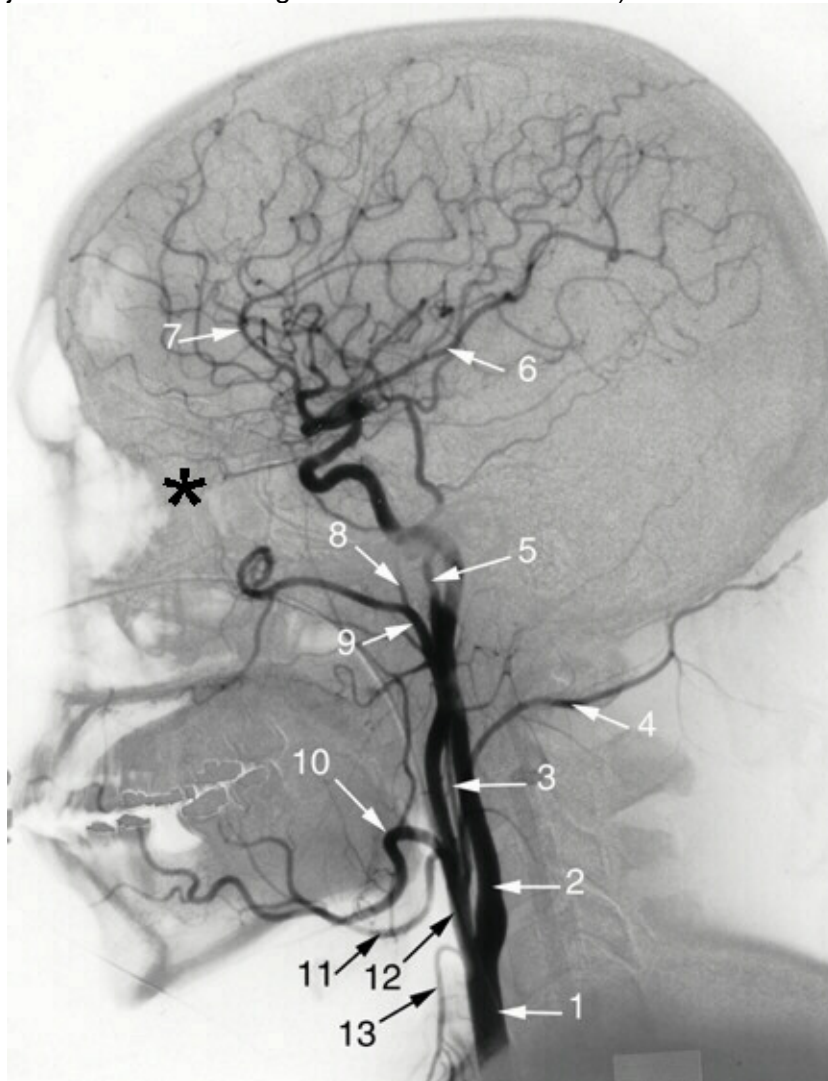
Clinical Note: Infections within Carotid sheath and Opioid drug use - Heroin (and fentanyl) addicts can cause infections within the Carotid sheath by attempting to inject drugs intravenously into the Internal Jugular vein.

Anatomical Note: The Internal Jugular Vein courses inside the Carotid Sheath. The External Jugular vein is NOT in the sheath but typically courses on the surface of the Sternocleidomastoid muscle.

VII. **LYMPHATICS OF HEAD AND NECK** - described as three groups of lymphatics and nodes: Superficial and Deep Rings of nodes and Deep Cervical chain

- A. Superficial Ring of nodes - drain areas adjacent to their location: consist of Submental, Submandibular, Buccal, Parotid, Retroauricular and Occipital nodes.
- B. Deep Ring of nodes - consist of Retropharyngeal and Pretracheal nodes.
- C. Deep Cervical Chain of lymph nodes - chain of nodes along Internal Jugular vein; receive lymph vessels from all nodes of head and neck.

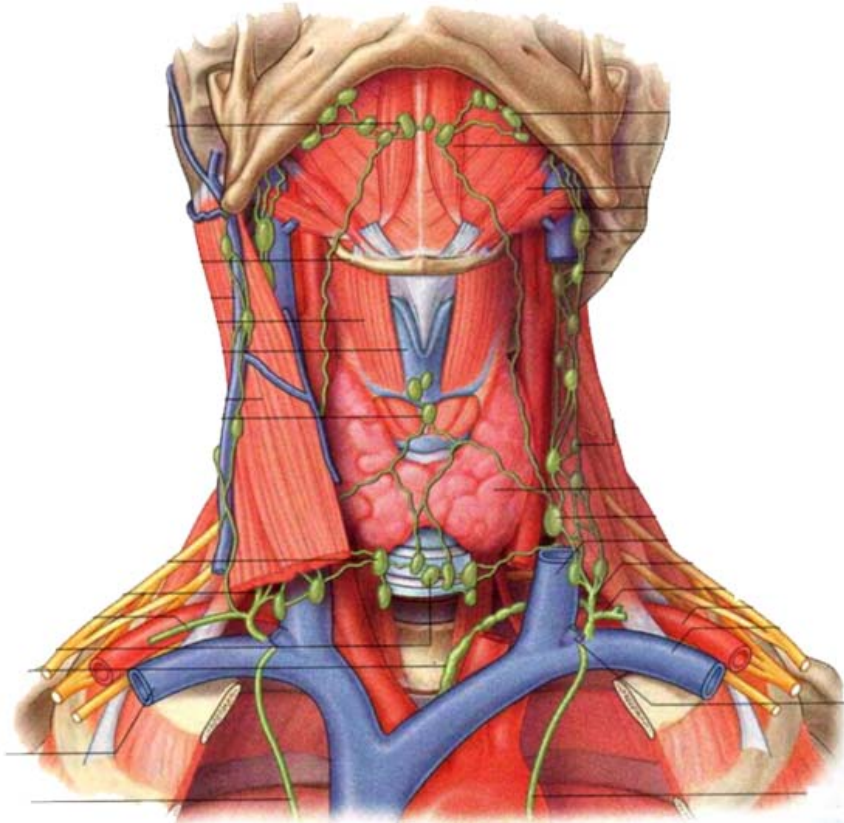
D. Jugular lymph trunk - efferent lymph vessels from deep cervical nodes drain into Thoracic Duct (on left), Right Lymphatic Duct (on right); these drain into Brachiocephalic veins (at junction of Internal Jugular and Subclavian Veins).



1. COMMON CAROTID
2. INTERNAL CAROTID
3. ASCENDING PHARYNGEAL
4. OCCIPITAL
5. SUPERFICIAL TEMPORAL
6. MIDDLE CEREBRAL
7. ANTERIOR CEREBRAL
8. MIDDLE MENINGEAL
9. MAXILLARY
10. FACIAL
11. LINGUAL
12. EXTERNAL CAROTID
13. SUPERIOR THYROID

\*- OPHTHALMIC ARTERY ARISING FROM CAROTID SIPHON

# NECK 1 - OUTLINE

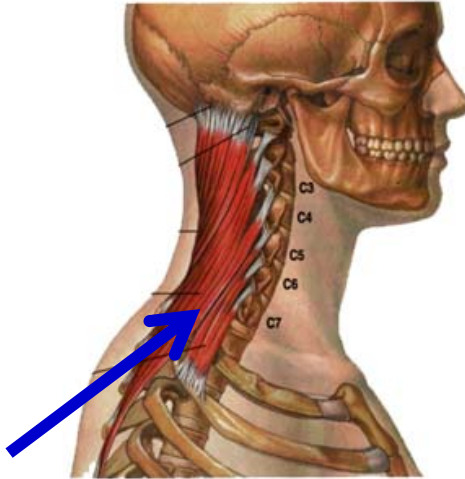


- I. OVERVIEW -  
NECK IS  
COMPARTMENTALIZED
- II. MUSCLES
- III. NERVES
- IV. ARTERIES
- V. VEINS
- VI. FASCIA
- VII. LYMPHATICS

**WORD OF THE DAY - CONTRACTURE - condition of sustained (permanent) SHORTENING of a structure (ex. muscle).**

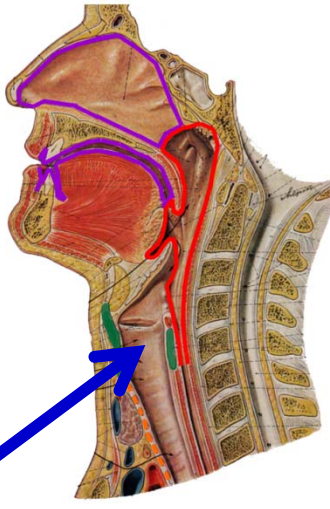
# I. OVERVIEW OF NECK - neck is compartmentalized

disease processes in or between compartments

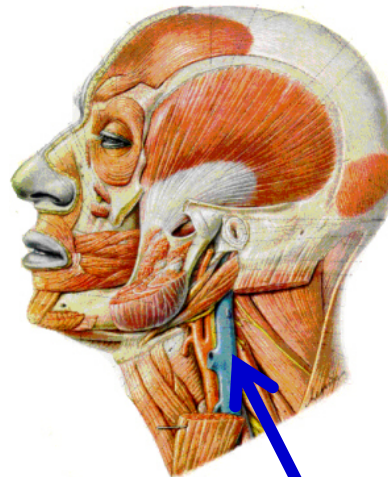


Posterior - **Vertebrae and Muscles**

1. Posterior  
Compartment -  
**Vertebrae and**  
**muscles which**  
**support and move**  
**head and neck**



Anterior - **Viscera**  
**(Pharynx, Larynx, etc.)**



Lateral - **Carotid Sheath**

2. Anterior  
Compartment- Viscera  
**and rostral**  
**continuation GI and**  
**Respiratory Systems**

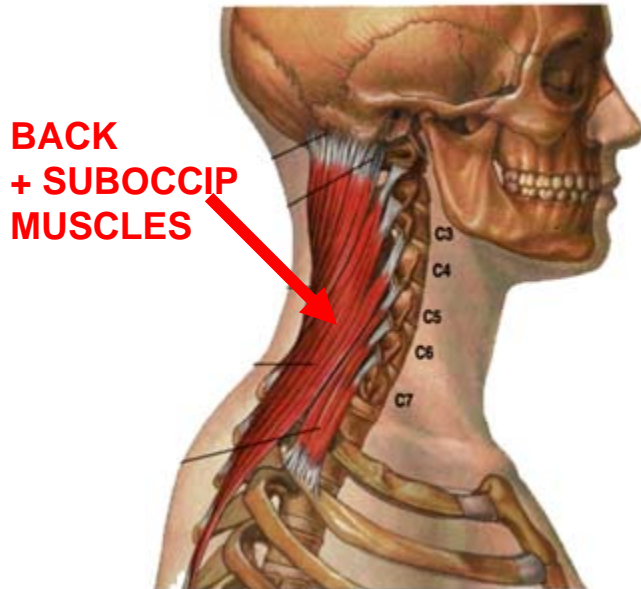
3. Lateral  
Compartment- Blood  
**vessels and nerve**



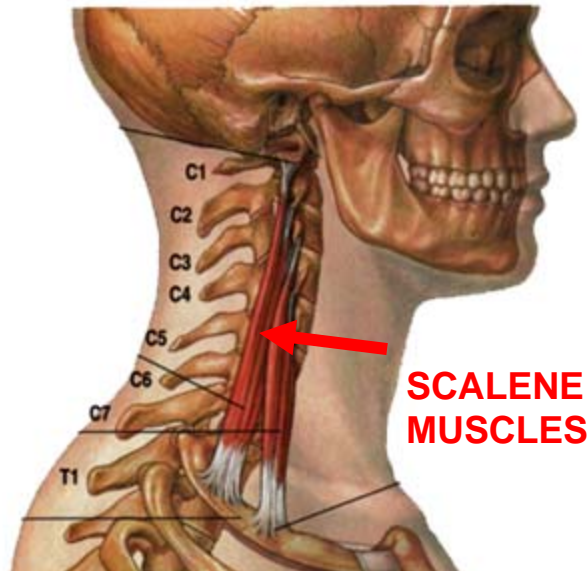
# 1. POSTERIOR COMPARTMENT

- muscles that move head and neck

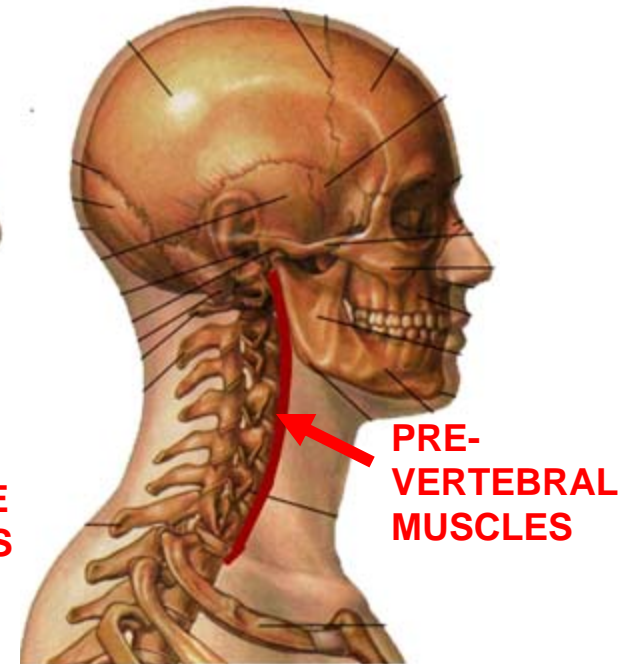
## NECK IS MOBILE



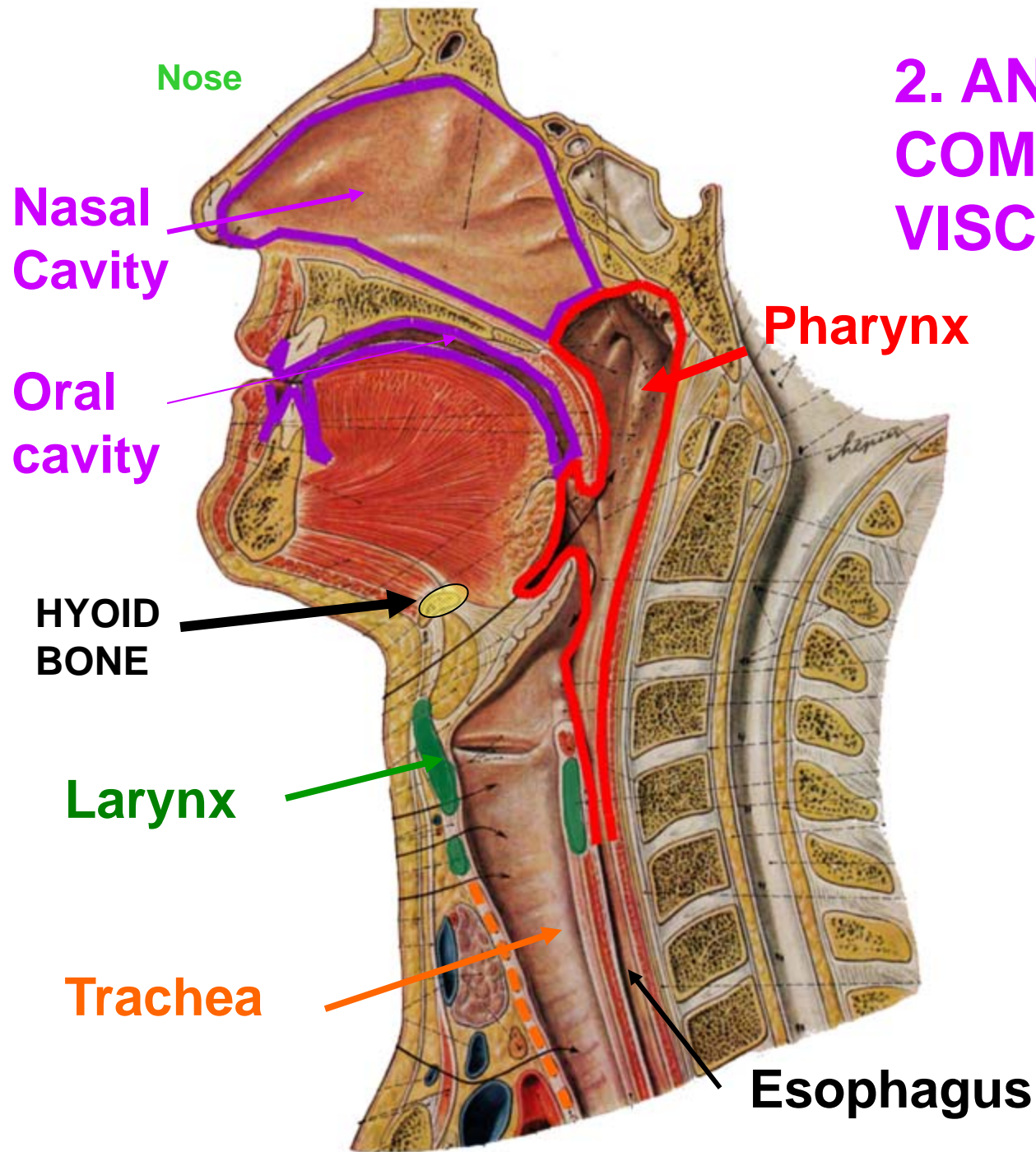
**Posterior side -  
Deep Muscles  
(extensors like  
back) and  
Suboccipital  
Muscles**



**Lateral side -  
Scalene  
muscles - flex  
neck laterally**



**Anterior side -  
Prevertebral Muscles -  
directly anterior to  
vertebrae - flex head  
and neck (anterior  
movement)**

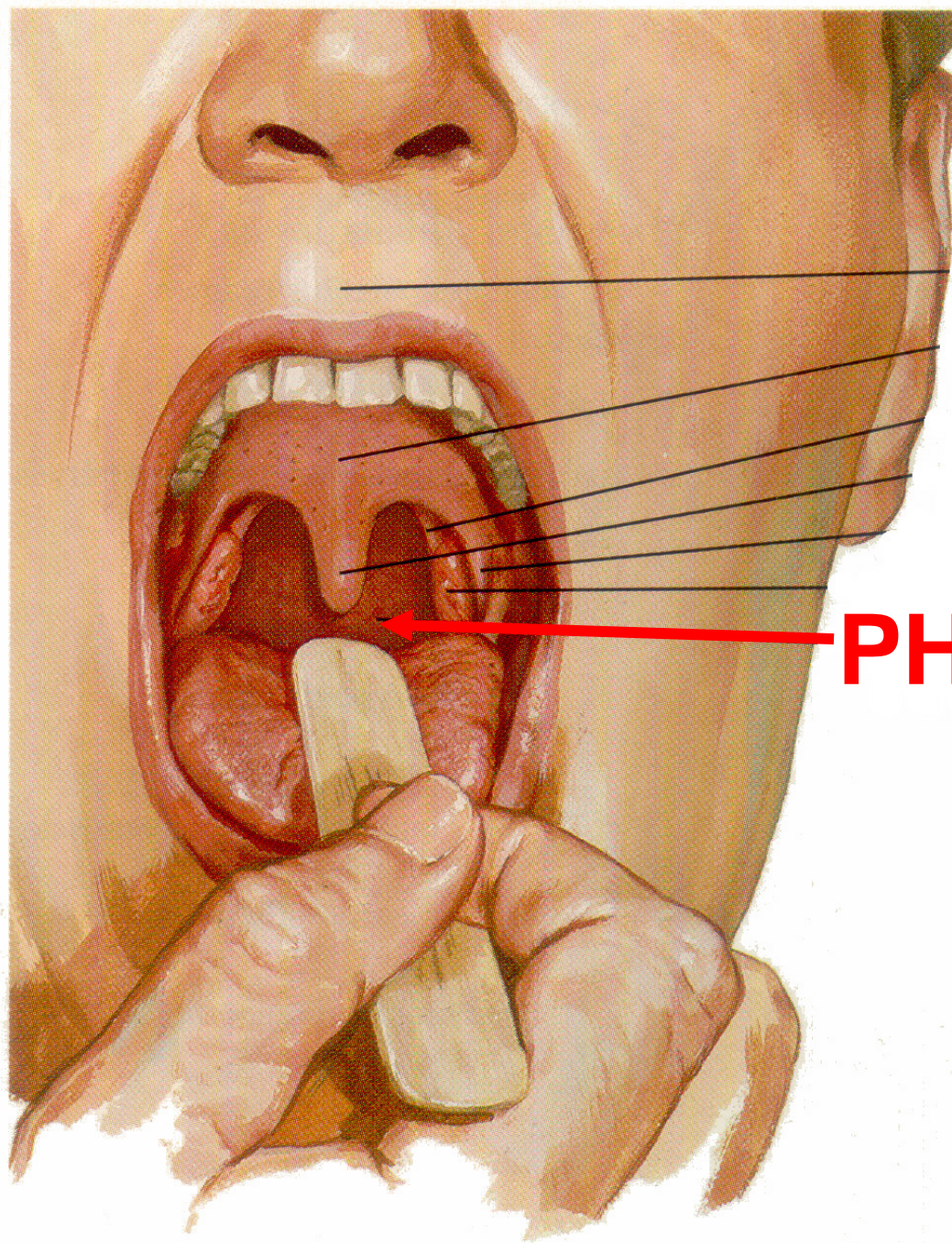


## 2. ANTERIOR COMPARTMENT - VISCERA

1) **Larynx & Esophagus** open into **pharynx**

2) **Pharynx** - a tube of muscles and fascia that opens to nasal and oral cavities

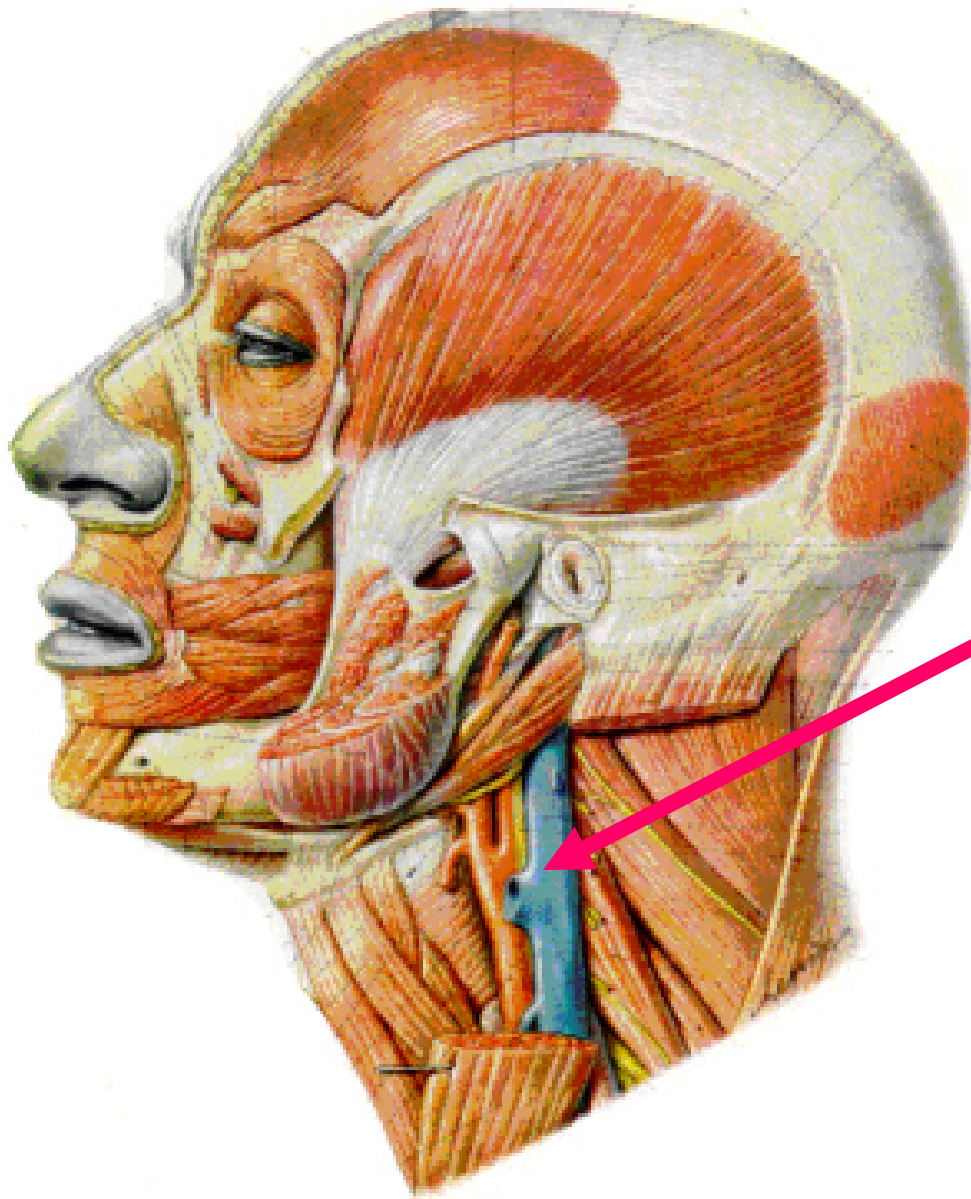
**SAY  
AAHH!**



**PHARYNX**

### 3. LATERAL COMPARTMENT - CAROTID SHEATH

## CLINICAL \*\*



Lateral Compartment-  
lateral and posterior to  
pharynx

Contained in Carotid  
Sheath

1) Common and Internal  
Carotid arteries; 2)  
Internal jugular vein, 3)  
Vagus nerve

Note: Sympathetic chain  
is posterior to (NOT IN)  
Carotid Sheath

## II. MUSCLES OF NECK



**KNOW MUSCLE, ACTION, INNERVATION;  
NOT REQUIRED: ORIGIN, INSERTION**

### Muscles not attached to Hyoid bone

MUSCLE		INSERTION	ACTION	NERVE
Sternocleidomastoid	Two heads 1) Sternum - Manubrium 2) Clavicle - medial 1/3	Both heads to Temporal bone - Mastoid process	Acting on both sides - flex neck; Acting singly - rotate head so face is directed to opposite side	Accessory nerve (XI)
Scalenus anterior and Scalenus medius	Vertebra- transverse processes of upper cervical	Rib 1	Flex neck and elevate rib 1	branches of ventral rami of cervical spinal nerves

### Infrahyoid muscles

MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
Omohyoid (Muscle has two bellies connected by an intermediate tendon)	Inferior belly from Scapula - medial to suprascapular notch (Intermediate tendon - linked to clavicle and rib 1) Superior belly - continues to insertion	Hyoid Bone	Depresses hyoid bone	Ansa cervicalis
Sternohyoid	Sternum - manubrium Clavicle	Hyoid bone	Depresses hyoid bone	Ansa cervicalis
Sternothyroid	Sternum - manubrium	Thyroid cartilage	Depresses thyroid cartilage, indirectly depresses hyoid bone, larynx	Ansa cervicalis
Thyrohyoid	Thyroid cartilage	Hyoid bone	Depresses hyoid bone, elevates larynx	C1 via branch hitchhiking with Hypoglossal nerve (XII)

# A. MUSCLES OF NECK - NOT ATTACHED TO HYOID - move head and neck

## 1. STERNO-CLEIDOMASTOID

O - Two heads: 1) Manubrium of sternum; 2) Clavicle (L. root - cleido) - medial 1/3

I - Mastoid process of temporal bone

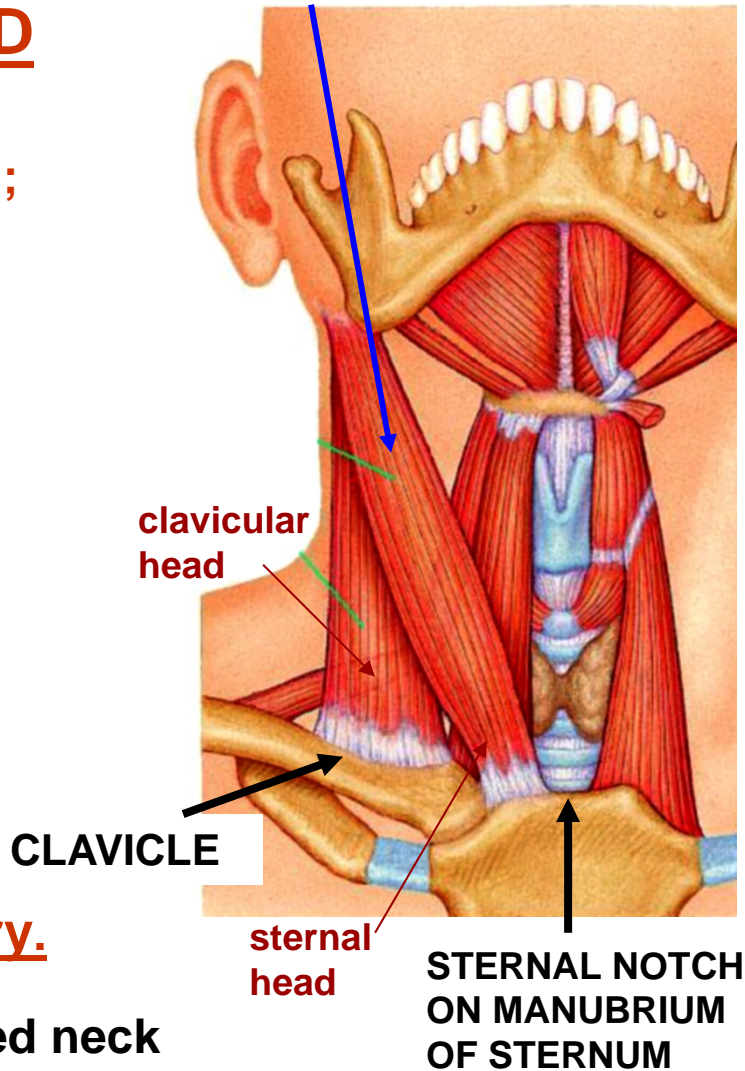
Act - bilateral - flex head; unilateral rotate head, face directed to opposite side

(MASTOID MOVES TOWARD STERNUM)

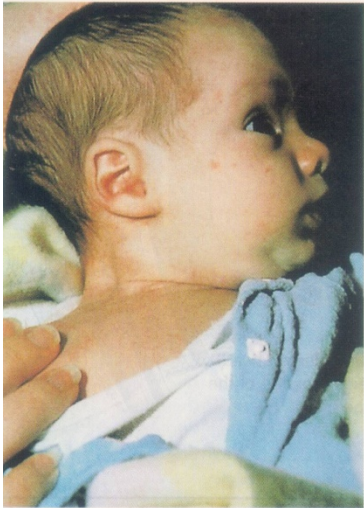
Inn - CN XI Accessory.

TORTICOLLIS = twisted neck

MOST IMPORTANT LANDMARK IN NECK

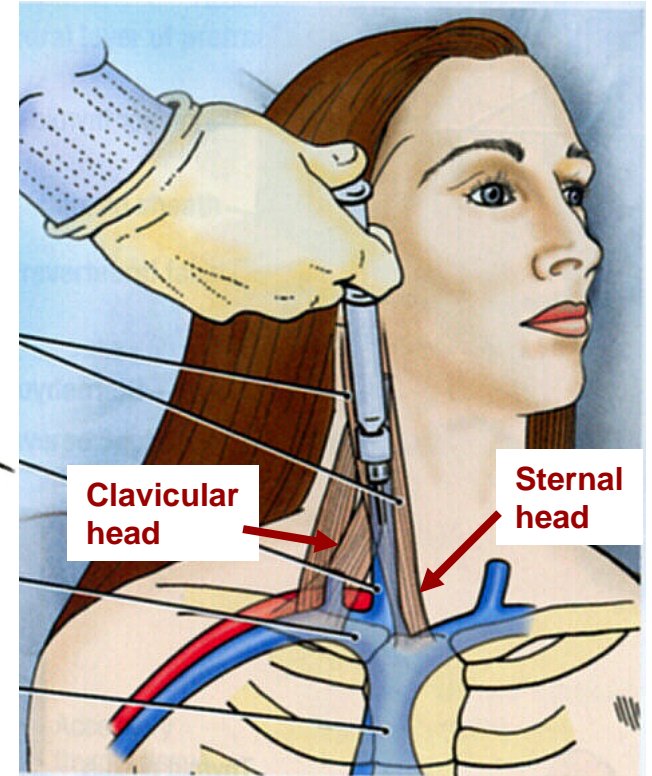
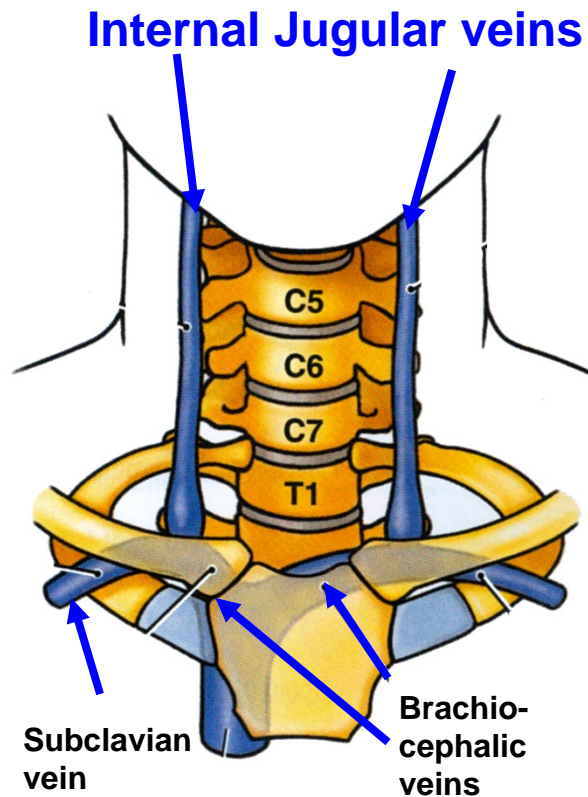
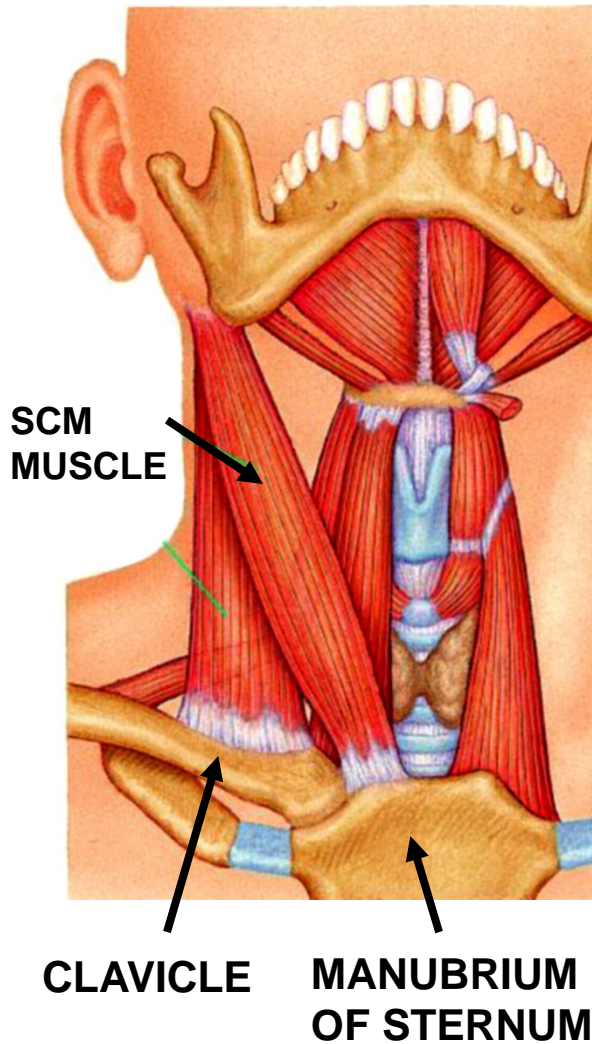


ACTION - PULL MASTOID TOWARD STERNUM



\* TORTICOLLIS – Contracture of Sternocleidomastoid (congenital or acquired); face to opposite side

# STERNOCLEIDOMASTOID: IMPORTANT LANDMARK IN PROCEDURES: VENOUS CATHETERIZATION

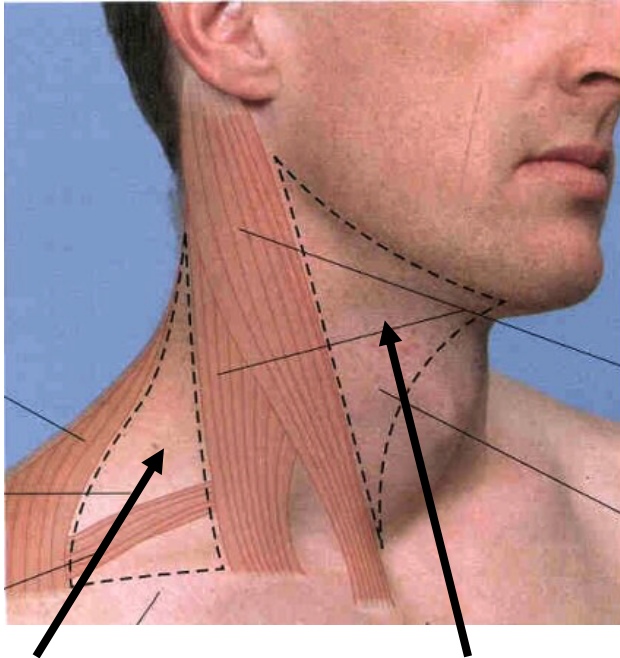


Internal Jugular vein can be accessed and catheterized **between Sternal and Clavicular heads** of Sternocleidomastoid

feel sternal head on yourself

# STERNOCLEIDOMASTOID: IMPORTANT LANDMARK IN EXAMINATION OF NECK

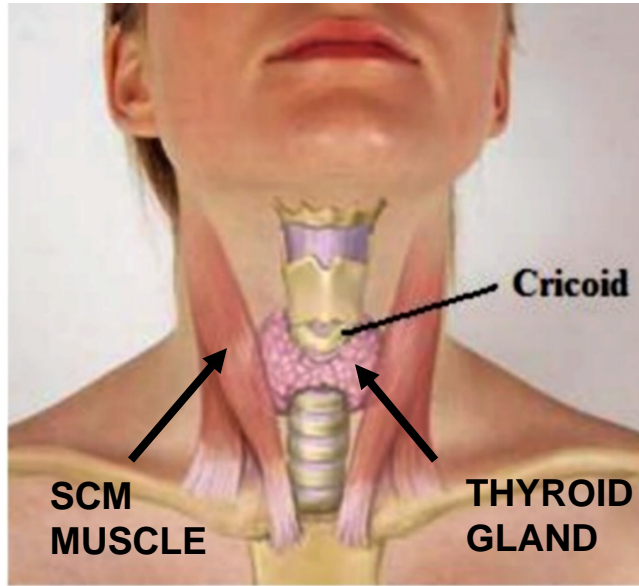
Sternocleidomastoid (SCM) defines areas in Neck



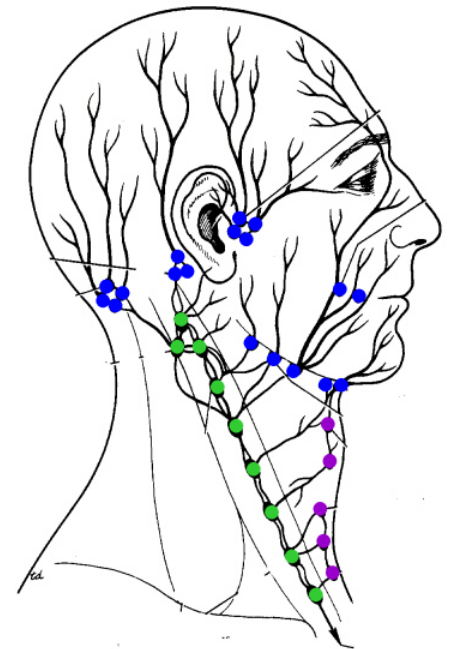
POSTERIOR TRIANGLE  
(Post. to Sternocleidomastoid)

ANTERIOR TRIANGLE  
(Ant. to Sternocleidomastoid)

**Thyroid gland: palpated in Anterior Triangle below Cricoid cartilage, medial to Sternocleidomastoid**



Stand behind patient; have patient swallow



Deep Cervical Chain of Lymph nodes are located **deep to Sternocleidomastoid**

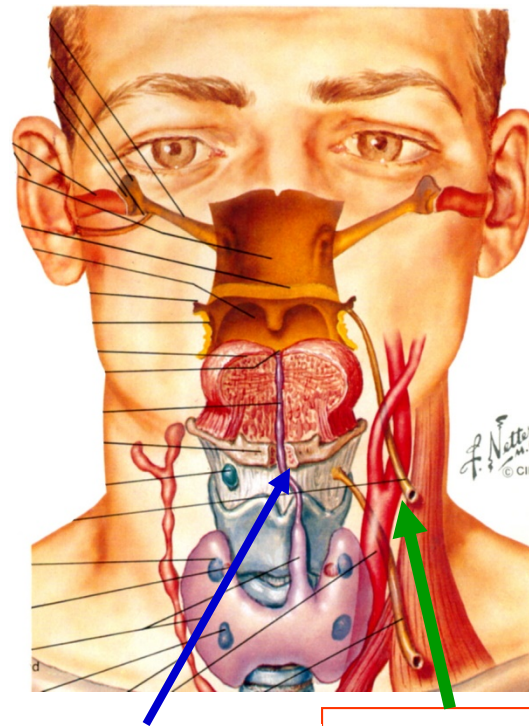
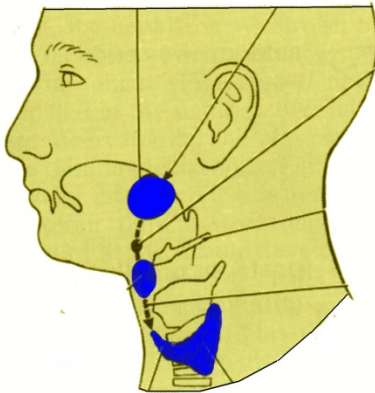
ICS: ENT EXAM  
Spring 2020



# USE STERNOCLEIDO MASTOID TO DIAGNOSE NECK MASSES: BRANCHIAL CLEFT CYSTS, FISTULI LATERAL NECK MASSES

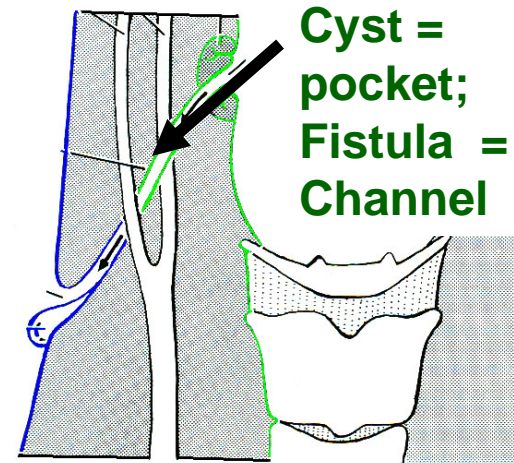
LATERAL NECK MASS - Branchial Cyst or (Fistula = Channel) -  
located Anterior to Sternocleidomastoid Muscle

Differentiate from  
Thyroglossal Duct Cysts  
- Midline masses



Thyroglossal  
Duct Cysts -  
Midline  
mass

Branchial  
Cysts,  
Fistula -  
Lateral  
neck mass



Branchial  
Cyst -  
Anterior  
to Sterno-  
cleido-  
mastoid



# MUSCLES OF NECK - NOT ATTACHED TO HYOID

## 2. SCALENUS ANTERIOR AND SCALENUS MEDIUS

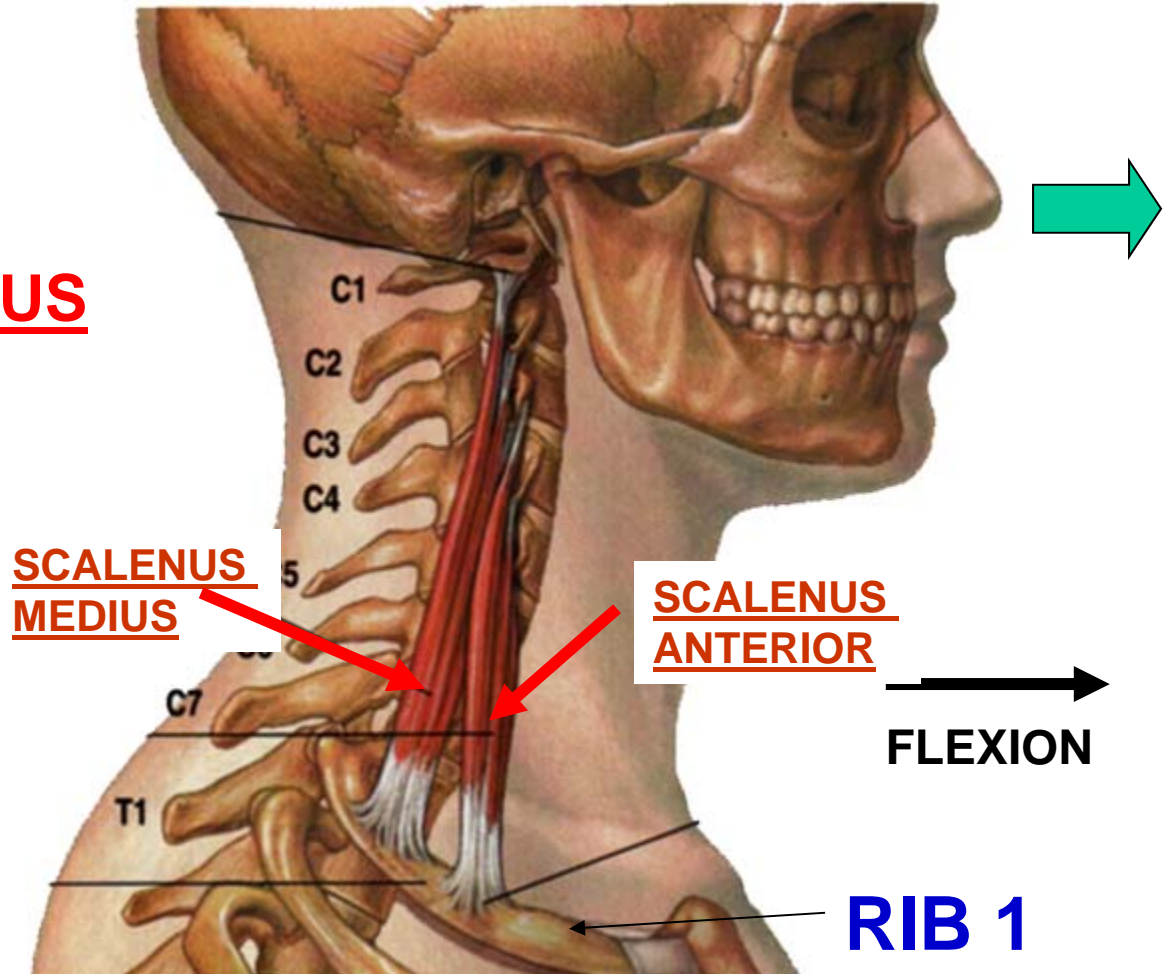
O - vertebrae- trans processes upper cervical

I - rib 1

A - flex neck, elevate rib 1

Inn - ventral rami of cervical spinal nerves

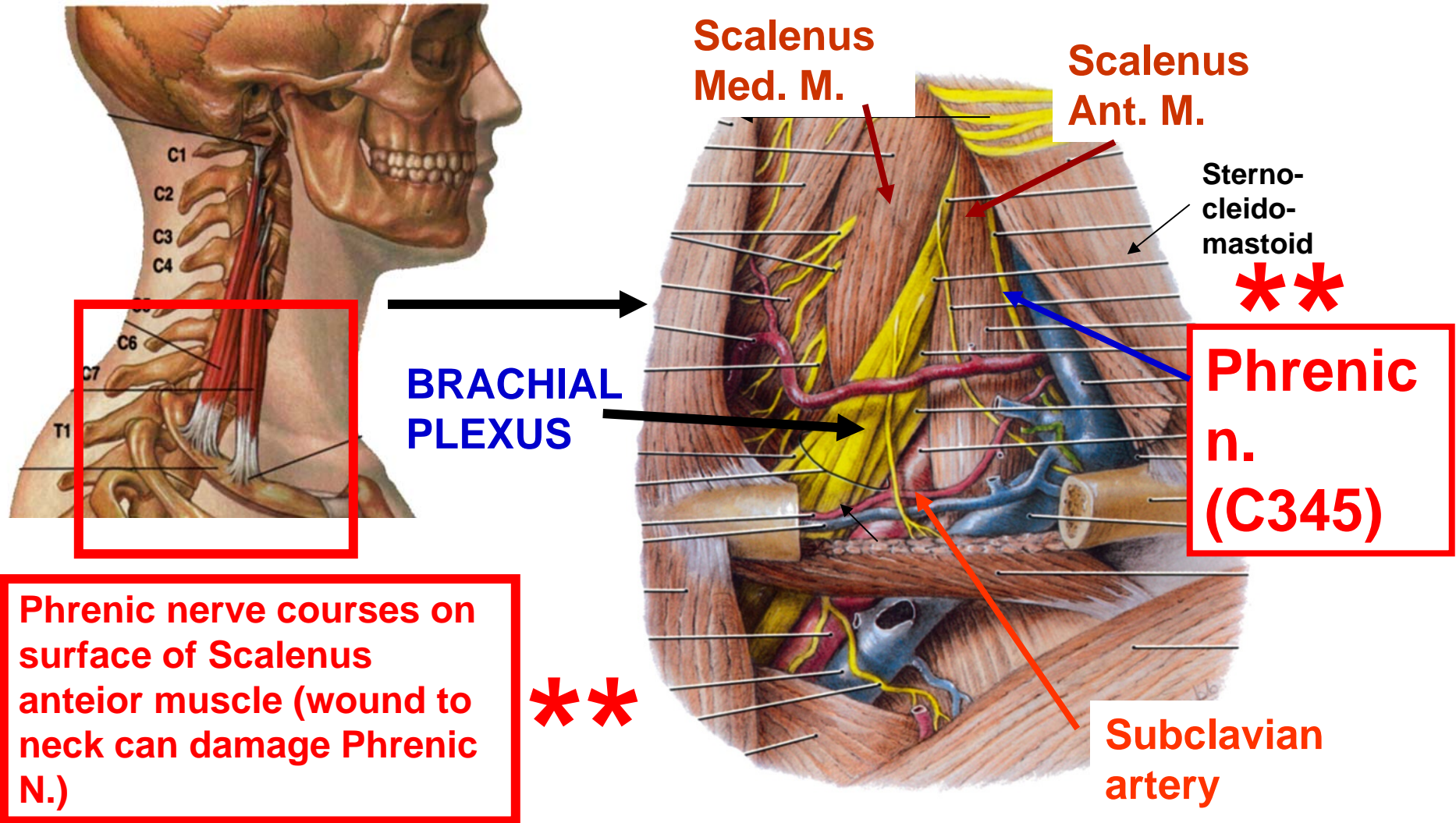
**\*\***



**SECOND MOST IMPORTANT LANDMARK  
IN NECK: BRACHIAL PLEXUS, PHRENIC NERVE;  
LATERAL (POSTERIOR ) TO STERNOCLEIDOMASTOID**

# SCALENUS ANTERIOR AND SCALENUS MEDIUS ARE IMPORTANT LANDMARKS

- **Brachial Plexus**, Subclavian Artery pass between Scalenus Ant. and Med.;
- **Phrenic nerve** (to Diaphragm) **courses on Scalenus Anterior**

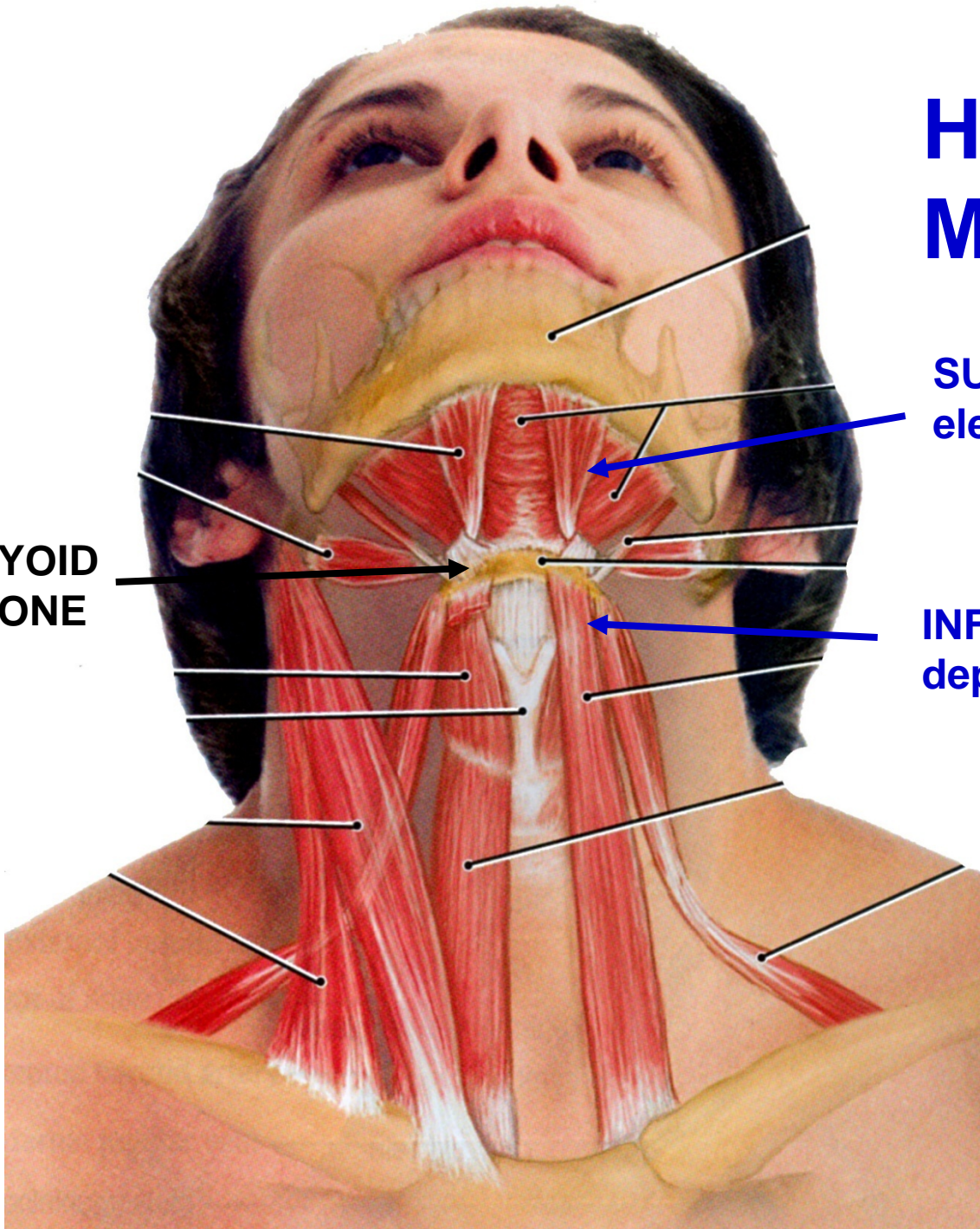


# HYOID MUSCLES

HYOID  
BONE

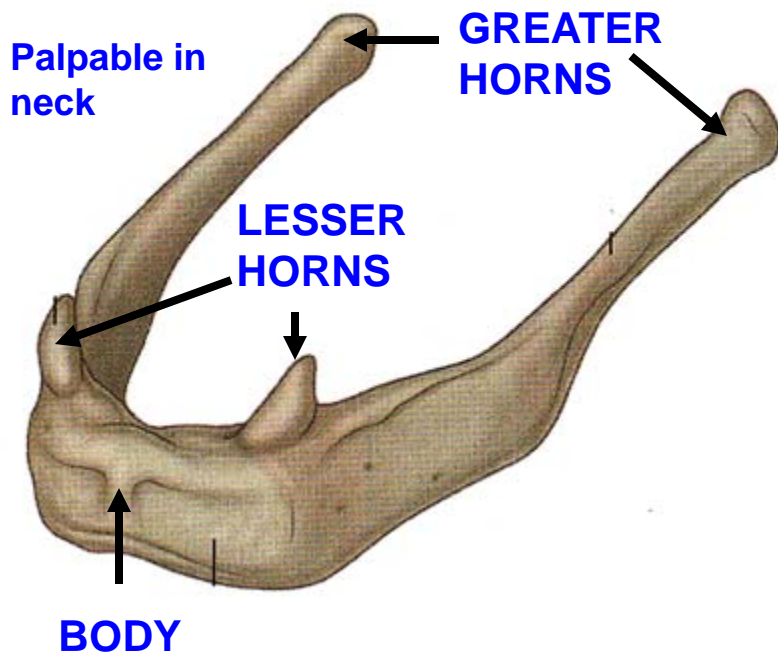
SUPRAHYOID MUSCLES -  
elevate hyoid

INFRAHYOID MUSCLES -  
depress hyoid

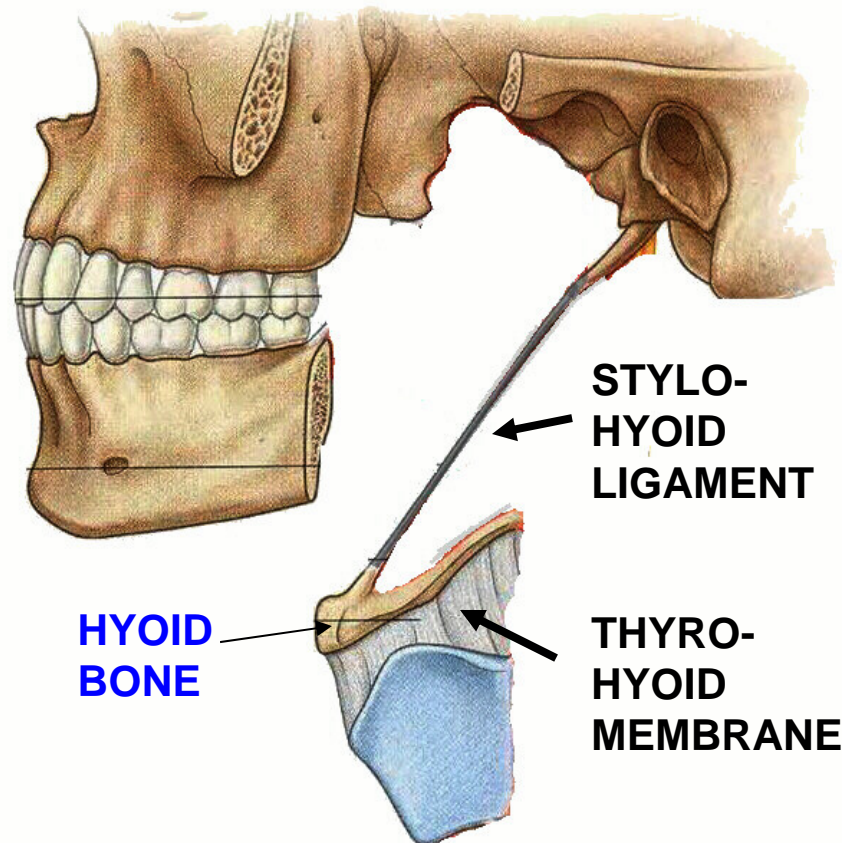


# A. HYOID BONE - 'free floating', no bony attachment; held by muscles, ligaments

Parts: Body, Greater and Lesser Horns; **Hyoid means "U" shaped**



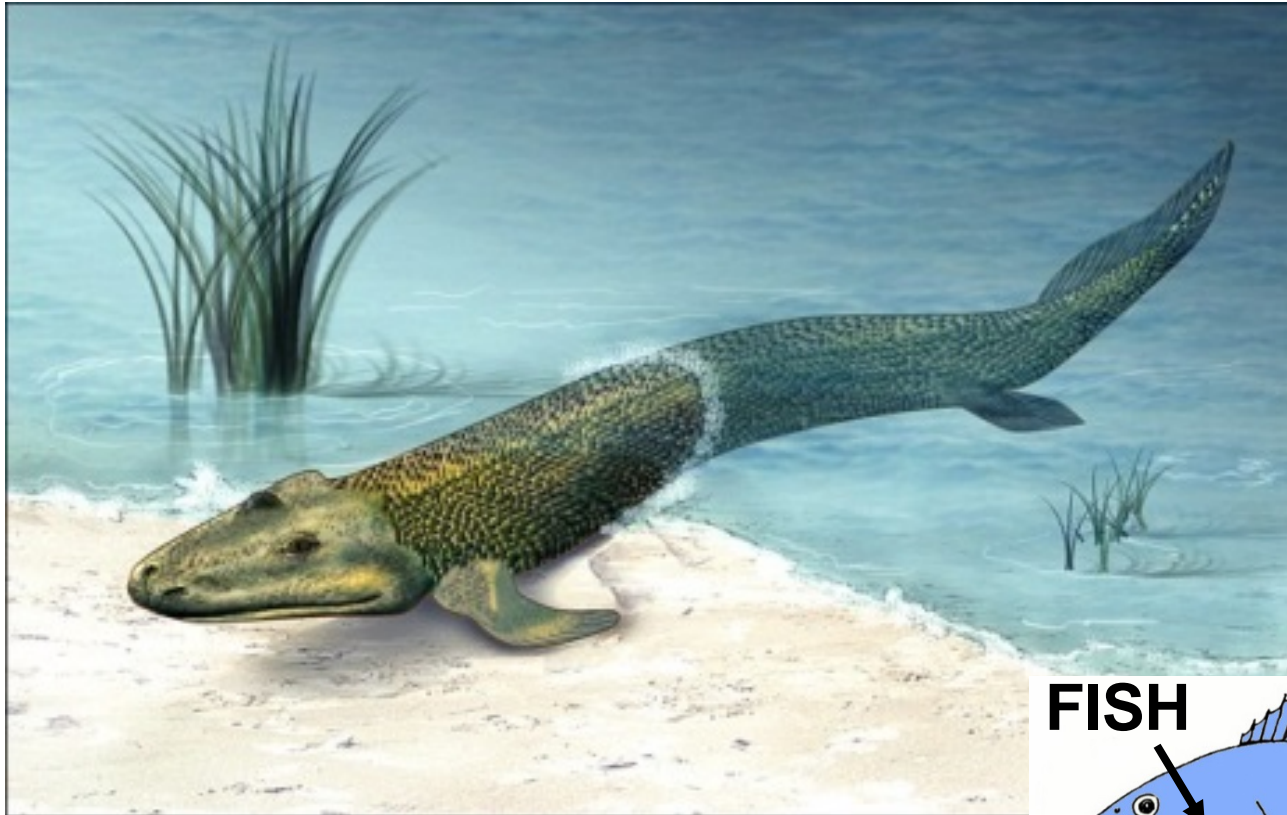
- All Infrahyoid & Suprahyoid attach to Body of Hyoid (except Sternothyroid inserts to thyroid cartilage)



Stylohyoid ligament - to Styloid process of temporal bone

Thyrohyoid membrane - to Thyroid cartilage

# FISH STORY: FISH COMES OUT OF WATER

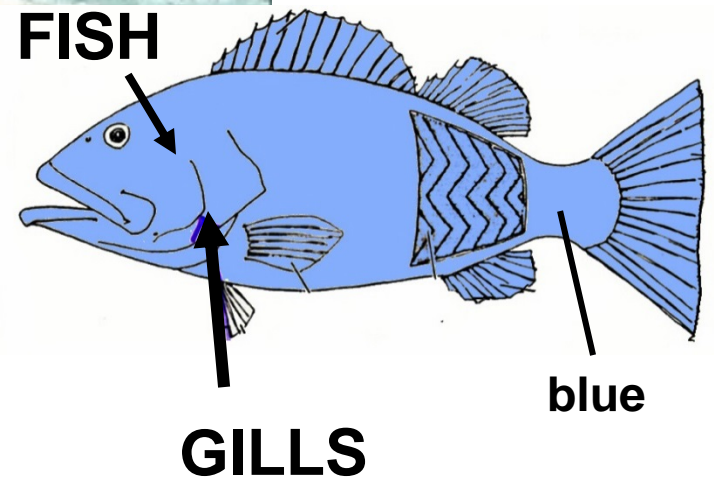


Anatomical requirements

- lungs breathe air
- limbs support body weight
- ear detect vibrations in air

- gills increasingly unnecessary as develop lungs

Embryology - use structures that formed gills to form middle ear structures for detecting sounds (vibrations in air)

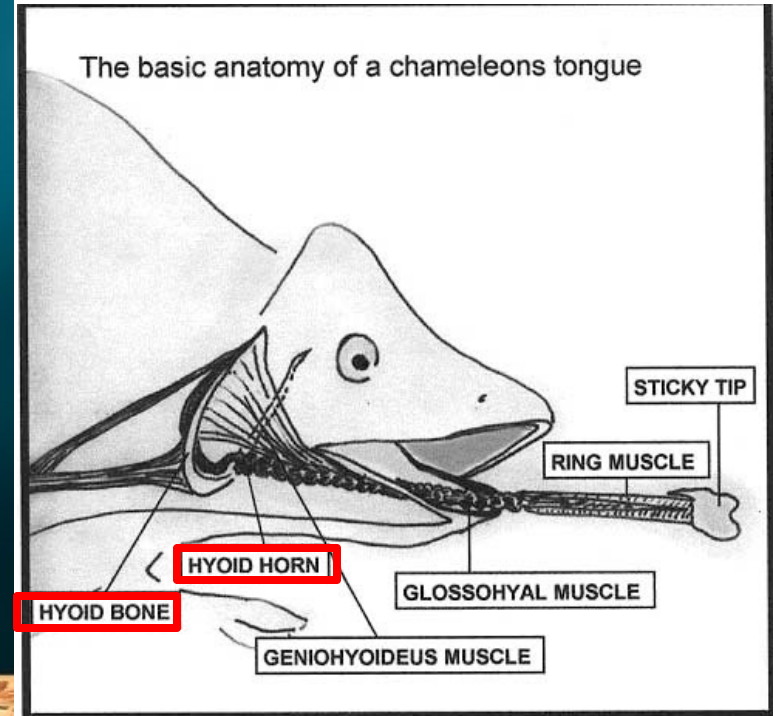


## STRUCTURES DERIVED FROM BRANCHIAL ARCHES

ARCH/NERVE	SKELETAL	LIGAMENTS	MUSCLES
First (V)	1) Malleus 2) Incus	1) Ant. ligament of malleus 2) Spheno-mandibular ligament	1) Muscles of Mastication 2) Tensor tympani 3) Tensor palati 4) Mylohyoid 5) Ant. belly of Digastric
Second (VII)	1) Stapes 2) Styloid process 3) Hyoid bone - lesser horn, upper half of body	Stylohyoid ligament	1) Muscles of Facial Expression 2) Stapedius 3) Stylohyoid 4) Post. belly of Digastric
Third (IX)	Hyoid bone - greater horn, lower half of body	-----	Stylopharyngeus
Fourth (X)	Cartilages of Larynx	-----	1) All muscles of Larynx 2) All muscles of Pharynx (except Stylopharyngeus) 3) All muscles of Soft Palate (except Tensor palati)
Sixth (XI)	-----	-----	1) Sternocleidomastoid 2) Trapezius

**HYOID BONE DEVELOPS AS ADAPTATION TO LIFE ON LAND - SPEECH, SWALLOWING**

# HYOID BONE - ATTACHES MOBILE TONGUE

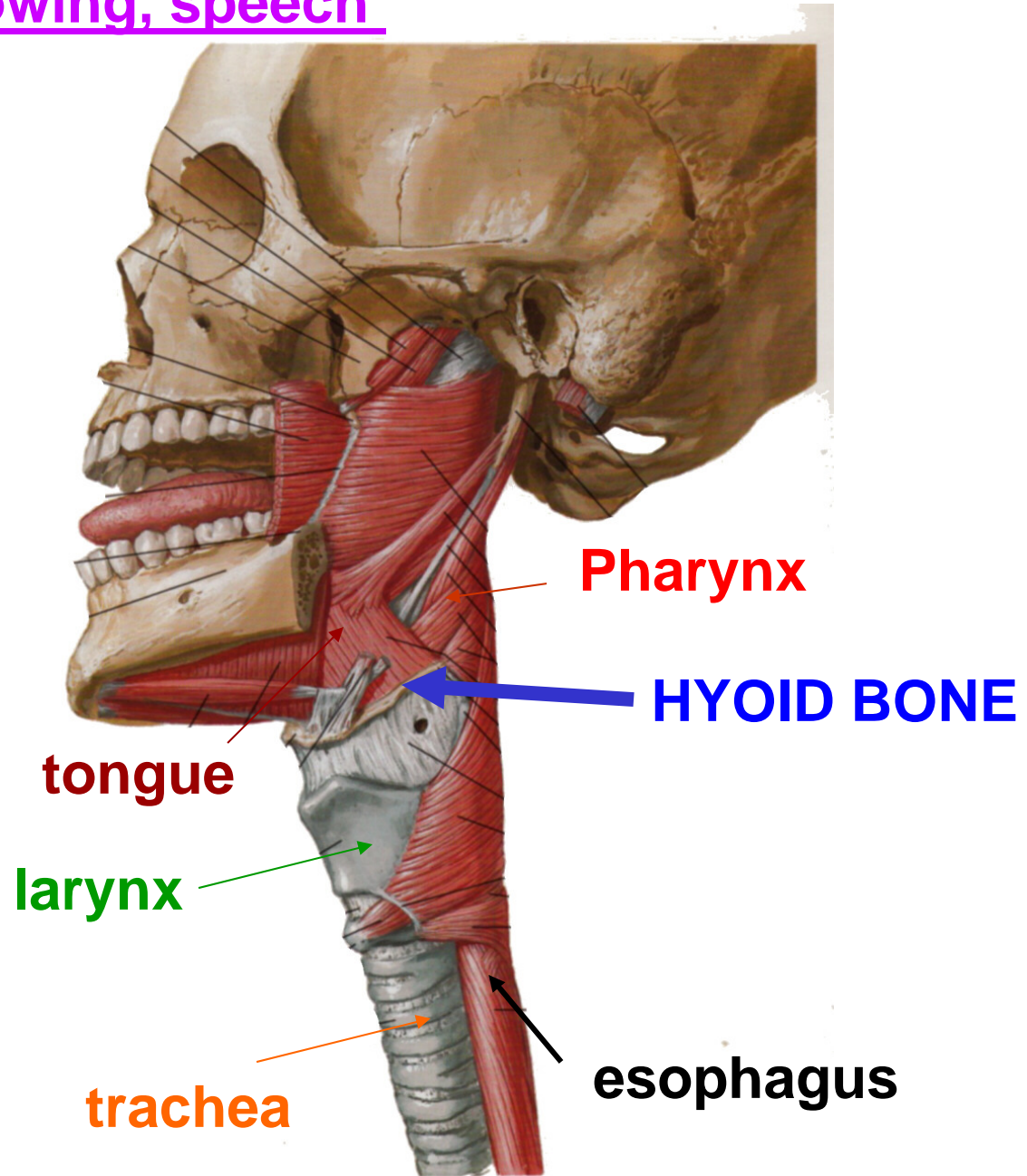


- **HYOID BONE FORMS ATTACHMENT FOR MUSCLES OF TONGUE**
- **CHAMELEON STRIKE WITH LONG TONGUE ATTACHED TO HYOID TO CAPTURE FLIES**
- **HUMANS USE HYOID FOR SPEECH, LANGUAGE INSTEAD OF CAPTURING FLIES**



**ANTERIOR COMPARTMENT - moveable, changes shape in swallowing, speech**

**Hyoid Bone – attached to larynx, pharynx and tongue; free floating; attached by ligaments and moved by muscles**

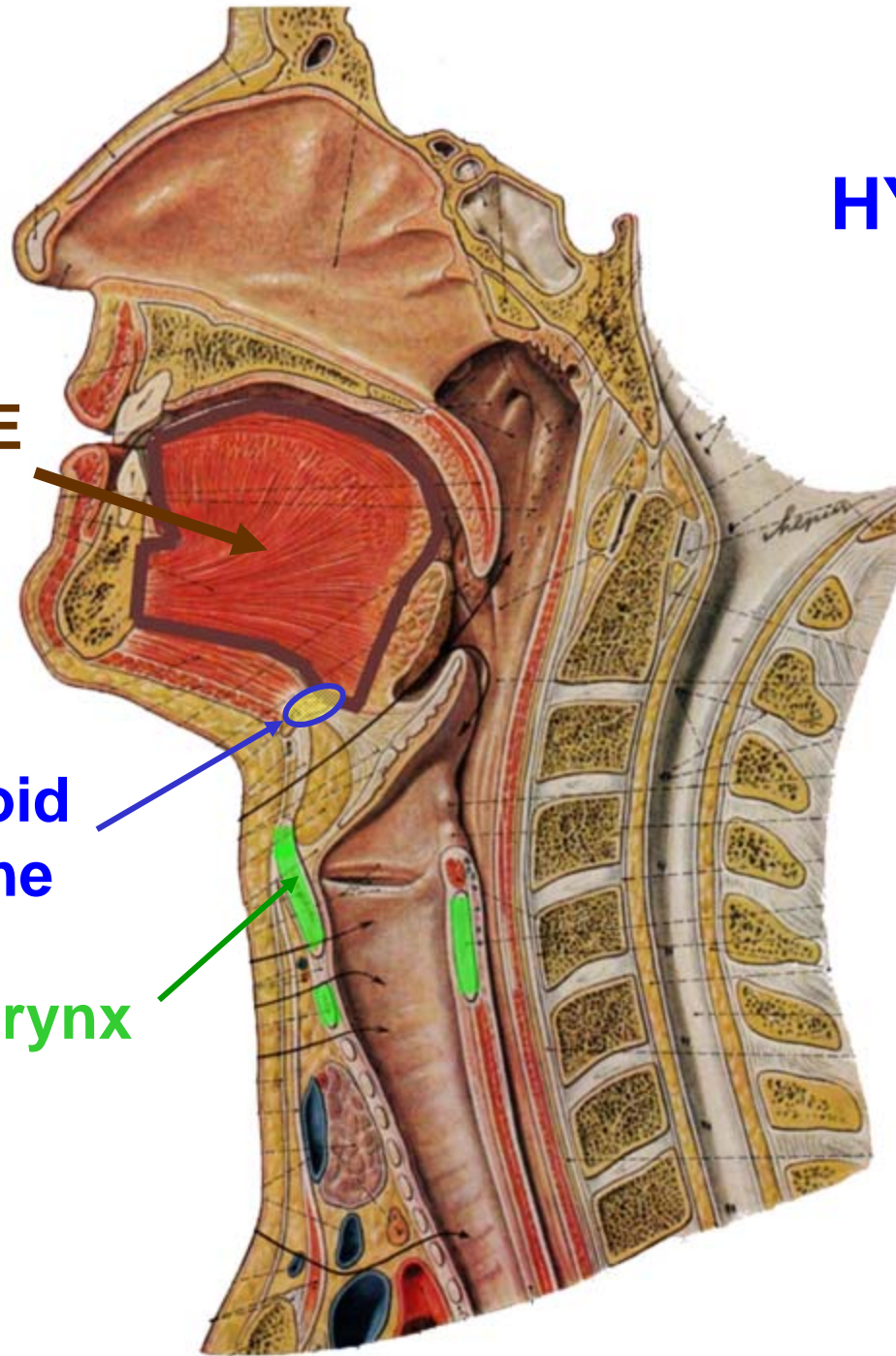


## HYOID BONE

TONGUE

Hyoid Bone

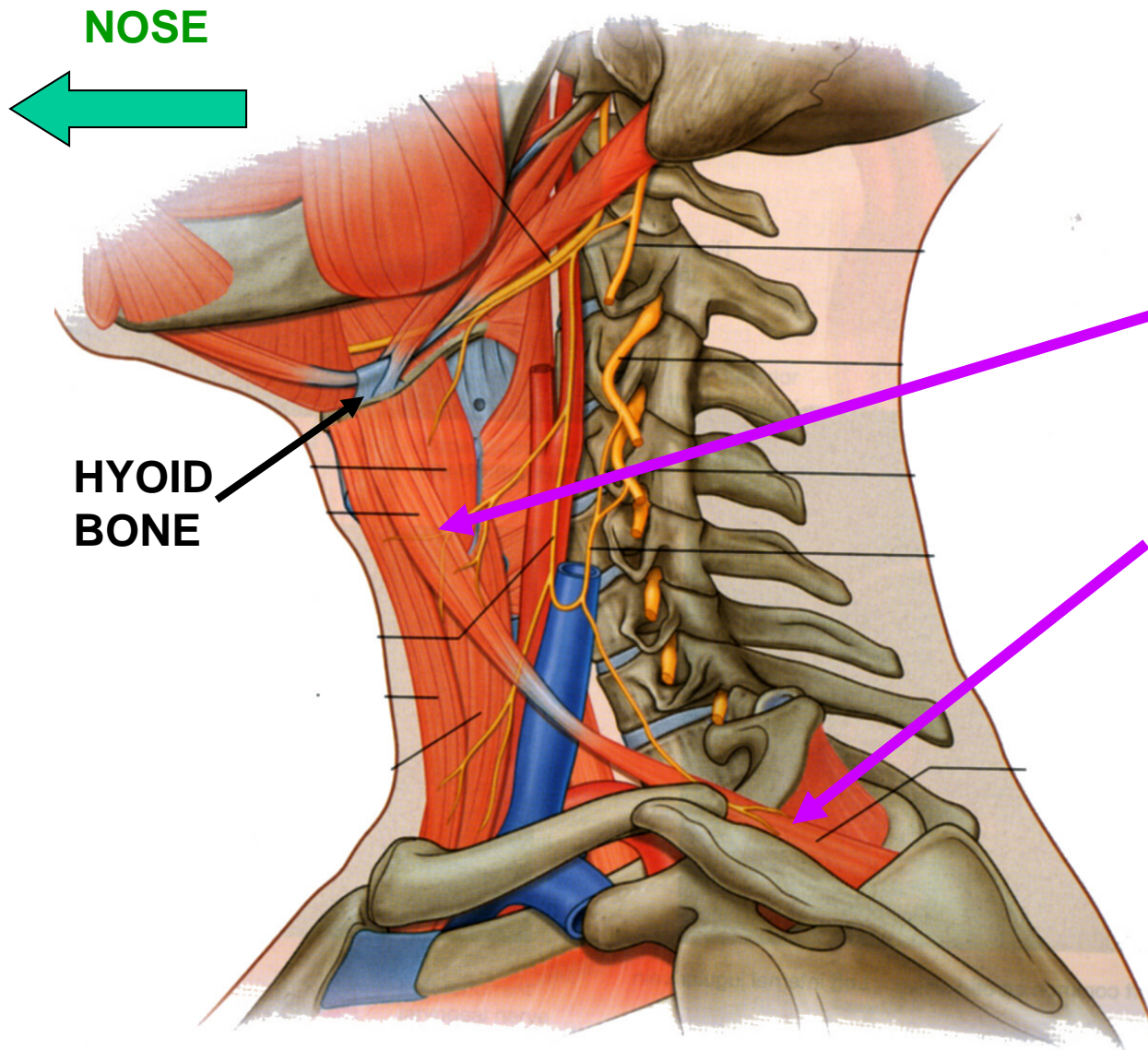
Larynx



- muscles that move hyoid bone move larynx and tongue, for Swallowing, Talking

- contraction of muscles can stabilize position of hyoid bone (ex. in movements of tongue)

## B. INFRAHYOID MUSCLES - all depress hyoid



1. OMOHYOID  
(omo = greek  
for shoulder) -  
Two bellies -

Inf. Belly-  
Scapula- medial  
to  
suprascapular  
notch

# INFRAHYOID MUSCLES - all depress hyoid - many named for origin/insertion

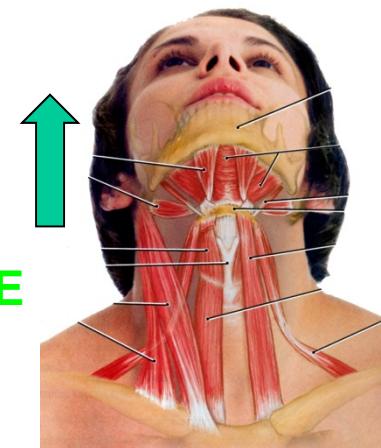
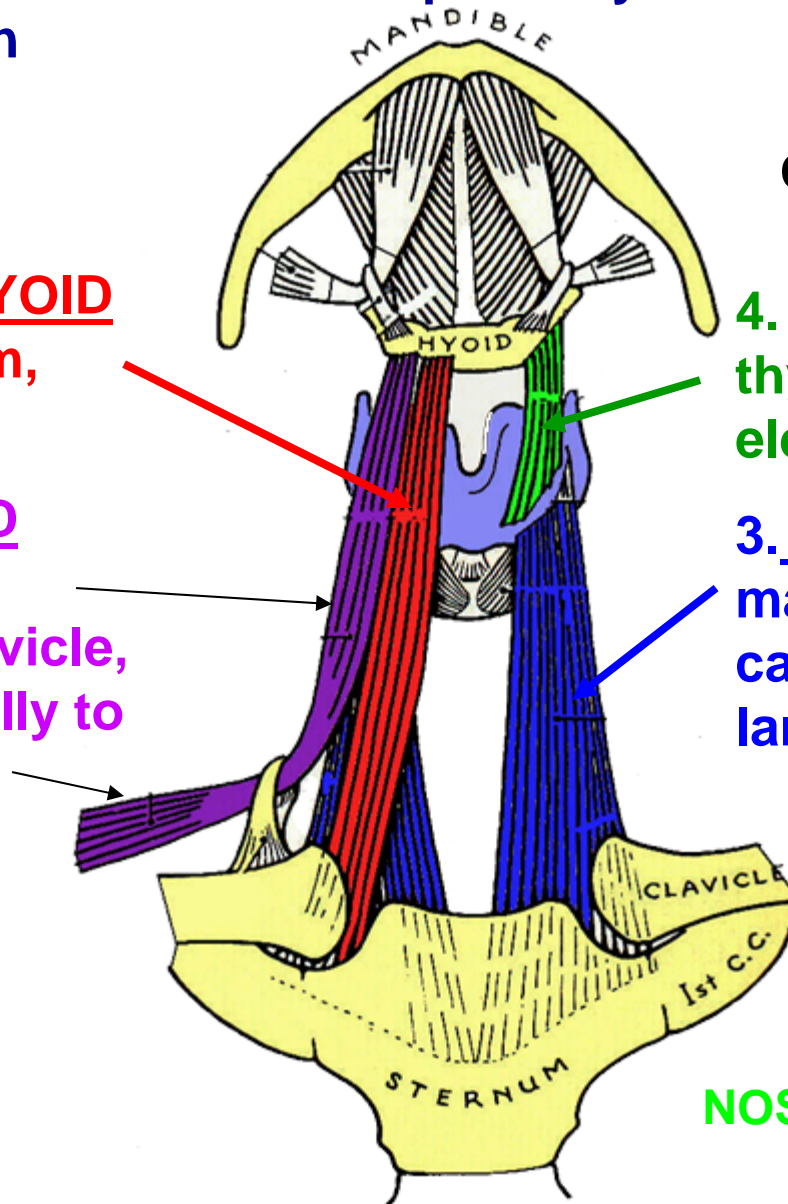
deeper

2. STERNOHYOID  
O- Manubrium, clavicle

1. OMOHYOID  
intermediate tendon to clavicle, rib 1; Sup. belly to hyoid

4. THYROHYOID - O - thyroid cartilage; also elevates larynx

3. STERNOTHYROID --O - manubrium I - thyroid cartilage; also depresses larynx



ORIENT - HEAD TILTED BACK

NOSE

# SUPRAHYOID MUSCLES - all elevate hyoid

## Suprahyoid muscles

MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
Digastric (has two bellies)	Posterior belly from <b>Temporal bone</b> - mastoid notch (medial to mastoid process) Anterior belly from <b>Mandible</b> - inner side	<b>Hyoid Bone</b> - via intermediate tendon	Elevates hyoid bone, Depresses mandible	Posterior belly - Facial nerve (VII) Anterior belly - Trigeminal nerve (V3)
Stylohyoid	<b>Temporal bone</b> - styloid process	<b>Hyoid bone</b>	Elevates hyoid bone	Facial nerve (VII)
Mylohyoid	<b>Mandible</b> - mylohyoid line	<b>Hyoid bone</b>	Elevates hyoid bone, Raises floor of mouth during swallowing	Trigeminal nerve (V3)
Geniohyoid	<b>Mandible</b> - inner side	<b>Hyoid bone</b>	Elevates hyoid bone, draws hyoid forward	C1 via branch hitch-hiking with Hypoglossal nerve (XII)

# SUPRAHYOID MUSCLES - all elevate hyoid

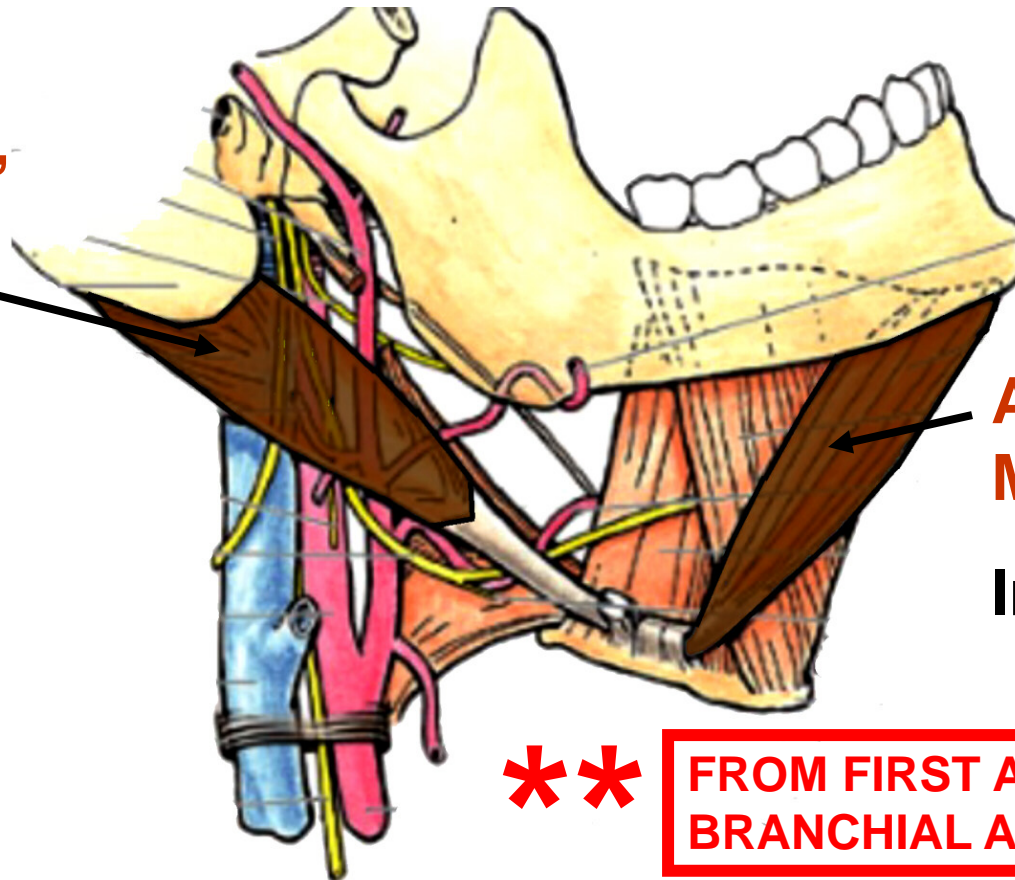
1. DIGASTRIC - two bellies / two cranial nerves - insert to hyoid via intermediate tendon

NOSE



Post Belly-  
Temp. Bone,  
mastoid  
notch  
(medial to  
mastoid  
process)

Inn - CN VII



Ant. Belly -  
Mandible

Inn. - CN V

\*\*\*

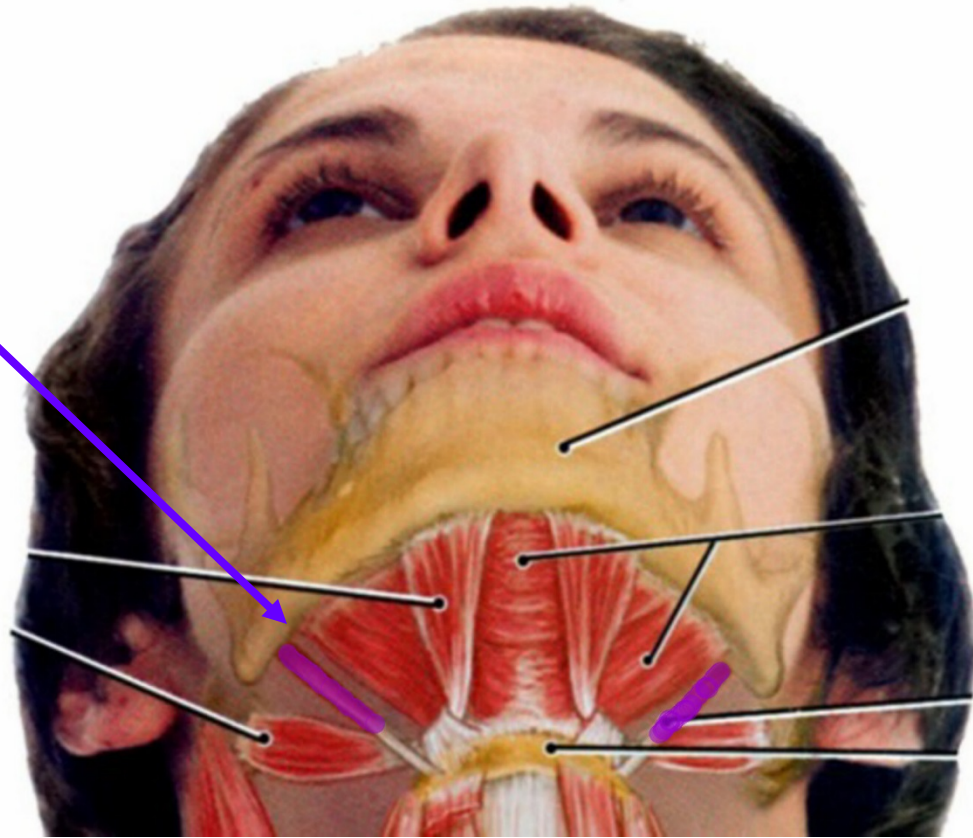
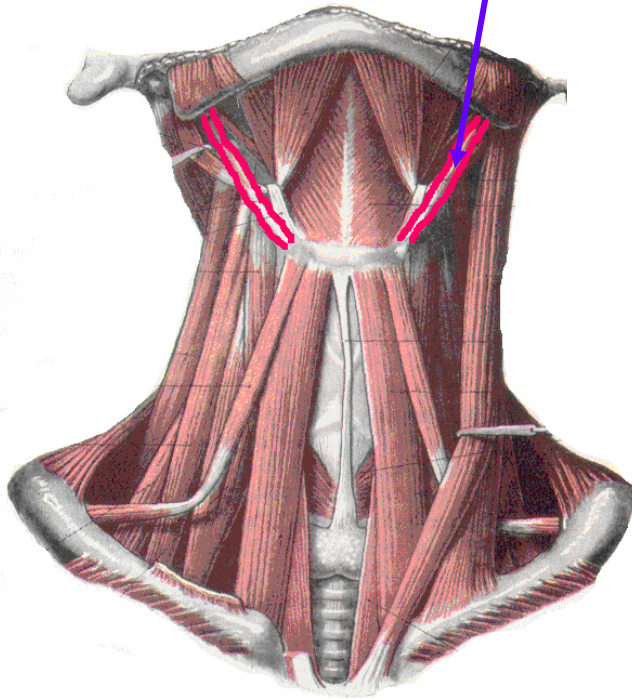
FROM FIRST AND SECOND  
BRANCHIAL ARCH

Act - Depress mandible - MAJOR EFFECT is OPEN MOUTH

# SUPRAHYOID MUSCLES - all elevate hyoid

## 2. STYLOHYOID

O - Styloid process of temporal bone; tendon splits to surround digastric tendon



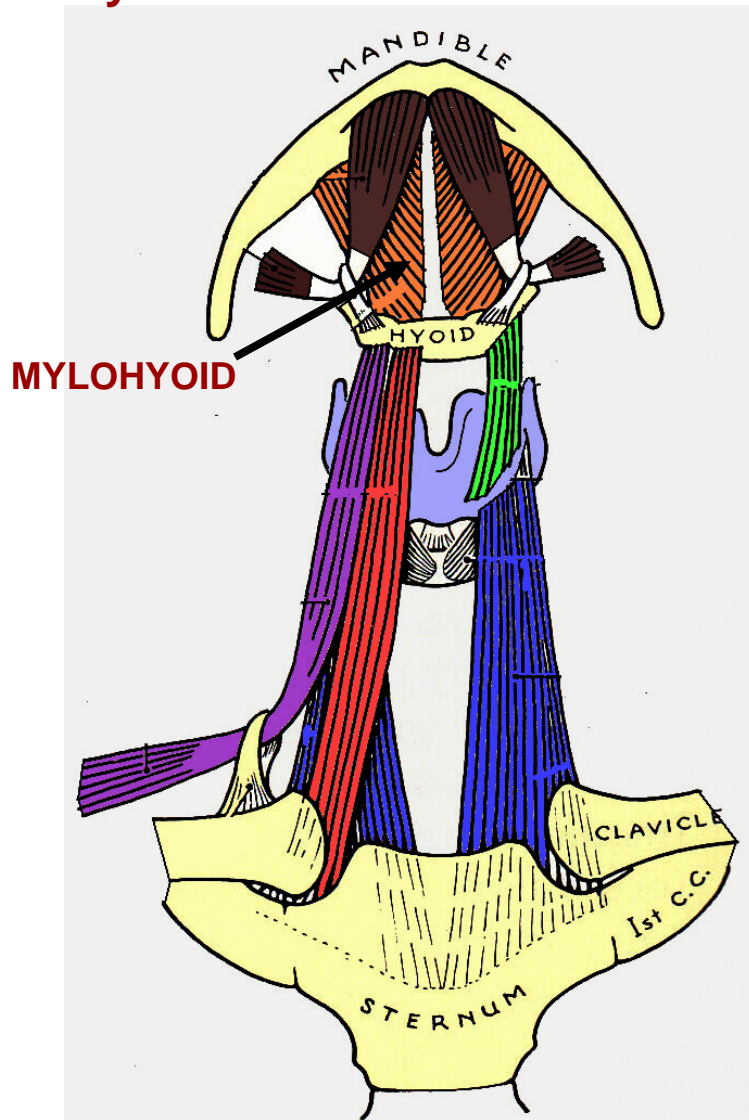
Inn - CN VII

(Note: Arch 2 - Muscles of Facial Expression, Stylohyoid, Post. Belly of Digastric, Stapedius)

# SUPRAHYOID MUSCLES - all elevate hyoid

## 3. MYLOHYOID - forms muscular floor of mouth

mylo = Gk. molar tooth

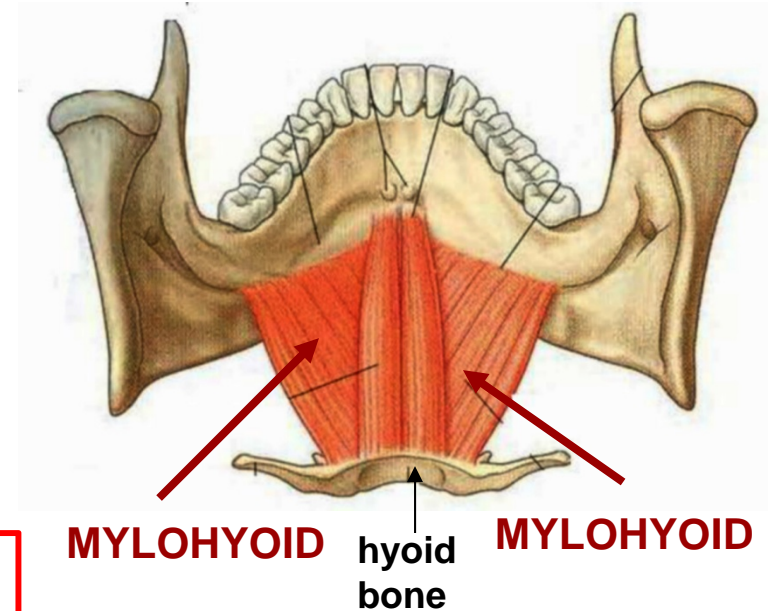


O -  
mylohyoid  
line on  
inner side  
of  
mandible

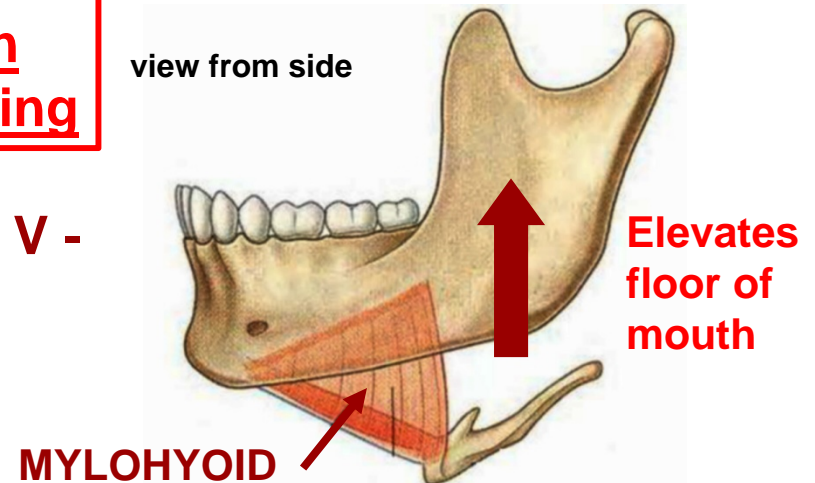
Act -  
**Elevates  
floor of  
mouth in  
swallowing**

Inn - CN V -  
from V3

view from inside mouth



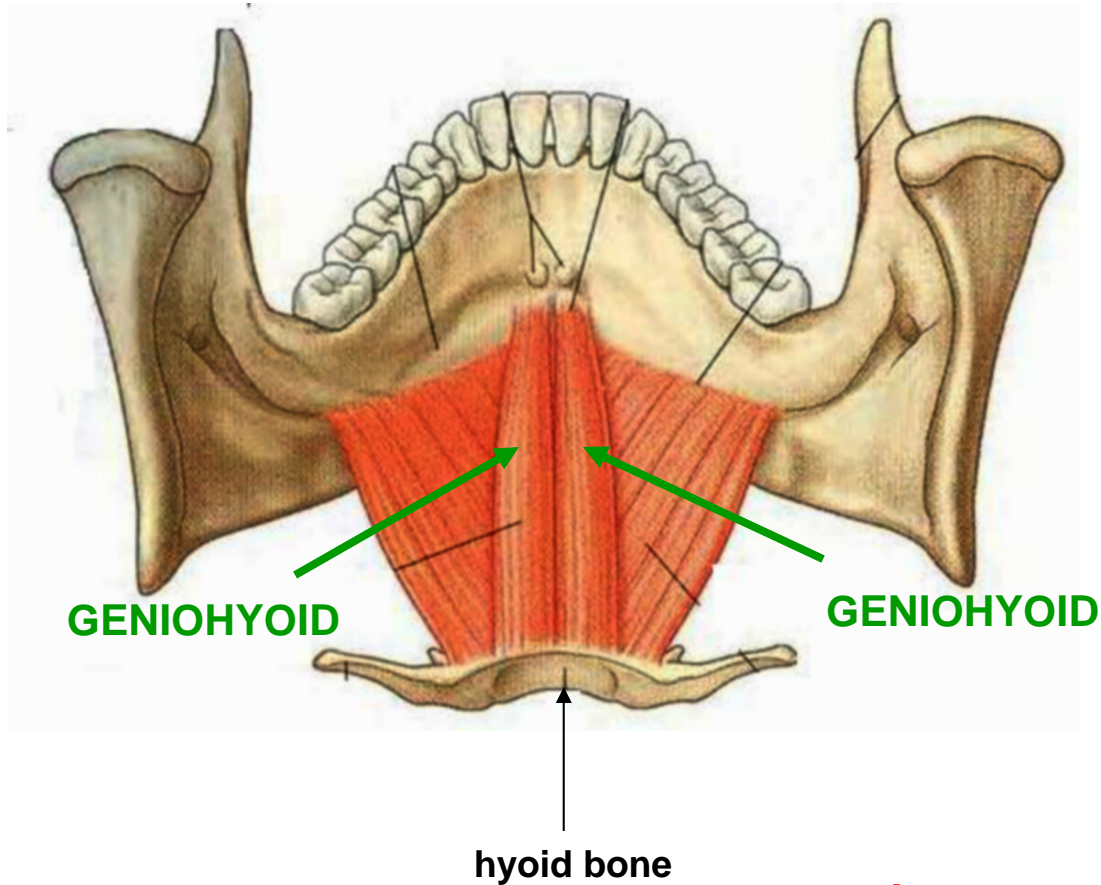
view from side





# SUPRAHYOID MUSCLES - all elevate hyoid

view from inside mouth



4. GENIOHYOID -  
O - inner side of  
mandible  
above mylohyoid

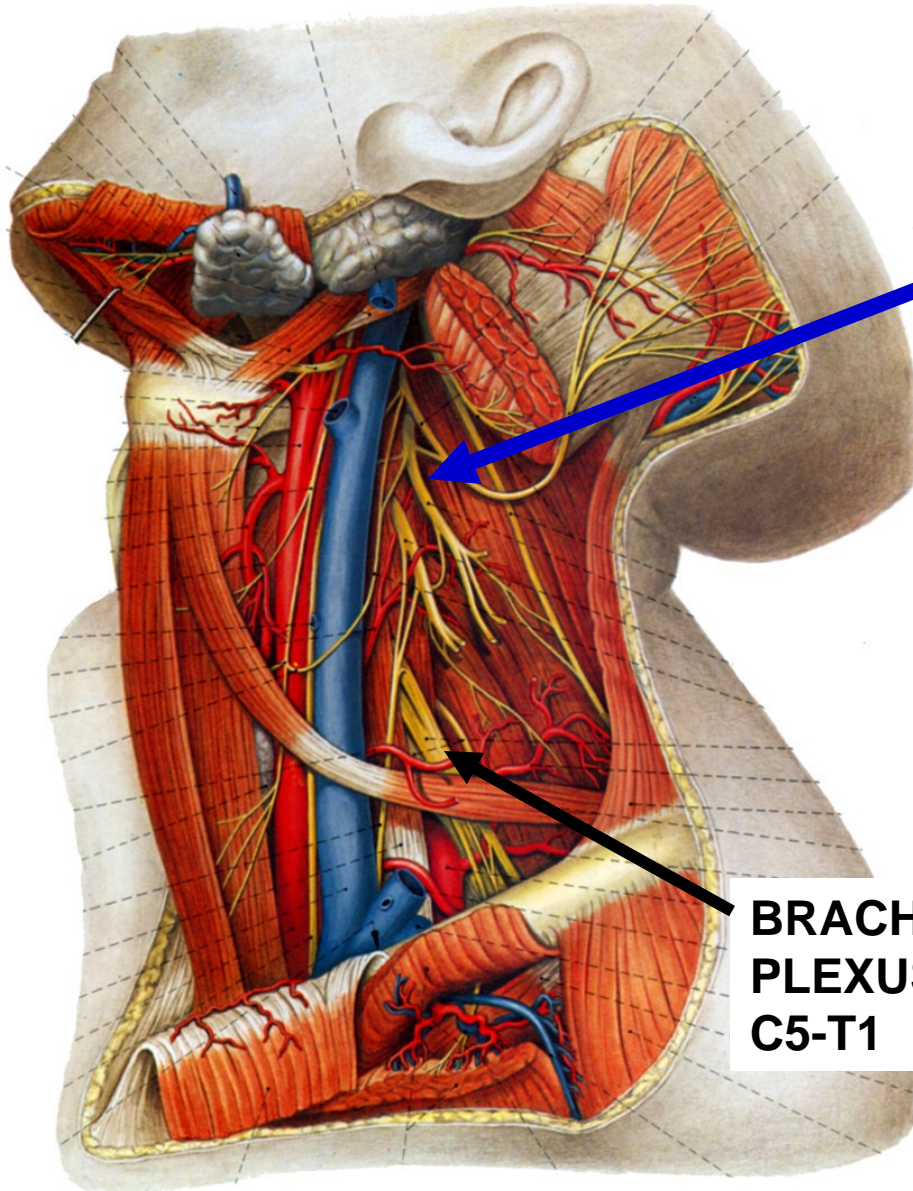
A - Elevates hyoid  
and draws forward

Inn - C1 branch  
hitch-hiking with  
Hypoglossal nerve  
(CN XII)

important in swallowing

### III. NERVES OF NECK

#### A. CERVICAL PLEXUS

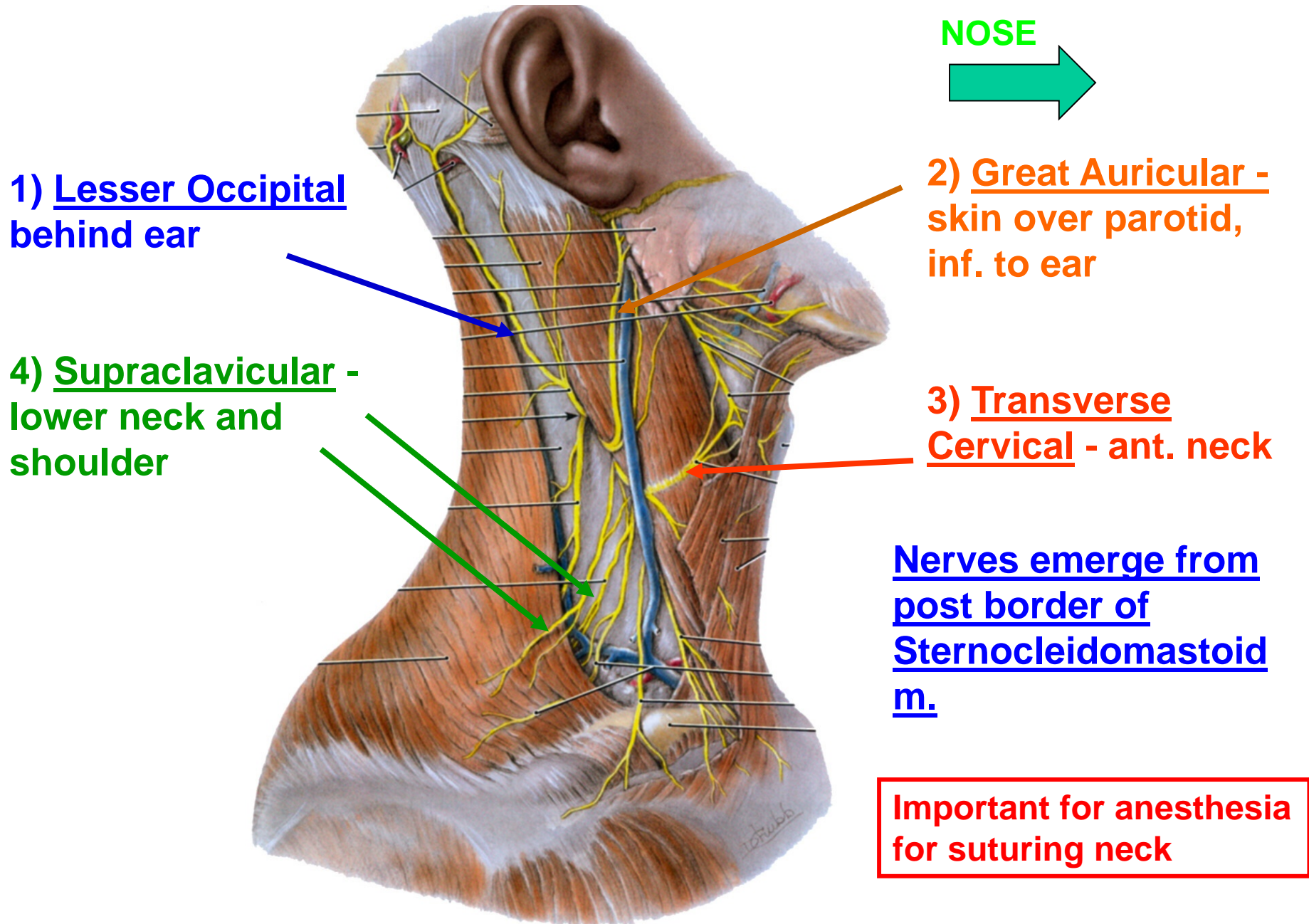


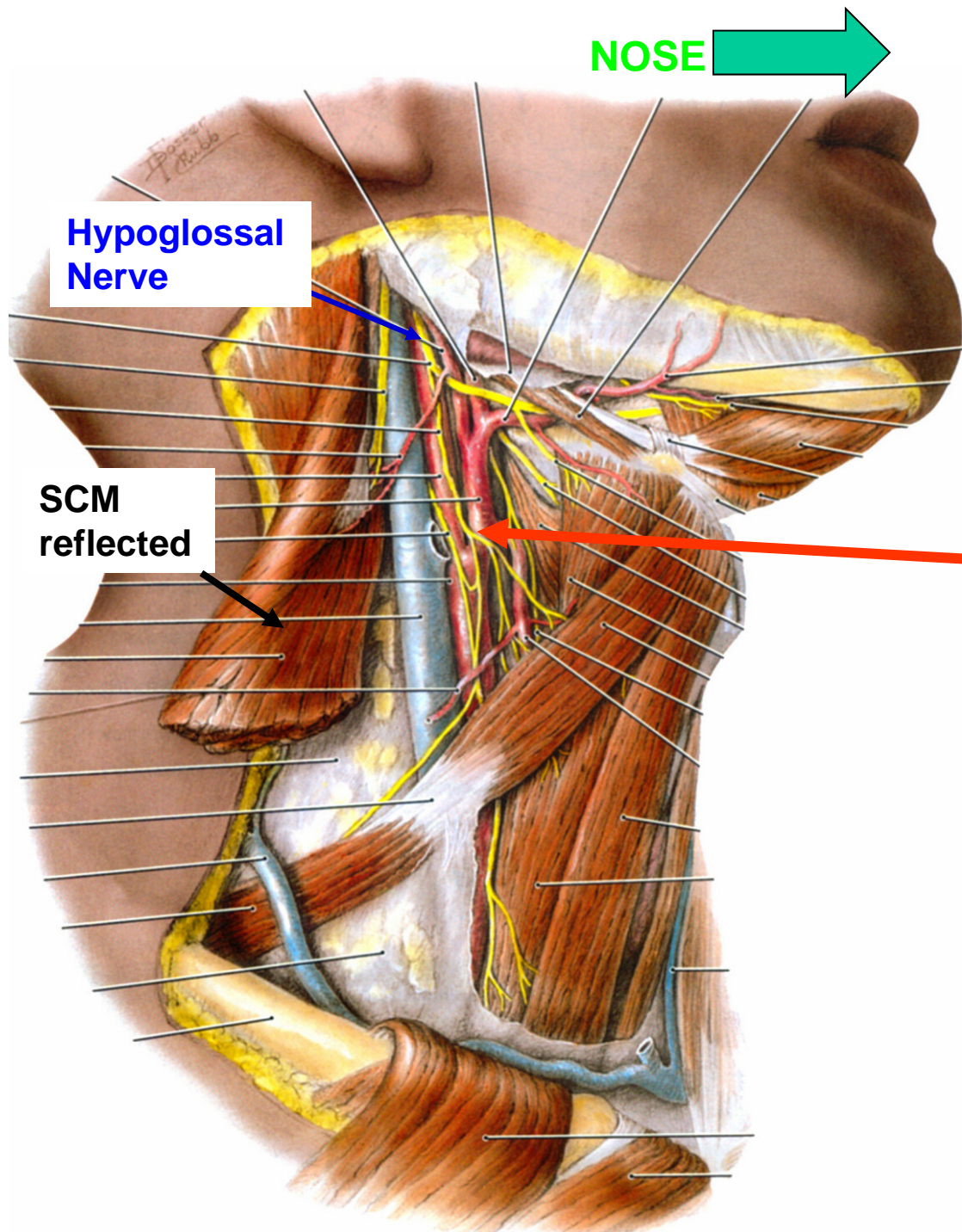
from C2-C4  
ventral primary  
rami

BRACHIAL  
PLEXUS  
C5-T1

not know detailed  
branching pattern:  
cervical plexus is  
deep and protected

## A. CERVICAL PLEXUS - cutaneous nerves





## B. ANSA CERVICALIS

- fibers from C1 join Hypoglossal Nerve (XII)

- some leave and join fibers of C2 and C3 to form ANSA (loop) Cervicalis

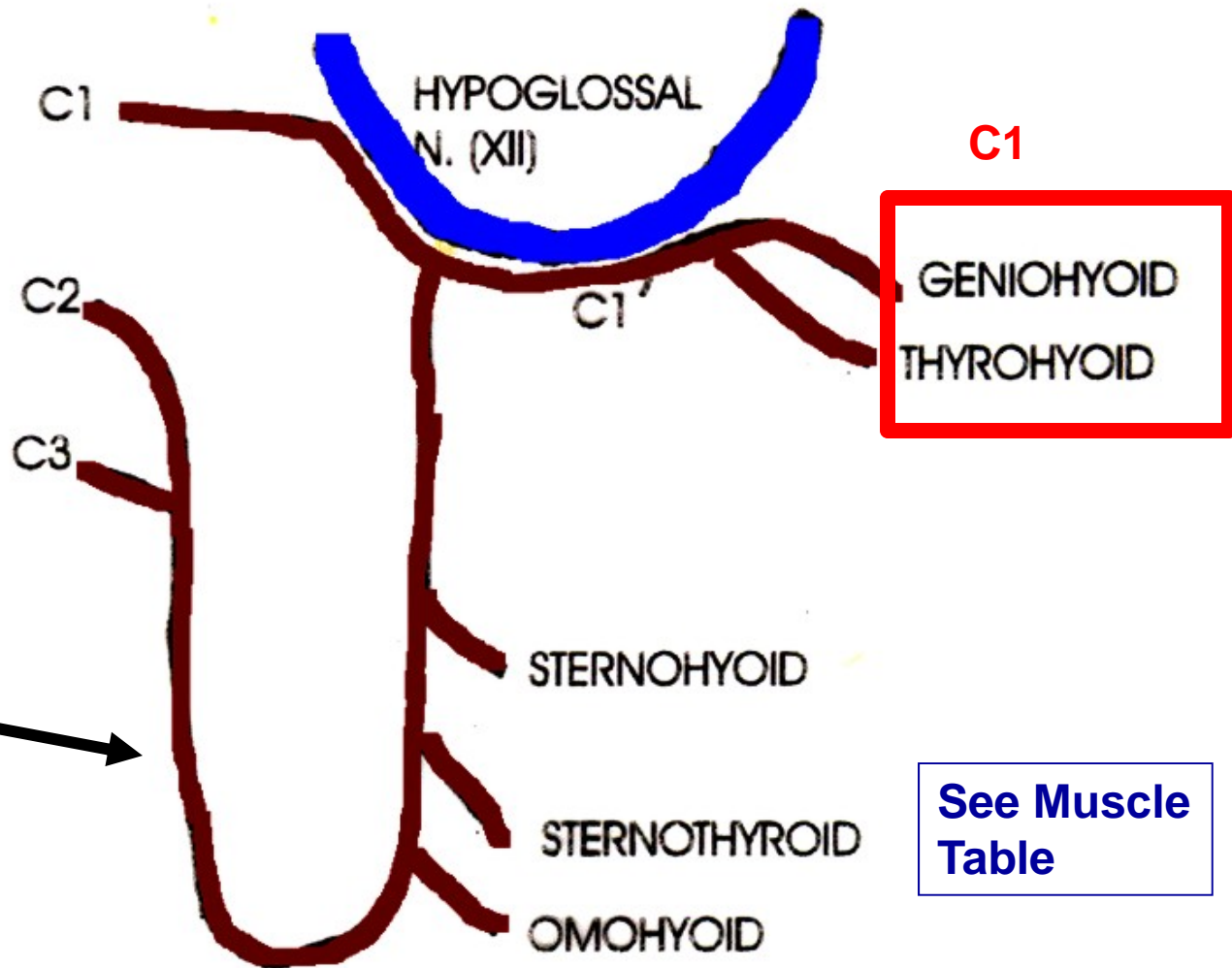
- other fibers continue with XII to innervate Thyrohyoid and Geniohyoid

(Looks like XII innervates neck muscles; actually C1-C3 do)

# ANSA CERVICALIS

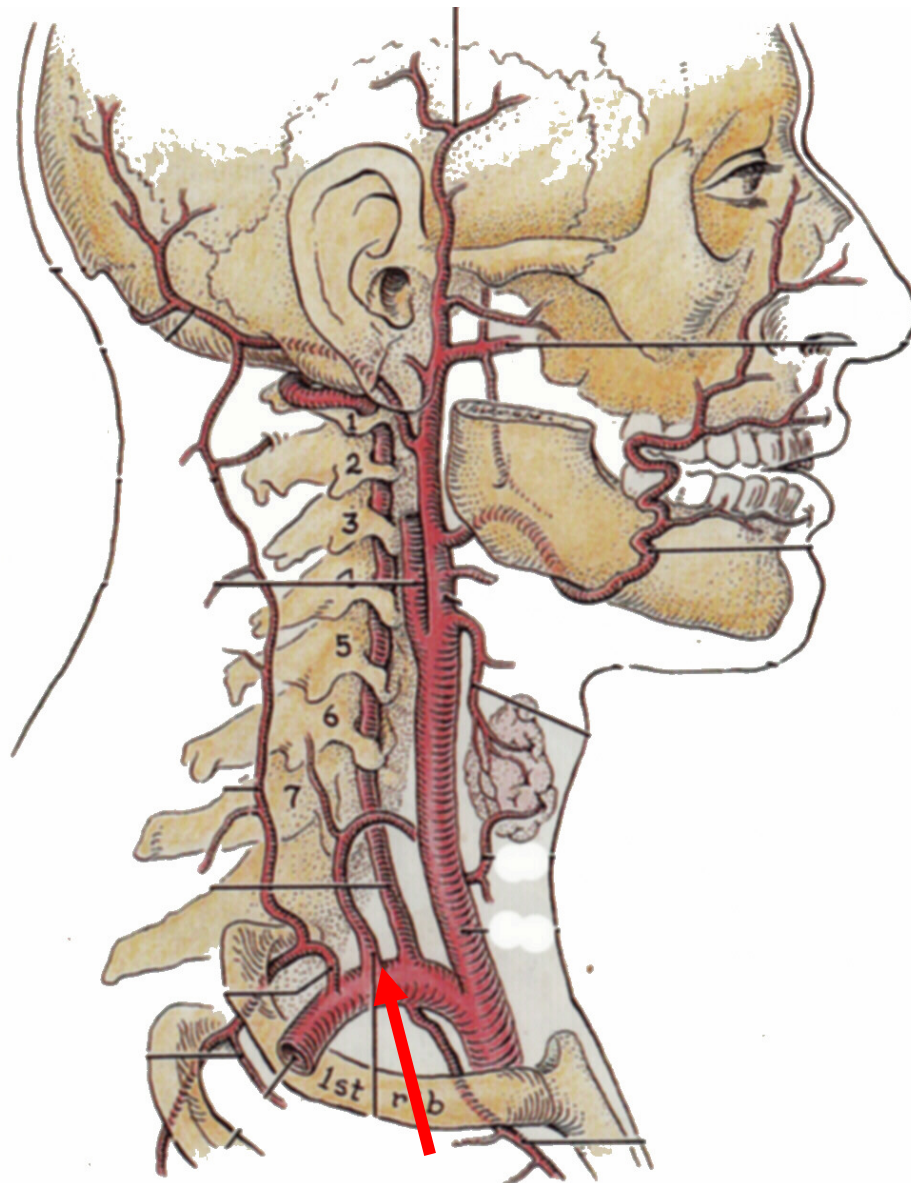
**CN XII  
Receives  
hitchhiking  
fibers**

**LOOP =  
ANSA  
CERVICALIS**



**See Muscle  
Table**

## IV. ARTERIES OF HEAD AND NECK



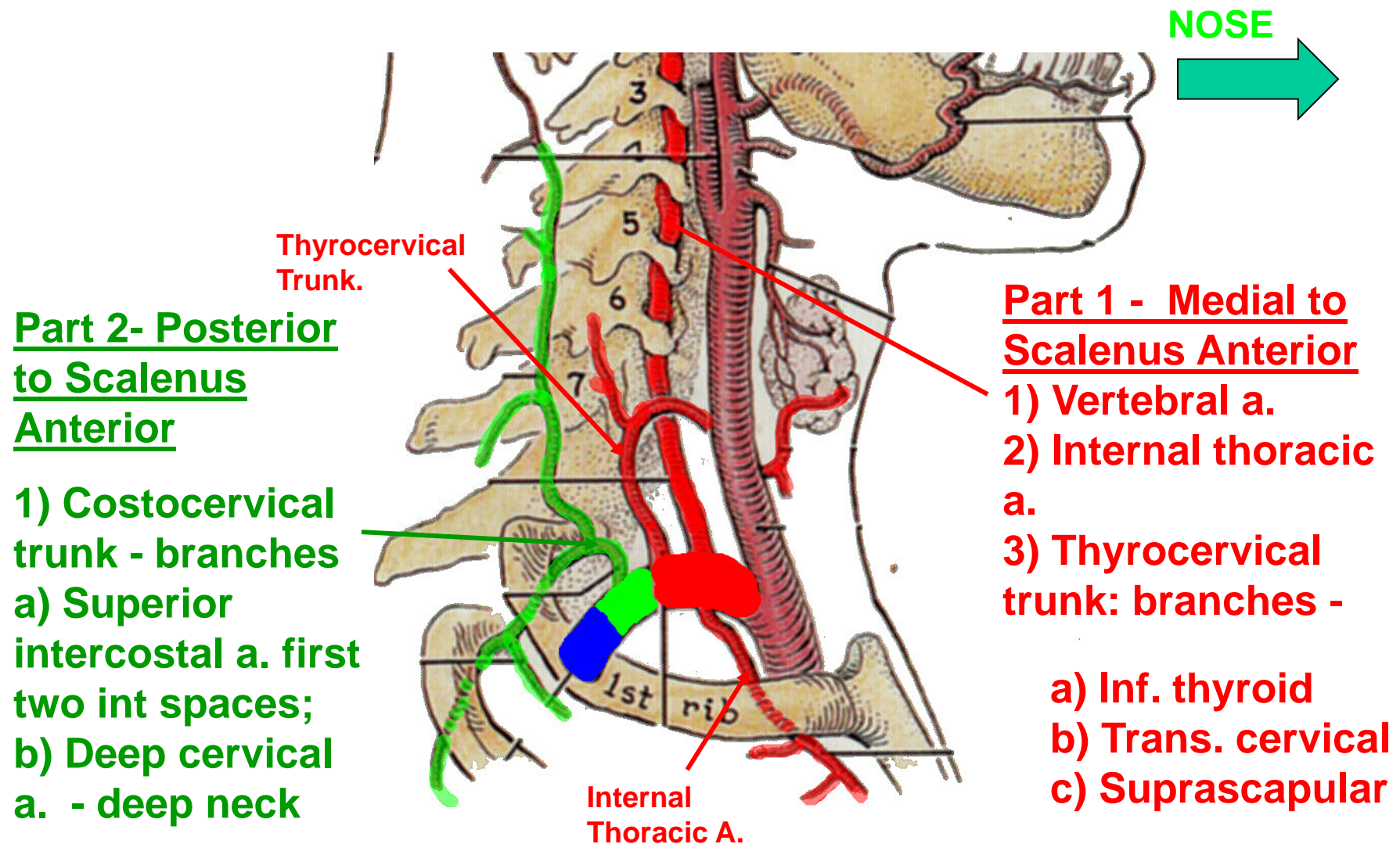
**SUBCLAVIAN A.**

### A. SUBCLAVIAN ARTERY

At root of neck -  
passes to arm -  
becomes Axillary a.  
( rib 1)

- Scalenus Anterior  
muscle divides  
Subclavian into 3  
parts

# SUBCLAVIAN ARTERY - divided into 3 parts by Scalenus Anterior muscle



**Part 3 - Lateral to Scalenus Anterior - No Branches**

**BRACHIAL  
PLEXUS**

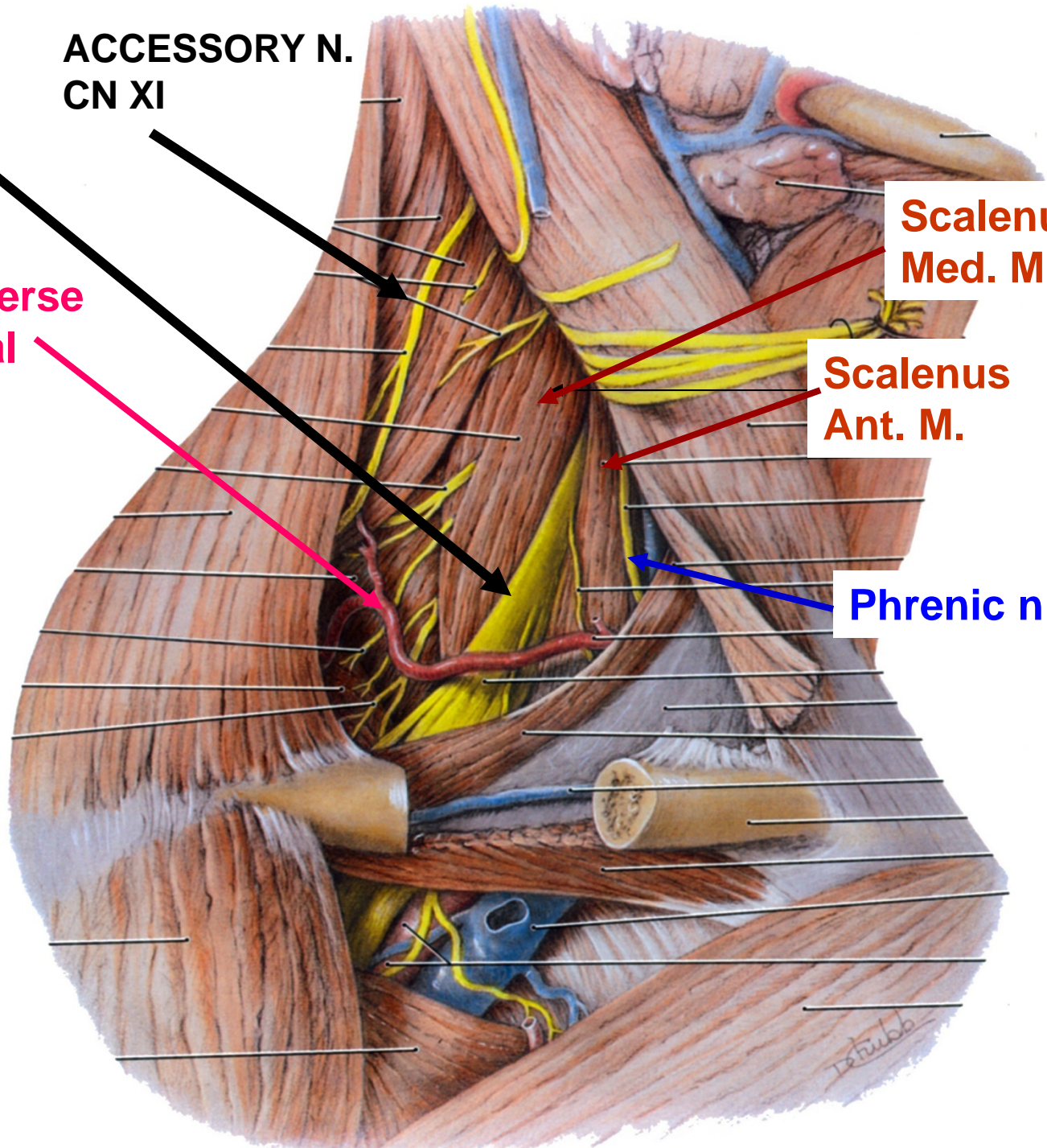
**ACCESSORY N.  
CN XI**

**Transverse  
cervical  
artery**

**Scalenus  
Med. M.**

**Scalenus  
Ant. M.**

**Phrenic n.**





**BRACHIAL PLEXUS**

**Transverse cervical artery**

**Supra-scapular artery**

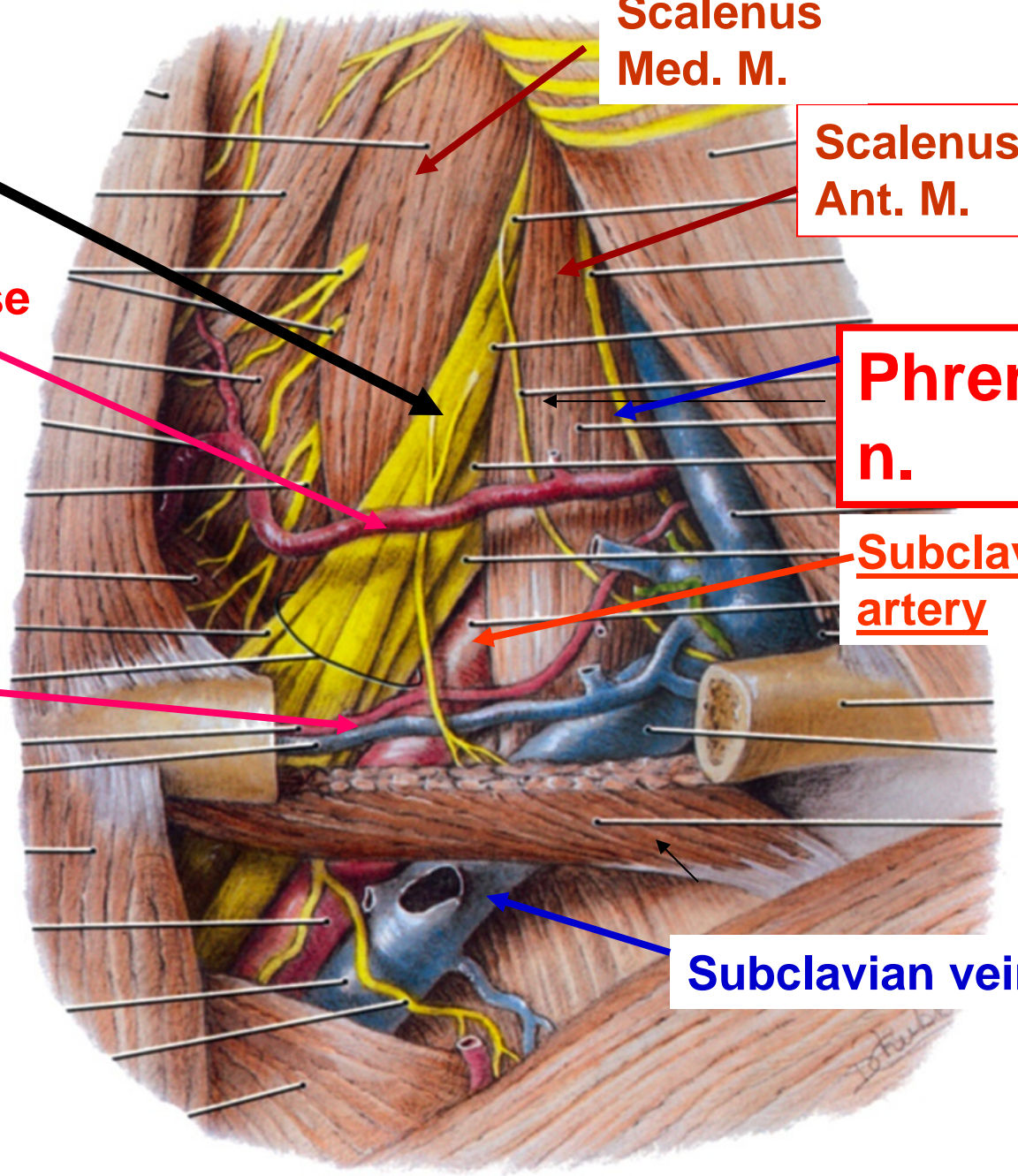
**Scalenus Med. M.**

**Scalenus Ant. M.**

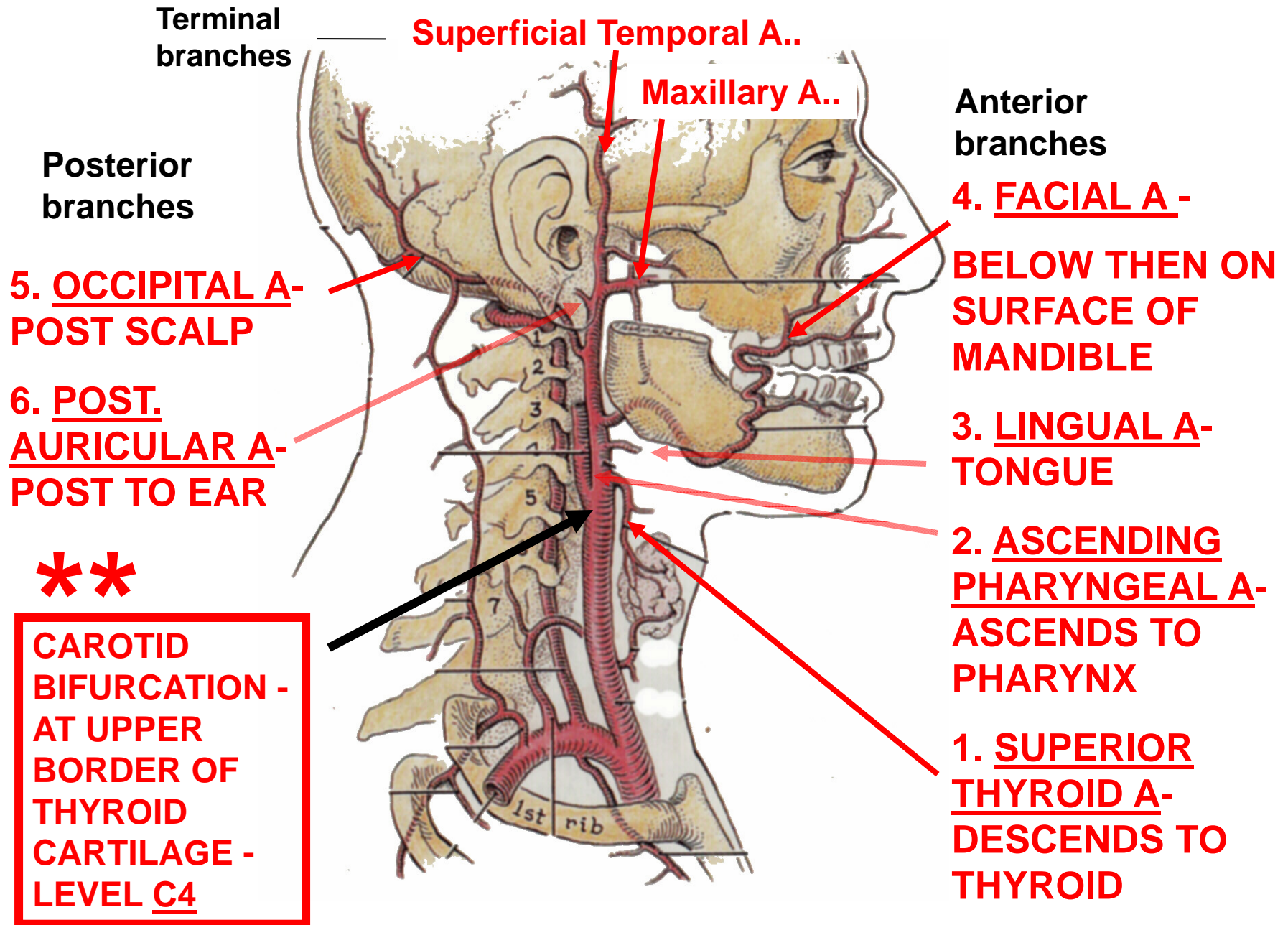
**Phrenic n.**

**Subclavian artery**

**Subclavian vein**

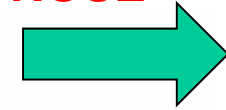


# B. EXTERNAL CAROTID ARTERY



# EXTERNAL CAROTID ARTERY

NOSE



Superficial Temporal-  
scalp and temporalis

Post Auricular- post. ear  
and scalp

Occipital-  
posterior scalp

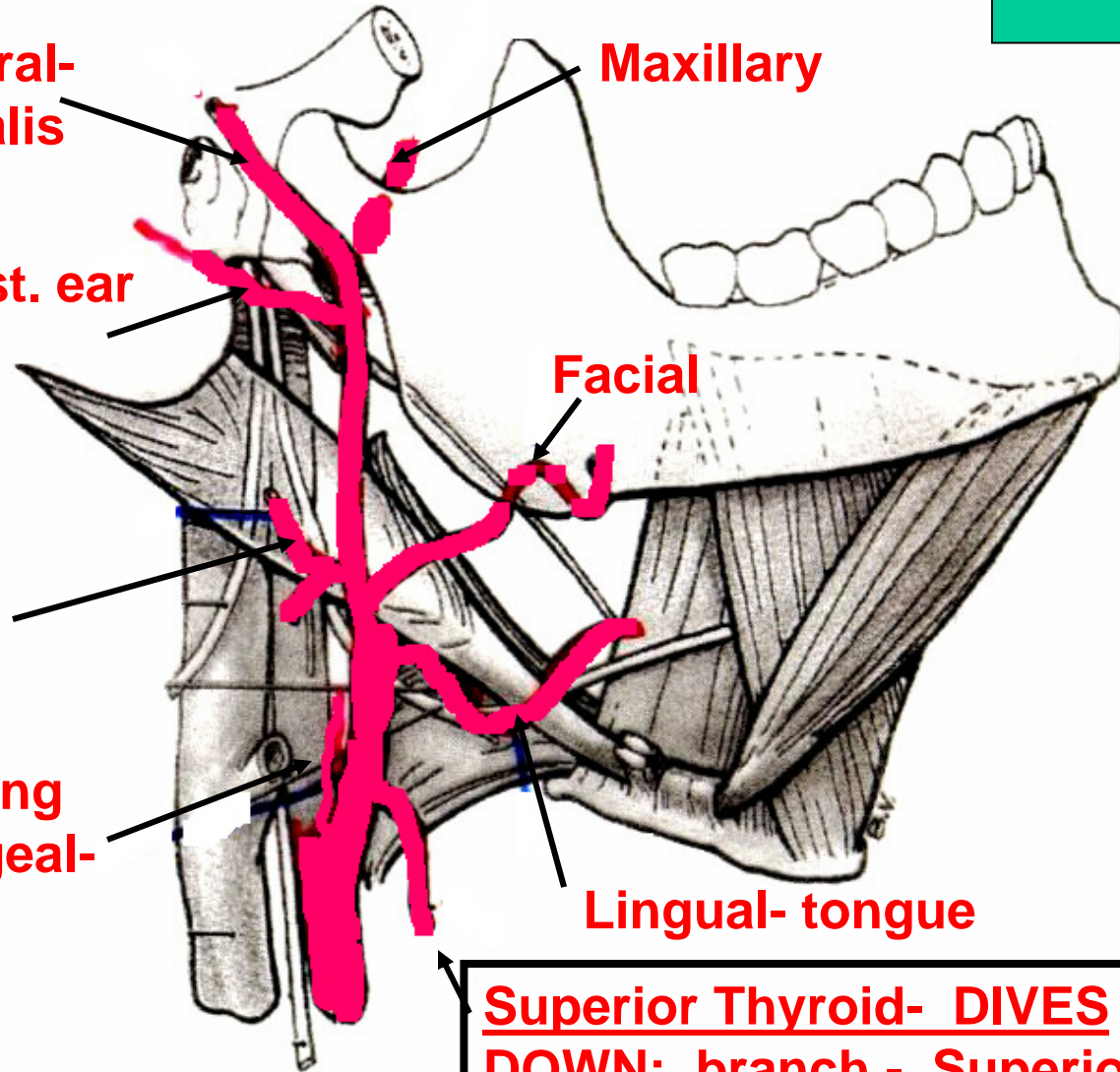
Ascending  
Pharyngeal-  
pharynx

Maxillary

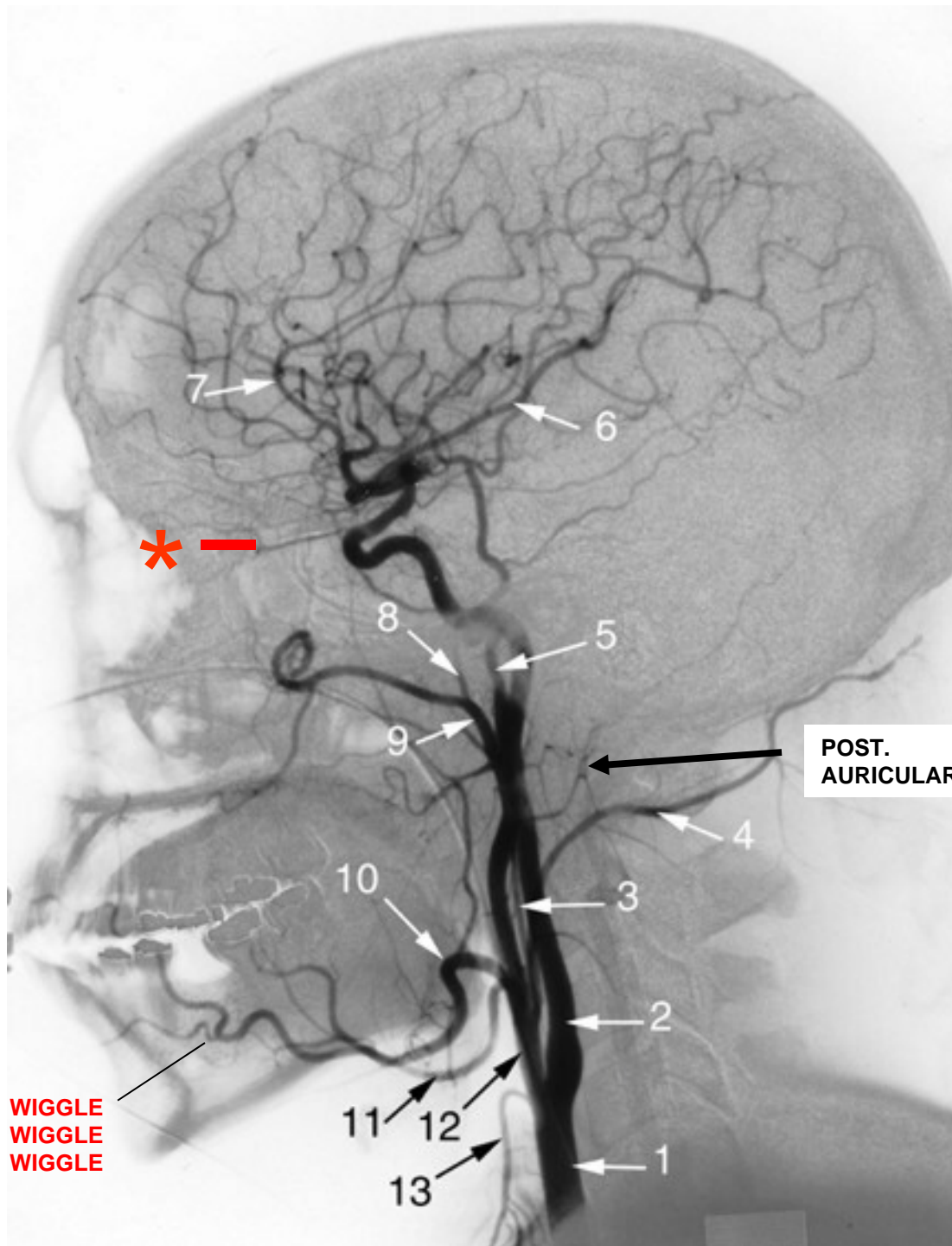
Facial

Lingual- tongue

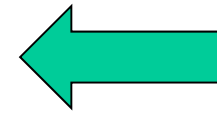
Superior Thyroid- DIVES  
DOWN: branch - Superior  
Laryngeal artery







NOSE



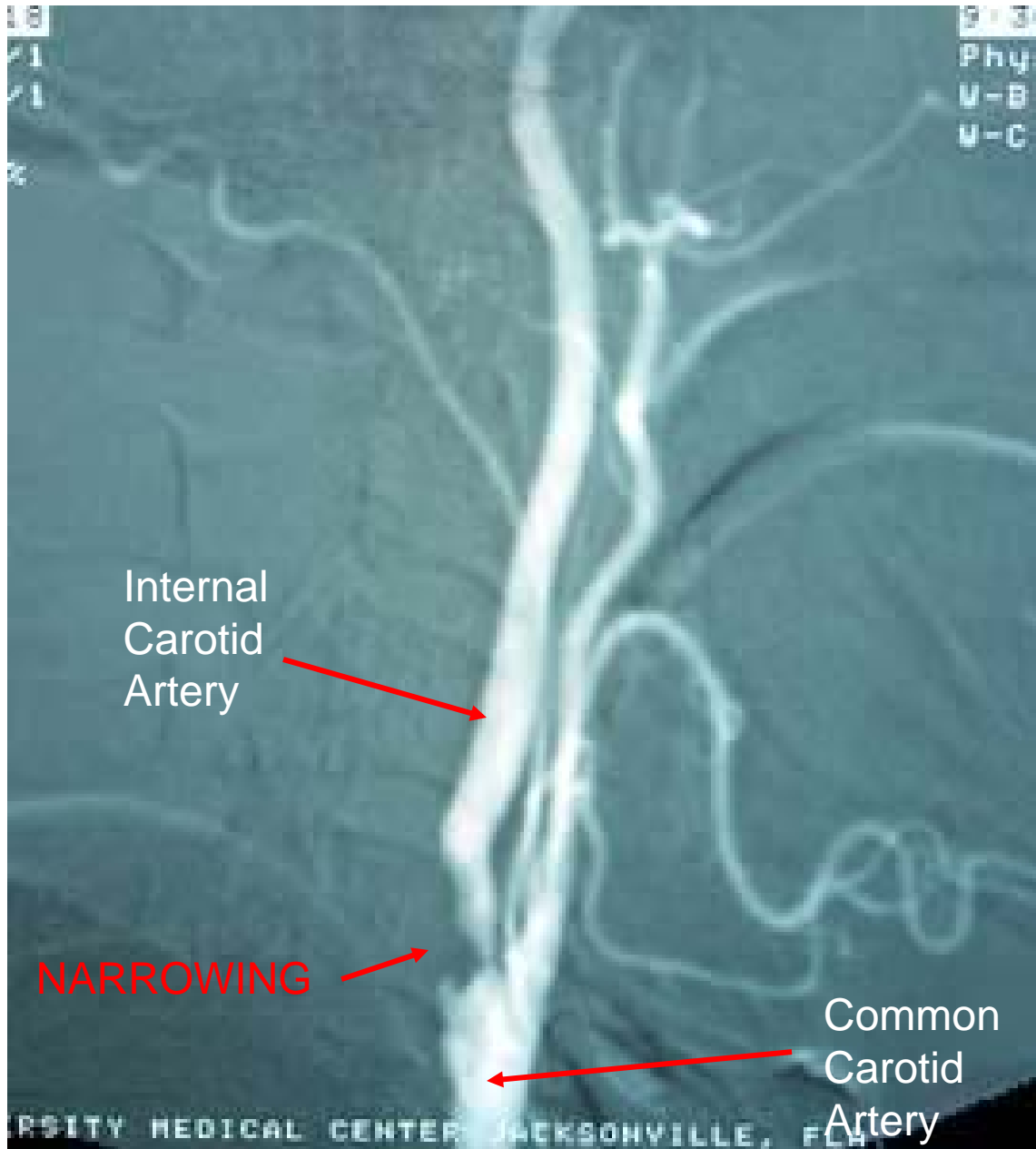
**KNOW THIS  
SLIDE**

1. COMMON CAROTID
2. INTERNAL CAROTID
3. ASCENDING PHARYNGEAL
4. OCCIPITAL
5. SUPERFICIAL TEMPORAL
6. MIDDLE CEREBRAL
7. ANTERIOR CEREBRAL
8. MIDDLE MENINGEAL
9. MAXILLARY
10. FACIAL
11. LINGUAL
12. EXTERNAL CAROTID
13. SUPERIOR THYROID

**\*- OPHTHALMIC ARTERY  
ARISING FROM CAROTID  
SIPHON**



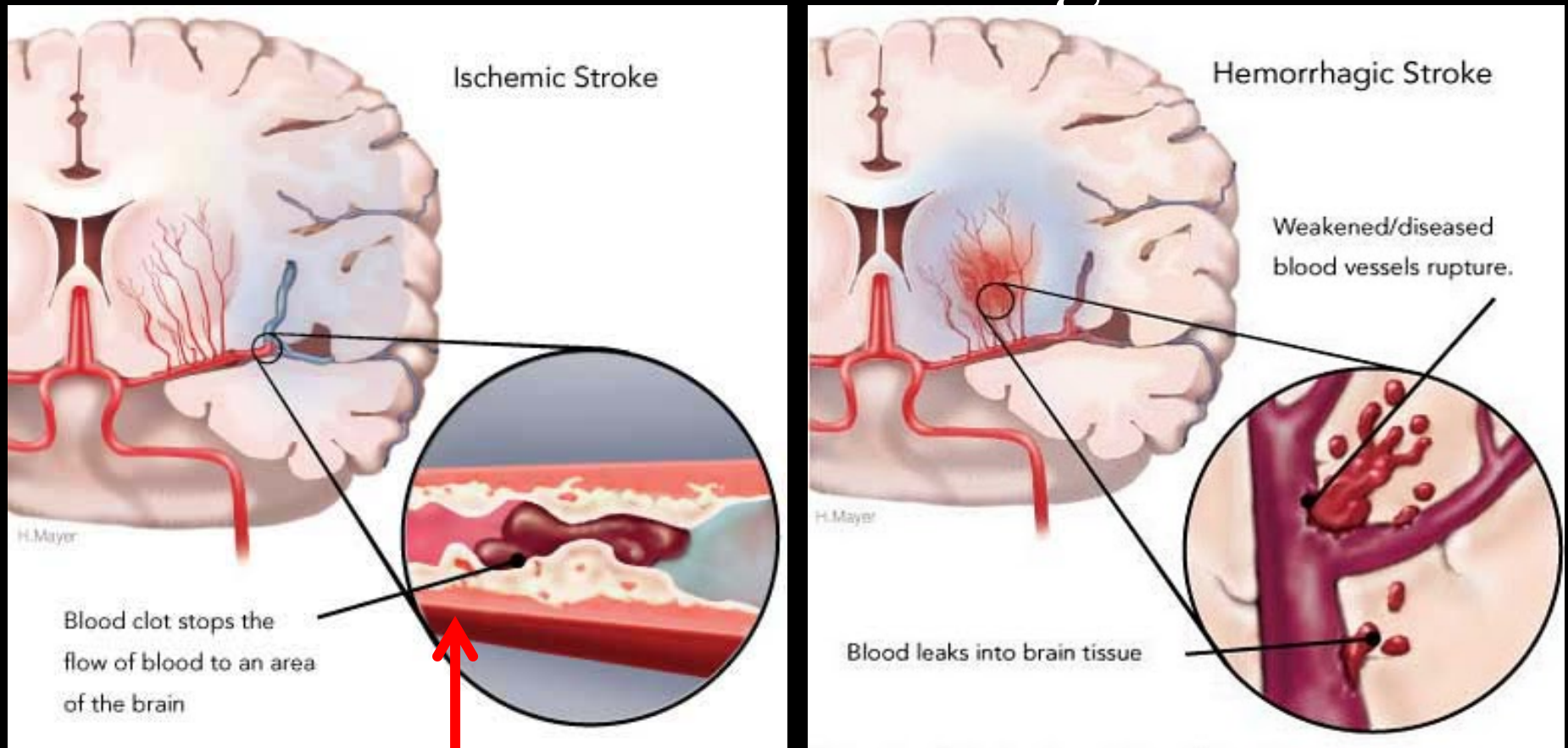
WIGGLE  
WIGGLE  
WIGGLE



The patient presented is a healthy 72 year old man who was found to have a preocclusive stenosis on work up.

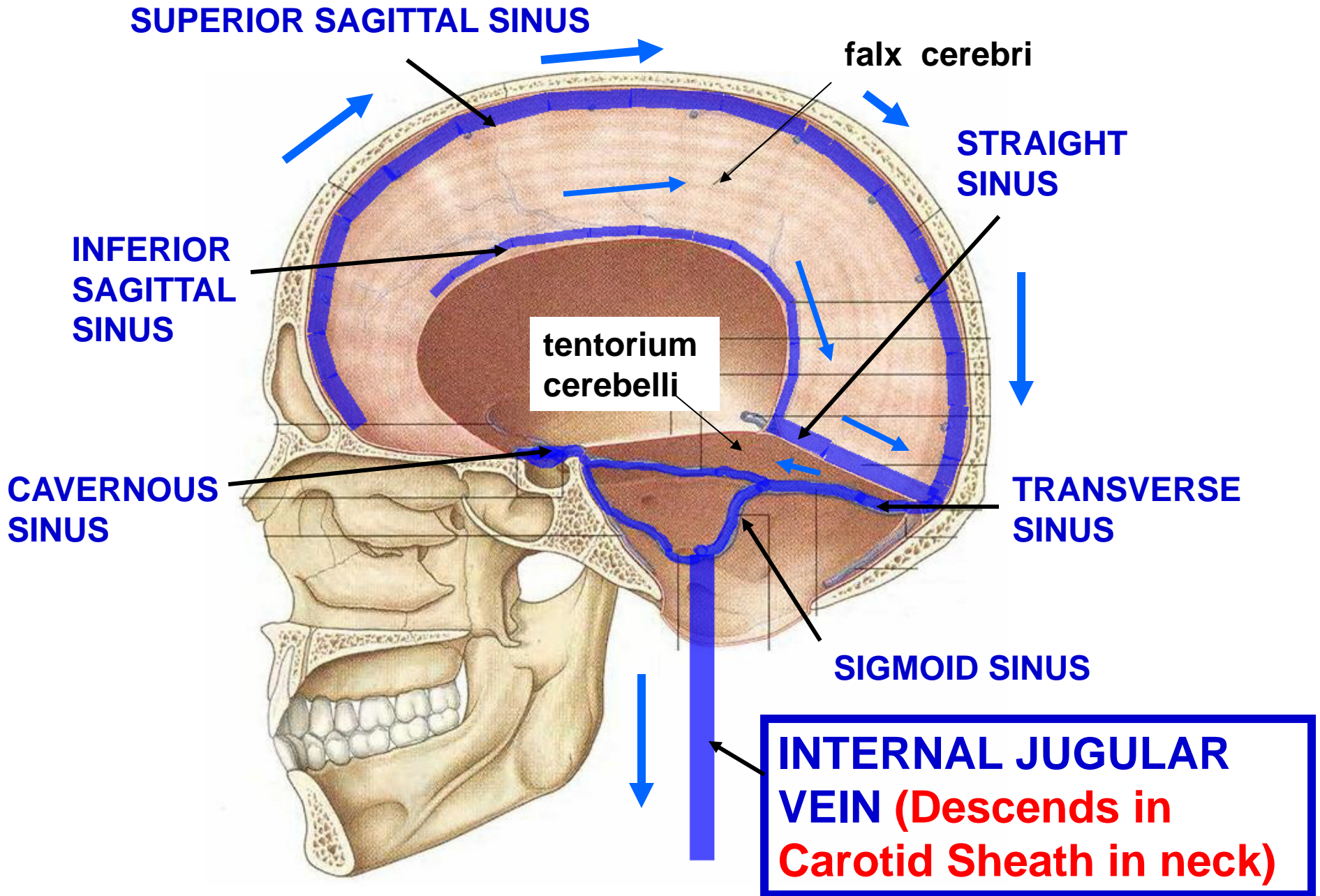
**STENOSIS -  
ABNORMAL  
NARROWING OF  
VESSEL**

# Ischemic vs. Hemorrhagic Stroke

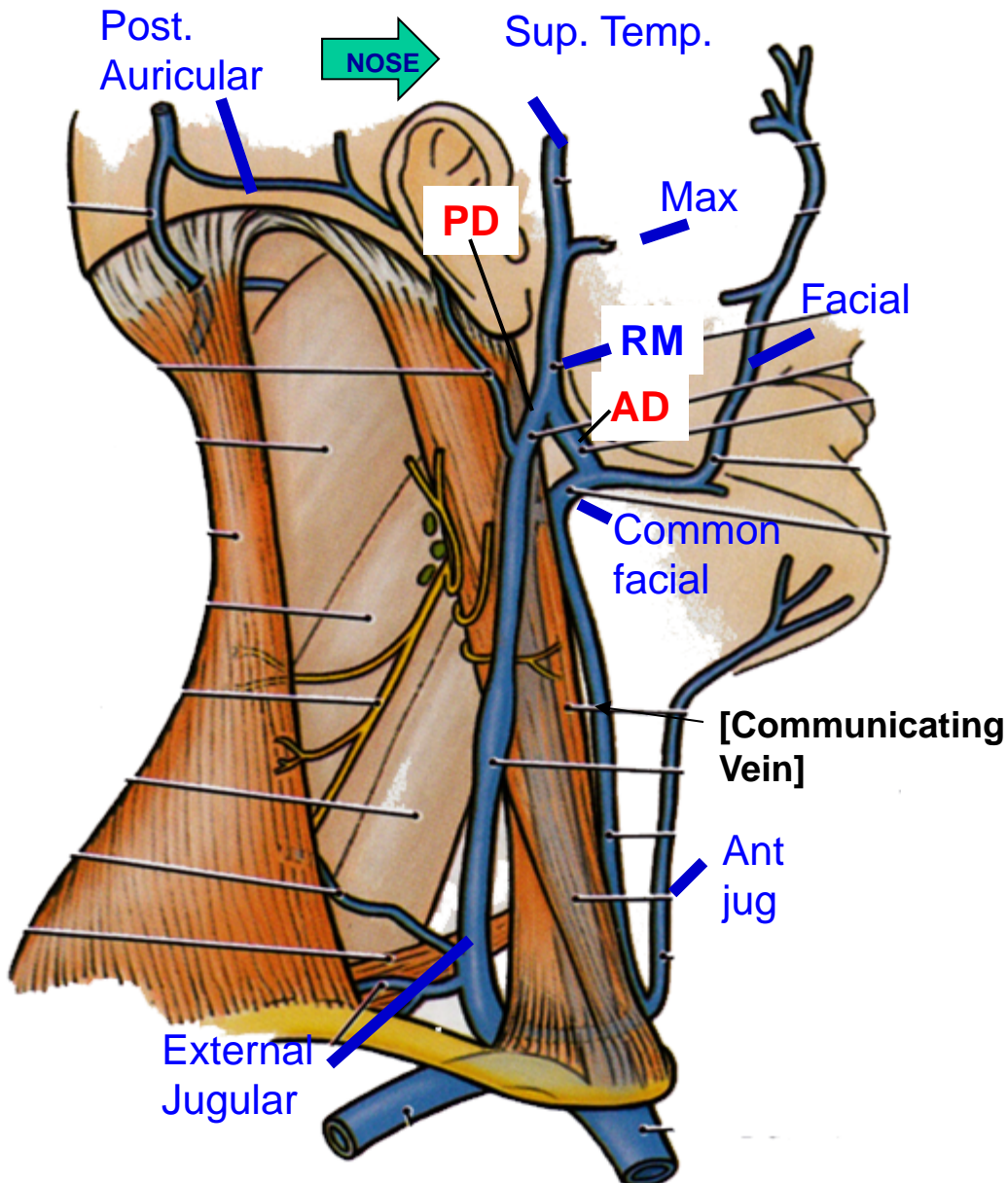


**Danger of Occlusion is Ischemic stroke – Insufficient blood supply to brain or giving rise to embolus (clot that is carried in arterial system, to brain)**

# VENOUS SINUSES OF BRAIN







## V. VEINS OF NECK - drain areas of External Carotid Artery

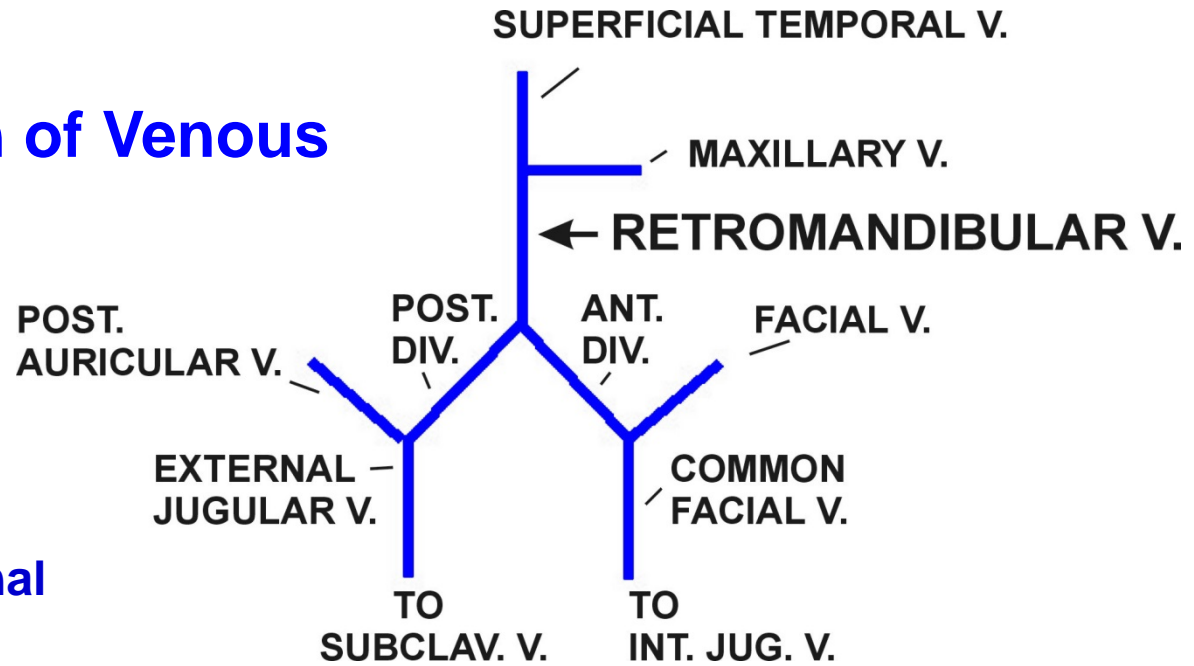
1. Superficial Temporal and Maxillary veins form Retromandibular V. (RM)
2. Retromand. V. Divides Ant. (AD) and Post. (PD) divisions
3. Ant. Division joins Facial V. to form Common Facial V. drains to Int. Jugular V.
4. Post. Division joins Post. Auricular V. to form External Jugular V (on surface of **Sternocleidomastoid muscle**) drains to **Subclavian V.**
5. Ant. Jugular from veins below mandible drains Ext. Jugular (above clavicle)

**EXTERNAL JUGULAR V. - ON SURFACE OF STERNOCLEIDOMASTOID; NOT IN CAROTID SHEATH**  
**INTERNAL JUGULAR V. - DEEP TO STERNOCLEIDOMASTOID; IN CAROTID SHEATH** \*\*\*

# VEINS OF NECK

Typical Pattern of Venous Drainage

Variations Common



Large External Jugular V.



Justin Bieber - teen 'idol'



Helen Schneider - singer



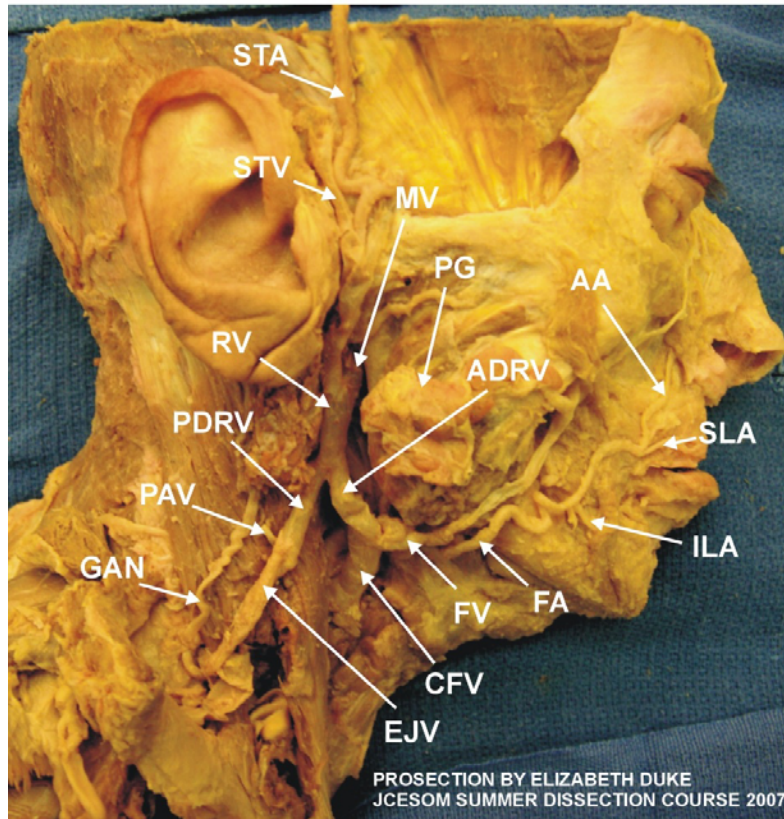
Bono - singer

Large Anterior Jugular V.

## DEEP STRUCTURES IN PAROTID GLAND: FORMATION OF RETROMANDIBULAR VEIN

285

NOTE: PAROTID GLAND DISSECTED AND REFLECTED



## VEINS OF NECK – Prosection 285

**Note: Posterior  
Auricular vein  
torn**

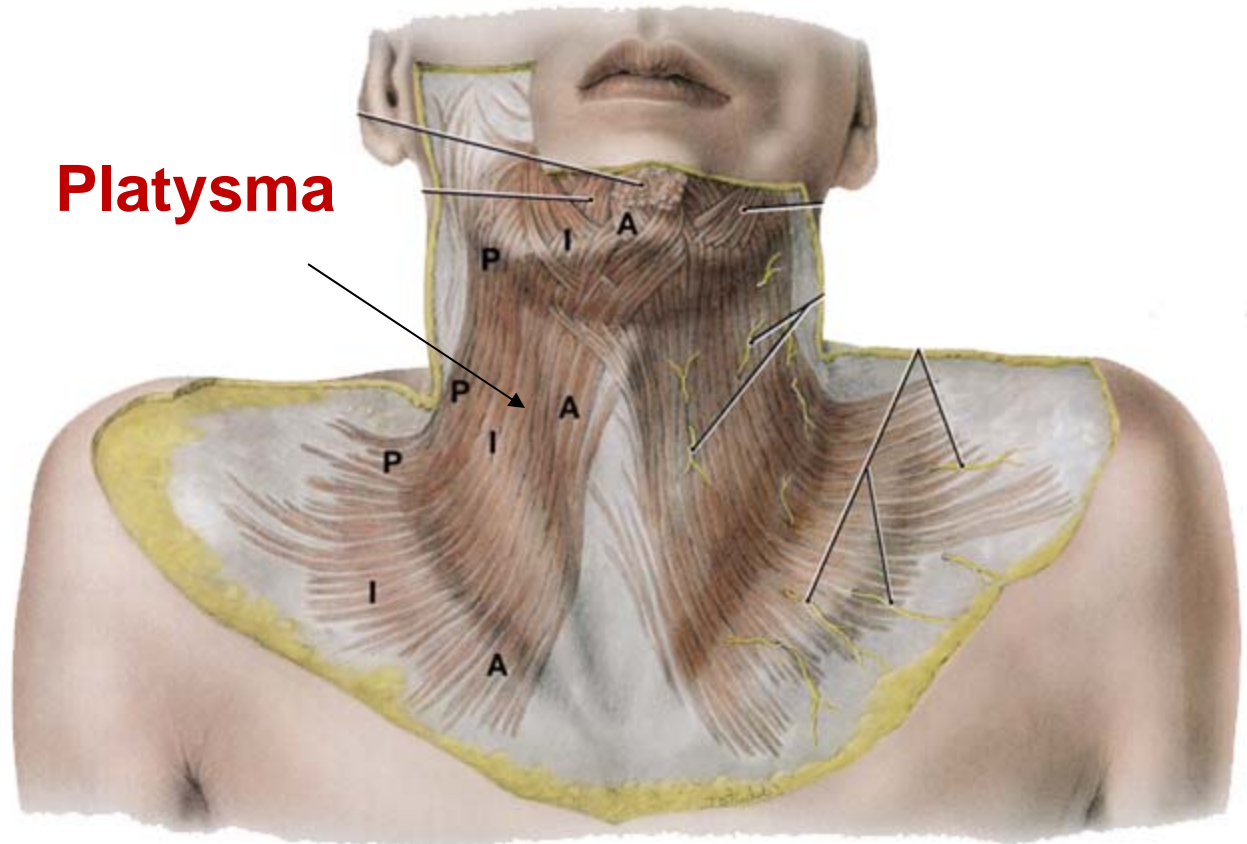
RV - RETROMANDIBULAR V  
ADRV - ANTERIOR DIVISION OF RV  
PDRV - POSTERIOR DIVISION OF RV  
FA - FACIAL ARTERY  
AA - ANGULAR ARTERY  
SLA - SUPERIOR LABIAL ARTERY  
ILA - INFERIOR LABIAL ARTERY  
FV - FACIAL VEIN  
GAN - GREAT AURICULAR NERVE  
STV - SUPERFICIAL TEMPORAL VEIN  
STA - SUPERFICIAL TEMPORAL ARTERY  
PAV - POSTERIOR AURICULAR VEIN (CUT)

MV - MAXILLARY VEIN  
CFV - COMMON FACIAL  
VEIN  
EJV - EXTERNAL  
JUGULAR VEIN  
PG - PAROTID GLAND  
(cut and reflected)

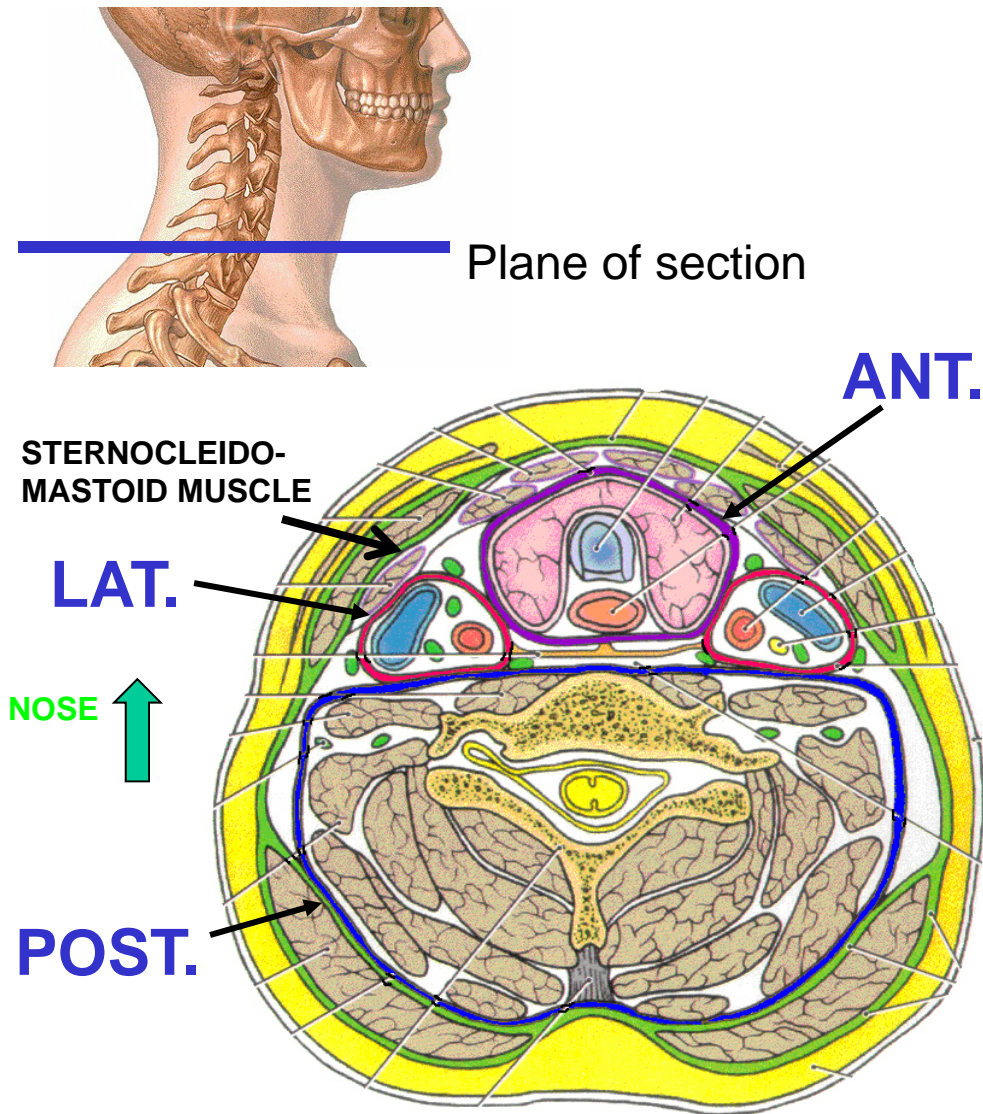
## VI. FASCIA OF NECK

### A. Superficial fascia:

- connective tissue below dermis
- completely surrounds neck - thin and hard to demonstrate
- contains **Platysma (muscle of Facial Expression CN VII)** and **Superficial veins**



# I. OVERVIEW OF NECK - neck is compartmentalized



1. Posterior Compartment - **Vertebrae and muscles** which support and move head and neck

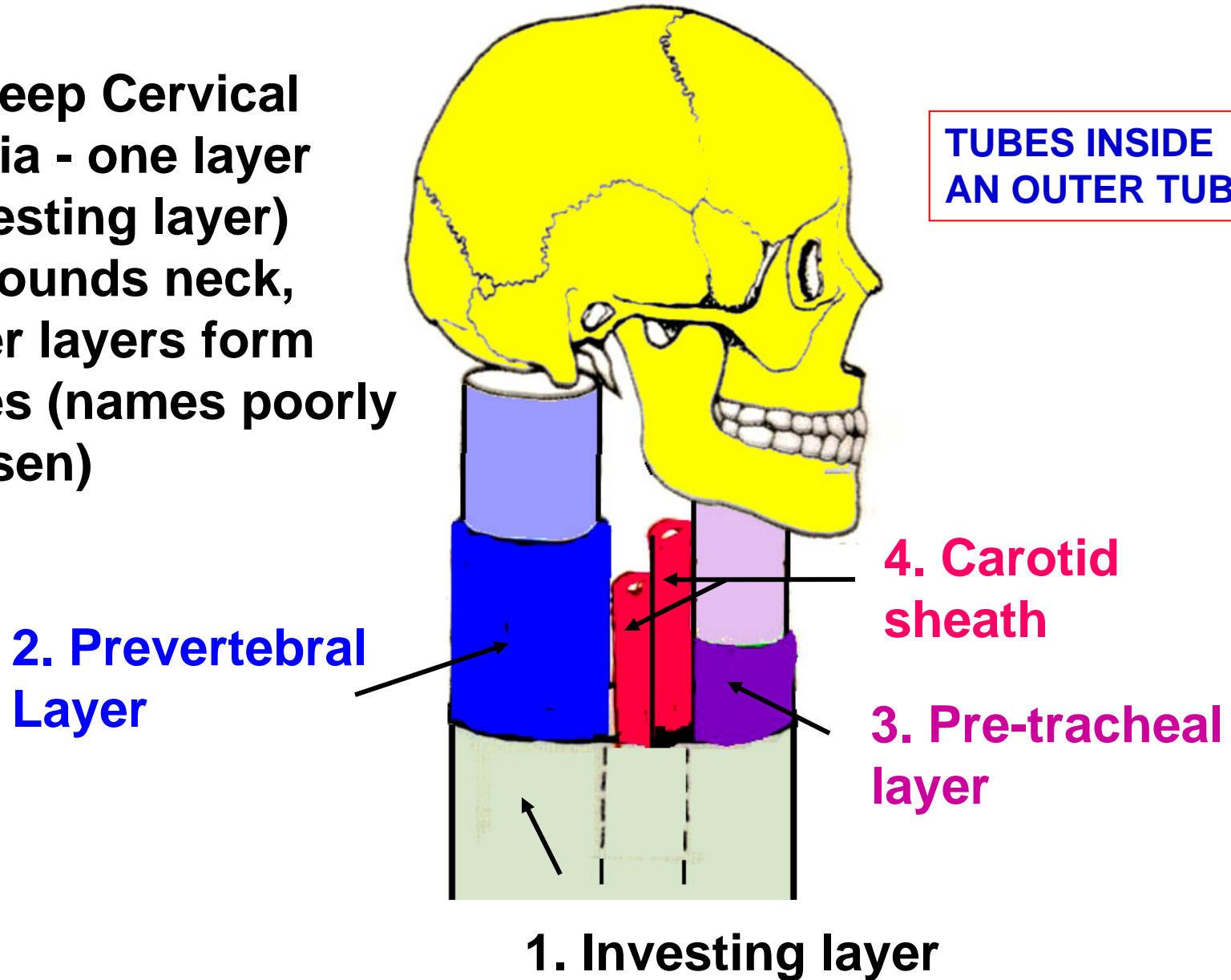
2. Anterior Compartment- **Viscera** and rostral continuation GI & Respiratory Systems

3. Lateral Compartment- Blood vessels and nerve - **Carotid sheath**

**HORIZONTAL SECTION THROUGH NECK**

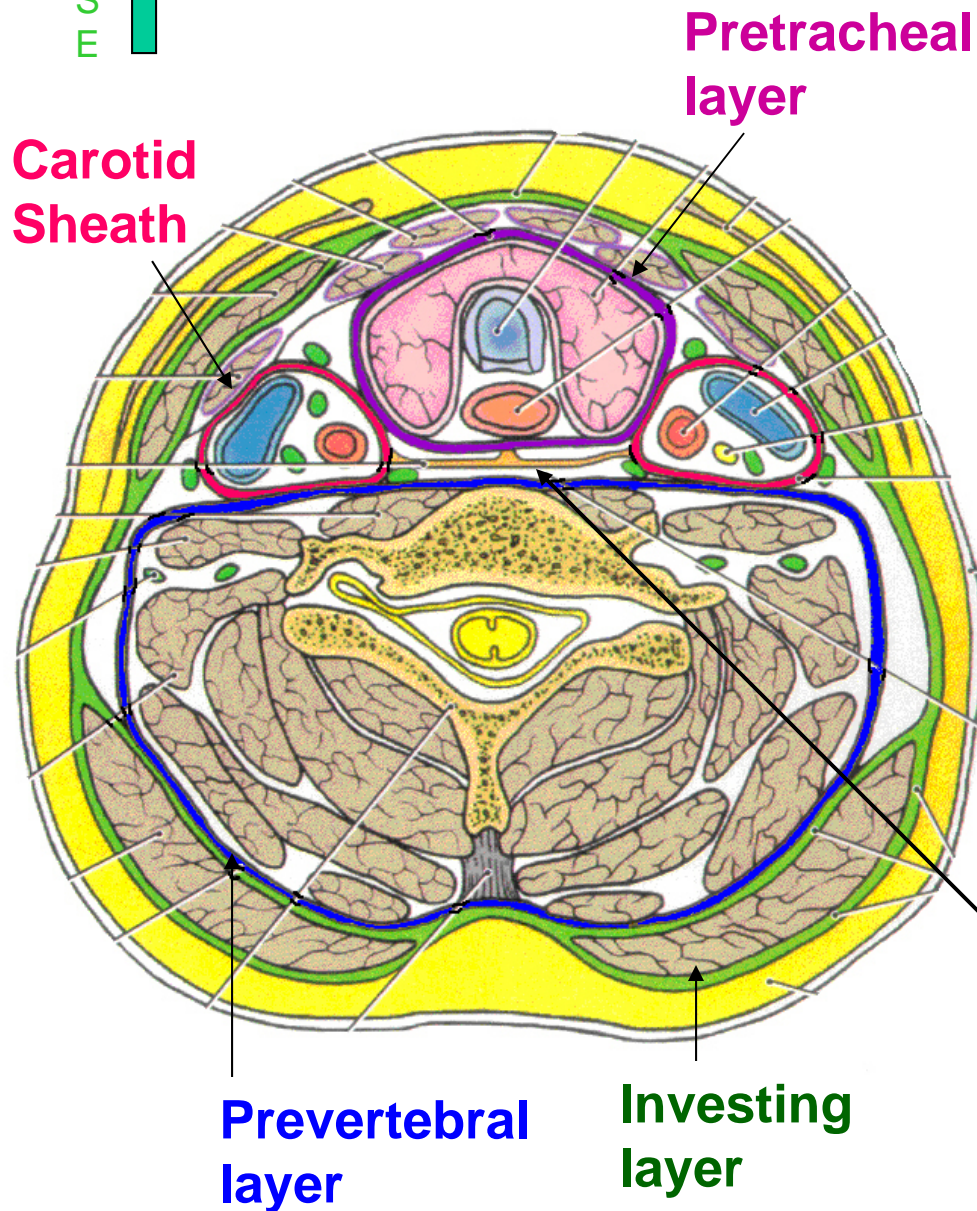
# FASCIA OF NECK

**B. Deep Cervical fascia - one layer (Investing layer) surrounds neck, other layers form tubes (names poorly chosen)**



N  
O  
S  
E

# FASCIA OF NECK



1. Investing layer of deep cervical fascia- surrounds neck, splits around sternocleidomastoid, trapezius, supra and infrahyoid m.

2. Prevertebral Layer- surrounds vert. column, muscles of neck, (prevertebral, lat. vertebral, suboccipital m.)

3. Pretracheal Layer- surrounds trachea, esophagus and thyroid continues to thorax. \*\*

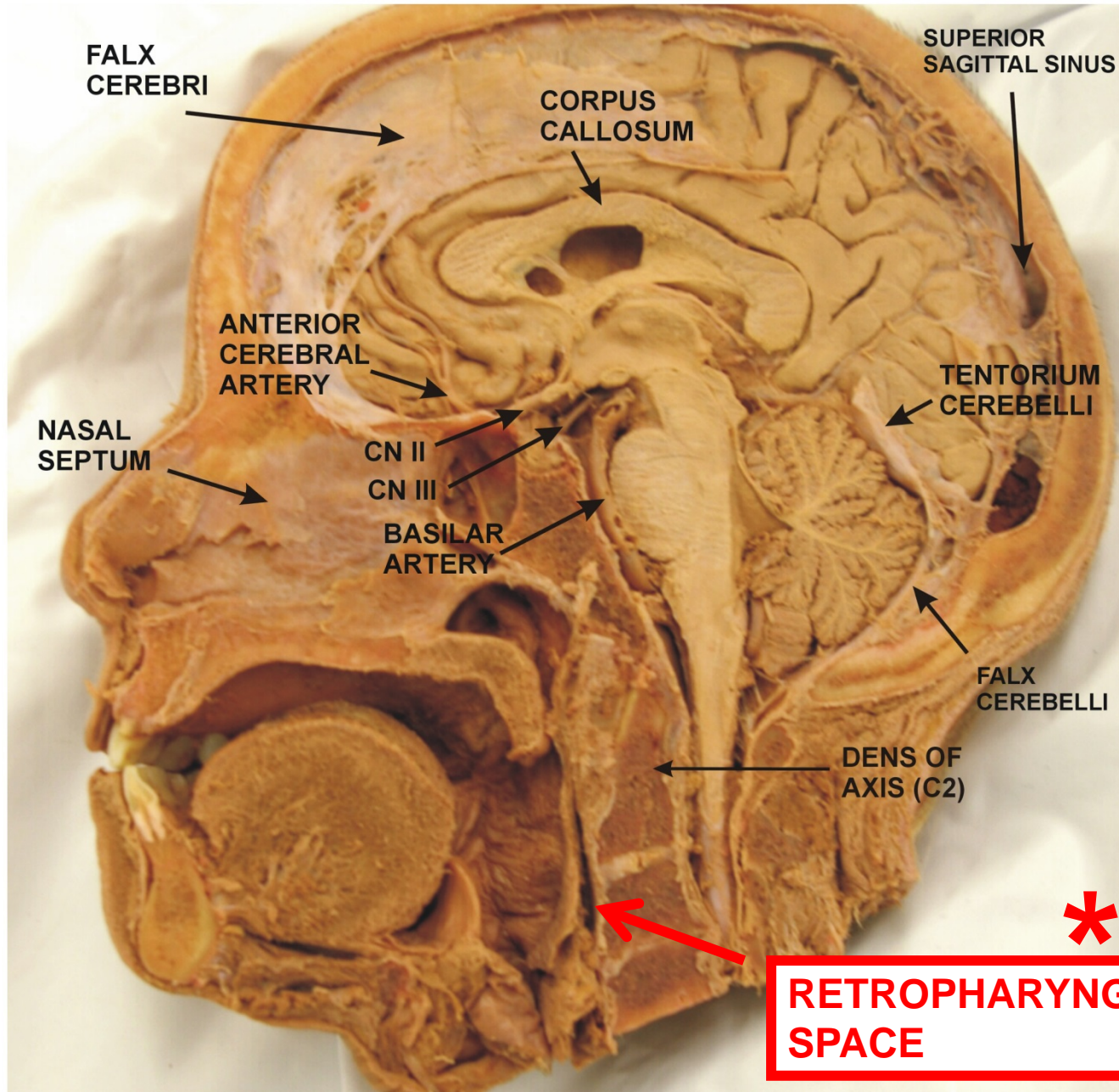
**CLINICAL**

4. Carotid Sheath- surrounds Common & Int carotid, Int jugular and X Vagus (not: Symp. Chain)

Retropharyngeal Space- between Pretracheal and Prevertebral layers - infection from head (tonsillitis) can spread to mediastinum \*\*

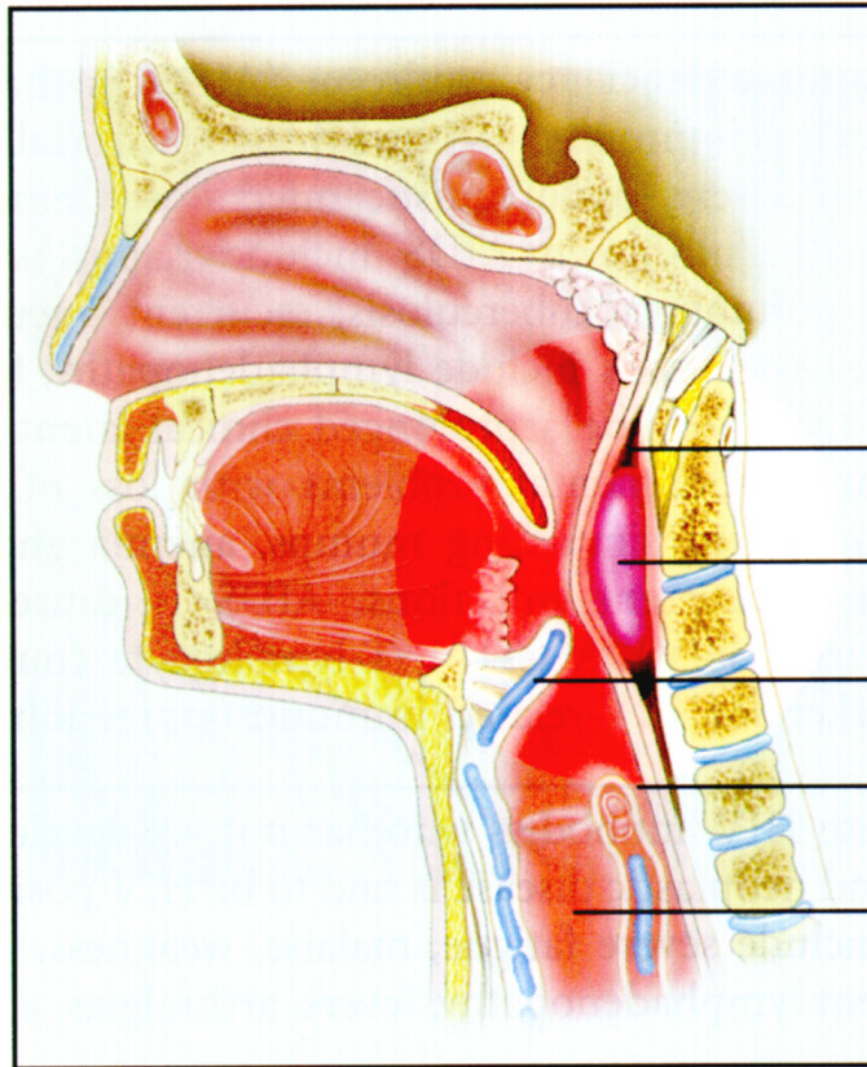
# MEDIAL VIEW OF BISECTED HEAD

1069





# RETROPHARYNGEAL ABSCESS



Infection in retropharyngeal space can spread unimpeded to thorax (mediastinum)



Retropharyngeal space

Abscess

Epiglottis

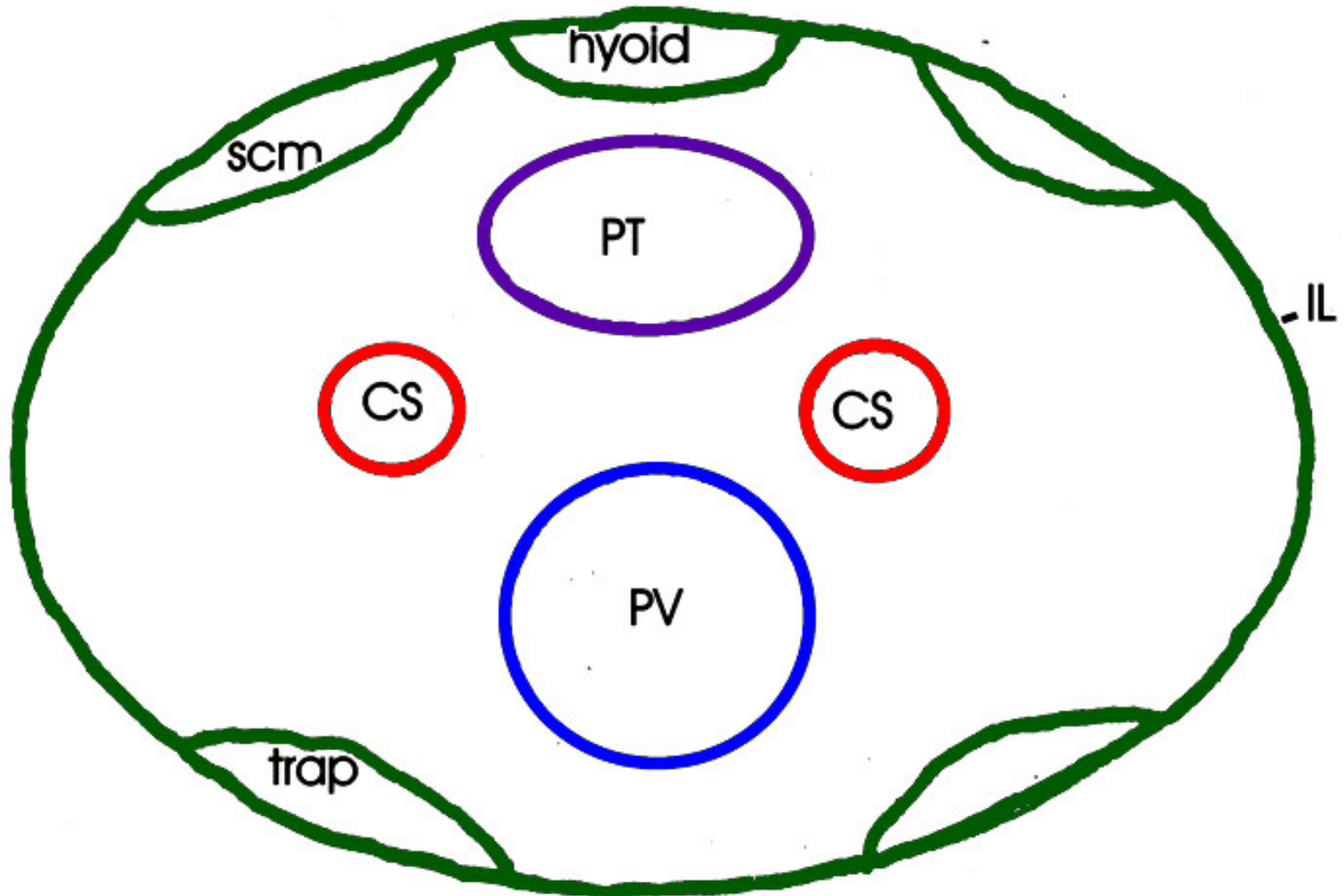
Esophagus

Trachea

**Retropharyngeal Abscess - can be difficult to diagnose (no external swelling; life-threatening as abscess can block airway; George Washington may have died of this.**

**CLINICALLY IMPORTANT**

# FASCIA OF NECK



## VII. LYMPHATICS OF HEAD AND NECK

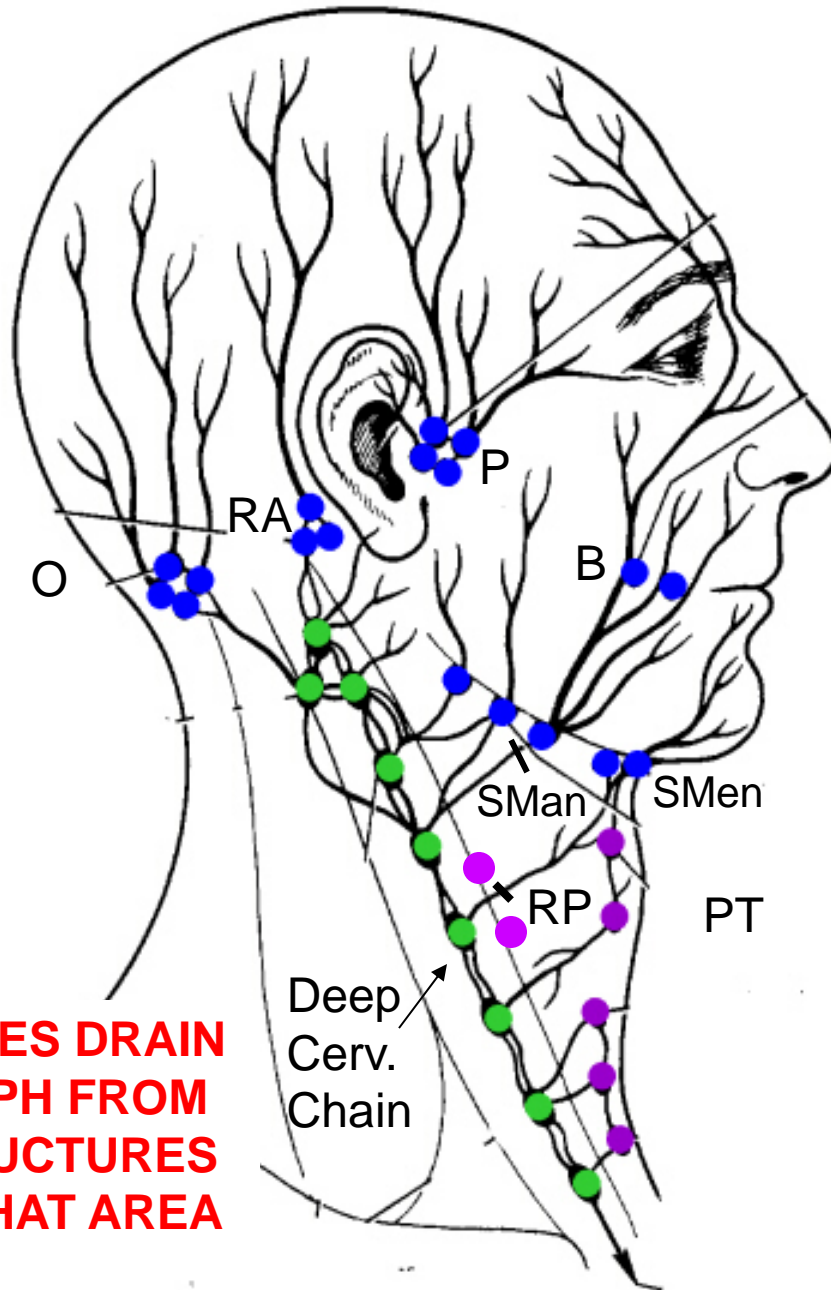
three groups (two arranged as rings; drain to chain); many named for regions drained

A. Superficial Ring; Submental, Submandibular, Buccal, Parotid, Retroauricular and Occipital nodes

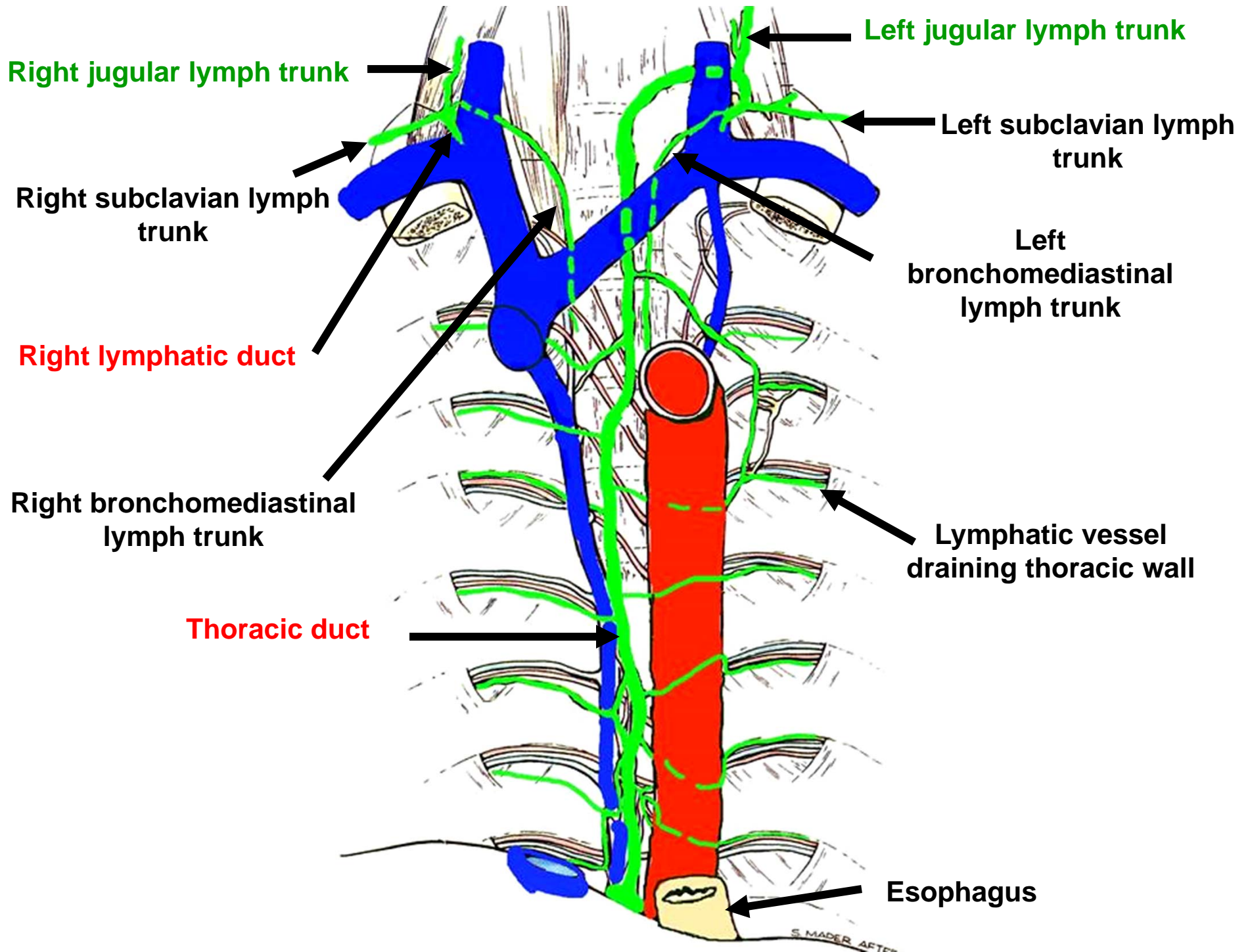
B. Deep Ring: Pretracheal, Retropharyngeal nodes

C. Deep cervical chain- along Internal Jugular vein; receive lymph from all above nodes

D. Jugular lymph trunk - to Right lymphatic duct or Thoracic duct



**NODES DRAIN LYMPH FROM STRUCTURES IN THAT AREA**



## NECK Part II

© 2021zillmusom

I. **TRIANGLES OF NECK** - for purposes of description and location of structures, neck is divided by Sternocleidomastoid muscle into an **Anterior triangle** (anterior to muscle) containing structures related to Carotid arteries and a **Posterior triangle** (posterior to muscle), containing structures related to Subclavian artery, Cervical and Brachial Plexuses.

### A. Posterior triangle

1. Boundaries: Anterior: Sternocleidomastoid; Posterior: Trapezius; Inferior: Clavicle; Superficial cover: Superficial fascia, Platysma and Investing layer; Floor: covered by Prevertebral layer of deep fascia.

2. Contents - Arteries: Subclavian artery, Superficial (Transverse) Cervical and Suprascapular arteries (from Thyrocervical trunk), Occipital artery; Veins: External Jugular vein; Nerves: Roots and Trunks of Brachial plexus, Phrenic nerve, Accessory nerve (CN XI), branches of cervical plexus.

Clinical Note: **Accessory nerve is considered to divide the posterior triangle into a clinically 'careful' zone (inferior) and 'carefree' zone (superior); brachial plexus is in 'careful' zone.** (On the other hand, would a patient want to be operated on by a surgeon who thinks part of the neck is 'carefree'?)

Note: Subclavian vein is not within posterior triangle

### B. Anterior triangle of neck

1. Boundaries: anterior by midline of neck, posterior by Sternomastoid muscle, superiorly by lower margin of Mandible.

2. Contents - Arteries: Carotid sheath with Common Carotid dividing into Internal and External Carotid arteries, numerous branches of External Carotid; Veins: Internal Jugular vein; Nerves: Hypoglossal nerve and descending branch of Ansa Cervicalis, Accessory and Vagus nerves; Lymphatics: Deep Cervical chain of lymph nodes.

## II. DEEP STRUCTURES OF NECK

A. Thyroid gland: Composed of two lateral lobes and a central isthmus, which is located below cricoid cartilage; Lateral lobes cover Common Carotid artery; Pyramidal lobe sometimes present above isthmus; when present, it is connected to the hyoid bone via a fibrous strand (no clinical consequences).

**Pyramidal lobe – is normal variant;** recall that thyroid forms **embryologically as a mass in tongue** that migrates to neck; thyroid tissue can be found along the path of migration.

1. Arterial supply: Gland is very vascular.

a. Superior Thyroid artery (from External Carotid Artery) - accompanied by Superior Laryngeal nerve.

b. Inferior Thyroid artery (branch of Thyrocervical trunk); Inferior Thyroid artery courses near Recurrent Laryngeal nerves (located in groove between trachea and esophagus).

Clinical Note: **Care must be taken during thyroid surgery not to damage Recurrent Laryngeal nerves when ligating Inferior Thyroid artery**; can paralyze all muscles of larynx on one side (except Cricothyroid muscle); patient has only hoarse voice or whisper.

2. Veins: Superior Thyroid veins follows arteries; Middle Thyroid vein; both veins drain into Internal Jugular vein; Inferior Thyroid vein - Left and right veins can join together and enter Left Brachiocephalic vein.

Clinical Note: **Inferior Thyroid veins course anterior to trachea; if large, can cause extensive bleeding in Tracheotomy** (emergency access to trachea; this is avoided by Cricothyrotomy: see Larynx lecture).

3. Parathyroid glands - 4 very small bodies located posterior to thyroid gland or within gland; position very variable.

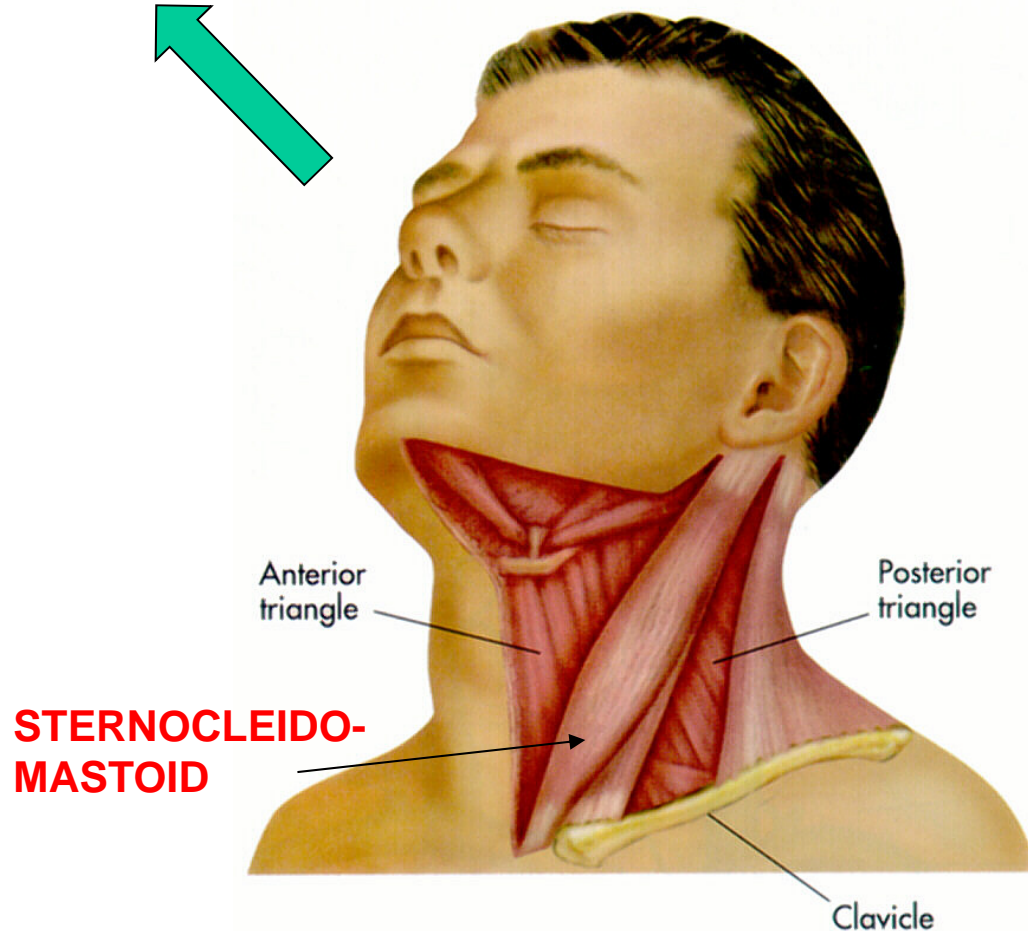
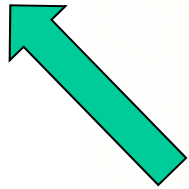
B. Sympathetic trunk - there are three cervical ganglia (Superior, Middle, Inferior); all 3 ganglia send gray rami to cervical spinal nerves. Most of head and neck is supplied by Superior Cervical ganglion; Superior Cervical ganglion sends postganglionic fibers via unnamed branches (e.g., joy to medical students) to form a plexus on Carotid arteries and their arterial branches.

C. Thoracic duct at root of neck - follows left margin of esophagus, enters Left Brachiocephalic vein (at junction of Internal Jugular and Subclavian veins)

D. Recurrent laryngeal nerve - Right recurrent laryngeal nerve courses under Subclavian artery; Left recurrent laryngeal under Aorta; both ascend in groove between trachea and esophagus.

# NECK Part 2

Nose



## OUTLINE

### I. TRIANGLES OF NECK

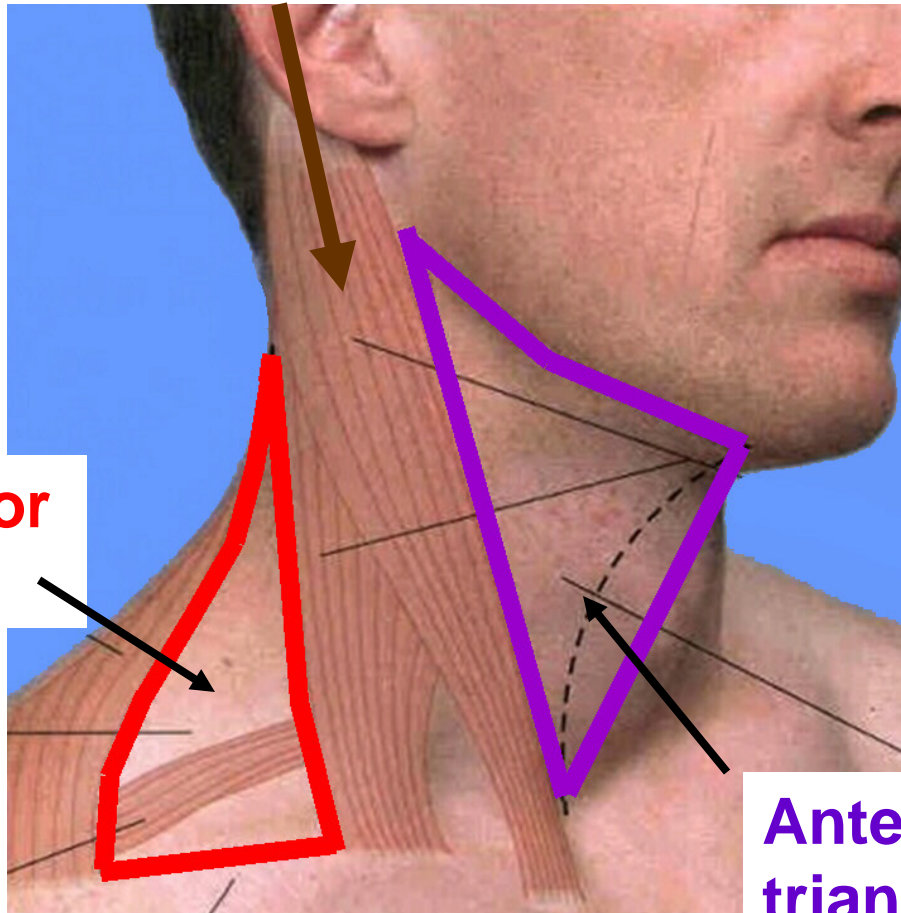
### II. DEEP STRUCTURES OF NECK

TO LOCATE STRUCTURES IN NECK ON PATIENT OR IN PRACTICAL EXAM MOST USEFUL LANDMARK IS **STERNOCLEIDOMASTOID MUSCLE**

# I. TRIANGLES OF NECK

## Sternocleidomastoid Muscle

Triangles of Neck – for description neck is divided into Anterior and Posterior Triangles by Sternocleidomastoid muscle



## Posterior triangle

Structures related to Subclavian Artery, Cervical, Brachial Plexus

## Anterior triangle

Structures related to Carotid Arteries



# A. POSTERIOR TRIANGLE

**Anterior -  
Sternocleidomastoid  
Muscle**

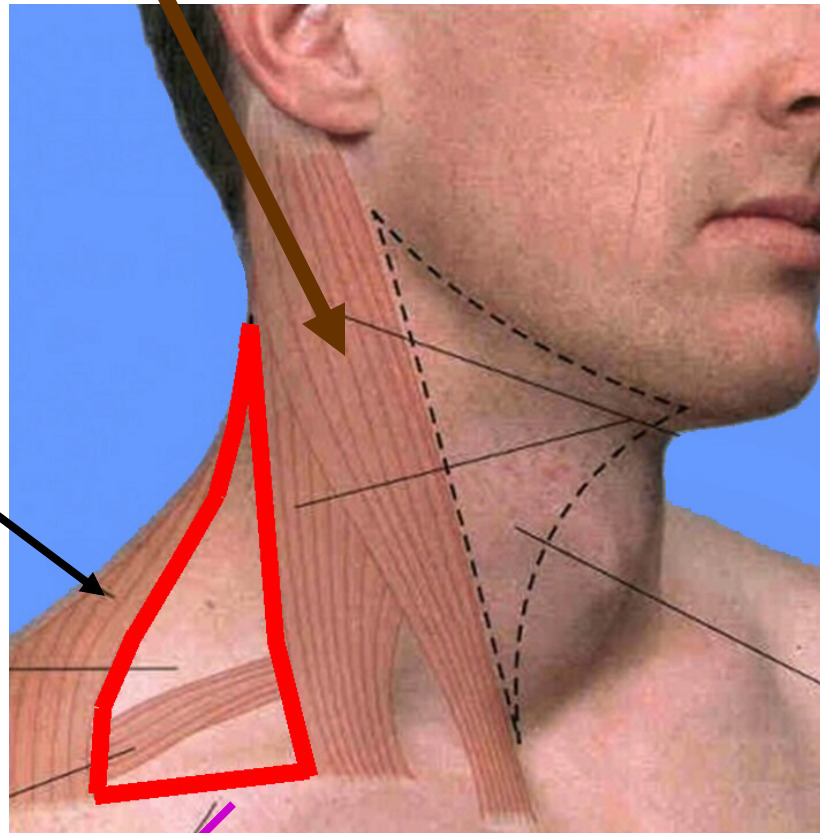


## 1. Boundaries

**Superficial cover  
- Superficial  
fascia, Platysma  
and Investing  
Layer**

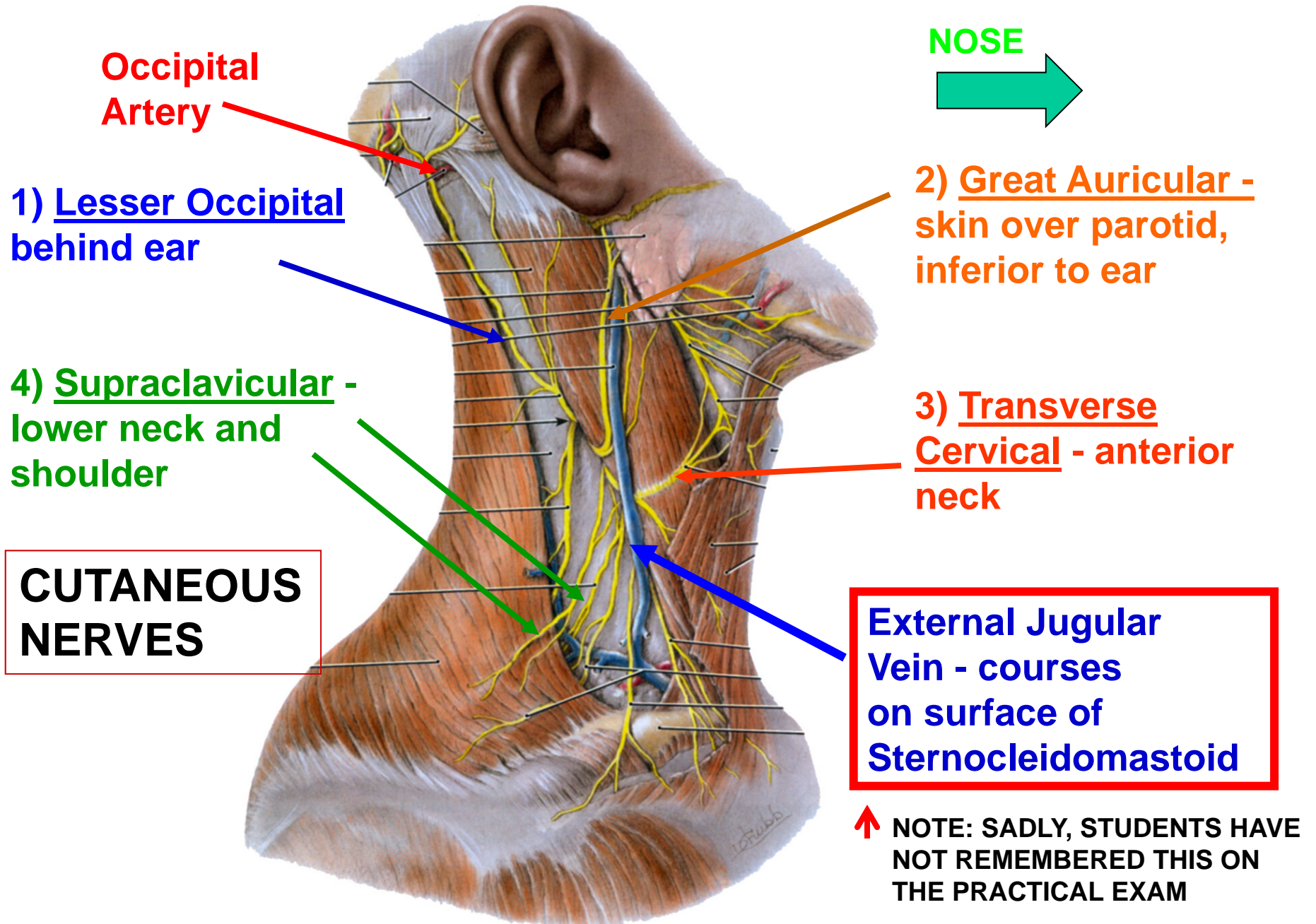
**Deep - (floor)  
Prevertebral  
layer of fascia**

**Posterior  
Trapezius**



**Inferior -  
Clavicle**

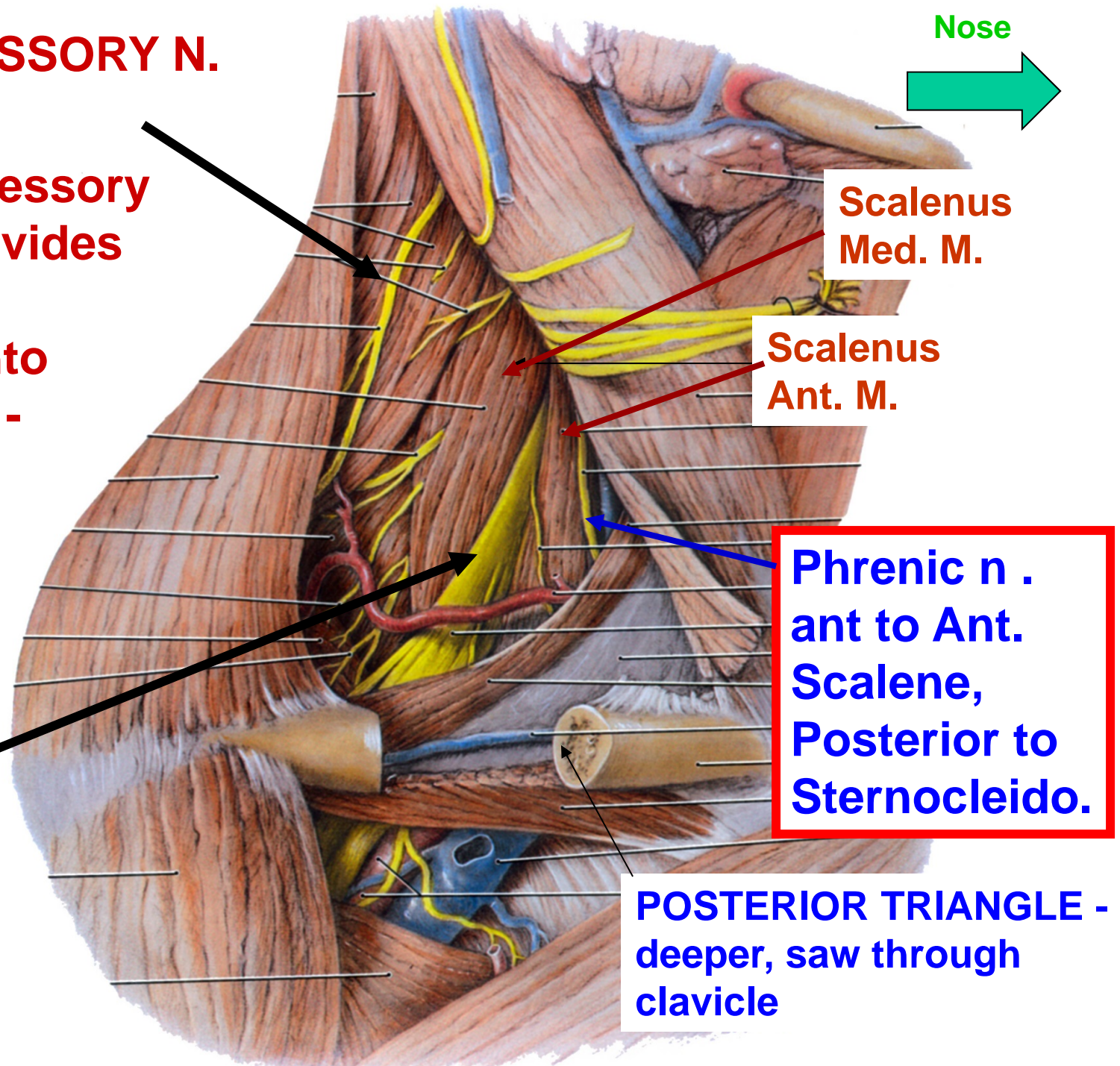
## B. CONTENTS OF POSTERIOR TRIANGLE



# ACCESSORY N. CN XI

Note: Accessory nerve - divides  
Posterior triangle into  
'Carefree' - superior  
'Careful' - inferior

BRACHIAL  
PLEXUS



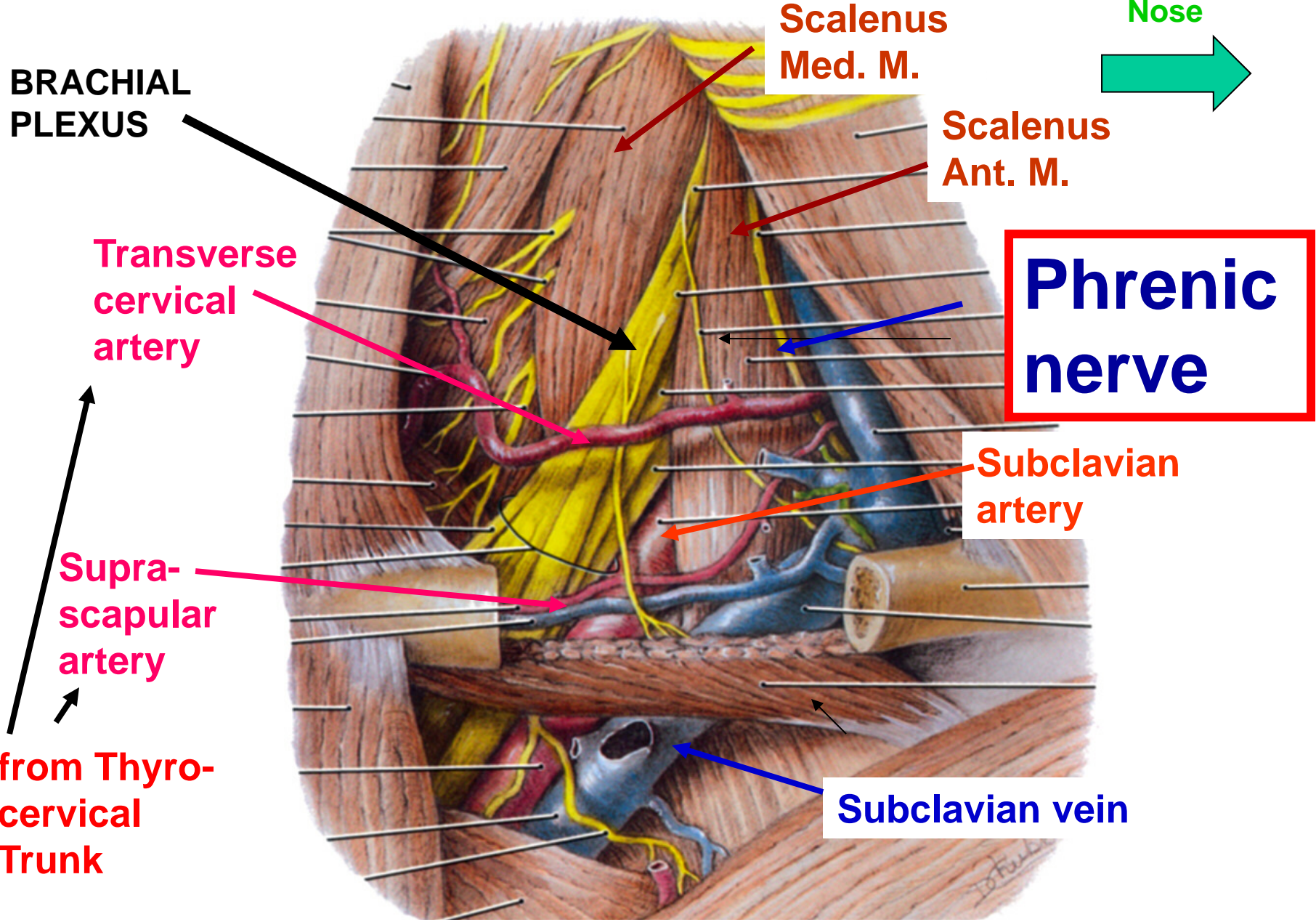
Nose

Scalenus  
Med. M.

Scalenus  
Ant. M.

Phrenic n .  
ant to Ant.  
Scalene,  
Posterior to  
Sternocleido.

POSTERIOR TRIANGLE -  
deeper, saw through  
clavicle



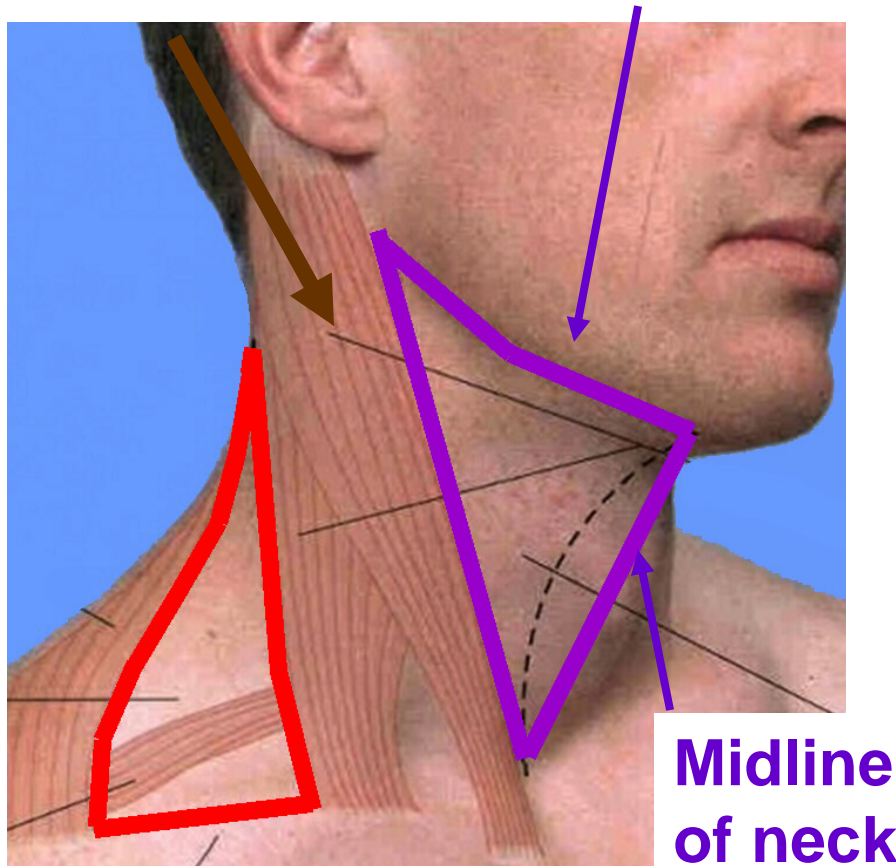
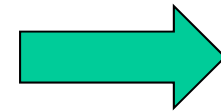
**note: Subclavian vein is not in the posterior triangle**

## B. ANTERIOR TRIANGLE OF NECK

**Sternocleidomastoid  
Muscle**

**Mandible**

**Nose**



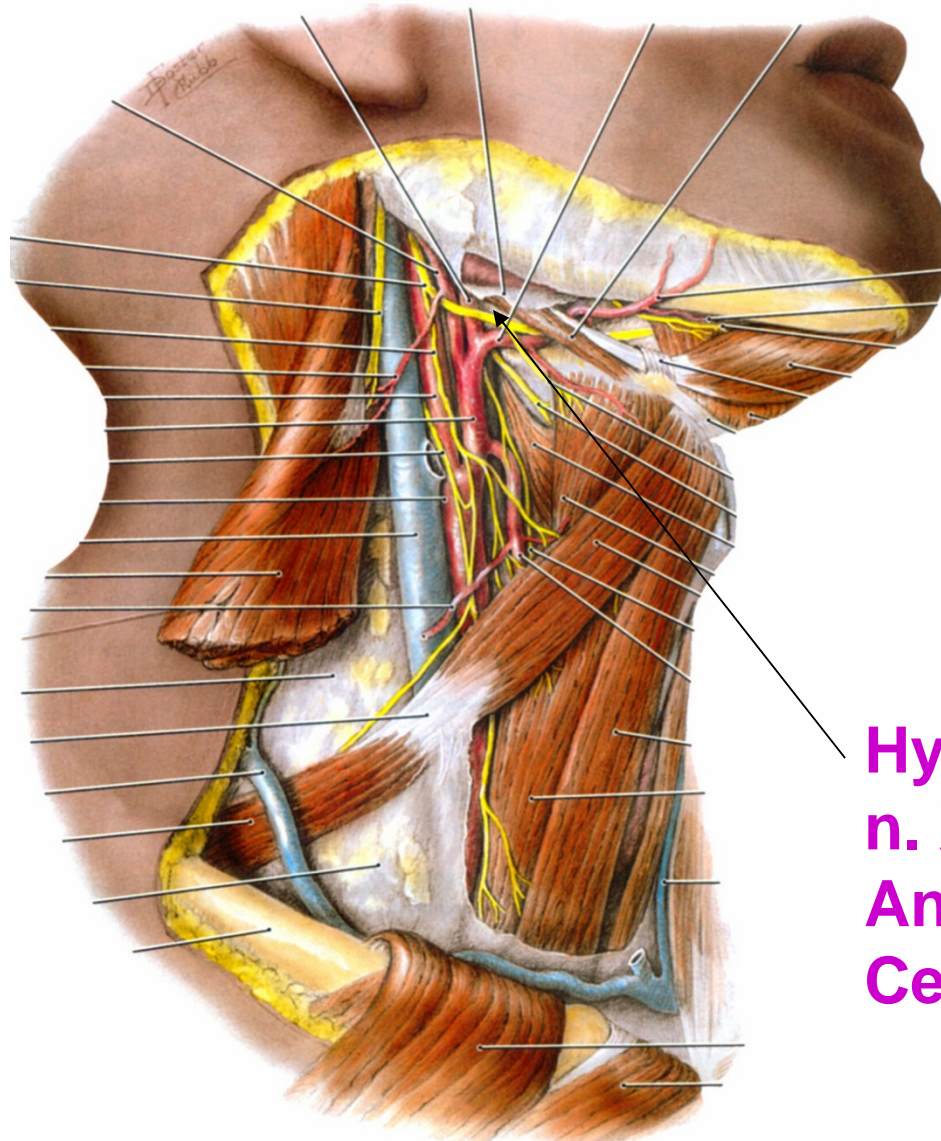
1. Boundaries-  
Ant. - Midline of neck  
Post. - Sternocleido-  
mastoid  
Superior - Mandible  
(lower margin).

Subdivided to  
smaller triangles (not  
required)

## 2. CONTENTS OF ANTERIOR TRIANGLE OF NECK

In Carotid sheath:  
Int. and Common Carotid A.,  
Int. Jug. V.,  
Vagus N.

Follow to branches of Ext. carotid



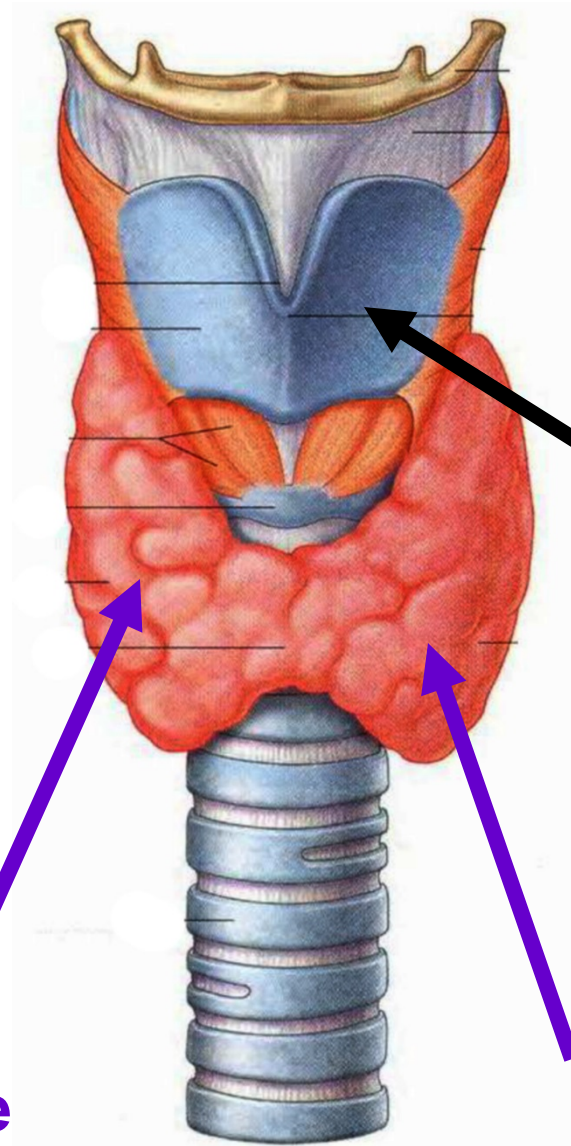
Nose



- cut through Sternocleido-  
mastoid

Hypoglossal  
n. XII and  
Ansa  
Cervicalis

## II. DEEP STRUCTURES OF NECK

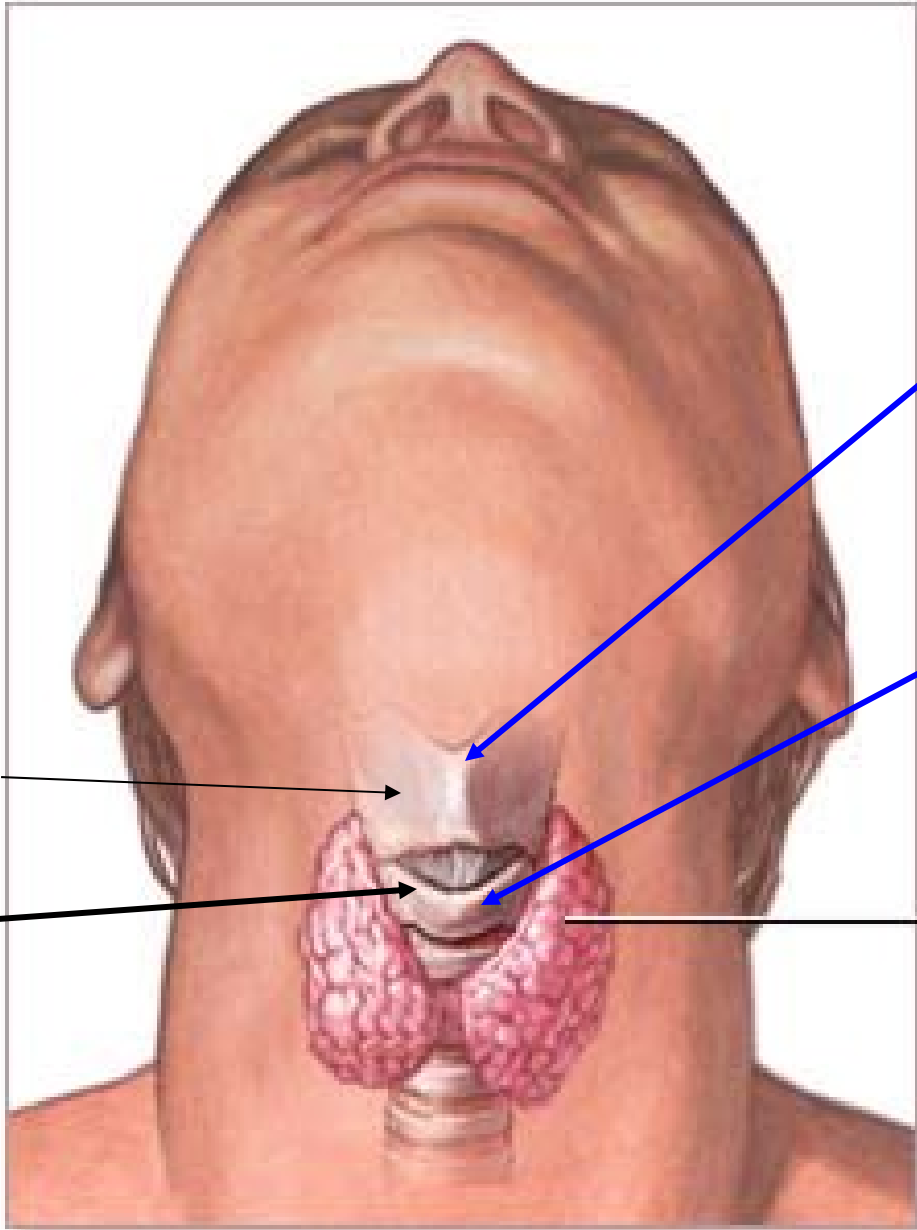


### A. THYROID GLAND

Two Lateral  
Lobes - inferior  
to and on sides  
of Thyroid  
cartilage

Lateral Lobe

Lateral Lobe



**PALPATE**

**PLATE**

**RING  
BELOW**

**LARYNGEAL  
PROMINENCE  
(ADAM'S APPLE)  
OF THYROID  
CARTILAGE**

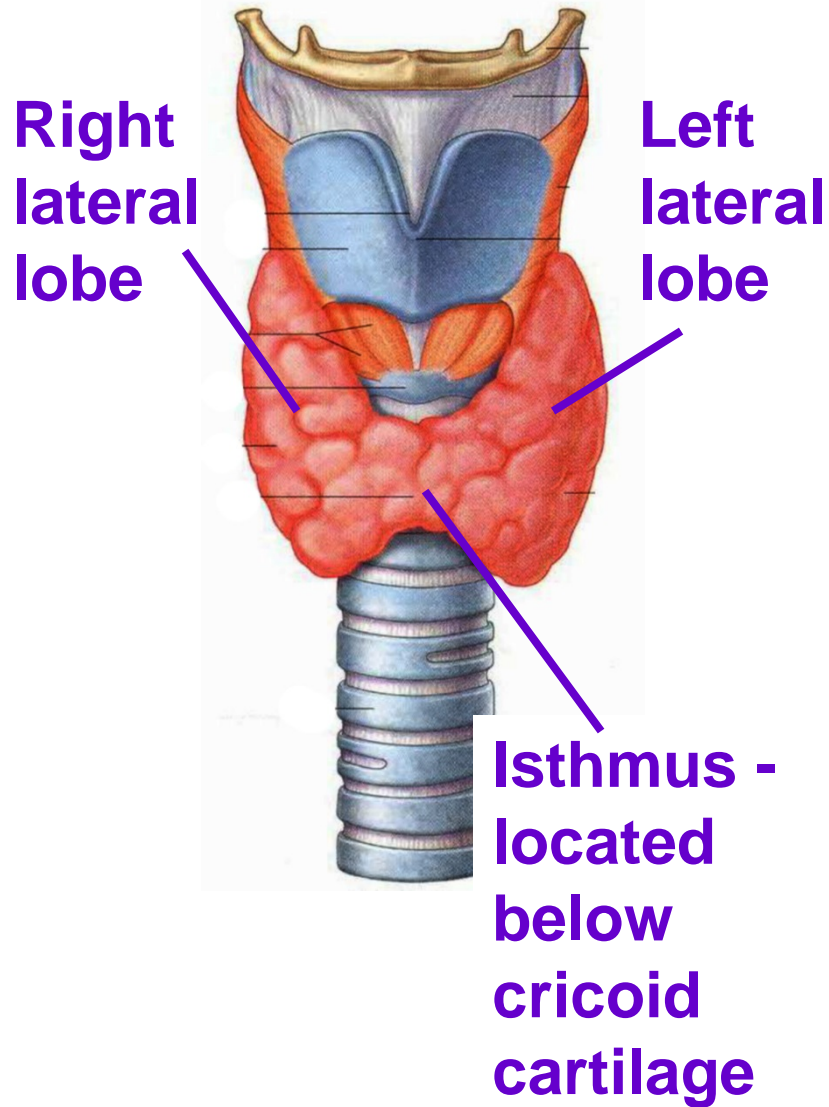
**CRICOID  
CARTILAGE**

**Thyroid gland**

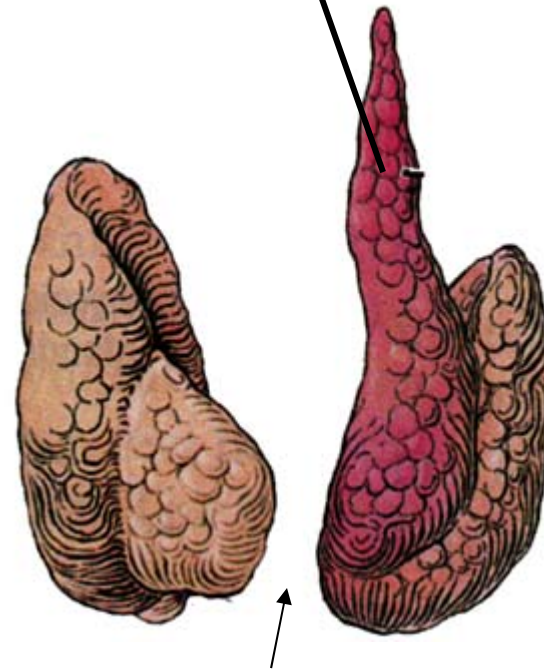


# THYROID GLAND

Normal variations common

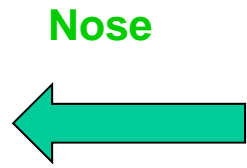


Pyramidal lobe - when present often attached to hyoid bone by fibrous strand

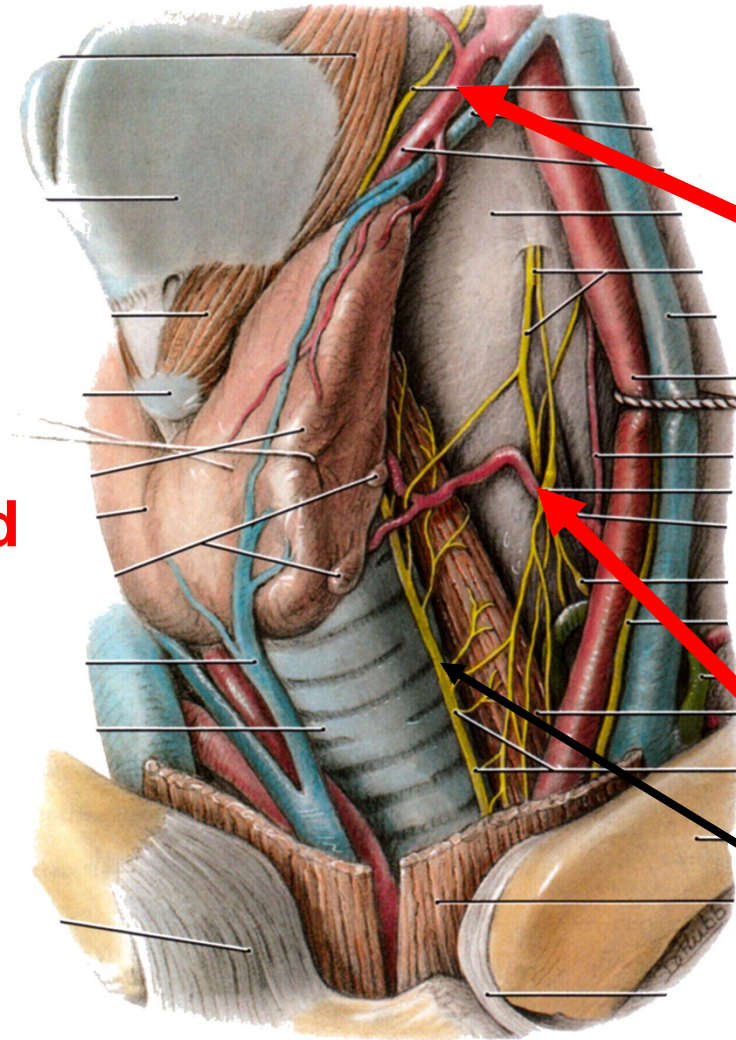


Absence of Isthmus

## THYROID GLAND - ARTERIAL SUPPLY



Very vascular-arteries accompanied by nerves



FROM EXT. CAROTID

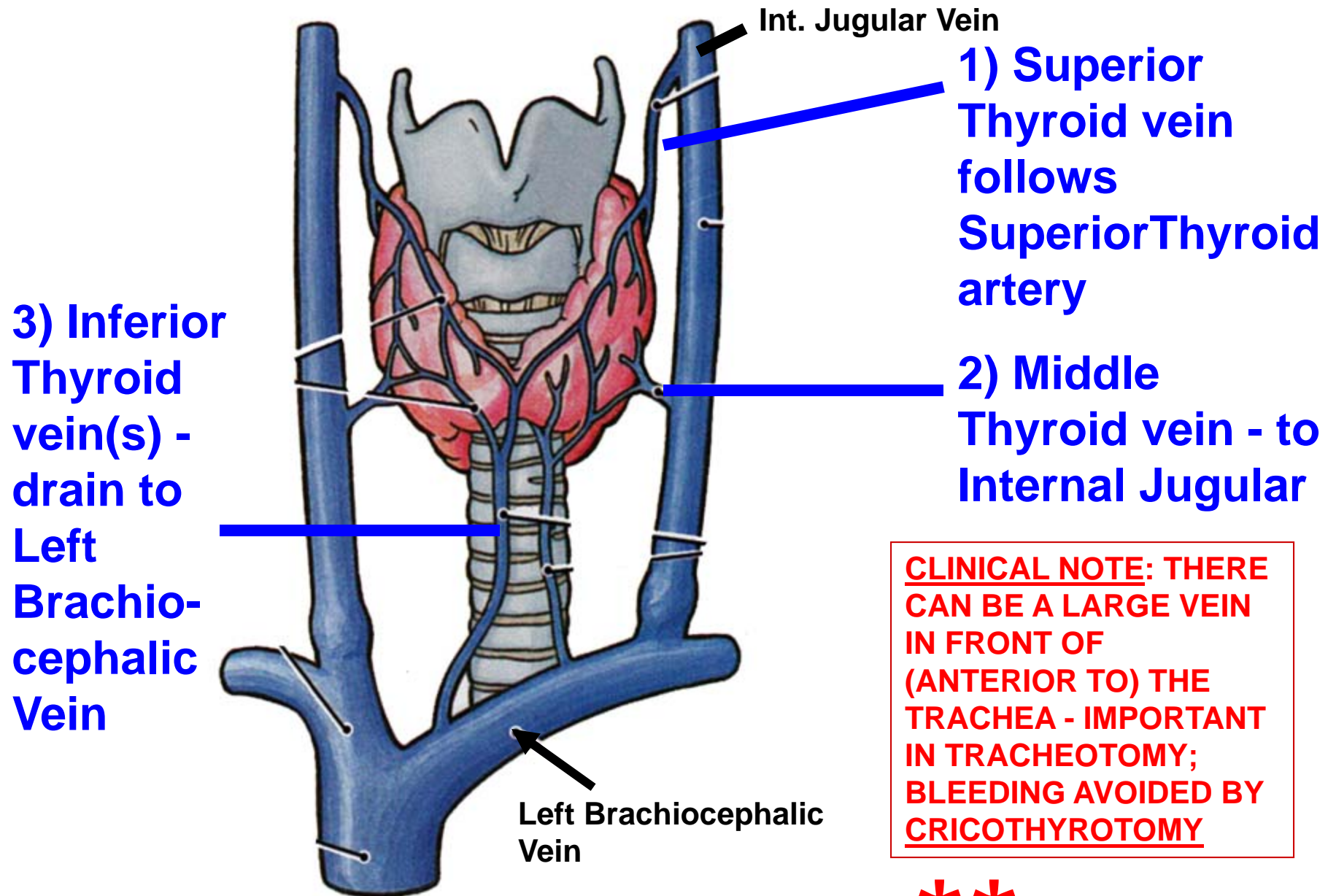
a) Sup. Thyroid artery (courses with Sup. Laryngeal n.)

FROM THYRO-CERVICAL TRUNK

b) Inf. Thyroid artery (courses with Recurrent Laryngeal n.)

**Clinical: In thyroid surgery care taken not to damage Recurrent Laryngeal Nerve; paralyze all muscles of Larynx (except Cricothyroid) on one side; patient has only hoarse voice or whisper.**

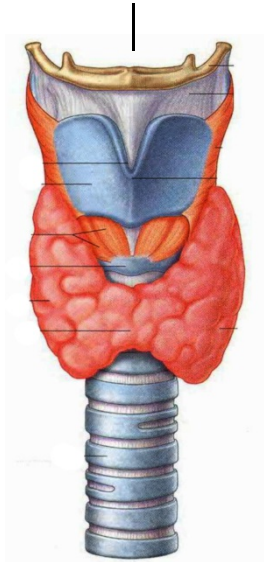
# THYROID GLAND - LOTS OF VEINS



**CLINICAL NOTE: THERE CAN BE A LARGE VEIN IN FRONT OF (ANTERIOR TO) THE TRACHEA - IMPORTANT IN TRACHEOTOMY; BLEEDING AVOIDED BY CRICOTHYROTOMY**

**\*\***

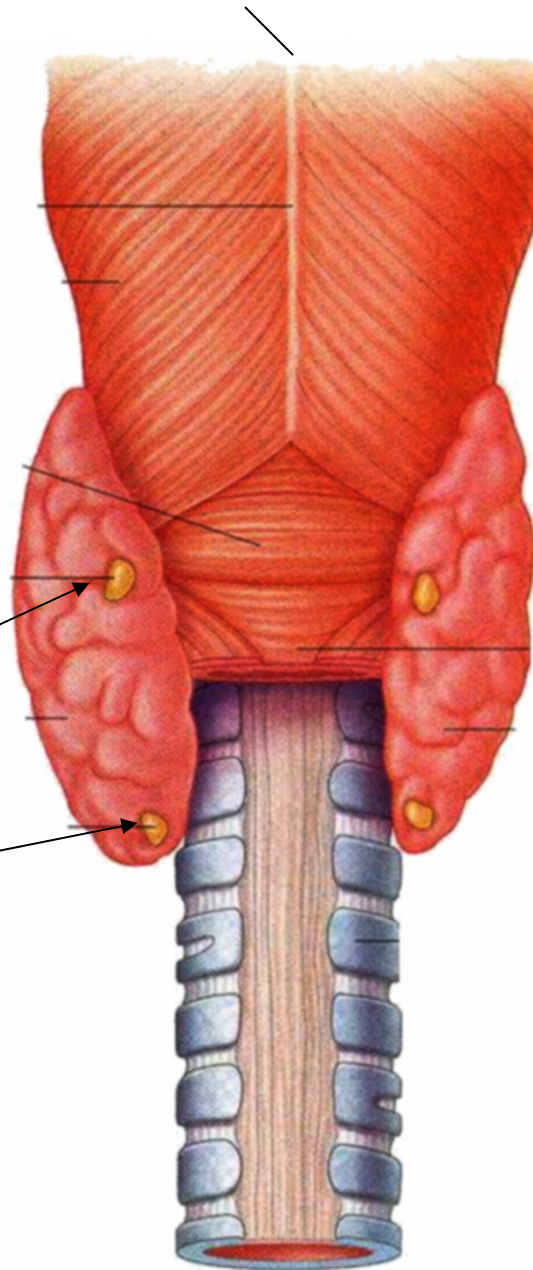
## ANT. VIEW



Superior  
parathyroid  
gland

Inferior  
parathyroid  
gland

## POSTERIOR VIEW



## PARATHYROID GLANDS

- 4 small  
bodies (2  
on each  
side)  
located  
posterior  
to or  
within  
Thyroid  
gland

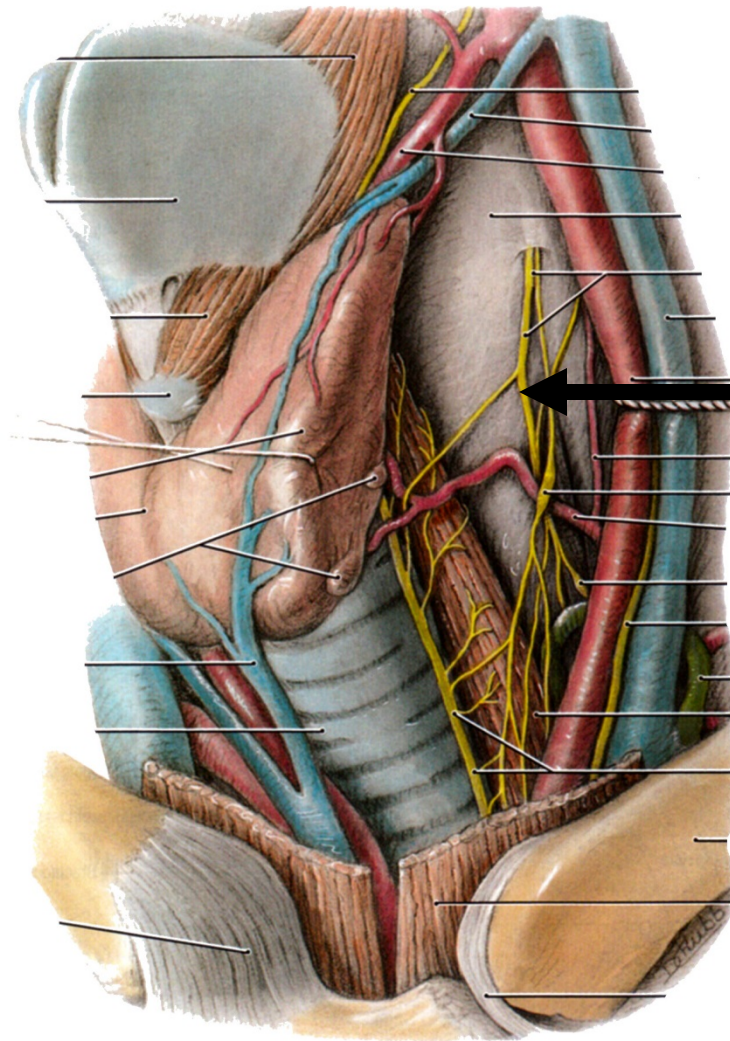
Nose



## SYMPATHETIC CHAIN

Directly  
Anterior  
to  
vertebrae

DO NOT  
confuse  
with  
Vagus  
nerve X



Sympathetic  
trunk- deep to  
(not in)  
Carotid Sheath

Note: Sympathetics  
to most of head  
are from Superior  
Cervical Ganglion