

Biology 323

Human Anatomy for Biology Majors

Lecture 17

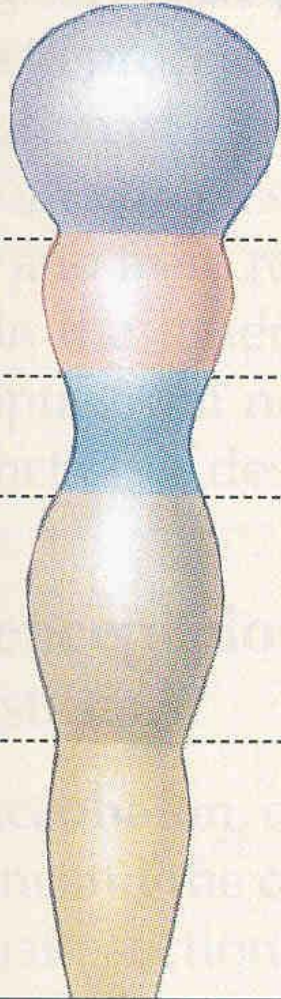
Dr. Stuart S. Sumida

Cranial Nerves and Soft Tissues of the Skull

Start with
BRAIN STUFF...

**Brain
(6-week embryo)**

**Brain Regions
at Birth**



Cerebrum

Diencephalon

Midbrain

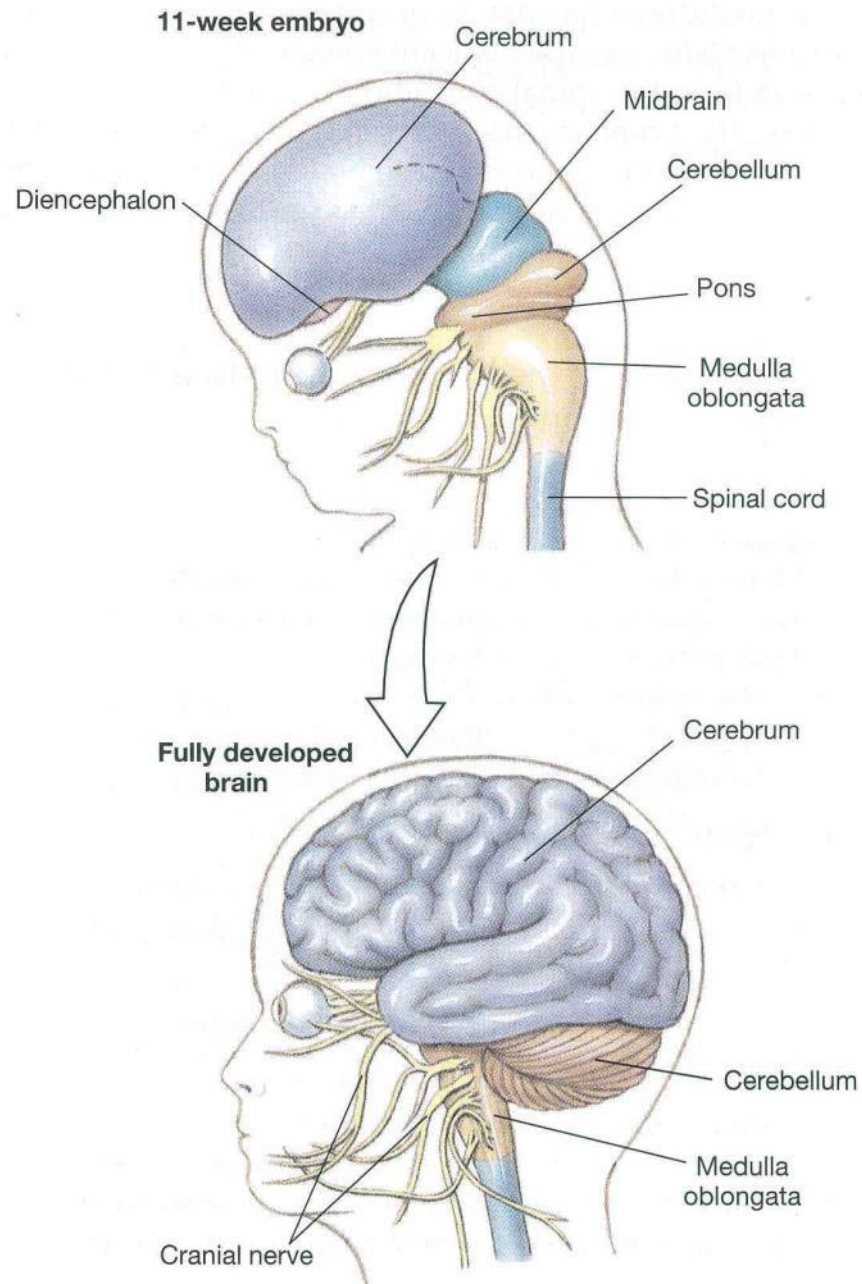
Cerebellum
and
Pons

Medulla
oblongata

FOREBRAIN

MIDBRAIN

HINDBRAIN



Forebrain:

Cerebrum – Perception, movement of somatopleure, sensoro-motor integration, emotion, memory, learning.

Diencephalon – Homeostasis, behavioral drives in hypothalamus; sensory relay and modification in thalamus; melatonin secretion in pineal gland.

Midbrain (Mesencephalon)

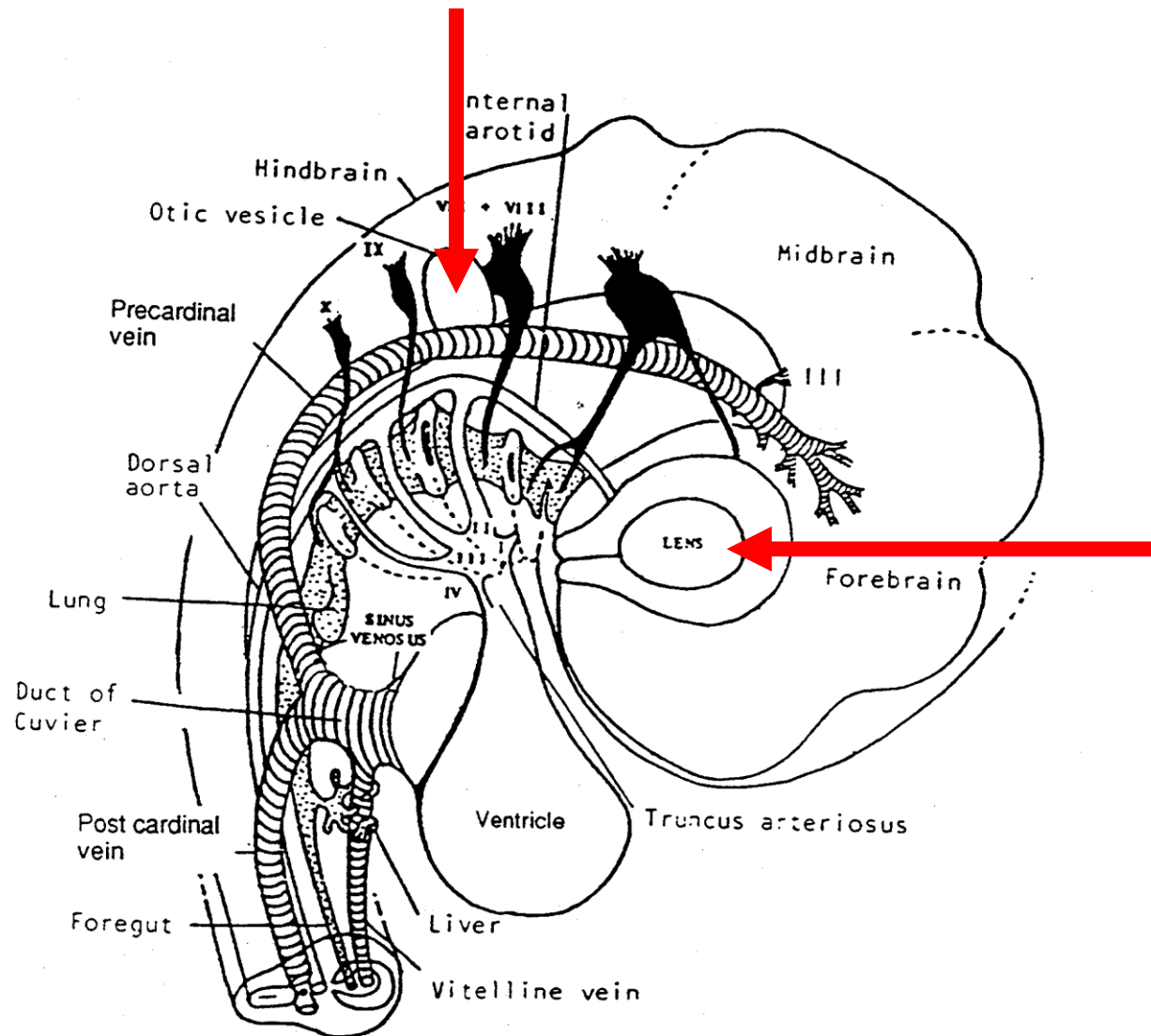
Control of eye movement.

Hindbrain

Cerebellum and Pons – control of movement, proprioceptive input; relays visual and auditory reflexes in pons.

Medulla Oblongata – Involuntary functions: blood pressure, sleep, breathing, vomiting.

See in Part 3 of your Laboratory Protocols....



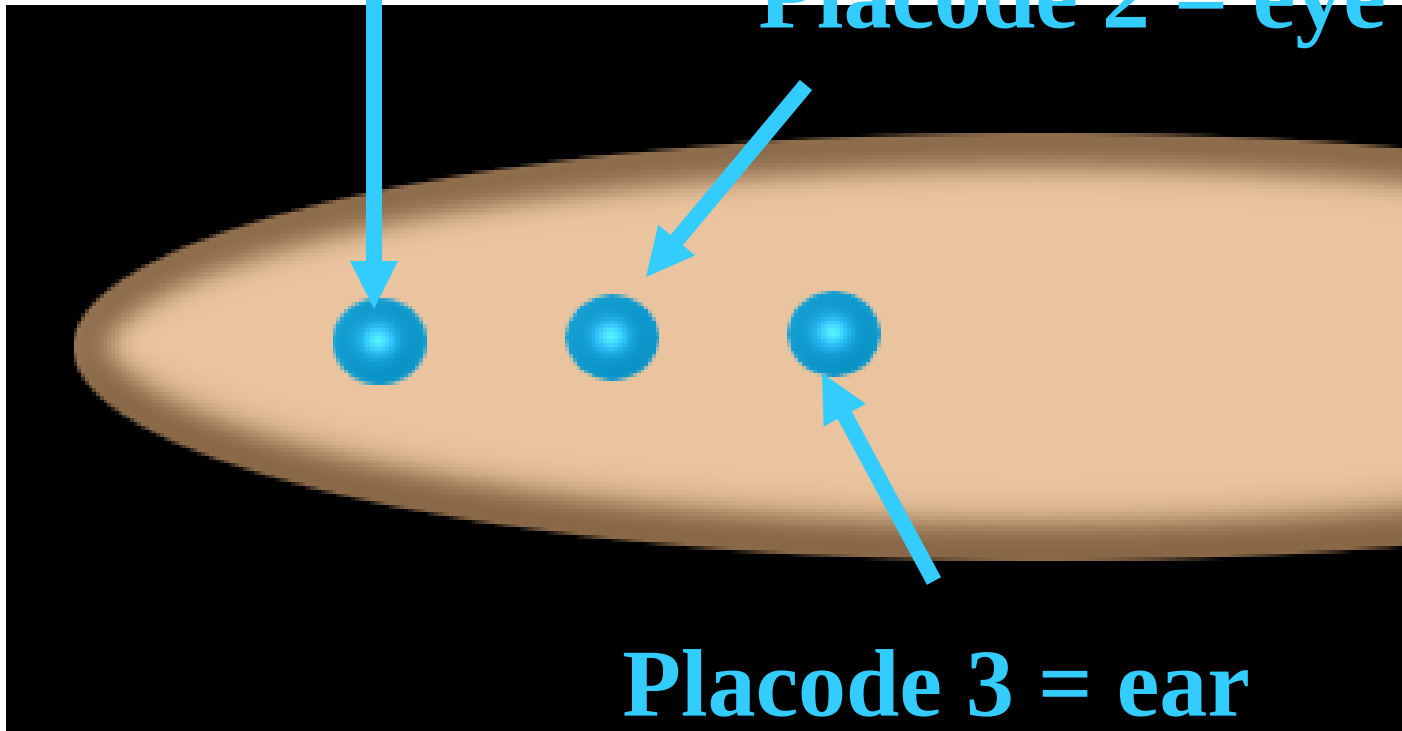
Development

- Special Sense organs = nose, eyes and ears, begin as small outcrops of ectoderm called placodes

Development

Placode 1 = nose

Placode 2 = eye



Placode 3 = ear

Development

- In the nose, the ectoderm become nerve cells that send their fibres through the cribriform plate of the ethmoid, back to the brain
- This is Cranial Nerve I = the Olfactory Nerve

Development

- The second placode becomes the lens of the eye.
- It sinks below the surface of the skin, and an outgrowth of the brain wraps around it.
- The outgrowth is the retina, and the stalk connecting it is Cranial Nerve II = The Optic Nerve

Eye starts out as photosensitive lobe of brain underlying surface of skin.

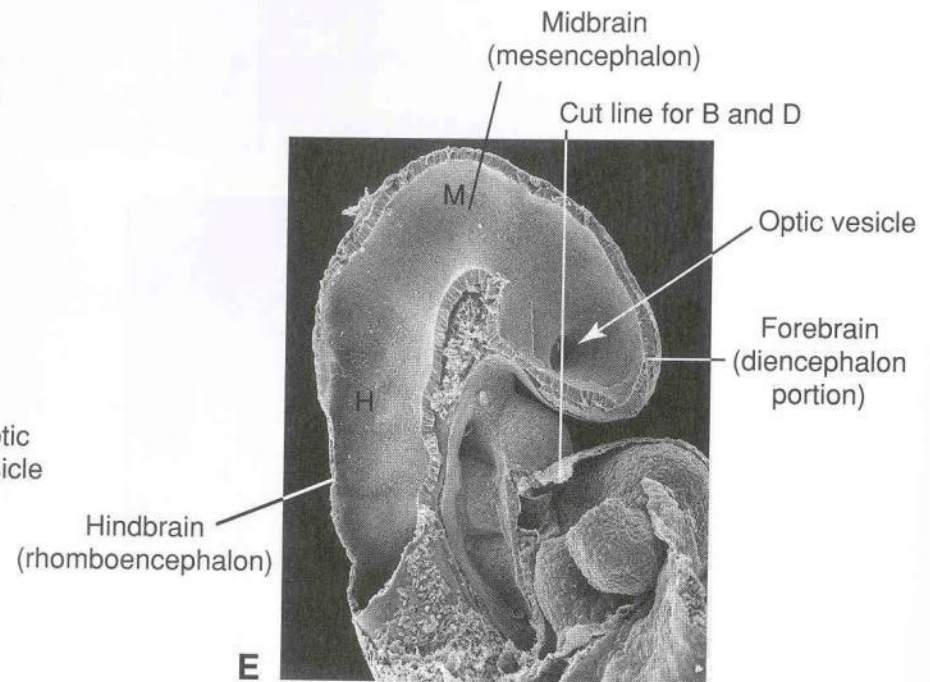
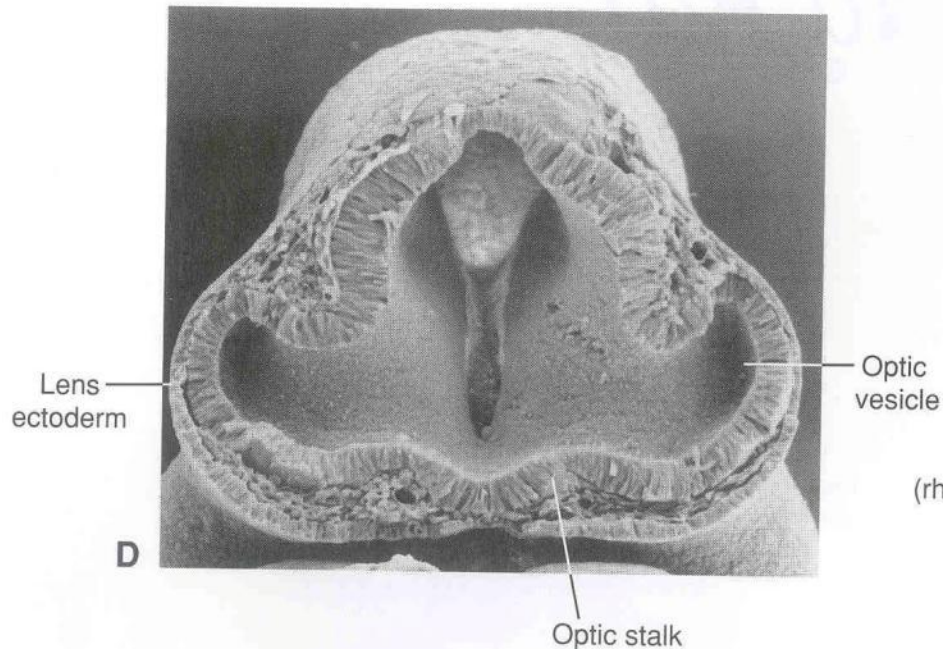
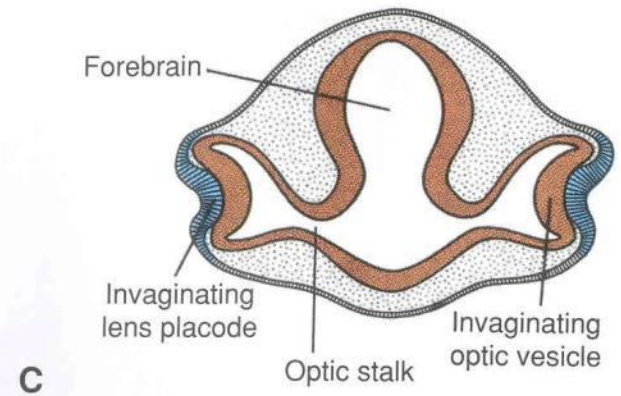
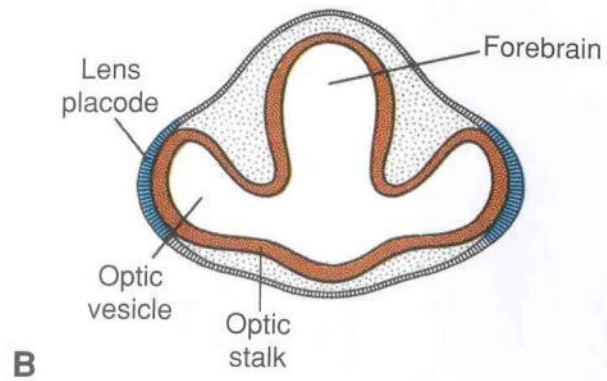
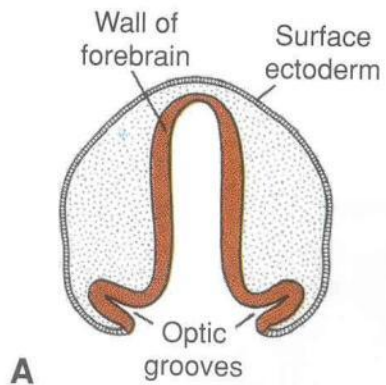
Lobe eventually becomes two-layered cup = retina.

Connected to brain by "stalk" that is the OPTIC NERVE (cranial nerve II).

Lens from ectodermal placode.

Marginal cells of retina become specialized as MUSCLE CELLS that regulate opening of pupil:

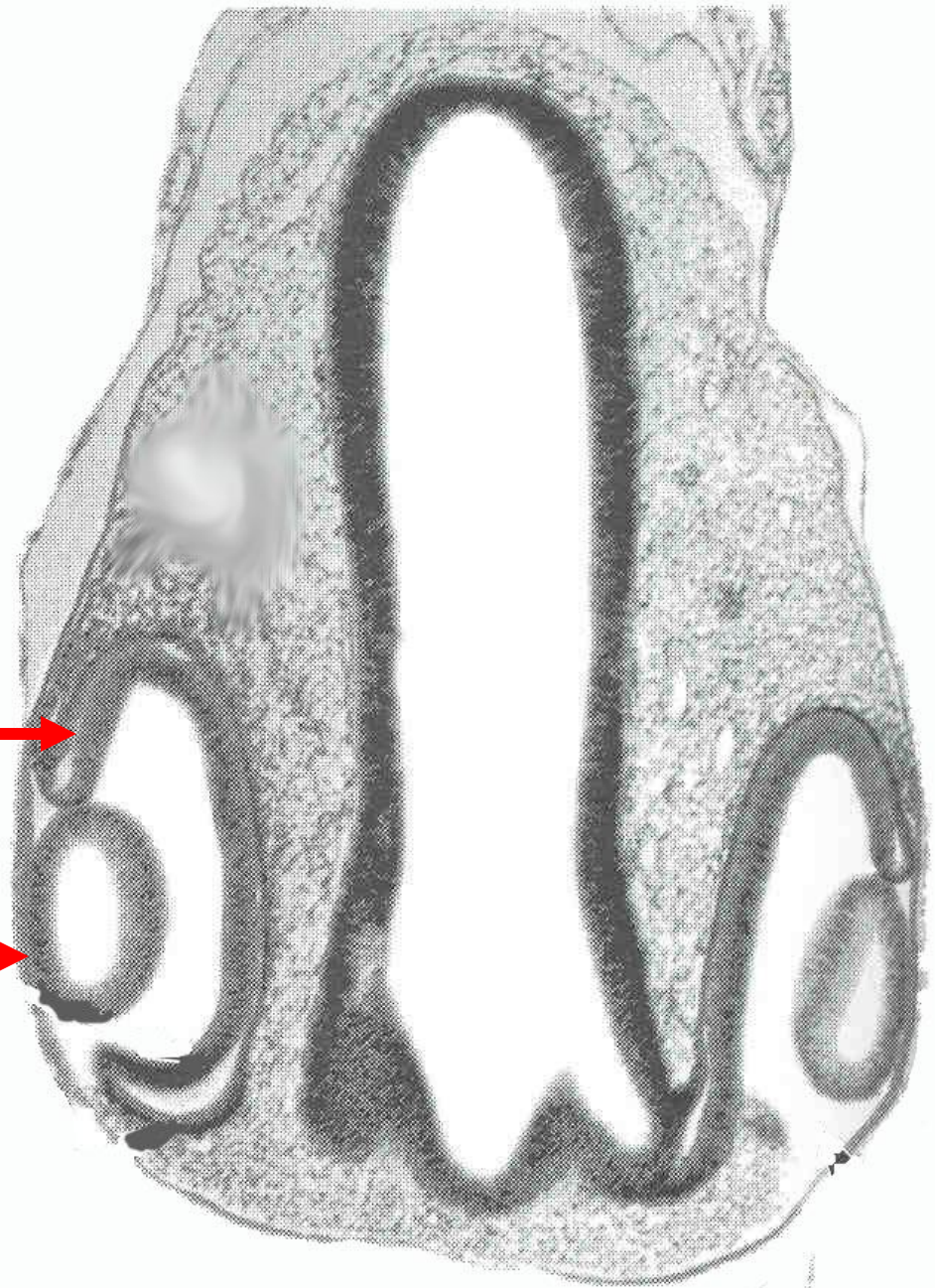
- Sphinctor pupillae (parasympathetically regulated)
- Dilator pupillae (sympathetically regulated)





Developing
Retina

Developing
Lens

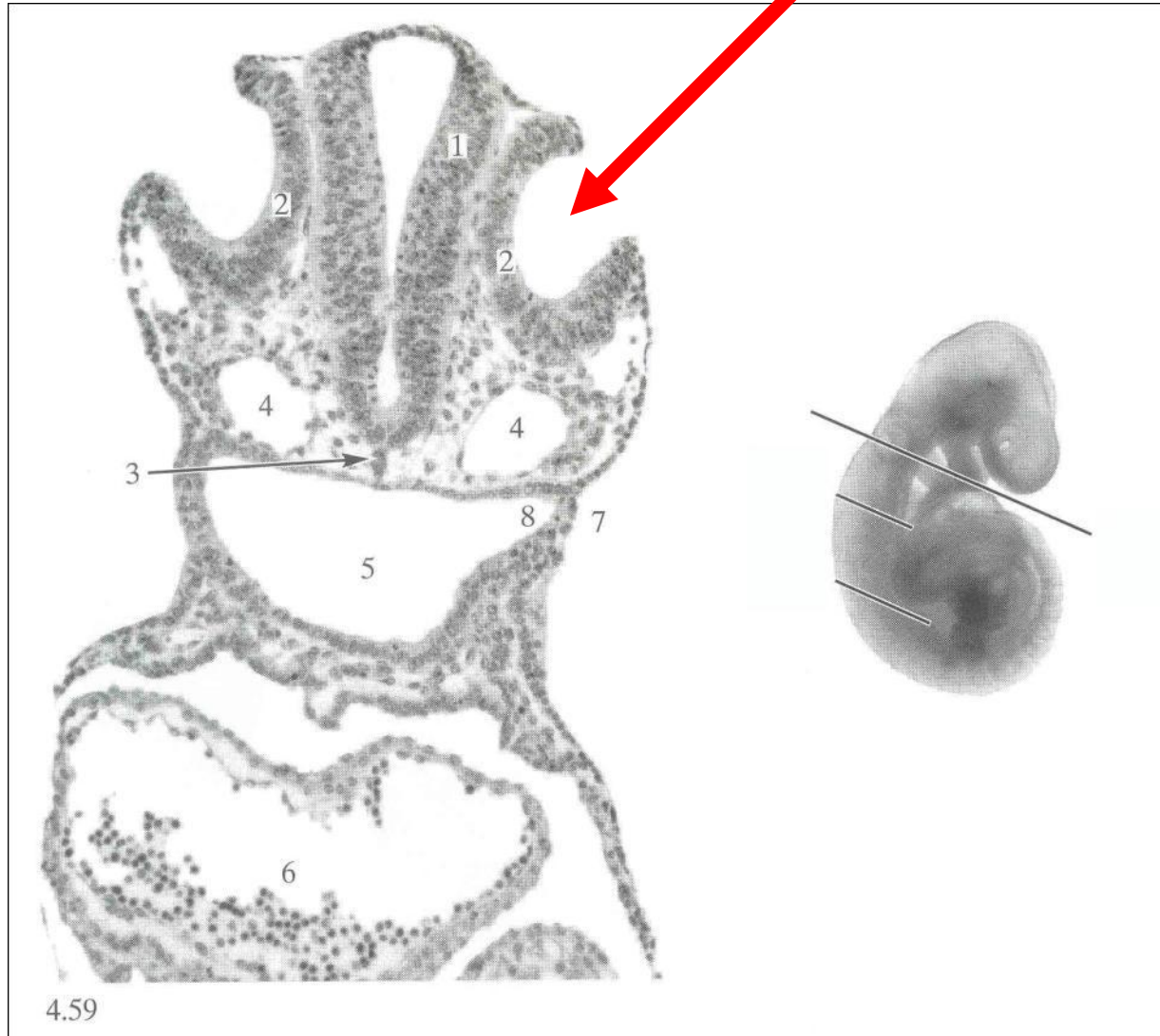


Development

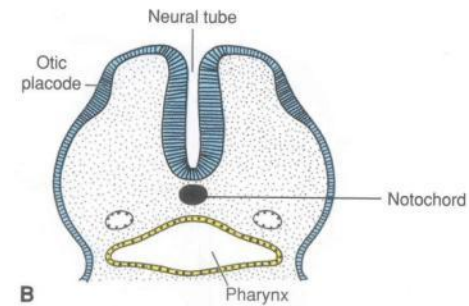
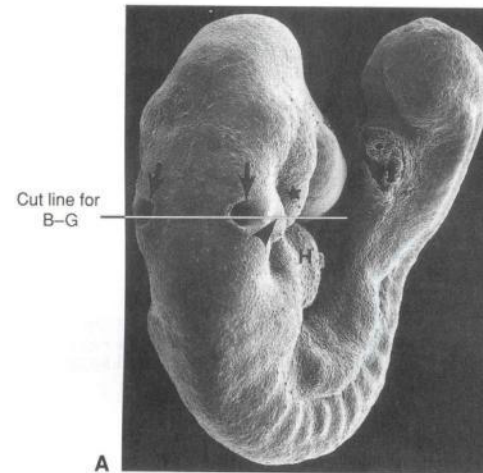
- **The Inner ear starts out as a lens, but turns into a fluid filled sac**
- **Receptor organs of hearing and balance.**
- **Cranial Nerve VIII = Auditory or Vestibulocochlear Nerve**

Cranial Nerve VIII
Vestibulocochlear Nerve
(Evolutionary branch of VII)

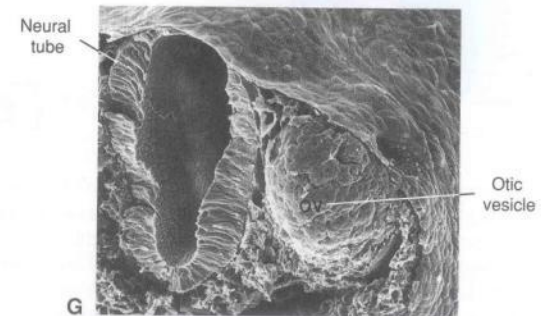
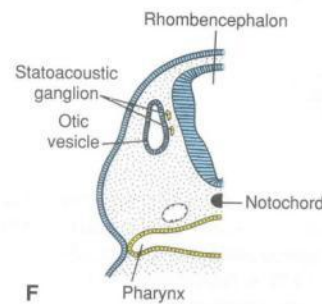
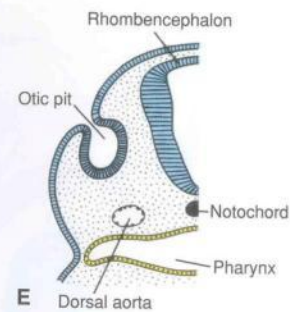
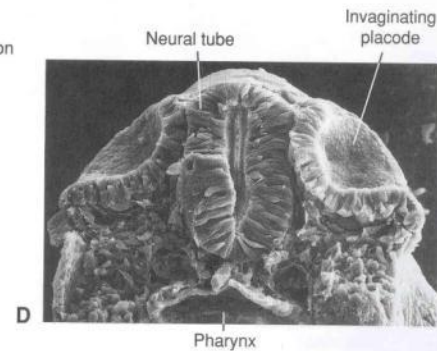
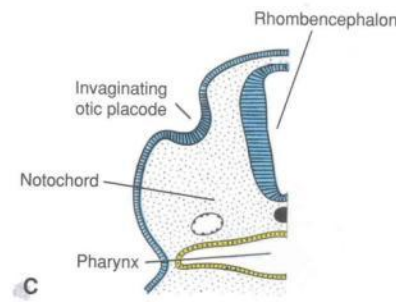
Otic Vesicle



Early Development of the Ear



*, mandible
arrowhead, 2nd pharyngeal arch
H, heart
arrow, invaginating otic placode



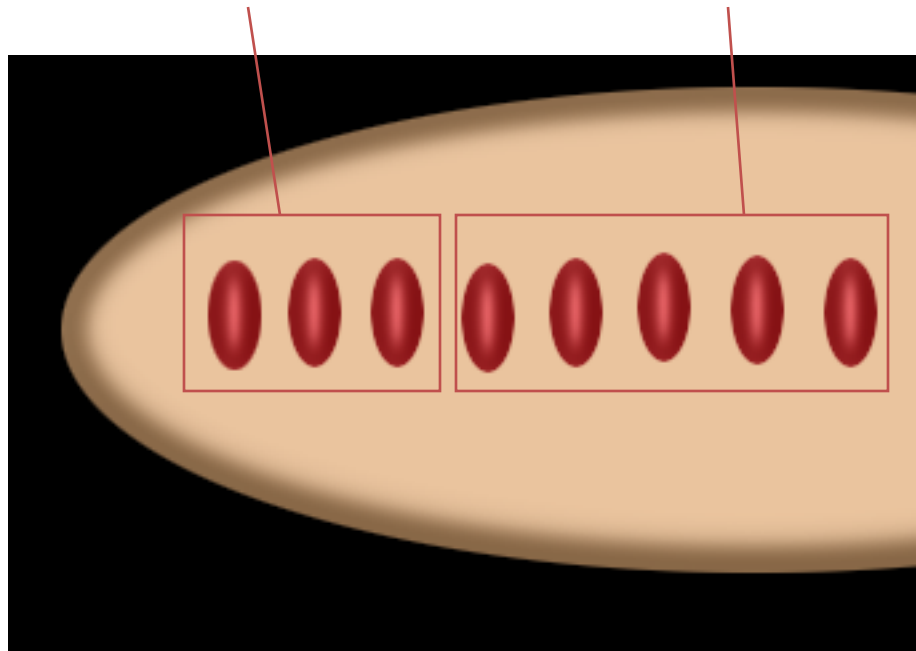
The ear consists of three different parts: the **external ear**, **middle ear**, and **internal ear**. The internal ear forms from **otic placodes (thickened ectoderm)** that develop on both sides of the hindbrain during the 4th week of development (A and B). These placodes invaginate to form otic vesicles (C–G).

Ventral Root Cranial Nerves

Somite Associated

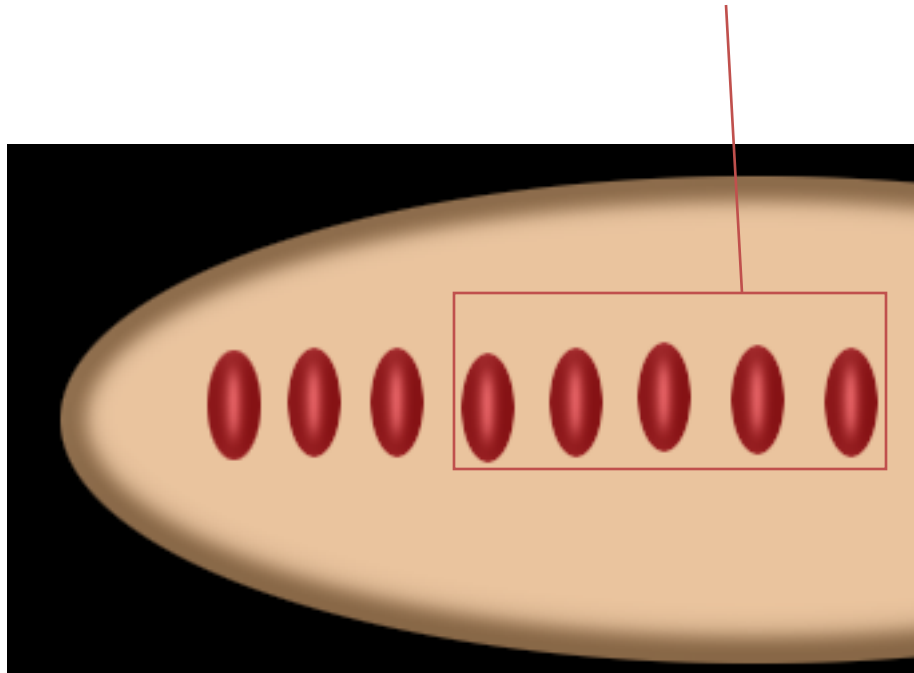
Development

- **Head somites can be divided into 2 sets. Pre-otic and post-otic**



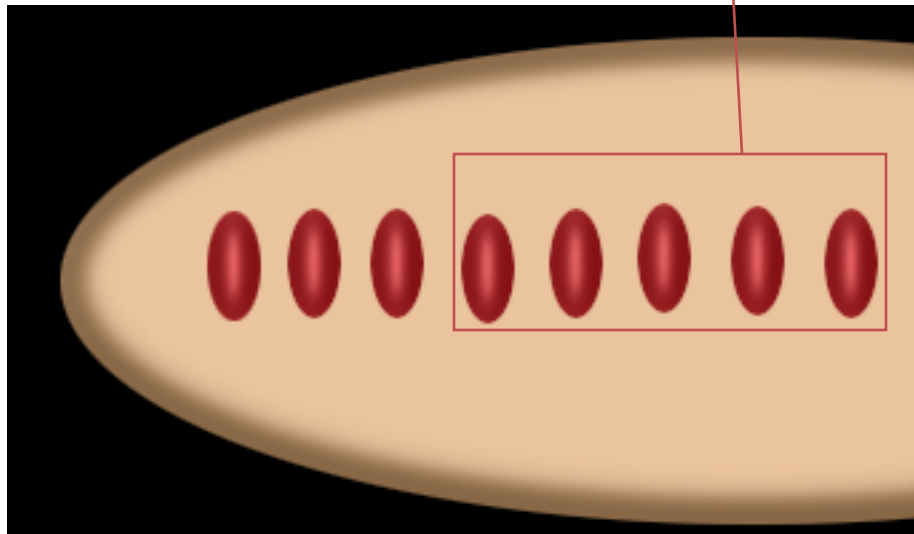
Development

- The sklerotomes of the post otic somites form the floor of the brain case



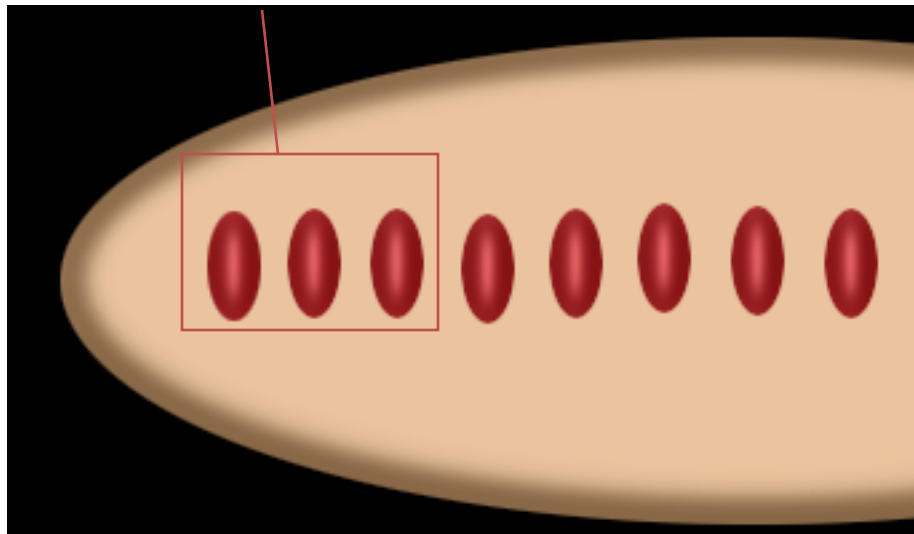
Development

....and their myotomes develop into muscles of the tongue



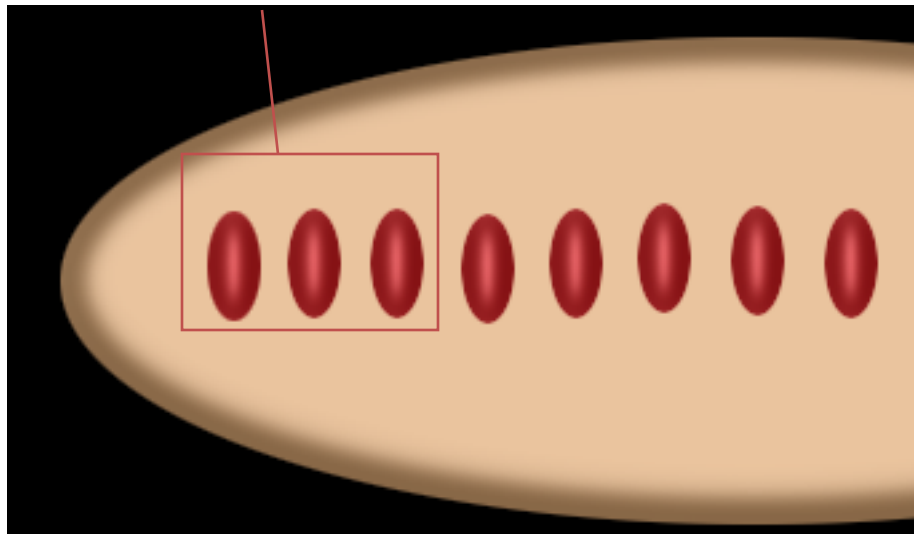
Development

The myotomes of the pre-otic somites form the muscles that move the eyeballs.



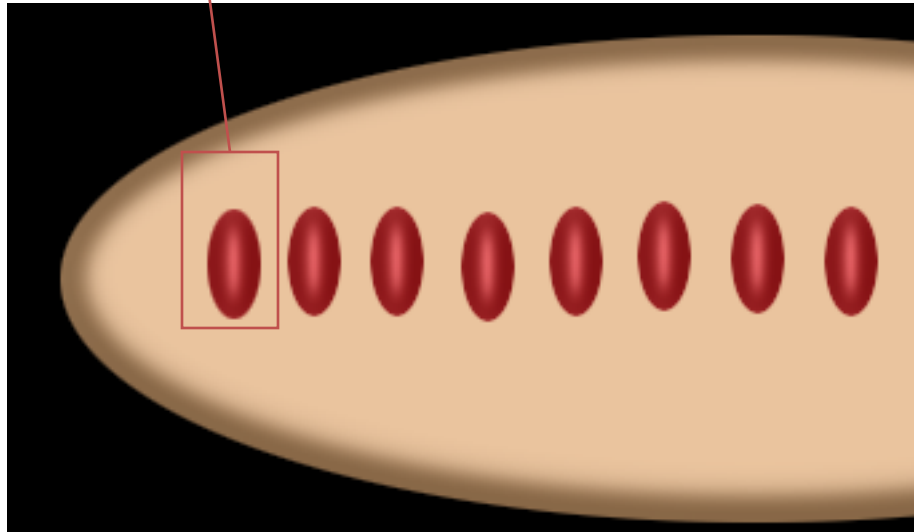
Development

Each is supplied by a different cranial nerve:



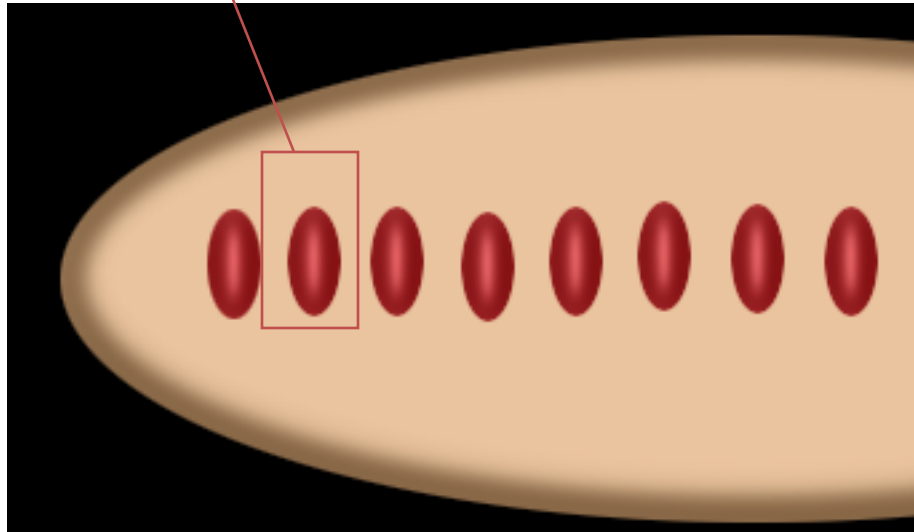
Development

Cranial Nerve III =
Oculomotor Nerve



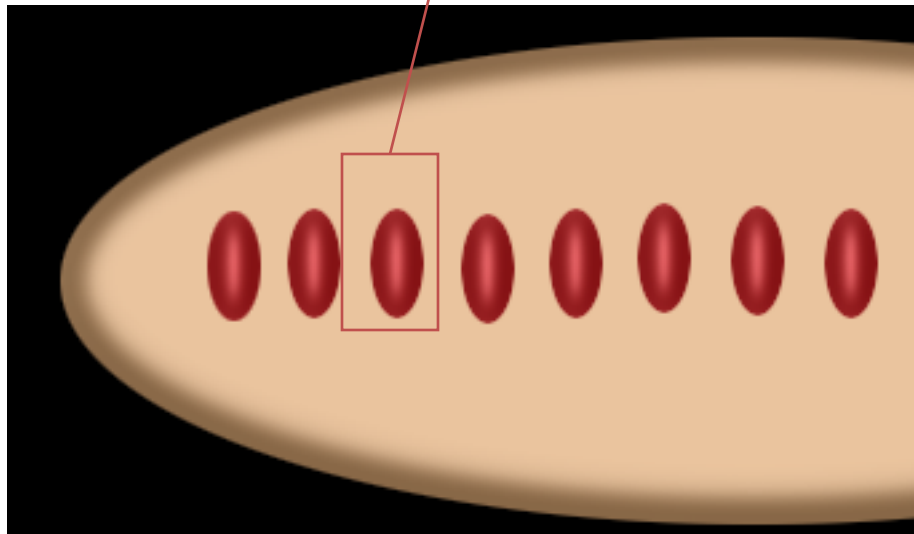
Development

Cranial Nerve IV =
Trochlear Nerve



Development

Cranial Nerve VI = Abducens Nerve



EYEBALL MOVING MUSCLES:

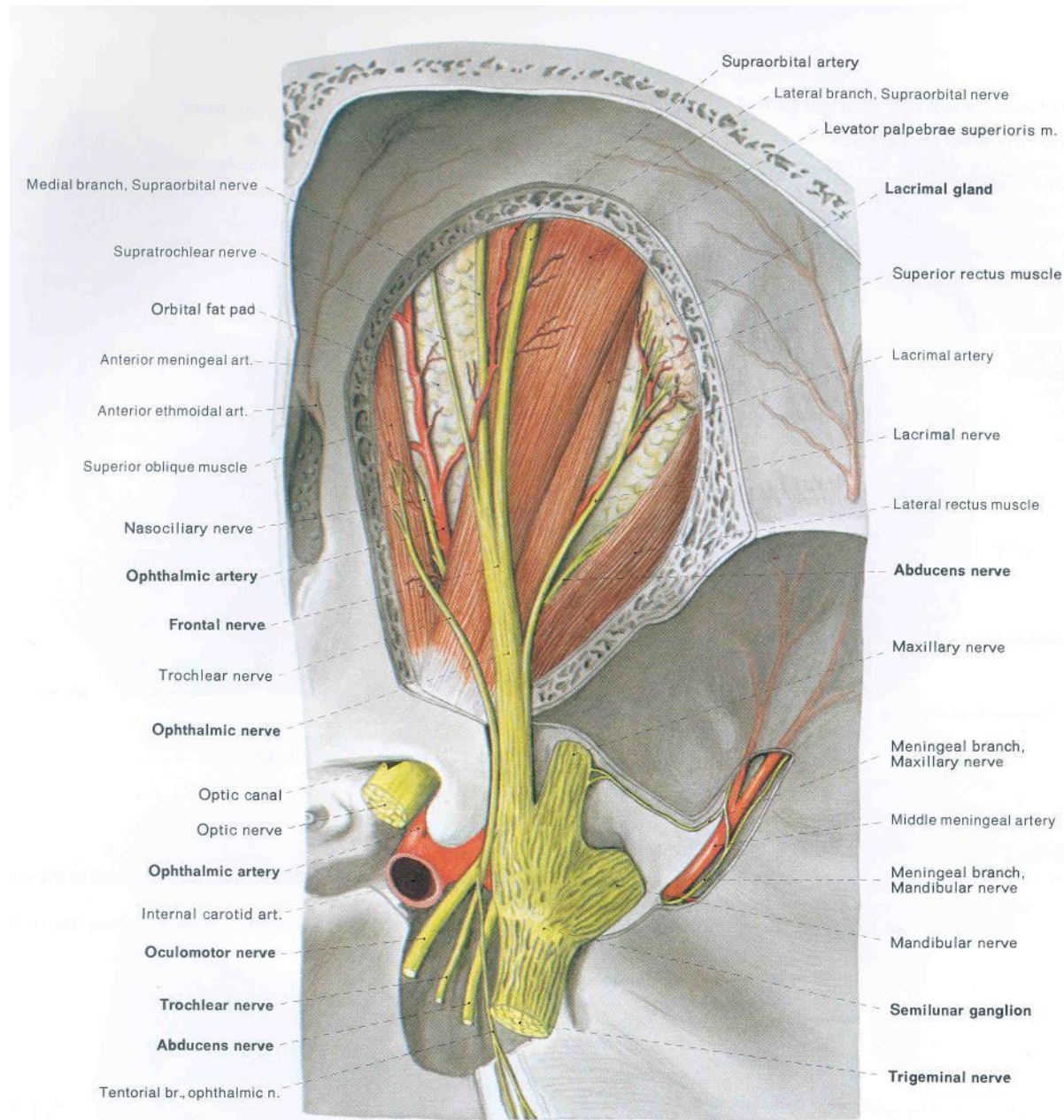
Rectus Muscles

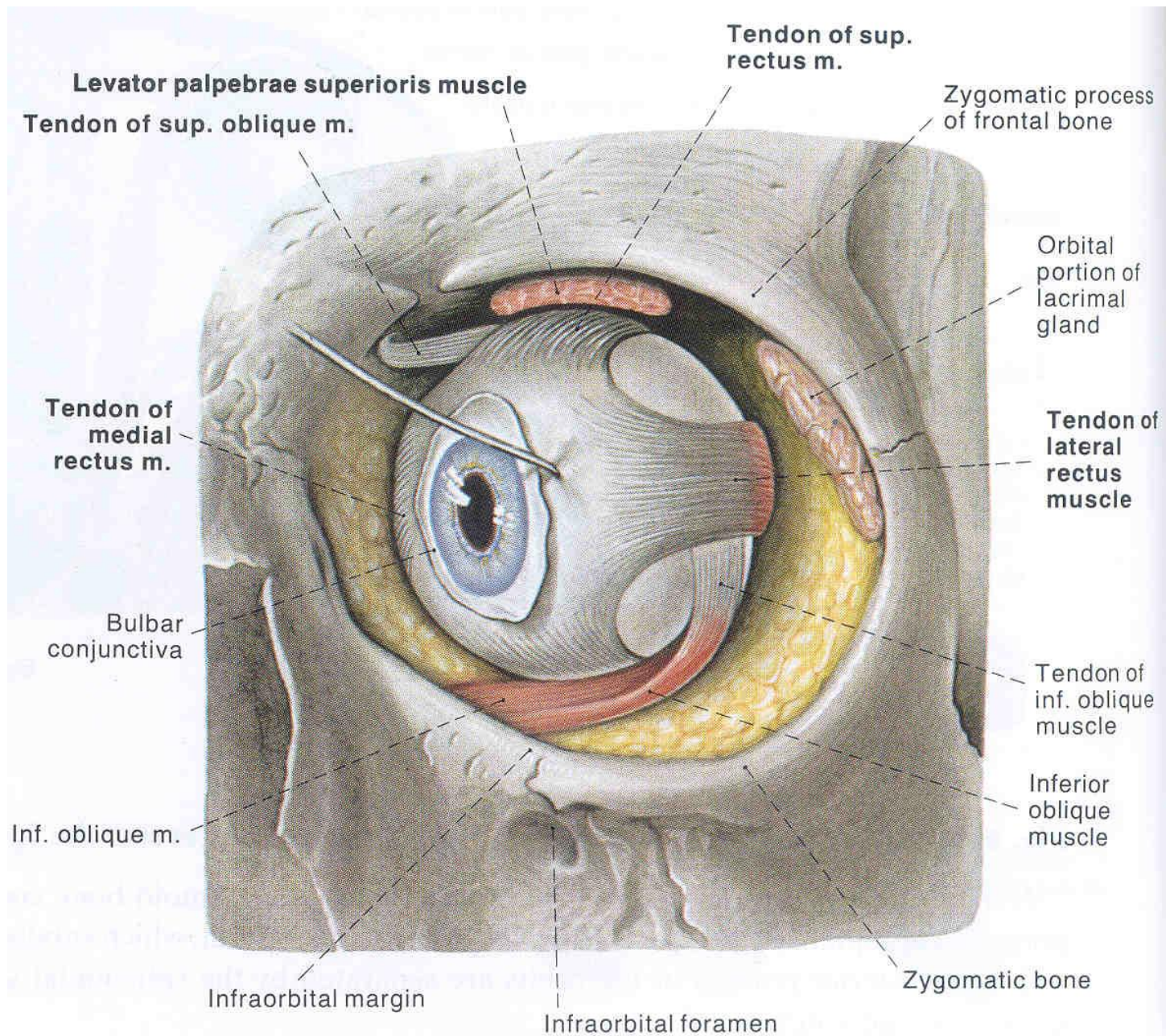
- Superior rectus - III
- Inferior rectus - III
- Lateral rectus - VI
- Medial rectus - III

Oblique muscles

- Superior oblique - IV
- Inferior oblique - III

Lavator palpebrae superioris - III



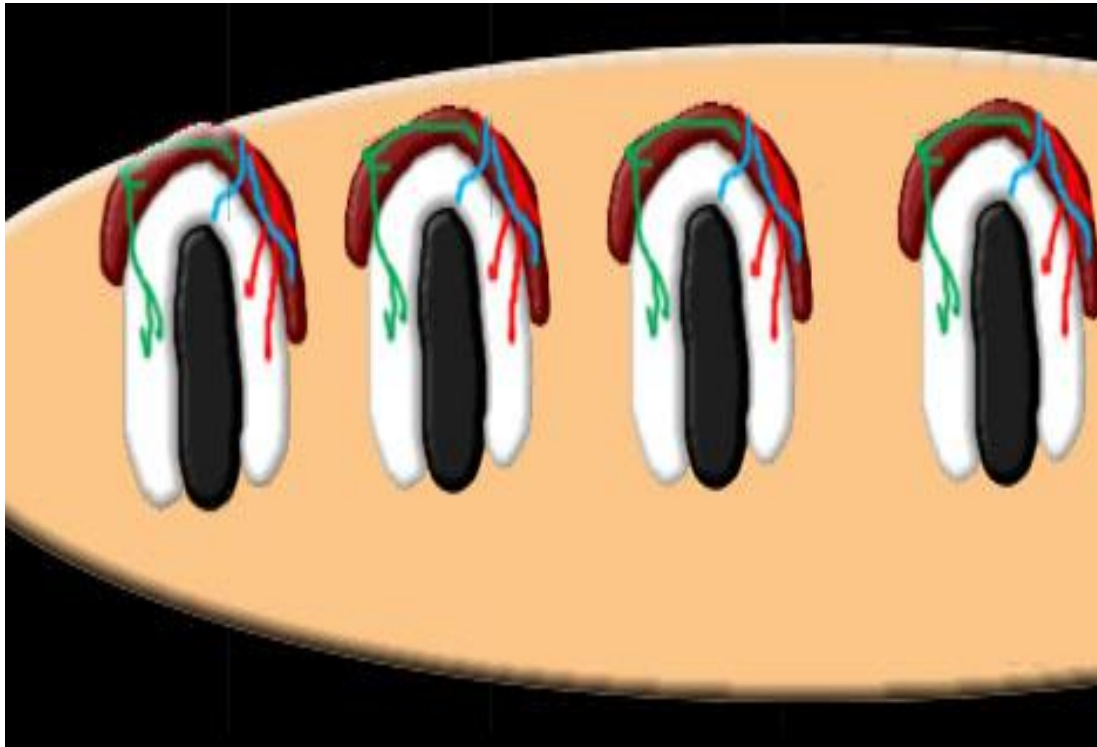


Dorsal Root Cranial Nerves

Gill Pouch Associated

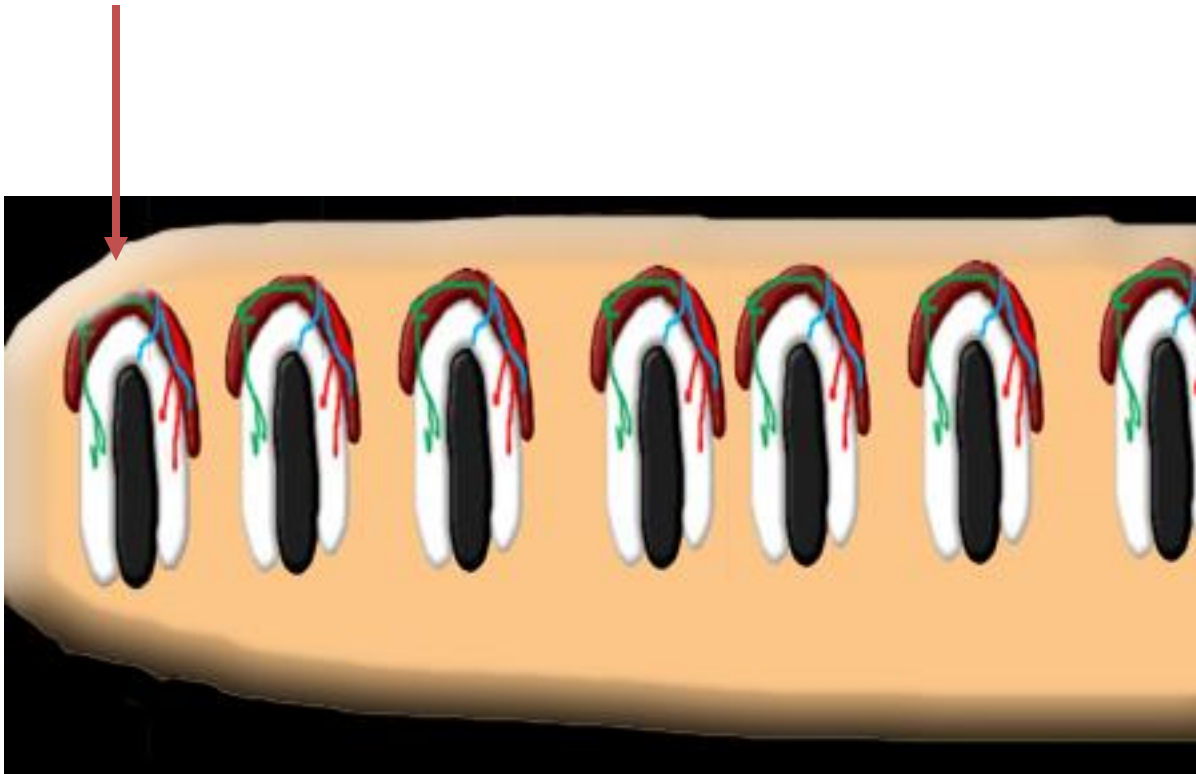
Development

Gill Arch Derivatives



Development

Mandibular arch

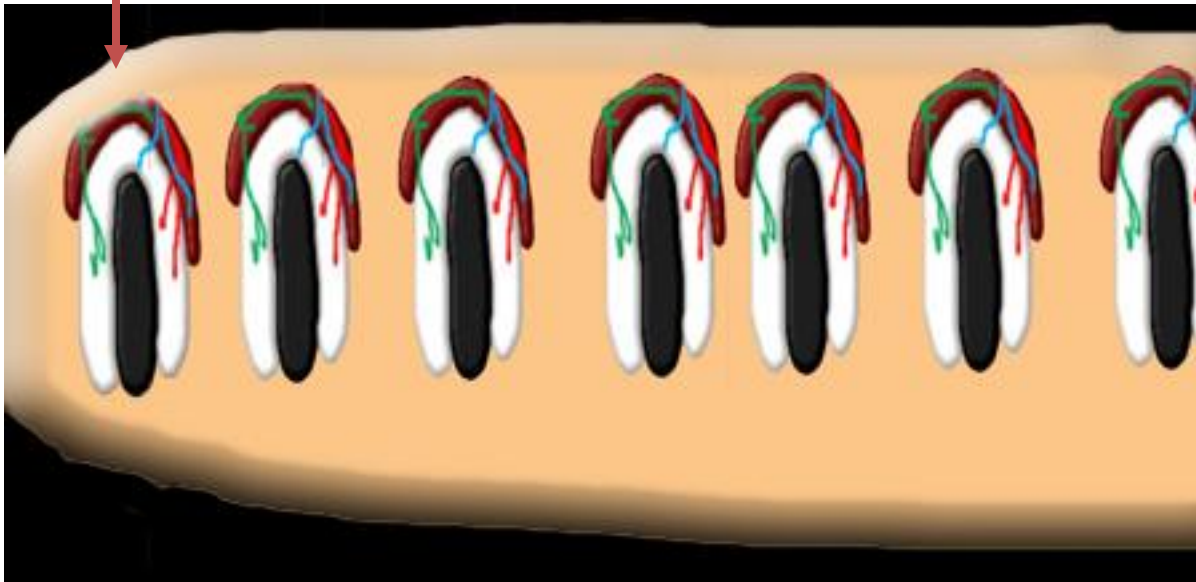


Cranial Nerve V: The Trigeminal Nerve (3 branches)

V1 Ophthalmic ,

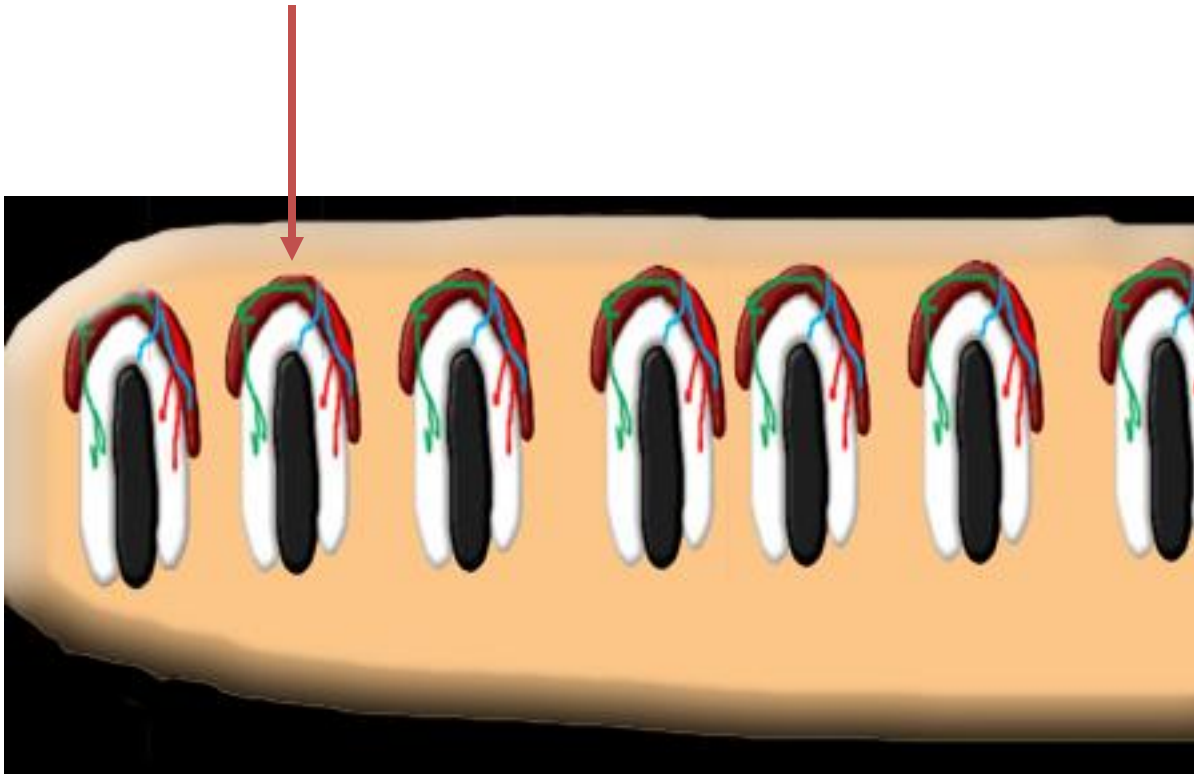
V2 Maxillary,

V3 Mandibular

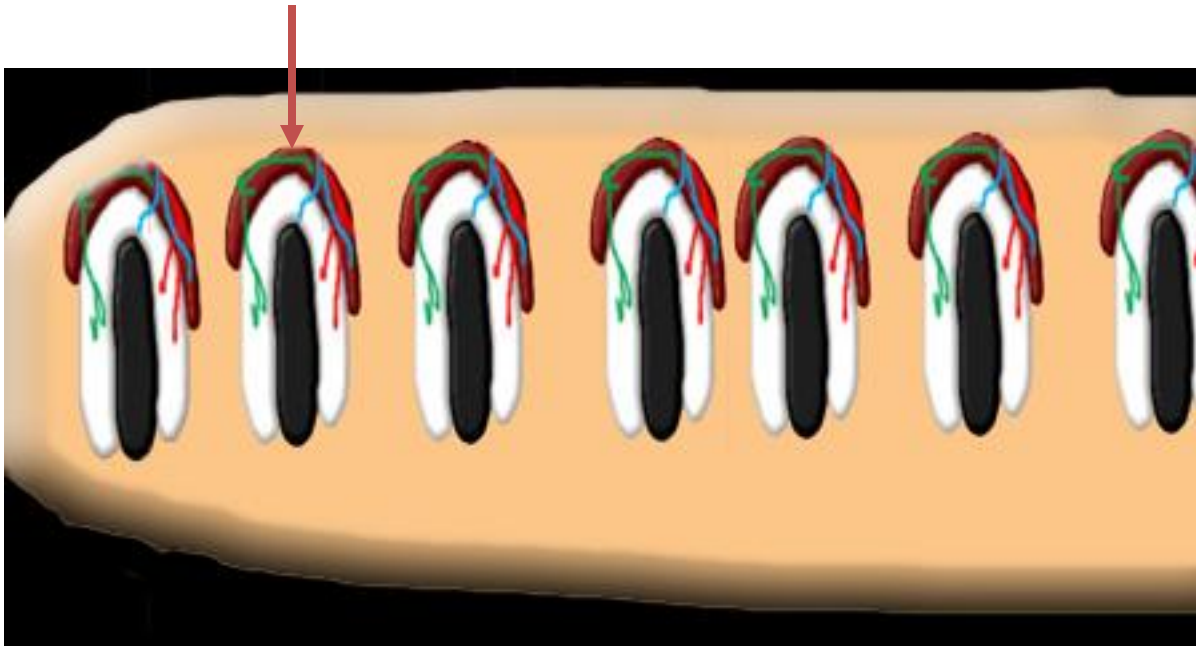


Development

Hyoid arch

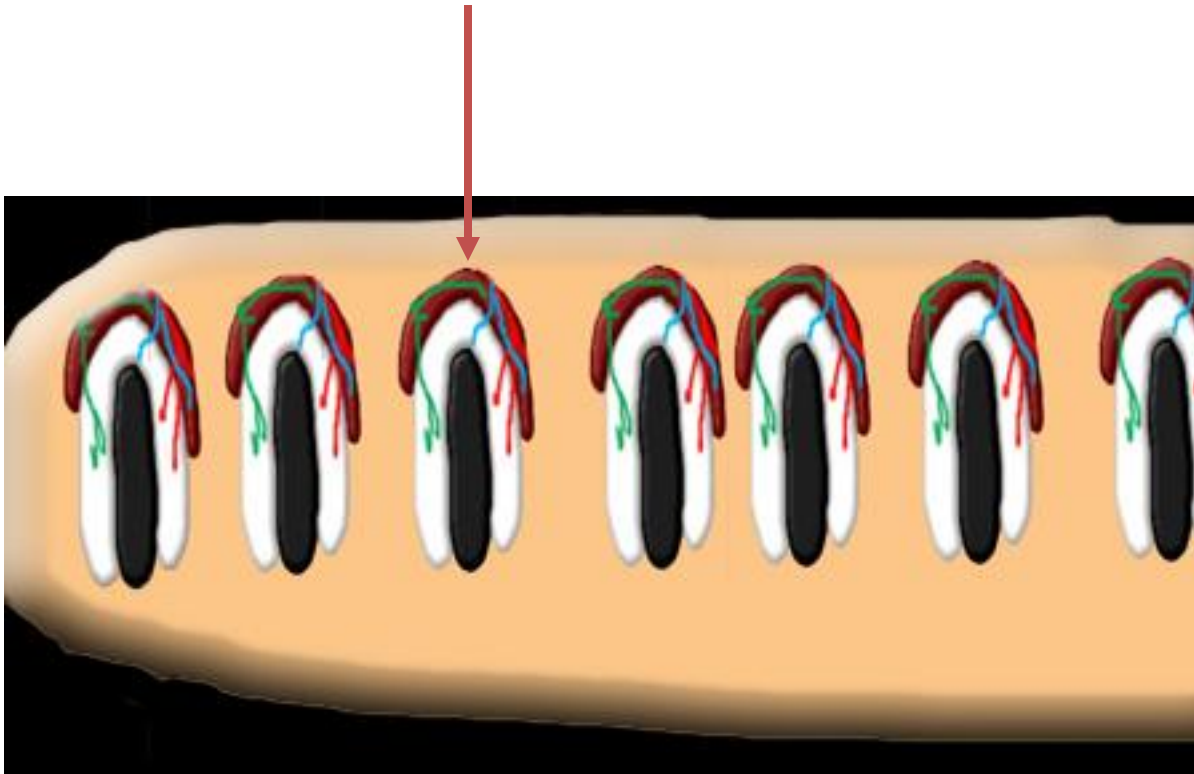


Cranial Nerve VII: Facial nerve

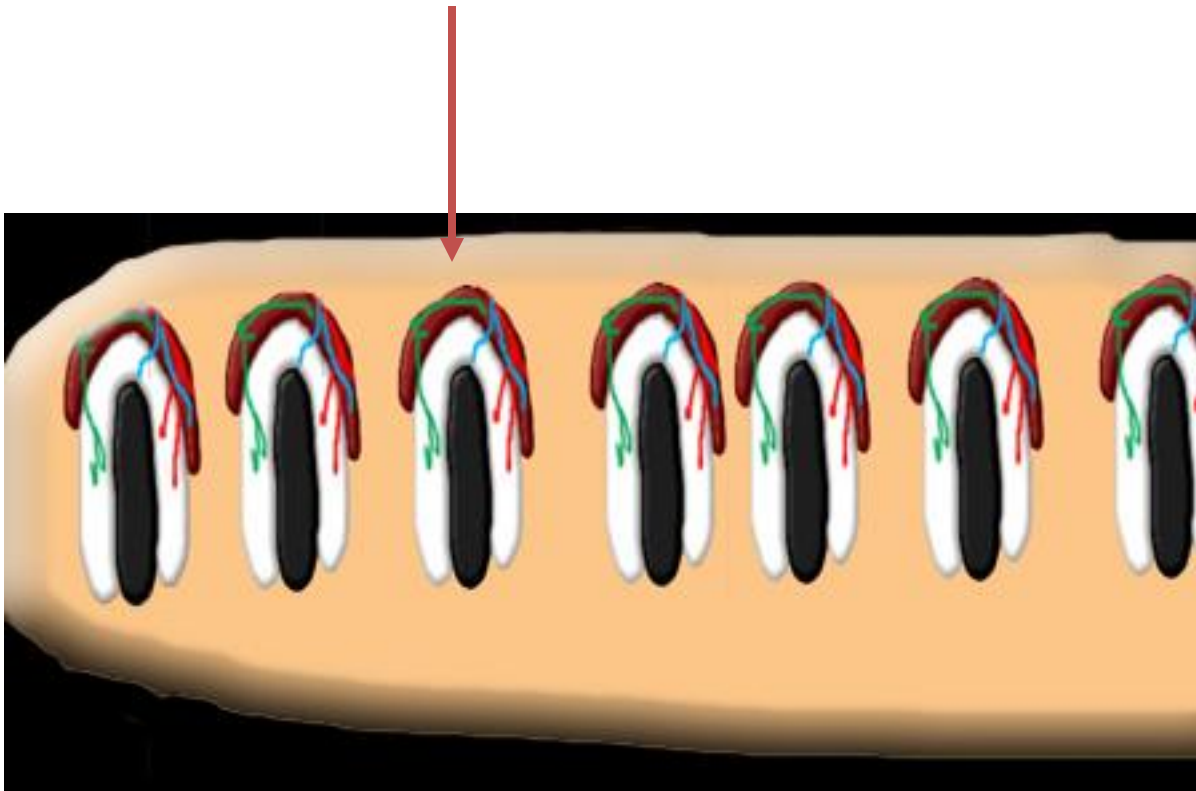


Development

Next arch

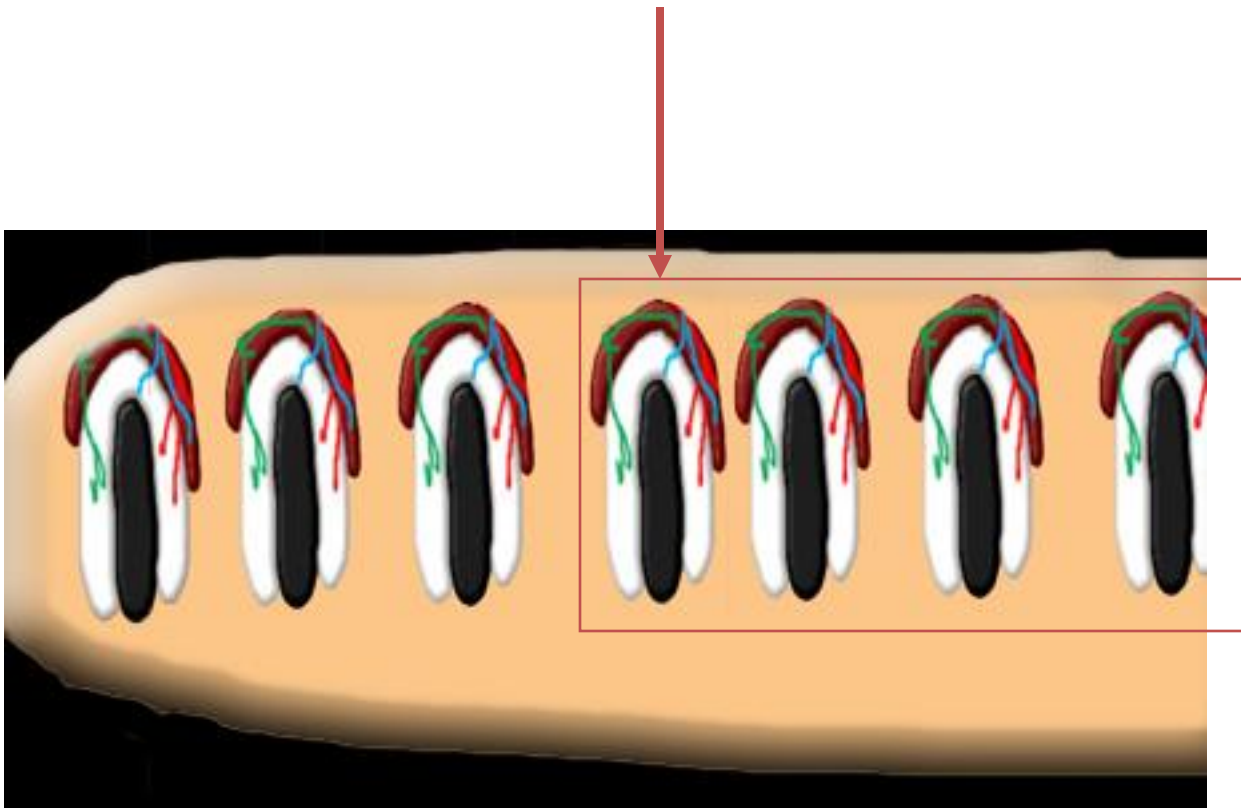


Cranial nerve IX: Glossopharyngeal Nerve

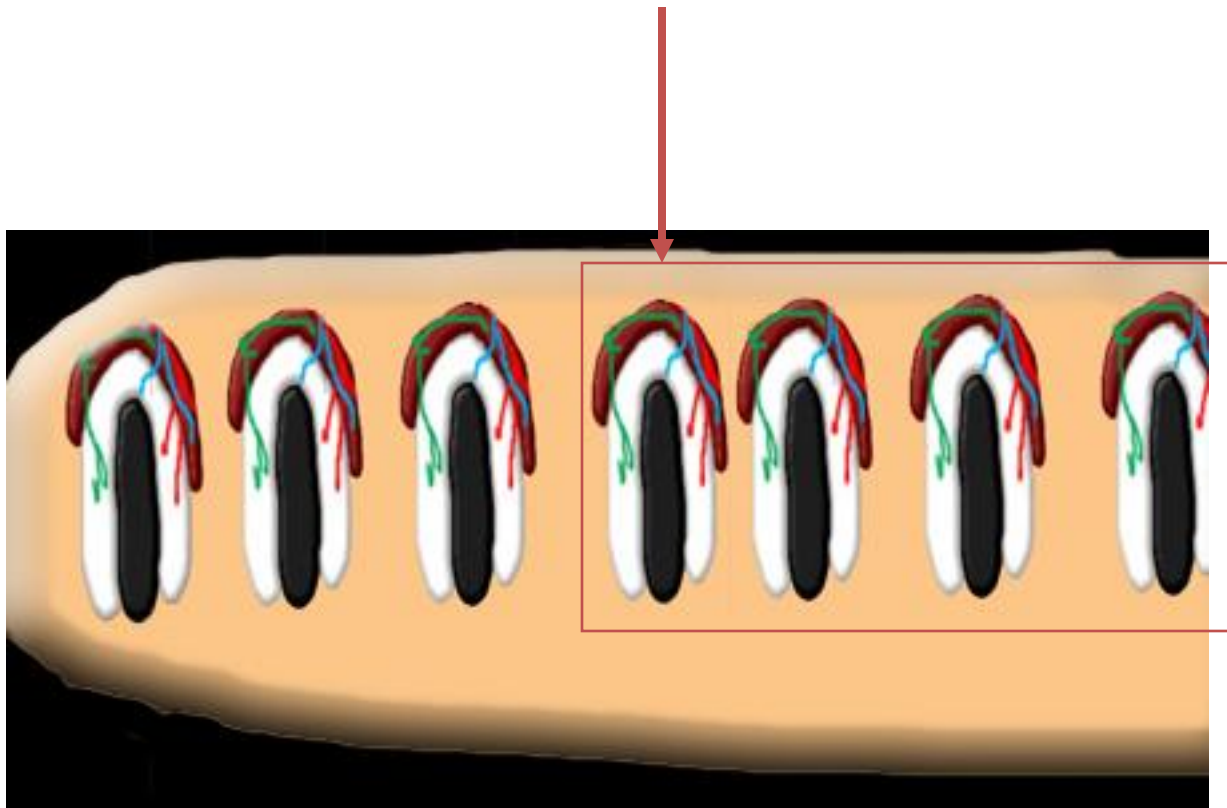


Development

Remaining arches



Cranial nerve X: The Vagus Nerve



The Cranial Nerves

Summary of Cranial Nerves

Is there a “#0” nerve?

The *Nervus Terminalis* (Nerve Zero) has been suggested as a primitive vertebrate structure serving the vomeronasal organ.

Special Sensory Nerves

I

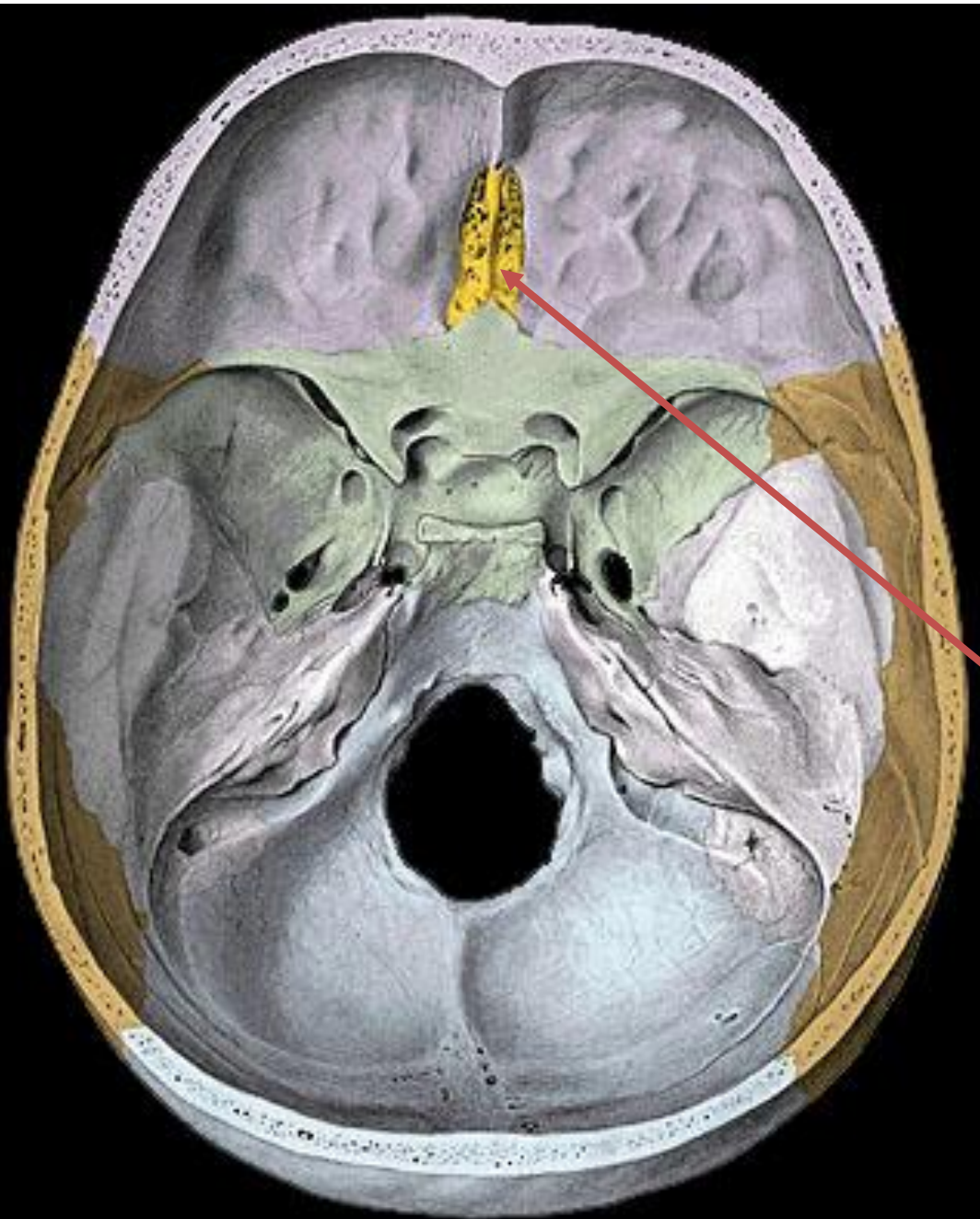
Cranial Nerve I

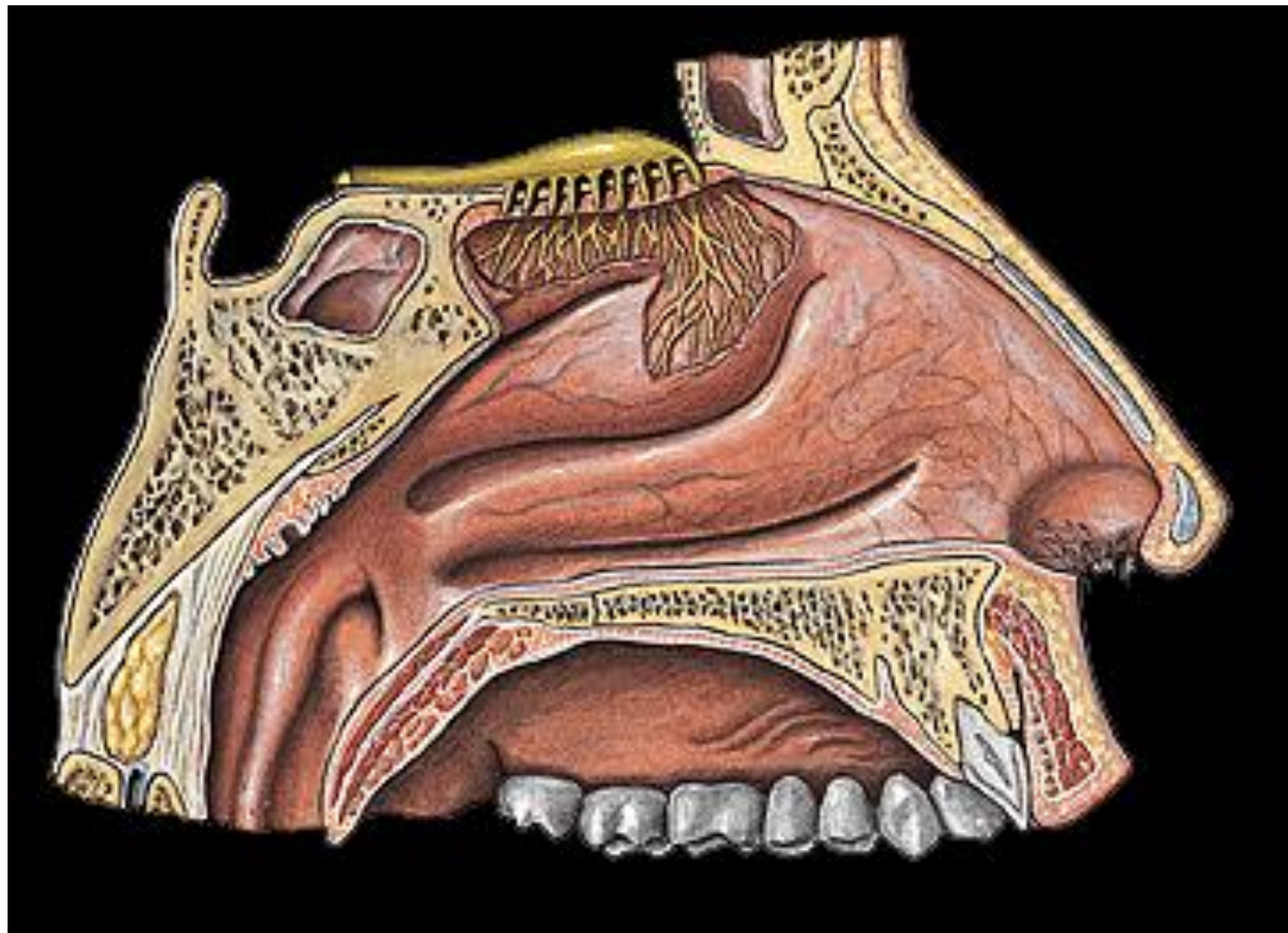
The Olfactory Nerve

Sensory

Smell

Cribriform plate of
ethmoid





II

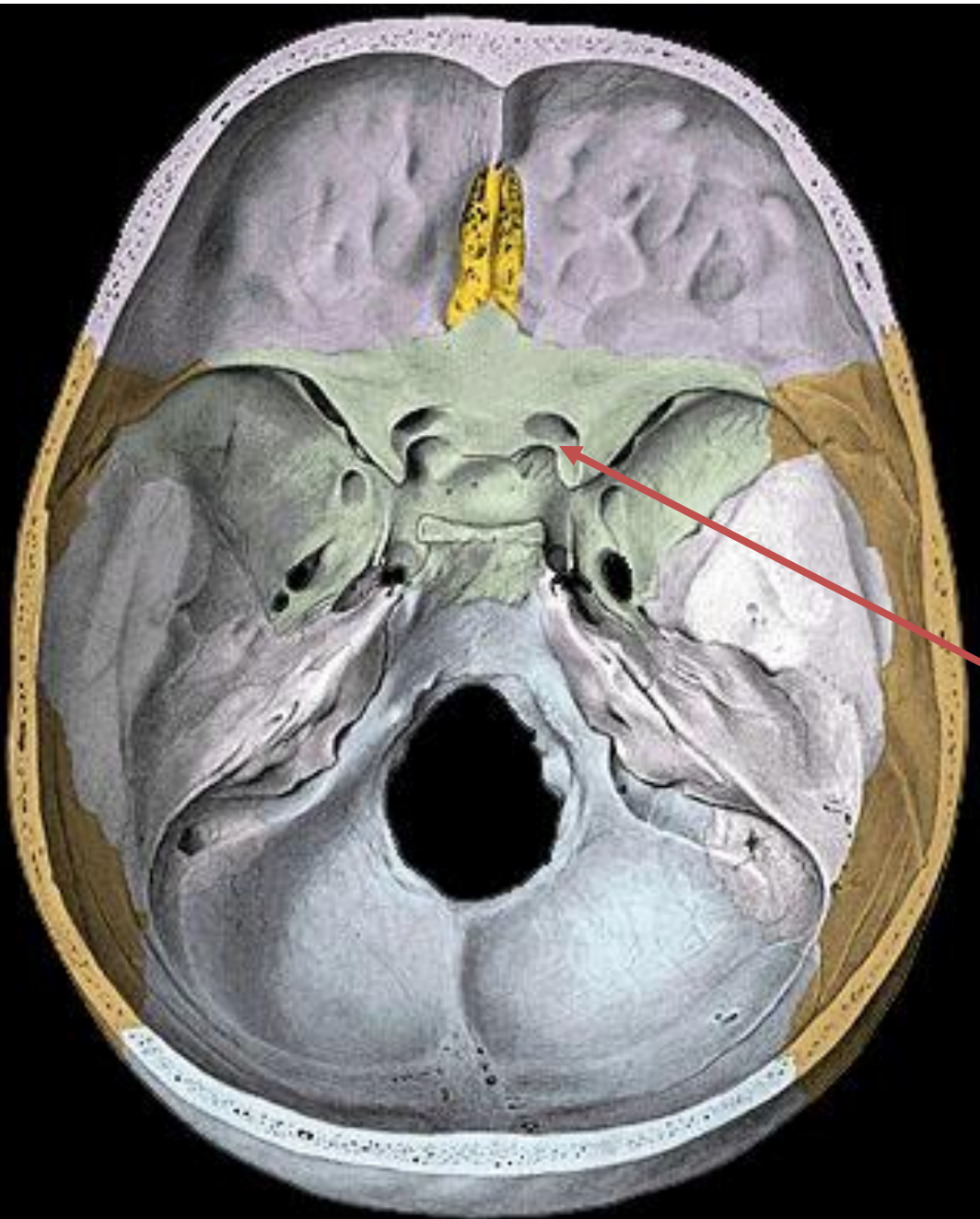
Cranial Nerve II

The Optic Nerve

Sensory

Vision

Optic foramen



Ventral Root Cranial Nerves

III

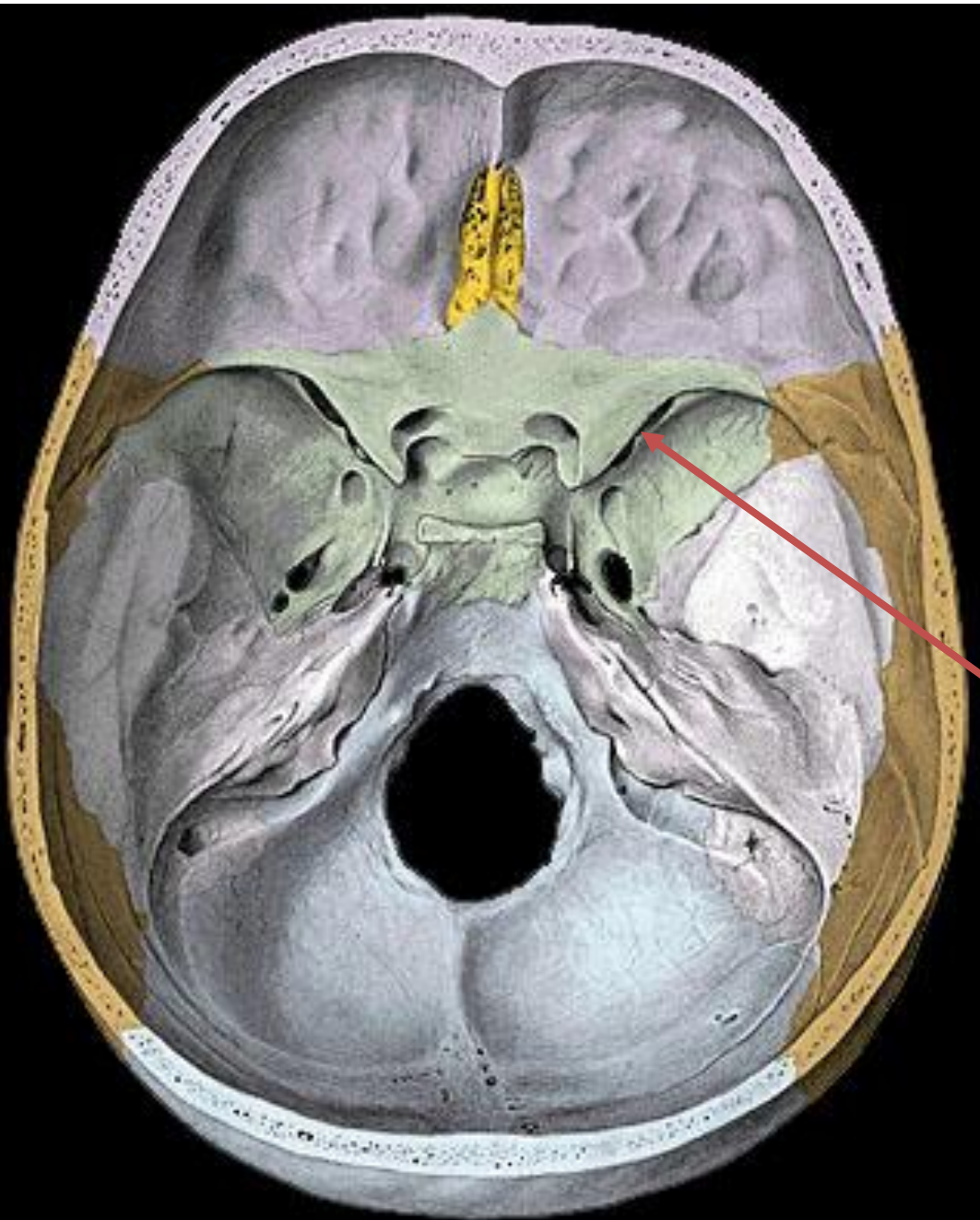
Cranial Nerve III

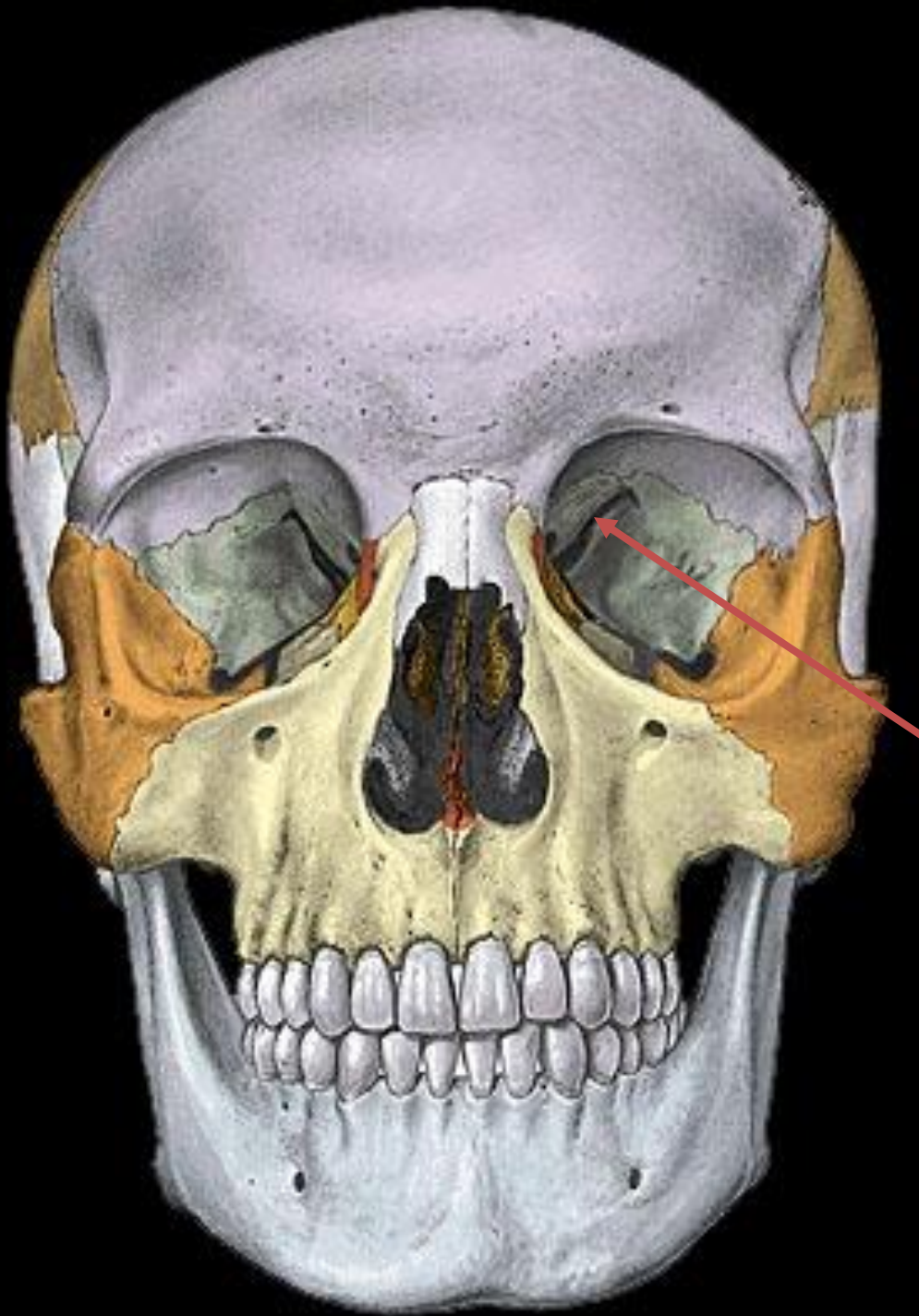
The Oculomotor
Nerve

Mainly motor

Eye Movement

Superior orbital
fissure





Cranial Nerve III

The Oculomotor
Nerve

Mainly motor

Eye Movement

Superior orbital
fissure

Detail on Oculomotor (III) Function:

- Motor to all extra-ocular muscles except lateral rectus and superior oblique.
- Parasympathetic innervation to sphincter pupillae and ciliaris muscles (synapse in ciliary ganglion).
- Sympathetic innervation to sphincter pupillae and ciliaris muscles. Fibers originate in upper thoracic levels, synapse in cervical ganglia, get to orbit via associated arteries.

IV

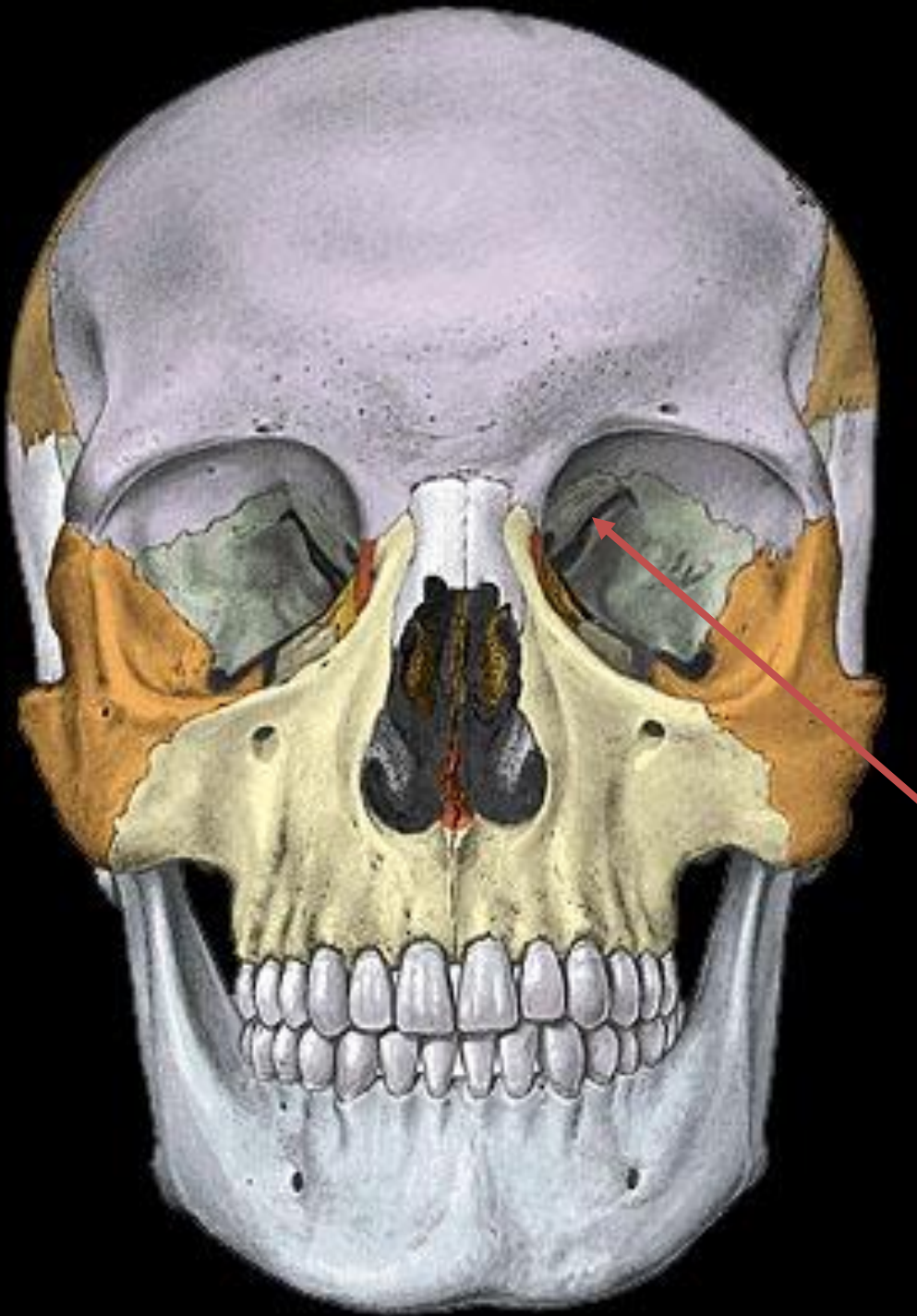
Cranial Nerve IV

The Trochlear
Nerve

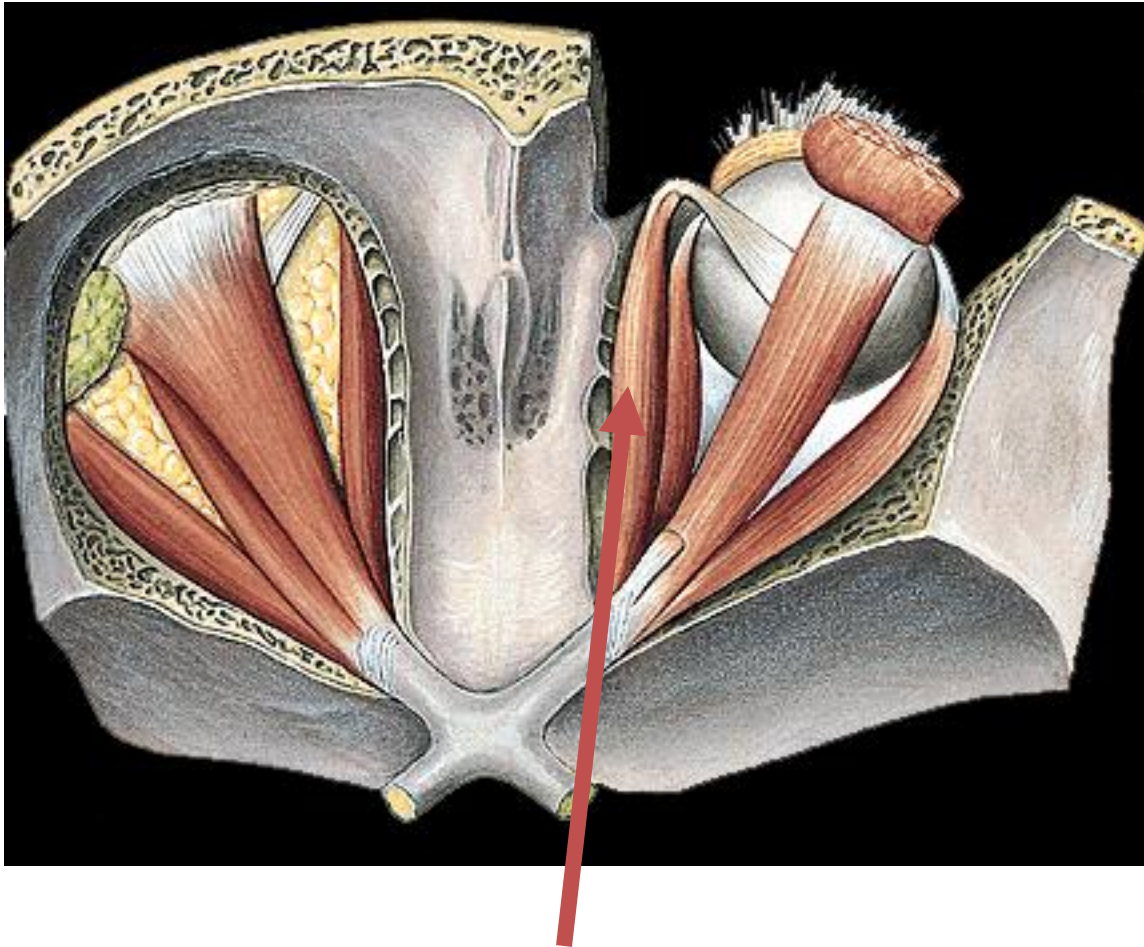
Mainly motor

Superior oblique

Superior orbital
fissure



Cranial Nerve IV



Superior oblique

VI



Cranial Nerve VI

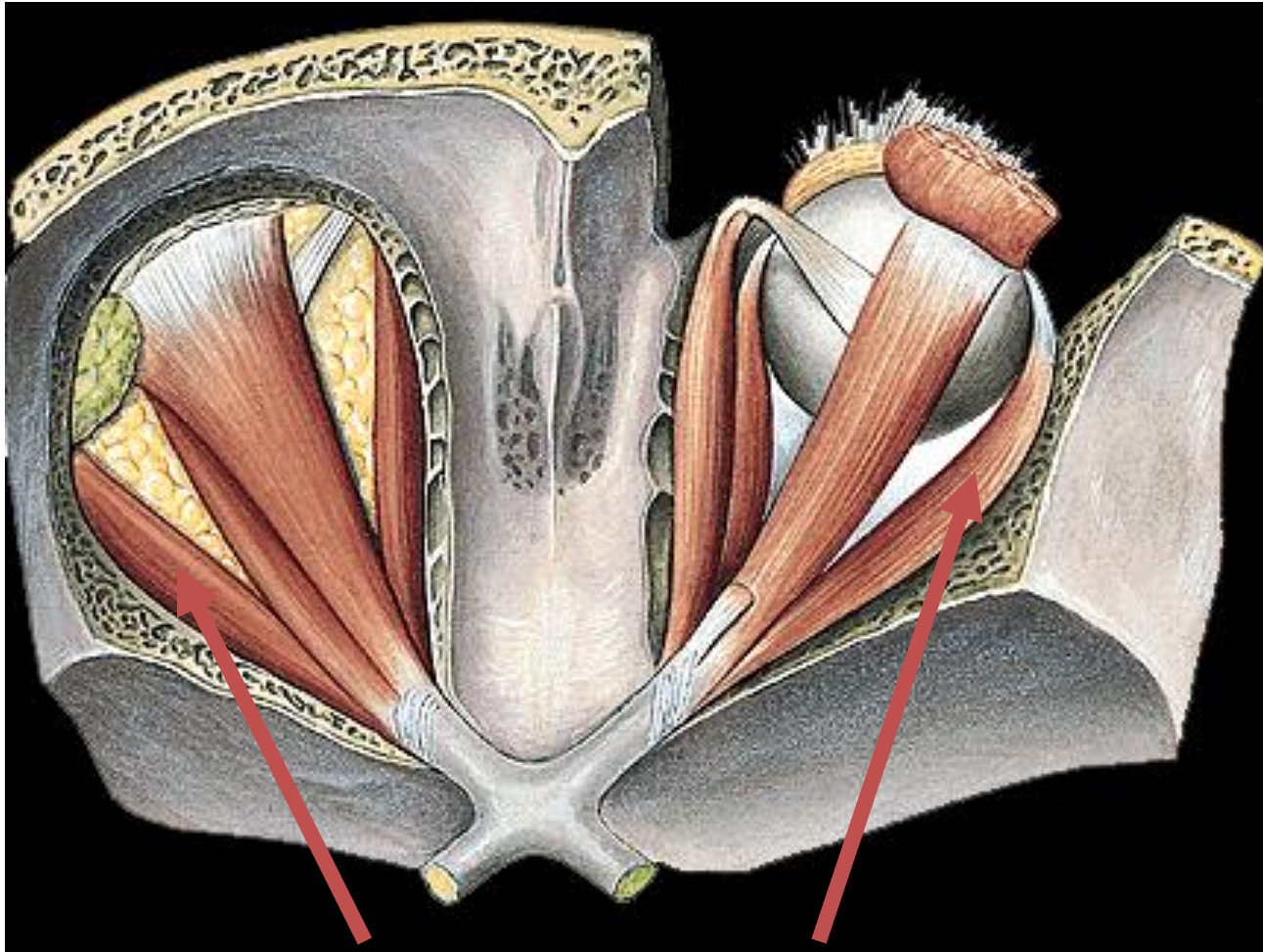
The Abducens
Nerve

Mainly motor

Lateral rectus

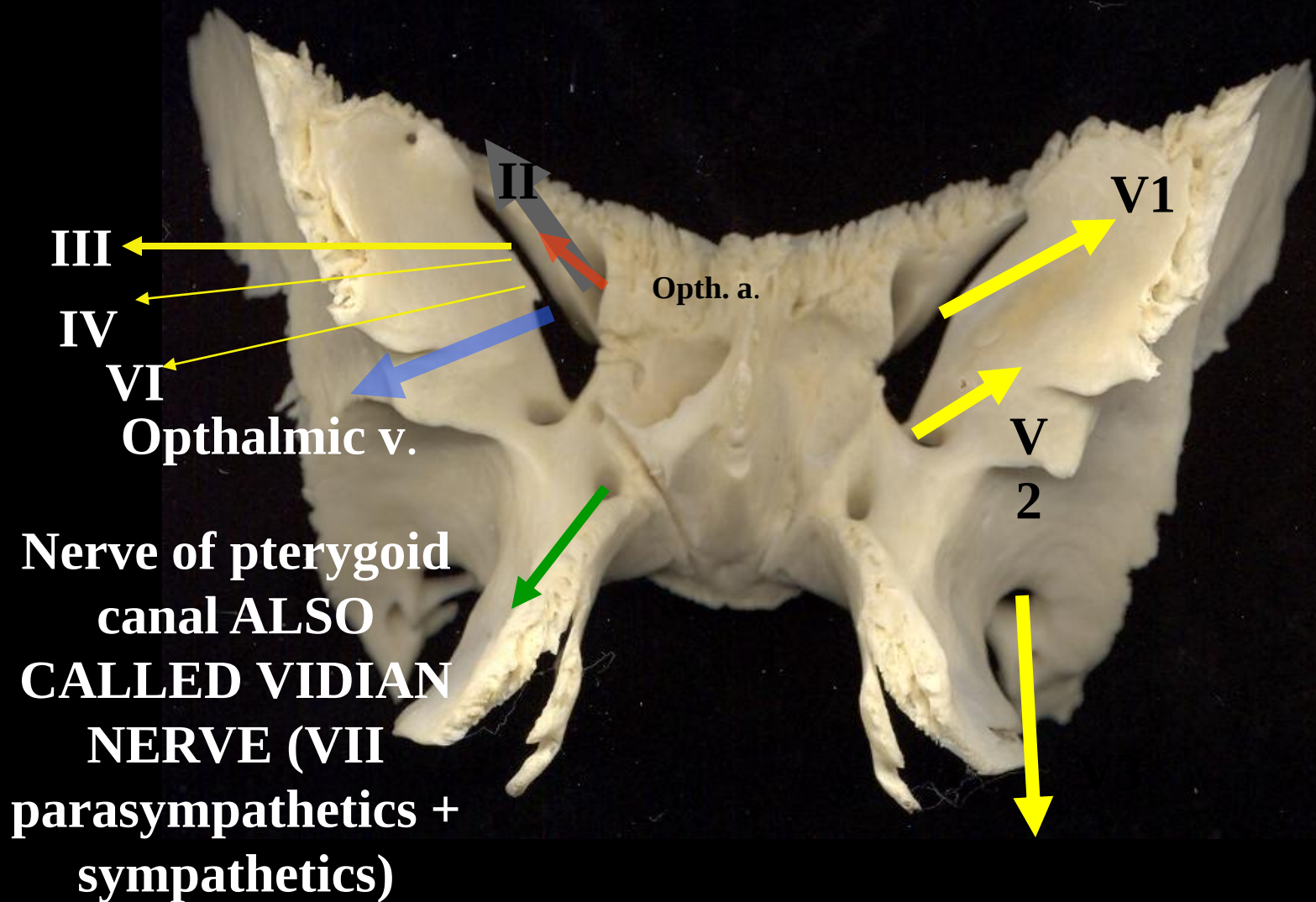
Superior orbital
fissure

Cranial Nerve VI



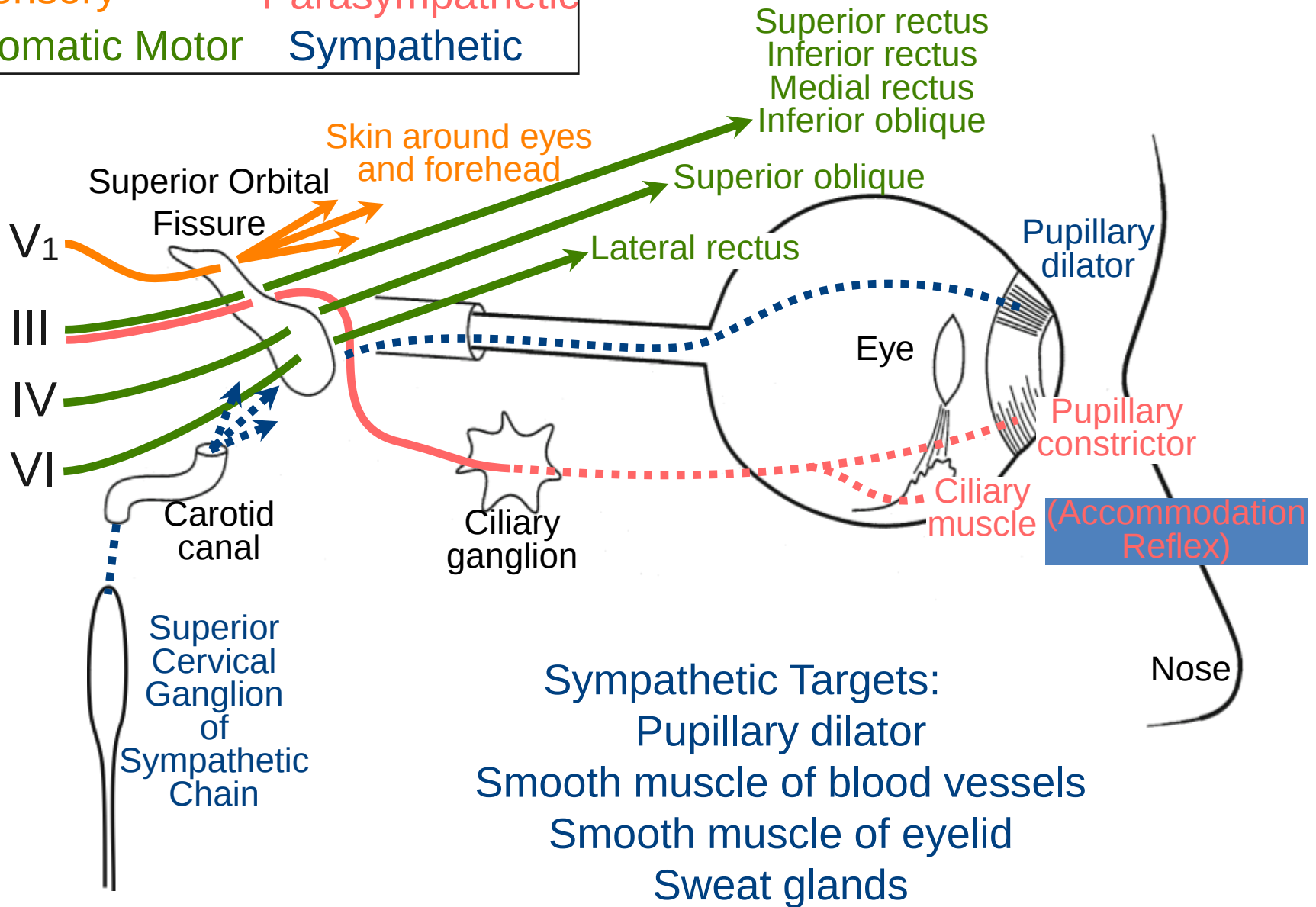
Lateral rectus

Sphenoid/ anterior view of orbital surface and foramina with associated cranial nerves indicated

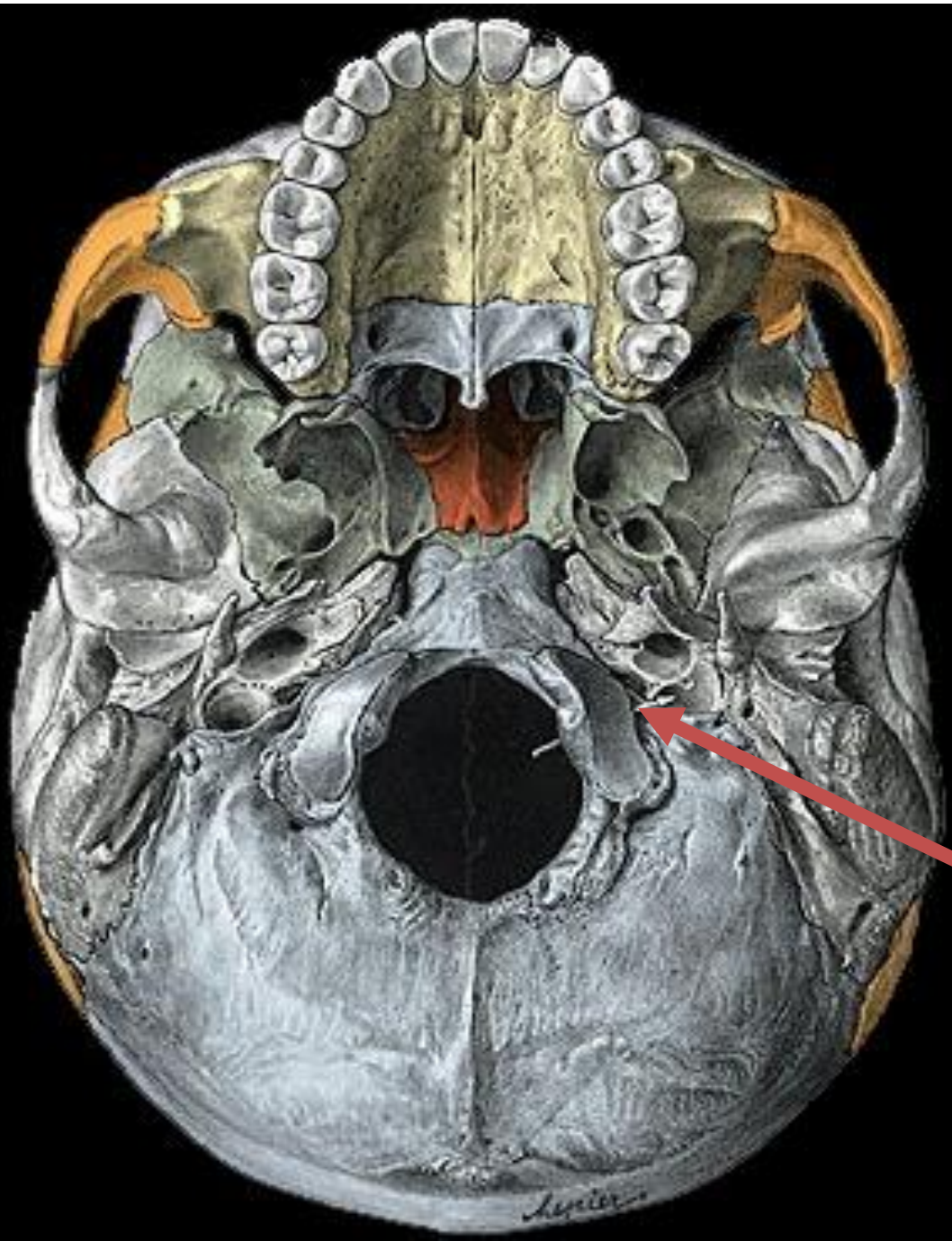


Pathways of the Oculomotor Nerve (CN III)

Sensory	Parasympathetic
Somatic Motor	Sympathetic



XII



Cranial Nerve XII

The Hypoglossal
Nerve

Mainly Motor

Tongue

Hypoglossal Canal

Dorsal Root Cranial Nerves

V



Cranial Nerve V

The Trigeminal
Nerve

Both

V_1 = ophthalmic

V_2 = maxillary

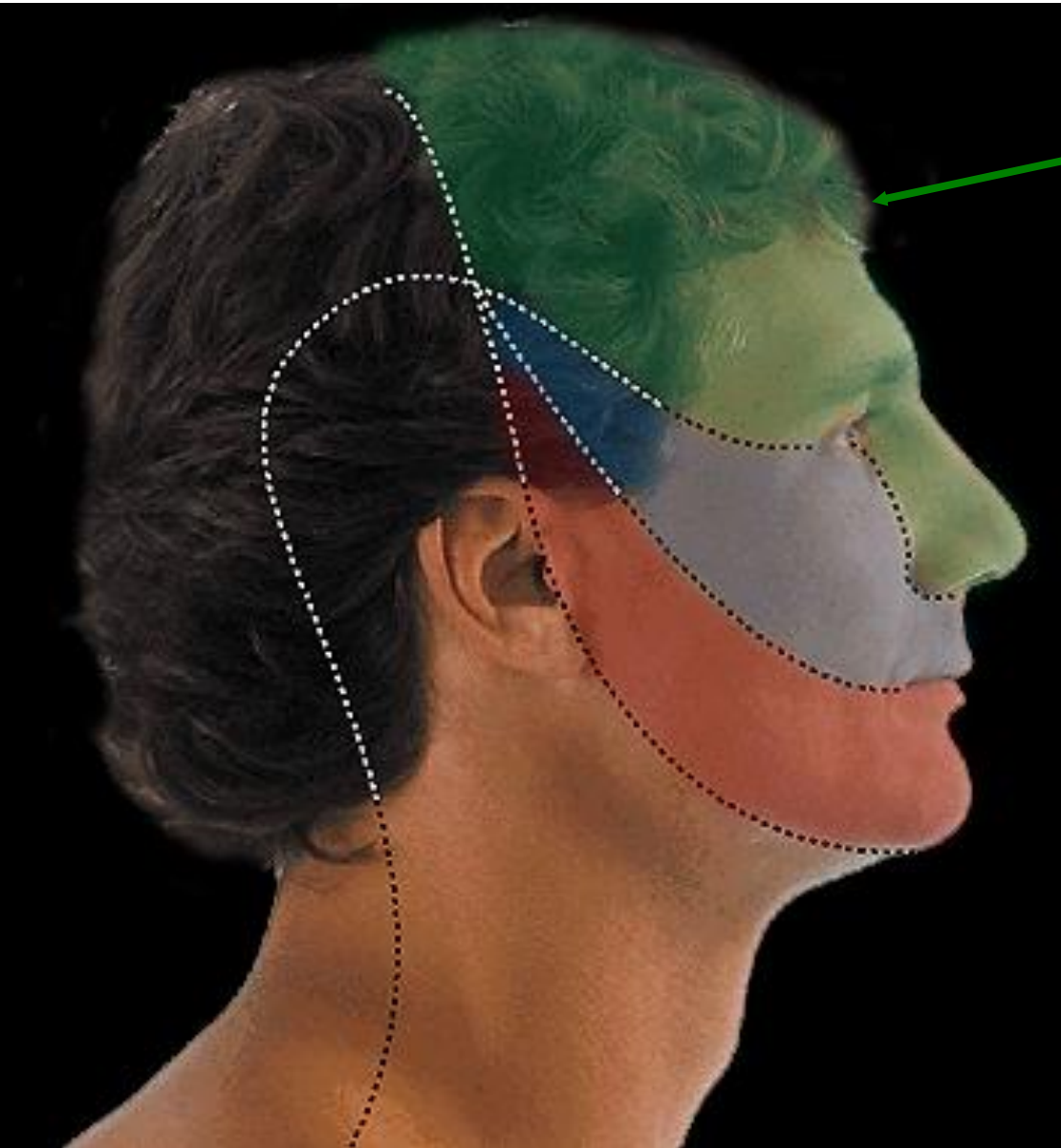
V_3 = mandibular

Cranial Nerve V₁

Ophthalmic
division

Sensory

Superior orbital
fissure

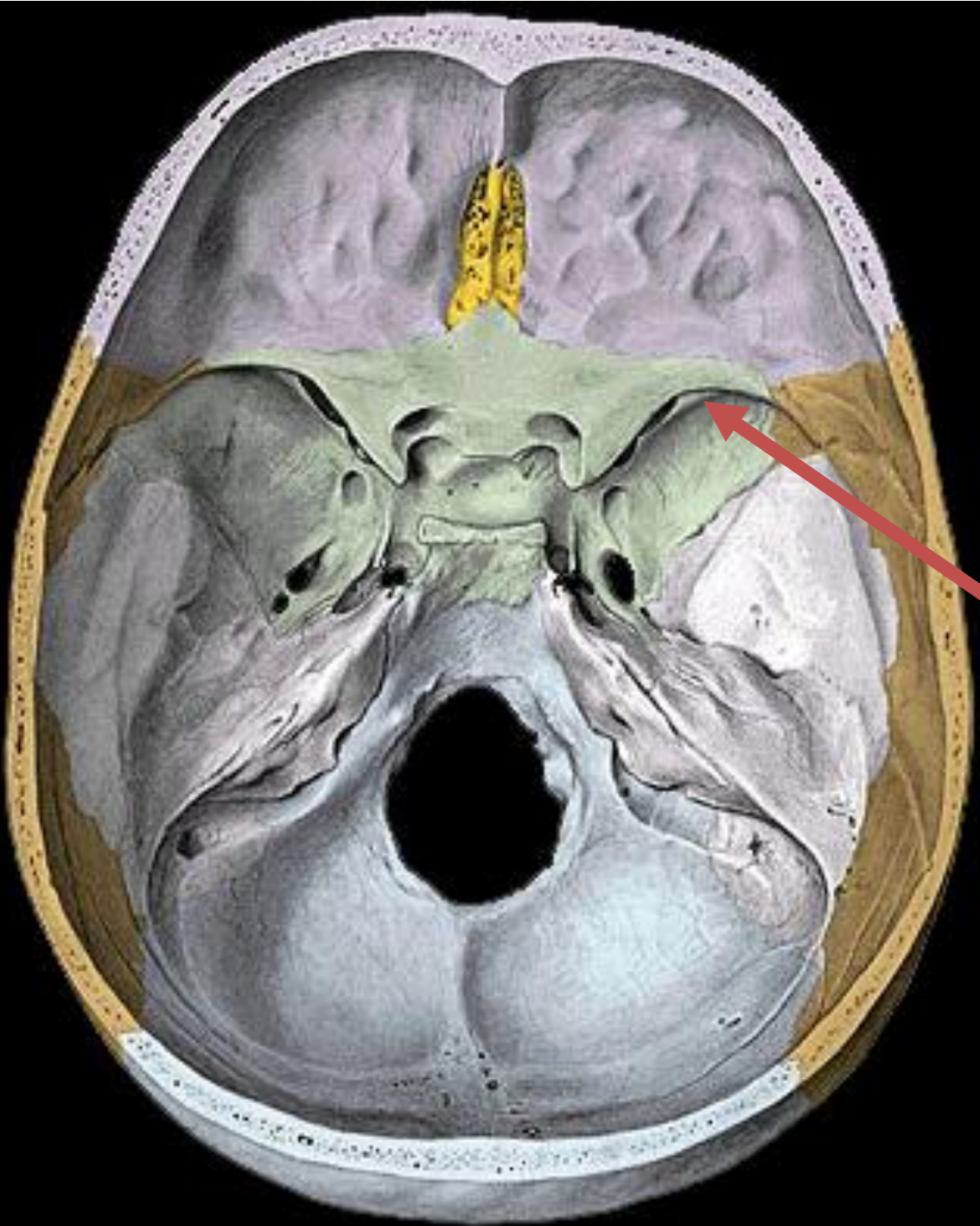


Cranial Nerve V₁

Ophthalmic
division

Sensory

Superior orbital
fissure



Detail on Ophthalmic (V-1) Function:

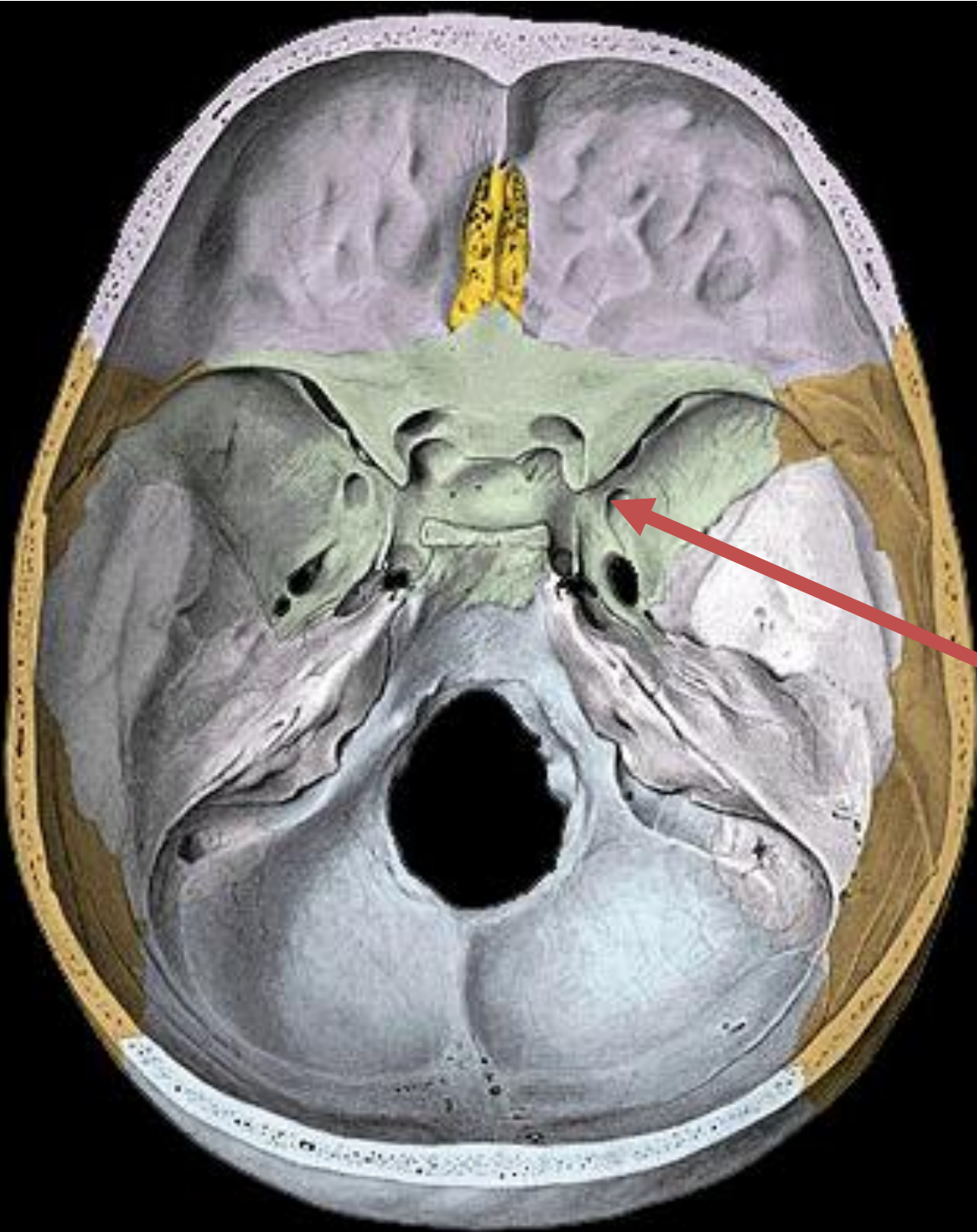
- Almost wholly sensory: eyeball, lacrimal gland, conjunctiva, part of nasal mucosa, from brow ridge superiorly.
- Carries a bit of sympathetic fibers for dilator pupillae. From upper thoracic levels, synapsing in upper cervical ganglion. Reaches via branches of internal carotid artery.

Cranial Nerve V₂

Maxillary division

Sensory

Foramen
rotundum

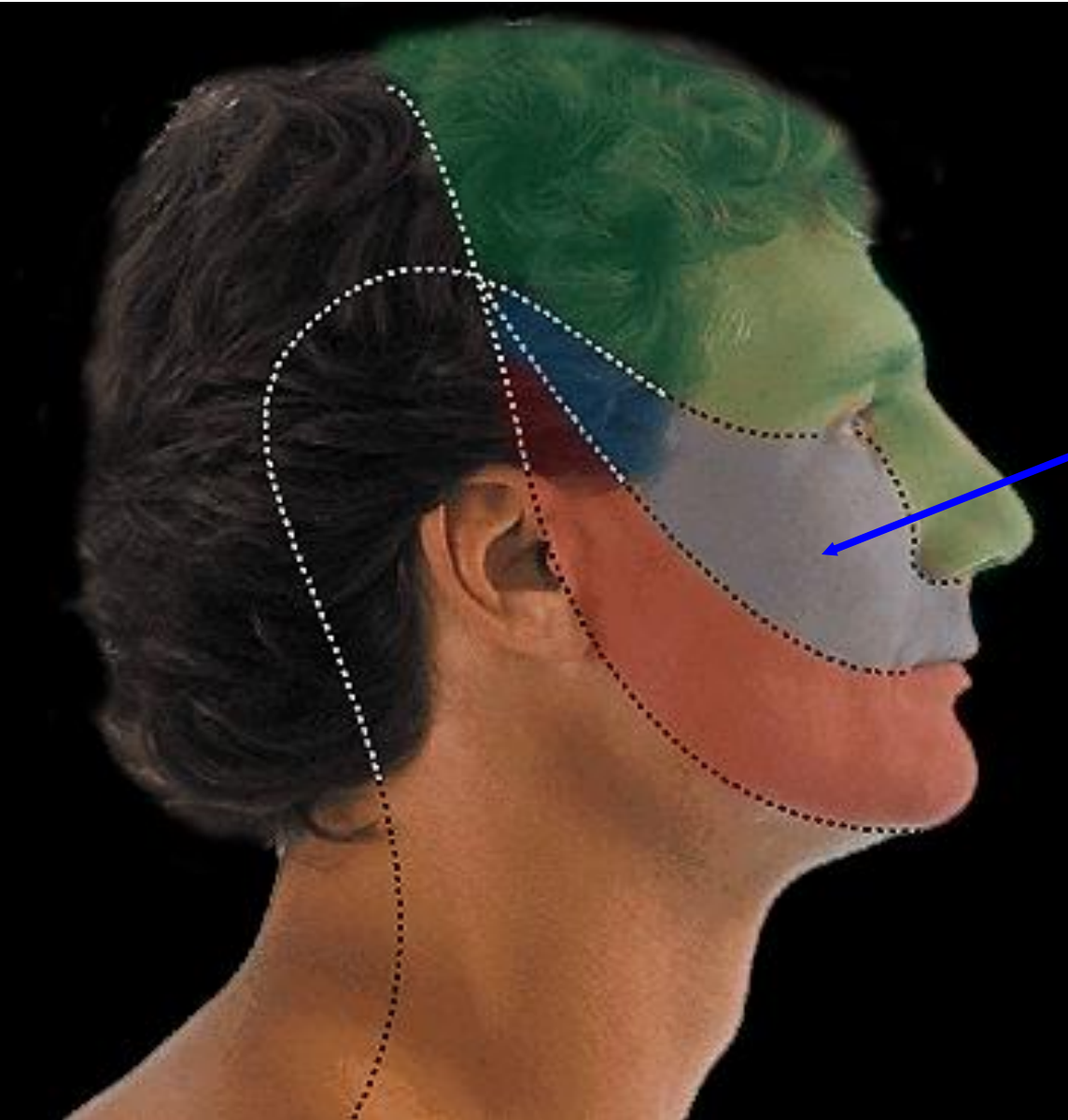


Cranial Nerve V₂

Maxillary division

Sensory

Foramen
rotundum

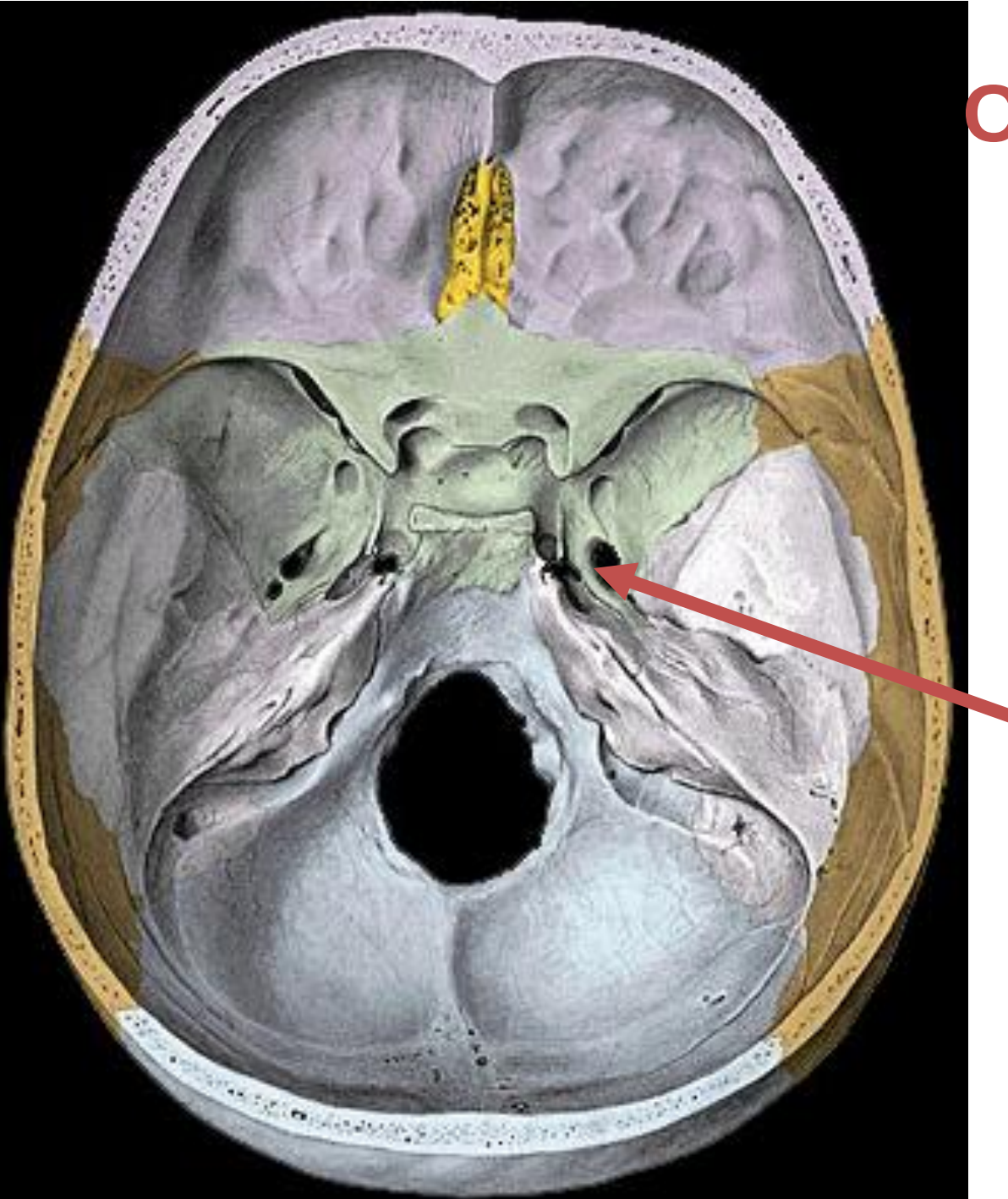


Cranial Nerve V₃

Mandibular
division

Both

Foramen ovale



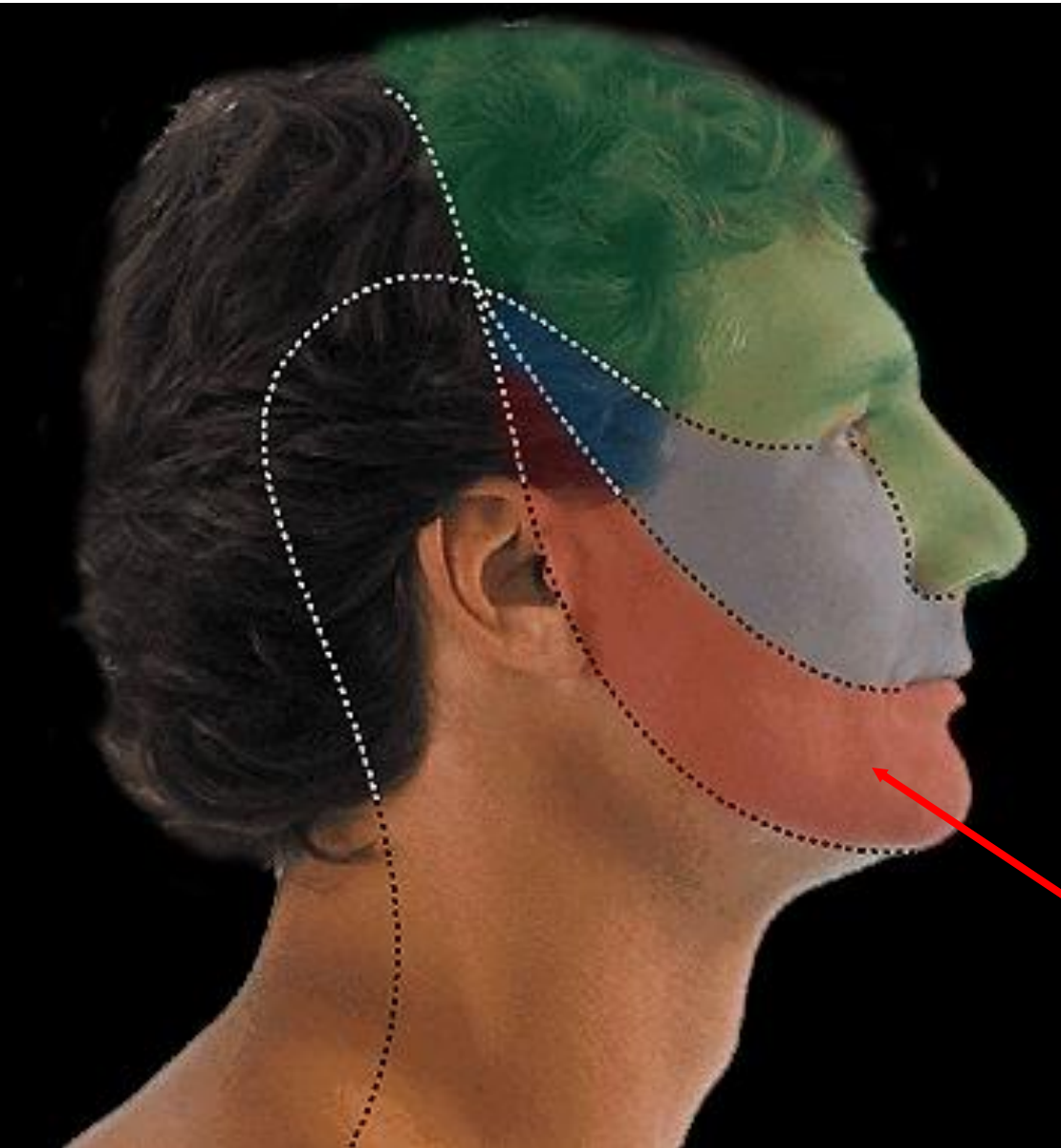
Cranial Nerve V₃

Mandibular
division

Both

Foramen ovale

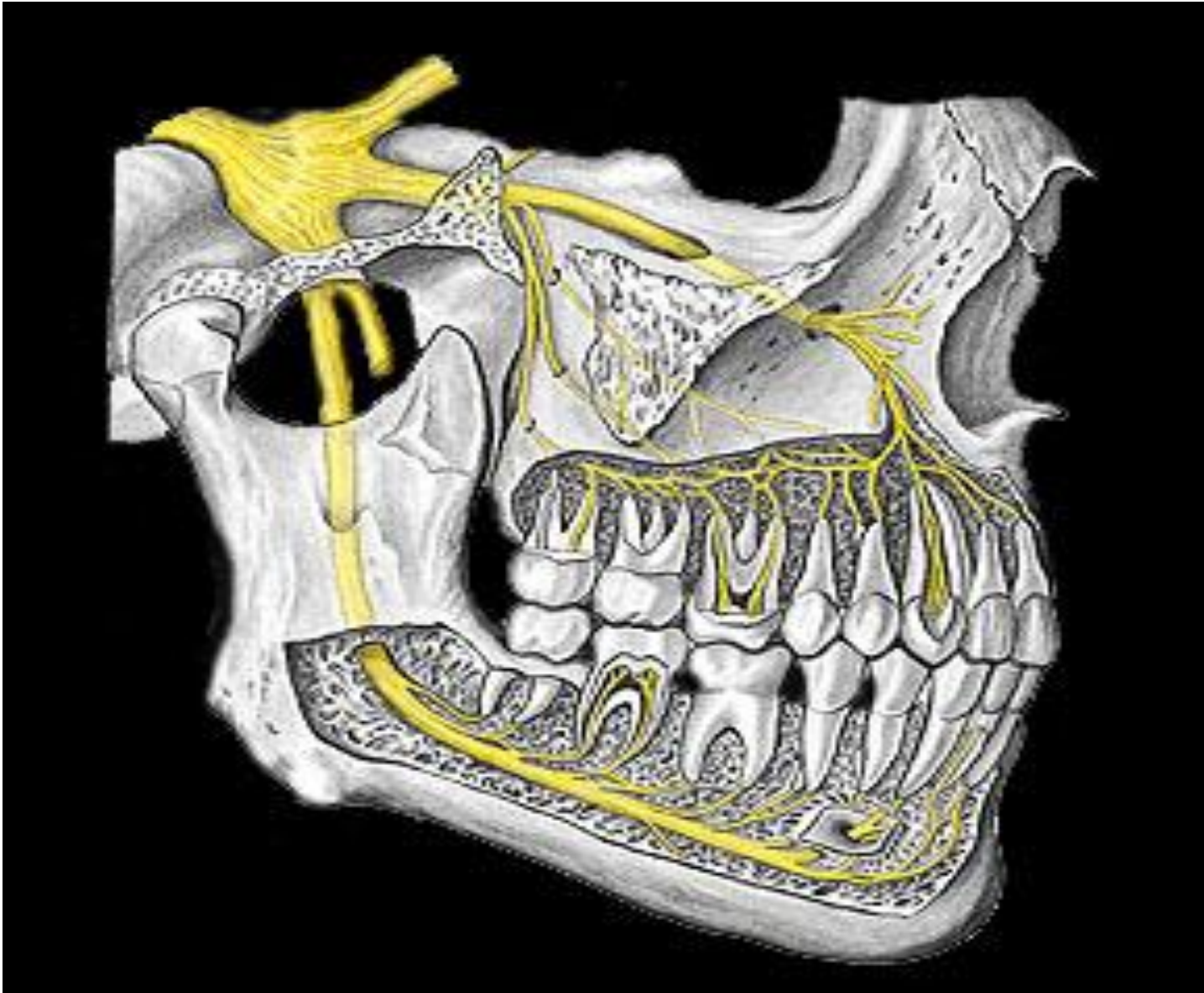
Sensory Component



Detail on Mandibular (V-3) Function:

- Sensory to lower jaw region, including teeth.
- Motor nerve to muscles of the mandibular arch: masseter, temporalis, anterior and posterior pterygoids, mylohyoid, tensor tympani, anterior digastric, and tensor veli palatini.
- The auriculotemporal branch contains secretomotor fibers to the parotid gland via the parotid branches.

Cranial Nerve V



vii

Cranial Nerve VII

The Facial Nerve

Both

Motor and sensory



Cranial Nerve VII

The Facial Nerve

Both motor and sensory
Muscles of facial expression

Parasympathetic:
Lacrimal ducts, taste, salivary glands

Cranial Nerve VII

The Facial Nerve

VII_a Temporal

VII_b Zygomatic

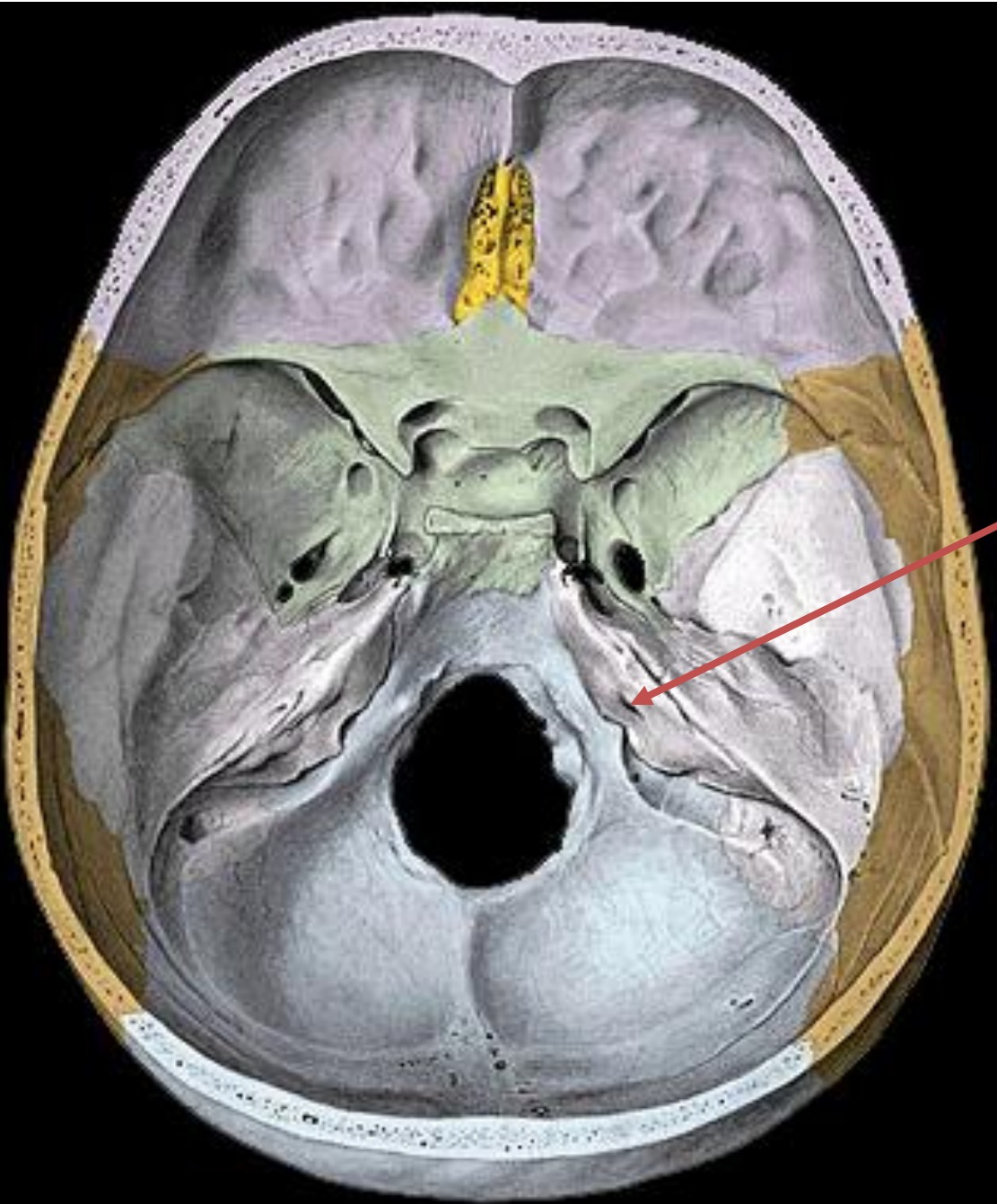
VII_c Buccal

VII_d Mandibular

VII_e Cervical

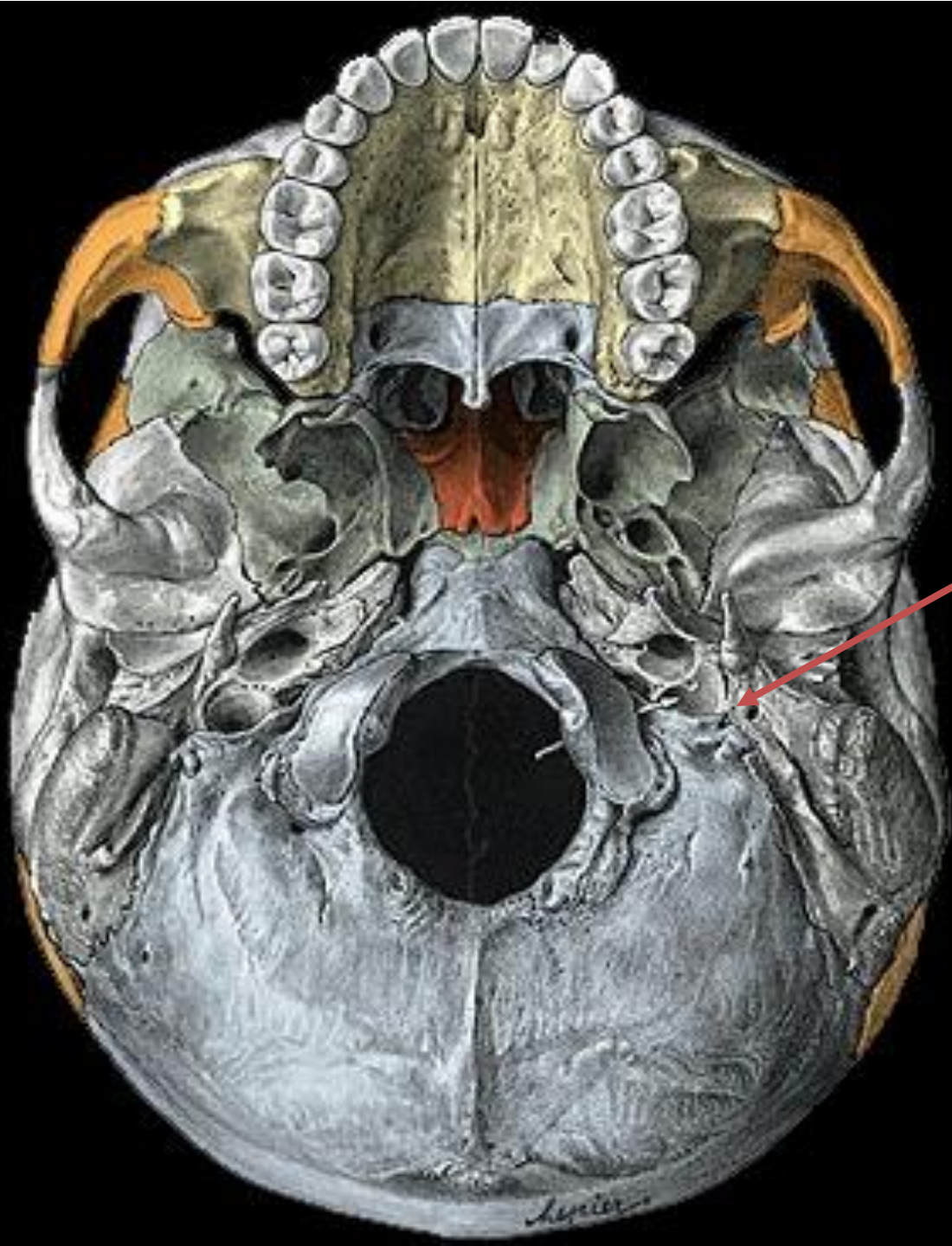
Cranial Nerve VII

Enter skull via
internal auditory
meatus

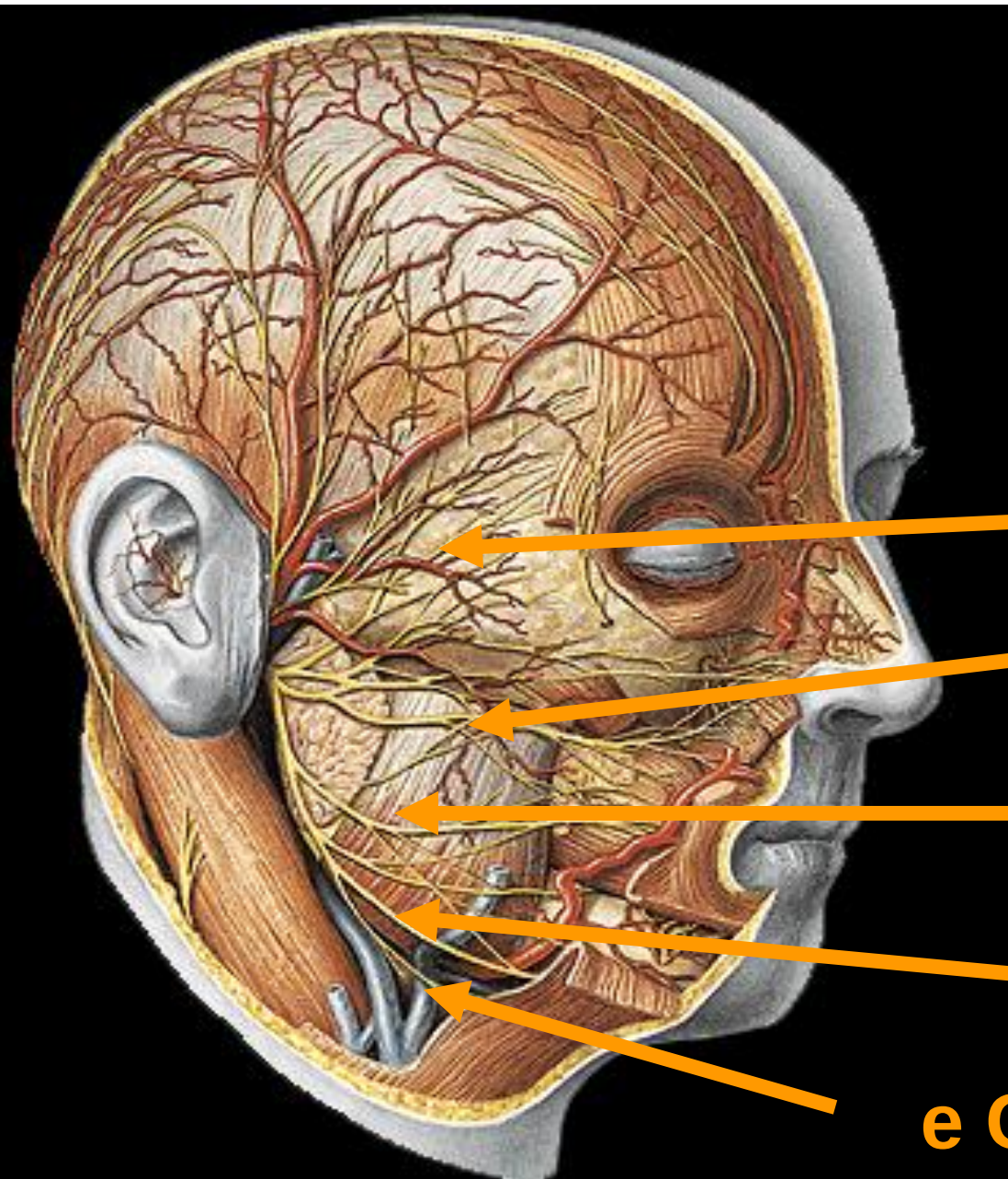


Cranial Nerve VII

Exit skull via
stylomastoid
foramen



Cranial Nerve VII



a Temporal

b Zygomatic

c Buccal

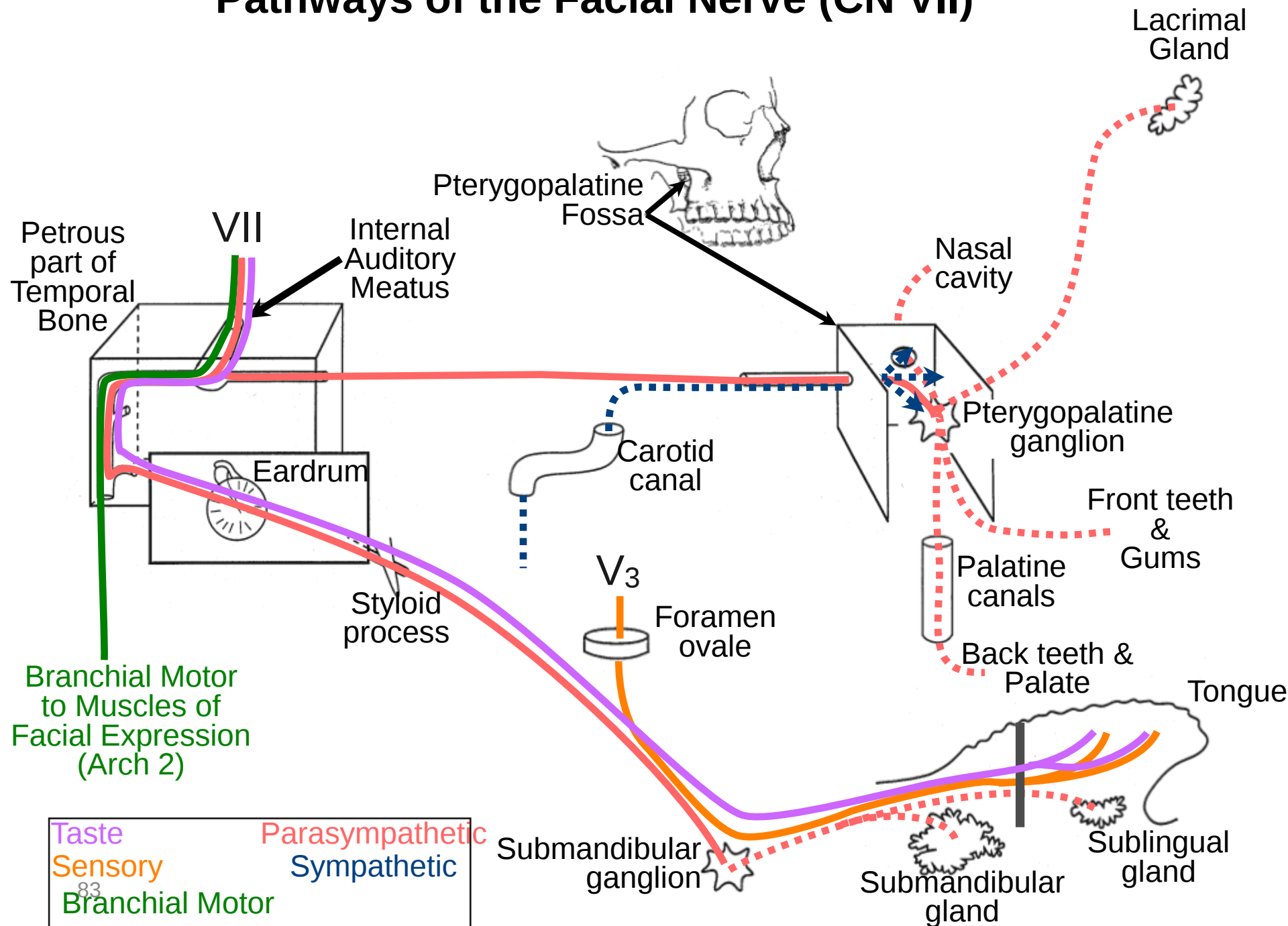
d Mandibular

e Cervical

Detail on Facial (VII) Function:

- Motor to muscles of the hyoid arch: posterior digastric, mm. of facial expression.
- Sends parasympathetic fibers via greater petrosal branch and pterygopalatine ganglion to lacrimal gland (secretomotor fibers).
- It may also supply parasympathetic innervation to palatine, pharyngeal, and nasal glands.

Pathways of the Facial Nerve (CN VII)







VIII

An Evolutionary Branch of VII

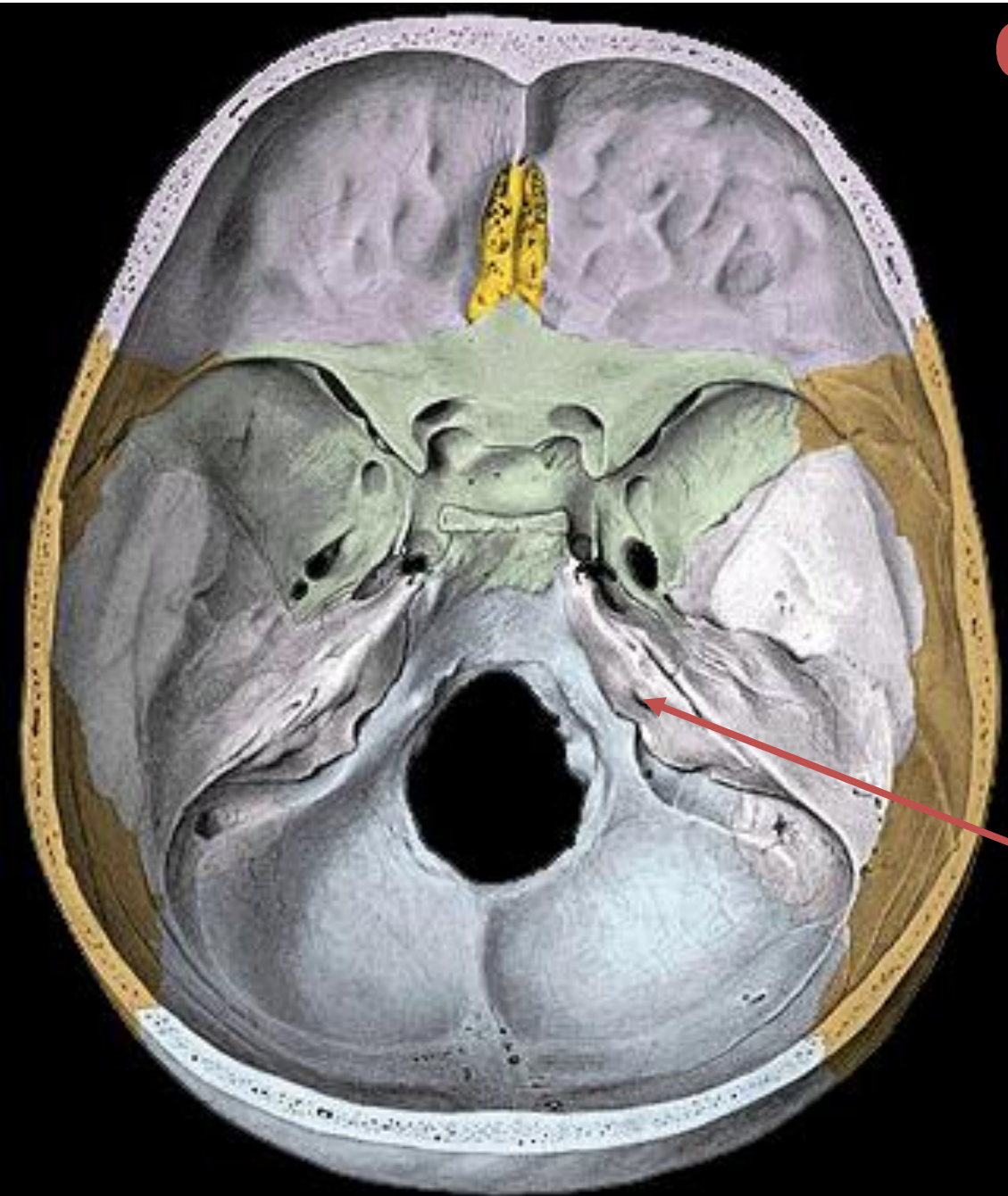
Cranial Nerve VIII

Vestibulocochlear
Nerve

Sensory

Hearing

Internal Auditory
Meatus



IX

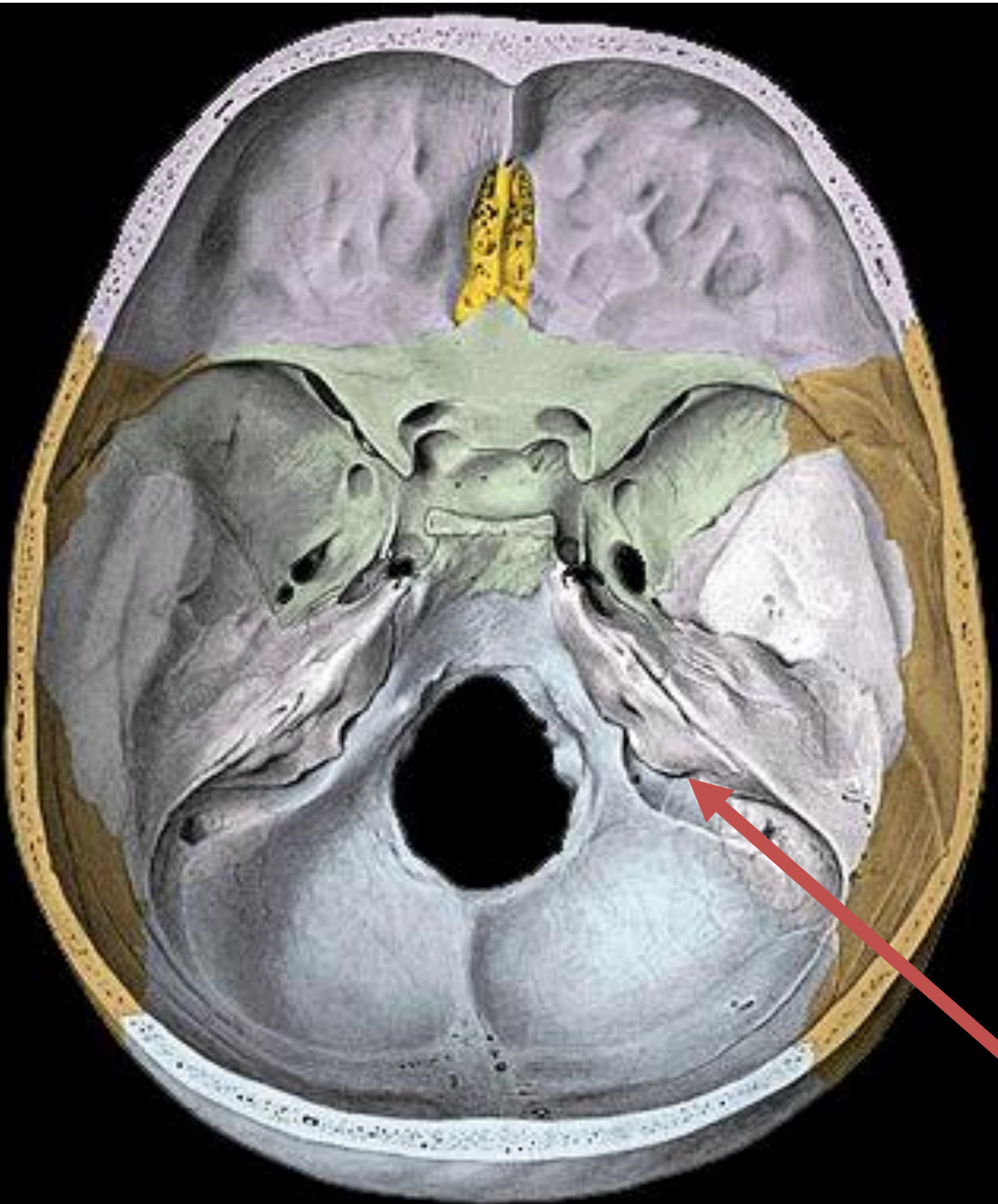
Cranial Nerve IX

The
Glossopharyngeal
Nerve

Both

Pharynx, posterior
tongue

Jugular foramen





Cranial Nerve IX

The
Glossopharyngeal
Nerve

Both

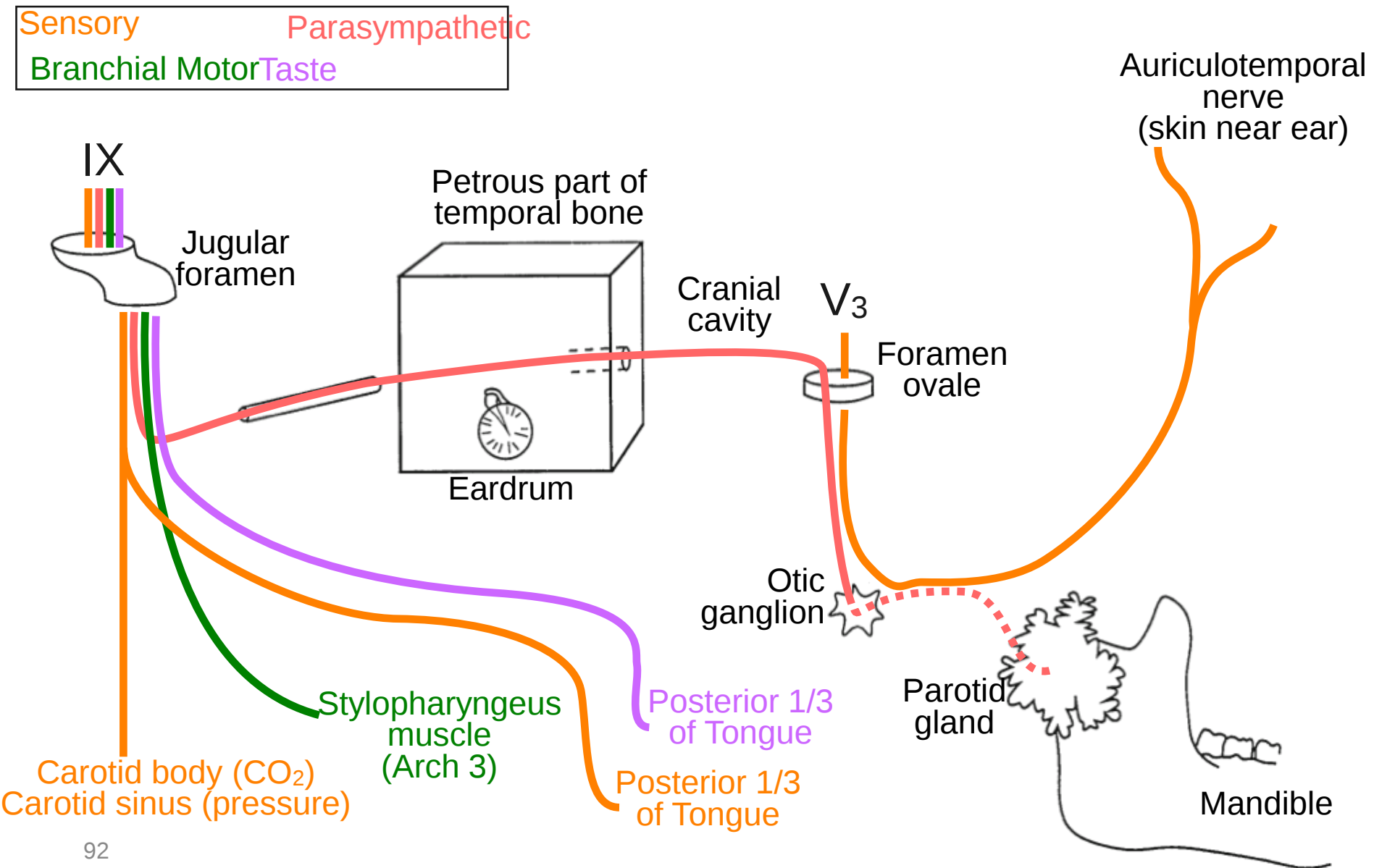
Pharynx, posterior
tongue

Jugular foramen

Detail on Glossopharyngeal (IX) Function:

- Motor to stylopharyngeus muscle.
- Parasympathetic secretomotor fibers to parotid gland.
- Sensory to pharynx, tonsils, and posterior 1/3 of tongue.
- Taste fibers for posterior 1/3 of tongue.

Pathways of the Glossopharyngeal Nerve (CN IX)



X

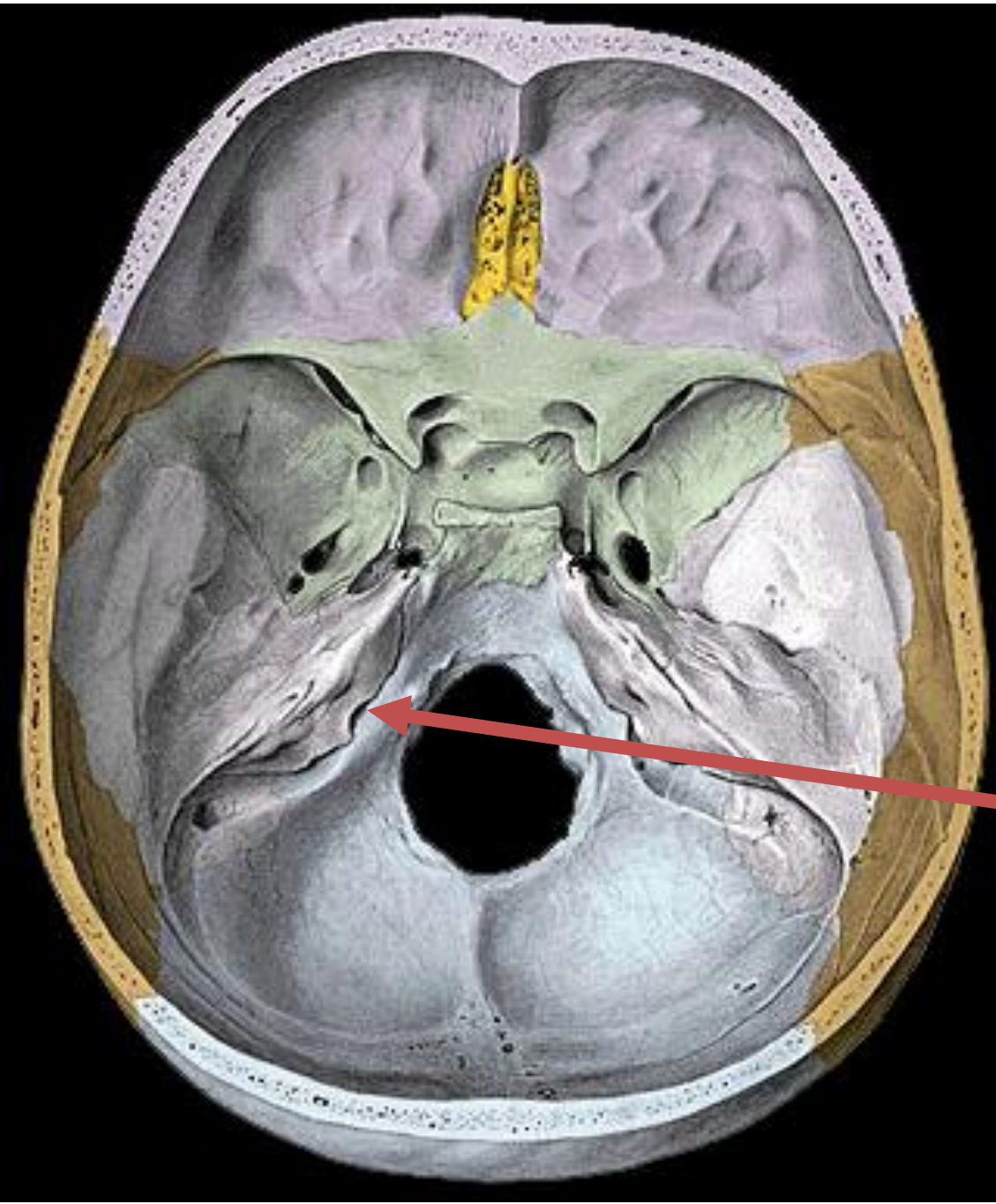
Cranial Nerve X

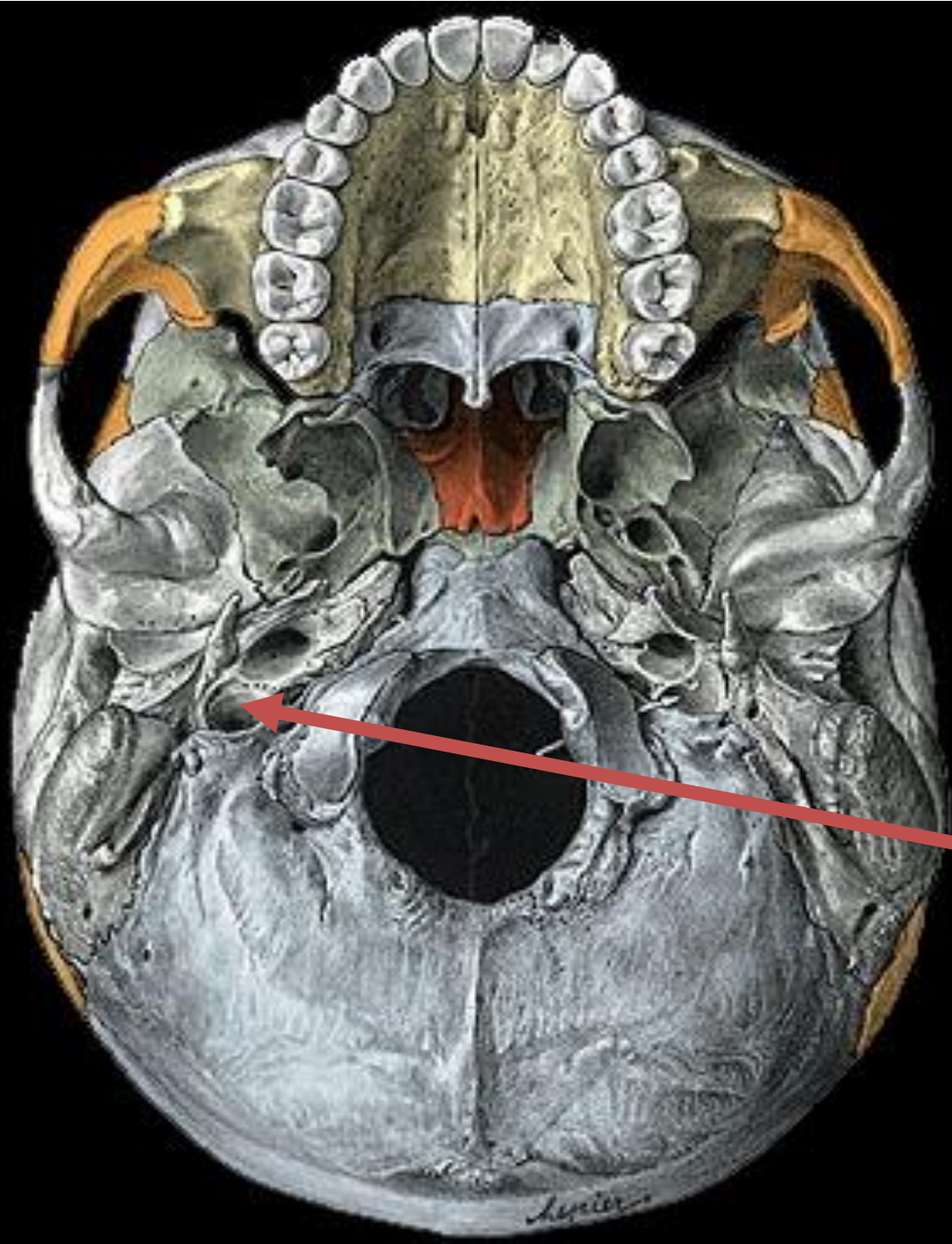
The Vagus Nerve

Both

Throat to end of
midgut

Jugular foramen





Cranial Nerve X

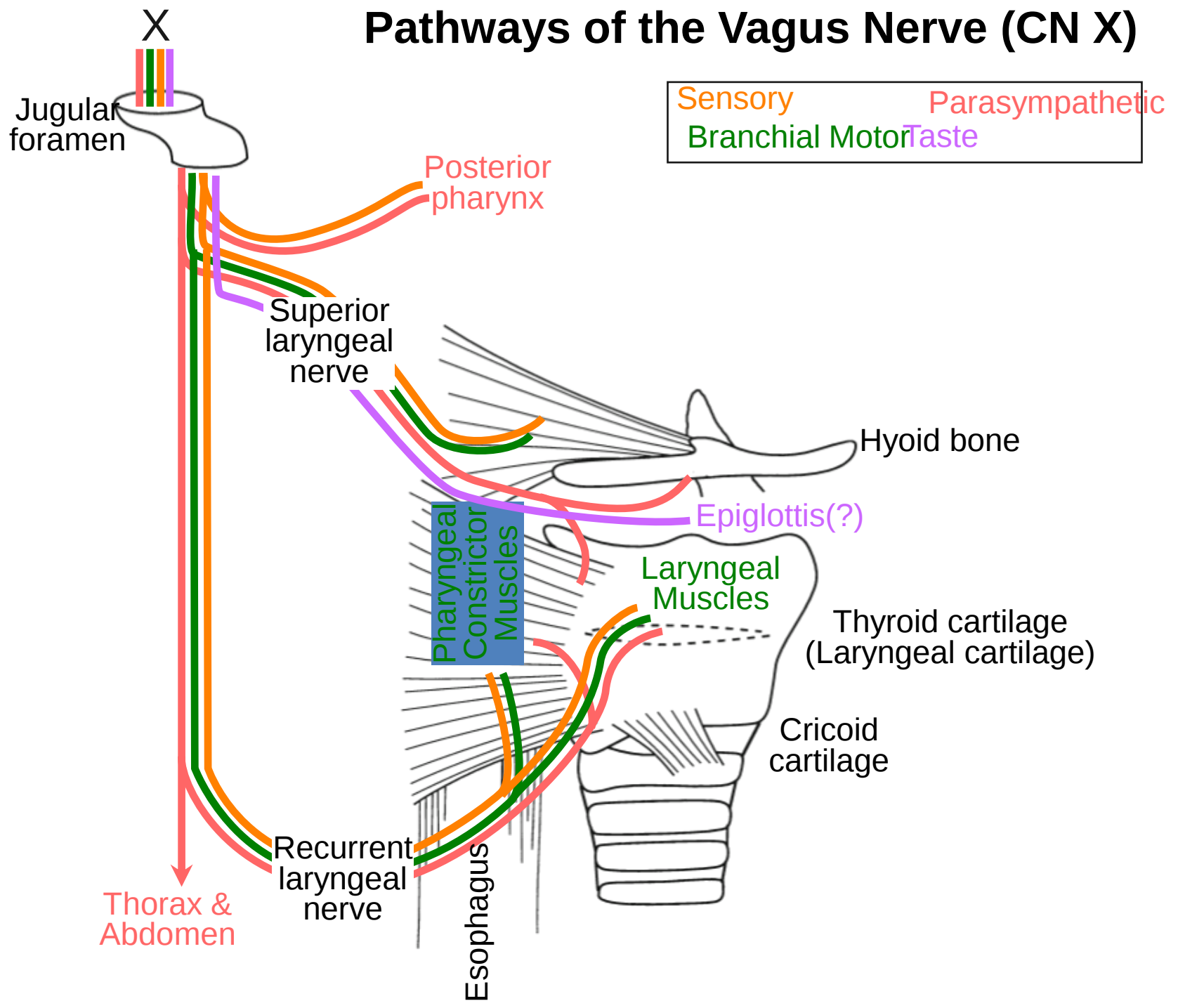
The Vagus Nerve

Both

Throat to end of
midgut

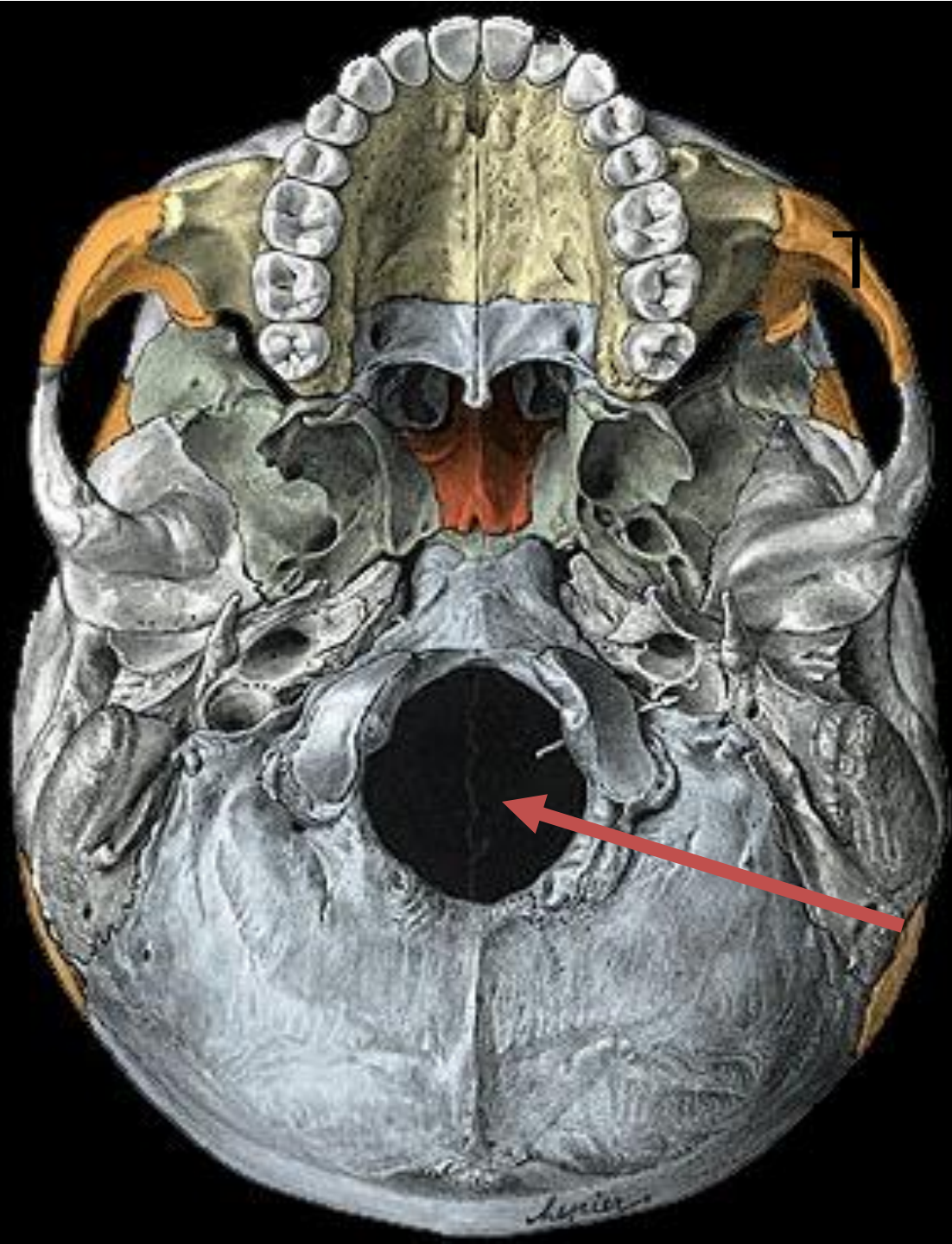
Jugular foramen

Pathways of the Vagus Nerve (CN X)



XI

An Evolutionary Branch of X



Cranial Nerve XI

11th Accessory Nerve

Mainly Motor

larynx, pharynx,
trapezius and
sternocleidomastoid

Foramen Magnum

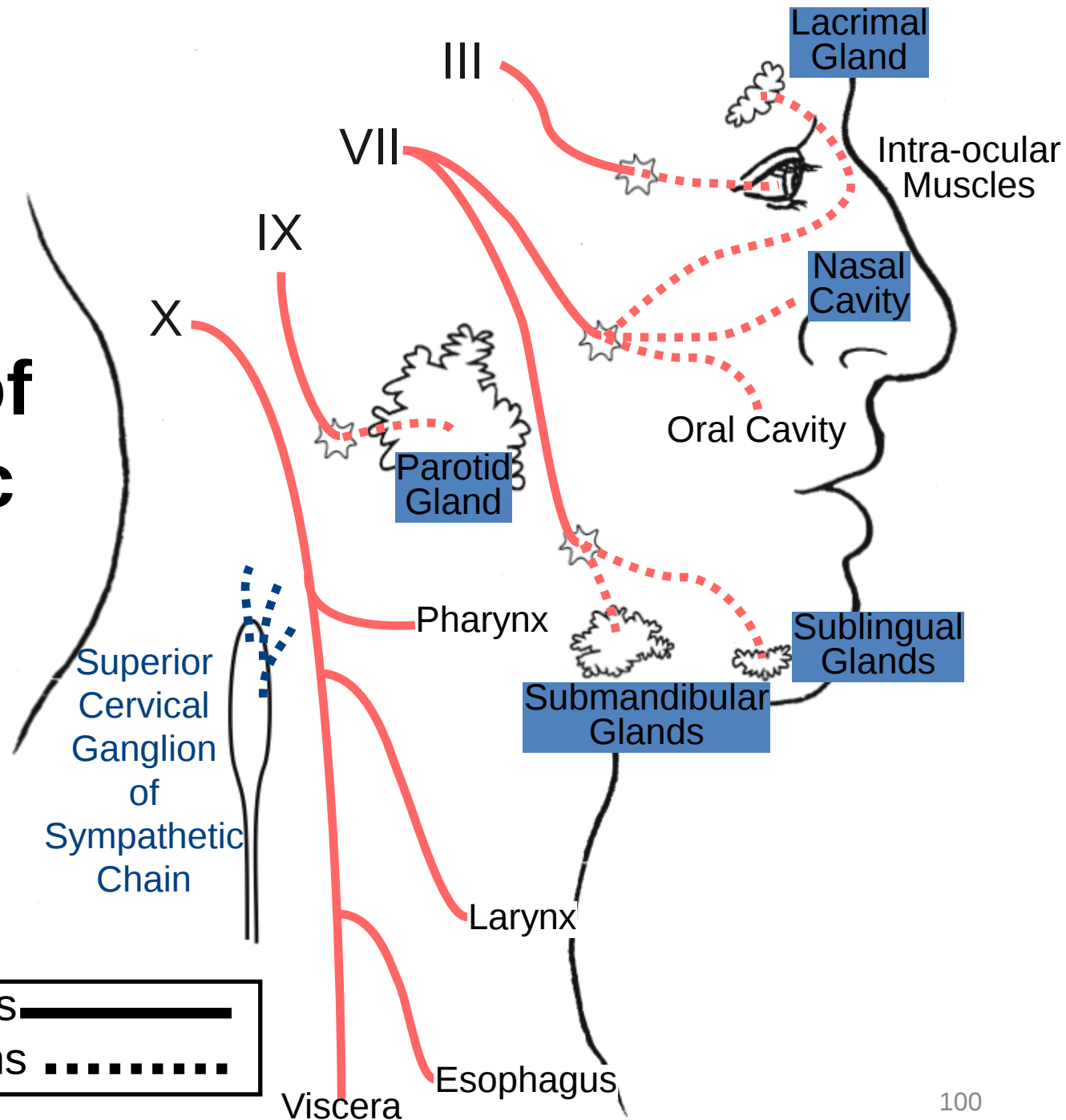
Review of Branchial Arches

- **Mandibular Arch (#1)**
 - Trigeminal nerve (CN V); Muscles of mastication; Chewing
- **Hyoid Arch (#2)**
 - Facial nerve (CN VII); Muscles of facial expression
- **First “Regular Visceral Arch (#3)**
 - Glossopharyngeal nerve (CN IX); Tongue & anterior pharynx; Swallowing
- **Remaining Arches (#s 4 & 6)**
 - Vagus nerve (CN X); Posterior pharynx & larynx; Swallowing & talking

Parasympathetic

Sympathetic

Overview of Autonomic Targets



I OLFACTORY	Cribraform plate ethmoid	Into nasal cavity	SPECIAL SENSORY	NASAL EPITHELIUM	X
II OPTIC	Optic canal of SPHENOID	Into orbit	SPECIAL SENSORY tract of brain	Retina	X
III OCCULOMOTOR	Superior orbital fissure of SPHENOID	Into superior orbit	MOTOR	EYE MUSCLES except below	via SHORT CILARY NN. (synapse in CILIARY GANGLION) [actions opposed by LONG CILIARY NN. (sympathetic)]
IV TROCHLEAR	Superior orbital fissure of SPHENOID	Into superior orbit	MOTOR	SUPERIOR OBLIQUE M.	X
VII ABDUCENS	Superior orbital fissure of SPHENOID	Into superior orbit	MOTOR	LATERAL RECTUS M.	X
XII HYPOGLOSSAL	Hypoglossal canal	Into tongue	MOTOR	INTRINSIC TONGUE MM.	X

	Exits braincase	Path through skull	Sensory or Motor	Targets	Autonomics
TRIGEMINAL V1 Opthalmic (“DRG”= semilunar ganglion)	Superior orbital fissure of SPHENOID	Into superior orbit	SENSORY	Supraorbital, supratrochlear nn. to forehead Lacrimal nerve to lateral eyelids and conjunctiva Nasociliary nerve -sensory branches through ciliary ganglion to eyeball -posterior ethmoidal nerve& anterior ethmoidal nerve (and external nasal nerve for nose tip) -Infratrochlear nerve to medial conjunctiva and medial eyelids	(Short ciliary carries III parasympathetics) (Long ciliary nerves – sensory to eyeball + sympathetic from carotid plexus to dilate pupil of eye, if not in short ciliarys) (Lacrimal n carries terminal hitchhiking VII parasympathetics to lacrimal gland)
V2 maxillary (“DRG”= semilunar ganglion)	Foramen rotundum of SPHENOID	Into pterygopalatine fossa; distributes to nasal epithelium and into infraorbital groove, canal and out onto face via foramen	SENSORY	Infraorbital n. – face above mouth Nasopalatine n. - mucosa Greater/lesser palatine nn.— roof of mouth Zygomaticotemporal n. skin of temple and overlying cheekbone; carries VII parasympathetics Superior alveolar nn. – upper teeth of temple and overlying cheekbone; carries VII parasympathetics Superior alveolar nn. – upper	(V II to lacrimal gland via zygomaticotemporal n. ; to nasal mucosa via nasopalatine n.)
V3 Mandibular (“DRG”= semilunar ganglion)	Foramen ovale of SPHENOID	into infratemporal fossa	BOTH	<u>Sensory:</u> -Inferior alveolar n. LOWER JAW + teeth, -Buccal n. MOUTH INTERIOR -Lingual n. touch ant. 2/3 tongue <u>Motor:</u> -mm. of mastication & tensor veli palatine m. -n. to mylohyoid: ant belly of digastrics and mylohyoid m.	(VII parasympathetics from chorda tympani travel via LingualCranial nerve n.)

Cranial nerve	Exits braincase	Path through skull	Sensory or Motor	Targets	Autonomics
VII + VIII FACIAL VESTIBULO- COCCHLEAR	Internal acoustic meatus of PETROUS TEMPORAL	Through FACIAL CANAL Exits: 1. Stylomastoid foramen to face mm. 2. Greater petrosal groove (GPN) on ant. petrous temporal in middle cranial fossa, traversing lateral foramen lacerum 3. Petrotympenic fissure (chorda tympani)	VII BOTH VIII SENSORY	Sensory: (“DRG”= geniculate ganglion for VII) to interior of ear canal & taste to ant. 2/3 tongue ■ VIII for hearing cochlea and balance semicircular canals [“DRG” =vestibular & cochlear (spiral) ganglia] Motor to: -mm. of facial expression, including buccinator -stapedius m. -post belly of digastrics m.	Parasympathetics from <i>nervus intermedius</i> to 1.Submandibular/sublingual glands via chorda tympani (syn. in SUBMANDIBULAR GANGLION) 2. Lacrimal gland (greater petrosal n to nerve of pterygoid canal to (syn. in PTERGOPALATINE GANGLION) to infraorbital n(V2) to zygomaticofacial n (V2) to lacrimal n. (v1) ** note deep petrosal sympathetics merge w/greater petrosal @ pterygoid canal
IX GLOSSOPHARY- NGEAL	BETWEEN PETROUS TEMPORAL AND BASIOCCIPTIAL Neural portion of jugular foramen + tympanic canaliculus (for lesser petrosal n.)	Into pharynx (into infratemporal fossa for lesser pet. n.)	BOTH	Sensory to: (“DRG”= sup/inf. Glossopharyngeal ganglia) -carotid body (O2) -taste/touch post 1/3 tongue -ext. ear & inner tympanic mem. + middle ear mucosa, aud. tube - pharynx Motor to: -stylopharyngeus	Lesser petrosal nerve Tympanic canaliculus to tympanic plexus on middle ear promontory to groove lateral to greater petrosal groove. Out through foramen ovale; synapse in Otic ganglion). Travel with V3 auriculotemporal n. to Parotid gland .
X VAGUS	BETWEEN PETROUS TEMPORAL AND BASIOCCIPTIAL Neural portion of jugular foramen		BOTH	Sensory to: (“DRG”= sup/inf. vagal ganglia) -ex. Ear canal, ext. tympanic mem. (can cause vomiting) -larynx, pharynx, viscera trachea, stretch receptors in aortic arch walls, chemoreceptors in aortic bodies -taste post. medial tongue Motor to: mm. of pharynx and larynx -palatoglossus m.	Viscera up to left colic flexure; glands of pharynx and larynx
XI ACCESSORY	Jug. For.		MOTOR	trapezius and	X

I	Olfactory			
II	Optic			
III	Oculomotor			
IV	Trochlear			
V	Trigeminal			
VI	Abducens			
VII	Facial			
VIII	Vestibulochochlar			
IX	Glossopharyngeal			
X	Vagus			
XI	Accessory			
XII	Hypoglossal			

**Motor, sensory, or
both**

I	O	Sensory		
II	O	Sensory		
III	O	Mainly motor		
IV	T	Mainly motor		
V	T	Both		
VI	A	Mainly motor		
VII	F	Both		
VIII	A	Sensory		
IX	G	Both		
X	V	Both		
XI	A	Mainly motor		
XII	H	Mainly motor		

Meninges (All from Neural Crest)

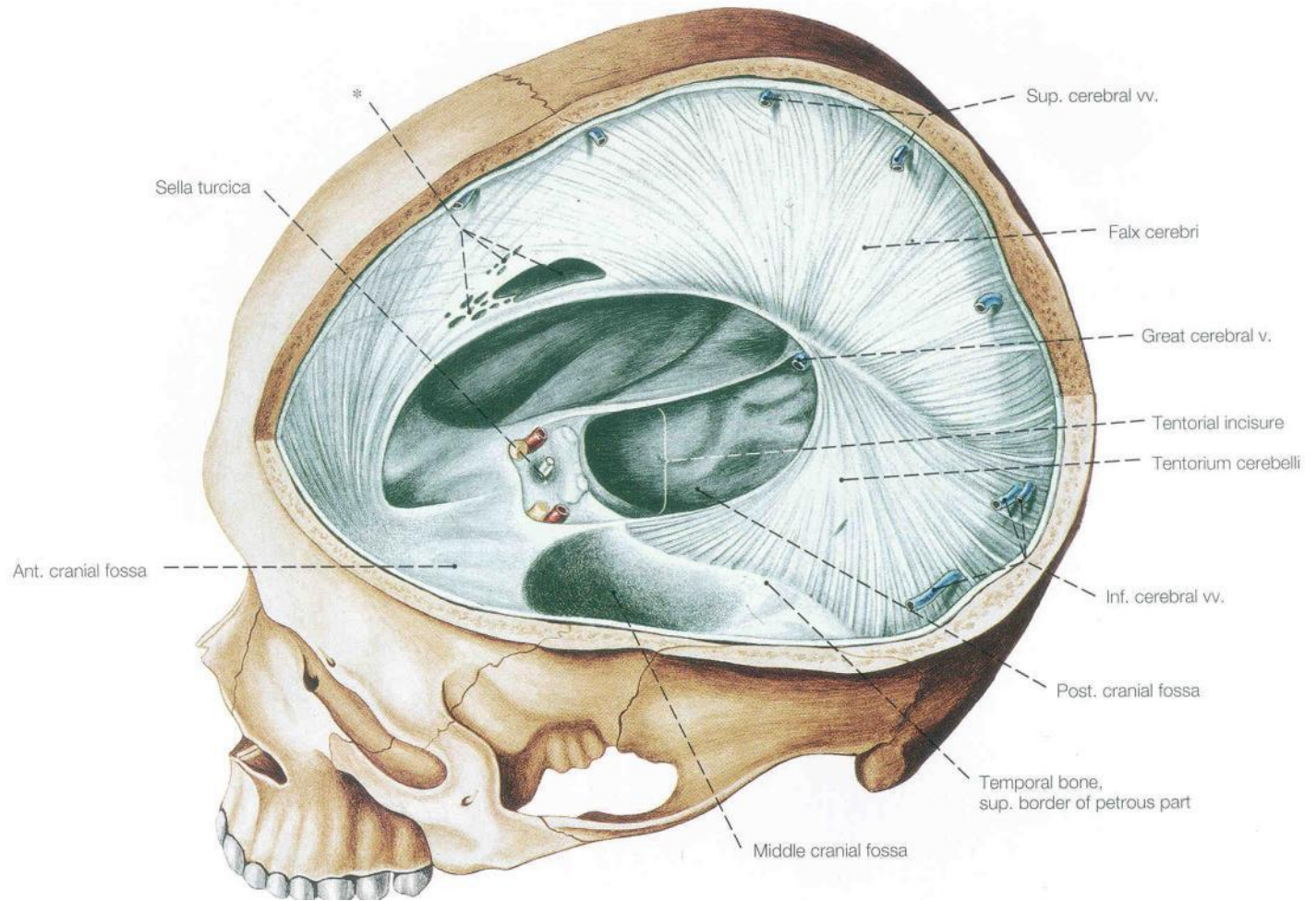
Outermost: *Dura mater*

Middle: *Arachnoid mater*

Deepest: *Pia mater*

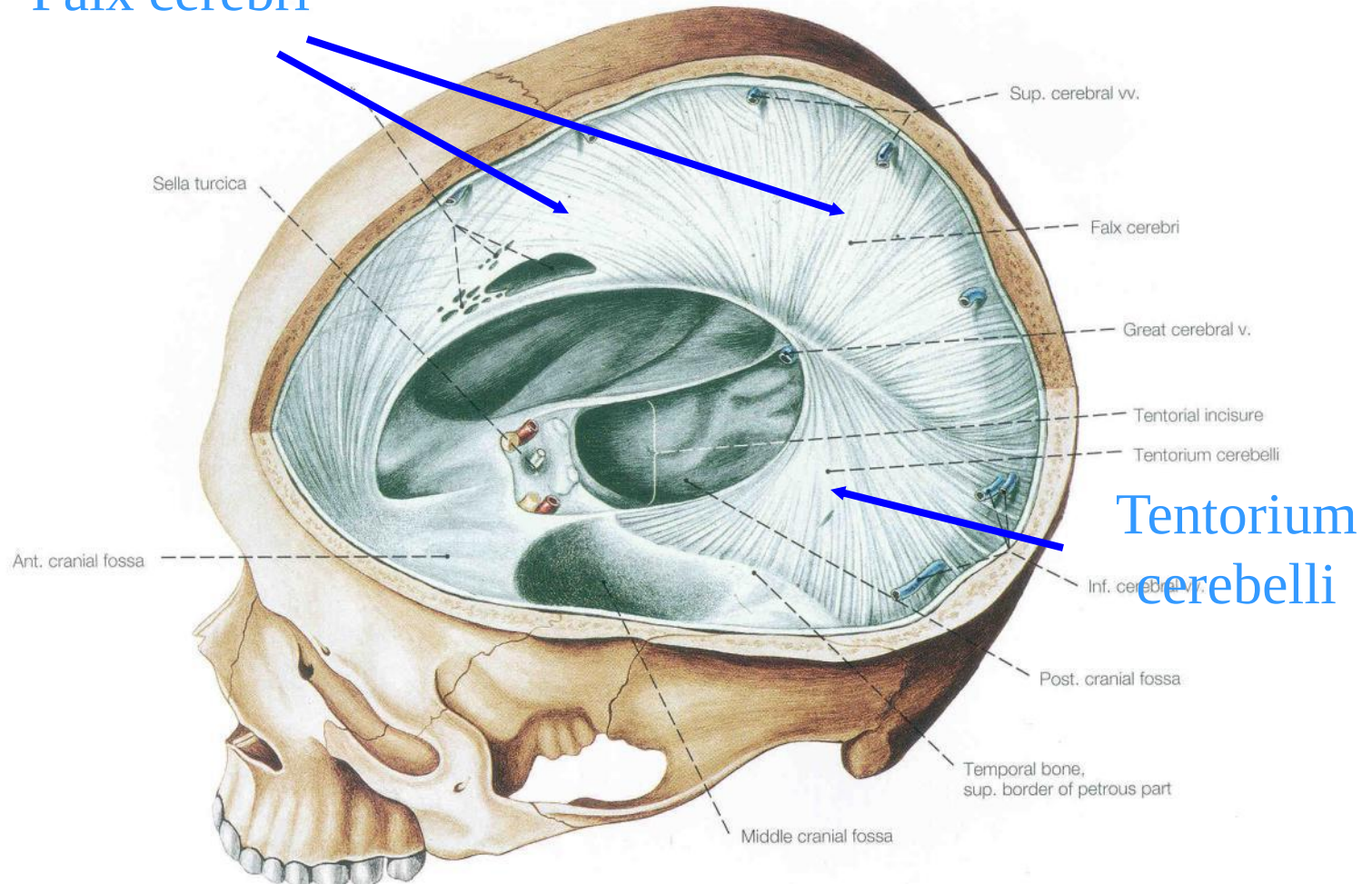
Cerebrospinal fluid between
Arachnoid and Pia mater

Meninges: *Dura mater*

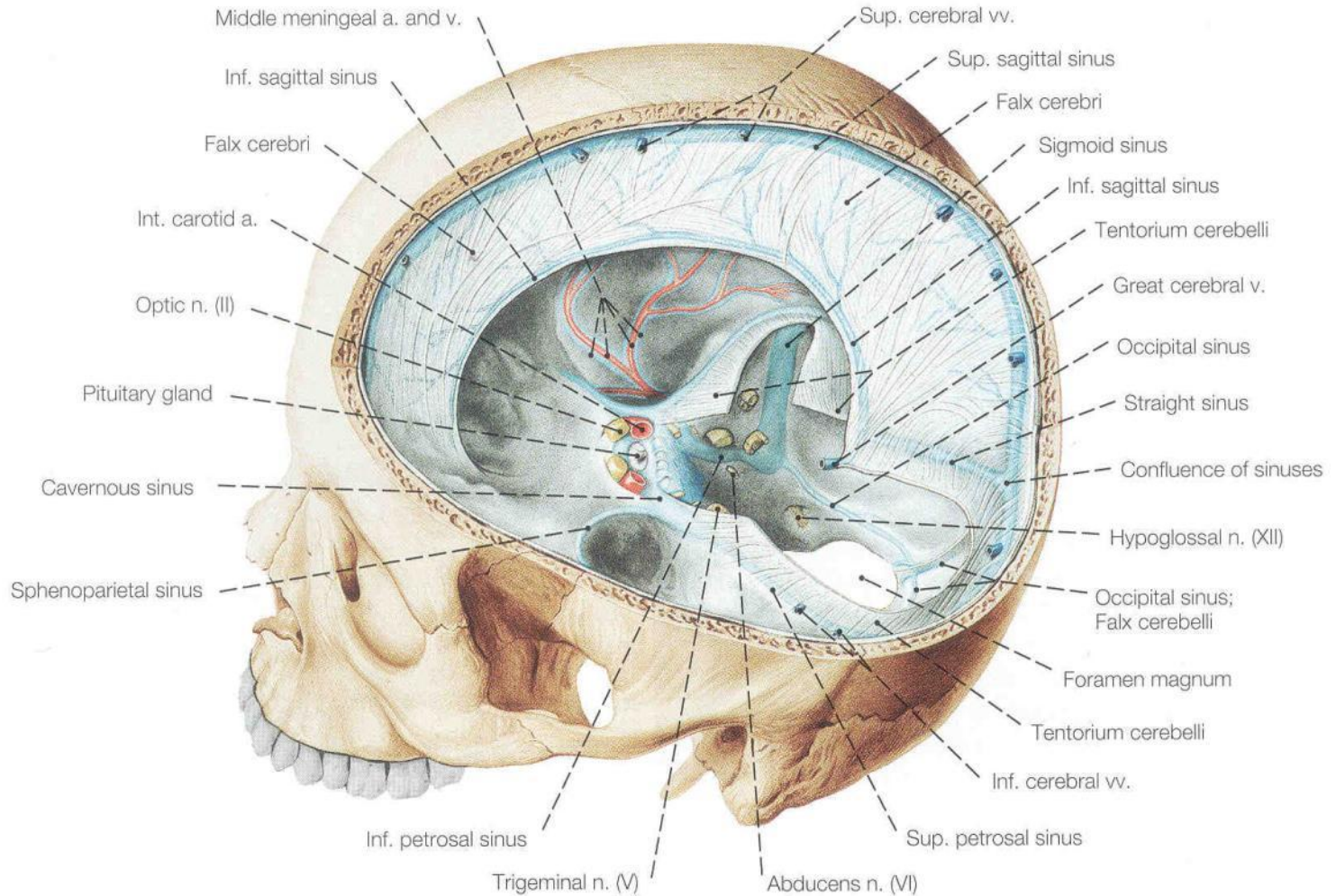


Dural Reflections

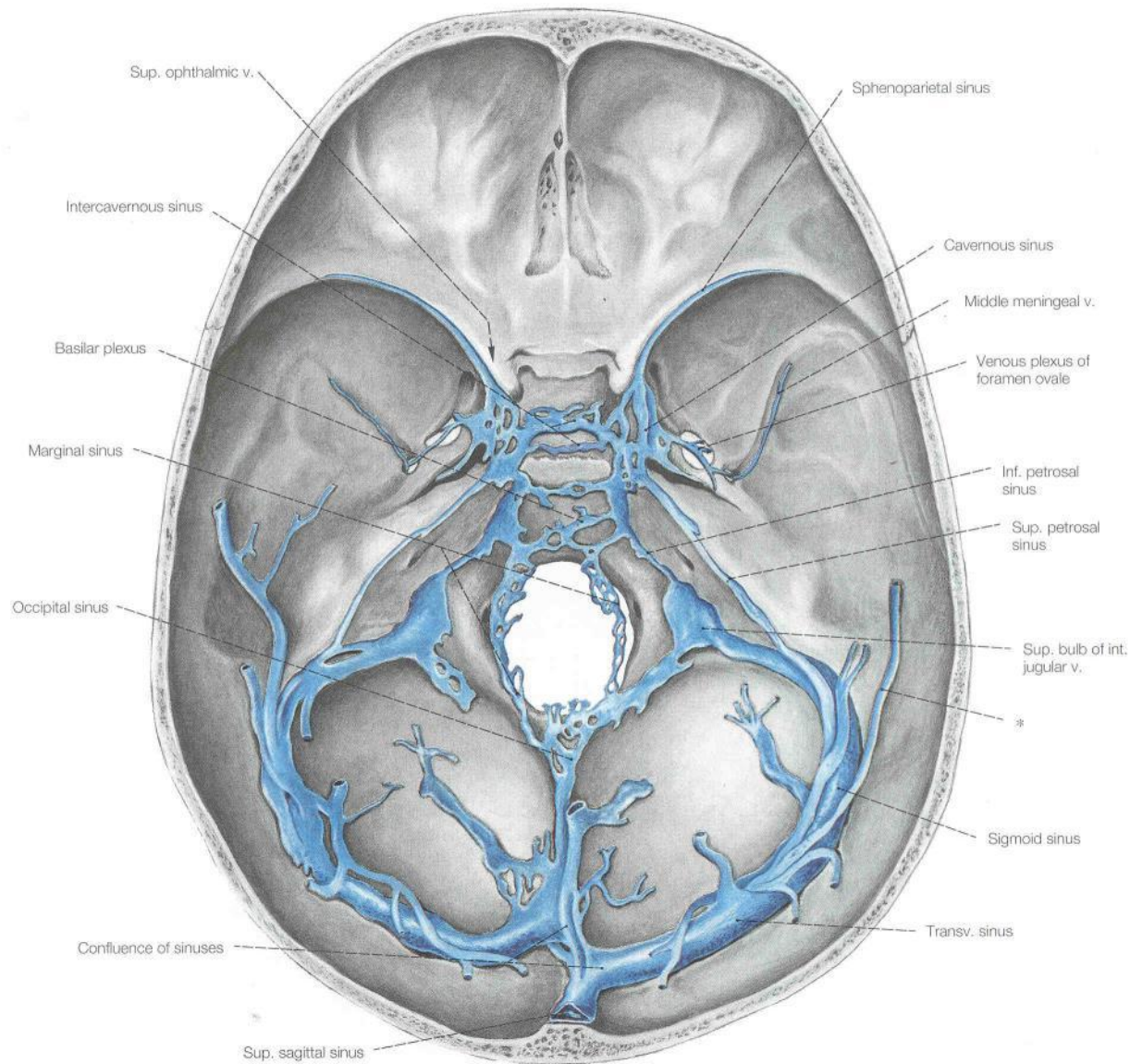
Falx cerebri



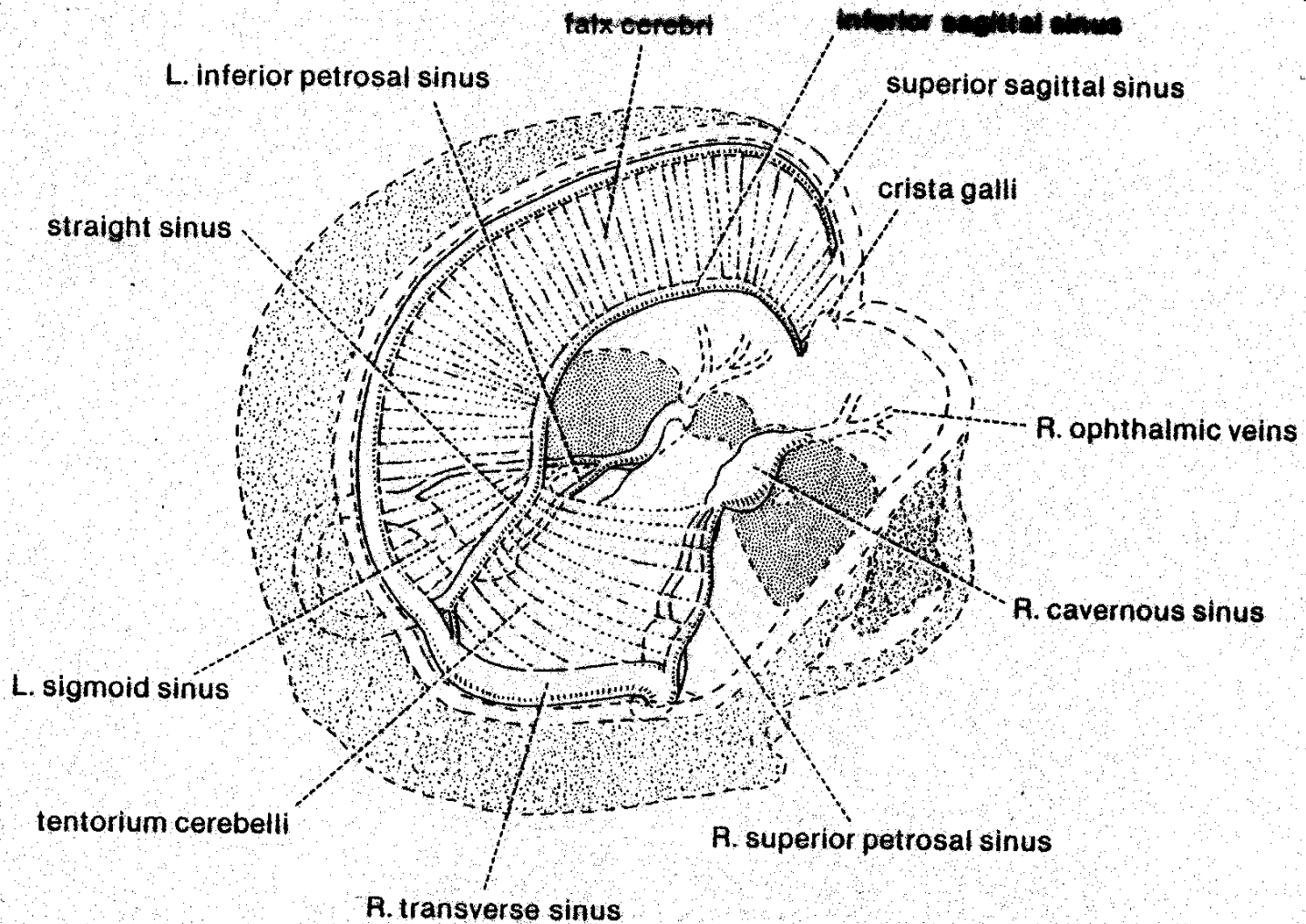
Vasculature: Venus Sinuses



Vasculature: Venus Sinuses



Vasculature: Venus Sinuses



VENOUS DRAINAGE OF THE SKULL:

**SUPERIOR SAGITTAL SINUS to RIGHT/LEFT
TRANSVERSE SINUS**

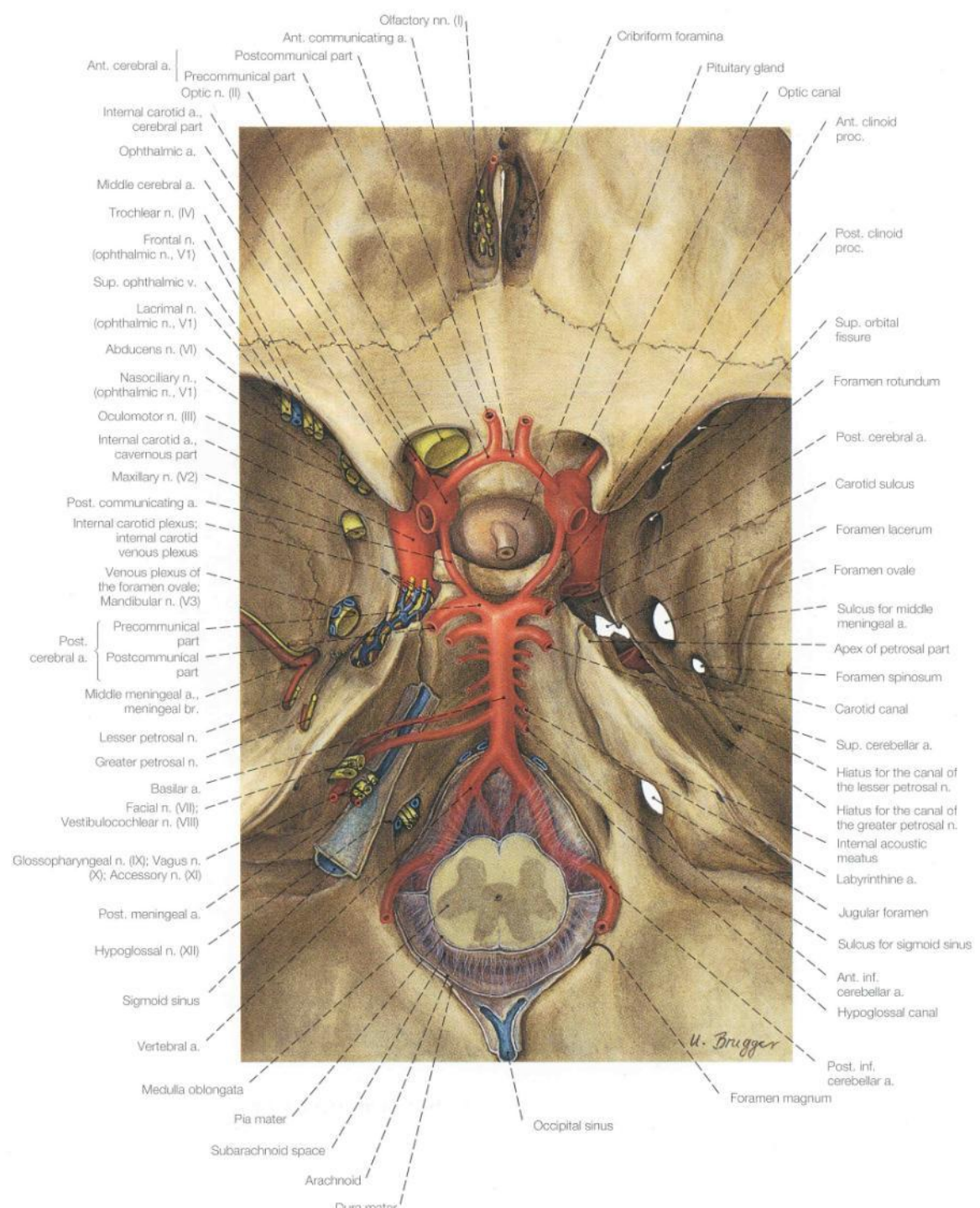
INFERIOR SAGITTAL SINUS TO STRAIGHT SINUS

**R/L TRANSVERSE SINUSES TO R/L SIGMOID
SINUSES**

**R/L SIGMOID SINUSES TO SUPERIOR BULB OF R/L
JUGULAR VEIN**

**ALSO TO JUGULAR: R/L MARGINAL SINUSES, R/L
CAVERNOUS SINUSES, OCCIPITAL SINUS, R/L**

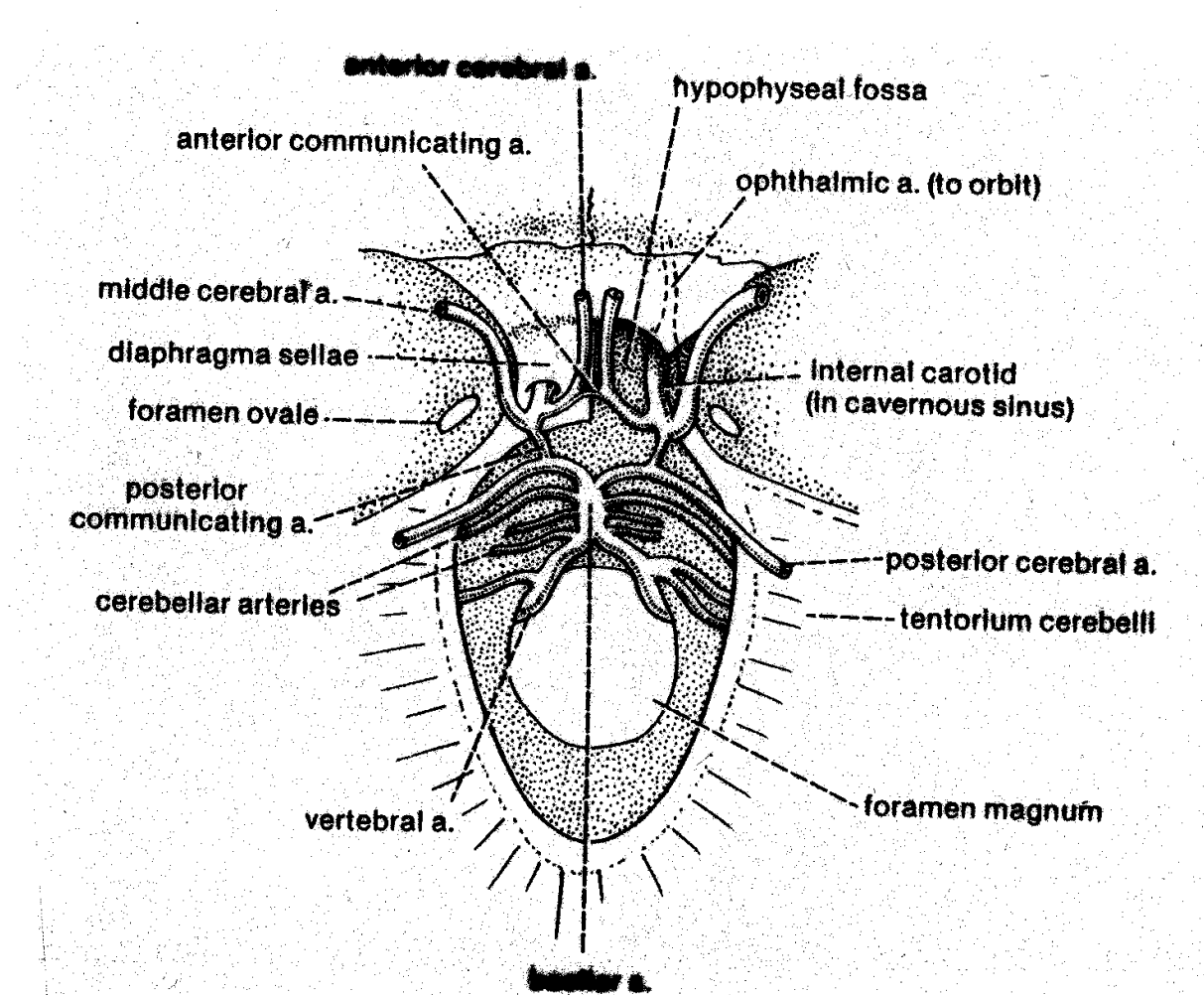
Vasculature: Arterial Supply



ARTERIES LEADING TO CIRCULOSUS ARTERIOSUS CEREBRI

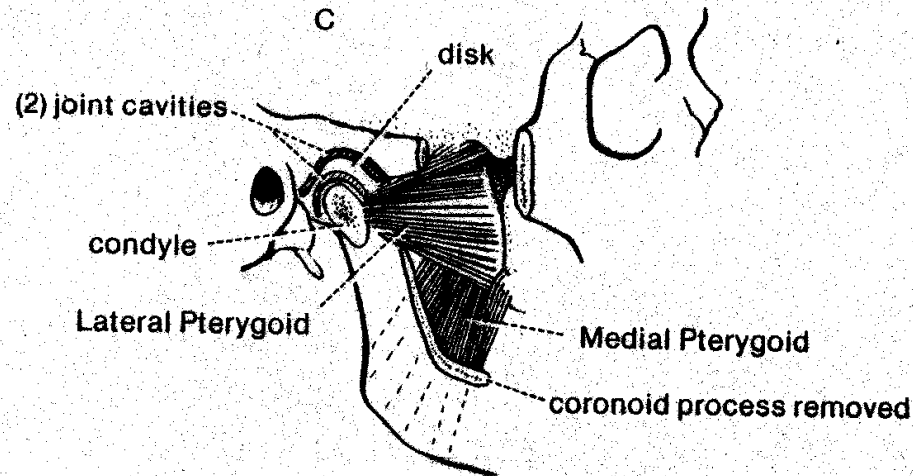
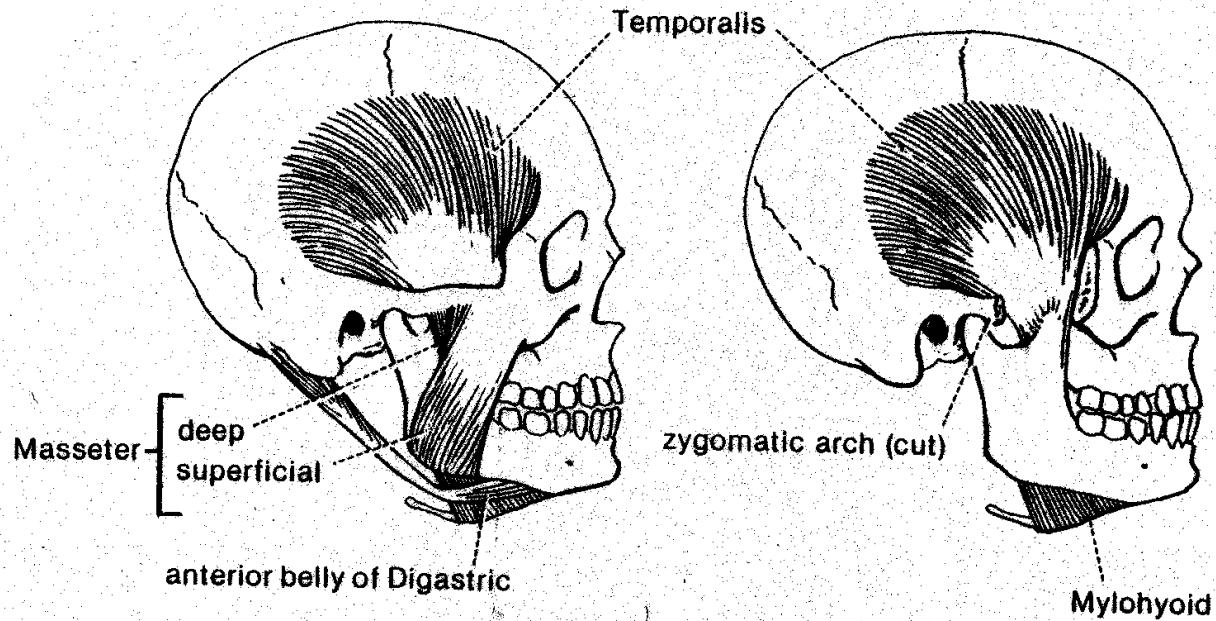
- Right Carotid Artery
 - Left Carotid Artery
- Basilar Artery (formed from right and left Vertebral Arteries)
- Also, know branches off of it!

Vasculature: Arterial Supply



Other Muscle
and Nerve
Stuff...

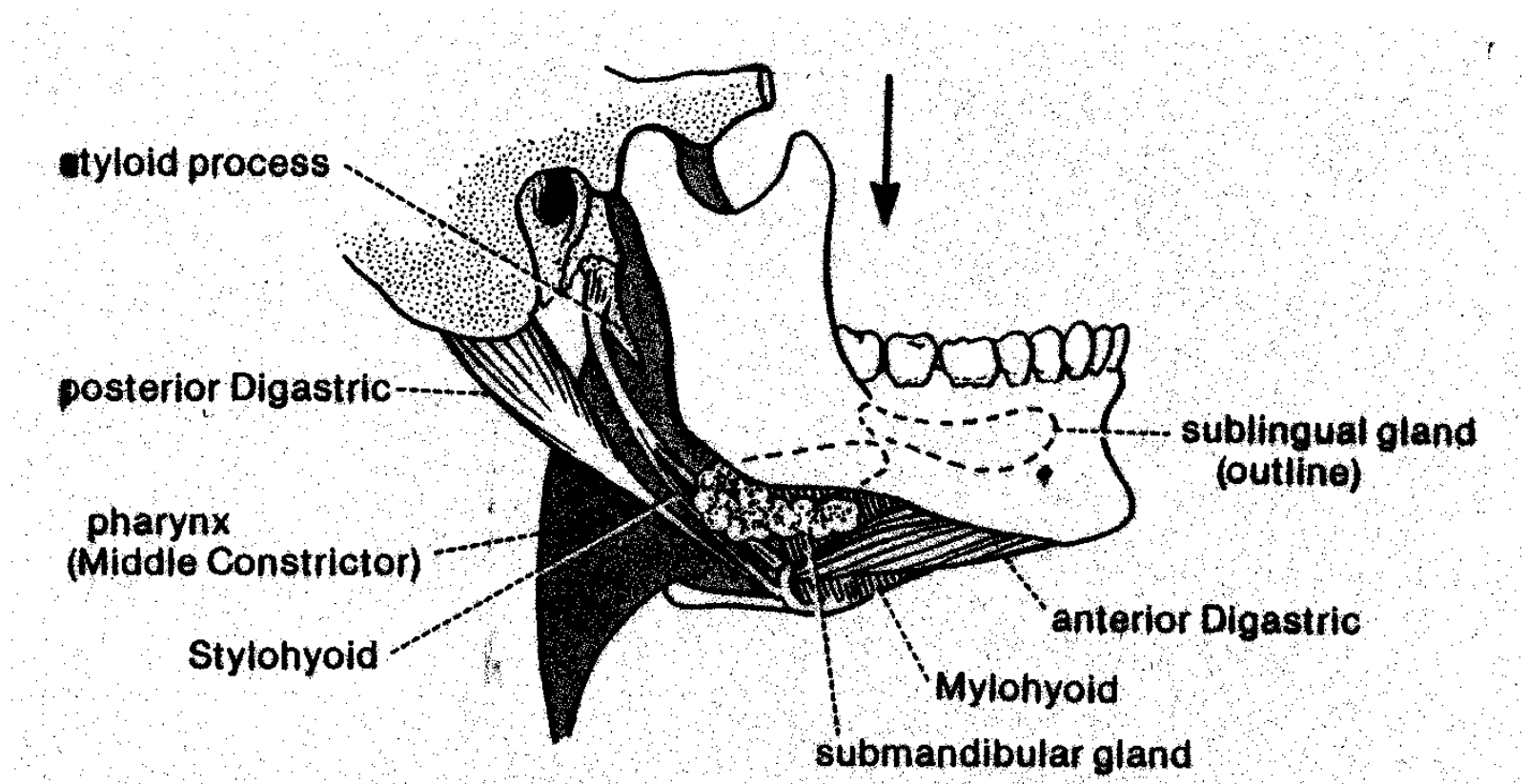
Jaw Moving Musculature:



Jaw Opening Musculature: Digastric Muscle

Anterior belly – innervated by Mandibular (V3) nerve

Posterior belly – innervated by Facial (VII) nerve



Major Muscles of the Mandibular Arch (innervated by V3):

- **Temporalis**
 - **Masseter**
- **Medial Head of Pterygoid**
- **Lateral Head of Pterygoid**
 - **Mylohyoid**
- **Anterior Belly of Digastric**
 - **Tensor Tympani**

“True” Muscles of mastication

All V3 innervation

1. Temporalis m.

2. Masseter m.

3. Medial pterygoid

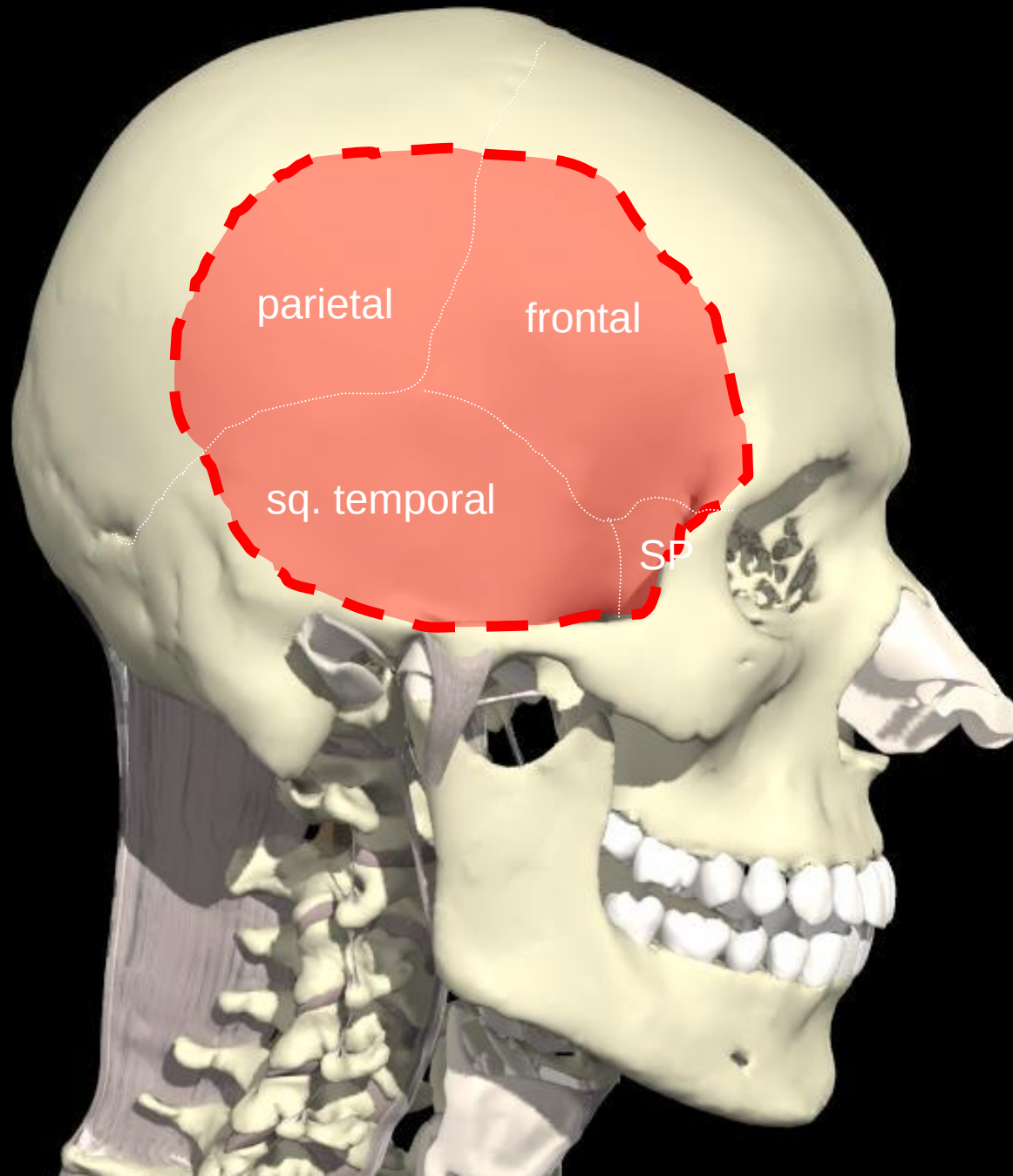
4. Lateral pterygoid
upper head: to articular disc
lower head: to neck of mandibular condyle

“Accessory” Muscles of mastication

Vital for normal chewing, but not mandibular adductors/protractors

- **Buccinator VII**
- **Digastric V3 & VII**
- **Tongue XII**

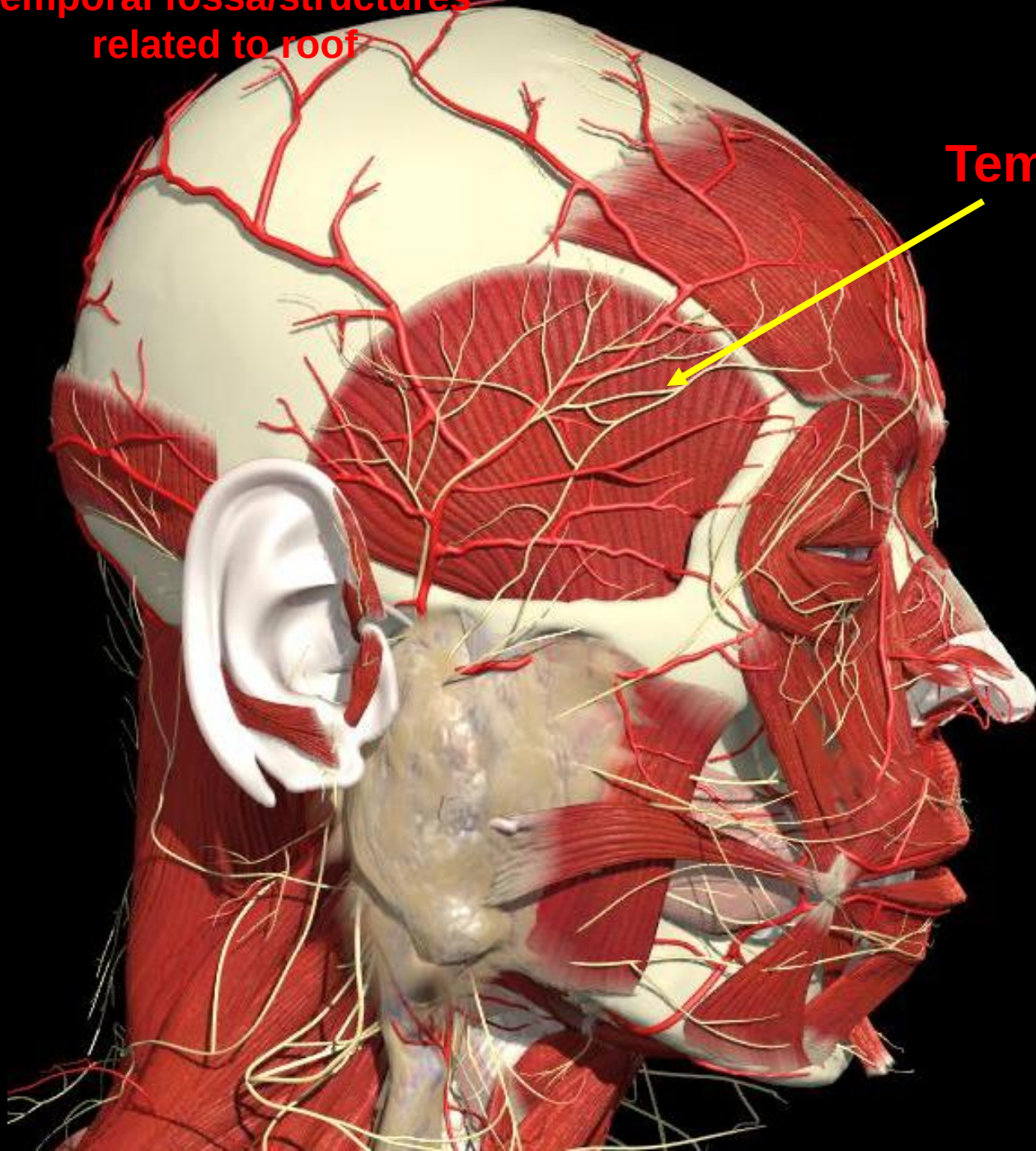
Temporal fossa/floor



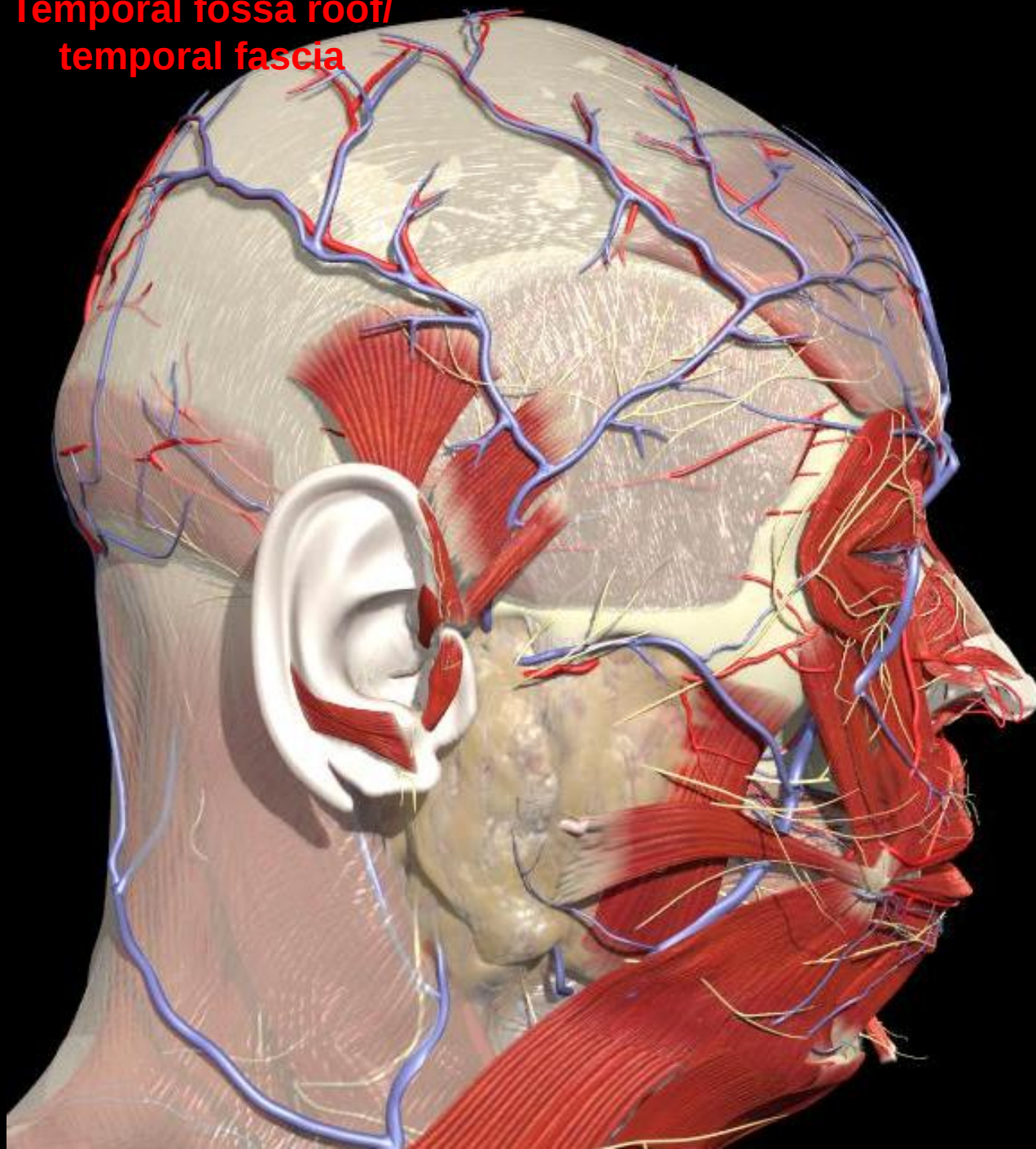
Floor:

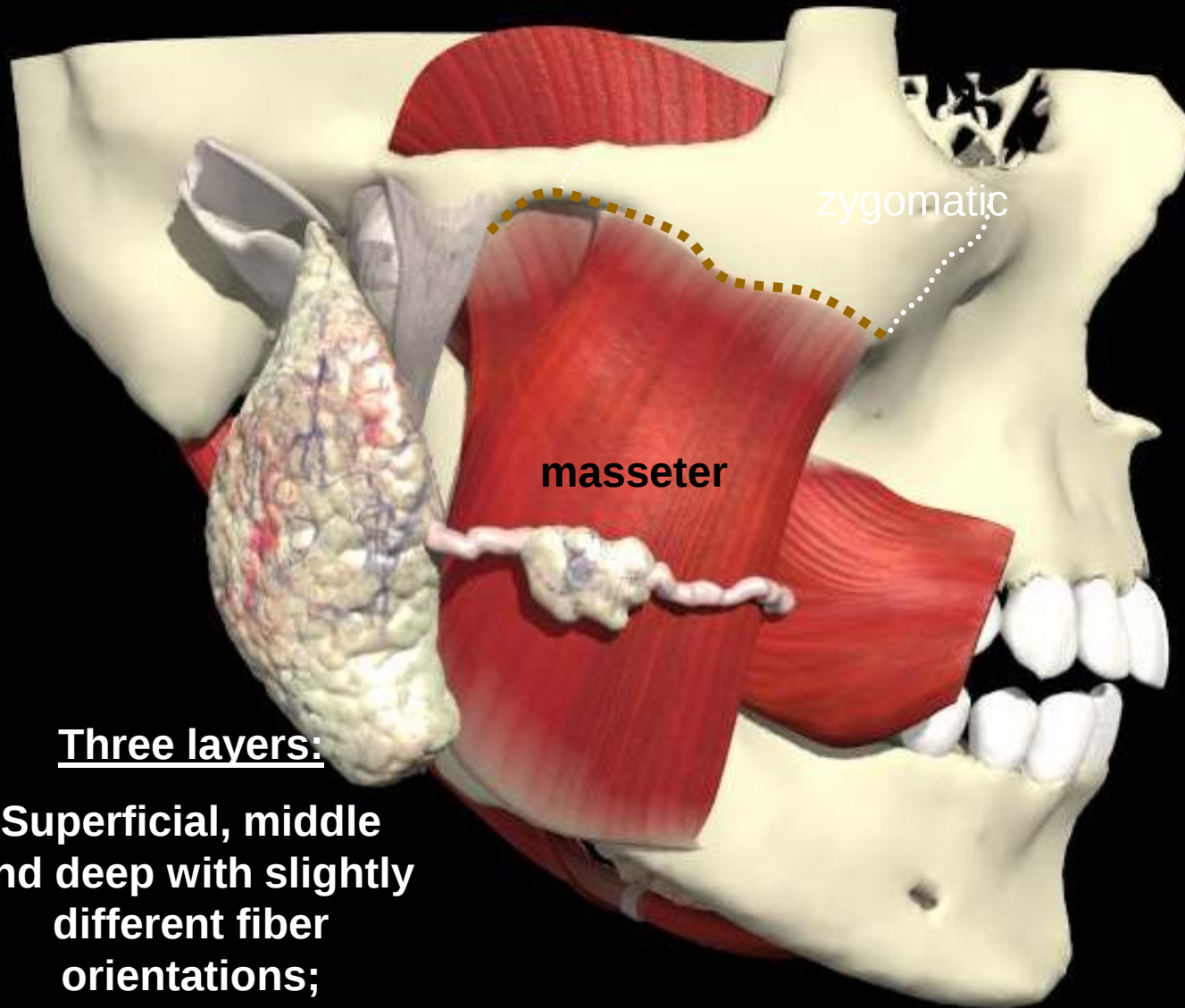
**Temporal fossa/structures
related to roof**

Temporalis m.



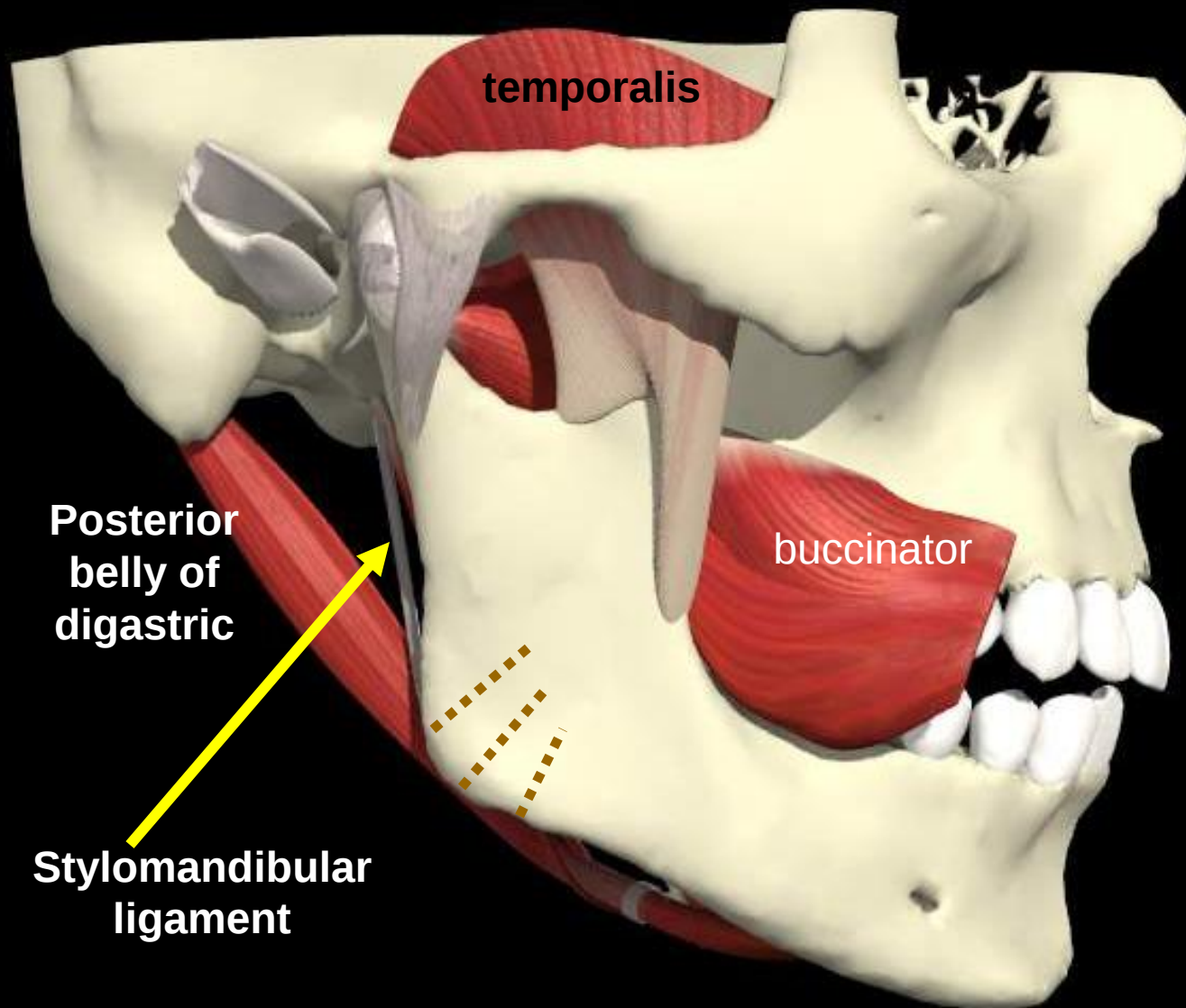
**Temporal fossa roof/
temporal fascia**

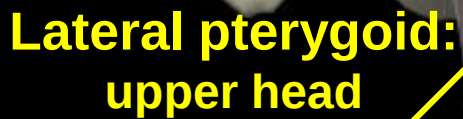




Three layers:

Superficial, middle
and deep with slightly
different fiber
orientations;
important in
recruitment for
chewing





Lateral pterygoid:
upper head

lower head

Line of action of lateral pterygoids is from anterior to posterior in horizontal plane. They PROTRACT or pull the mandible forward.

INFRATEMPORAL FOSSA

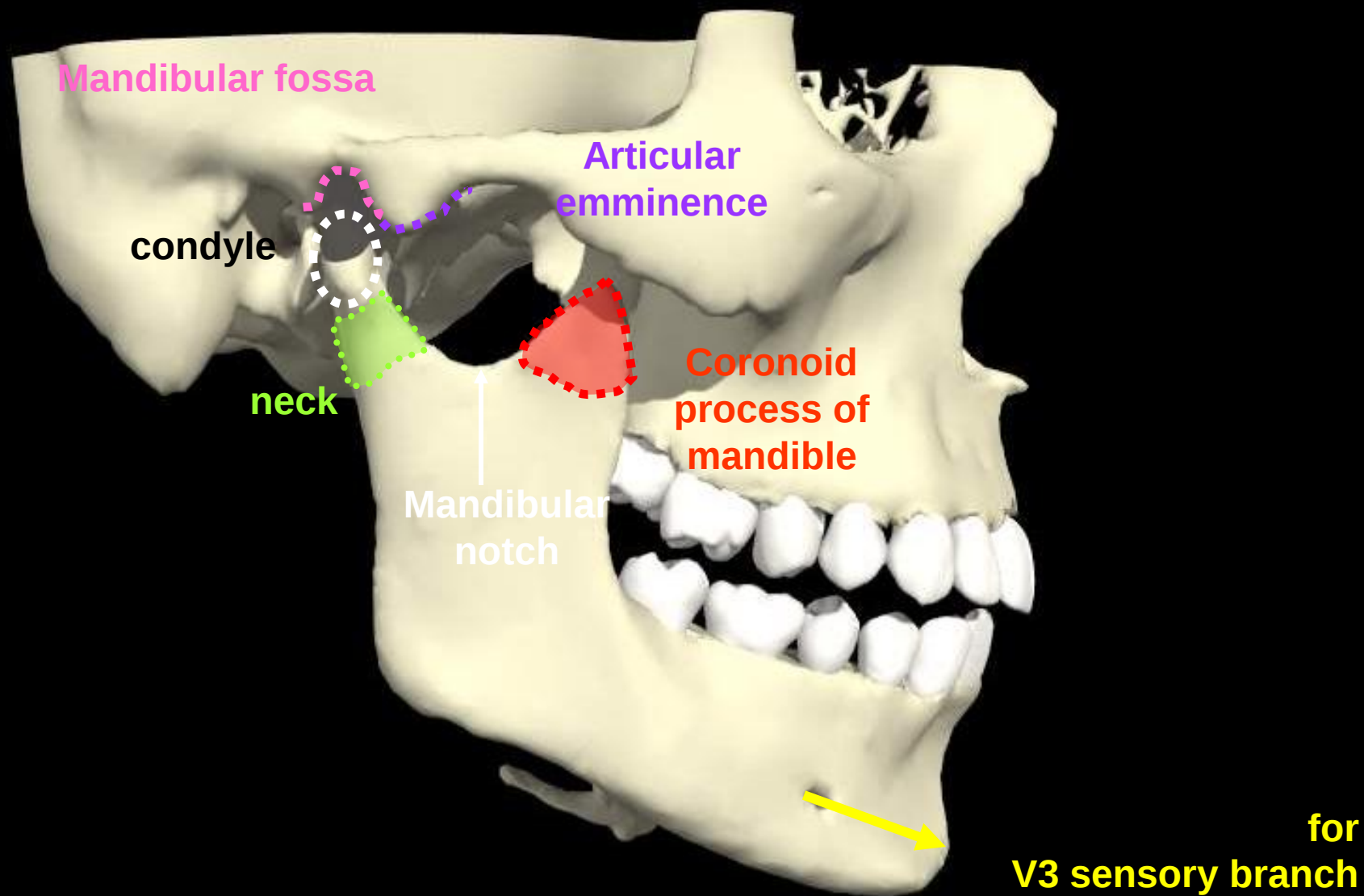
borders:

Lateral: ramus of mandible

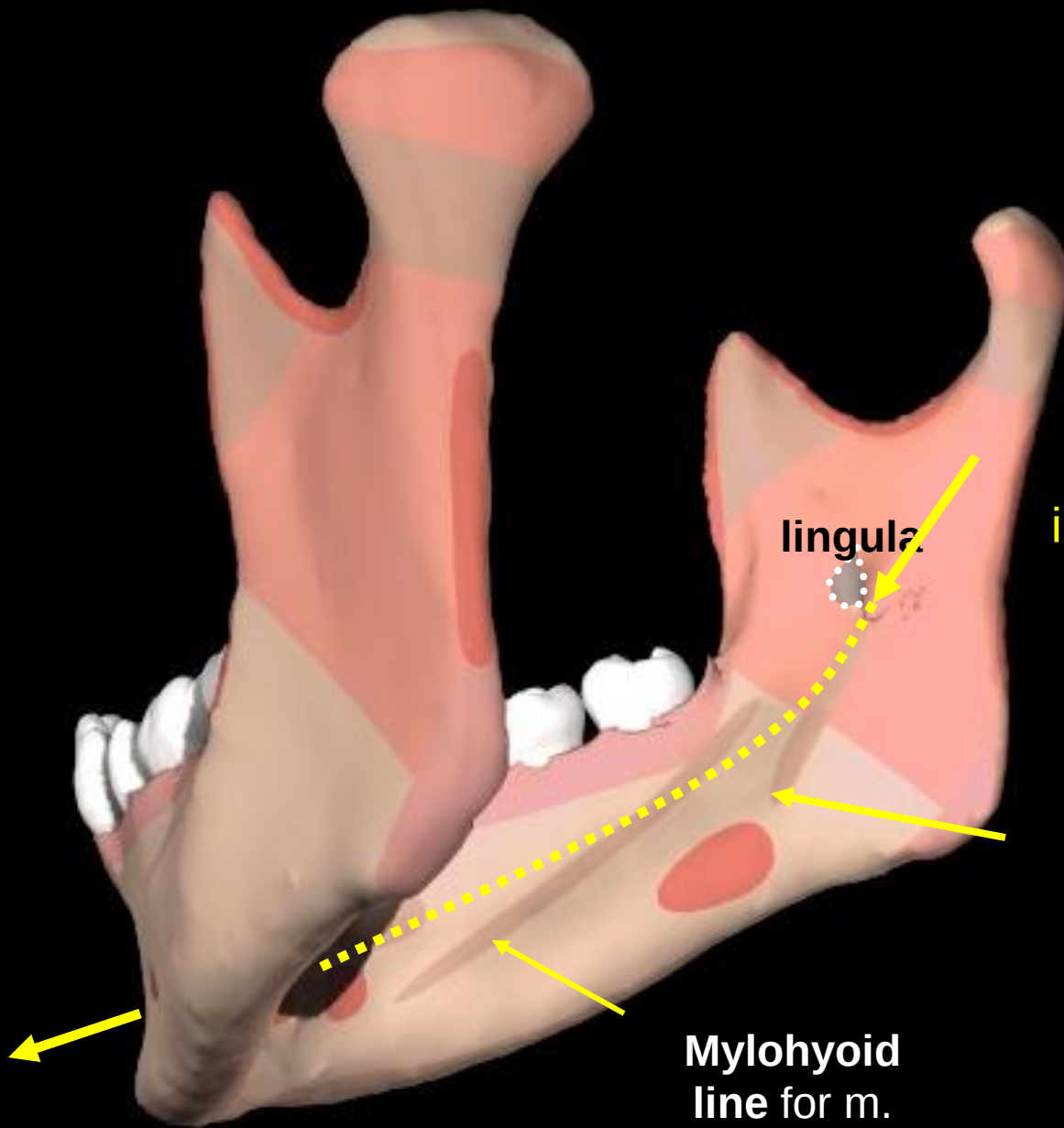
Medial: lateral pterygoid plate

Roof: greater wing of sphenoid, adj. maxilla & palatine bones

Inferior: continuous with deep cervical fascia



Injectations to numb the lower teeth also numb chin and lower lip but not uppers

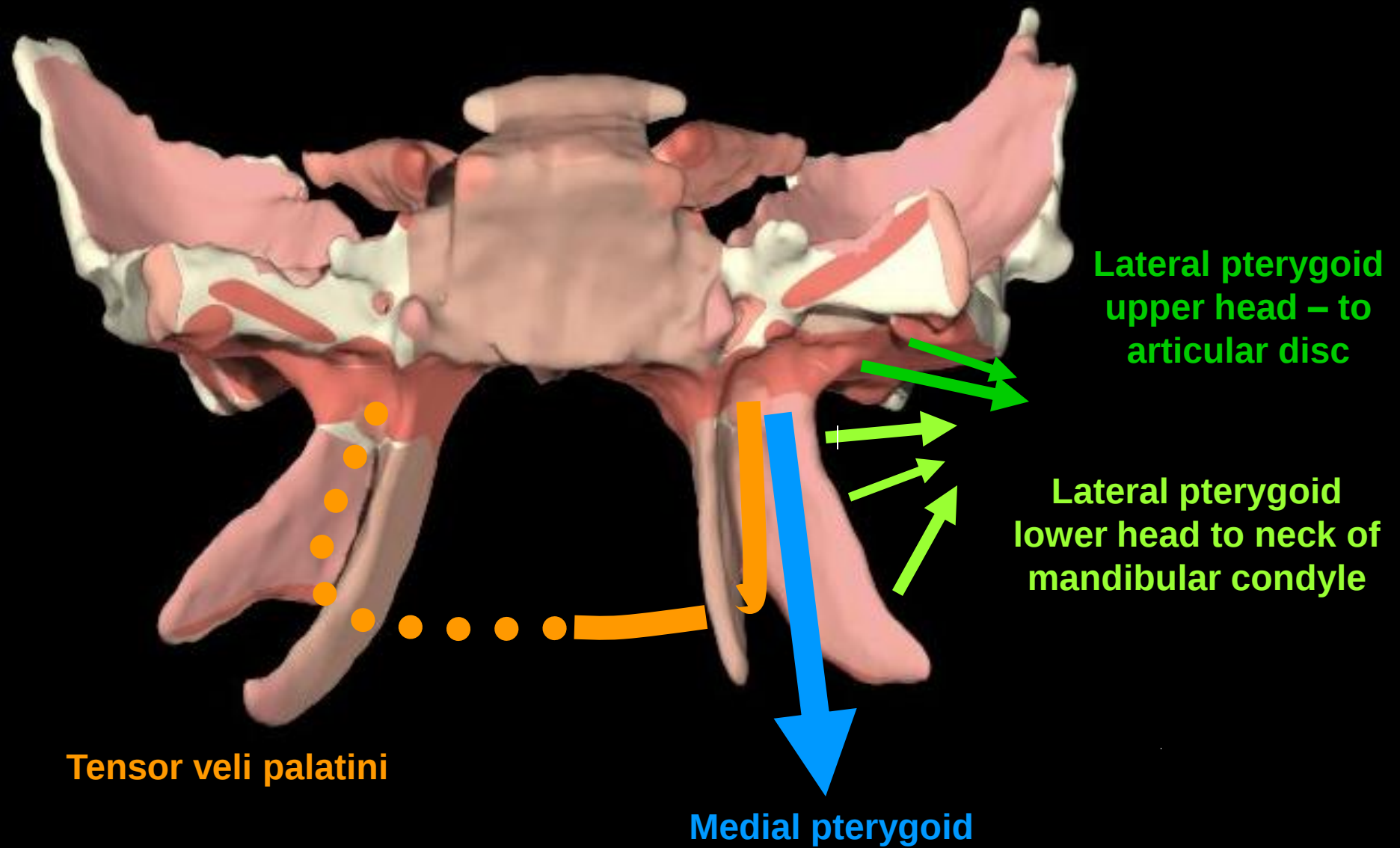


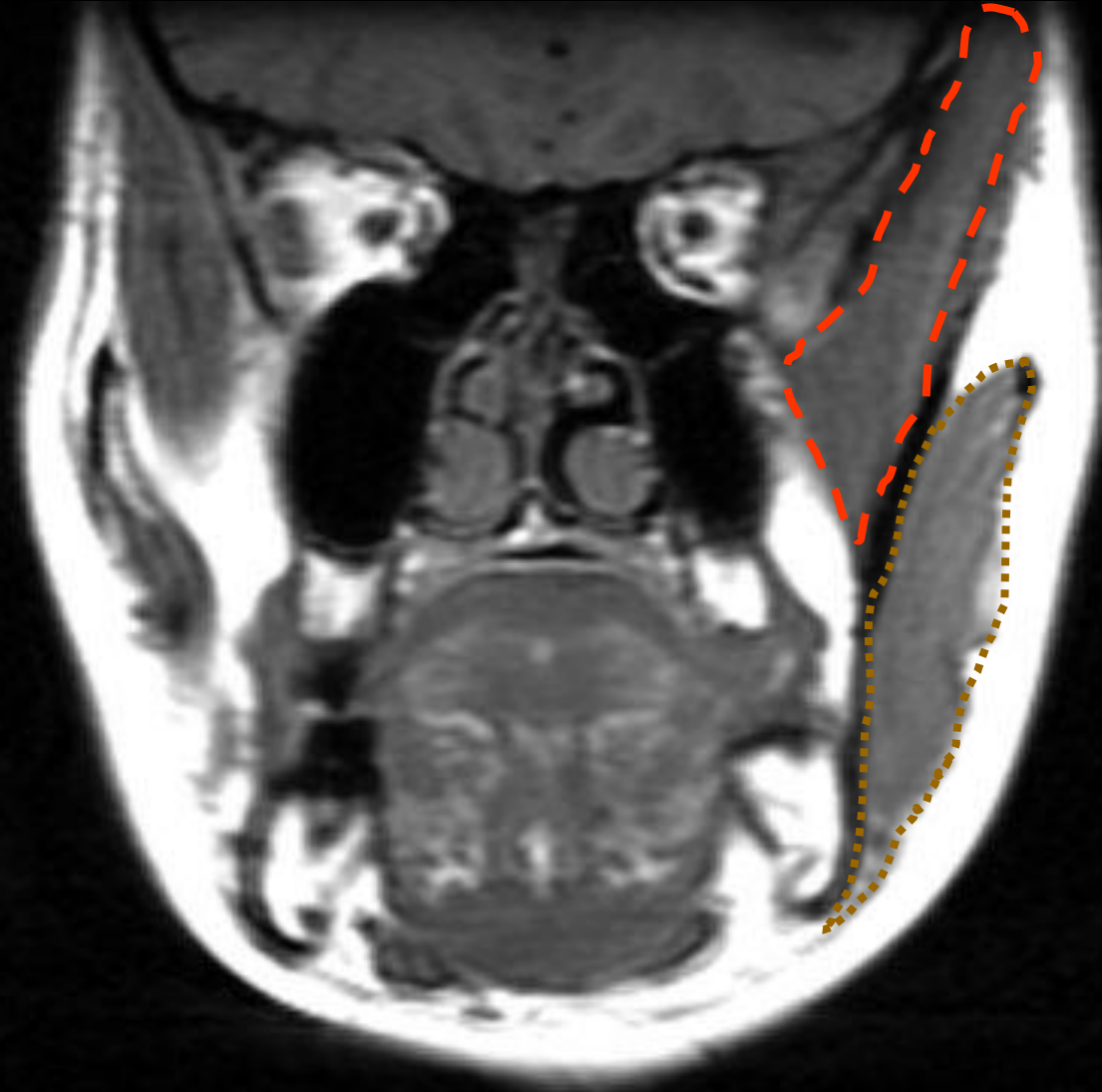
lingula

Mandibular foramen for inferior alveolar branch of V3, VV.

Mylohyoid groove for V3 branch to mylohyoid

Mylohyoid line for m. attachment

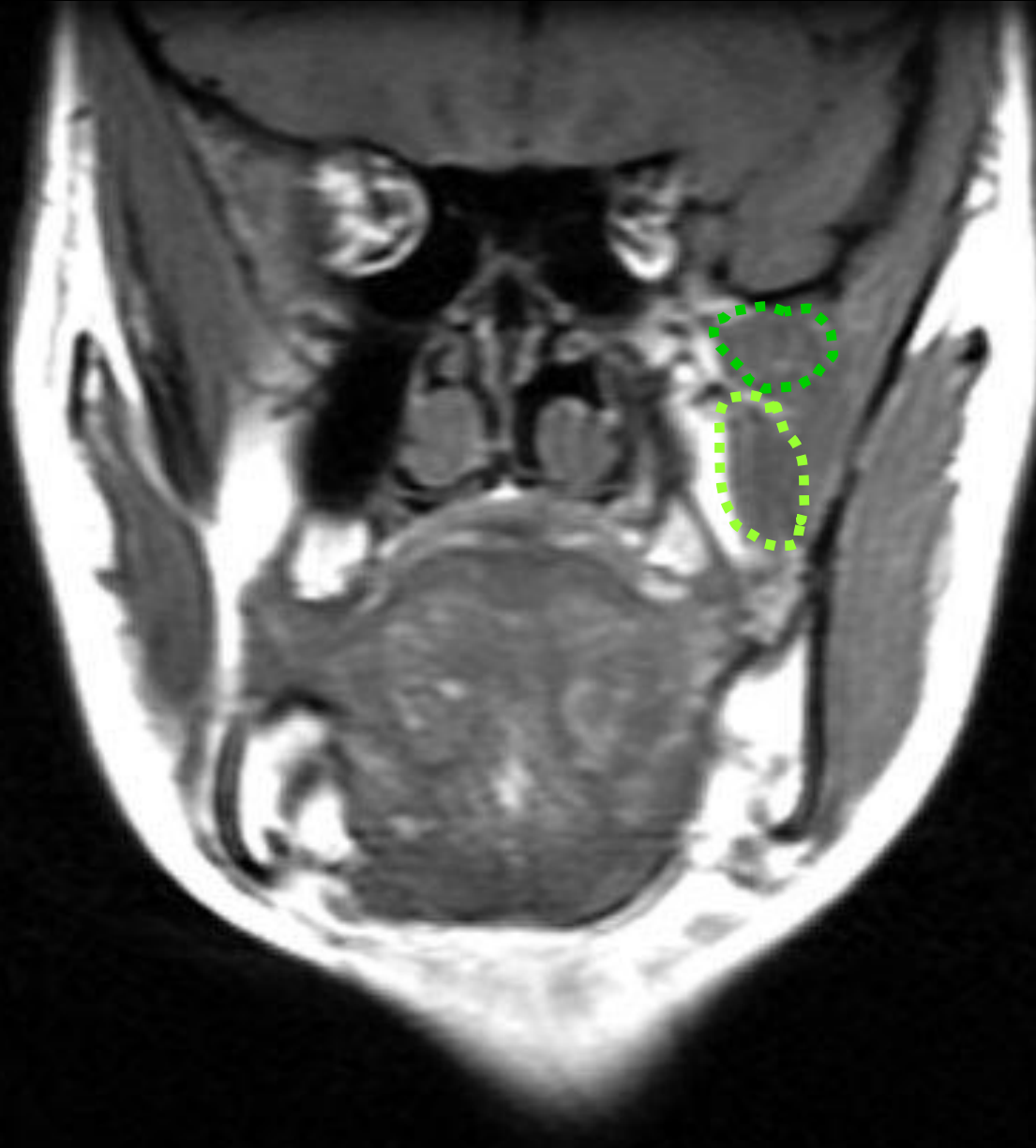




Temporalis m.

Masseter m.

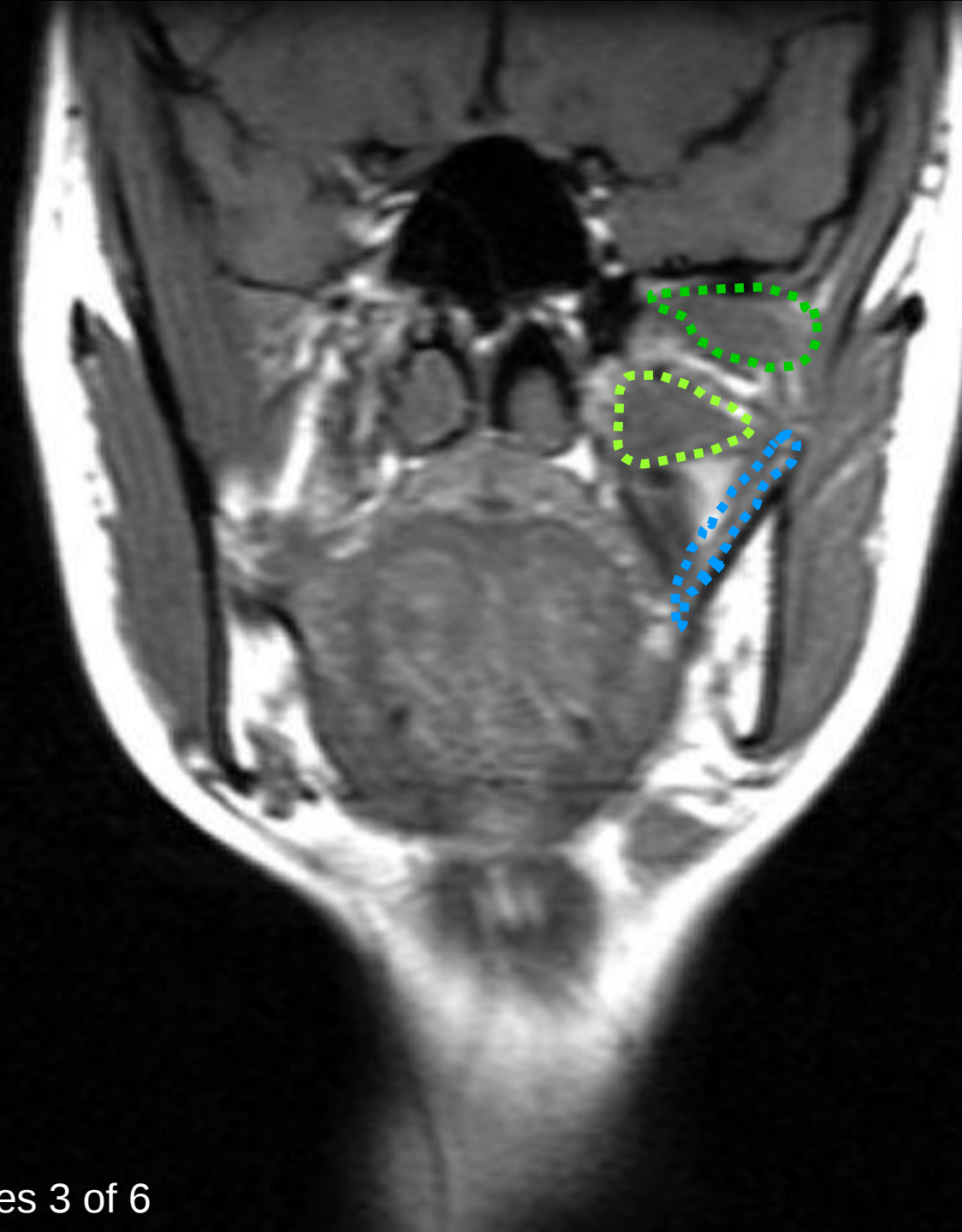
MRI series 1 of 6 – coronal section, anterior to posterior



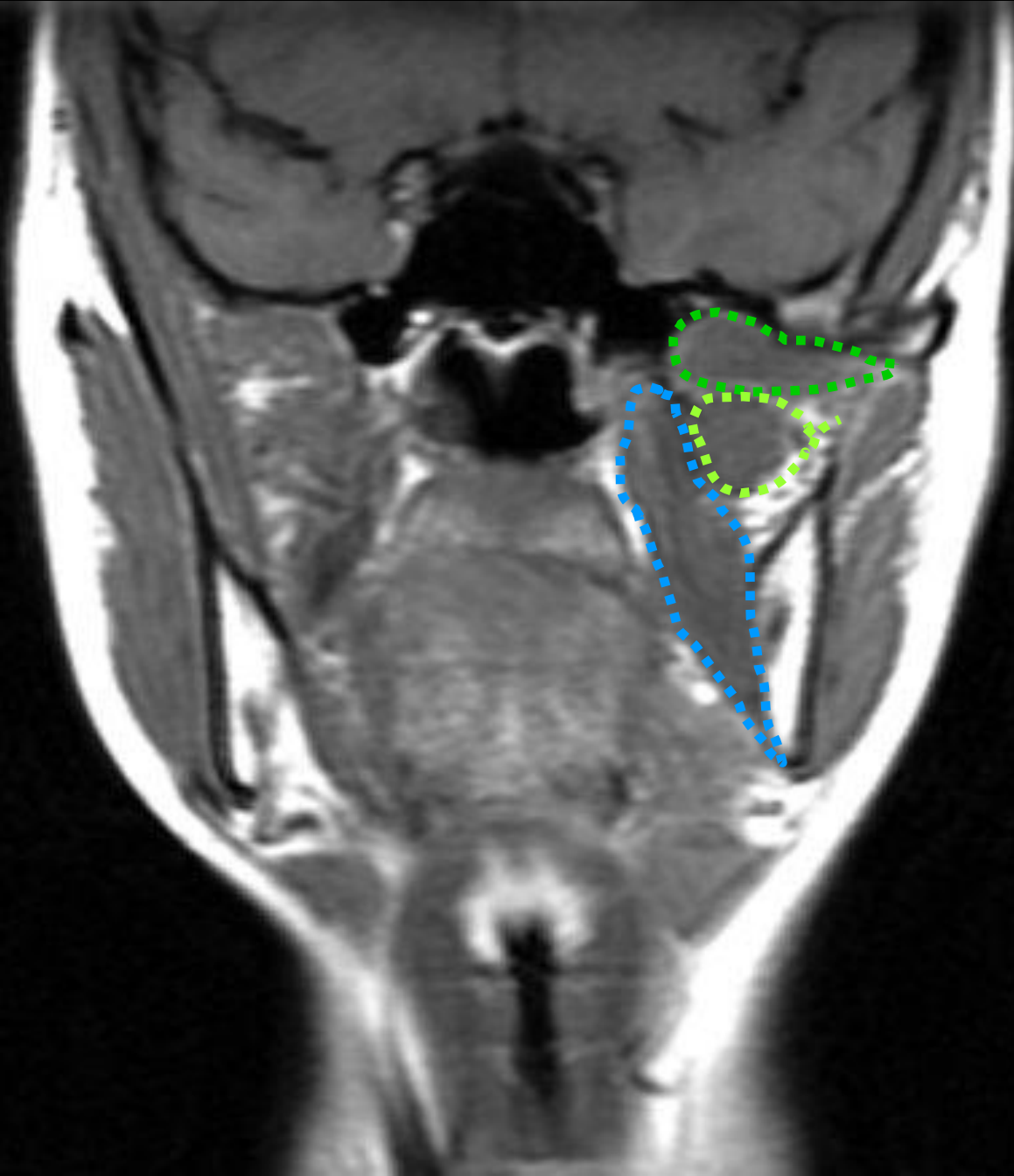
**Lateral
pterygoid**

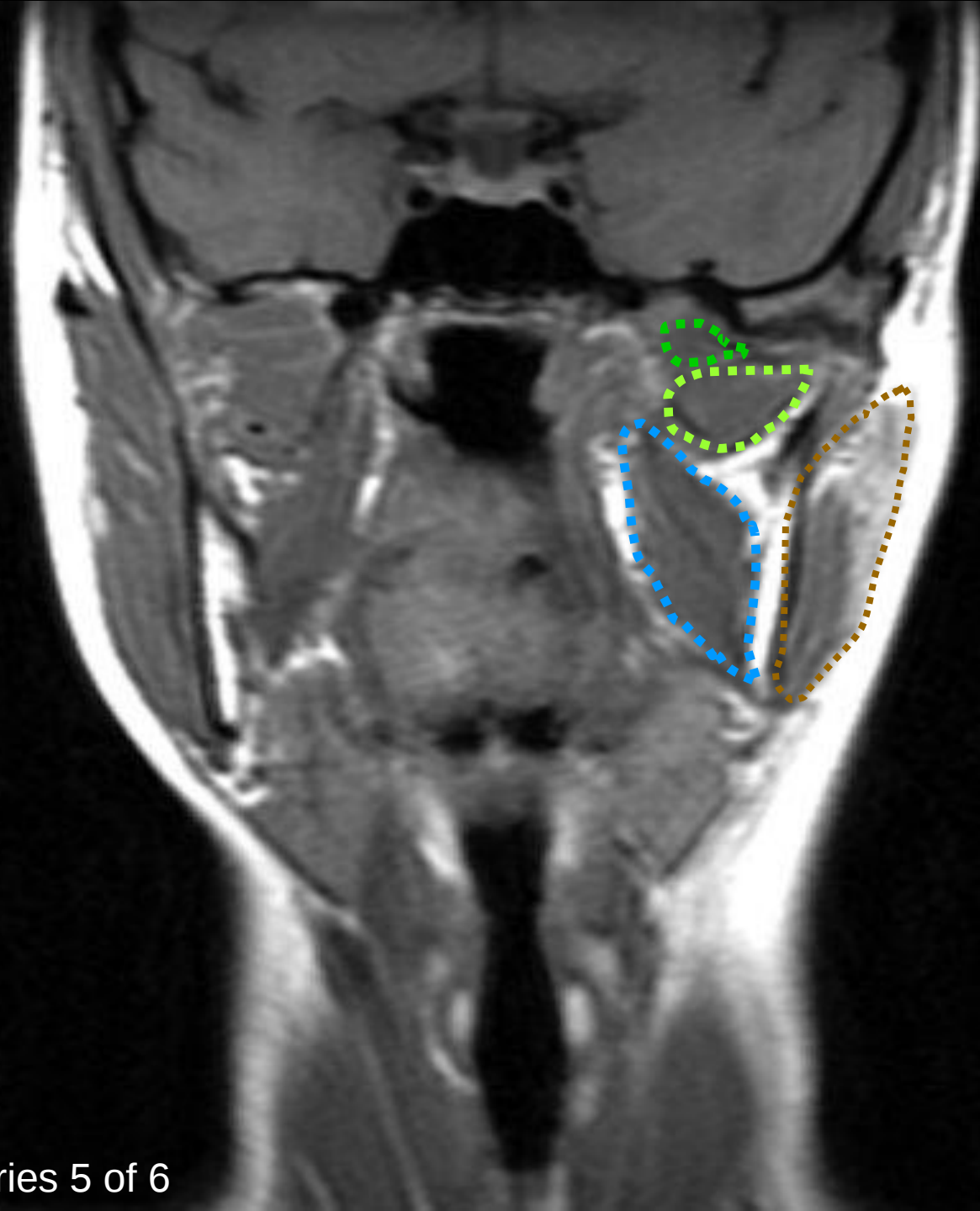
**Upper head: to
articular
disc**

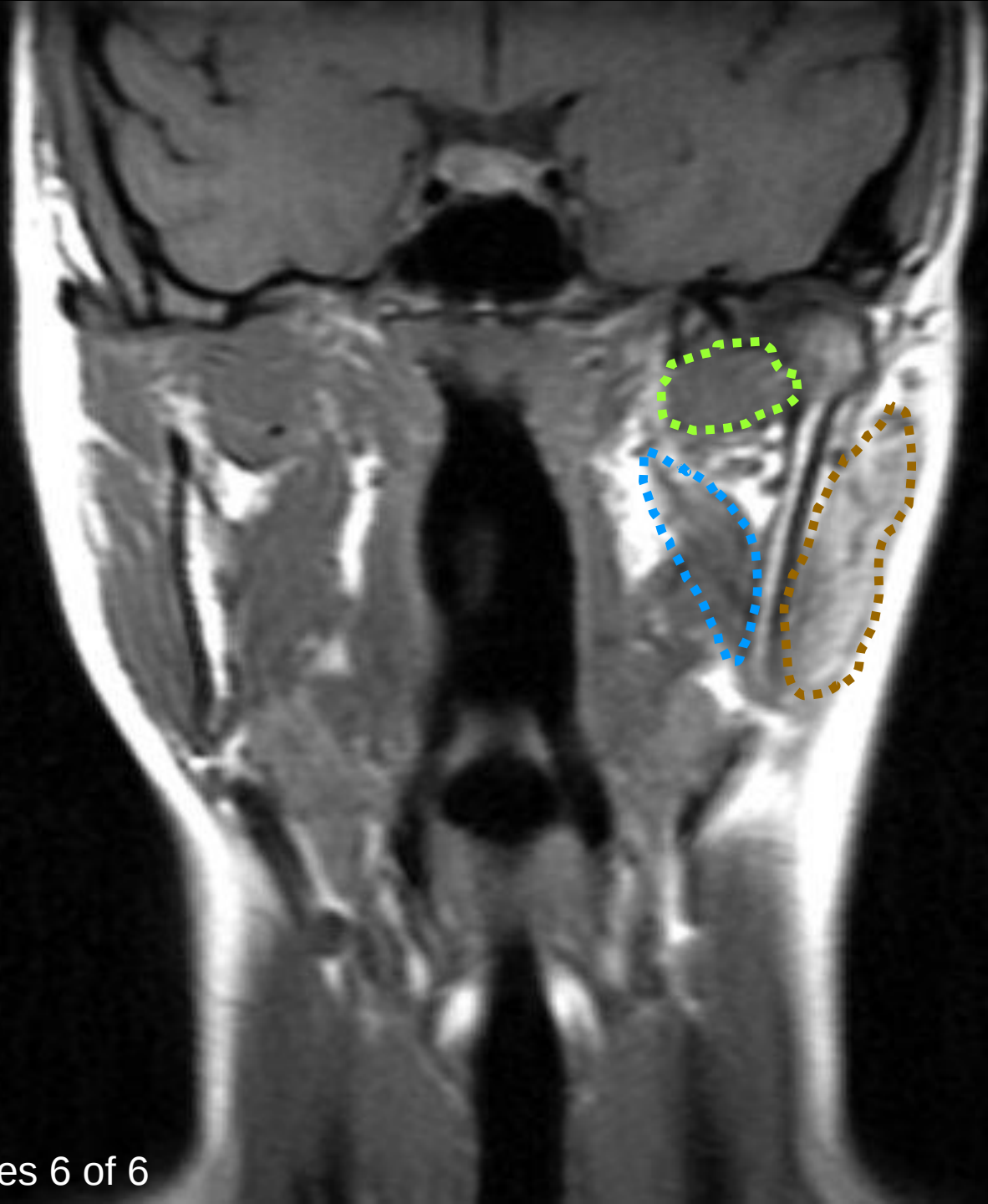
**Lower head:
to neck of
mandibular
condyle**



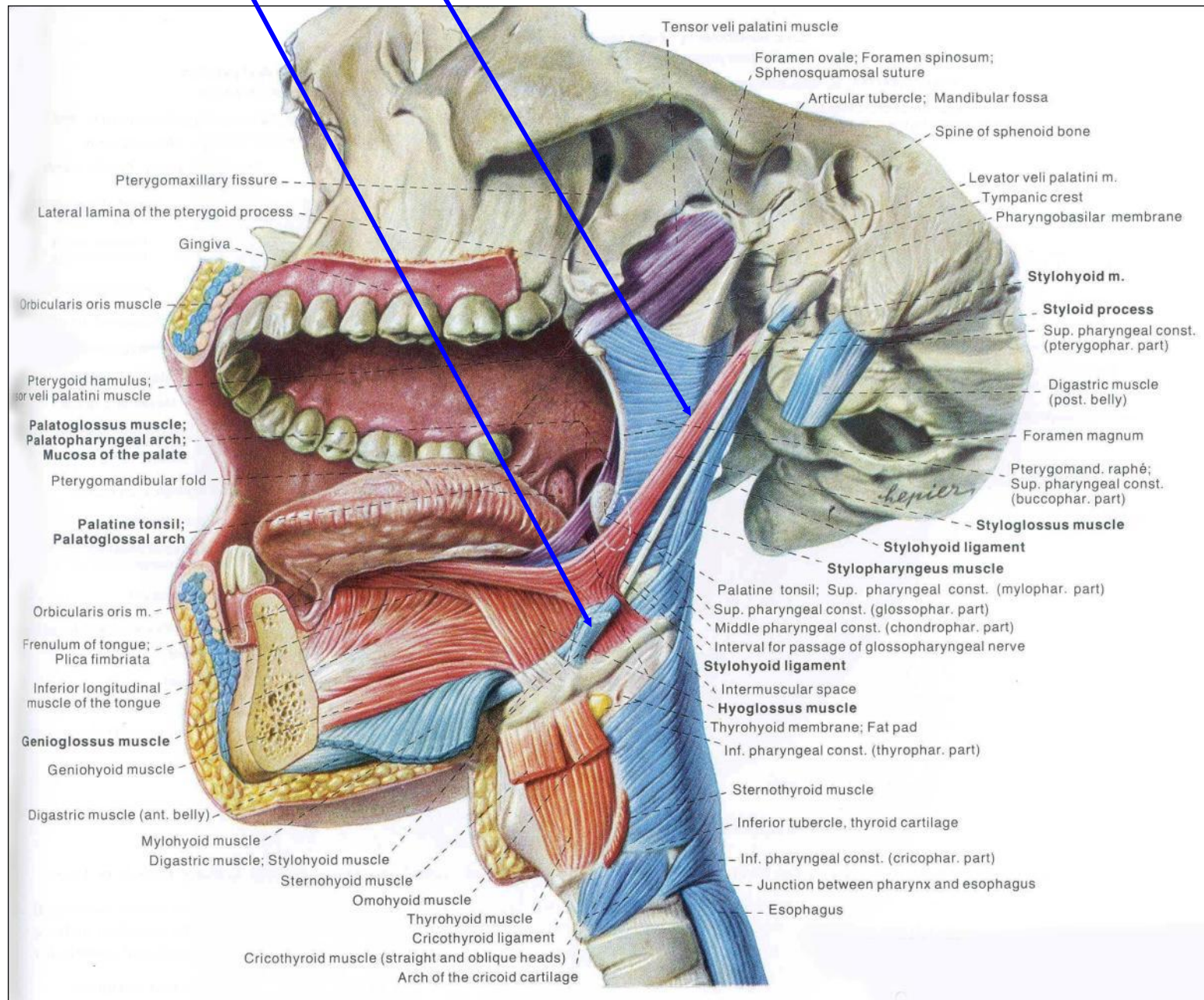
Medial pterygoid



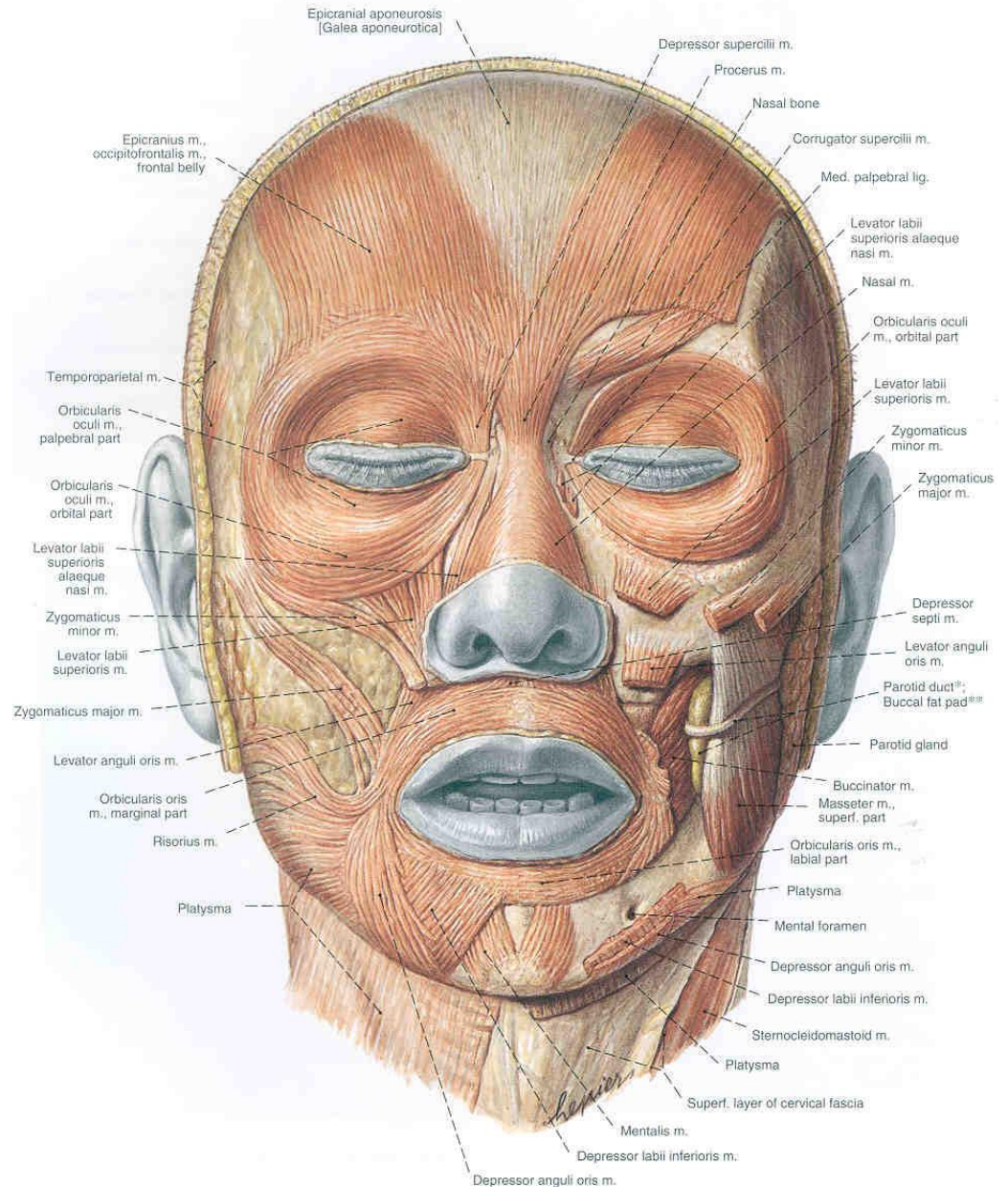




Stylohyoid, styloglossus, tongue muscles in general.

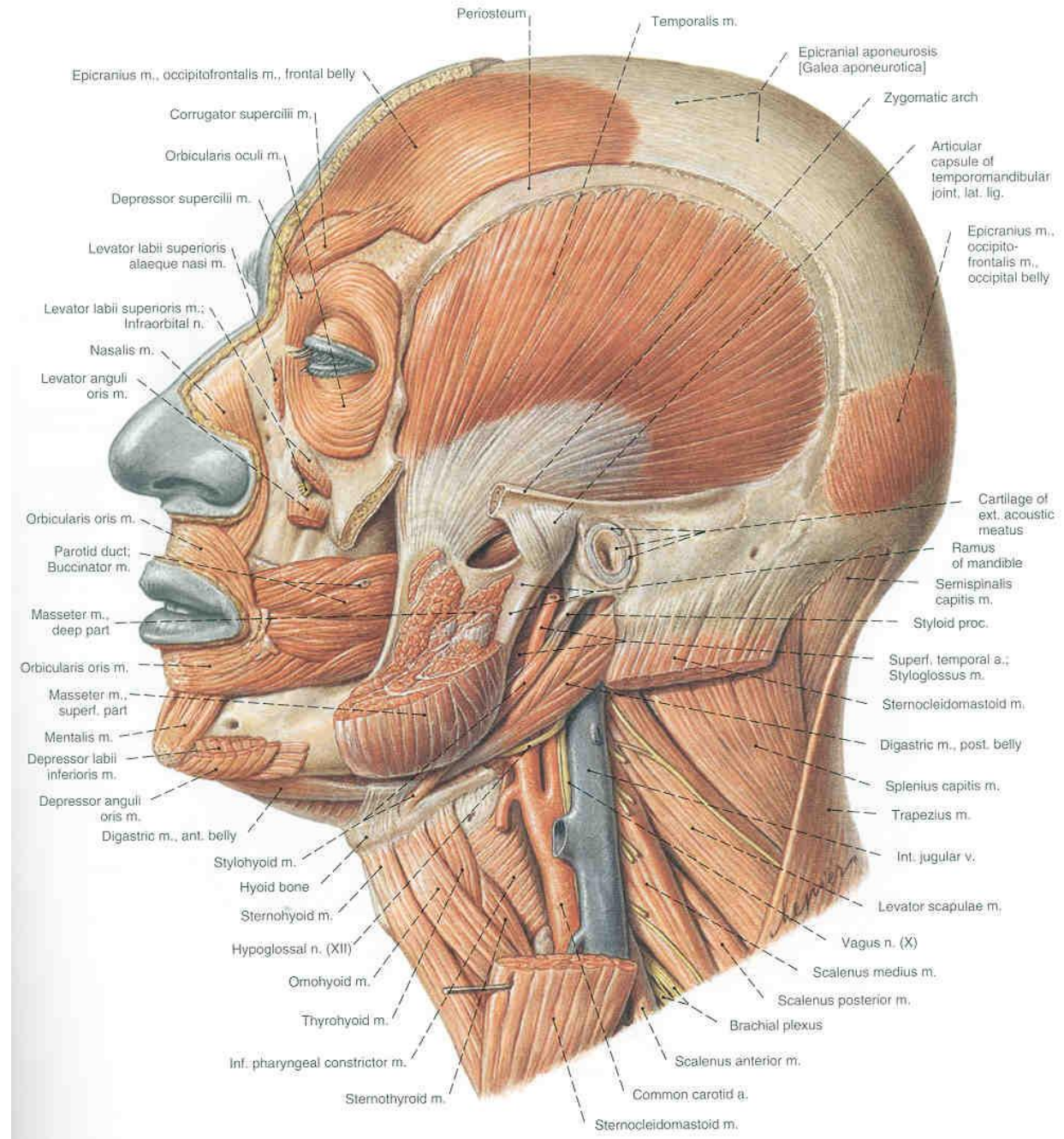


Superficial Facial Muscles (all innervated by VII)



Some
muscles of
mastication
(Innervated
by V₃)

Deeper
Facial
Muscles (All
innervated
by VII)



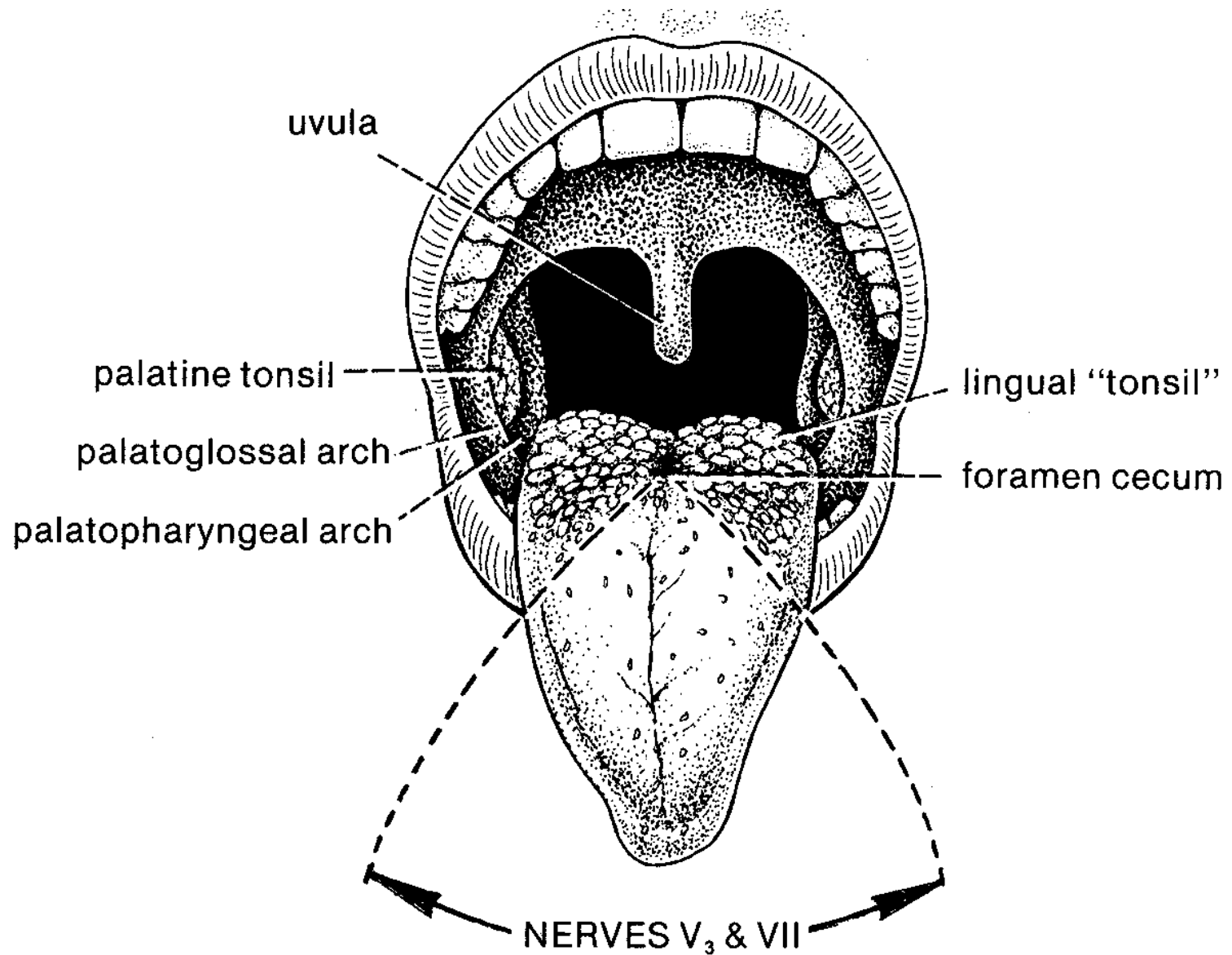
Major Muscles of the Hyoid Arch (innervated by VII):

- **Posterior Belly of Digastric**
 - **Facial Muscles (!!)**
 - **Stapedius**
 - **Stylohyoid**

Facial Muscles You Have to Remember:

- Obicularis Oris
- Obicularis Occuli
 - Frontalis
 - Buccinator
 - Platysma
- Zyogmaticus Major
- Depressor Anguli Oris

Tongue: Surface



Extrinsic and Intrinsic Tongue Muscles

