Cranial nerves: II, IV & VI

NEW YORK INSTITUTE OF TECHNOLOGY
College of Osteopathic Medicine

Paths and Functions of Somatic Afferents and Efferents of the Head and Neck

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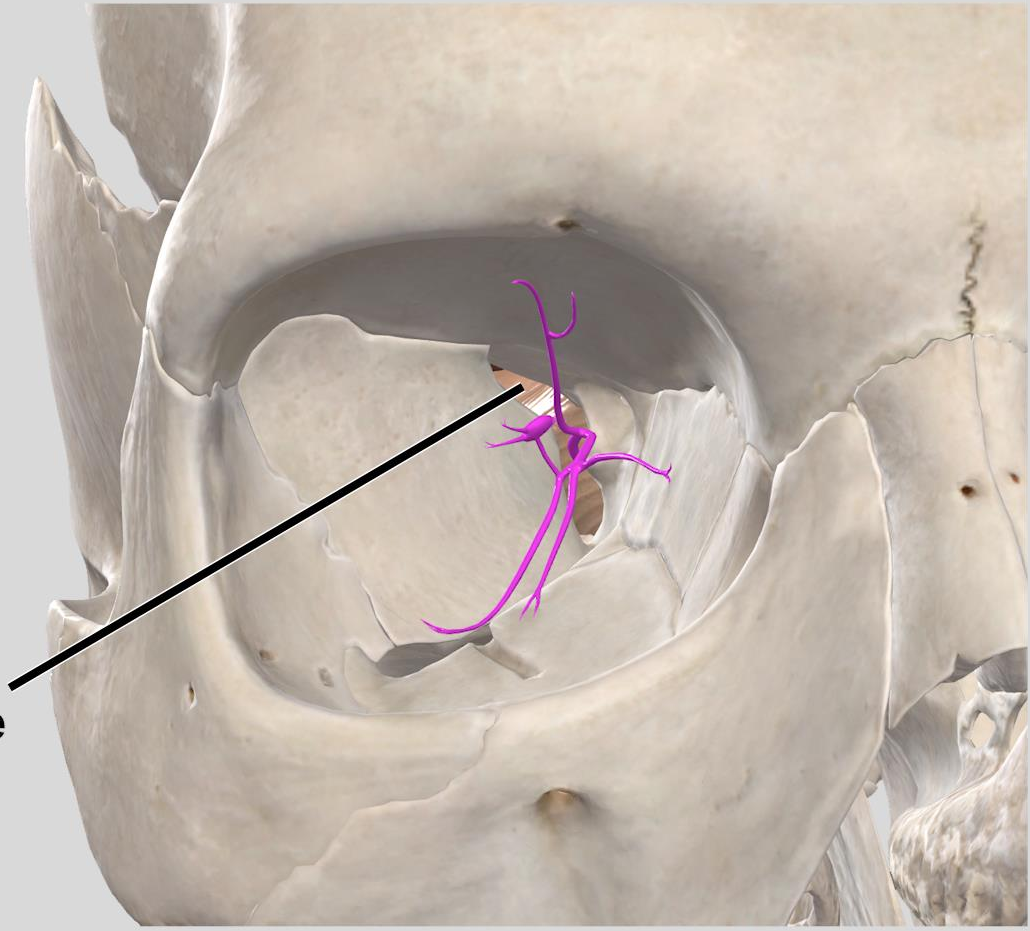
Do.
Make.
Heal.
Innovate.
Reinvent the Future.

Oculomotor

Main motor nerve for eye

Travels in the lateral wall of the cavernous sinus

Exits endocranium through superior orbital fissure



Oculomotor

Nerve splits into 2 divisions

Superior division

Innervates:

- superior rectus
- levator palpebrae superioris

Inferior division

Innervates:

- medial rectus
- inferior rectus
- inferior oblique

- ciliary body
- sphincter pupillae

via ciliary ganglion → short ciliary nerves

Oculomotor

Oculomotor palsy examples

Ptosis

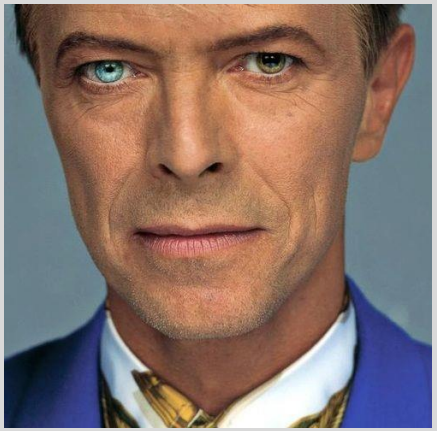
weak or paralyzed levator palpebrae superioris

lesion located in the superior division

Complete lesion

weakness or paralysis of 4 of the 6 extraocular muscles. Unopposed muscles pull eye down and out

Anisocoria



David Bowie

Weakness or paralysis of sphincter pupillae. Affected eye remains more dilated than contralateral eye.

medial rectus palsy

lesion located in inferior division

Trochlear

Smallest of the cranial nerves

Exits dorsally off the midbrain

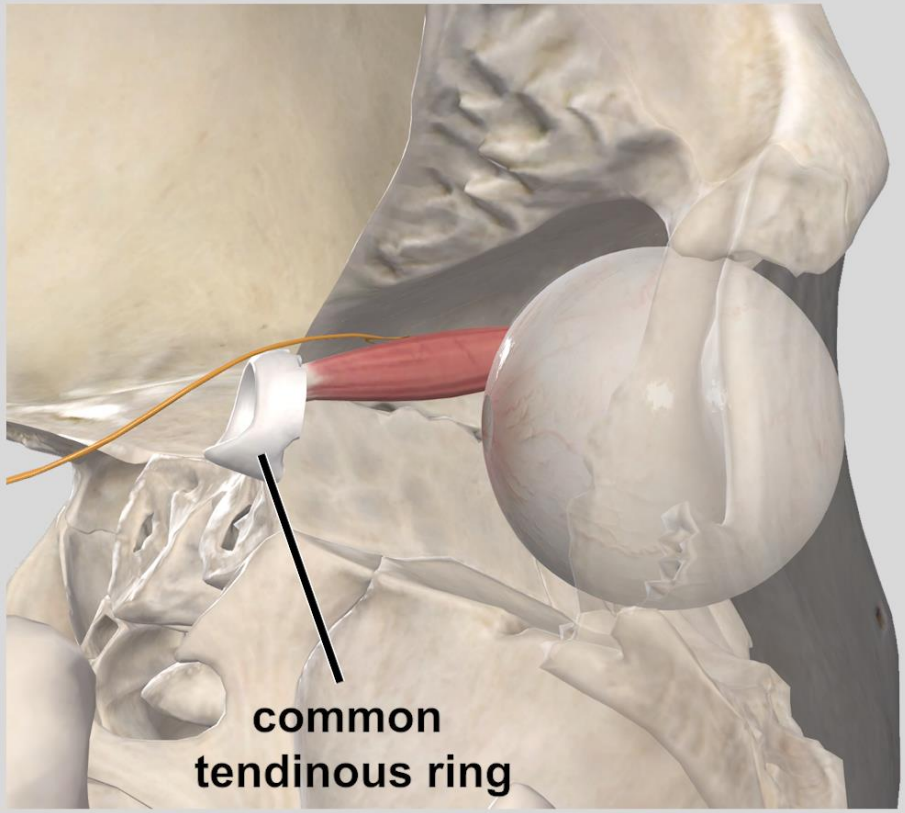
Travels in the lateral wall of the cavernous sinus

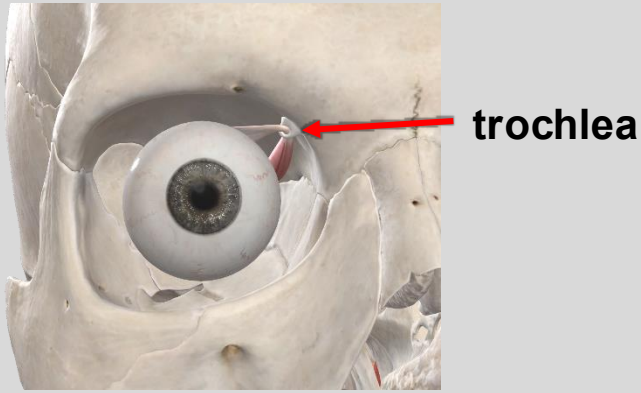
Exits endocranium through superior orbital fissure

Innervates only the superior oblique muscle

Trochlear nerves pulls on the only eye muscle to use a trochlea (pulley)

right lateral view





Trochlear

Trochlear nerve (Fourth Nerve) Palsy

Small size of trochlear makes it susceptible to damage

Lesion produces weakness / paralysis of superior oblique

Unopposed muscles draw the affected eye up and in

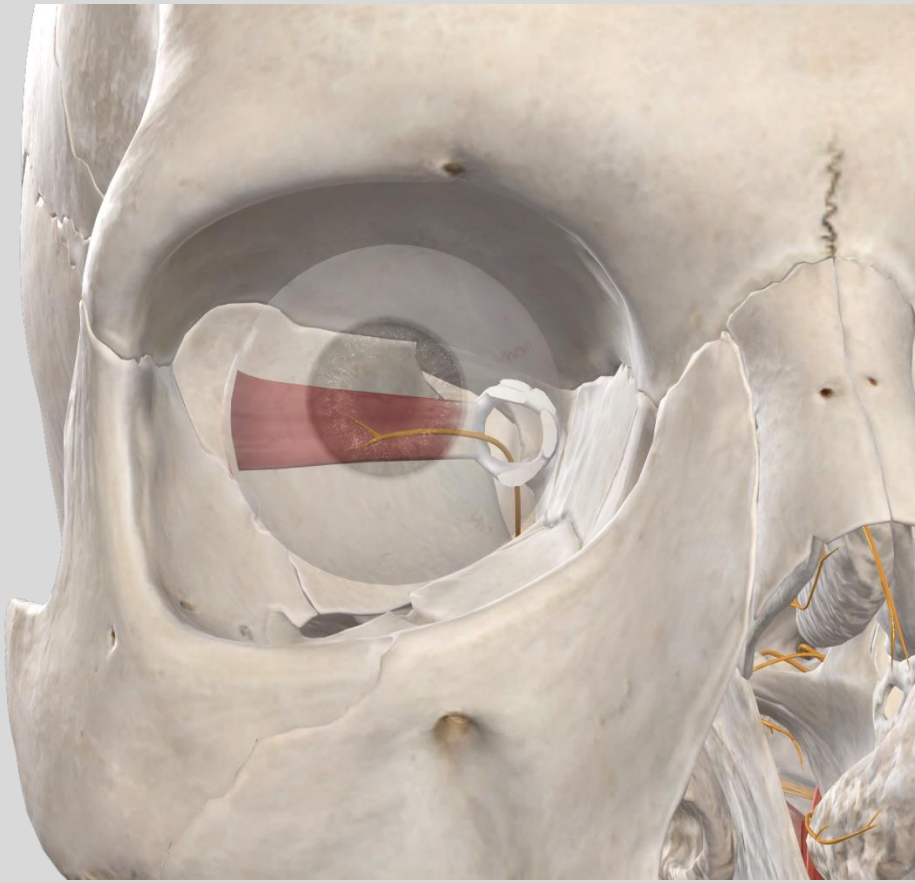
This is an extreme example of trochlear nerve palsy. The effect is often more subtle than this.

Abducens / Abducent

Travels in lateral wall of cavernous sinus

Exits endocranium at superior orbital fissure

Only innervates lateral rectus



A-B-ducens innervates the muscle that A-B-ducts the eye

Clinical Correlate

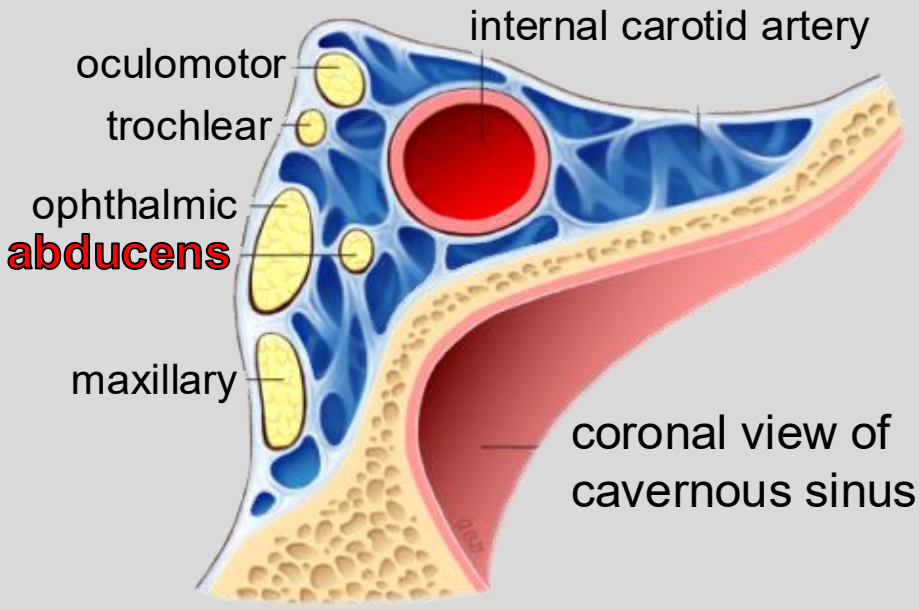
Abducens Palsy

Lesion produces weakness / paralysis of the lateral rectus muscle

Unopposed medial rectus pulls eye towards nose

Abducens lies most medial in the cavernous sinus

This placement puts the nerve ***the most at risk*** for compression related to aneurysms and blood clots



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Don’t get hung up on the branching patterns!

For each nerve, answer these 3 questions

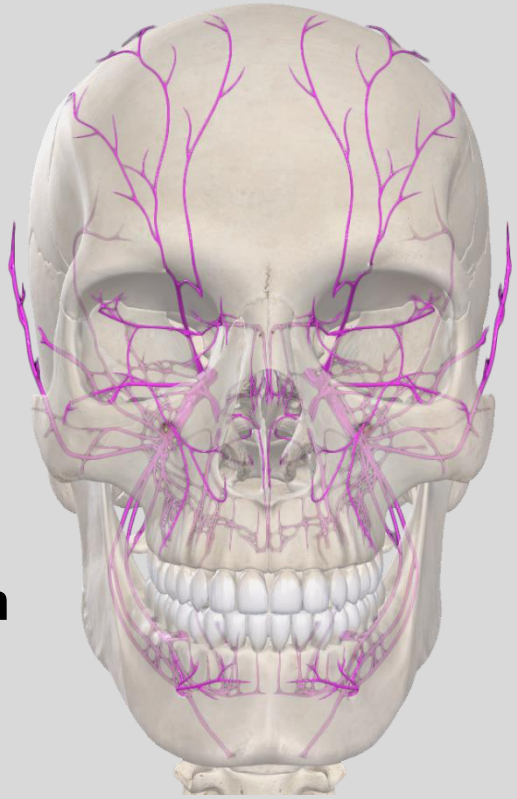
1. **What root / division is the nerve from?**
2. **Where does it exit the endocranium and skull?**
3. **What does the nerve innervate?**

Trigeminal

Trigeminal is the largest cranial nerve

It provides sensation to most of the head and neck

The name trigeminal, refers to the unique trifurcation taken off the brain

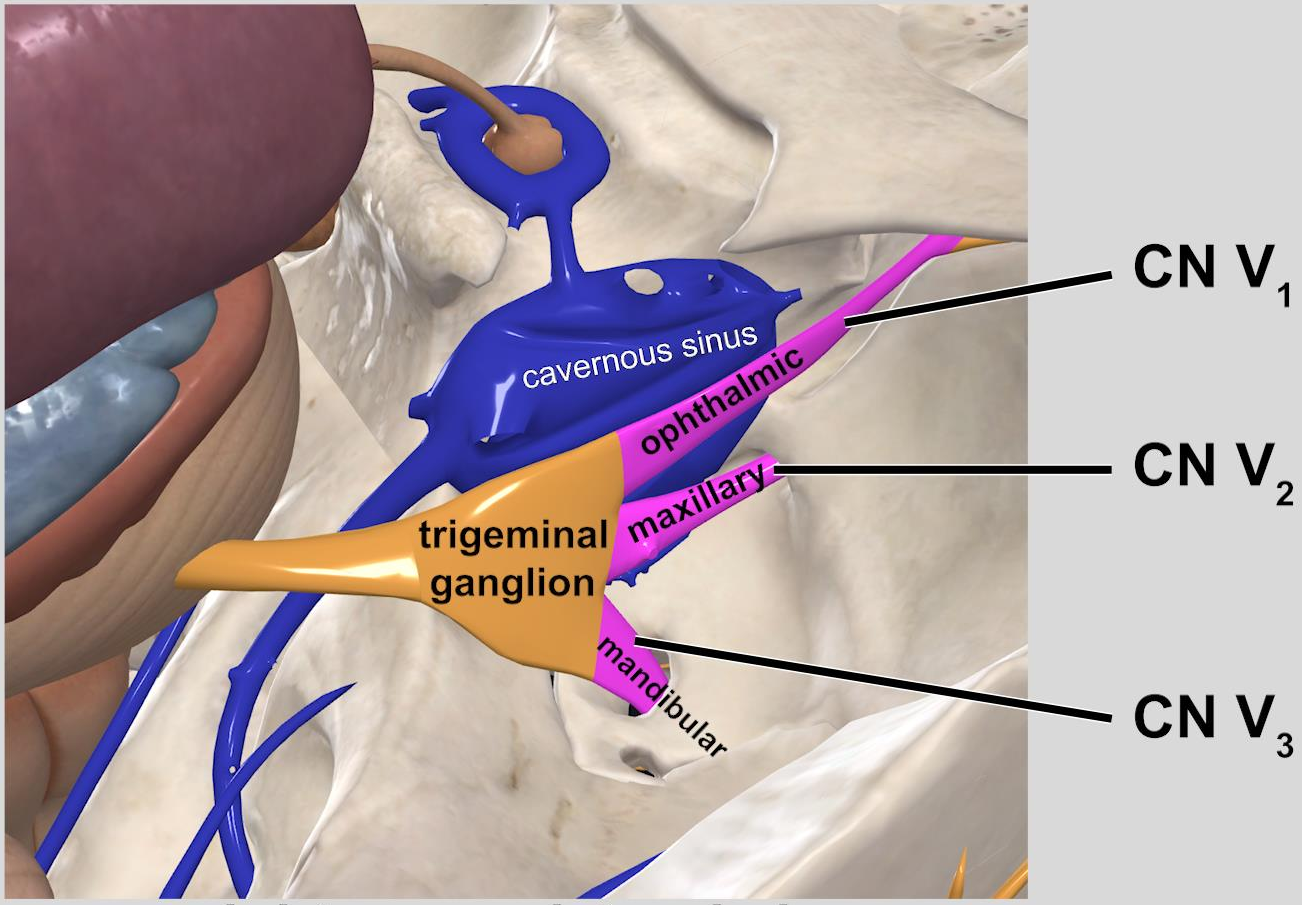


Latin: *trigeminus* = triplet

Trigeminal

Trigeminal starts as roots leaving the brain and entering the trigeminal ganglion

From the ganglion, trigeminal splits into its 3 major divisions



right superolateral view

CN V_1 — Ophthalmic

Smallest division of trigeminal

Travels in lateral wall of cavernous sinus

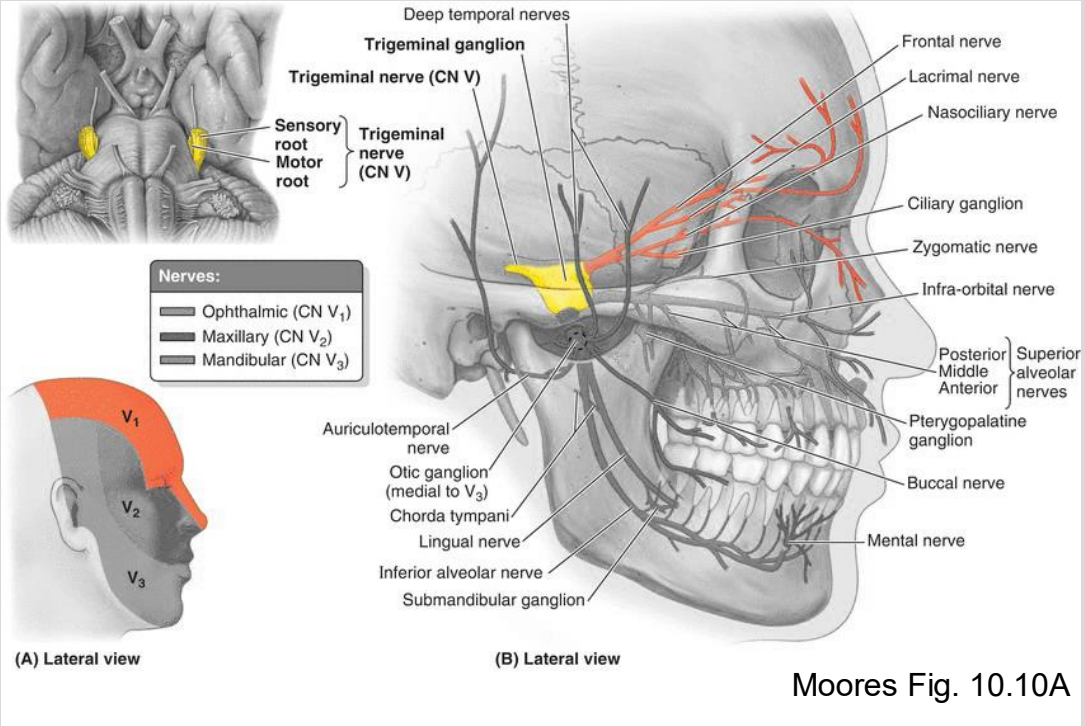
Exits endocranium through superior orbital fissure

100% sensory

Provides sensation from upper eyelid through the scalp, cornea and most of external nose

Has three main branches

- Frontal nerve
- Nasociliary nerve
- Lacrimal nerve

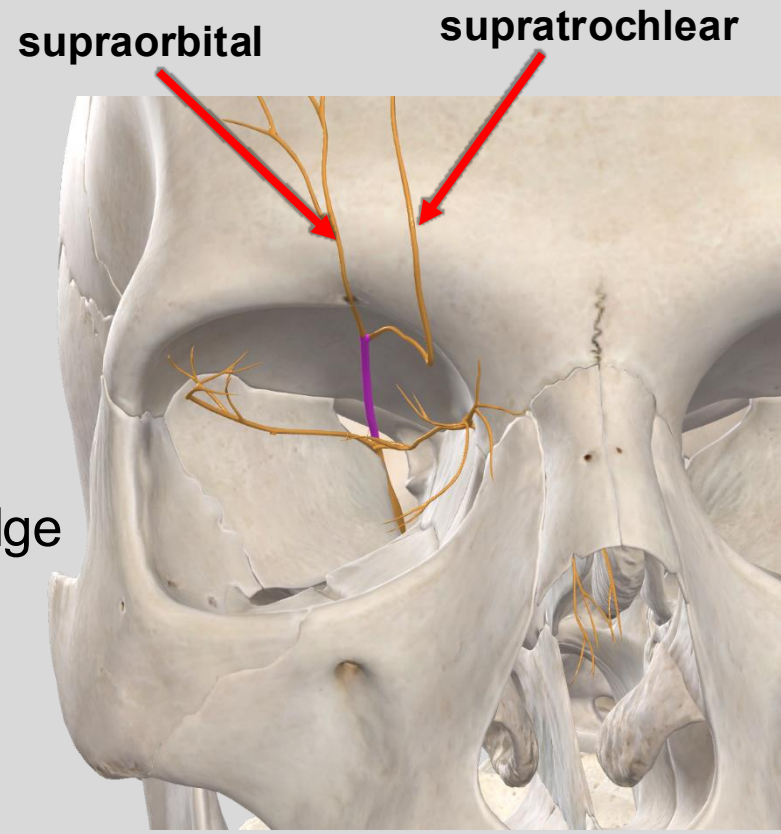


Moores Fig. 10.10A

Greek: ophthalmikos = *of the eye*

CN V_1 — Ophthalmic

Frontal Nerve



Runs along roof of orbit

Has 2 terminal branches

<u>Supraorbital nerve</u>

Exits skull via supraorbital foramen / notch

Innervates skin of upper eyelid and brow ridge

<u>Supratrochlear nerve</u>

Lies on medial wall of orbit

Exits skull from the medial orbital rim

Innervates the midline of brow ridge and nose

CN V_1 — Ophthalmic

Nasociliary Nerve

Runs anteromedially through the orbit

Several branches of nasociliary

Anterior and Posterior ethmoidal nerves

Pierce ethmoid to innervate paranasal sinuses and part of nasal septum

Long Ciliary nerves

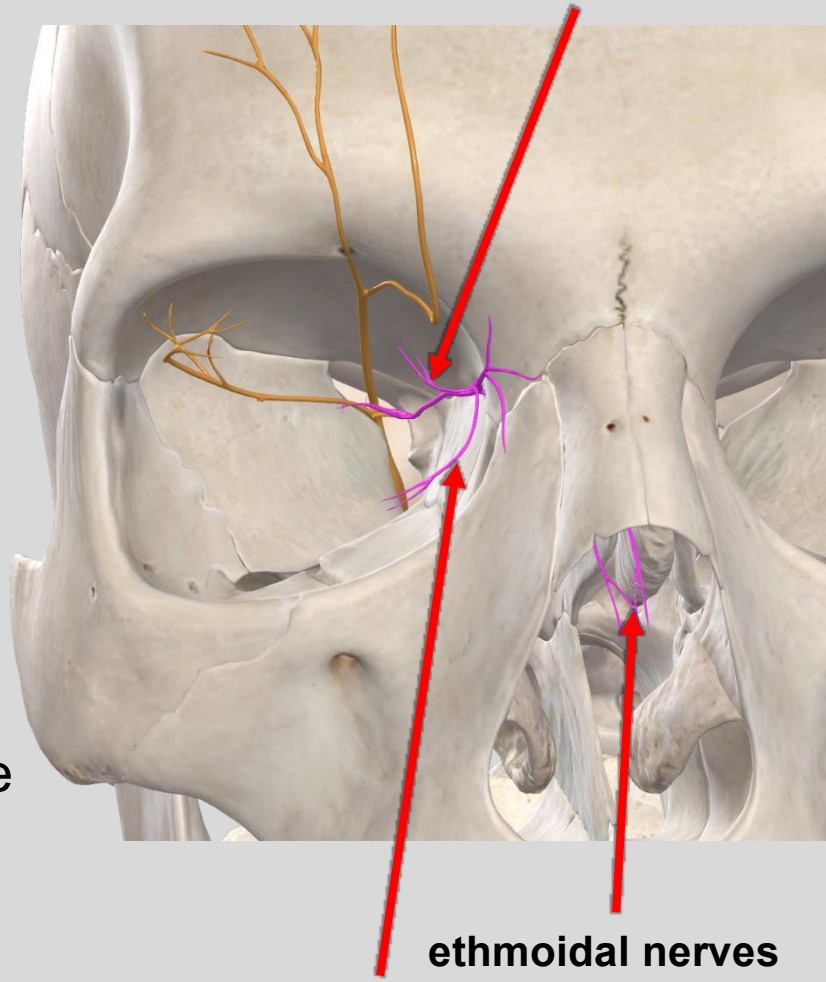
Provides sensation to rest of eyeball

Routes postganglionic sympathetics to eye

Infratrochlear nerve

Exits skull from medial orbital rim

Cutaneous sensation to most of nose, both eyelids and conjunctiva

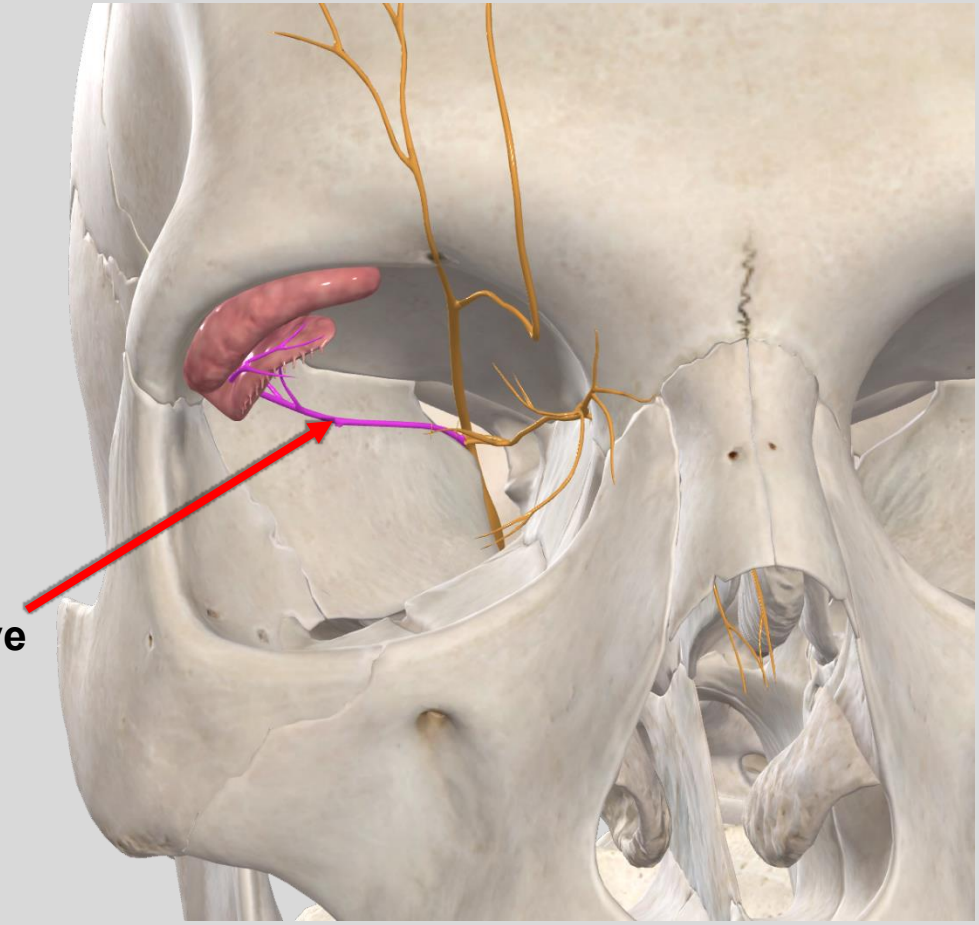


CN V_1 — Ophthalmic

Lacrimal Nerve

Smallest branch of ophthalmic

Moves along posterolateral wall to lacrimal gland



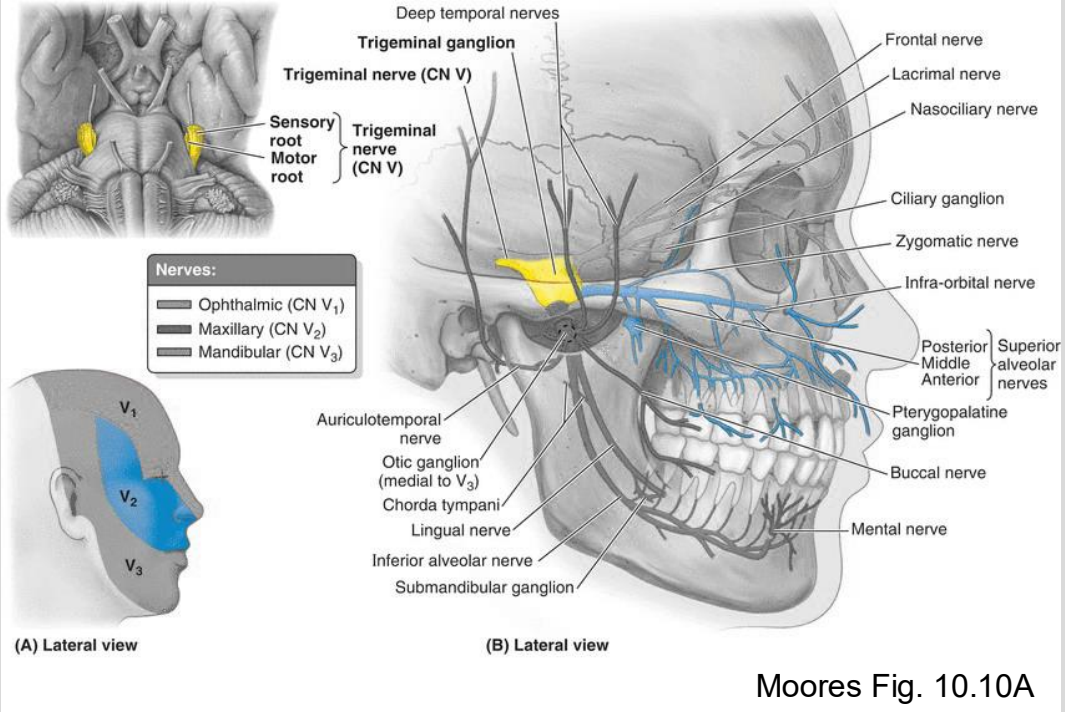
Provides ***sensory innervation*** to lacrimal gland

CN V_2 — Maxillary

100% sensory nerve

Has the most difficult branching pattern to see in a dissection

Exits the endocranium at the foramen rotundum



Moores Fig. 10.10A

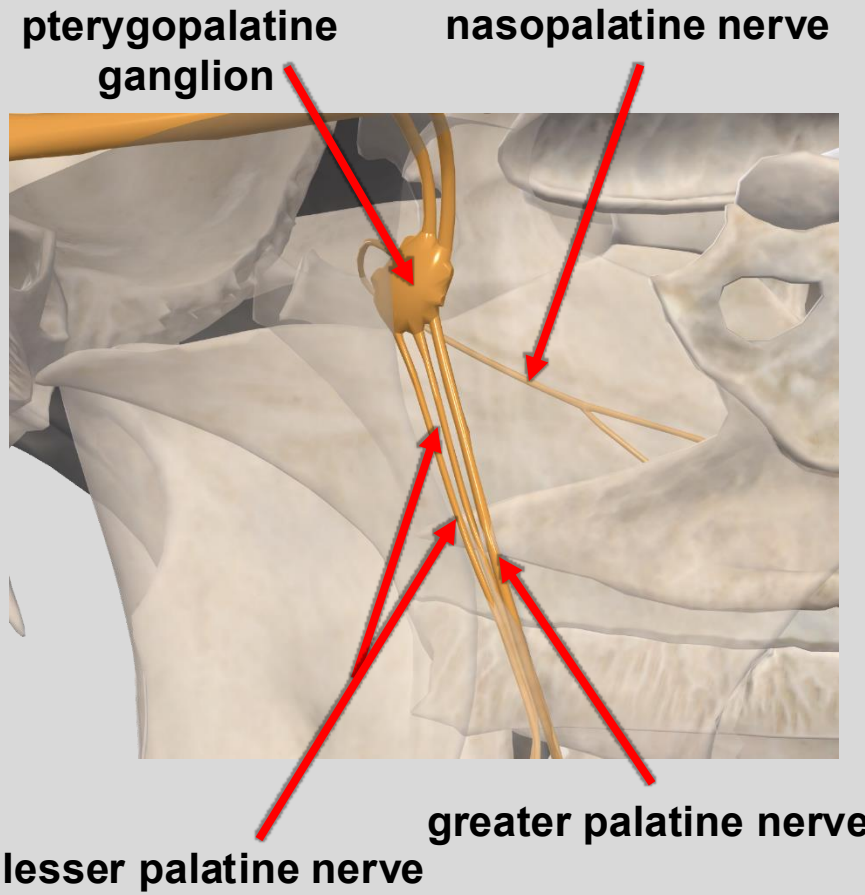
You are responsible for only 5 of the multiple branches

1. Greater palatine nerve
2. Lesser palatine nerve
3. Nasopalatine nerve
4. Zygomatic nerve
5. Infraorbital nerve

CN V_2 — Maxillary

One branch of V_2 heads inferiorly into the pterygopalatine ganglion

Trigeminal *does not synapse* in the ganglion



3 nerves descend from the ganglion

1. Greater palatine nerve

   exits skull from greater palatine foramen

   innervates hard palate

2. Lesser palatine nerve

   exits skull from lesser palatine foramina

   innervates soft palate

3. Nasopalatine nerve

   enters nasal passage

   innervates lateral wall and lower half of nasal septum

   exits skull from incisive canal and innervates anterior-most hard palate

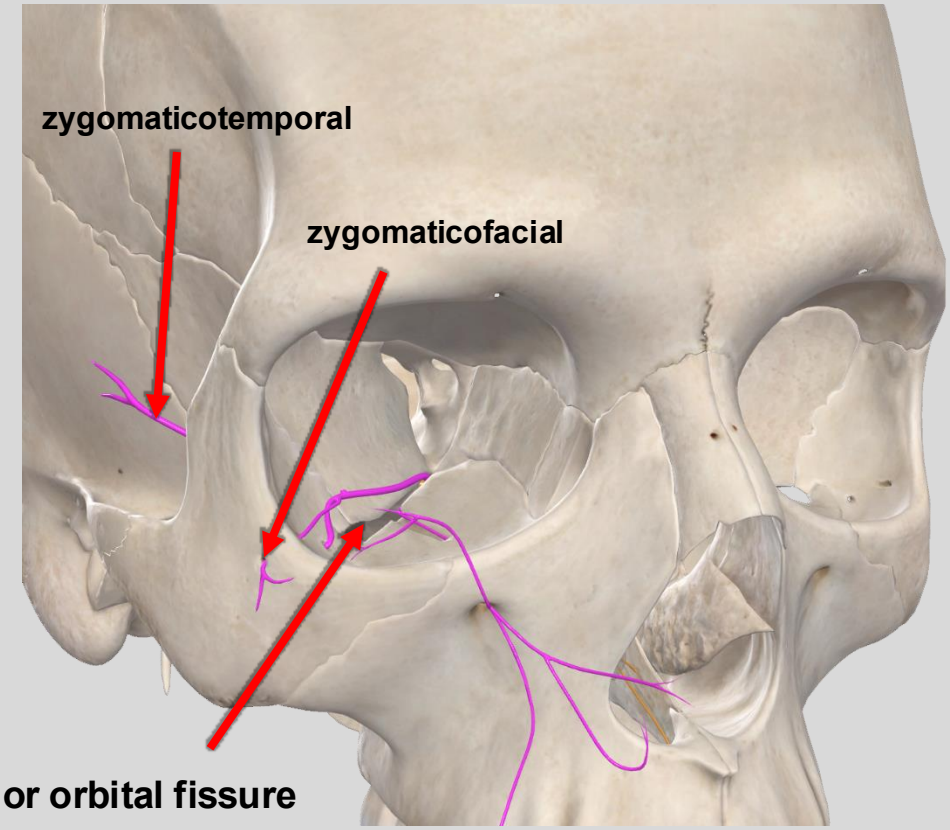
CN V_2 — Maxillary

The second branch of V_2 travels anteriorly into the inferior orbital fissure

Gives off the zygomatic nerve

Zygomatic has 2 terminal branches

1. zygomaticofacial nerve
2. zygomaticotemporal nerve



Nerves *exit skull* through foramina of same name

Both provide cutaneous innervation to their respective regions of the face

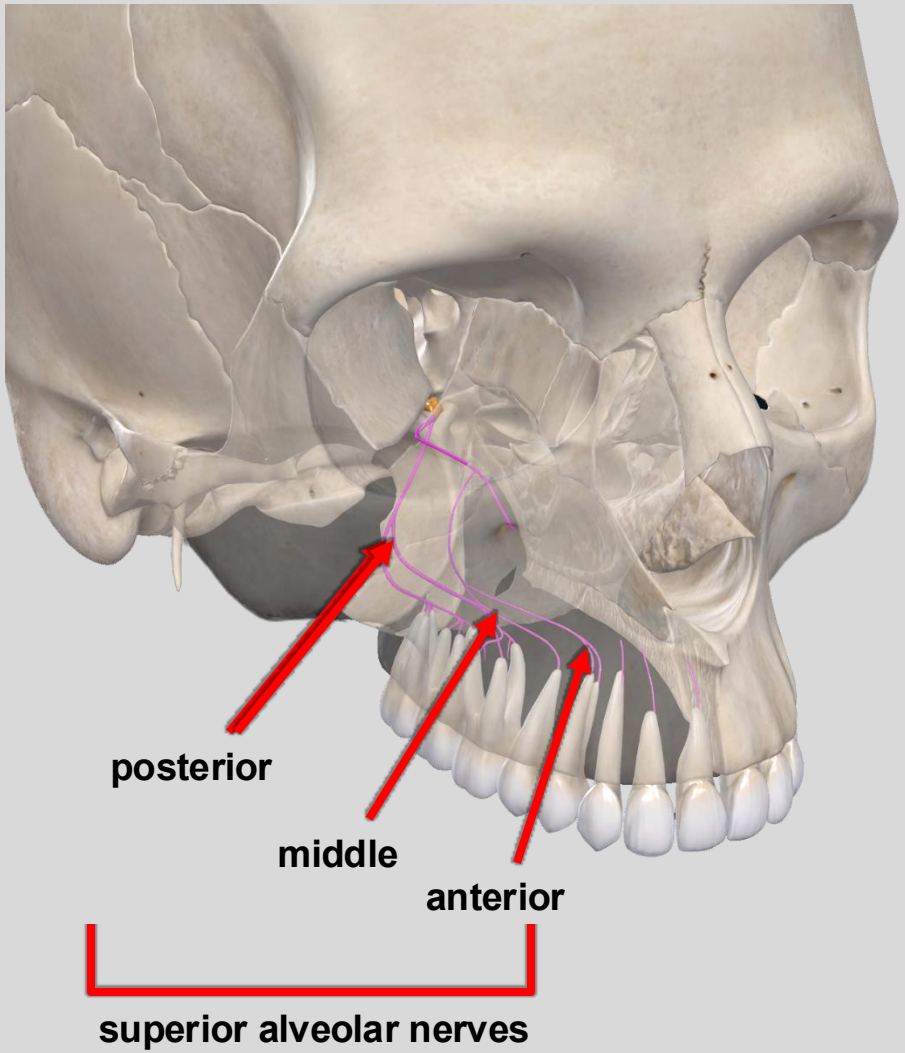
CN V_2 — Maxillary

Infraorbital nerve

Courses in infraorbital groove

Sends out 3 branches to the upper teeth and gums

- Anterior superior alveolar nerve
- Middle superior alveolar nerve
- Posterior superior alveolar nerve



Note: You *do not* need to know which specific tooth is innervated by a specific superior alveolar nerve

CN V_2 — Maxillary

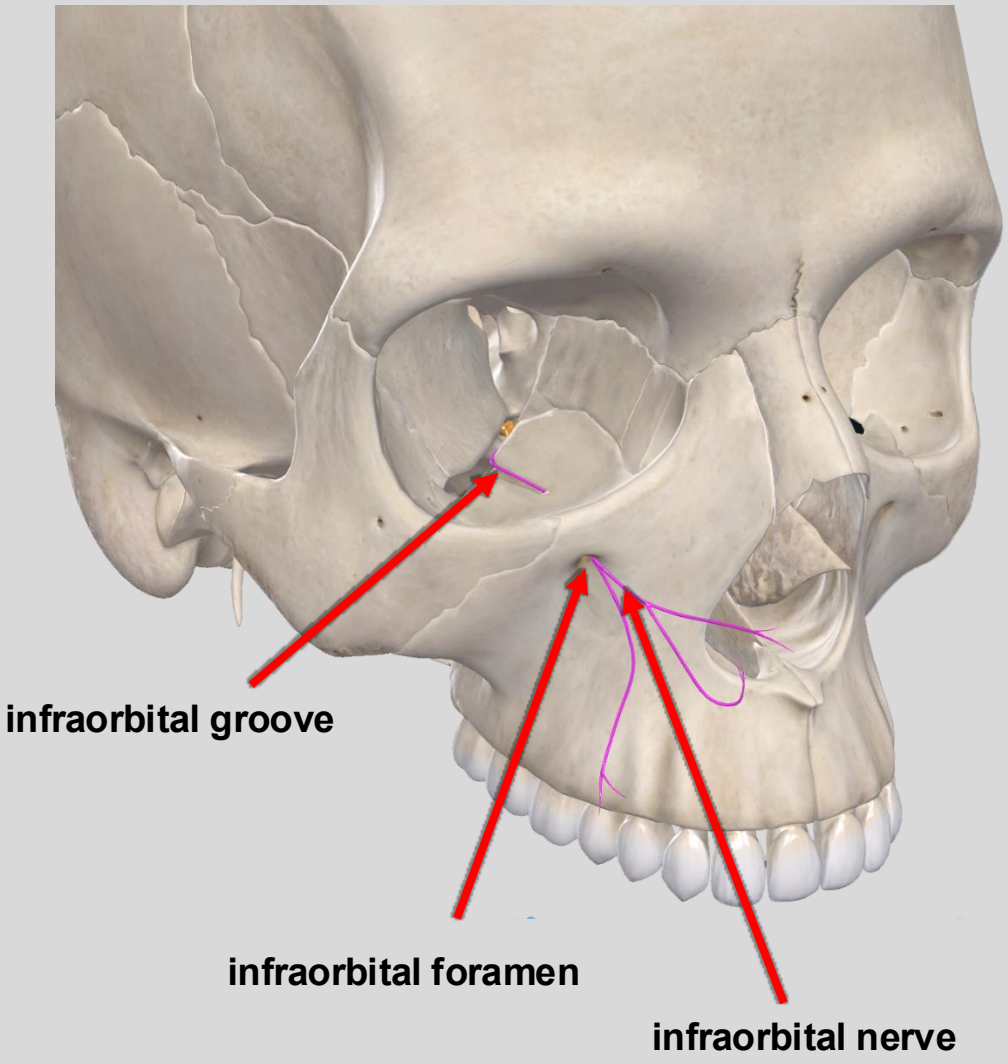
Infraorbital nerve

Courses in infraorbital groove

Exits skull from infraorbital foramen

Provides cutaneous innervation to

- Lower eyelid
- Lateral nose
- Upper lip



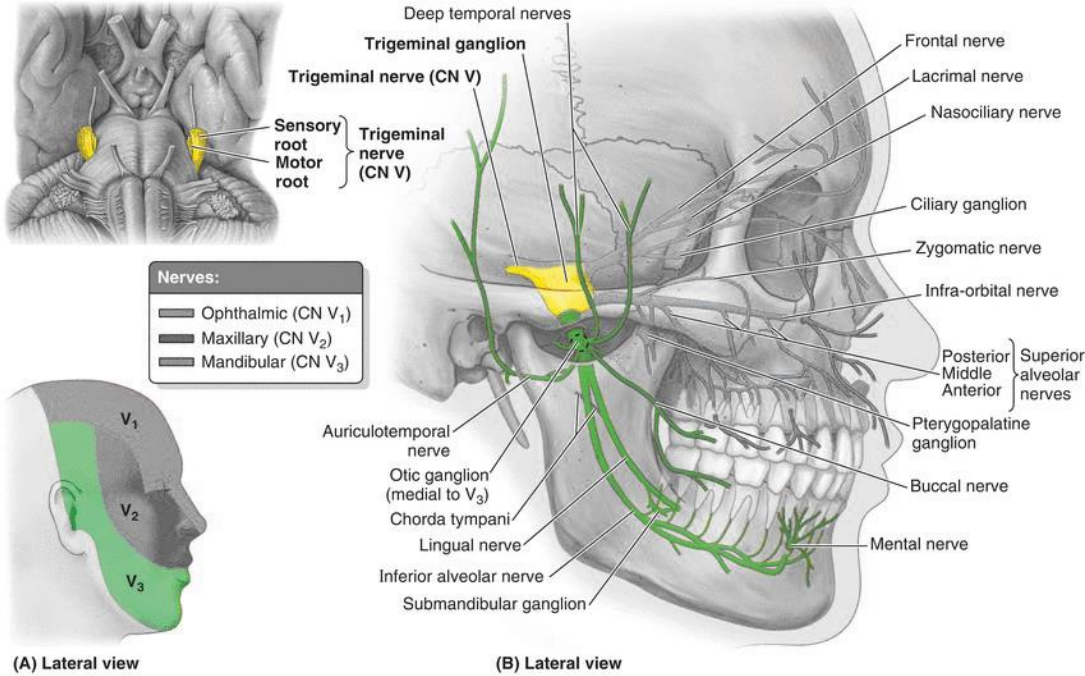
CN V_3 — Mandibular

Sensory nerve of the mandible

The *only part of trigeminal* that has a motor component

Motor roots *do not pass* through the trigeminal ganglion

Trigeminal ganglion is solely a *sensory ganglion*.



Moores Fig. 10.10A

Motor and sensory components join up to form CN V_3

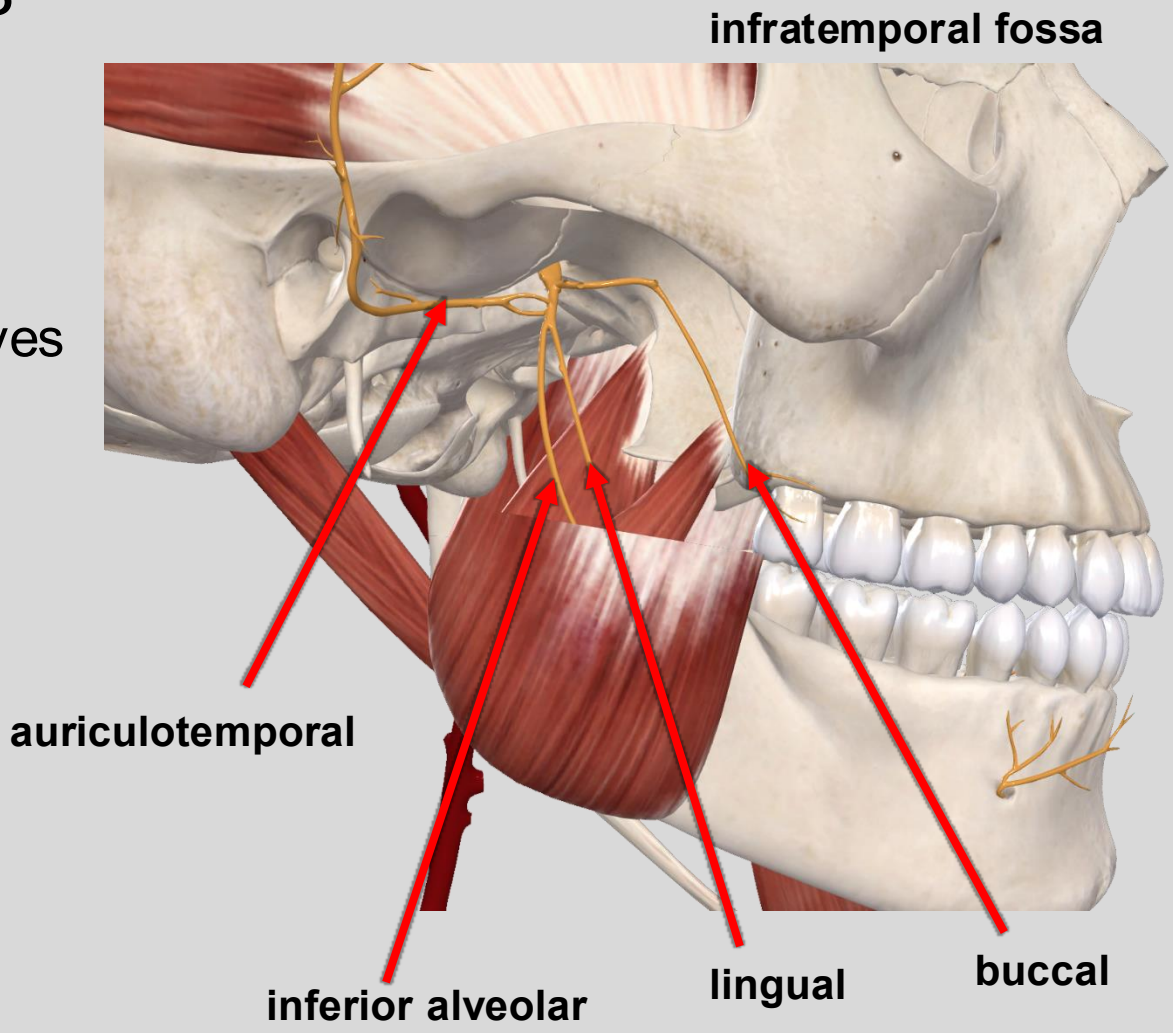
CN V_3 *exits endocranium* through foramen ovale

CN V_3 — Mandibular

Mandibular nerve enters the infratemporal fossa

There are 4 major sensory nerves

1. auriculotemporal nerve
2. buccal / long buccal nerve
3. lingual nerve
4. inferior alveolar nerve



CN V_3 — Mandibular

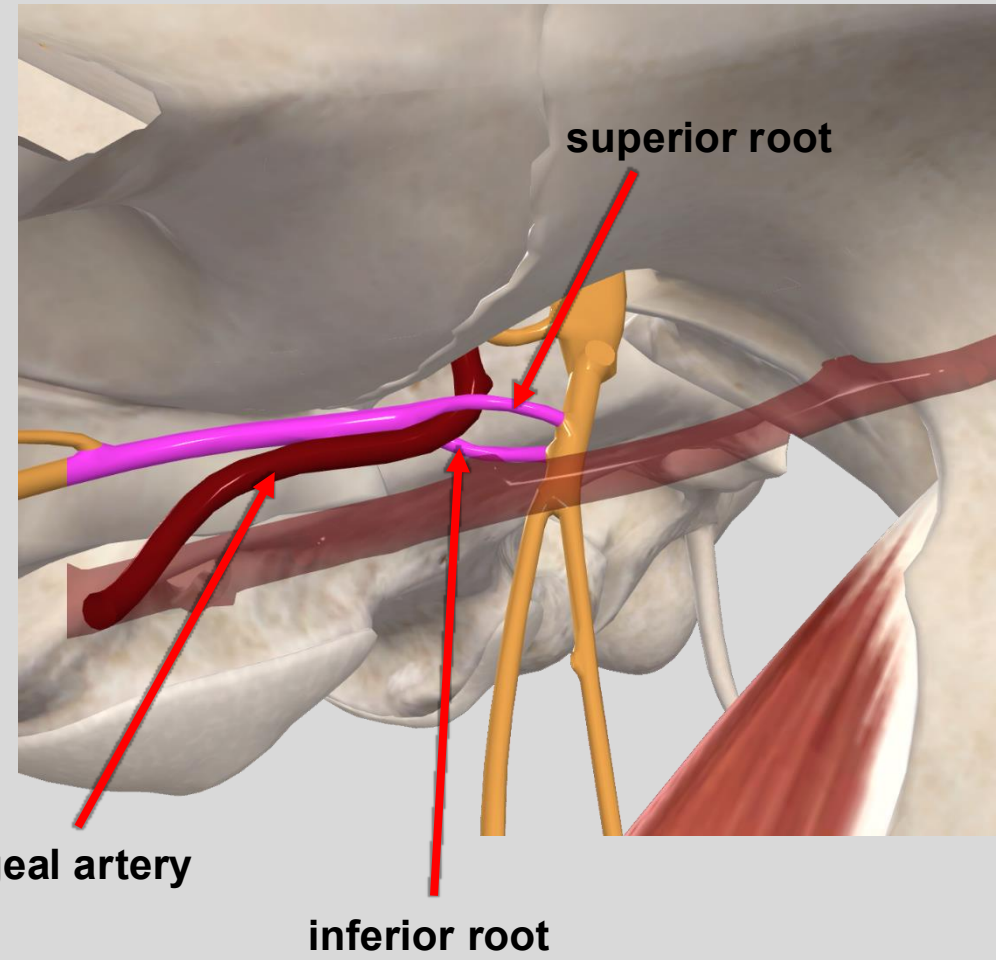
Auriculotemporal Nerve

Sensory innervation for temples and ear

Starts as two separate roots

- Superior root
- Inferior root

Splits around the middle meningeal artery



CN V_3 — Mandibular

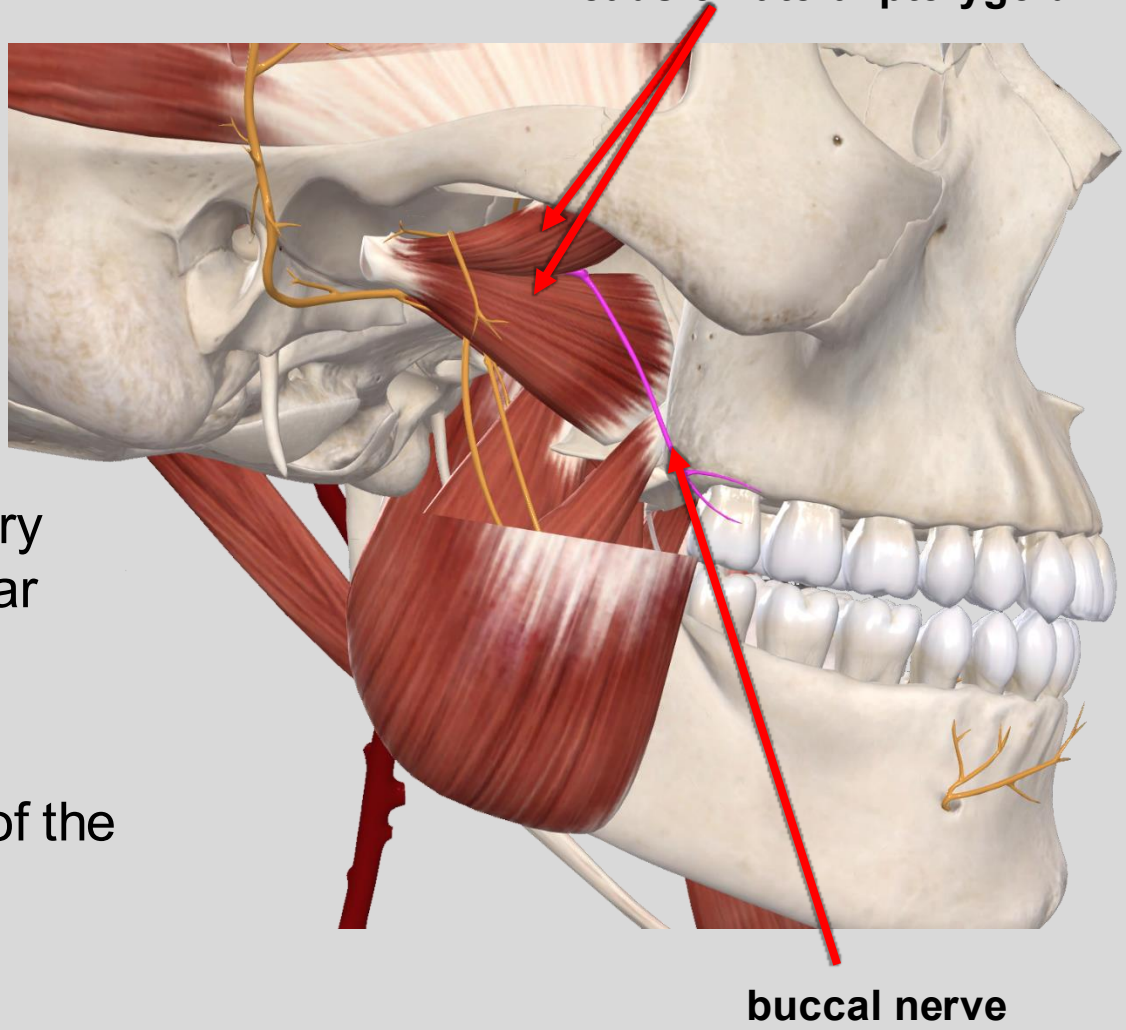
(Long) Buccal Nerve

Passes between both heads of lateral pterygoid muscle

Provides sensory information for the cheek mucosa

Variably known to provide sensory innervation to 2nd & 3rd mandibular molars

Can be confused with a branch of the facial nerve (buccal branch)



Buccal nerve is *strictly sensory*

CN V_3 — Mandibular

Inferior Alveolar Nerve

The only nerve to *enter* the mandible

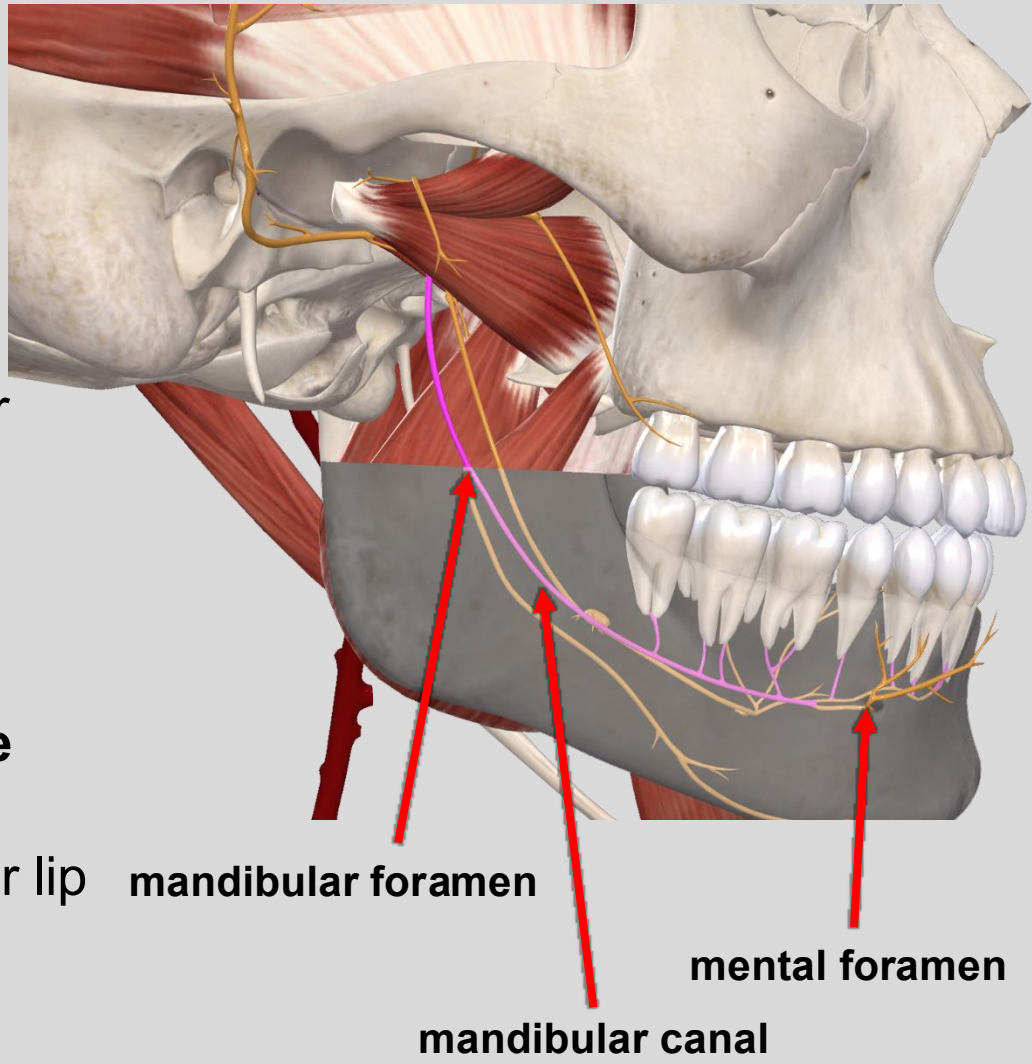
- enters at mandibular foramen
- travels in the mandibular canal

Innervates most or all the mandibular teeth

Exits skull at mental foramen

Changes names to the **mental nerve**

Provides sensory innervation to lower lip and chin



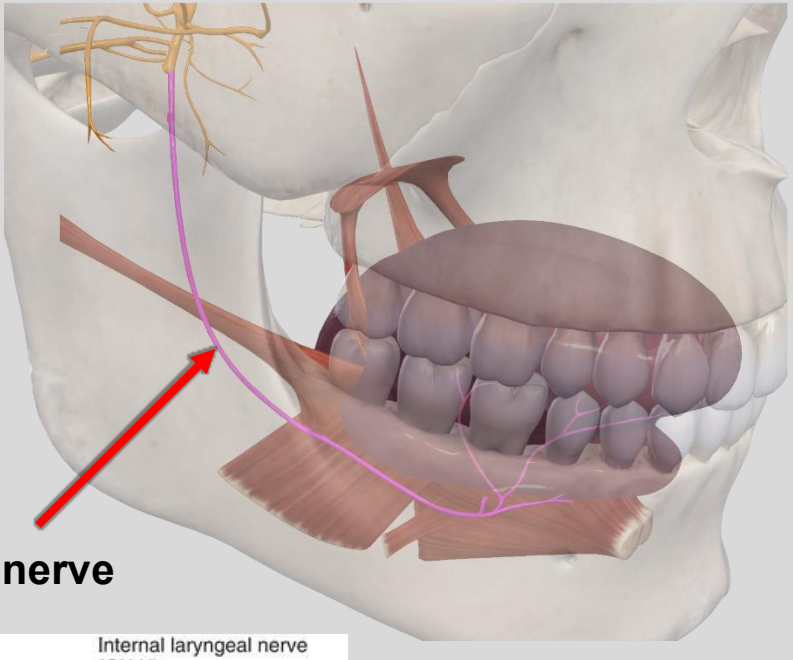
Latin: mentālis = chin

CN V_3 — Mandibular

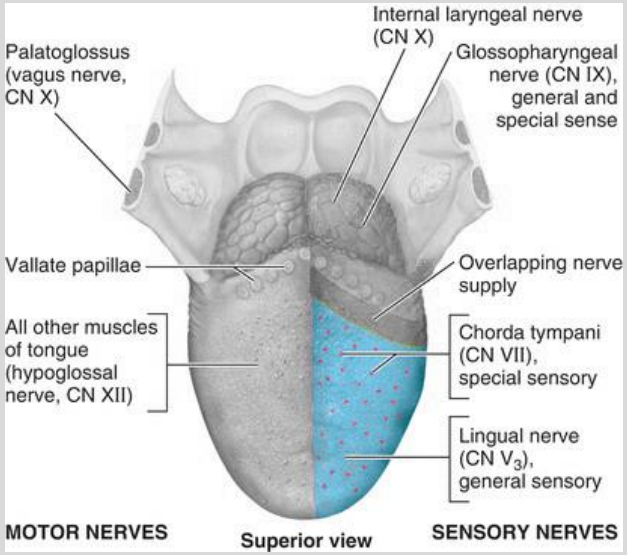
Lingual Nerve

Lingual nerve runs parallel to inferior alveolar nerve

Turns anteromedially near mandibular foramen



Provides somatic sensation to the anterior 2/3^{rds} of the tongue



Moores Fig. 8.91

CN V_3 — Mandibular

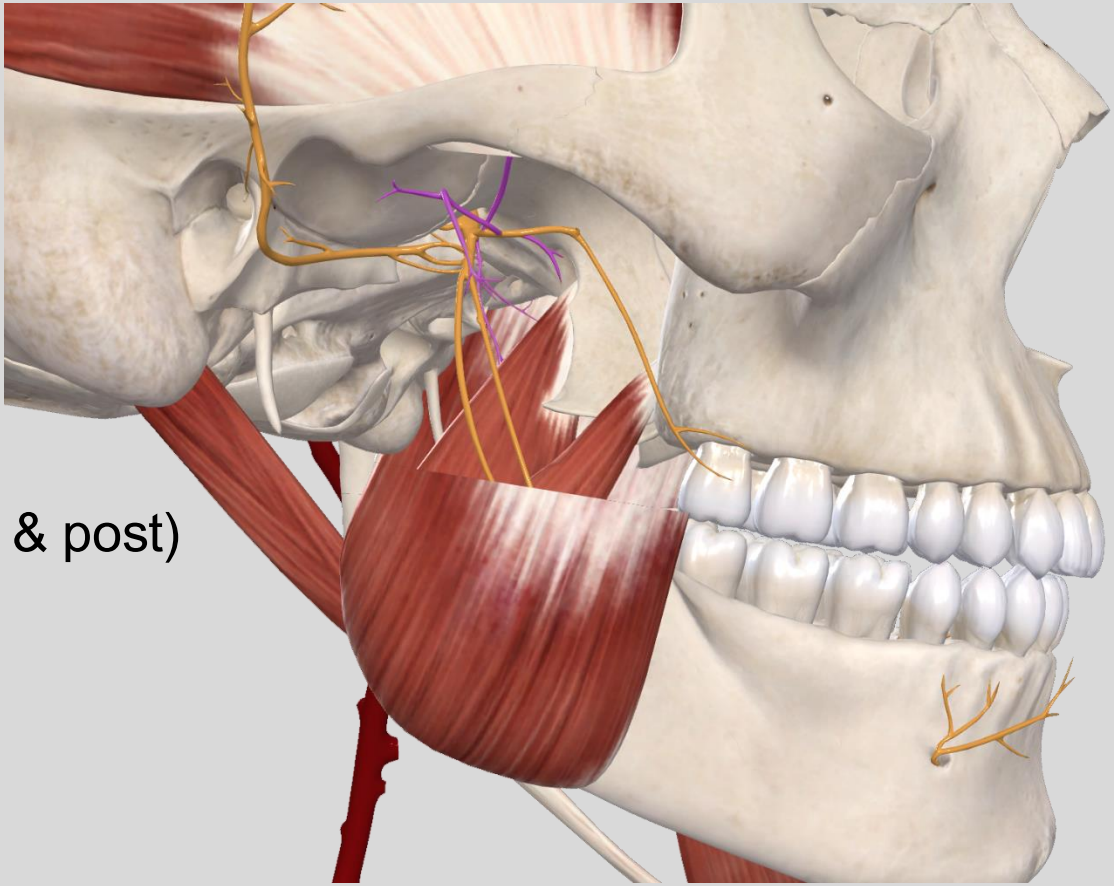
Motor Component

Smallest portion of V_3

Innervates *all* the muscles of mastication

5 branches that go to their respective masticatory muscles

1. Deep temporal nerves (ant & post)
2. Lateral pterygoid nerve
3. Medial pterygoid nerve
4. Masseteric nerve
5. Nerve to mylohyoid



This nerve innervates two different muscles

CN V_3 — Mandibular

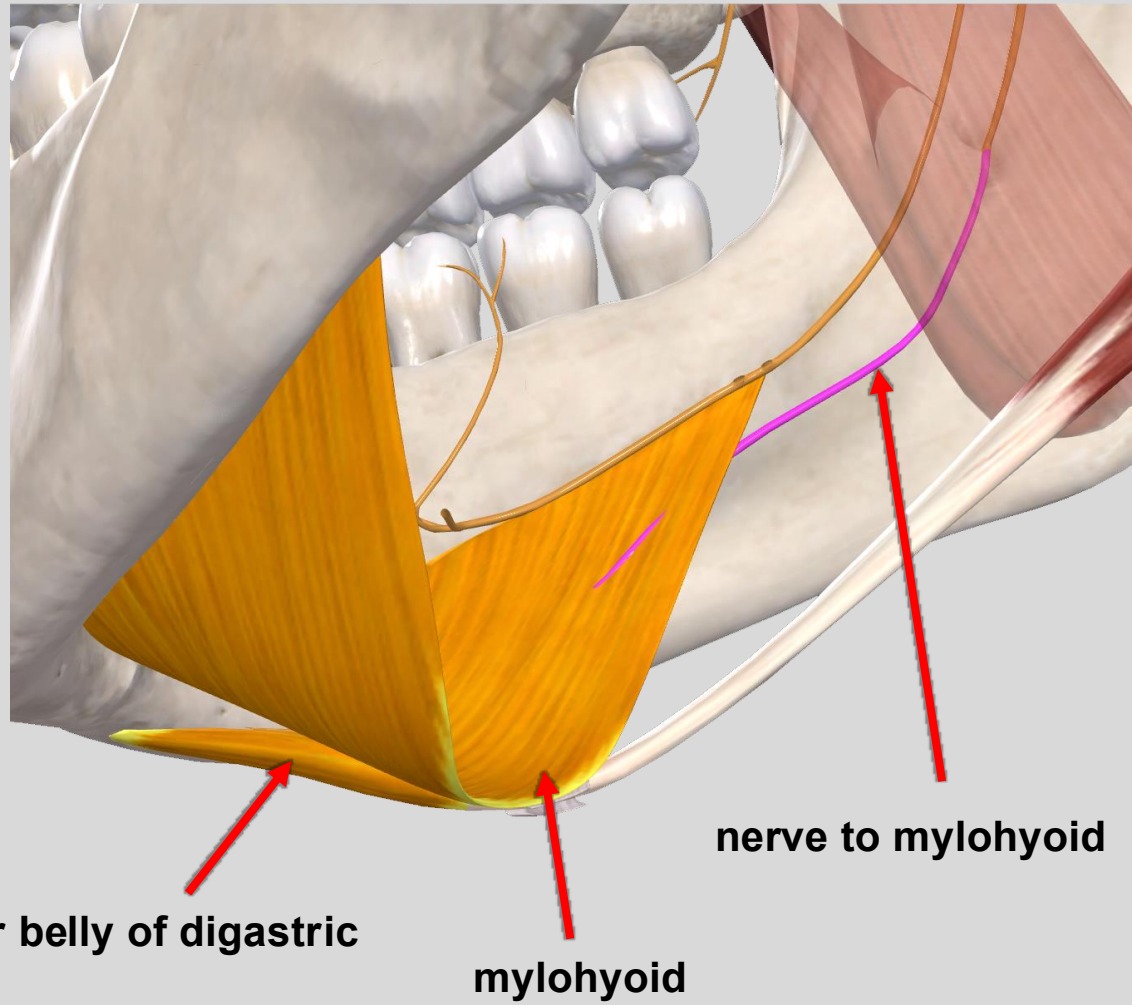
Motor Component

Nerve to mylohyoid runs with and branches off the inferior alveolar nerve

Rides along medial side of mandible to reach its destination

Innervates 2 muscles

1. Mylohyoid
2. Anterior belly of digastric

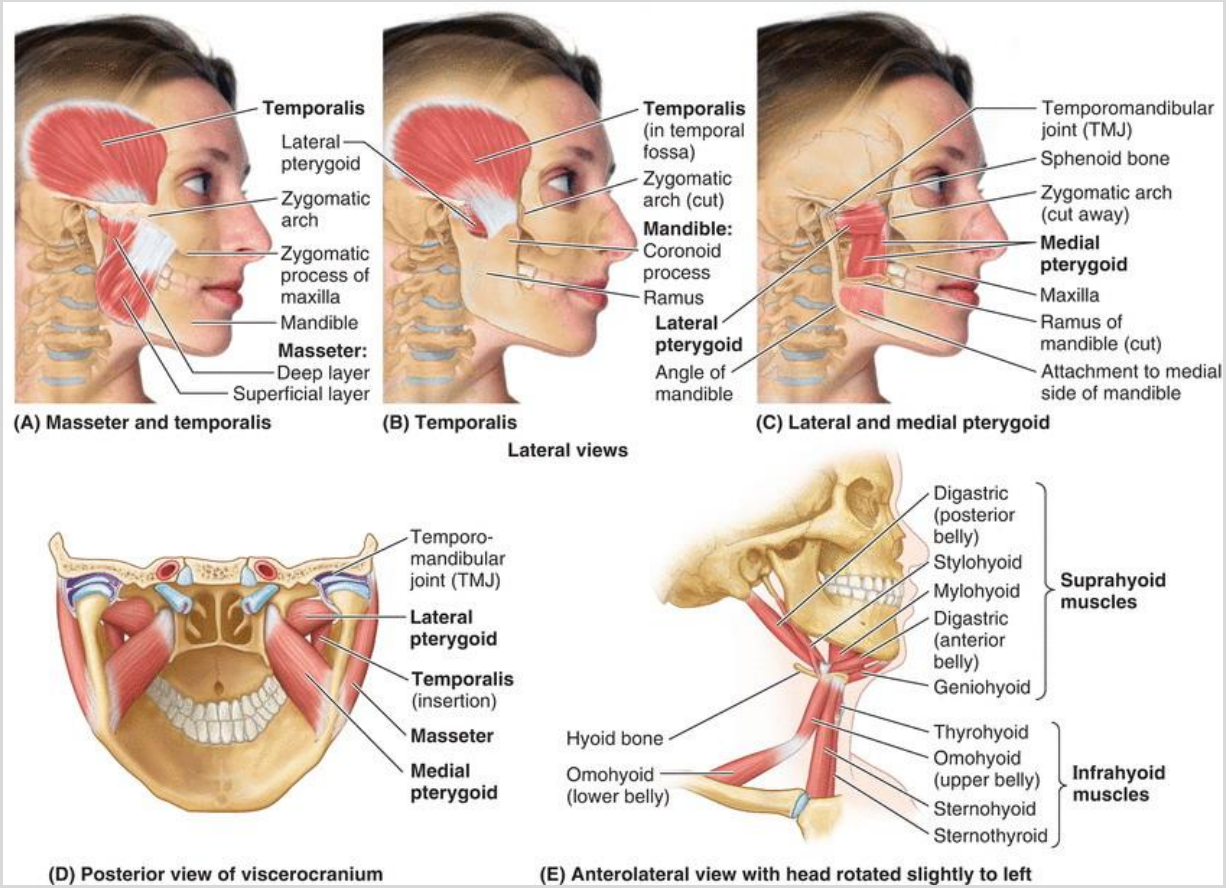


CN V_3 — Mandibular

Muscles of Mastication

Mastication = chewing

This is a complicated process involving multiple muscles acting together

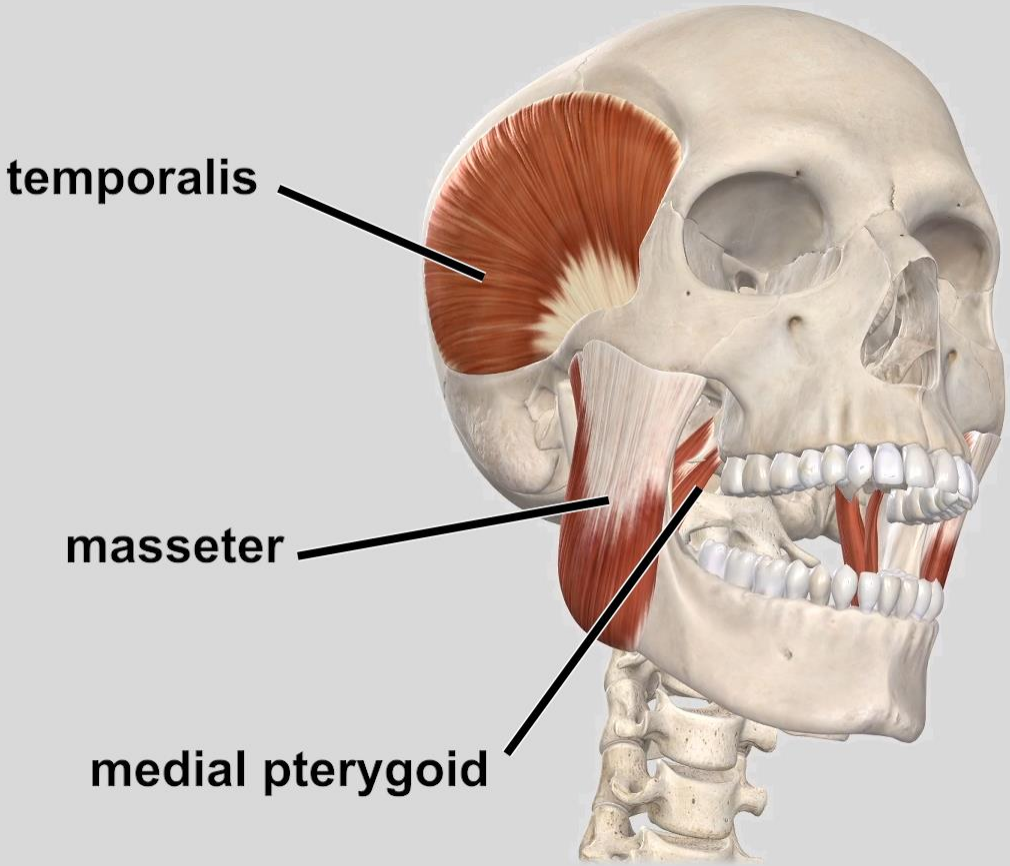


Moores Fig. 8.72

CN V_3 — Mandibular

Muscles of Mastication

In general, these muscles close the jaw



CN V_3 — Mandibular

Muscles of Mastication

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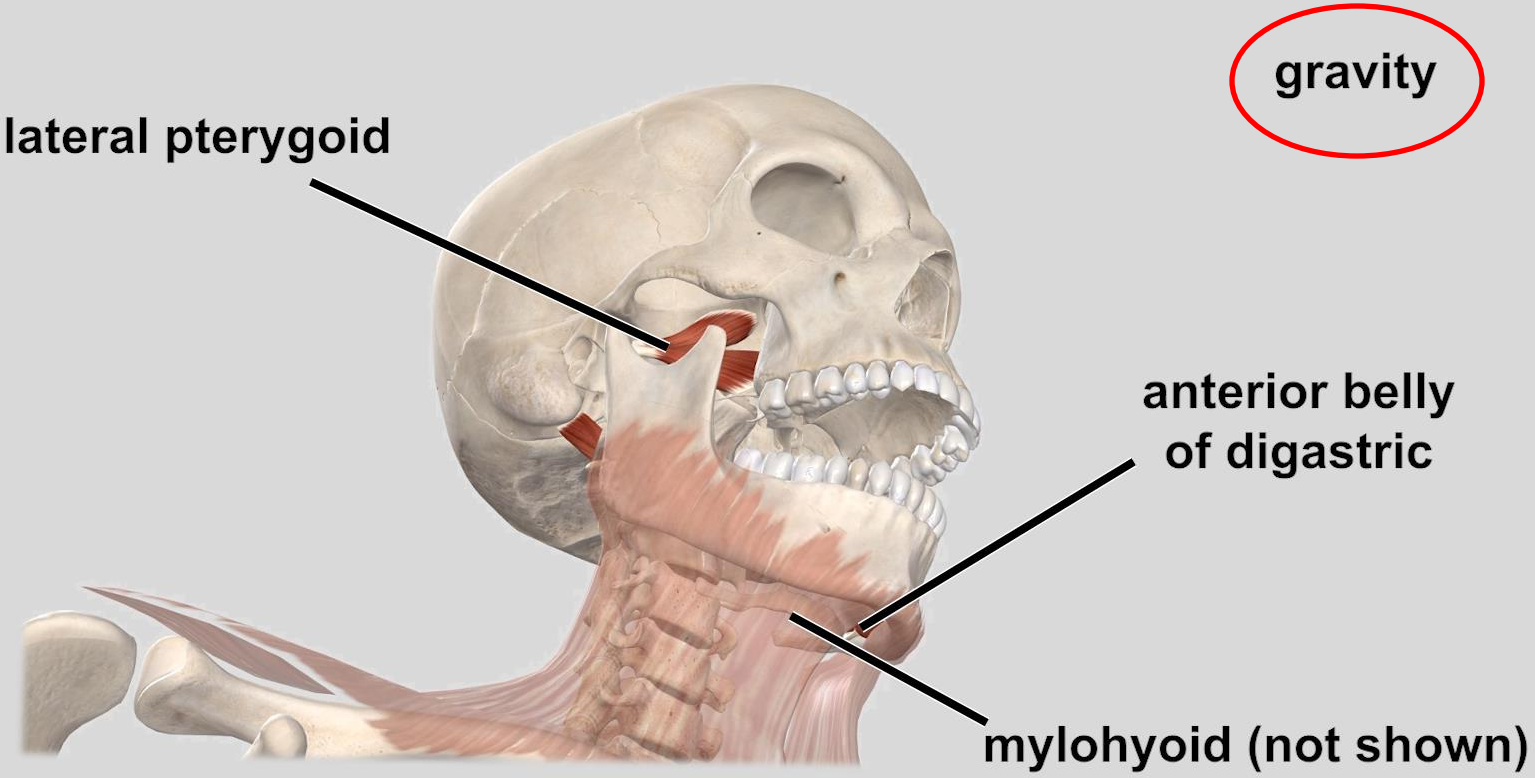


CN V_3 — Mandibular

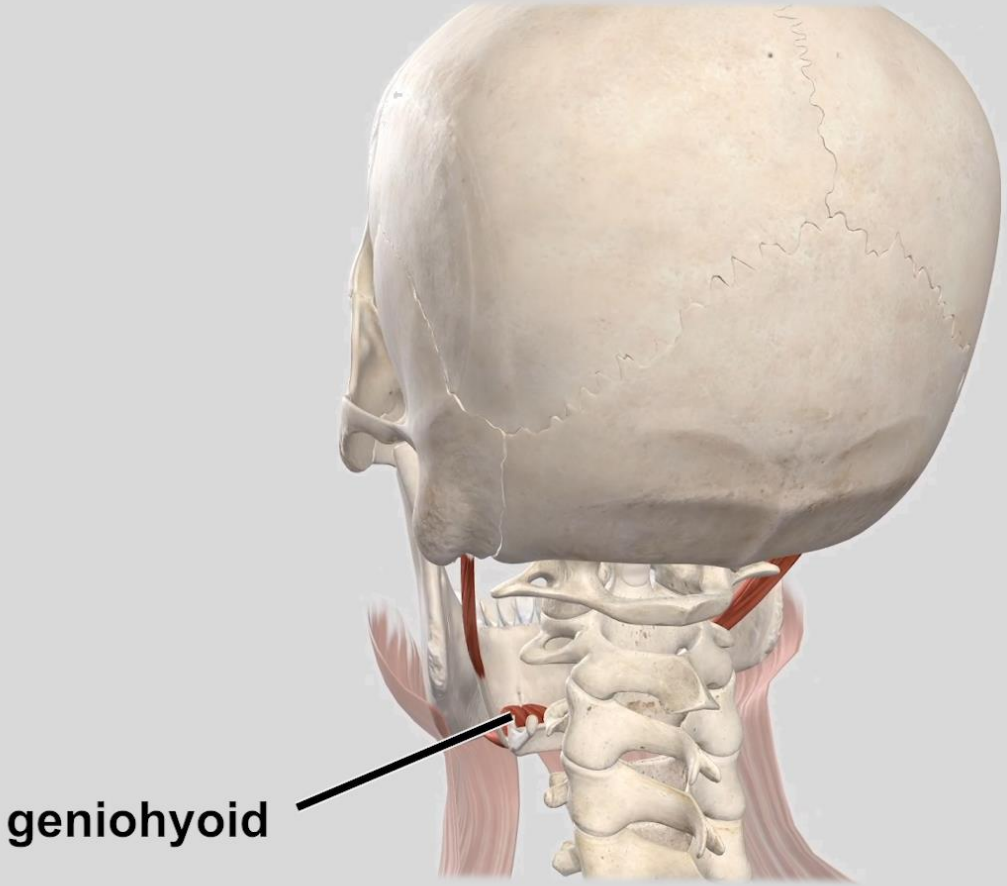
Muscles of Mastication

"Accessory muscles" of mastication

digastric (post belly)

geniohyoid

infrahyoid muscles



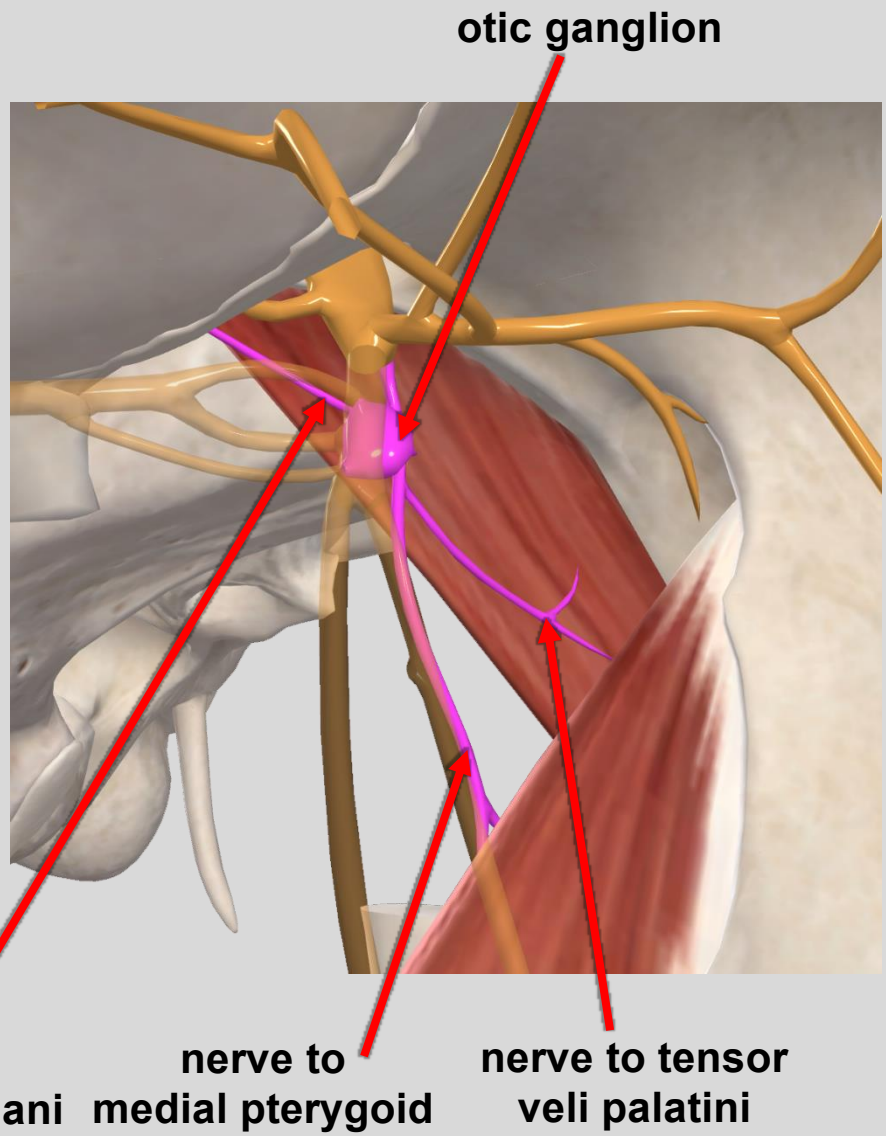
CN V_3 — Mandibular

3 nerves pass through otic ganglion

1. Nerve to medial pterygoid
2. Nerve to tensor veli palatini
3. Nerve to tensor tympani

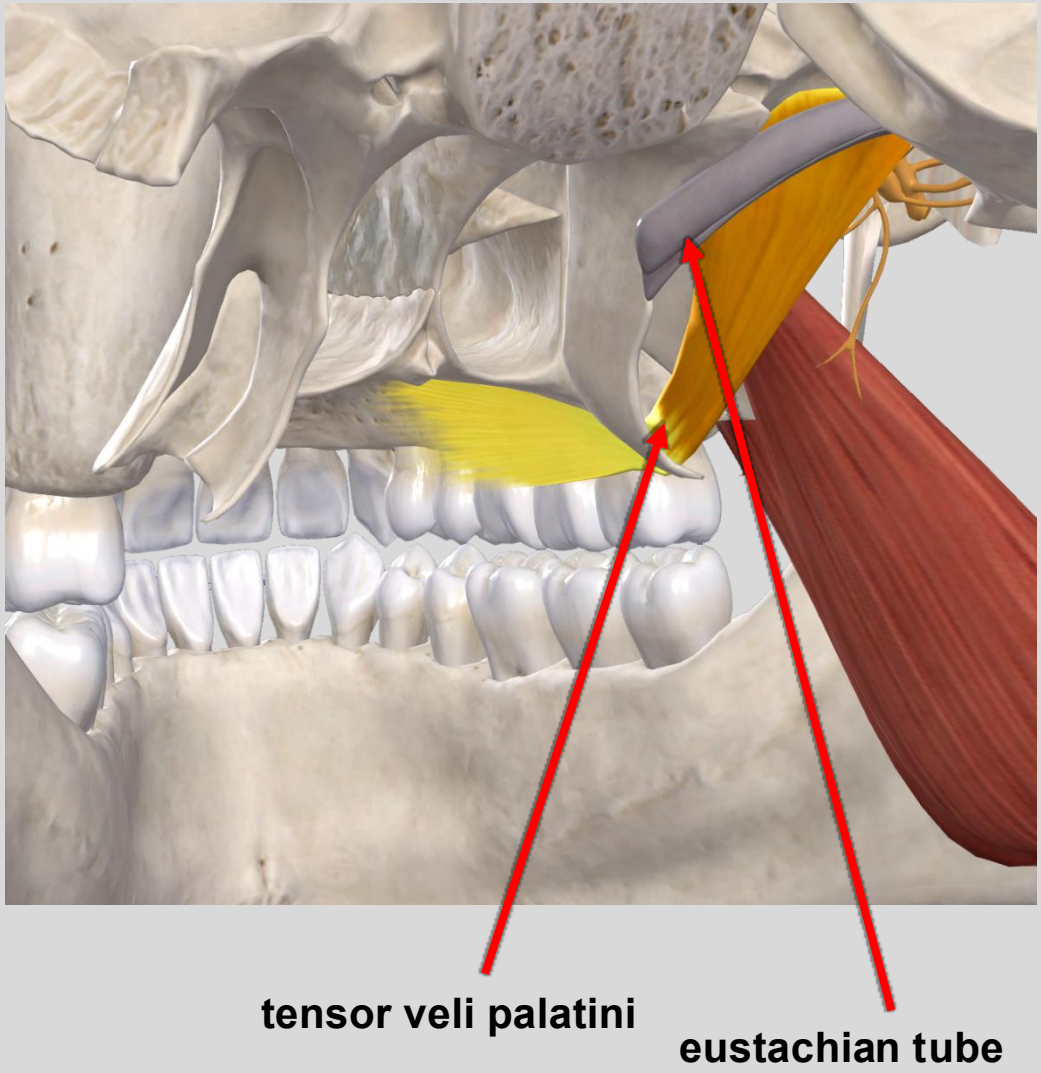
These nerves *do not synapse* in the ganglion. They just pass through it

Otic and pterygopalatine ganglion are more important for autonomics (CN VII, CN IX)



CN V_3 — Mandibular

Nerve to Tensor veli palatini



Innervates the tensor veli palatini

Stiffens soft palate in prep for swallowing

Attaches to floor of eustachian tube
Opens tube during swallowing, equalizing pressure in ears ("popping" them)

CN V_3 — Mandibular

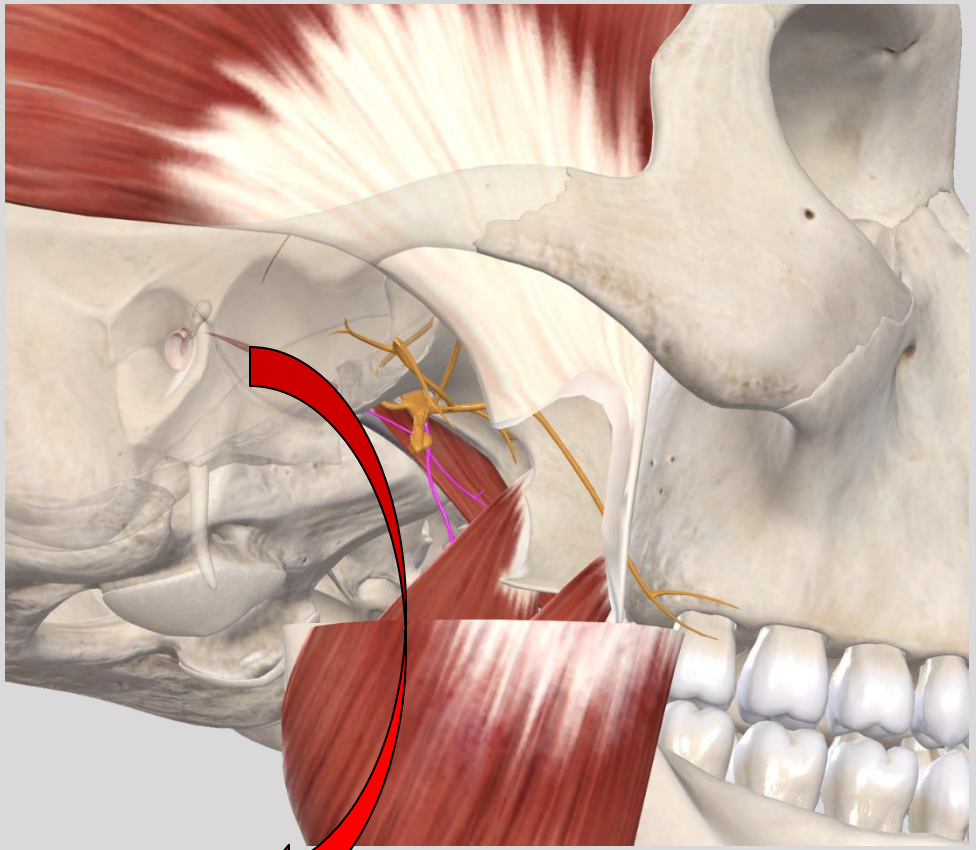
Nerve to Tensor tympani

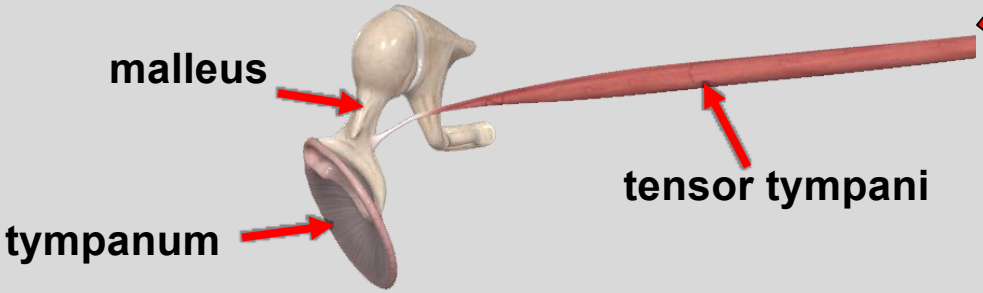
Innervates the tensor tympani

Attaches to the malleus, stiffening the tympanic membrane

Reduces vibrations from tympanic membrane to ear ossicles, dulling sound

Activates in response to loud sounds





CN V — Trigeminal

Clinical Correlates

Trigeminal neuralgia (tic douloureux)

Misfiring of one or more branches of trigeminal

Patients complain of acute, intense pain on face

Can be stimulated by a slight breeze

Most cases are idiopathic

Treatment varies from local anesthesia to nerve resection

CN V — Trigeminal

Clinical Correlates

TMJ disorders

Problem related to the temporomandibular jaw joint

Unbalanced muscle firing produces

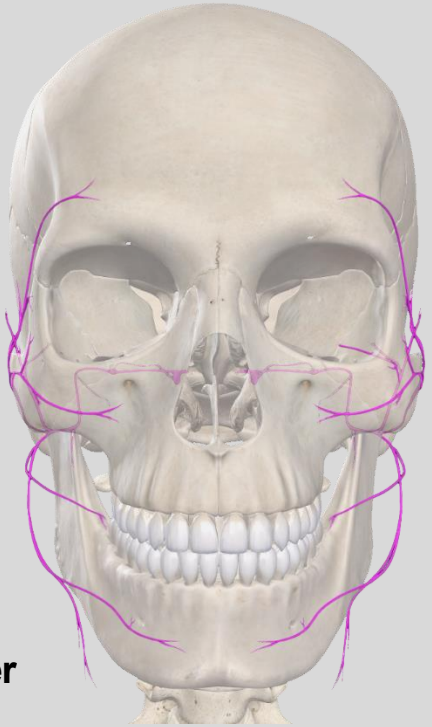
- Misaligned teeth
- Can lead to tooth grinding (bruxism)
- Jaw tenderness
- Headaches
- Lock jaw
- Ear pain (e.g., through auriculotemporal nerve aggravation)

CN VII — Facial

Main motor nerve for the face

Innervates all the muscles of facial expression (20+ muscles)

Major autonomic nerve for the face

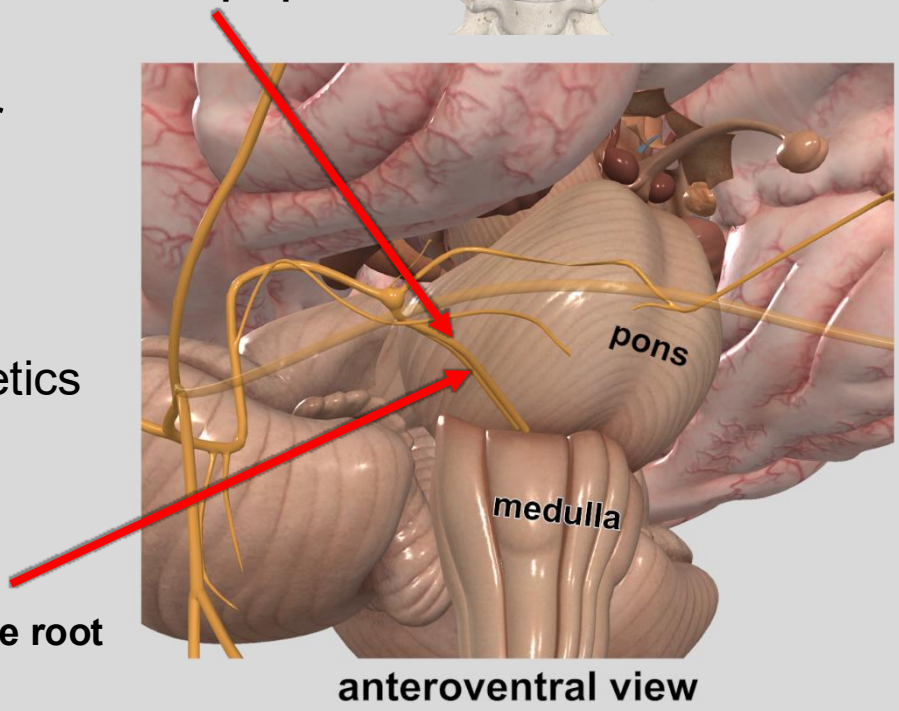


Facial consists of 2 roots

1. Primary motor root (facial nerve proper) = somatic motor

2. Intermediate root / nerve = sensory & parasympathetics

Exits endocranium through internal acoustic meatus



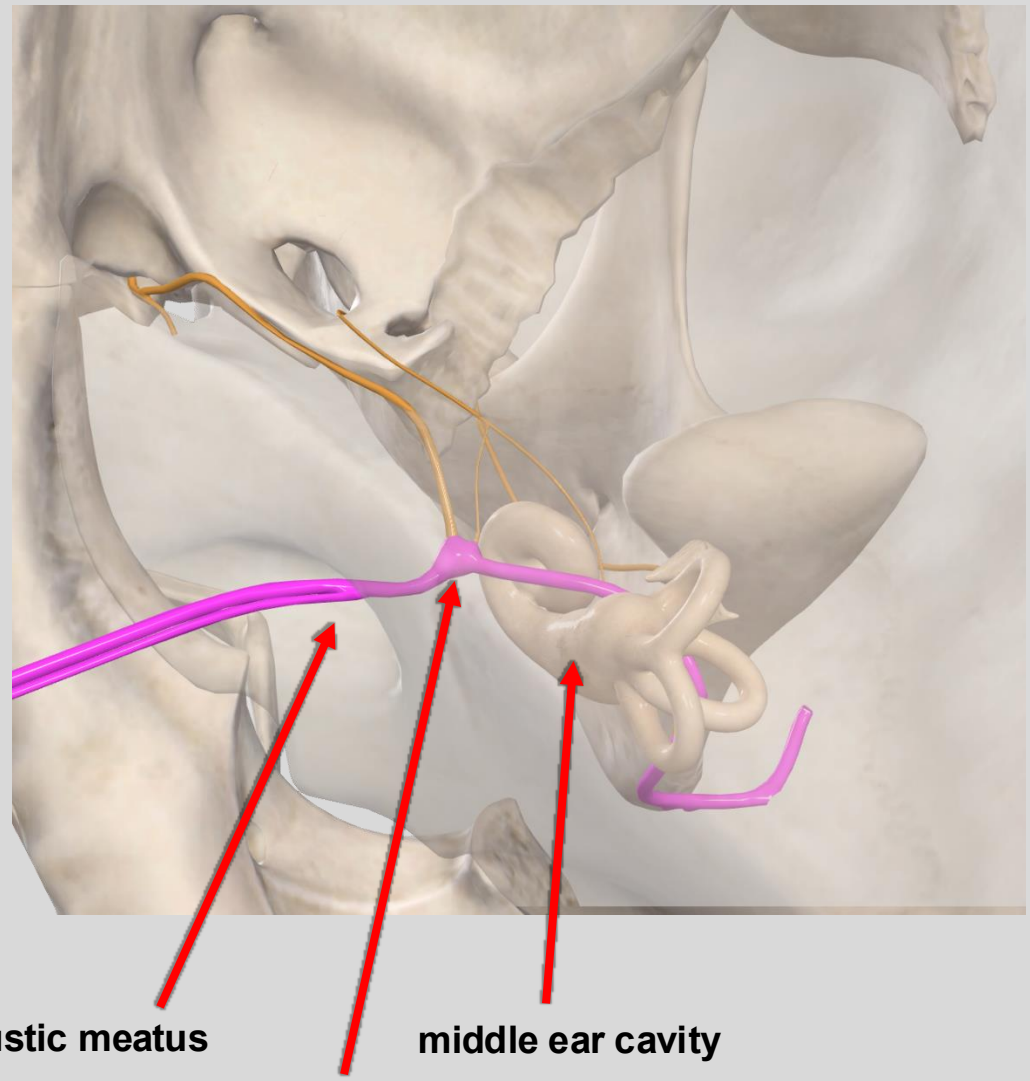
CN VII — Facial

Facial nerve takes the *longest intraosseous course* of any cranial nerve

Facial nerve travels through the facial canal

At geniculum, facial nerve expands into geniculate ganglion

Geniculate ganglion is important for the autonomic component of facial



Latin: genu = knee

CN VII — Facial

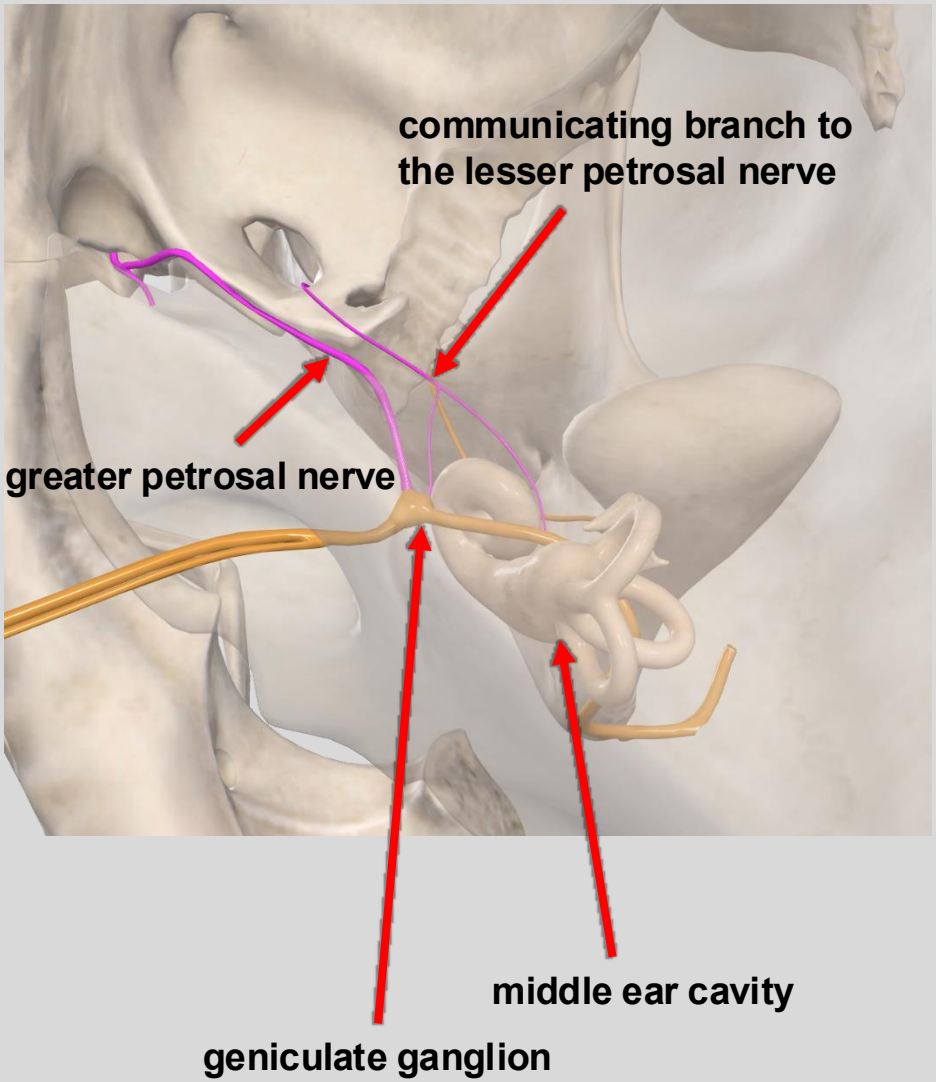
3 branches exit the geniculate ganglion

1) Greater (superficial) petrosal nerve

2) Communicating branch to the lesser petrosal nerve

3) External petrosal nerve
(not shown in Complete Anatomy)

These branches send autonomic innervation around the head



CN VII — Facial

Nerve to Stapedius

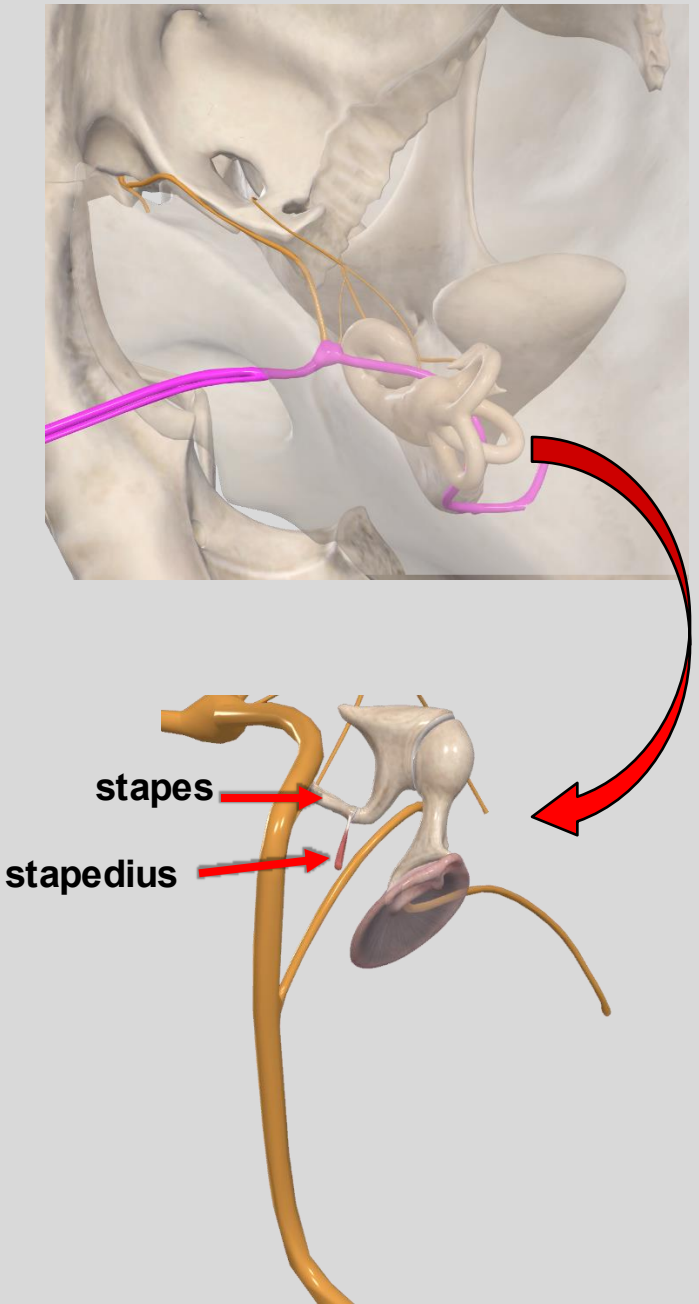
Facial nerve continues around the tympanum

Sends out the nerve to stapedius

Innervates the stapedius muscle

Muscle locks down the stapes around loud noises

Dulls sound, protecting the ear



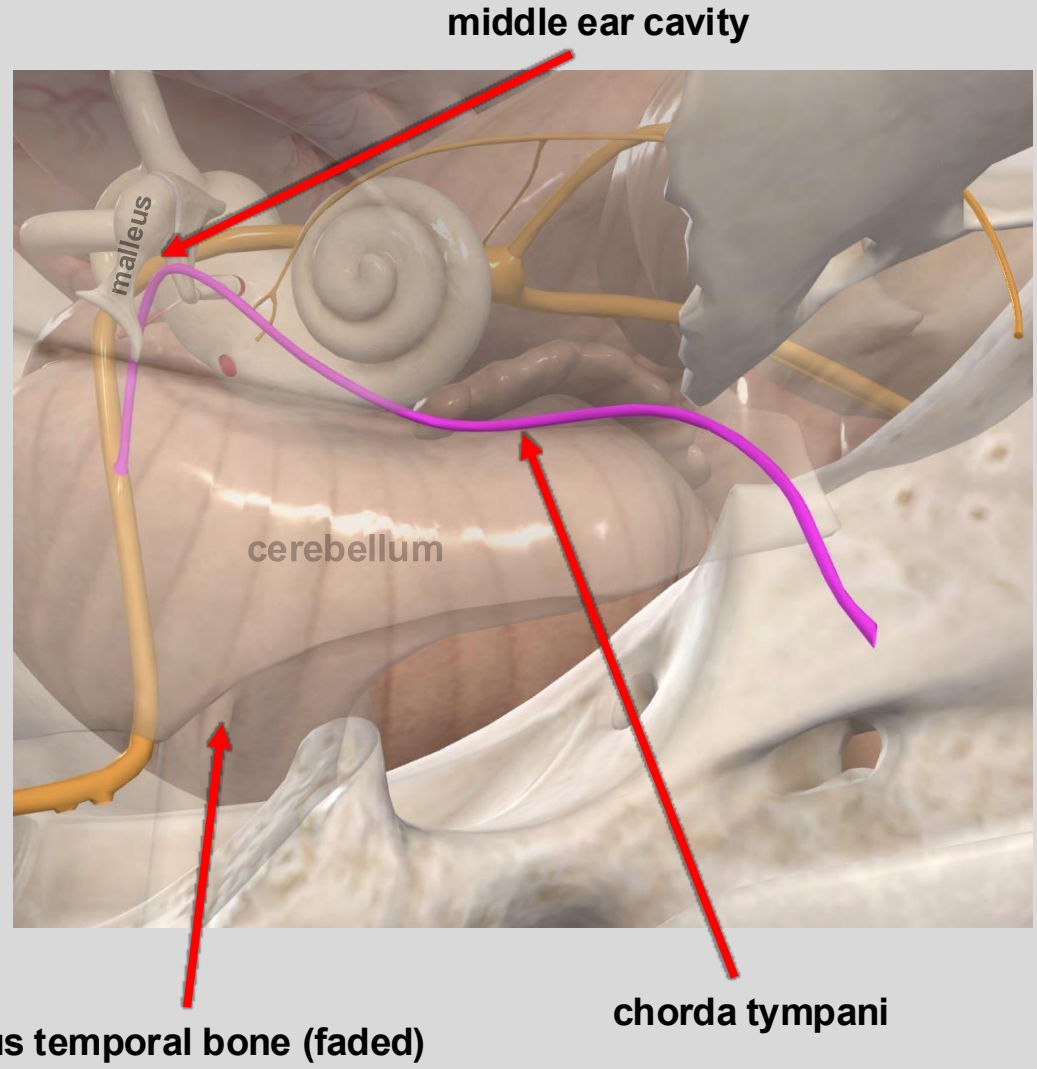
CN VII — Facial

Chorda tympani

Facial sends a branch into the middle ear: chorda tympani

Chorda tympani passes through middle ear and *exits skull* through the petrotympanic fissure

Joins with lingual nerve to provide taste to anterior 2/3^{rds} of tongue



CN VII — Facial

The rest of facial *exits the skull* through the stylomastoid foramen

After exiting, facial sends out the posterior auricular nerve

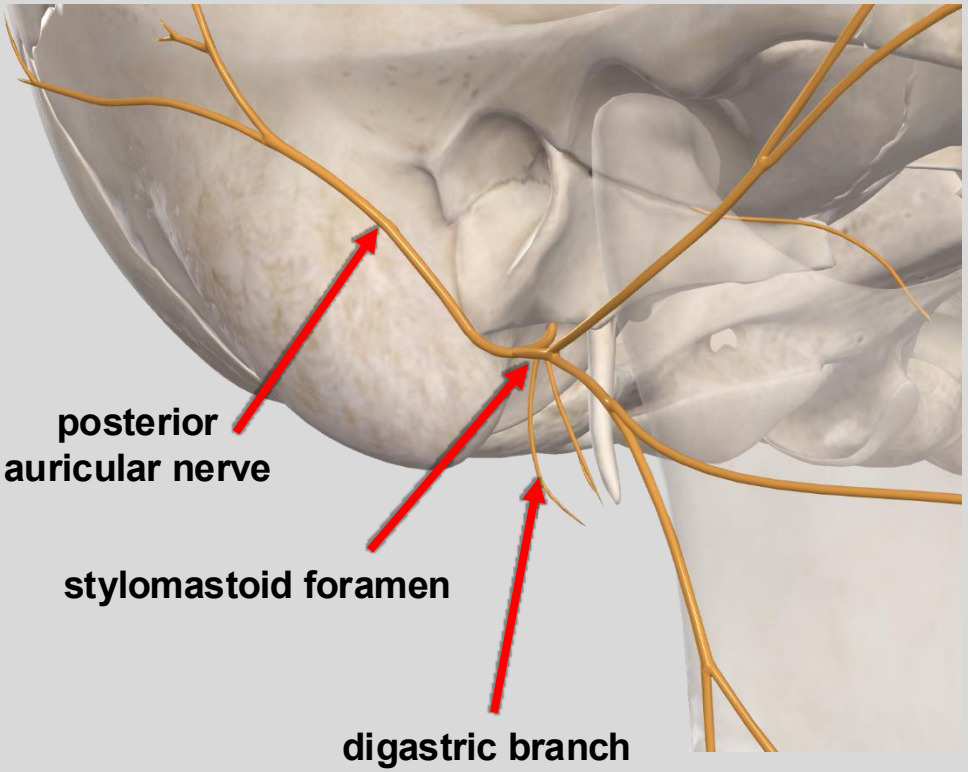
innervates vestigial ear muscles

The digastric branch innervates the posterior belly of digastric

Digastric muscle has dual innervation

Anterior belly = CN V_3

Posterior belly = CN VII



The rest of facial continues on to form the **parotid plexus**

CN VII — Facial

Parotid Plexus

This happens deep within the parotid gland

5 branches of parotid plexus

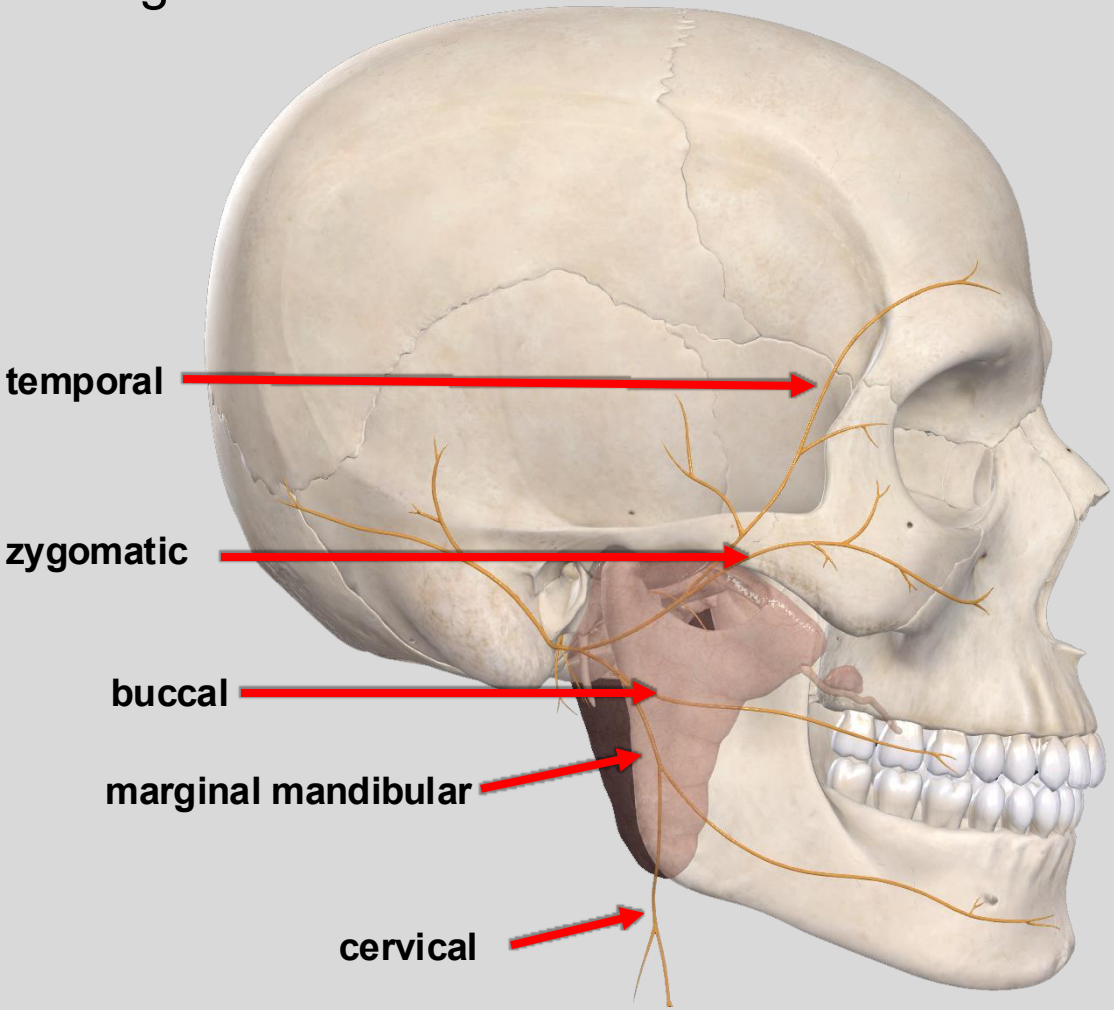
1) Temporal

2) Zygomatic

3) Buccal

4) Marginal Mandibular

5) Cervical



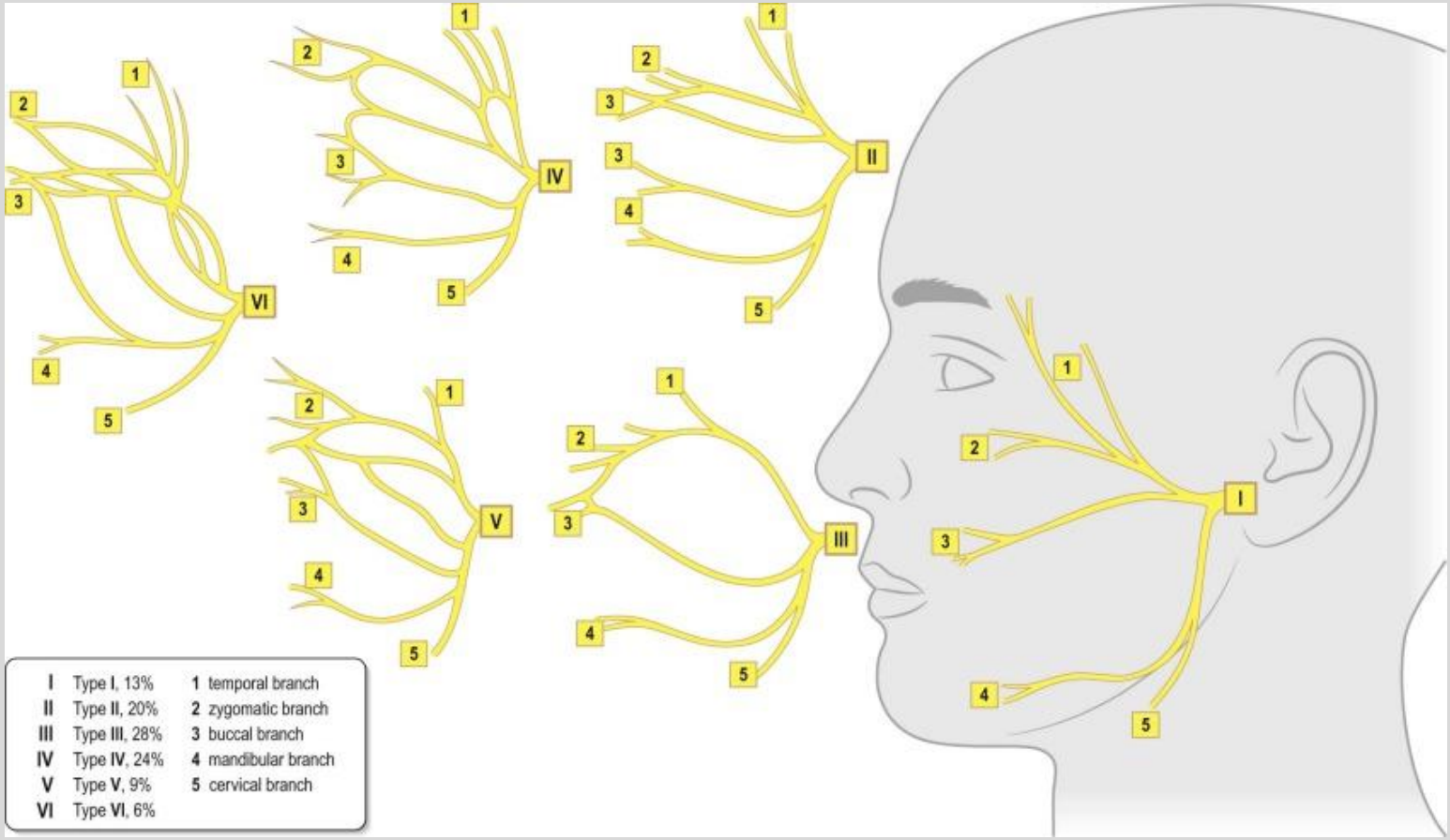
All branches innervate nearby muscles of facial expression

CN VII — Facial

Parotid Plexus

Arbourization pattern of the parotid plexus is highly variable

You will only be tested on the "textbook" version



Gray's Anatomy

CN VII — Facial

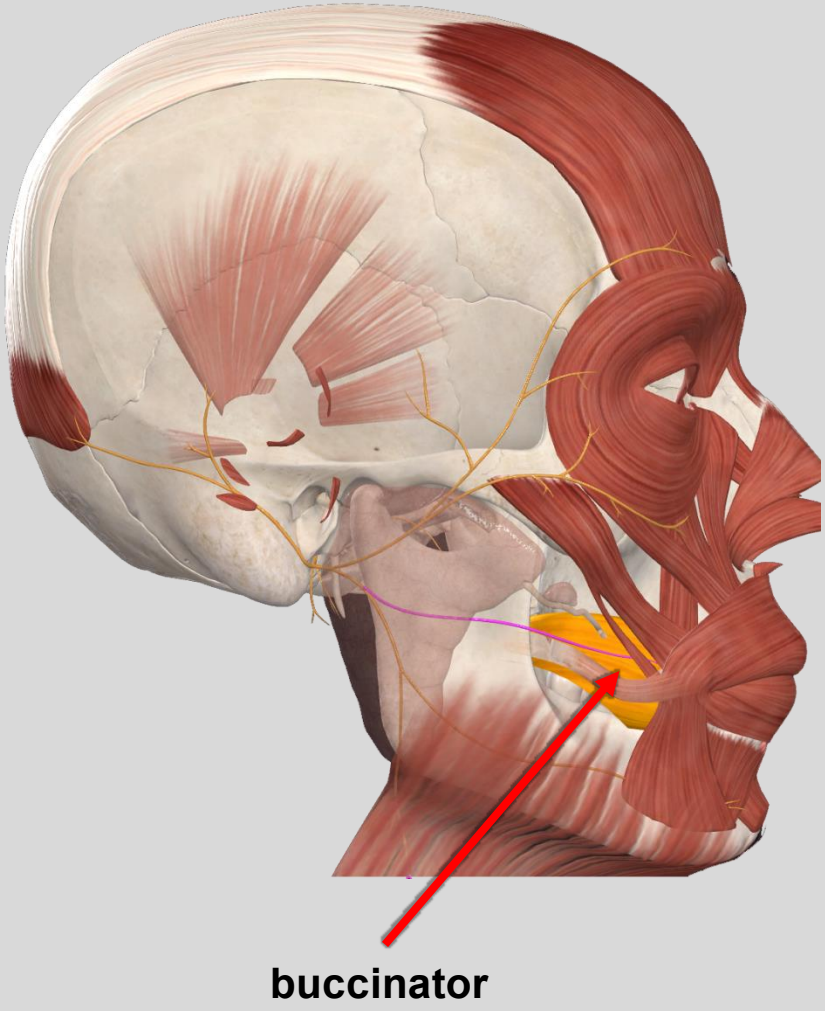
Parotid Plexus

Don't confuse your innervations!

Buccinator is a *muscle of facial expression* that tenses the cheeks

Buccal nerve (V_3) = *sensory* innervation to cheek mucosa

Buccal branch of Facial (VII) = *motor* innervation to buccinator



CN VII — Facial

Clinical Correlate

Bell's Palsy

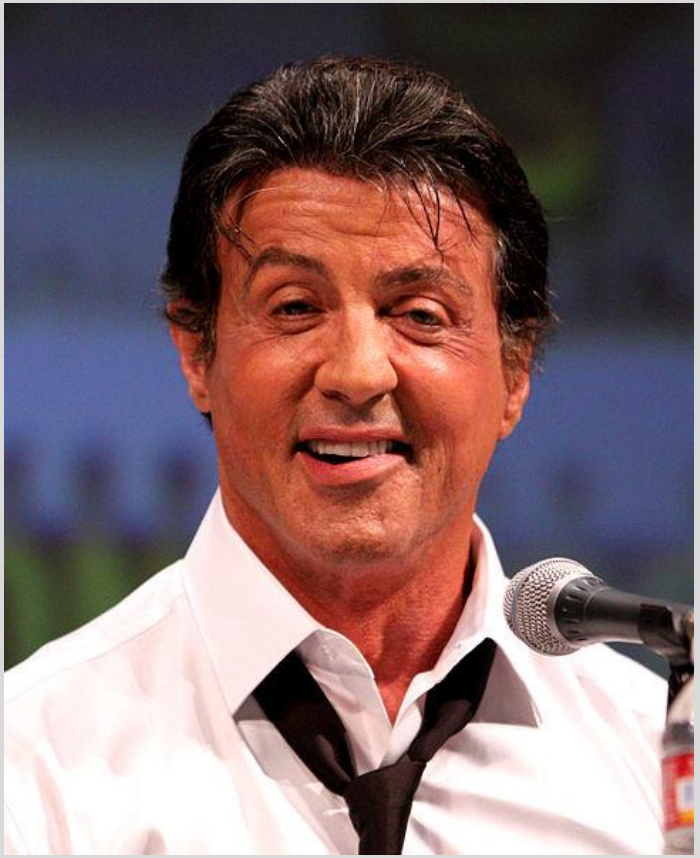
Lesion to one or more branches of parotid plexus

Causes partial / total paralysis of ipsilateral facial muscles

Most cases are idiopathic

Symptoms usually to resolve over weeks / months

Occasionally Bell's Palsy is permanent



Sylvester Stallone
(permanent partial Bell's Palsy)

Lecture Feeback Survey

https://comresearchdata.nyit.edu/redcap/surveys/?s=HRCY448FWYXREL4R

Cranial nerves: IX, X, XI & XII

NEW YORK INSTITUTE OF TECHNOLOGY
College of Osteopathic Medicine

Paths and Functions of Somatic Afferents and Efferents of the Head and Neck

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Department of Biomedical and Anatomical Sciences

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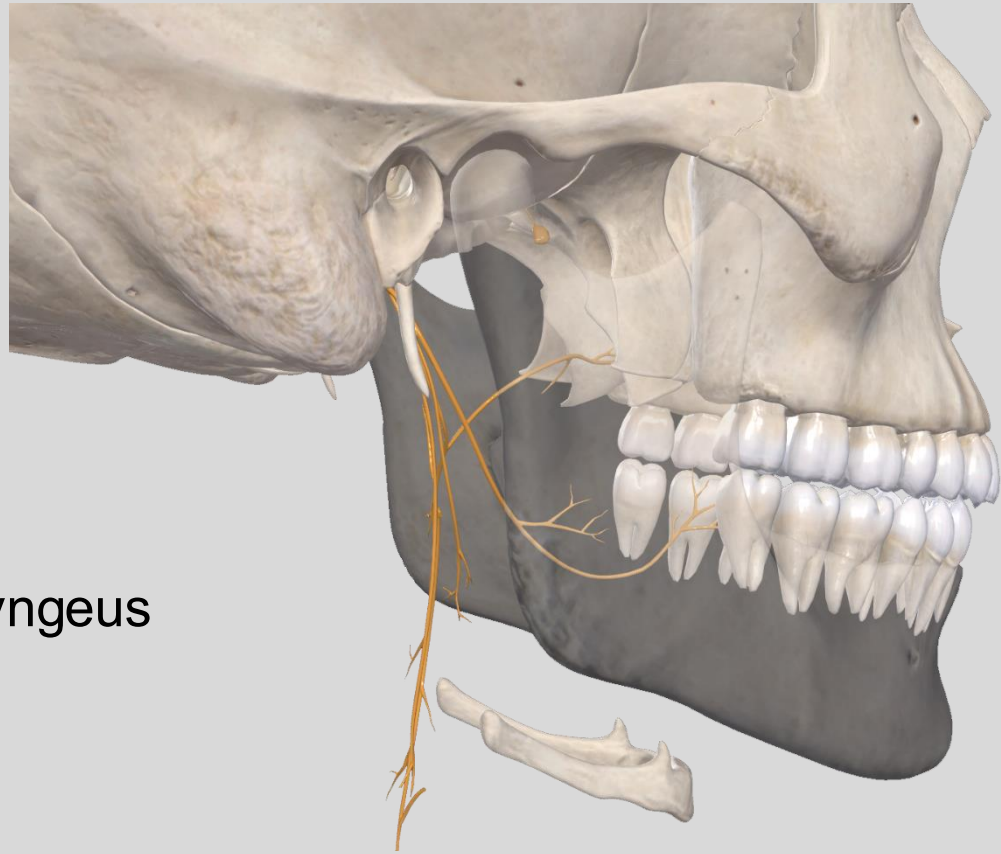
Do.
Make.
Heal.
Innovate.
Reinvent the Future.

CN IX — Glossopharyngeal

The primary sensory nerve of the pharynx



Transmits somatic sensory and taste innervation for the proximal 1/3rd of the tongue

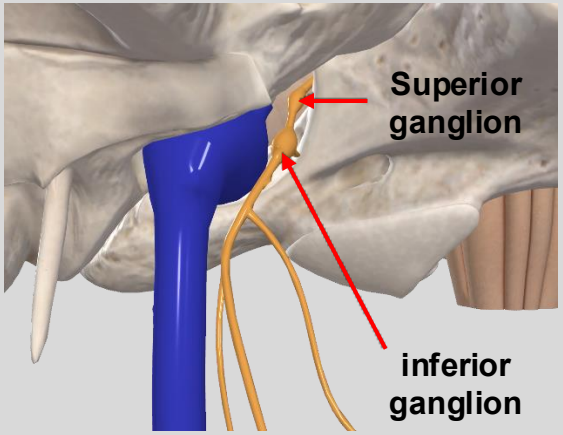
Innervates a single muscle: stylopharyngeus

Exits endocranium and skull through the jugular foramen

CN IX — Glossopharyngeal

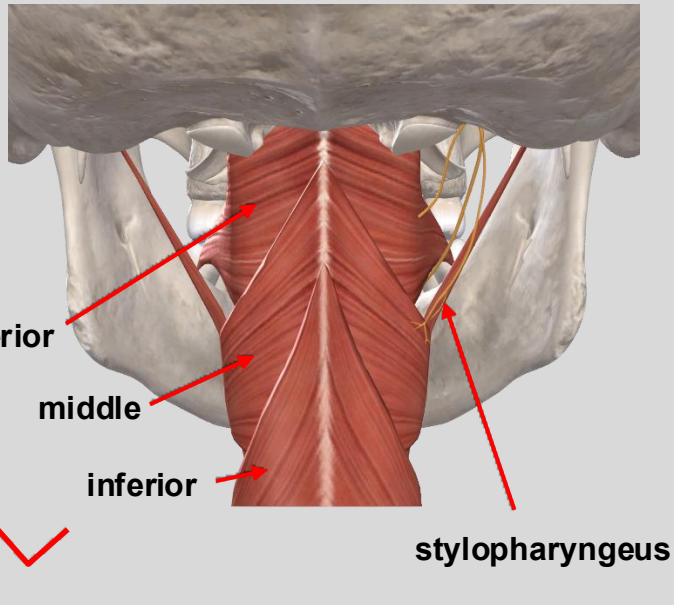
Forms two successive ganglia

- Superior ganglion
- Inferior / Petrous ganglion

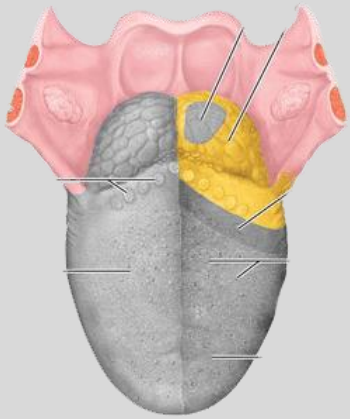


Sends single motor branch to stylopharyngeus

Nerve dives between superior and middle pharyngeal constrictors where it forms the afferent limb of the pharyngeal plexus



Exits constrictors and goes to the posterior tongue

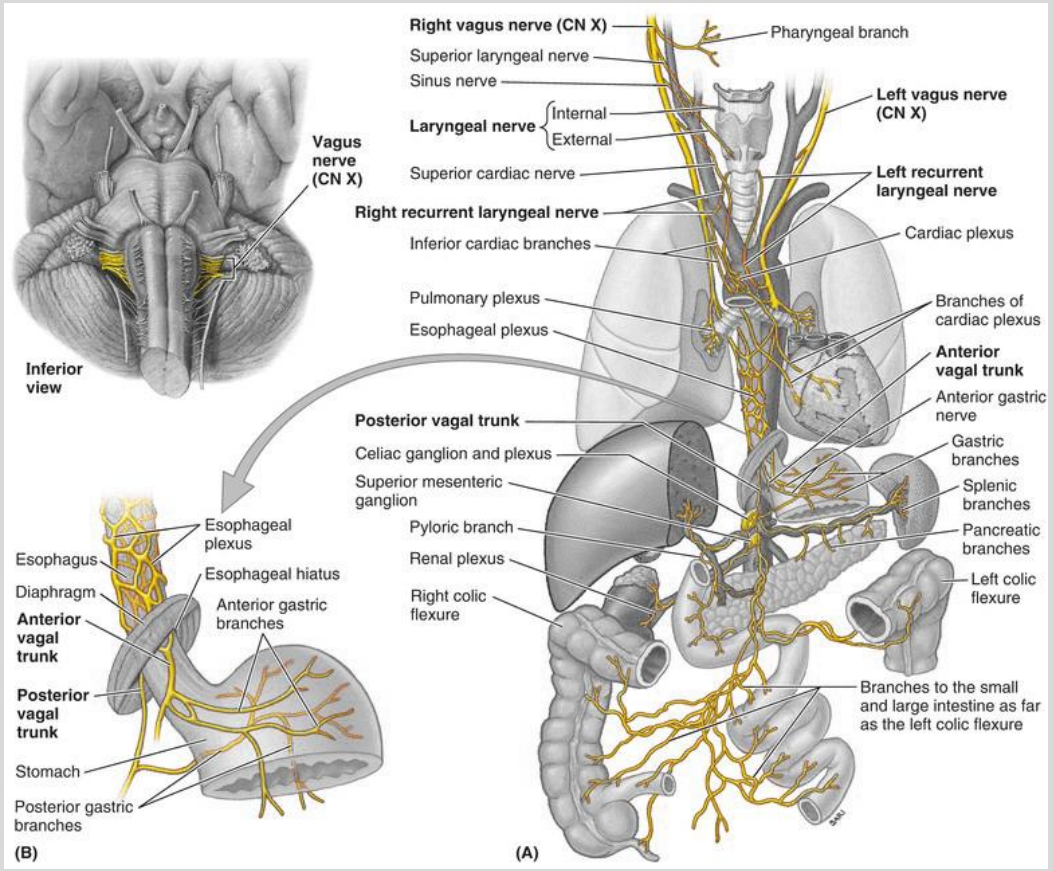


CN X — Vagus

CN X has the most complicated distribution of all the cranial nerves

Main conduit of parasympathetic innervation below the neck

This lecture will only focus on the branches active in the head and neck

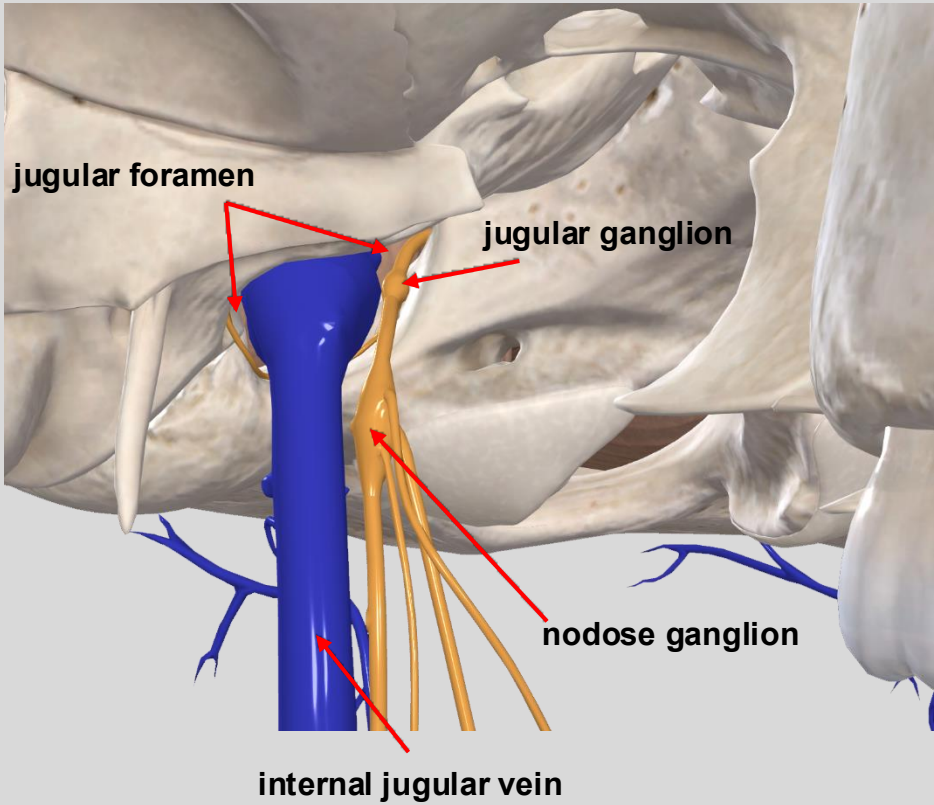


Moores Fig. 10.16

Latin: vagus = wanderer

CN X — Vagus

Exits endocranium and skull from jugular foramen



Forms 2 ganglia outside the jugular foramen

1. Superior / Jugular ganglion (sensory)
2. Inferior / Nodose ganglion (parasympathetics)

You are responsible for just 3 branches of vagus

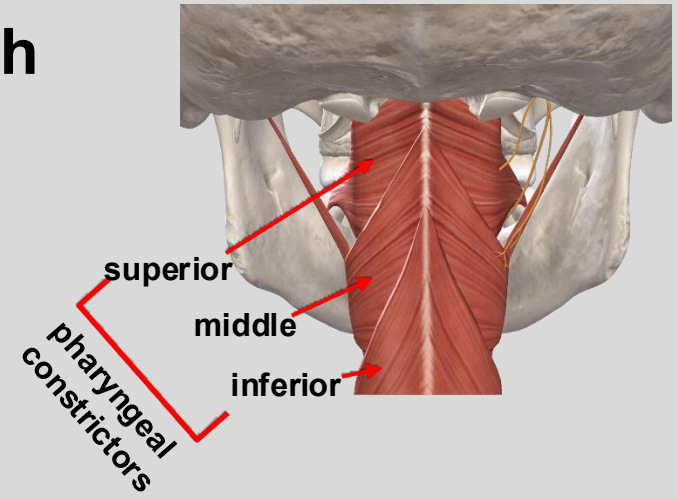
1. Pharyngeal
2. Superior Laryngeal
3. Recurrent Laryngeal / Inferior Laryngeal

CN X — Vagus

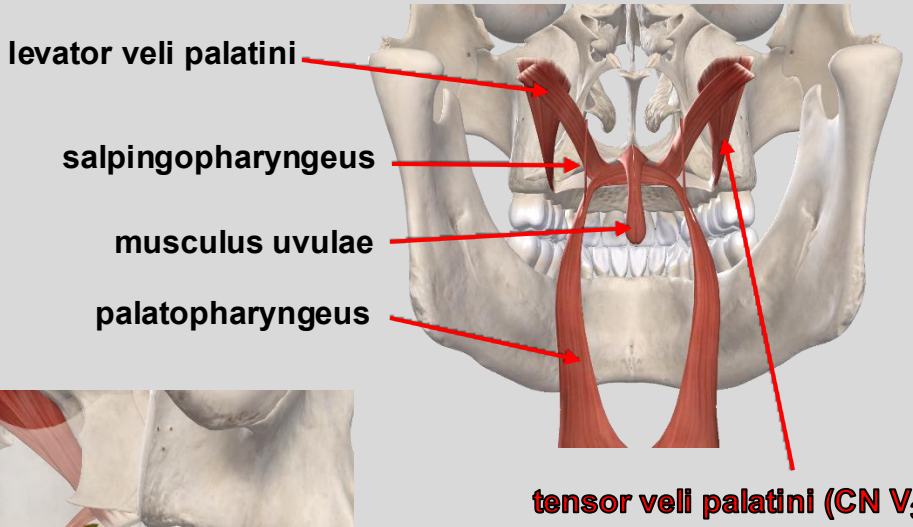
Pharyngeal Branch

The first branch off vagus as it descends

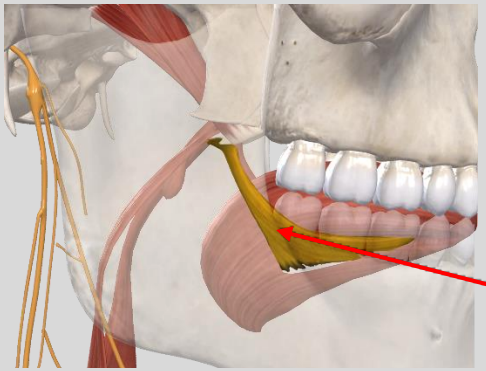
Provides the motor limb to the pharyngeal plexus



Motor innervation for most of the soft palate



Will innervate the palatoglossus muscle of the tongue



CN X — Vagus

Superior Laryngeal Nerve

Descends neck to innervate larynx

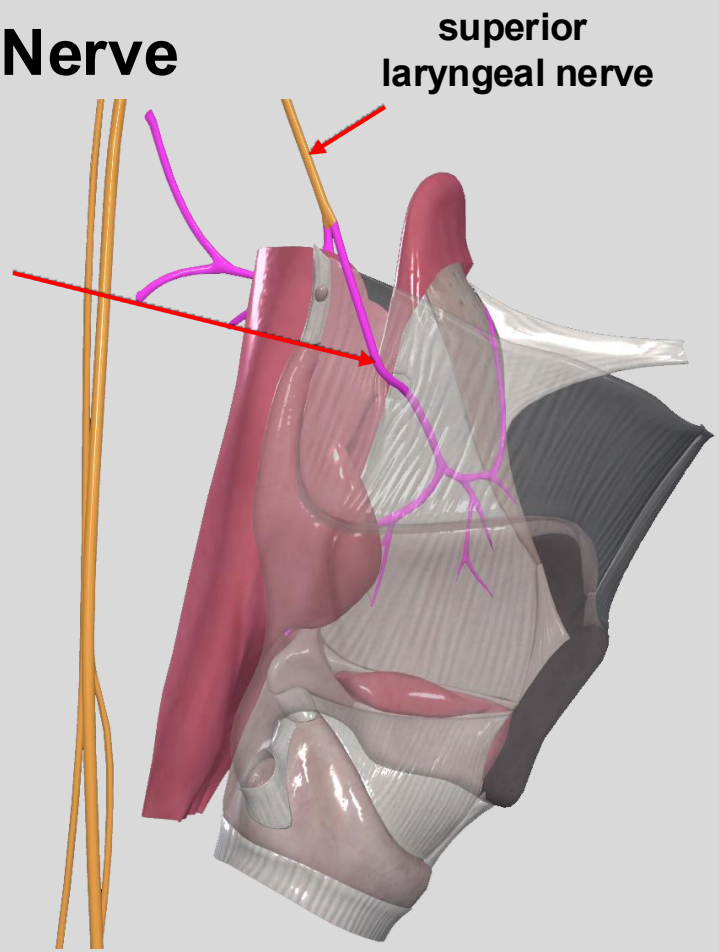
Divides into 2 branches

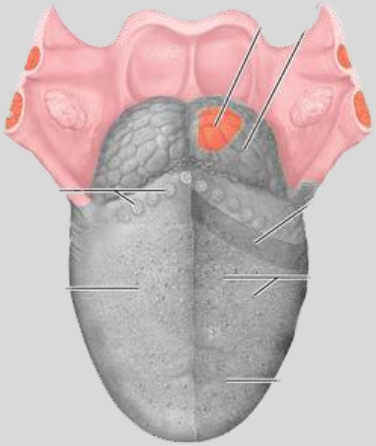
1. Internal laryngeal nerve (sensory)
2. External laryngeal nerve (motor)

<u>Internal laryngeal</u>

Goes through thyrohyoid membrane to innervate mucosa above vocal folds

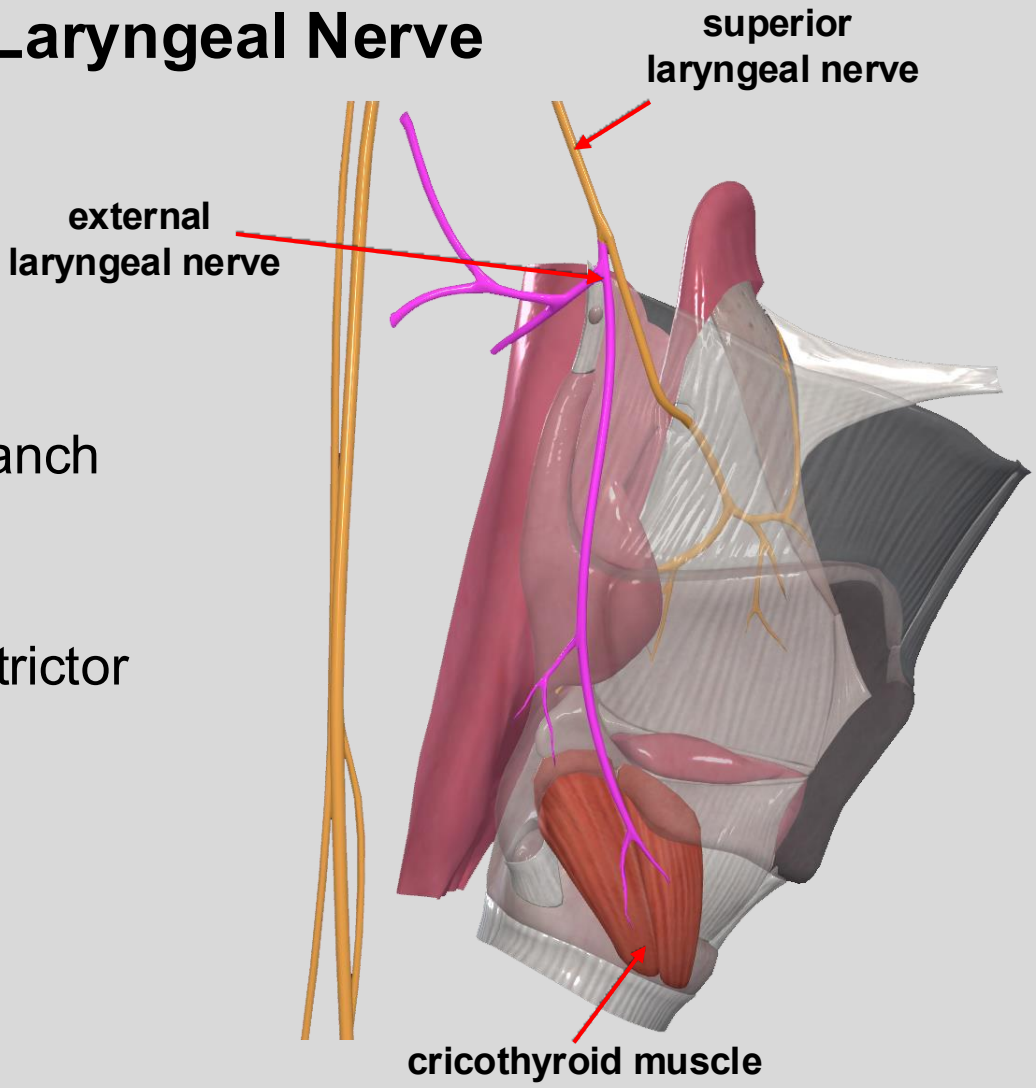
Small branch will provide taste sensation to parts of the tongue, pharynx and soft palate





CN X — Vagus

Superior Laryngeal Nerve



External laryngeal is the smaller branch

Provides motor innervation to:

portion of inferior pharyngeal constrictor

cricothyroid muscle

Cricothyroid is the only intrinsic larynx muscle innervated by superior laryngeal

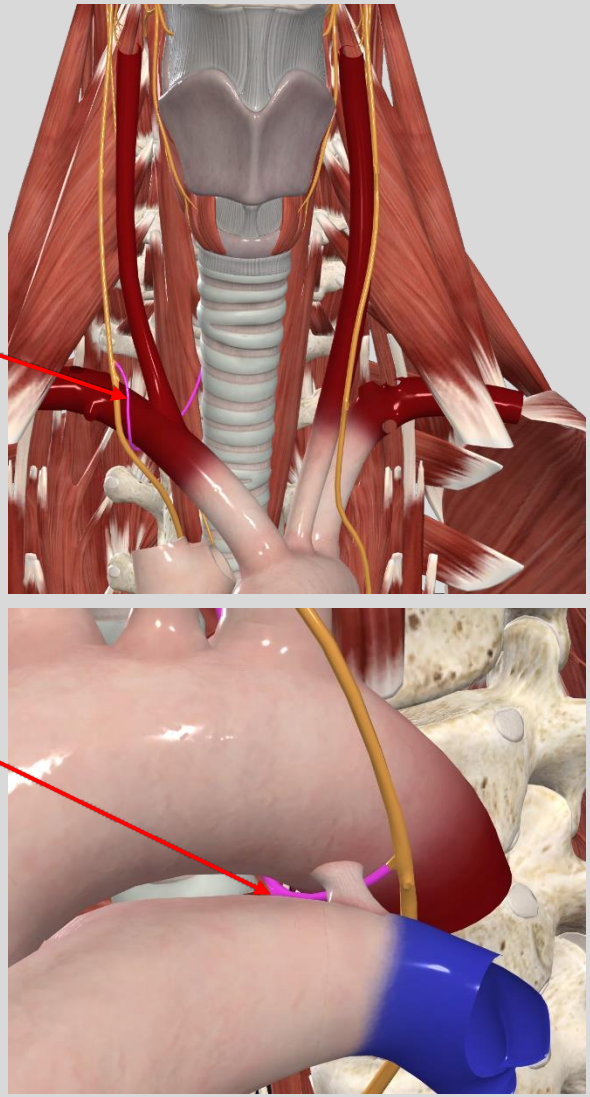
CN X — Vagus

Recurrent Laryngeal Nerve

Final branch of vagus to go to the head and neck. Branches off in thorax

Left recurrent wraps around aortic arch (ligamentum arteriosum)

Right recurrent wraps around the right subclavian artery



Both sides ascend to larynx in the tracheo-esophageal groove, providing sensory innervation to trachea and esophagus

At the level of the larynx, recurrent laryngeal changes to inferior laryngeal

CN X — Vagus

Inferior Laryngeal Nerve

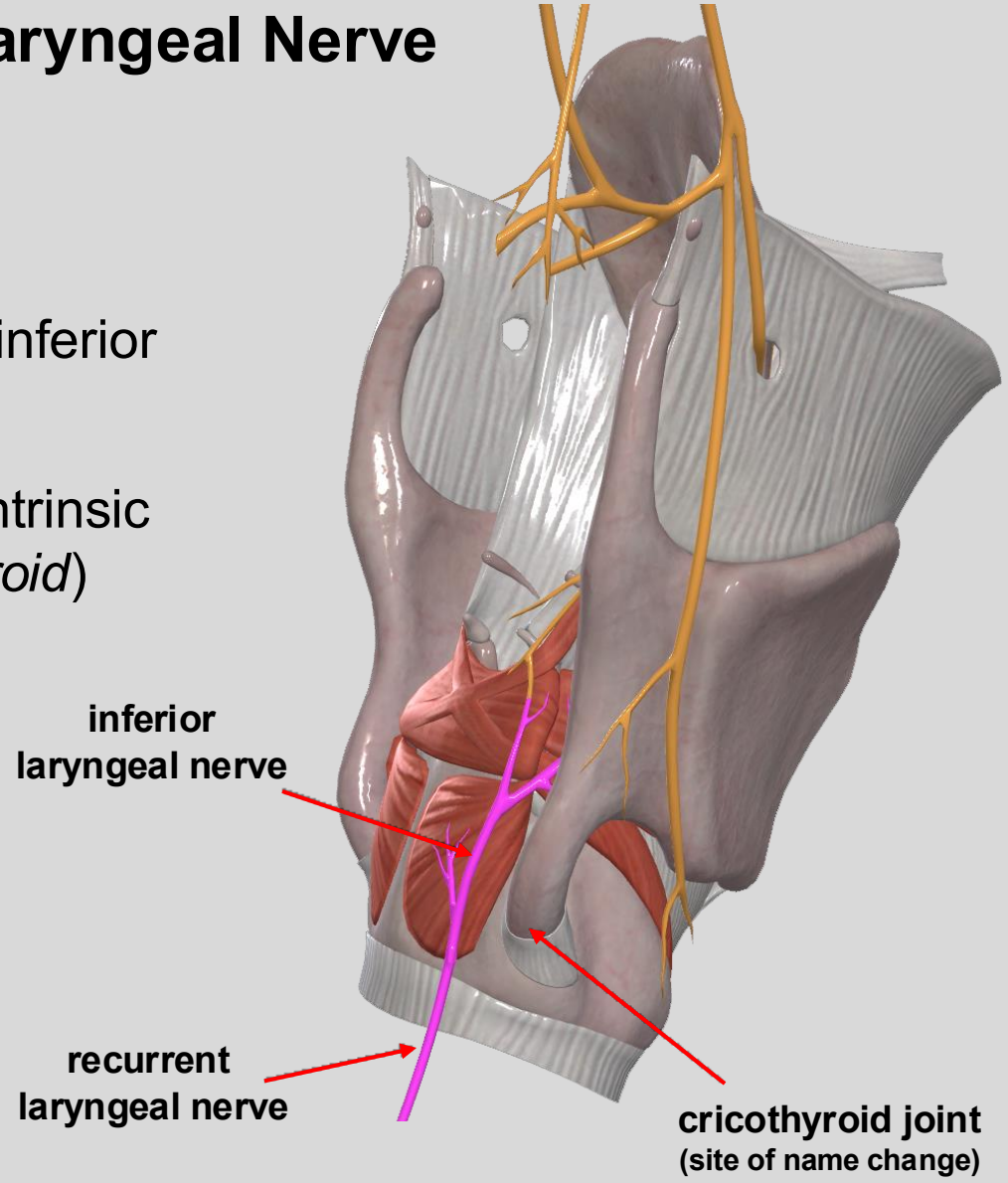
Main innervation for the larynx

Afferent component = sensation to inferior glottic cavity

Efferent component = motor to all intrinsic laryngeal muscles (*except cricothyroid*)

Divides into 2 terminal branches

- Anterior branch
- Posterior branch



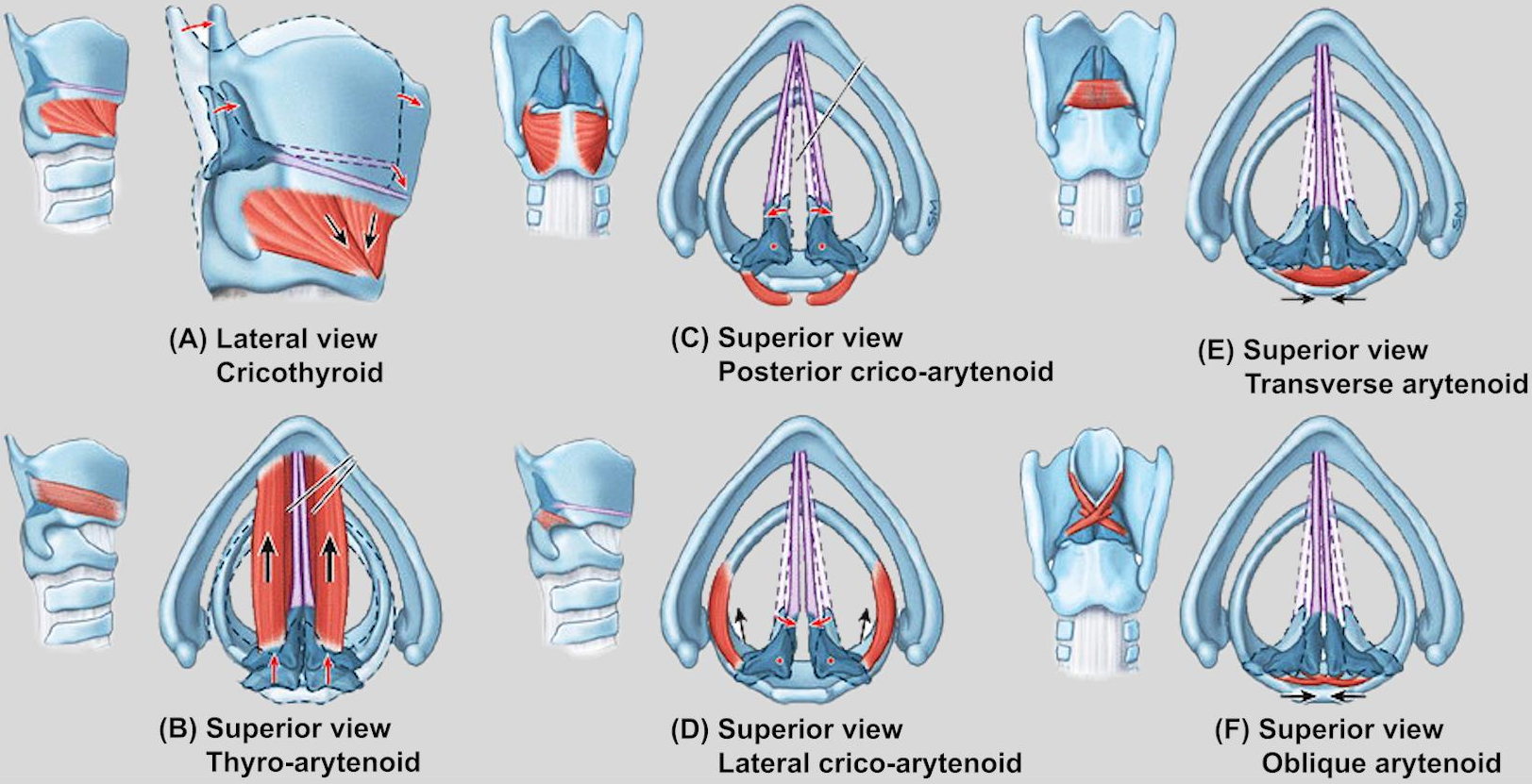
Note: You *do not* need to know which branch innervates which muscle

Laryngeal Muscles

Posterior crico-arytenoids are *the only* muscles that A-B-duct the vocal folds

Cricothyroid is *the only* intrinsic laryngeal muscle innervated by the superior laryngeal nerve

Moores Fig. 9.39



CN X — Vagus

Clinical Correlates

Recurrent laryngeal nerve damage

Result of surgical accidents

e.g. thyroid tumour removal

Consequence of compression from tumours or aneurysms

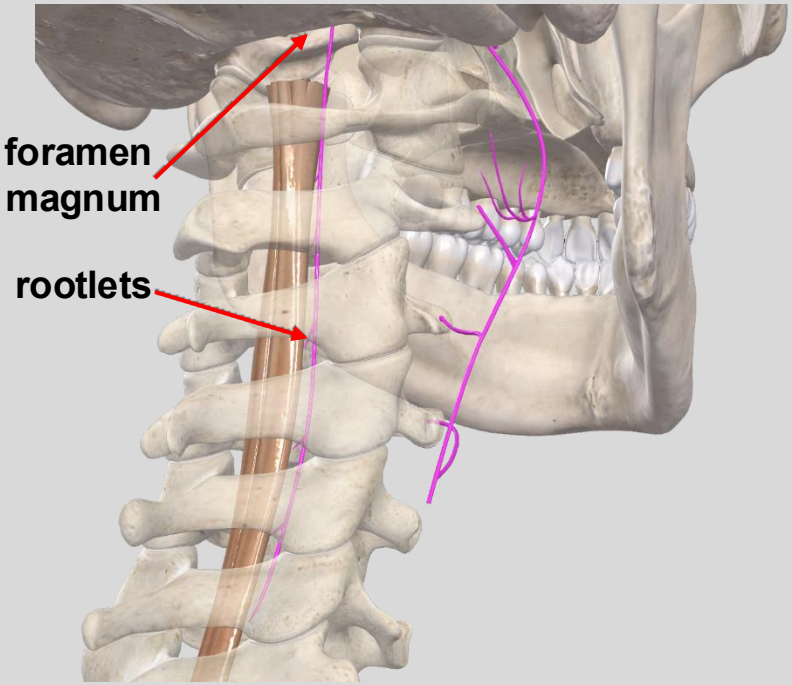
Lesion produces partial / total paralysis of most laryngeal muscles

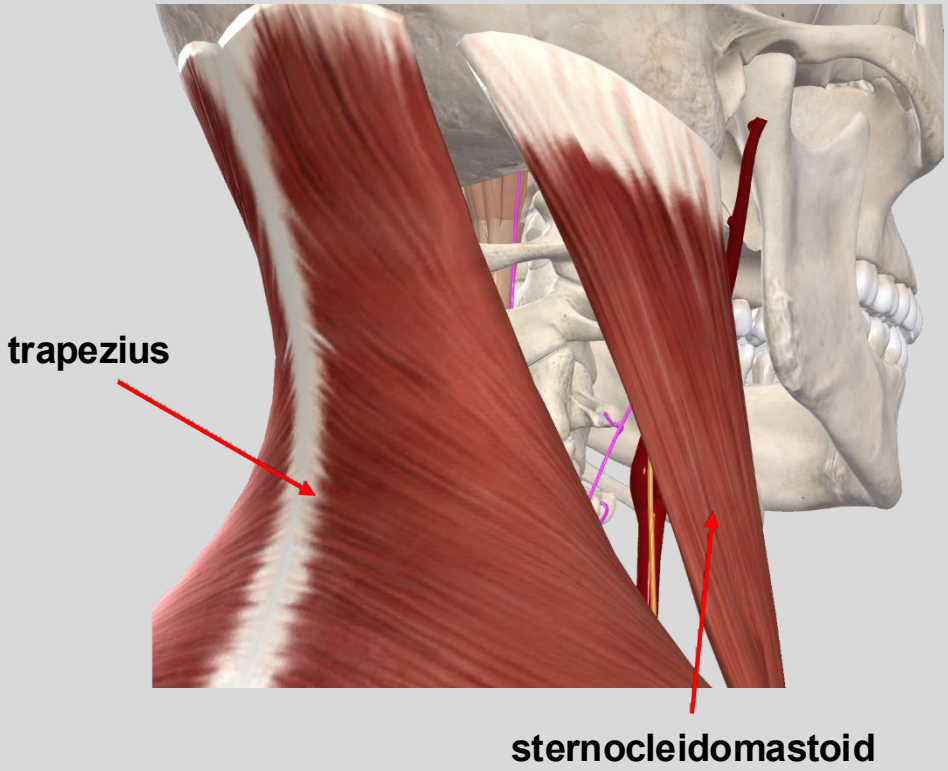
Unilateral lesion result in a voice that sounds hoarse

Bilateral lesion produces muteness and trouble breathing (vocal folds can't abduct)

Only muscle left unaffected is the cricothyroid

CN XI — Spinal Accessory





Starts as rootlets from first 5–6 cervical segments of spinal cord

Enters *the endocranium* through the foramen magnum

Exits *the endocranium and skull* through the jugular foramen

Parallels the internal carotid before branching off to innervate sternocleidomastoid and trapezius

CN XI — Spinal Accessory

Clinical Correlates

CN XI can be damaged in whiplash accidents or during birth

Shoulder drop

Trapezius weakness / paralysis

Shoulder slopes towards side of lesion

Torticollis

Sternocleidomastoid hypertonicity or entrapment

Head tilts towards lesion. *Face* turns away

CN XII — Hypoglossal

Main motor nerve for the tongue

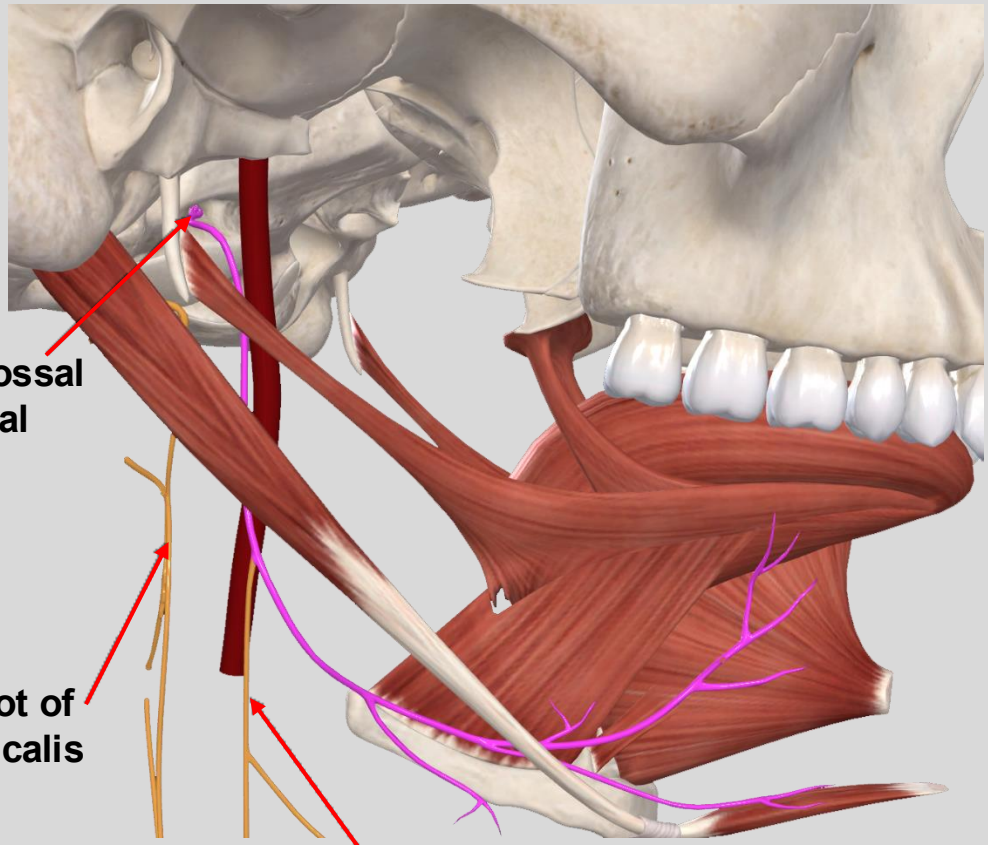
Innervates all tongue muscle **except for** palatoglossus

Exits the endocranium & skull through the hypoglossal canal

Crosses anteriorly between internal carotid artery and internal jugular vein

Cervical plexus nerves (C1 & C2) “hitch a ride” with CN XII to their destination (superior root of ansa cervicalis)

Enters tongue from inferolateral direction



CN XII — Hypoglossal

Tongue Muscles

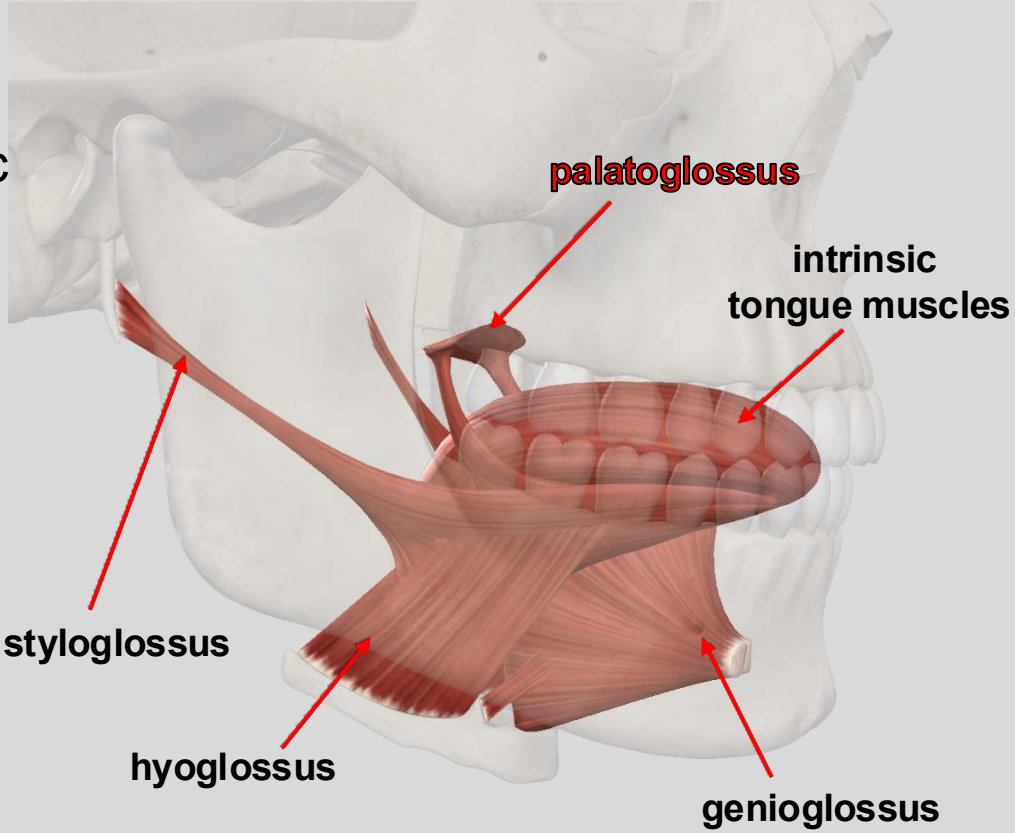
All the *glossus muscles are extrinsic

Genioglossus extends

Hyoglossus retracts & depresses

Styloglossus retracts and elevates

Palatoglossus elevates



Palatoglossus is ***the only muscle not innervated*** by hypoglossal

Stern's Law

Two muscles of the palate and tongue region have innervation exceptions

tensor veli palatini and palatoglossus

Jack Stern came up with a helpful way to remember this relationship

Stern's Law

-tensor = CN V_3

-palate = CN X

-glossus = CN XII

CN XII — Hypoglossal

Clinical Correlate

Hypoglossal lesion test (Genioglossus test)

Lesions to hypoglossal present as weakness or paralysis of most tongue muscles

A common test for hypoglossal damage is to have patient stick out tongue

Weakened / paralyzed genioglossus will present asymmetric activation

Results in the tongue deviating to the lesion side

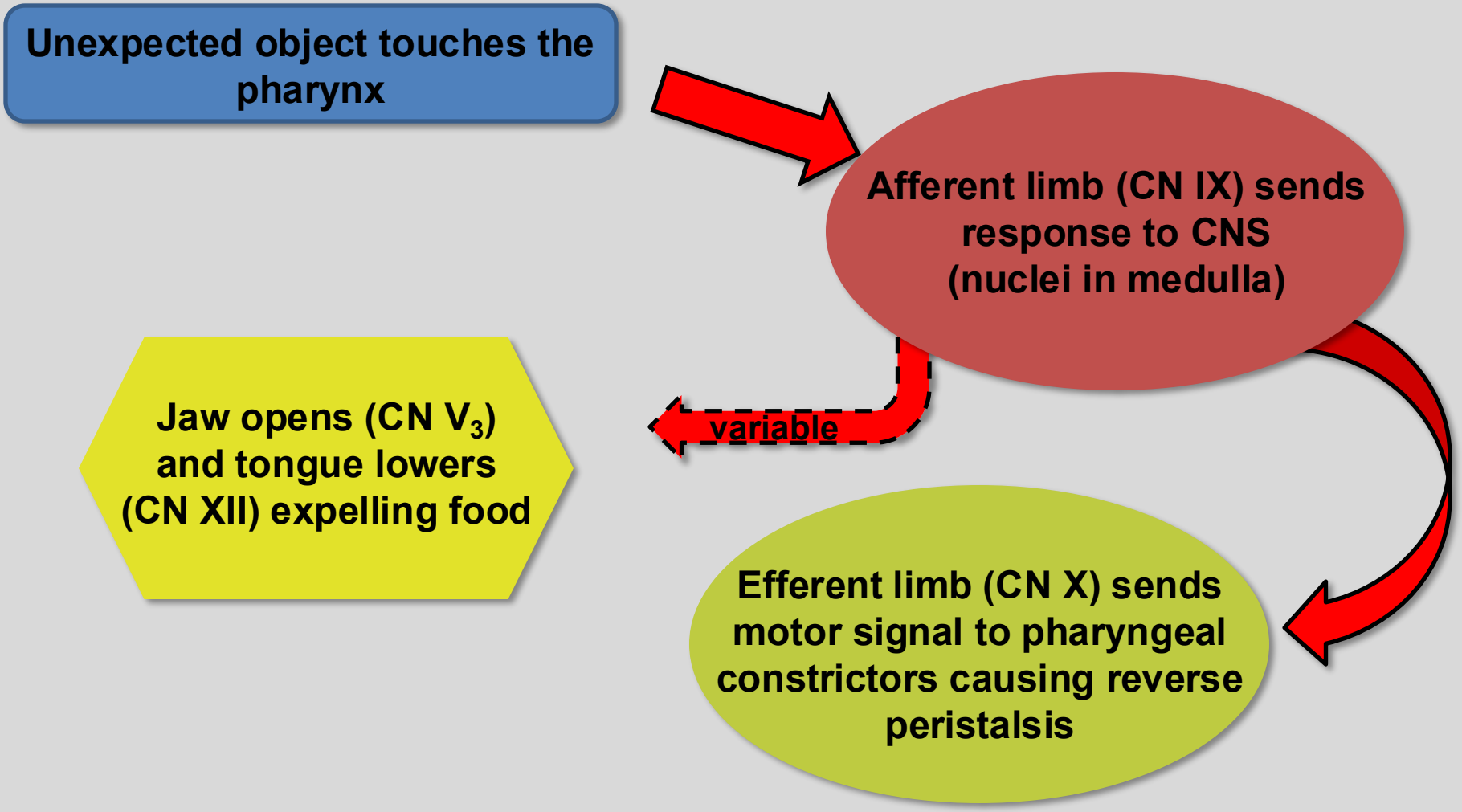
Most behaviours of the head and neck require cranial nerves to work together and with proper timing

Let's briefly compare two examples:

1. **Gag reflex**
2. **Deglutition (swallowing)**

Gag Reflex

Gag reflex contributions vary between individuals but stay consistent within individuals



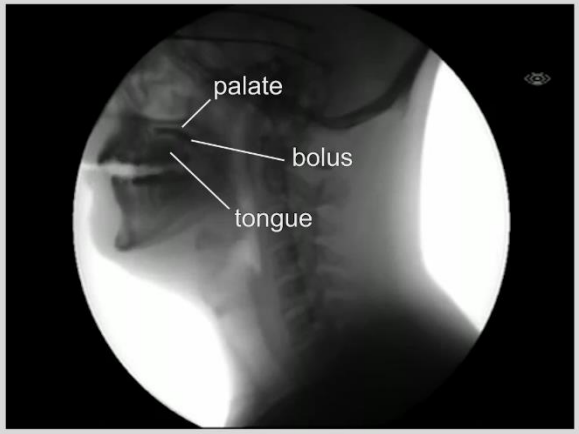
37% of people lack an appreciable gag reflex

Swallowing (Deglutition)

3 stages to swallowing

Stage 1 — CN XII

Tongue pushes food bolus to back of mouth



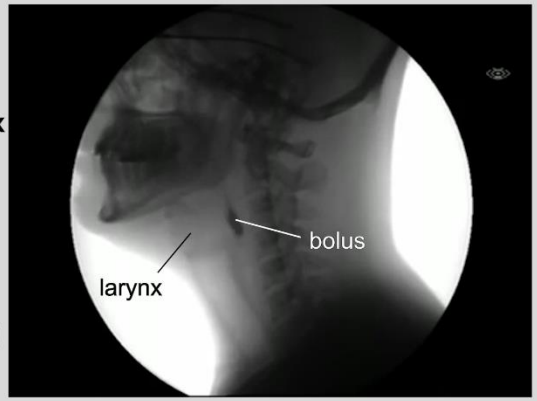
Michael Farnan (YouTube)

Stage 2 — CN V_3, IX, X

Soft palate is lifted sealing the nasopharynx (CN V_3, X)

Pharynx is lifted and widened (CN IX, X)

Epiglottis shuts, closing off trachea



Michael Farnan (YouTube)

Stage 3 — CN X

Rhythmic contraction of pharyngeal constrictors

Michael Farnan (YouTube)

Misfiring nerves produce dysphagia (trouble swallowing)

Ianessa Humbert (https://shorturl.fm/jVAR9)

Michael Farnan (https://www.youtube.com/watch?v=umnnA50IDIY)

Lecture Feeback Survey

https://comresearchdata.nyit.edu/redcap/surveys/?s=HRCY448FWYXREL4R