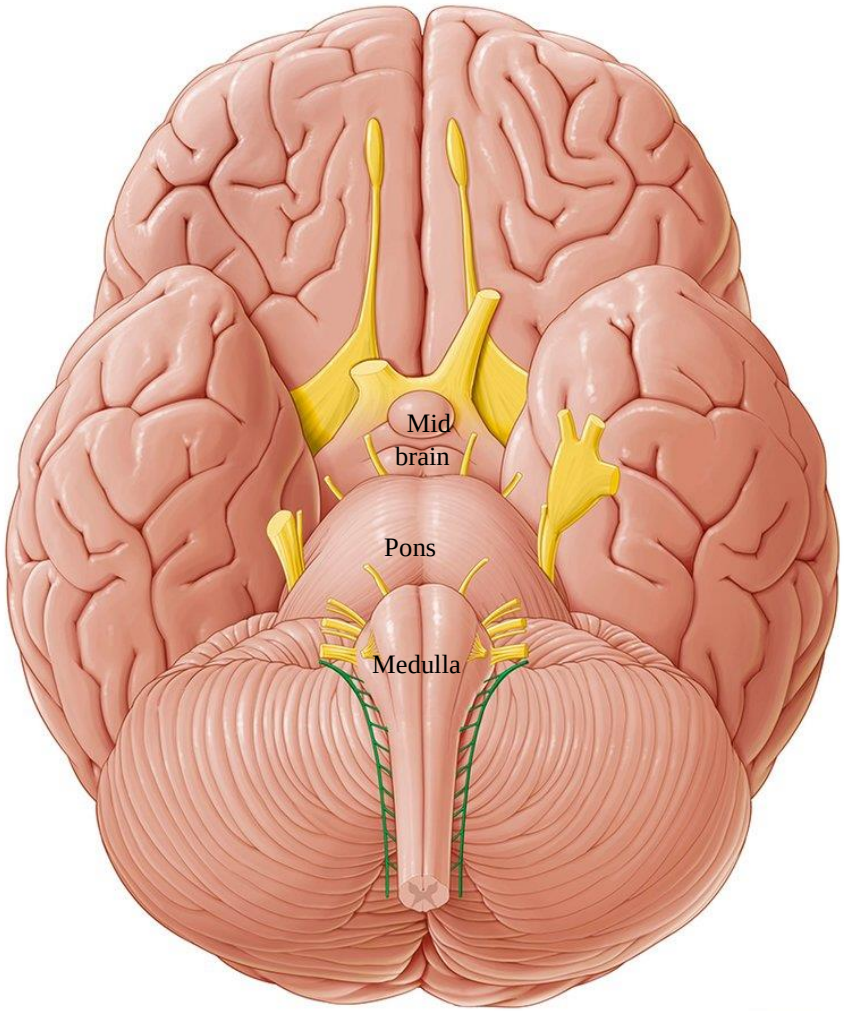
Extracranial course of cranial nerves

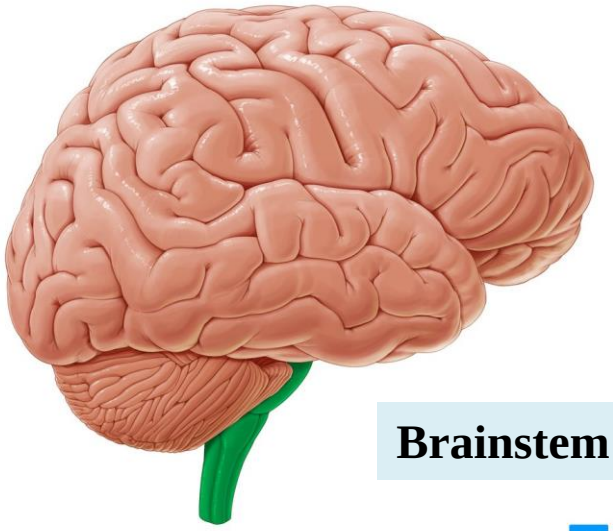
Oculomotor, Trochlear, Abducent, Trigeminal, Facial and Accessory nerves

Dr. Heba Kalbouneh
Associate Professor of Anatomy and Histology

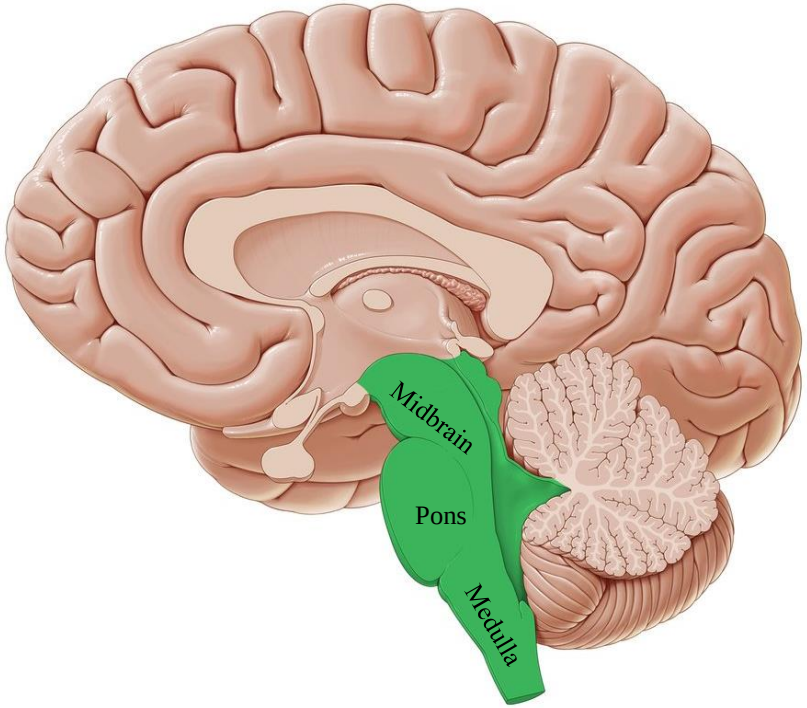
Dr. Heba Kalbouneh



Inferior view



Brainstem



Facial nerve

Motor: Innervates the muscles of facial expression, the posterior belly of the digastric, the stylohyoid and the stapedius muscles.

General Sensory: A small area around the concha of the auricle, EAM

Special Sensory: Provides special taste sensation to the anterior 2/3 of the tongue.

Parasympathetic: Supplies many of the glands of the head and neck, including:

1- Submandibular and sublingual salivary glands (via the submandibular ganglion/ chorda tympani)

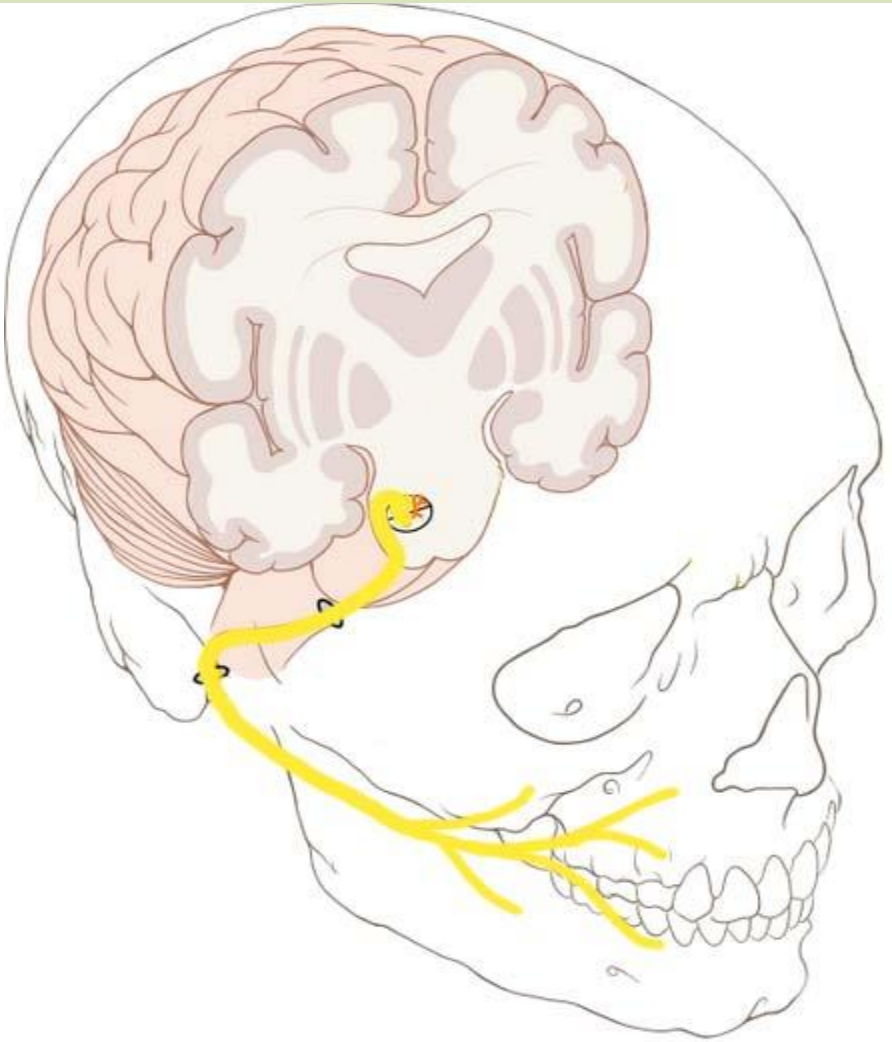
2- Nasal, palatine and pharyngeal mucous glands (via the pterygopalatine ganglion/ greater petrosal)

3- Lacrimal glands (via the pterygopalatine ganglion/ greater petrosal)

Anatomically, the course of the facial nerve can be divided into two parts:

Intracranial – the course of the nerve through the cranial cavity, and the cranium itself.

Extracranial – the course of the nerve outside the cranium, through the face and neck.



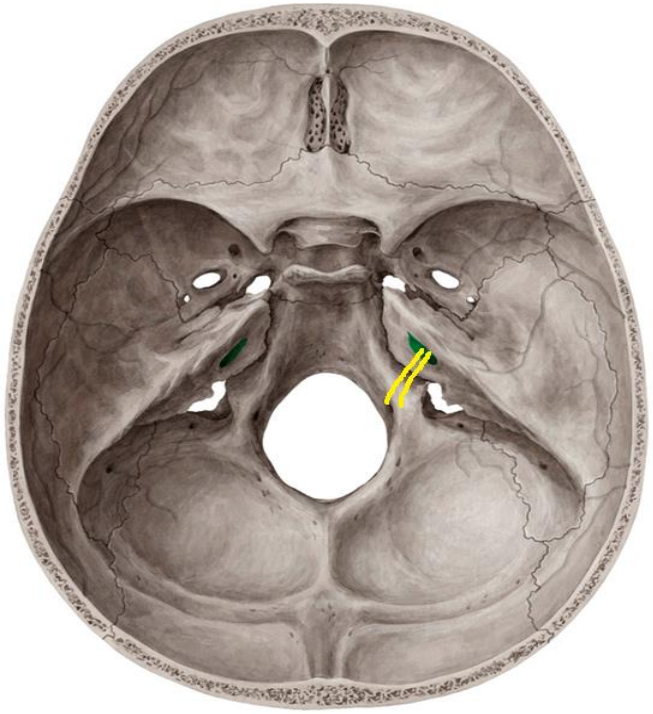
Intracranial course

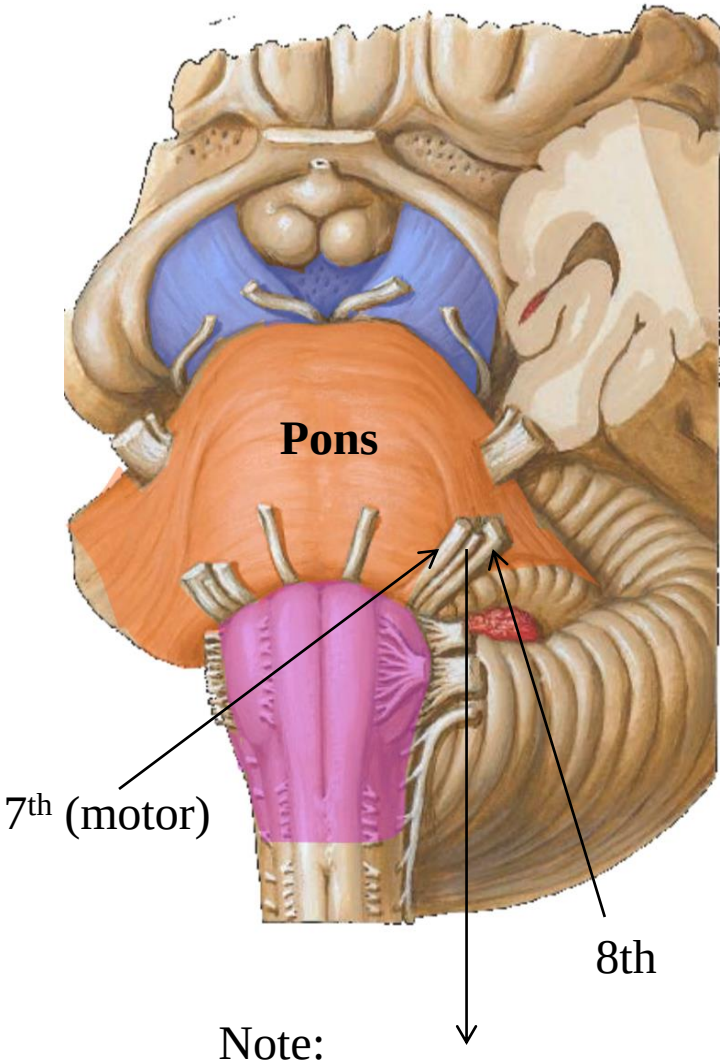
The nerve arises in the **pons**.
It begins as two roots; a large **motor root**, and a small **sensory root**

The two roots travel through the internal acoustic meatus.

↓ ↓ ↓

Here, they are in very close proximity to the inner ear.





Note:
The part of the facial nerve that runs between the motor root of facial and vestibulocochlear nerve is sometimes known as the *nervus intermedius*
It contains the sensory and parasympathetic fibers of the facial nerve

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Still within the temporal bone, the roots leave the internal acoustic meatus, and enter into the **facial canal**.

The canal is a 'Z' shaped structure.

Within the facial canal, three important events occur:

*Firstly the two roots **fuse** to form the facial nerve.*

*Next, the nerve forms the **geniculate ganglion** (a collection of sensory neurons cell bodies of the facial nerve /MAINLY TASTE).*

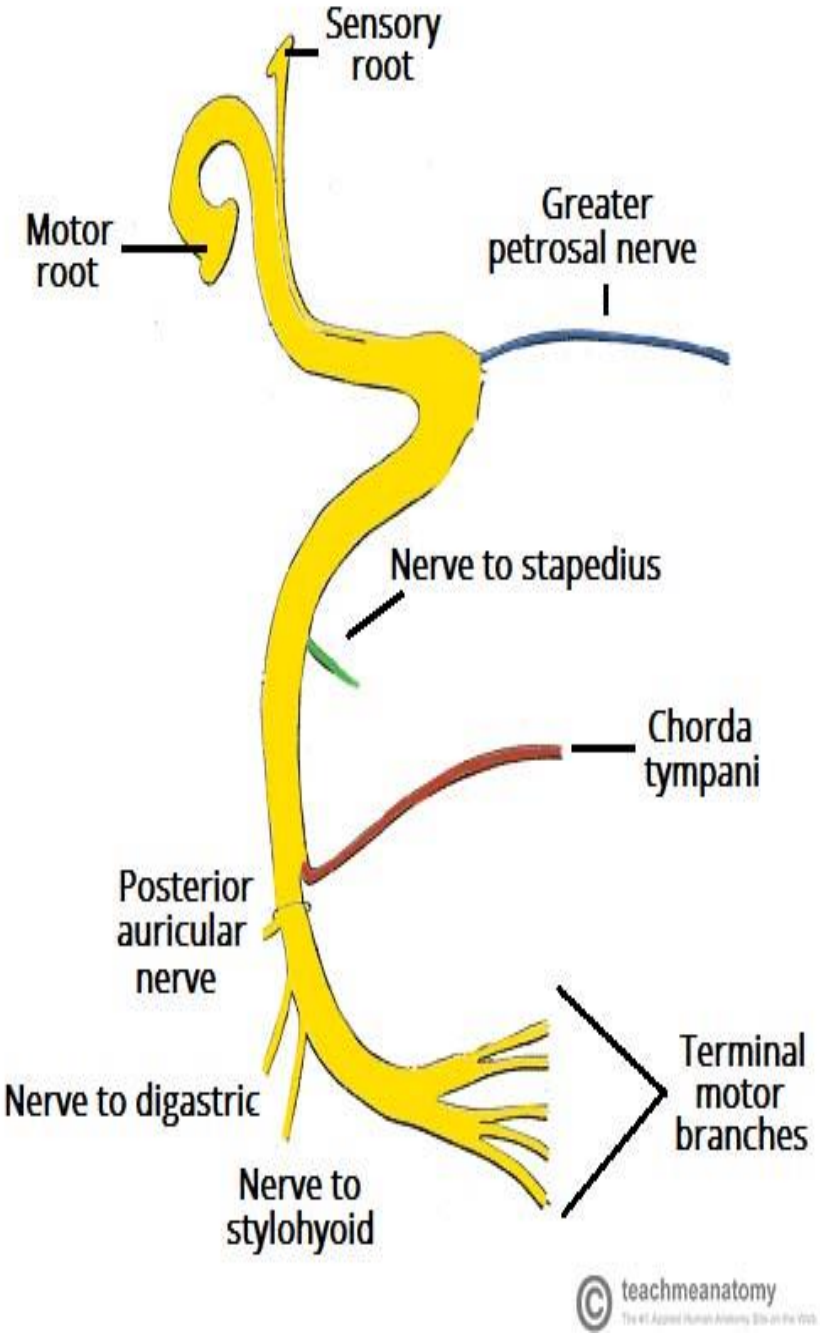
Lastly, the nerve gives rise to:

***Greater petrosal nerve** – parasympathetic fibers to lacrimal gland and nasal, palatine and pharyngeal mucous glands.*

***Nerve to stapedius** – motor fibres to stapedius muscle of the middle ear.*

***Chorda tympani** – taste from the anterior 2/3 of tongue and parasympathetic fibers to the submandibular and sublingual glands.*

The facial nerve then exits the facial canal (and the cranium) via the **stylomastoid foramen**.



Extracranial course

After exiting the skull, the facial nerve turns superiorly to run just anterior to the outer ear

Extracranial branches:

1- **Posterior auricular nerve**

2- Branch to posterior belly of the digastric muscle

3- Branch to stylohyoid muscle

The main trunk of the nerve, now termed the **motor root** of the facial nerve enters the parotid gland *(Note – the facial nerve does not contribute towards the innervation of the parotid gland, which is innervated by the glossopharyngeal nerve).*

Within the parotid gland, the nerve terminates by splitting into five branches:

Temporal branch

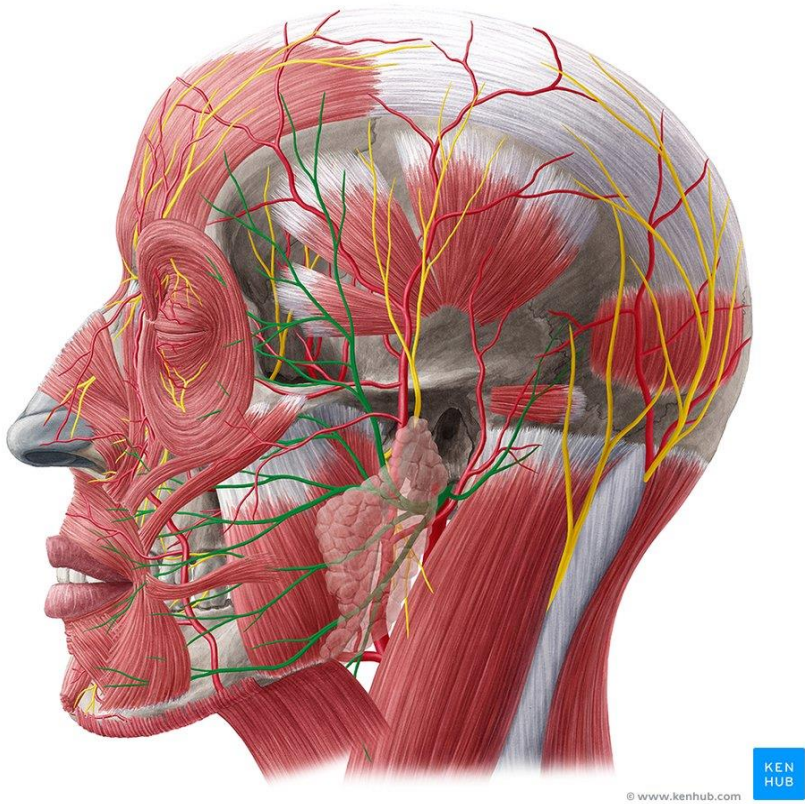
Zygomatic branch

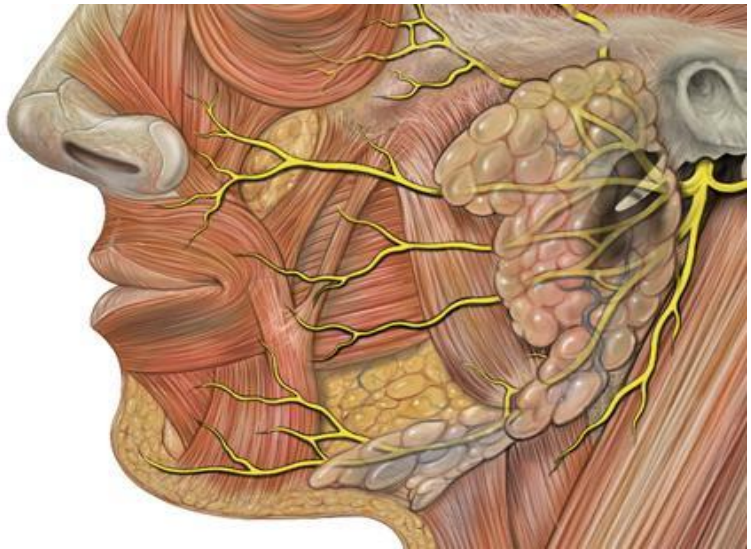
Buccal branch

Marginal mandibular branch

Cervical branch

These branches are responsible for innervating the muscles of facial expression.



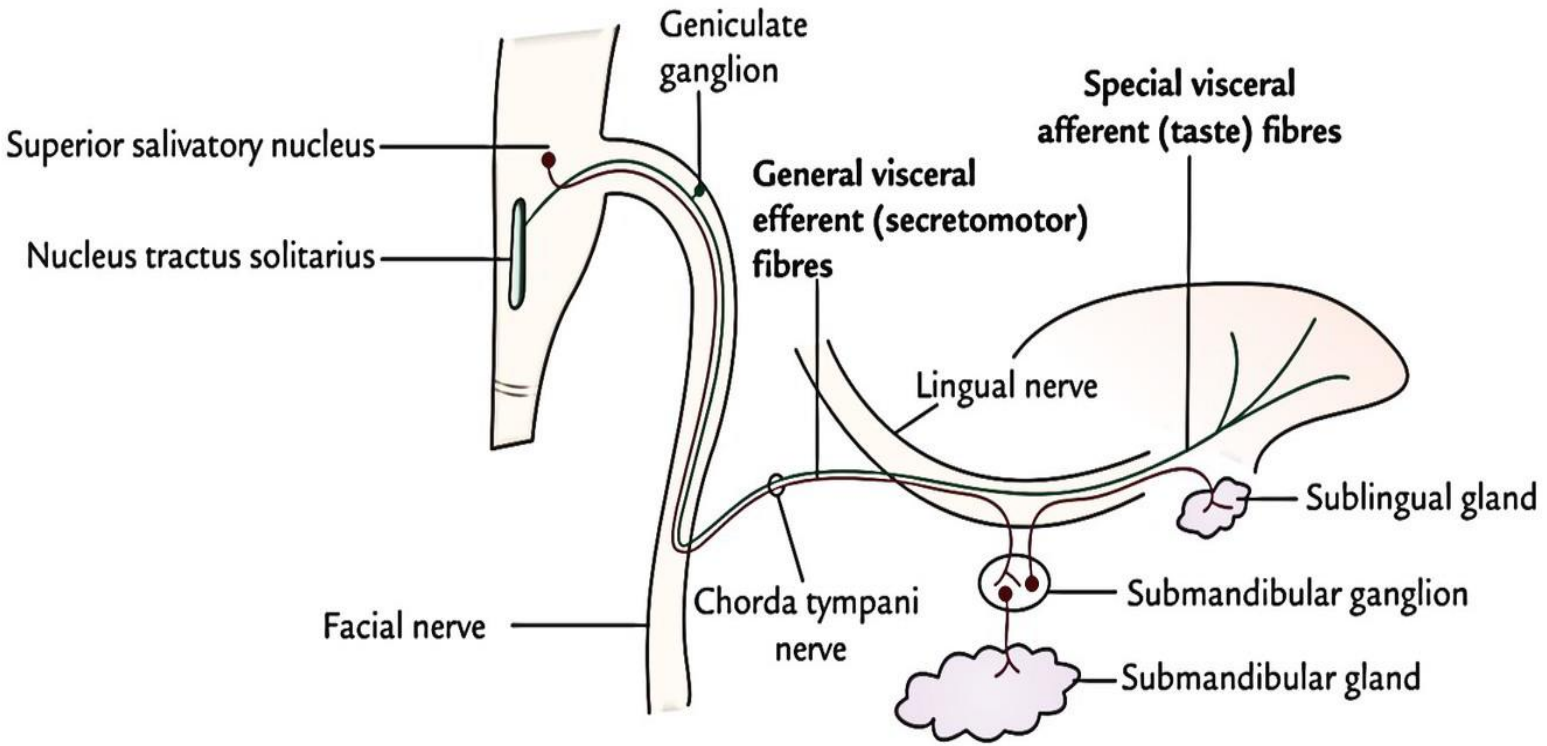


The **chorda tympani** arises in the facial canal, and travels across the bones of the middle ear, exiting via the **petrotympanic fissure**, and entering the infratemporal fossa.

Here, the chorda tympani 'hitchhikes' with the **lingual nerve**.

Submandibular ganglion
Branches from this ganglion travel to the submandibular and sublingual salivary glands

Taste
From the anterior 2/3 of the tongue.



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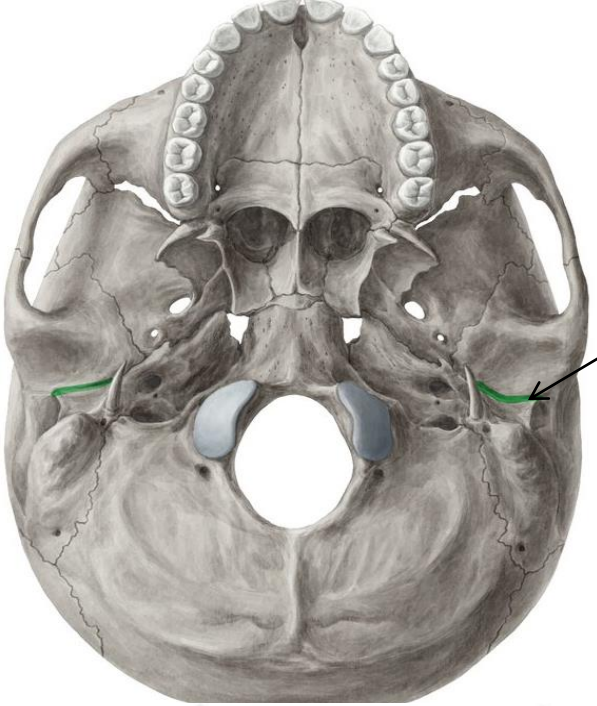
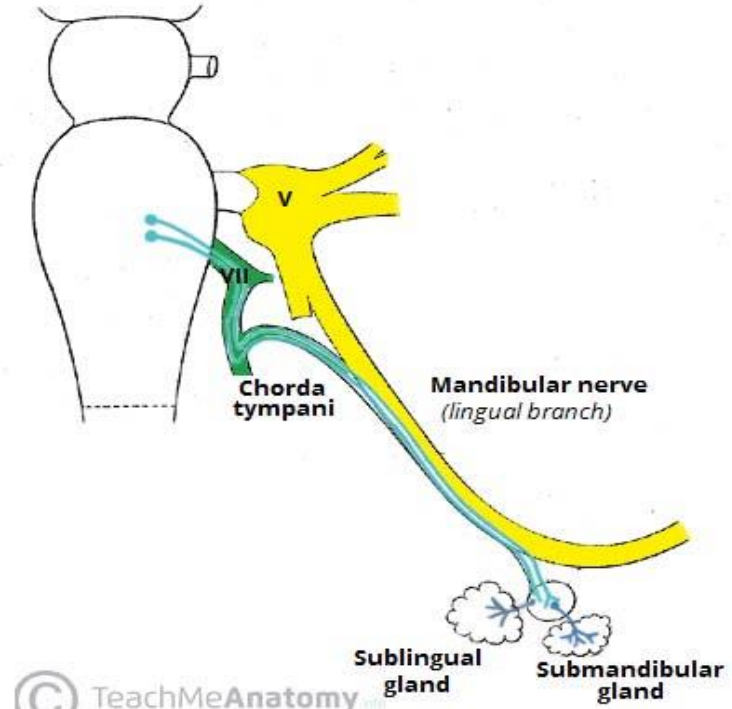
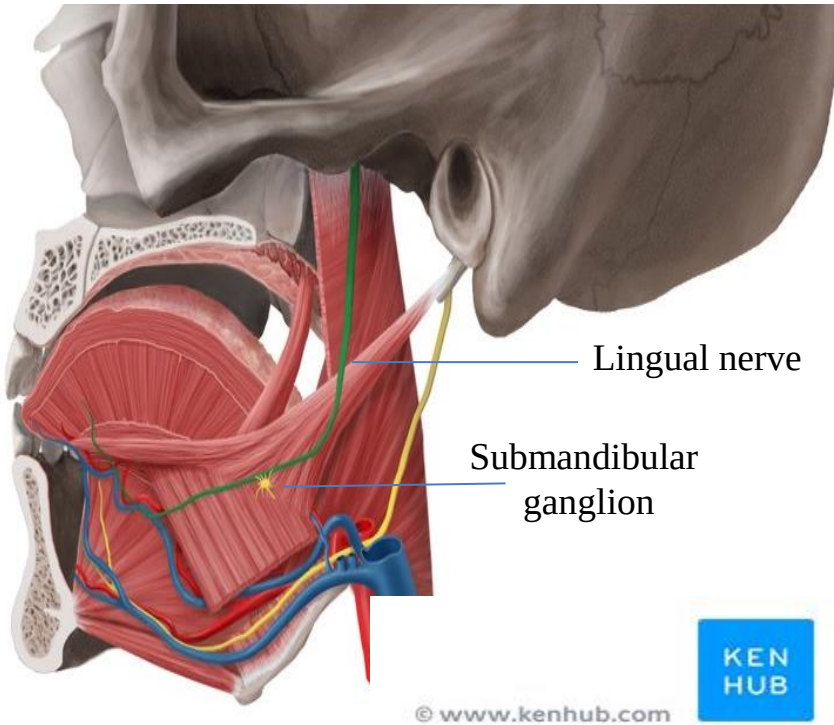
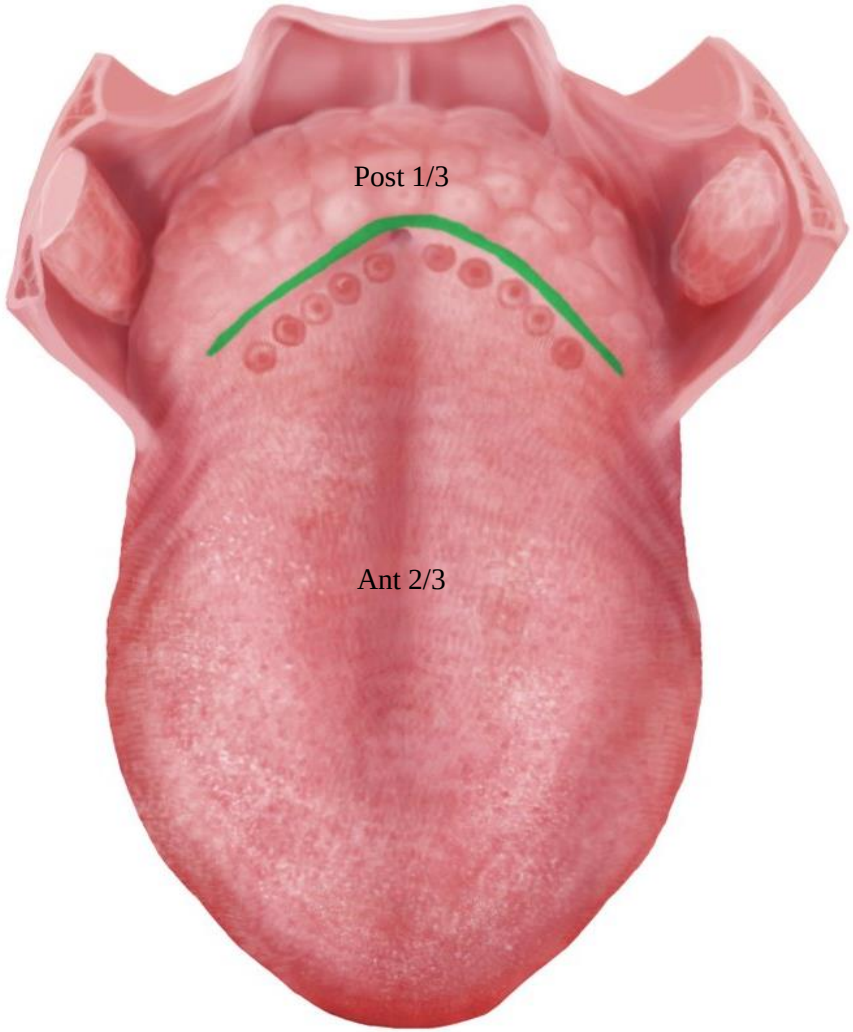


The **petrotympanic fissure** is a fissure in the temporal bone

The chorda tympani runs through the fissure to join with the lingual nerve in the infratemporal fossa



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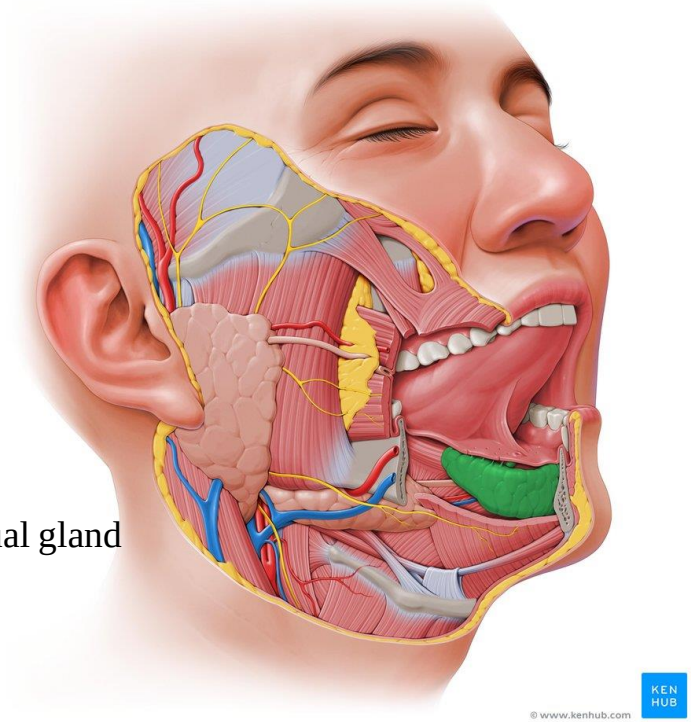
Sublingual gland
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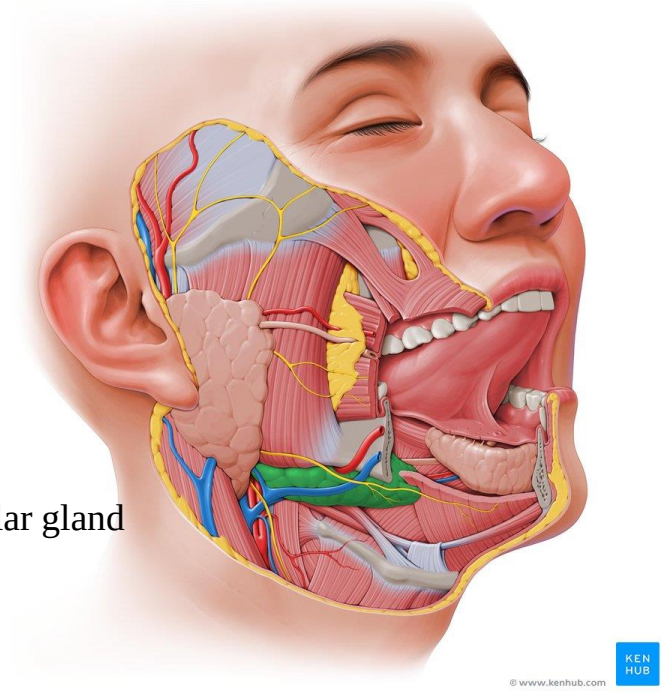
Submandibular gland
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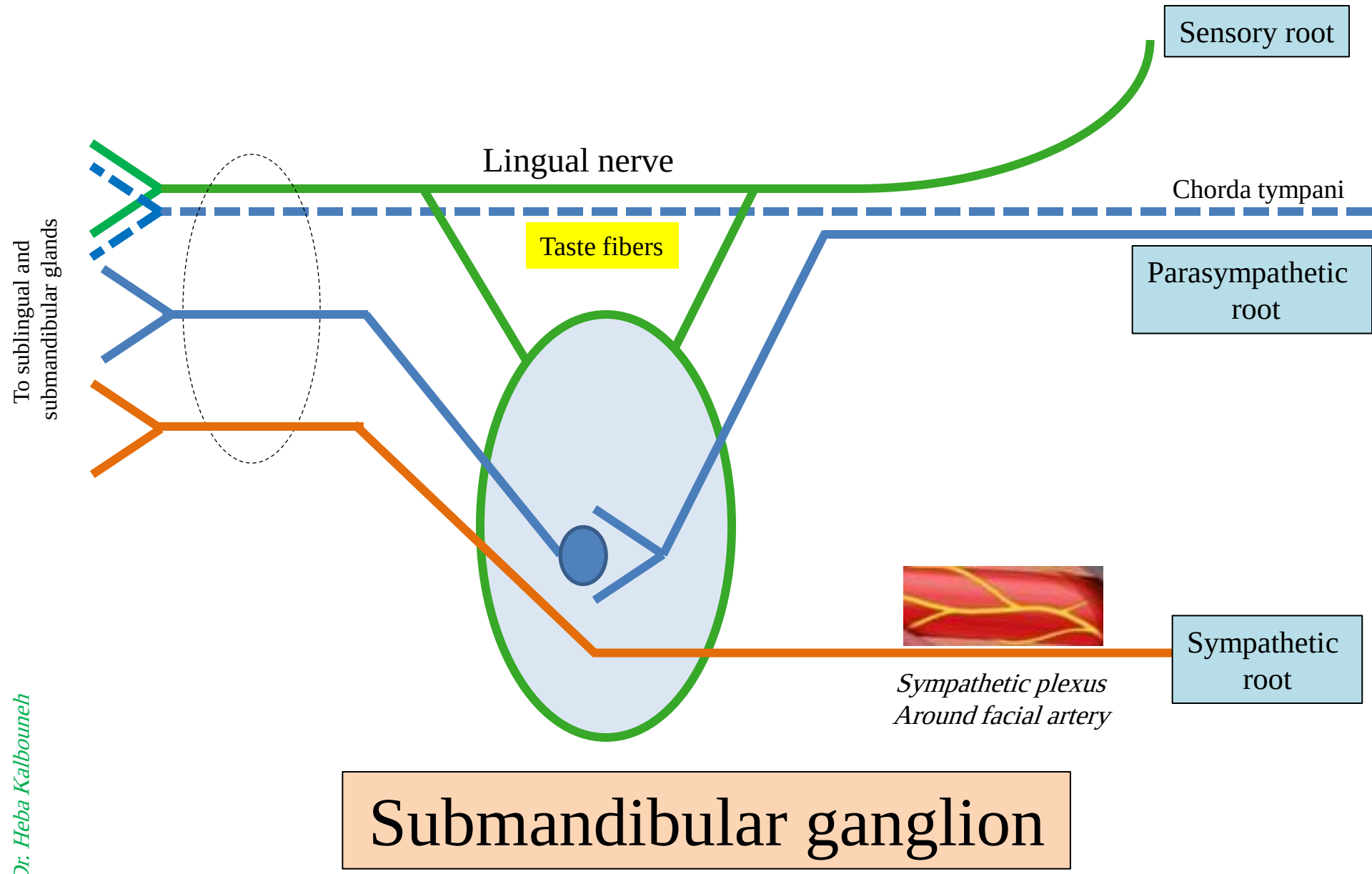
Anatomically, it's connected to lingual nerve
Functionally, it's associated with the facial nerve (chorda tympani)



Submandibular ganglion

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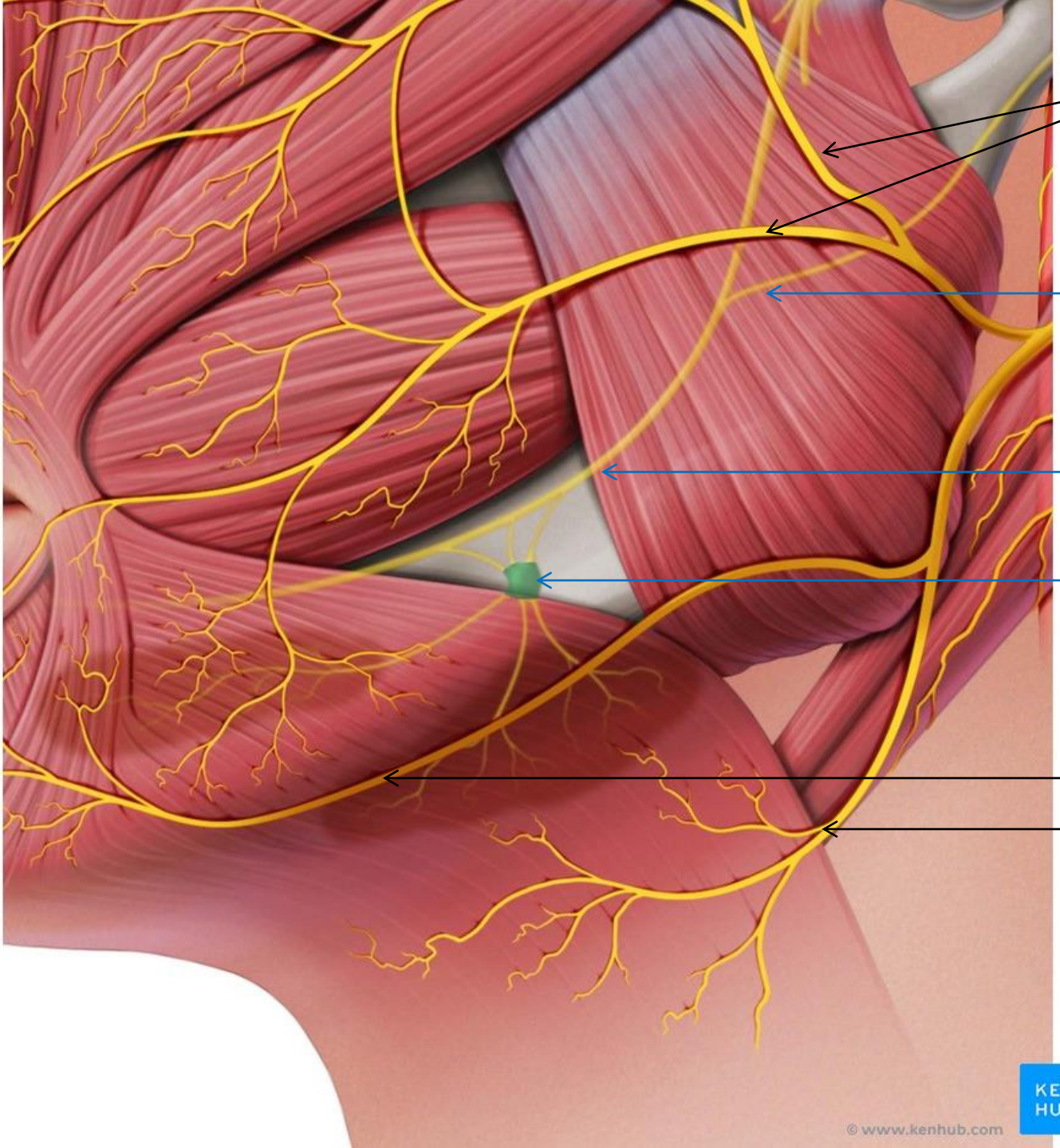

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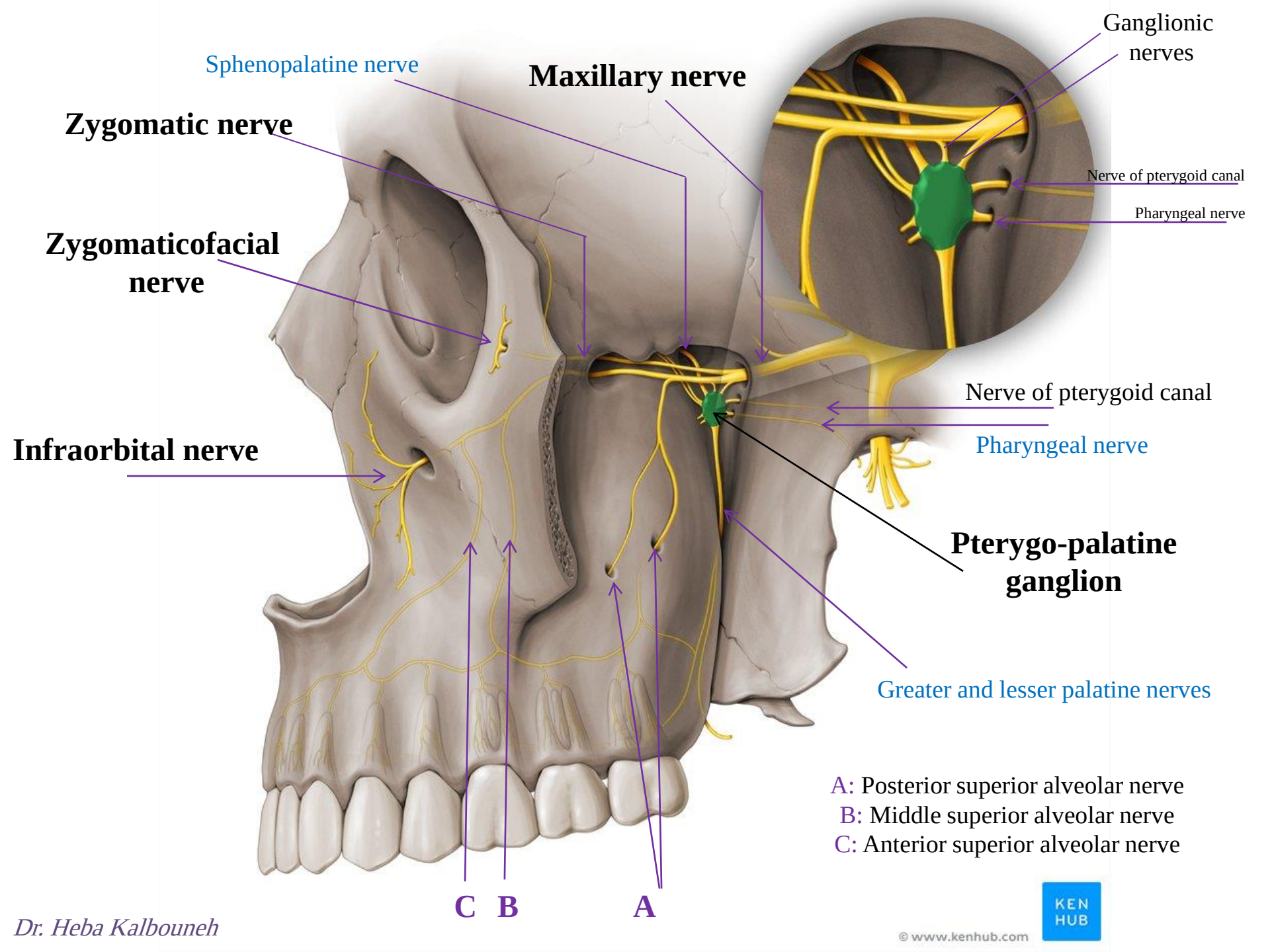

A: Posterior superior alveolar nerve
B: Middle superior alveolar nerve
C: Anterior superior alveolar nerve

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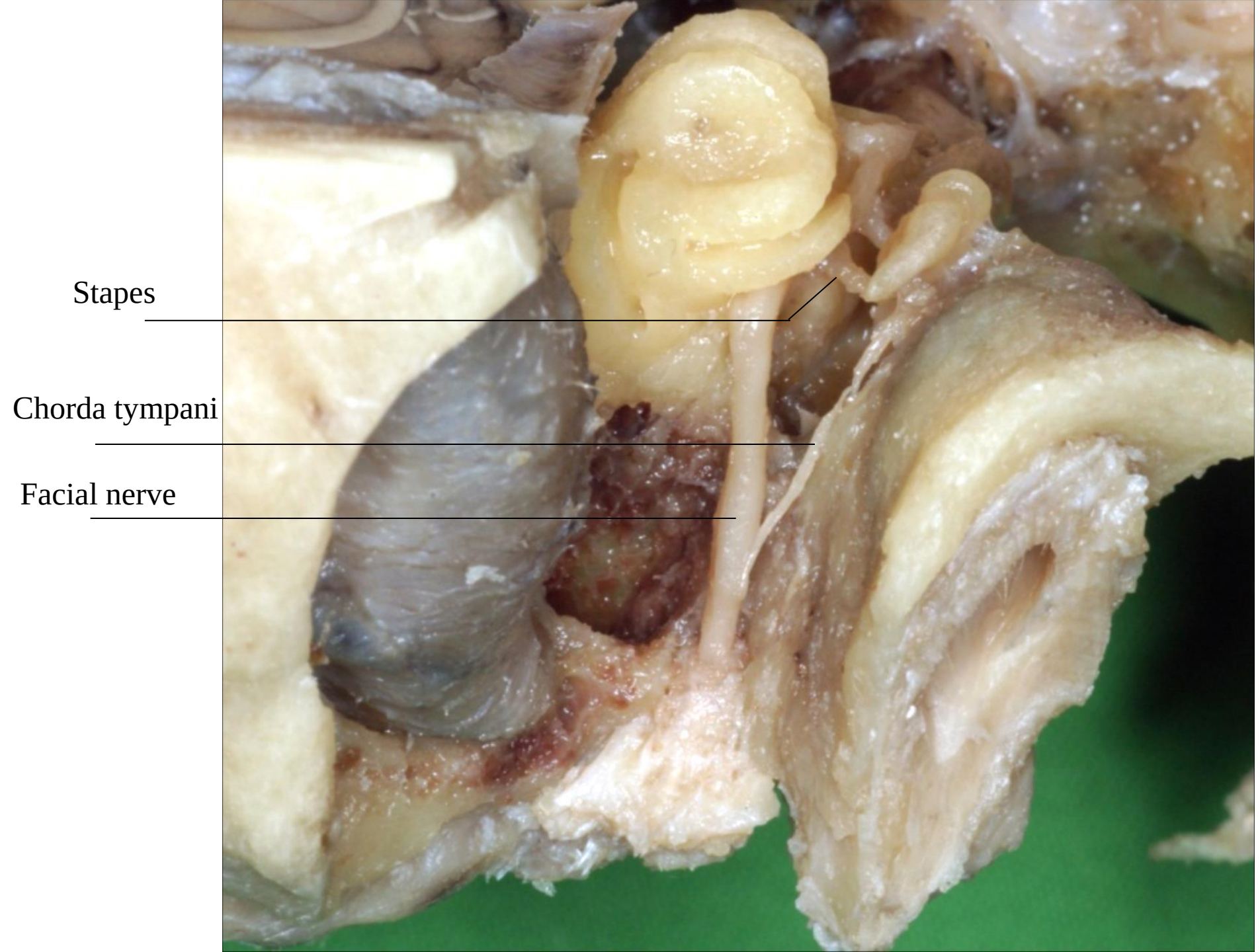

Stapes
Chorda tympani
Facial nerve

Greater petrosal nerve

Preganglionic parasympathetic fibers to:

1- Lacrimal gland

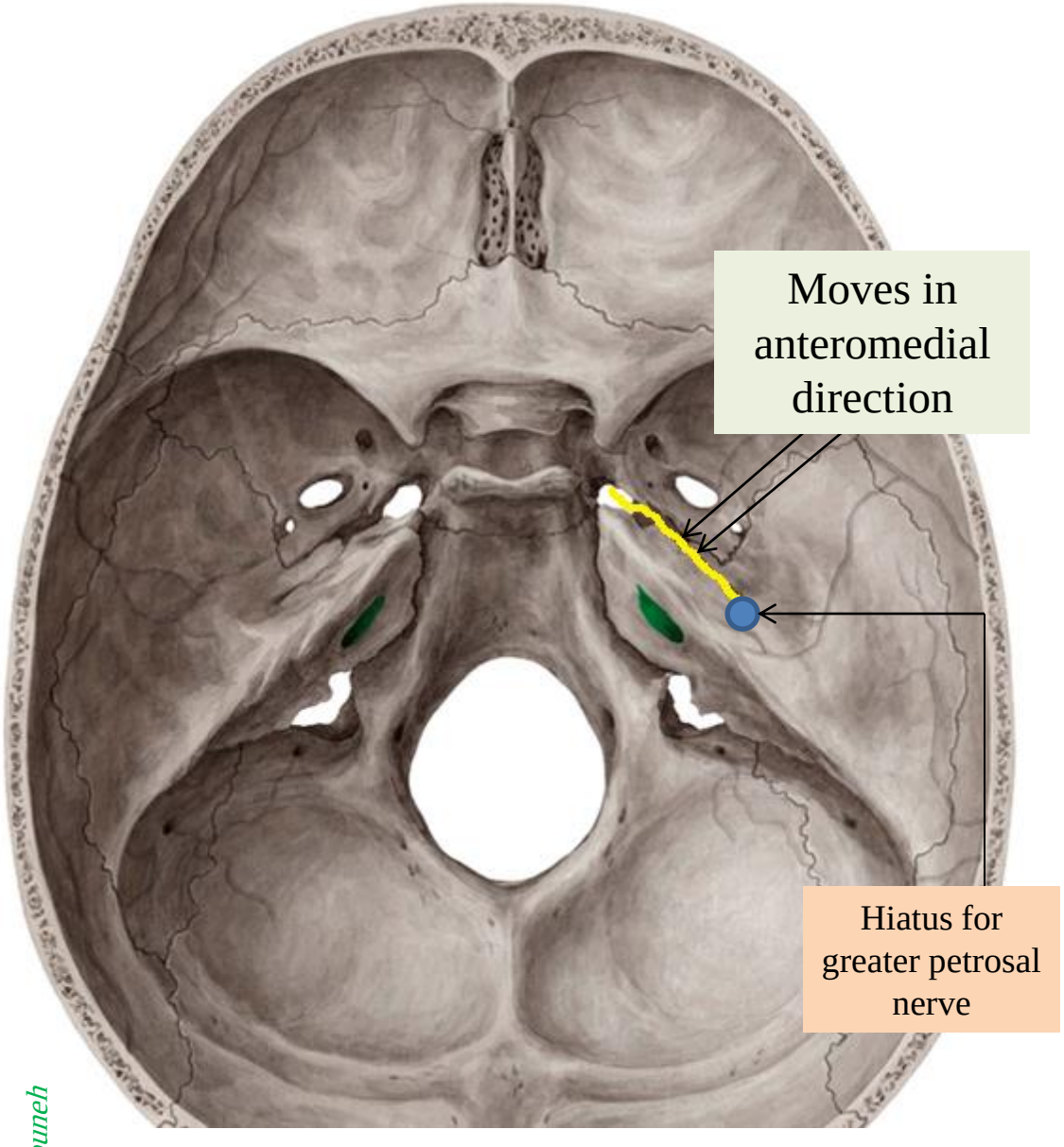
2- Nasal, palatine and pharyngeal mucous glands

✓Arises in the facial canal

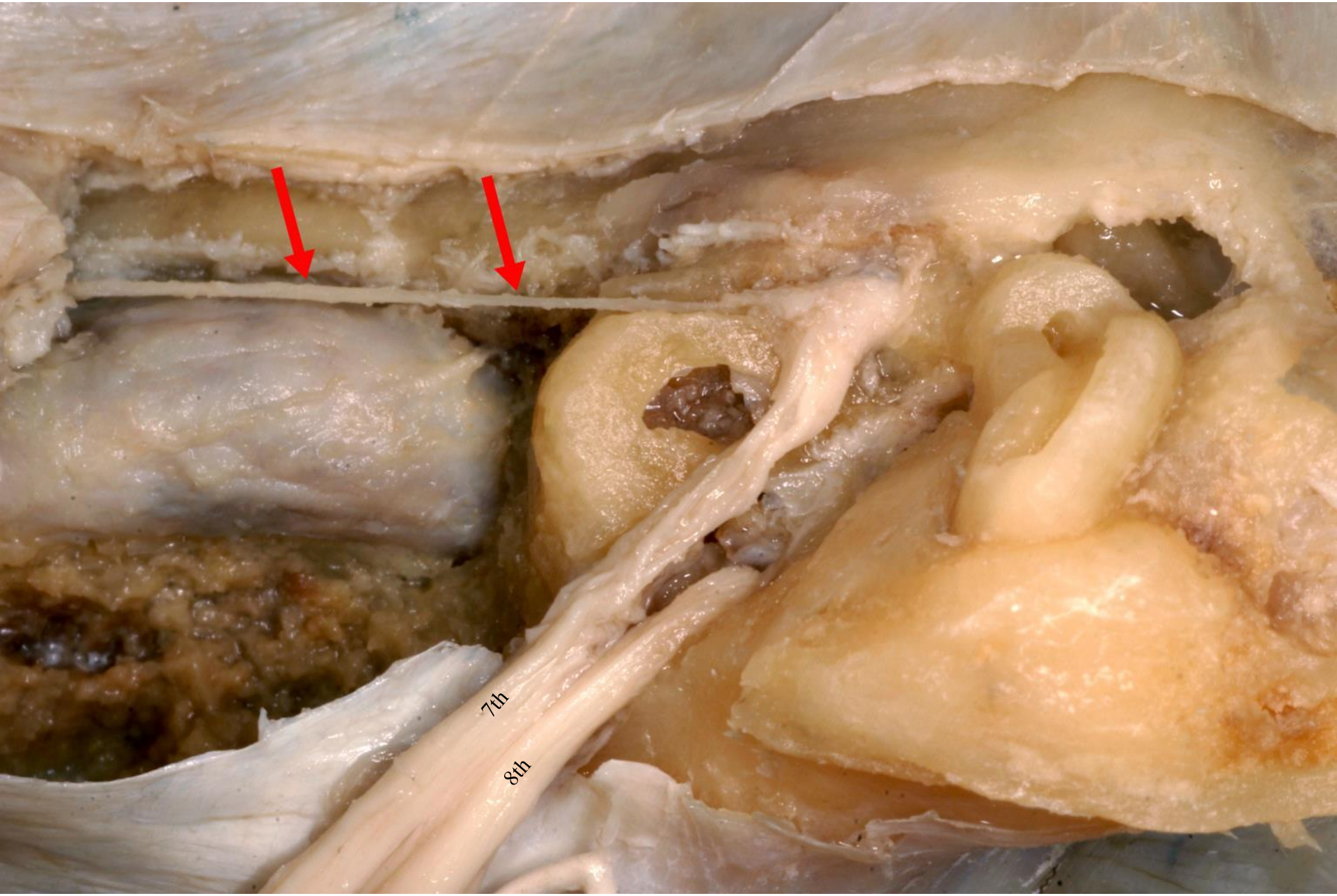
✓It enters the middle cranial fossa through the hiatus of the facial canal

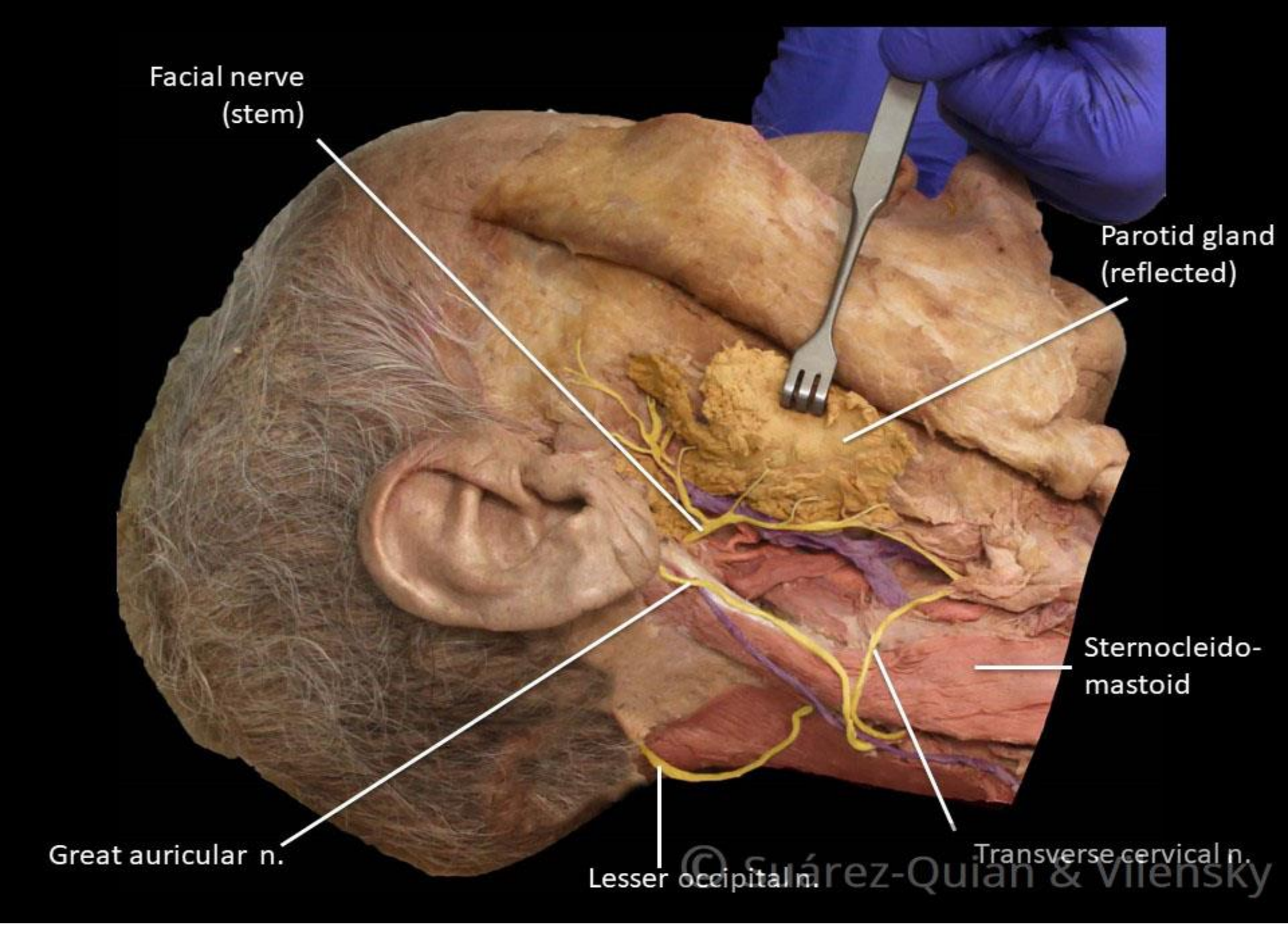
✓It travels across (but not through) the foramen lacerum, combining with the deep petrosal nerve (a sympathetic nerve) to form the **nerve of the pterygoid canal**.

✓ The nerve of pterygoid canal (vidian nerve) passes through the pterygoid canal to reach the pterygopalatine ganglion

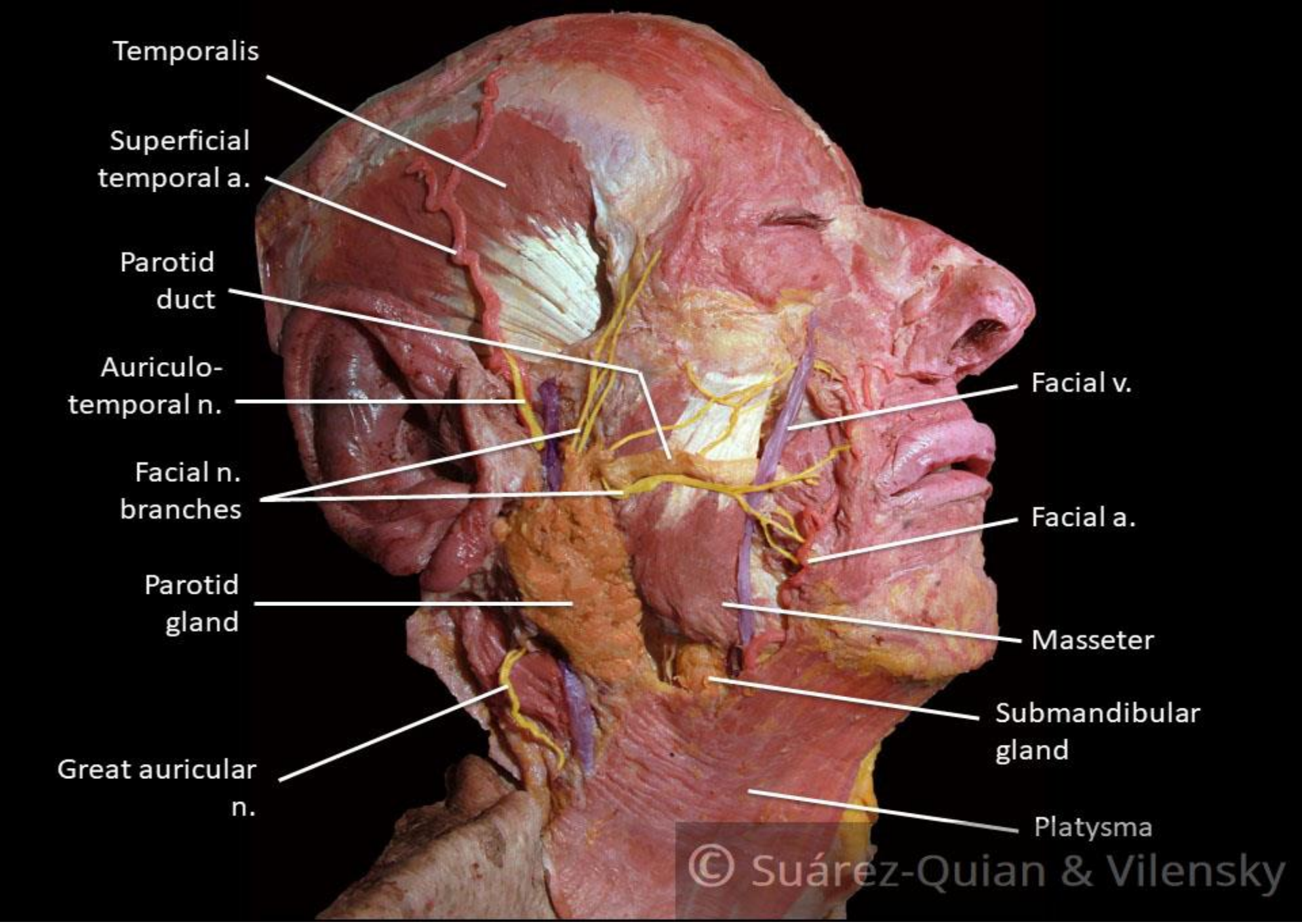


Greater petrosal nerve

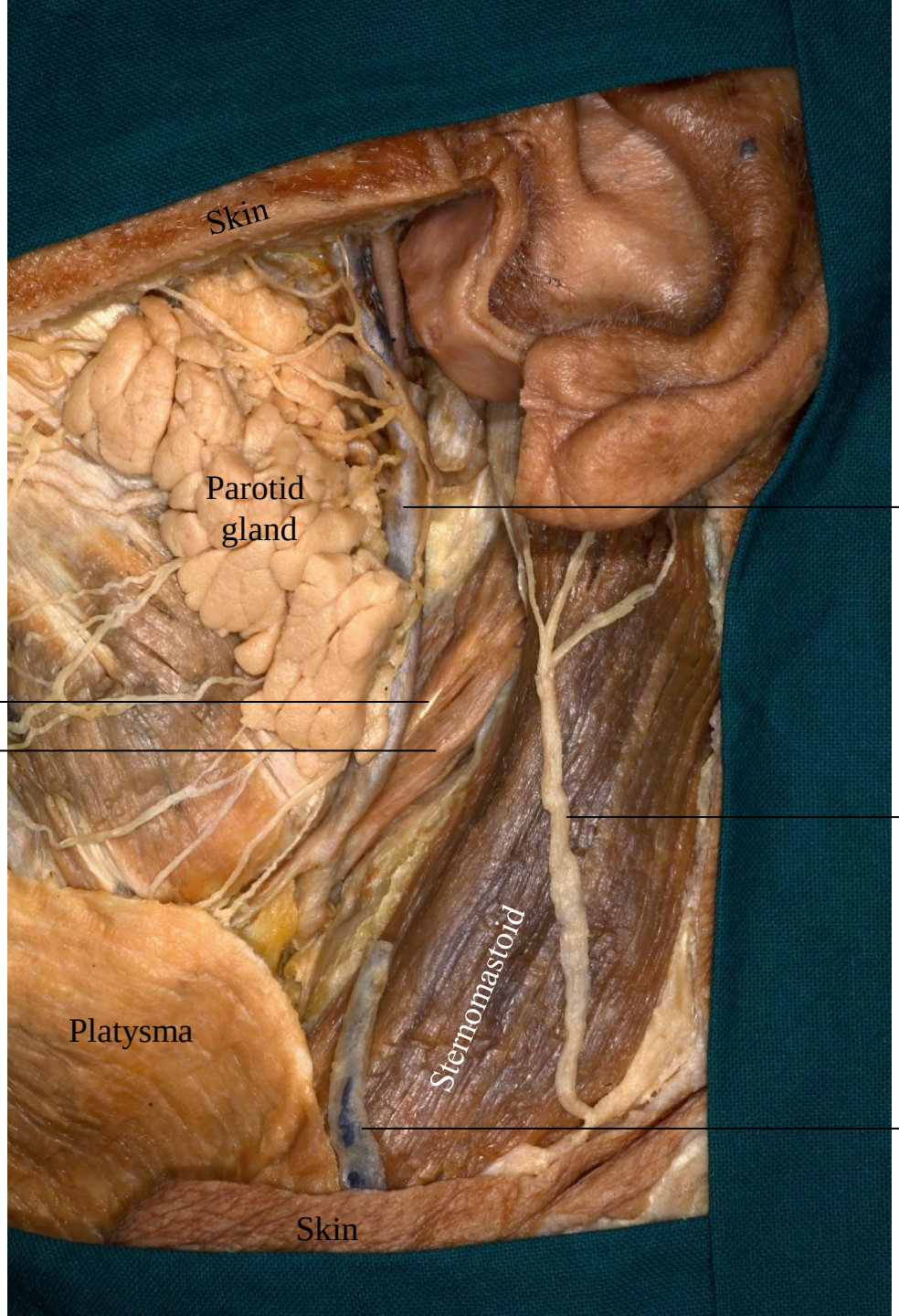


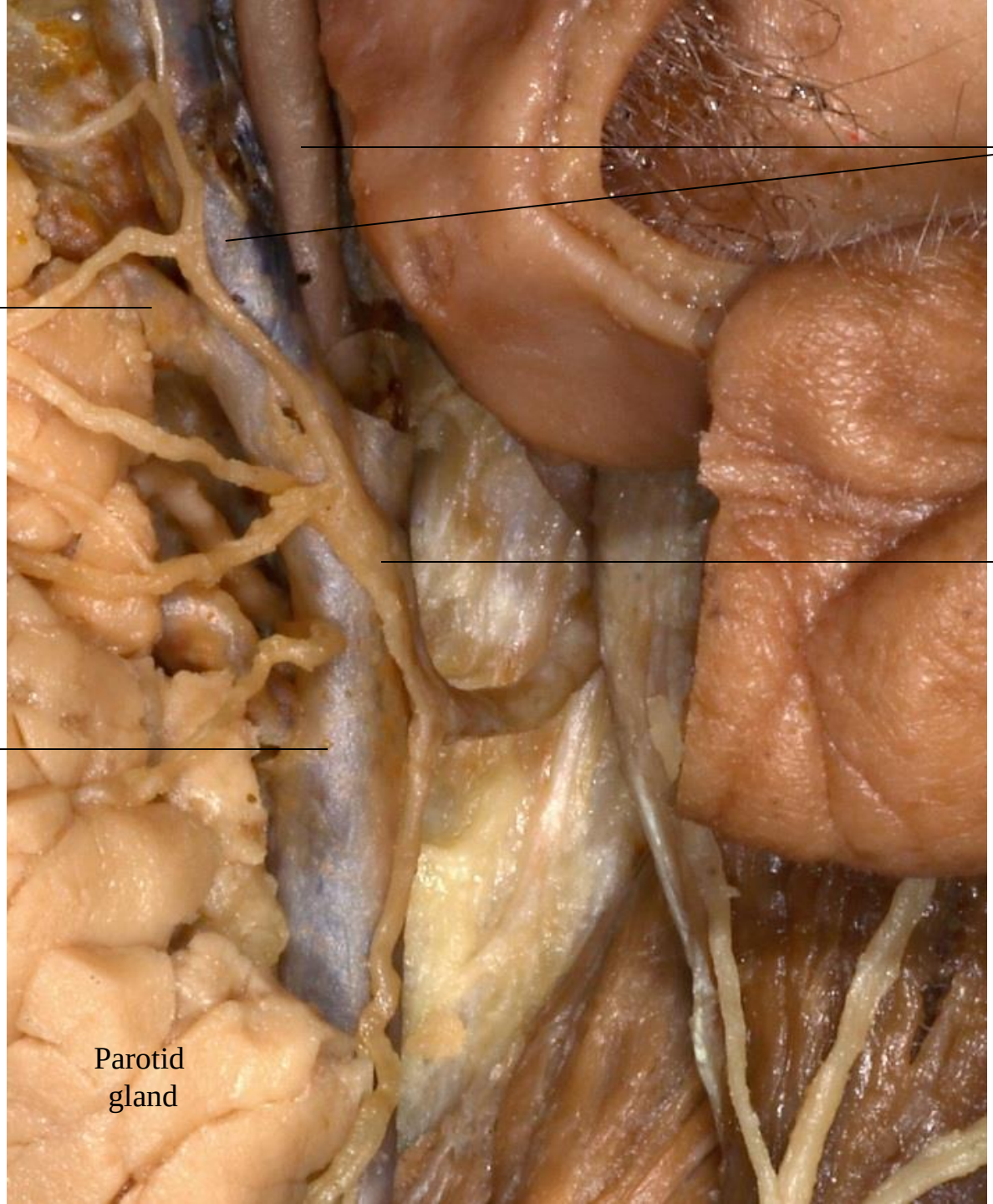


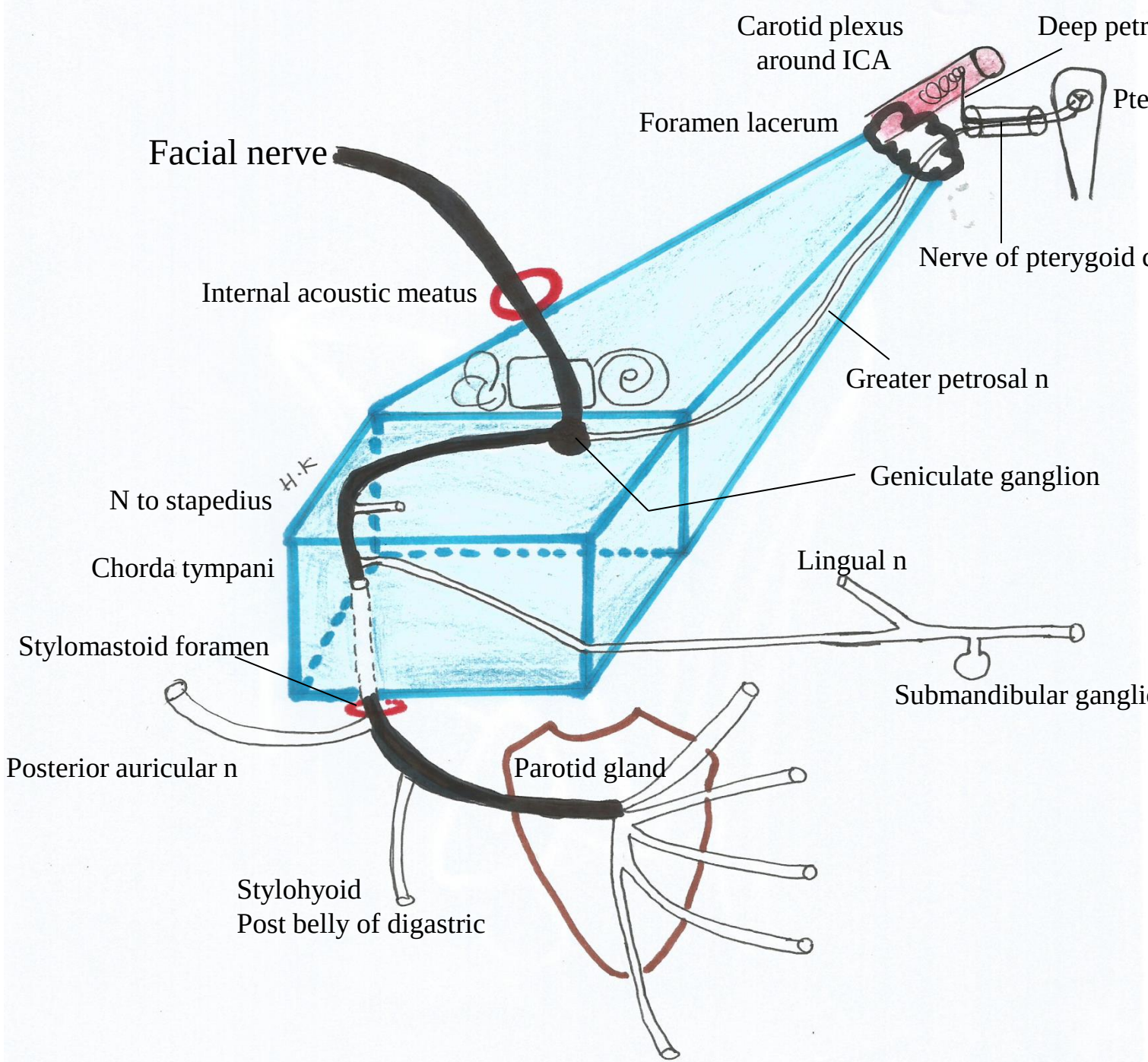
Dissection 1 – Relationship of the facial nerve and parotid gland. Image from All in One Anatomy Review.



Dissection 2 – Demonstrating the branches of the facial nerve. Image from All in One Anatomy Review.


Skin
Parotid gland
Retromandibular vein
????
Great auricular nerve
Sternomastoid
Platysma
External jugular vein
Skin


Superficial temporal artery and vein
Maxillary vein
Facial nerve (Motor)
Retromandibular vein
Parotid gland



Right sided weakness of the muscles of facial expression, due to facial nerve paralysis.

The facial nerve has a wide range of functions. Thus, damage to the nerve can produce a varied set of symptoms, depending on the site of the lesion.

Intracranial Lesions

Intracranial lesions occur during the intracranial course of the facial nerve (proximal to the stylomastoid foramen).

The muscles of facial expression will be paralysed or severely weakened. The other symptoms produced depend on the location of the lesion, and the branches that are affected:

Chorda tympani – reduced salivation and loss of taste on the ipsilateral 2/3 of the tongue.

Nerve to stapedius – ipsilateral hyperacusis (hypersensitive to sound).

Greater petrosal nerve – ipsilateral reduced lacrimal fluid production.

The most common cause of an intracranial lesion of the facial nerve is middle ear pathology – such as a tumour or infection. If no definitive cause can be found then the disease is termed **Bell's palsy.**

Left sided facial palsy

Extracranial Lesions

Extracranial lesions occur during the extracranial course of the facial nerve (distal to the stylomastoid foramen).

Only the **motor function** of the facial nerve is affected, therefore resulting in paralysis or severe weakness of the muscles of facial expression.

There are various causes of extracranial lesions of the facial nerve:

Parotid gland pathology – e.g a tumor, parotitis, surgery.

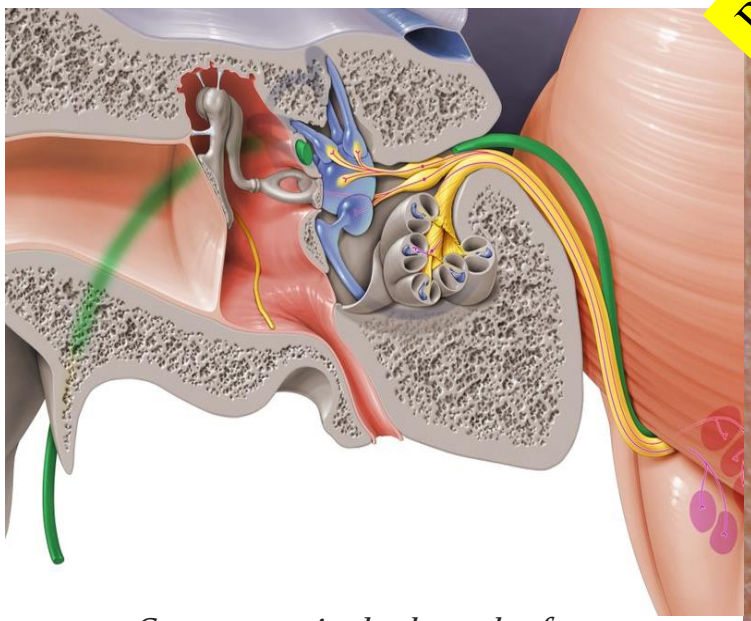
Infection of the nerve – particularly by the herpes virus.

Compression during forceps delivery – the neonatal mastoid process is not fully developed, and does not provide complete protection of the nerve.

Idiopathic – If no definitive cause can be found then the disease is termed **Bell's palsy.**

Ramsay Hunt syndrome type 2 is the reactivation of herpes zoster in the geniculate ganglion. It is sometimes called **herpes zoster oticus**. A triad of ipsilateral facial paralysis, ear pain, and vesicles on the face, on the ear, or in the ear is the typical presentation.

Read only ☺



Sensory auricular branch of the facial nerve???

Herpes zoster oticus, day 6. Image courtesy of Manolette Roque, MD, ROQUE Eye Clinic.

Testing the facial nerve

To test the facial nerve, the patient is asked to show the teeth by separating the lips with the teeth clenched, to close the eyes, to raise eyebrows, to puff out cheeks, and to whistle

Taste on each half of the anterior two thirds of the tongue can be tested with sugar, salt, vinegar, and quinine for the sweet, salt, sour, and bitter sensations, respectively.

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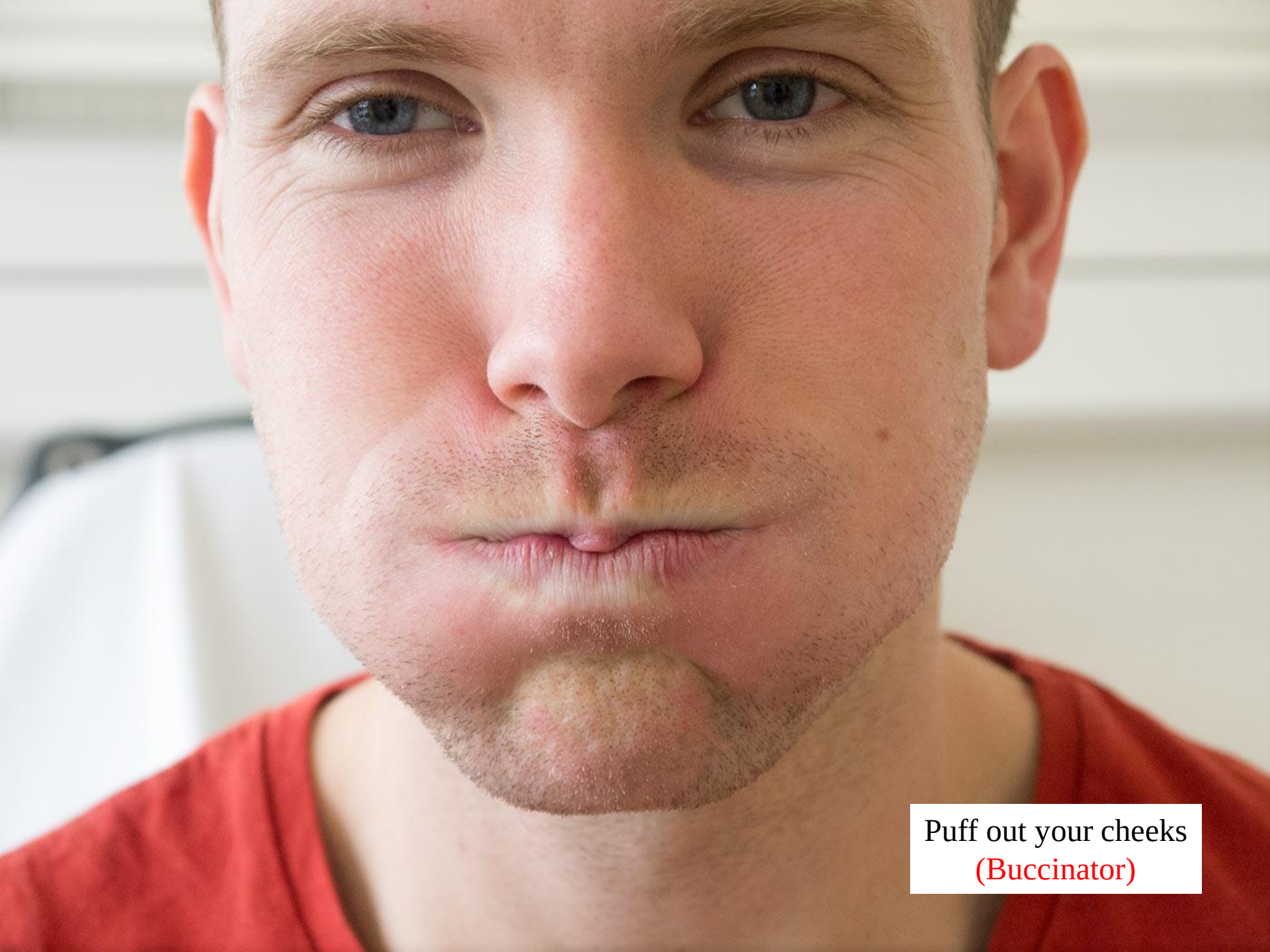
Raise up your eyebrows
(Frontalis)

Close your eyes tightly
Try to open them by applying gentle upwards pressure
(Orbicularis oculi)

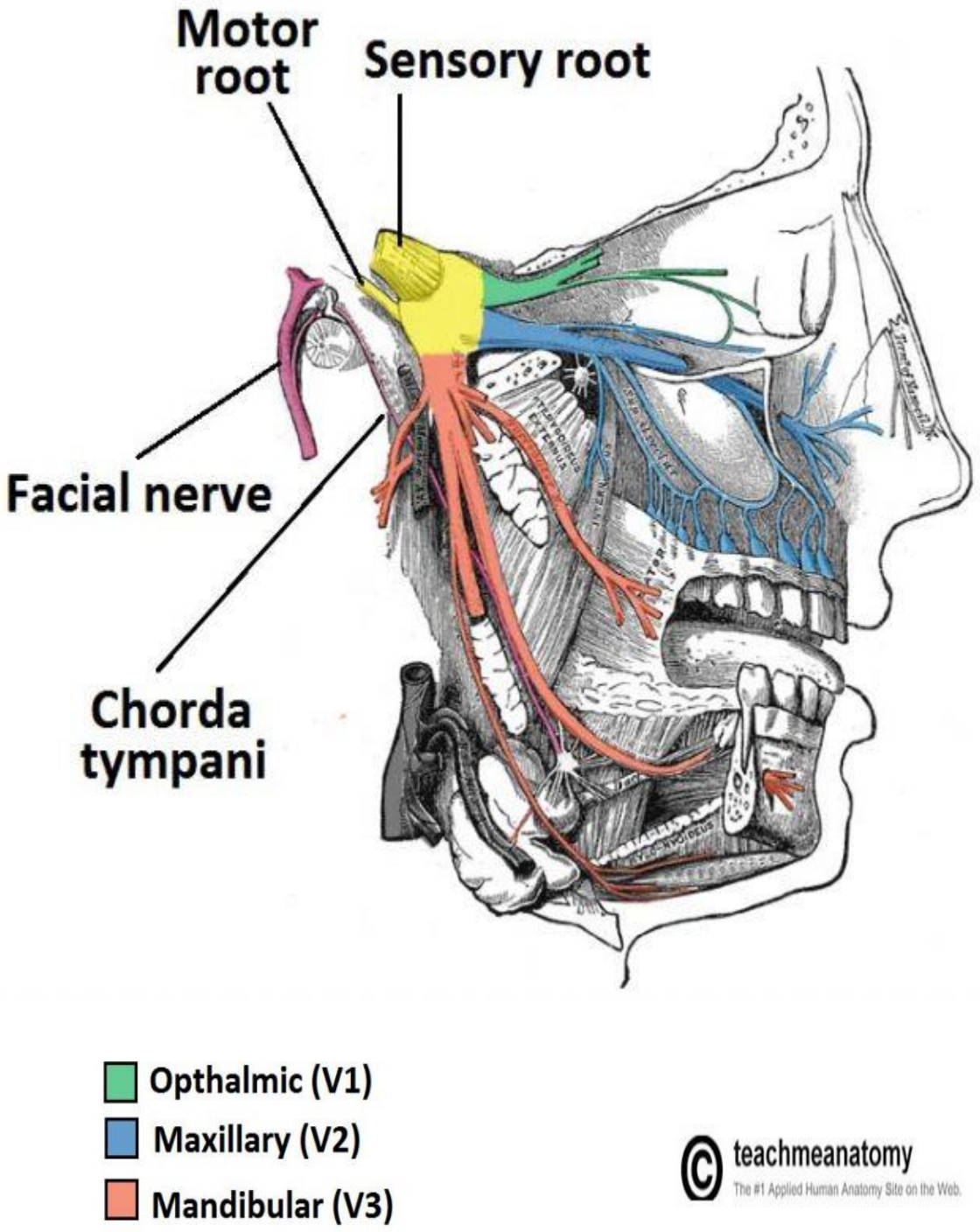

Puff out your cheeks
(Buccinator)


Smile/ show your teeth
Look for any deviation of the angle of the mouth

Trigeminal nerve

The trigeminal nerve is associated with derivatives of the 1st pharyngeal arch.

Sensory: The three terminal branches of CN V innervate the skin, mucous membranes and sinuses of the face.
Motor: Only the mandibular branch of CN V has motor fibres. It innervates the muscles of mastication: medial pterygoid, lateral pterygoid, masseter and temporalis. The mandibular nerve also supplies other 1st pharyngeal arch derivatives: anterior belly of digastric, mylohyoid, tensor veli palatini and tensor tympani.



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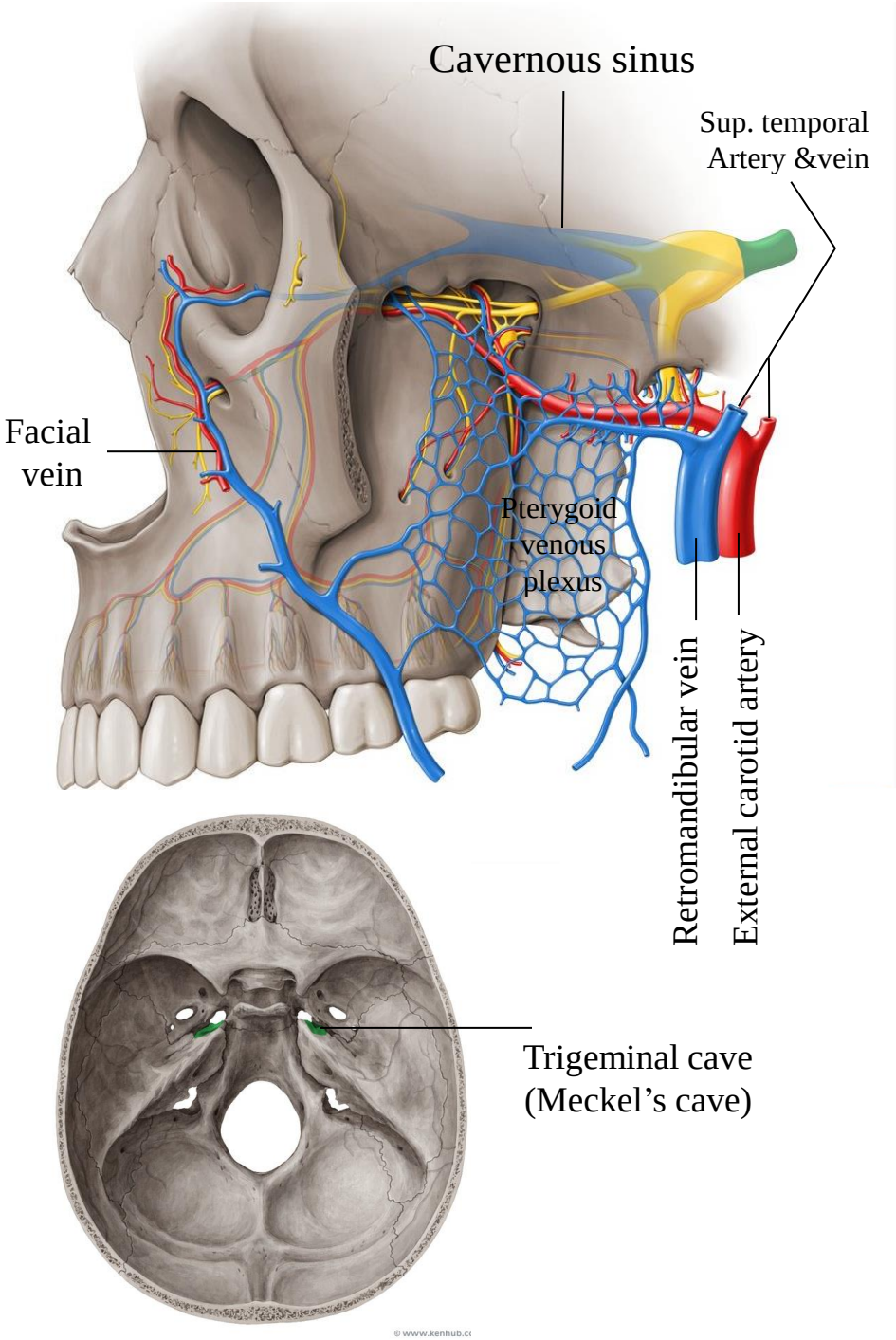
Trigeminal nerve

Anatomical course

✓Originates from **pons**, as two roots, one large (sensory) and one small (motor)
✓In **middle cranial fossa**, the sensory root expands into the trigeminal ganglion. The trigeminal ganglion is located lateral to the cavernous sinus, in a depression of the temporal bone. This depression is known as the **trigeminal cave (Meckel's cave)**.
✓The peripheral aspect of the trigeminal ganglion gives rise to 3 divisions: **ophthalmic** (V1), **maxillary** (V2) and **mandibular** (V3).

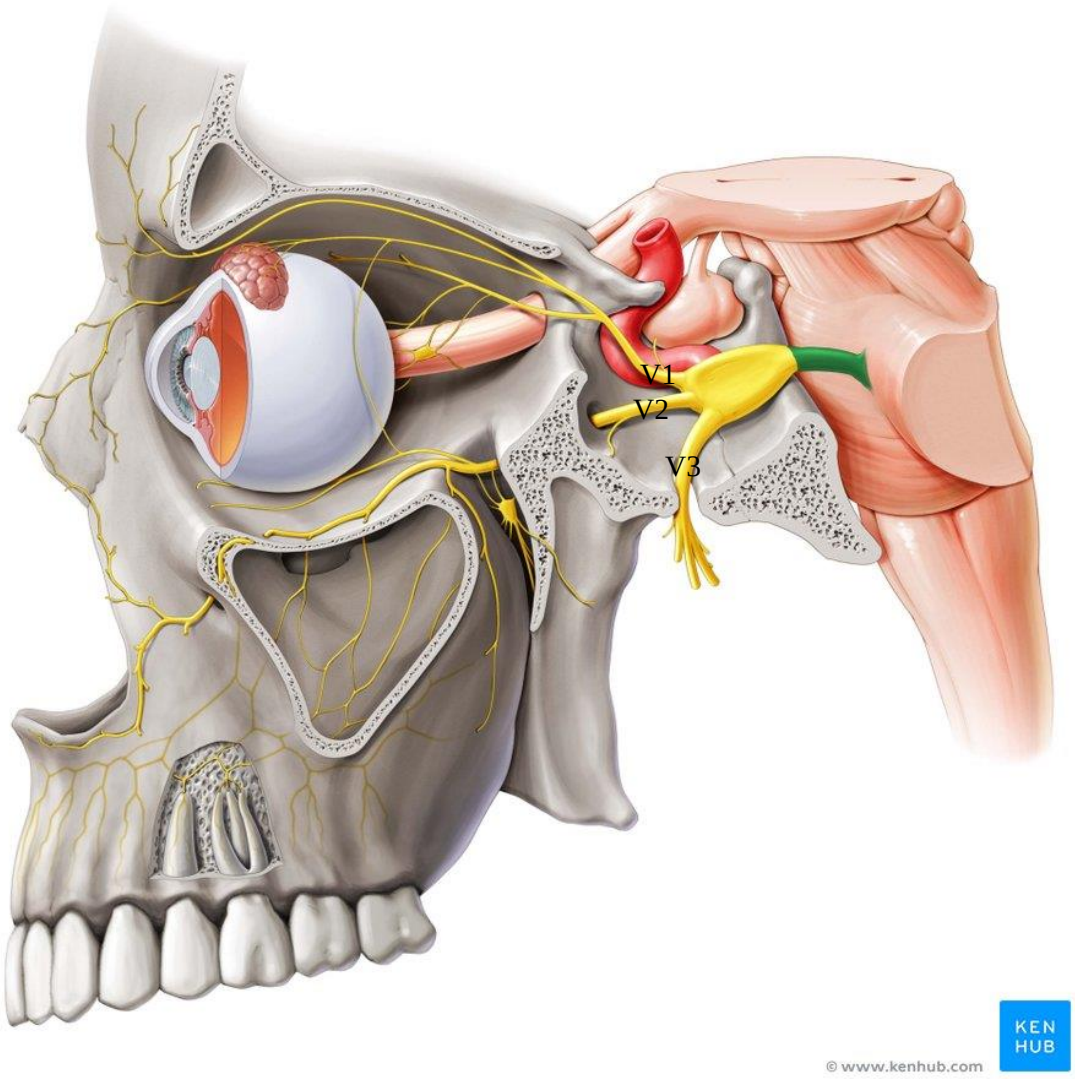


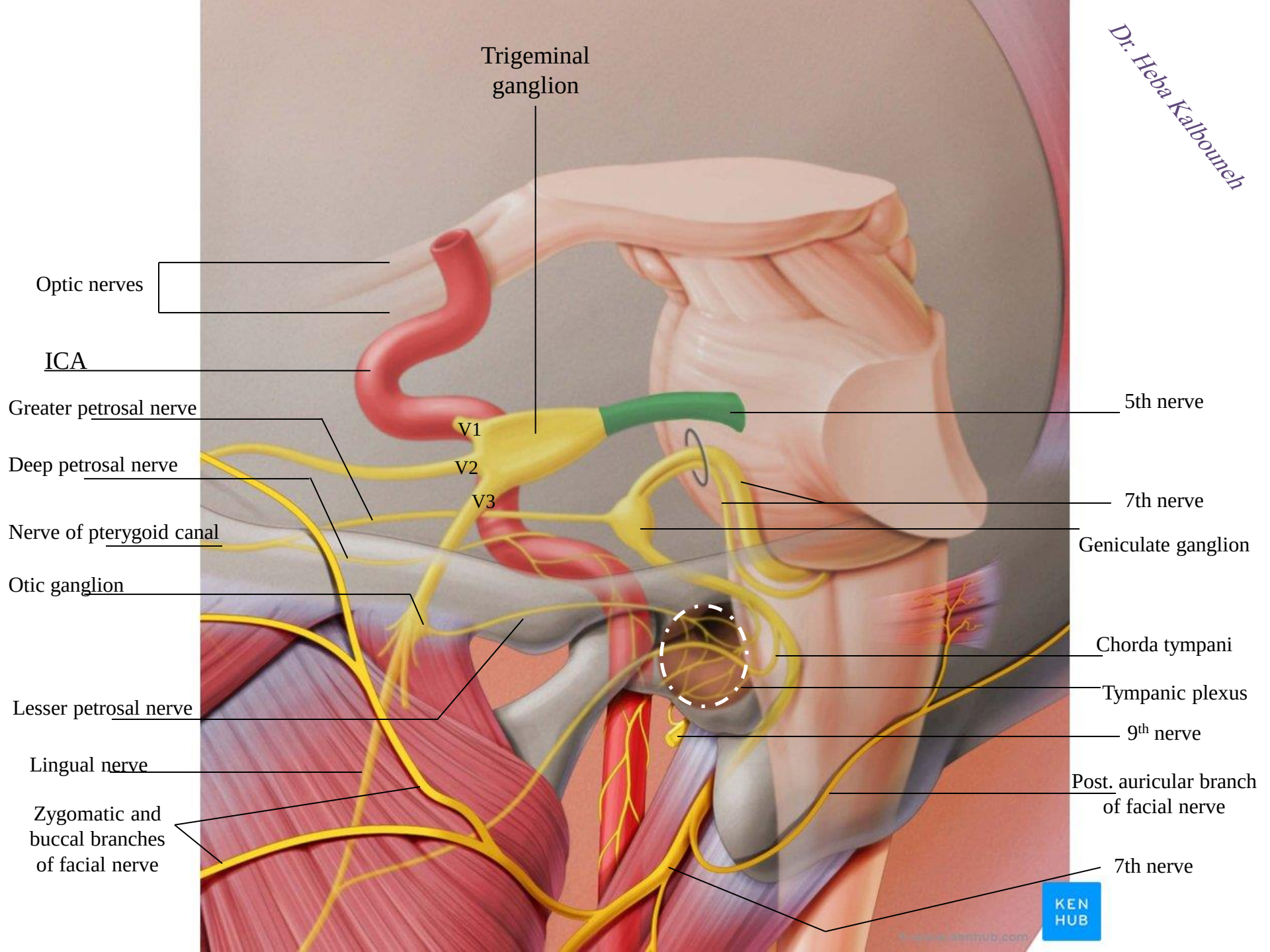
Trigeminal nerve

✓The motor root passes inferiorly to the sensory root, along the floor of the trigeminal cave. Its fibers are only distributed to the **mandibular division**.

✓The ophthalmic nerve and maxillary nerve travel lateral to the cavernous sinus exiting the cranium via the **superior orbital fissure** and **foramen rotundum** respectively. The mandibular nerve exits via the **foramen ovale** entering the infra-temporal fossa.

(*Note – be aware that while we talk about the nerves exiting the cranial cavity, the sensory components can also be said to be entering the cranial cavity, since they are afferent fibers).*




Trigeminal ganglion
Optic nerves
ICA
Greater petrosal nerve
Deep petrosal nerve
Nerve of pterygoid canal
Otic ganglion
Lesser petrosal nerve
Lingual nerve
Zygomatic and buccal branches of facial nerve
V1
V2
V3
5th nerve
7th nerve
Geniculate ganglion
Chorda tympani
Tympanic plexus
9th nerve
Post. auricular branch of facial nerve
7th nerve
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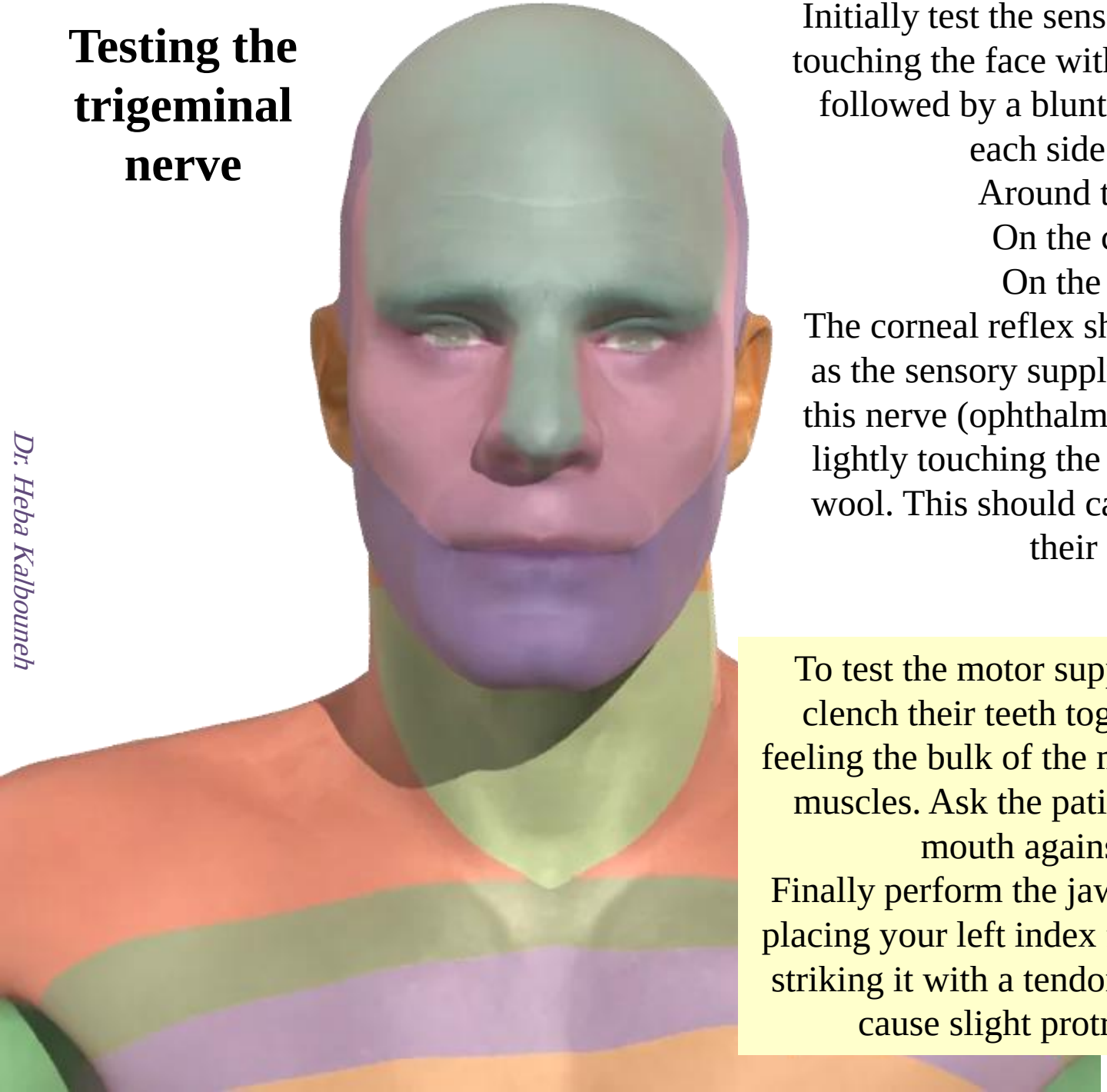
Testing the trigeminal nerve



Initially test the sensory branches by lightly touching the face with a piece of cotton wool followed by a blunt pin in three places on each side of the face:
Around the jawline.
On the cheek and.
On the forehead.
The corneal reflex should also be examined as the sensory supply to the cornea is from this nerve (ophthalmic division). Do this by lightly touching the cornea with the cotton wool. This should cause the patient to shut their eyelids.

To test the motor supply, ask the patient to clench their teeth together, observing and feeling the bulk of the masseter and temporalis muscles. Ask the patient to then open their mouth against resistance.
Finally perform the jaw jerk on the patient by placing your left index finger on their chin and striking it with a tendon hammer. This should cause slight protrusion of the jaw.

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Testing the ophthalmic division


Testing the maxillary division


Testing the mandibular division


Corneal reflex test
Testing the ophthalmic division


Masseter and the temporalis muscles can be palpated and felt to harden as they contract
Feeling the masseter muscles

Masseter and the temporalis muscles can be palpated and felt to harden as they contract

Feeling the temporalis muscles


The jaw jerk

Accessory nerve

Anatomical Course

The accessory nerve is divided into spinal and cranial parts.

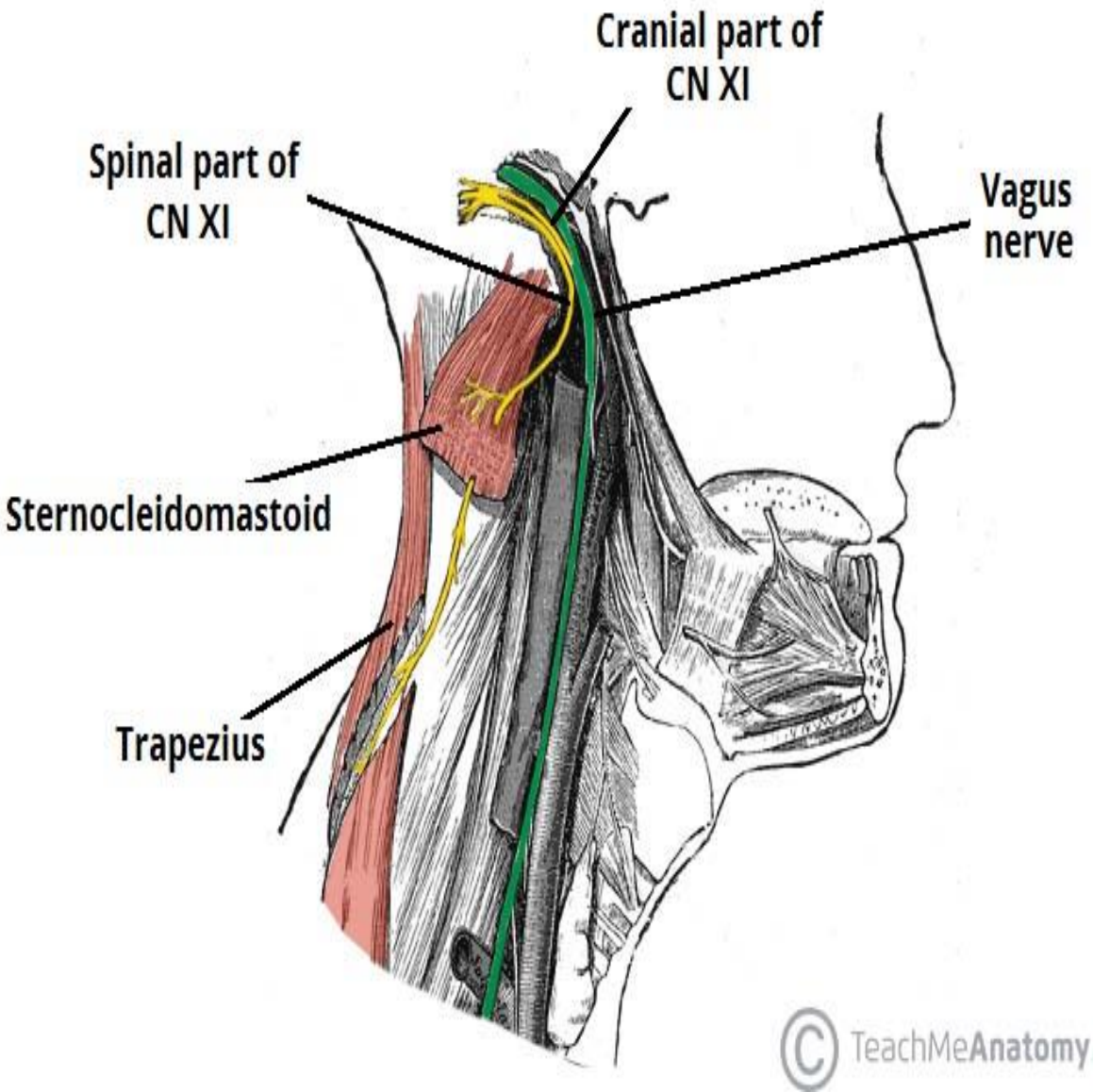
Spinal Component

The spinal portion arises from neurons of the upper spinal cord, specifically C1-C5/C6 spinal nerve roots. These fibers coalesce to form the spinal part of the accessory nerve, which then runs superiorly to enter the cranial cavity via the **foramen magnum**.

The nerve transverses the posterior cranial fossa to reach the **jugular foramen.** It briefly meets the cranial portion of the accessory nerve, before exiting the skull (along with the glossopharyngeal and vagus nerves).

Motor Function

The spinal accessory nerve innervates two muscles – the sternocleidomastoid and trapezius.



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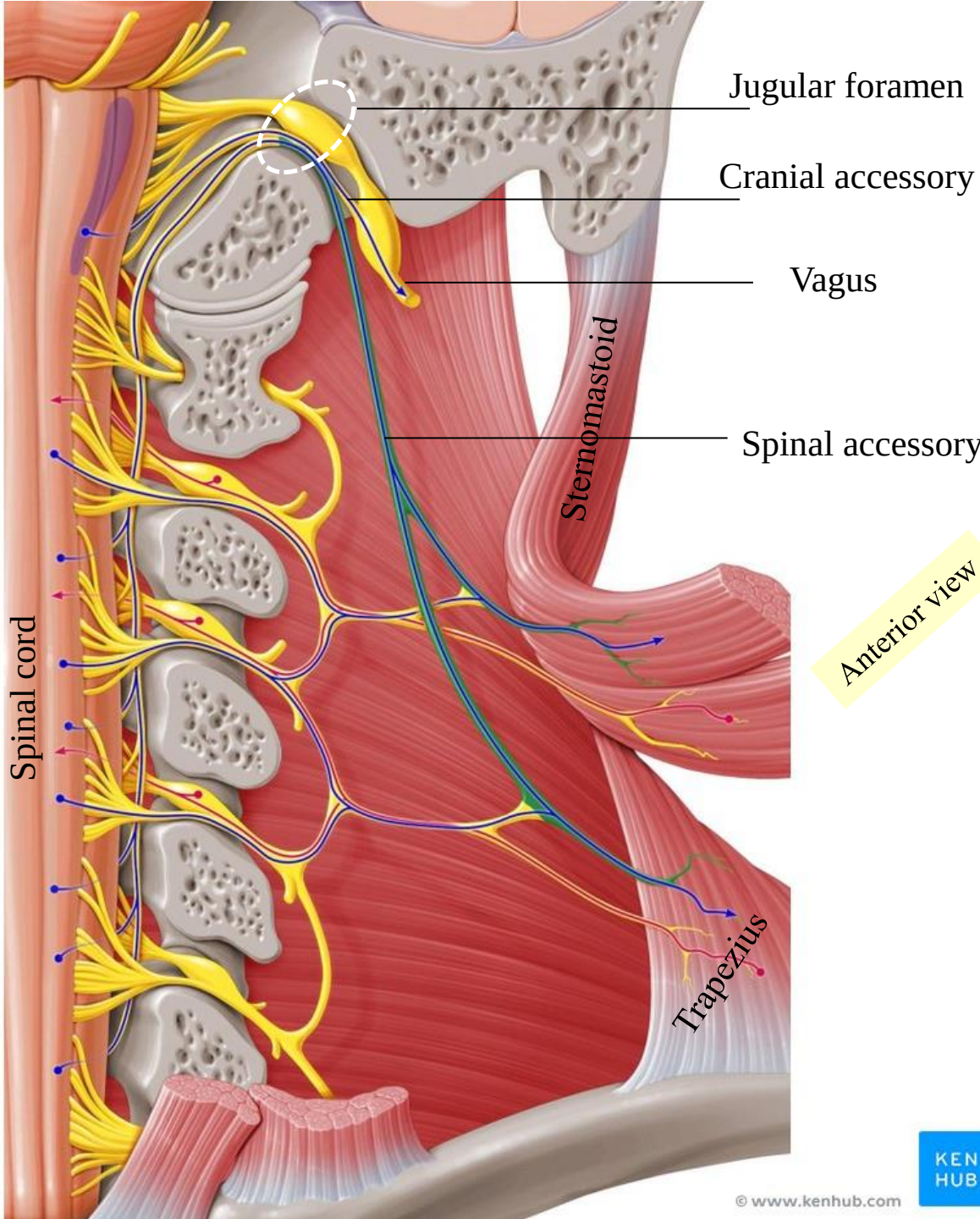
Accessory nerve

Outside the cranium, the spinal part descends along the **internal carotid artery** to reach the sternocleidomastoid muscle, which it innervates. It then moves across the posterior triangle of the neck to supply motor fibers to the trapezius.

Note: The extracranial course of the accessory nerve is relatively superficial and thus leaves it vulnerable to damage.



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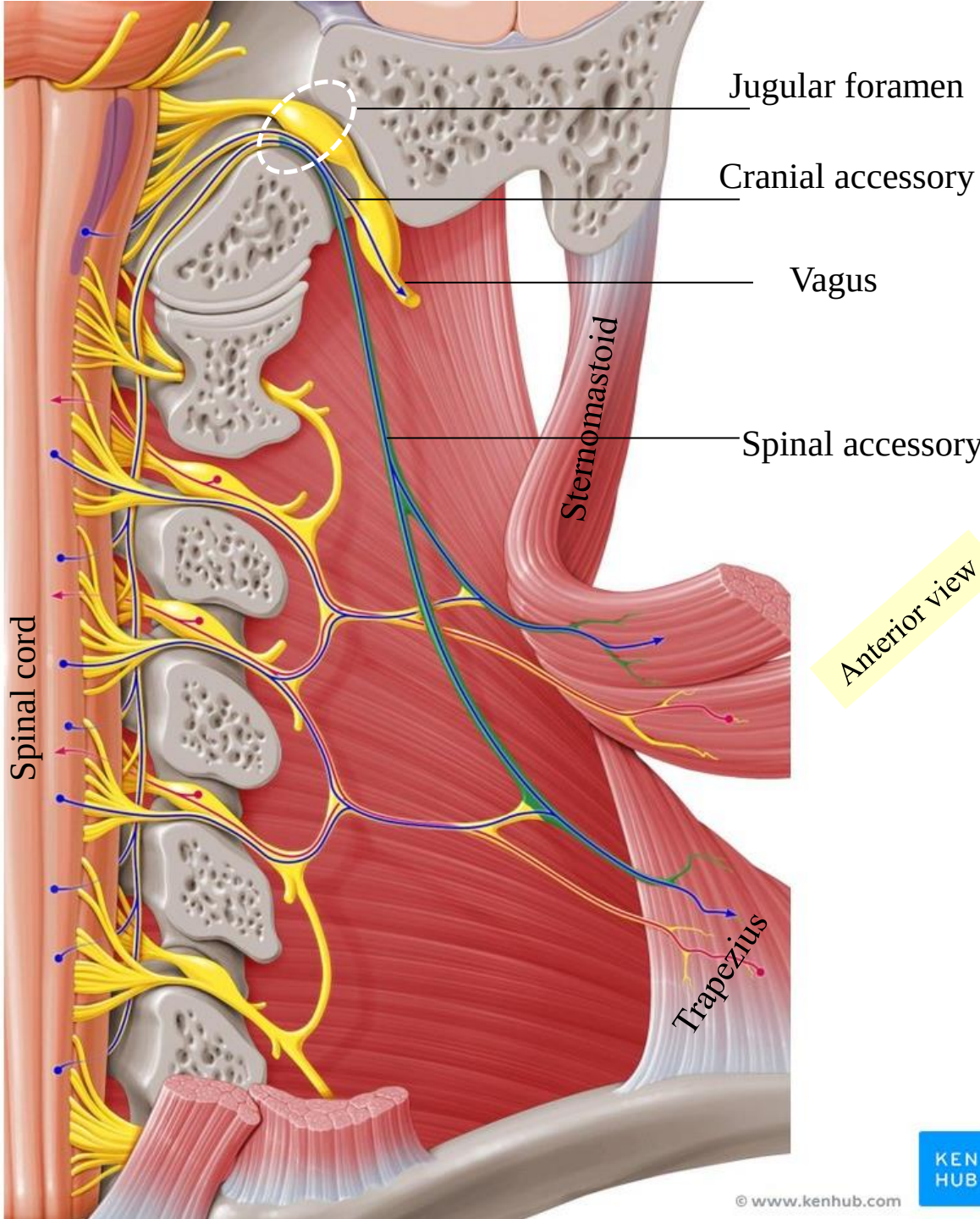
Accessory nerve

Cranial Component
The cranial portion is much smaller, and arises from the **medulla oblongata**.
It leaves the cranium via the **jugular foramen**, where it briefly contacts the spinal part of the accessory nerve.

Immediately after leaving the skull, cranial part combines with the **vagus nerve** (CN X)

The fibers from the cranial part are then distributed through the **vagus nerve**. For this reason, the cranial part of the accessory nerve is considered as part of the vagus nerve.



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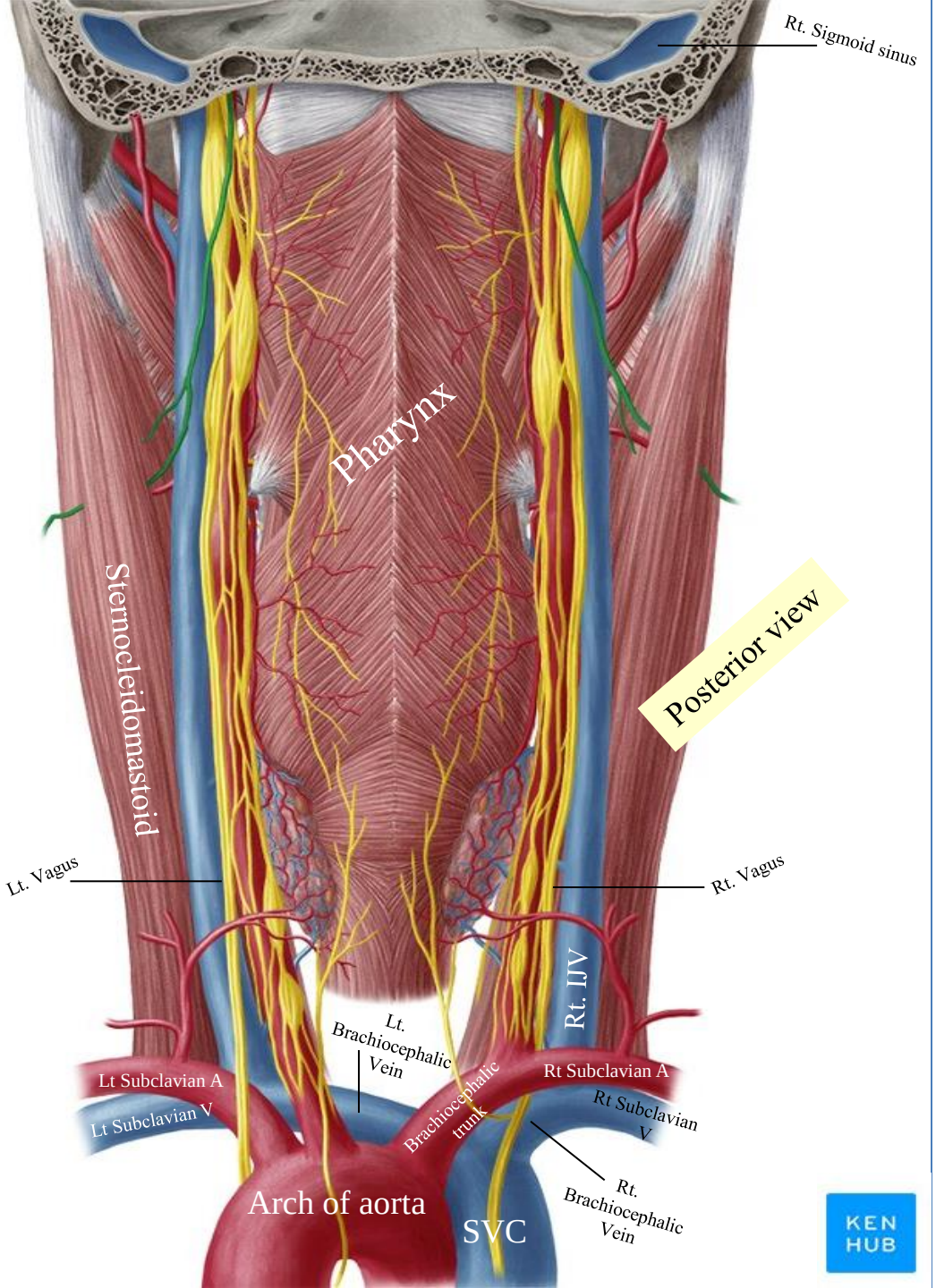

Testing the accessory nerve

Ask the patient to rotate the head to one side against resistance, causing the sternocleidomastoid of the opposite side to come into action. Then the patient should be asked to shrug the shoulders, causing the trapezius muscles to come into action.

Sternocleidomastoid muscle test against resistance


Trapezius muscle test against resistance

Oculomotor nerve

Motor: Innervates the majority of the extraocular muscles (levator palpebrae superioris, superior rectus, inferior rectus, medial rectus and inferior oblique).
Parasympathetic: Supplies the sphincter pupillae and the ciliary muscles of the eye.

Anatomical Course

- ✓ It originates from the **midbrain**
- ✓ It enters the lateral aspect of the **cavernous sinus**
- ✓ It leaves the cranial cavity via the **superior orbital fissure**. At this point, it divides into superior and inferior branches:

Superior branch – Supplies the superior rectus and levator palpabrae superioris.
Inferior branch – Supplies inferior rectus, medial rectus and inferior oblique.
Also supplies pre-ganglionic parasympathetic fibers to the ciliary ganglion, which ultimately innervates the sphincter pupillae and ciliary muscles via **short ciliary nerves.**

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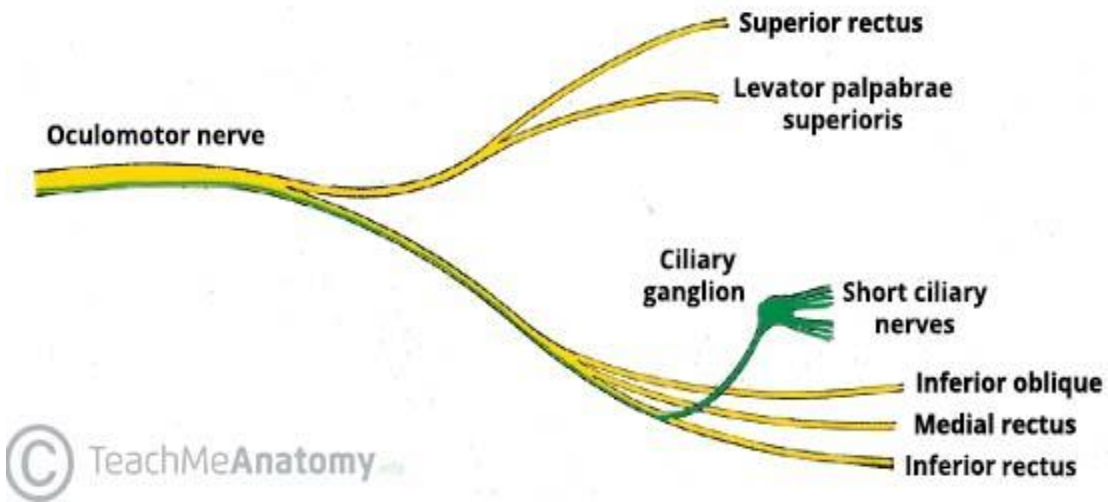

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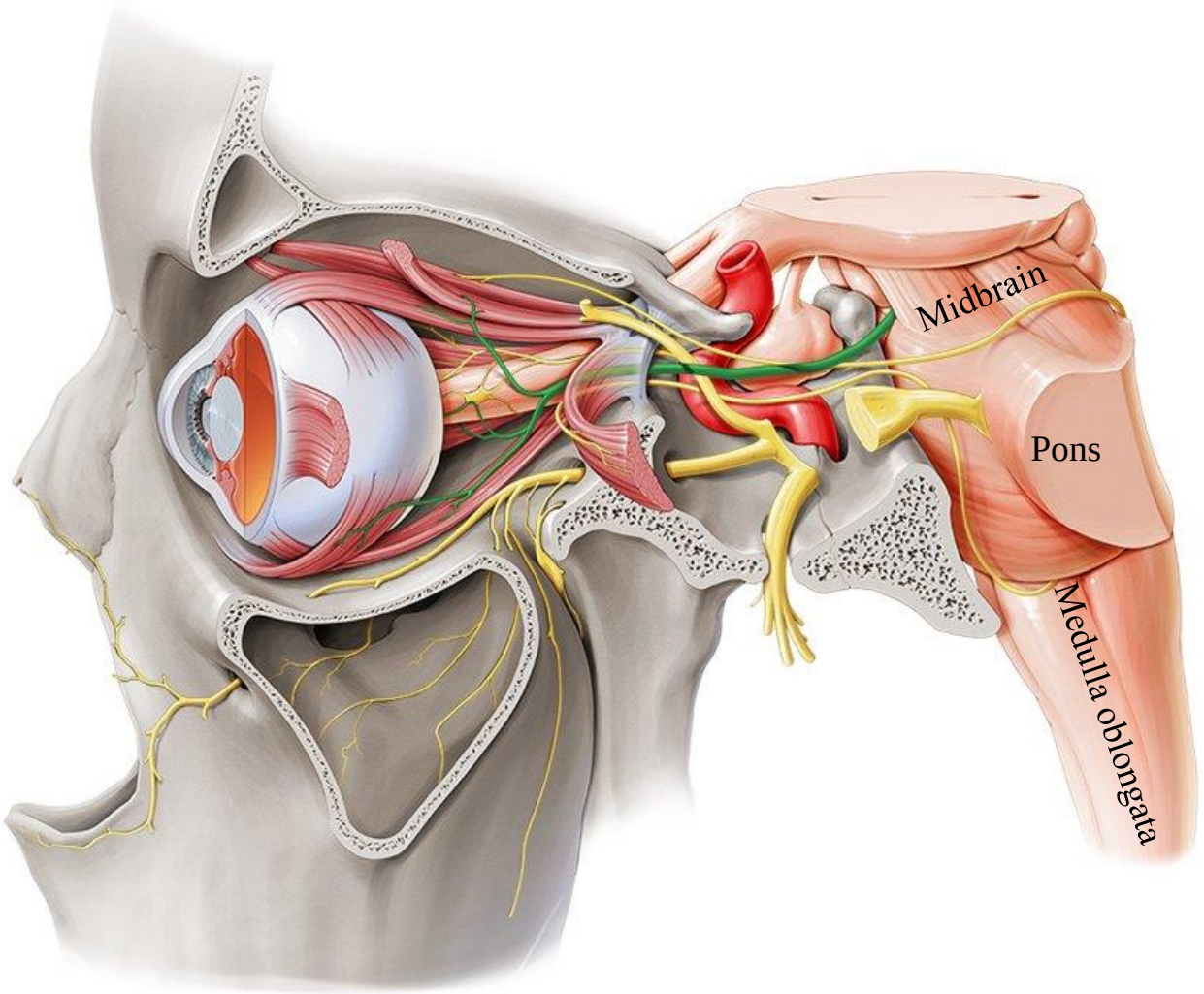
Oculomotor nerve

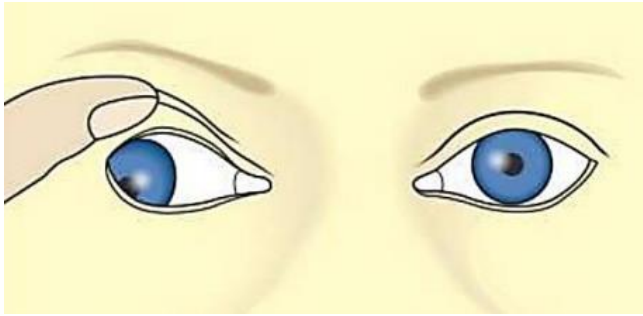


Oculomotor nerve palsy is a condition resulting from damage to the oculomotor nerve. There are several pathological causes, for example:

- ✓ Raised intracranial pressure (compresses the nerve against the temporal bone).
- ✓ Cavernous sinus infection
- ✓ Trauma

Note

The right upper eyelid is elevated by a finger to overcome the right ptosis



The clinical features:

Dilated pupil – due to the unopposed action of the dilator pupillae muscle.

Ptosis – due to paralysis of the levator palpabrae superioris and unopposed activity of the orbicularis oculi muscle.

Down and out position of the eye at rest – due to paralysis of the superior, inferior and medial recti, and the inferior oblique (and therefore the unopposed activity of the lateral rectus and superior oblique).

The patient is unable to elevate, depress or adduct the eye

Trochlear nerve

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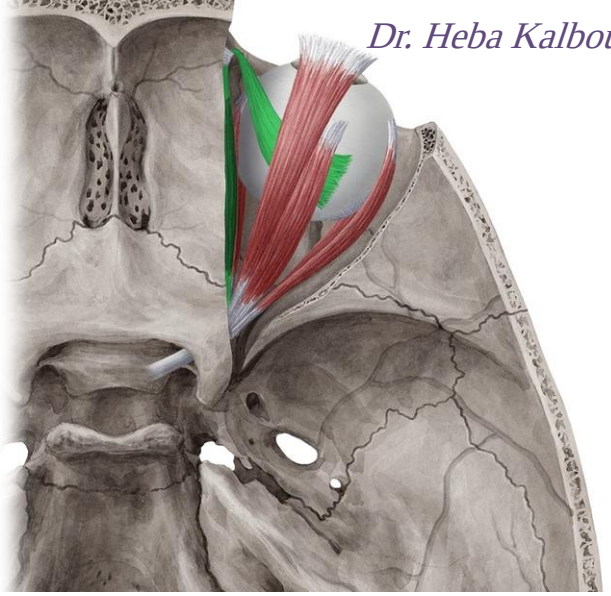
- ✓ It is the smallest cranial nerve (by number of axons), yet has the longest intracranial course.



Anatomical course

- ✓ It originates from the posterior aspect of the **midbrain** (it is the only cranial nerve to exit from the posterior surface of the brain).
- ✓ It moves along the lateral wall of the **cavernous sinus**
- ✓ It enters the orbit of the eye via the **superior orbital fissure**.
- ✓ The trochlear nerve innervates a single muscle – the **superior oblique**

Trochlear nerve palsy: The affected eye deviates **upward and slightly inward**

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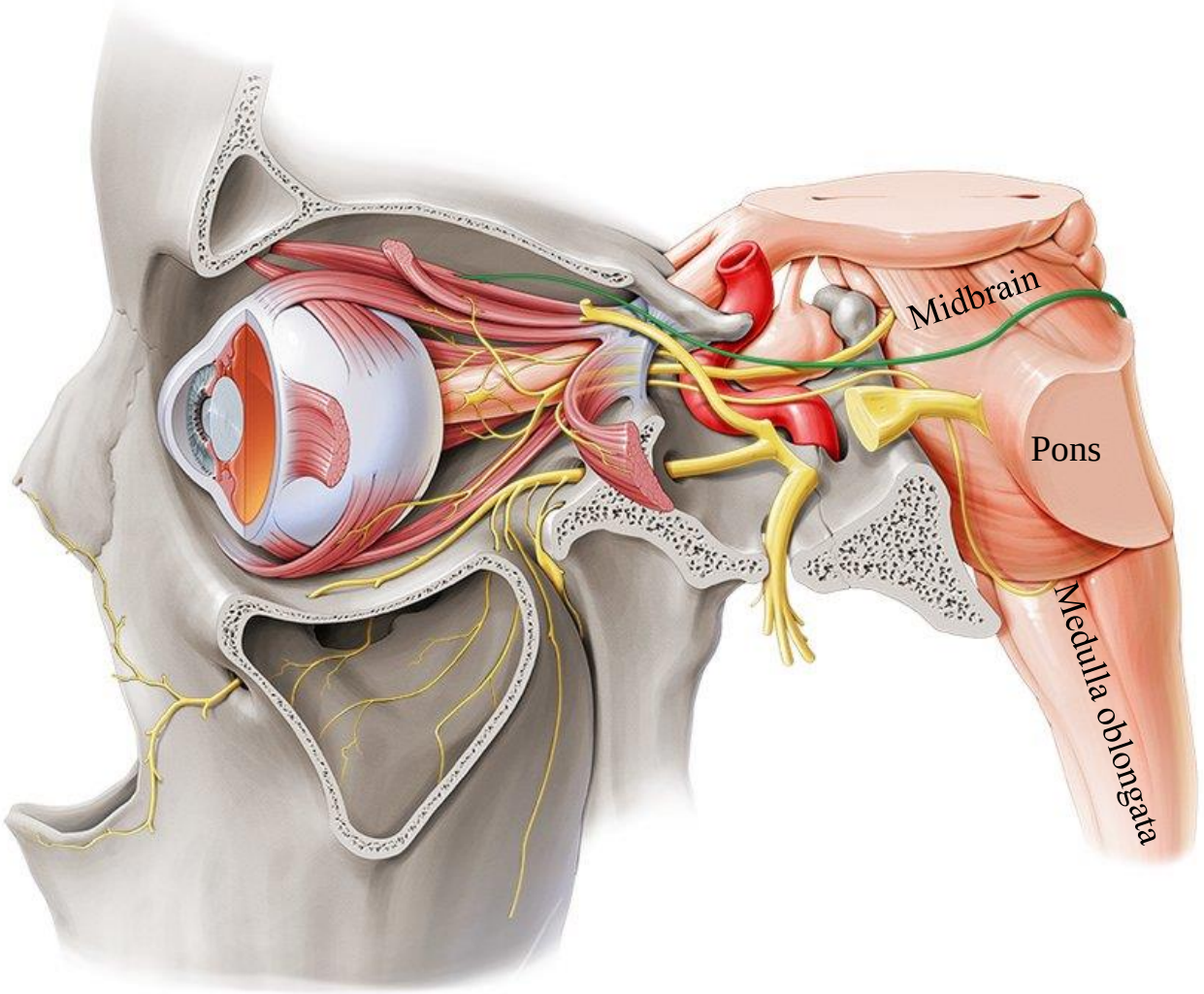
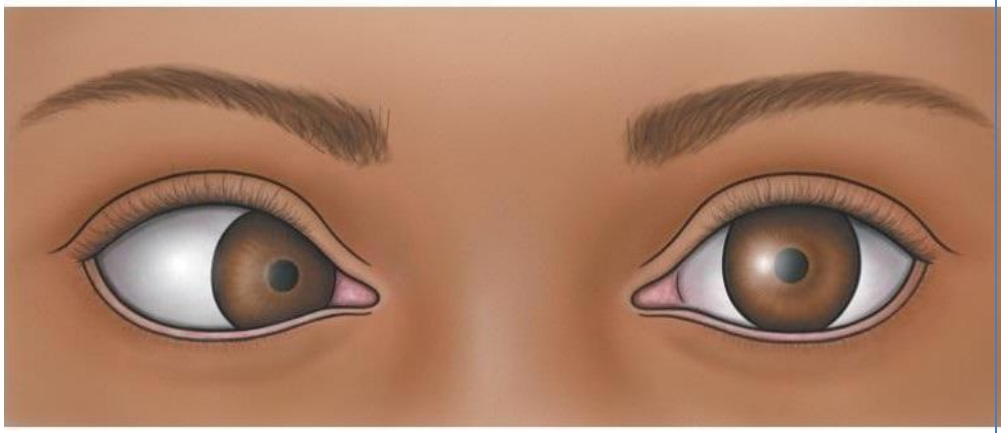
Trochlear nerve



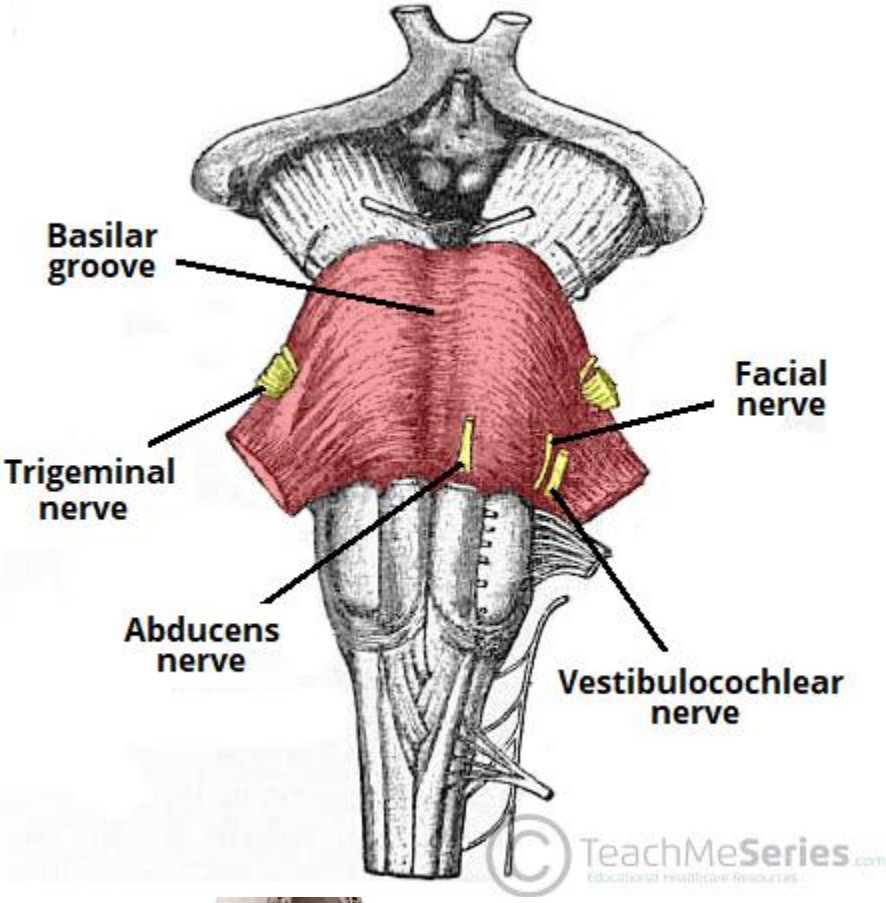
Abducens nerve

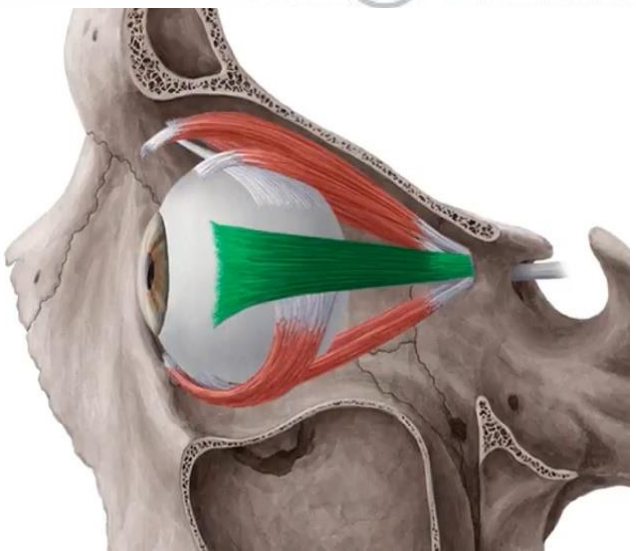
Anatomical course

- ✓ It originates from **pons.**
- ✓ It exits the brainstem at the junction of the pons and the medulla.
- ✓ It enters the cavernous sinus then enters the bony orbit via the superior orbital fissure.
- ✓ It innervates the **lateral rectus** muscle.



Abducens nerve palsy: the affected eye resting in **adduction** (due to unopposed activity of the medial rectus), and inability to abduct the eye.





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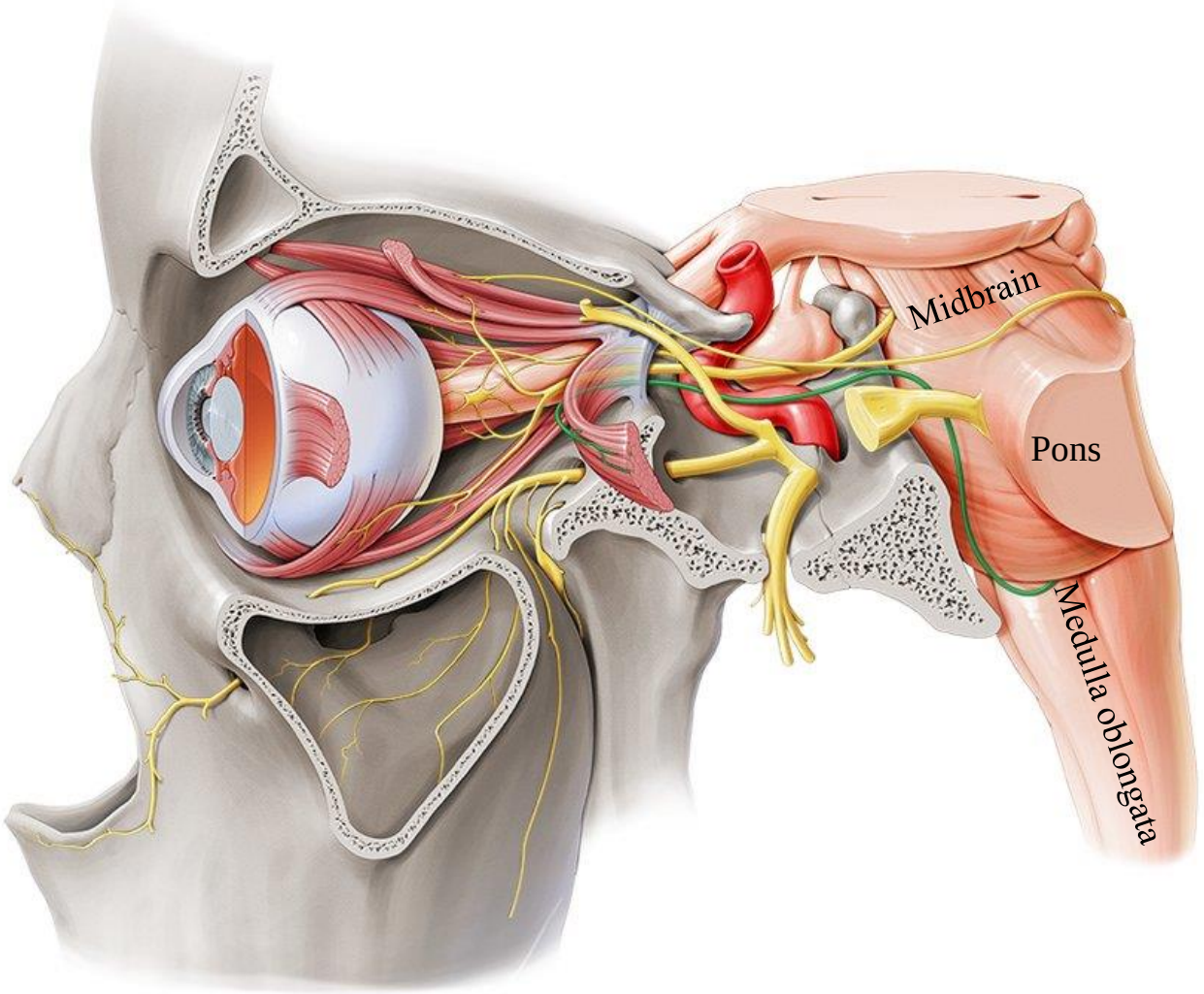
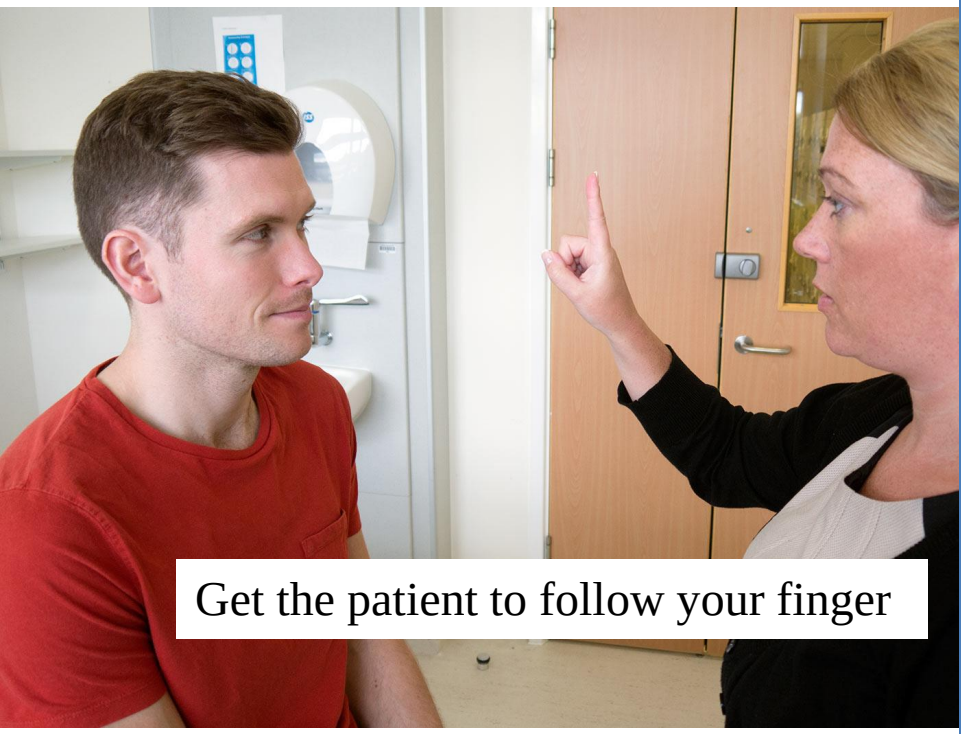
Abducens nerve



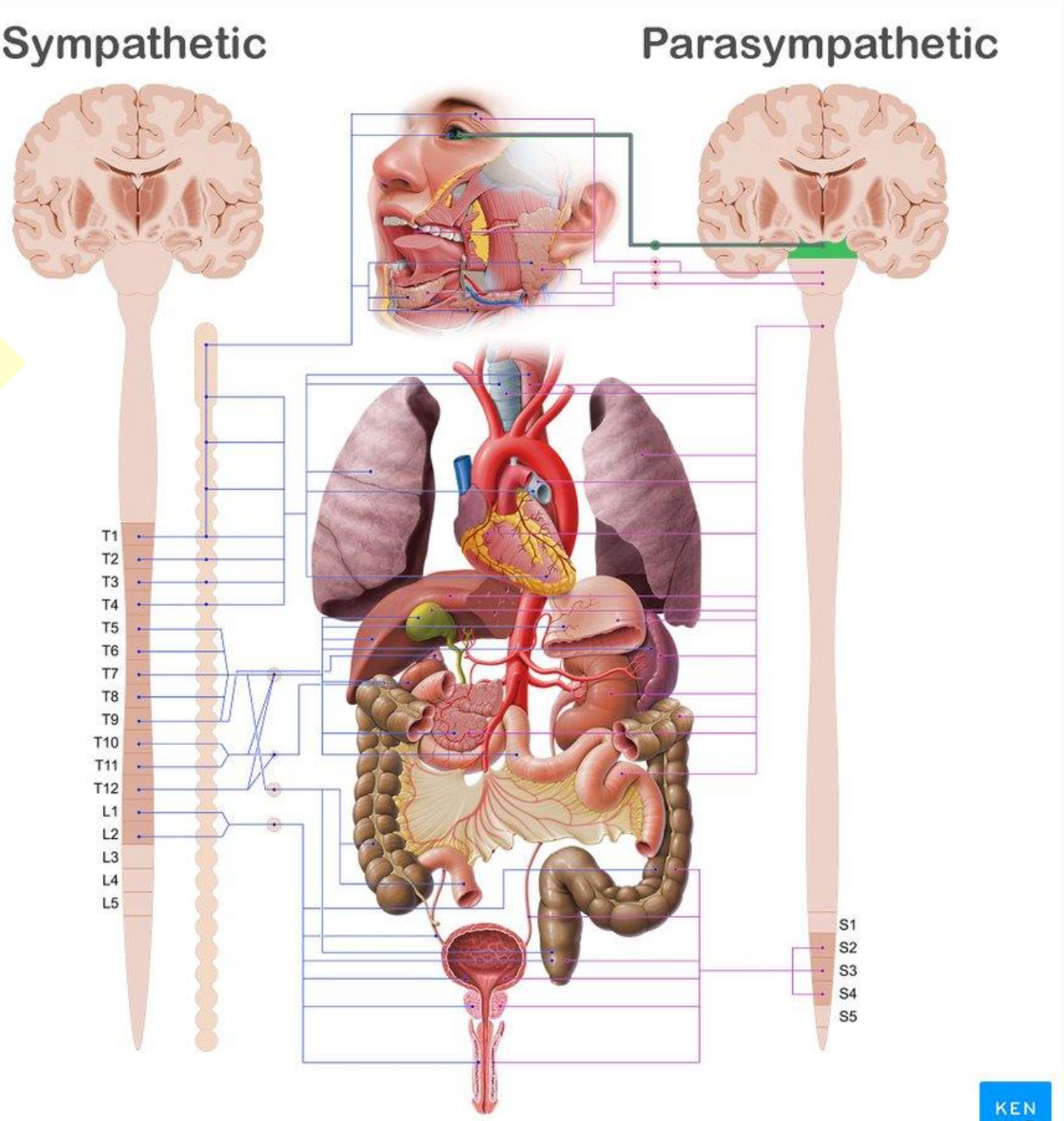


Testing Oculomotor Nerve (CN III), Trochlear Nerve, Abducent Nerve (CN VI)

Asking the patient to keep their head perfectly still directly in front of you, you should draw two large joining H's in front of them using your finger and ask them to follow your finger with their eyes. It is important the patient does not move their head.

Always ask if the patient experiences any double vision, and if so, when is it worse?


Get the patient to follow your finger



Oculomotor nerve

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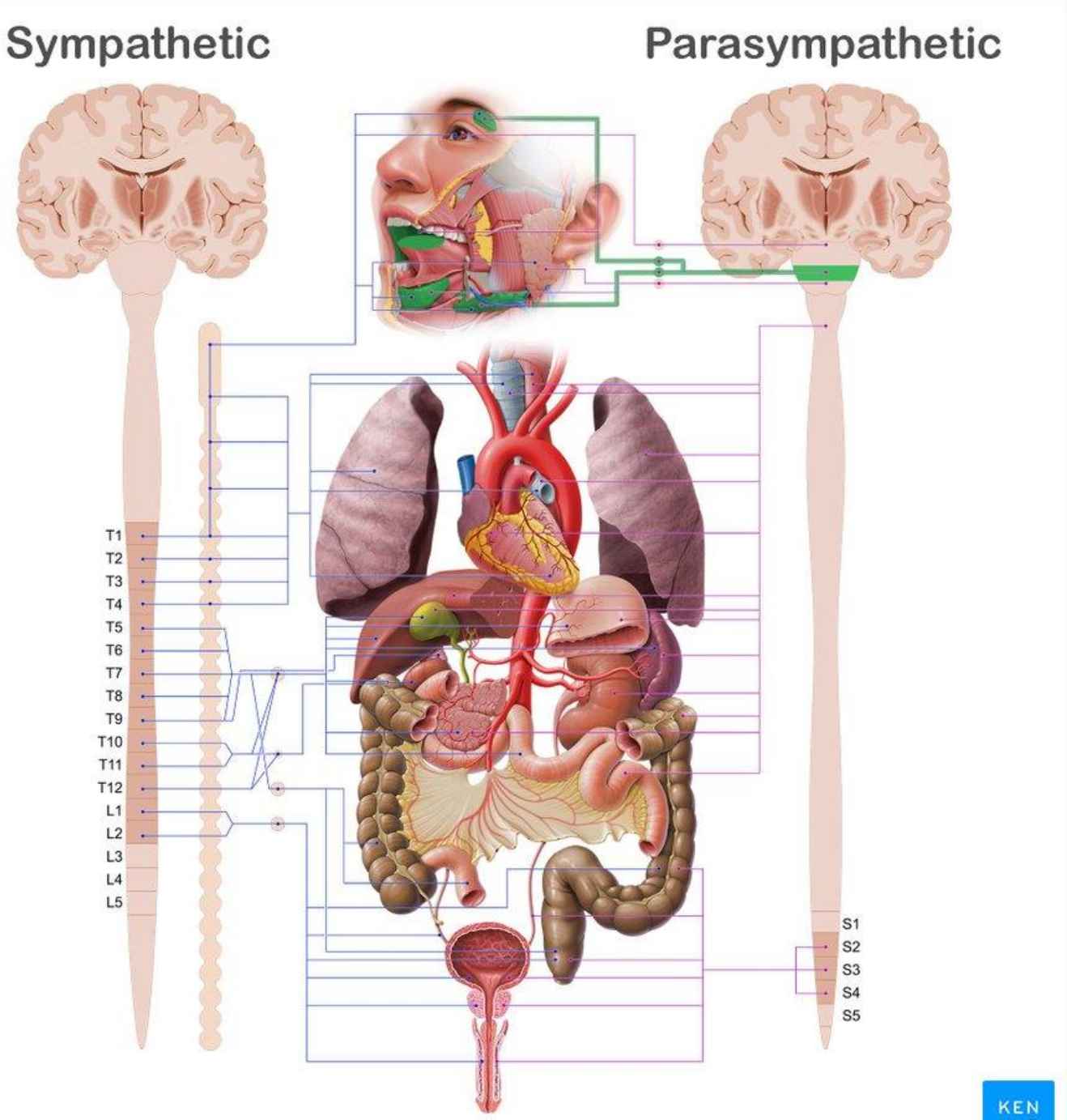
Facial nerve



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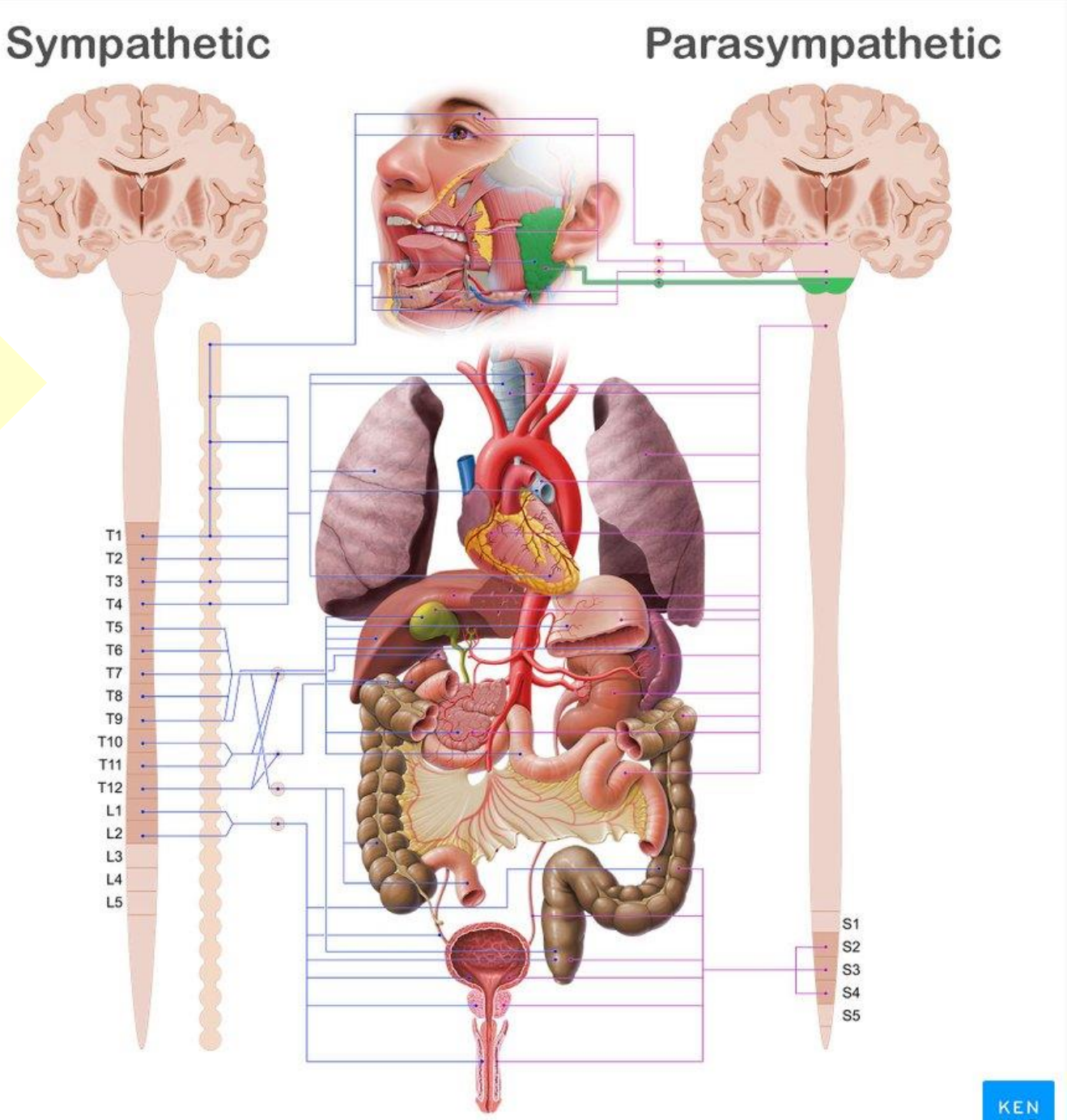
Glossopharyngeal nerve



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