

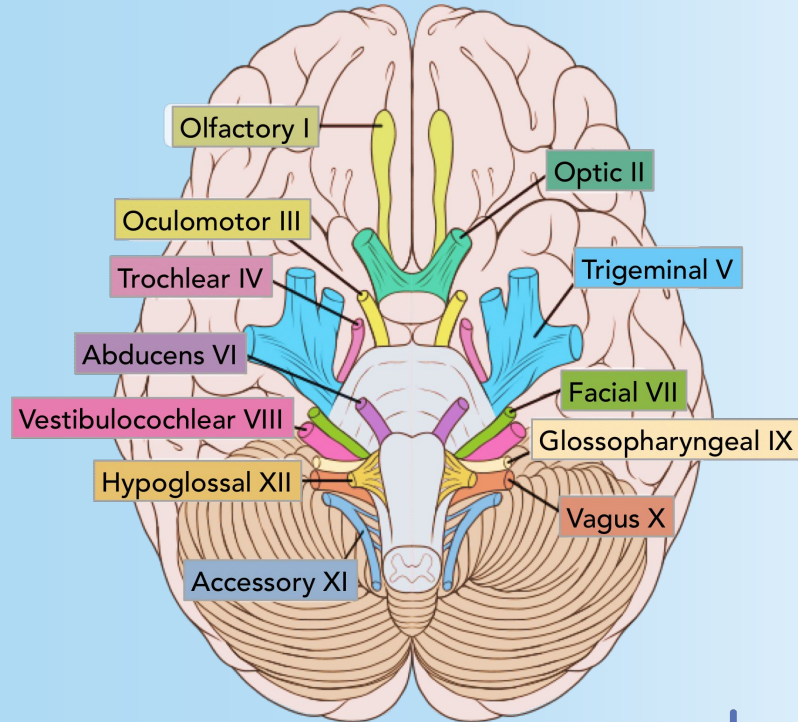
# The Cranial Nerves

*April 2023*

# Today's Agenda

- CN I, V, VII-XII
  - Function
  - Pathway
  - Innervation
- Example cases

*Cranial nerve II, III, IV, VI innervates the eye → I will not go through them in this presentation*



# The 12 Cranial Nerves

	<b>Nerve:</b>	<b>Function:</b>
I	<b>Olfactory</b>	Smell
II	<b>Optic</b>	Vision
III	<b>Oculomotor</b>	Eye movement, pupil reflex
IV	<b>Trochlear</b>	Eye movement
V	<b>Trigeminal</b> V1 - ophthalmic V2 - maxillary V3 - mandibular	Face sensation, chewing
VI	<b>Abducens</b>	Eye movement

VII	<b>Facial</b> (with 5 branches)	Face movement, taste
VIII	<b>Vestibulocochlear</b>	Hearing, balance
IX	<b>Glossopharyngeal</b>	Throat sensation, taste, swallowing
X	<b>Vagus</b>	Movement, sensation, abdominal organs
XI	<b>Accessory</b>	Neck movement
XII	<b>Hypoglossal</b>	Tongue

Mnemonic: *Oh, Oh, Oh, To Touch And Feel Very Good Velvet. Ah Heaven!*

# Functional components of the CN

Cranial nerves can either be **motor** or **sensory** nerves (or **both**)

They can also carry **parasympathetic** nerve fibers

- 1973 (CN X, IX, VII, III)

**Sensory = Afferent** - carry signals to the brain about senses (touch, taste, smell etc.)

**Motor = Efferent** - carry signals from the brain to muscles/glands → movement

**Parasympathetic** = “rest and digest” functions (slows HR, dilates vessels etc.)

I	<b>Some</b>
II	<b>Say</b>
III	<b>Marry</b>
IV	<b>Money</b>
V	<b>But</b>
VI	<b>My</b>
VII	<b>Brother</b>
VIII	<b>Says</b>
IX	<b>Big</b>
X	<b>Brains</b> (or boobs if you will)
XI	<b>Matter</b>
XII	<b>More</b>

# Functional components of the CN

## Afferent (**sensory**) fibers:

- GSA - general somatic afferent
- SSA - special somatic afferent
- GSA - general visceral afferent
- SVA - special visceral afferent

## Efferent (**motor**) fibers:

- GSE - general somatic efferent
- SVE - special visceral efferent
- GVE - general visceral efferent

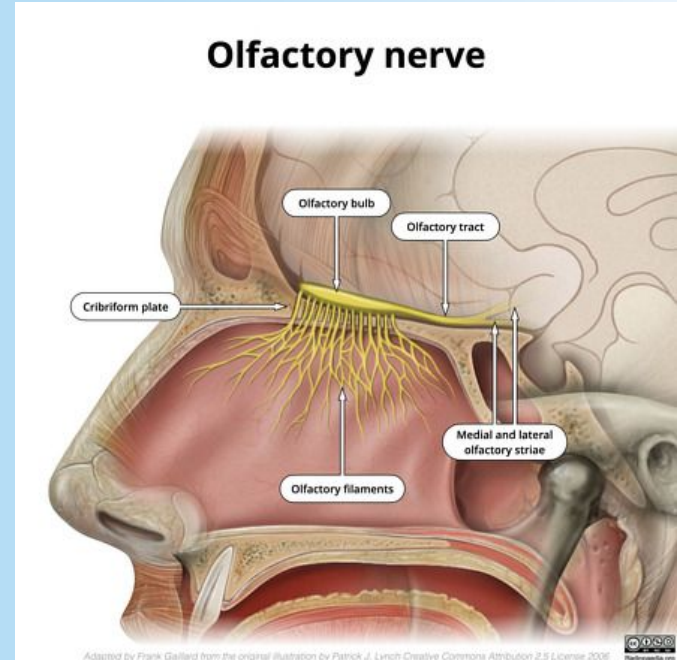
About the terms special, general, somatic and visceral:

The information is classified as **special** if it travels from our special senses (vision, smell, taste, hearing and balance), while **general** describes information to/from everywhere else.

The information carried by a nerve is called **somatic** if it goes to/from the skin and skeletal muscles, or **visceral** if it travels to/from our internal organs.

# CN I - Olfactory

- Main function: **smell**
- Lesion of nerve: loss of smell = **anosmia**
  - typically caused by fracture of ethmoid bone or Foster-Kennedy syndrome
- **Sensory** - Special visceral afferent (SVA)
- Shortest cranial nerve
- Exits brain directly from telencephalon/cerebrum
- Goes through **cribriform plate** of ethmoid bone
- Ends in olfactory epithelium of the nasal mucosa

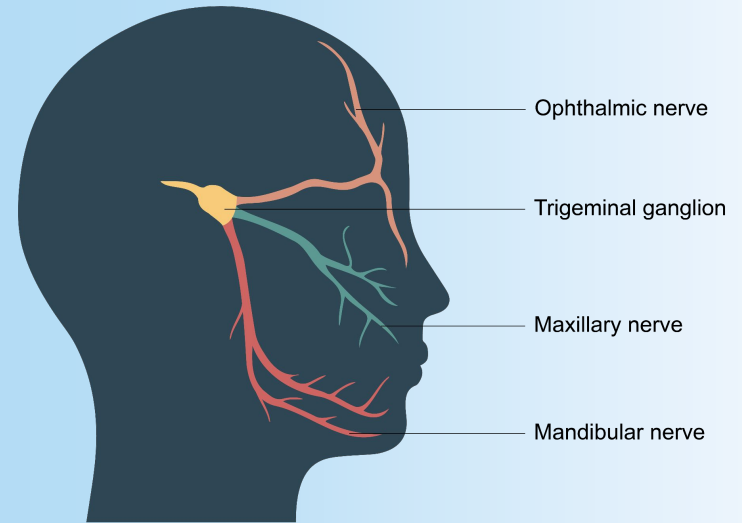


# CN I - summary

CN I - Olfactory nerve	
<b>Type of fiber:</b>	Sensory (SVA: special visceral afferent)
<b>Exit from brainstem:</b>	Telencephalon
<b>Exit from skull:</b>	Cribriform plate of ethmoid bone
<b>Main function:</b>	Smell
<b>Clinical - lesion:</b>	Anosmia (loss of smell)

# CN V - Trigeminal nerve

- Main function: face sensation, chewing
- Divided into 3 branches:
  - V1: ophthalmic (S)
  - V2: maxillary (S)
  - V3: mandibular (M)
- From mnemonic: “But” = Both **Sensory** and **Motor**
- Arises from lateral aspect of pons
- Mnemonic - where the branches exit the skull:  
**Sanding Room Only**
  - V1 ophthalmic - Superior orbital fissure
  - V2 maxillary - Rotundum (foramen rotundum)
  - V3 mandibular - Ovale (foramen ovale)

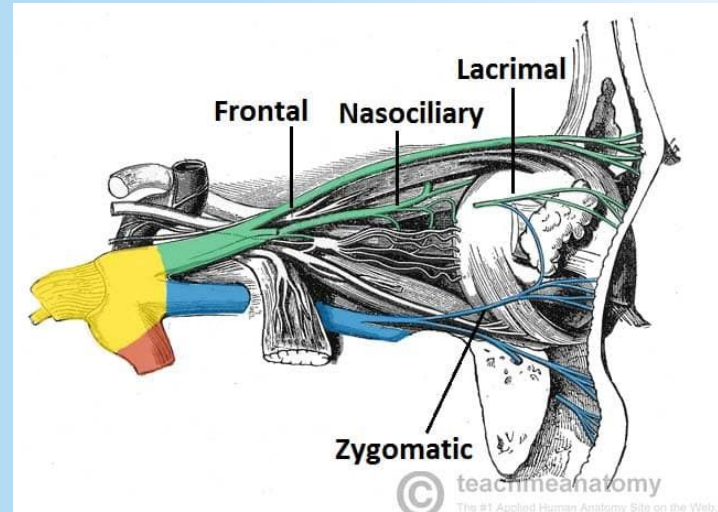


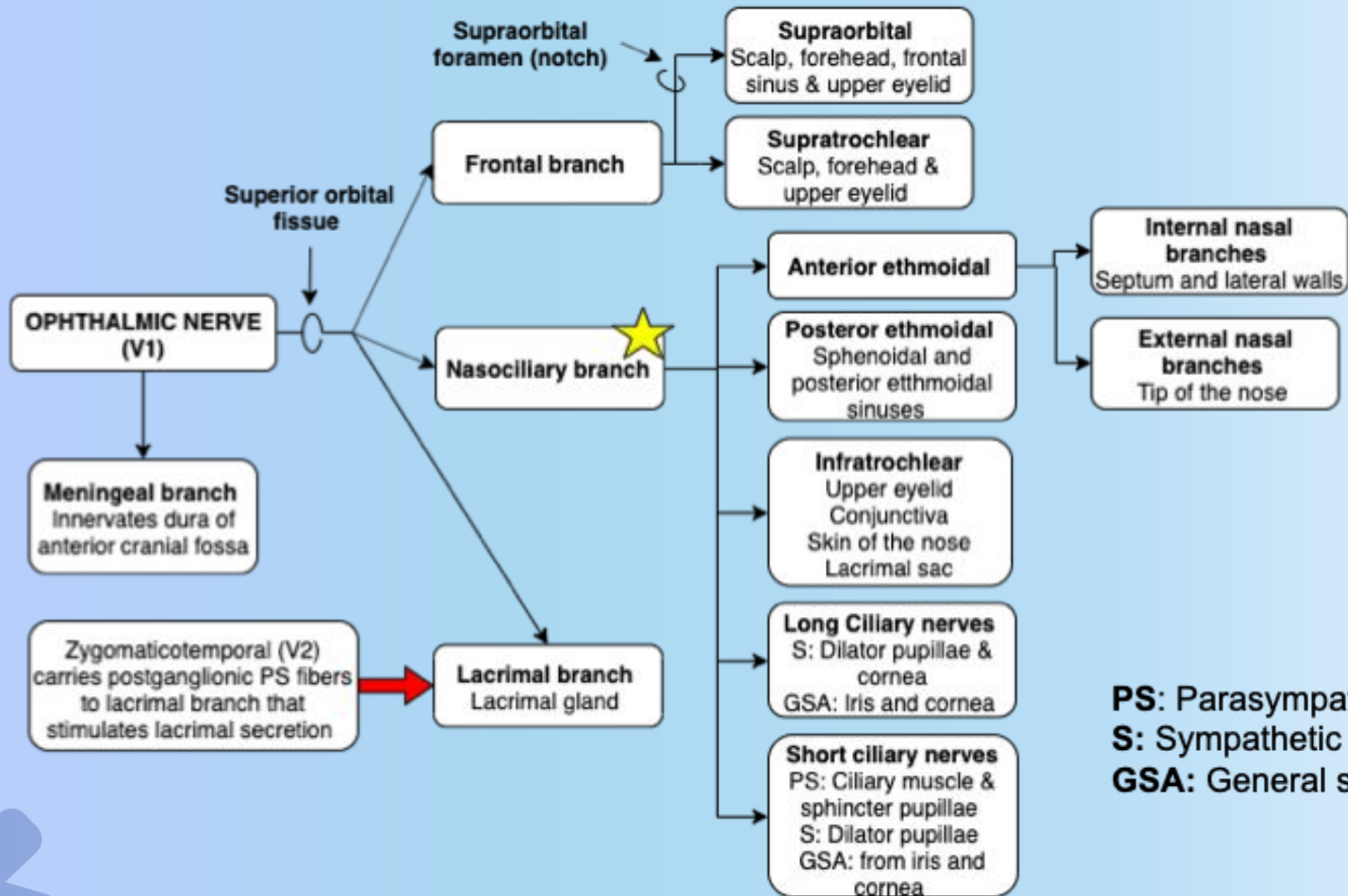


# CN V1 - Ophthalmic division

- **Sensory** - General somatic afferent (GSA)
- Runs in the lateral wall of the cavernous sinus
- Exits through superior orbital fissure
- **Sensory innervation of:**
  - Eyeball
  - Tip of Nose
  - Skin of face above eyes

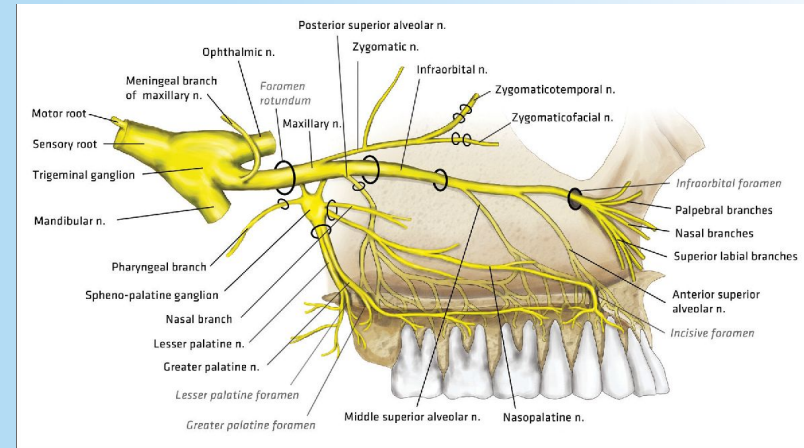
Afferent limb of the corneal reflex -  
nasociliary branch



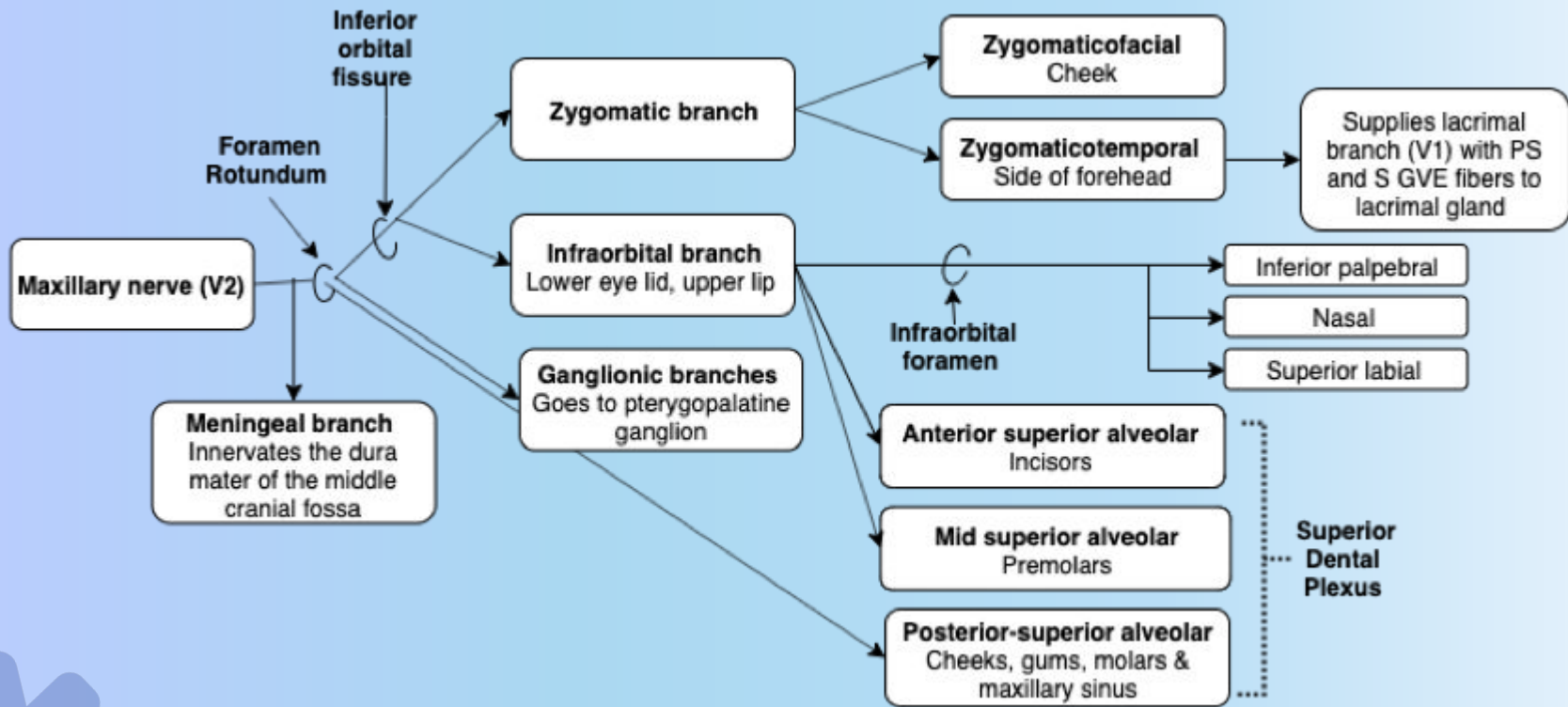


# CN V2 - Maxillary division

- **Sensory** - General somatic afferent (GSA)
- Runs in the lateral wall of the cavernous sinus
- Exits through foramen Rotundum, enter the pterygopalatine fossa
- **Sensory innervation of:**
  - Palate
  - Paranasal sinuses
  - Maxillary teeth
  - Skin of face between eye and upper lip



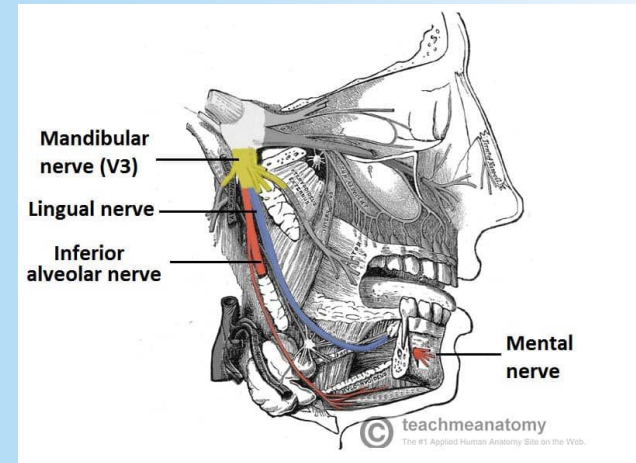
Afferent limb of sneeze reflex



# CN V3 - Mandibular division

- **Sensory** - General somatic afferent (GSA)
- **Motor** - Special visceral efferent (SVE)
- Exits skull through foramen Ovale
- **Sensory innervation of:**
  - Anterior Ear
  - Teeth and gums of mandible
  - Face below lower lip and mouth
  - Sensation of  $\frac{2}{3}$  anterior part of tongue

Afferent AND Efferent limb of jaw jerk reflex

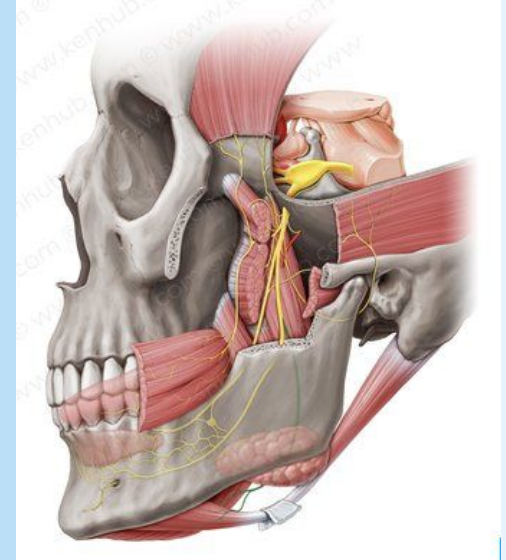


# CN V3 - Mandibular division

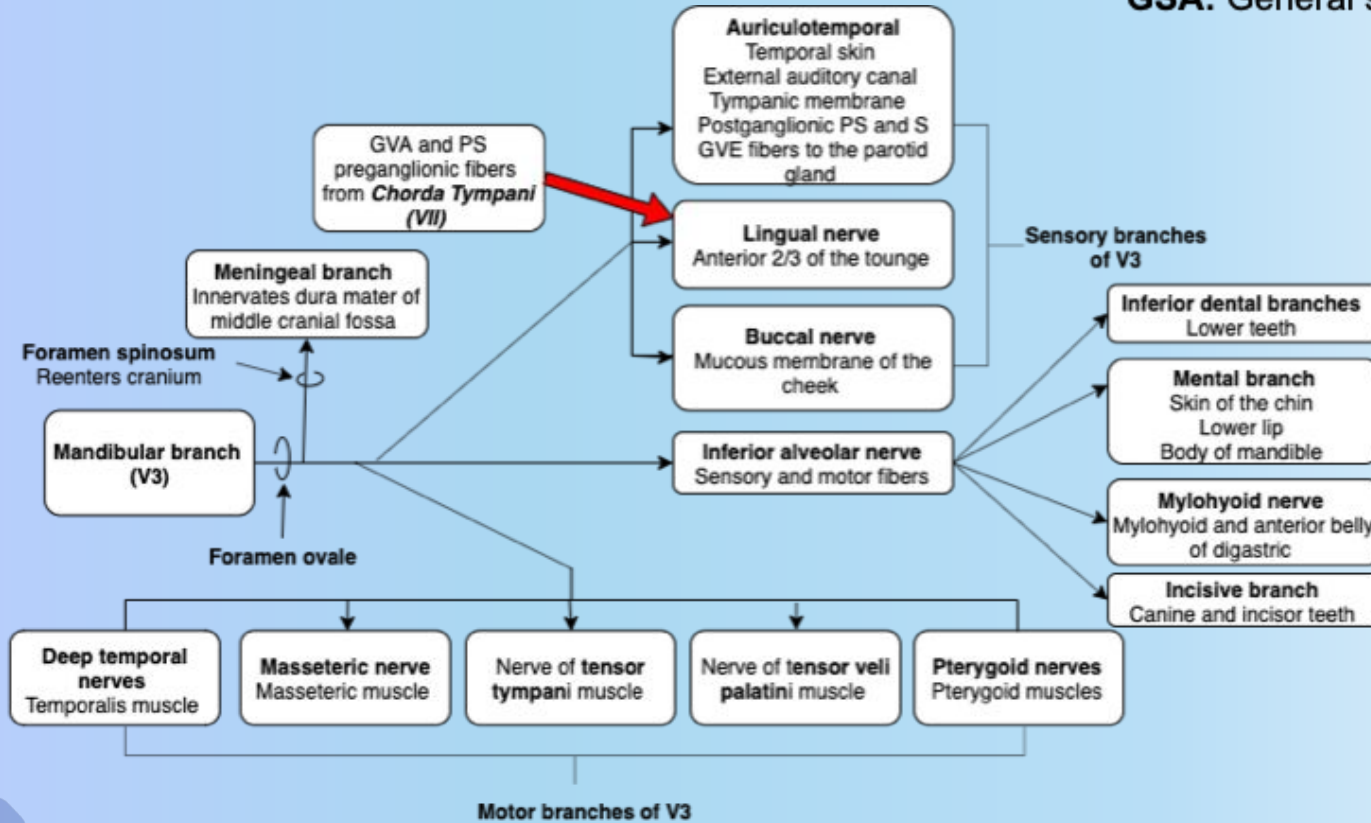
- **Motor innervation:**

- Anterior belly of digastric muscle
- Mylohyoid m.
- Tensor veli palatini
- Tensor tympani
- Innervates muscle of mastication (chewing)

<b>M</b> asseter <b>M</b> edial Pterygoid <b>T</b> emporalis	<b>M</b> oves the mandible <b>UP</b> (closes the mouth)
<b>L</b> ateral Pterygoid	<b>L</b> owers the mandible (open mouth)



**PS:** Parasympathetic fibers  
**S:** Sympathetic fibers  
**GSA:** General somatic afferent fibers



# CN V - Summary

CN V - Trigeminal nerve	
<b>Type of fiber:</b>	Both - General somatic afferent, Special visceral efferent)
<b>Exit from brainstem:</b>	Pons - anteriorly to the pyramidal eminence
<b>Exit from skull:</b>	V1 - <b>S</b> uperior orbital fissure V2 - Foramen <b>R</b> otundum V3 - Foramen <b>O</b> vale
<b>Main function:</b>	Sensation of face and tongue Muscles of mastication
<b>Clinical - lesion:</b>	Loss of general sensation (face and mucous membranes) Loss of corneal reflex Flaccid paralysis of muscles of mastication. Deviation of patient's jaw to the weak side Paralysis of tensor tympanii = <b>hypacusis</b>



# CN VII - Facial nerve

- **Sensory, Motor** AND Parasympathetic (“1973”)

## Sensory innervation:

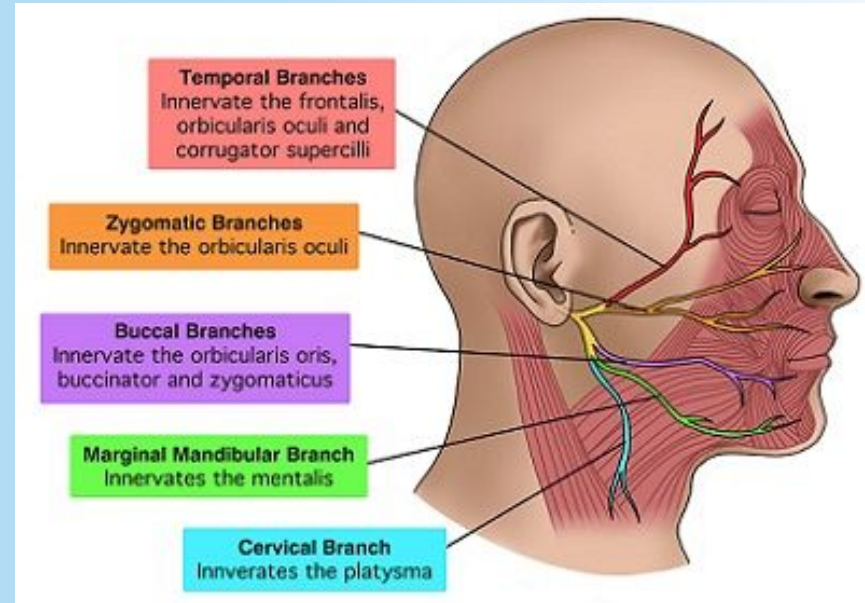
- Taste  $\frac{2}{3}$  ant. parts of tongue (SVA)
- Palate and nasal mucosa (GVA)
- External acoustic meatus, auricle (GSA)

## Motor innervation:

- Muscles of facial expression (SVE)

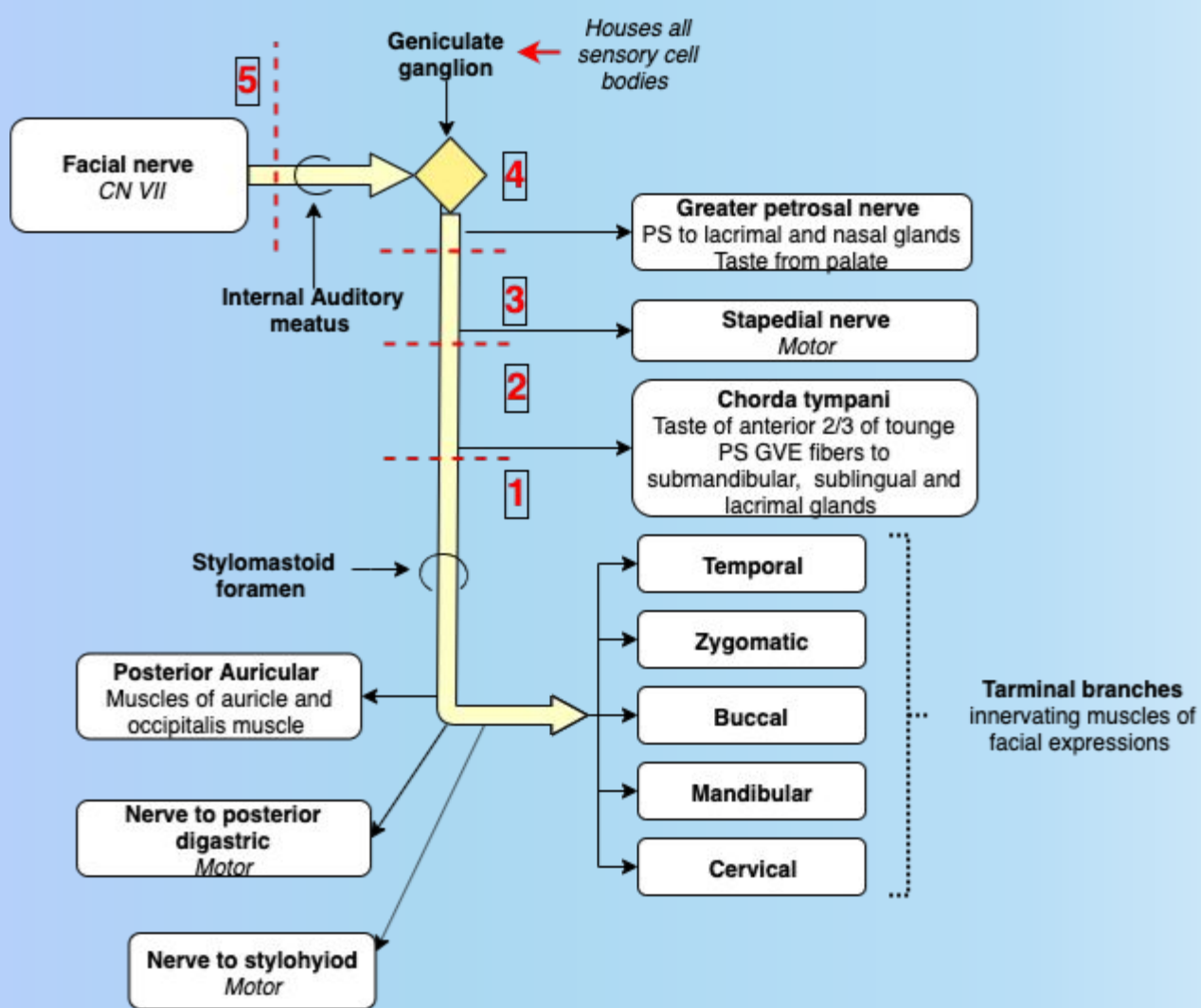
## Parasympathetic innervation:

- Lacrimal, submandibular, sublingual, nasal, palatine glands (GVE)



Efferent limb of the corneal (blink) reflex

→ remember, V1 has the afferent limb of the corneal reflex

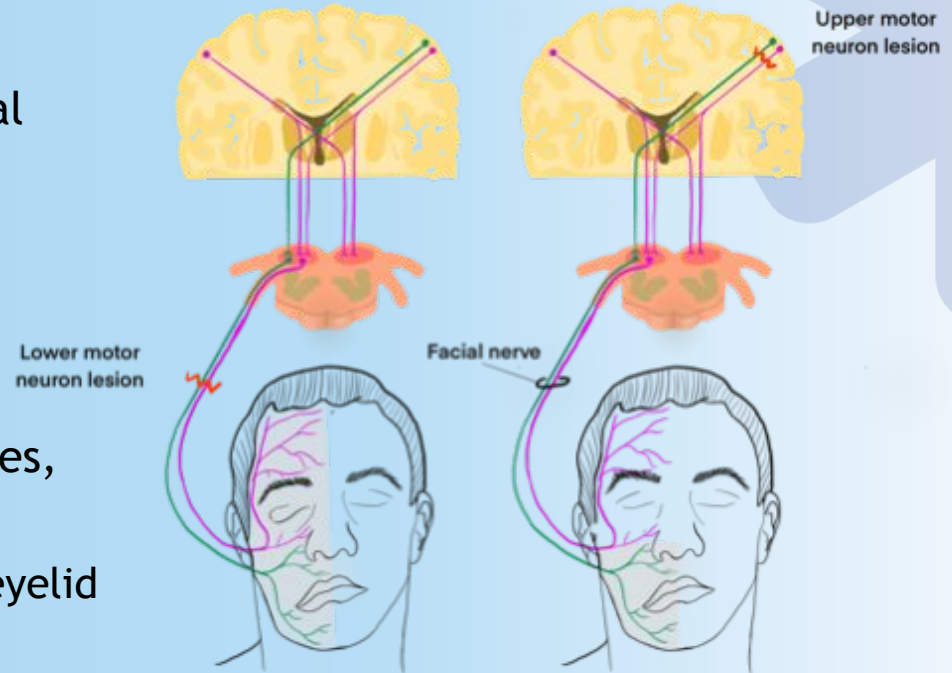


# Lesions of Facial nerve

- Loss of function of muscles of facial expression
- Loss of corneal reflex

## Bells Palsy

- Ipsilateral paralysis of facial muscles, with lesion of peripheral nerve
  - drooping of mouth
  - drooping eye - unable to close eyelid



# CN VII - Summary

CN VII - Facial nerve	
<b>Type of fiber:</b>	Both - (Special visceral afferent & efferent, general somatic efferent, parasympathetic: general visceral efferent)
<b>Exit from brainstem:</b>	Pons - cerebellopontine angle
<b>Exit from skull:</b>	Stylomastoid foramen
<b>Main function:</b>	Innervates muscles of facial expression Taste from anterior $\frac{2}{3}$ of the tongue (Chorda Tympani) Innervation of all salivary glands (EXCEPT parotid) Innervates Stapedius muscle of inner ear
<b>Clinical - lesion:</b>	UMN: Contralateral paralysis of lower face LMN: Ipsilateral paralysis of upper & lower face Loss of corneal reflex Loss of taste from anterior $\frac{2}{3}$ of the tongue <b>Hyperacusis</b>

# CN VIII - Vestibulocochlear

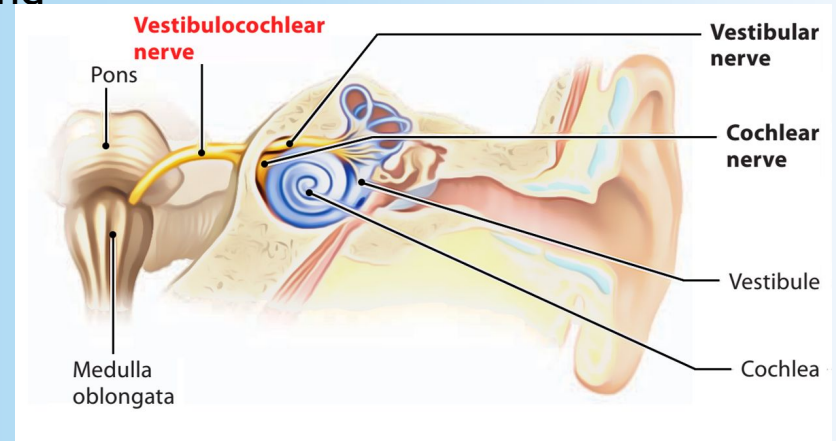
- Function: **hearing and balance**
- **Sensory** - Special somatic afferent (SSA)
- Exit brainstem via cerebellopontine angle
- Goes through internal acoustic meatus and innervates sensory cells of inner ear

## 2 branches:

- 1) Cochlear - innervates cochlea
- 2) Vestibular - innervates vestibule

## Lesions:

- Hearing loss
- Tinnitus
- Disequilibrium, vertigo, nystagmus



# CN VIII - Summary

CN VIII - Vestibulocochlear nerve	
<b>Type of fiber:</b>	Sensory - special somatic afferent
<b>Exit from brainstem:</b>	Pons - cerebellopontine angle
<b>Exit from skull:</b>	Does not leave the skull - goes through internal acoustic meatus
<b>Main function:</b>	Hearing and balance
<b>Clinical - lesion:</b>	Hearing loss (Sensorineural deafness) Tinnitus Disequilibrium, vertigo, nystagmus

# CN IX - Glossopharyngeal

- **Sensory, Motor AND Parasympathetic** (“1973”)

## Sensory innervation:

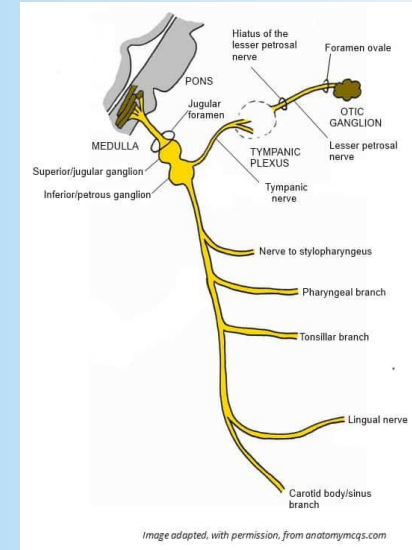
- Taste  $\frac{1}{3}$  posterior part of tongue + vallate papillae (SVA)
- $\frac{1}{3}$  post. part of tongue & pharyngeal wall, tympanic cavity, auditory tube. Carotid sinus, palatine tonsil and soft palate (GVA)
- External acoustic meatus, auricle (GSA)

## Motor innervation:

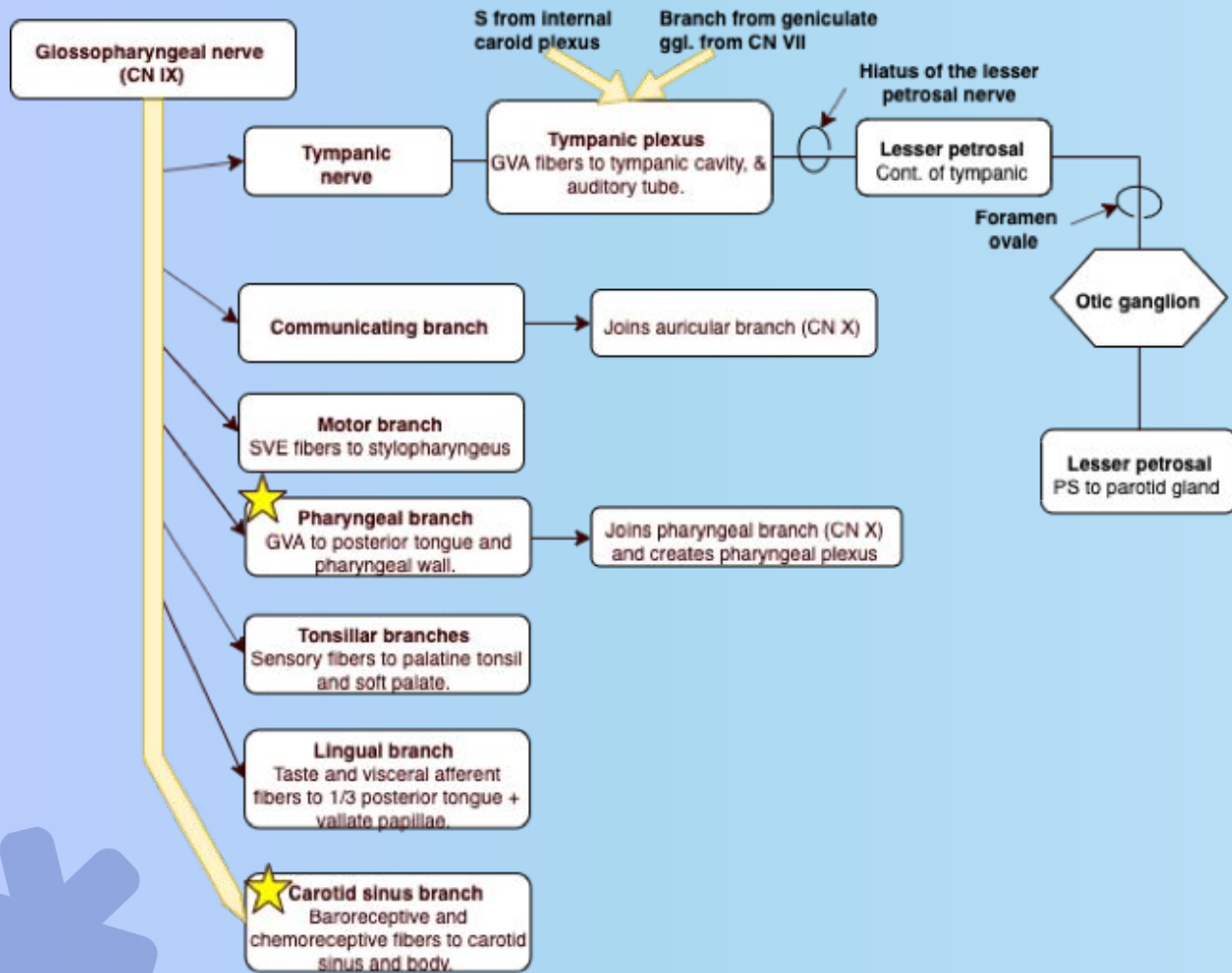
- Innervation of Stylopharyngus (SVE)

## Parasympathetic innervation:

- Parotid gland (GVE)



Afferent limb of the carotid sinus and body reflexes.  
Afferent limb of the gag reflex





# CN IX - Summary

CN IX - Glossopharyngeal nerve	
<b>Type of fiber:</b>	Sensory, Motor, Parasympathetic
<b>Exit from brainstem:</b>	Medulla: Postolivary sulcus
<b>Exit from skull:</b>	Jugular foramen
<b>Main function:</b>	Sensory innervation of pharynx Innervation of carotid body and sinus Taste from $\frac{1}{3}$ posterior part of tongue
<b>Clinical - lesion:</b>	Loss of gag reflex Loss of carotid sinus reflex Loss of taste from posterior $\frac{1}{3}$ of the tongue Glossopharyngeal neuralgia

# CN X - Vagus

- **Sensory, Motor AND Parasympathetic** (“1973”)

## Sensory innervation:

- Mucous membranes of lower pharynx, larynx, trachea
- Taste: supraglottic region
- Visceral sensation from lung, liver, kidneys, stomach, part of intestines
- **Aortic body**: baroreceptors for blood pressure and chemoreceptors for PaO<sub>2</sub> and PaCO<sub>2</sub>

## Motor innervation:

- **Swallowing**: most muscles of pharynx (not stylopharyngeus) and soft palate (palatoglossus)
- Speech: larynx through recurrent laryngeal nerve

## Parasympathetic innervation:

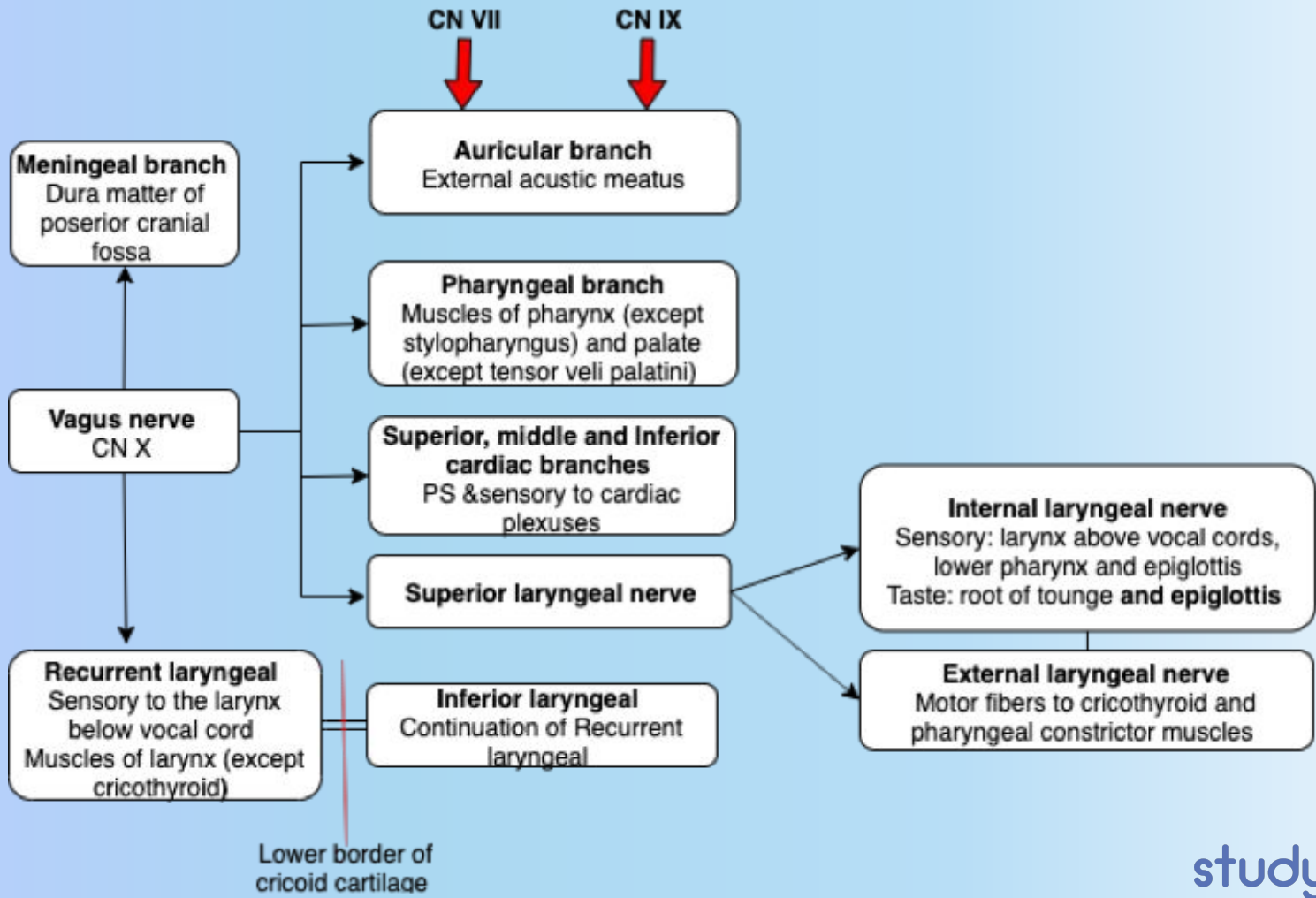
- Parotid gland (GVE)

## Parasympathetic innervation:

- Promotes motility in smooth muscles, the esophagus, stomach and most of the intestine
- Innervates the SA and AV node - decrease heart rate

Afferent and efferent limb of the **cough** reflex  
Efferent limb: **gag** reflex, **sneeze** reflex

→ remember, IX: afferent limb of gag reflex. V2: afferent limb of sneeze reflex



# CN X - Summary

CN X - Vagus nerve	
Type of fiber:	Sensory, Motor, Parasympathetic
Exit from brainstem:	Medulla: Postolivary sulcus
Exit from skull:	Jugular foramen
Main function:	.
Clinical - lesion:	Loss of reflexes Ipsilateral paralysis of soft palate, pharynx, larynx = dysarthritia, dysphagia, dysphonia Deviation of the uvula <b>towards</b> the <b>opposite</b> side of the lesion

# CN XI - Accessory

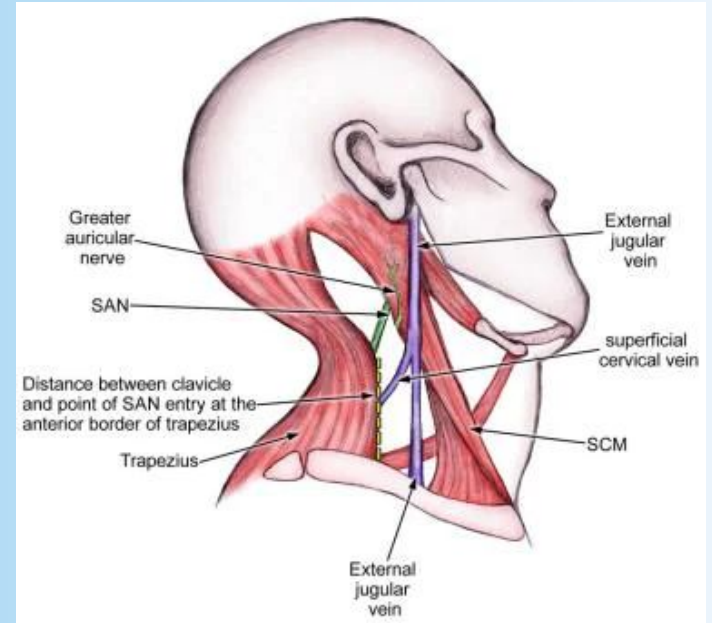
- **Motor** - Special somatic afferent (SSA)
- Exit from brainstem/spinal cord
  - Cranial: Postolivary sulcus
  - Spinal: C2-C5/6

## Innervates:

- Cranial - joins Vagus in recurrent laryngeal nerve
- Spinal - innervates sternocleidomastoid (SCM) and trapezius muscles

## Lesion:

- Trapezius paralysis
  - inability to shrug ipsilateral shoulder
  - shoulder drop
- Flaccid paralysis of SCM
  - difficulty moving the head opposite side of the lesion



# CN XI - Summary

CN XI - Accessory nerve	
<b>Type of fiber:</b>	Motor
<b>Exit from brainstem:</b>	Cranial - Medulla: Postolivary sulcus Spinal - Spinal cord: passes through foramen magnum and joins the cranial root
<b>Exit from skull:</b>	Jugular foramen
<b>Main function:</b>	Cranial: joins Vagus and innervates laryngeal muscles Spinal: innervates SCM and trapezius muscle
<b>Clinical - lesion:</b>	Trapezius paralysis Flaccid paralysis of SCM

# CN XII - Hypoglossal

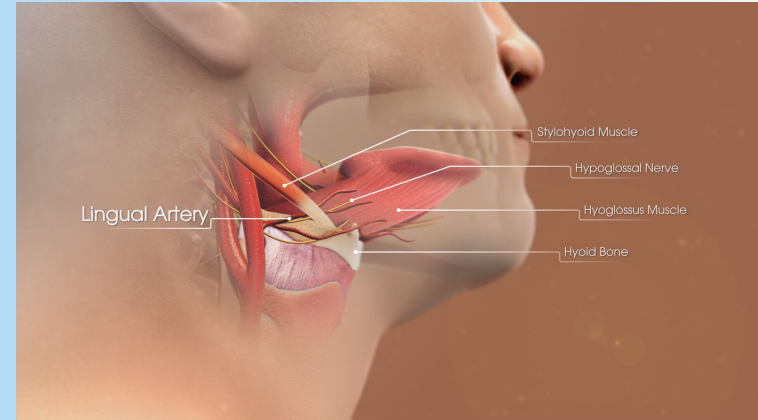
- **Motor**
- Exit the skull through the hypoglossal canal

## Innervates:

- Extrinsic and intrinsic muscles of the tongue
  - Except palatoglossus (CN X)
- Carries C1 sensory fibers to meninges
  - fibers are not a part of hypoglossal nerve

## Lesion:

- Tongue will deviate towards injured side
  - “Lick your wounds”



# CN XII - Summary

CN XII - Hypoglossal nerve	
<b>Type of fiber:</b>	Motor
<b>Exit from brainstem:</b>	Medulla oblongata: Preolivary sulcus
<b>Exit from skull:</b>	Hypoglossal foramen → hypoglossal canal
<b>Main function:</b>	Control muscles of the tongue → all except palatoglossus
<b>Clinical - lesion:</b>	Deviation of the tongue - to the <b>injured</b> side



# Do you remember?

<b>All muscles of the palate is innervated by vagus (CN X) except?</b>	Tensor Veli Palatini (V3 - mandibular)
<b>All muscles of the tongue is innervated by hypoglossal (CN XII) except?</b>	Palatoglossus (Vagus X)
<b>All muscles of the pharynx is innervated by vagus (CN X) except?</b>	Stylopharyngus (Glossopharyngeal IX)
<b>All muscles of the larynx is innervated by the recurrent laryngeal nerve except?</b>	Cricothyroid (External laryngeal)

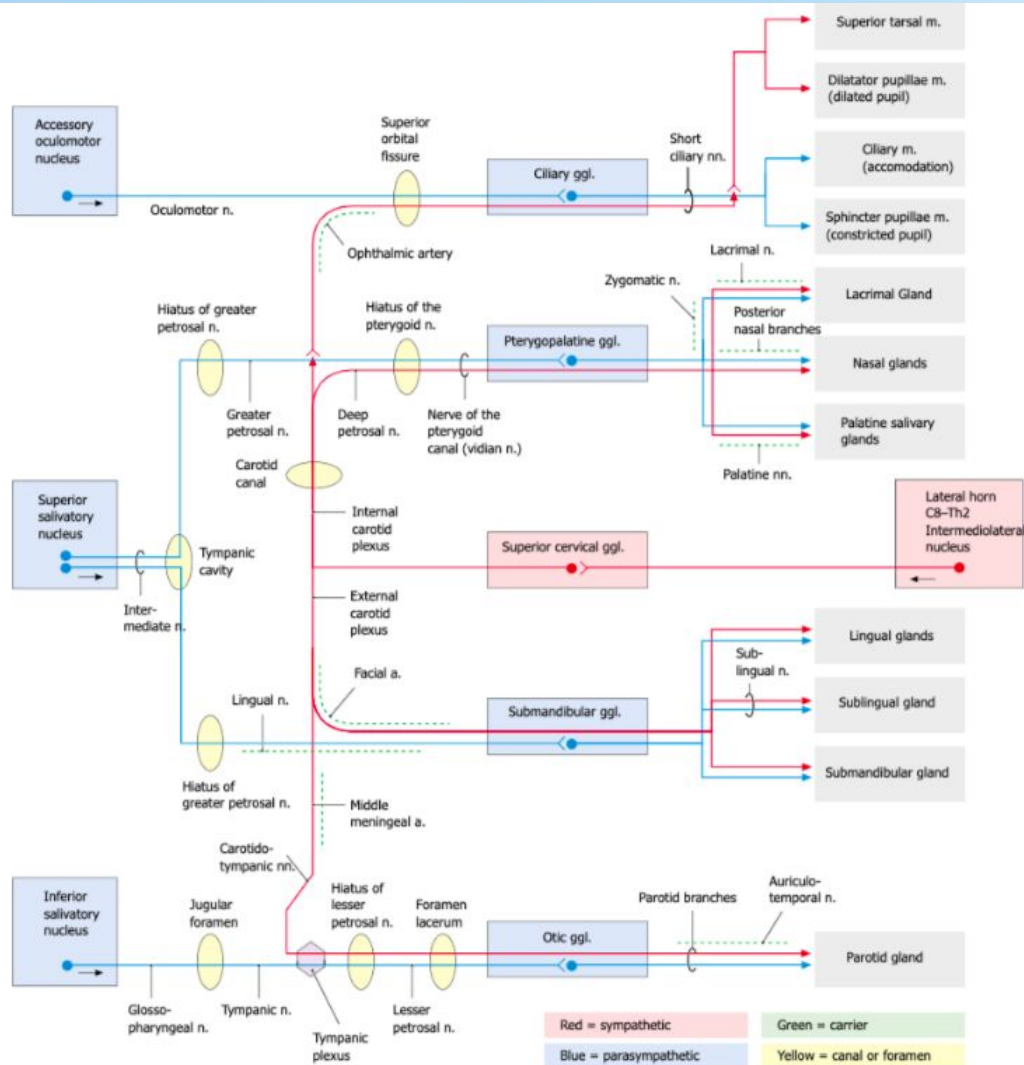
# Reflexes

Reflex	Afferent limb	Efferent limb
Corneal reflex	CN V1 - nasociliary branch	CN VII - Facial nerve
Pupillary light reflex	CN II - Optic nerve	CN III - Oculomotor
Accommodation	CN II - Optic nerve	CN III - Oculomotor
Lacrimation	CN V1 - Ophthalmic division	CN VII - Facial nerve
Jaw jerk	CN V3 - Mandibular division	CN V3 - Mandibular division
Gag reflex	CN IX - Glossopharyngeal	CN X - Vagus
Cough reflex	CN X - Vagus	CN X - Vagus
Sneeze reflex	CN V2 - Maxillary division	CN X - Vagus

Name of nerve	Exit from brainstem	Exit from skull
Olfactory (I)		Cribiform plate of ethmoid bone – technically never exits skull
Optic nerve (II)		Optic canal to the retina
Oculomotor nerve (CN III)	Arises from brainstem on the medial side of the cerebral crus of the midbrain. Aka in the interpeduncular fossa.	Superior orbital fissure
Trochlear nerve (CN IV)	OBS! Only one arising from dorsal portion. Arises medially and inferiorly to the inferior colliculus of the midbrain	Superior orbital fissure
Trigeminal nerve (CN V)	Arises anteriorly to the pyramidal eminence of pons.	V1: Superior orbital fissure V2: Foramen rotundum V3: Foramen ovale
Abducent nerve (CN VI)	Arises from the inferior pontine sulcus (bulbopontine sulcus)	Superior orbital fissure
Facial nerve (CN VII)	Arises from cerebellopontine angle on the pons	Facial canal (stylomastoid foramen) and petrotympanic fissure
Vestibulocochlear nerve (CN VIII)	Arises from cerebellopontine angle on the pons	Never exits the skull – goes through internal acoustic meatus
Glossopharyngeal nerve (CN IX)	Arises form postolivary sulcus on the medulla	Jugular foramen
Vagus nerve (CN X)	Arises form postolivary sulcus on the medulla	Jugular foramen
Accessory nerve (CN XI)	Arises form postolivary sulcus on the medulla	Jugular foramen
Hypoglossal nerve (CN XII)	Arises form preolivary sulcus on the medulla	Hypoglossal canal



# Ganglions



— sensory fibres  
— motor fibres

**Optic (II)**  
**sensory:** eye



**Trochlear (IV)**  
**motor:** superior oblique muscle



**Abducent (VI)**  
**motor:** external rectus muscle



**Trigeminal (V)**  
**sensory:** face, sinuses, teeth, etc.

**motor:** muscles of mastication



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**Olfactory (I)**  
**sensory:** nose



**Intermediate motor:**  
submaxillary and sublingual gland

**sensory:**  
anterior part of tongue and soft palate

**Glossopharyngeal (IX)**  
**motor:**  
pharyngeal musculature

**sensory:**  
posterior part of tongue, tonsil, pharynx

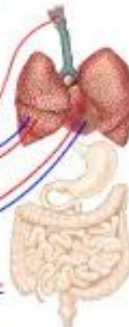


**Vestibulocochlear (VIII)**  
**sensory:**  
inner ear



vestibular  
cochlear

**Vagus (X)**  
**motor:**  
heart, lungs, bronchi, gastrointestinal tract



**sensory:**  
heart, lungs, bronchi, trachea, larynx, pharynx, gastrointestinal tract, external ear

**Facial (VII)**  
**motor:**  
muscles of the face



**Hypoglossal (XII)**  
**motor:**  
muscles of the tongue



**Accessory (XI)**  
**motor:**  
sternocleidomastoid and trapezius muscles





Good luck on your exam!

