

# Cranial nerves

*December 2019*

# Topics of this presentation

- Pathway, branches and innervation of Cranial nerves I, V, VII-XII
  - Olfactory (CN I)
  - Trigeminal (CN V)
    - Ophthalmic (V<sub>1</sub>)
    - Maxillary (V<sub>2</sub>)
    - Mandibular (V<sub>3</sub>)
  - Facial (CN VII)
  - Vestibulocochlear (CN VIII)
  - Glossopharyngeal (CN IX)
  - Vagus (CN X)
  - Accessory (CN XI)
  - Hypoglossal (CN XII)

**PS: Every case is found in the Head and Neck chapter of Grey's Anatomy Review 2nd edition**

# Cranial Nerves

I Olfactory nerve

II Optic

III Oculomotor

IV Trochlear

Trigeminal

V ➤ *Ophthalmic (V<sub>1</sub>)*

➤ *Maxillary (V<sub>2</sub>)*

➤ *Mandibular (V<sub>3</sub>)*

VI Abducent

VII Facial

VIII Vestibulocochlear

IX Glossopharyngeal

X Vagus

Accessory

XI - *Cranial root*

- *Spinal root*

XII Hypoglossal nerve

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

# Functional components of the CN

I	Some
II	Say
III	Marry
IV	Money
V	But
VI	My
VII	Brother
VIII	Says
IX	Big
X	Brains (Boobs)
XI	Matter
XII	More

CN nerves can be either **S**ensory and/or **M**otor nerves.

They can also carry parasympathetic fibers.

- **1973** (CN 10, 9, 7, 3)

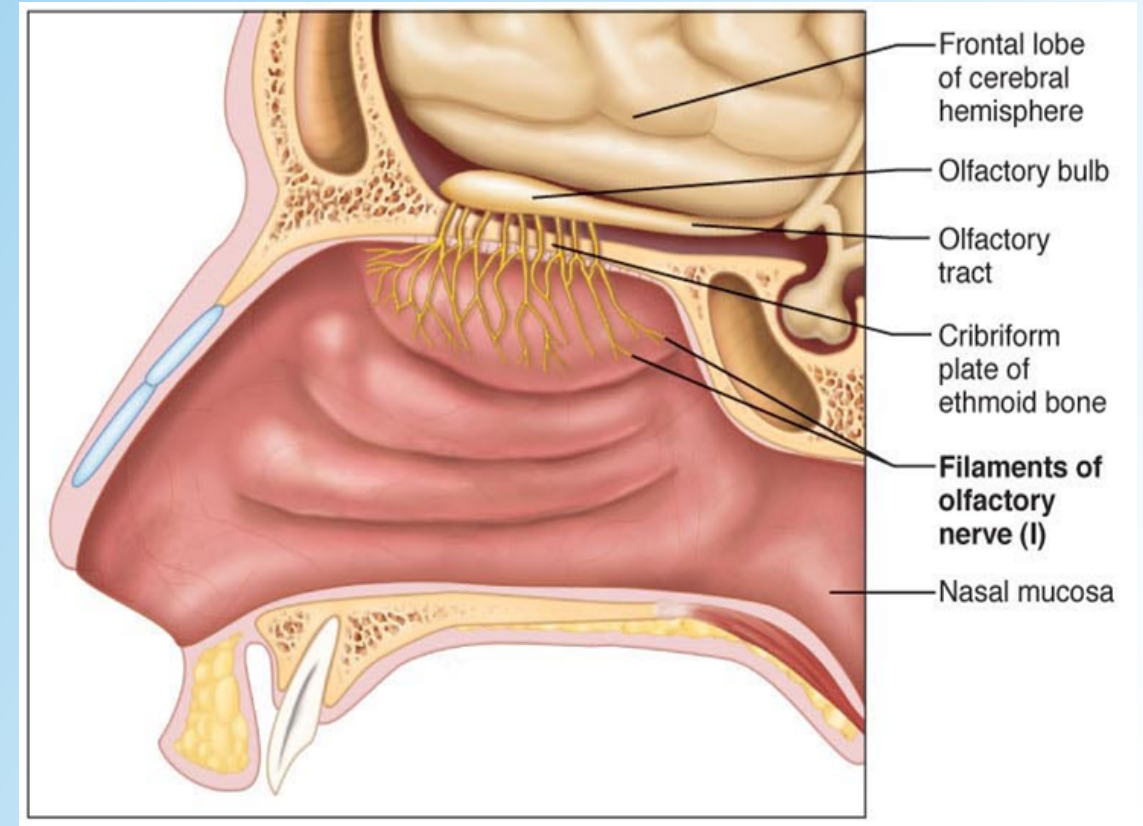


# CN I - Olfactory

- **S**ensory – Special visceral afferent (SVA)
- Extension of telencephalon
- Axons that exit through the cribriform plate of ethmoid

## Lesion

- Loss of smell (*anosmia*) – Typically caused by fracture of ethmoid bone or Foster-Kennedy syndrome
  - Fracture may cause runny nose (rhinorrhea) from CSF leakage



# Olfactory – summary

<b>Type of fiber</b>	<b>S</b> ensory (Special visceral afferent)
<b>Exit from brainstem</b>	Extension of telencephalon
<b>Exit from skull</b>	Cribiform plate of ethmoid bone
<b>Main function</b>	Smell
<b>Clinical appearances with lesion</b>	Loss of smell (anosmia)

# Trigeminal (V)

- **S**ensory and **M**otor
- Arises from lateral aspect of pons.

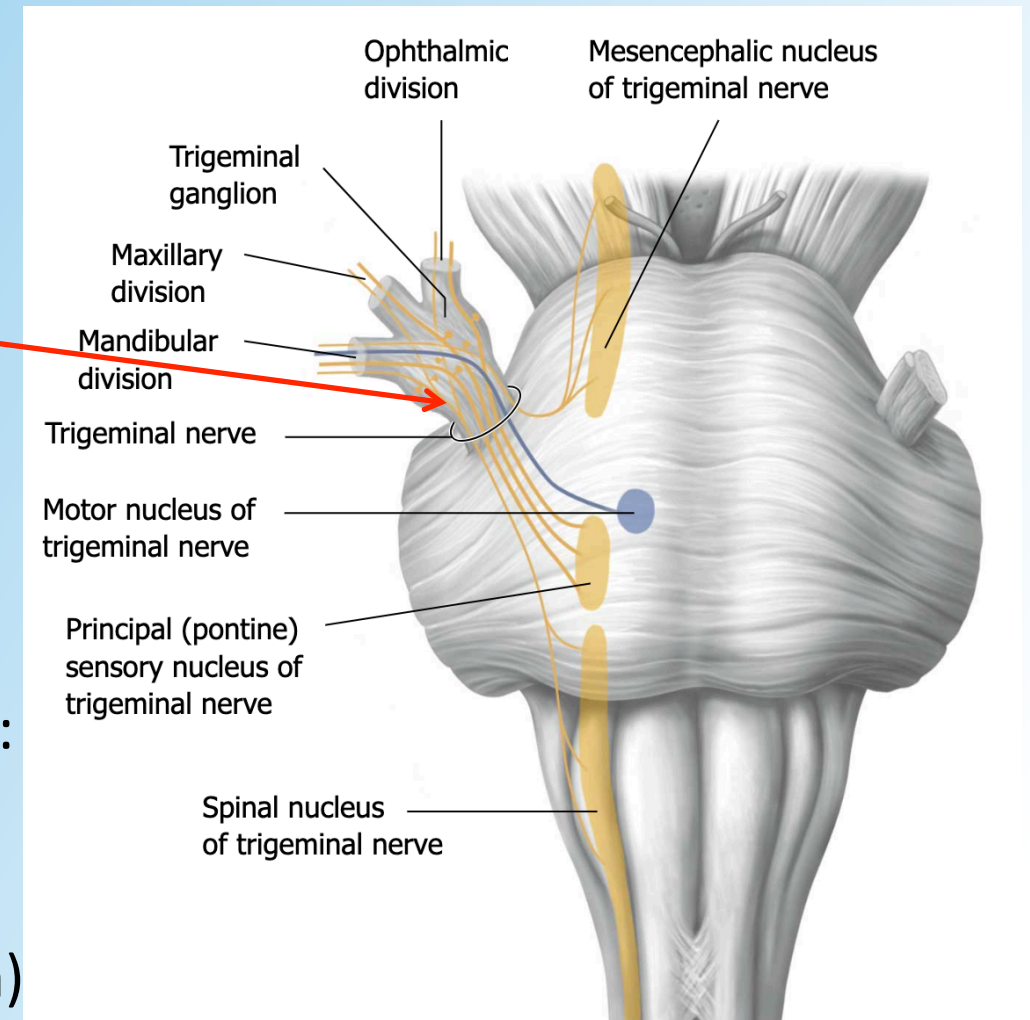
3 divisions

- Ophthalmic (V1)
  - Maxillary (V2)
  - Mandibular (V3)
- Mnemonic of where the branches exit the skull:  
**S**candale **R**oyale **O**rgy

V1 Ophthalmic **S**uperior orbital fissure

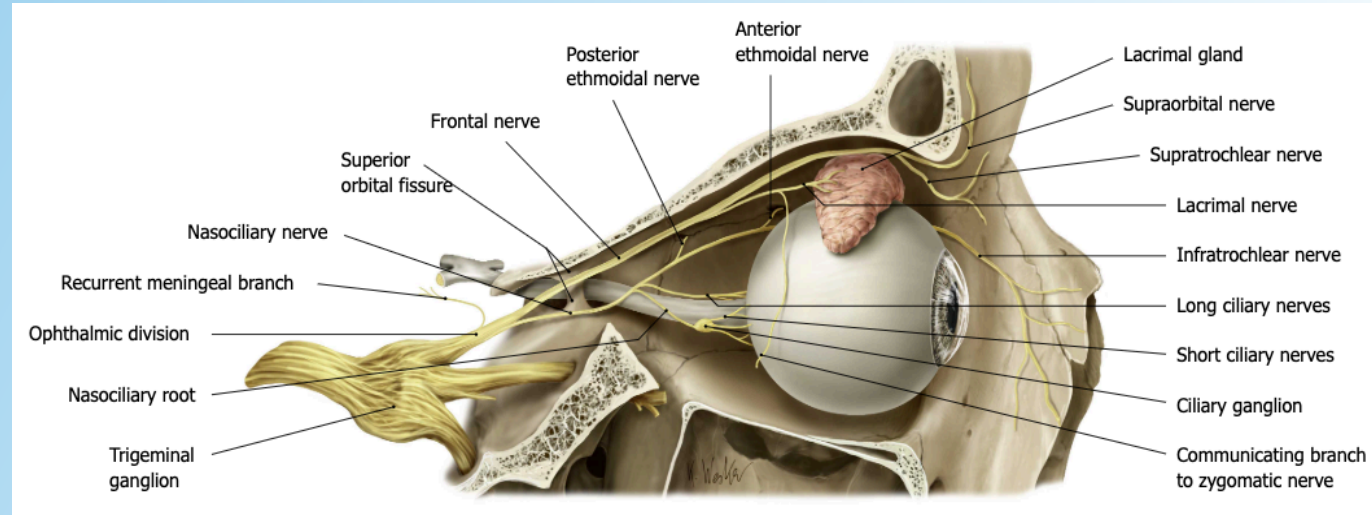
V2 Maxillary **R**otundum (foramen rotundum)

V3 Mandibular **O**vale (foramen ovale)



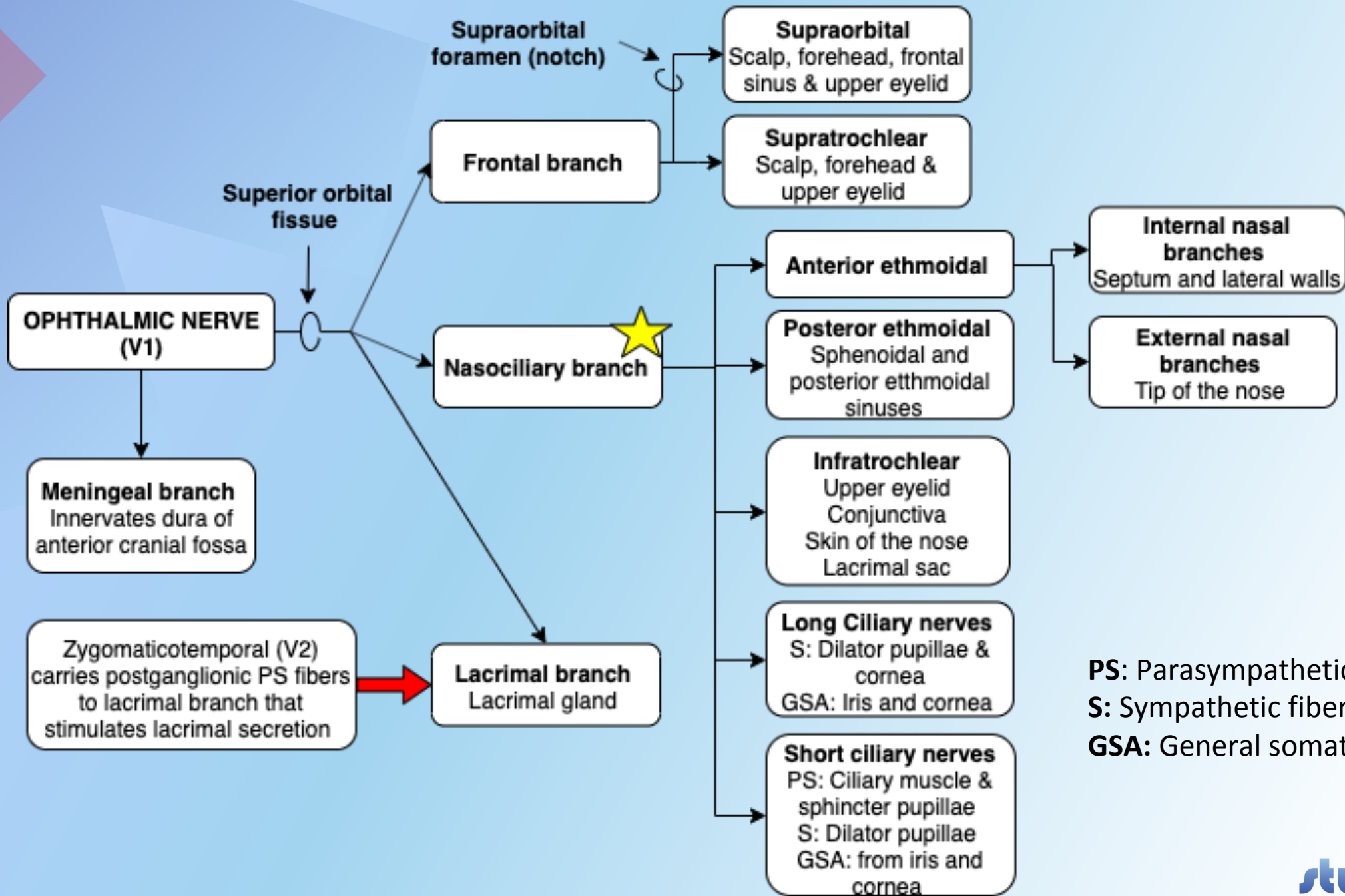
# Ophthalmic division (V1)

- **S**ensory – General somatic afferent (GSA)
- Runs in the lateral wall of the cavernous sinus
- Exits through Superior Orbital foramen
- Sensory innervation of
  - Eyeball
  - Tip of nose
  - Skin of face above eyes



★ Afferent limb of the corneal reflex  
- Nasociliary branch





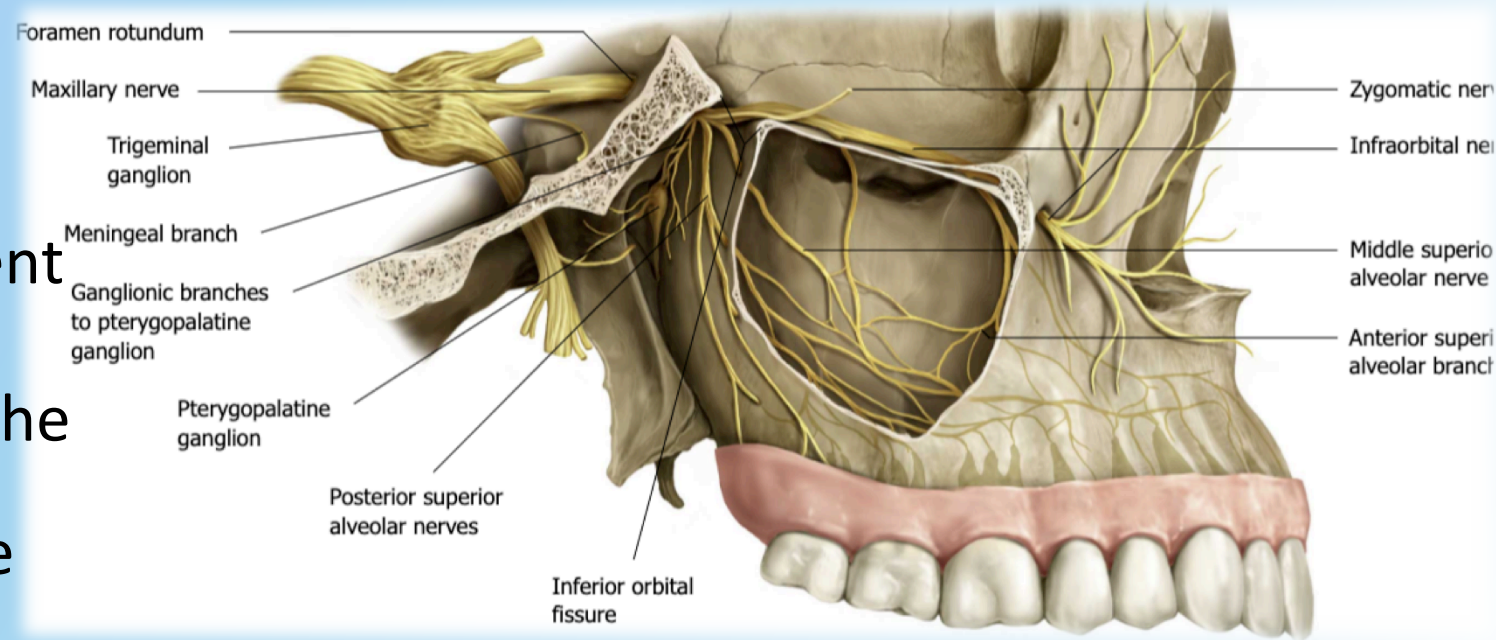
**PS:** Parasympathetic fibers

**S:** Sympathetic fibers

**GSA:** General somatic afferent fibers

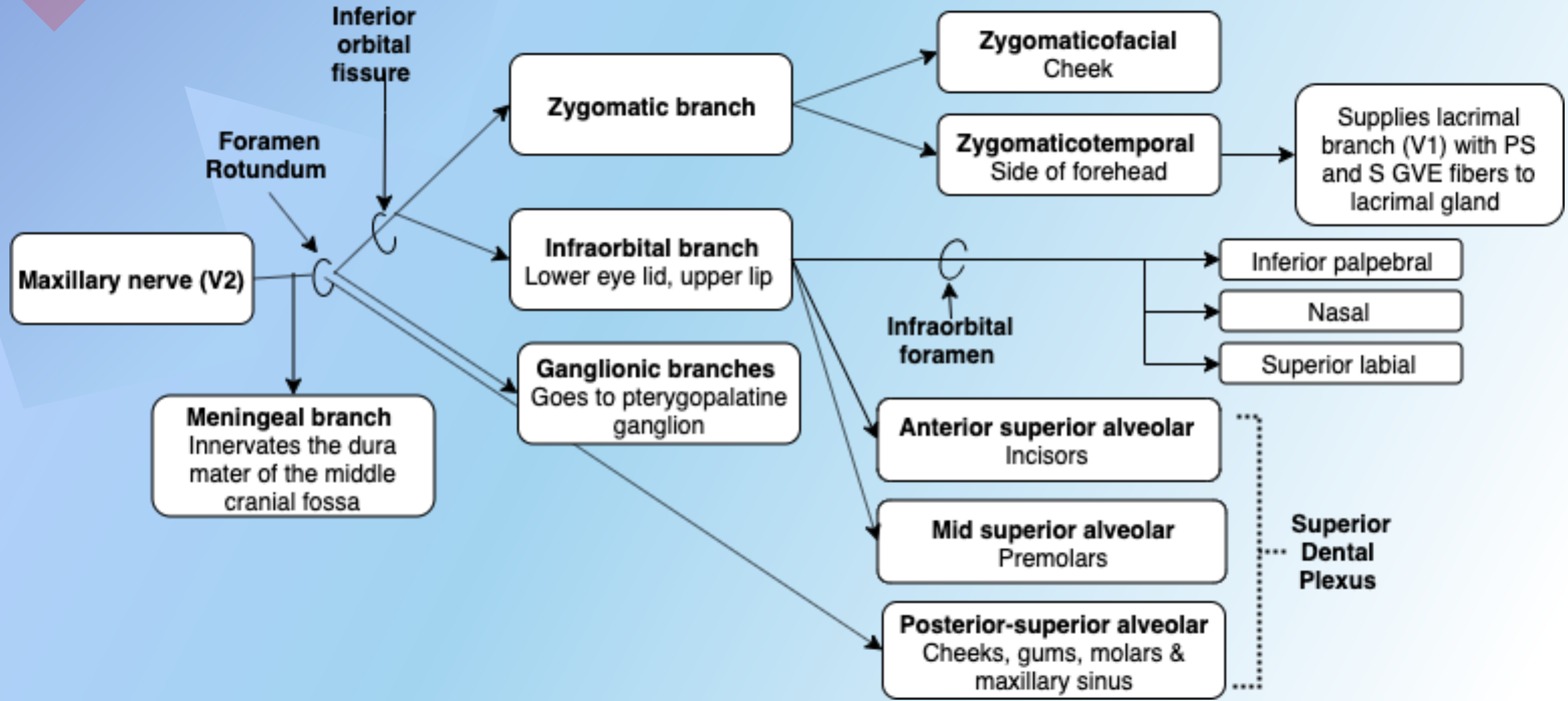
# Maxillary (V2)

- **S**ensory – General somatic afferent (GSA)
- Runs through the lateral wall of the cavernous sinus, exits through foramen rotundum and enter the pterygopalatine fossa.
- Sensory innervation of
  - Skin of the face between the eyes and the upper lip
  - Palate
  - Paranasal sinuses
  - Maxillary teeth



Afferent limb of the sneeze reflex

**PS:** Parasympathetic fibers  
**S:** Sympathetic fibers  
**GVE:** General visceral efferent





# Mandibular (V3)

- **S**ensory – General somatic afferent (GSA) and **M**otor - Special visceral efferent (SVE)
- Exits the skull through foramen Ovale

## Sensory innervation

- Anterior ear
- Teeth and gums of mandible
- Face below lower lip and the mouth
- Sensation of 2/3 anterior part of the tongue



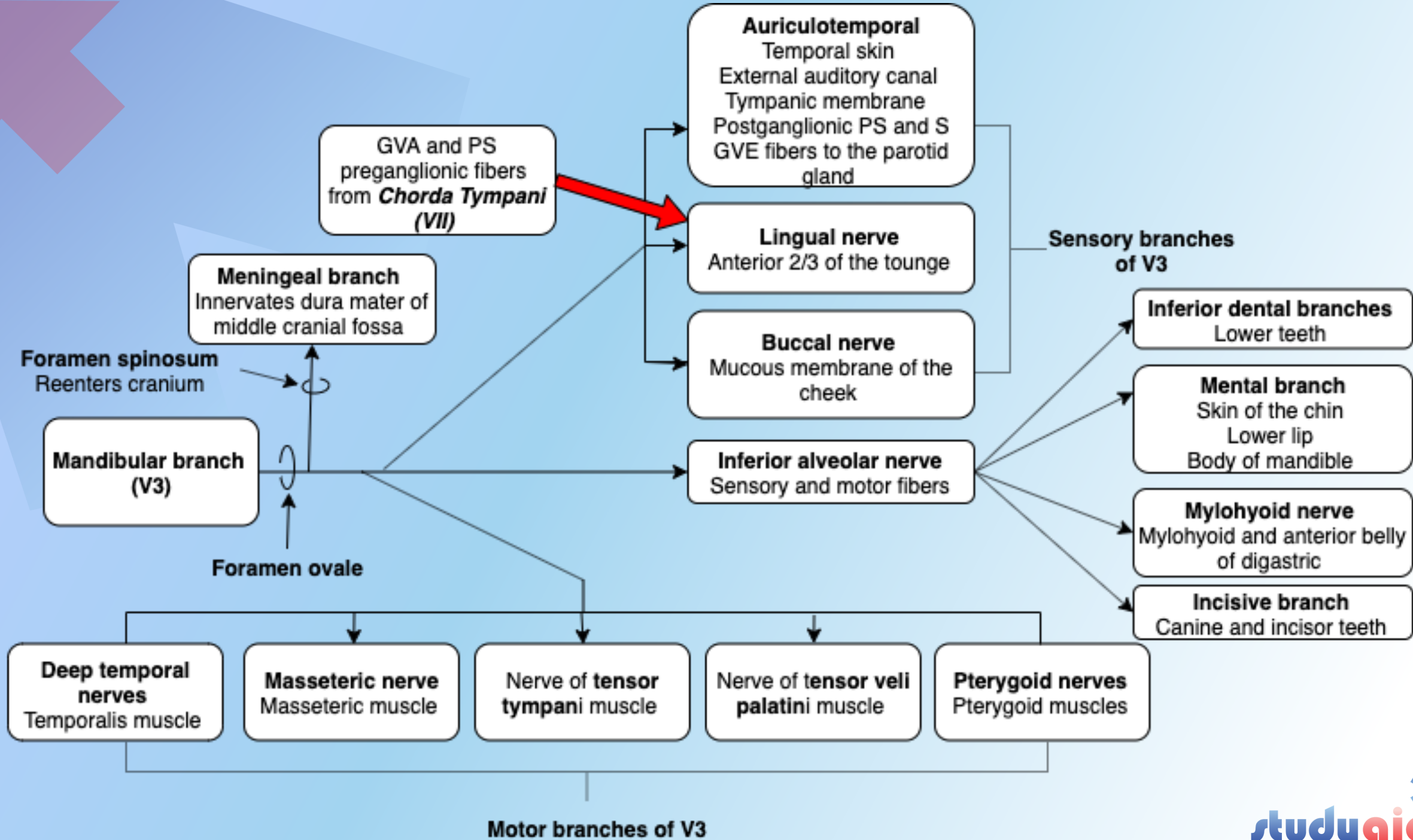
Efferent AND afferent limb of the jaw jerk reflex

# Mandibular (V3)

## Motor

- Anterior belly of digastric
- Mylohyoid
- Tensor veli palatini
- Tensor tympani
- **Innervates muscles of mastication**

<b>M</b> asseter <b>M</b> edial Pterygoid Te <b>M</b> poralis	<b>M</b> oves the mandible UP (Closes the mouth)
<b>L</b> ateral Pterygoid	<b>L</b> ower the mandible (Opens the mouth)

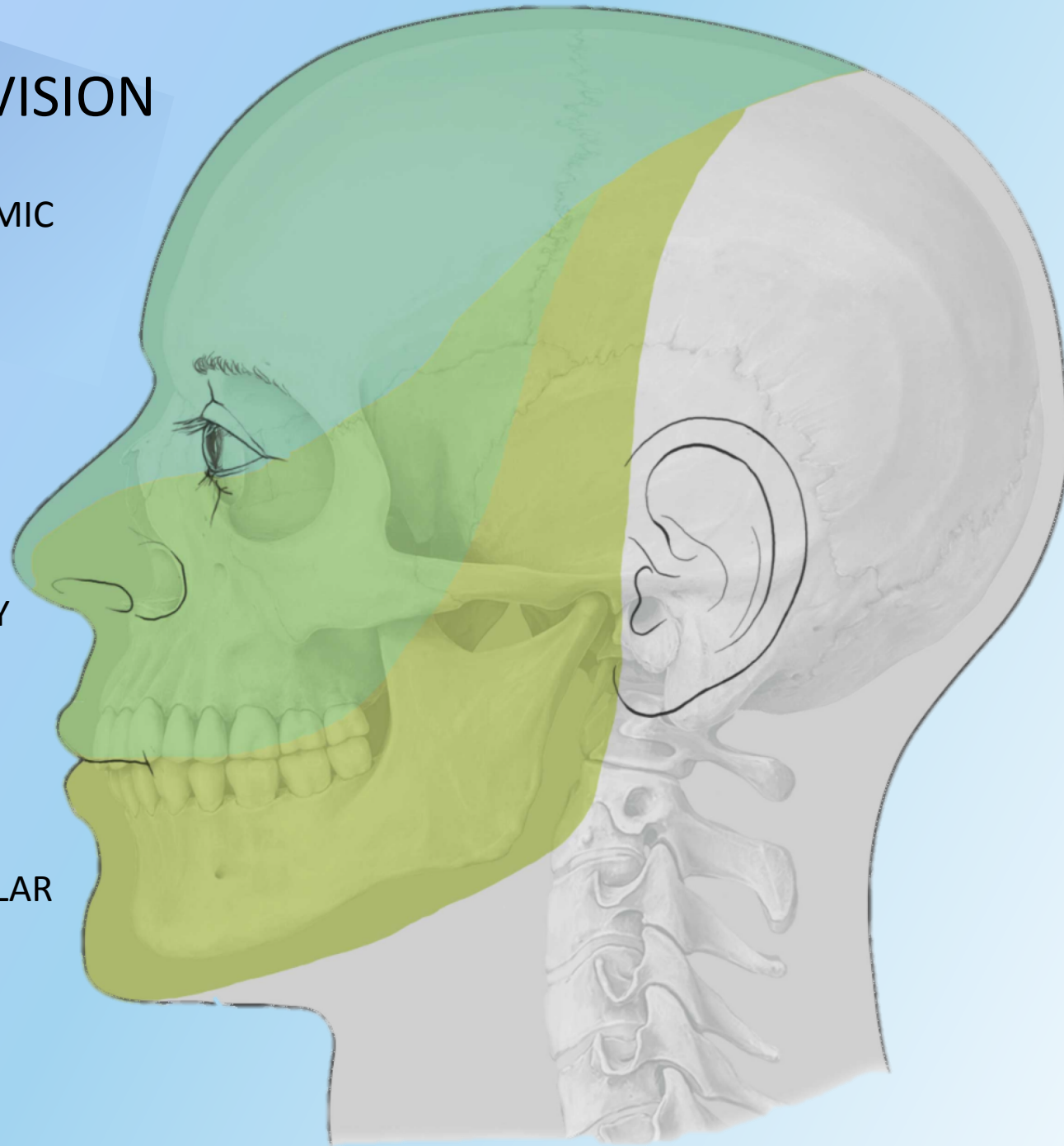


# AREAS OF THE 3 DIVISION

OPHTHALMIC

MAXILLARY

MANDIBULAR



# Trigeminal – Summary

## Innervation of the Dura Mater

Anterior cranial fossa	V1
Middle cranial fossa	V2 & V3
Posterior cranial fossa	CN X and C1 (via XII)

<b>Embryonic origin</b>	1st pharyngeal arch
<b>Type of fiber</b>	<b>Both</b> (General somatic afferent, special visceral efferent)
<b>Exit from brainstem</b>	Pons: anteriorly to the pyramidal eminence
<b>Exit from skull</b>	V1 – Superior orbital fissure V2 – Foramen Rotundum V3 – Foramen Spinosum
<b>Main function</b>	Sensation of face and tongue Innervation of muscles of mastication
<b>Clinical appearances with lesion</b>	Loss of general sensation from the face and mucous membranes of the oral and nasal cavities. Loss of corneal reflex Flaccid paralysis of muscles of mastication. Deviation of patient's jaw to the weak side Paralysis of tensor tympanii = hypacusis



# Facial nerve (VII)

Sensory	SVA	Taste fibers from anterior 2/3 of tongue
	GVA	Palate and nasal mucosa
	GSA	External acoustic meatus, auricle.
<hr/>		
Motor	SVE	Muscles of facial expression
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Parasympathetic	GVE	Lacrimal, submandibular, sublingual, nasal and palatine glands

Exits from the cerebellopontine angle of the pons

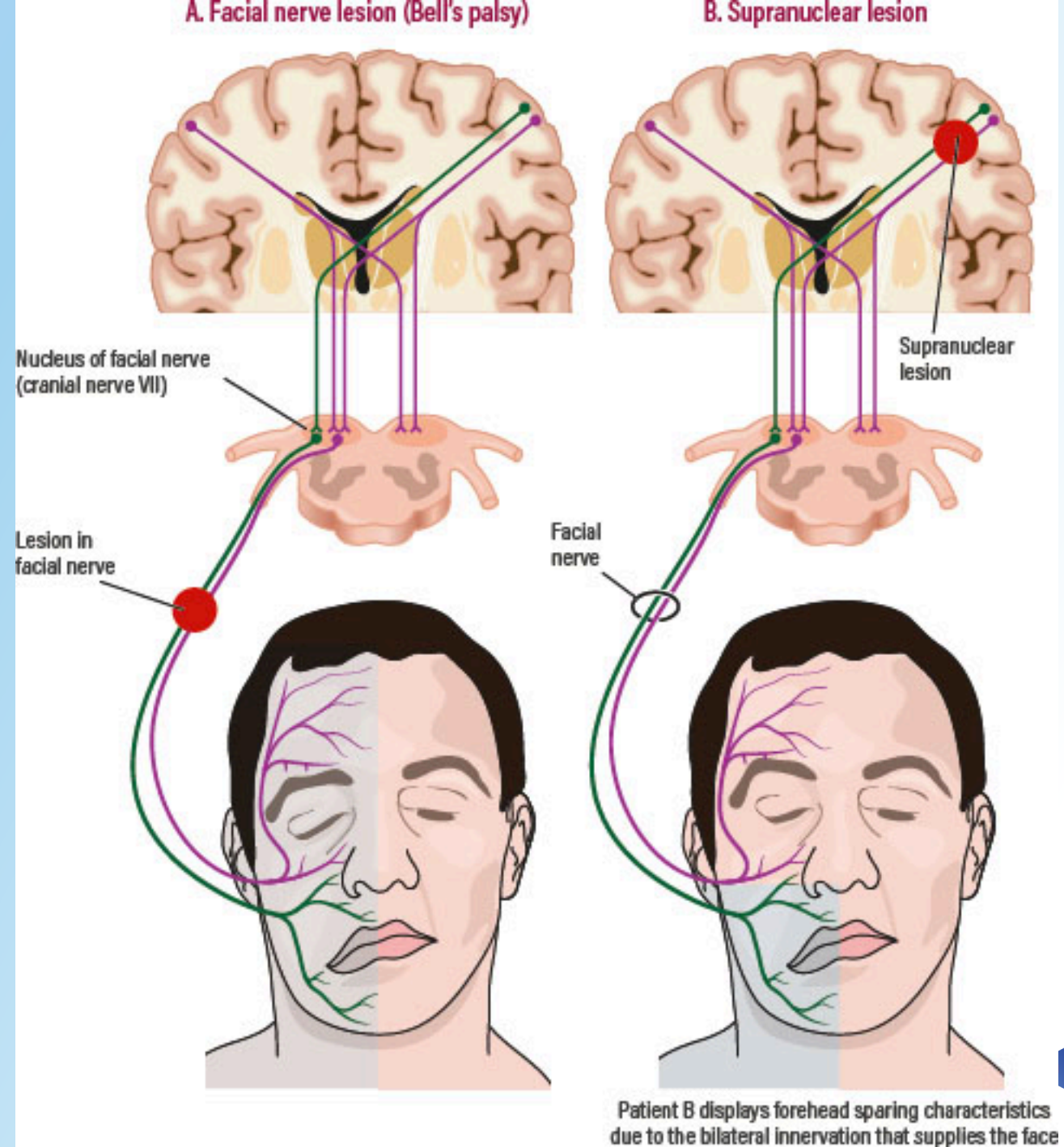
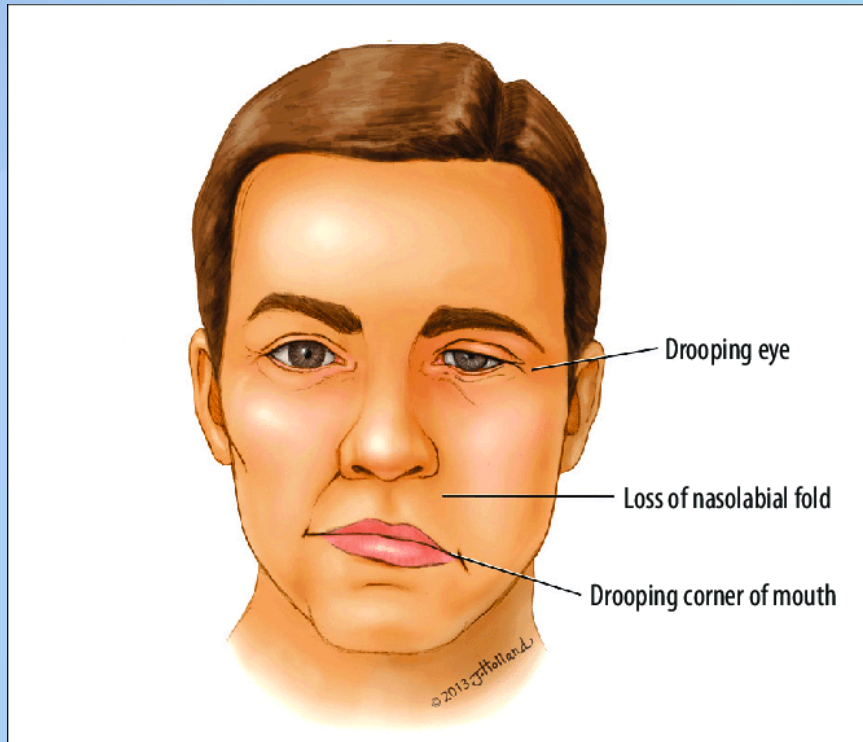
Exits the skull through stylomastoid foramen

★ Efferent limb of the corneal (blink) reflex

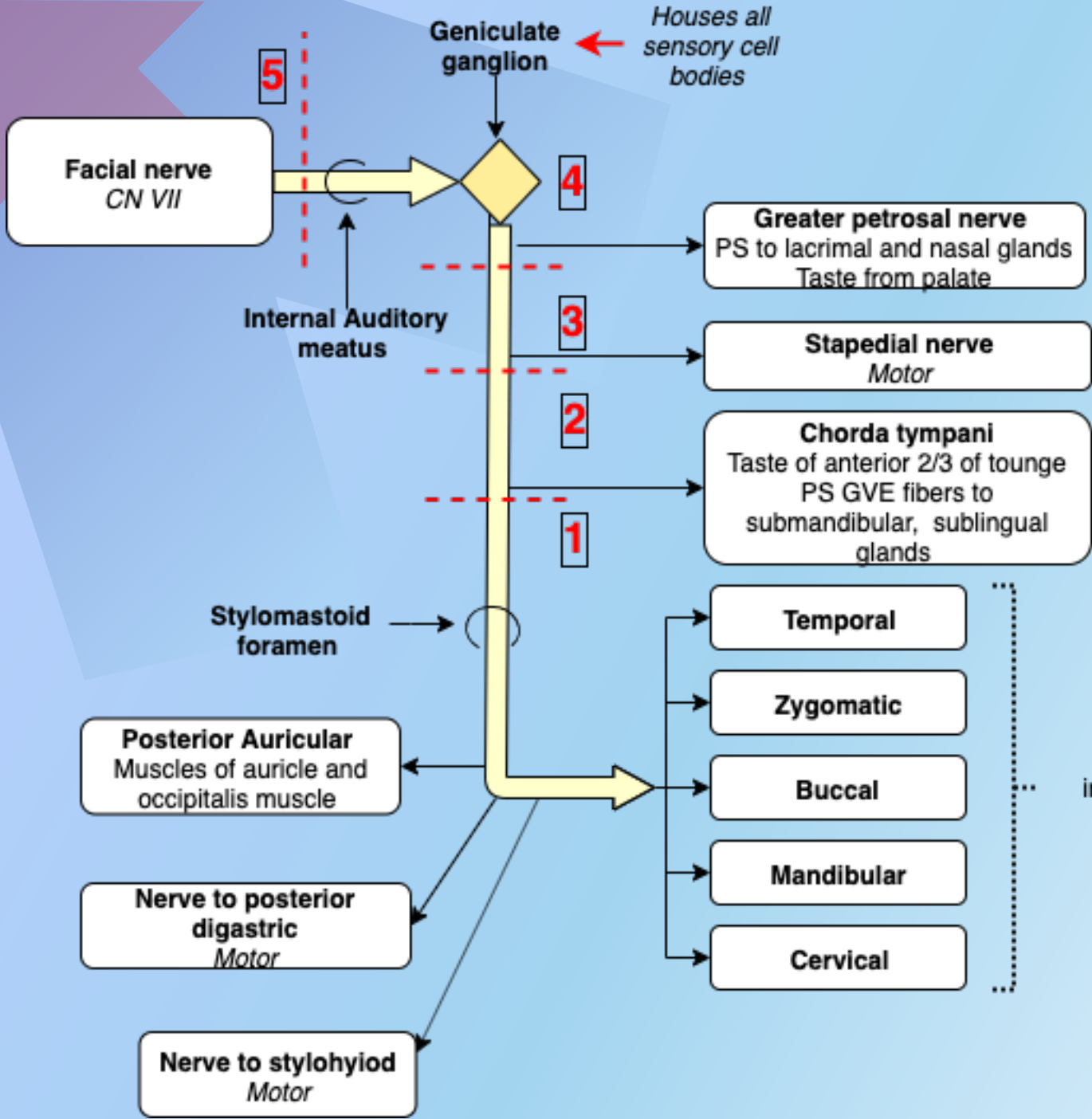
- Loss of this reflex can lead to corneal ulceration

# Bell's palsy

- Ipsilateral paralysis of facial muscles, with lesion of peripheral nerve

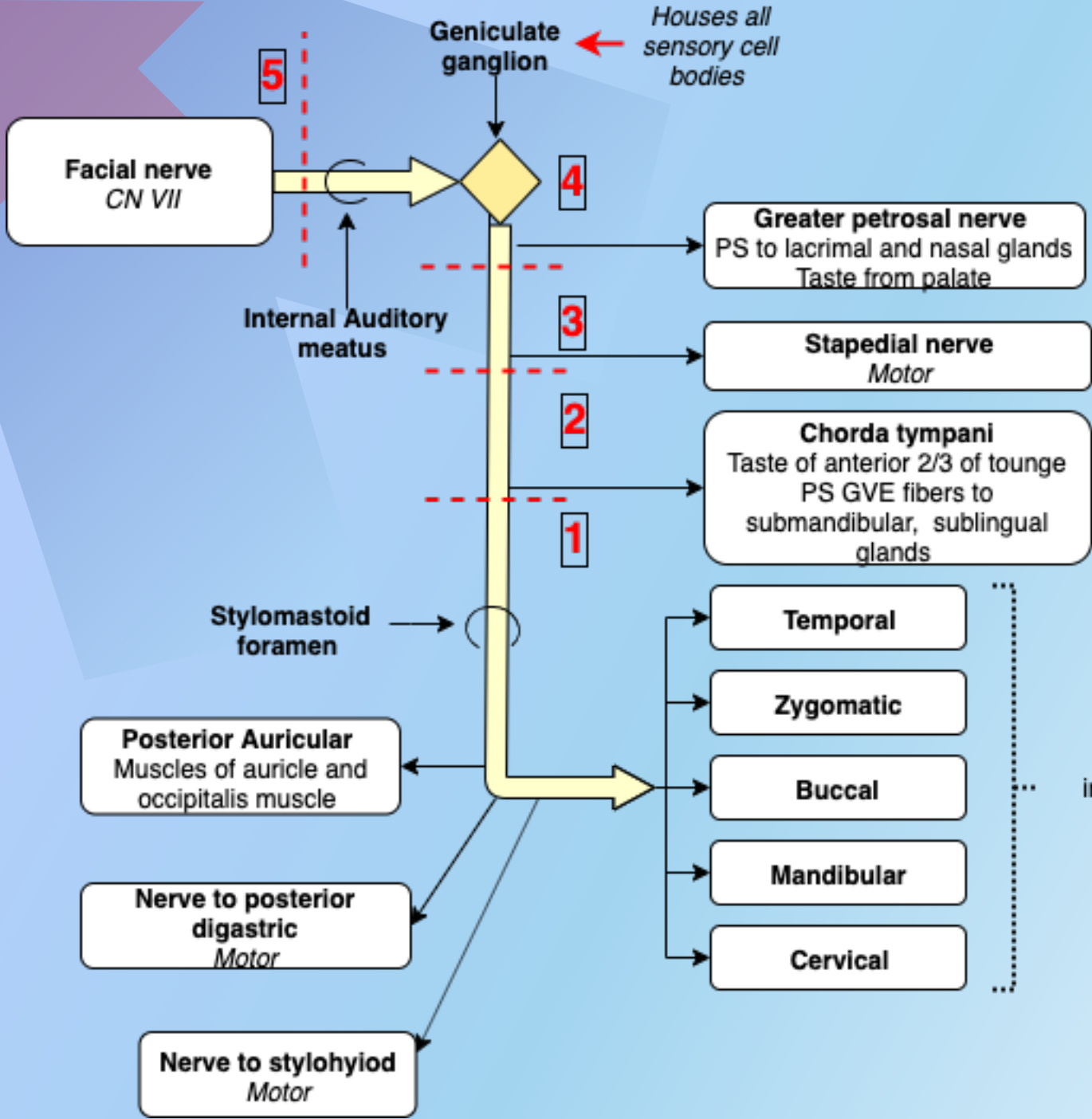






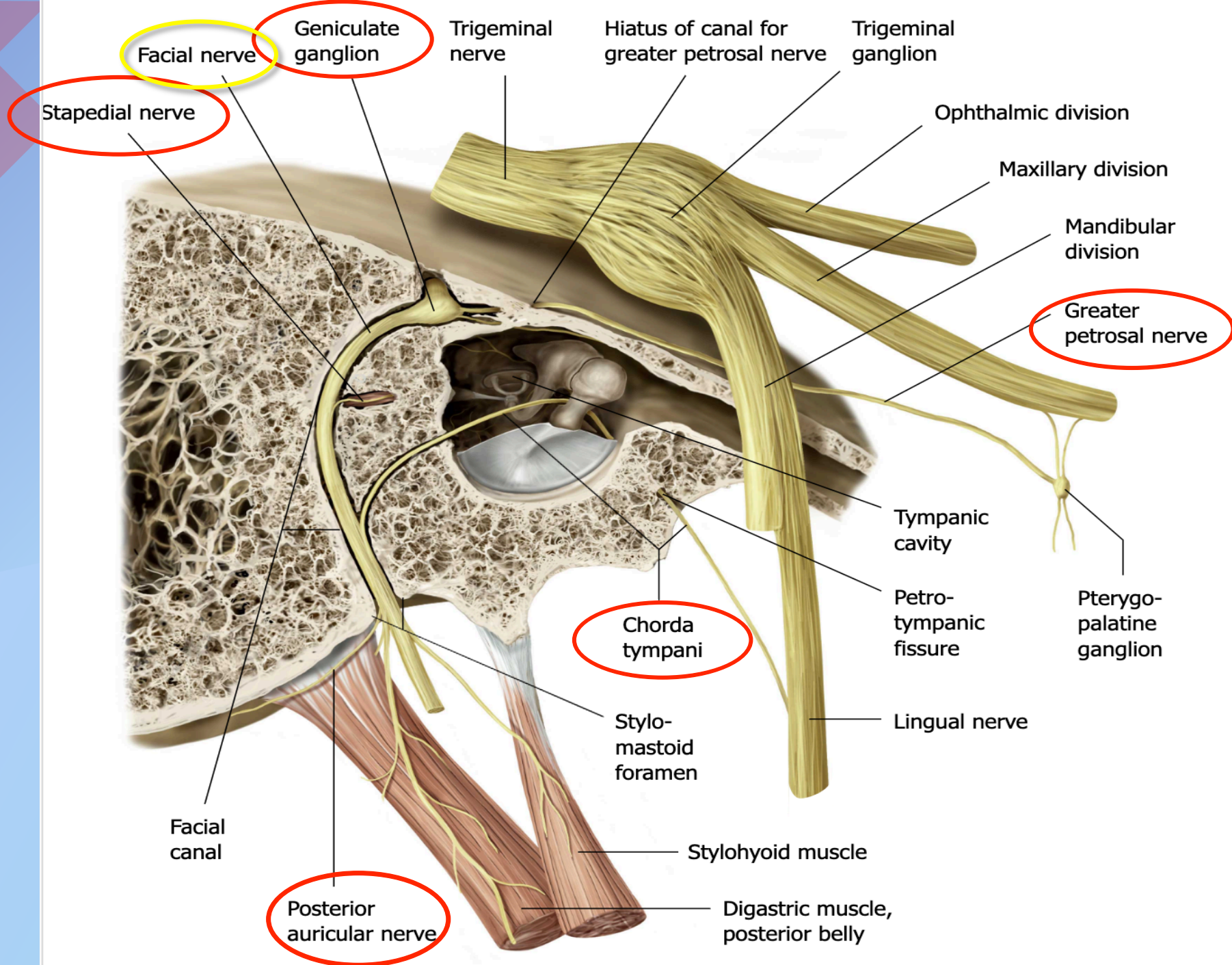
Pathway goes through internal acoustic meatus, through the facial canal and out through the stylomastoid foramen

**NB!** Chorda tympani exits the facial canal, goes between malleolus and incus and exits via the petrotympanic fissure

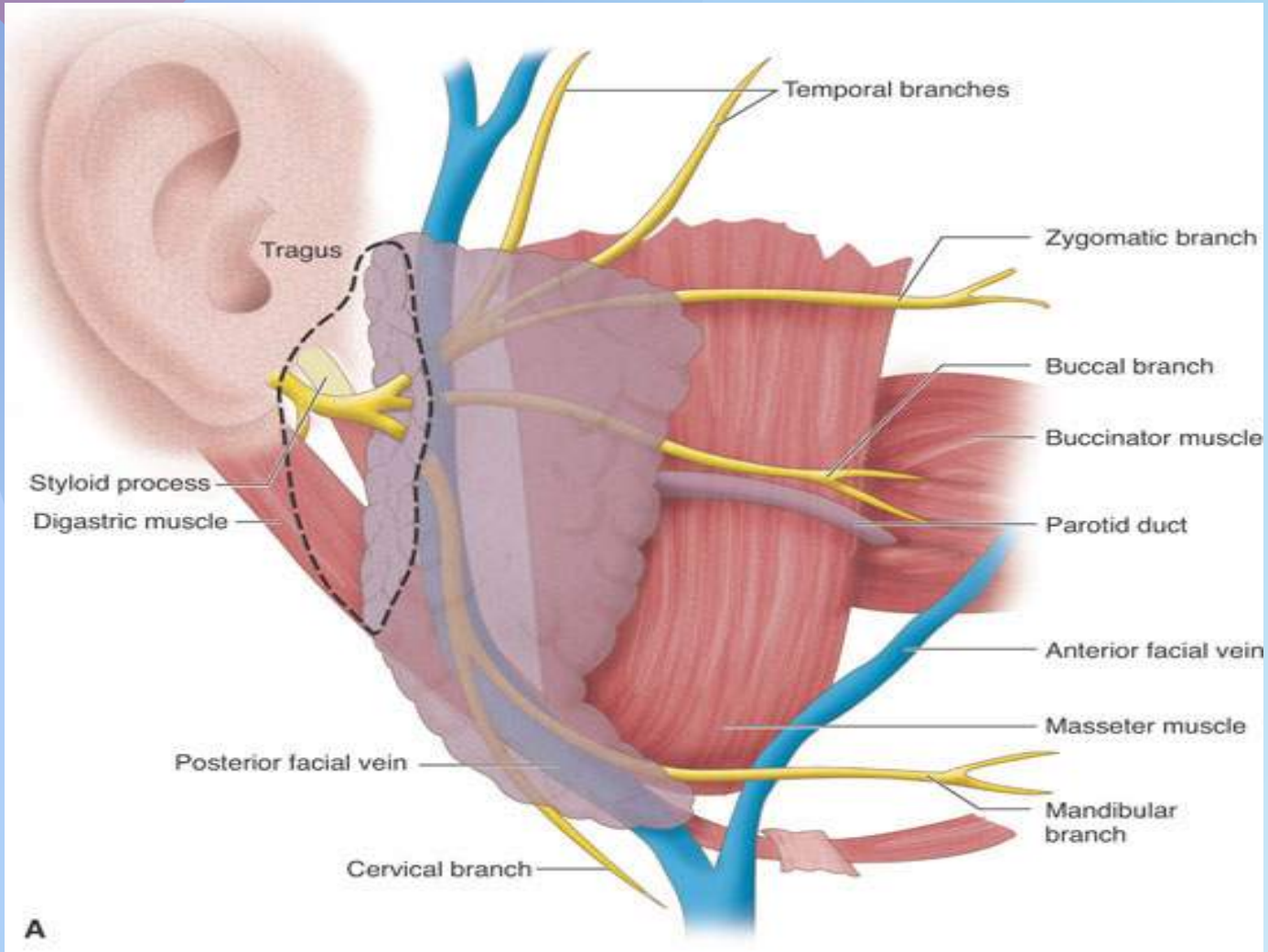


Consequences of lesion – step by step

- 1 Loss of muscles of facial expression
- 2 Loss of taste in anterior 2/3 of the tongue and disturbances with salivation
- 3 Paralysis of stapedius muscle =hyperacusis
- 4 Problems with lacrimation
- 5 Accompanied by problems with hearing and balance (deafness and dizziness)







## CLINICAL CORRELATION

Facial nerve passes through the parotid gland after exiting from the stylomastoid foramen. BUT it does not innervate the parotid gland.

This means that damage to the parotid gland, or a tumor of the parotid can damage the facial nerve.

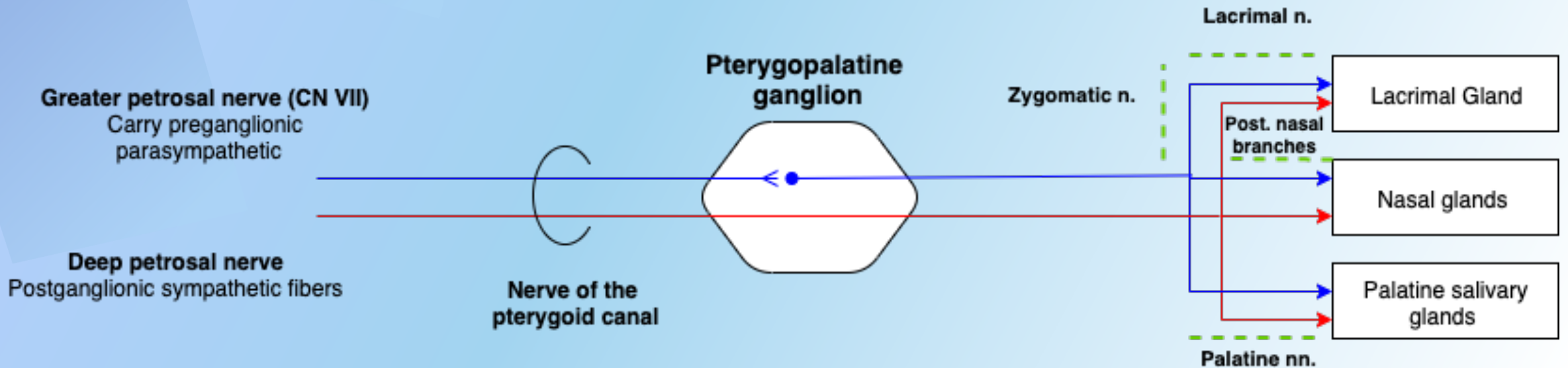
UMN = Upper motor neuron

LMN = Lower motor neuron

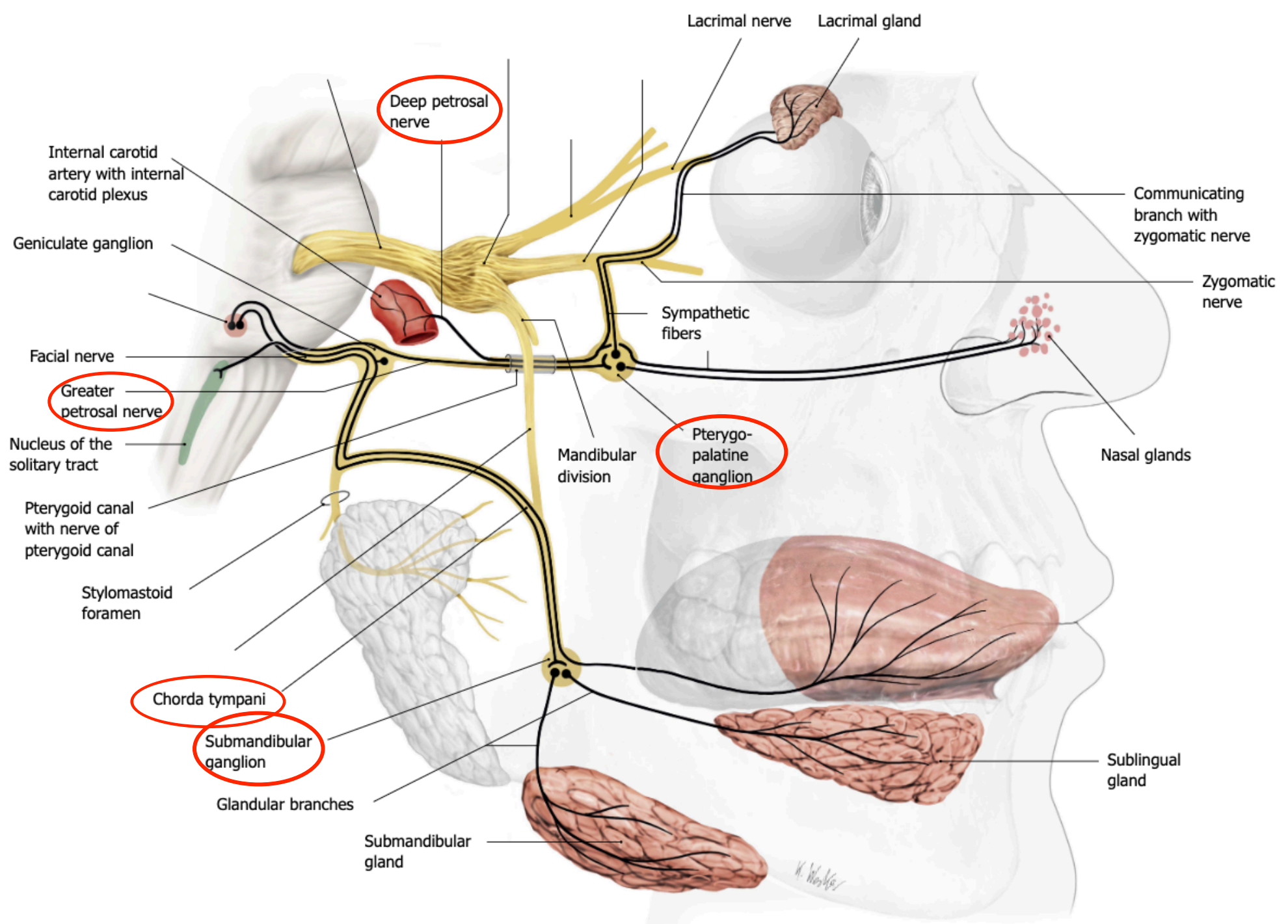
# Facial nerve – Summary

<b>Embryonic origin</b>	2nd pharyngeal arch
<b>Type of fiber</b>	<b>B</b> oth (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 2/3 of the tongue (Chorda Tympani) Innervation of all salivary glands (EXCEPT parotid) Innervates Stapedius muscle of inner ear
<b>Clinical appearances with lesion</b>	UMN: Contralateral paralysis of lower face LMN: Ipsilateral paralysis of upper & lower face Loss of corneal reflex Loss of taste from anterior 2/3rds of the tongue Hyperacusis

# Pterygopalatine ganglion



Parasympathetic  
Sympathetic





# Vestibulocochlear (VIII)

**S**ensory – Special somatic efferent (SVE)

Exits 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

## Lesion

- Hearing loss (Sensoneurinal deafness)
- Tinnitus
- Disequilibrium, vertigo & nystagmus.

# Vestibulocochlear – Summary

<b>Type of fiber</b>	<b>S</b> ensory (Special somatic efferent)
<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 appearances with lesion</b>	Hearing loss (Sensoneurinal deafness) Tinnitus Disequilibrium, vertigo & nystagmus

# Glossopharyngeal (IX)

## Sensory

SVA	Taste 1/3 posterior part of tongue and vallate papillae
GVA	1/3 posterior part of tongue & pharyngeal wall Tympanic cavity and auditory tube Carotid sinus Palatine tonsil and soft palate
GSA	External acoustic meatus

## Motor

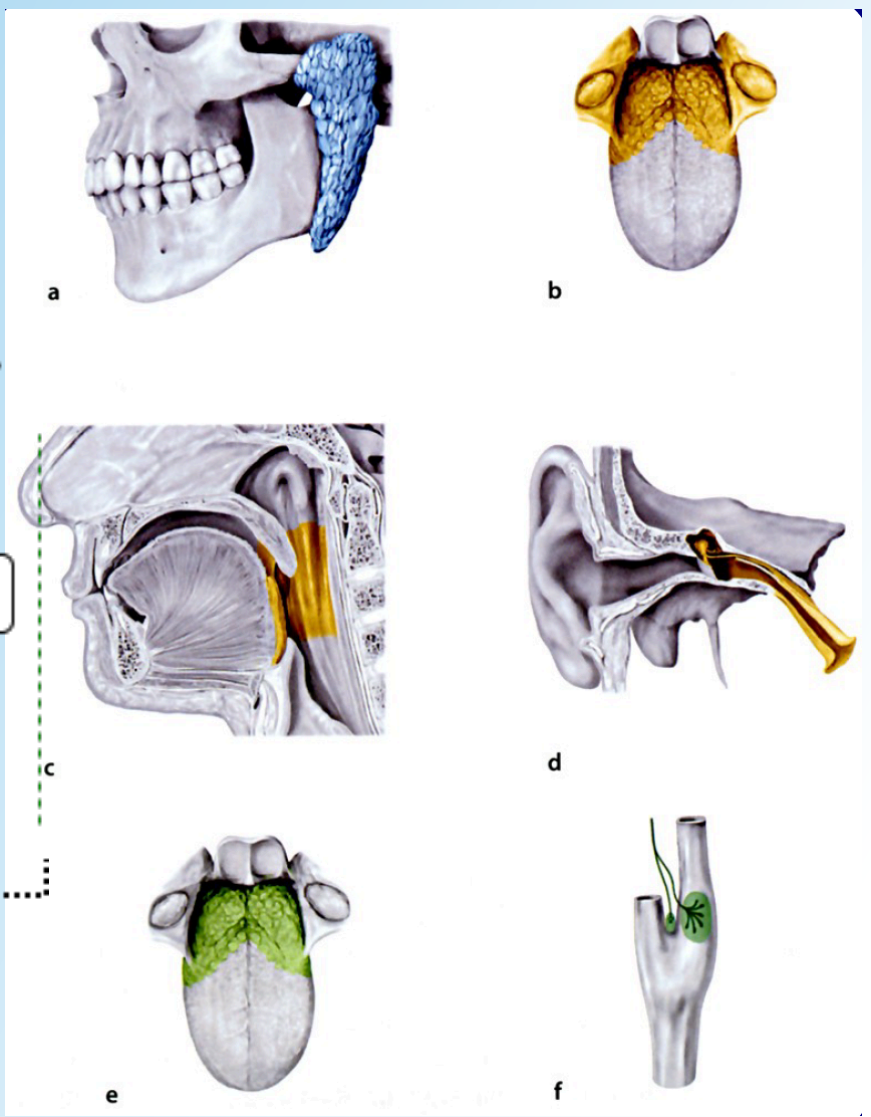
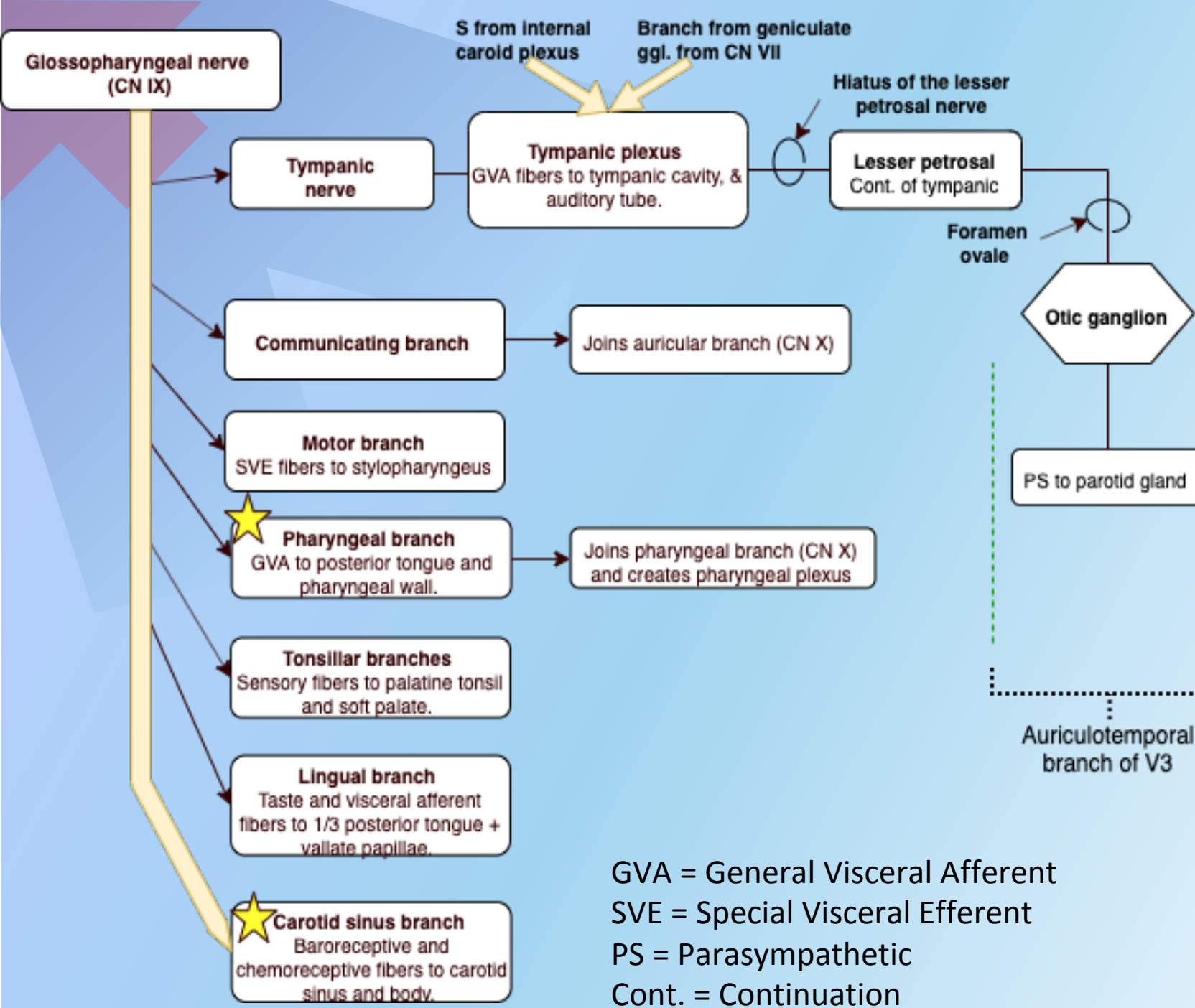
SVE Innervation of Stylopharyngus

## Parasympathetic

GVE Parotid gland

- Exit brainstem from postolivary sulcus
- Exit the skull through jugular foramen

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



GVA = General Visceral Afferent  
 SVE = Special Visceral Efferent  
 PS = Parasympathetic  
 Cont. = Continuation

# Glossopharyngeal

## Lesion

- Loss of gag reflex
- Loss of carotid sinus reflex
- Loss of taste from posterior 1/3 of tongue
- Glossopharyngeal neuralgia



# Glossopharyngeal – Summary

<b>Embryonic origin</b>	3rd pharyngeal arch
<b>Type of fiber</b>	Both (SVE, SVA, GSA, GVE, GSA) Parasympathetic fibers (General visceral afferent)
<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 1/3 posterior part of tongue
<b>Clinical appearances with lesion</b>	Loss of gag reflex Loss of carotid sinus reflex Loss of taste from posterior 1/3 of the tongue Glossopharyngeal neuralgia

# Vagus nerve (X)

- **S**ensory, **M**otor, and parasympathetic
- Exit brainstem in the postolivary sulcus
- Exit through the jugular foramen

## Innervates

- Muscles of pharynx (not stylopharyngeus) & larynx and palate (not tensor veli palatini)
- Smooth muscles and glands of the pharynx, esophagus, and GIT\*
- GVA from mucous membranes of lower pharynx, larynx, trachea and esophagus

## Lesion

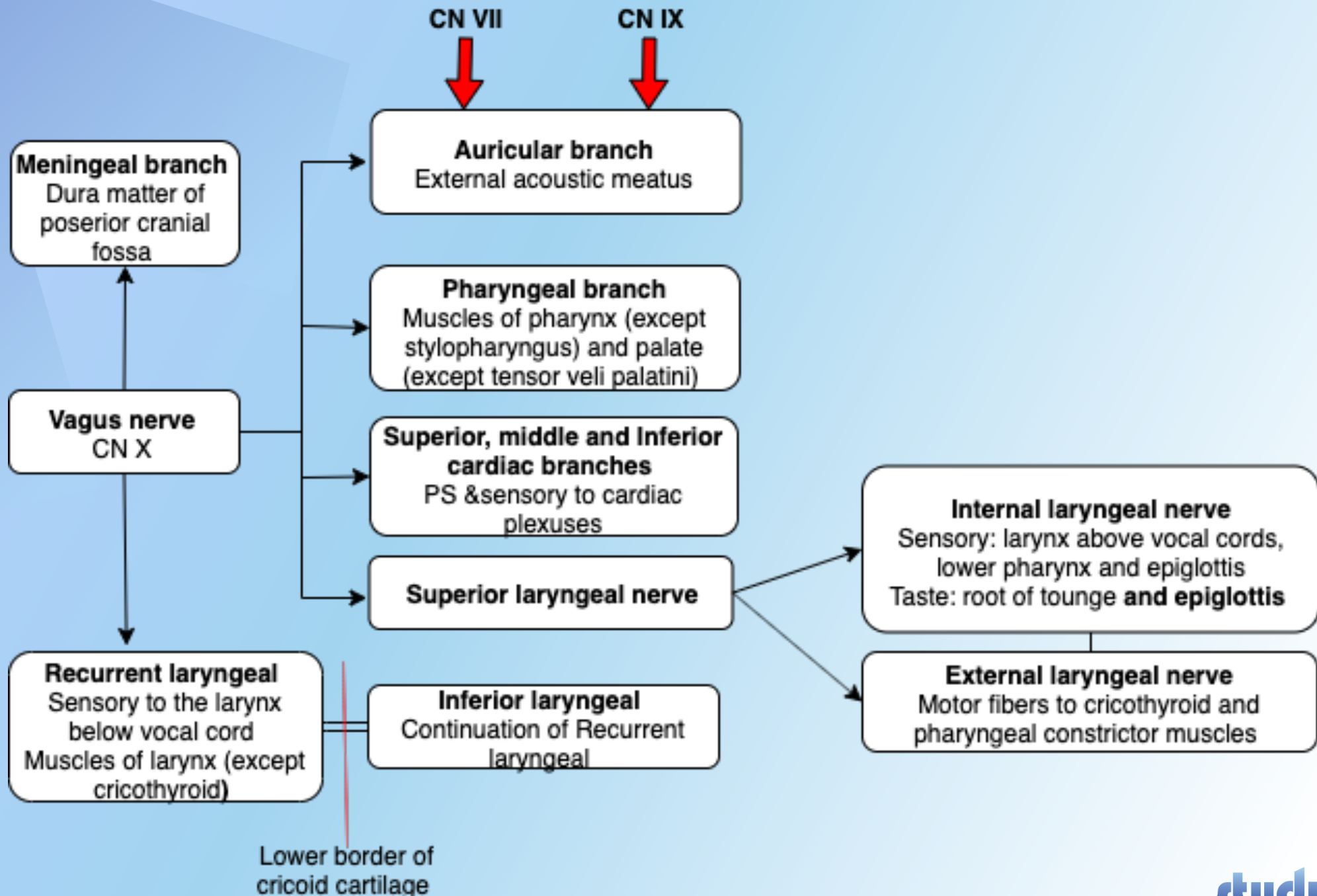
Loss of reflexes

Ipsilateral paralysis of soft palate, pharynx, larynx = dysarthria, dysphagia, dysphonia

Afferent and efferent limb: *Cough reflex*  
Efferent limb: *Sneeze reflex & Gag reflex*

\*from the stomach to the transverse colon





# Vagus – Summary

<b>Embryology</b>	4 <sup>th</sup> and 6 <sup>th</sup> pharyngeal arches
<b>Type of fiber</b>	<b>B</b> oth (SVE, SVA, GVA, GSA, GVE) (Special Visceral efferent & afferent , General Visceral Afferent, general somatic afferent) Parasympathetic fibers (General visceral efferent)
<b>Exit from brainstem</b>	Medulla: Postolivary sulcus
<b>Exit from skull</b>	Jugular foramen
<b>Lesion</b>	Loss of reflexes Ipsilateral paralysis of soft palate, pharynx, larynx = dysarthritia, dysphagia, dysphonia Deviation of the uvula towards the opposite side of the lesion

# Accessory nerve (XI)

## Motor

Exit from brainstem/spinal cord

- Cranial: Postolivary sulcus
- Spinal: C2-C5/6

Innervates

- Cranial: Joins vagus in recurrent laryngeal
- Spinal: Innervates sternocleidomastoid and trapezius

## Lesion

Trapezius paralysis

- Inability to shrug ipsilateral shoulder
- Shoulder drop

Flaccid paralysis of SCM

- Difficulty moving the head opposite the side of the lesion

# Accessory – Summary

<b>Embryonic origin</b>	5th pharyngeal arch
<b>Type of fiber</b>	<b>M</b> otor (General somatic efferent & special visceral efferent)
<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 sternocleidomastoid and trapezius muscle.
<b>Clinical appearances with lesion</b>	Trapezius paralysis Flaccid paralysis of SCM

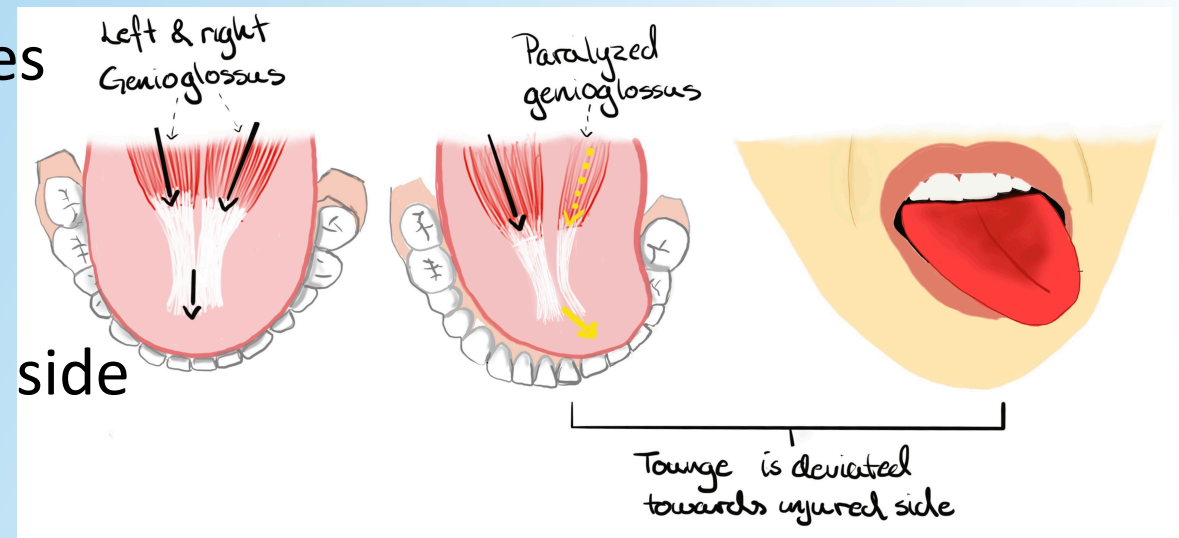


# Hypoglossal (XII)

- **M**otor
- Exits 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"



# Hypoglossal – Summary

Type of fiber	<b>M</b> otor (General somatic efferent)
Exit from brainstem	Medulla oblongata: Preolivary sulcus
Exit from skull	Hypoglossal foramen
Main function	Control muscles of the tongue – all except palatoglossus.
Clinical appearances with lesion	Deviation of the tongue – to the <b>injured</b> side

# Do you remember the exceptions?

All muscles of the palate is innervated by vagus (X) EXCEPT

TENSOR VELI PALATINI – Mandibular V3

All muscles of the tongue is innervated by hypoglossal (XII) EXCEPT

PALATOGLOSSUS - Vagus (X)

All muscles of the pharynx is innervated by vagus (X) EXCEPT

STYLOPHARYNGUS – Glossopharyngeal (IX)

All muscles of the larynx is innervated by the recurrent laryngeal nerve EXCEPT

CRICOTHYROID – External laryngeal

# Reflexes

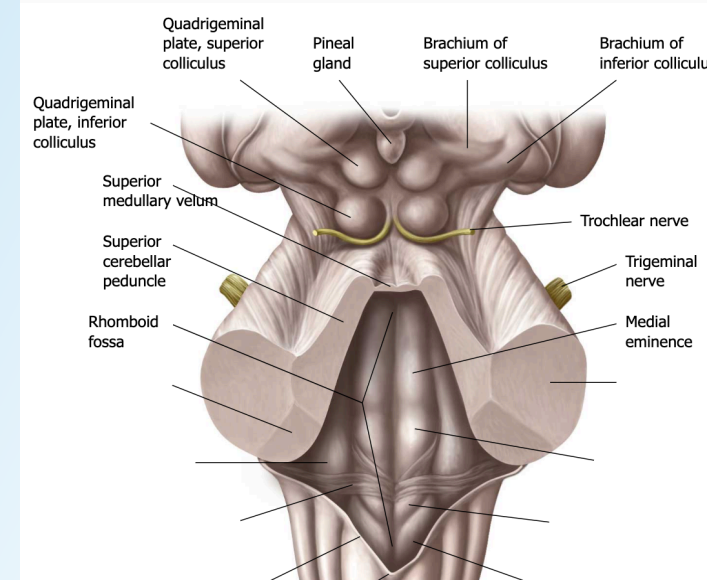
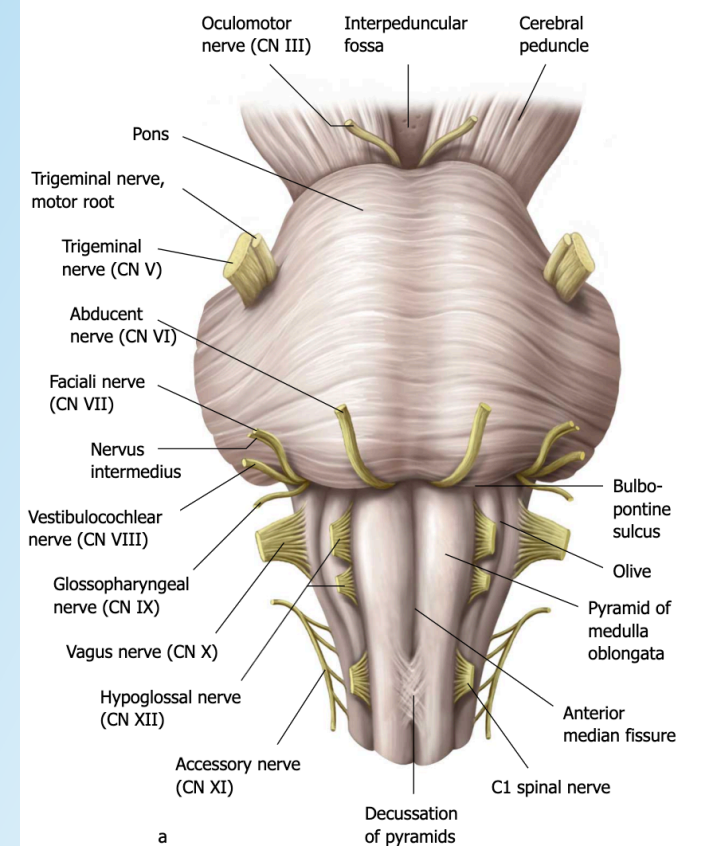
Reflex	Afferent limb	Efferent limb
Corneal reflex	V1 - Nasociliary branch	Facial nerve <sup>1</sup> – CN VII
Pupillary light reflex	Optic nerve – CN II	Oculomotor <sup>2</sup> – CN III
Accommodation	Optic nerve – CN II	Oculomotor <sup>2</sup> – CN III
Lacrimation	Ophthalmic division – CN V1	Facial nerve <sup>1</sup> – CN VII
Jaw jerk	Mandibular division – CN V3 (Sensory)	Manidbular division – CN V3- (Motor)
Gag reflex	Glossopharyngeal – CN IX	Vagus – CN X
Cough reflex	Vagus – CN X	Vagus – CN X
Sneeze reflex	Maxillary division – CN V2	Vagus – CN X

<sup>1</sup> Orbicularis oculi, innervated by temporal branch of VII, closes the eye

<sup>2</sup> Parasympathetic fibers from Edinger-Westphal nucleus of CN III



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



# Ganglions

