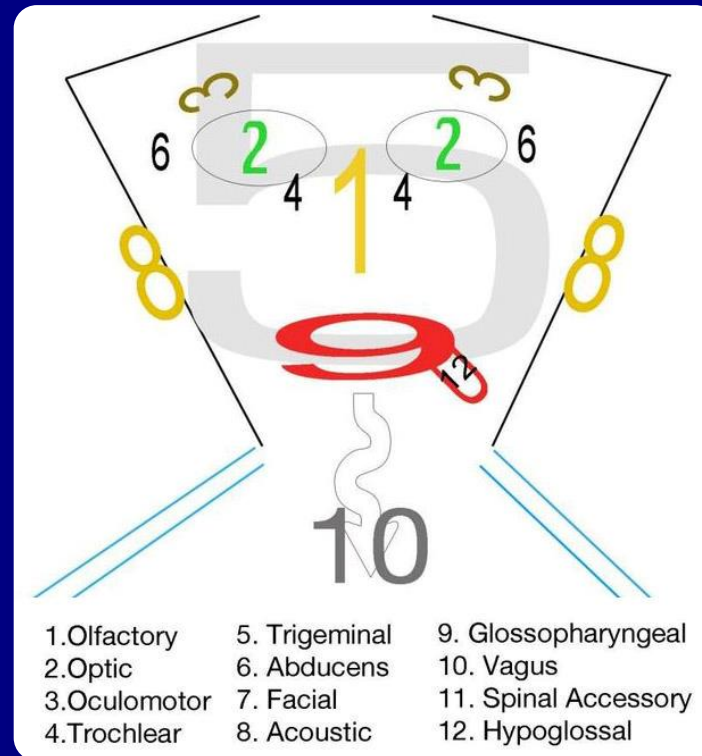




Cranial nerves



Functional components of the cranial nerves

General somatic afferents (somatic sensation):

→ E.g., fibers convey impulses from the skin and striated muscle spindles

General visceral afferents (visceral sensation):

→ E.g., fibers convey impulses from the viscera and blood vessels

General visceral efferents (visceromotor function):

→ Fibers innervate the smooth muscle of the viscera, intraocular muscles, heart, salivary glands, etc.

General somatic efferents (somatomotor function):

→ Fibers innervate striated muscles

Additionally, cranial nerves may contain special fiber types that are associated with particular structures in the head:

Special somatic afferents:

→ E.g., fibers conduct impulses from the retina and from the auditory and vestibular apparatus

Special visceral afferents:

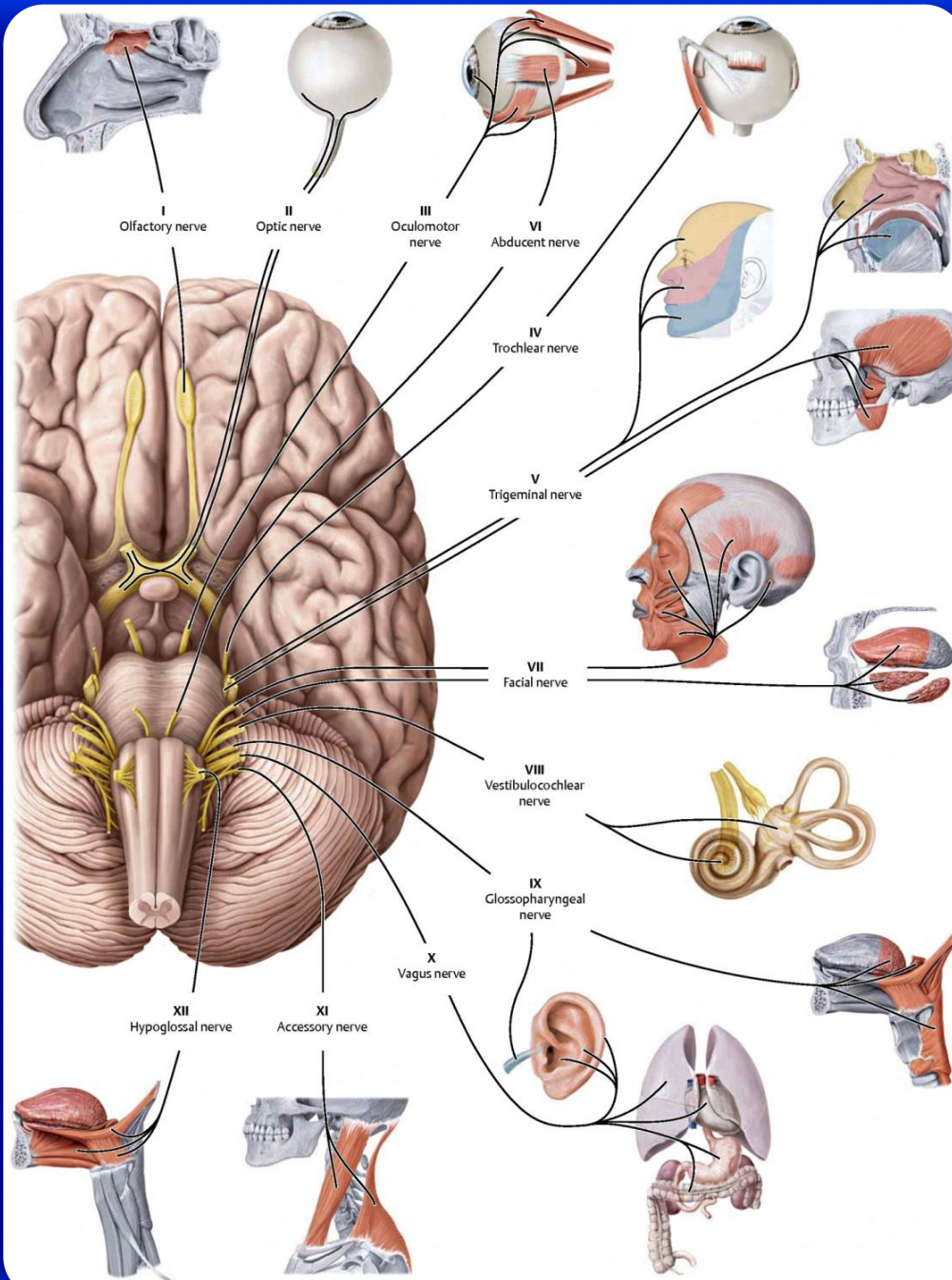
→ E.g., fibers conduct impulses from the taste buds of the tongue and from the olfactory mucosa

Special visceral efferents:

→ E.g., fibers innervate striated muscles derived from the branchial arches (*branchiogenic efferents and branchiogenic muscles*)

Topographical origin	Name	Functional fiber type
Telencephalon	• Olfactory nerve (CN I)	• Special visceral afferent
Diencephalon	• Optic nerve (CN II)	• Special somatic afferent
Mesencephalon	• Oculomotor nerve (CN III)* • Trochlear nerve (CN IV)*	• Somatic efferent • Visceral efferent (parasympathetic) • Somatic efferent
Pons	• Trigeminal nerve (CN V) • Abducent nerve (CN VI)* • Facial nerve (CN VII)	• Special visceral efferent (<i>first branchial arch</i>) • Somatic efferent • Somatic efferent • Special visceral efferent (<i>second branchial arch</i>) • Special visceral afferent • Visceral efferent (parasympathetic) • Somatic afferent
Medulla oblongata	• Vestibulocochlear nerve (CN VIII) • Glossopharyngeal nerve (CN IX) • Vagus nerve (CN X) • Accessory nerve (CN XI)* • Hypoglossal nerve (CN XII)*	• Special somatic afferent • Special visceral efferent (<i>third branchial arch</i>) • Special visceral afferent • Visceral afferent (parasympathetic) • Somatic afferent • Special visceral efferent (<i>fourth branchial arch</i>) • Special visceral afferent • Visceral efferent (parasympathetic) • Visceral afferent • Somatic afferent • Special visceral efferent (<i>fifth branchial arch</i>) • Somatic efferent • Somatic efferent

Topographical and functional organization of the cranial nerves



Overview of the Cranial Nerves

Overview of the nuclei of cranial nerves III - XII

Motor nuclei: (give rise to efferent [motor] fibers, left in C)

Somatic efferent (somatic motor) nuclei (red):

- Nucleus of oculomotor nerve (CN III: eye muscles)
- Nucleus of trochlear nerve (CN IV: eye muscles)
- Nucleus of abducent nerve (CN VI: eye muscles)
- Nucleus of accessory nerve (CN XI, spinal root: shoulder muscles)
- Nucleus of hypoglossal nerve (CN XII: lingual muscles)

Visceral efferent (visceral motor) nuclei (blue):

Nuclei associated with the parasympathetic nervous system (light blue):

- Visceral oculomotor (Edinger-Westphal) nucleus (CN III: papillary sphincter and ciliary muscle)
- Superior salivatory nucleus (CN VII, facial nerve: submandibular and sublingual glands)
- Inferior salivatory nucleus (CN IX, glossopharyngeal nerve: parotid gland)
- Dorsal vagal nucleus (CN X: viscera)

Nuclei of the branchial arch nerves (dark blue):

- Trigeminal motor nucleus (CN V: muscles of mastication)
- Facial nucleus (CN VII: facial muscles)
- Nucleus ambiguus (CN IX, glossopharyngeal nerve; CN X, vagus nerve; CN XI, accessory nerve [cranial root]: pharyngeal and laryngeal muscles)

Sensory nuclei: (where afferent [sensory] fibers terminate, right in C)

Somatic afferent (somatic sensory) and vestibulocochlear nuclei (yellow):

Sensory nuclei associated with the trigeminal nerve (CN V):

- Mesencephalic nucleus (proprioceptive afferents from muscles of mastication)
- Principal (pontine) sensory nucleus (touch, vibration, joint position)
- Spinal nucleus (pain and temperature sensation in the head)

Nuclei of the vestibulocochlear nerve (CN VIII):

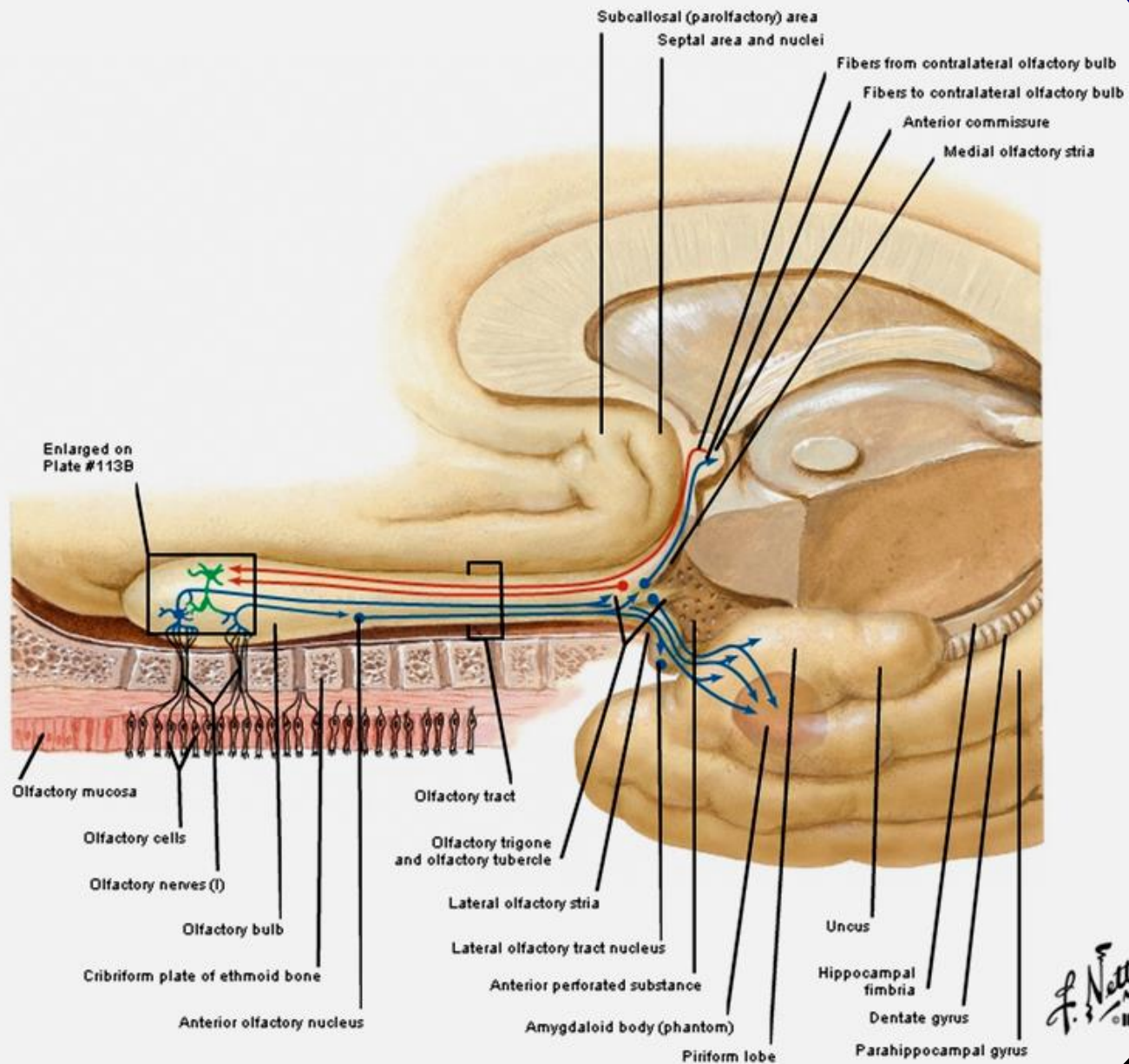
- Vestibular part (sense of balance):
 - Medial vestibular nucleus
 - Lateral vestibular nucleus
 - Superior vestibular nucleus
 - Inferior vestibular nucleus
- Cochlear part (hearing):
 - Anterior cochlear nucleus
 - Posterior cochlear nucleus

Visceral afferent (visceral sensory) nuclei (green):

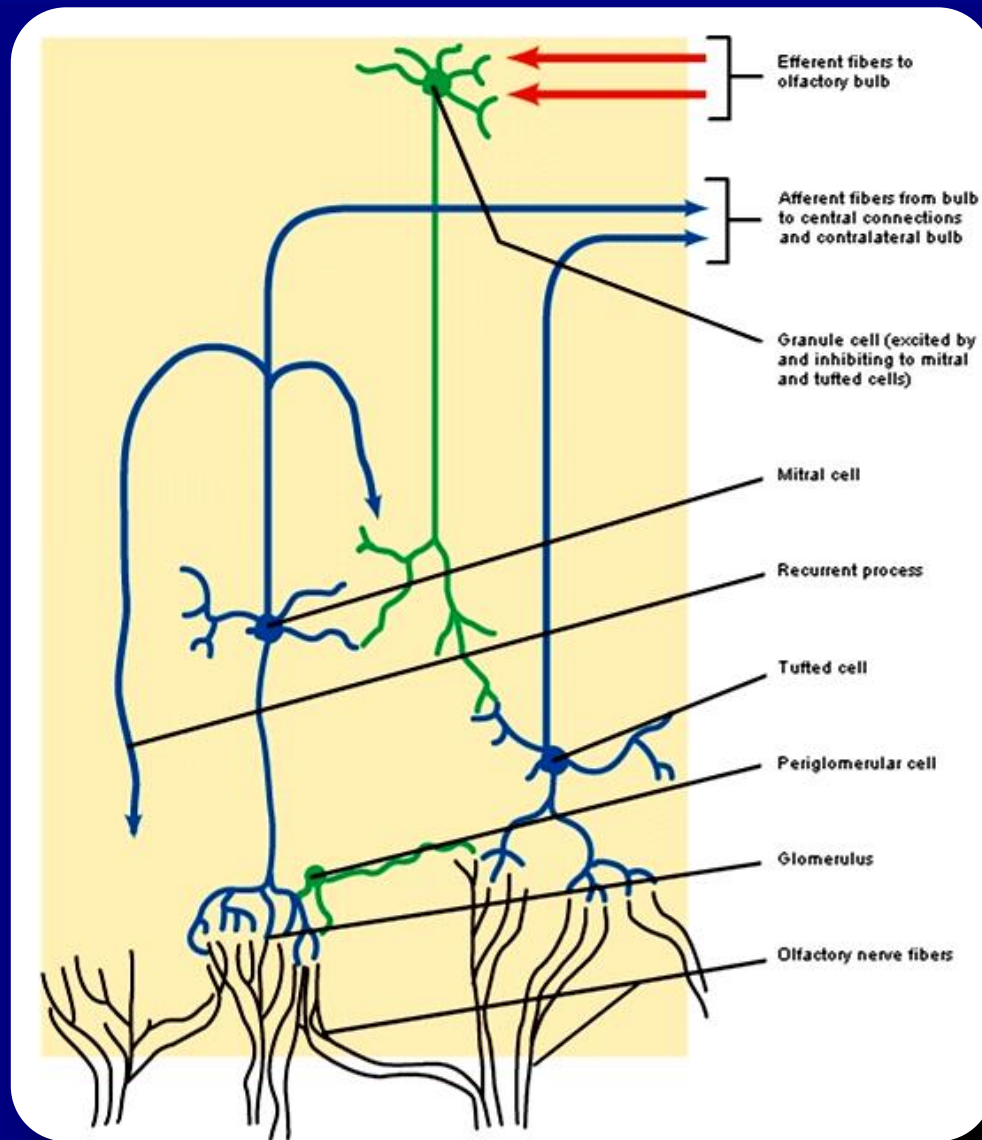
- Nucleus of the solitary tract (nuclear complex):
 - Superior part (special visceral afferents [taste] from CN VII [facial], CN IX [glossopharyngeal], and CN X [vagus] nerves)
 - Inferior part (general visceral afferents from CN IX [glossopharyngeal] and CN X [vagus] nerves)

Cranial nerves	Sensory ganglia	Autonomic ganglia
Oculomotor nerve (CN III)		<ul style="list-style-type: none"> • Ciliary ganglion
Trigeminal nerve (CN V)	<ul style="list-style-type: none"> • Trigeminal ganglion 	
Facial nerve (CN VII)	<ul style="list-style-type: none"> • Geniculate ganglion 	<ul style="list-style-type: none"> • Pterygo-palatine ganglion • Submandibular ganglion
Vestibulocochlear nerve (CN VIII)	<ul style="list-style-type: none"> • Spiral ganglion • Vestibular ganglion 	
Glossopharyngeal nerve (CN IX)	<ul style="list-style-type: none"> • Superior ganglion • Inferior (petrosal) ganglion 	<ul style="list-style-type: none"> • Otic ganglion
Vagus nerve (CN X)	<ul style="list-style-type: none"> • Superior (jugular) ganglion • Inferior (nodose) ganglion 	<ul style="list-style-type: none"> • Prevertebral and intramural ganglia

Ganglia associated with cranial nerves



Olfactory nerve (I)



Olfactory nerve (I) – olfactory bulb cells

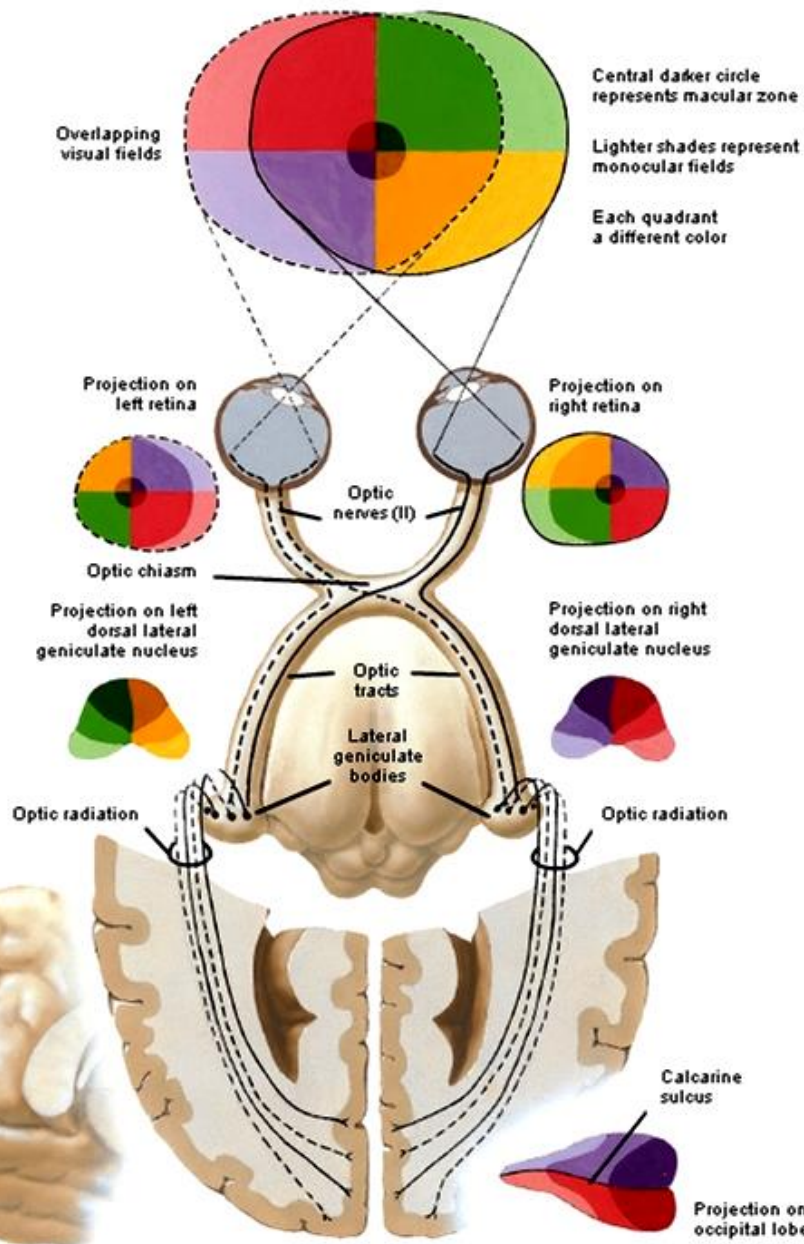
Damage to the olfactory nerve results in anosmia (loss of olfactory sensation).

It may result from ethmoid bone fracture or Foster-Kennedy syndrome (meningioma of anterior cranial fossa).

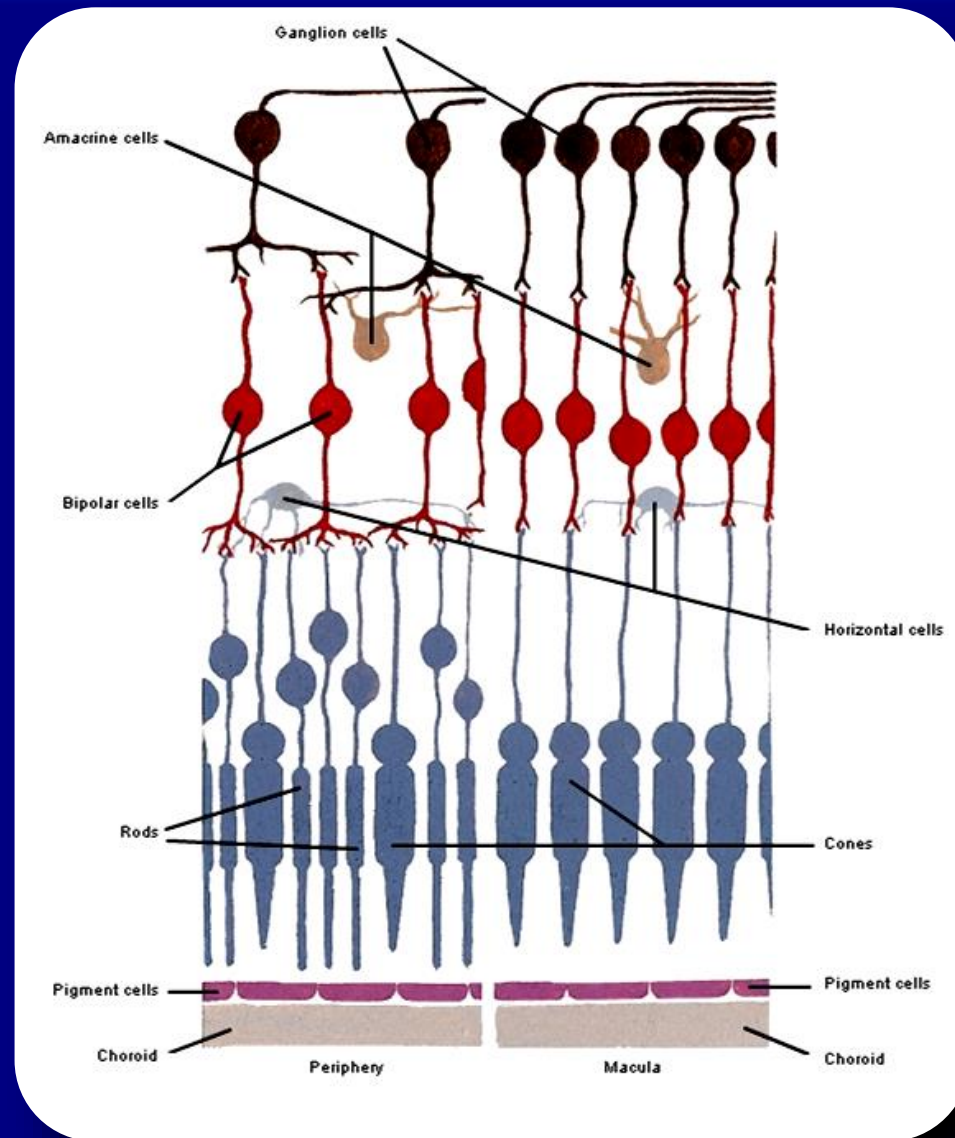
Tear of olfactory nerves is commonly associated with the flow of cerebrospinal fluid through the nose (rhinorrhea).

Cranial nerves	Sensory ganglia	Autonomic ganglia
Oculomotor nerve (CN III)		<ul style="list-style-type: none"> • Ciliary ganglion
Trigeminal nerve (CN V)	<ul style="list-style-type: none"> • Trigeminal ganglion 	
Facial nerve (CN VII)	<ul style="list-style-type: none"> • Geniculate ganglion 	<ul style="list-style-type: none"> • Pterygo-palatine ganglion • Submandibular ganglion
Vestibulocochlear nerve (CN VIII)	<ul style="list-style-type: none"> • Spiral ganglion • Vestibular ganglion 	
Glossopharyngeal nerve (CN IX)	<ul style="list-style-type: none"> • Superior ganglion • Inferior (petrosal) ganglion 	<ul style="list-style-type: none"> • Otic ganglion
Vagus nerve (CN X)	<ul style="list-style-type: none"> • Superior (jugular) ganglion • Inferior (nodose) ganglion 	<ul style="list-style-type: none"> • Prevertebral and intramural ganglia

Ganglia associated with cranial nerves



Optic nerve (II)
– visual pathway



Optic nerve (II) – structure of retina

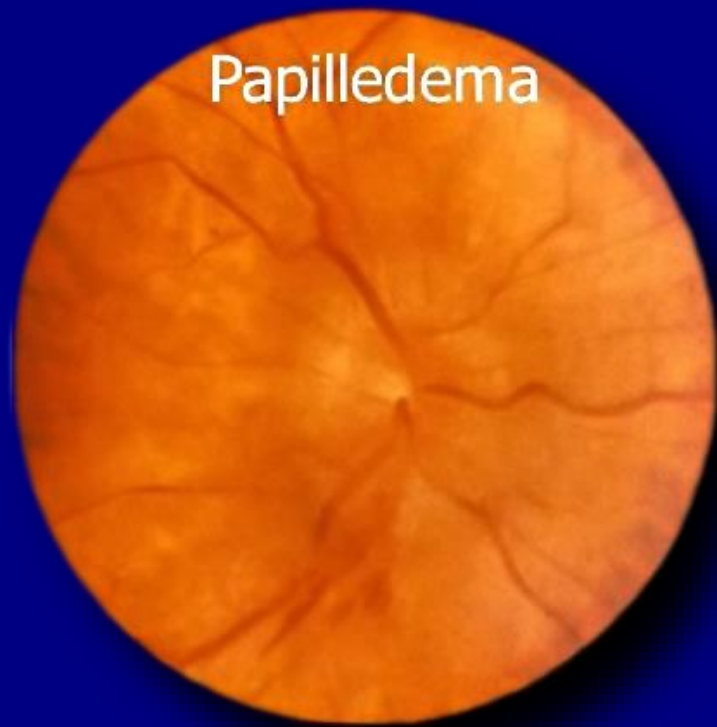
Optic nerve:

- When transected, ipsilateral blindness and loss of direct pupillary reflex results
- Increased intracranial pressure results in **papilledema** (a “choked” optic disk)
- Constriction results in optic atrophy

Normal

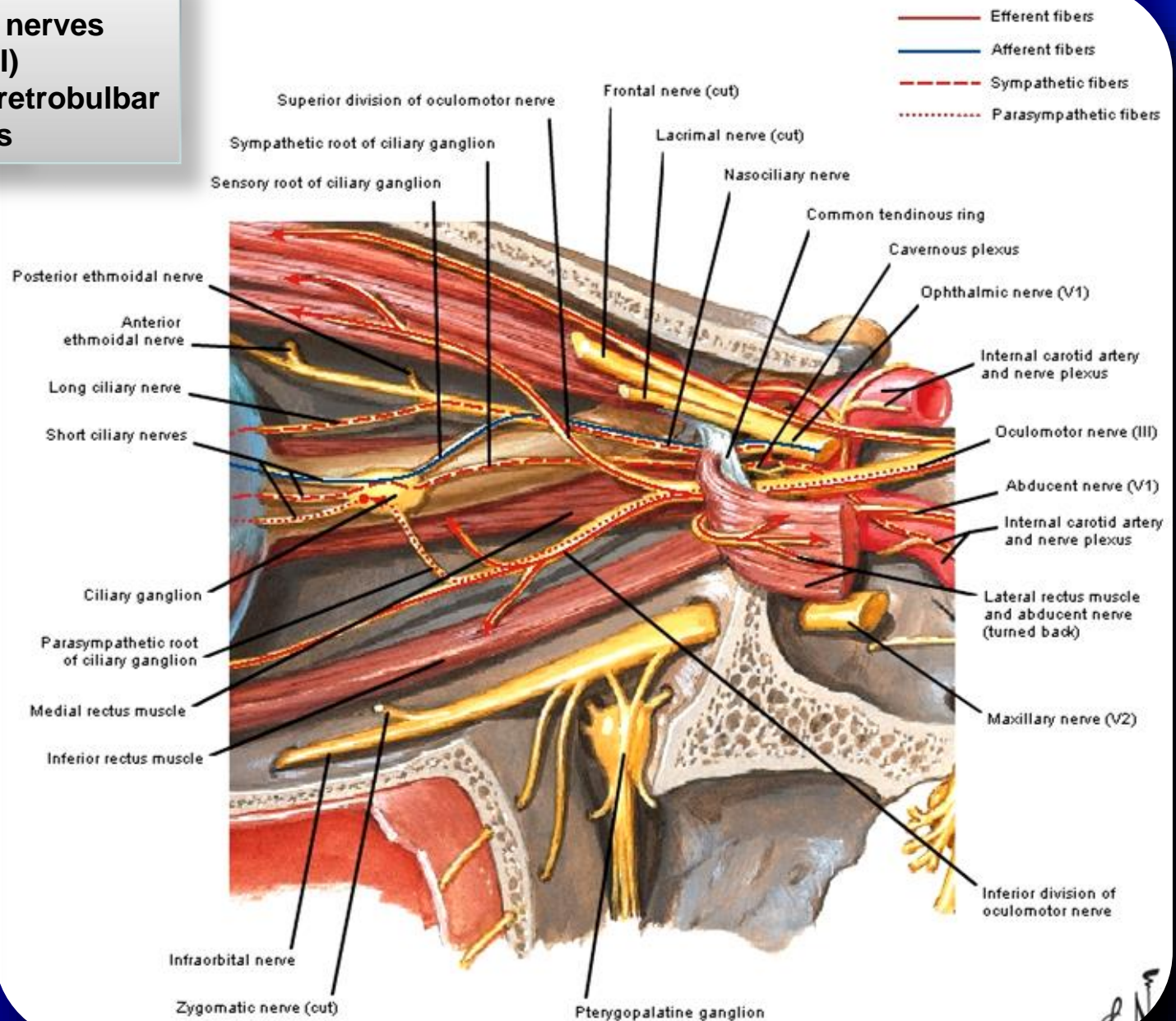


Papilledema

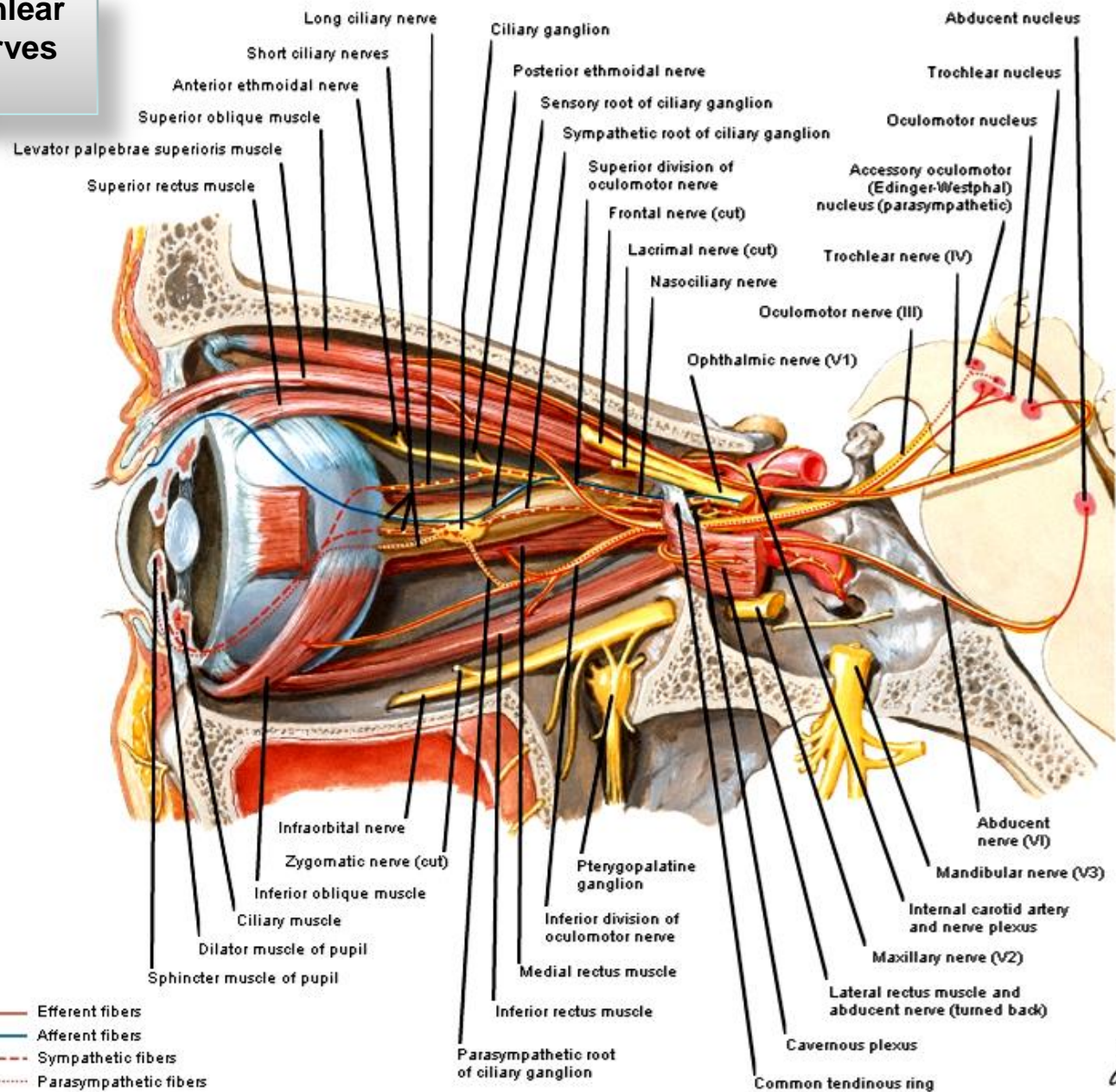


Oculomotor, trochlear and abducent nerves (III, IV, VI)

– enlargement of retrobulbar portions



Oculomotor, trochlear and abducent nerves (III, IV, VI)



Oculomotor nerve: moves the eye, constricts the pupil, accommodates, and converges.

Subdural or epidural hematoma causing a transtentorial herniation, aneurysms of internal carotid and posterior communicating arteries commonly results in oculomotor paralysis.

- Denervation of levator palpebrae results in **ptosis** (drooping of the upper eyelid).
- Unopposed action of the lateral rectus and superior oblique causes the affected eye to look **down and out**.
- Paralysis results in **diplopia** (double vision) when the patient looks in the direction of the paretic muscle.
- Loss of parasympathetic innervation results in a dilated and fixed pupil and paralysis of accommodation (**cycloplegia**).



Ptosis before and after surgery



Diplopia



Cycloplegia

Trochlear nerve paralysis:

- Extorsion of the eye and weakness of downward gaze.
- Vertical diplopia (increases when looking down).
- Head tilting, to compensate for extorsion.



Compensatory head posture in left 4th nerve palsy.

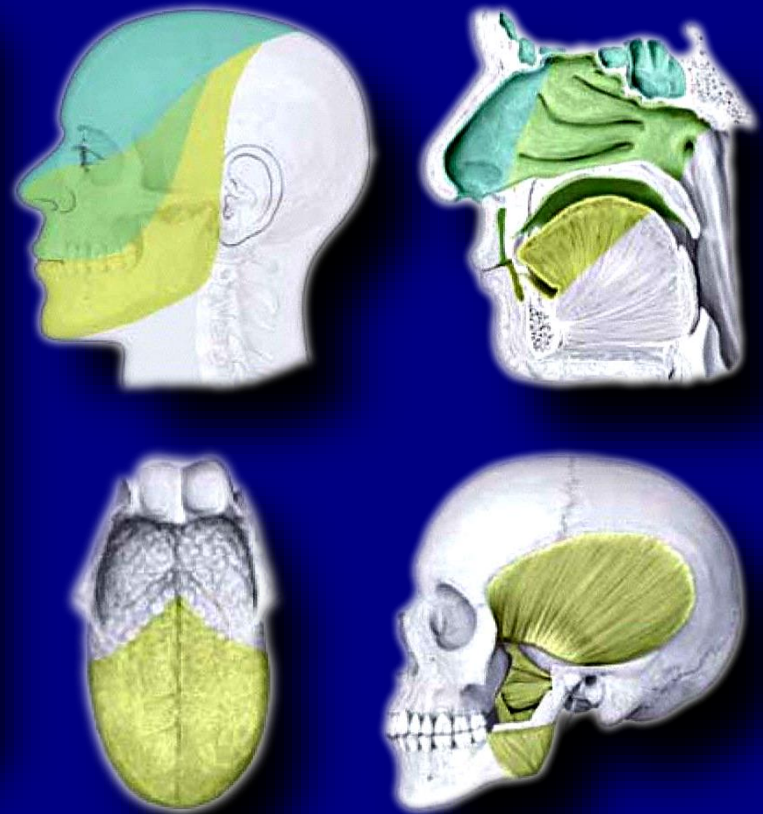
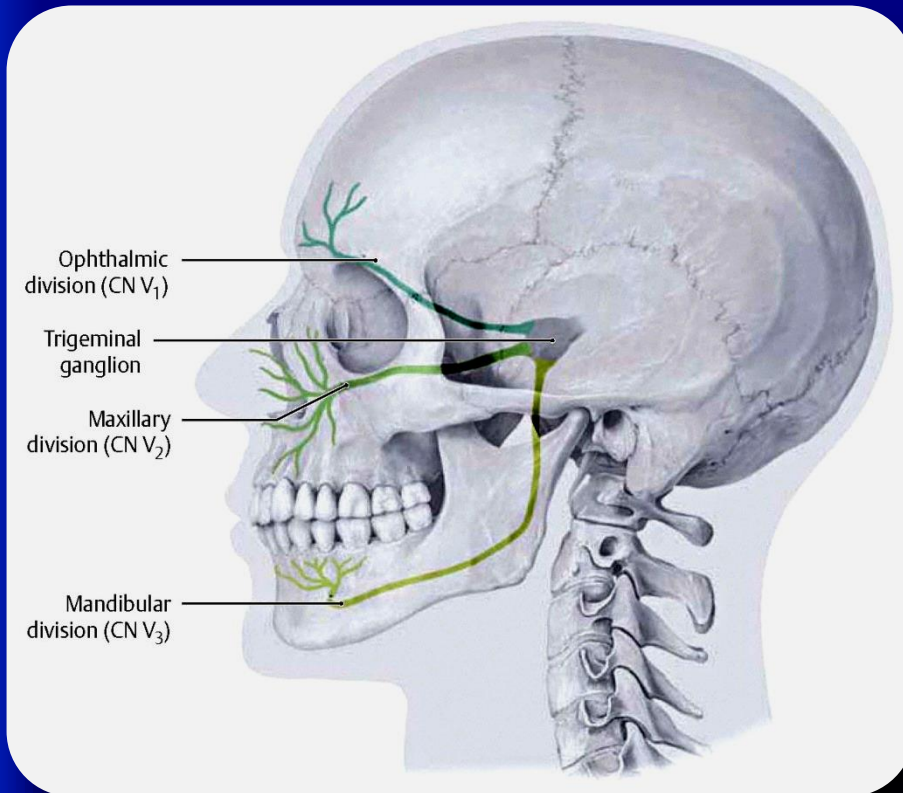
Head is tilted to the right. Face is turned to the right. And chin is depressed.

Abducent nerve lesion:

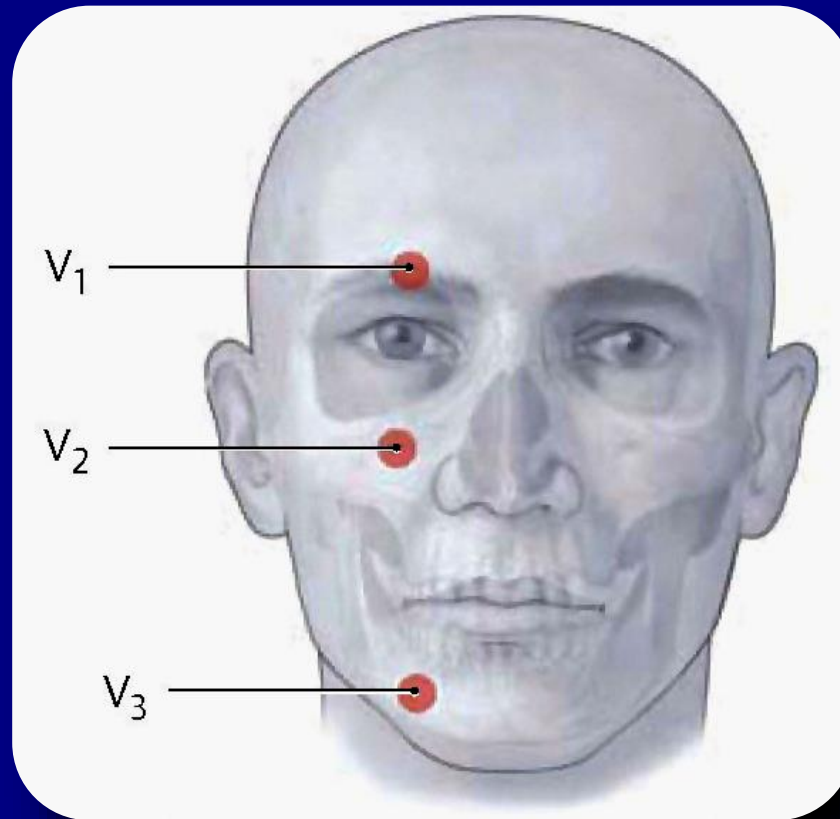
- Convergent strabismus (esotropia) with inability to abduct the eye due to unopposed action of the medial rectus muscle.
- Horizontal diplopia (with maximum separation of the double images when looking toward the paretic lateral rectus muscle).



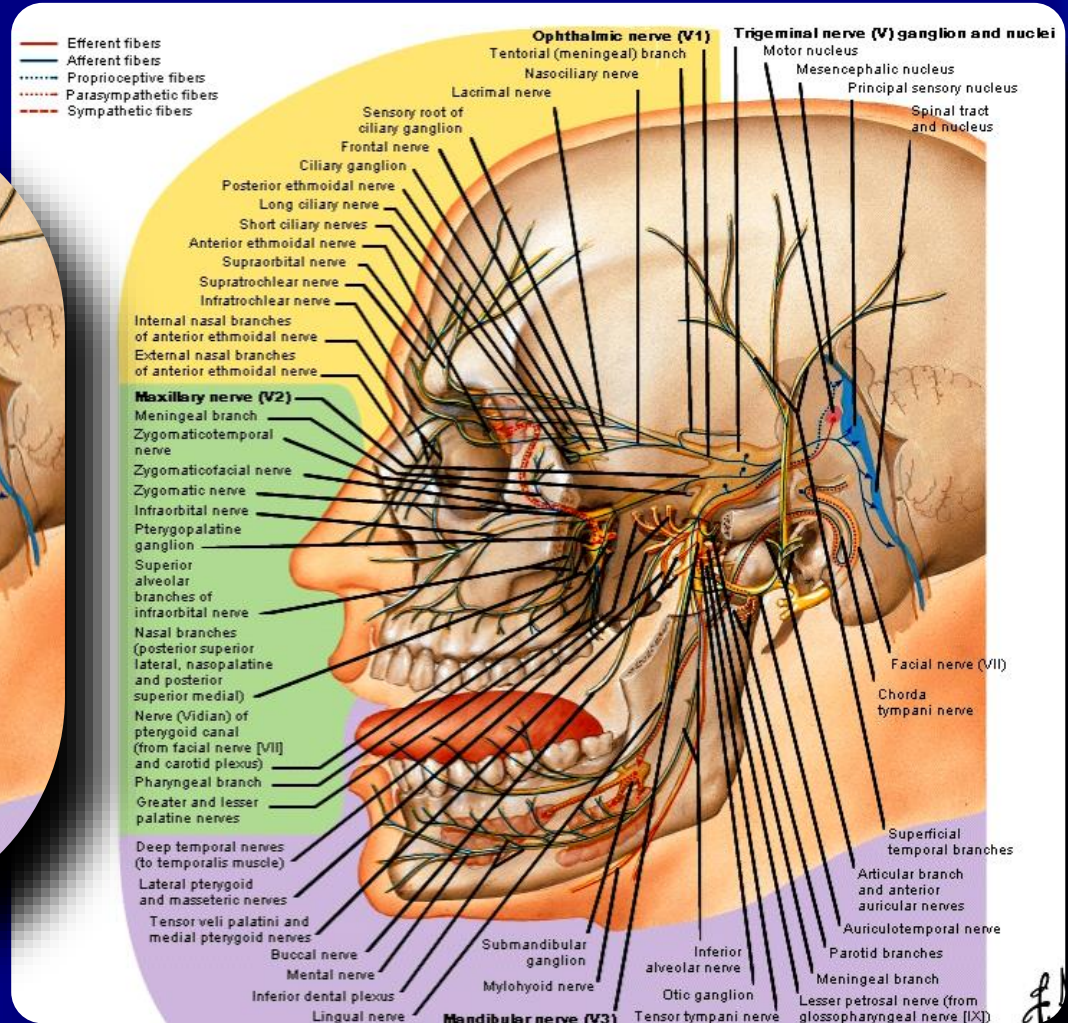
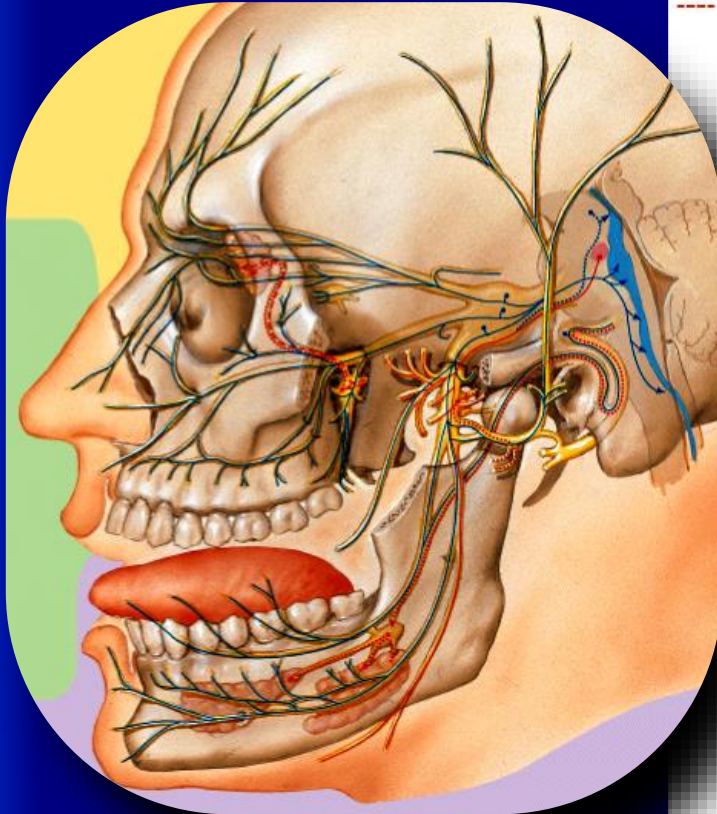
Course and distribution of the trigeminal nerve

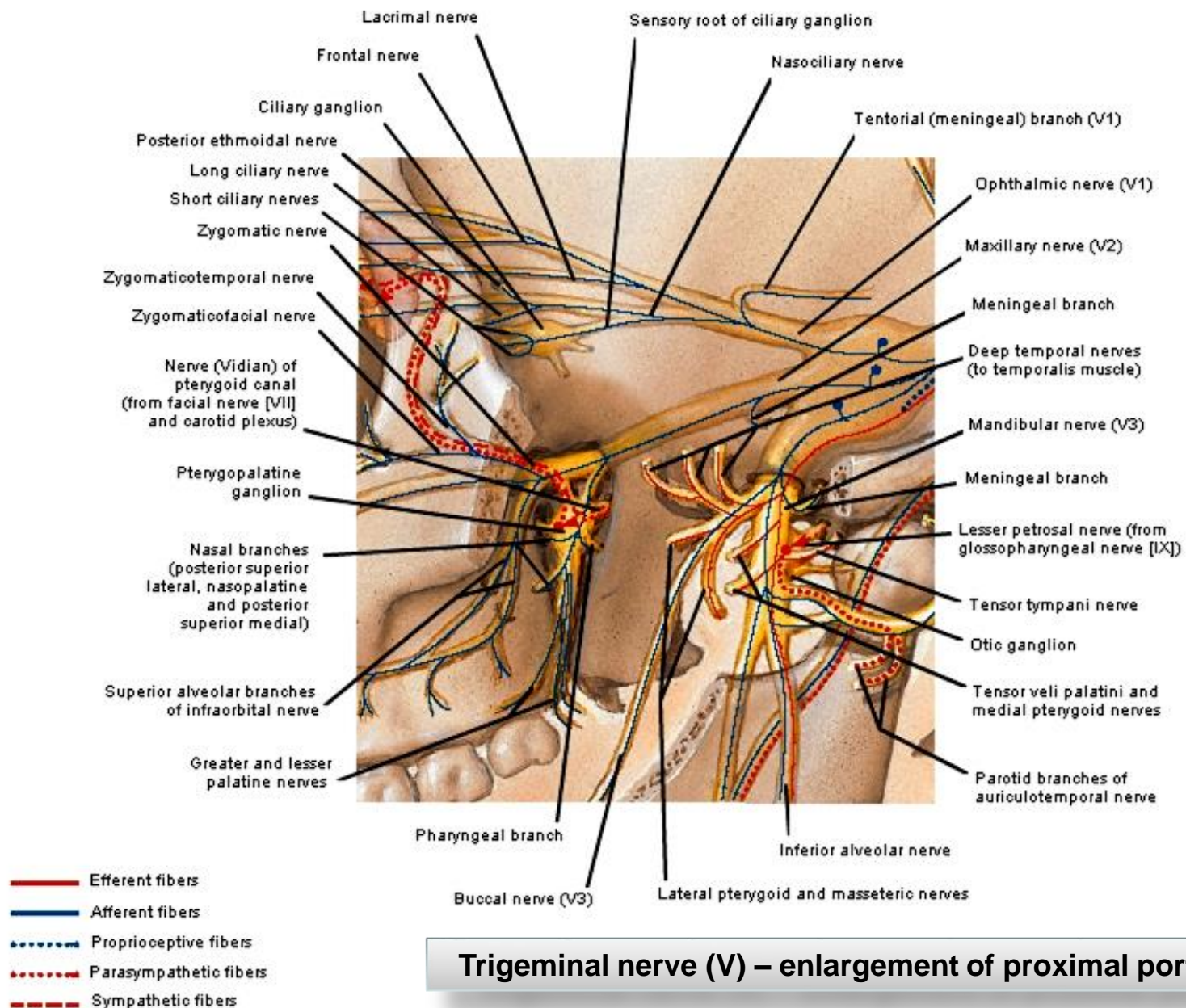


Clinical assessment of trigeminal nerve function

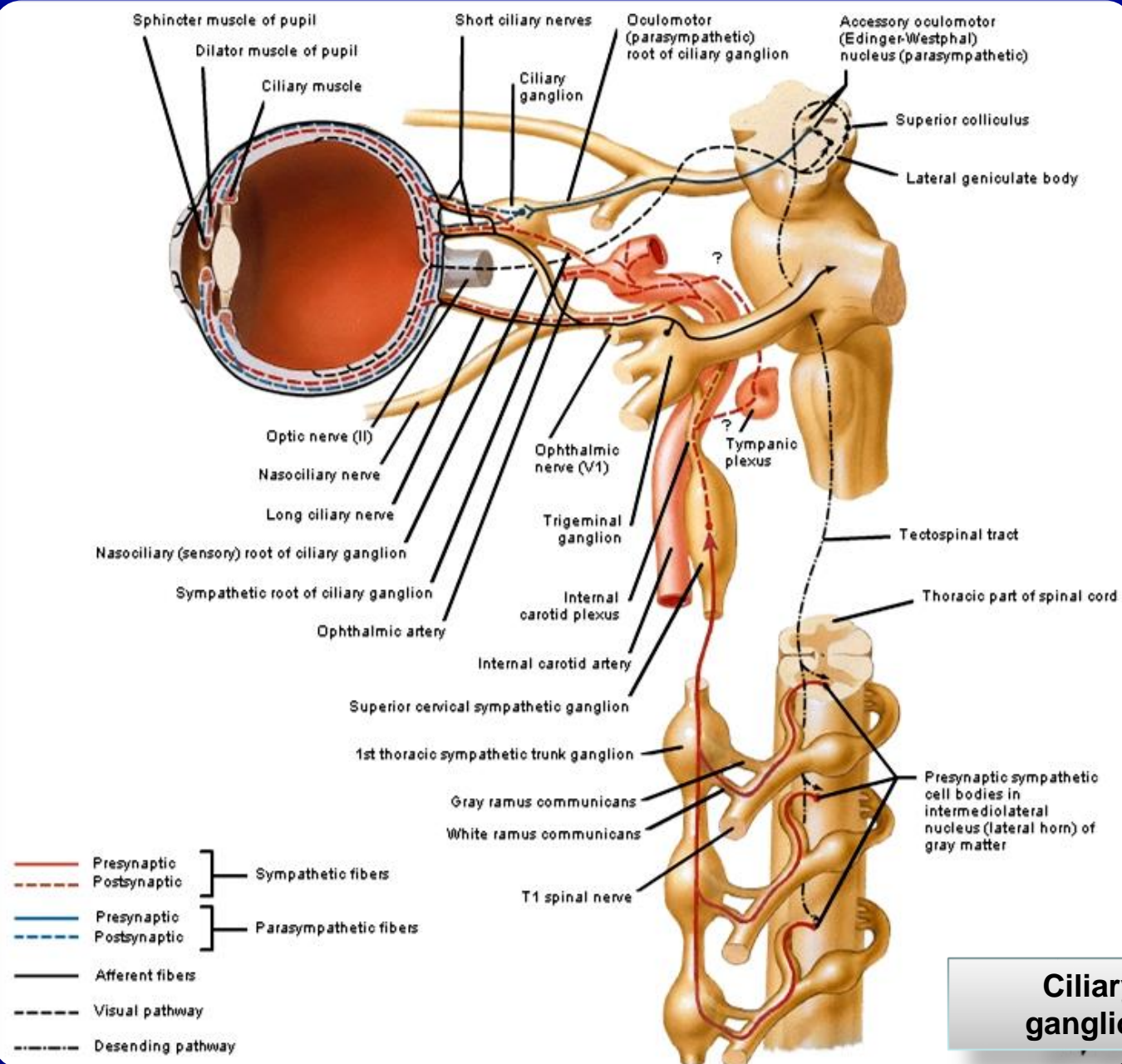


Trigeminal nerve (V)

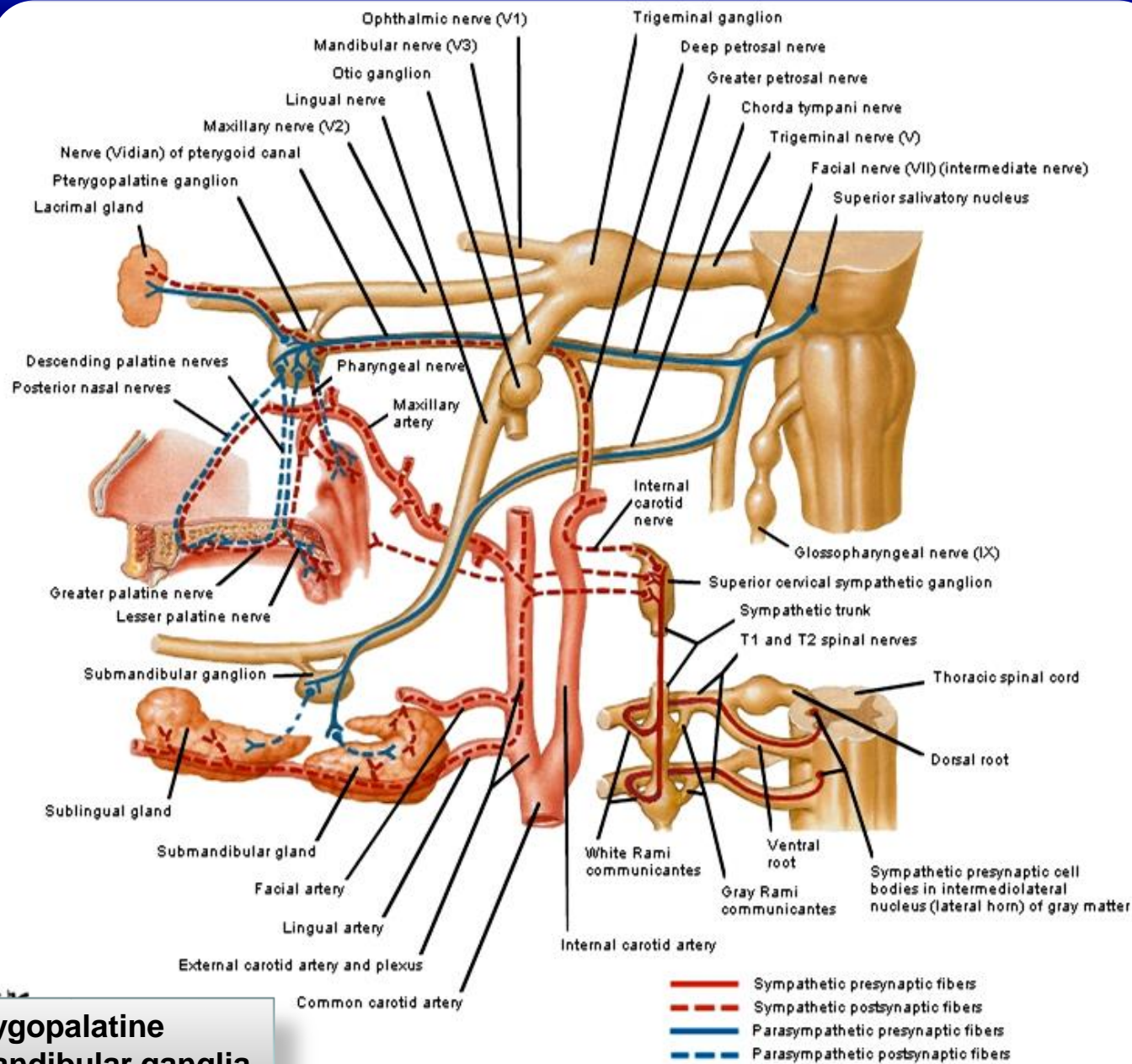




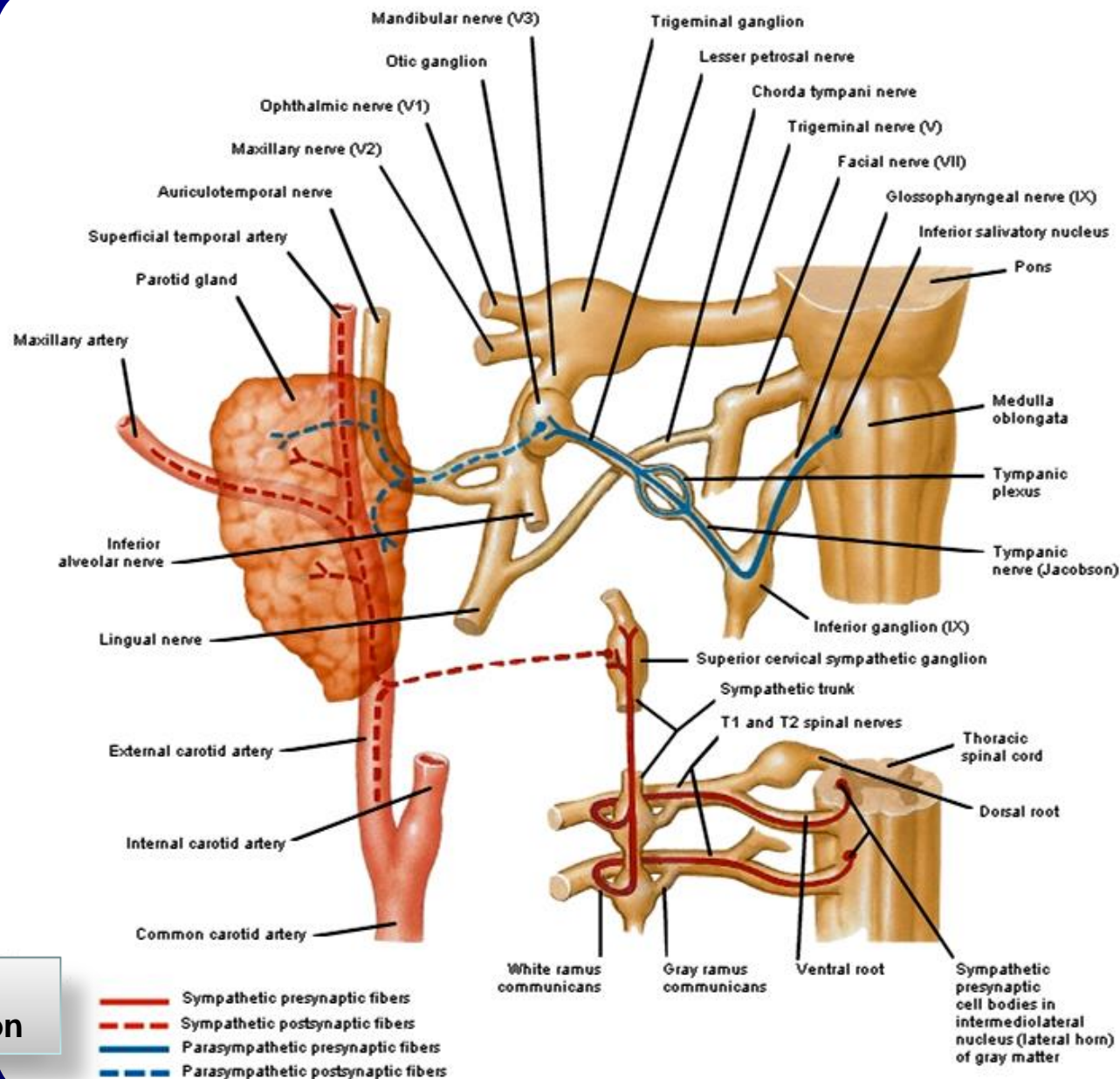
Trigeminal nerve (V) – enlargement of proximal portions



Ciliary ganglion



Pterygopalatine and submandibular ganglia



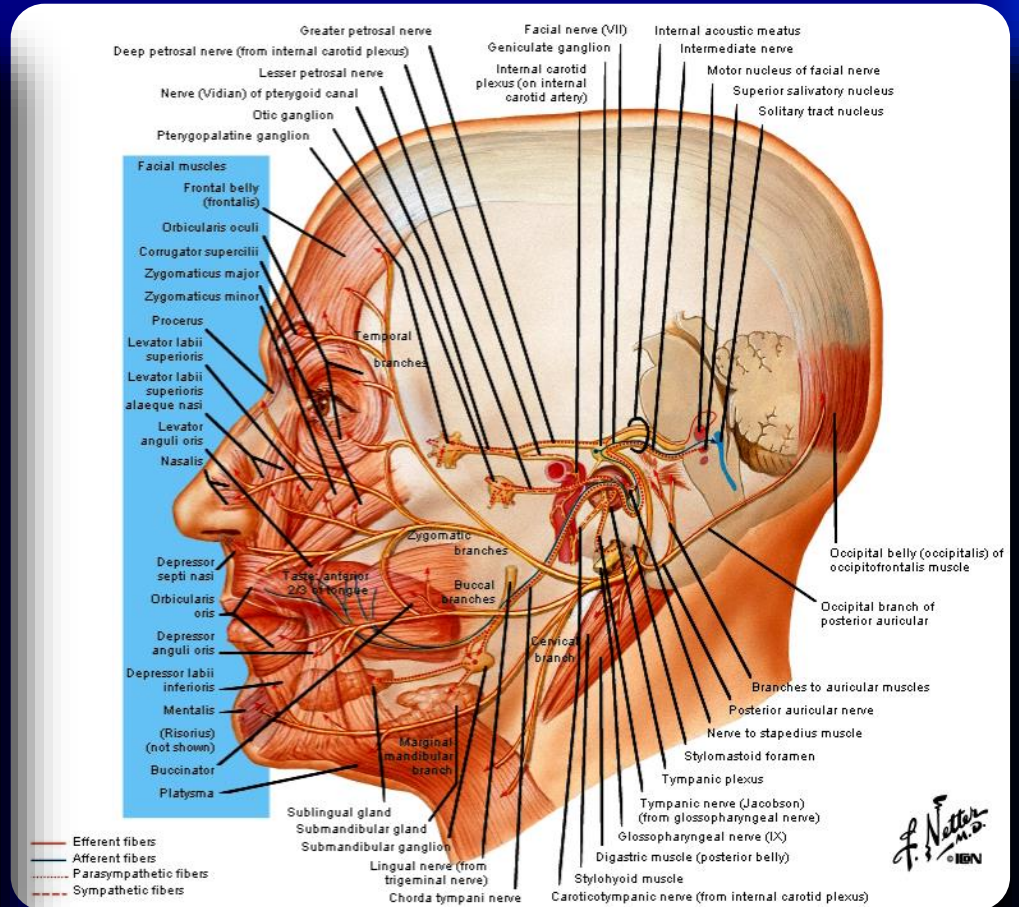
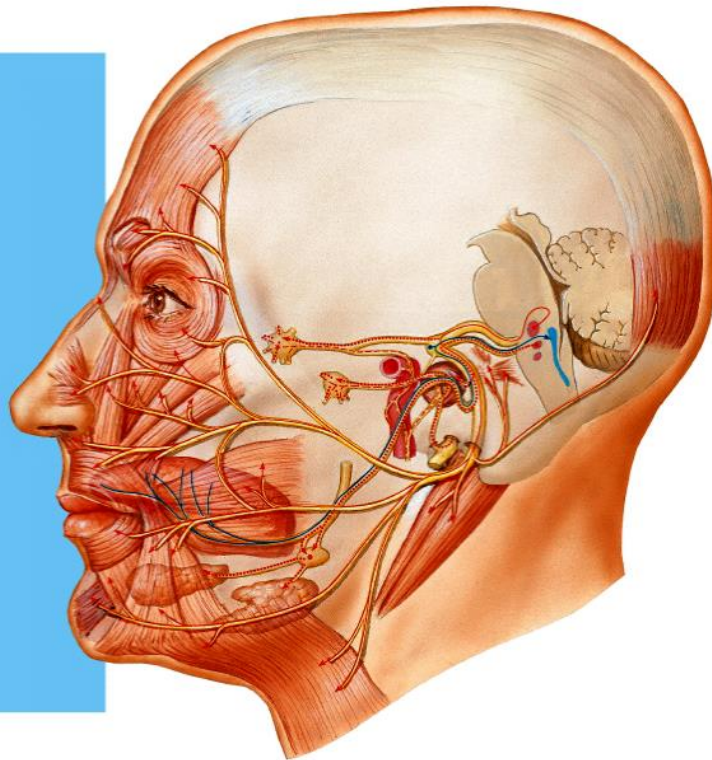
Otic ganglion

Trigeminal nerve lesion (e.g. trigeminal neuralgia):

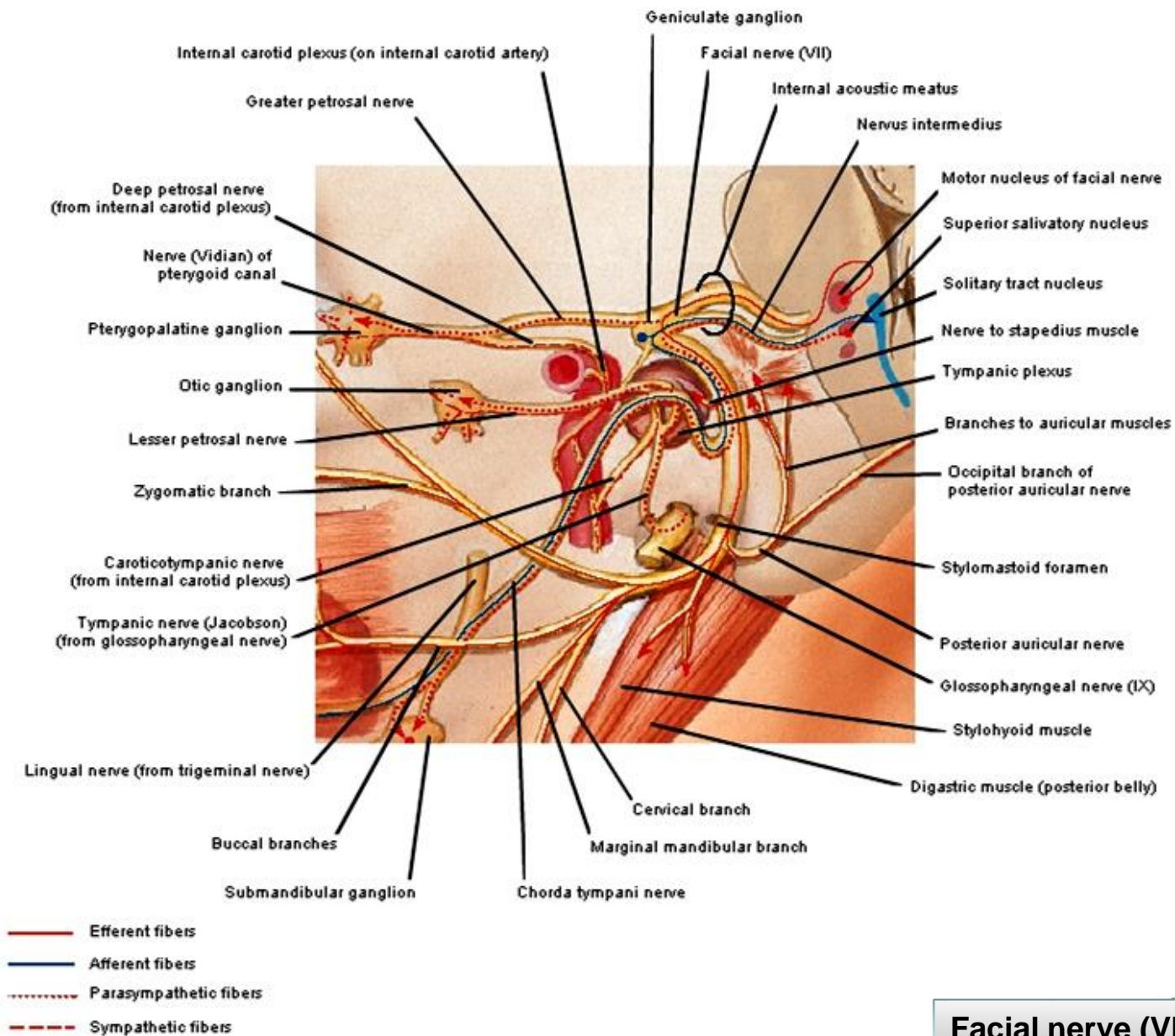
- Loss of general sensation from the face and mucous membranes of the oral and nasal cavities.
- Loss of corneal reflex (afferent limb).
- Flaccid paralysis of muscles of mastication.
- Deviation of patient's jaw to the weak side (due to unopposed action of the lateral pterygoid).
- Paralysis of tensor tympani, leading to hypacusis = partial deafness to low-pitched sounds).



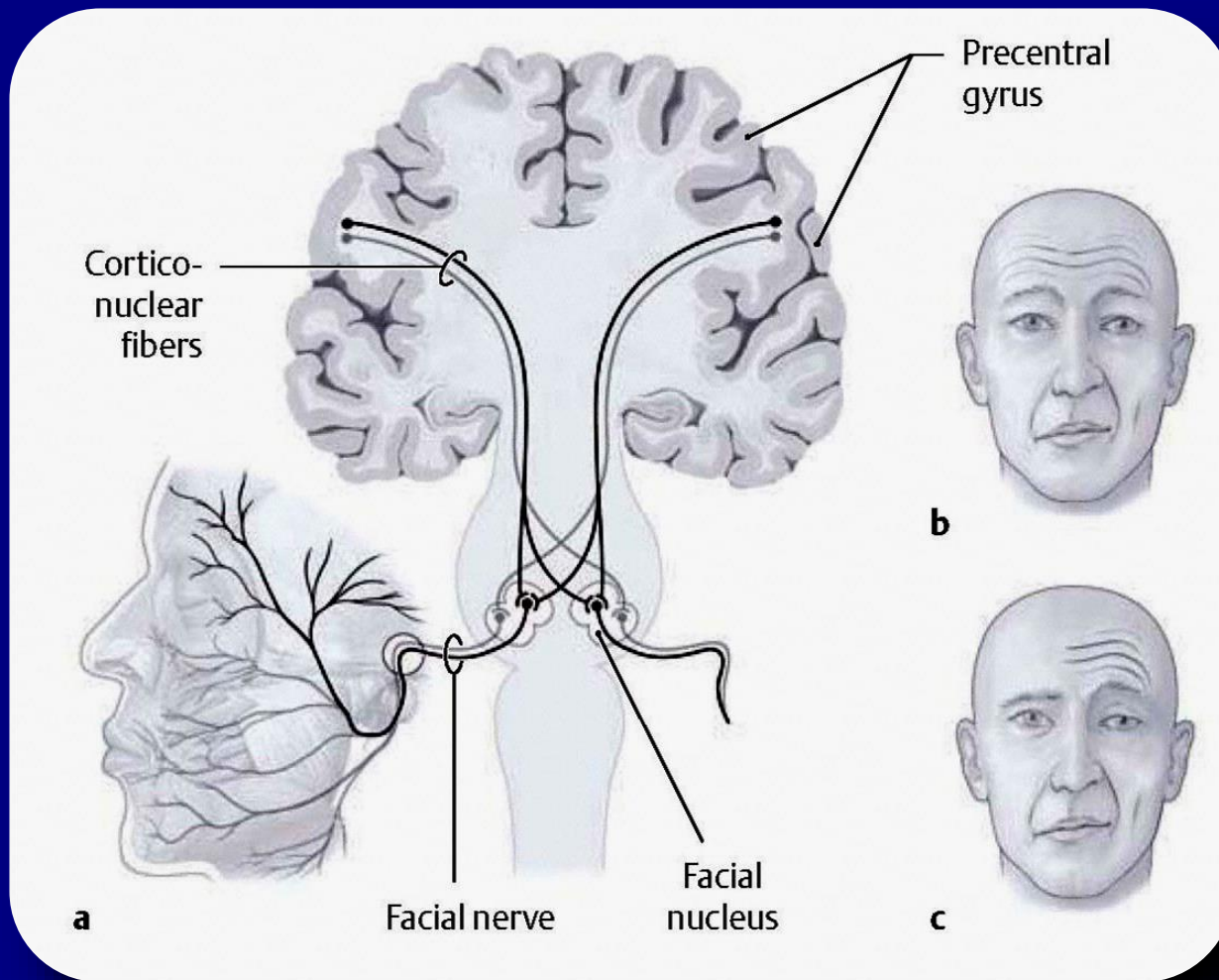
Trigeminal neuralgia



Trigeminal nerve (V)

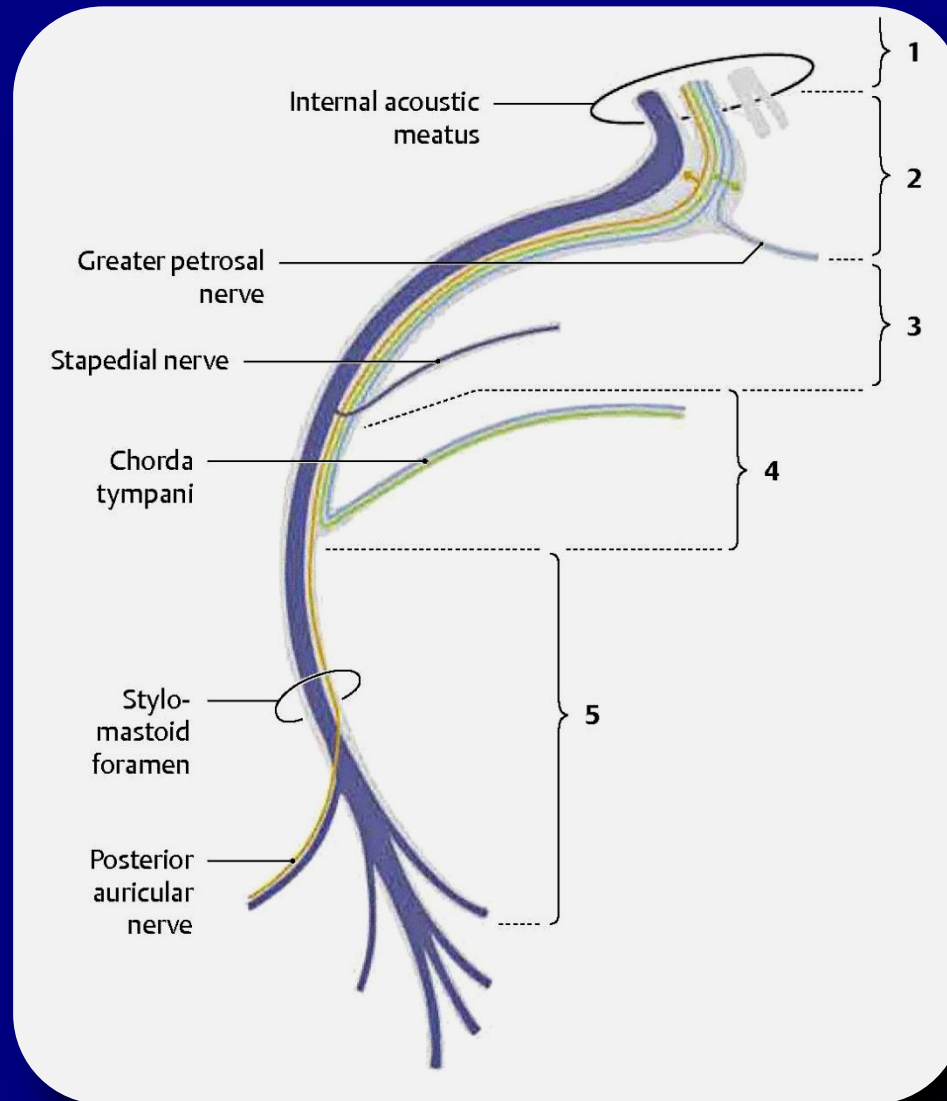


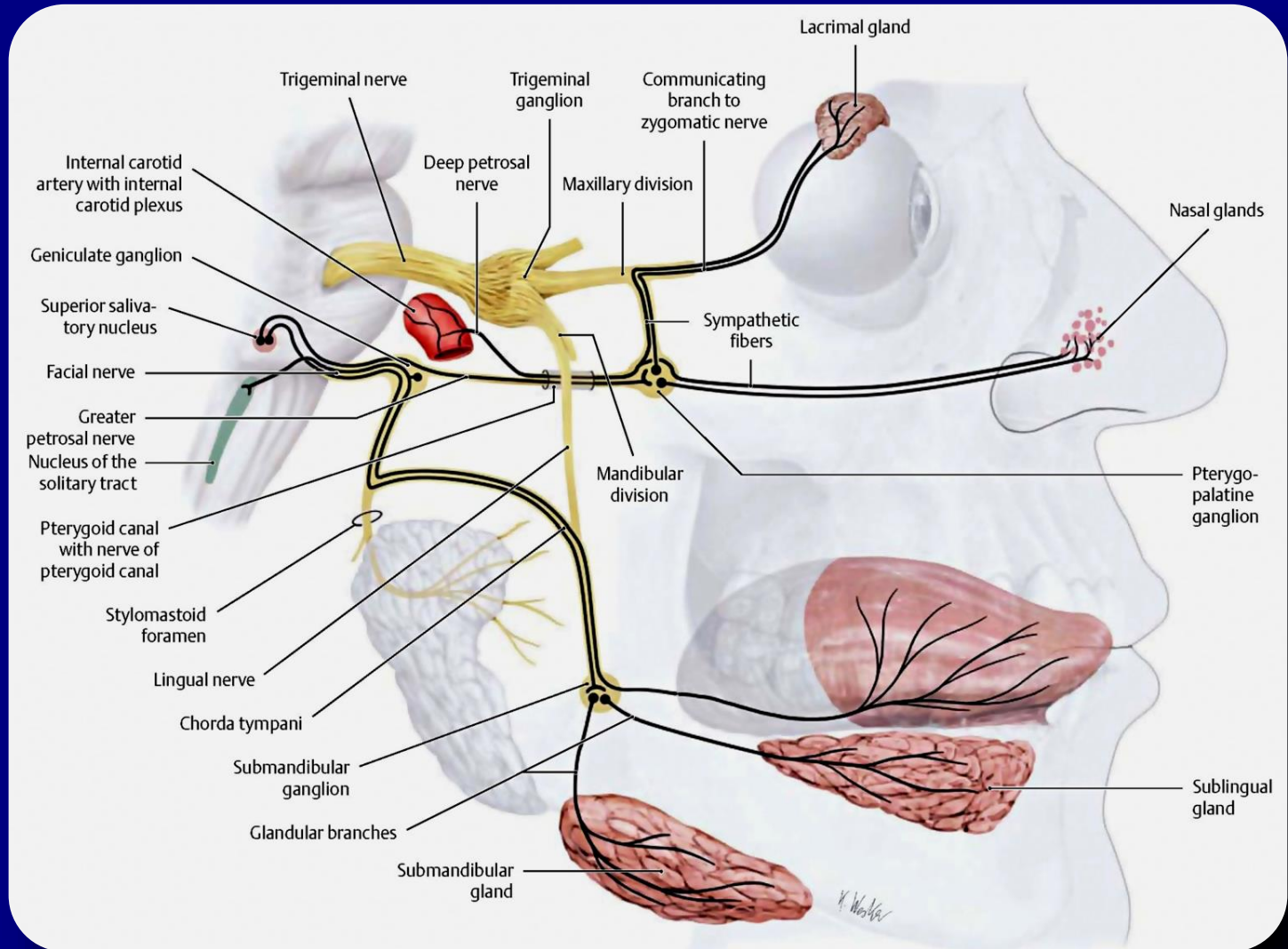
Facial nerve (VII)



Central and peripheral facial paralysis

Branching pattern of the facial nerve: diagnostic significance in temporal bone fractures





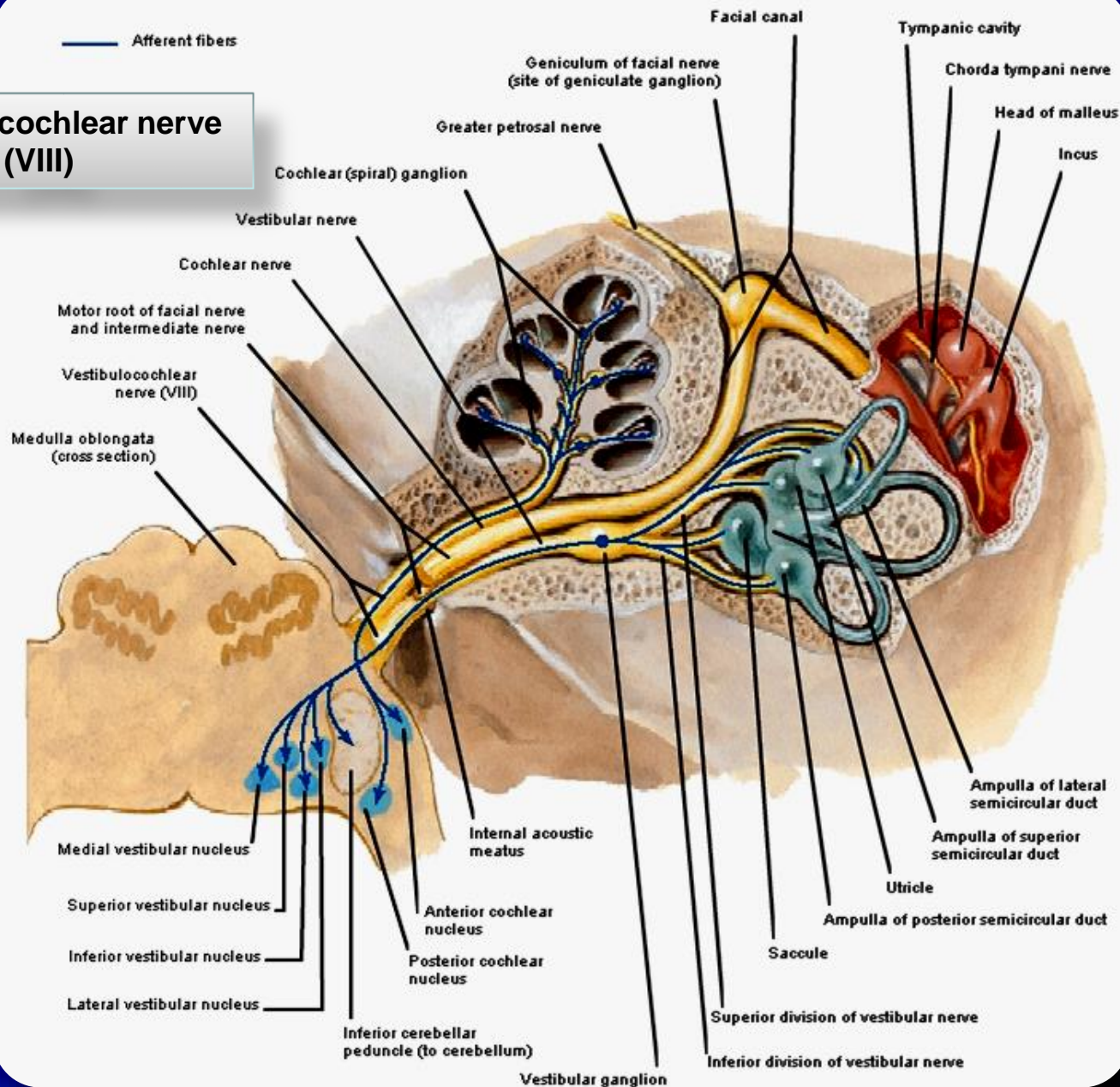
Parasympathetic visceral efferents and visceral afferents (gustatory fibers) of the facial nerve

Facial nerve lesion:

- Flaccid paralysis of the muscles of facial expression (upper and lower face)
- Loss of corneal (blink) reflex (efferent limb), which may lead to corneal ulceration
- Loss of taste from the anterior two-thirds of the tongue
- Hyperacusis (increased acuity to sounds), due to stapedius paralysis



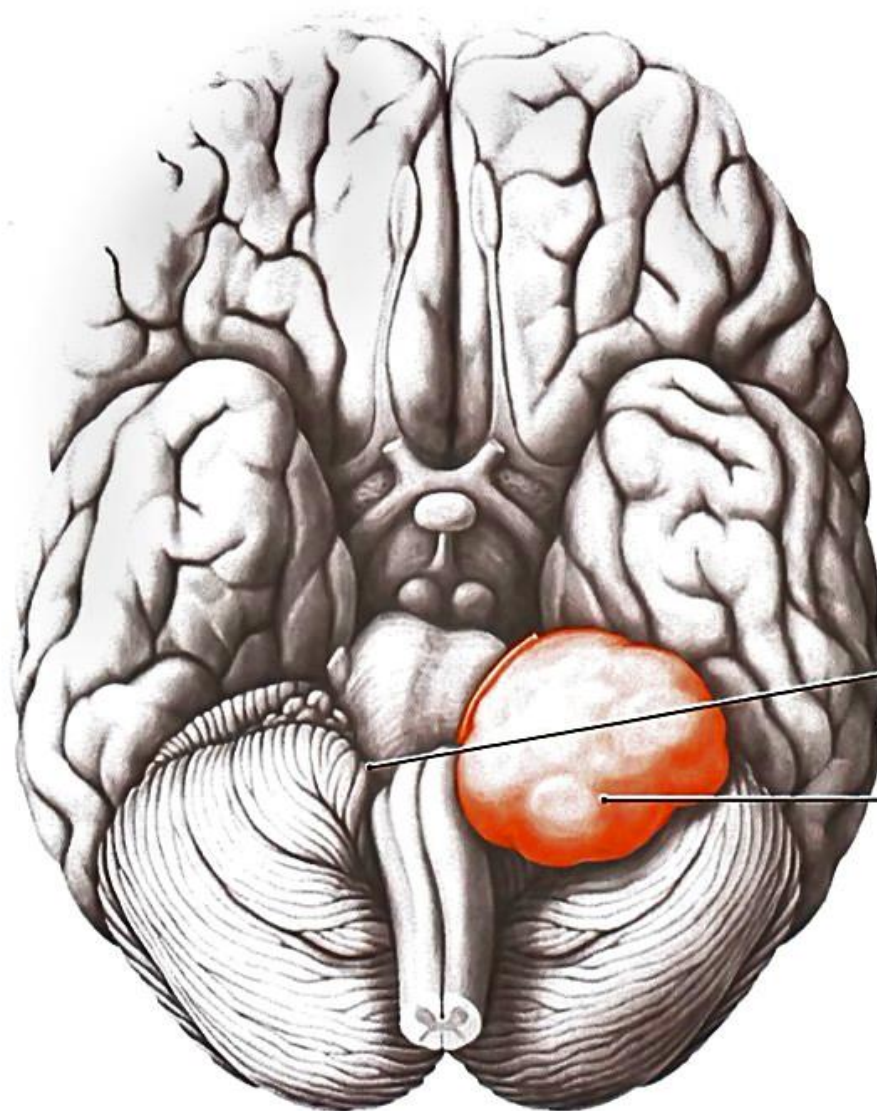
Vestibulocochlear nerve (VIII)



Vestibulocochlear nerve lesion:

- Results in hearing loss (sensoneurinal deafness).
- Cause tinnitus (ear ringing).
- Results in disequilibrium, vertigo, and nystagmus.



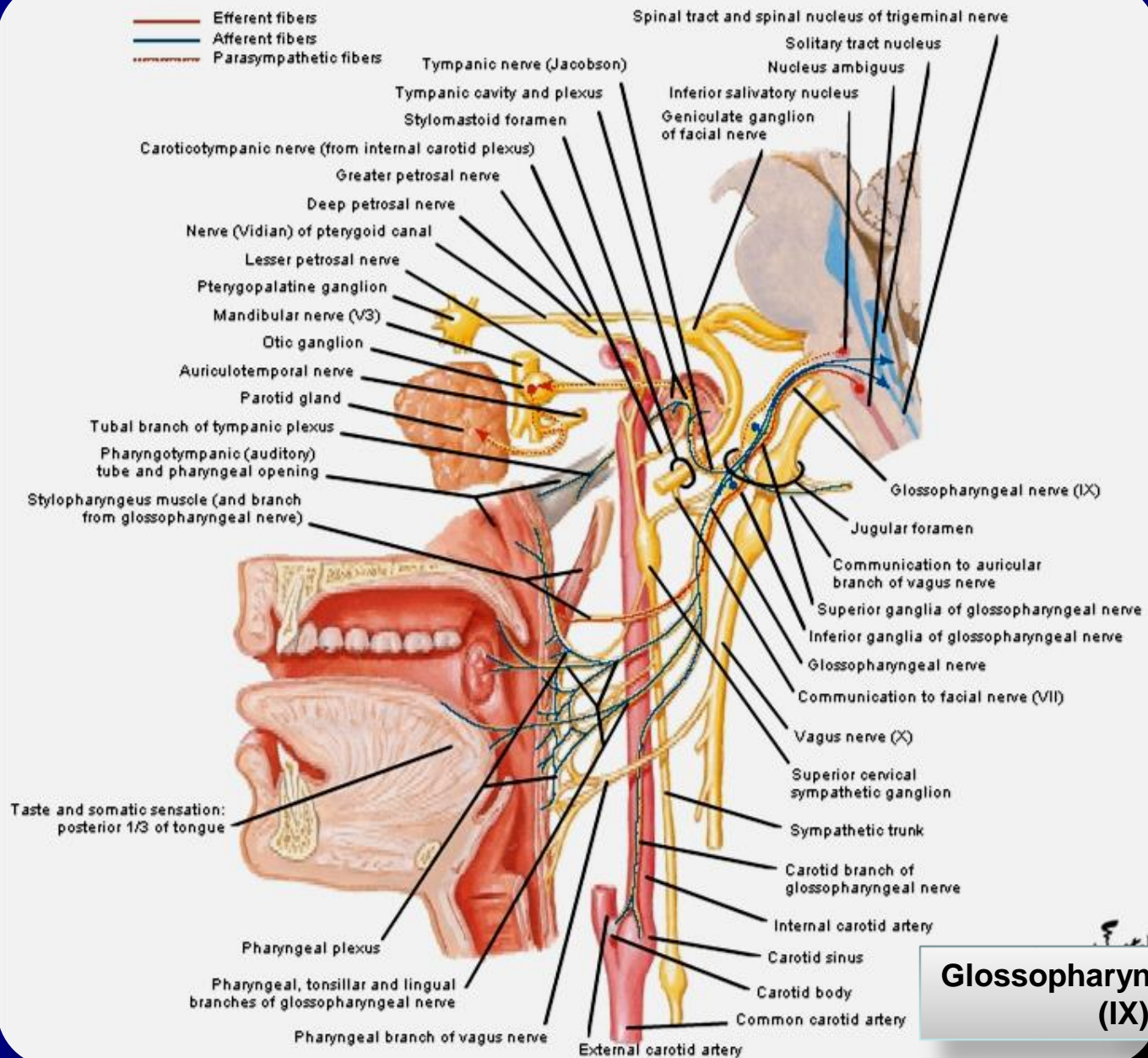


Cerebello-
pontine angle

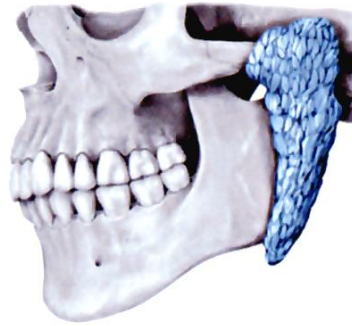
Acoustic
neuroma
(vestibular
schwannoma)

Question:

- Which other cranial nerves may be injured in case of acoustic neuroma?



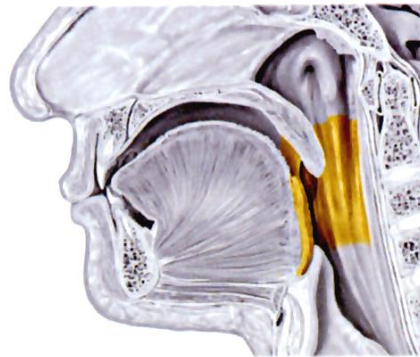
Glossopharyngeal nerve (IX)



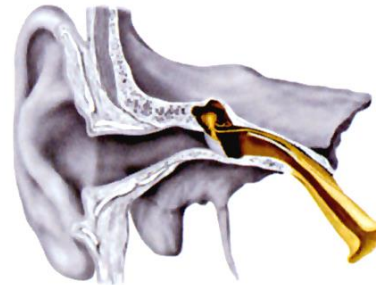
a



b



c



d



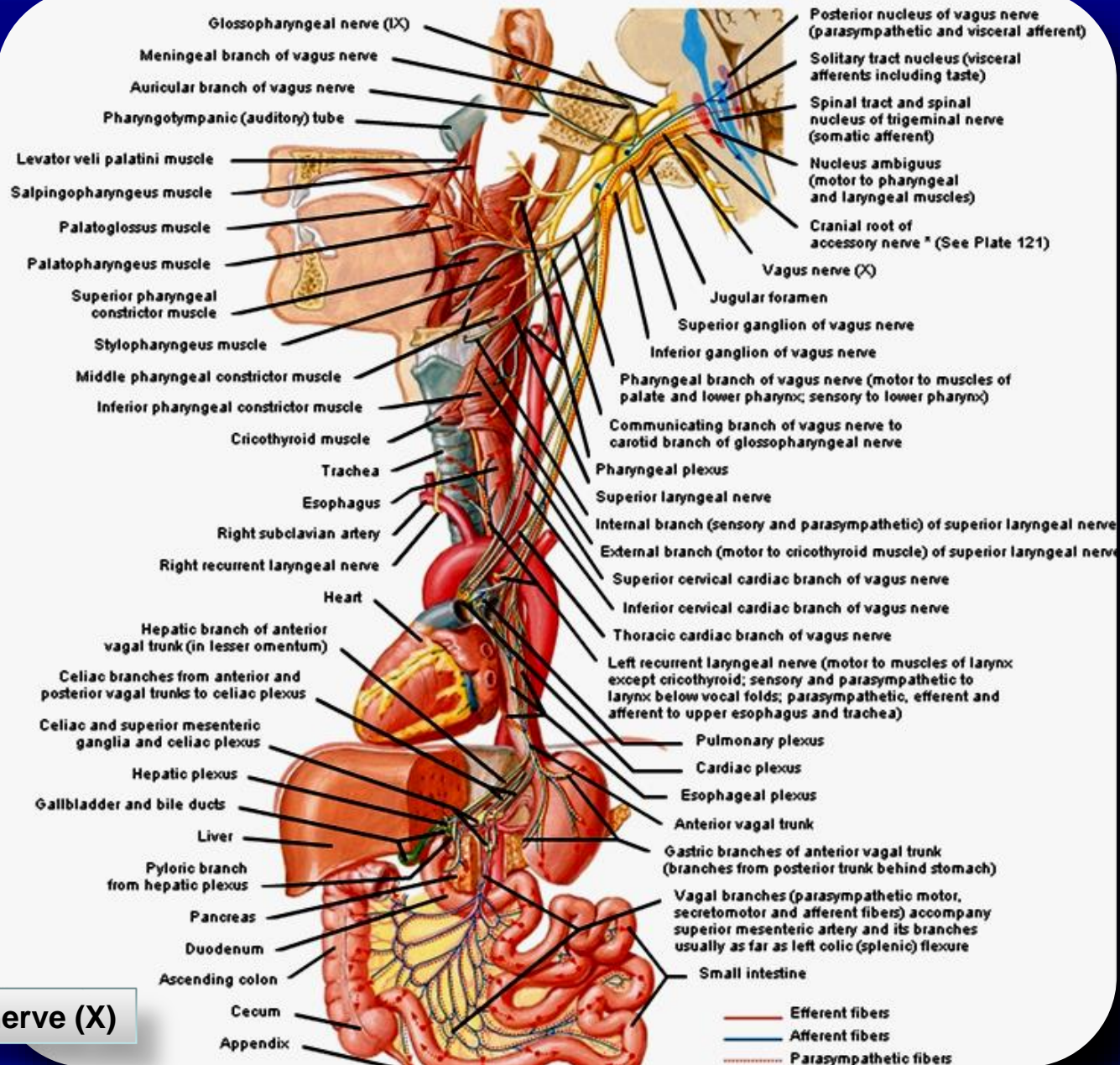
e



f

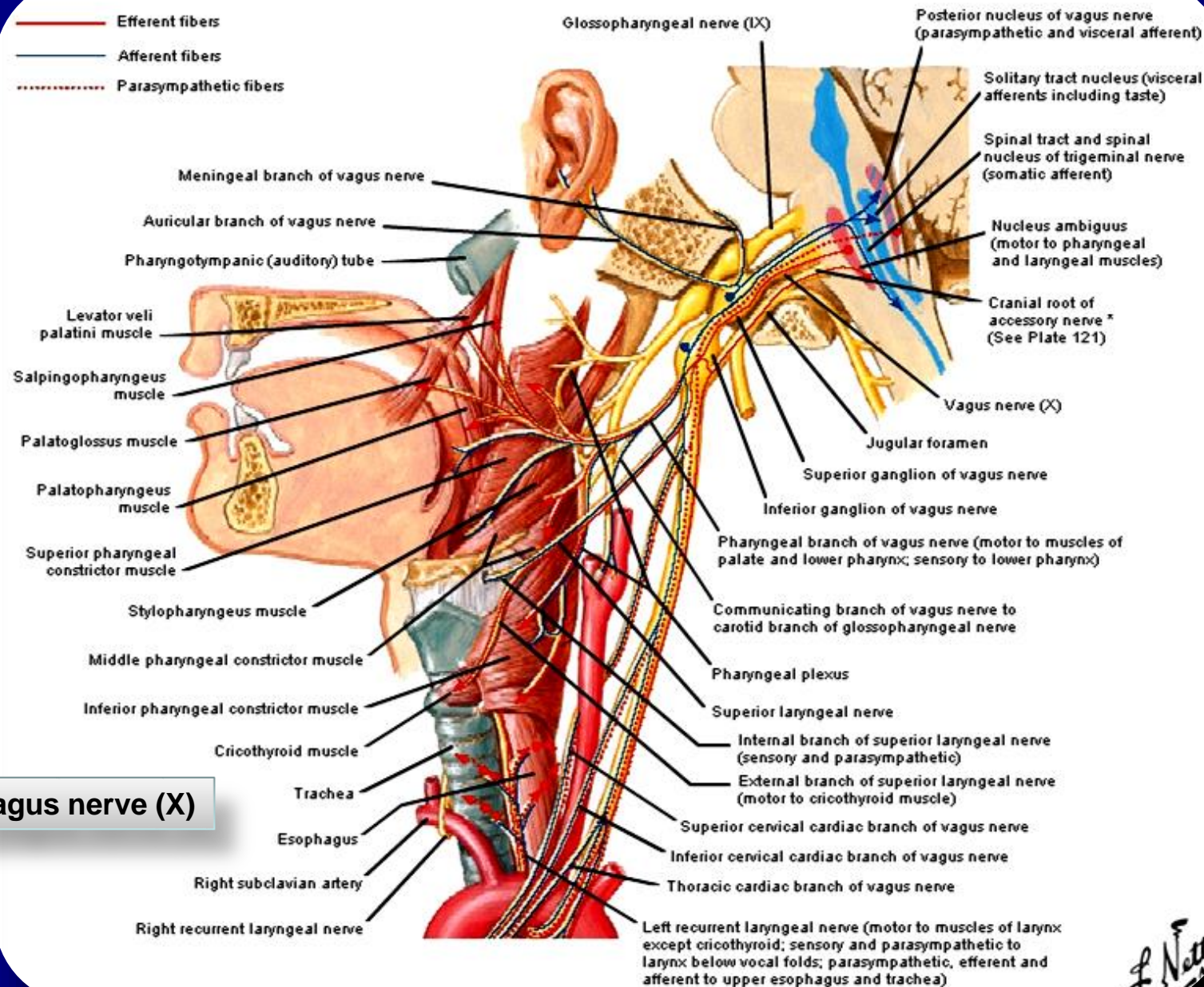
Glossopharyngeal nerve lesion:

- Loss of gag (pharyngeal) reflex (interruption of afferent limb).
- Loss of carotid sinus reflex.
- Loss of taste from posterior third of the tongue.
- Glossopharyngeal neuralgia.



Vagus nerve (X)

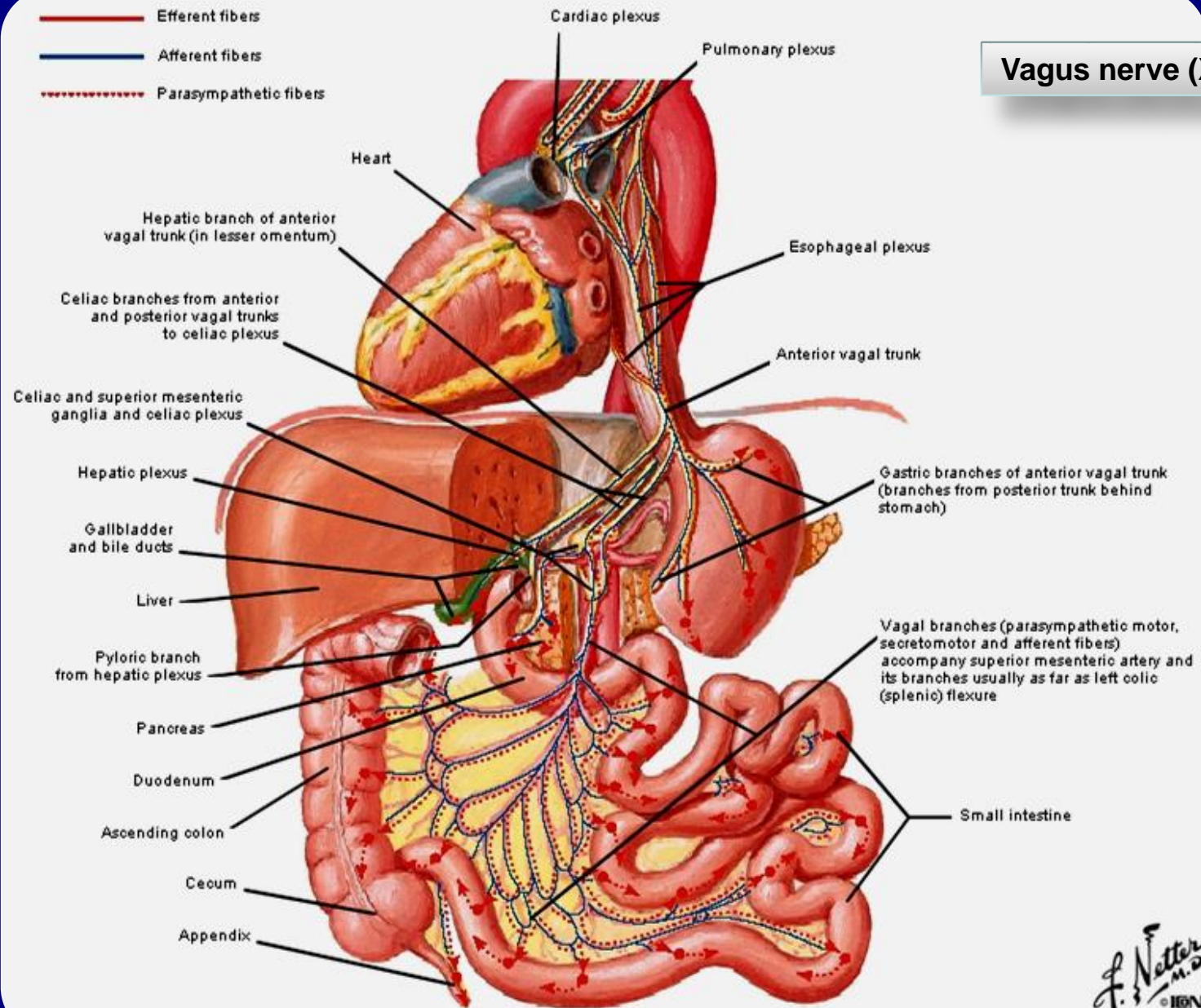
- Efferent fibers
- Afferent fibers
- Parasympathetic fibers

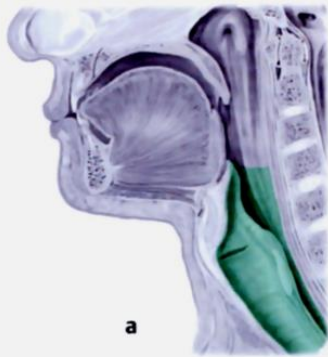


Vagus nerve (X)

L. Netter

Vagus nerve (X)

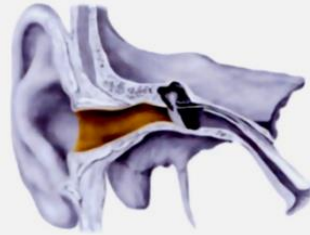




a



b



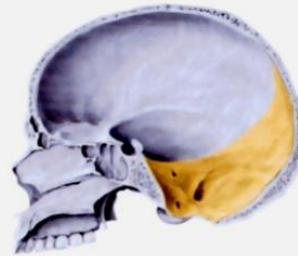
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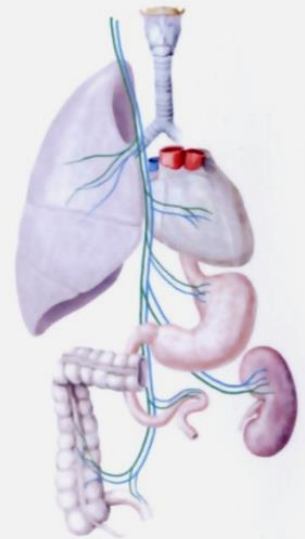
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e



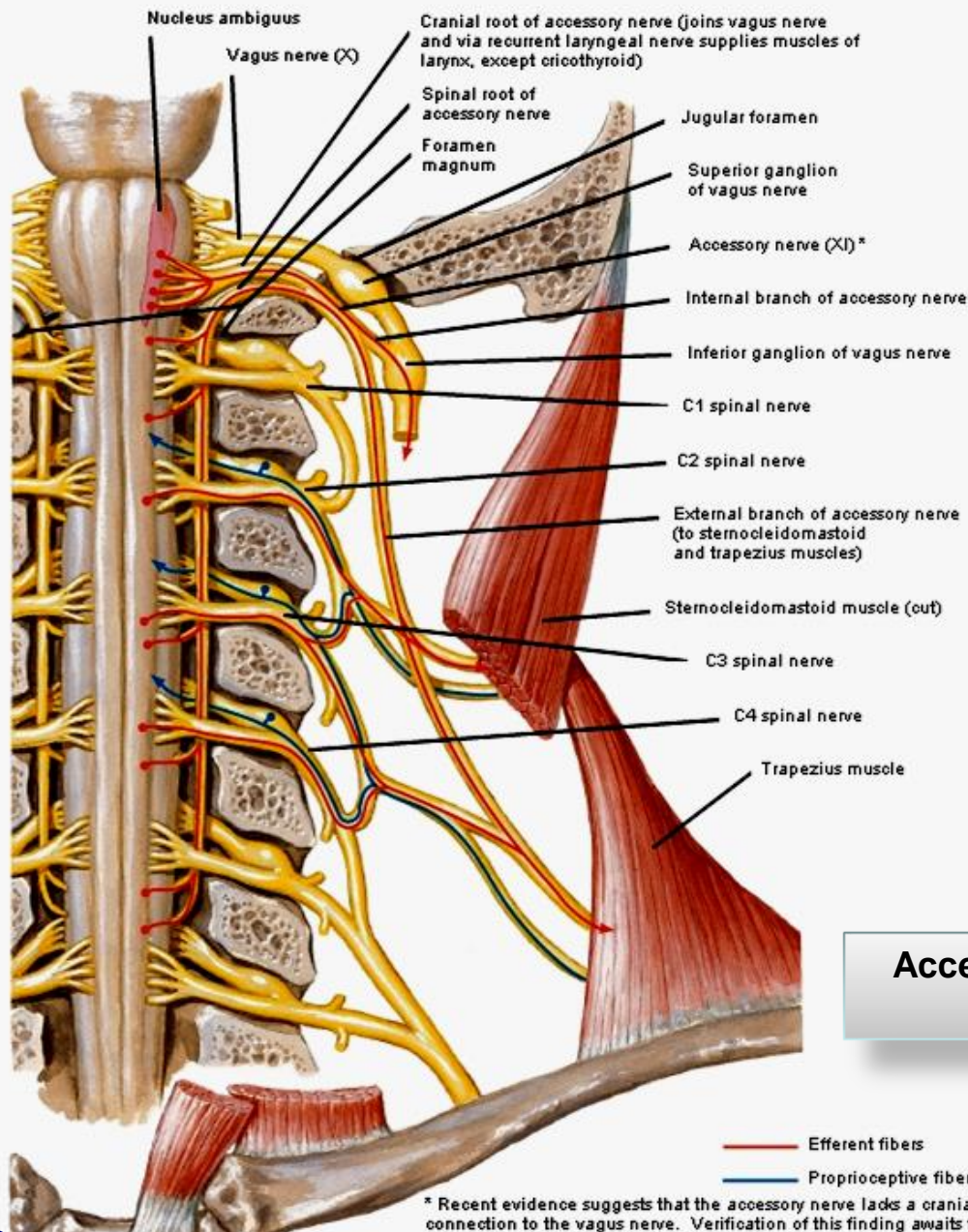
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g

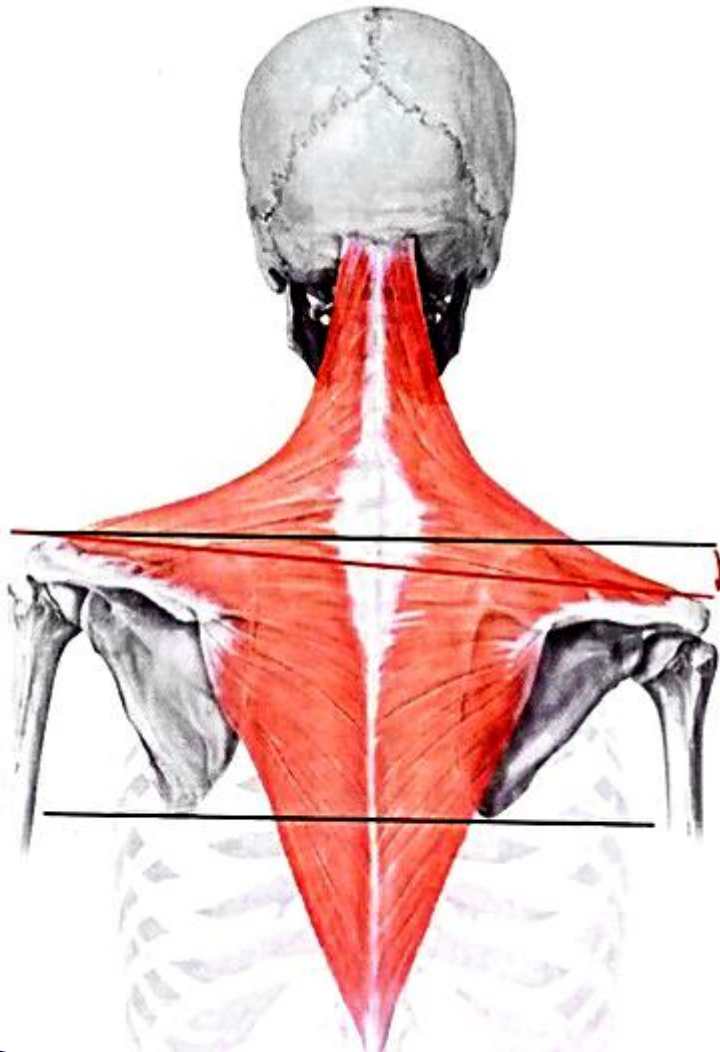
Vagus nerve injury:

- Ipsilateral paralysis of the soft palate, pharynx, and larynx leading to dysphonia (hoarseness), dysarthria, and dysphagia.
- Anesthesia of the pharynx and larynx, leading to unilateral loss of the cough reflex.
- Loss of gag (palatal) reflex (efferent limb).



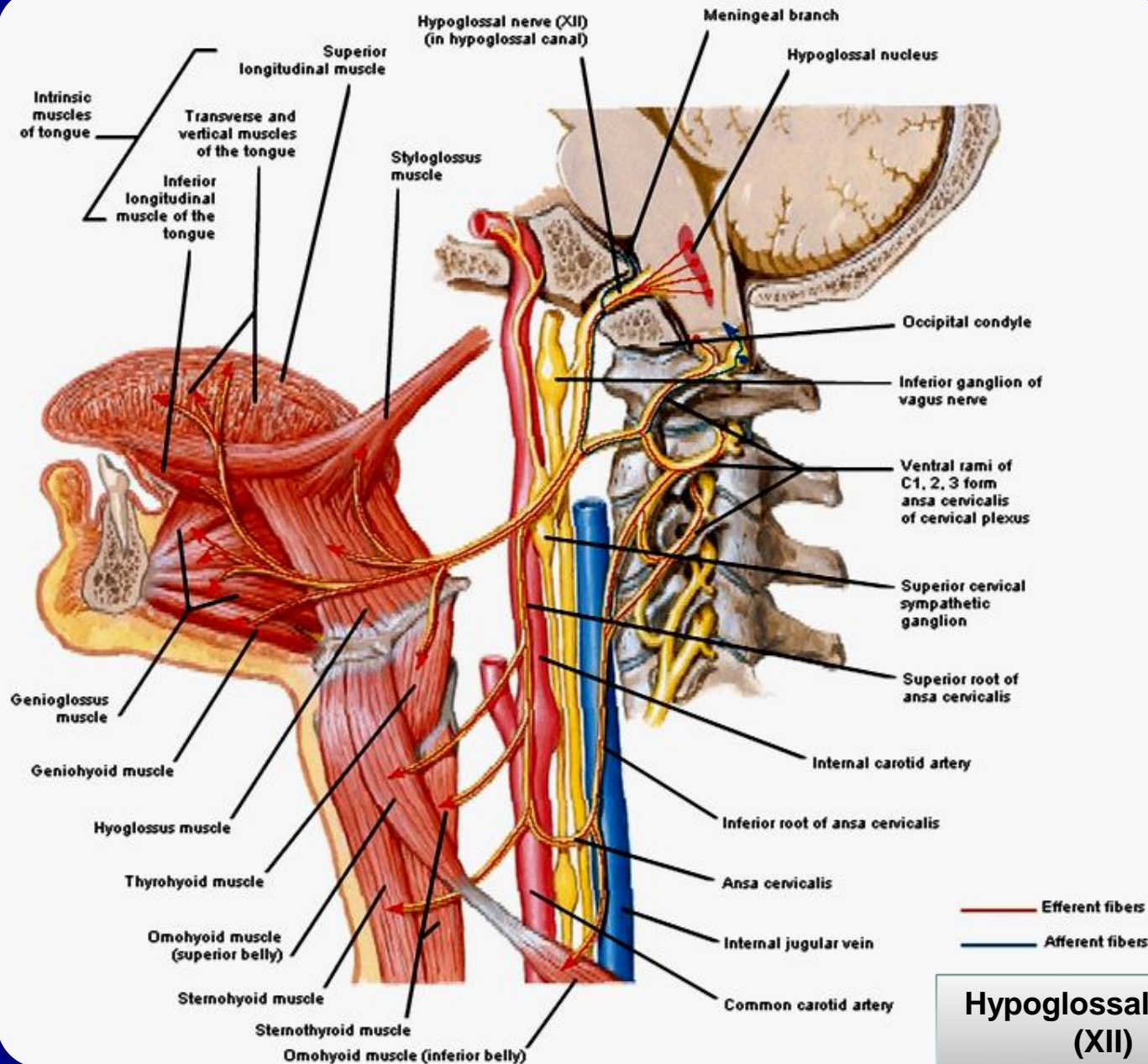
Accessory nerve (XI)

* Recent evidence suggests that the accessory nerve lacks a cranial root and has no connection to the vagus nerve. Verification of this finding awaits further investigation.

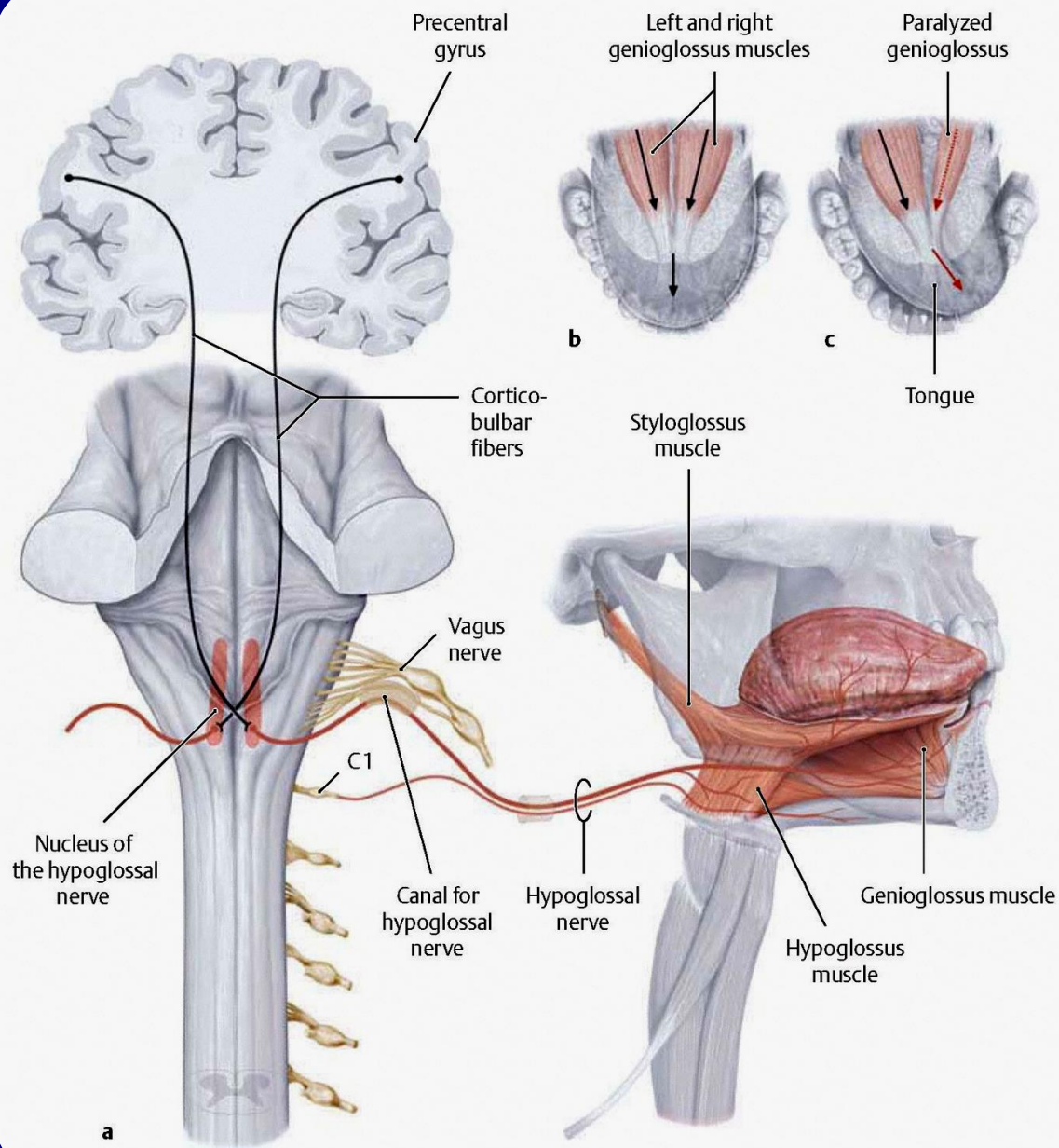


Accessory nerve lesion:

- Difficulty in turning the head to the side opposite the lesion.
- Shoulder drop.
- Inability to shrug the ipsilateral shoulder.



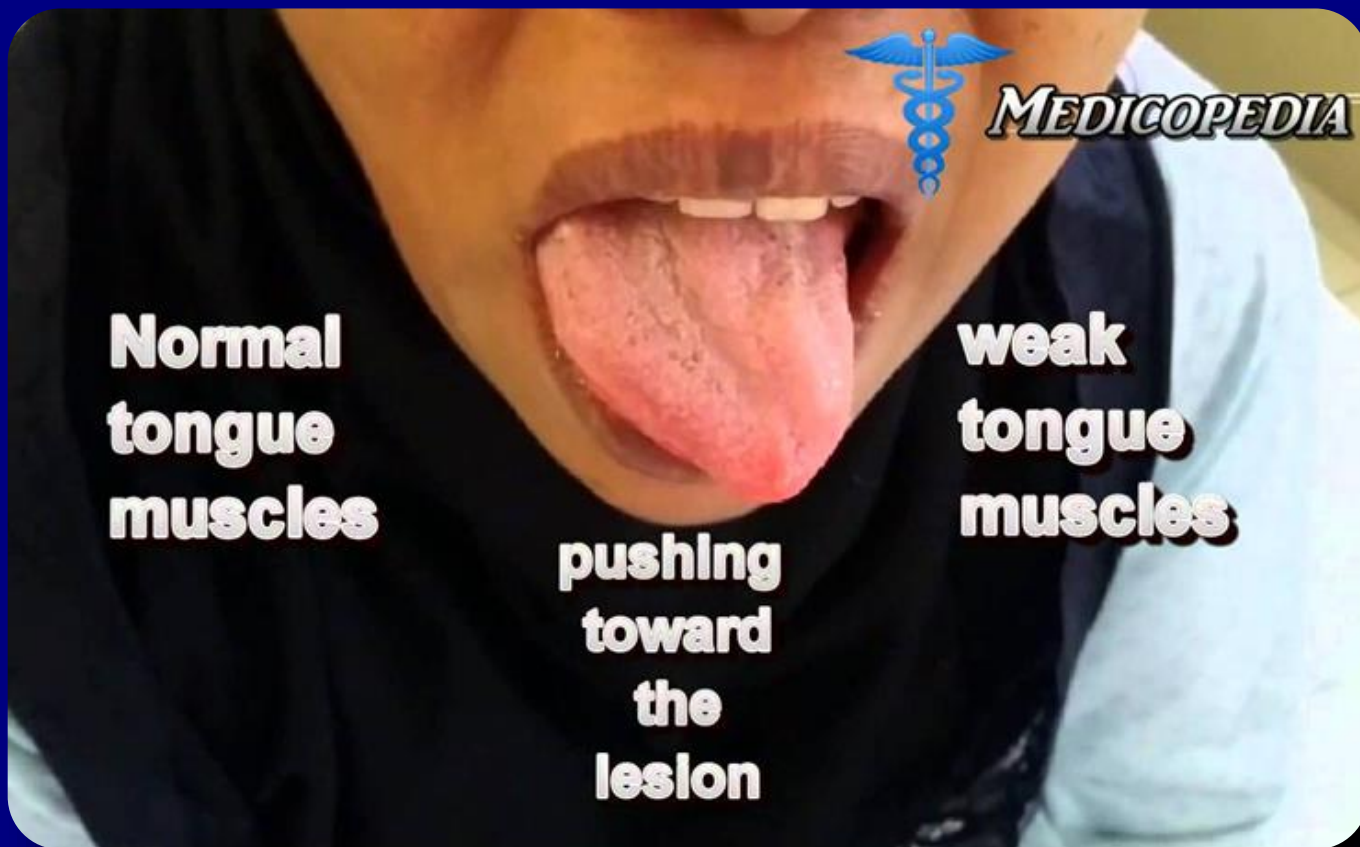
Hypoglossal nerve (XII)



Distribution
of the hypoglossal nerve

Hypoglossal nerve lesion:

- Hemiparalysis of the tongue (tongue when protruded, points toward the weak side due to unopposed action of the opposite genioglossus muscle).



CN XII: Hypoglossal nerve palsy

Thank you very much

