

Cephalgia



Introduction

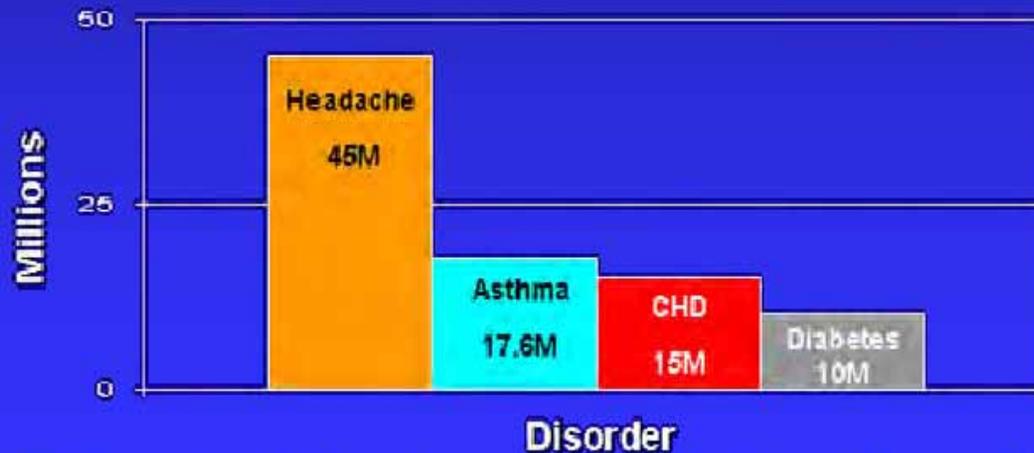
- Diagnosis of the primary headache disorders rests on clinical criteria defined by the ICHD.
- Identification of secondary causes of headache are uncovered by this systematic process of history and physical.

“The principle indication for performance of ancillary diagnostic testing rests upon information or concerns revealed during this fundamental process!”

Impact of Headache

- **Highly significant health problem**

- > 45 million Americans suffer from chronic recurrent headaches, > 30 million Dx with migraine
- 43 million suffer from asthma, diabetes and coronary heart disease combined

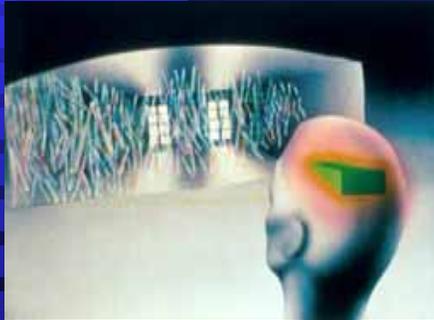


Silberstein SD, Rosenberg J. *Neurology*. 2000;54:1553; Lipton RB et al. *Neurology*. 1997;48(suppl 3):S4

The FIRST step:

**MAKE THE CORRECT
HEADACHE DIAGNOSIS !**

Headache Assessment



History

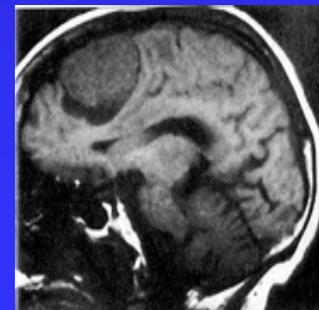
PE

MRI or CT

Primary

- ❖ Migraine
- ❖ Tension
- ❖ Chronic Daily

Secondary



General Statistics

- Second most common complaint after back pain
- “Everyone” has headaches (HA)
- More than 80 million ER visits in U.S. per year
- Frequency of HA due to rich nerve supply and psychological implications of head pain

General Statistics

- Nerves responsible for HA have their source from myelinated C fibers and A-delta fibers in cranial nerves V, IX, X, and roots C1, C2, C3
- Pain sensitive structures include the eye, ear, paranasal sinuses, large extra and intra cranial arteries, dural sinuses, periosteum of the skull skin, cranial muscles, and the upper cervical spine

Anatomy Review

- Cranial nerve V

CN V: Trigeminal nerve

Functional category: general somatic function: pain, temp, proprioception..etc

Functional category: branchial motor
function: mastication

- The name reflects the three main branches
 - ◆ Ophthalmic (V1) Maxillary (V2) Mandibular (V3)
 - ◆ Provides sensory innervation to the entire face
 - ◆ Motor branch to the muscles of mastication
 - ◆ Exits the brainstem on the ventrolateral surface of the pons enters a small fossa just posterior, inferior and lateral to the cavernous sinus called Meckel's cave
 - ◆ This houses the Trigeminal ganglion aka semilunar & gasserian ganglion

Trigeminal continued

- Gasserian ganglion is the sensory ganglion
 - ◆ The Ophthalmic branch passes through the inferior portion of the cavernous sinus to exit the skull via the superior orbital fissure
 - ◆ The maxillary division exits the skull via the foramen rotundum
 - ◆ The mandibular branch leaves the skull by way of the foramen ovale

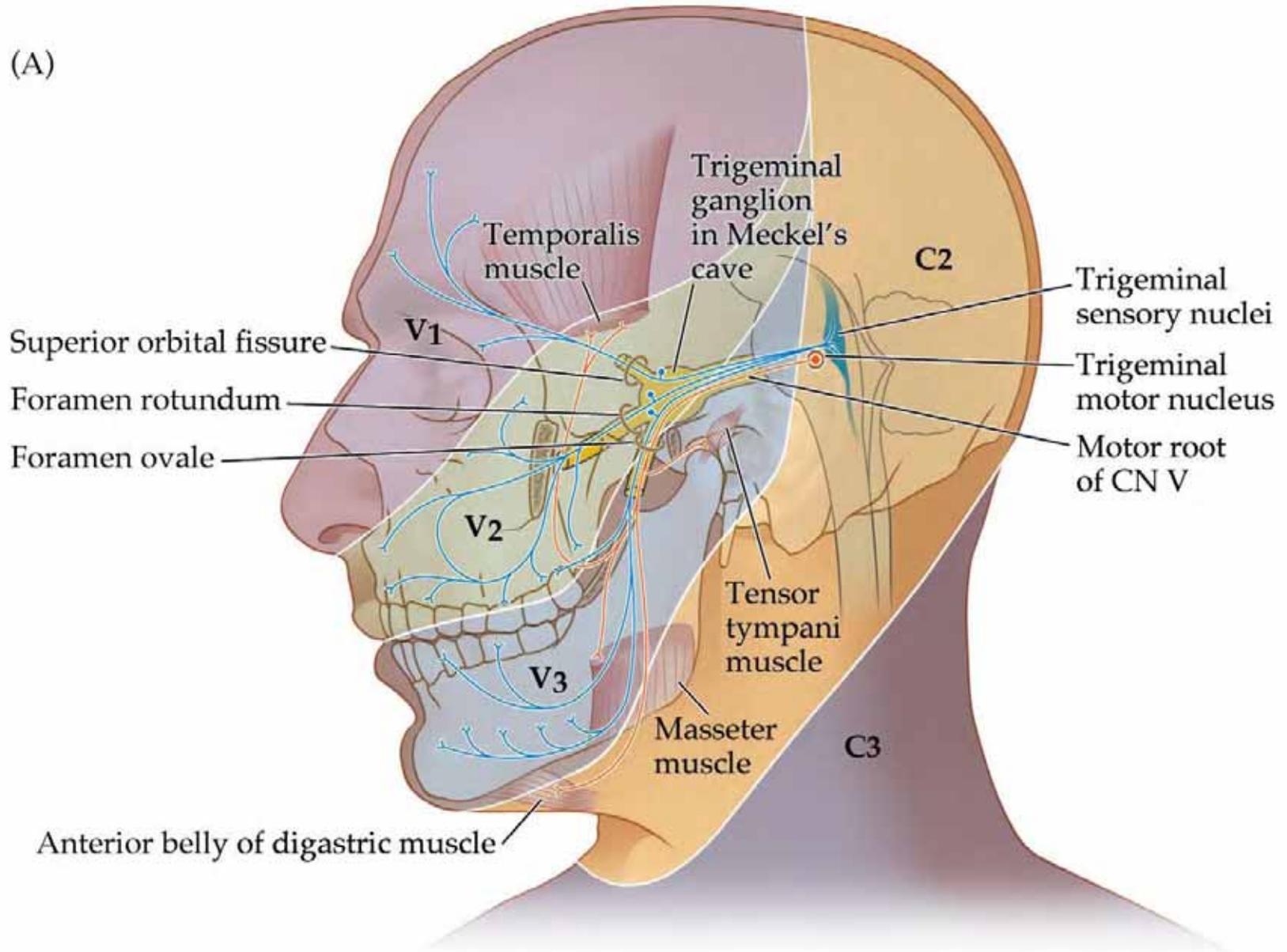
Trigeminal continued

- Sensory distribution is of the face, nasal sinuses, nose, anterior 2/3 of the tongue, supratentorial dura mater...posterior fossa is CN X and upper cervical nerve roots. Taste anterior 2/3 is CN VII
- Trigeminal nuclei receive inputs primarily from CN V but smaller degree of input from CN VII, IX, X for the external ear, middle ear, pharynx and infratentorial regions
- The Trigeminal sensory system is analogous to the DC-ML and Anterolateral system of the spinal cord

Trigeminal continued

- Trigeminal nuclear complex runs from the midbrain through the medulla to the upper cervical region and consists of three nuclei
 - ◆ Mesencephalic nucleus
 - ◆ Chief trigeminal sensory nucleus
 - ◆ Spinal trigeminal nucleus

(A)



(B)

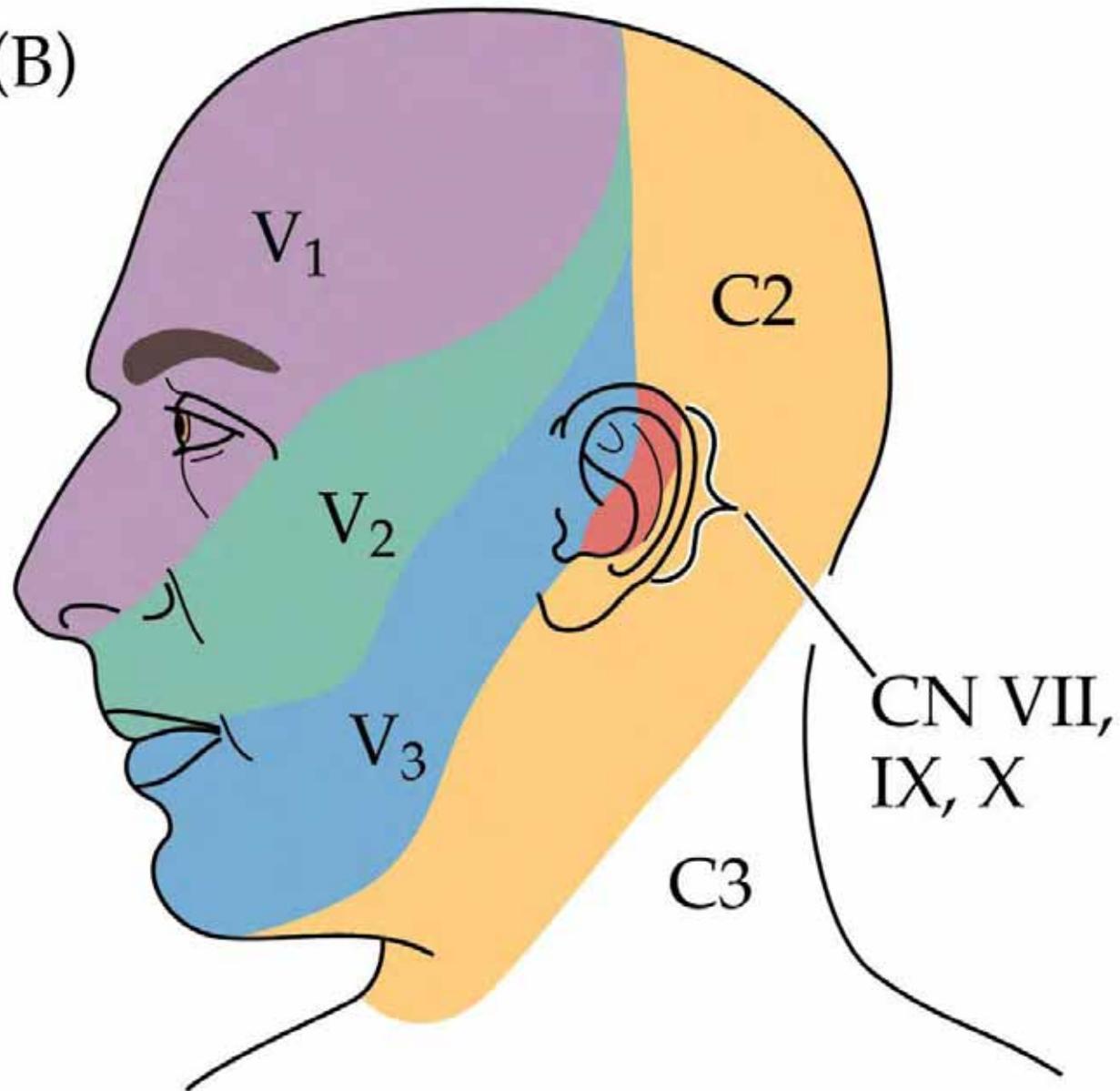


TABLE 12.6 Analagous Trigeminal and Spinal Somatosensory Systems

NUCLEUS	SENSORY MODALITIES	MAIN PATHWAY TO THALAMUS	MAIN THALAMIC NUCLEUS ^a
TRIGEMINAL SENSORY SYSTEMS			
Mesencephalic trigeminal nucleus	Proprioception	—	—
Chief trigeminal sensory nucleus	Fine touch, dental pressure	Trigeminal lemniscus	VPM
Spinal trigeminal nucleus	Crude touch, pain, temperature	Trigeminothalamic tract	VPM
SPINAL SENSORY SYSTEMS			
Posterior column nuclei	Fine touch, proprioception	Medial lemniscus	VPL
Dorsal horn	Crude touch, pain, temperature	Spinothalamic tract	VPL

^aVPL, ventral posterior lateral nucleus; VPM, ventral posterior medial nucleus.

Trigeminal continued

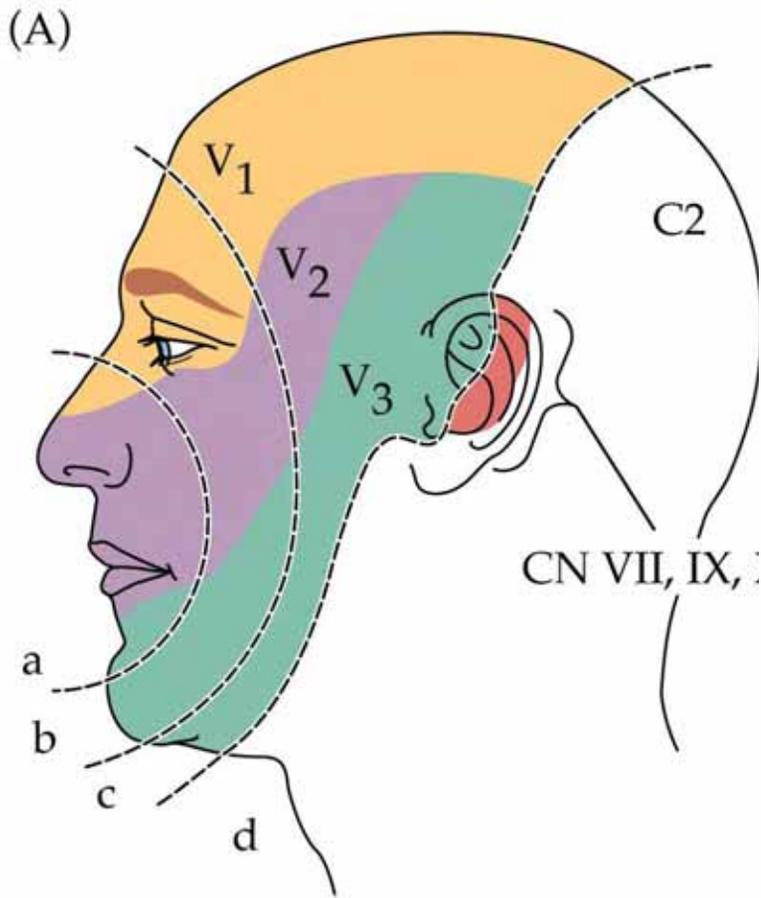
- Fine touch and dental pressure enter the lateral pons of the Chief Tri nucleus (dorsal columns nuclei) crosses at eh trigeminal lemniscus to ascend with the medial lemniscus then to the VPM (remember the lateral goes to the VPL) tertiary fibers then traverse ipsilaterally to the appropriate sensory cortex of the face.
- A second pathway from the chief tri nucleus ascends as the dorsal trigeminothalamic tract (Lateral spinothalamic tract) to the ipsilateral VPM

Trigeminal continued

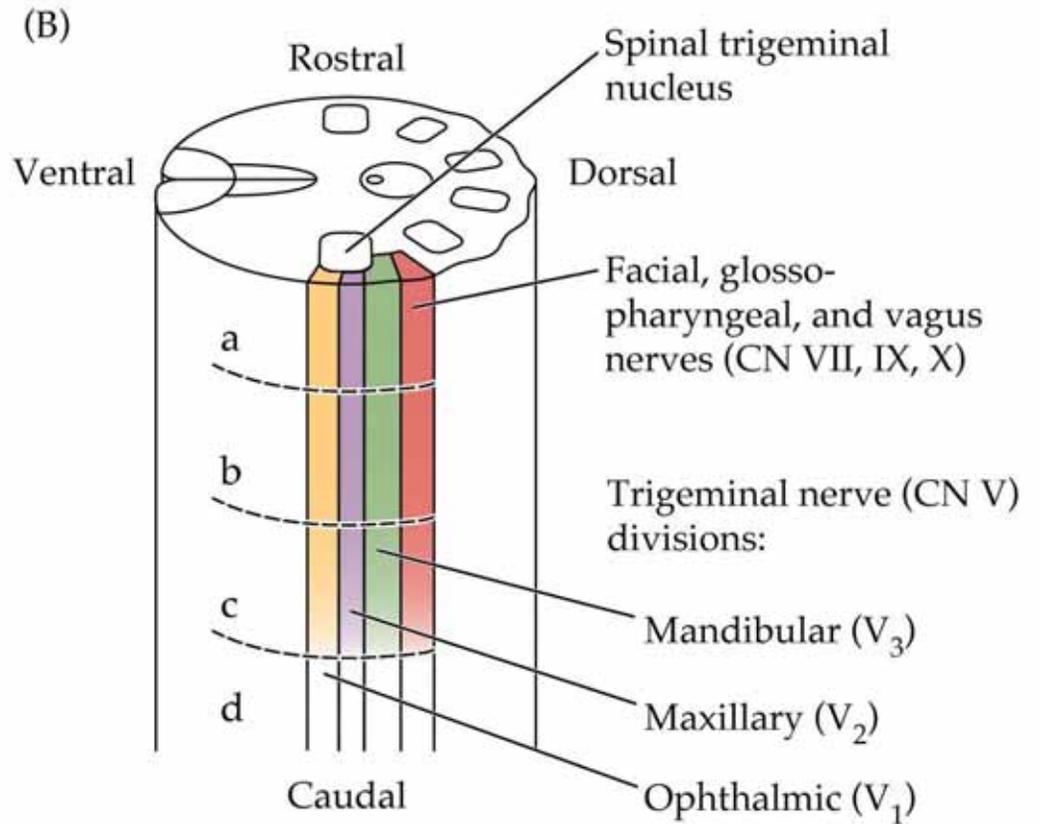
- Medium and small diameter fibers conveying crude touch, pain and temp. enters the lateral pons and descends as the Spinal trigeminal tract (tract of lissauer), synapses in the spinal trigeminal nucleus (extension of dorsal columns) and crosses to form the trigeminothalamic tract (ventral spinothalamic tract).

Trigeminal continued

- The spinal trigeminal tract and nucleus are somatotopically arranged in an “onion-skin” representation
 - ◆ V3 is dorsal
 - ◆ V2 is middle
 - ◆ V1 is ventral
 - ◆ Also it layers mouth rostral and down



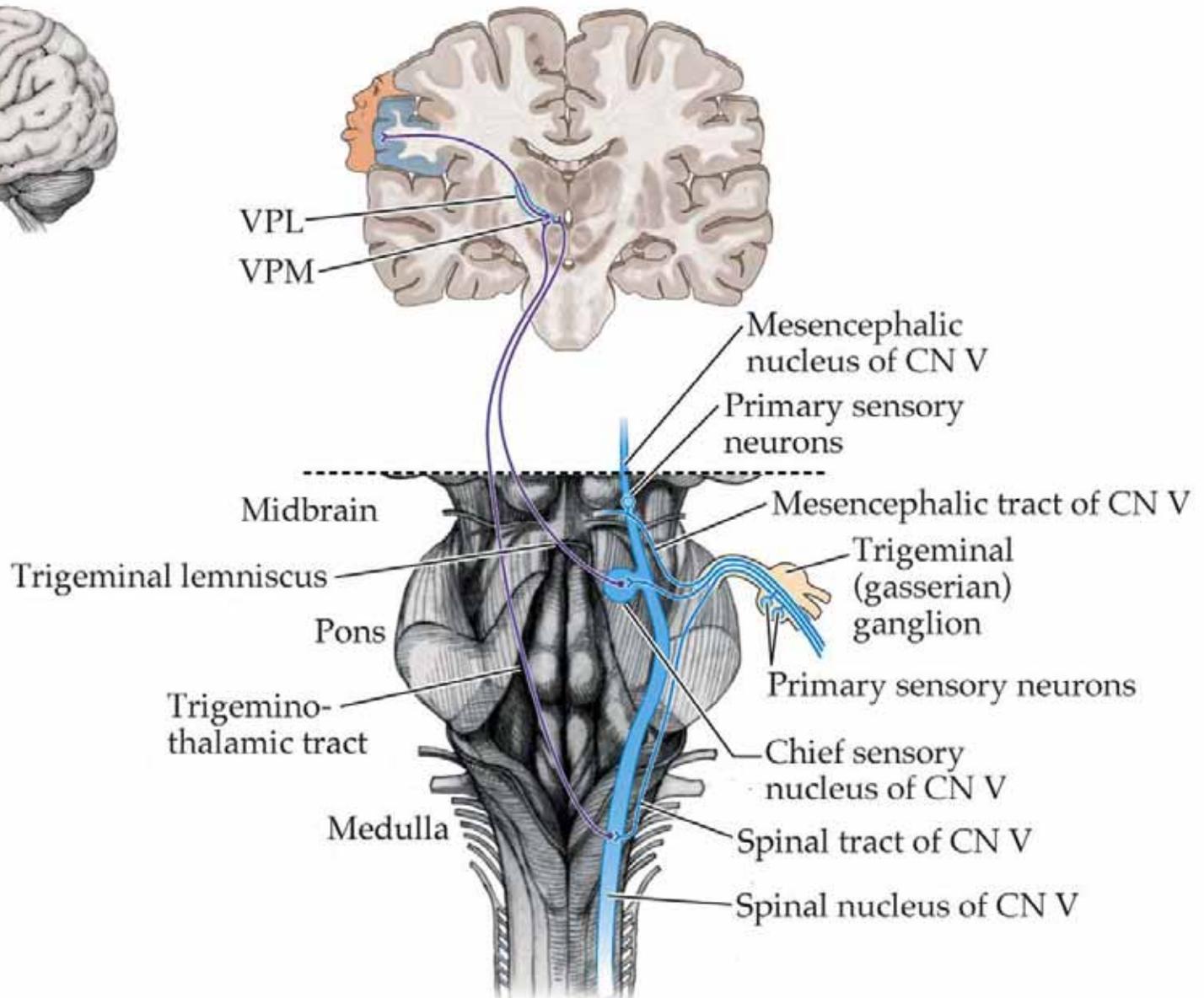
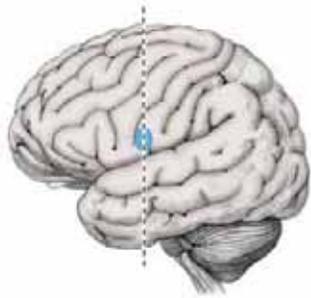
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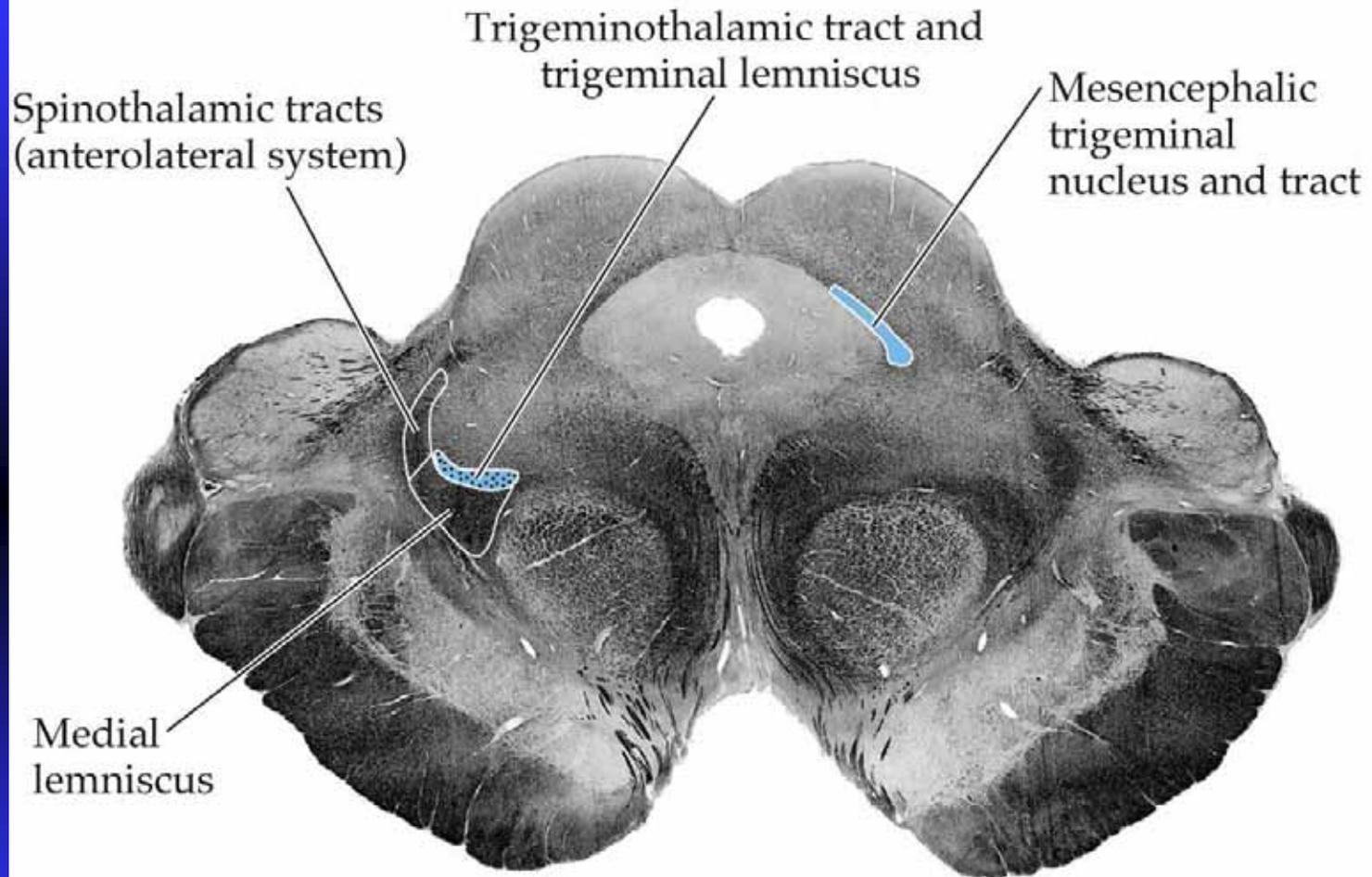


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Trigeminal continued

- Mesencephalic trigeminal nucleus and tract run along the periaqueductal grey matter conveying proprioception information from muscle of mastication, extraocular eye muscles and possible tongue
- Only case of primary neuron for the sensory system lying within the CNS
- These fibers are involved with the monosynaptic jaw jerk reflex with the motor nucleus of the trigeminal





(Midbrain section modified from Martin JH. 1996. Neuroanatomy: Text and Atlas, 2nd Ed. McGraw-Hill, New York.)

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Trigeminal continued

- Branchial motor is from the trigeminal motor nucleus, it is located in the upper pons by where the trigeminal exits the brainstem
- It travels and passes through the trigeminal ganglion and exits the skull through the foramen ovale to supply the muscles of mastication, tensor tympani, mylohyoid and the anterior belly of the digastric.
- Upper motor supply is bilateral so lesions rarely present with weakness but can have mild hyperreflexia

Anatomy Review

- Cranial Nerve VII

CN VII: Facial Nerve

Functional Category: Branchial Motor **Function:** Muscle of Expression, stapedius, digastric

Functional Category: Parasympathetic **Function:** lacrimal Glands Salivary glands (Except Parotid)

Functional Category: Visceral Sensory

Function: Taste for Ant. 2/3 Tongue

Functional Category: Somatic Sensory **Function:** External Auditory meatus

- Main function is facial expression
- Small branch for parasympathetic efferents called nervus intermedius (tears & salivation)
- Special and motor sensation

Facial nerve continued

- The facial nucleus is located in the branchial motor column caudal to the trigeminal
- The fibers leaving wrap around the abducens nucleus forming a bump on the floor of the fourth ventricle known as the facial colliculus exits ventrolateral at the pontomedullary junction, the cerebellopontine angle
- It crosses the subarachnoid space to enter the internal auditory meatus. Passing through the auditory canal of the petrous temporal bone with CN VIII

Facial nerve continued

- Here it bends posteroinferior running now in the facial canal also holding the sensory neurons (facial ganglia, geniculate ganglion)
 - ◆ These neurons are for taste and the external auditory meatus
- The main portion exits the skull at the stylomastoid foramen passing through the parotid gland and dividing into five main branches

Facial nerve continued

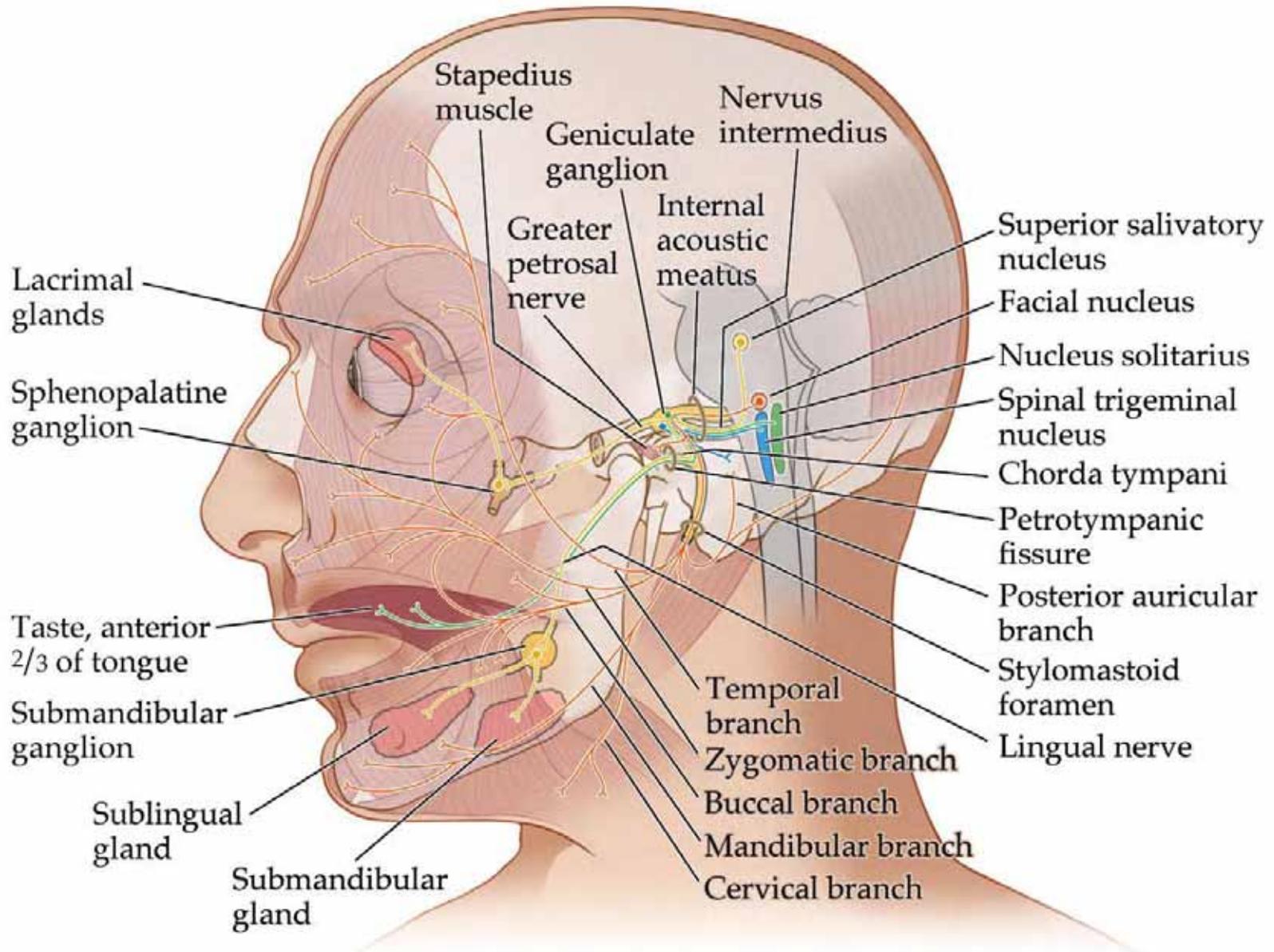
- Temporal, zygomatic, buccal, mandibular, and cervical branches for the branchial motor function, there is a small branch that innervates the stapedius
- Preganglionic fibers originate in the superior salivatory nucleus carried by two branches off the main trunk
 - ◆ Greater petrosal nerve to the sphenopalatine ganglion where post ganglionic supply the lacrimal glands and the nasal passages

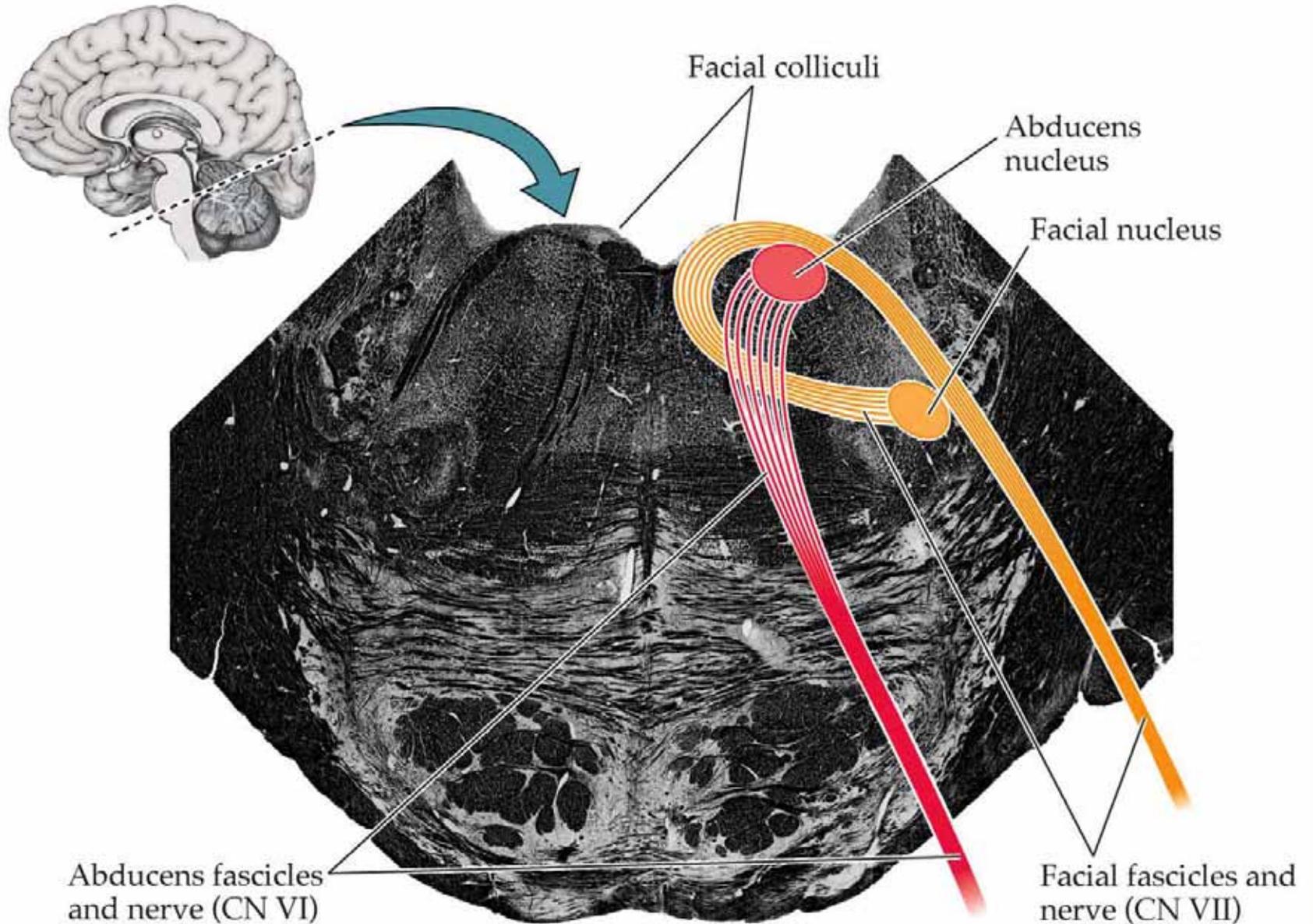
Facial nerve continued

- The chorda tympani leaves the facial before the stylomastoid canal to traverse the middle ear and exits the skull at the petrotympanic fissure just medial to the TMJ. It joins the lingual nerve (CN V3 branch) to reach the submandibular ganglion where post ganglionic fibers supply the submandibular and sublingual salivary glands

Facial nerve continued

- The chorda tympani and lingual nerve carry special sensory fibers for taste of the anterior 2/3 of the tongue
- Neurons are in the geniculate ganglion and project back to the rostral nucleus solitarius (gustatory nucleus) fibers ascend from here via the central tegmental tract to the VPM then to the cortical taste are typically and ipsilateral tract
- The sensory for the external auditory meatus travels to the trigeminal nuclei





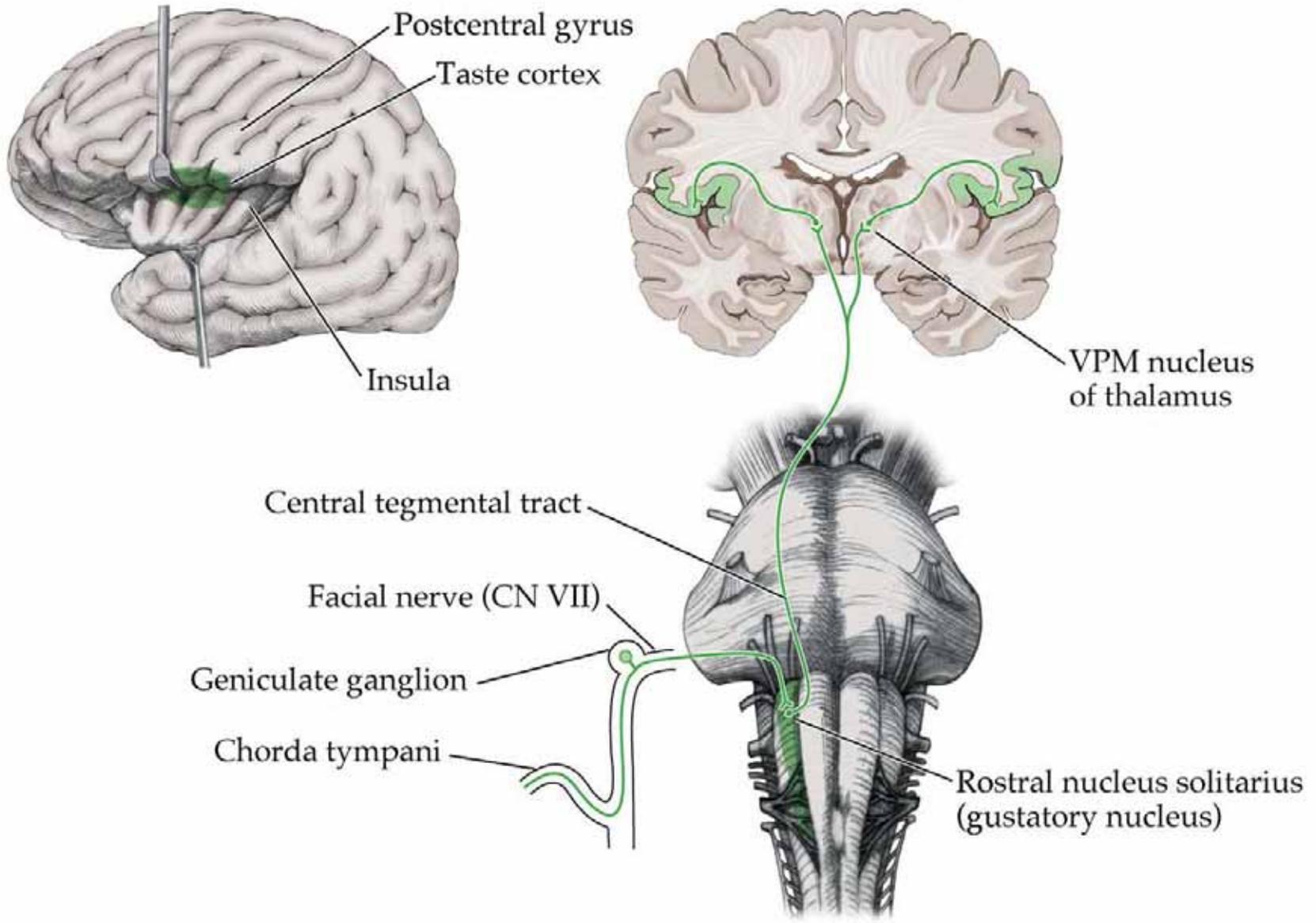


Table VII-1 Nerve Fiber Modality and Function of the Facial Nerve

Nerve Fiber Modality	Nucleus	Function
General sensory (afferent)	Spinal of the trigeminal nerve	To carry sensation from the skin of the concha of the auricle, a small area of skin behind the ear, and possibly to supplement V_2 , which carries sensation from the wall of the external auditory meatus and the external surface of the tympanic membrane
Special sensory (afferent)	Solitarius (rostral gustatory portion)	For taste sensation from the anterior two-thirds of the tongue
Branchial motor (efferent)	Motor of cranial nerve VII	To supply the muscles of facial expression (ie, frontalis, occipitalis, orbicularis oculi, corrugator supercilii, procerus, nasalis, levator labii superioris, levator labii superioris alaeque nasi, zygomaticus major and minor, levator anguli oris, mentalis, depressor labii inferioris, depressor anguli oris, buccinator, orbicularis oris, risorius, and platysma). In addition, the branchial motor fibers supply the stapedius, stylohyoid, and posterior belly of digastric muscles
Visceral motor (parasympathetic efferent)	Superior salivatory (lacrima)	For stimulation of the lacrimal, submandibular, and sublingual glands as well as the mucous membrane of the nose and hard and soft palates

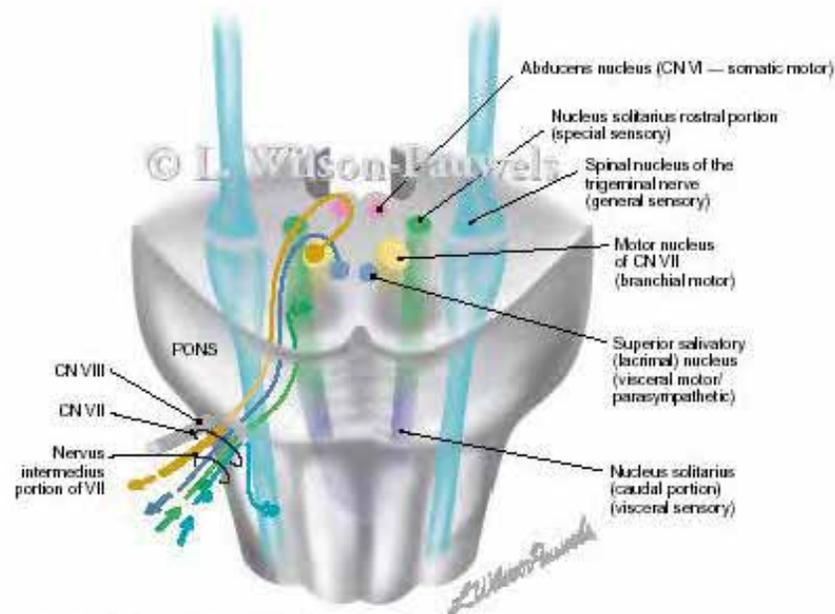


Figure VII-2 Nervus intermedius—fibers spread apart.

Facial nerve continued

■ Upper vs. Lower motor lesions

- ◆ UMN supplies contralateral LMN lower facial
- ◆ UMN Supplies ips and contralateral LMN of upper face
- ◆ LMN affect entire half of face

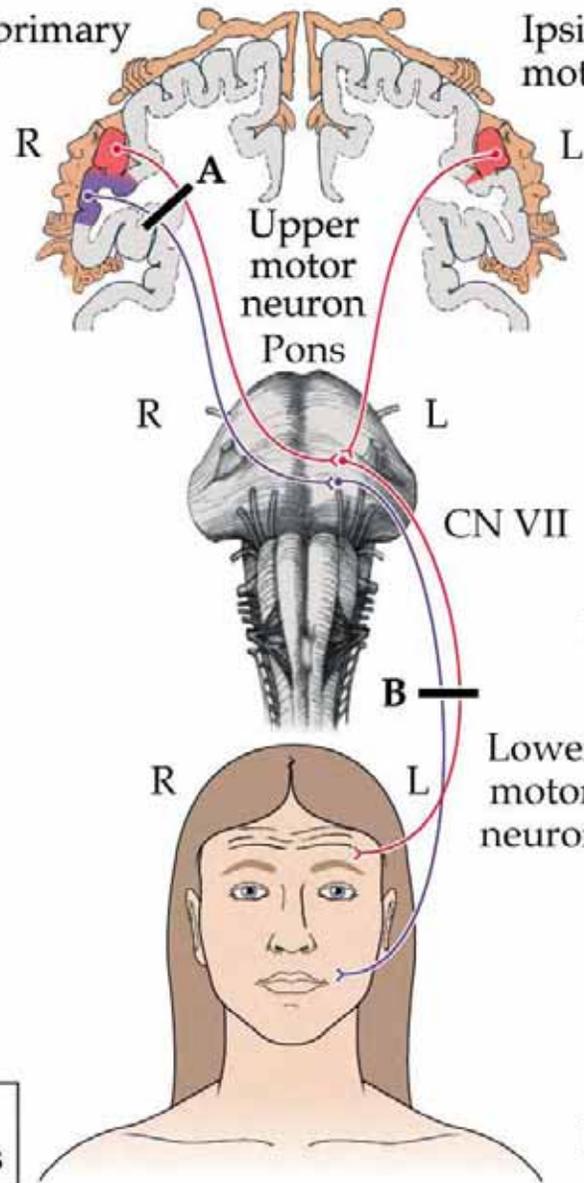
■ Check the neighbors out...LMN don't have any

■ Bell's palsy most common

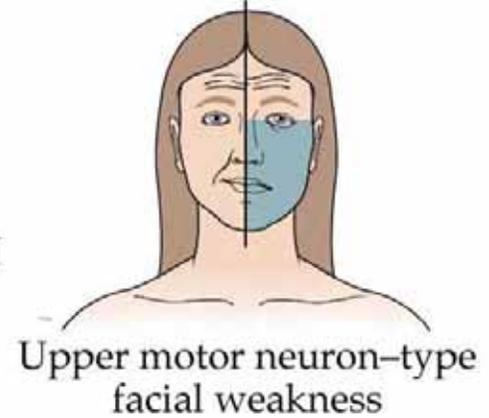
- ◆ Dry eyes, full facial weakness, hyperacusis, retroauricular pain and droopy lid
- ◆ Treatment is controversial with 80% recovery in the 3 weeks
- ◆ Sometimes the regenerating nerve hits the wrong target motor and lacrimal findings
 - ◆ Crocodile tears, synkinesis

Contralateral primary motor cortex

Ipsilateral primary motor cortex

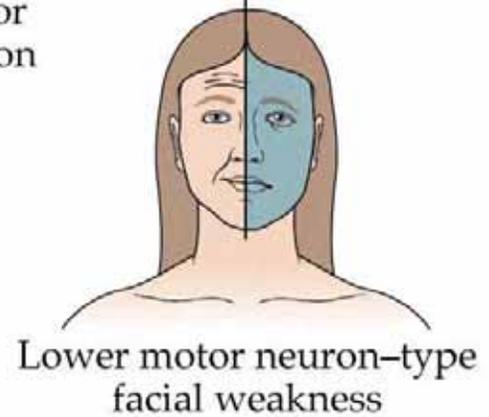


Lesion A



Upper motor neuron-type facial weakness

Lesion B



Lower motor neuron-type facial weakness

Key
■ Region of weakness

Facial nerve clinical

■ Corneal reflex

- ◆ A monosynaptic and polysynaptic pathway
- ◆ Afferent limb is CN V1
- ◆ Efferent limb is the facial nerve to the obicularis oculi
- ◆ Ipsilateral reduction is due to peripheral and brainstem lesion
- ◆ Contralateral is from higher centers of the brain

Anatomy Review

- Cranial nerve IX

CNIX: Glossopharyngeal Nerve

- Functional category: branchial motor
 - ◆ function: stylopharyngeous muscle
- Functional category: parasympathetic
 - ◆ function: parotid gland
- Functional category: somatic sensory
 - ◆ function: middle ear, pharynx, post. 1/3 tongue
- Functional category: special sensory
 - ◆ function: tastes post. 1/3 tongue
- Functional category: visceral sensory
 - ◆ function: chemo & baro receptors of carotid body

Glossopharyngeal nerve continued

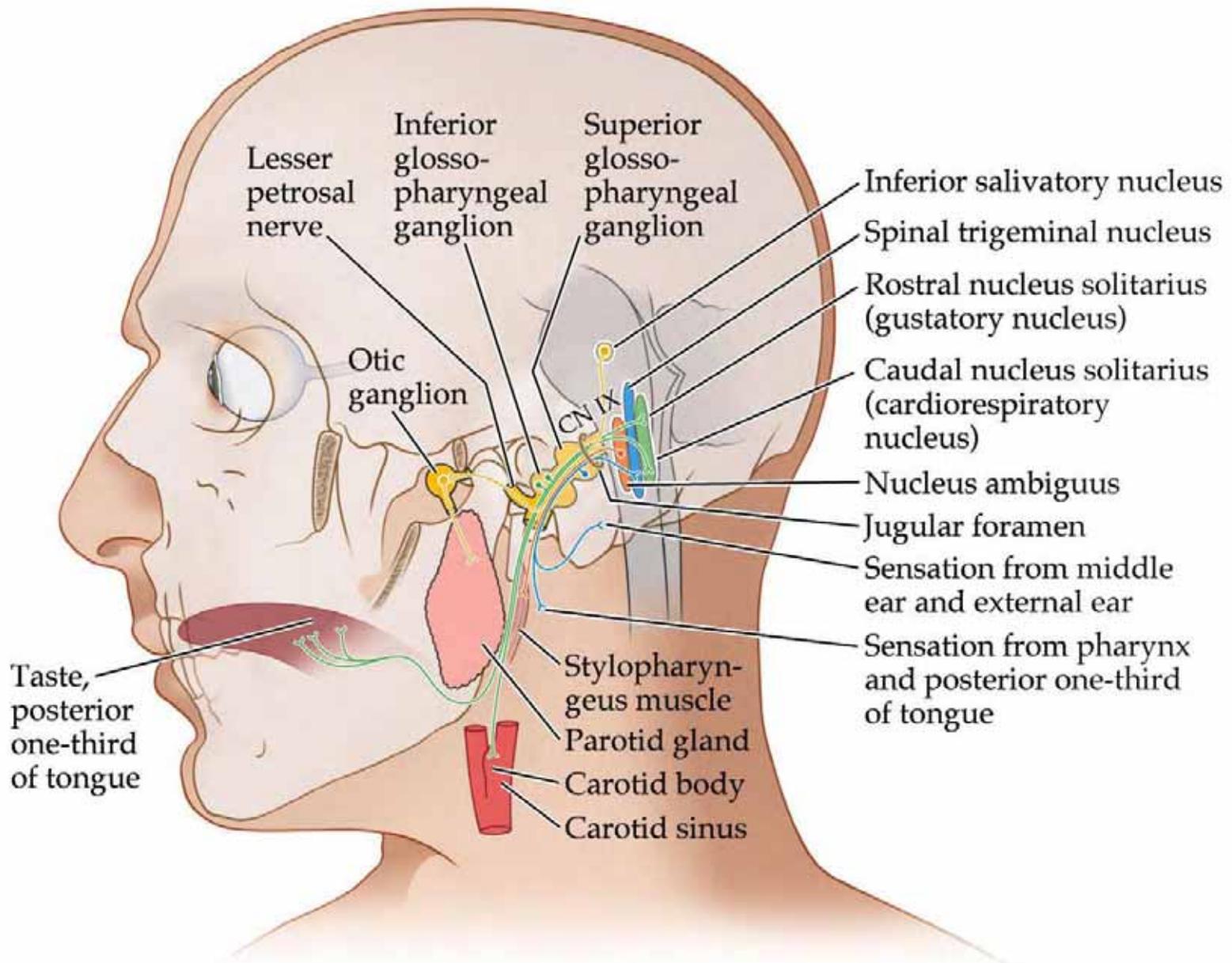
- Named for sensation of the posterior 1/3 of tongue and the pharynx
- It exits the brainstem upper ventrolateral medulla just below CN VIII it exits the skull by the jugular foramen
- Branchial motor portion of this nerve supplies the stylopharyngeus muscle...elevates the pharynx with swallowing and talking contributes with CN X to the gag reflex, this is from the nucleus ambiguus in the medulla

Glossopharyngeal nerve continued

- Parasympathetic preganglionic fibers arise from inferior salivatory nucleus they leave the CN IX via the lesser petrosal nerve and synapse with the otic ganglion to provide post-ganglionic fibers to the parotid gland
- Chemo and baroreceptors afferent input to the caudal nucleus solitarius aka cardiorespiratory nucleus
- Taste afferents travel to the rostral nucleus solitarius aka gustatory nucleus
- General afferents for pain and temp for the post. 1/3 of the tongue, pharynx, middle ear and region of the external meatus pass to two sensory ganglia located just inside the jugular foramen

Glossopharyngeal nerve continued

- General and special visceral sensory information neurons are in the inferior glossopharyngeal ganglion
- General somatic is to both the inferior (petrosal) and superior (jugular) glossopharyngeal ganglion



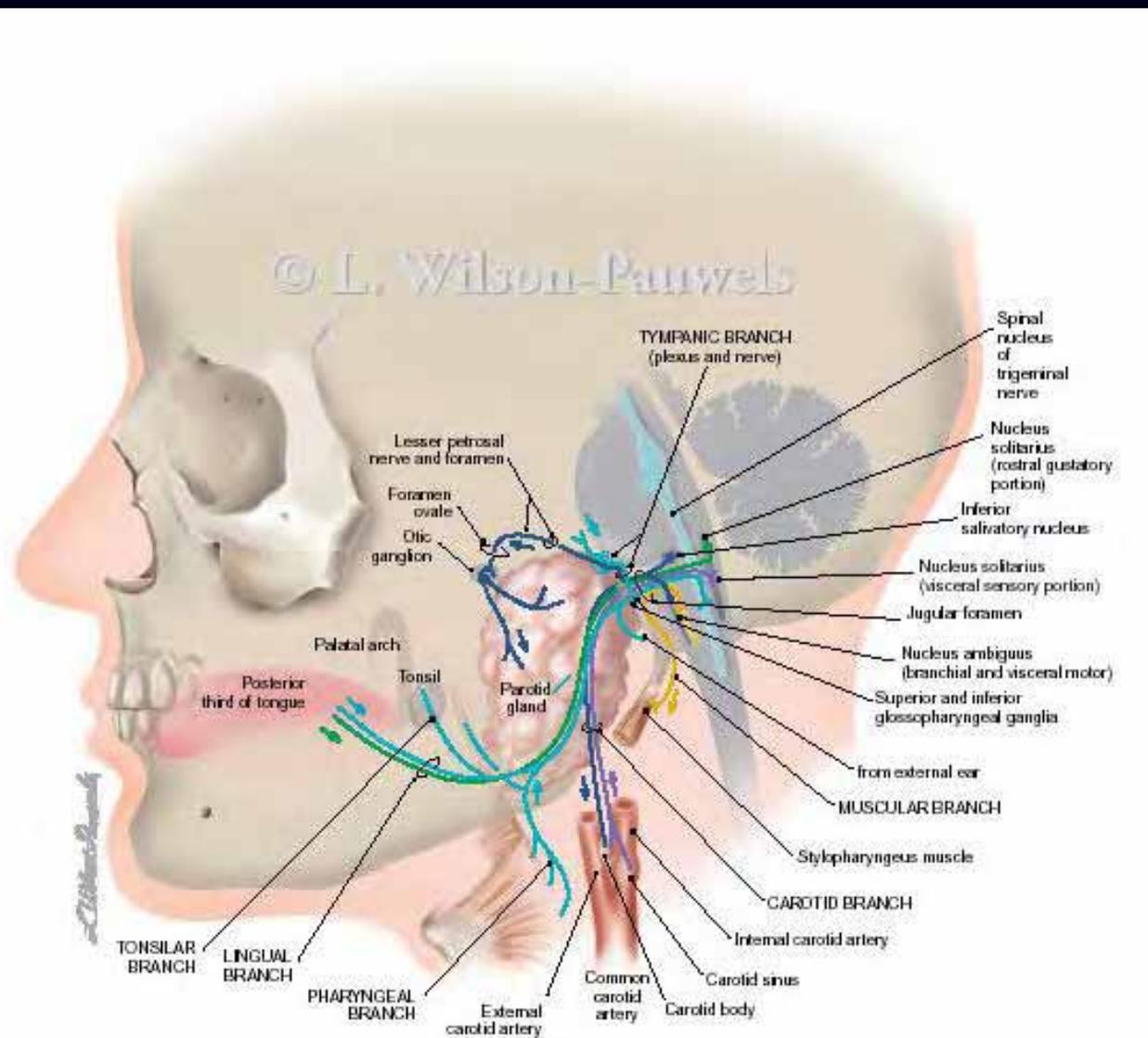


Figure IX-1 Overview of the glossopharyngeal nerve.

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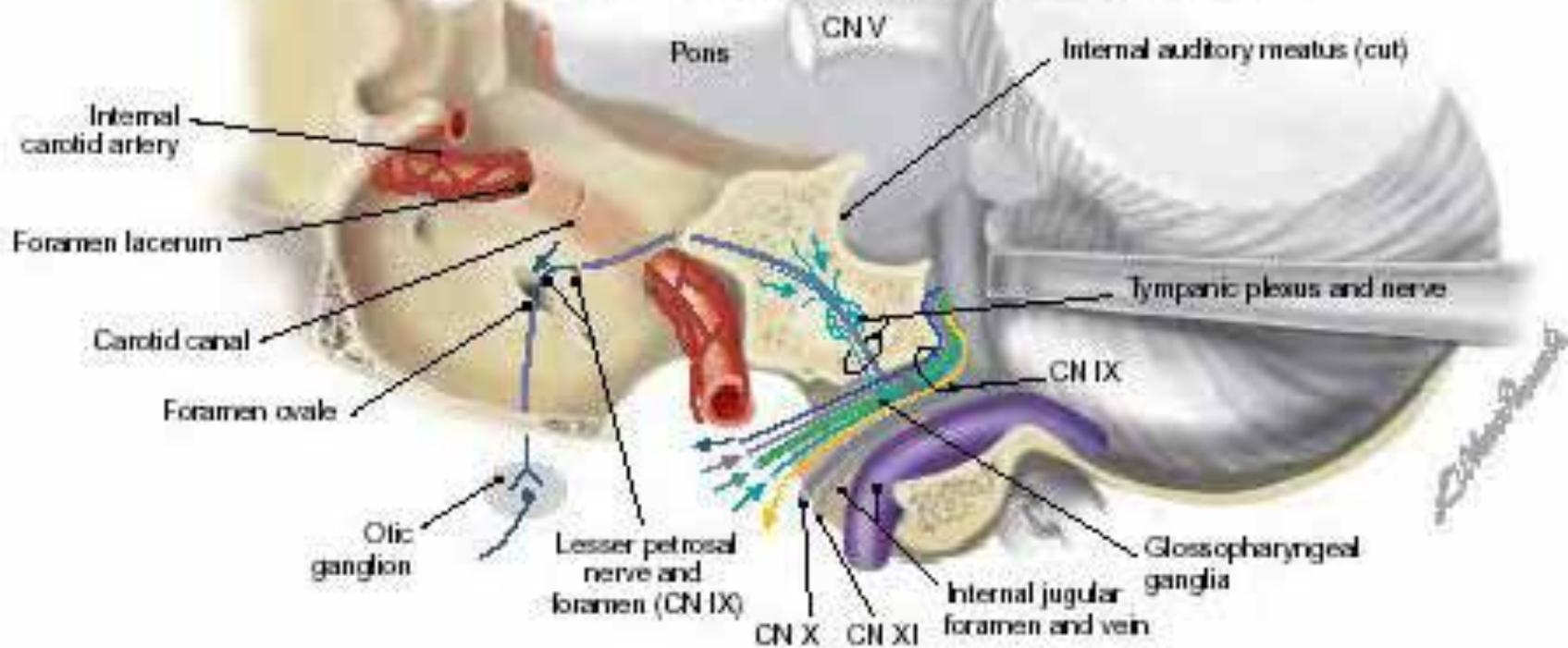


Figure IX-2 Tympanic branch of cranial nerve IX (cut through the petrous temporal bone).

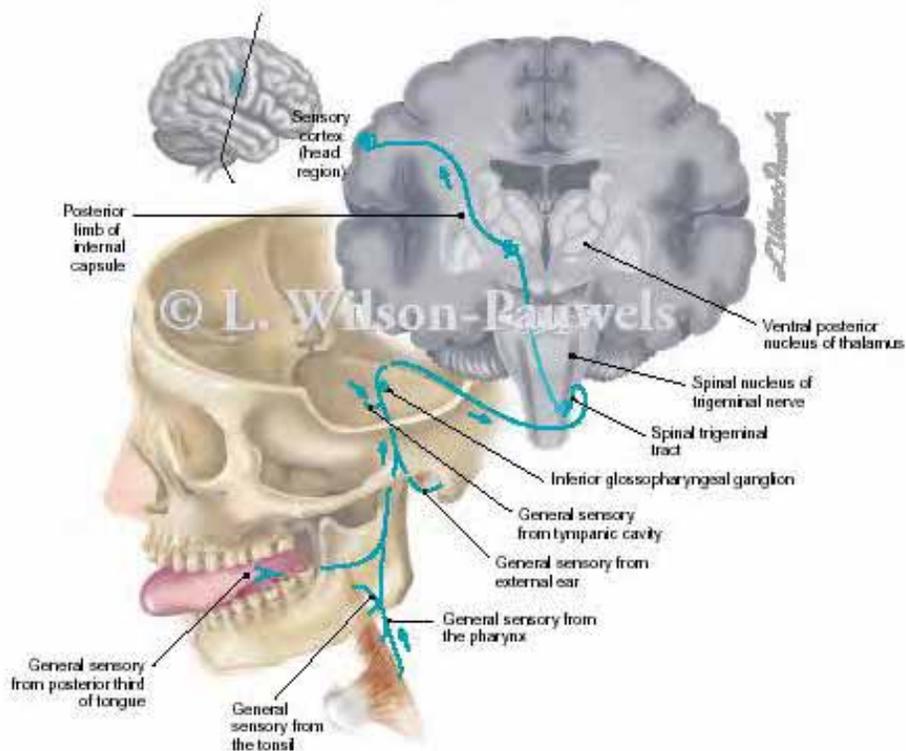


Figure IX-3 General sensory component of the glossopharyngeal nerve.

Table IX-1 Nerve Fiber Modality and Function of the Glossopharyngeal Nerve

<i>Nerve Fiber Modality</i>	<i>Nucleus</i>	<i>Function</i>
General sensory (afferent)	Spinal trigeminal	Provides general sensation from the posterior one-third of the tongue, the tonsil, the skin of the external ear, the internal surface of the tympanic membrane, and the pharynx
Visceral sensory (afferent)	Of the tractus solitarius—middle part	Provides subconscious sensation from the carotid body (chemoreceptors) and from the carotid sinus (baroreceptors)
Special sensory (afferent)	Of the tractus solitarius—rostral part (gustatory nucleus)	Carries taste from the posterior one-third of the tongue
Branchial motor (efferent)	Ambiguus	Supplies the stylopharyngeus muscle
Visceral motor (parasympathetic efferent)	Inferior salivatory Ambiguus	Stimulates the parotid gland For control of blood vessels in the carotid body

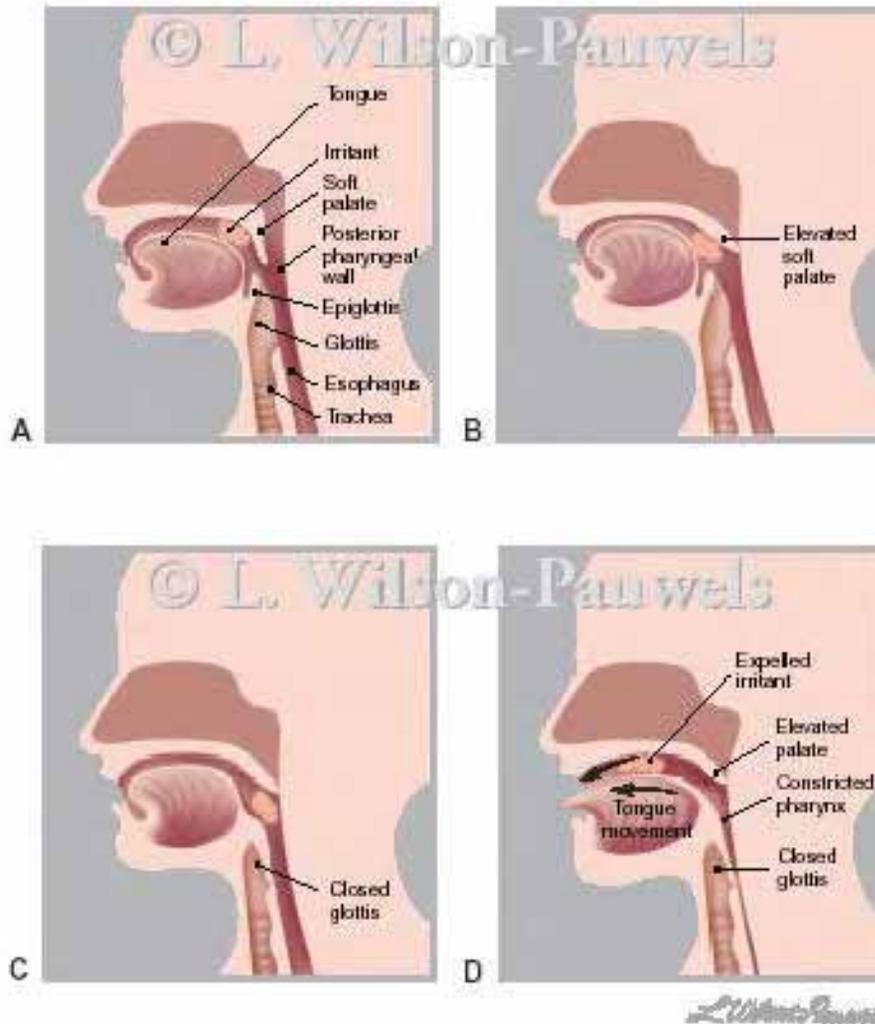


Figure IX-12 Steps in the gag reflex. *A*, Irritant in the mouth. *B*, Soft palate elevates, closing the upper respiratory airway. *C*, Glottis is closed to protect the lower respiratory airway. *D*, Pharyngeal wall constricts causing expulsion of the foreign object.

Anatomy Review

- Cranial nerve X

CN X: Vagus nerve

■ Functional category

- ◆ Branchial motor
- ◆ Parasympathetic
- ◆ General somatic
- ◆ Visceral sensory
 - Special
- ◆ Visceral sensor
 - General

■ Function

- ◆ Swallowing & voice
- ◆ Heart, lung, gut
- ◆ Pharynx, meninges
- ◆ Taste pharynx, epiglottis
- ◆ Chemo and baroreceptors from the aortic arch

Vagus nerve continued

- Vagus is latin for wandering
- Exits the brainstem below CN IX between the inferior olive and inferior cerebellar peduncle, it leaves the cranial vault through the jugular foramen
- The largest part provides parasympathetic to the heart, lungs and digestive tract all the way to the splenic flexure

Vagus nerve continued

- Preganglionic parasympathetic arise from the dorsal motor nucleus of CN X in the rostral to caudal medulla. This forms the vagal trigone on the floor of the fourth ventricle
- Post ganglionic fibers are located in the terminal ganglia found at or near the effectors organ
- Branchial motor portion controls pharyngeal muscles for swallowing and the gag reflex and the larynx (voice box)
- The efferent fibers arise from the nucleus ambiguus

Vagus nerve continued

- The recurrent laryngeal nerve loops back up the thoracic cavity when it leaves the vagus nerve
- It innervates the muscle of the larynx except the cricothyroid muscle which is by the superior laryngeal nerve
- Fibers are from the nucleus ambiguus which drop briefly on the CN IX but mainly with CN X

Vagus nerve continued

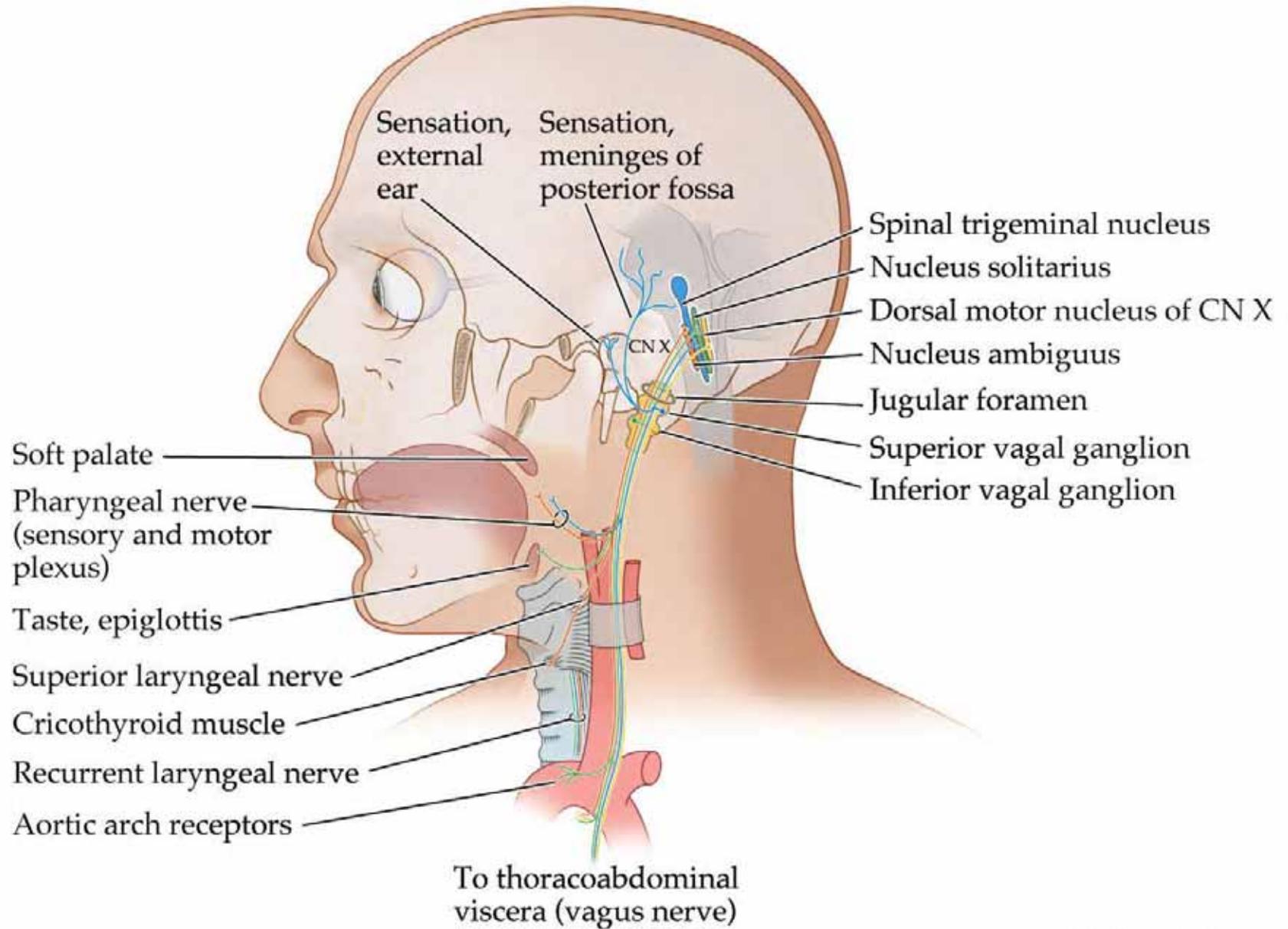
- General somatic fibers input from the larynx, pharynx, meninges of the posterior fossa external auditory meatus below the larynx and pharynx it is the spinal nerves that have afferent input
- Chemo and baroreceptors of the aortic arch, cardiorespiratory system, digestive system go to the caudal nucleus of solivatorius (cardiorespiratory nucleus)

Vagus nerve continued

- Primary sensory neurons for CN X general and special visceral sensation are located in the inferior (nodose) vagal ganglion
- Primary neurons for general somatic sensation are located in the inferior and the superior (jugular) vagal ganglion both lie just inside the jugular foramen

TABLE 12.5 Cranial Nerves: Peripheral Sensory and Parasympathetic Ganglia (*Part 2*)

NERVE	NAME	PERIPHERAL GANGLIA	FUNCTION(S) OF GANGLIA
CN IX	Glossopharyngeal nerve	Otic ganglion	Parasympathetics to parotid gland
		Superior (jugular) glossopharyngeal ganglion	Primary sensory neuron cell bodies for sensation from middle ear, external auditory meatus, pharynx, and posterior one-third of tongue
		Inferior (petrosal) glossopharyngeal ganglion	Primary sensory neuron cell bodies for sensation from middle ear, external auditory meatus, pharynx, posterior one-third of tongue, and for taste from posterior tongue, and carotid body inputs
CN X	Vagus nerve	Parasympathetic ganglia in end organs	Parasympathetics to heart, lungs, and digestive tract to level of splenic flexure
		Superior (jugular) vagal ganglion	Primary sensory neuron cell bodies for sensation from pharynx, outer ear, and infratentorial meninges
		Inferior (nodose) vagal ganglion	Primary sensory neuron cell bodies for laryngeal sensation for taste from epiglottis, and for reflex inputs from aortic arch receptors and other thoracoabdominal viscera
CN XI	Spinal accessory nerve	None	—
CN XII	Hypoglossal nerve	None	—



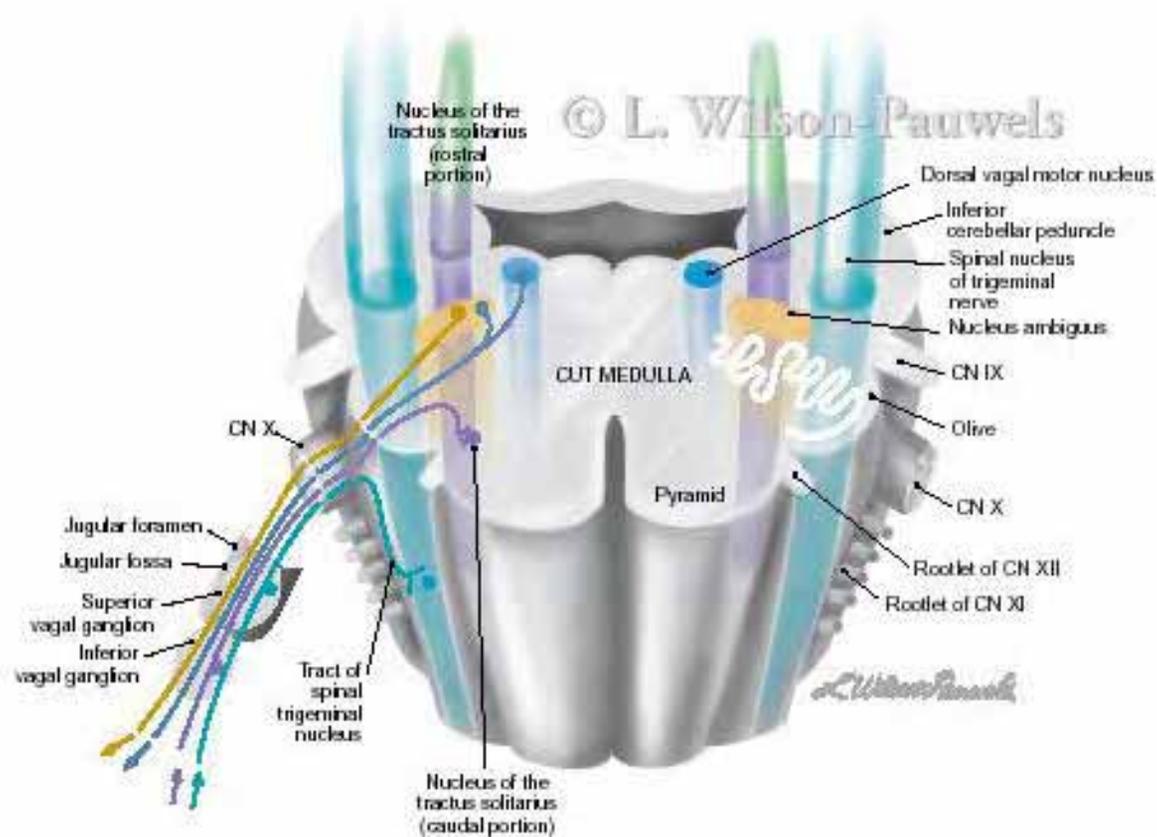


Figure X-1 Cross-section of the medulla at the point of entry of cranial nerve X illustrating the nuclei associated with this nerve.

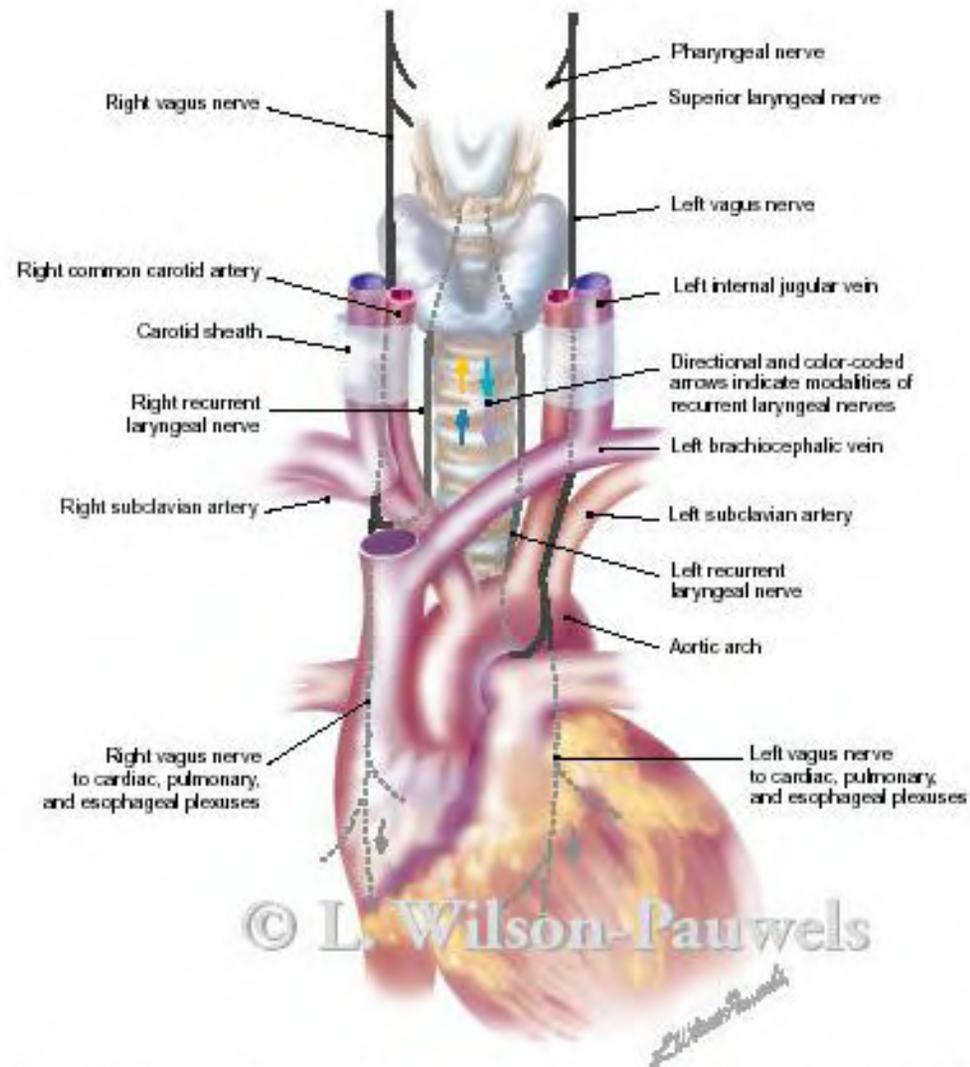


Figure X-3 Route of the right and left recurrent laryngeal nerves (nerve is shown in grey for clarity).

Table X-2 Branches of the Vagus Nerve

Location	Branch	Modality			
		General Sensory	Visceral Sensory	Branchial Motor	Visceral Motor
Jugular fossa	Meningeal	✓			
	Auricular	✓			
Neck	Pharyngeal	✓	✓	✓	✓
	Branches to carotid body		✓		
	Superior laryngeal	✓	✓	✓	✓
	Internal laryngeal	✓	✓		✓
	External laryngeal			✓	
	Recurrent laryngeal (right)	✓	✓	✓	✓
	Cardiac		✓		✓
Thorax	Cardiac		✓		✓
	Recurrent laryngeal (left)	✓	✓	✓	✓
	Pulmonary		✓		✓
	Esophageal		✓		✓
Abdomen	Gastrointestinal		✓		✓

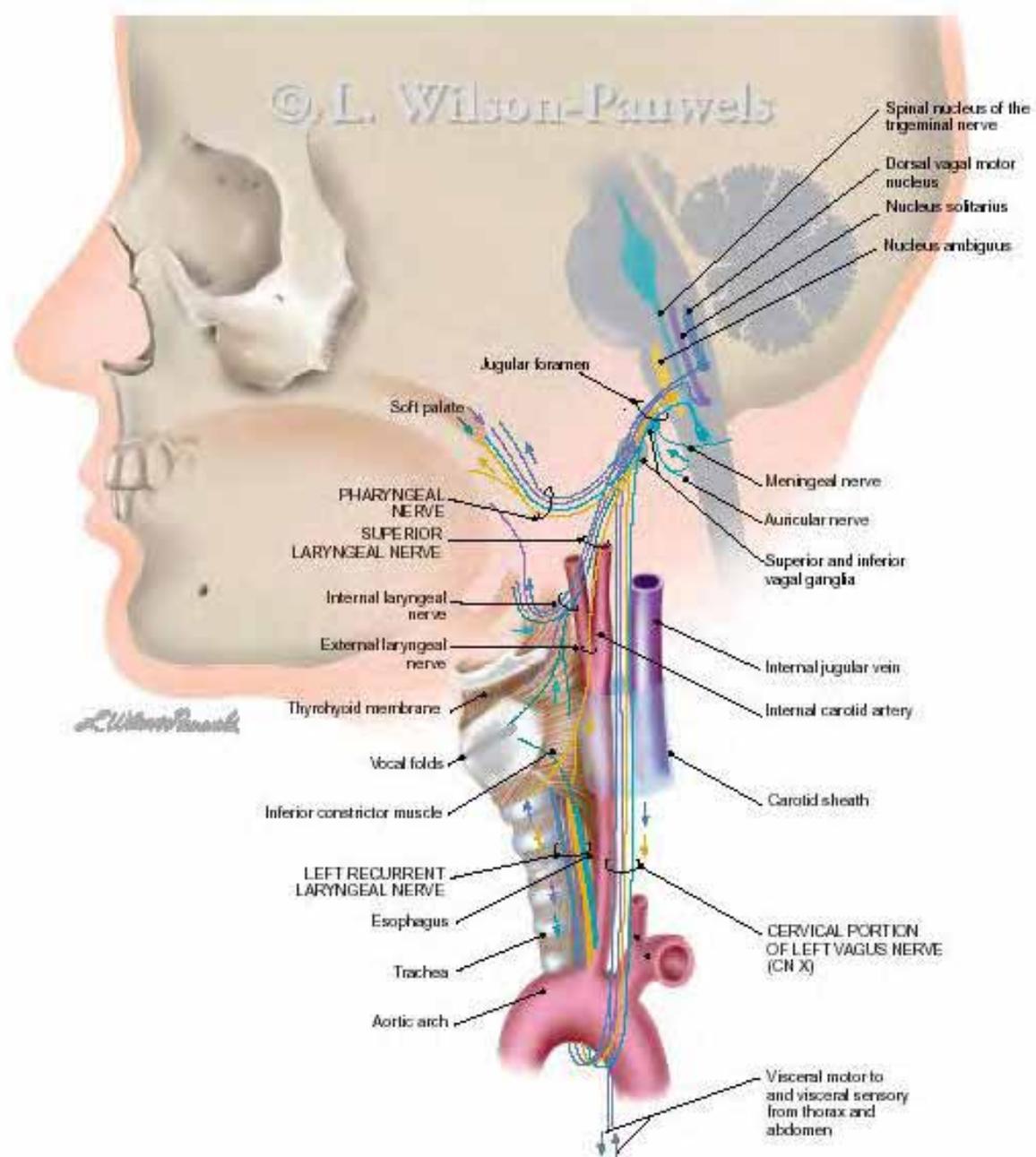


Figure X-4 Overview of the vagus nerve.

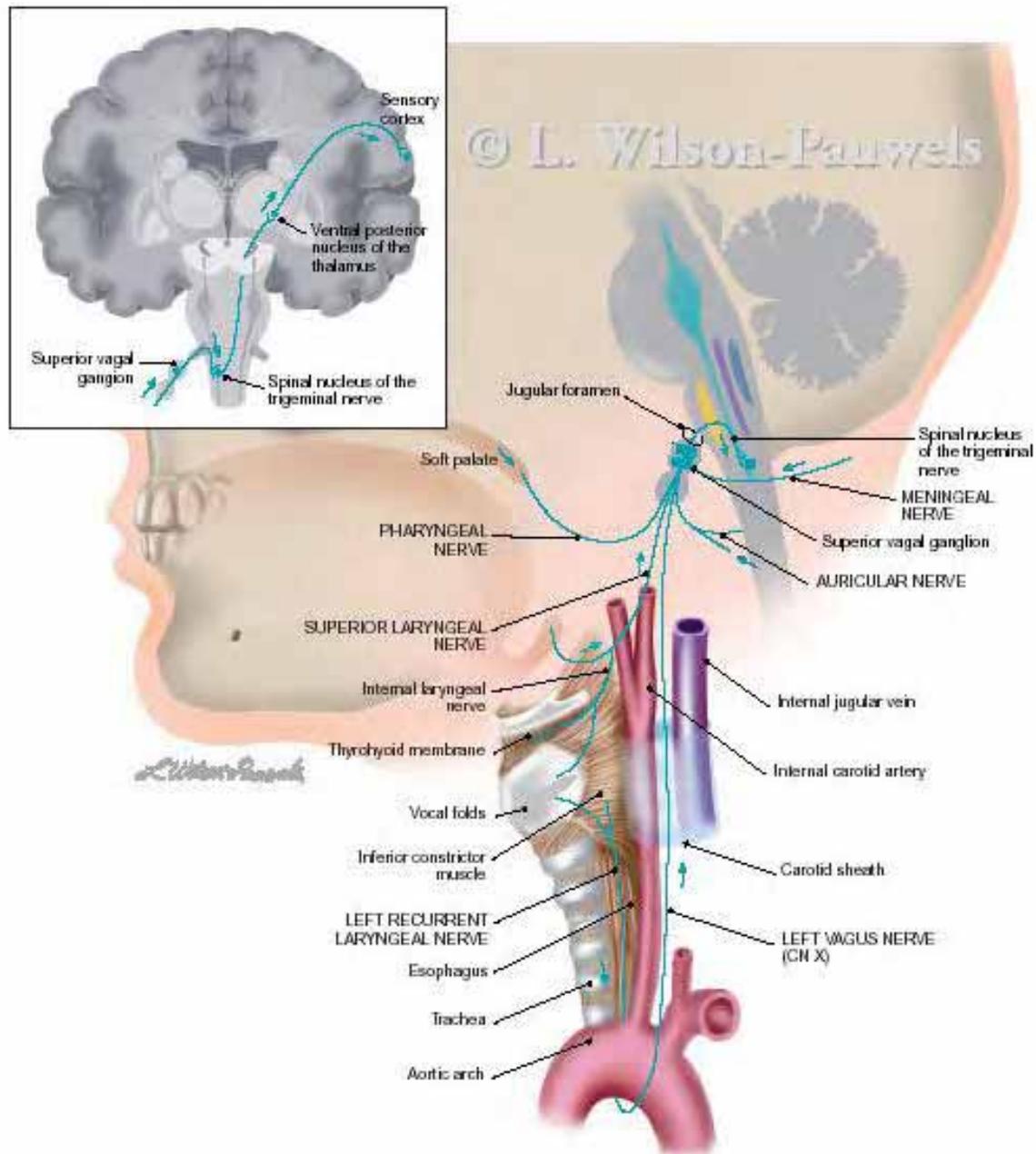


Figure X-6 General sensory component of the vagus nerve.

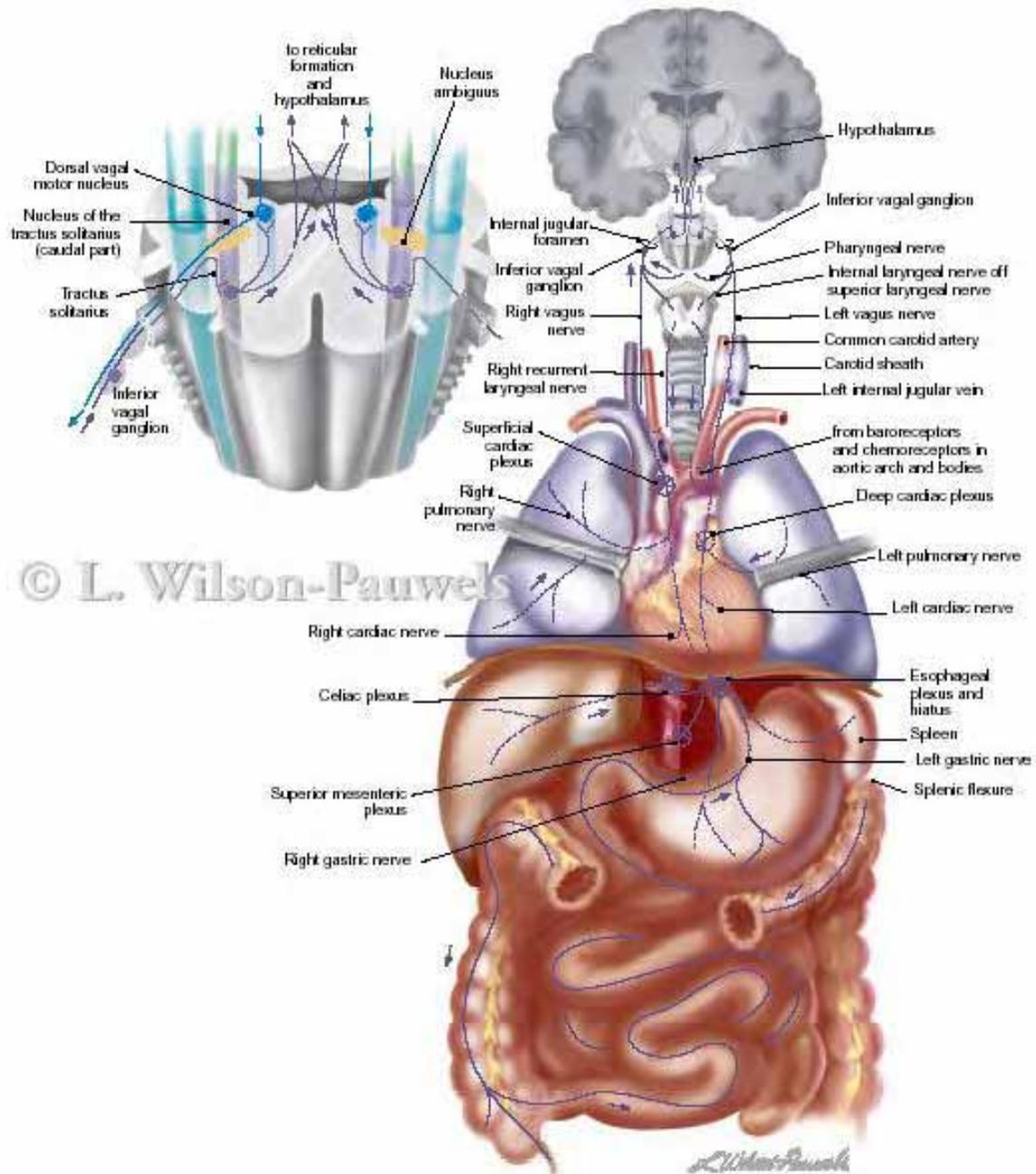


Figure X-7 Visceral sensory component of the vagus nerve.

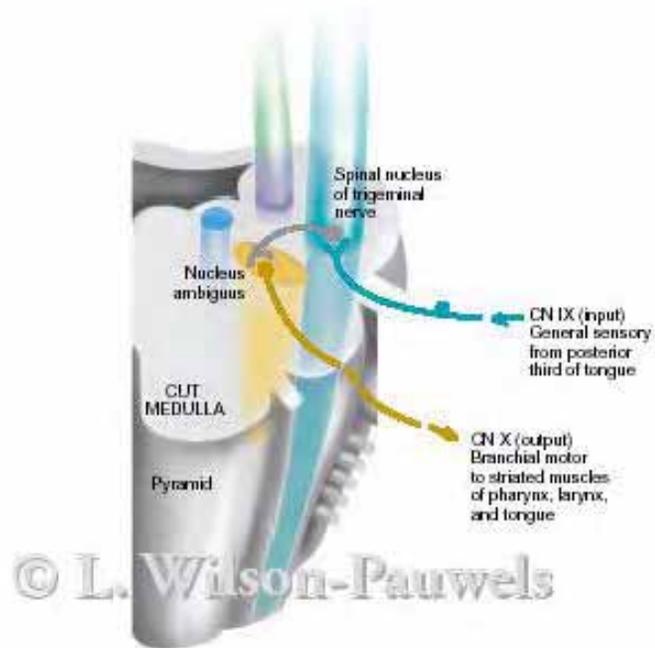


Figure X-12 Gag reflex involving cranial nerve IX (input) and cranial nerve X (output).

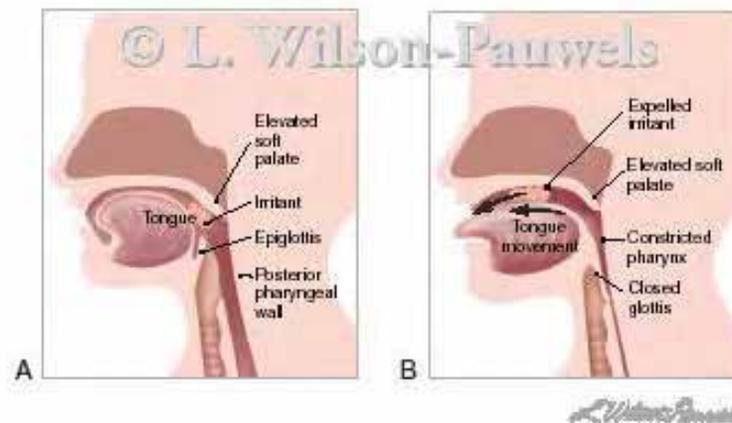


Figure X-13 The gag reflex. *A*, Irritant in the oropharynx stimulates the posterior tongue. As a result, cranial nerve IX's general sensory afferent nerve fibers are stimulated. *B*, A reflex response by cranial nerve X cell bodies in the nucleus ambiguus stimulates branchial motor efferent nerves resulting in elevation of the soft palate, closure of the glottis, and contraction of the pharyngeal wall to expel the foreign object.

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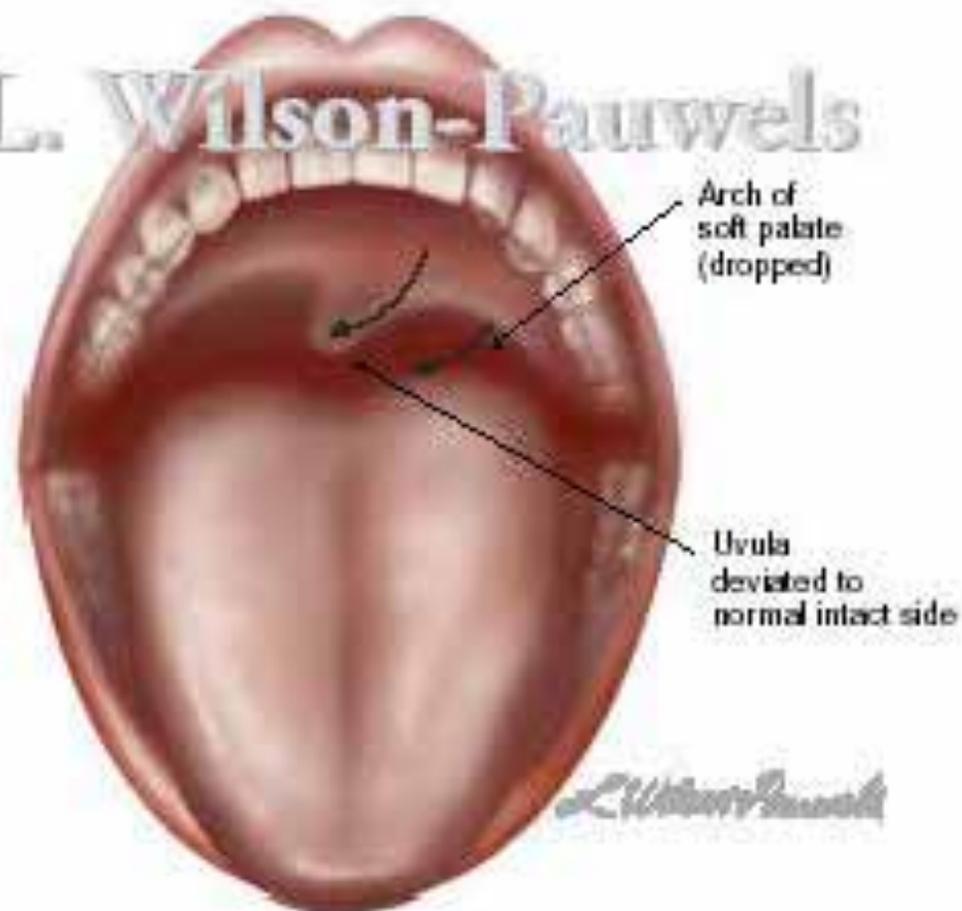


Figure X-14 Lower motor neuron lesion (LMNL) on the left side.