Cranial nerves and their nuclei

鄭海倫　整理

Cranial Nerves

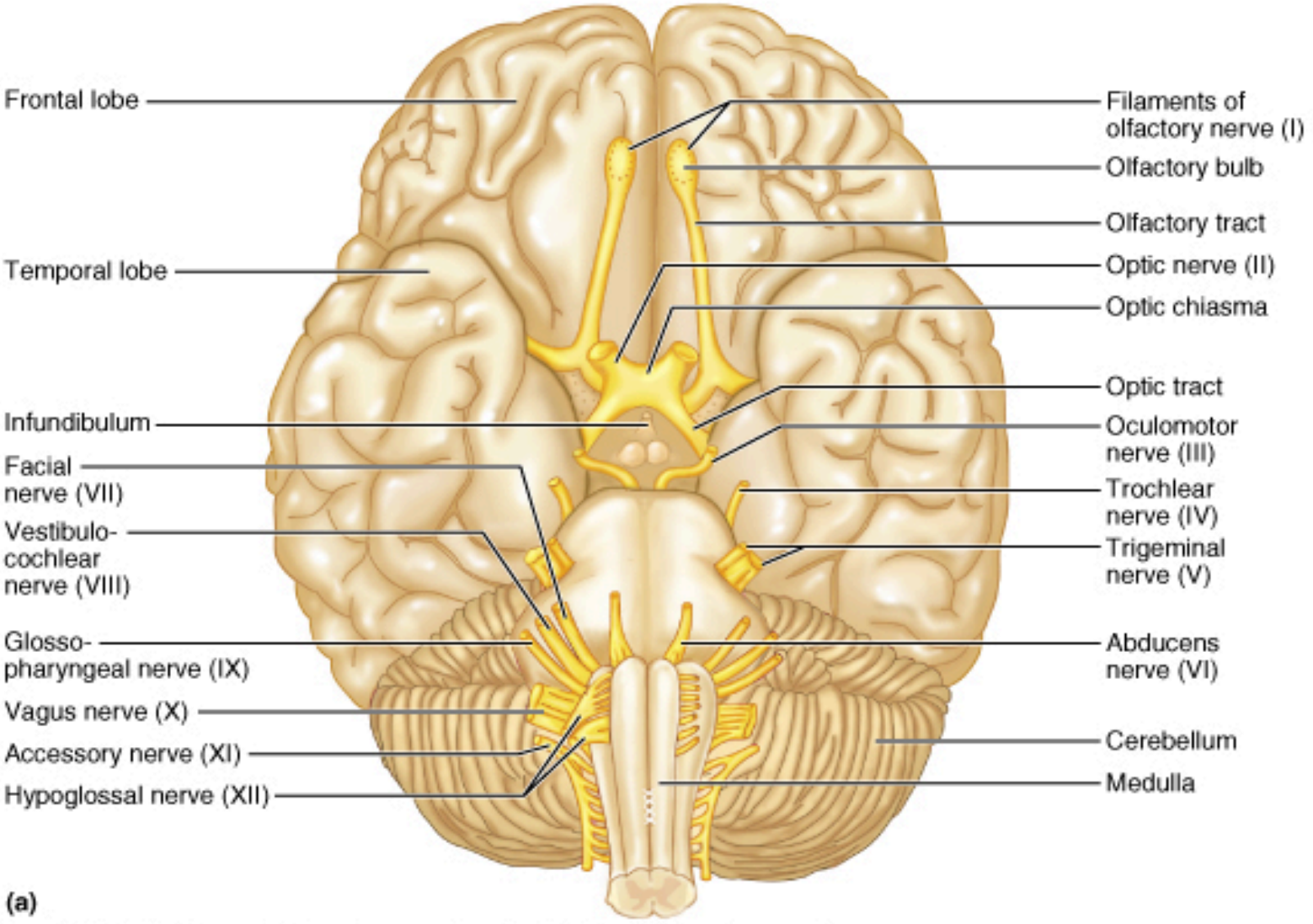


Figure 13.4a

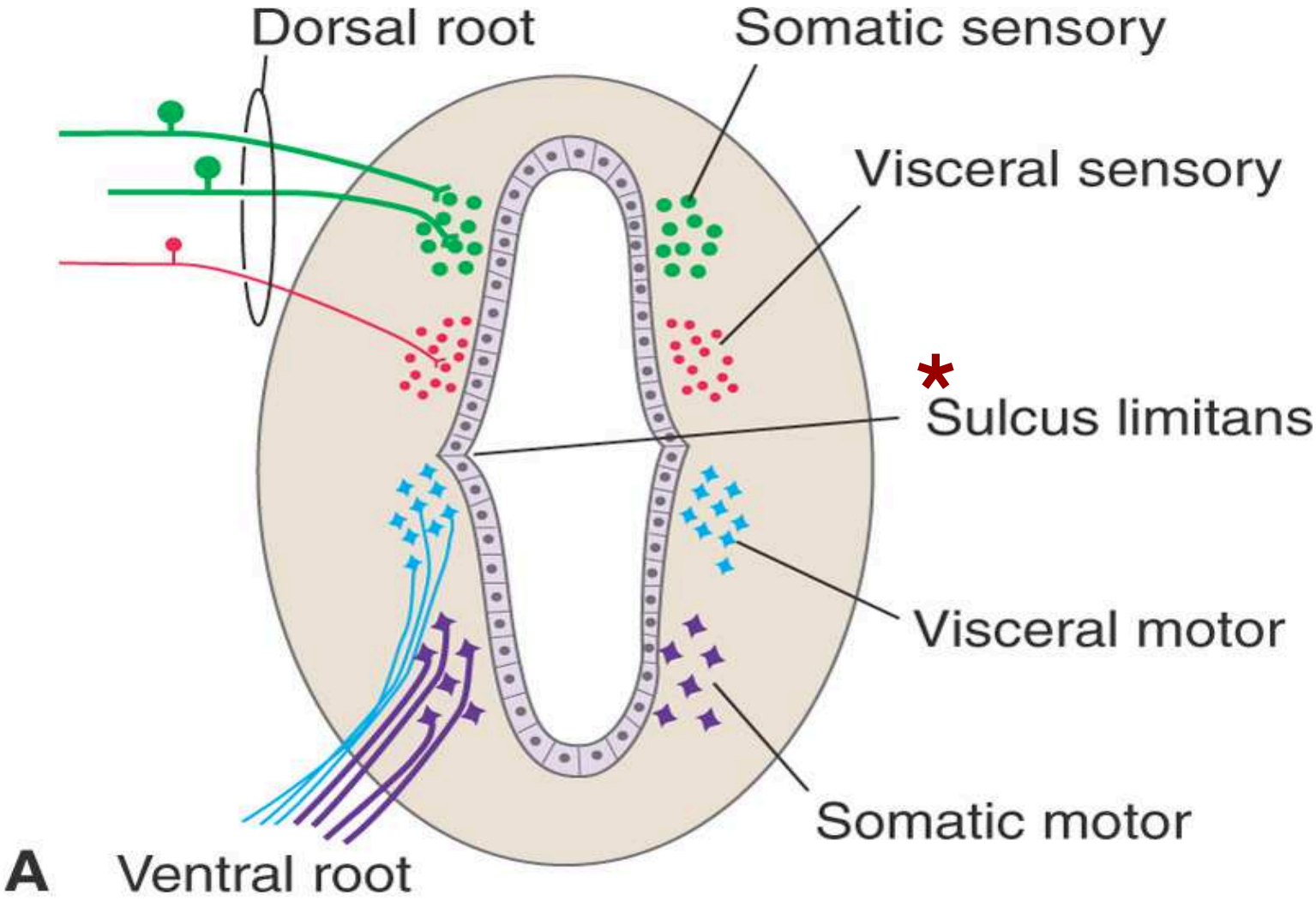
Location of the cranial nerves

- Anterior cranial fossa: C.N. 1–2
- Middle cranial fossa: C.N. 3-6
- Posterior cranial fossa: C.N. 7-12

Functional components in nerves

- General Somatic Efferent
- Special Visceral Afferent
- GSE GSA GVE GVA
- (SSE) SSA SVE SVA

Neuron columns in the embryonic spinal cord



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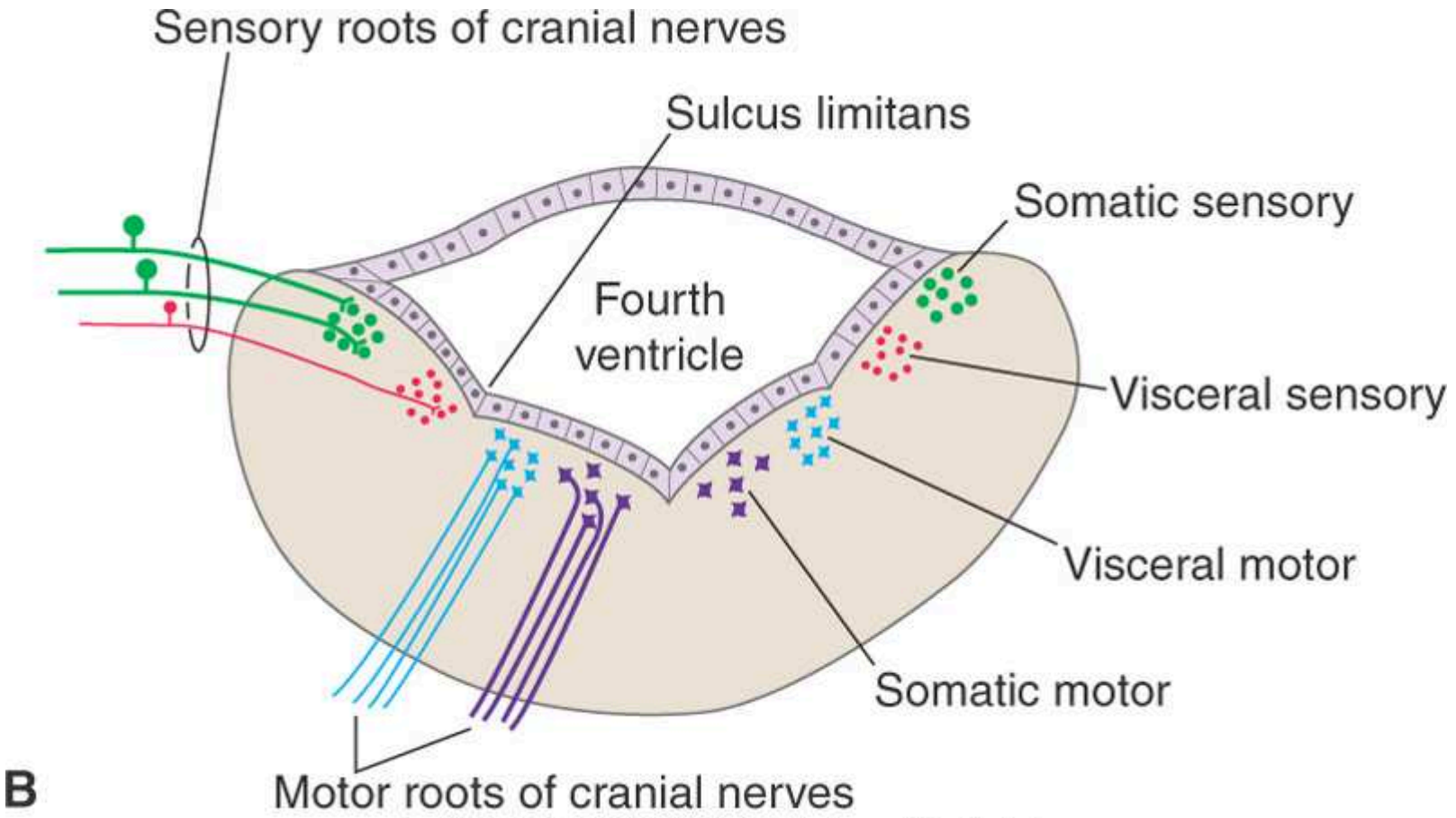
The floor of the 4th ventricle in the embryonic rhombencephalon



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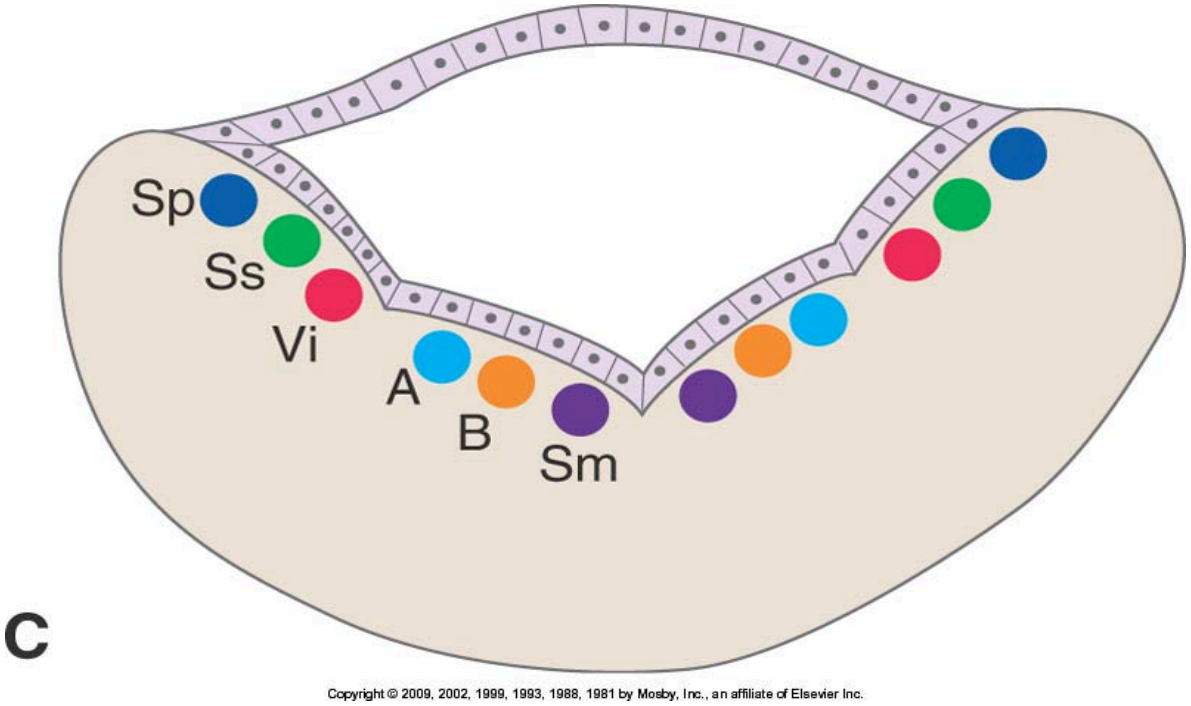

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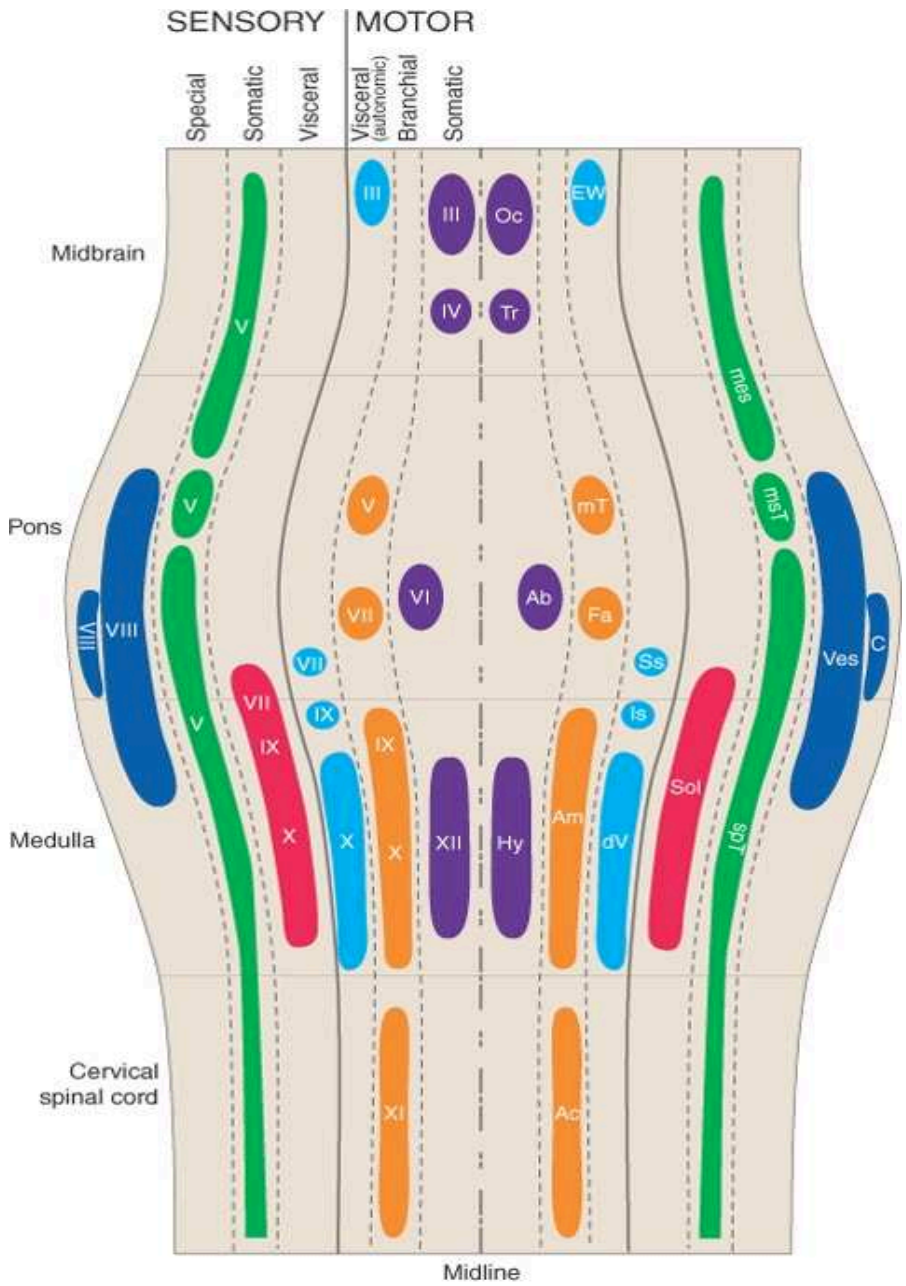
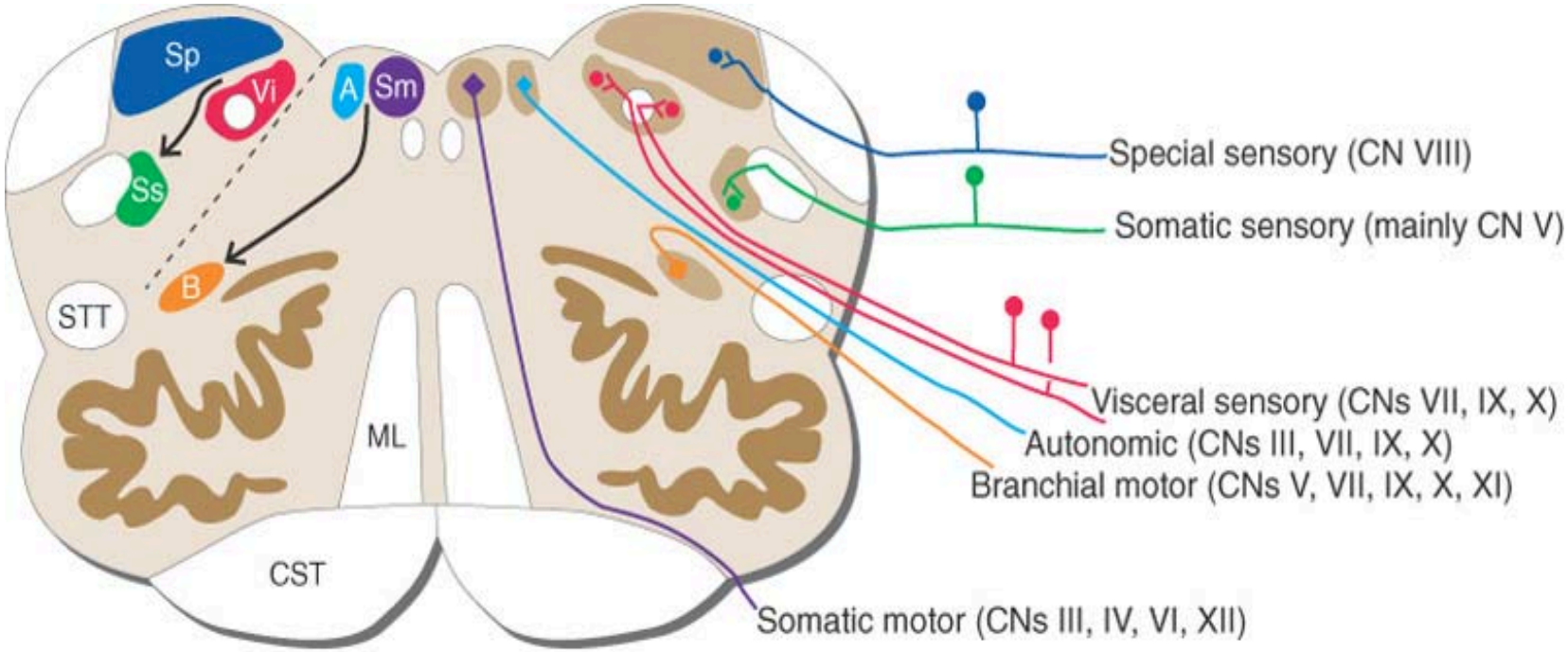
Sp: special sensory
Ss: somatic sensory
Vi: visceral sensory
A: preganglionic autonomic (visceral motor)
B:branchial motor
Sm: somataic motor



(Modified from Nieuwenhuys R et al: The human central nervous system: a synopsis and atlas, *ed 3, New York, 1988, Springer-Verlag.)*



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- STT: spinothalamic tract
- CST: corticospinal tract
- ML: medial lemniscus

Sensory nerve

- Olfactory (1)
- Optic (2)
- Vestibulocochlear (8)

Motor nerve

- Oculomotor (3)
- Trochlear (4)
- Abducens (6)
- Accessory (11)
- Hypoglossal (12)

Mixed nerve

- Trigeminal (5)
- Facial (7)
- Glossopharyngeal (9)
- Vagus (10)

Innervation of branchial muscles

- Trigemial
- Facial
- Glossopharyngeal
- Vagus

Cranial Nerve I: Olfactory

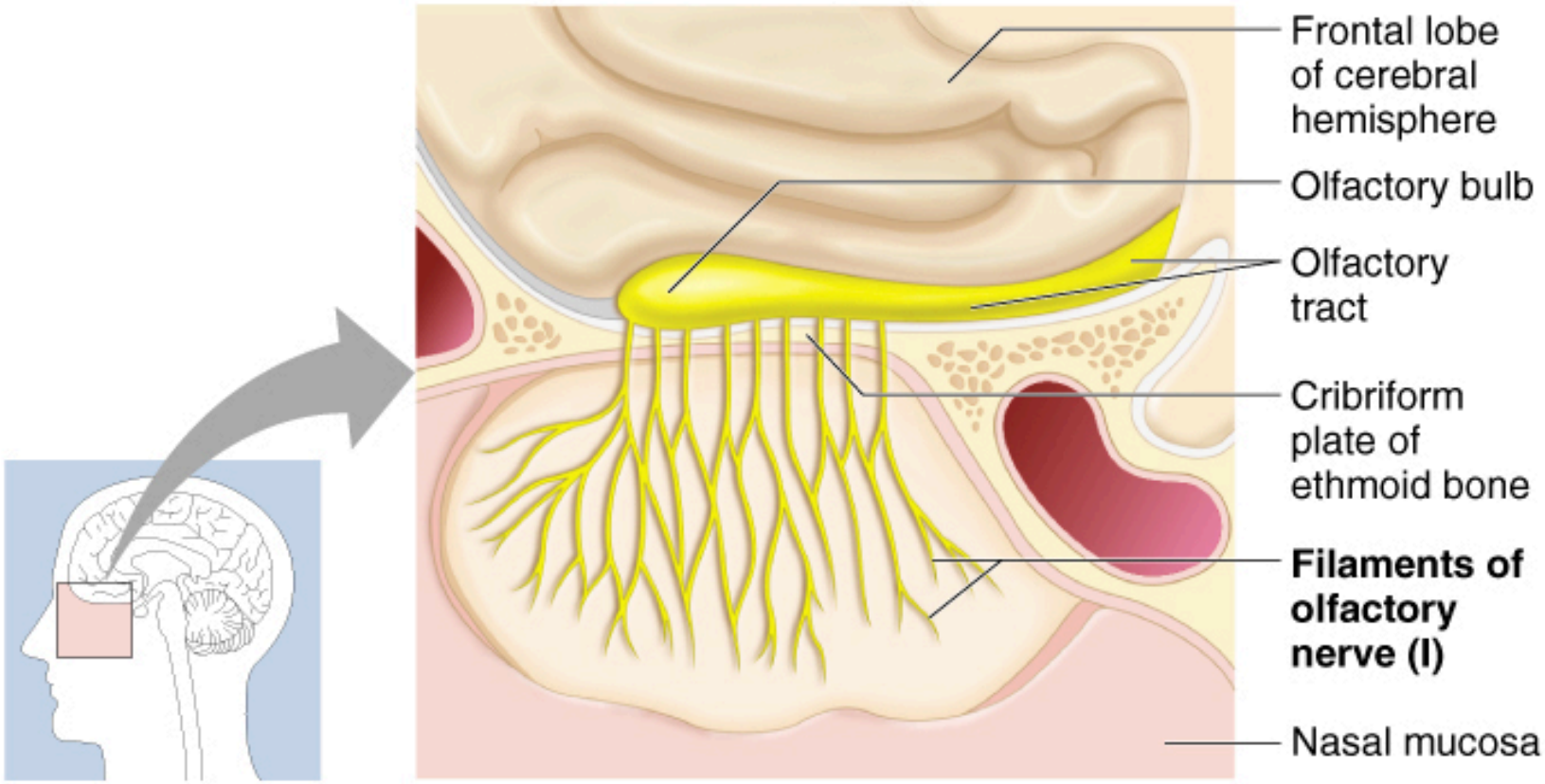


Table 13.2(l)

Cranial Nerve II: Optic

- Arises from the retina of the eye
- Optic nerves pass through the optic canals and converge at the optic chiasm
- They continue to the thalamus **(lateral geniculate body)** where they synapse
- From there, the optic radiation fibers run to the visual cortex **(area 17)**
- Functions solely by carrying afferent impulses for vision

Cranial Nerve II: Optic

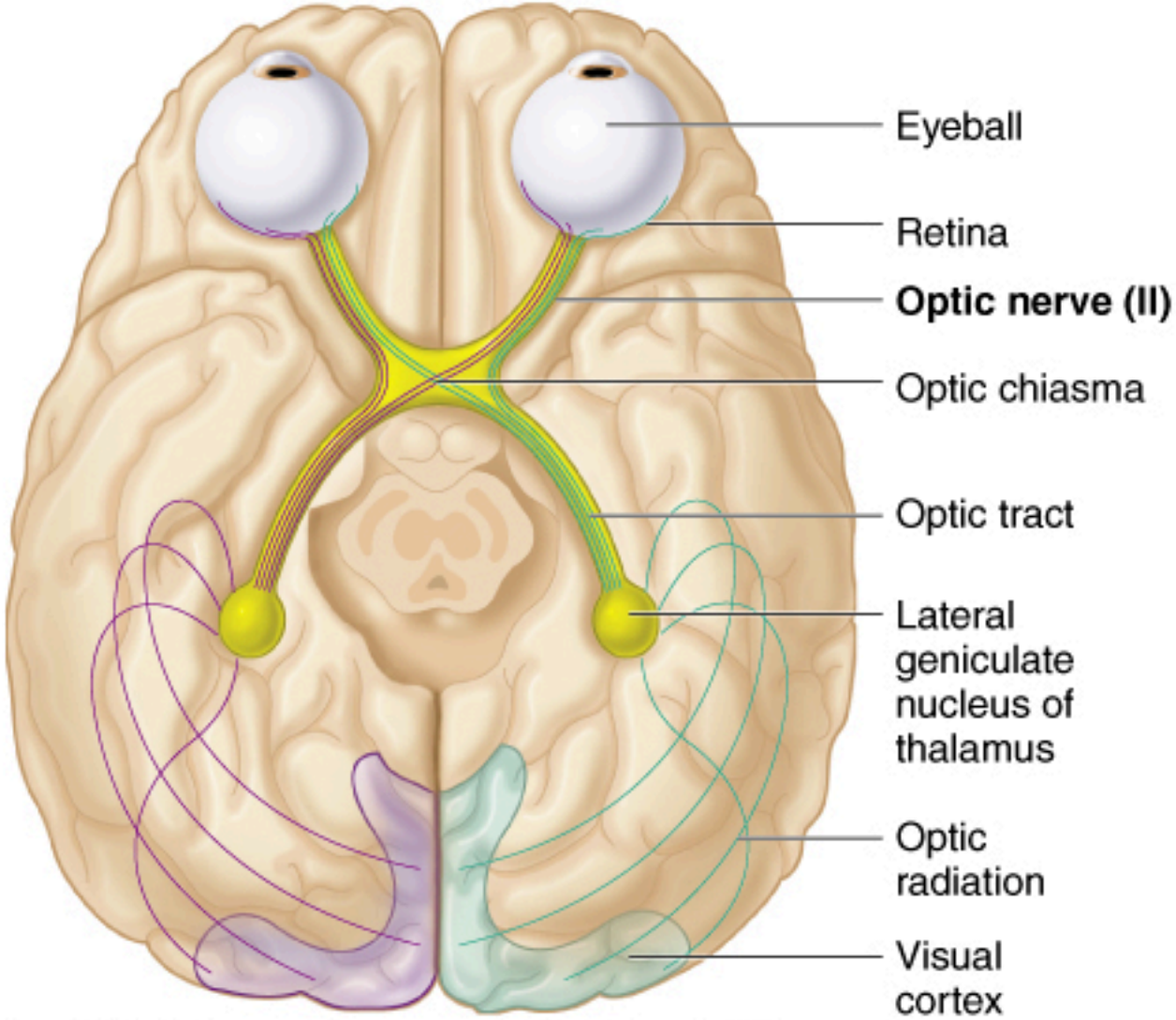


Table 13.2(II)

Cranial Nerve III: Oculomotor

- Fibers extend from the ventral midbrain, pass through the superior orbital fissure, and go to the extrinsic eye muscles
- Functions in raising the eyelid, directing the eyeball, constricting the iris, and controlling lens shape

Cranial Nerve III: Oculomotor

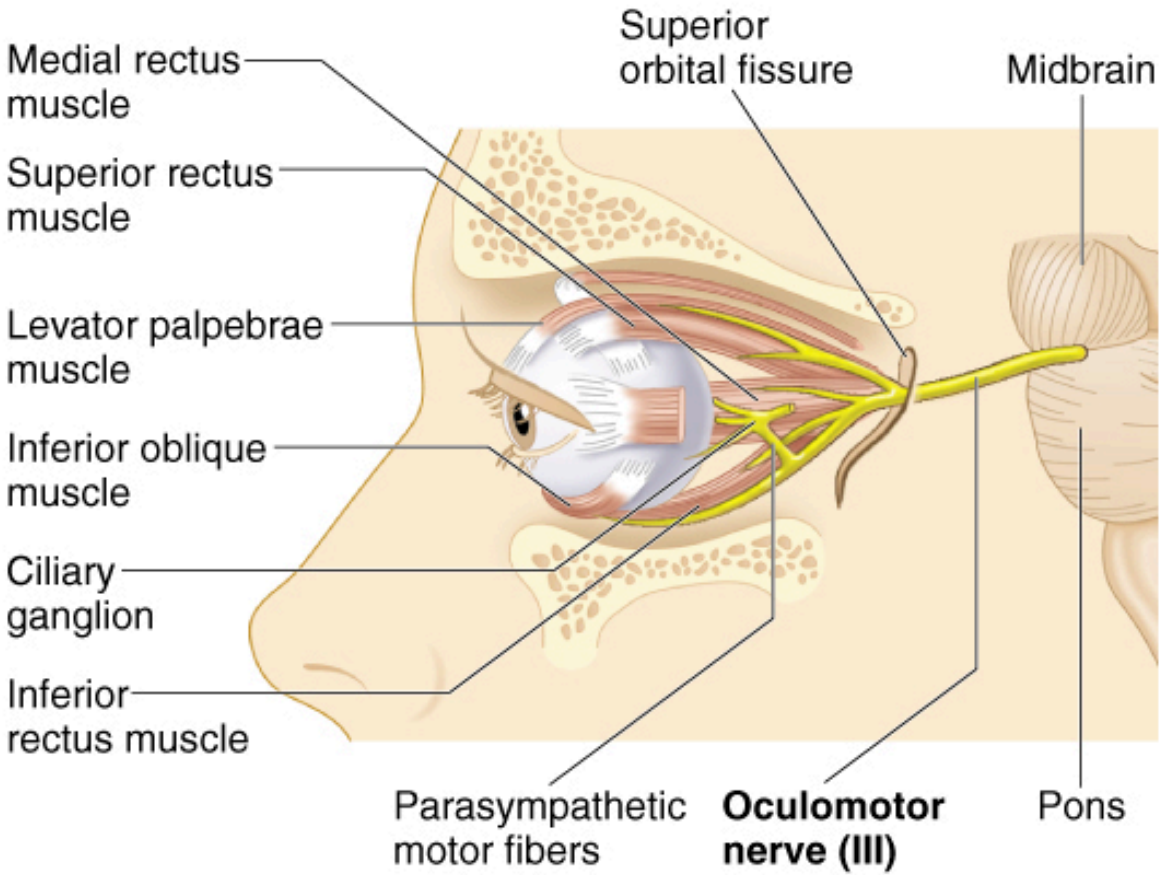


Table 13.2(III)

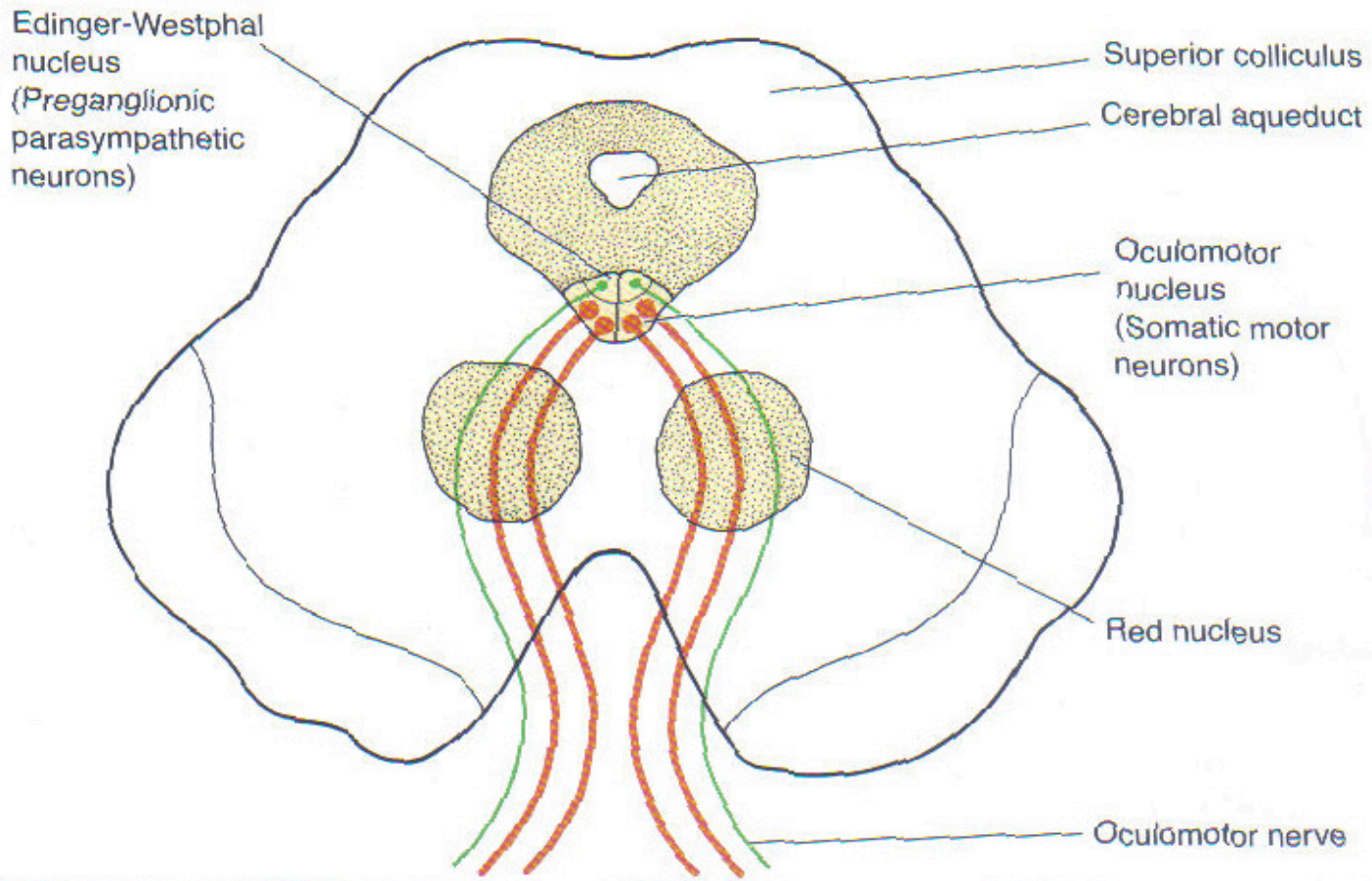


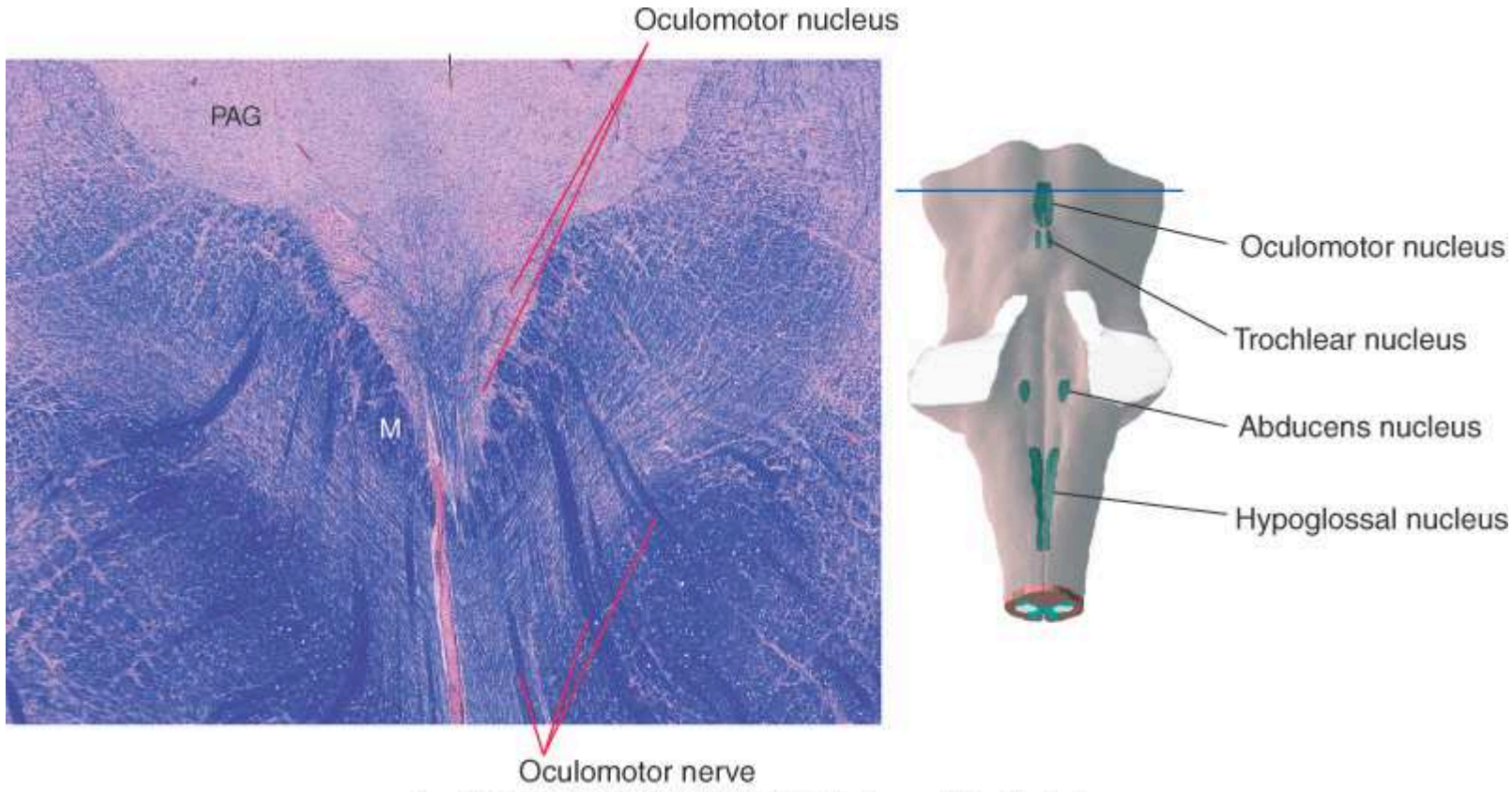
FIGURE 8-2 *Origins of the oculomotor nerves in the midbrain at the level of the superior colliculus. Motor neurons are red; preganglionic parasympathetic neurons are green.*

1.Oculomotor nucleus (GSE)

- Motor to ocular muscles: rectus (superior對側, inferior同側and medial同側),inferior oblique同側, levator palpebrae superioris雙側

2. Edinger-Westphal nucleus (GVE)

- to ciliary ganglion → ciliarlis and sphincter pupillae muscles



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Oculomotor nucleus: a series of cell columns or subnuclei

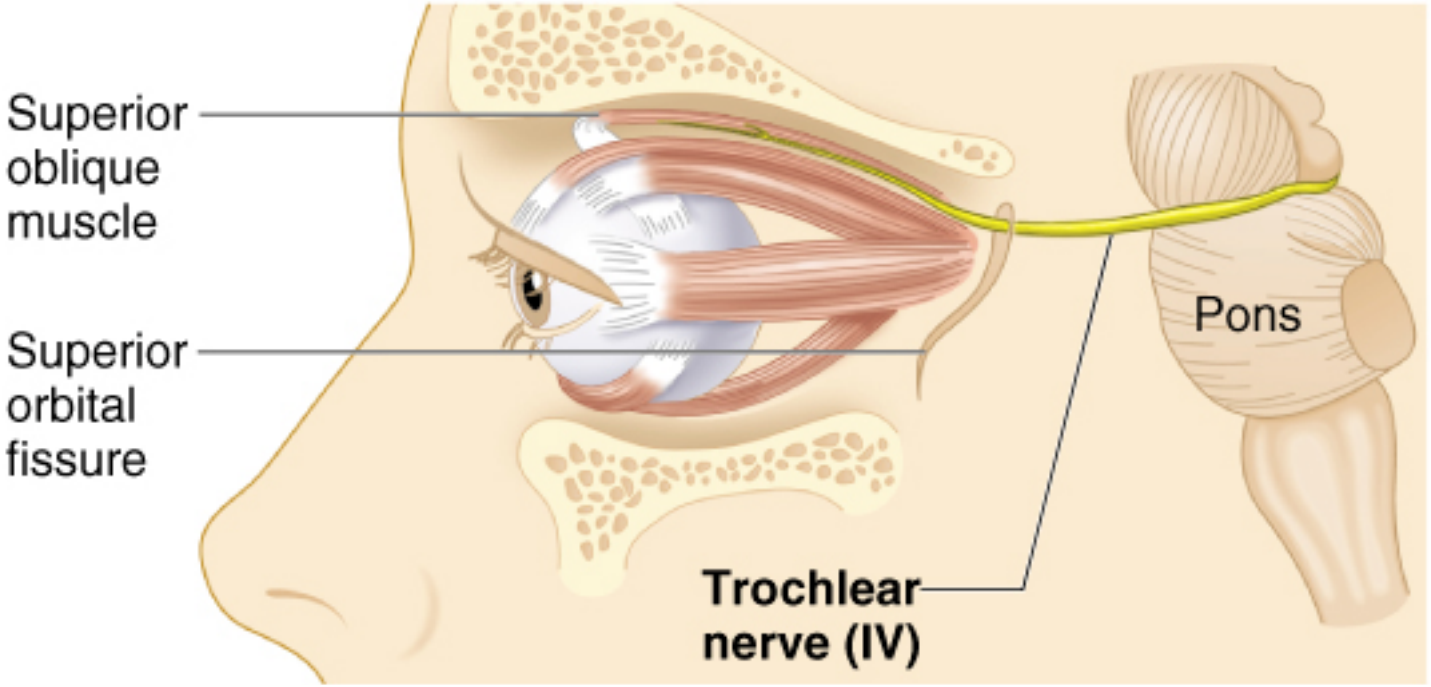
M: medial longitudinal fasciculus

PAG: periaqueductal gray

Cranial Nerve IV: Trochlear

- Fibers emerge from the dorsal midbrain and enter the orbits via the superior orbital fissures; innervate the superior oblique muscle
- Primarily a motor nerve that directs the eyeball

Cranial Nerve IV: Trochlear



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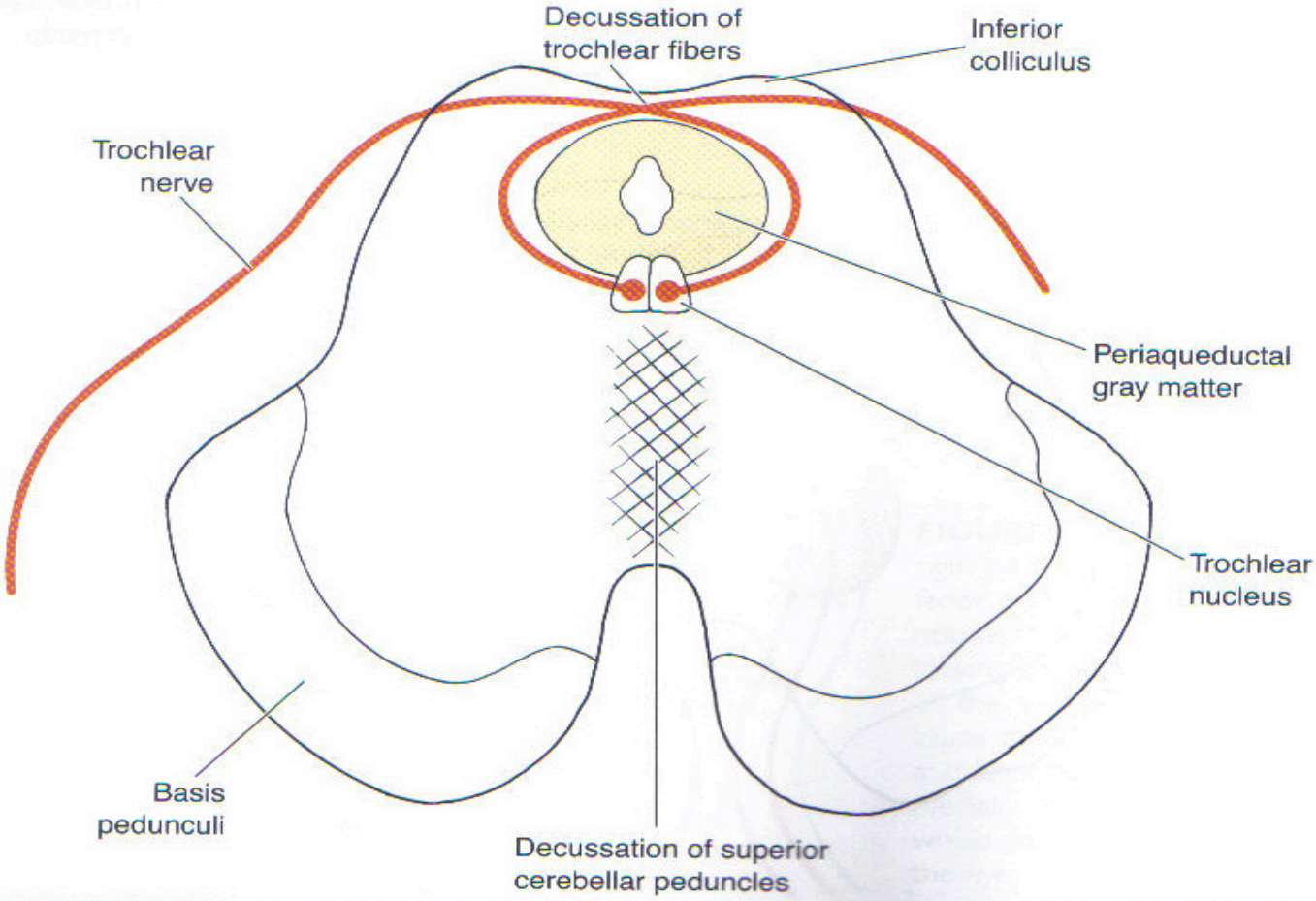
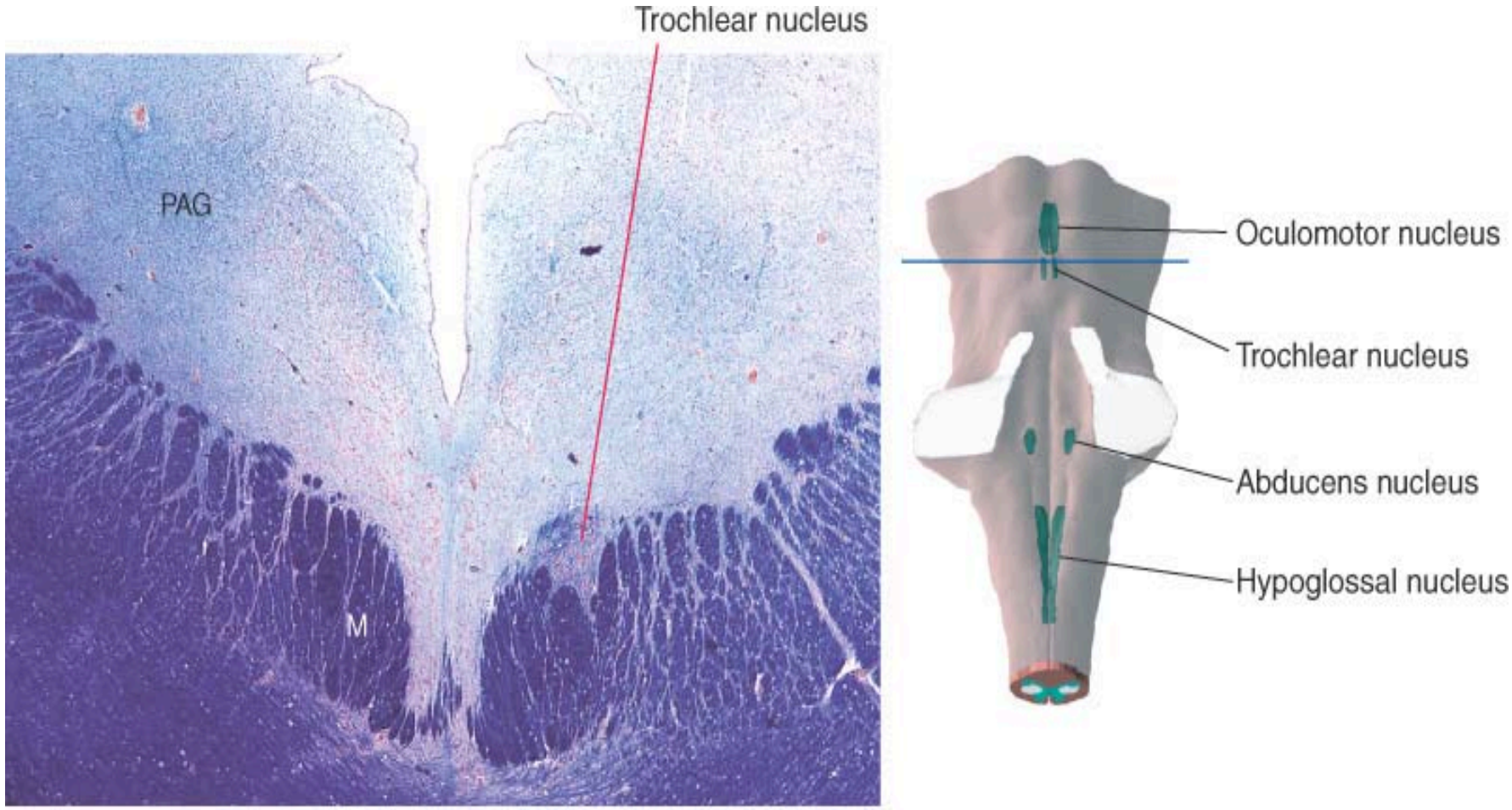


FIGURE 8-3 Origins of the trochlear nerves in the midbrain. The axons from the left and right trochlear nuclei are directed dorsally and caudally; they decussate in the superior medullary velum, which is below the inferior colliculi.



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Trochlear nucleus (GSE)

- To contralateral (對側) superior oblique muscle
- Located at the level of the inferior colliculus
- It indents the medial longitudinal fasciculus

Cranial Nerve VI: Abducens

- Fibers leave the inferior pons and enter the orbit via the superior orbital fissure
- Primarily a motor nerve innervating the lateral rectus muscle

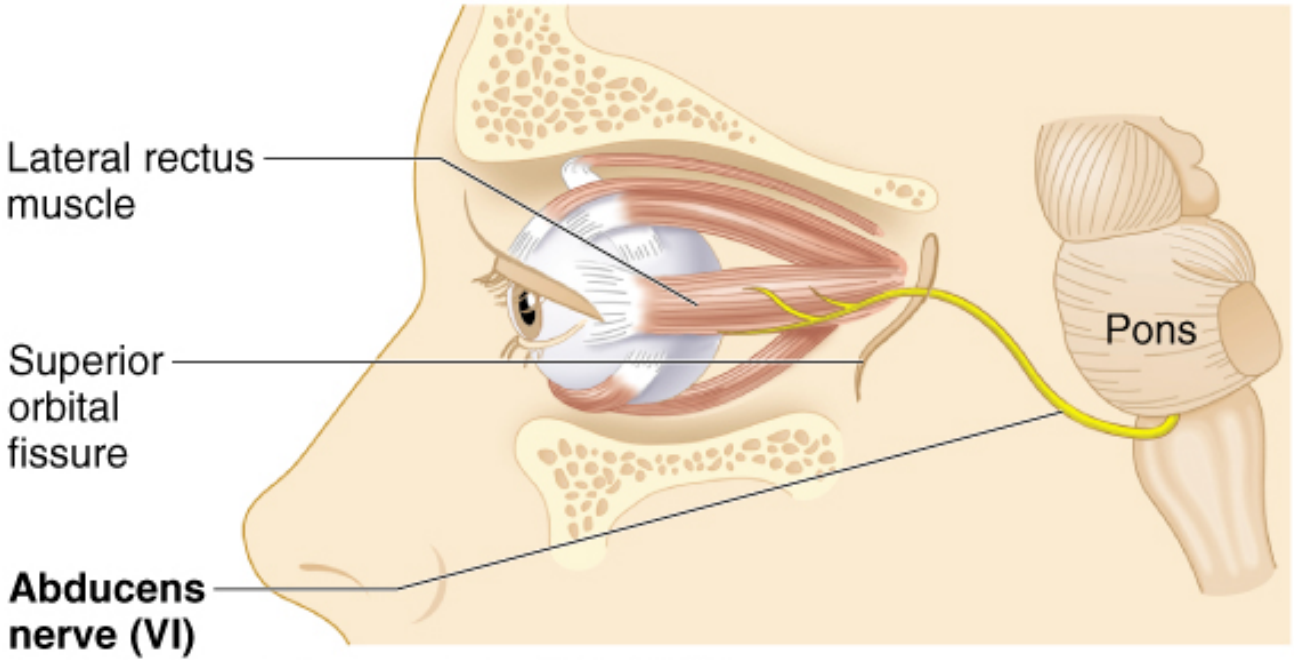


Table 13.2(VI)

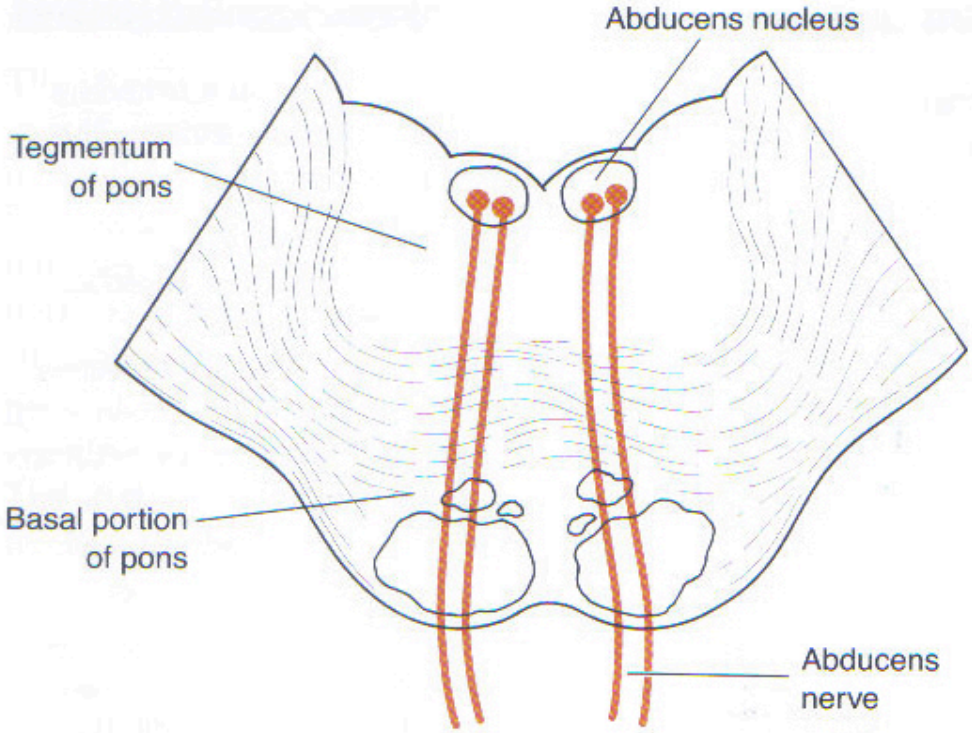
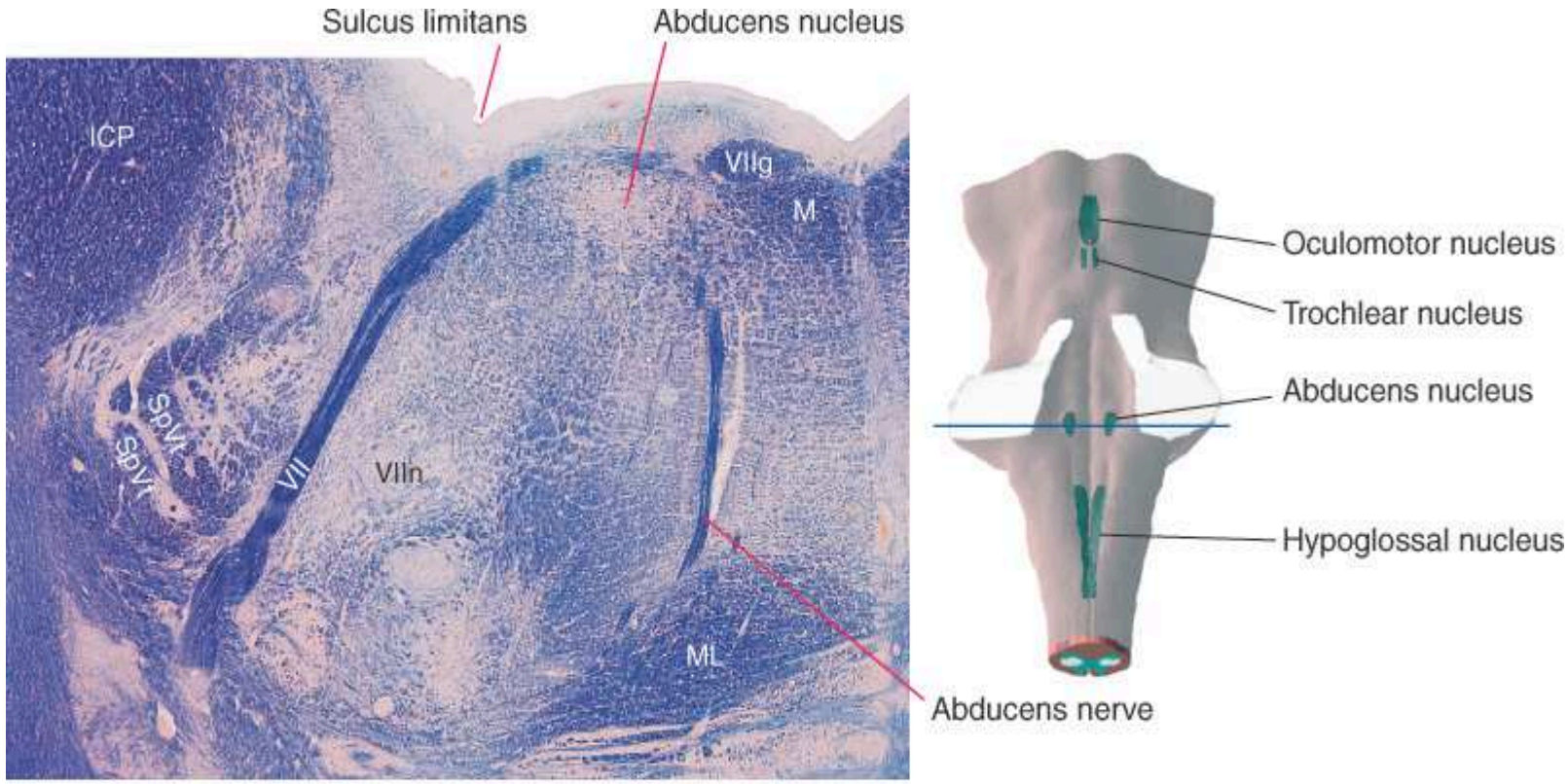


FIGURE 8-4 Origins of the abducens nerves in the caudal part of the pons.

Abducens nucleus (GSE)

- To lateral rectus muscle
- Located in the caudal pons beneath the floor of the 4th ventricle



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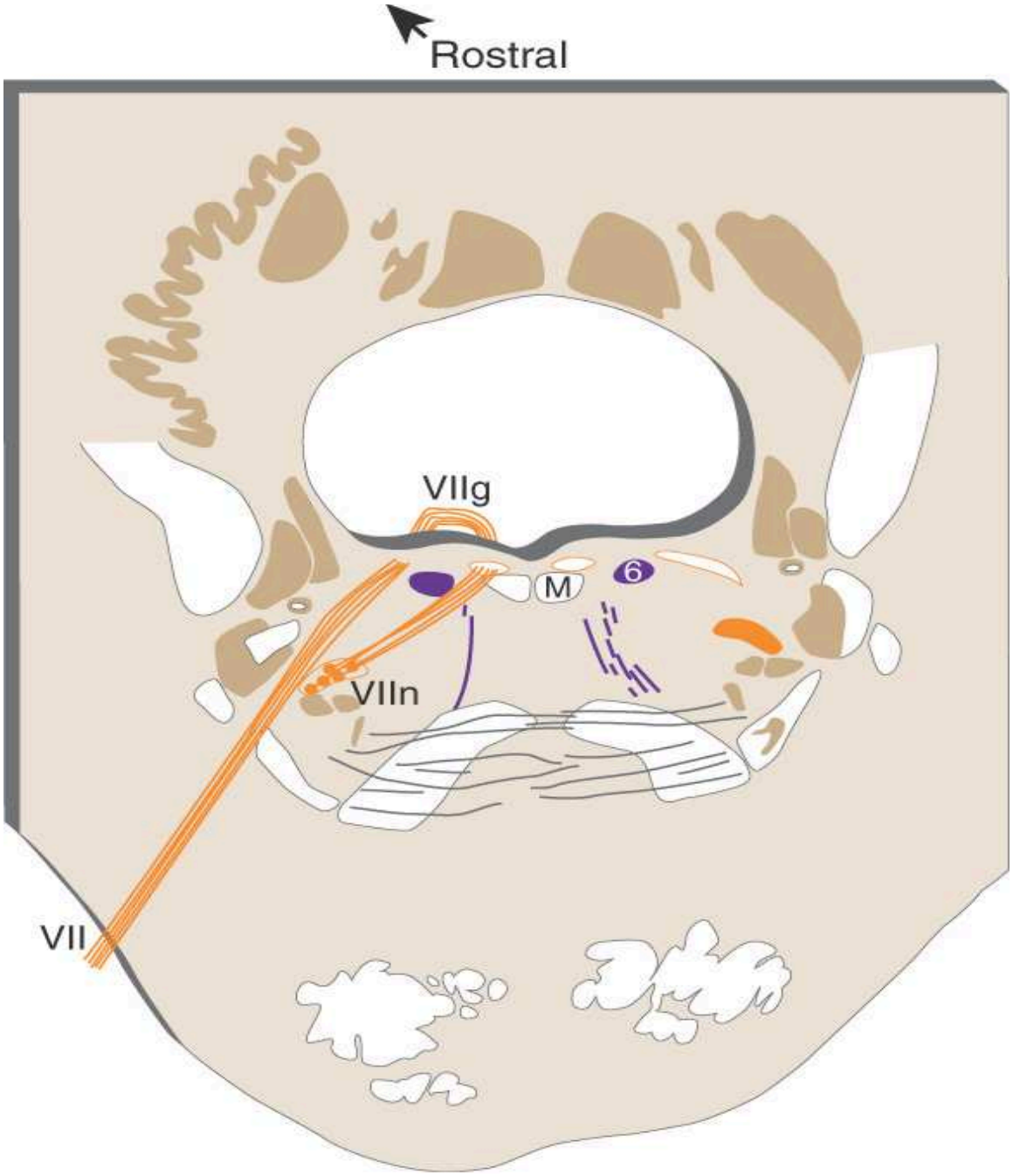
ICP: inferior cerebellar peduncle ML: medial lemniscus
SpVt: spinal trigeminal tract
VII: facial nerve
VIIg: internal genu of the facial nerve
VIIn: facial motor nucleus



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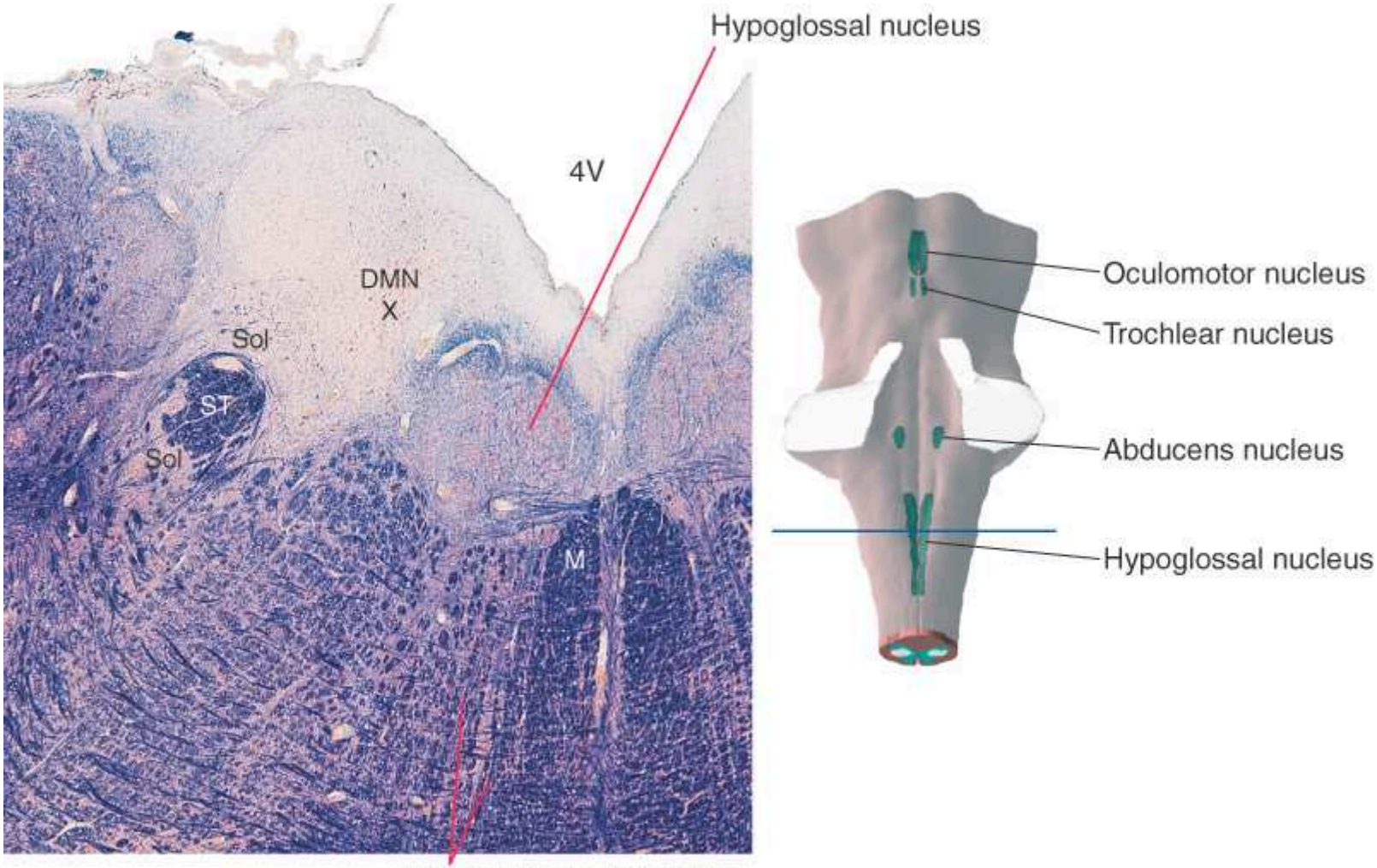

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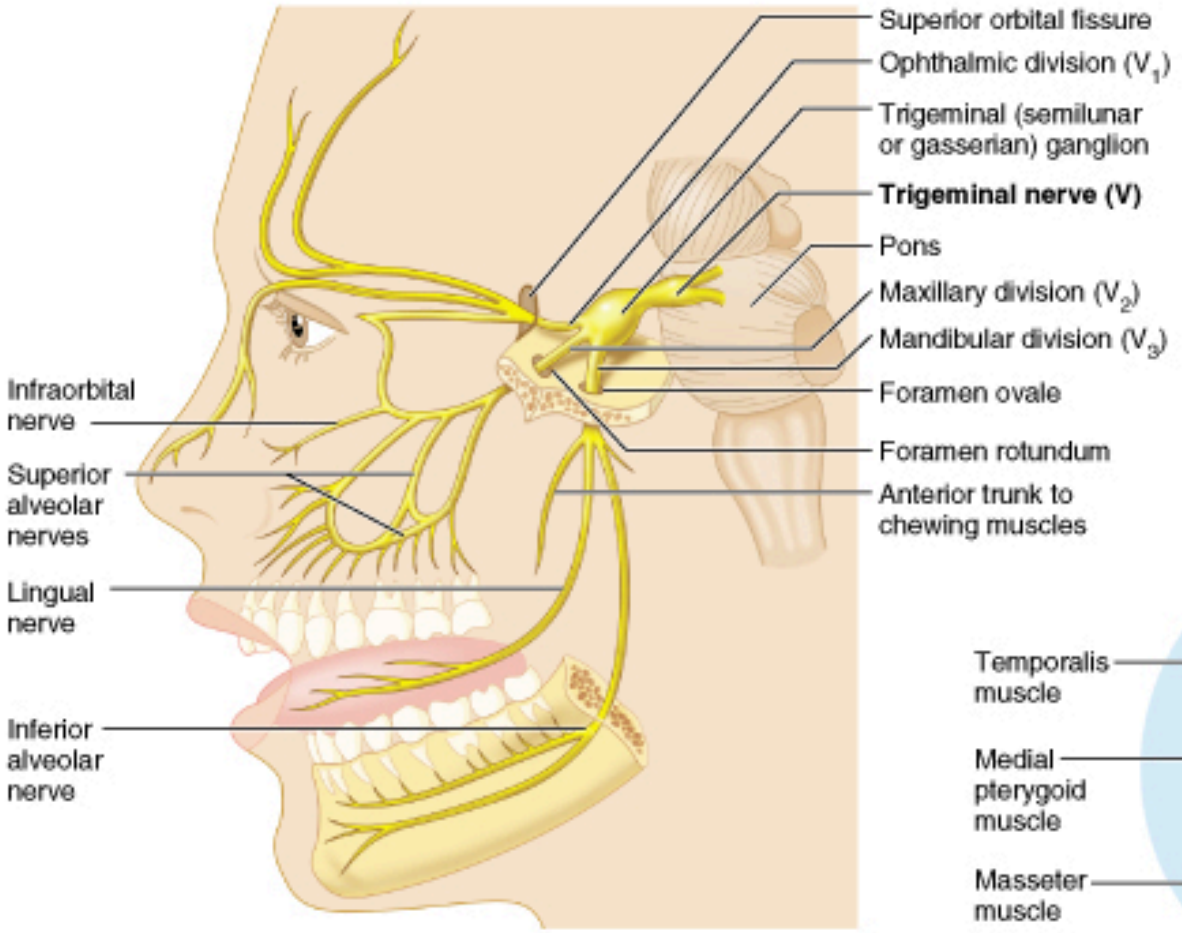
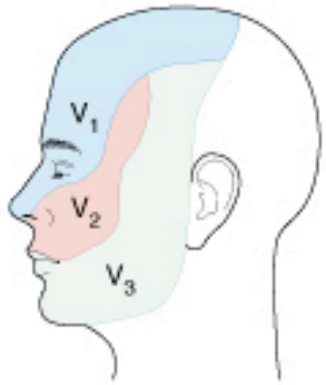
DMN X: dorsal motor nucleus of the vagus
ST: solitary tract Sol: nucleus of the solitary tract
4V: 4th ventricle

Cranial Nerve V: Trigeminal

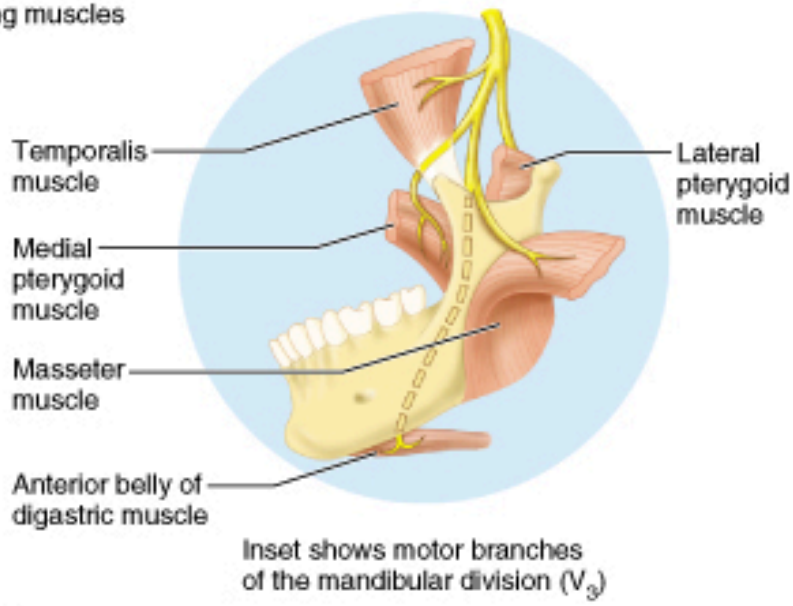
- Composed of three divisions: ophthalmic (V_1), maxillary (V_2), and mandibular (V_3)
- Fibers run from the face to the pons via the superior orbital fissure (V_1), the foramen rotundum (V_2), and the foramen ovale (V_3)
- Conveys sensory impulses from various areas of the face (V_1) and (V_2), and supplies motor fibers (V_3) for mastication

Cranial Nerve V: Trigeminal



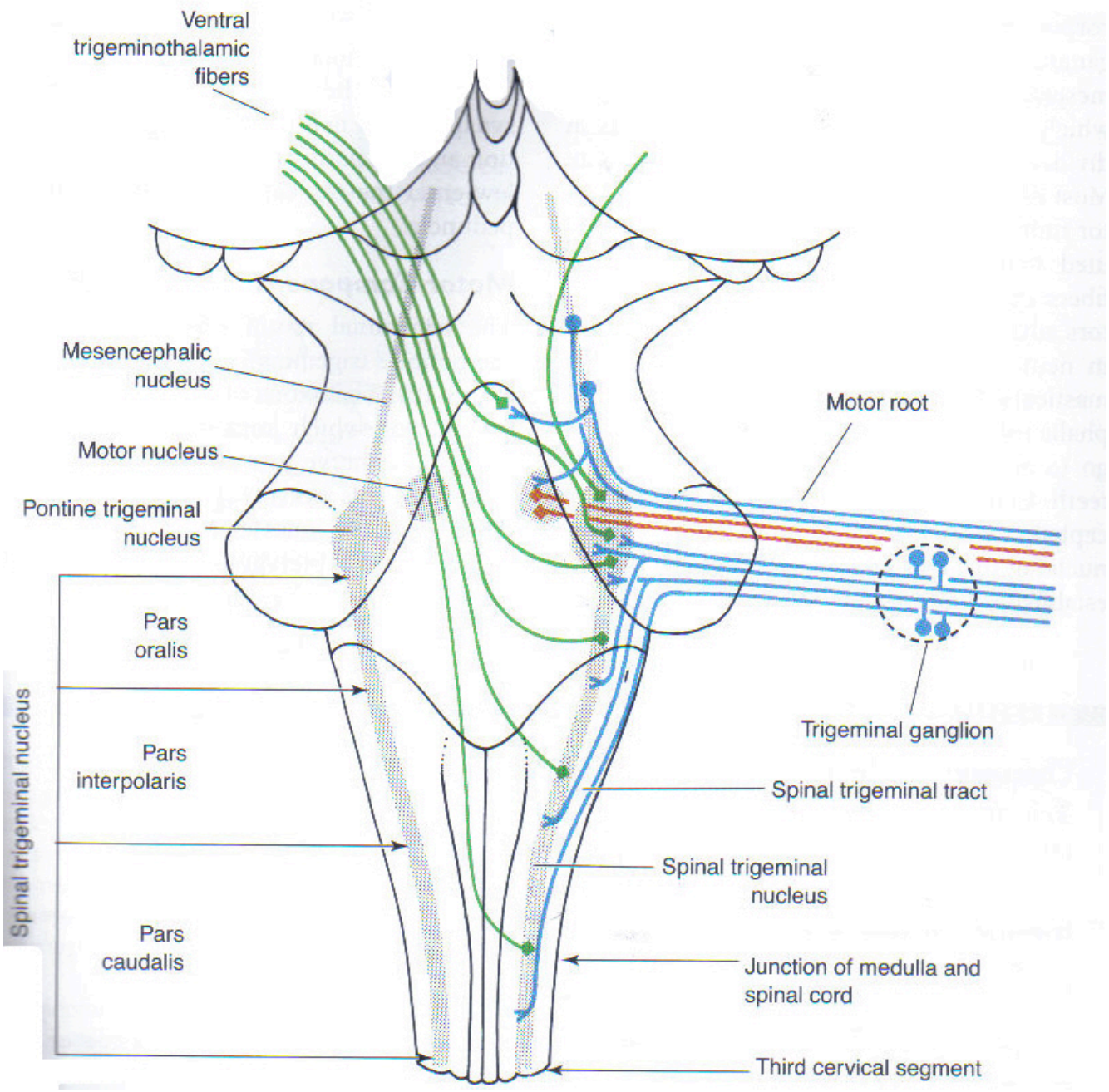


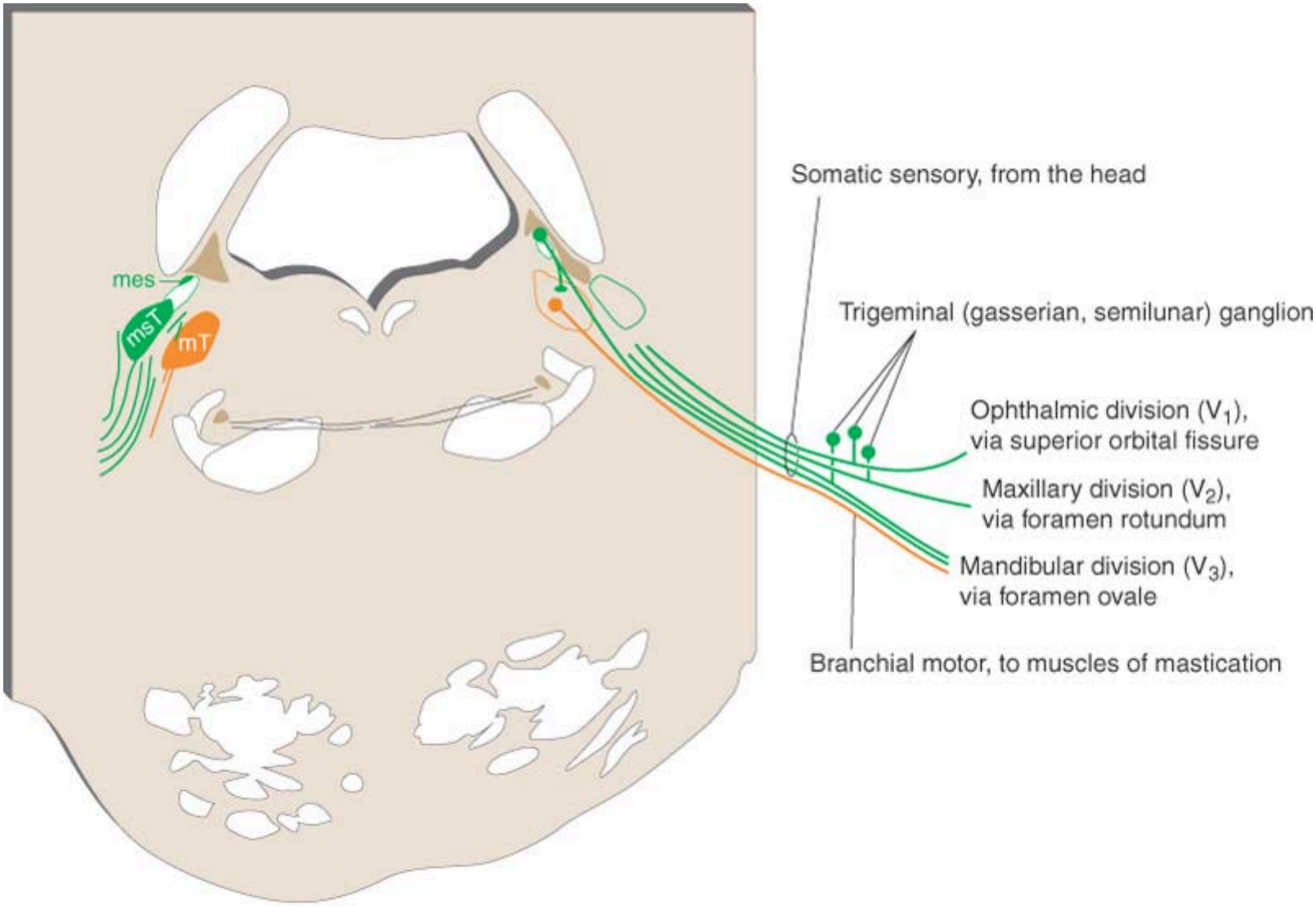
Distribution of sensory fibers of each division



Inset shows motor branches of the mandibular division (V_3)

Table 13.2(V)


Ventral trigeminothalamic fibers
Mesencephalic nucleus
Motor nucleus
Pontine trigeminal nucleus
Pars oralis
Pars interpolaris
Pars caudalis
Spinal trigeminal nucleus
Motor root
Trigeminal ganglion
Spinal trigeminal tract
Spinal trigeminal nucleus
Junction of medulla and spinal cord
Third cervical segment



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1. Main sensory nucleus

2. Nucleus of the spinal trigeminal:

receives information of pain and temperature

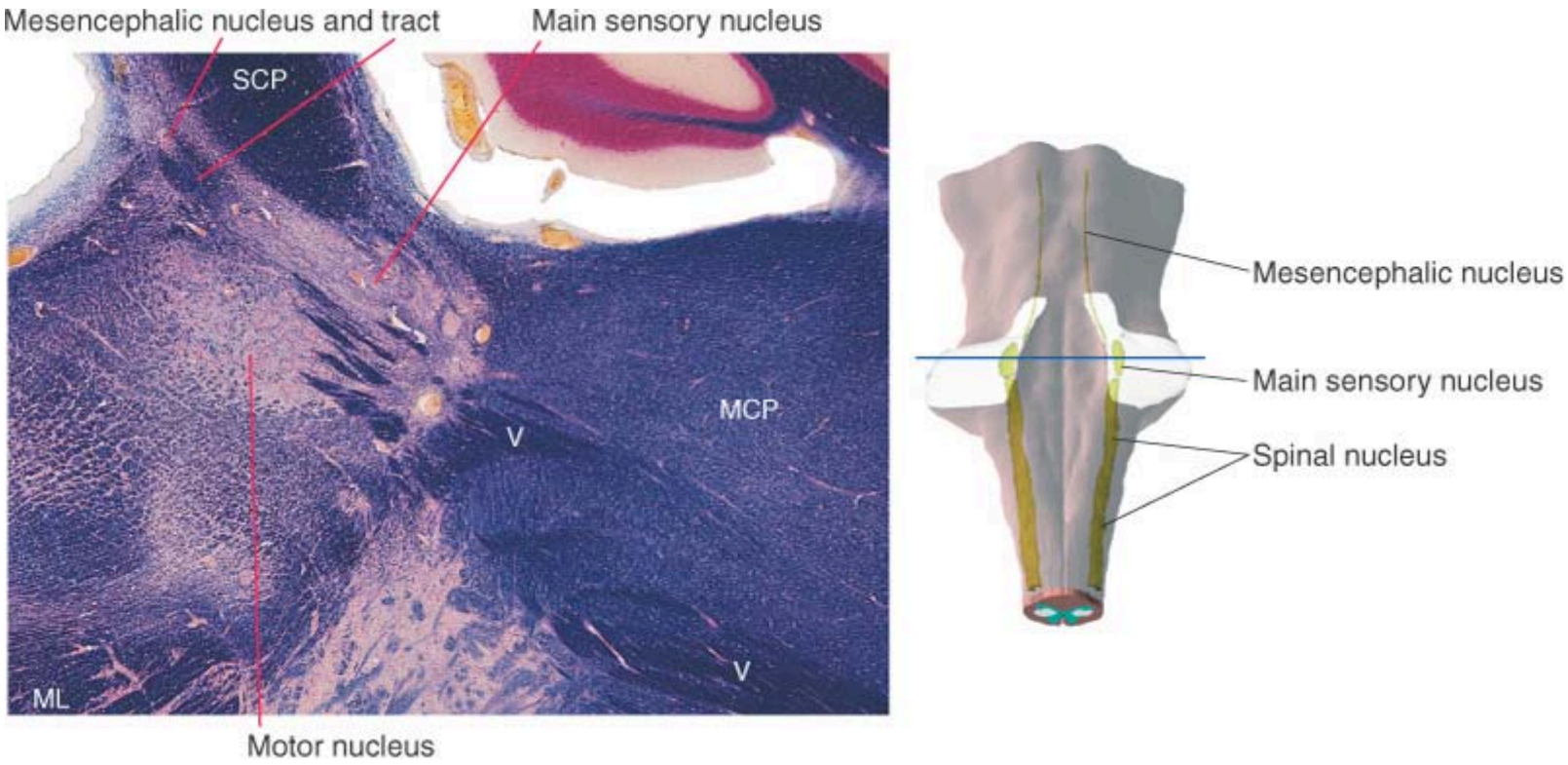
3. Mesencephalic nucleus

Central processes → motor nuclei of trigeminal

Peripheral processes → mandibular division

4. Trigeminal motor nucleus (SVE):

inervates muscles of mastication



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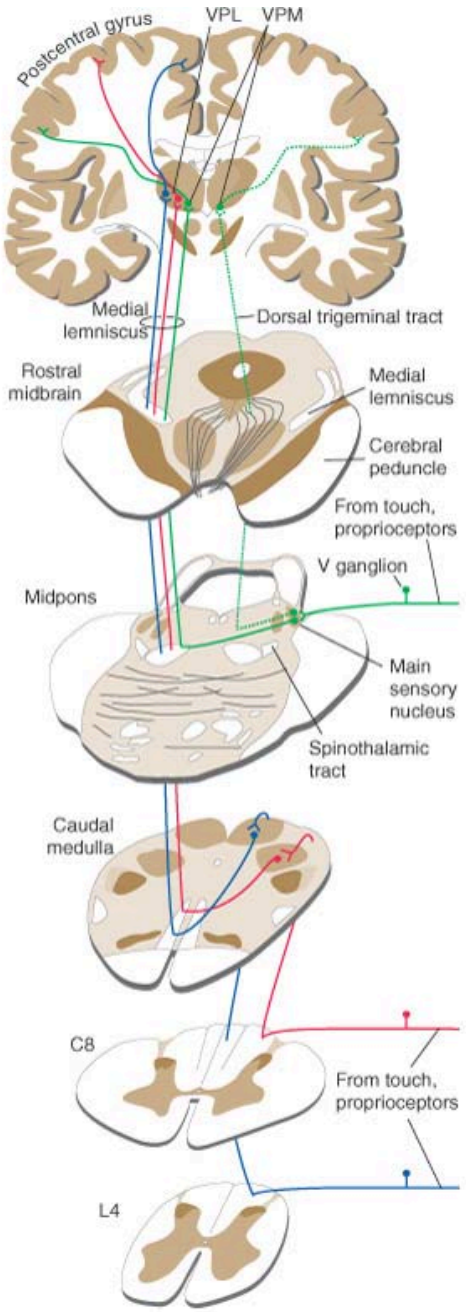
SCP: superior cerebellar peduncle
MCP: middle cerebellar peduncle
V: trigeminal nerve



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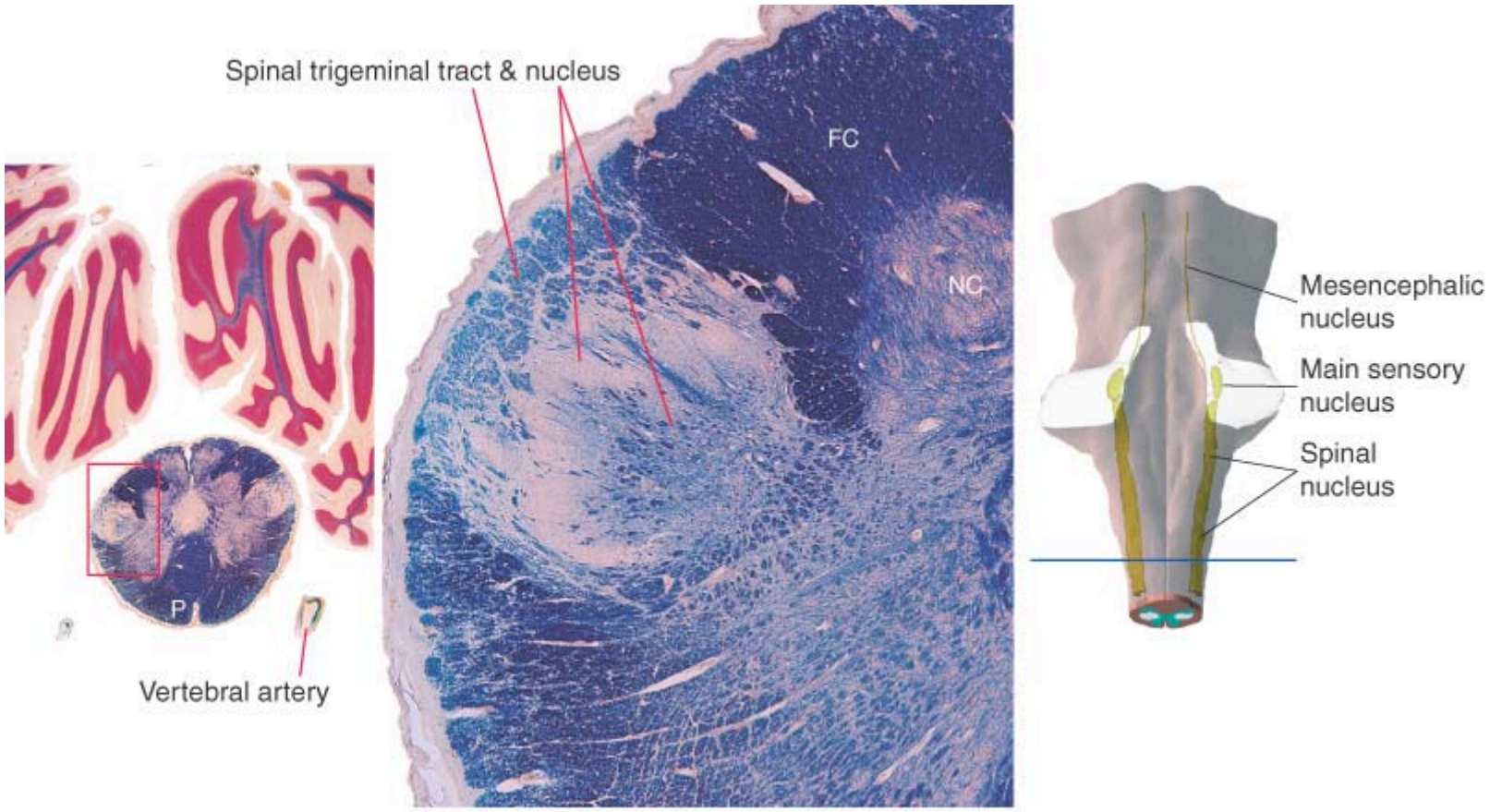

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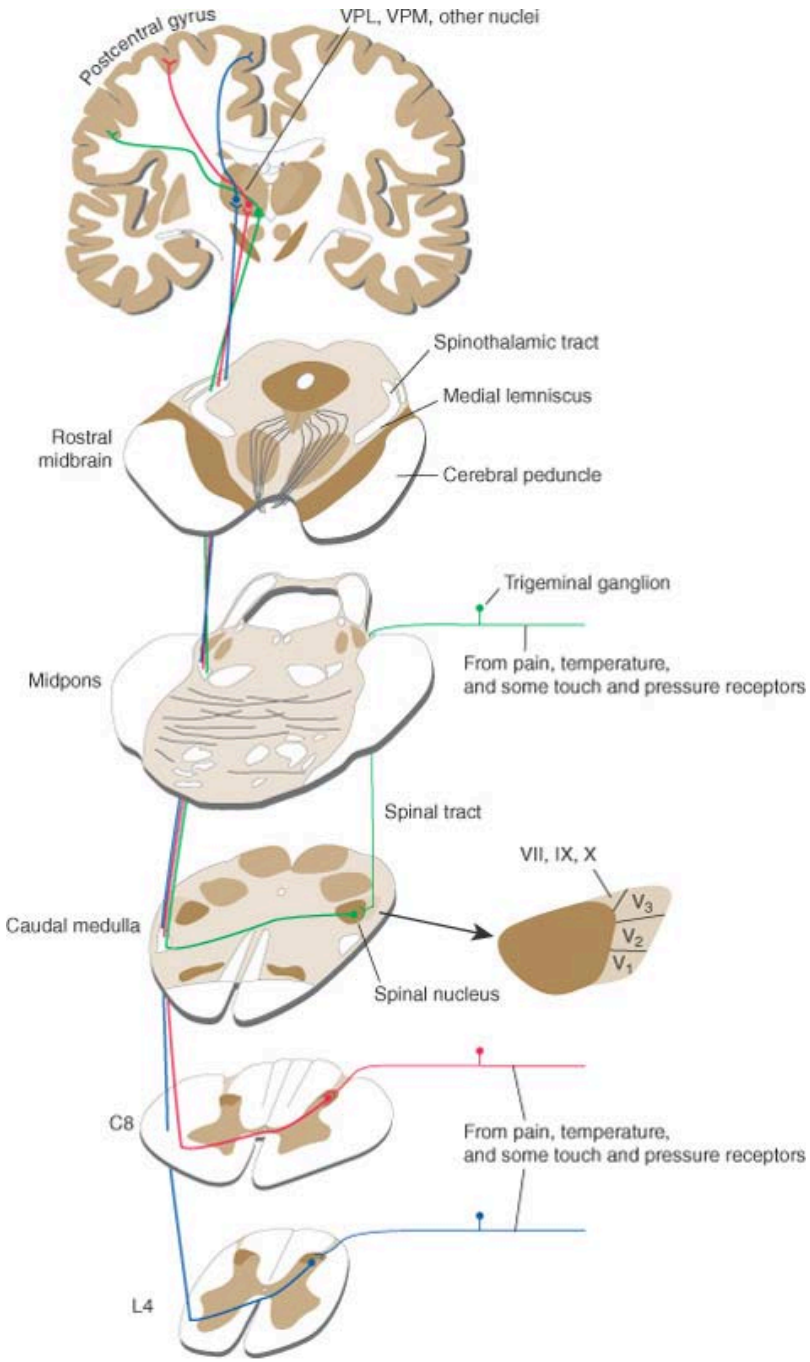
P: pyramid
FC: fasciculus cuneatus
NC: nucleus cuneatus



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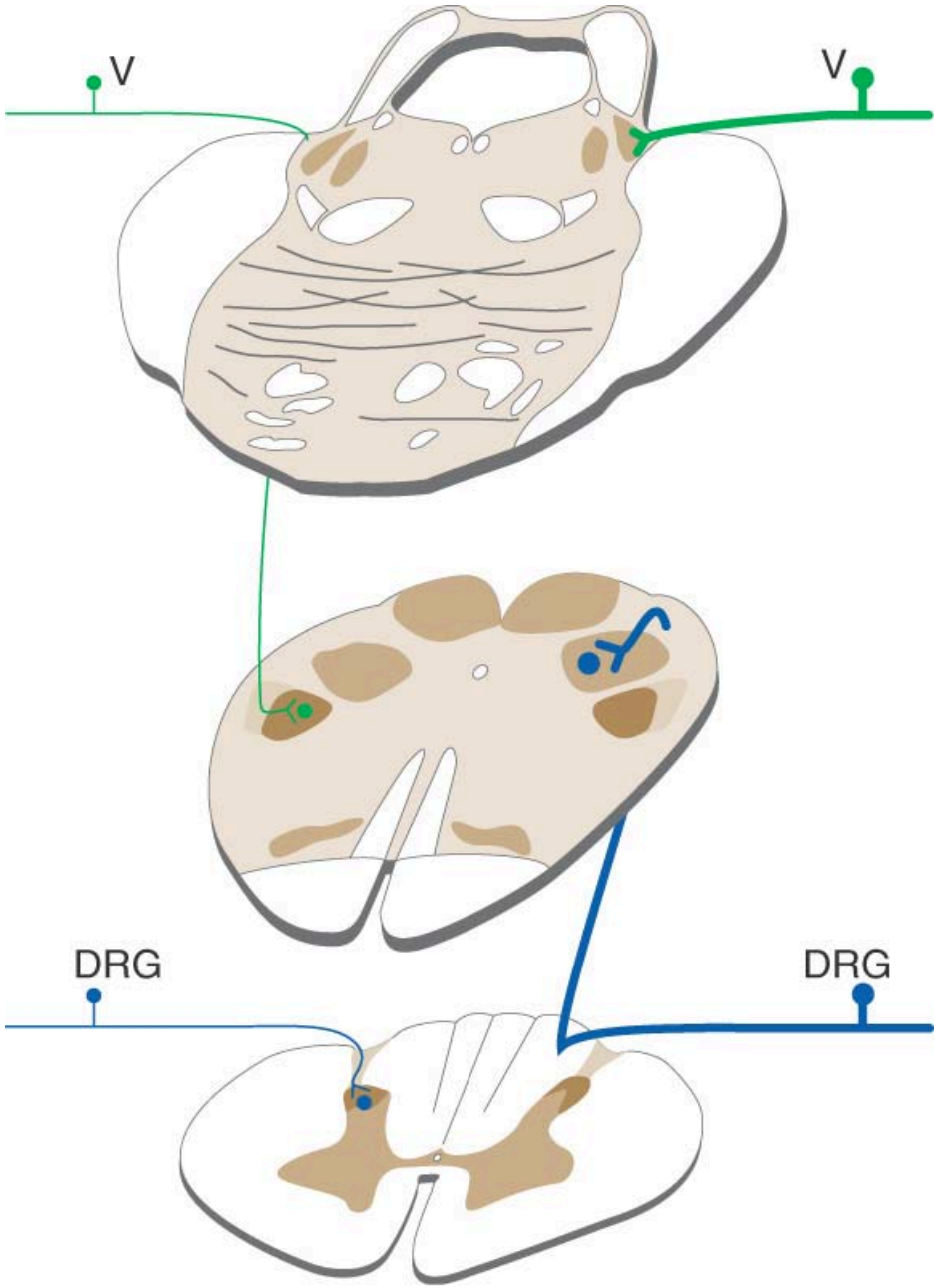

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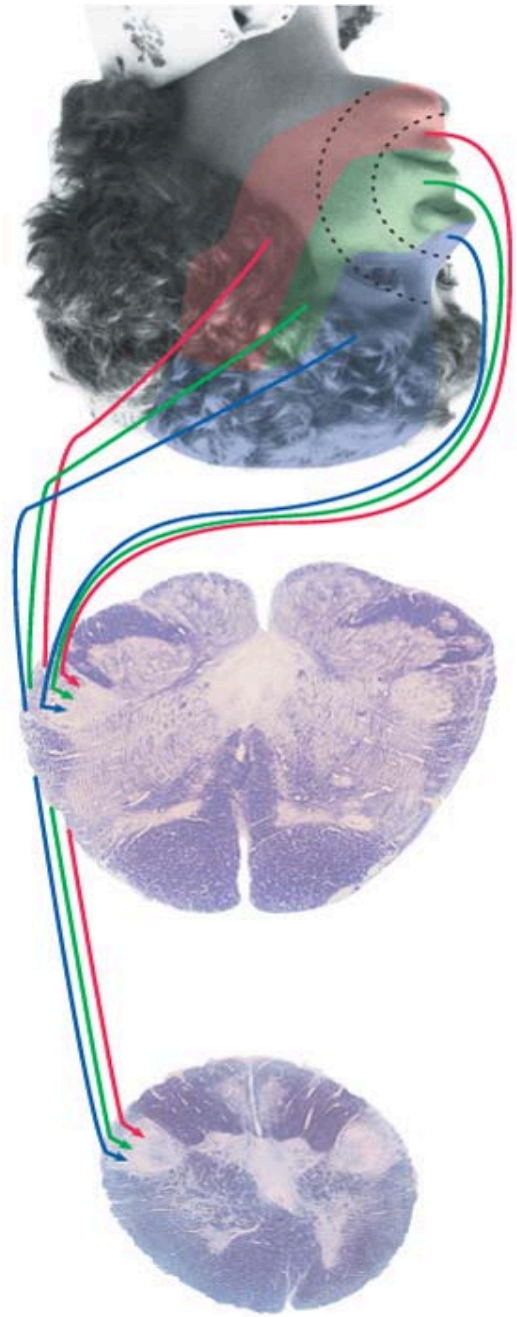

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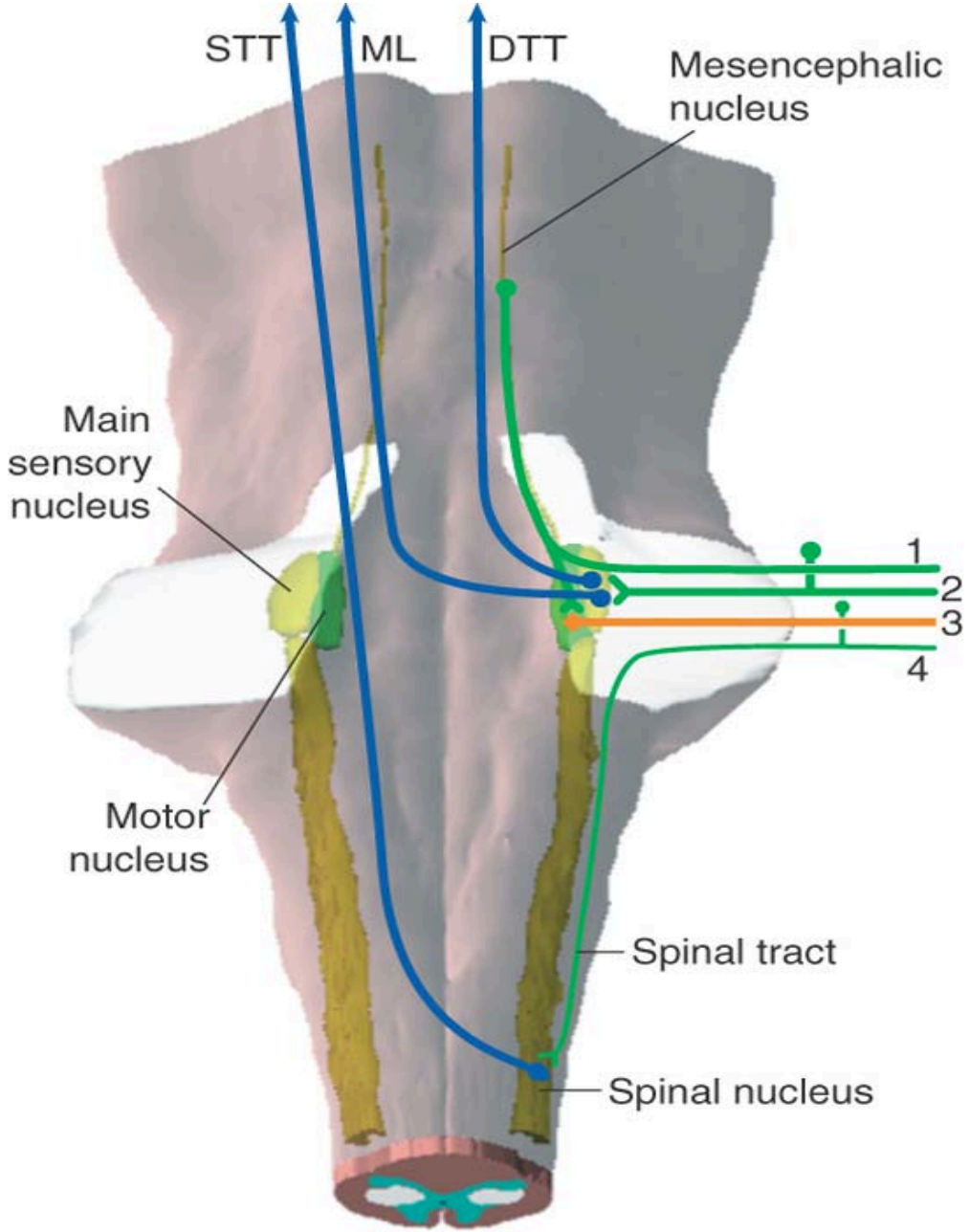

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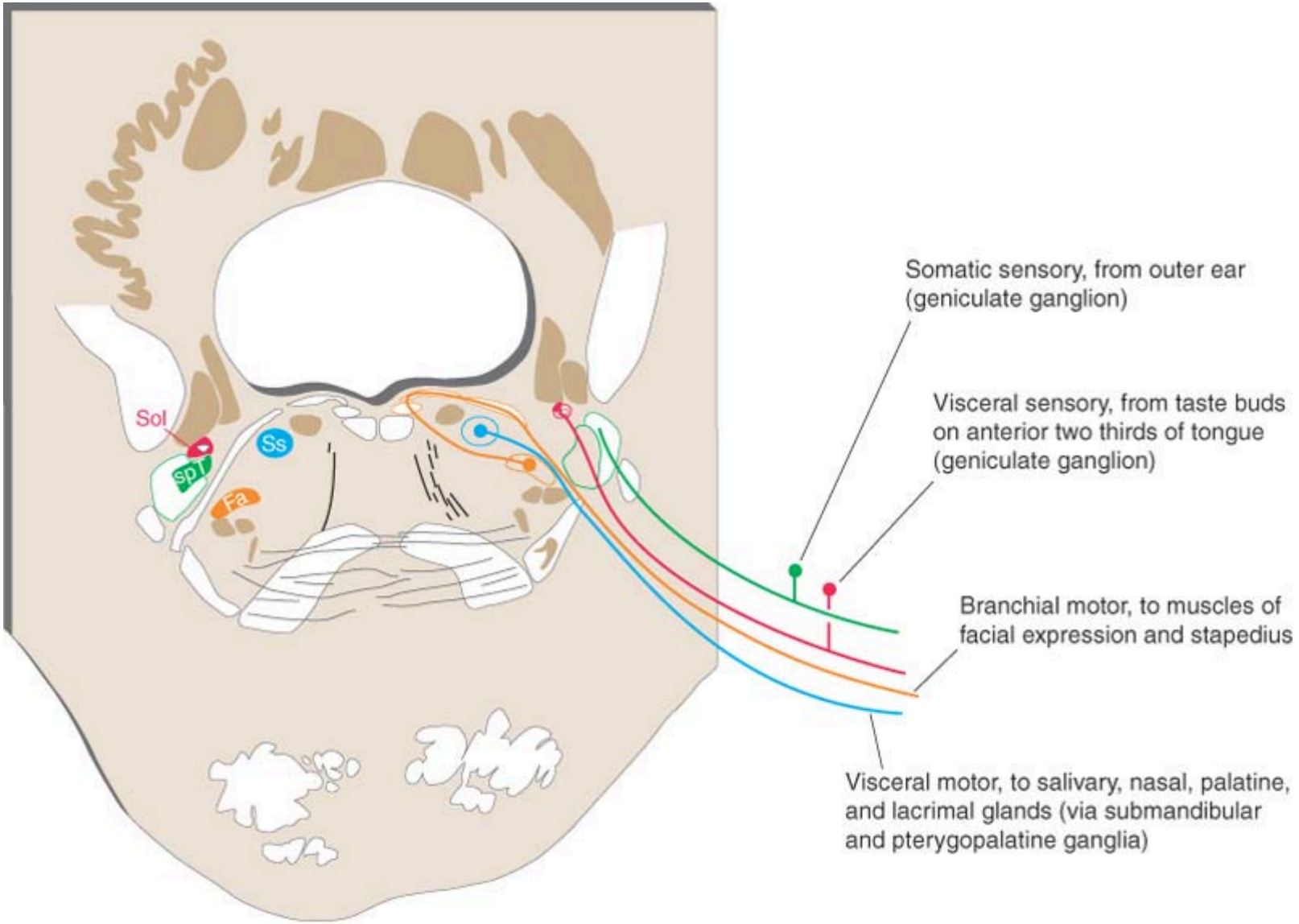

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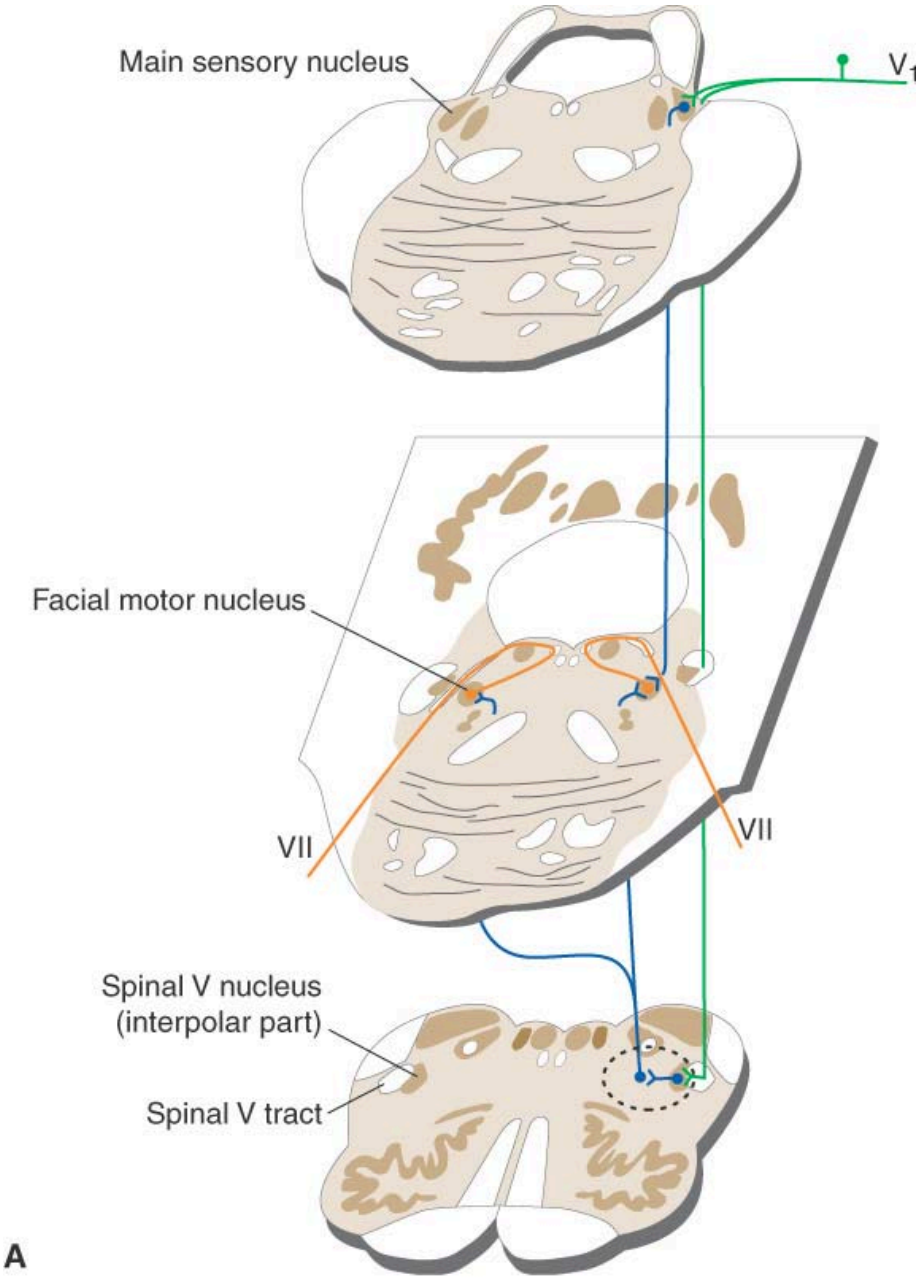

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Cranial Nerve VII: Facial

- Fibers leave the pons, travel through the internal acoustic meatus, and emerge through the stylomastoid foramen to the lateral aspect of the face
- Mixed nerve with five major branches
- Motor functions include facial expression, and the transmittal of autonomic impulses to lacrimal and salivary glands
- Sensory function is taste from the anterior two-thirds of the tongue

Cranial Nerve VII: Facial

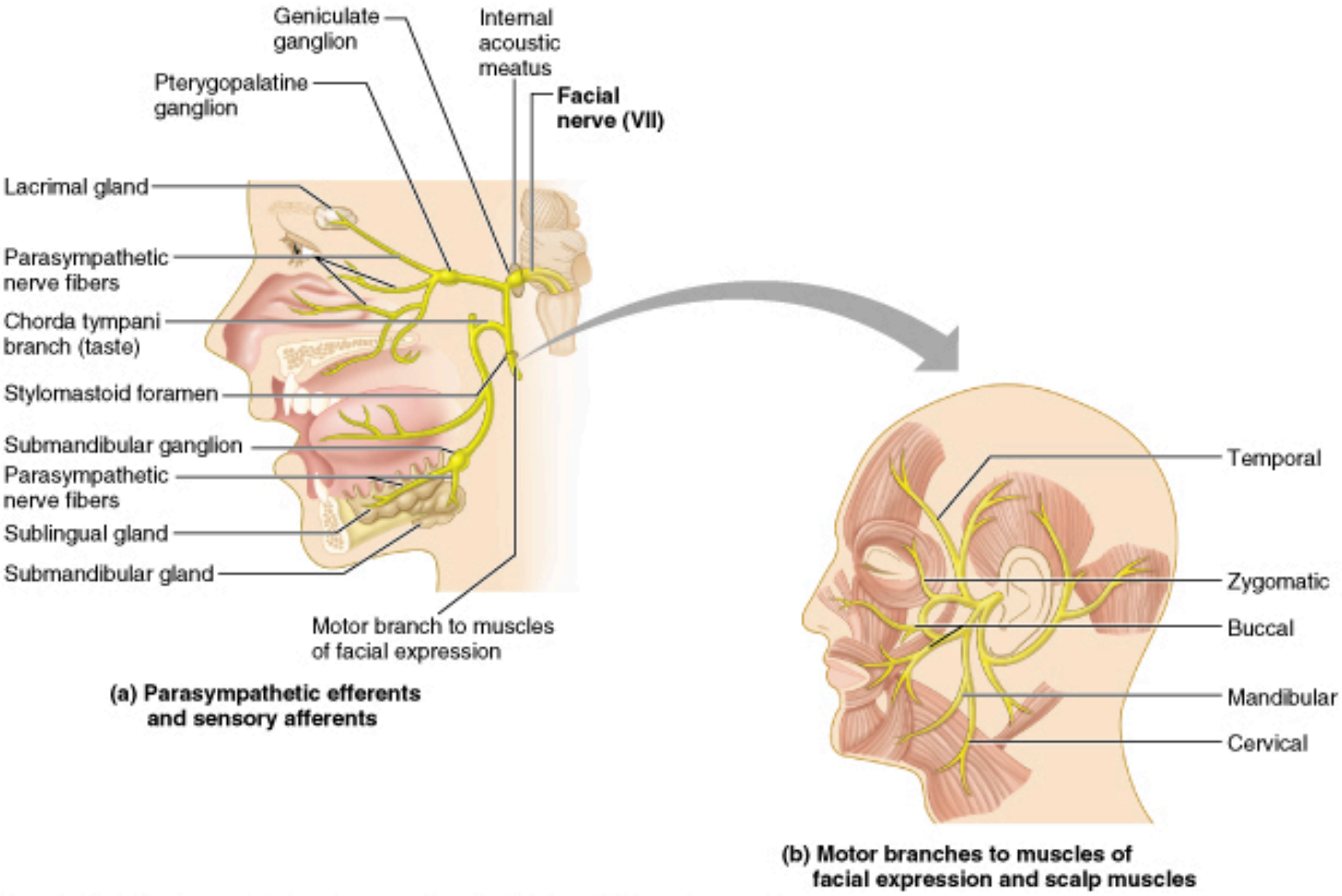
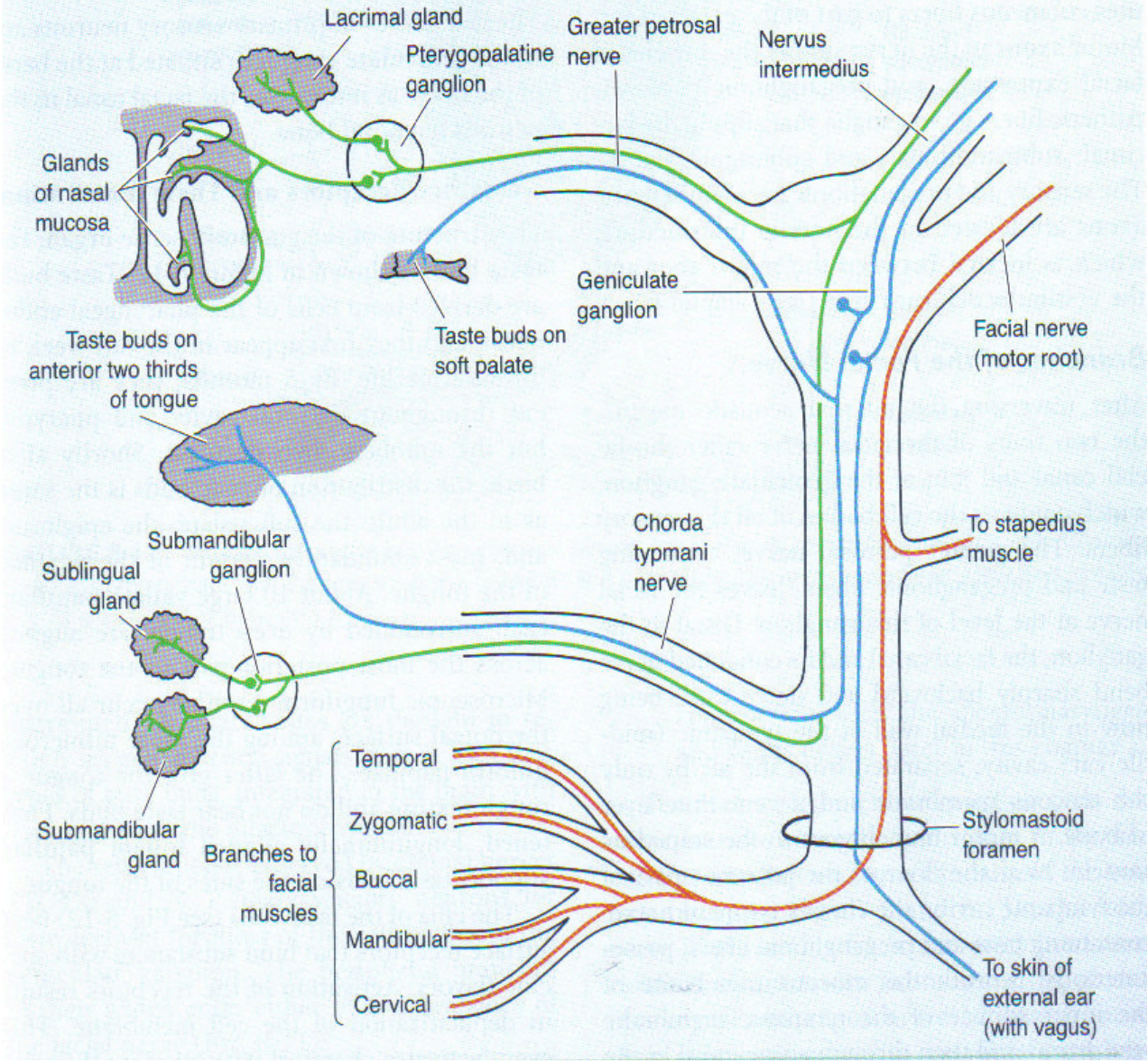


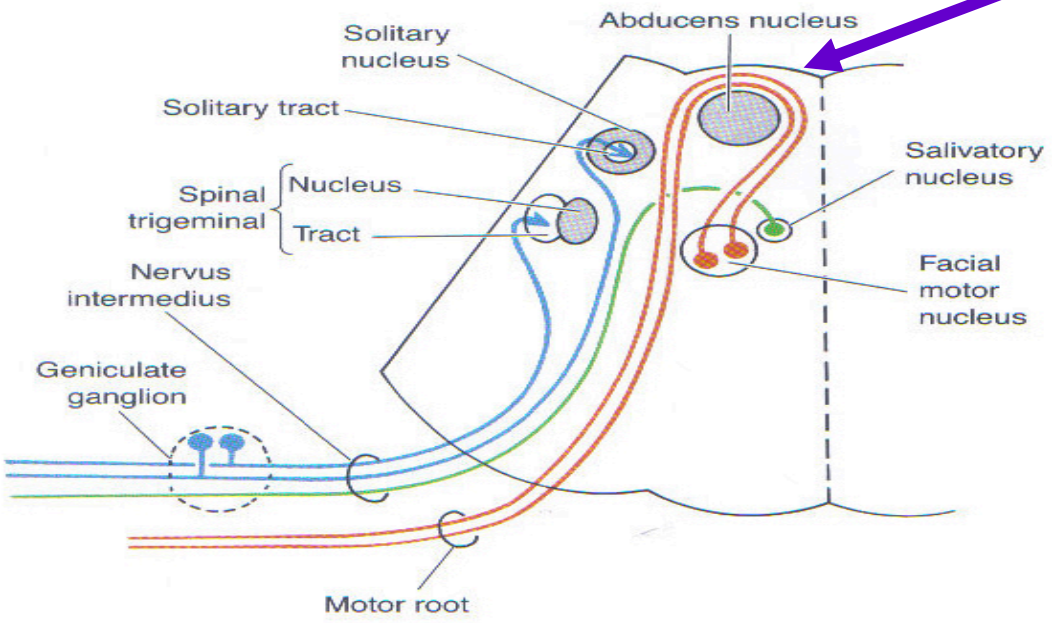
Table 13.2(VII)

The Facial Nerve and the Middle Ear

The facial nerve is vulnerable in the middle ear, which is a region commonly invaded by bacteria and surgery. The exact site of a lesion can be determined by applying knowledge of the branches containing different functional components (Fig. 8-11).



Facial colliculus



1. Motor nucleus of facial nerve (facial nucleus)

2. Superior salivatory nucleus

To chorda tympani branch and join the lingual branch of C.N. V_3

3. Lacrimal nucleus

To greater petrosal branch and terminate the pterygopalatine ganglion

1. Geniculate ganglion

Central processes → nervus intermedius

Peripheral processes → chorda tympani, greater petrosal and lesser palatine

(some fibers join the auricular branch of the vagus)

2. Gustatory nucleus

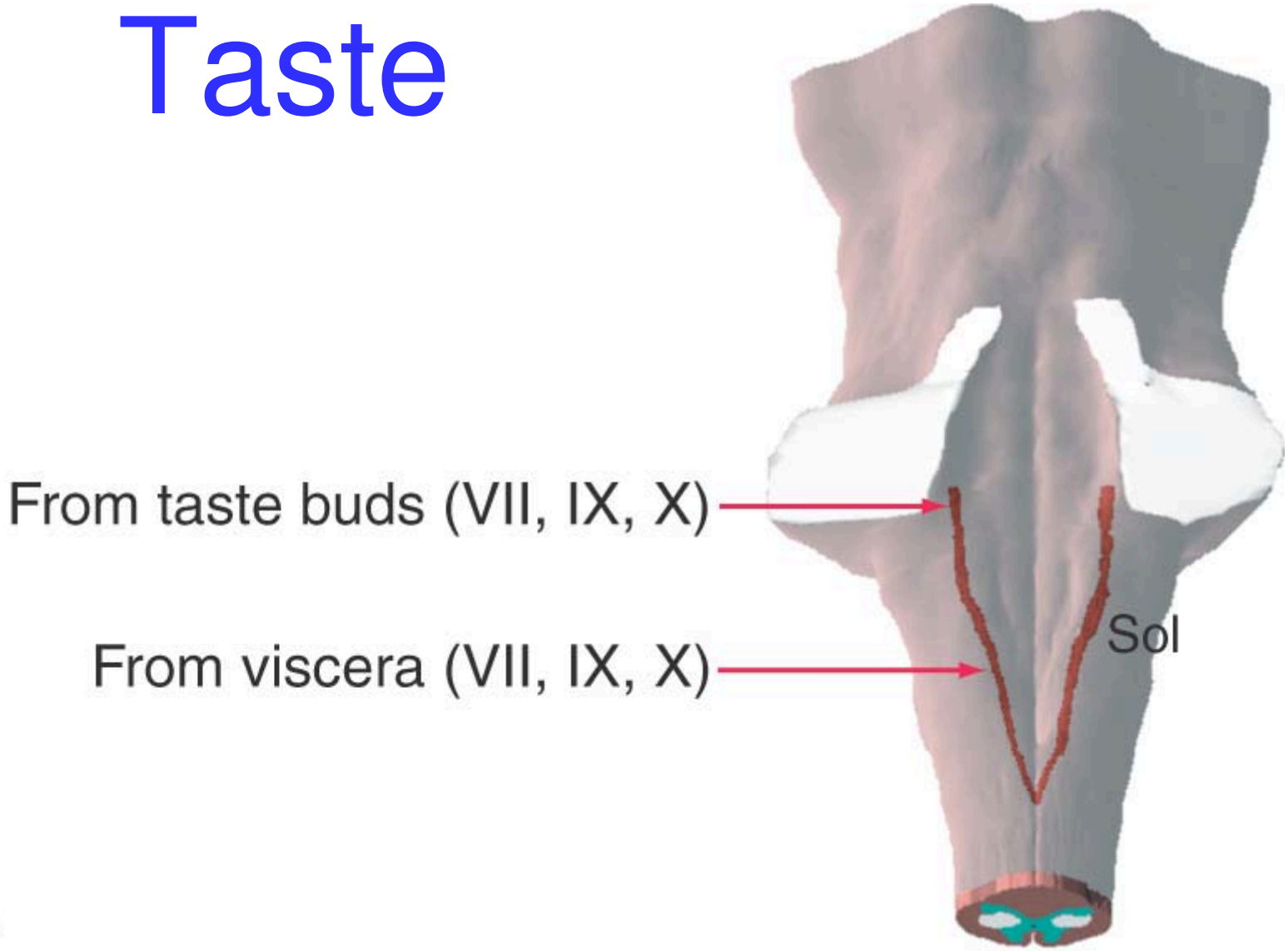
(The large-celled rostral part of the nucleus of the tractus solitarius)

Enter the brain in the nervus intermedius and turn in the tractus solitarius, then terminate in the nucleus of the tractus solitarius

3. Nucleus of spinal trigeminal tract

From the nervus intermedius

Taste



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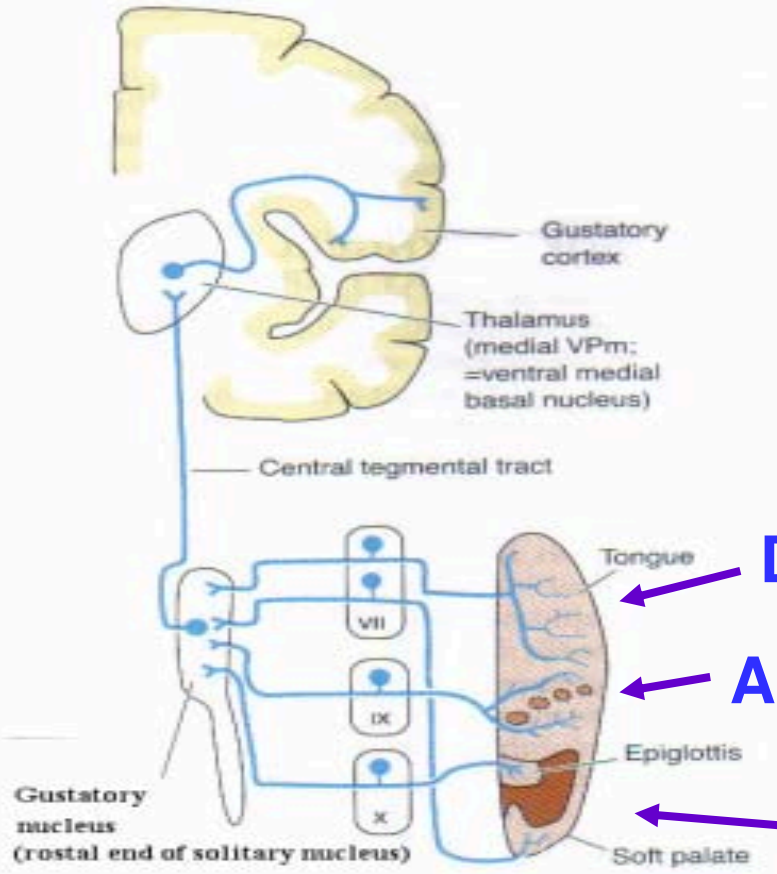
Taste sensation

- Facial
- Glossopharyngeal
- Vagus



Dorsum of the tongue

Around the circumvallate papillae

Root of the tongue

Cranial Nerve VIII:Vestibulocochlear

- Fibers arise from the hearing and equilibrium apparatus of the inner ear, pass through the internal acoustic meatus, and enter the brainstem at the pons-medulla border
- Two divisions – cochlear (hearing) and vestibular (balance)
- Functions are solely sensory for the sense of equilibrium and of hearing

Cranial Nerve VIII: Vestibulocochlear

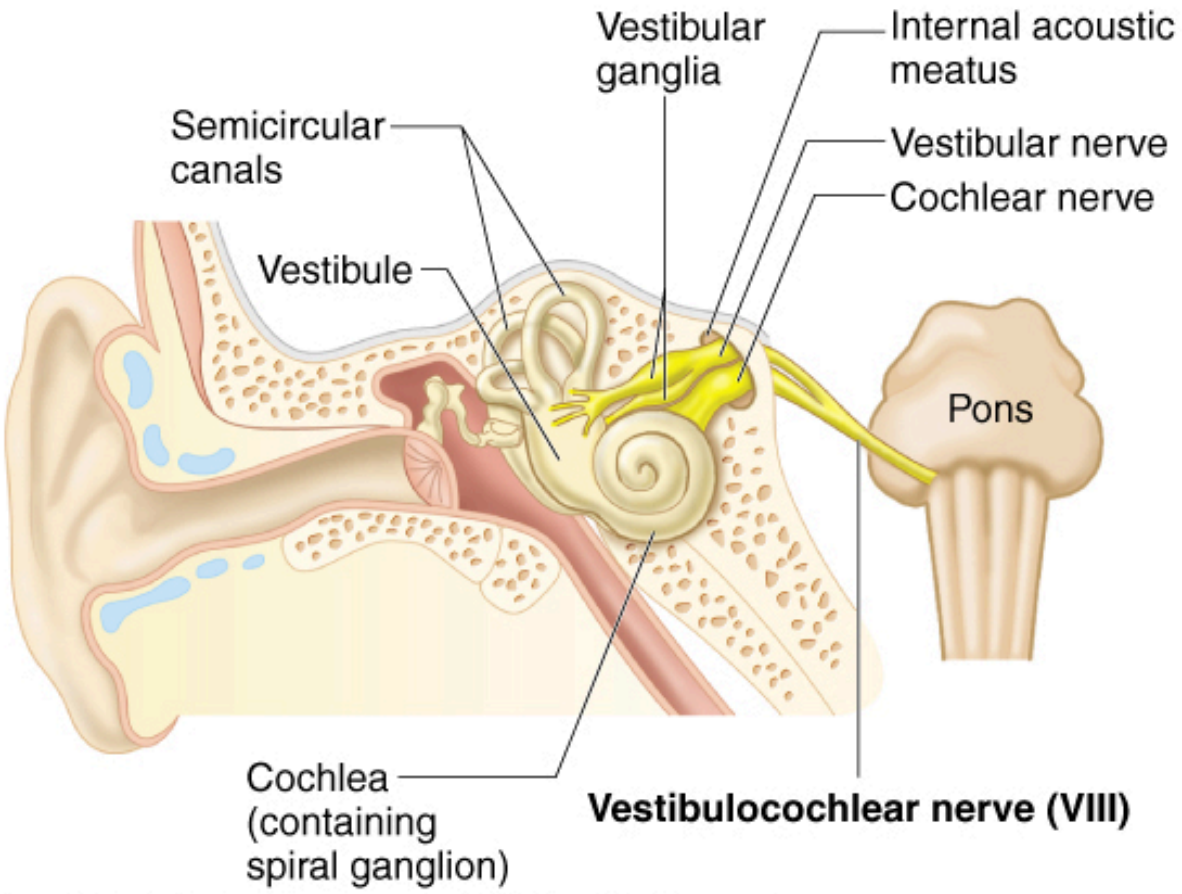


Table 13.2(VIII)

Cranial Nerve IX: Glossopharyngeal

- Fibers emerge from the medulla, leave the skull via the jugular foramen, and run to the throat
- Nerve IX is a mixed nerve with motor and sensory functions
- Motor – innervates part of the tongue and pharynx, and provides motor fibers to the parotid gland
- Sensory – fibers conduct taste and general sensory impulses from the tongue and pharynx

Cranial Nerve IX: Glossopharyngeal

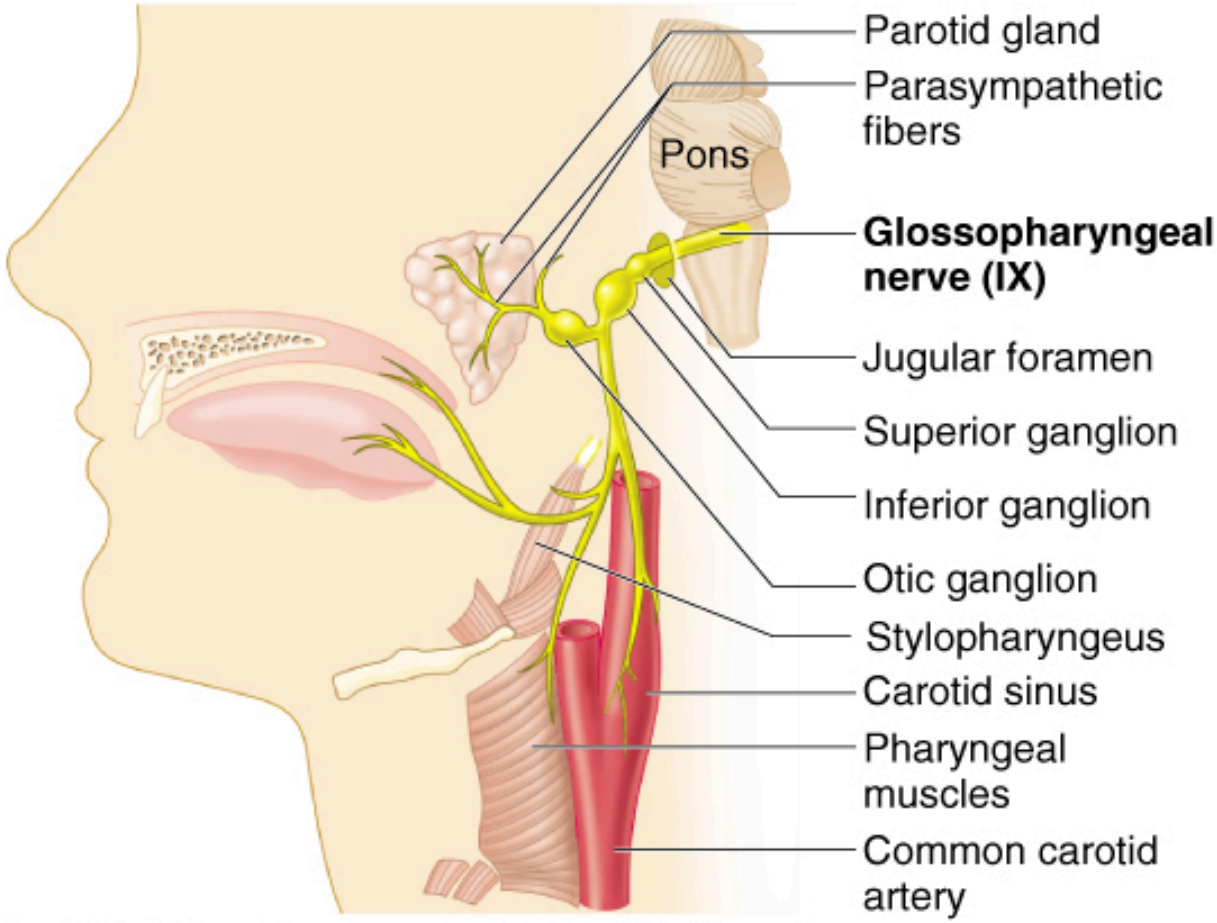
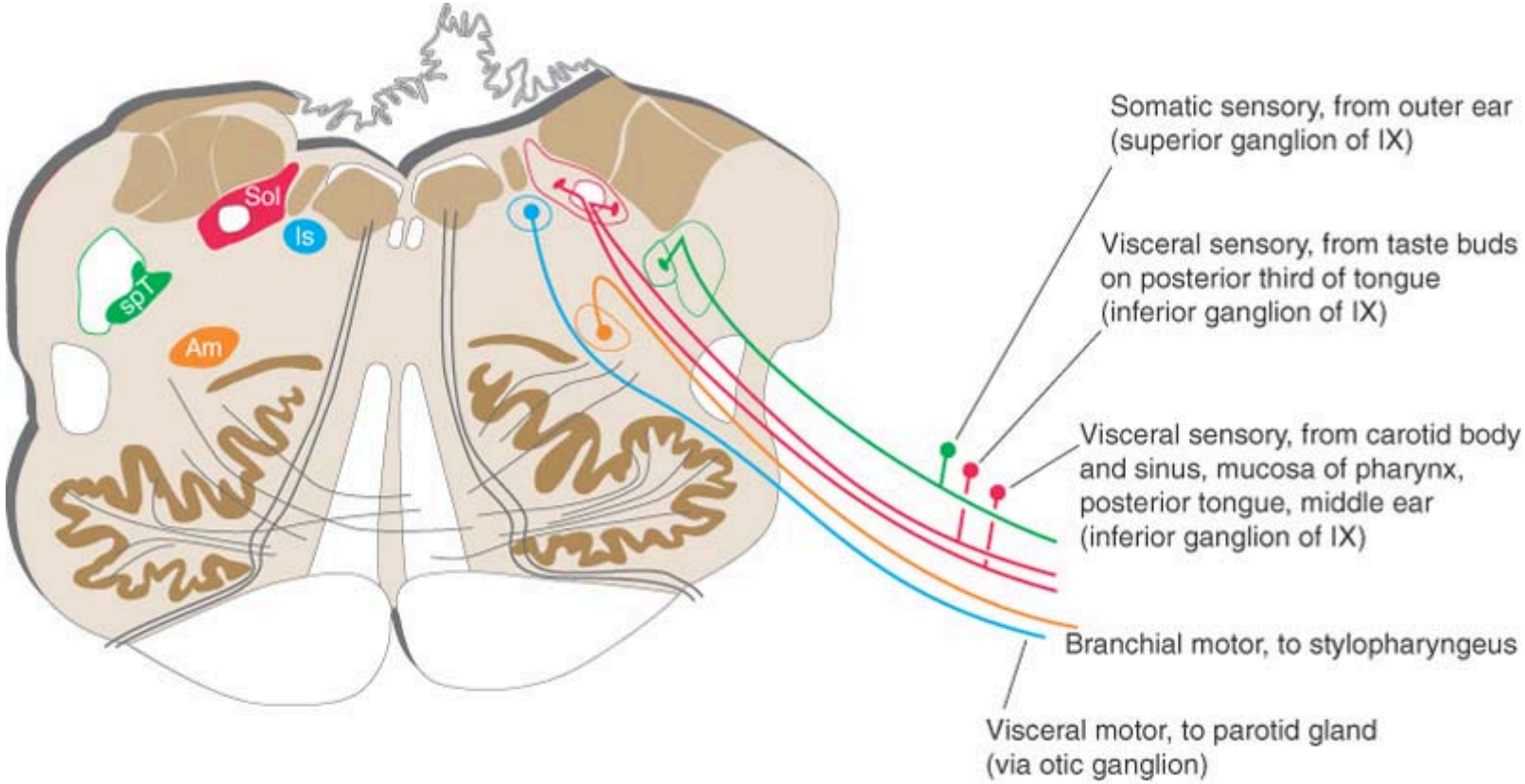


Table 13.2(IX)



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1. Nucleus ambiguus (SVE)
   - Branchial motor to stylopharyngeus
2. Inferior salivary nucleus (GVE)
   - to parotid gland (via otic ganglion)

3. Spinal trigeminal nucleus

- Somatic sensory from outer ear (superior ganglion of IX)

4. Nucleus of the solitary tract

- Visceral sensory from carotid body and sinus, mucosa of pharynx, posterior tongue, middle ear (inferior ganglion of IX)
- Visceral sensory from taste buds on posterior third of tongue (inferior ganglion of IX)

Cranial Nerve X: Vagus

- The only cranial nerve that extends beyond the head and neck
- Fibers emerge from the medulla and emerge via the jugular foramen
- The vagus is a mixed nerve
- Most motor fibers are parasympathetic fibers to the heart, lungs, and visceral organs
- Its sensory function is in taste

Cranial Nerve X: Vagus

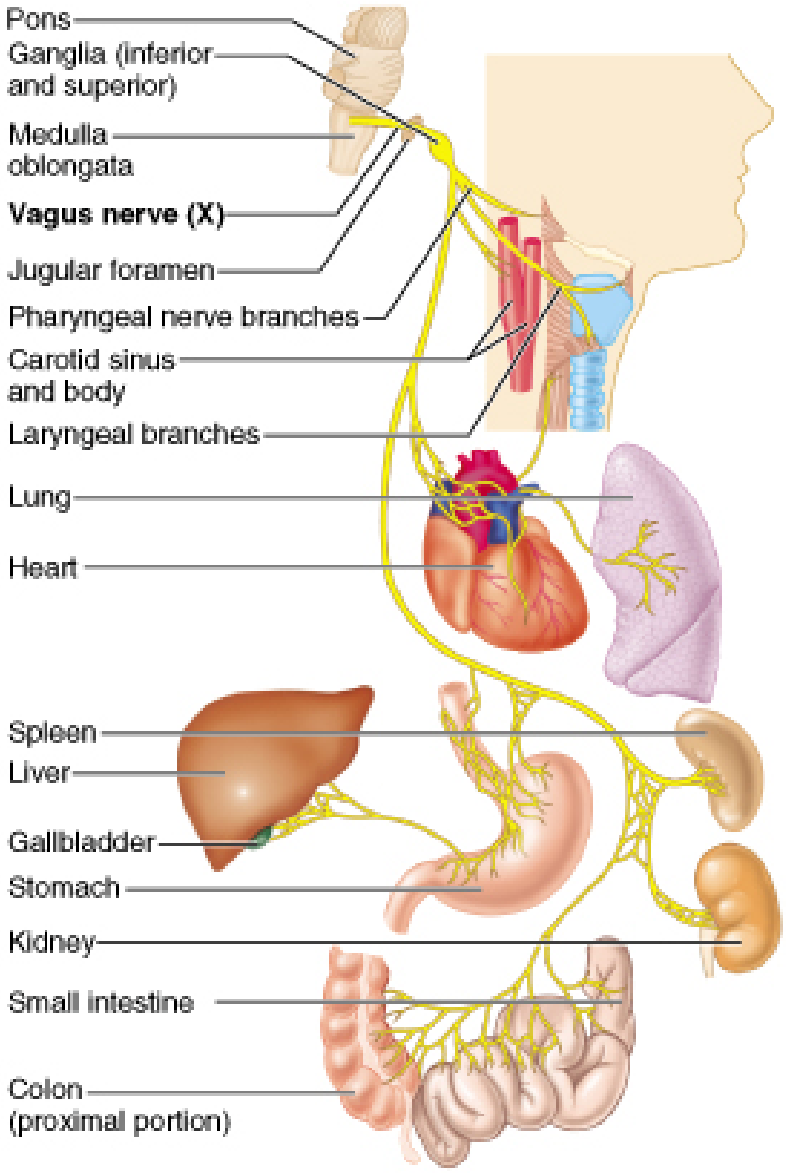
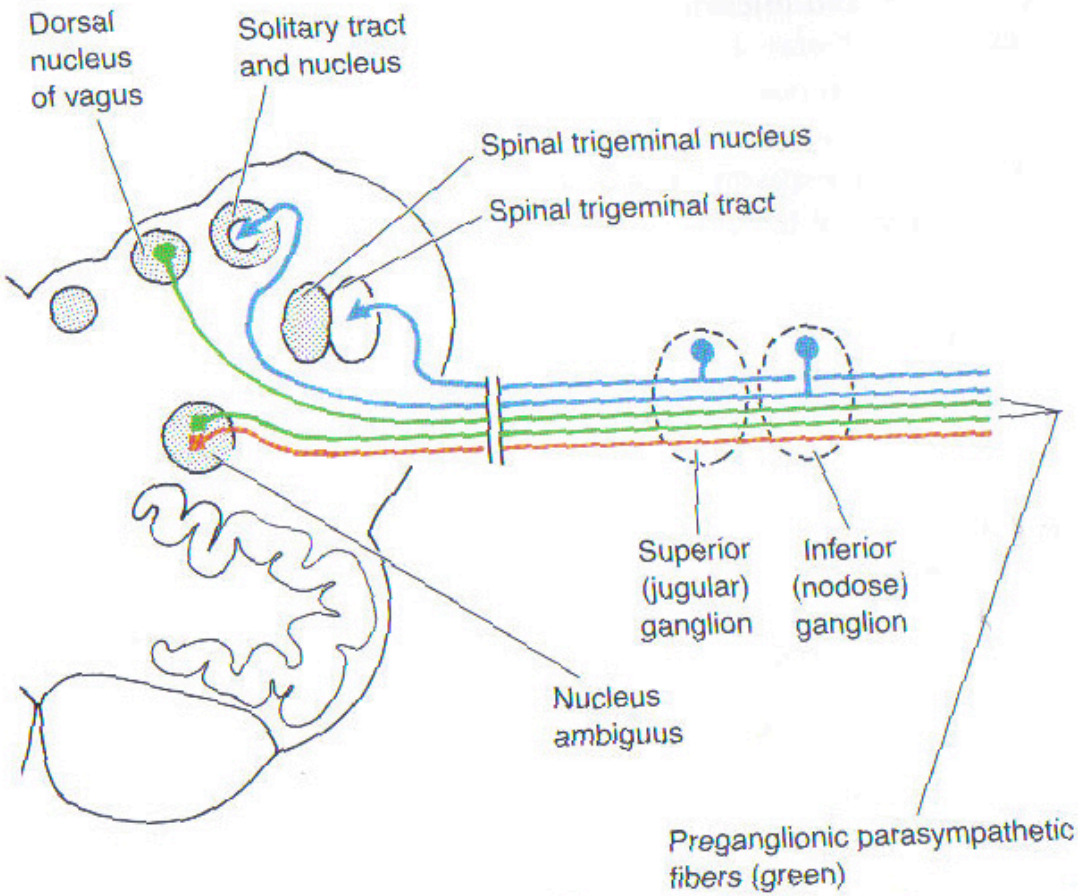
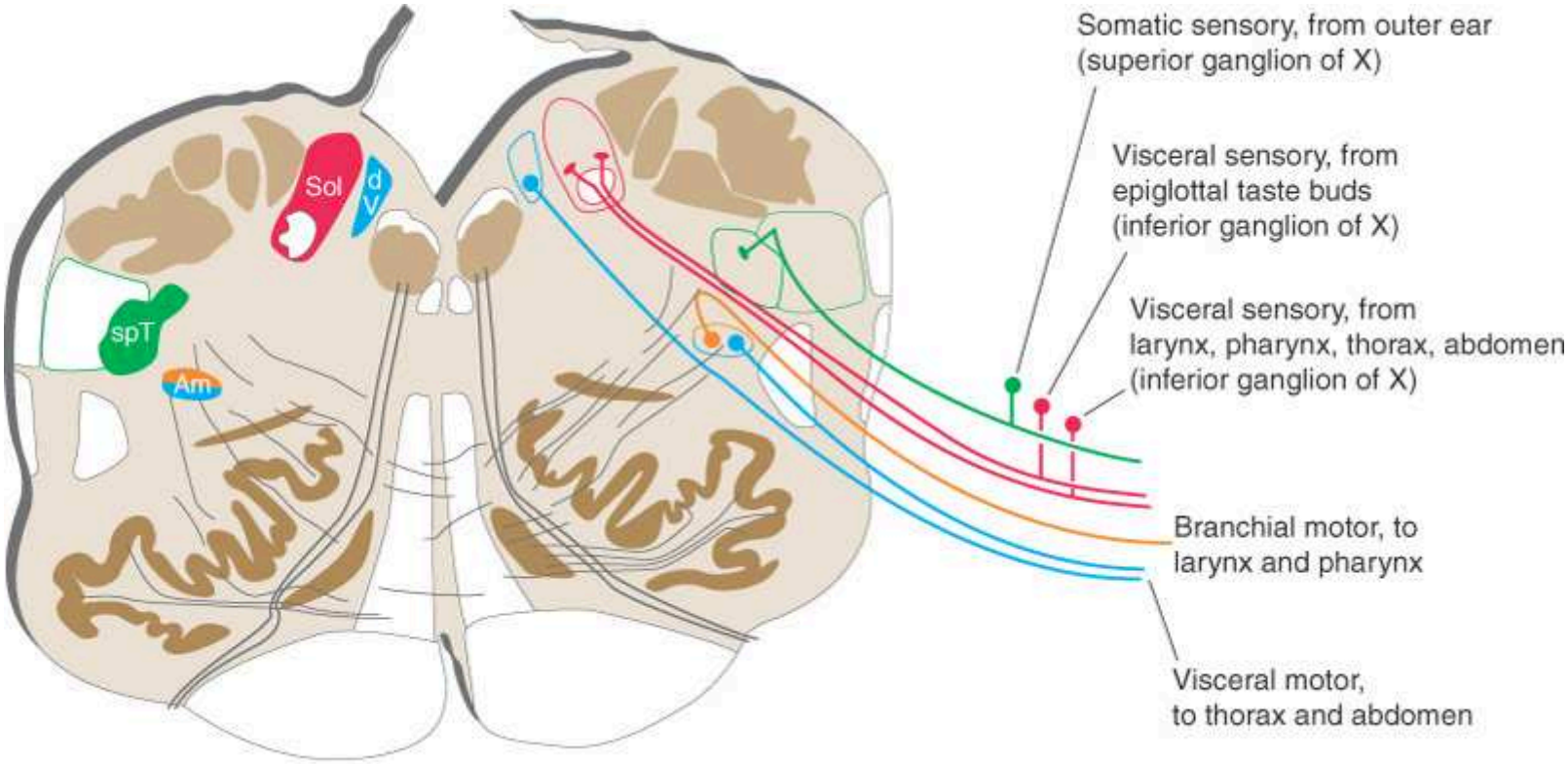


Table 13.2(X)


Dorsal nucleus of vagus
Solitary tract and nucleus
Spinal trigeminal nucleus
Spinal trigeminal tract
Superior (jugular) ganglion
Inferior (nodose) ganglion
Nucleus ambiguus
Preganglionic parasympathetic fibers (green)



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1. Nucleus ambiguus (SVE)

- A hybrid nucleus
- Branchial motor to larynx and pharynx and autonomic motor to thorax and abdomen

2. dorsal motor nucleus (GVE)

- autonomic motor to thorax and abdomen

3. Spinal trigeminal nucleus

- Somatic sensory from outer ear (superior ganglion of X)

4. Nucleus of the solitary tract

- Visceral sensory from larynx , pharynx ,thorax and abdomen (inferior ganglion of X)

Cranial Nerve XI: Accessory

- The spinal root passes upward into the cranium via the foramen magnum
- The accessory nerve leaves the cranium via the jugular foramen
- Primarily a motor nerve supplying:
  - Fibers to the larynx, pharynx, and soft palate
  - Innervates the trapezius and sternocleido-mastoid, which move the head and neck

Cranial Nerve XI: Accessory

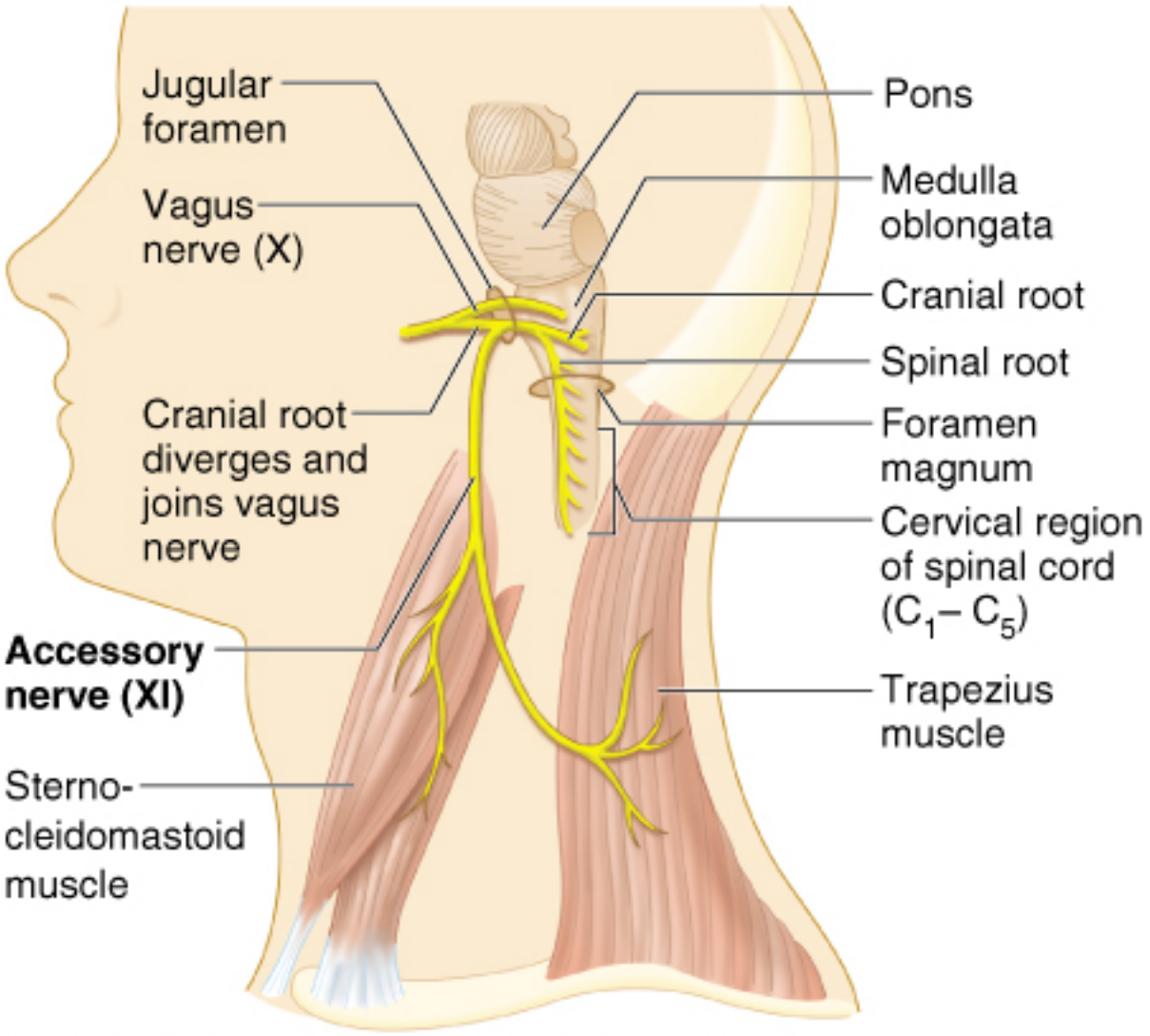
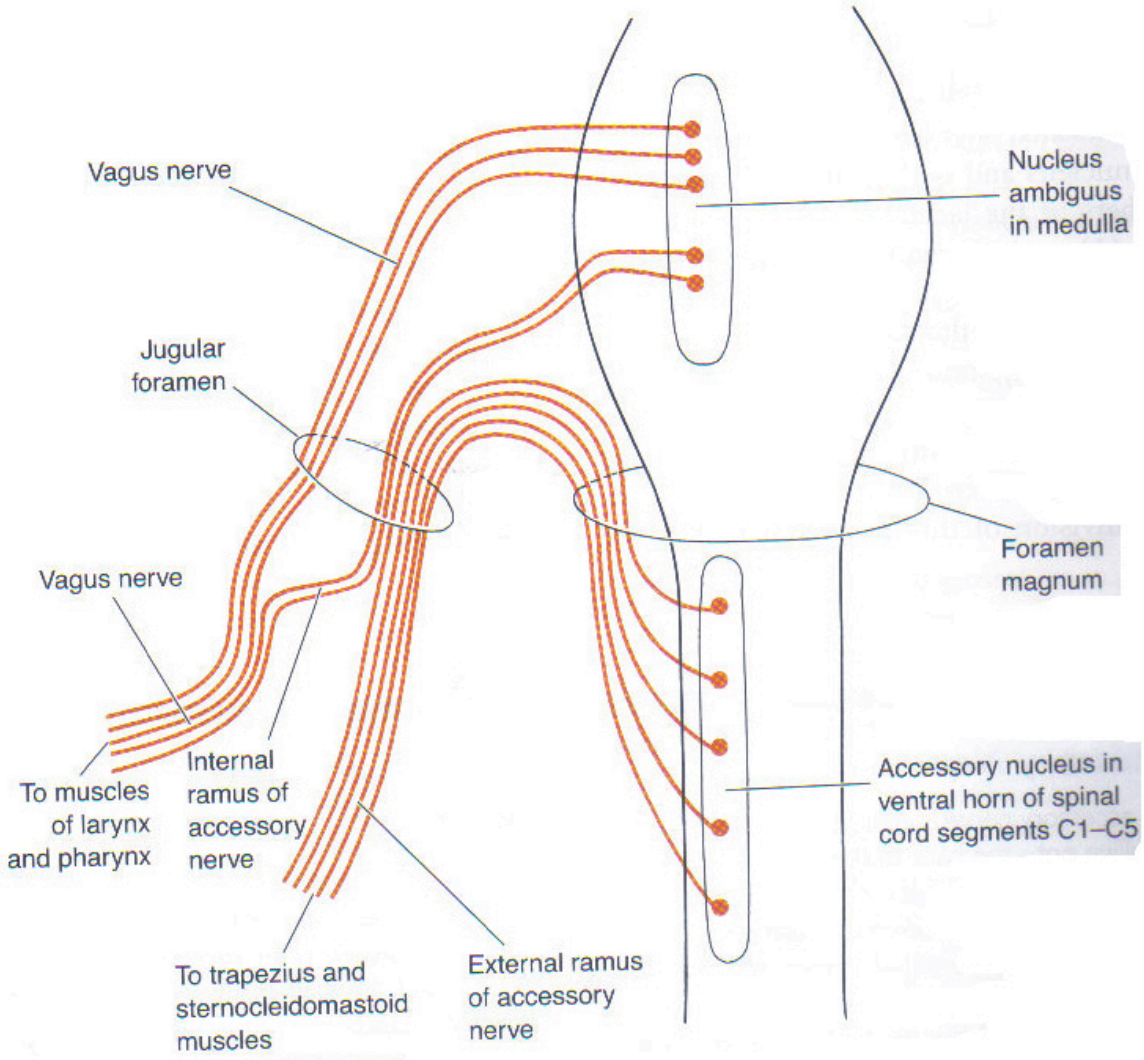


Table 13.2(XI)


Vagus nerve
Nucleus ambiguus in medulla
Jugular foramen
Foramen magnum
Vagus nerve
To muscles of larynx and pharynx
Internal ramus of accessory nerve
Accessory nucleus in ventral horn of spinal cord segments C1–C5
To trapezius and sternocleidomastoid muscles
External ramus of accessory nerve

- Formed from a cranial root emerging from the medulla and a spinal root arising from the superior region of the spinal cord

1. Cranial root

    Nucleus ambiguus (SVE)

2. Spinal root

    Spinal accessory nuclei (GSE)

Cranial Nerve XII: Hypoglossal

- Fibers arise from the medulla and exit the skull via the hypoglossal canal
- Innervates both extrinsic and intrinsic muscles of the tongue, which contribute to swallowing and speech

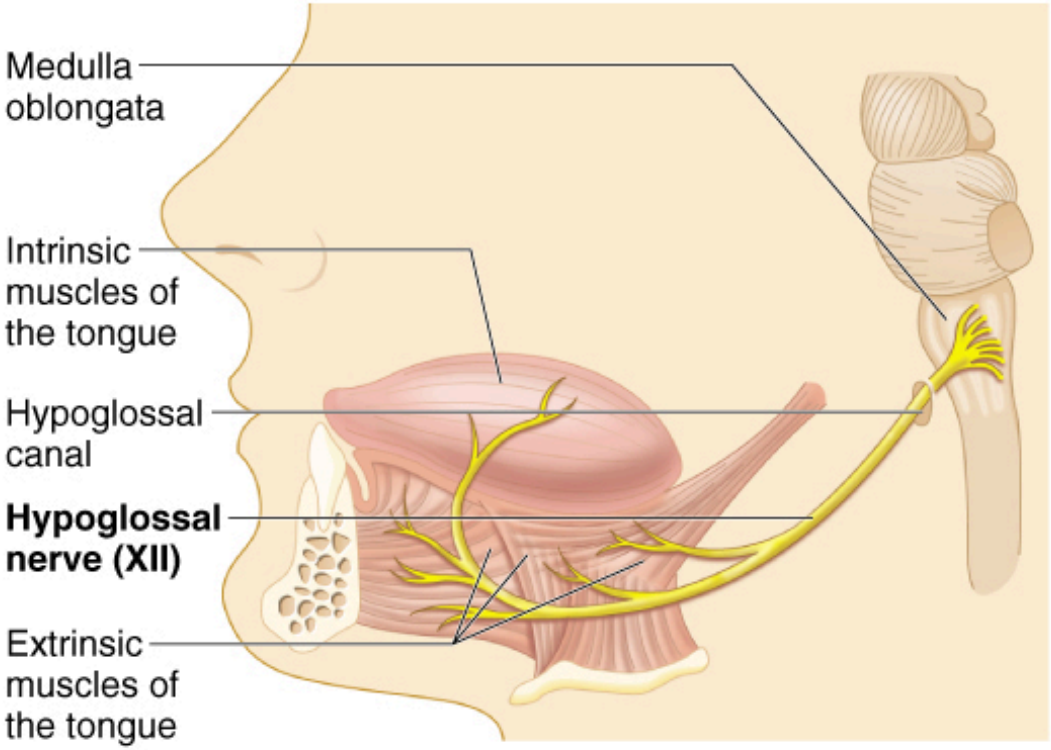
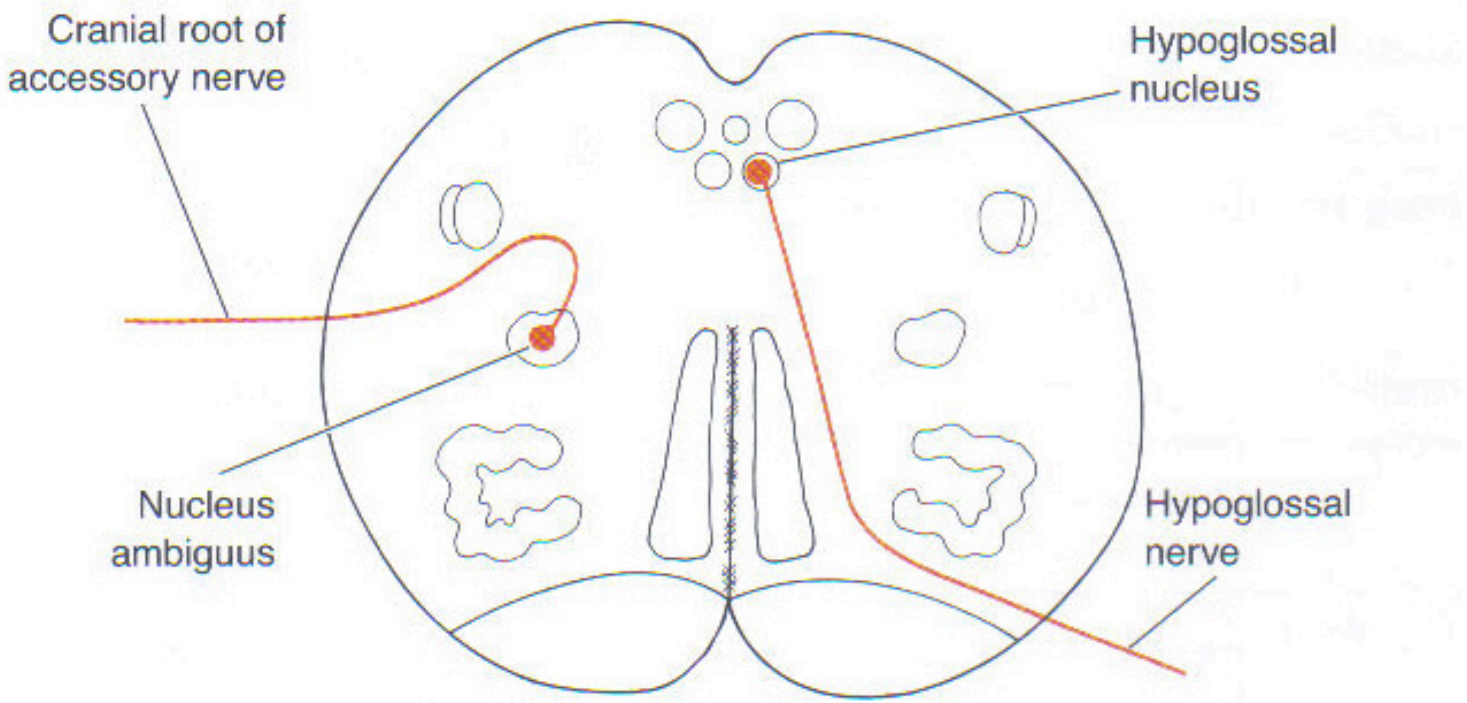


Table 13.2(XII)

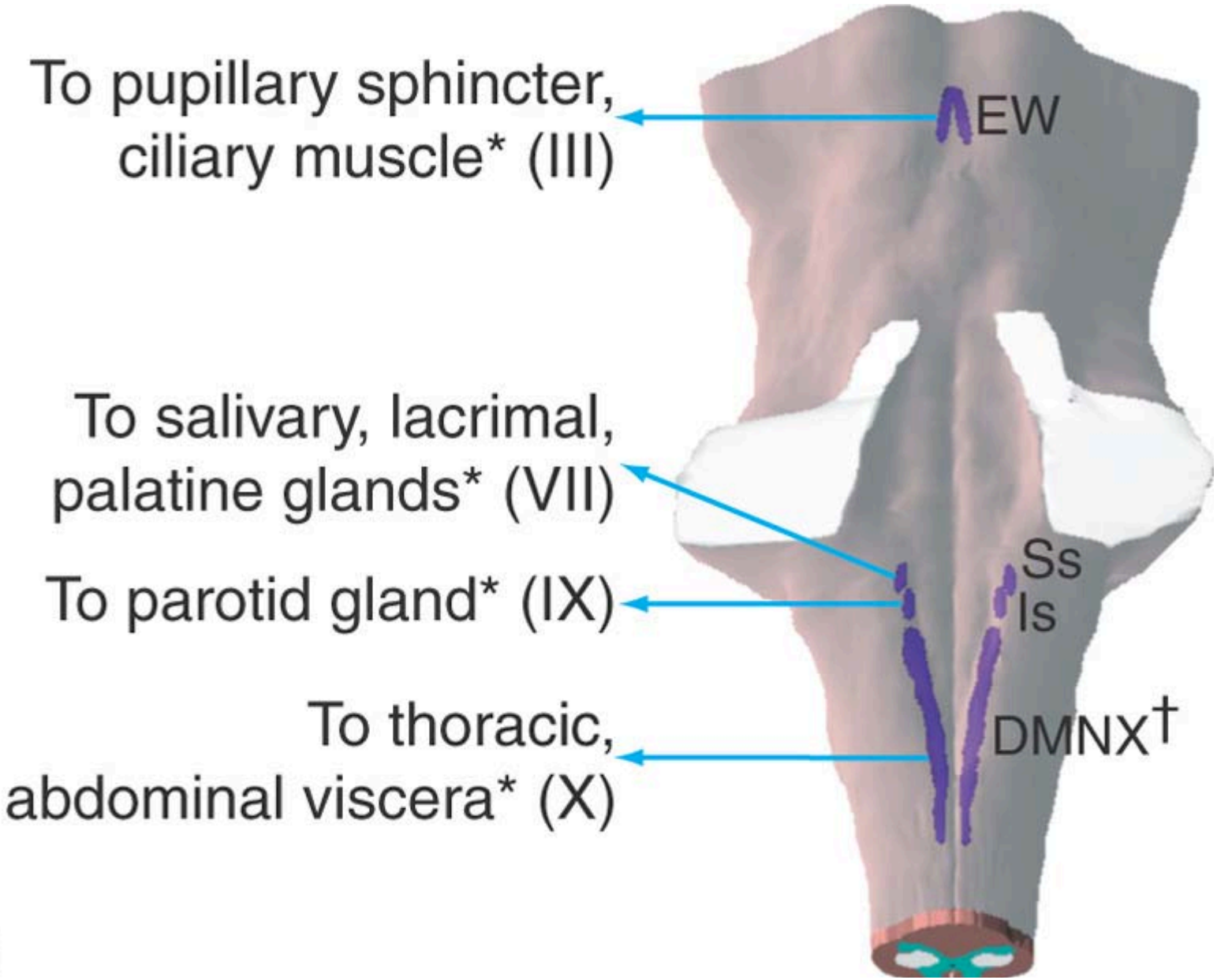

Cranial root of accessory nerve
Hypoglossal nucleus
Nucleus ambiguus
Hypoglossal nerve

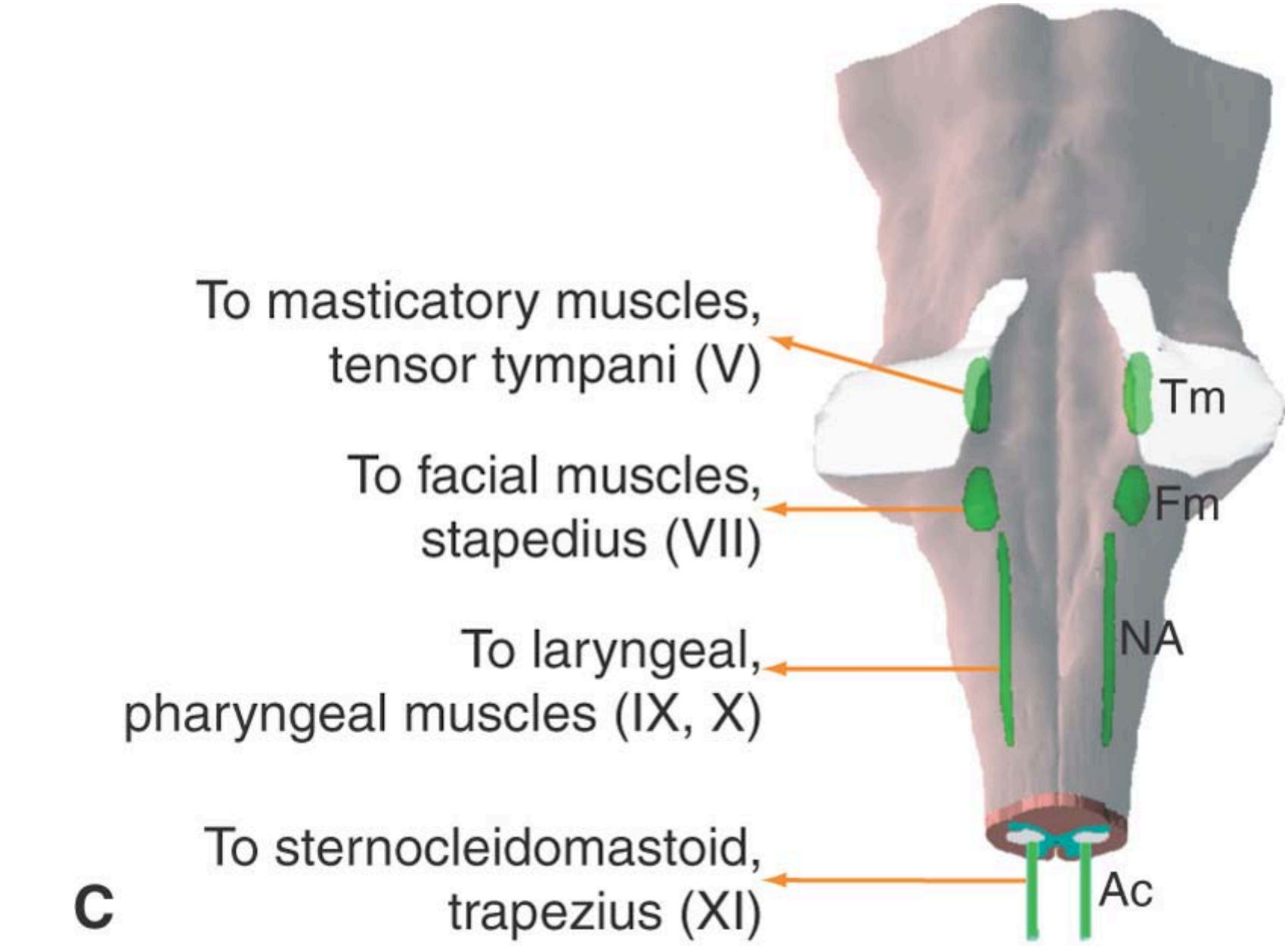
Hypogolssal nucleus

- Lying between the dorsal nucleus of the vagus and the midline of the medulla
- Sents off GSE fibers

Parasympathetic ganglion

- Ciliary ganglion
- Pterygopalatine ganglion
- Submandibular ganglion
- Otic ganglion


To pupillary sphincter, ciliary muscle* (III)
To salivary, lacrimal, palatine glands* (VII)
To parotid gland* (IX)
To thoracic, abdominal viscera* (X)
EW
Ss
Is
DMNX†
B



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