Cranial Nerve

- **12 pairs of cranial nerves**, which are numbered I–XII, from rostral to caudal.
- They are called cranial nerves because they originated from brain
- Are covered by tubular sheaths derived from the cranial meninges

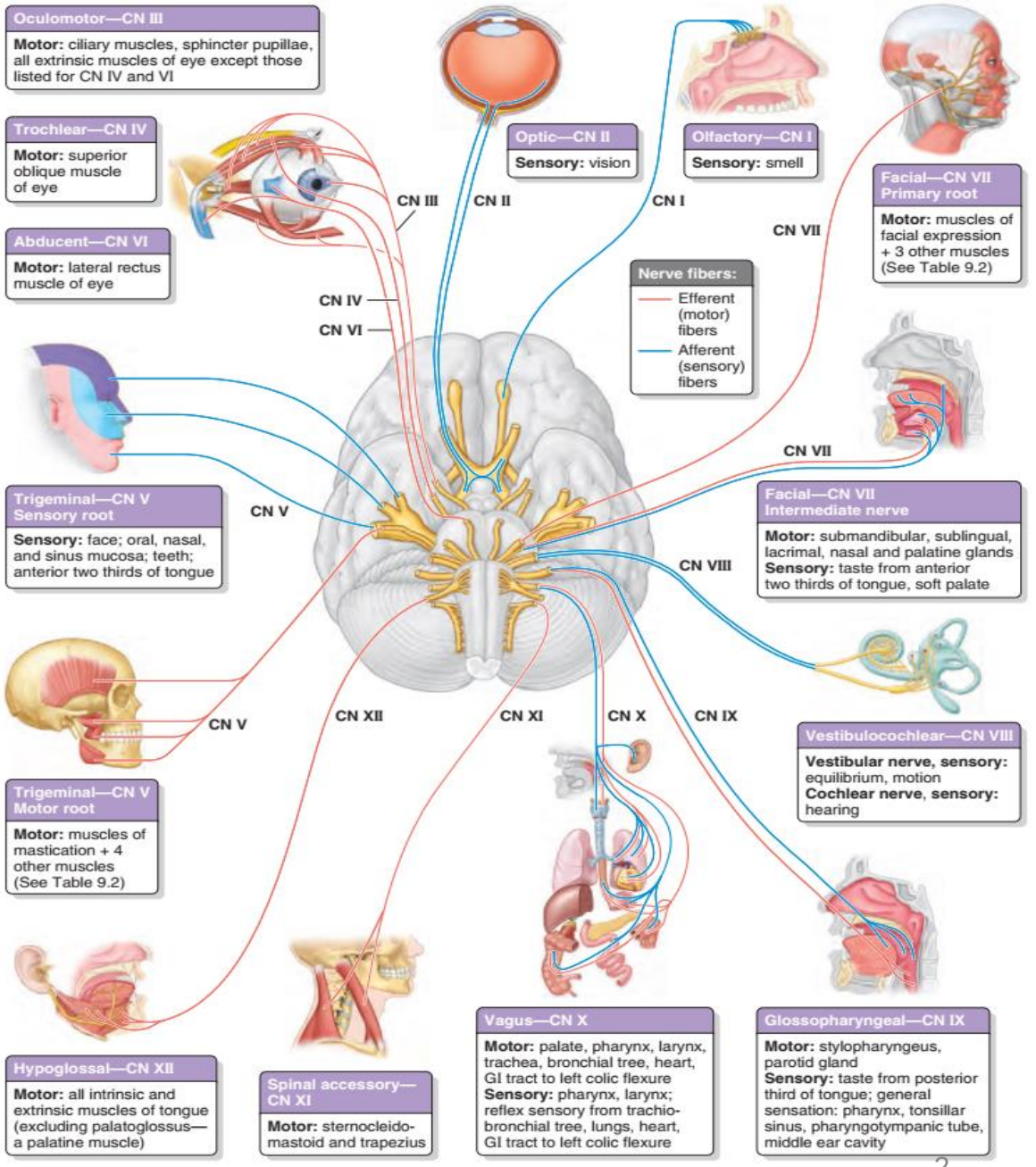
- All the nerves are distributed in the head and neck, except CN X
- All cranial nerves originate from the brain except CN-XI

Cranial nerves

Motor fibers (motor nerve) or **sensory fibers** (sensory nerve) or both the motor and sensory fibers (**mixed nerve**).

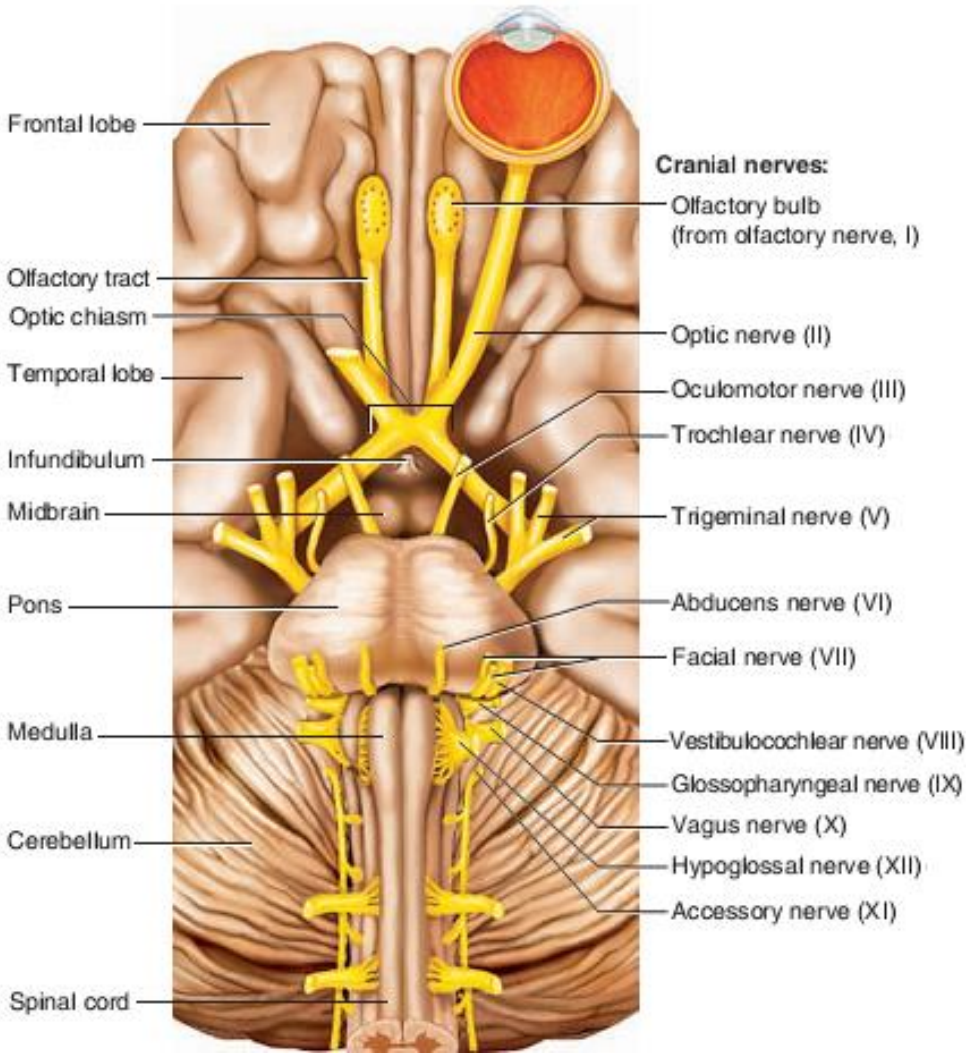
Nuclei—groups of neurons in which afferent fibers terminate and from which efferent fibers originate.

Except for CN I and II, the nuclei of cranial nerves are located in the brainstem



Cranial nerves

- They are
  - Olfactory (I)
  - Optic (II)
  - Oculomotor (III)
  - Trochlear (IV)
  - Trigeminal (V)
  - Abducens (VI)
  - Facial (VII)
  - Vestibulocochlear (VIII)
  - Glossopharyngeal (IX)
  - Vagus (X)
  - Accessory (XI)
  - Hypoglossal (XII)



Classification of cranial nerves

- The cranial nerves classified in to different group based on:

Their central location(origin):

- CN I & II are rise from telencephalon & diencephalon, respectively

- CN III & IV are originate from the midbrain

- CN V, VI & VII nerves are from **pons**

- CN VIII, IX, X, XI, & XII are associated with the **medulla oblongata**

Pure sensory cranial nerves-- I, II,& VIII

- These nerves are unique to the head and are associated with the special senses of **smelling**, **seeing**, & **hearing**.

- Their cell bodies are located in ganglia outside the brain

Pure motor cranial nerves--III, IV, VI, XI, & XII

- Their cell bodies lie within the brain

Mixed Cranial nerves---V, VII, IX, & X

They contain axons of both sensory neurons entering the brain stem and motor neurons leaving the brain stem.

A cranial nerve consists of

- The motor fibers of cranial nerves can be of the following three types:

1. **General somatic efferent (GSE) fibers**
   - ✓ They supply the **striated muscles** which develop from somites
   - ✓ equivalent to anterior grey horn cells of spinal cord
   - ✓ receive impulse from corticobulbar/corticonuclear fibers

2. **General visceral efferent (GVE) fibers**
   - ✓ They supply the glands, smooth muscles of viscera and vessels
   - ✓ Parasympathetic fibers
   - ✓ Receive input from hypothalamus

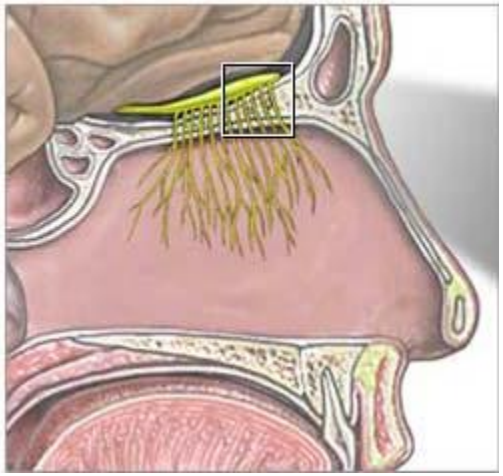
3. **Special visceral efferent (SVE) fibers**
   - ✓ They supply the **muscles** which develop from **pharyngeal arches**.

Sensory Nuclei of Cranial Nerves:

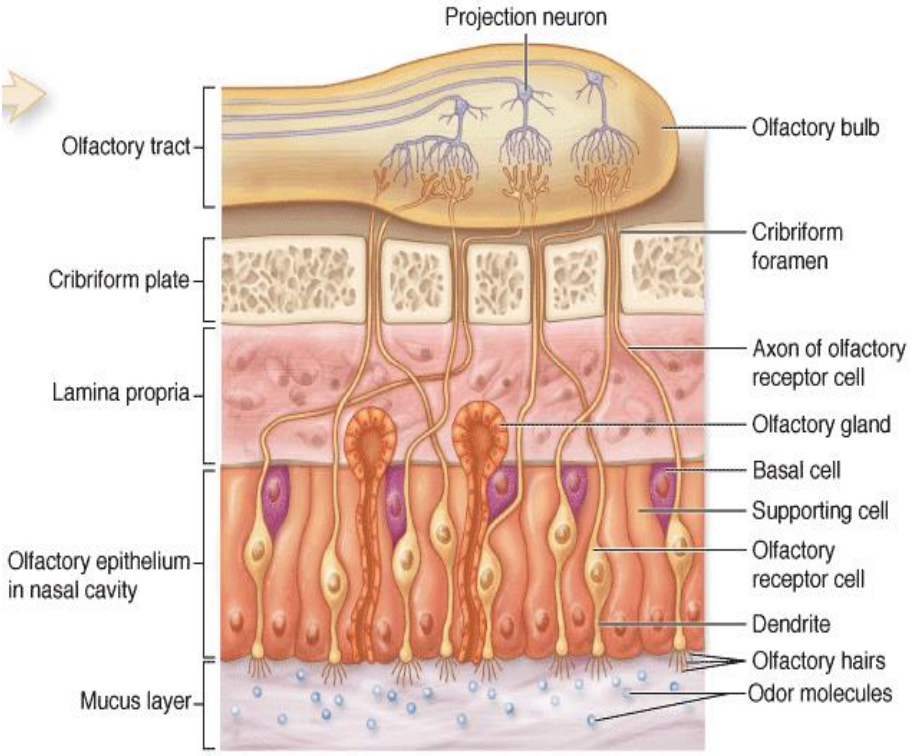
- ***General Somatic Sensory (Somatic Afferents):***
  - Receive general sensations of pain, touch, and temperature from skin and proprioceptive sensations of vibration from muscle & joints of the head).
- ***General Visceral Sensory (GVA):***
  - Receive afferent input from **chemo- & baro-receptors** of abdominal & thoracic viscera and the head & neck,
  - Carry general sensations of distension and ischemic pain from viscera
- **Special visceral afferent (SVA) fibers**
  - They carry special sensations of taste and smell.
- ***Special Somatic Sensory (SSA):***
  - Receive special afferent input carrying special sensations of vision, hearing, and balance.

Purely Sensory Cranial Nerves

A. Olfactory Nerves (CN I):-



- Is a special visceral afferent (**SVA**) nerve
- Is derived from the **nasal (olfactory) placode or olfactory organ**
- Consists of unmyelinated axons of bipolar neurons & **terminate** in olfactory bulb.
- **Olfactory tract** – is a bundle of white matter arise from posterior end of olfactory bulb



Unique features of CN I

- Is the only cranial nerve that **projects directly** to the telencephalon.

- Located on the body surface in the olfactory epithelium of the nasal cavity & their dendrites lie free in the mucous of nasal cavity.

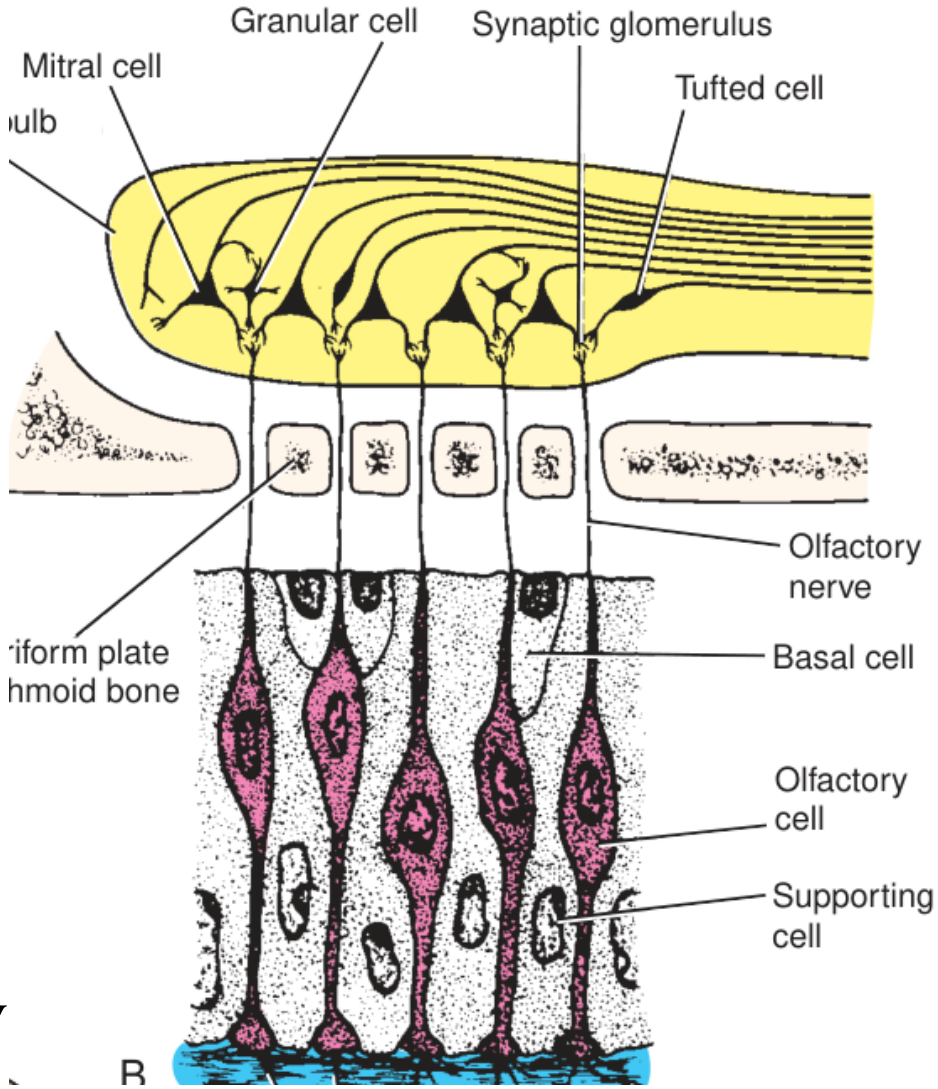
- Undergo continuous turnover, i.e., they are **continuously replaced by stem cells** in the olfactory neuroepithelium.

•Ovoid structure

•Possesses several types of nerve cells, the largest of which is the **mitral cell**

•Synapse with incoming olfactory nerve fibers.

•The axons of these secondary neurons form **olfactory tract.**

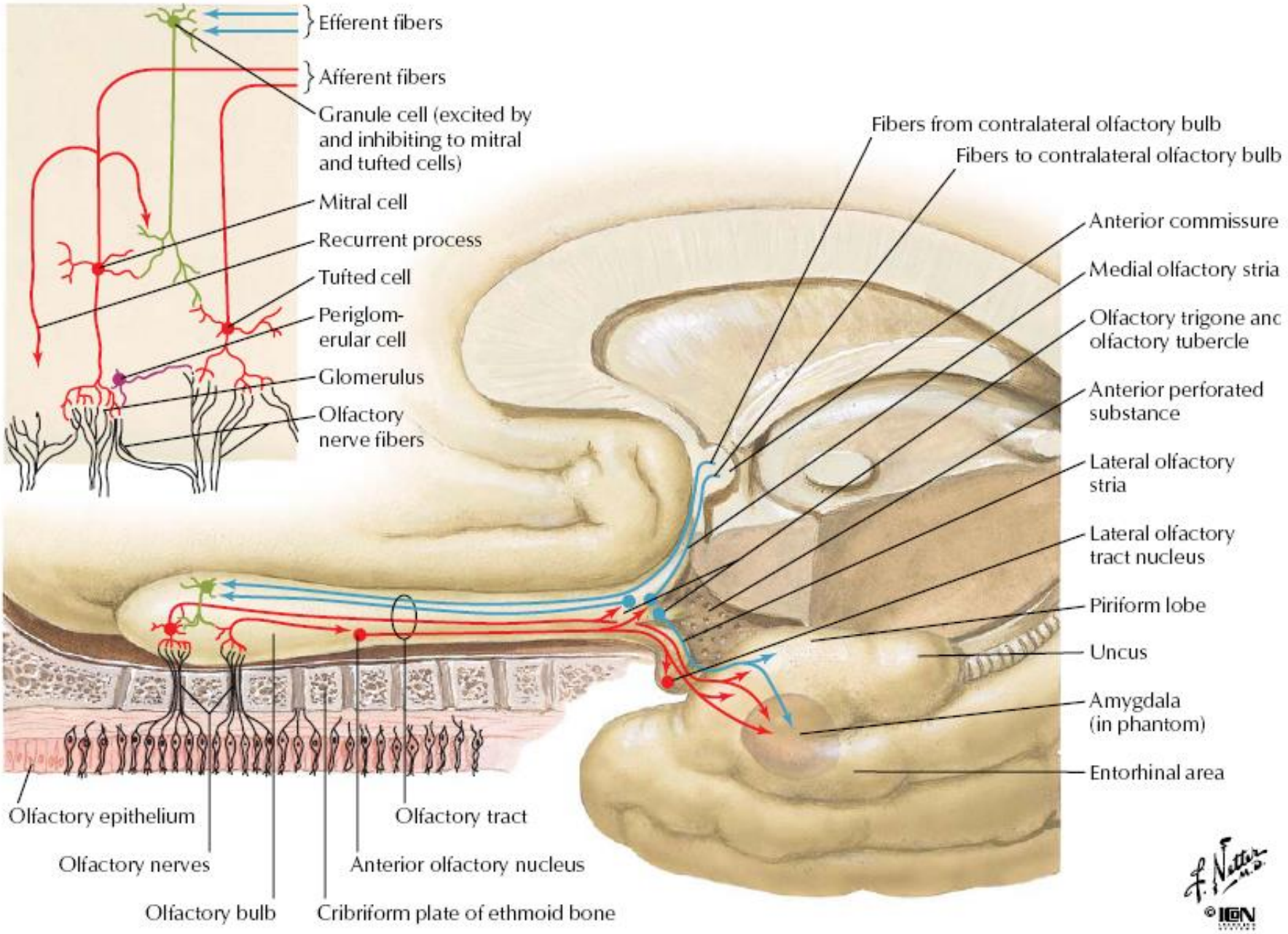


olfactory tract

- Is narrow band of white matter runs from the **posterior end of the olfactory bulb** beneath the inferior surface of the frontal lobe of the brain.

- Near to anterior perforated substance, it divides into:
  - **lateral striae:** carries the axons to the olfactory area of the cerebral cortex, the
    - Periamygdaloid and
    - Prepiriform areas (Piriform cortex)
  - **Medial olfactory striae:** carries the fibers that cross the median plane in the anterior commissure to pass to the olfactory bulb of the opposite side

- **The olfactory afferent pathway has only two neurons**


Efferent fibers
Afferent fibers
Granule cell (excited by and inhibiting to mitral and tufted cells)
Mitral cell
Recurrent process
Tufted cell
Periglom-erular cell
Glomerulus
Olfactory nerve fibers
Fibers from contralateral olfactory bulb
Fibers to contralateral olfactory bulb
Anterior commissure
Medial olfactory stria
Olfactory trigone anc olfactory tubercle
Anterior perforated substance
Lateral olfactory stria
Lateral olfactory tract nucleus
Piriform lobe
Uncus
Amygdala (in phantom)
Entorhinal area
Olfactory epithelium
Olfactory nerves
Olfactory bulb
Cribriform plate of ethmoid bone
Anterior olfactory nucleus
Olfactory tract
F. Netter M.D.
©

Clinic correlation

- **Anosmia**: The loss of sense of smell is called anosmia.

- Anosmia can occur for a number of reasons such as
  - atrophic rhinitis (degenerative disorder of nasal mucosa),
  - fracture of the anterior cranial fossa (ethmoidal fracture)

Clinical testing of olfactory nerve:

- The olfactory nerve is tested clinically by asking the patient to smell **common odors** such as peppermint, garlic, or cloves from each nostril separately with eyes closed

B. Optic Nerve (CN II):

- Is derived from the **ganglion cells of the retina &** enters the skull via the optic canal of the sphenoid bone.

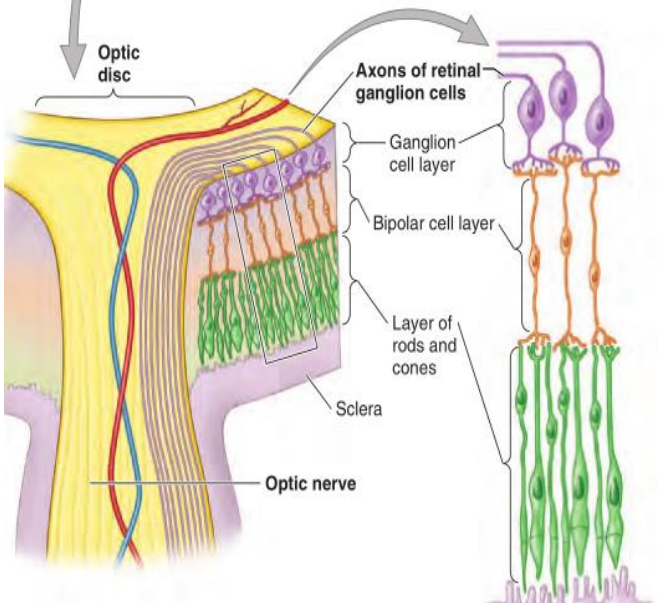
- Is a special somatic afferent (**SSA**)

- Regulate **vision** and **pupillary light reflexes**

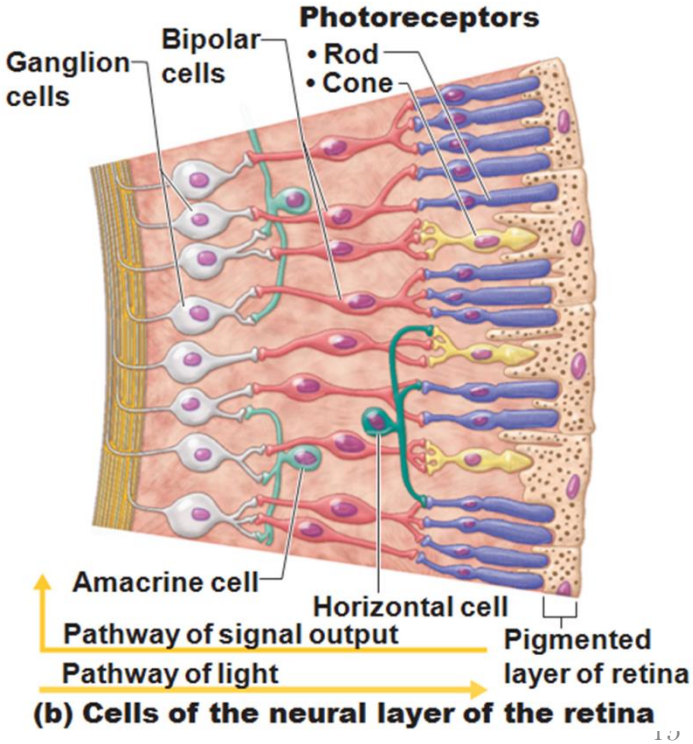
- **Its unique features:**
  - It consists of second-order sensory neurons.
  - Entirely enclosed in meningeal sheaths and subarachnoid space
  - Is not a true peripheral nerve since its fiber has no neurilemmal sheath but it is a tract of the diencephalon
  - Its fibers are myelinated by oligodendrocytes
  - Its fibers cannot regenerate if cut/damaged

Optic..

- The fibers of the optic nerve are the ***axons of the cells in the ganglionic layer of the retina***.

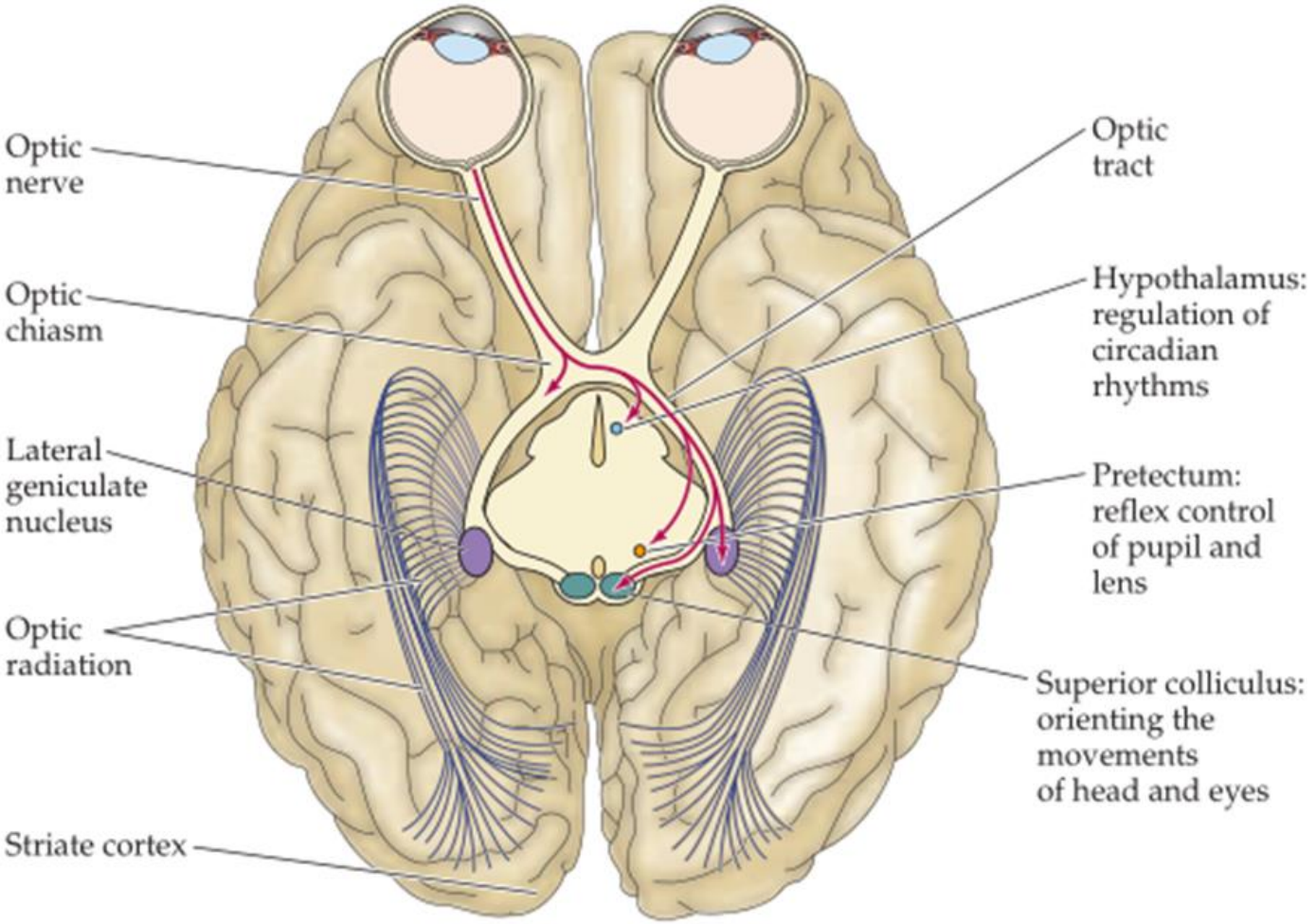


- They converge on the optic disc and exit from the eye, as the optic nerve.



Optic Nerve(CN II)

– Begin at the lamina cribrosa of the sclera
  - ❖ Unmyelinated nerve fibers before piercing
  - ❖ Myelinated, after piercing the sclera



CN-II: Optic Nerve

Optic chiasma

- The optic nerve leaves the orbital cavity and unites with the optic nerve of the opposite side to form the optic chiasma.
- Situated at anterior wall & floor of 3rd ventricle
- Fibers from nasal half of each retina cross & enter optic tract of opposite side.

Optic Tract:

- The optic tract passes posterolaterally around the cerebral peduncle.
- Most fibers of optic tract terminate in lateral geniculate body ➔ Optic radiation ➔ IC ➔ visual cortex (B-17)
- Few terminate of optic tract terminate in pretectal nucleus & superior colliculus

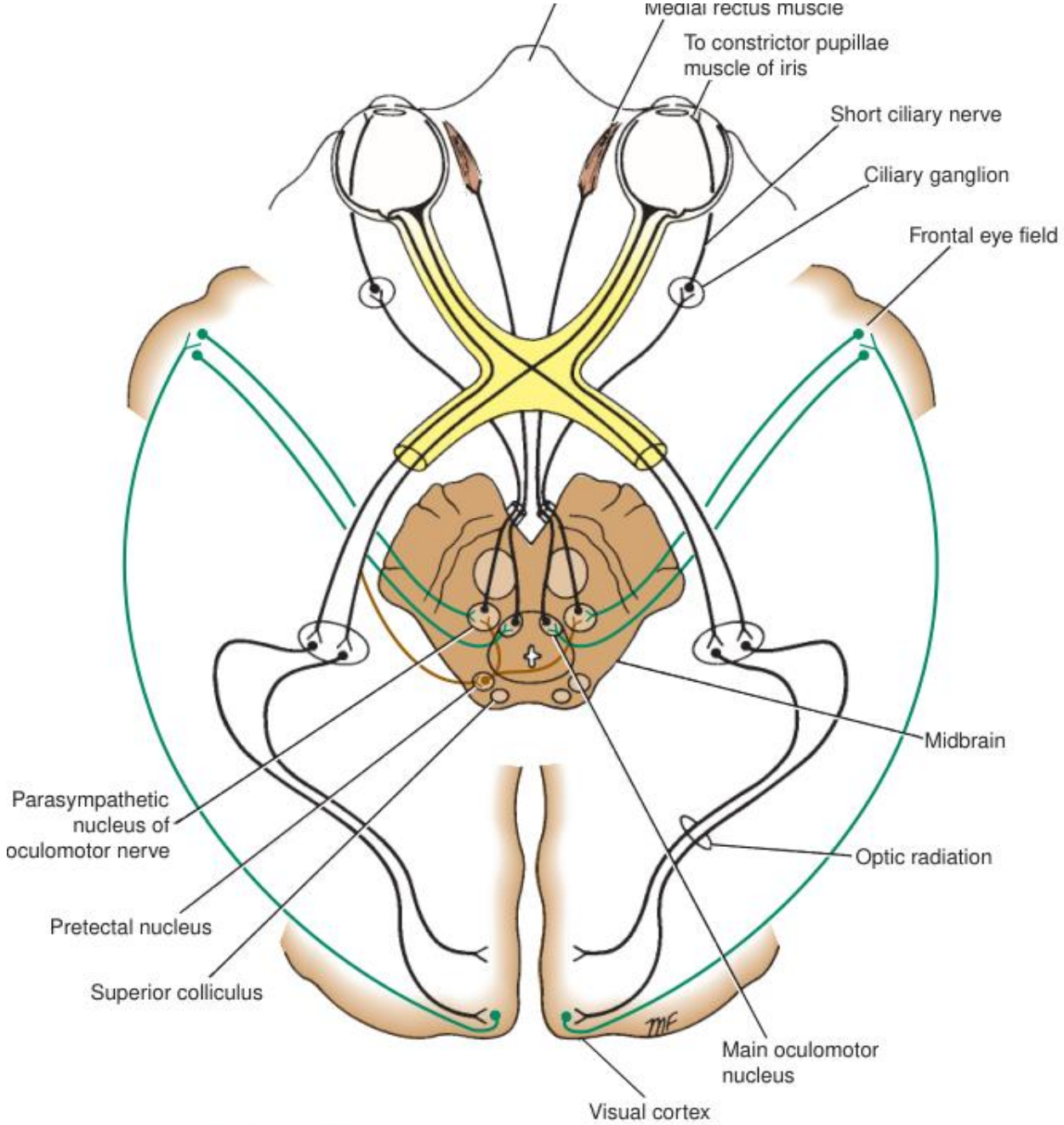
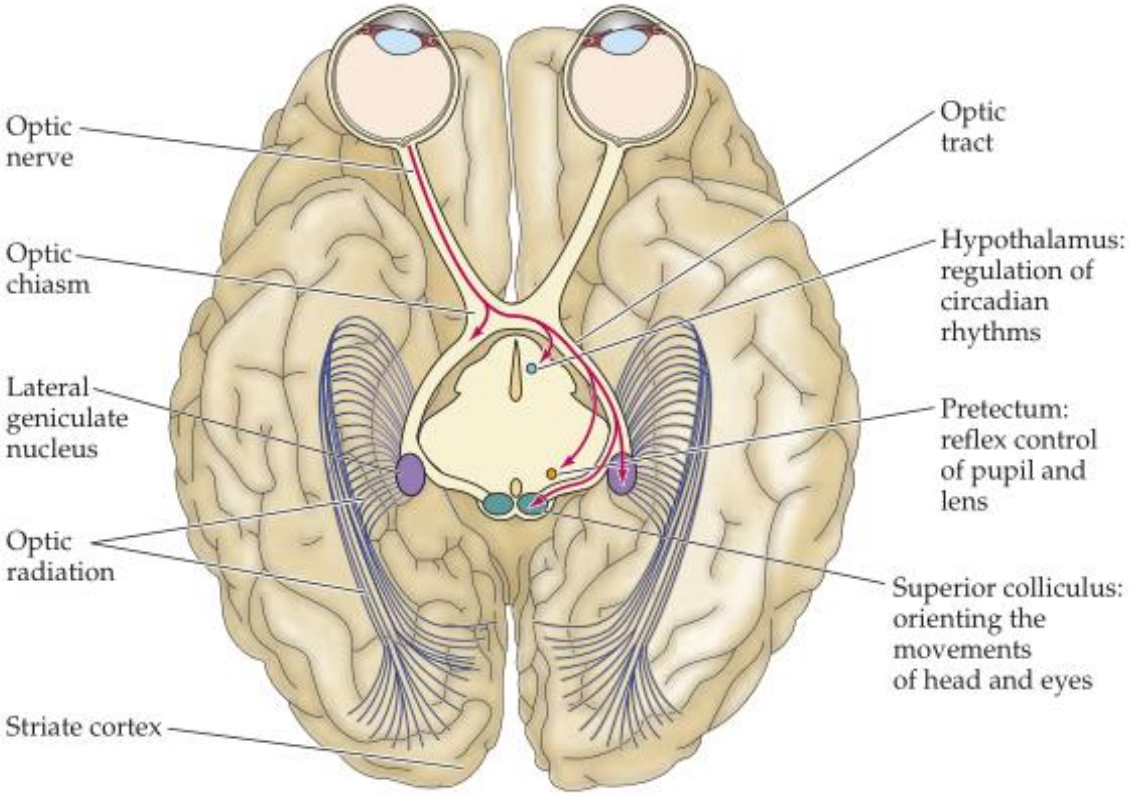
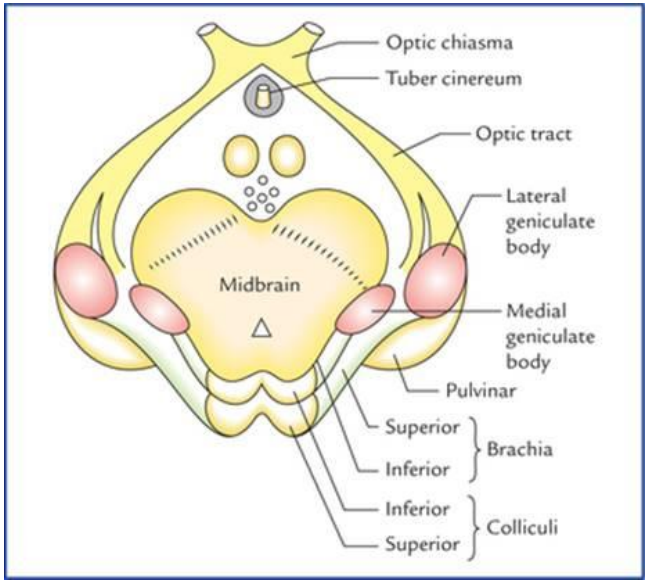


Figure 11-3 Optic pathway and the visual reflexes.

Lateral Geniculate Body

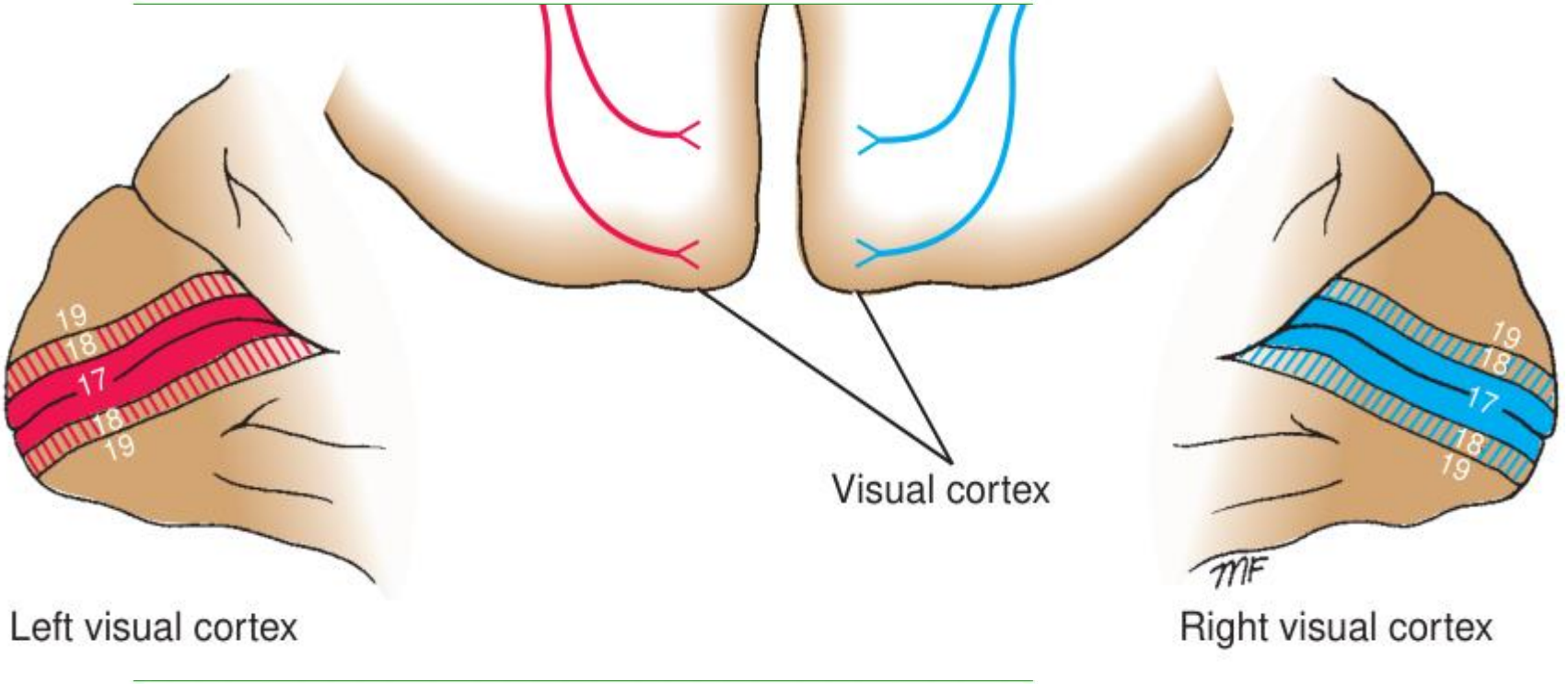
- The lateral geniculate body is a small, oval swelling projecting from the thalamus.
- It synapse the axons of the optic tract.
- The axons of the nerve cells within the geniculate body leave it to form the optic radiation.





Optic Radiation

- The fibers of the optic radiation are the axons of the nerve cells of the lateral geniculate body.
- OR passes posteriorly through the retrolenticular part of the IC and **terminates in the visual cortex (area 17).**
- The visual association cortex **(areas 18 and 19)** is responsible for recognition of objects and perception of color.



Neurons of the Visual Pathway

- 4 neurons conduct visual impulses to the visual cortex:

1. Rods and cones: specialized receptor neurons in the retina

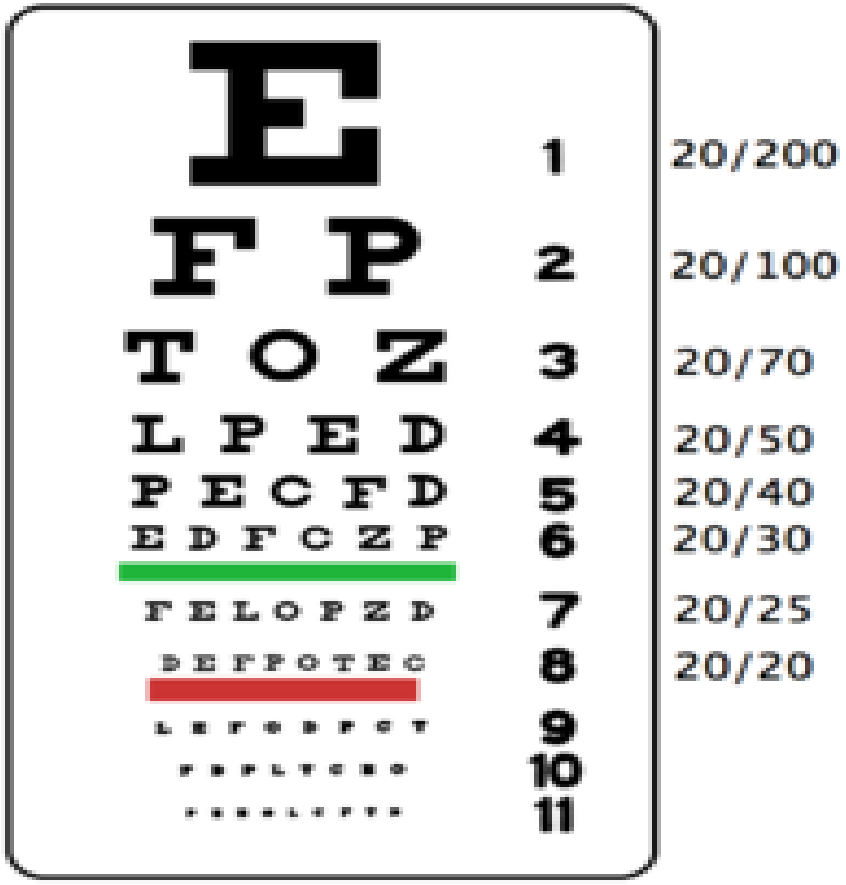
2. Bipolar neurons: connect the rods & cones to the ganglion cells

3. Ganglion cells: whose axons pass to the lateral geniculate body

4. Neurons of the lateral geniculate body: whose axons pass to the cerebral cortex.

Clinical correlation

- **Function:**
  - vision
- Clinical test for damage:
  - tests peripheral vision and visual acuity
- Effects of damage:
  - blindness in part or all of the visual field

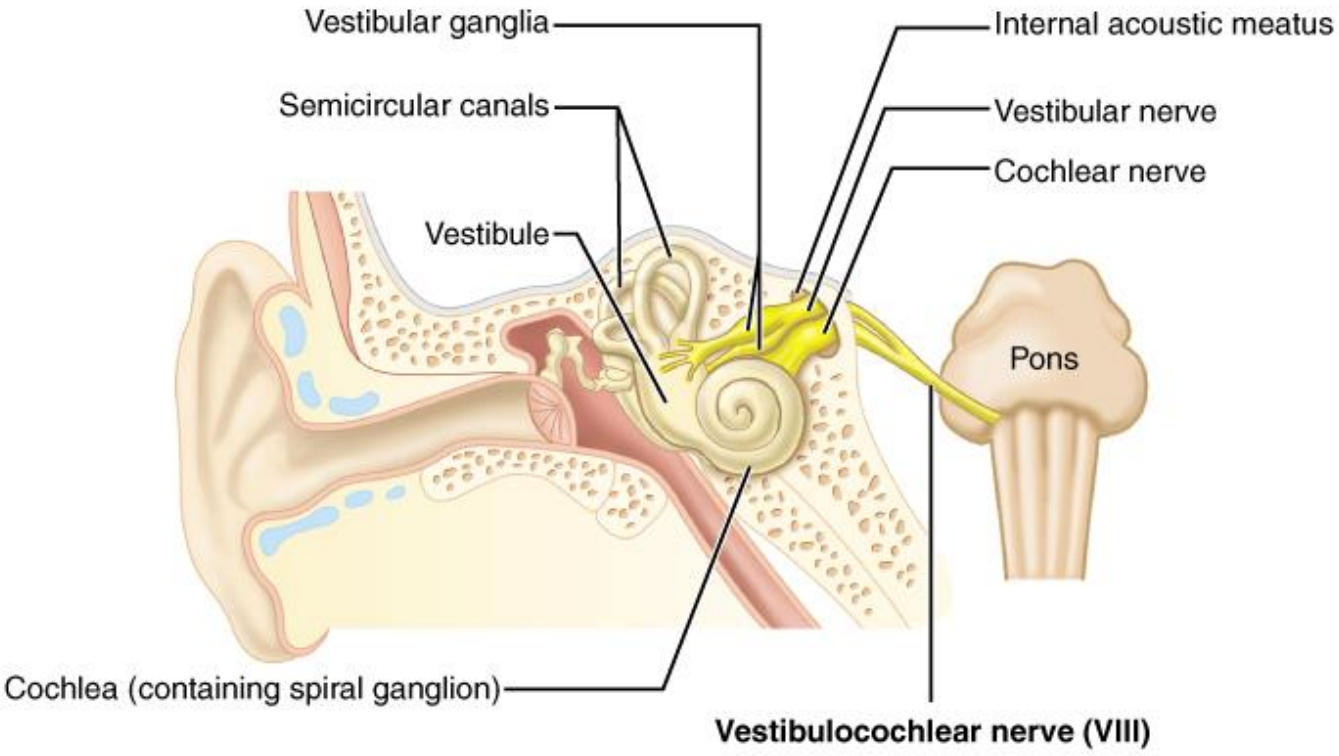


Papilledema: swelling of optic disc (Early sign of increased ICP)

C. Vestibulocochlear nerve(CN-VIII)

- SSA:
- This nerve consists of 2 distinct parts
  - Vestibular nerve: equilibrium & balance
  - Cochlear nerve: Hearing

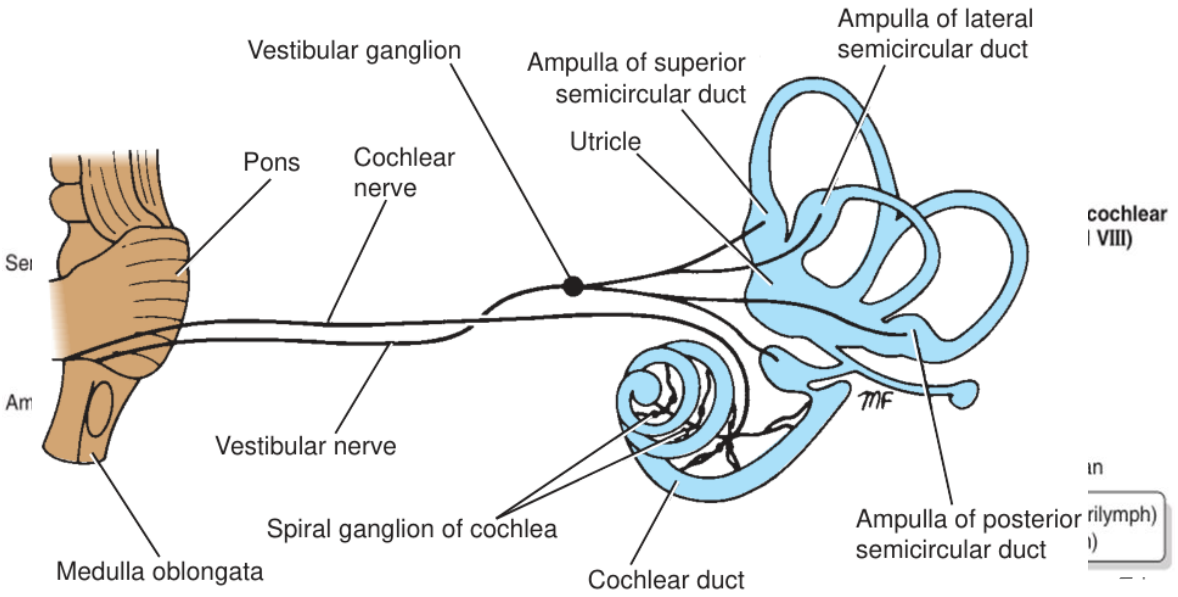
- 1st-order sensory bipolar neurons.



Vestibular Nerve

- Conducts nerve impulses from:
  - the **utricle and saccule:** concerning position of the head;
  - **semicircular canals**: concerning movements of the head.

- **vestibular ganglion:** contain cell bodies 1st order **Neuron.**
  - Their central process form fibers of the vestibular nerve
  - situated in the internal acoustic meatus.
  - enter the anterior surface of the brainstem in a groove between the pons and **MO**.



- When they enter the vestibular nuclear complex,
- The fibers:
    - divide into short ascending and long descending fibers;
    - Few pass directly to the **cerebellum** through the inferior cerebellar peduncle, by passing the vestibular nuclei.

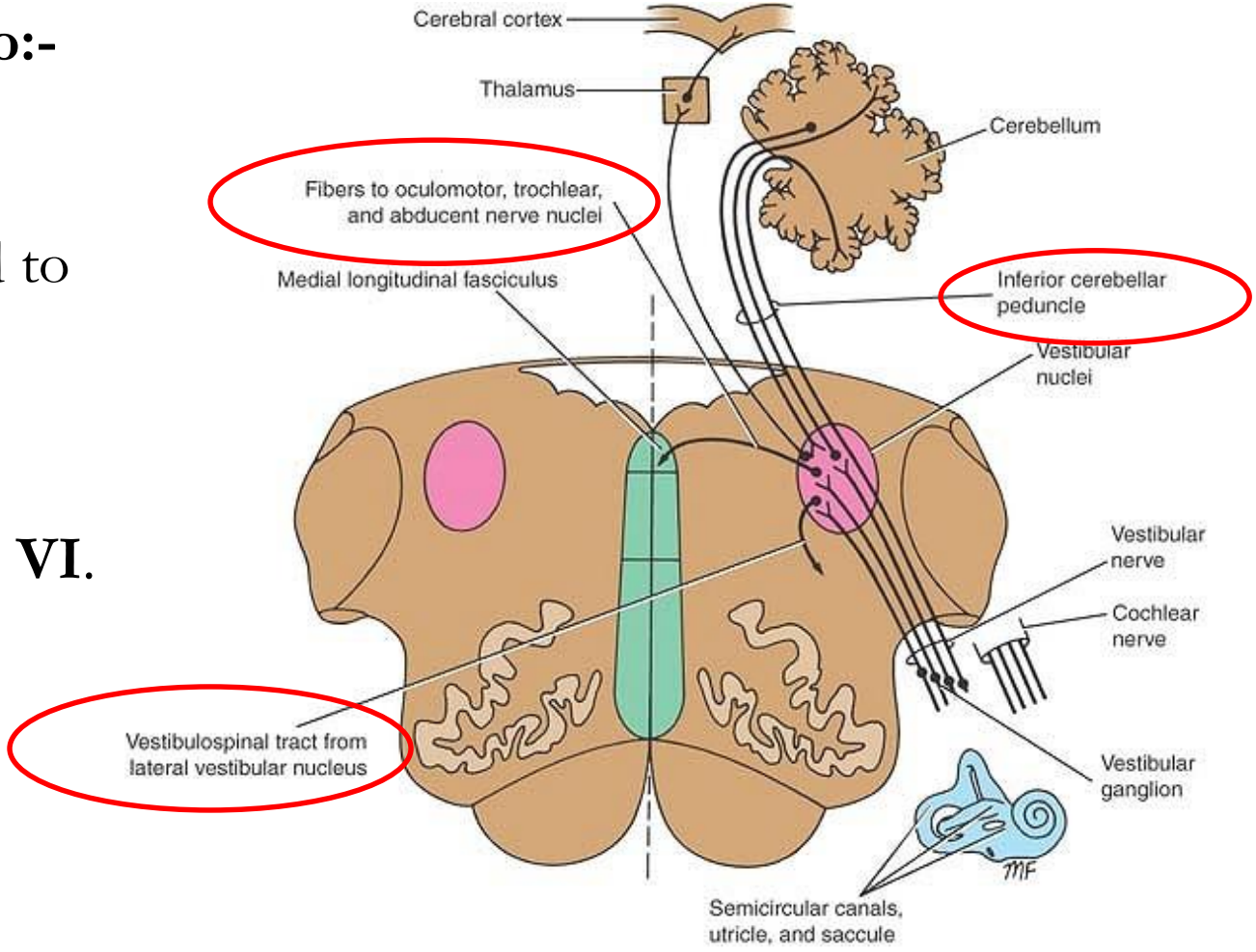
Vestibular Nuclear Complex

- Consists of nuclei beneath the floor of the fourth ventricle.

- Can be categorized as:
    1. Lateral vestibular nucleus,
    2. Superior vestibular nucleus,
    3. Medial vestibular nucleus,
    4. Inferior vestibular nucleus

Send efferent fibers to:-

- ❑ Cerebellum
- ❑ Descend uncrossed to the spinal cord
- ❑ Nuclei **CN III, IV, VI**.



- Ascending fibers relay in the **ventral posterior nuclei of the thalamus**.

- Then pass to the cerebral cortex, (vestibular area in the postcentral gyrus)

Cochlear Nerve

- Conducts impulses from the organ of Corti in the cochlea.

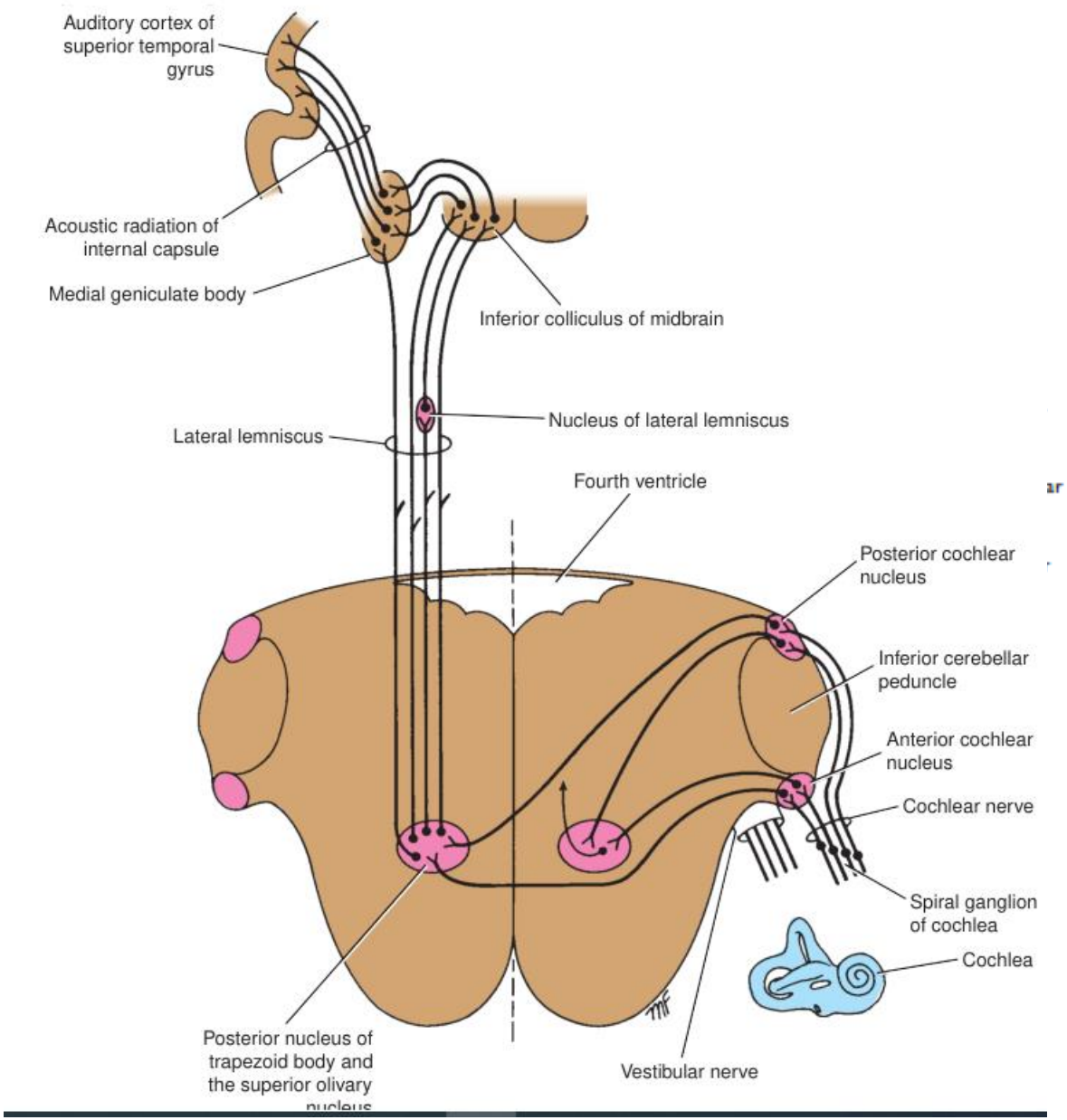
- Spiral ganglion of the cochlea:
  - Their central processes forms fibers of the cochlear nerve.
  - enter to brainstem at junction b/n pons and **MO**.

Cochlear Nuclei

- Anterior and posterior situated on the surface of the inferior cerebellar peduncle.

- Send axons ➔ to end in the trapezoid body and the olivary nucleus ➔axons from here ascend through the posterior part of the pons and midbrain and form the **lateral lemniscus**.

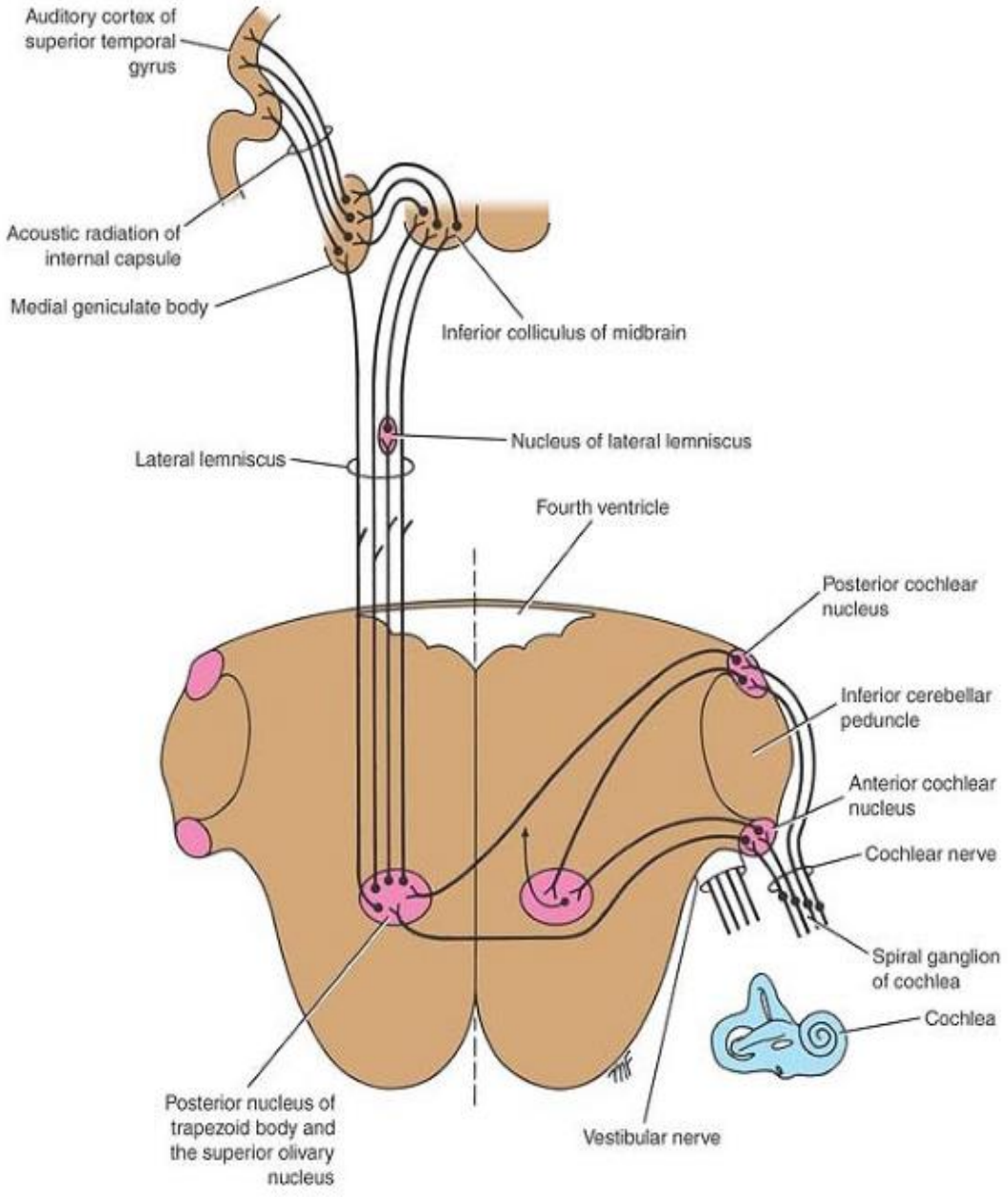
The cochlear nuclei send axons (second-order neuron fibers) that run medially through the pons to *end in the* trapezoid body and the olivary nucleus.



On reaching the midbrain, the fibers of the lateral lemniscus either

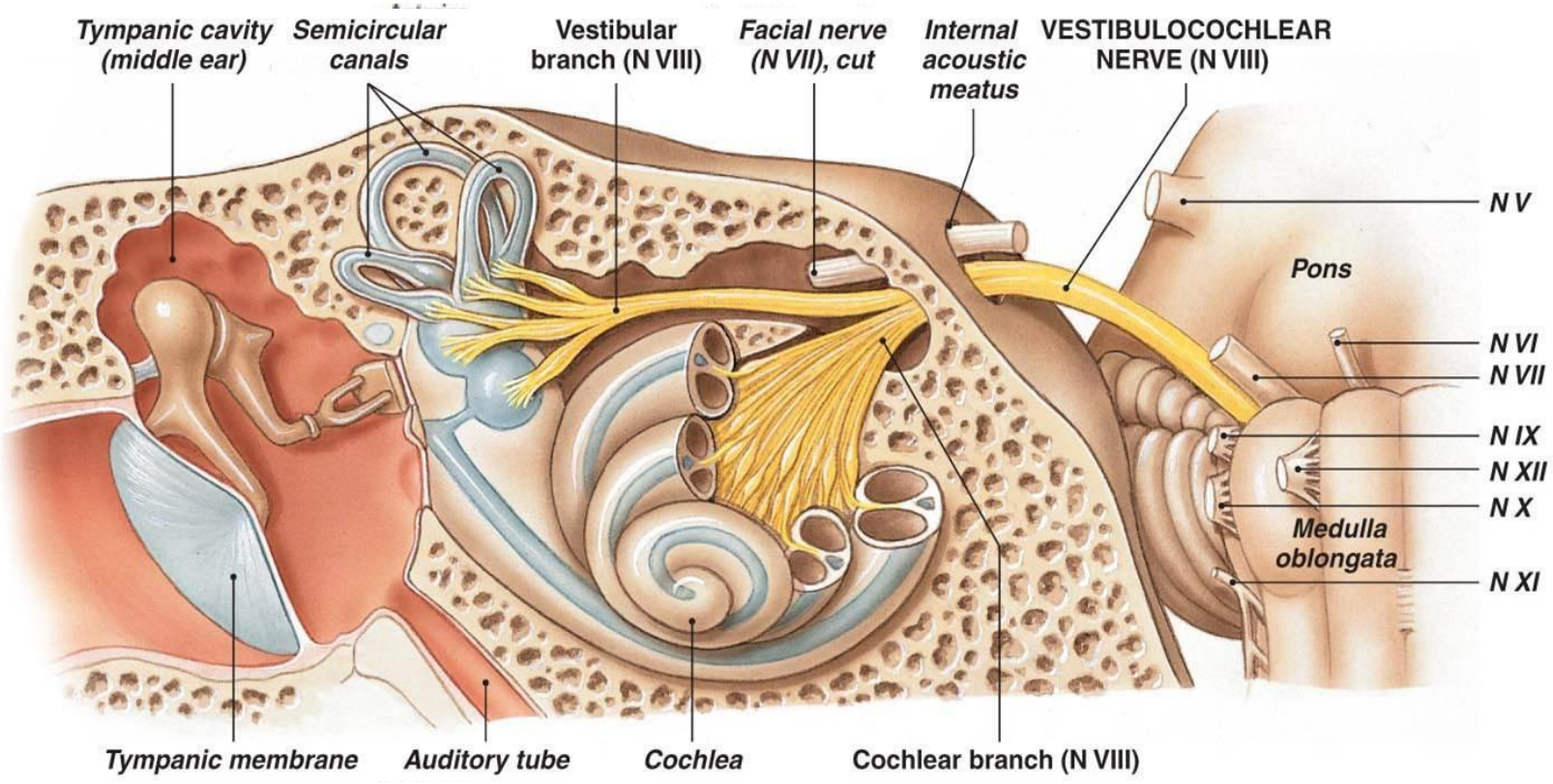
- ➢ *terminate in the nucleus of the inferior colliculus* or
- ➢ *relayed in the medial geniculate body* and

- Pass to the auditory cortex of the cerebral hemisphere through the ***acoustic radiation of the internal capsule***



Clinical correlation

- Clinical tests: test hearing, balance, and ability to walk a straight line
- Effects of damage: deafness, dizziness, nausea, loss of balance

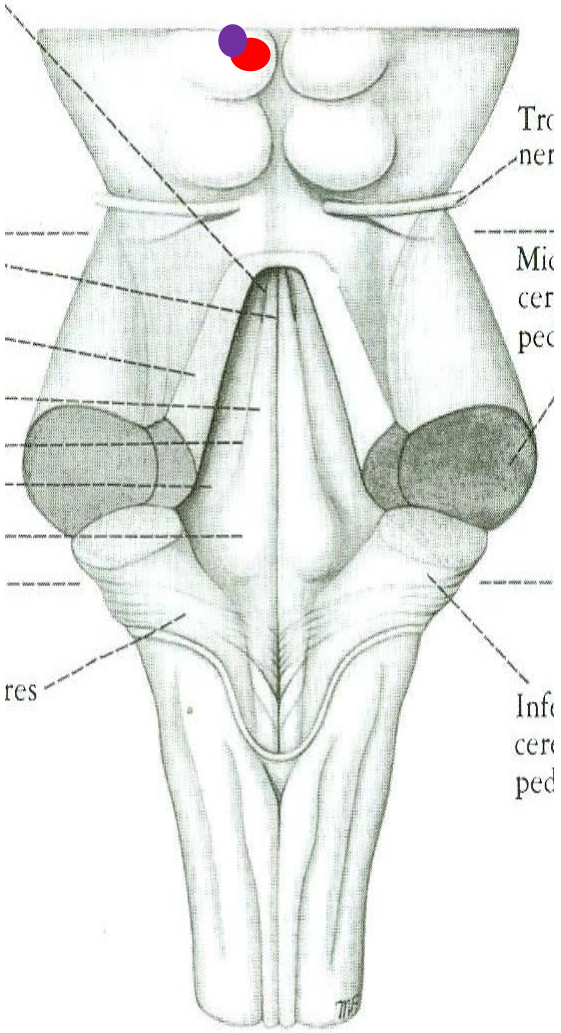


Purely motor cranial nerves:

A. Oculomotor nerve (CN - III):

- Pure motor nerve

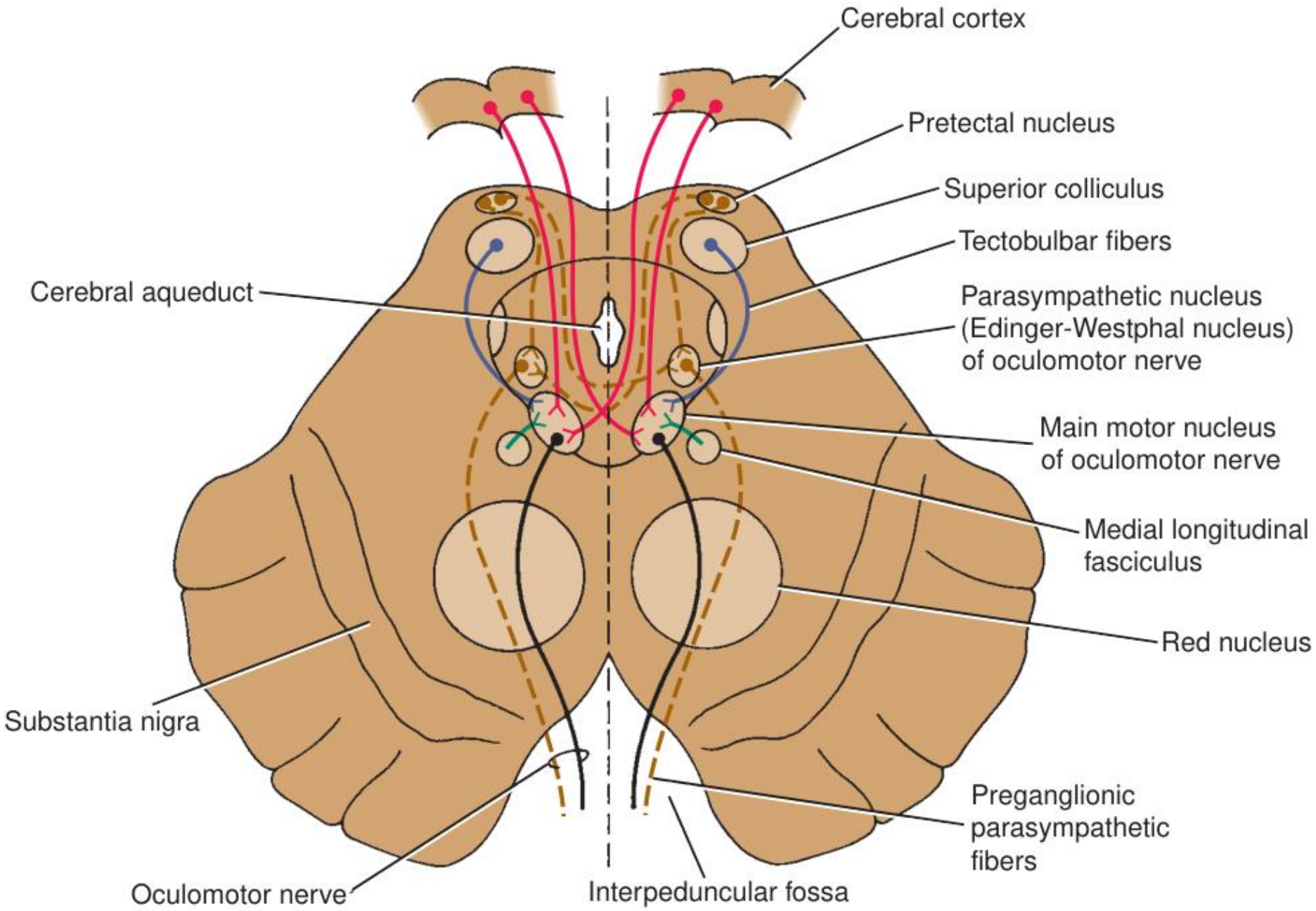
- Function: eye movements, opening of eyelid, constriction of pupil, focusing, **accommodates**, and **converges**.



- Has two motor nuclei in the midbrain:

1. ***Main motor nucleus*** (**GSE**)
   - ✓ Arising fiber supply all extraoculi muscles except LR and SO
2. ***Accessory parasympathetic nucleus*** (edinger-westphal nucleus) or GVE

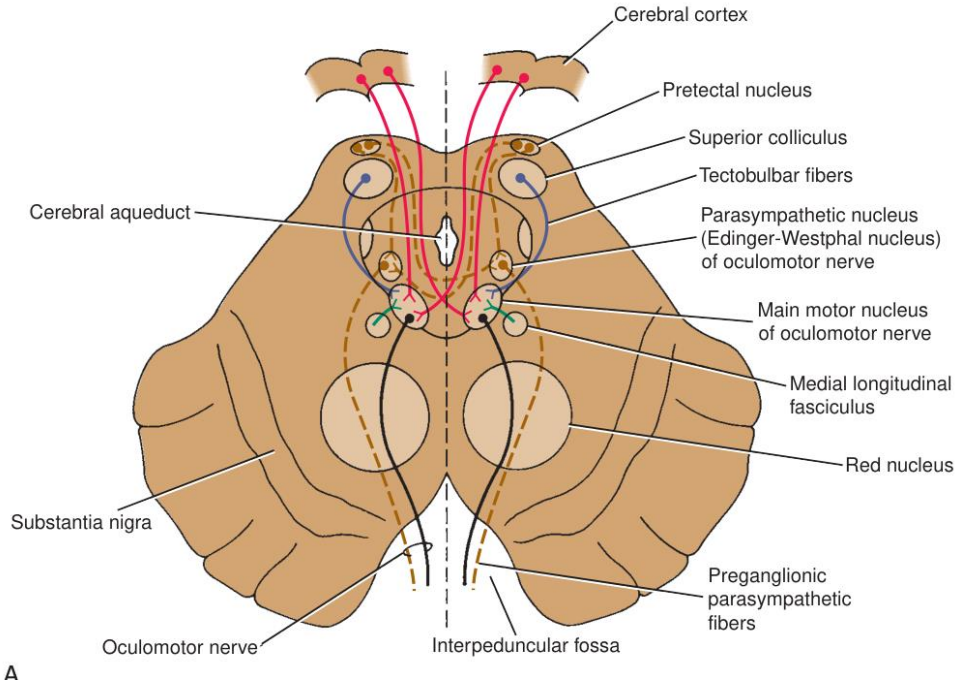
✓Arising Fiber supply the sphincter pupillae and ciliaris muscles.


Cerebral cortex
Pretectal nucleus
Superior colliculus
Tectobulbar fibers
Cerebral aqueduct
Parasympathetic nucleus
(Edinger-Westphal nucleus)
of oculomotor nerve
Main motor nucleus
of oculomotor nerve
Medial longitudinal
fasciculus
Red nucleus
Substantia nigra
Preganglionic
parasympathetic
fibers
Oculomotor nerve
Interpeduncular fossa
A

2. Accessory parasympathetic nucleus (Edinger –Westphal Nucleus of CN - III):

- Lies posterior/dorsal to main motor nucleus.

- Its fibers carried in inferior division of CN – III & synapse in **ciliary ganglion.**

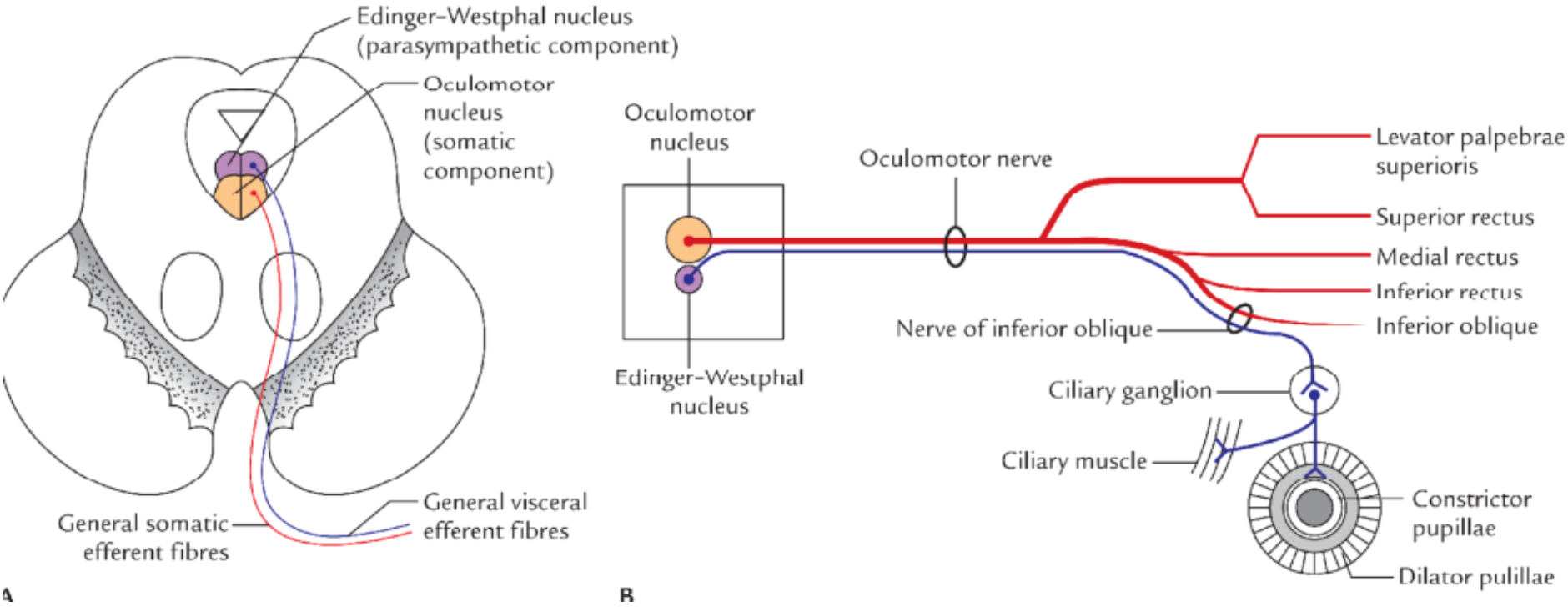


- Supply intrinsic muscles of the eye, **constrictor pupillae & ciliary muscle.**

Accessory motor nucleus

Receives

- Corticonuclear fibers for the accommodation reflex
- Fibers from the pretectal nucleus for the direct and consensual **light reflexes**

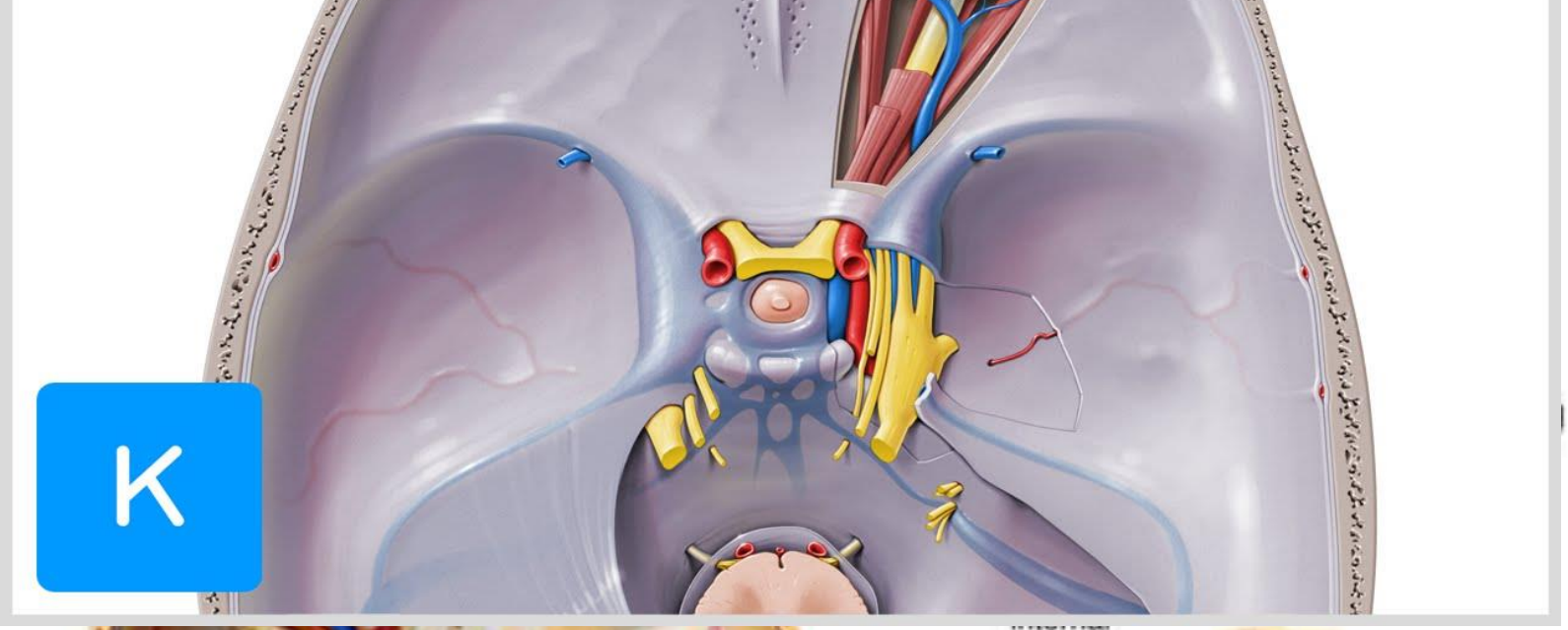


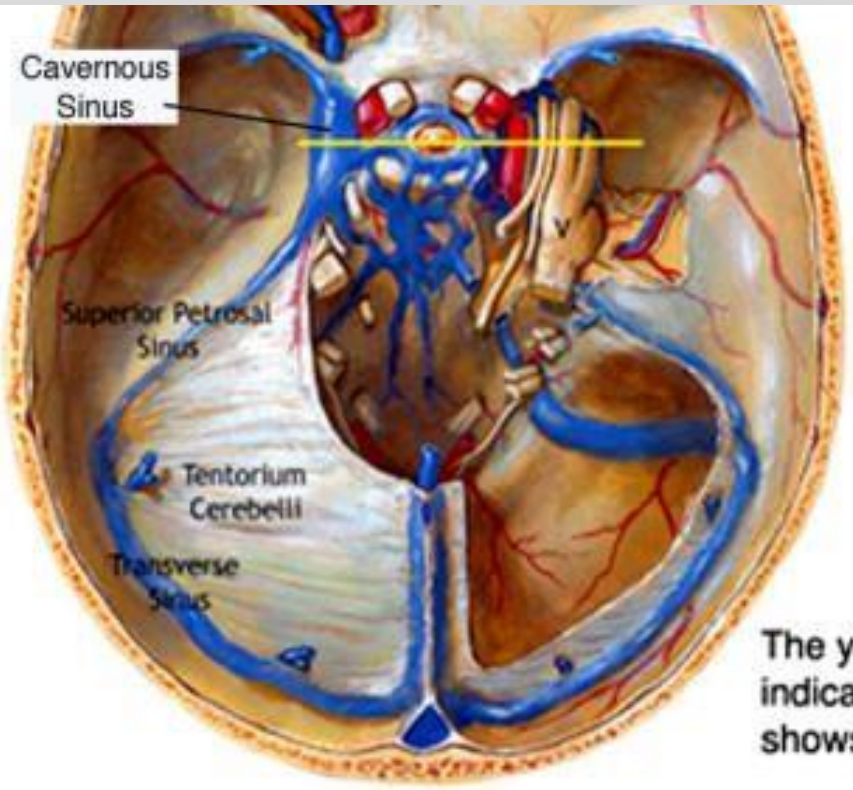
Course of the Oculomotor Nerve

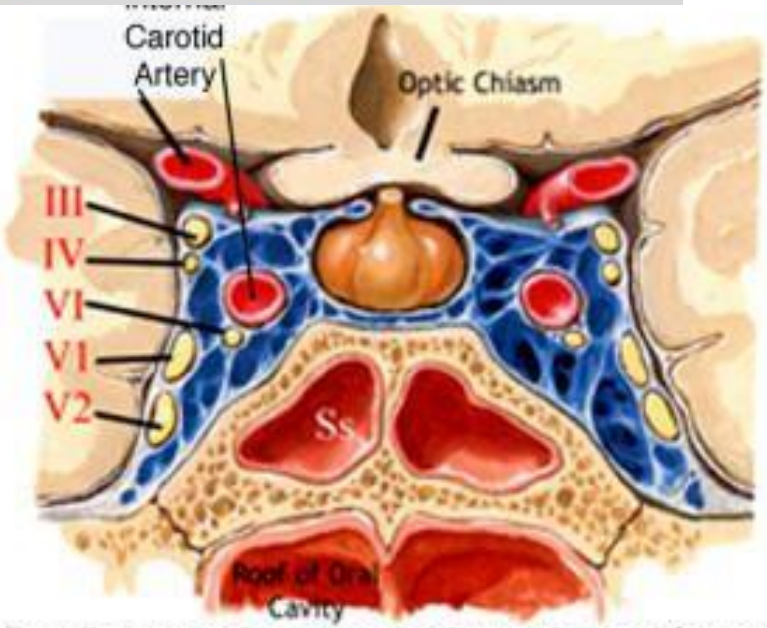
- Begin at the level of superior colliculus (**MIDBRAIN**)
- Passes through to red nuclei
- Passes through ***interpeduncular fossa*** of midbrain
- Exit ventral side of brain stem
- Passes b/n superior cerebellar and posterior cerebral arteries
- Pierces dura lateral to the posterior clinoid process
- Travel's in the lateral wall of the cavernous sinus
- Enter the orbit through sup. Orbital fissure

Within this fissure, CN III divides into a

- *Superior division (supplies SR and levator palpebrae superioris) and*
- *Inferior division (supplies IR and MR and IO).*







The yellow line crossing over the hypophyseal fossa indicates the plane of section of th image above. It shows the cavernous sinus and its contents.

The damage of oculomotor nerve results

Cause

- Compression by aneurysm of the posterior communicating artery
- Compression by aneurysm of ICA

- **Ptosis** (drooping of the upper eyelid), due to paralysis of the levator palpebrae superioris.
- Lateral **strabismus** (i.e., lateral squint)
- **Dilated** and fixed pupil.
- Loss of **accommodation**
- **Double** vision or diplopia occurs on looking medially, inferiorly, and superiorly, due to paralysis of the medial rectus, inferior rectus, and inferior oblique muscles.

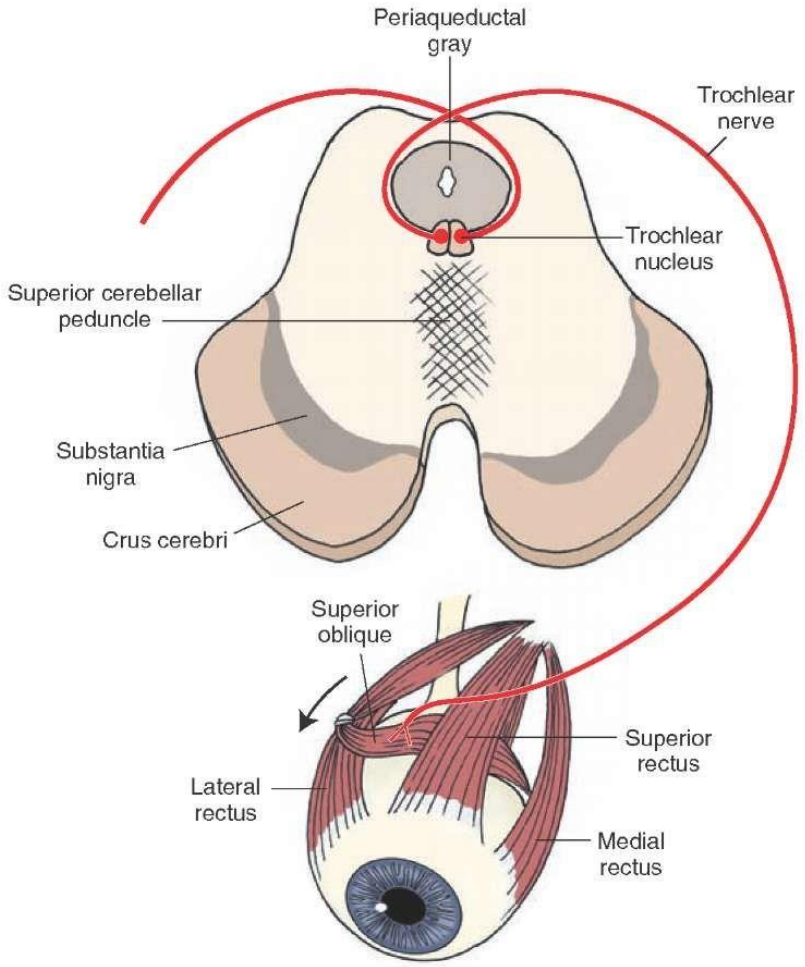
Clinical tests for injury:

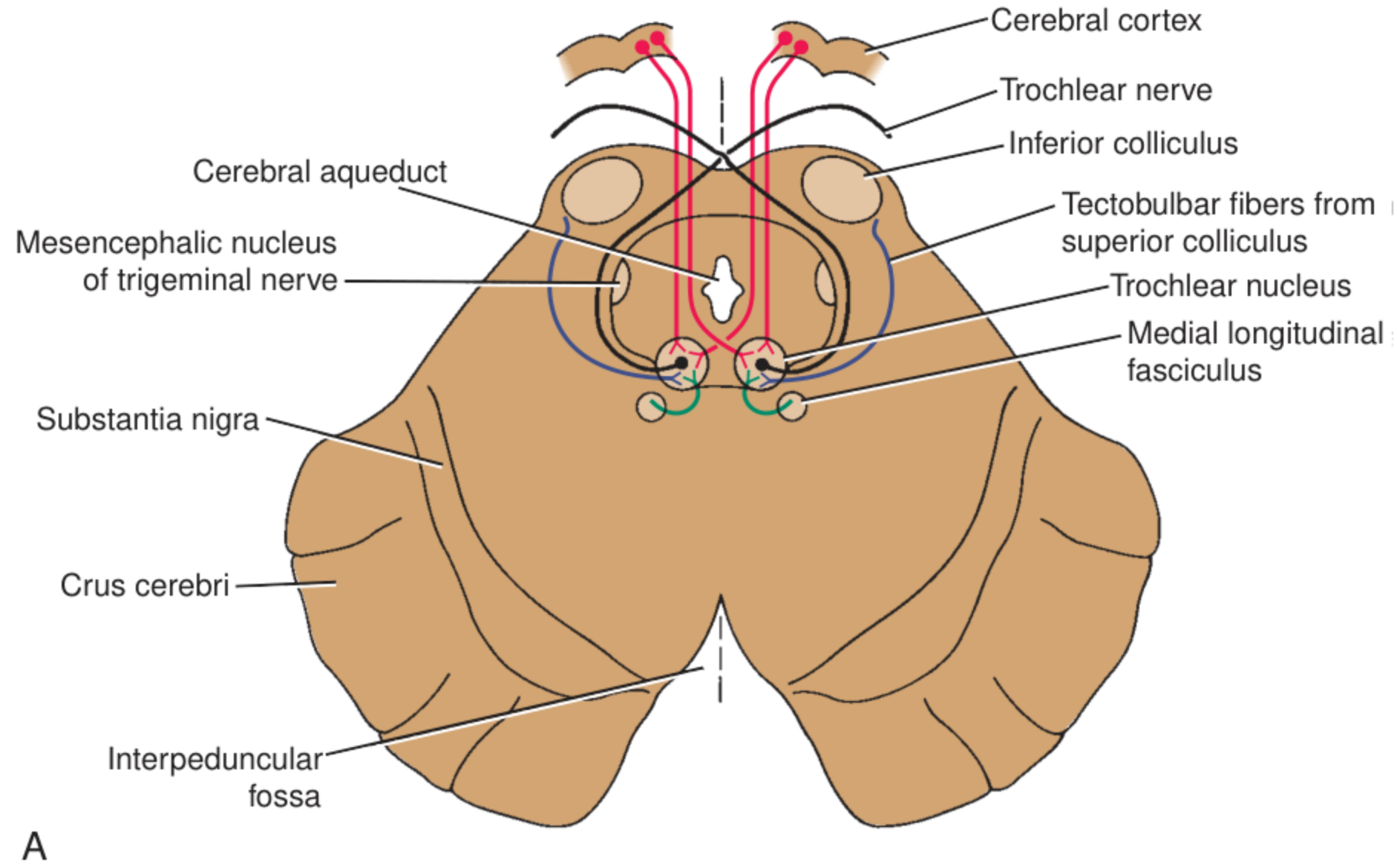
– Differences in pupil size; pupillary response to light

Purely Motor Cranial Nerves: CN - IV

CN IV: Trochlear Nerve

- General somatic efferent to one extra-ocular muscle- *superior oblique*
- Nucleus located in gray mater surrounding cerebral aqueduct.
- Receives:
  - Corticonuclear fibers from both CH
  - Tectobulbar fiber from supcolliculus
  - Fibers of medial longitudinal fasciculus.




Cerebral cortex
Trochlear nerve
Inferior colliculus
Cerebral aqueduct
Tectobulbar fibers from superior colliculus
Mesencephalic nucleus of trigeminal nerve
Trochlear nucleus
Medial longitudinal fasciculus
Substantia nigra
Crus cerebri
Interpeduncular fossa
A

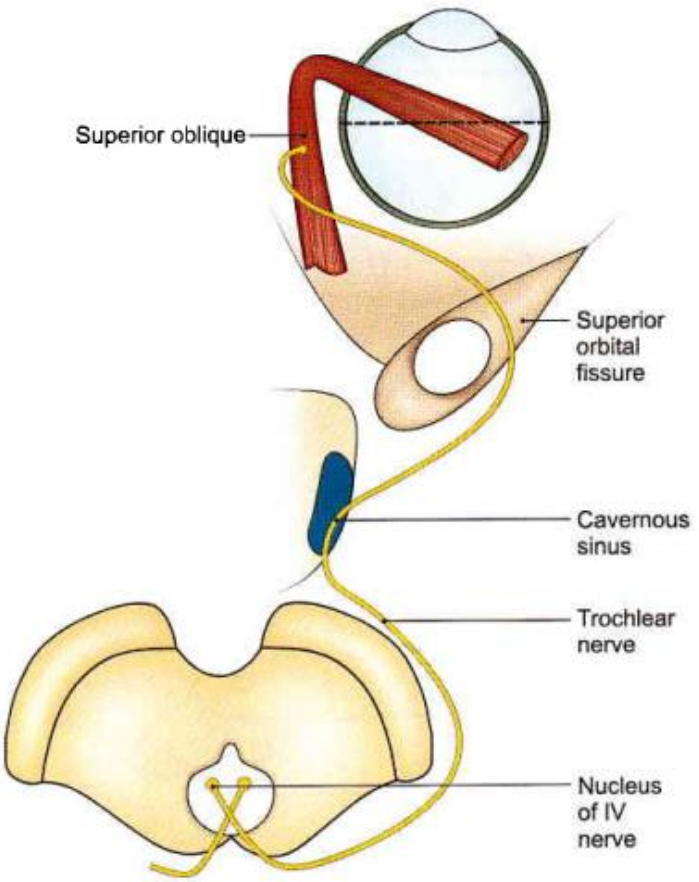
Unique Features CN IV

1. It is the only cranial nerve that emerge from the **dorsal aspect** of the brainstem (mid brain).

2. The only one that have the **contralateral nucleus**.

3. The only cranial nerve that have the longest intracranial course

4. It is highly susceptible to **increased ICP**



5. It is the **most slender** of all the cranial nerves

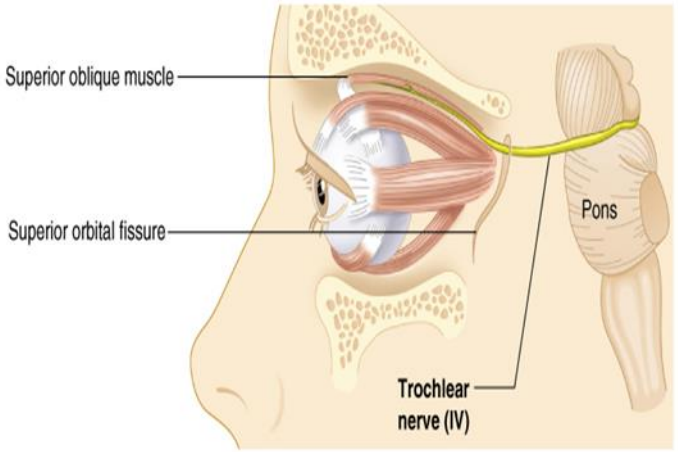
6. It is the only CN whose nuclear fibers decussate before emerging on the surface of the brain.

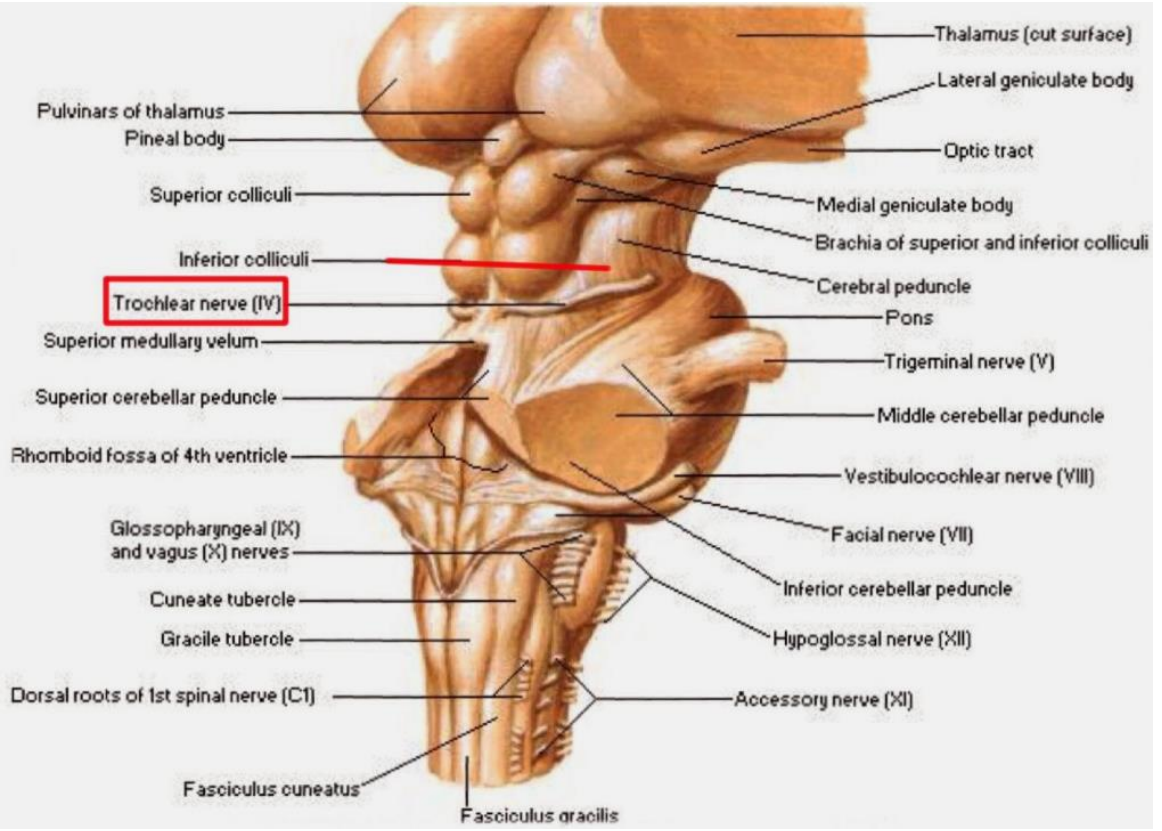
Course of trochlear nerve

- The nerve fibers, after leaving the nucleus,

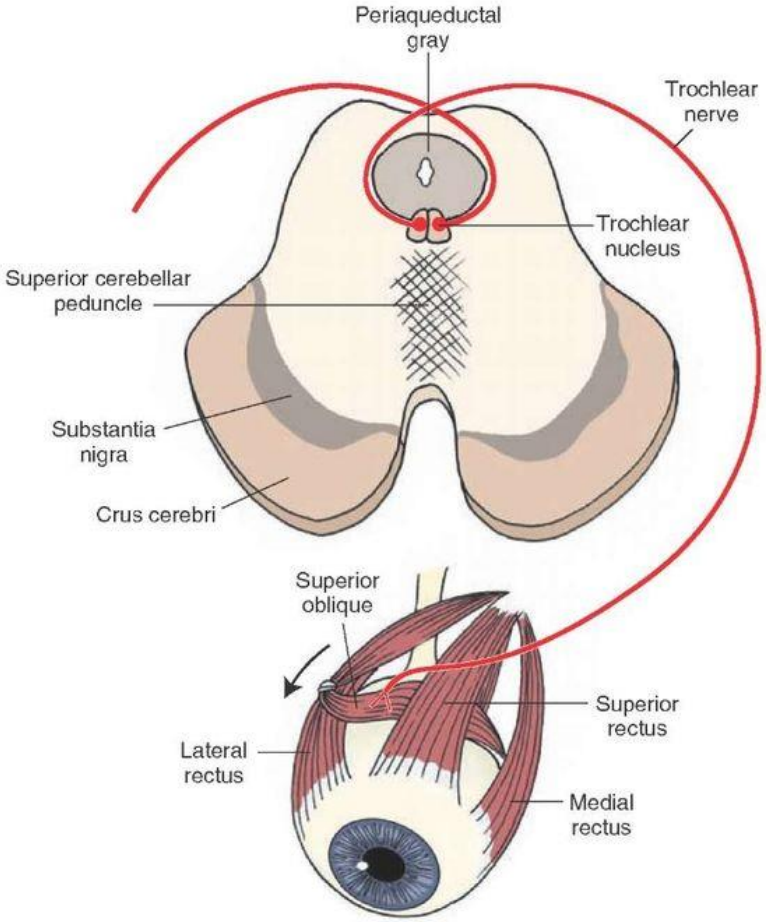
pass posteriorly around the central gray matter to reach the posterior surface of the midbrain.

- Then, nerve winds round the superior cerebellar peduncle and cerebral peduncle
- Passes forward through the middle cranial fossa in the lateral wall of the cavernous sinus





- and enters the orbit through the superior orbital fissure
- Runs medially above the levator palpebrae superioris
- Finally supply superior oblique



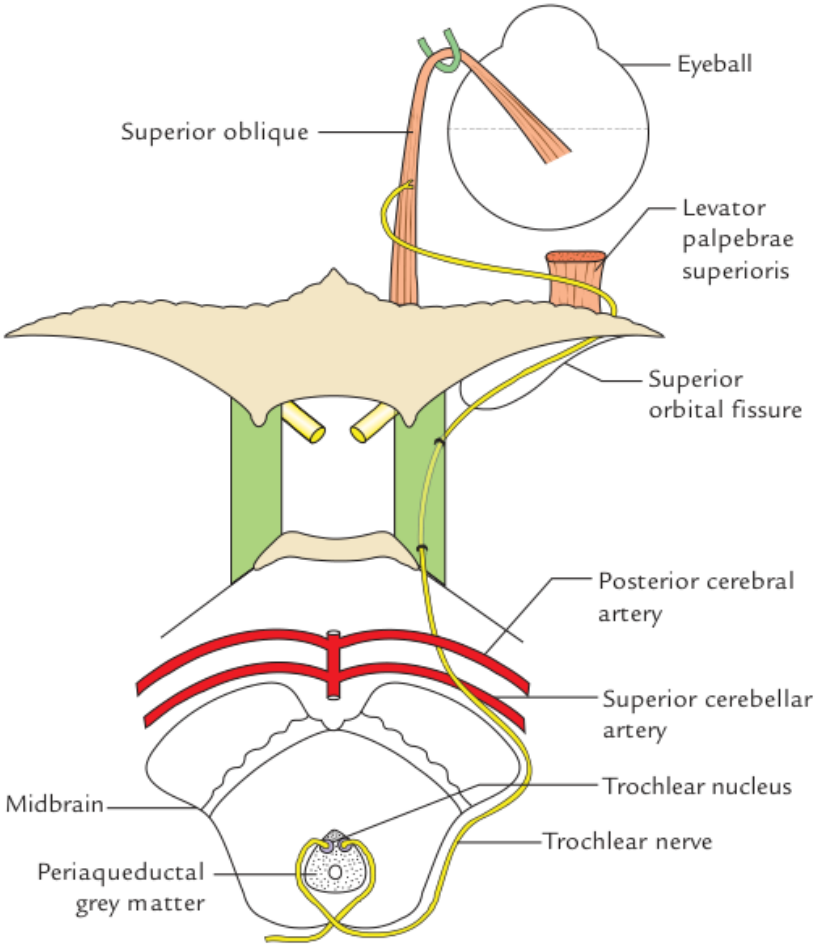


Fig. 22.5 Origin, course, and distribution of the trochlear nerve.

Clinical correlation

- Clinical test for injury: ability to rotate eye inferolaterally

- Effects of damage – unable to move the eye inferior and laterally

Abducent nerve (VI)

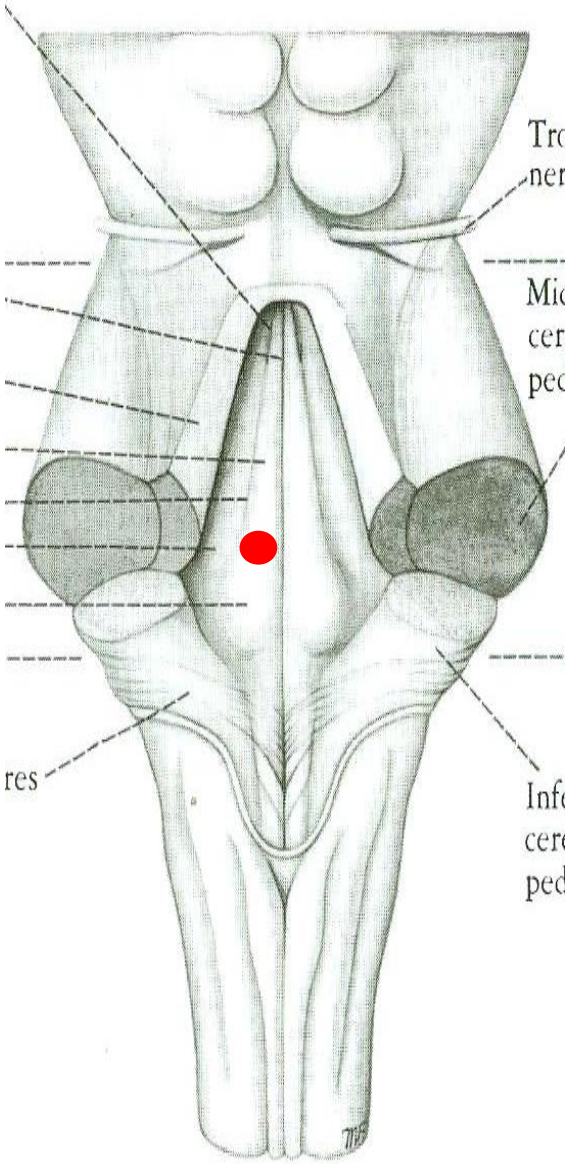
- General somatic efferent to one extra-ocular muscle, the **lateral rectus**.

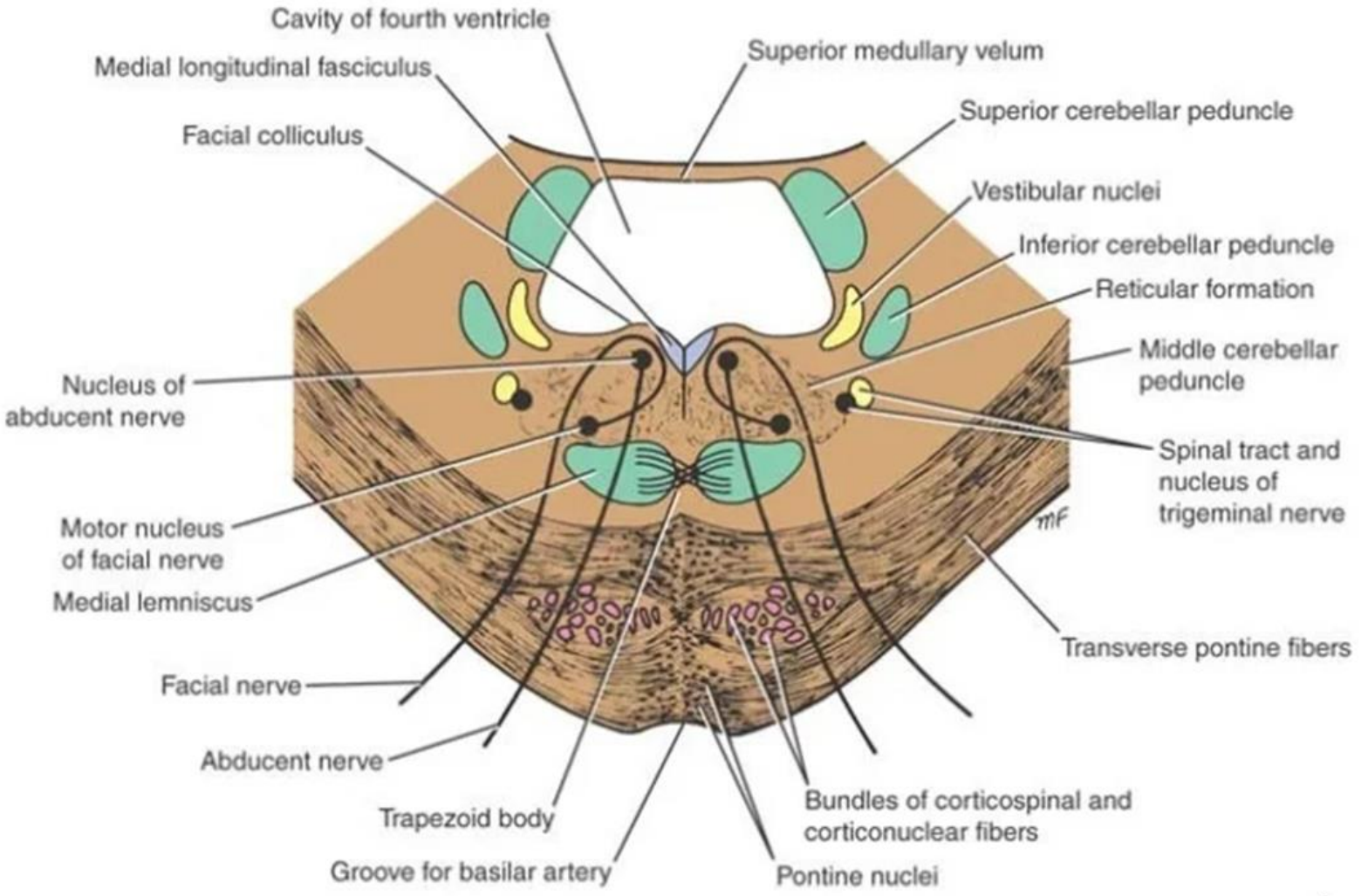
- Nucleus lies in lower pons near midline

- The small motor nucleus is situated

✓beneath the floor of the upper part of the fourth ventricle, and

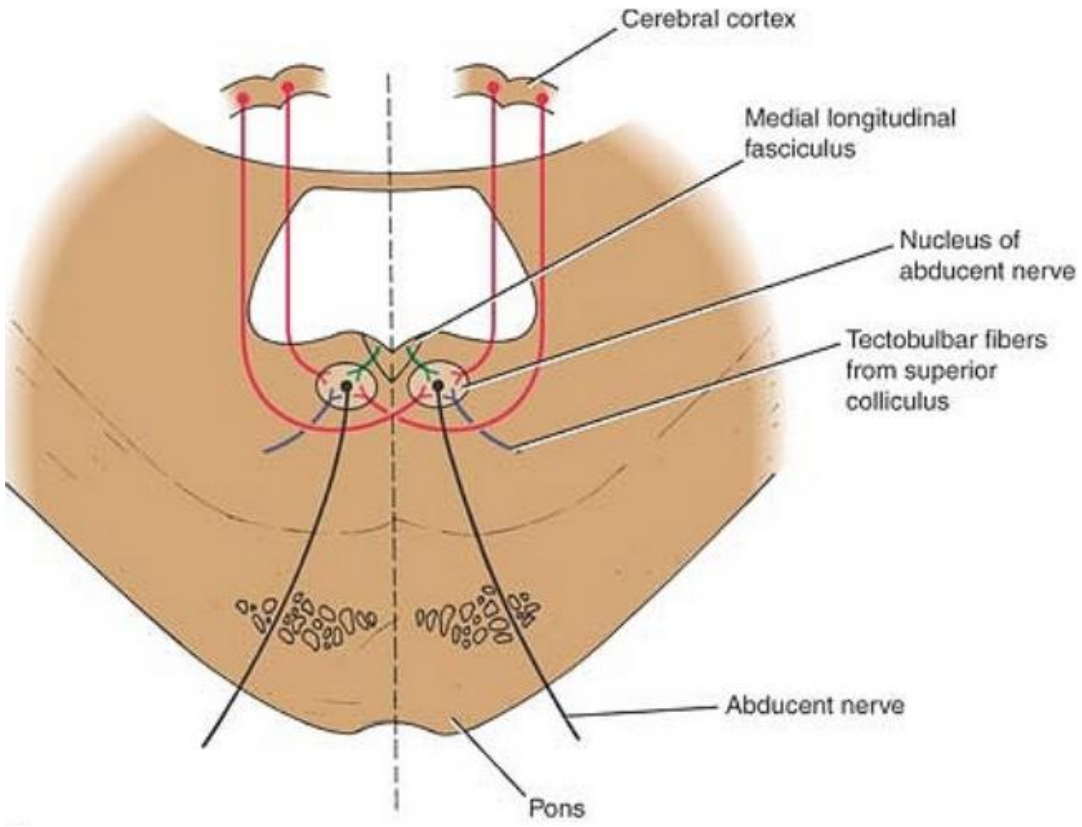
✓**beneath the facial colliculi**




Cavity of fourth ventricle
Medial longitudinal fasciculus
Facial colliculus
Superior medullary velum
Superior cerebellar peduncle
Vestibular nuclei
Inferior cerebellar peduncle
Reticular formation
Middle cerebellar peduncle
Nucleus of abducent nerve
Spinal tract and nucleus of trigeminal nerve
Motor nucleus of facial nerve
Medial lemniscus
MF
Transverse pontine fibers
Facial nerve
Abducent nerve
Trapezoid body
Groove for basilar artery
Bundles of corticospinal and corticonuclear fibers
Pontine nuclei

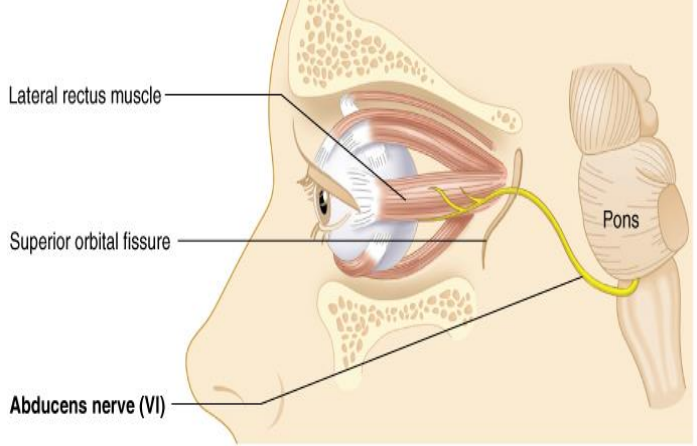
The nucleus receives

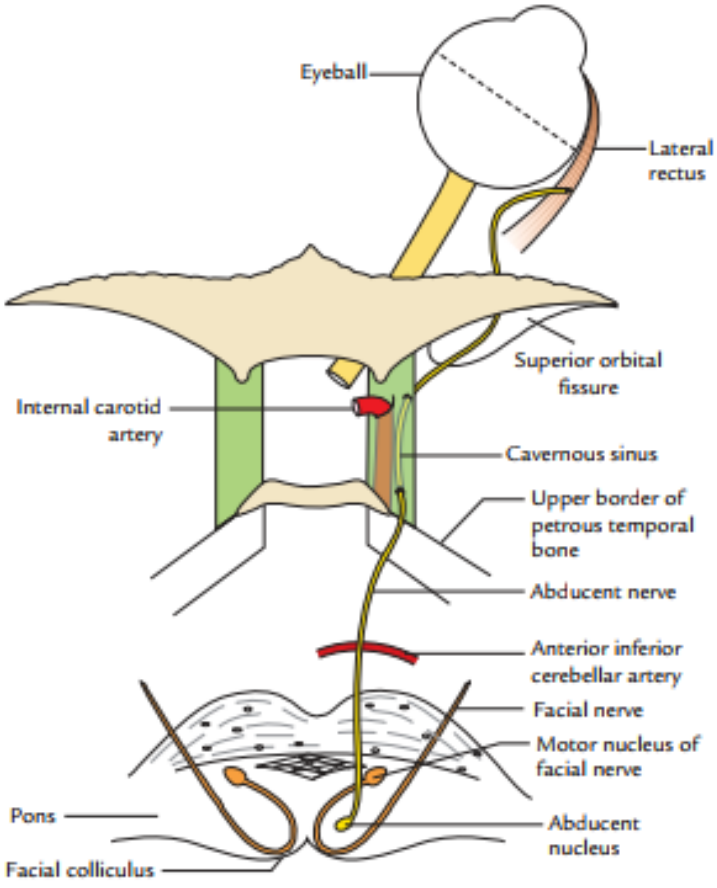
- **corticonuclear fibers** from both cerebral hemispheres.
- *tectobulbar tract* from the ***superior colliculus***
- fibers from the medial longitudinal fasciculus



Course of abducent nerve

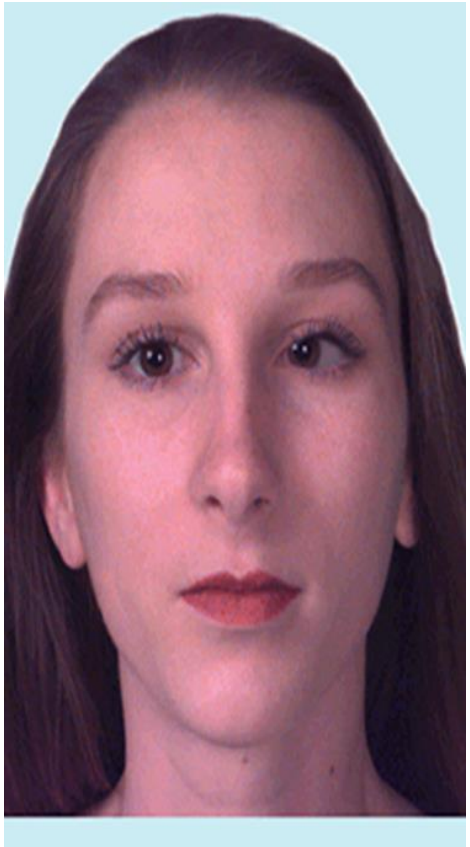
- Enters the cavernous sinus by piercing the posterior wall close to the floor of the sinus.
- In the cavernous sinus, it runs forward inferolateral to the internal carotid artery
- Enters the orbit through the **lower part of superior orbital fissure** within the tendinous ring
- In the orbit, it runs forward, toward the lateral side to supply the lateral rectus muscle





Clinical correlation

- Clinical test: lateral eye movement
- Effects of damage:
- Its lesion lead to adduction, inability to abduct the eye, and diplopia



C. Accessory Nerve (CN XI):

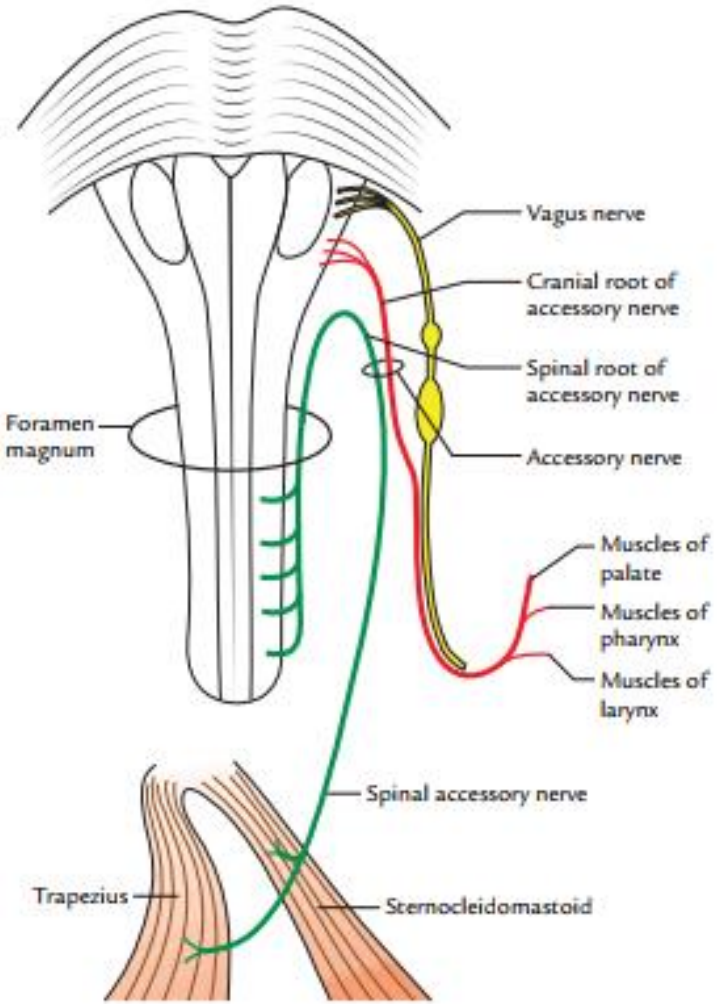
- Is purely motor
- Has spinal & cranial root

Spinal root:

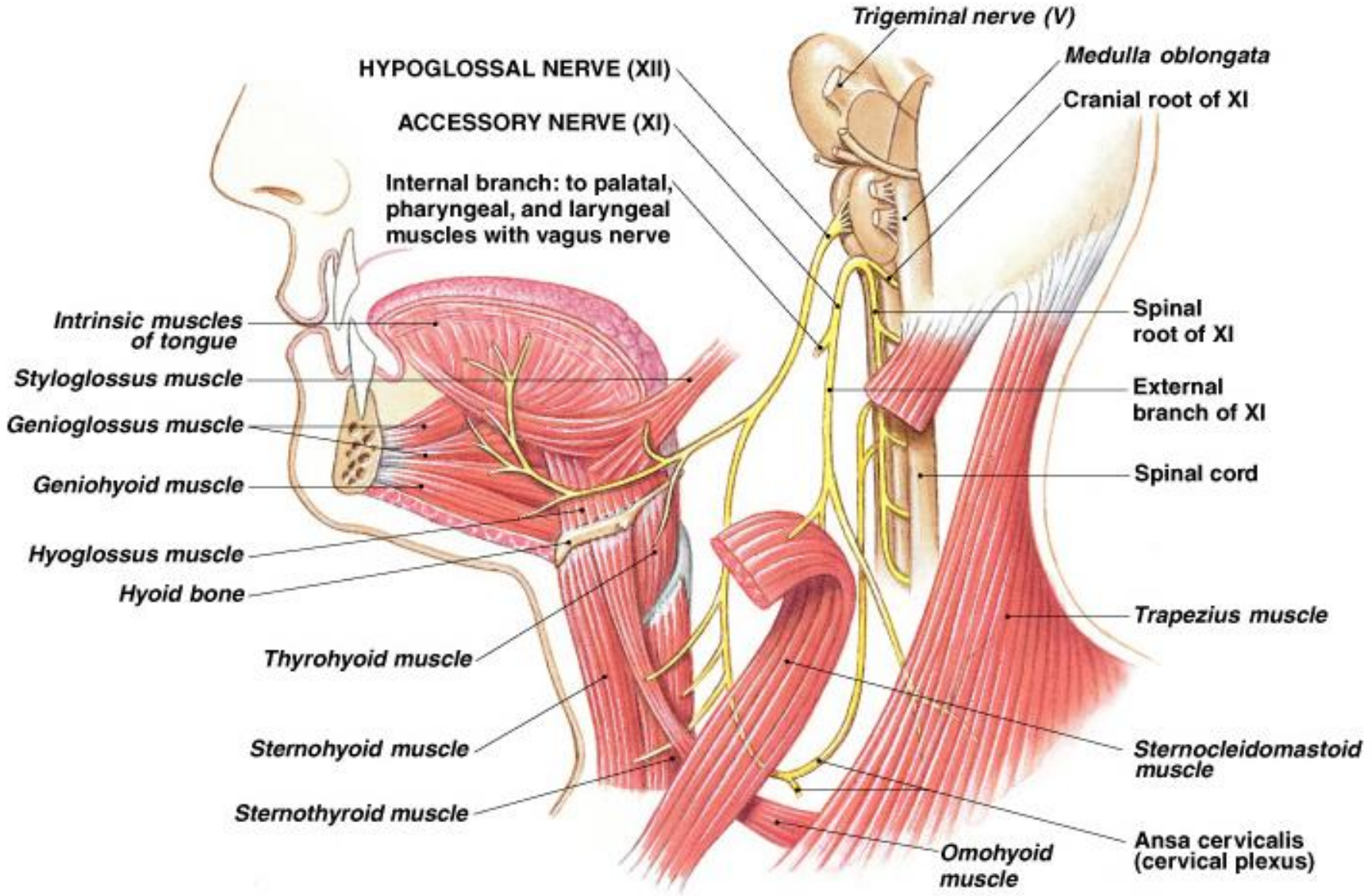
- Formed by C1- C5 spinal segments

- Enter post cranial fossa through foramen magnum➔ join cranial root

- Both exit through jugular foramen
- Destinations:
  - cranial branch: joins vagus nerve.



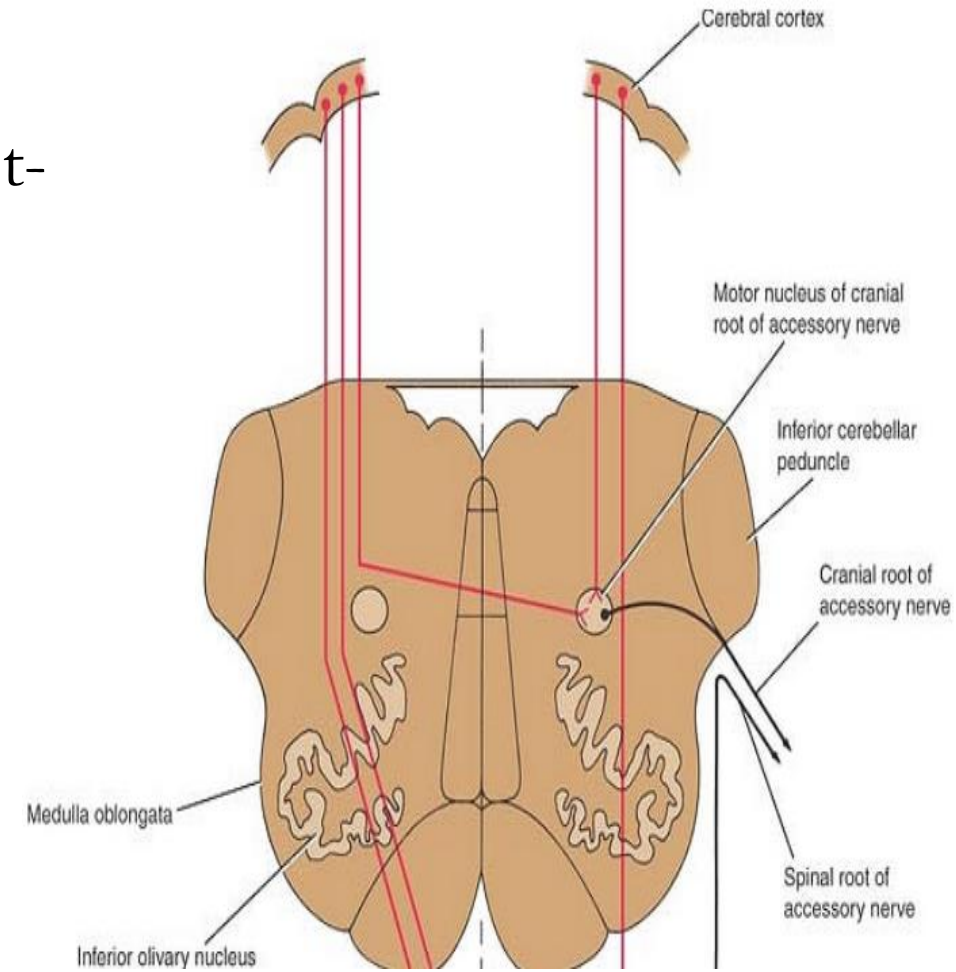
- External branch: Supply SCM and trapezius muscles



Cranial root

- Originates from **nucleus ambiguous** between the post-olivary sulcus & inferior cerebellar peduncle

- The nucleus receives corticonuclear fibers from both cerebral hemispheres.

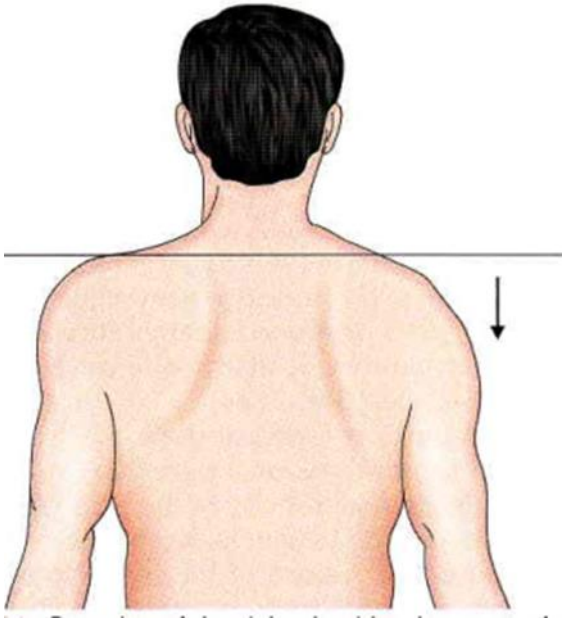


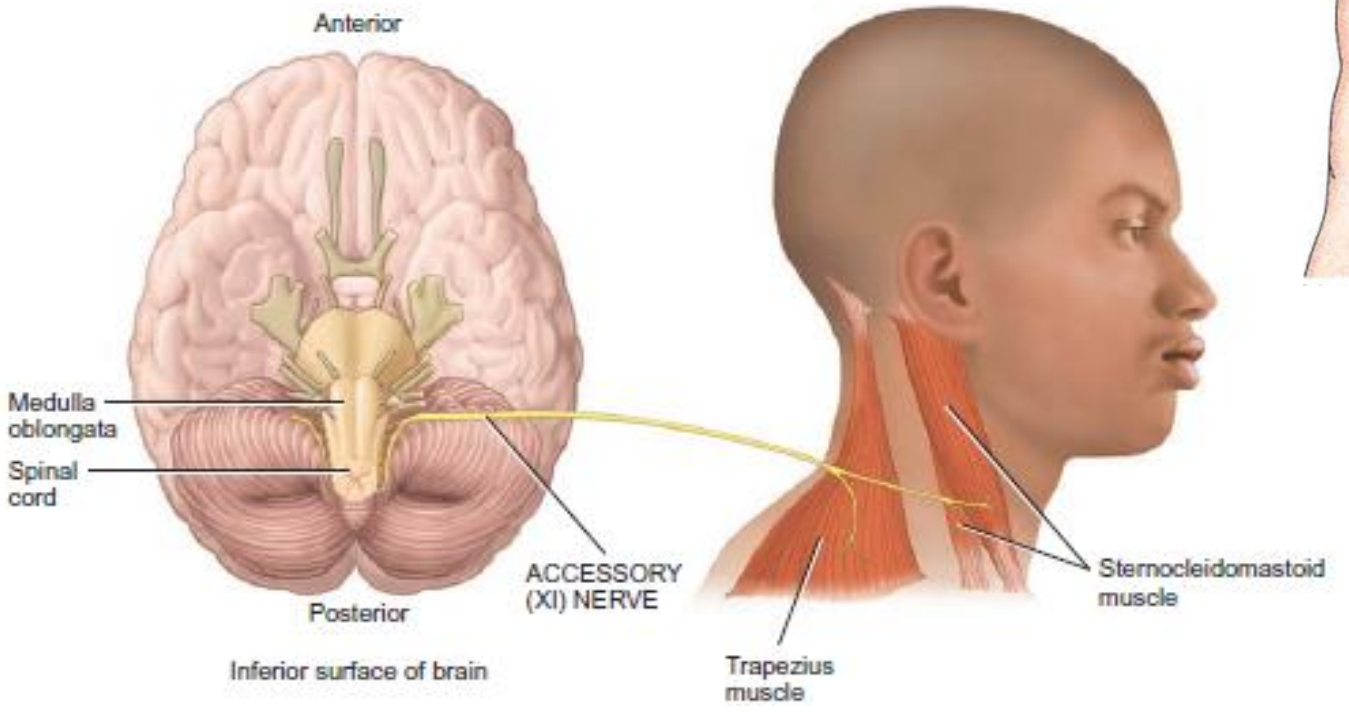
- The nerve emerge from the anterior surface of the medulla oblongata between the olive and the inferior cerebellar peduncle.

❖**Clinical tests**: *rotate head and shrug shoulders against resistance*

❖**Effects of damage**:

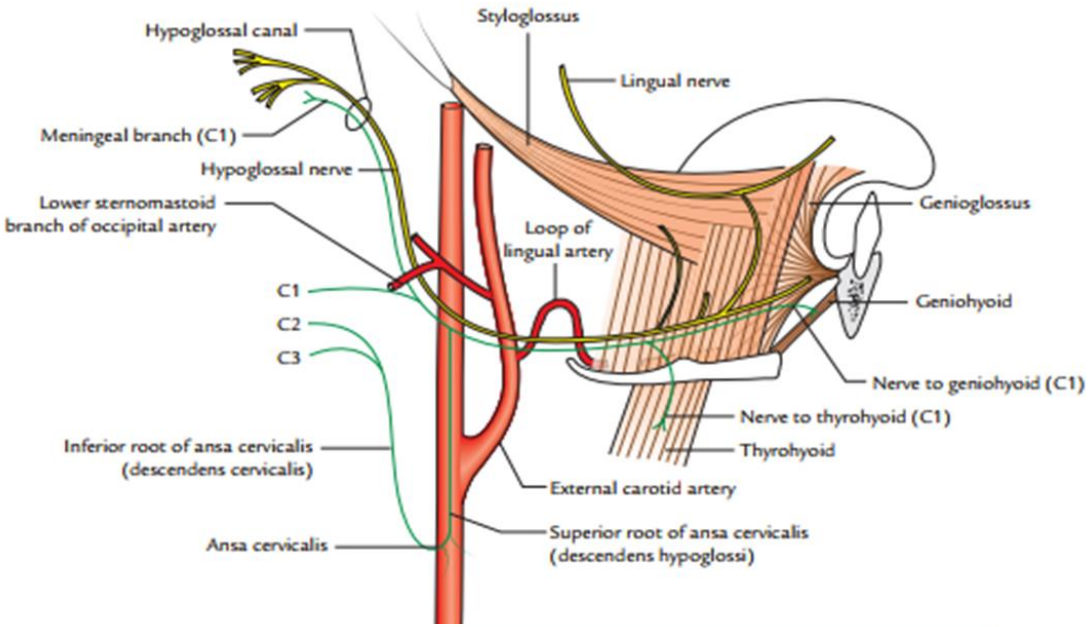
- *paralysis of SCM muscle impaired movement of head, neck, & shoulders*
- Paralysis of trapezius results in
  - A shoulder droop
  - Inability to shrug the ipsilateral shoulder



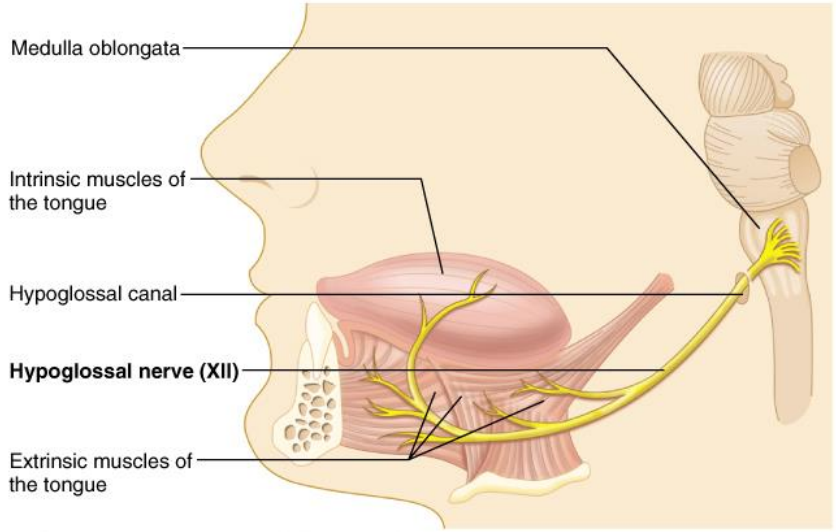


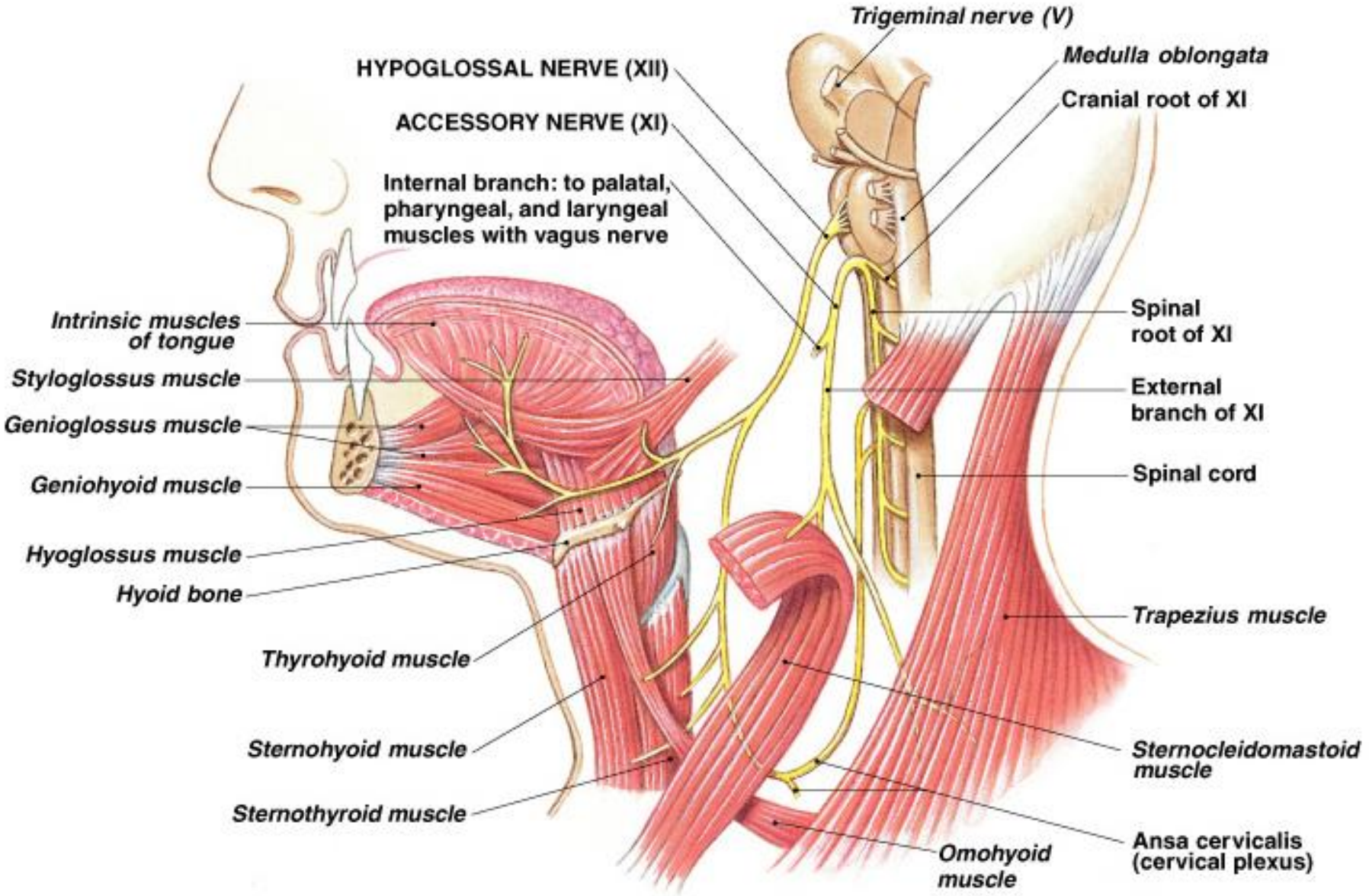
CN XII: HYPOGLOSSAL

- It is a motor cranial nerve.
- Innervate both intrinsic and extrinsic muscles of tongue except **palatoglossus**



- **Function:** tongue movements for speech, food manipulation, and swallowing



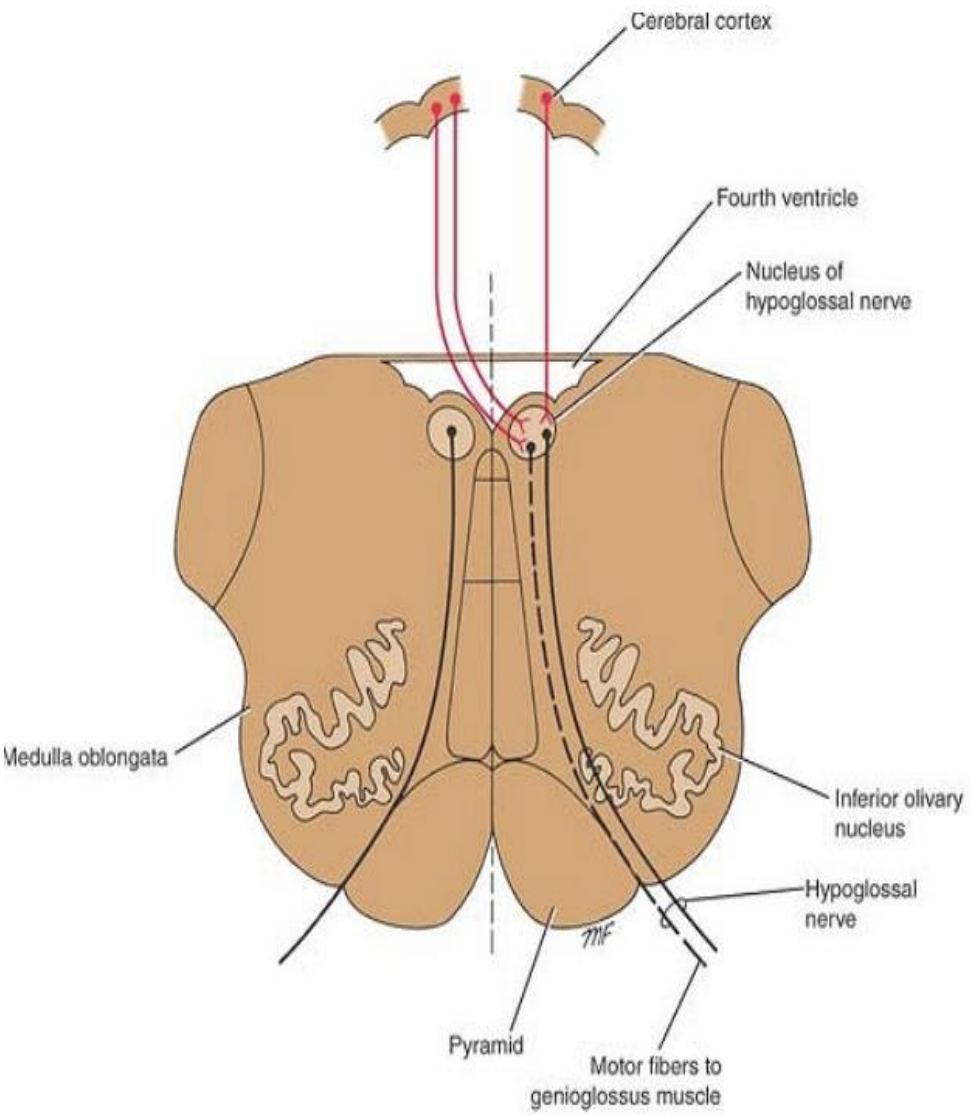

Trigeminal nerve (V)
Medulla oblongata
Cranial root of XI
HYPOGLOSSAL NERVE (XII)
ACCESSORY NERVE (XI)
Internal branch: to palatal, pharyngeal, and laryngeal muscles with vagus nerve
Intrinsic muscles of tongue
Styloglossus muscle
Genioglossus muscle
Geniohyoid muscle
Hyoglossus muscle
Hyoid bone
Thyrohyoid muscle
Sternohyoid muscle
Sternothyroid muscle
Spinal root of XI
External branch of XI
Spinal cord
Trapezius muscle
Sternocleidomastoid muscle
Ansa cervicalis (cervical plexus)
Omohyoid muscle

Hypoglossal Nerve (XII)

- General somatic motor

- The hypoglossal nucleus is situated
  - Close to the midline
  - Immediately beneath the floor of the lower part of the 4th ventricle.

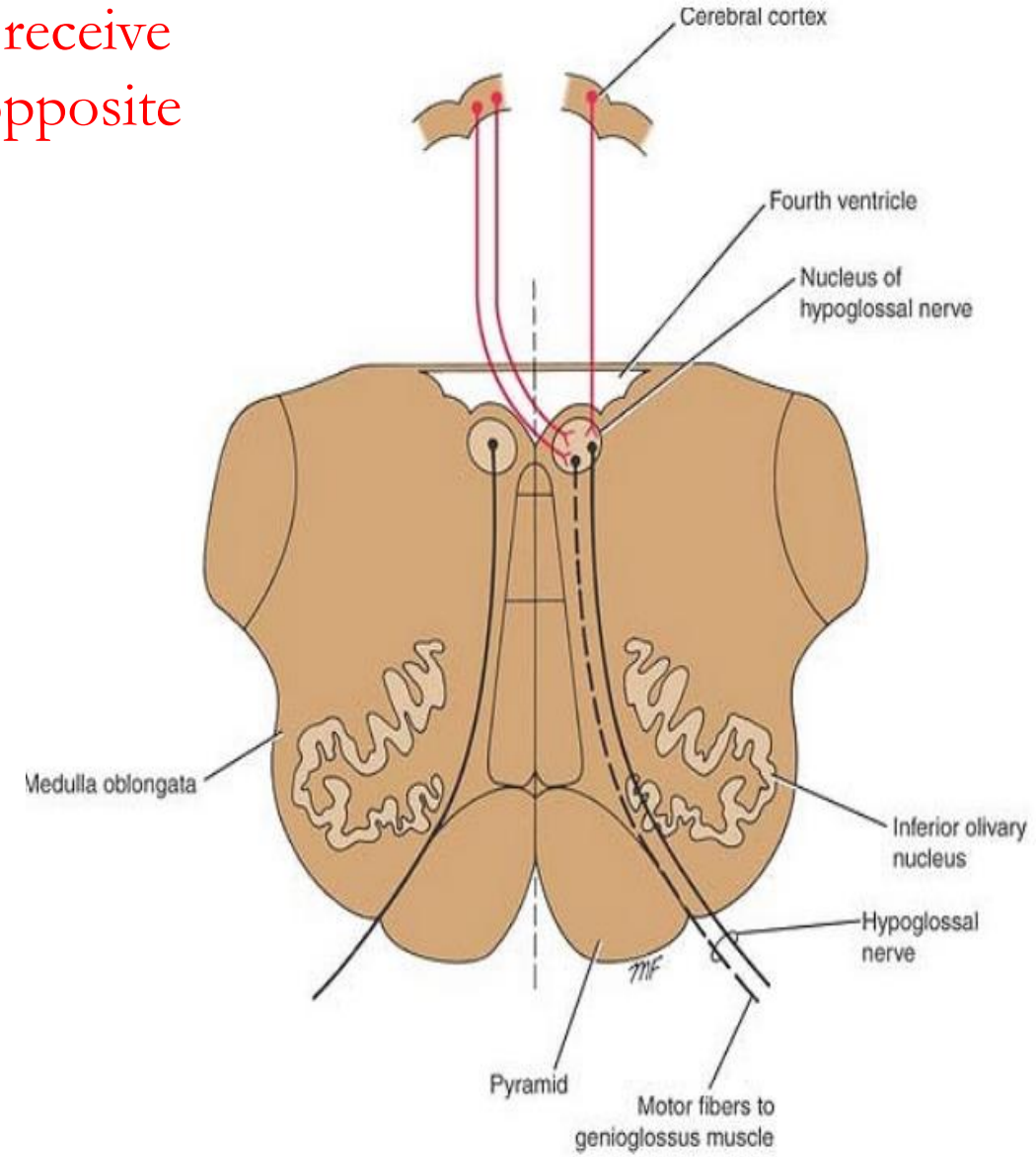
- It receives corticonuclear fibers from both cerebral hemispheres.



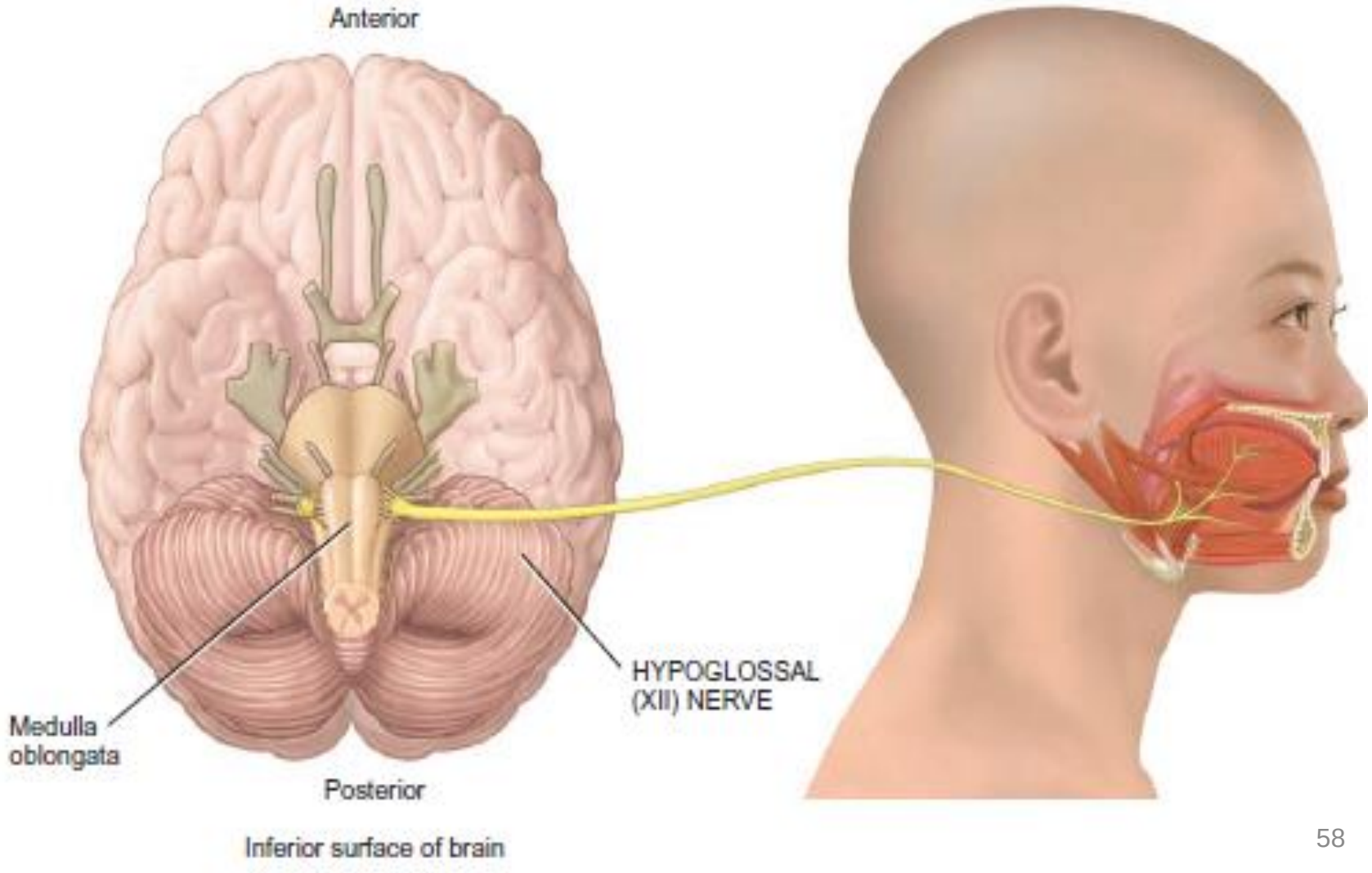
- However, the cells responsible for supplying the **genioglossus muscle** only receive corticonuclear fibers from the opposite cerebral hemisphere.

- The hypoglossal nerve fibers pass anteriorly through the medulla oblongata

- Emerge as a series of roots in the groove between the pyramid and olive

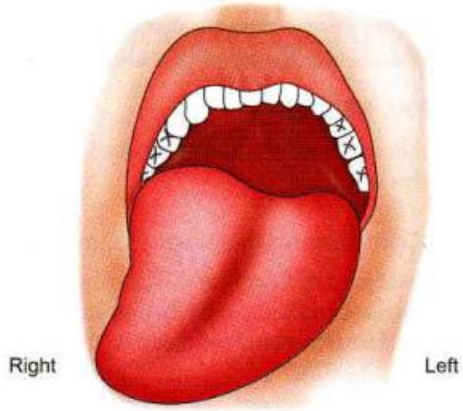


- Clinical test: tongue function
- Effects of damage: difficulty in speech and swallowing; atrophy of tongue; inability to stick out (protrude) tongue



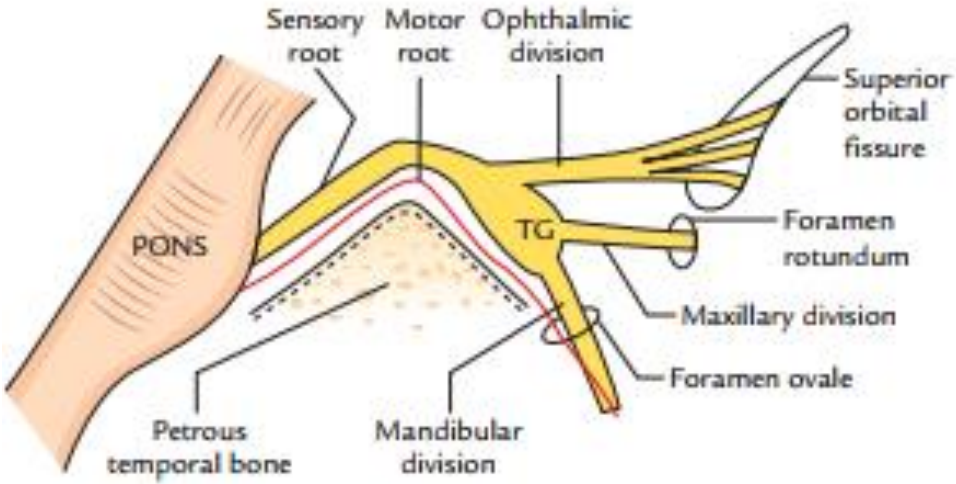
Upper motor neuron or supranuclear lesions of the hypoglossal nerve

- Cause weakness of the opposite half of the tongue, and on protrusion, the tongue deviates to the side opposite to that of lesion.
- **Lower motor neuron (nuclear and infranuclear) Lesions of the hypoglossal nerve :-**
  - Result in paralysis of the ipsilateral half of the tongue and on protrusion the tongue deviates towards the side of lesion due to unopposed action of genioglossus of the healthy side.



Mixed Cranial Nerves

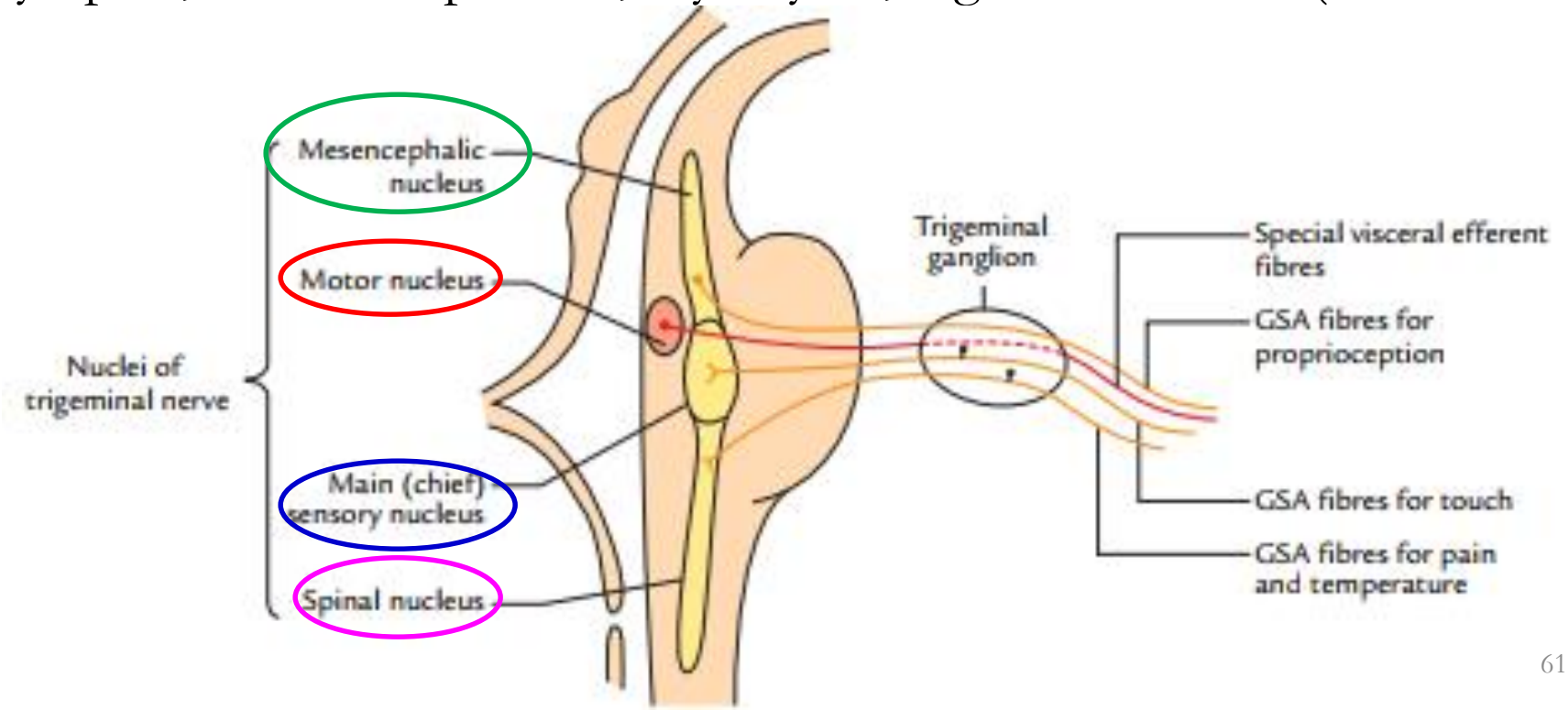
Trigeminal (V) Nerve



- ✓ It is a mixed cranial nerve
- ✓ the largest.
- ✓ originate from ventrolateral aspect of pons
- ✓ Sensory and motor roots emerge separately
- ✓ sensory nerve to the greater part of the head (GSA)
- ✓ motor nerve to several muscles, including the muscles of mastication (SVE)

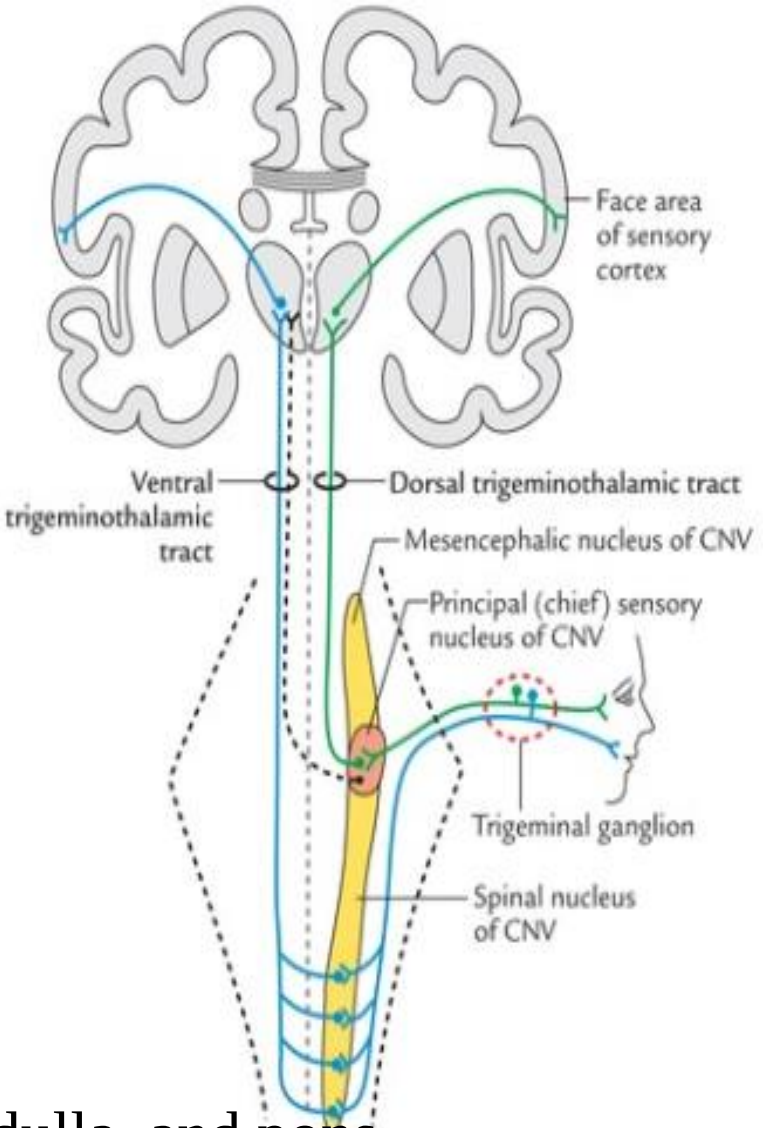
CN – V Has 4 nuclei:

- **Principal sensory**: Discriminative tactile sensation & pressure
- **Spinal nuclei:** Pain & temperature
- Mesencephalic: Proprioceptive sensations from the muscles of mastication, temporomandibular joint, and teeth
- **One motor nucleus**: Innervate muscles of mastication, tensor tympani,tensor veli palatine, mylohyoid, digastrics muscle (anterior belly)



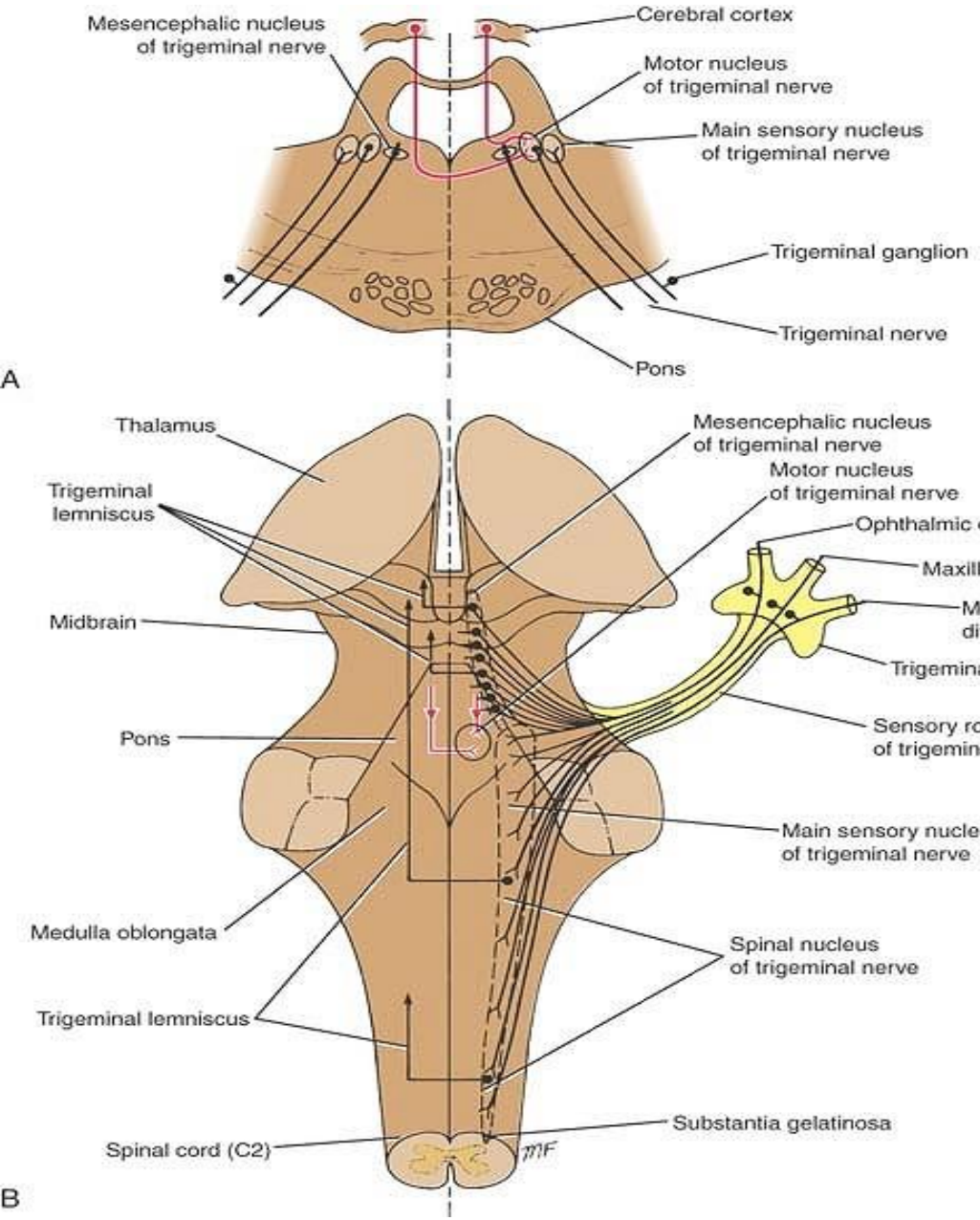
A. Main Sensory Nucleus

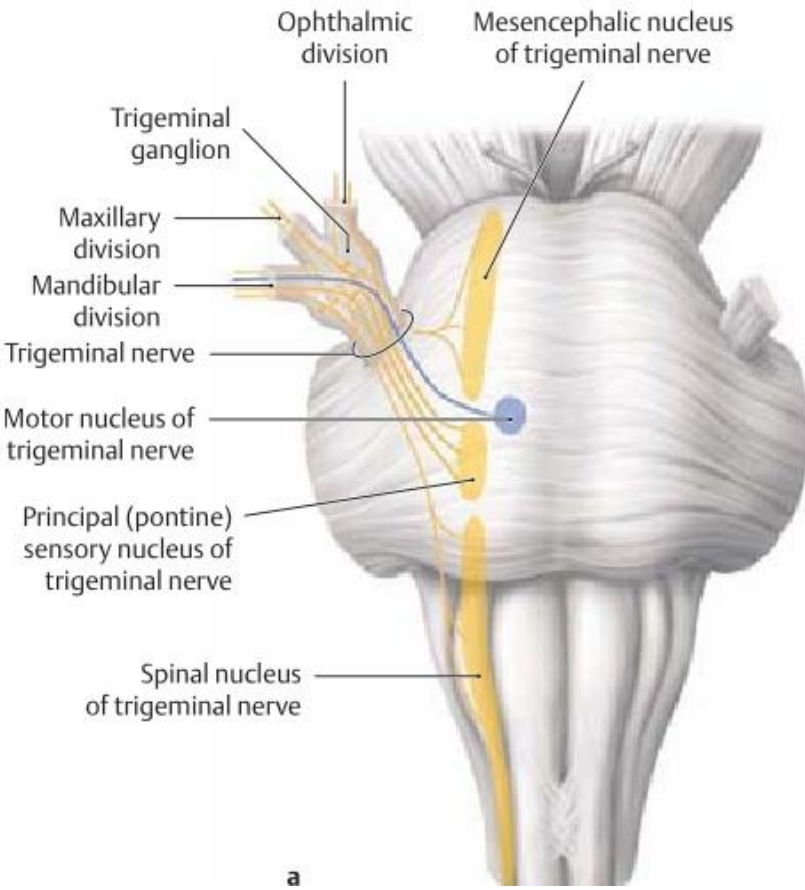
- The main sensory nucleus lies in the posterior part of the pons, lateral to the motor nucleus
- It is continuous below with the spinal nucleus.
- Projects via an uncrossed dorsal and a crossed ventral trigeminothalamic tract to the VPM nucleus of the thalamus.



B. Spinal nucleus

- Is located in the spinal cord (C1–C3), medulla, and pons.
- Receives pain and temperature input from the face and oral cavity.


Mesencephalic nucleus of trigeminal nerve
Cerebral cortex
Motor nucleus of trigeminal nerve
Main sensory nucleus of trigeminal nerve
Trigeminal ganglion
Trigeminal nerve
Pons
A
Thalamus
Trigeminal lemniscus
Midbrain
Pons
Medulla oblongata
Trigeminal lemniscus
Spinal cord (C2)
Mesencephalic nucleus of trigeminal nerve
Motor nucleus of trigeminal nerve
Ophthalmic division
Maxillary divis
Mandibula division
Trigeminal gangli
Sensory root of trigeminal nerve
Main sensory nucleus of trigeminal nerve
Spinal nucleus of trigeminal nerve
Substantia gelatinosa
B

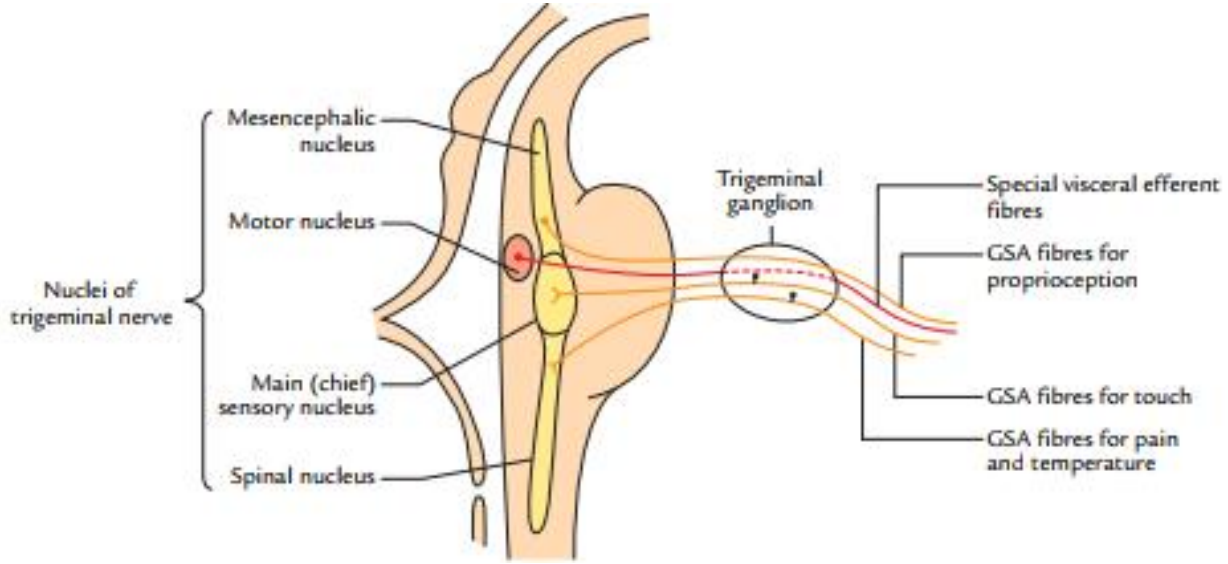

Ophthalmic division
Mesencephalic nucleus of trigeminal nerve
Trigeminal ganglion
Maxillary division
Mandibular division
Trigeminal nerve
Motor nucleus of trigeminal nerve
Principal (pontine) sensory nucleus of trigeminal nerve
Spinal nucleus of trigeminal nerve
a

C. Mesencephalic nucleus

- Serves **GSA proprioception** from the head.
- Consists of large pseudounipolar neurons.

- Receives proprioceptive input sensations from the muscles of mastication, temporomandibular joint, and teeth

- Stretch (jaw jerk) reflex and regulate the force of bite.

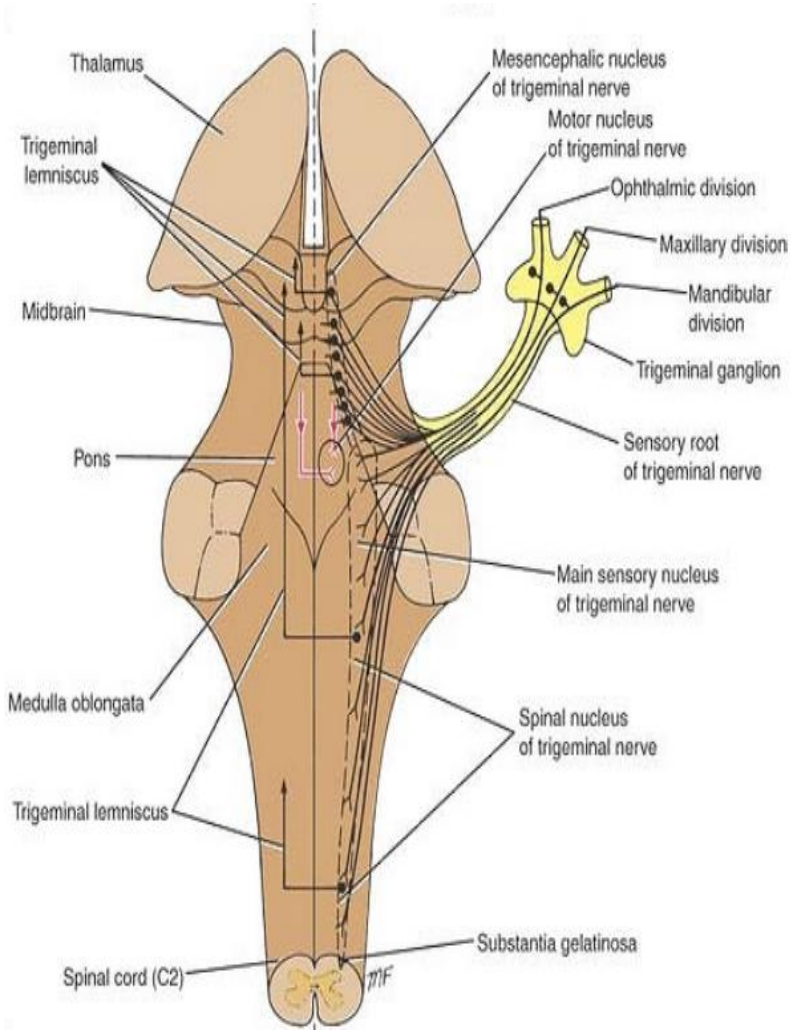


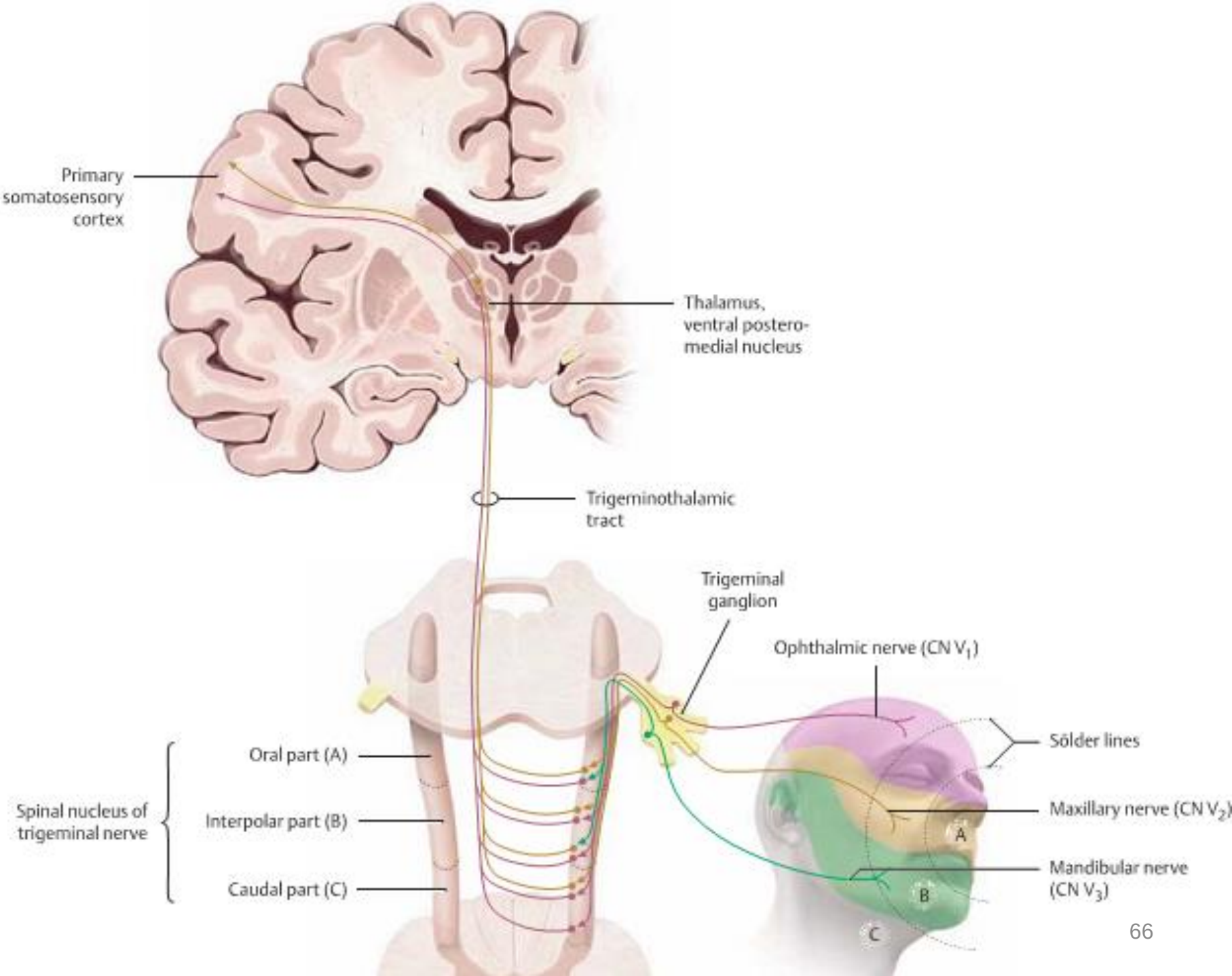
Sensory component of the trigeminal nerve

- The axons of the neurons in the
  - ❖Main sensory
  - ❖Spinal nuclei
  - ❖Mesencephalic nucleus

- Cross the median plane and ascend as the **trigeminal lemniscus** to terminate on the nerve cells of the **ventral posteromedial** nucleus of the thalamus.

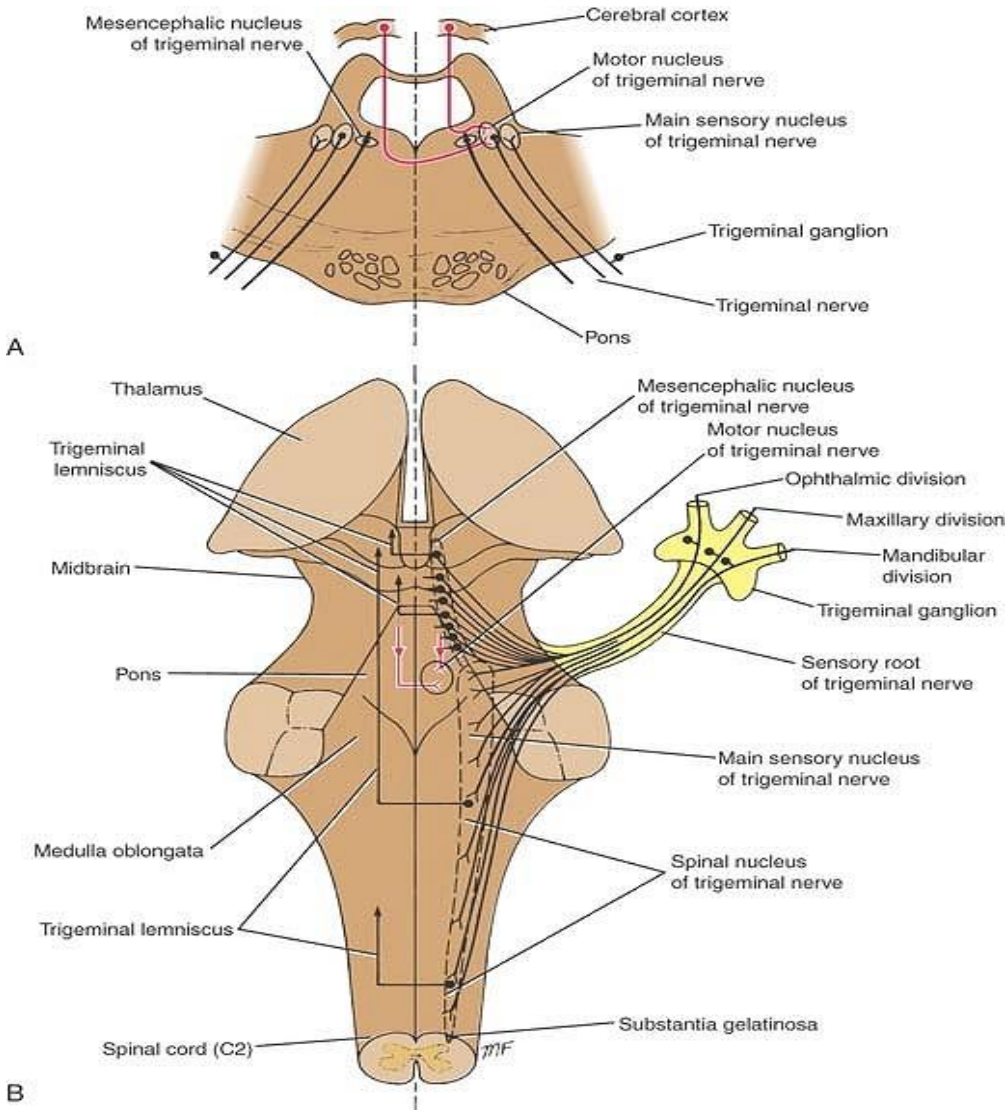
- The axons of these cells now travel through the IC to the postcentral gyrus of the cerebral cortex.

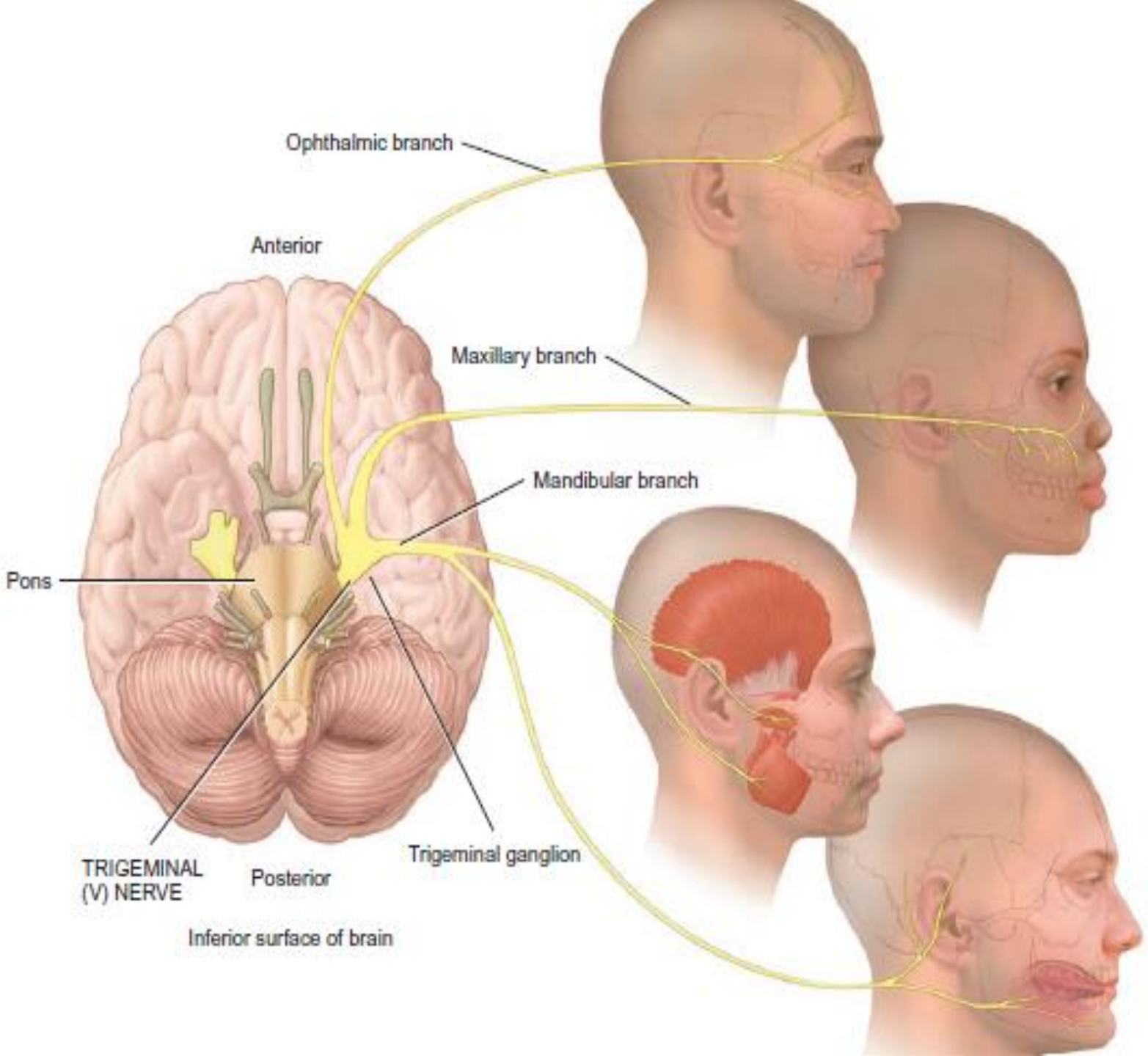



Primary somatosensory cortex
Thalamus, ventral postero-medial nucleus
Trigeminothalamic tract
Trigeminal ganglion
Ophthalmic nerve (CN V1)
Sölder lines
Maxillary nerve (CN V2)
Mandibular nerve (CN V3)
Spinal nucleus of trigeminal nerve
Oral part (A)
Interpolar part (B)
Caudal part (C)
A
B
C

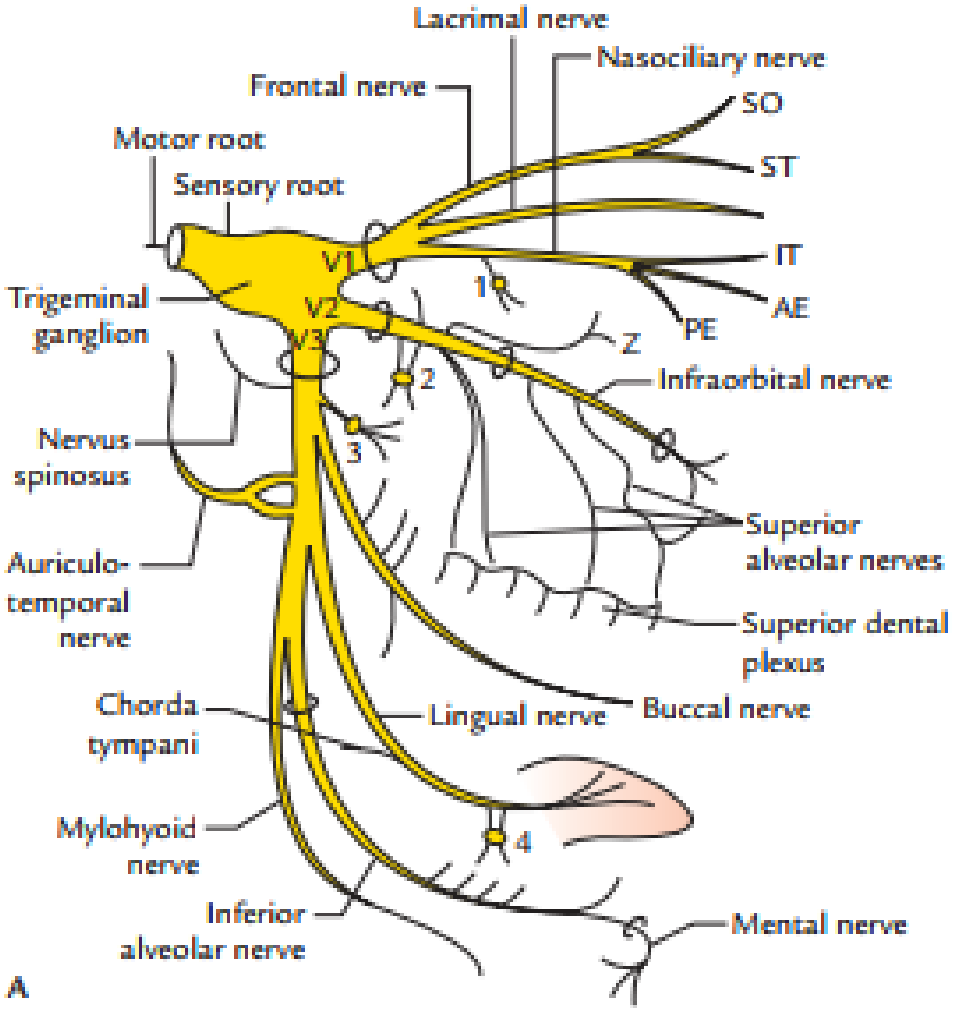
D. Motor Component of the Trigeminal Nerve (SVE)

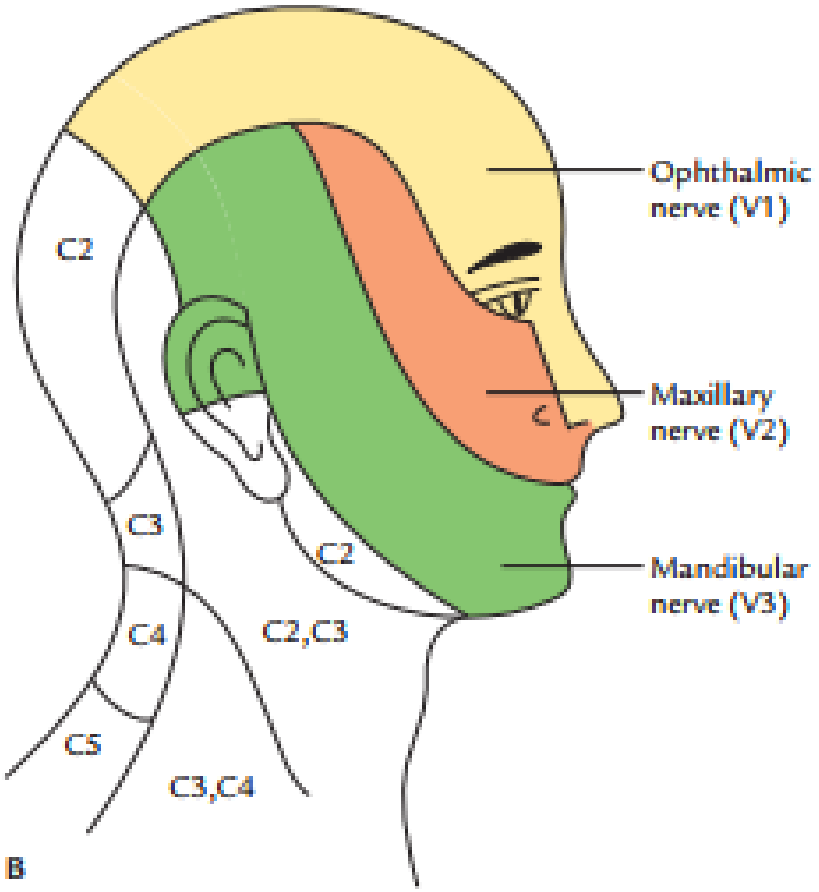
- Receives corticonuclear fibers from both cerebral hemispheres.
- It also receives fibers from the:
  - Reticular formation,
  - Red nucleus,
  - Tectum
  - Medial longitudinal fasciculus.
- fibers from the mesencephalic nucleus, (forming a monosynaptic reflex arc)




Ophthalmic branch
Anterior
Maxillary branch
Mandibular branch
Pons
TRIGEMINAL
(V) NERVE
Posterior
Trigeminal ganglion
Inferior surface of brain

Trigeminal nerve… cont.





Nerve/Division	Distribution
Ophthalmic (sensory)	**Upper 3rd** of the face including eyeball, conjunctiva, nasal cavity, lacrimal gland, scalp up to vertex. forms the **afferent limb of corneal reflex**
Maxillary (sensory)	**Middle 3rd** of the face including most of nasal cavity, upper teeth and gums, maxillary sinus, mucous membrane of pharynx, palate, dura mater of middle cranial fossa. Conveys secretomotor fibres to the lacrimal gland and the glands of palate, nose, and oral cavity
Mandibular (mixed)	**Sensory**: **Lower 3rd** of the face (except the small area over the angle of mandible) including part of auricle, temple **Motor**: muscles of ***mastication***, anterior belly of digastric, mylohyoid, & tensor tympani & tensor veil palatini muscles. forms both the limbs of **masticatory reflex**

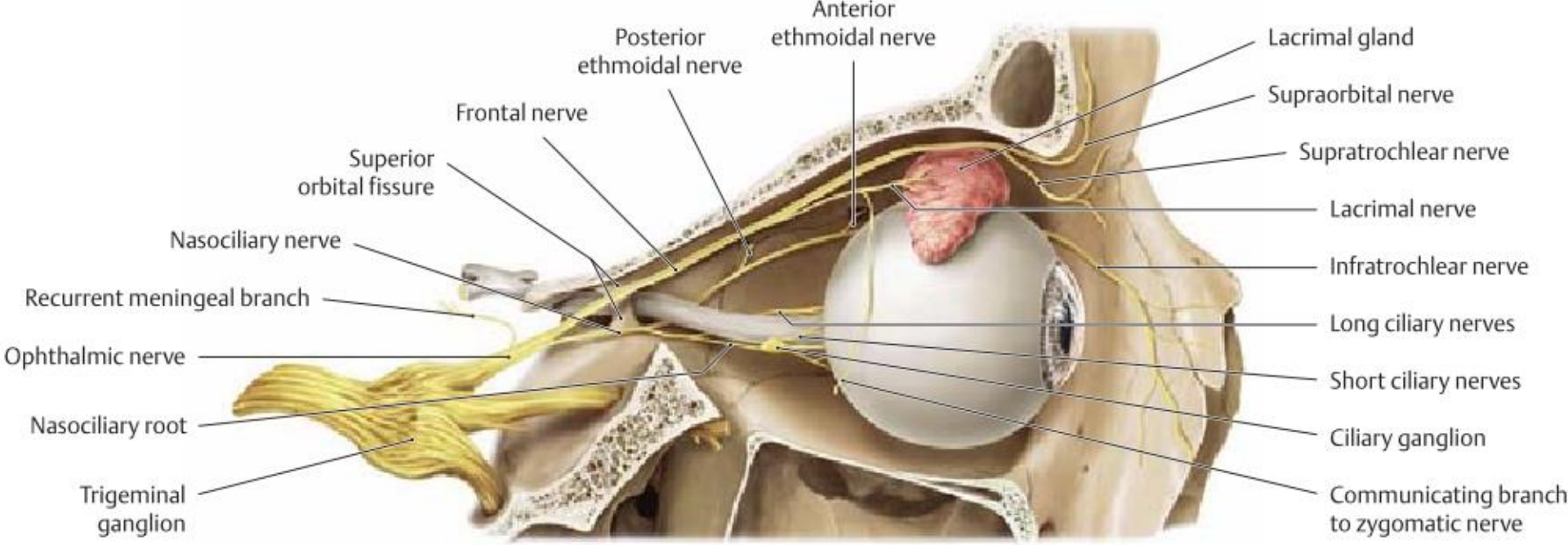
Trigeminal divisions

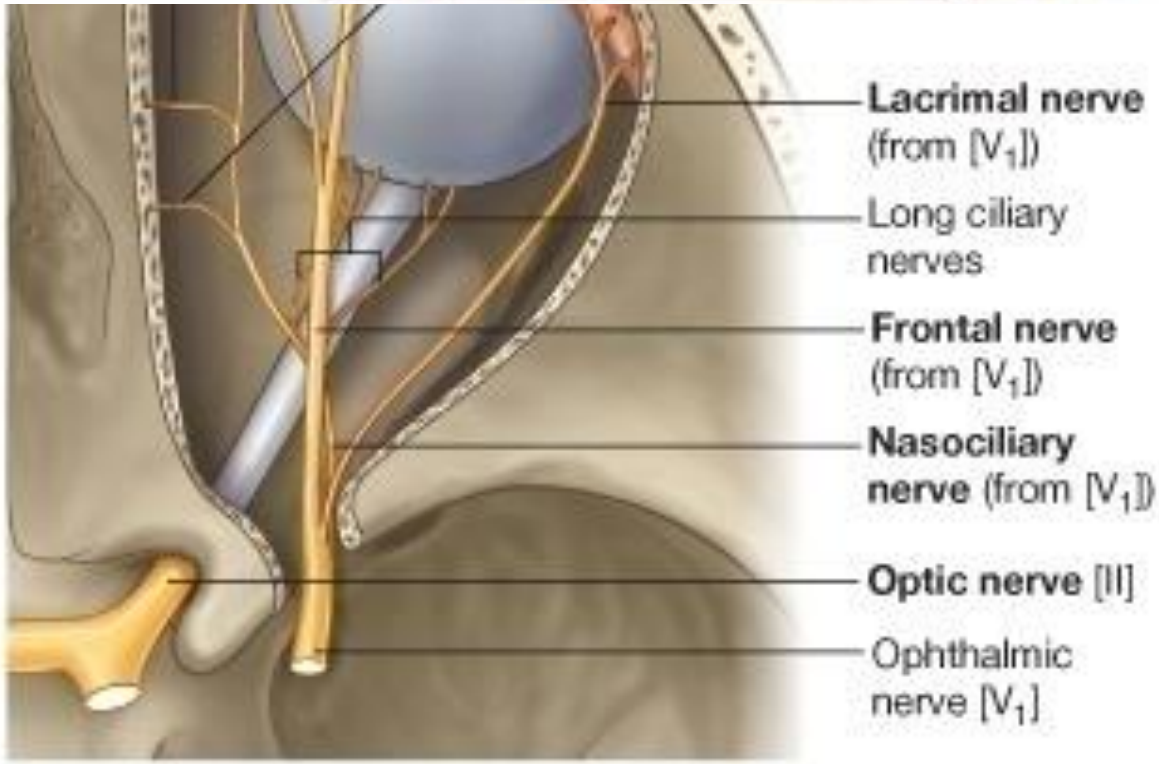
1. Ophthalmic Nerve (CN V_1)

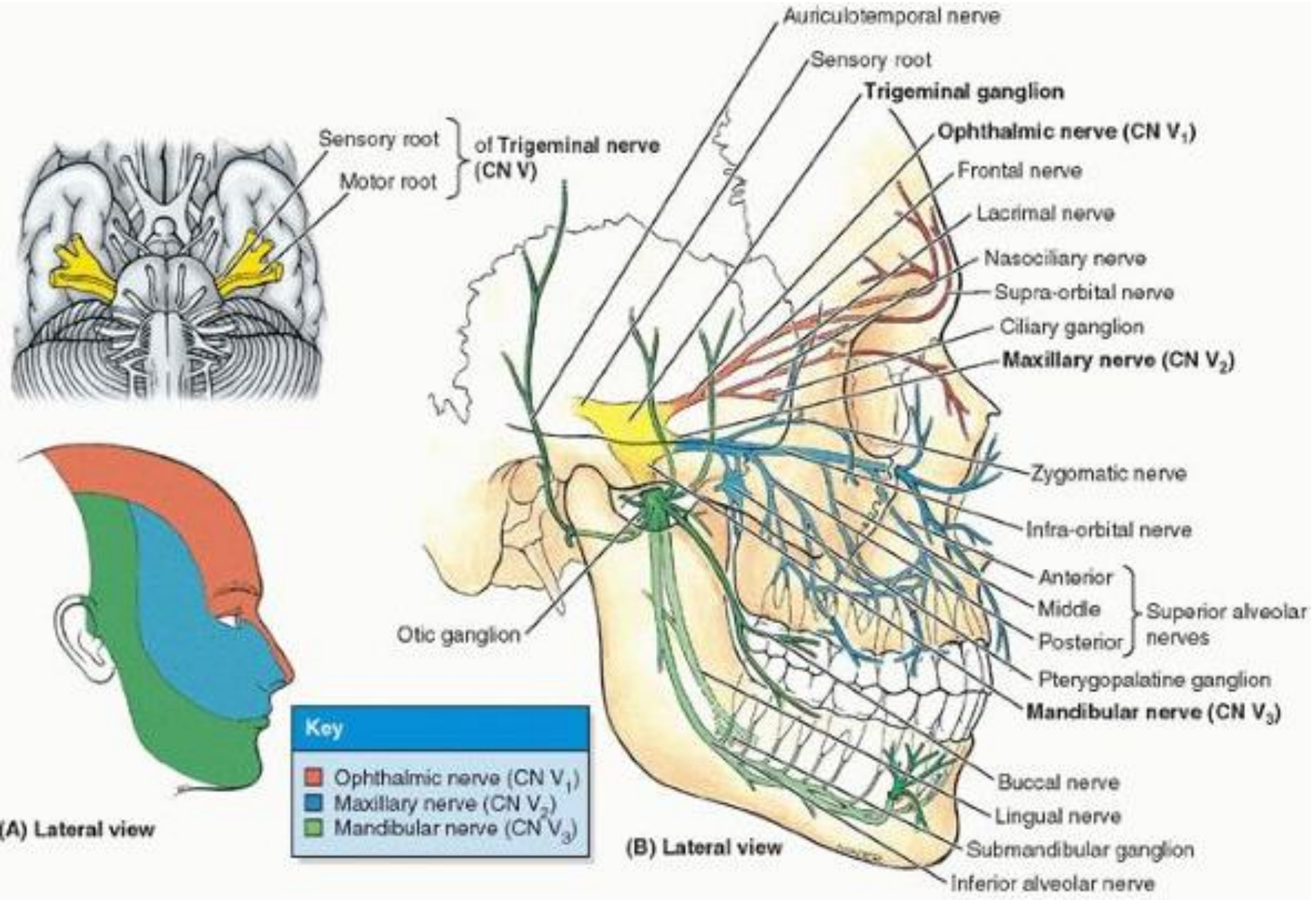
- Smallest
- Most of its fibers passes through superior orbital fissure.

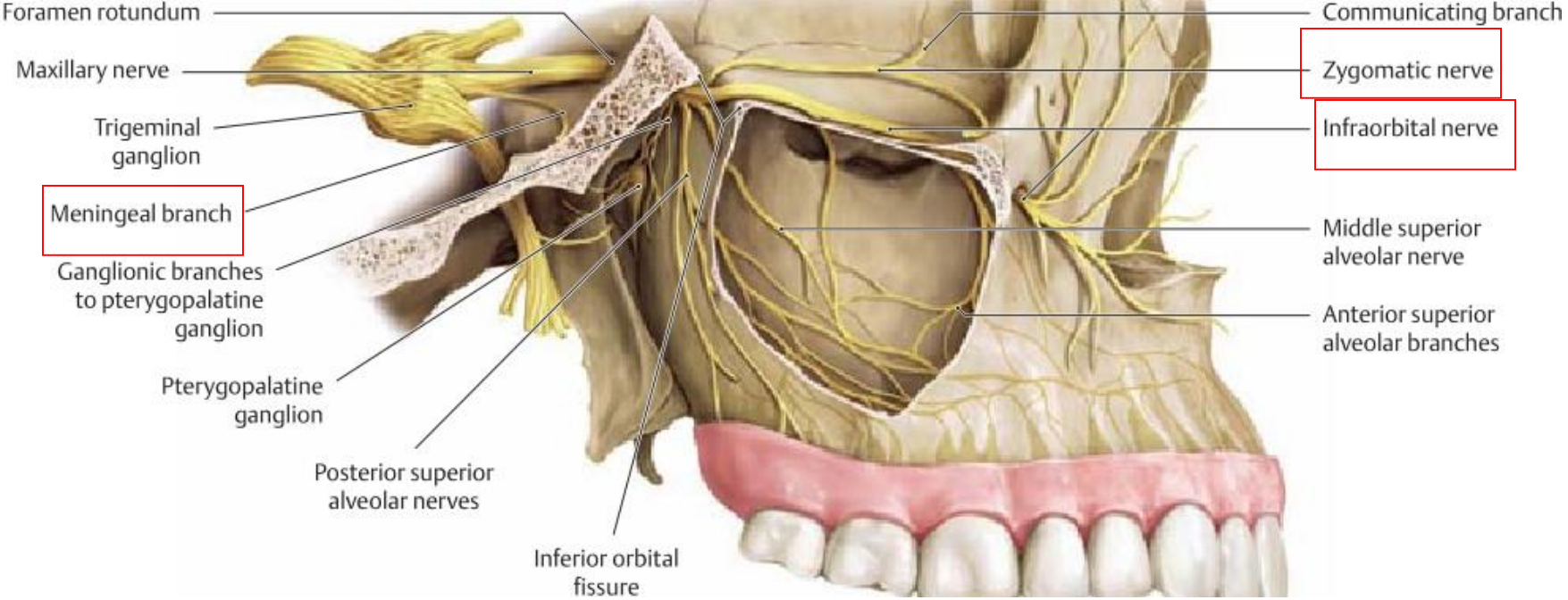
Branches

- Tentorial nerve (a meningeal branch):
- Lacrimal nerve
- Frontal nerve:
  - Supra-orbital nerve
  - Supra-trochlear nerve
- Nasociliary nerve
  - Sensory root of ciliary ganglion
  - Short ciliary nerves
  - Long ciliary nerves
  - Infratrochlear nerves
  - Anterior and posterior ethmoidal nerves


Anterior ethmoidal nerve
Posterior ethmoidal nerve
Frontal nerve
Superior orbital fissure
Nasociliary nerve
Recurrent meningeal branch
Ophthalmic nerve
Nasociliary root
Trigeminal ganglion
Lacrimal gland
Supraorbital nerve
Supratrochlear nerve
Lacrimal nerve
Infratrochlear nerve
Long ciliary nerves
Short ciliary nerves
Ciliary ganglion
Communicating branch to zygomatic nerve


Lacrimal nerve (from [V1])
Long ciliary nerves
Frontal nerve (from [V1])
Nasociliary nerve (from [V1])
Optic nerve [II]
Ophthalmic nerve [V1]


Sensory root
Motor root
of Trigeminal nerve (CN V)
Auriculotemporal nerve
Sensory root
Trigeminal ganglion
Ophthalmic nerve (CN V1)
Frontal nerve
Lacrimal nerve
Nasociliary nerve
Supra-orbital nerve
Ciliary ganglion
Maxillary nerve (CN V2)
Zygomatic nerve
Infra-orbital nerve
Anterior
Middle
Posterior
Superior alveolar nerves
Otic ganglion
Pterygopalatine ganglion
Mandibular nerve (CN V3)
Buccal nerve
Lingual nerve
Submandibular ganglion
Inferior alveolar nerve
Key
Ophthalmic nerve (CN V1)
Maxillary nerve (CN V2)
Mandibular nerve (CN V3)
(A) Lateral view
(B) Lateral view



- Maxillary Nerve (CN V_2)

- Exit the cranial cavity via the foramen rotundum.
  - Branches
- All branches are sensory only.

1. **Meningeal branches** : with in middle cranial fossa.
2. **Zygomatic nerve** : enter the orbit through the inferior orbital fissure.
3. **Infraorbital nerve** : enter orbit via inferior orbital fissure.

- It's other terminal branches form superior dental plexus.

• Sensory branches of Mandibular Nerve (CN V_3)

- Passes through foramen ovale

1. **Meningeal branch** : reenters middle cranial fossa to supply to the dura.
2. **Auriculotemporal nerve : supply the :**
   - Temporal skin, External auditory canal, Tympanic membrane
3. Buccal nerve : supply mucous membrane of cheek.
4. Lingual nerve : supply
   - Anterior 2/3 of the tongue;
   - Gustatory fibers from chorda tympani.
5. Inferior alveolar nerve : passes to mandibular canal via mandibular foramen, where it gives inferior dental branches.

Has efferent fibers that supply the:

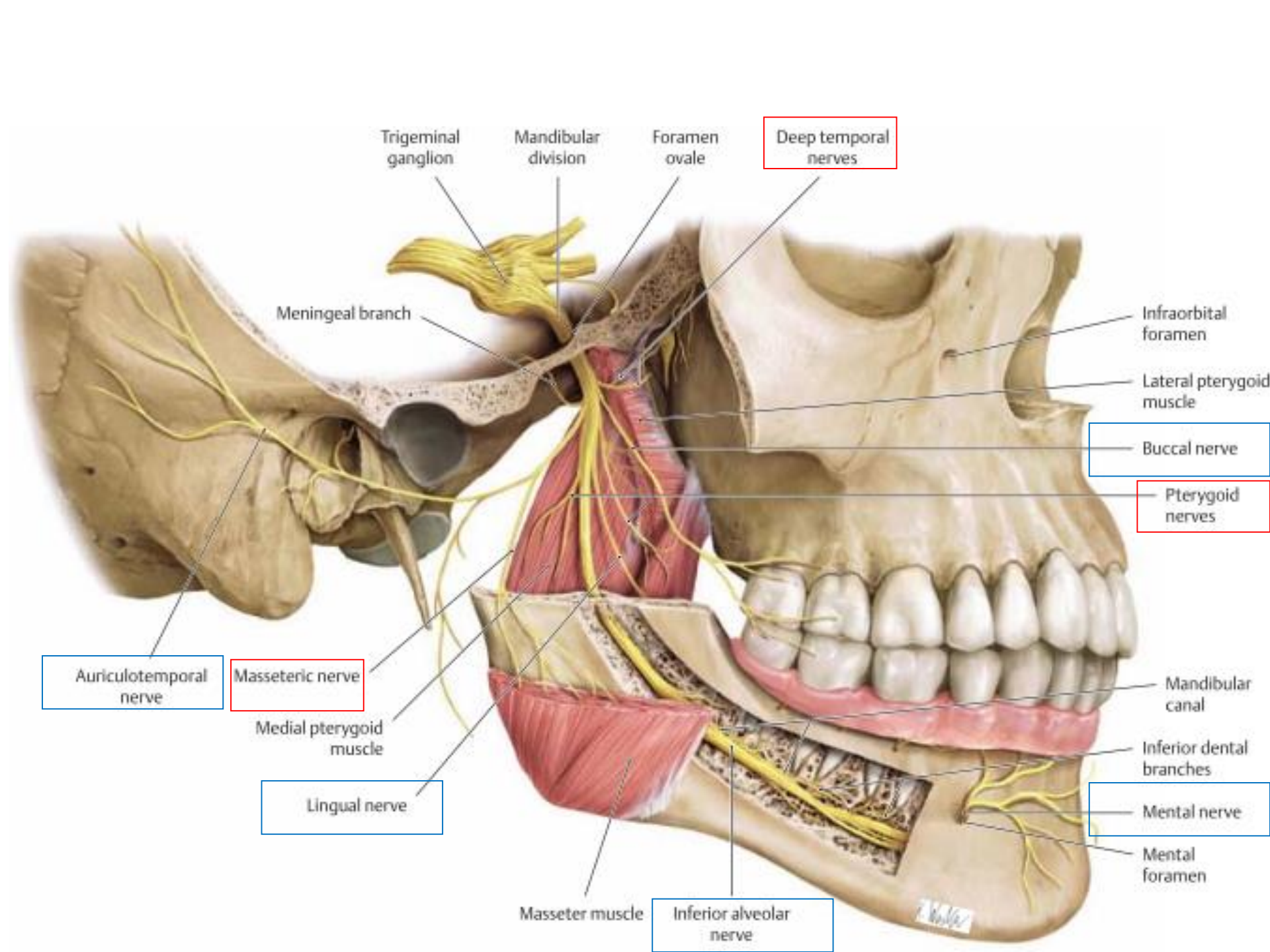
- Mylohyoid and Anterior belly of digastric muscle

6. Mental nerve : is a terminal branch.

supplies: - skin of chin and lower lip; the bony of mandible.

Motor branches

1. **Masseter nerve** : masseter muscle.
2. **Deep temporal nerves** : temporalis muscle.
3. **Pterygoid nerves** : pterygoid muscles.
4. Nerve to tensor tympani muscle
5. Nerve of the tensor veli paltini muscle


Trigeminal ganglion
Mandibular division
Foramen ovale
Deep temporal nerves
Meningeal branch
Infraorbital foramen
Lateral pterygoid muscle
Buccal nerve
Pterygoid nerves
Auriculotemporal nerve
Masseteric nerve
Medial pterygoid muscle
Lingual nerve
Mandibular canal
Inferior dental branches
Mental nerve
Mental foramen
Masseter muscle
Inferior alveolar nerve

Injury to the Trigeminal Nerve:

- May be injured by trauma, tumors, aneurysms, or meningeal infections.
- If the entire nerve is cut or damaged:
  - Ipsilateral paralysis of muscles of mastication **(*difficulty in chewing & speaking*),** with deviation of mandible toward the side of lesion.
  - Ipsilateral anaesthesia of the face & anterior part of scalp, auricle & mucous membranes of nose & loss of general sensation from ant 2/3rd of tongue.
  - Loss of corneal reflex & sneezing reflex.
- ***T*rigeminal neuralgia**: ➔ a complex sensory disorder of sensory root of CN V with sudden onset, & excruciating pain:

  ➔ Typically pain is in the distribution of [V3] & [V2] nerves,

Facial (VII) Nerve

- It is a mixed cranial nerve

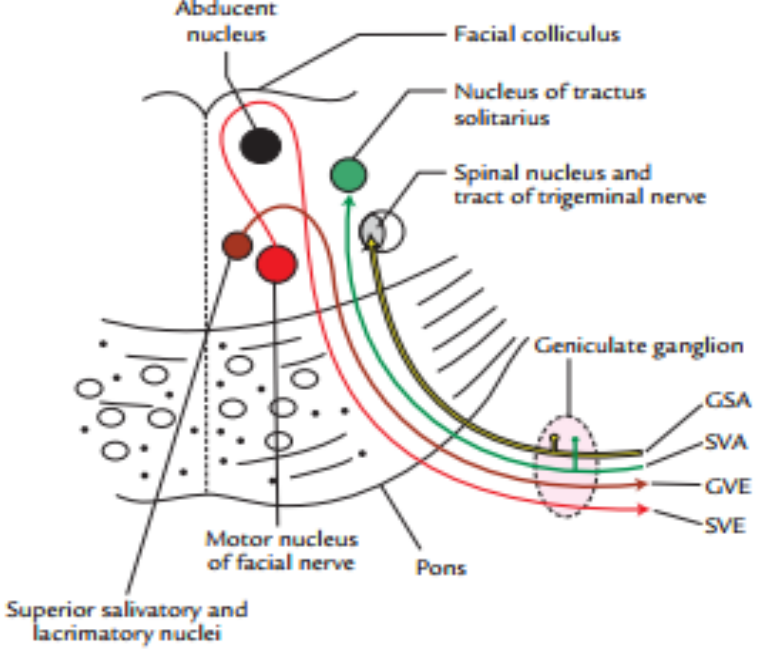
- It originate from the **pons**
- It emerges in the cerebellopontine angle b/n the pons and olive.

- It gives motor innervation for muscles of fascial expression

- Its sensory input from anterior 2/3rd of tongue

- Its autonomic motor axons extend to lacrimal glands, nasal glands, palatine glands, and sublingual & submandibular glands.

Facial Nerve (VII)



The facial nerve has three nuclei:

1. **Main motor nucleus SVE**
2. **Parasympathetic nuclei** GVE
   - ✓superior salivatory and lacrimatory
   - ✓Supply lacrimal, submandibular gland
3. **Sensory nucleus SVA**
   - tractus solitarius)
   - Taste (anterior 2/3rd of tongue)
4. General somatic sensory

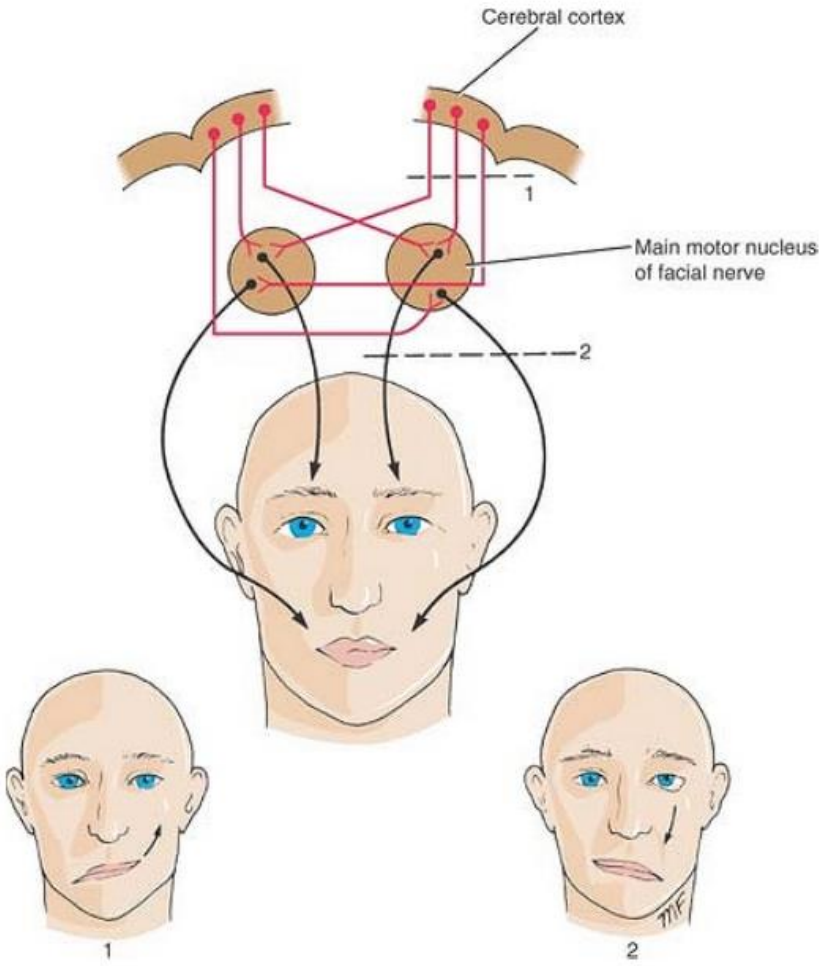
1. Main motor nuclei

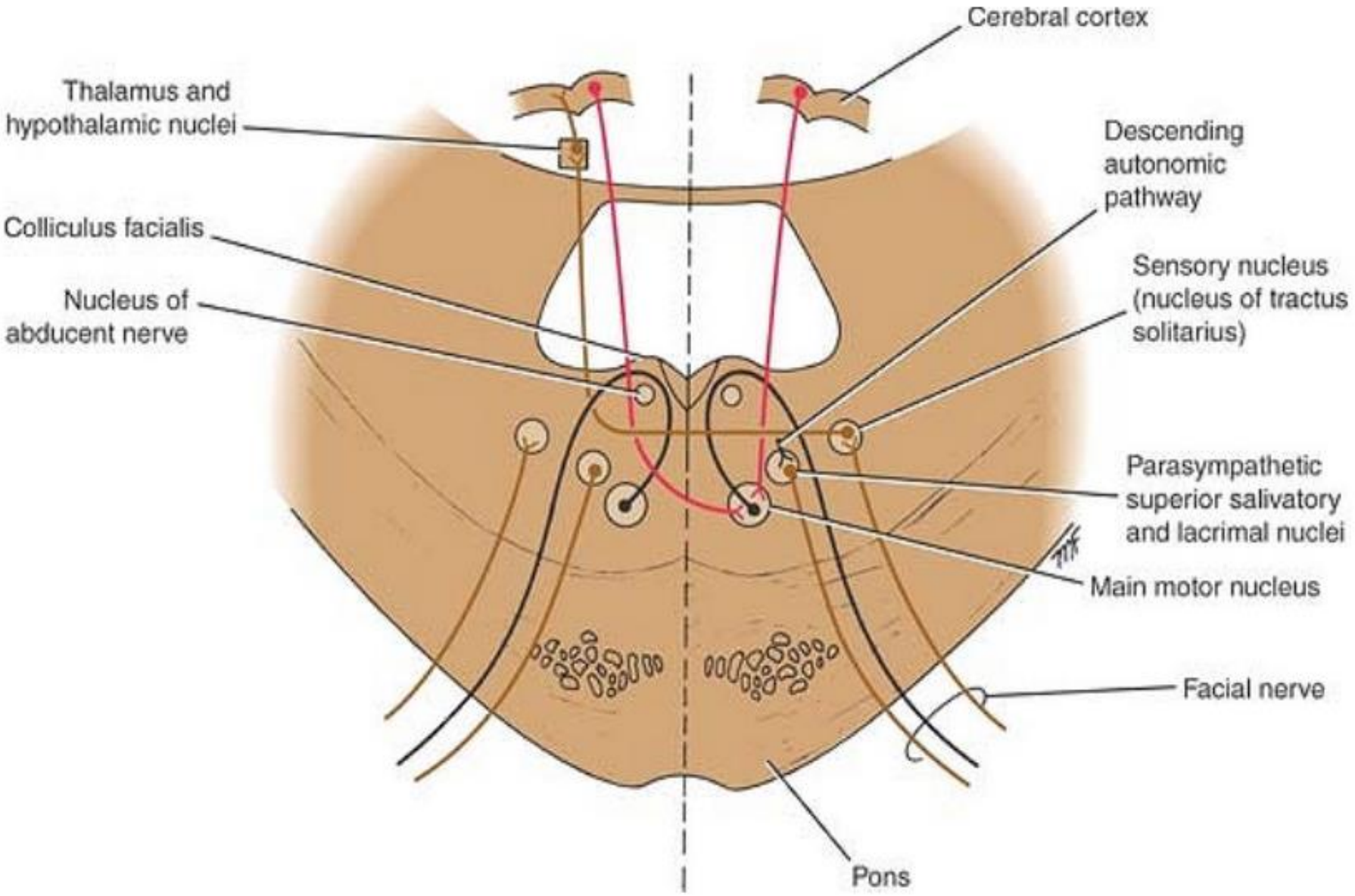
- lie deep in lower part of pons

- The axons first loops backward around the abducent nucleus, then they run forward and emerge at lower border of the pons.

- Nucleus supplying **upper part of face** receive corticonuclear fibers from both hemispheres

- Nucleus supplying **lower part of face** receives corticonuclear fibers only from opposite side

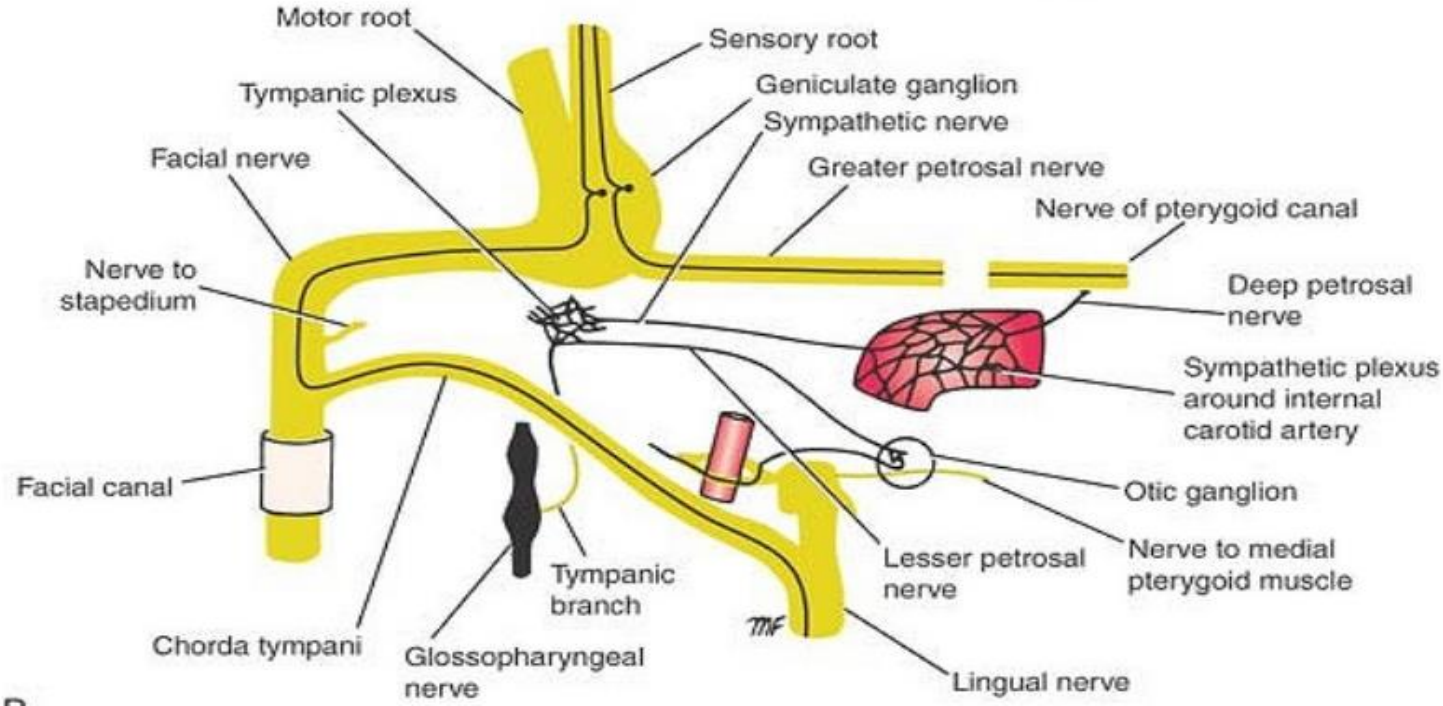


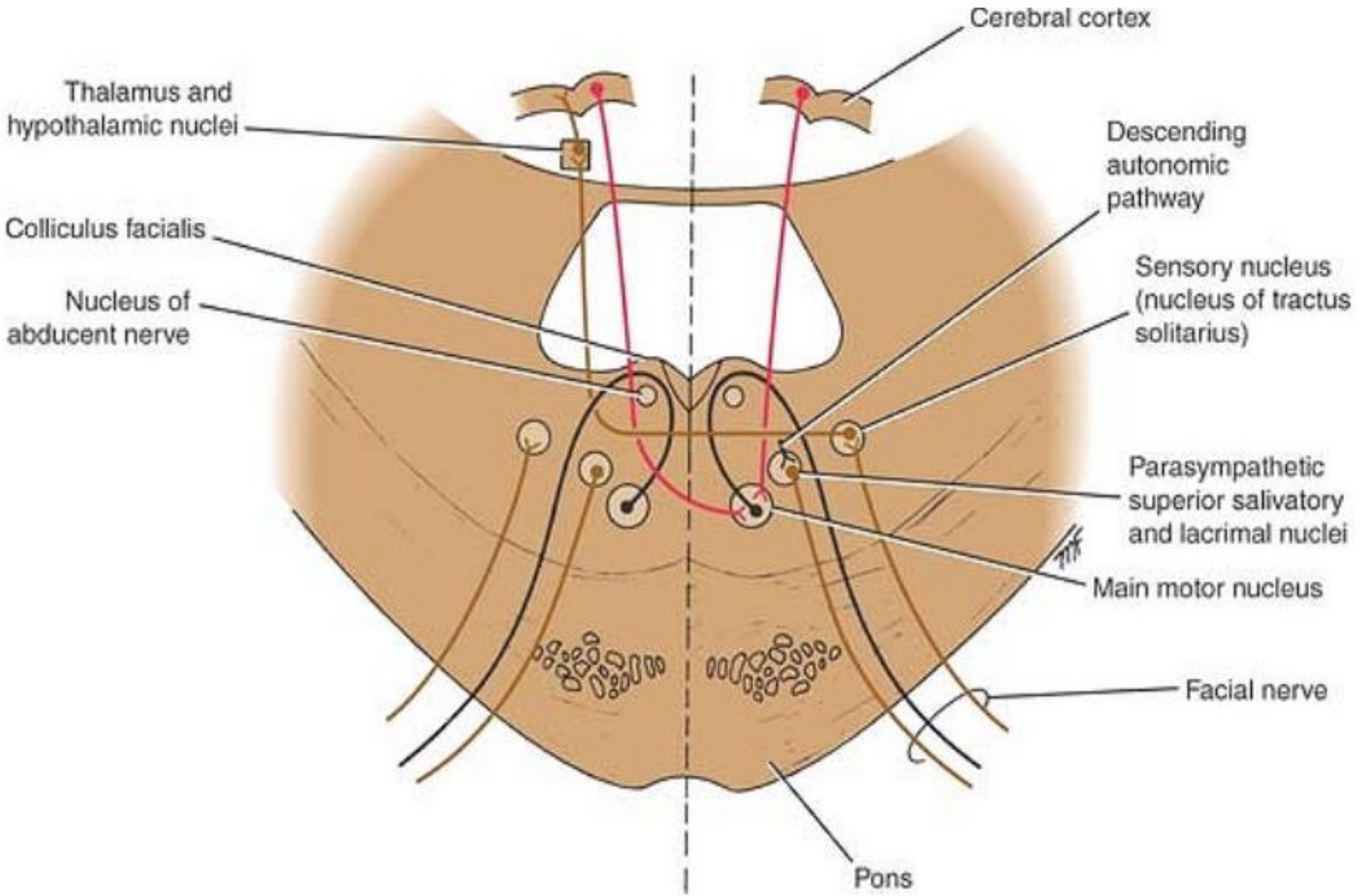

Cerebral cortex
Thalamus and hypothalamic nuclei
Descending autonomic pathway
Colliculus facialis
Sensory nucleus (nucleus of tractus solitarius)
Nucleus of abducent nerve
Parasympathetic superior salivatory and lacrimal nuclei
Main motor nucleus
Facial nerve
Pons

Sensory Nucleus

- The sensory nucleus is the upper part of the nucleus of the tractus solitarius and lies close to the motor nucleus.

- Sensations of taste travel through the peripheral axons of nerve cells situated in the geniculate ganglion on the 7th cranial nerve.
- The central processes of these cells synapse on nerve cells in the tractus solitarius nucleus.




Cerebral cortex
Thalamus and hypothalamic nuclei
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Sensory nucleus (nucleus of tractus solitarius)
Nucleus of abducent nerve
Parasympathetic superior salivatory and lacrimal nuclei
Main motor nucleus
Facial nerve
Pons

3. Parasympathetic nuclei:-

- Lie posterolateral to motor nuclei

(i). Superior Salivatory Nucleus: receives afferent fibers from:

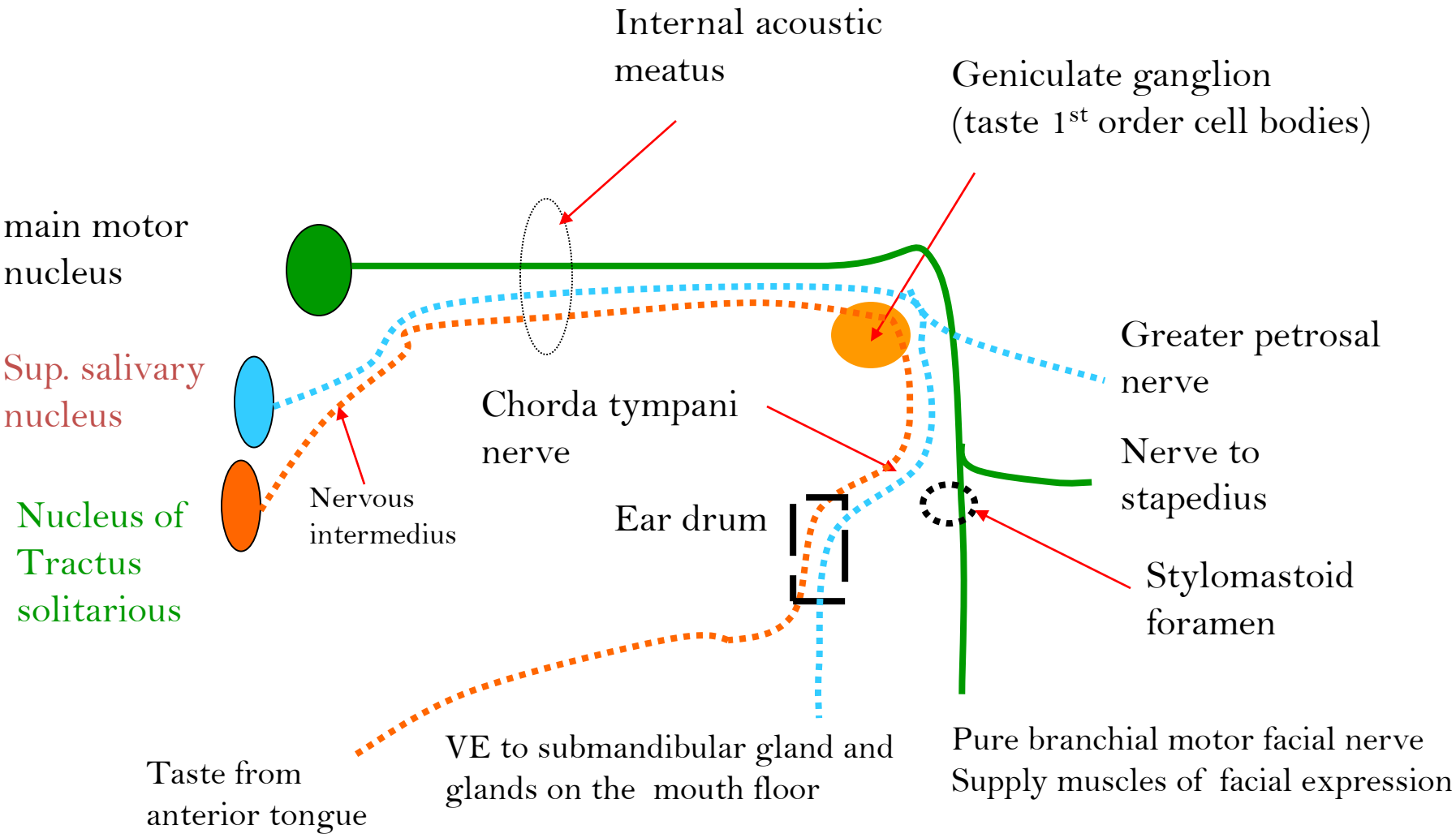
- ***Hypothalamus***
- ***Nucleus of solitary tract ➔ taste - oral cavity***

(ii). Lacrimal Nucleus: receive afferent fibers from:

❖Hypothalamus ➔ for emotional response

❖Sensory nuclei of CN-V for reflex lacrimation secondary to irritation of cornea or conjunctiva

Facial Nerve…cont.



Branches in the temporal bone

1. Greater petrosal nerve (parasympathetic) : arises at geniculate ganglion.
   - Passes to the pterygopalatine ganglion
2. Stapedial nerve: supply stapedial muscle.
3. Chorda tympani : it contains gustatory fibers.

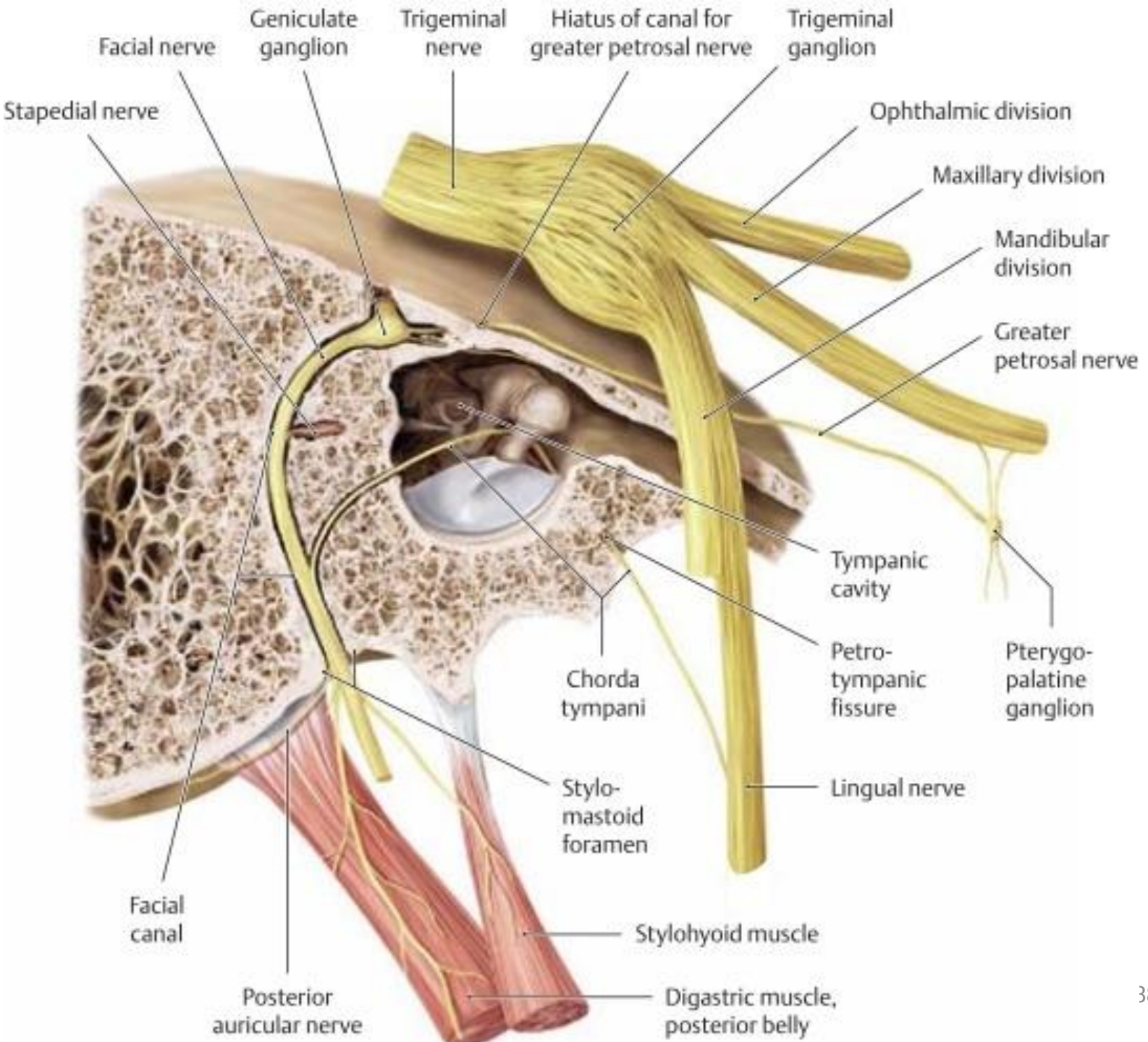
Branches for the muscles of expression

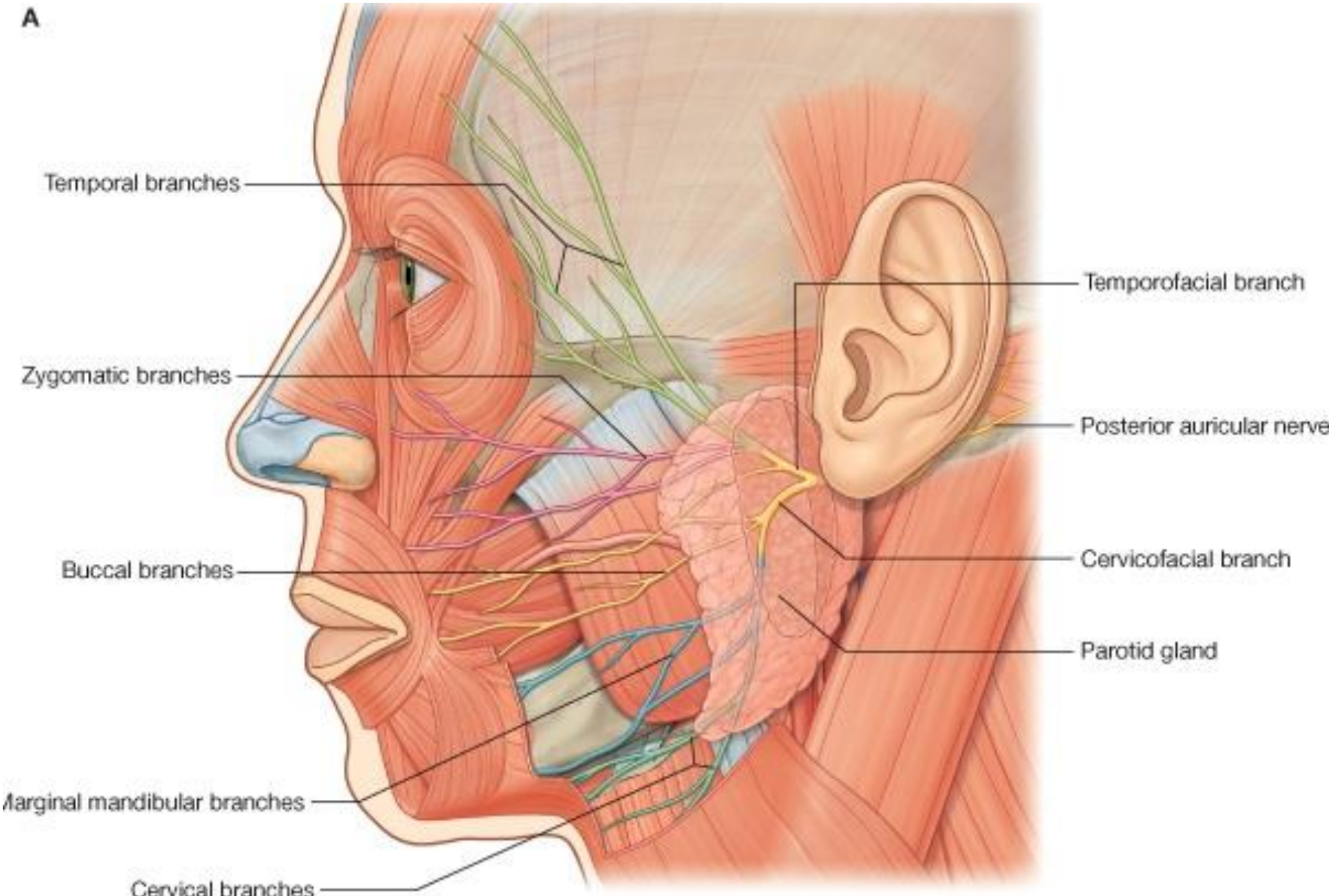
1. **Posterior auricular nerve** :

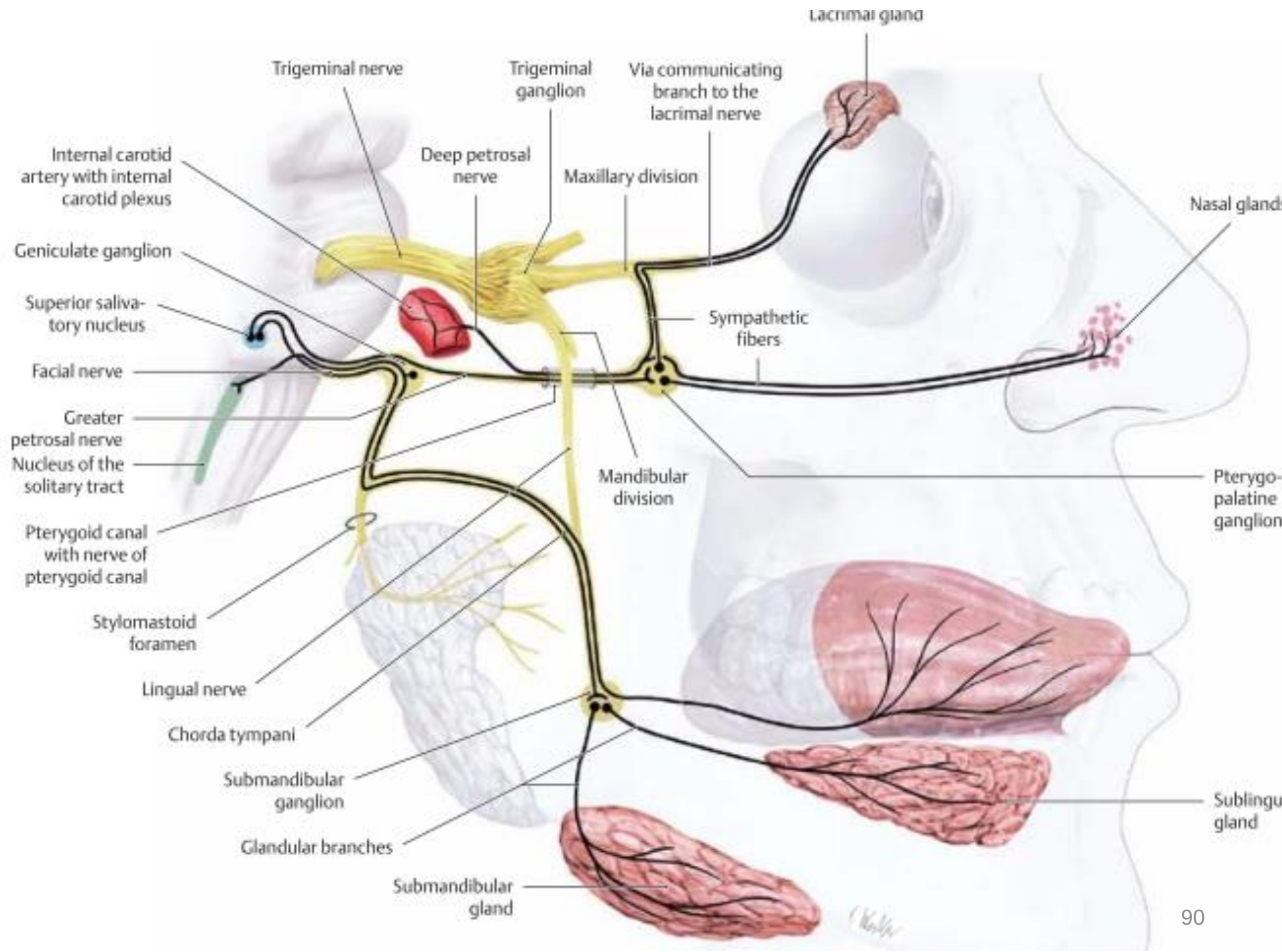
- Supplies : posterior auricular and occipitalis muscle.

2. **Intraparotid plexus** : from which:

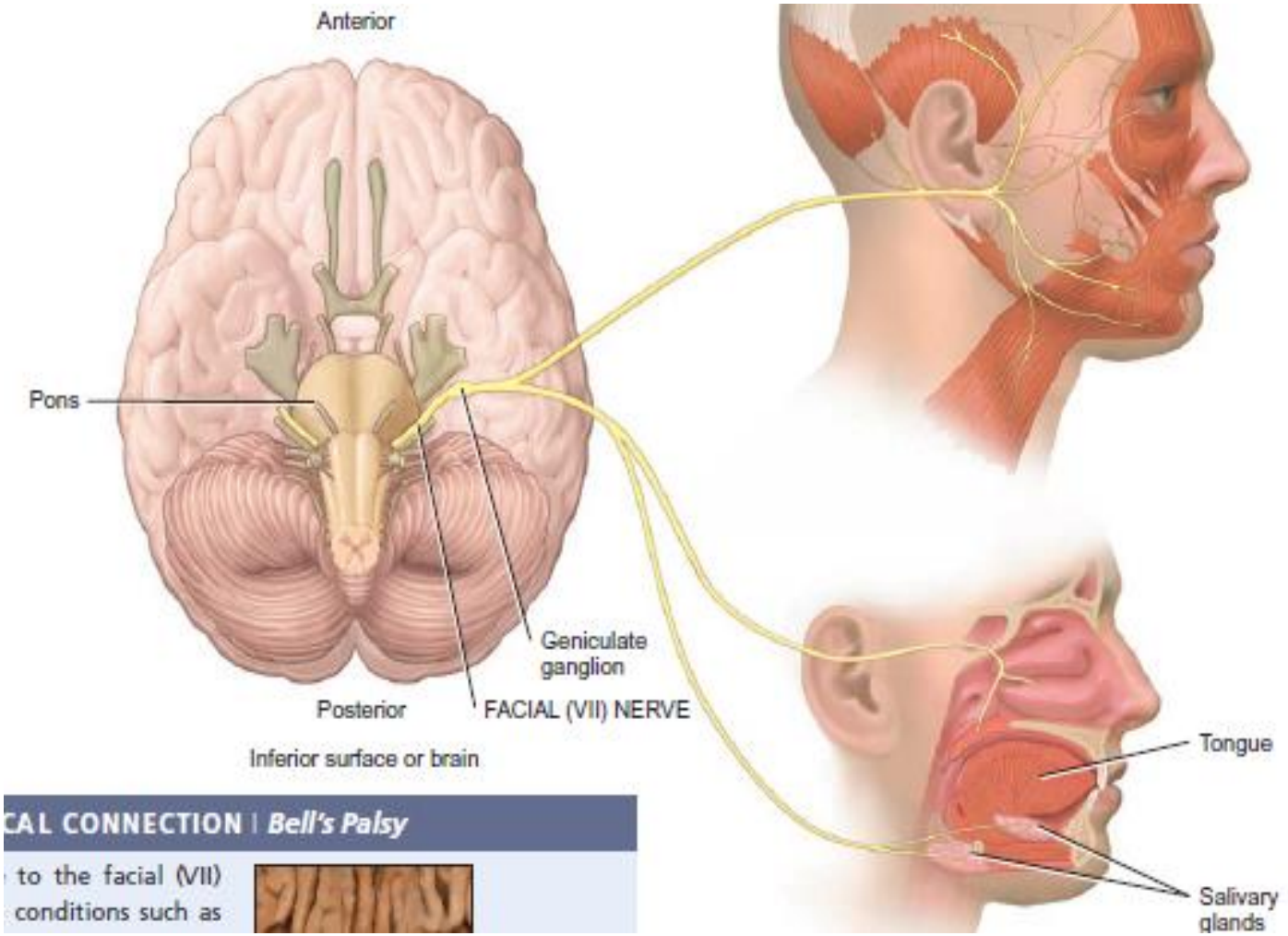
- **Temporal**, **zygomatic**, **buccal**, marginal **mandibular** and **cervical** are distributed to muscles of facial expression.


Facial nerve
Geniculate ganglion
Trigeminal nerve
Hiatus of canal for greater petrosal nerve
Trigeminal ganglion
Stapedial nerve
Ophthalmic division
Maxillary division
Mandibular division
Greater petrosal nerve
Tympanic cavity
Petro-tympanic fissure
Pterygo-palatine ganglion
Chorda tympani
Stylo-mastoid foramen
Lingual nerve
Facial canal
Stylohyoid muscle
Posterior auricular nerve
Digastric muscle, posterior belly


A
Temporal branches
Zygomatic branches
Buccal branches
Marginal mandibular branches
Cervical branches
Temporofacial branch
Posterior auricular nerve
Cervicofacial branch
Parotid gland


Lacrimal gland
Trigeminal nerve
Trigeminal ganglion
Via communicating branch to the lacrimal nerve
Internal carotid artery with internal carotid plexus
Deep petrosal nerve
Maxillary division
Nasal glands
Geniculate ganglion
Superior salivatory nucleus
Sympathetic fibers
Facial nerve
Greater petrosal nerve
Nucleus of the solitary tract
Mandibular division
Pterygopalatine ganglion
Pterygoid canal with nerve of pterygoid canal
Stylomastoid foramen
Lingual nerve
Chorda tympani
Submandibular ganglion
Sublingual gland
Glandular branches
Submandibular gland

- Clinical test: motor functions – close eyes, smile, whistle, frown, raise eyebrows; sensory : taste
- Effects of damage: inability to control facial muscles; distorted sense of taste



CAL CONNECTION | *Bell's Palsy*

to the facial (VII)
conditions such as

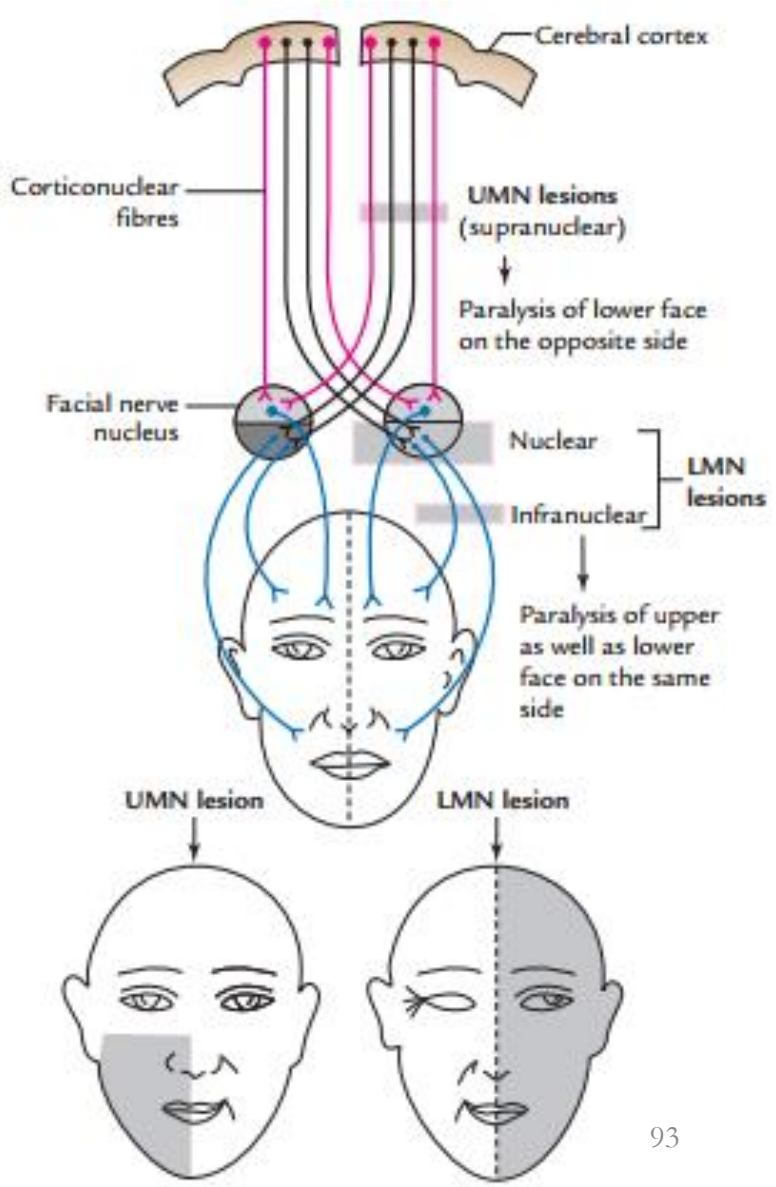
CN - VII: Clinical Aspects

- Is the most frequently paralyzed.
- **An upper motor or supranuclear lesion** usually result from vascular involvement of corticobulbar pathways, e.g. in cerebral haemorrhage, will produce a contralateral spastic **paralysis of muscles of lower half of the face.**
- patient with supranuclear lesion can still close eyes & wrinkle forehead since the muscles of upper half of face have a bilateral nerve supply.

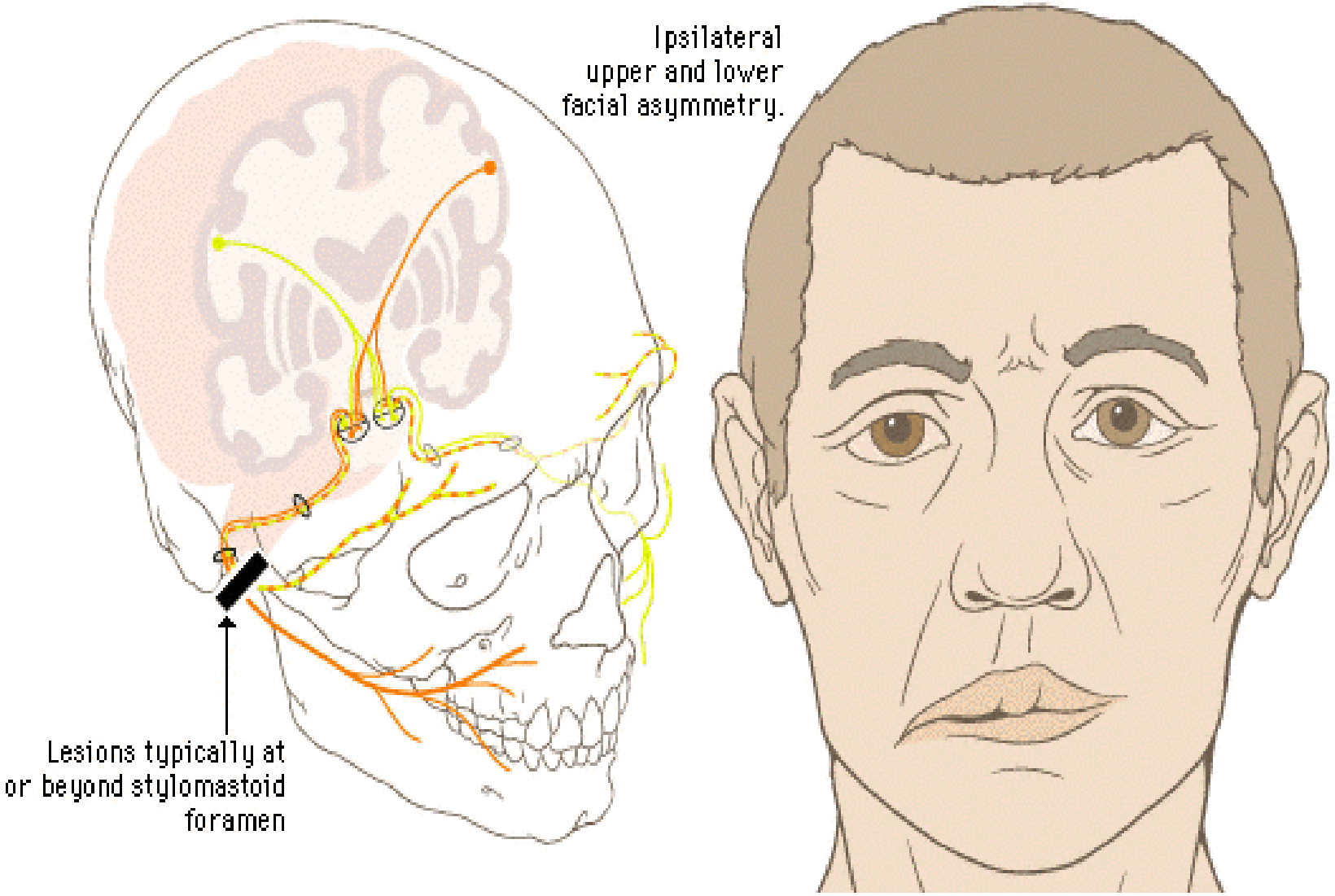
- **Infranuclear palsies or** LMN-Lesion **:** may result from compression in cerebellopontine angle, fractures of temporal bone & invasion by a malignant parotid tumour results in paralysis of muscles of facial expression on ipsilateral side.

Characteristic features of a LMN lesion/**Bell's Palsy** of CN – VII:

- Marked facial asymmetry
- Atrophy of facial muscles
- Patient is unable to close the affected eye because orbicularis- oculi muscle is paralyzed
- Eyebrow droops
- Smoothing out of forehead & nasolabial folds
- Drooping of corner of mouth
- Loss of efferent limb of corneal/conjunctival reflex ➔ (cannot blink)
- Lips cannot be held tightly together
- Difficulty keeping food in mouth while chewing on the affected side



• Lower Motor Neuron Lesion



Glossopharyngeal (IX) Nerve

- Mixed cranial nerve
- Originate from the posterolateral sulcus of medulla oblongata
- Exit via jugular foramen
- Its sensory axons arise from:

  (1) Taste buds on the posterior 1/3rd of the tongue

  (2) Baroreceptors in the carotid sinus

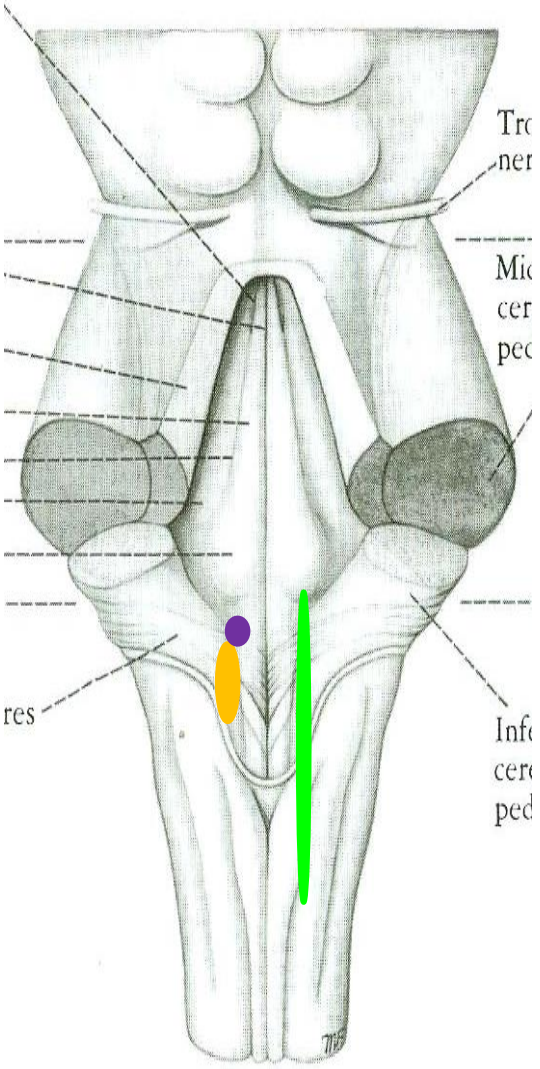
  (3) Chemoreceptors in the carotid bodies

  (4) External ear to convey touch, pain, and thermal sensations.
- Its motor axons assist muscle involving in swallowing and stimulate the parotid gland to secrete saliva.
- Innervate stylopharyngeus muscle,

Glossopharyngeal nerve (cranial nerve IX)

- has three nuclei:

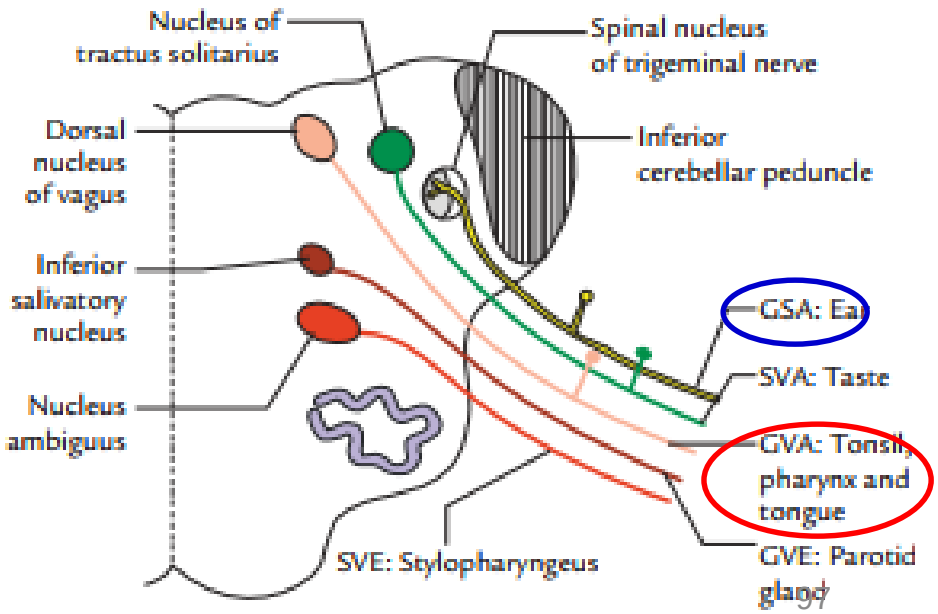
1. Main motor nucleus
   - ➢ **Nucleus ambigus (SVE)**
   - ➢ Supply the stylopharyngeus muscle
2. Parasympathetic **nucleus**
   - **Inferior salivary nucleus**
   - Supplies parotid gland (**GVE**)
3. Sensory nucleus
   - **Nucleus of tractus solitarius** (SVA)
   - Taste(posterior 1/3rd of tongue)

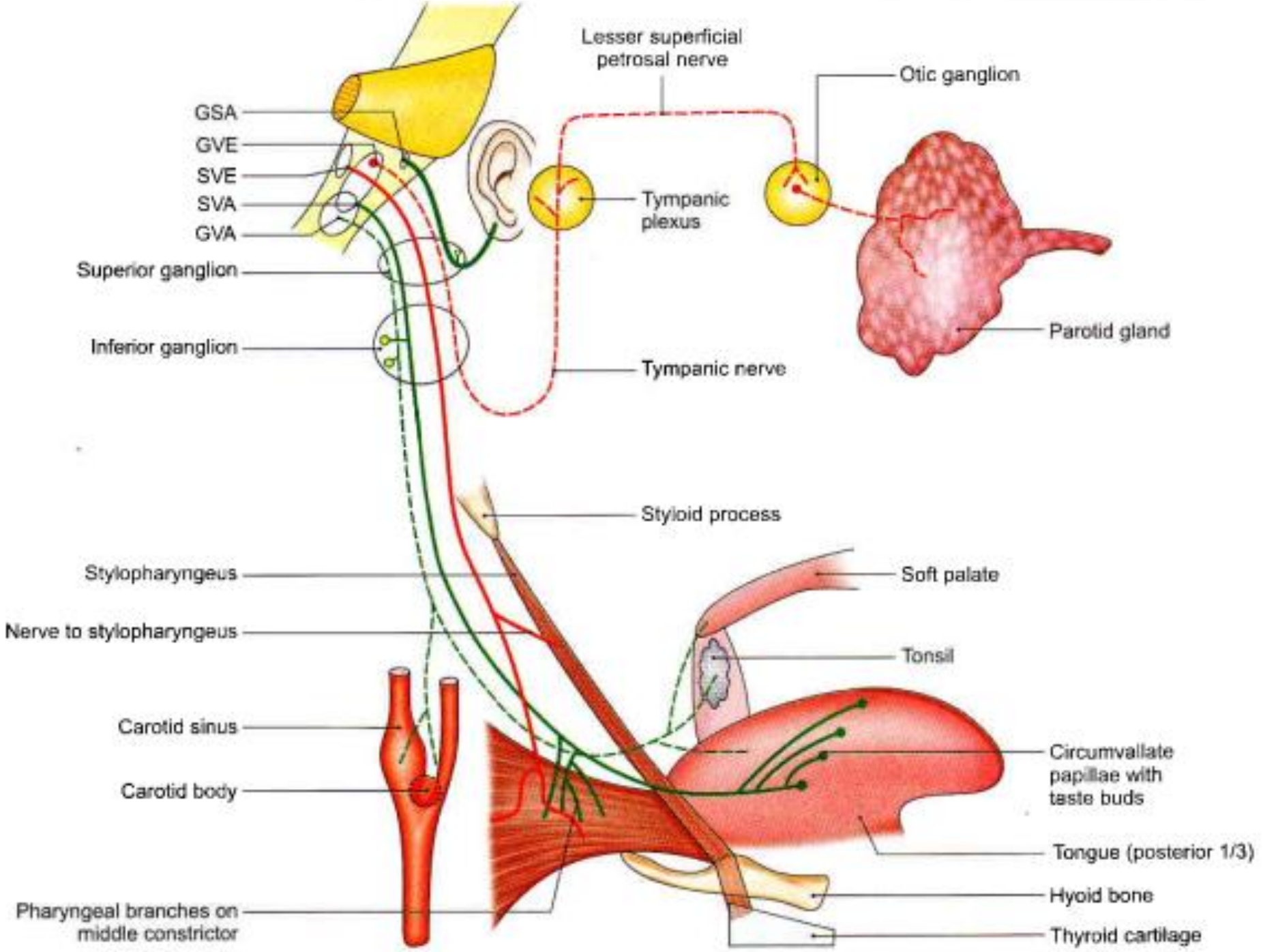


Glossopharyngeal nerve (IX):

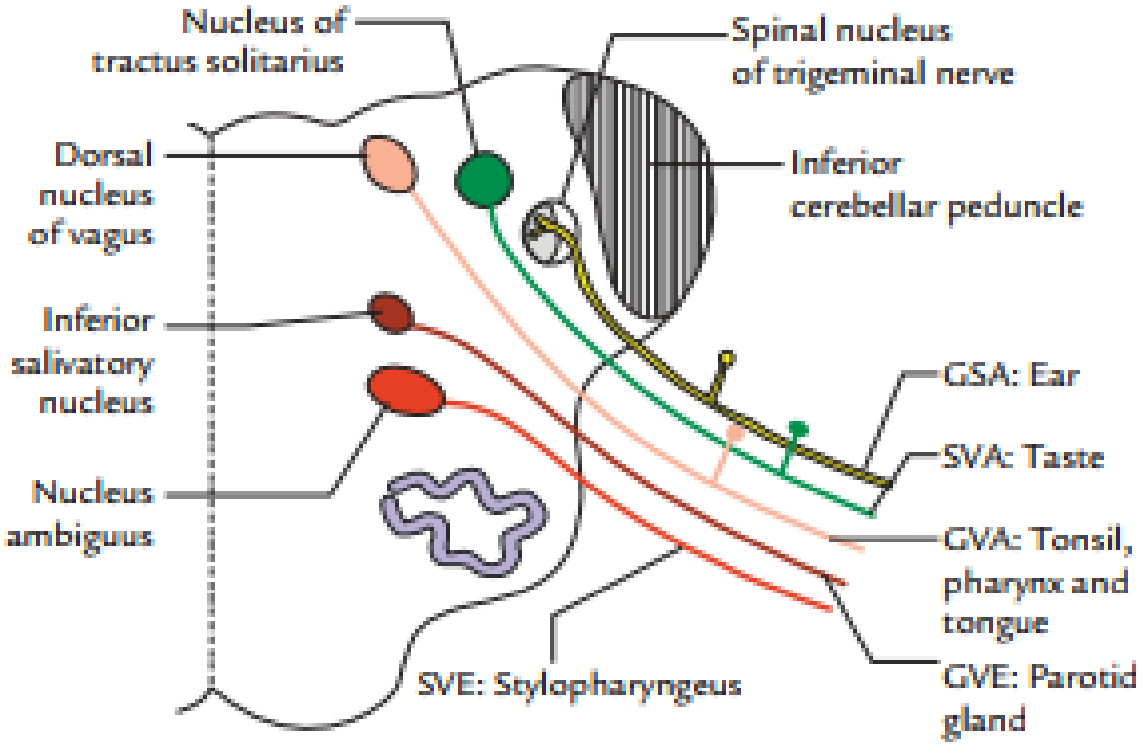
- **GSA** carry proprioceptive sensation from ear terminate in **spinal nucleus of trigeminal nerve**

- **GVA**= carry general sensations of pain, touch, and temperature from the mucous membrane of the pharynx, carotid sinus tonsil, soft palate




Lesser superficial petrosal nerve
Otic ganglion
GSA
GVE
SVE
SVA
GVA
Tympanic plexus
Superior ganglion
Inferior ganglion
Parotid gland
Tympanic nerve
Styloid process
Stylopharyngeus
Soft palate
Nerve to stylopharyngeus
Tonsil
Carotid sinus
Circumvallate papillae with taste buds
Carotid body
Tongue (posterior 1/3)
Hyoid bone
Pharyngeal branches on middle constrictor
Thyroid cartilage

Cont.

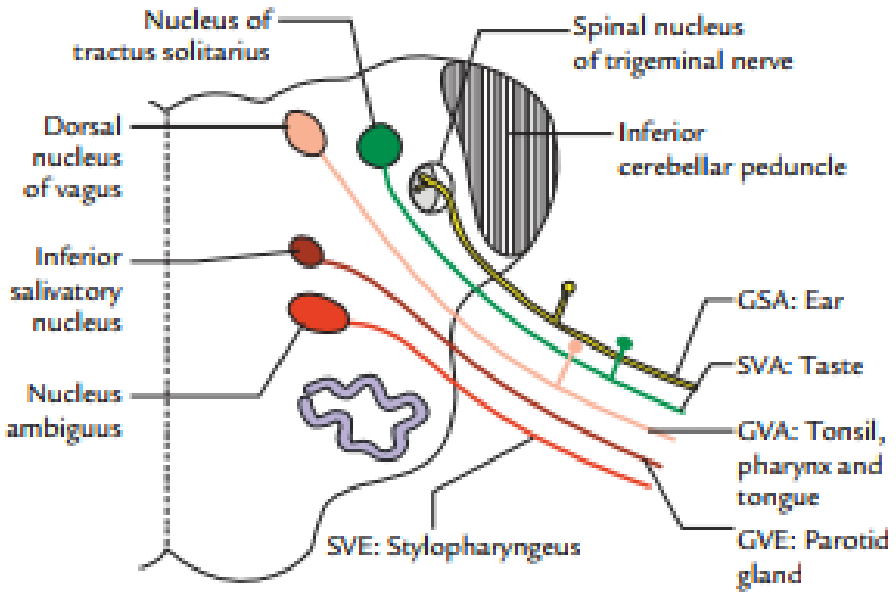


1. Main motor /SVE

- Lie deep in the reticular formation
- Formed by superior part of **nucleus ambiguus**
- Receive corticonuclear fibers from both cerebral hemispheres
- Efferent fibbers supply ***stylopharyngeus muscle***

2. Parasympathetic nuclei: Inferior Salivatory Nucleus/GVE

- Receive afferent fibers from :
  - Hypothalamus via descending autonomic pathway
  - Olfactory system via reticular formation
  - Oral cavity/taste/: nucleus of solitary tract
- Efferent fibers route via ***tympanic nerve ➔Otic ganglion ➔ Parotid gland***



3. Sensory Nucleus:

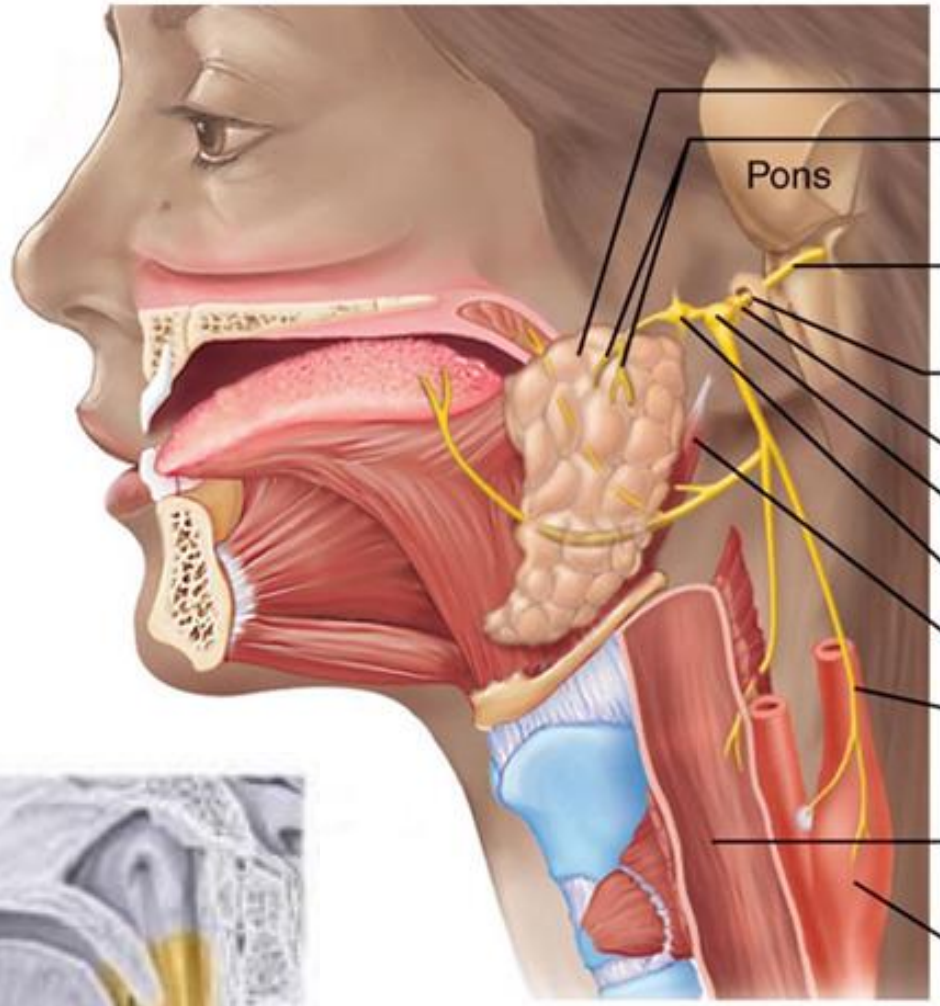
SVA:

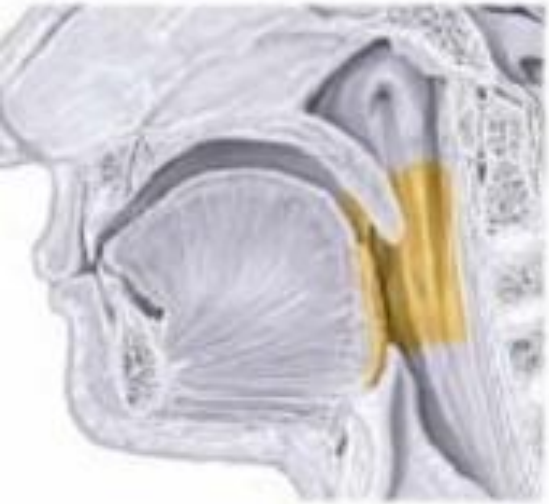
- Part of nucleus of tractus solitarius (nucleus solitarius)
- Afferent information of taste

- **GVA**: Afferents from ***carotid sinus /baroreceptors*** terminate in **nucleus solitarius:** ➔ connected to **dorsal motor nucleus of CN X** ➔ ***Regulate arterial blood pressure.***

- **GSA**: via ***superior ganglion of CN IX*** but ends in spinal nucleus of CN V

The Glossopharyngeal Nerves -IX

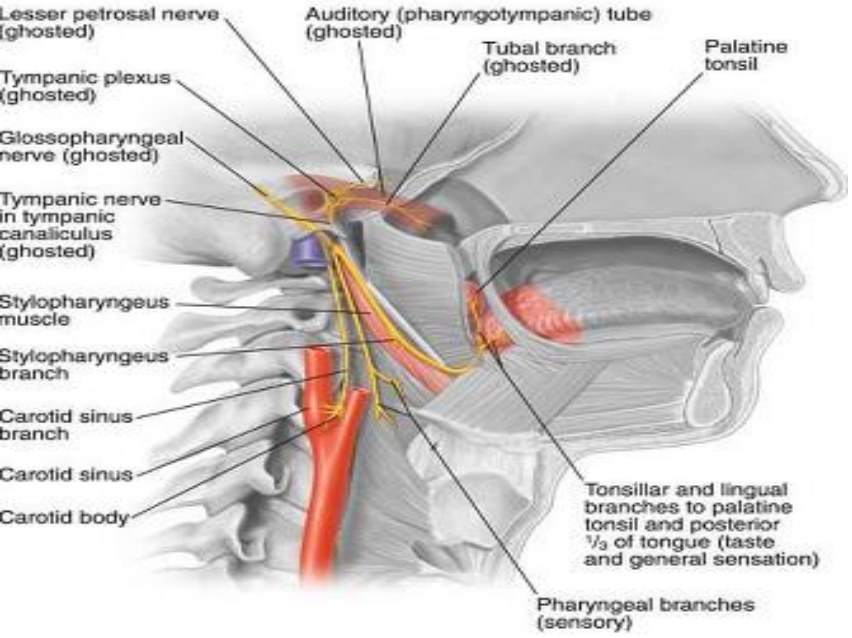


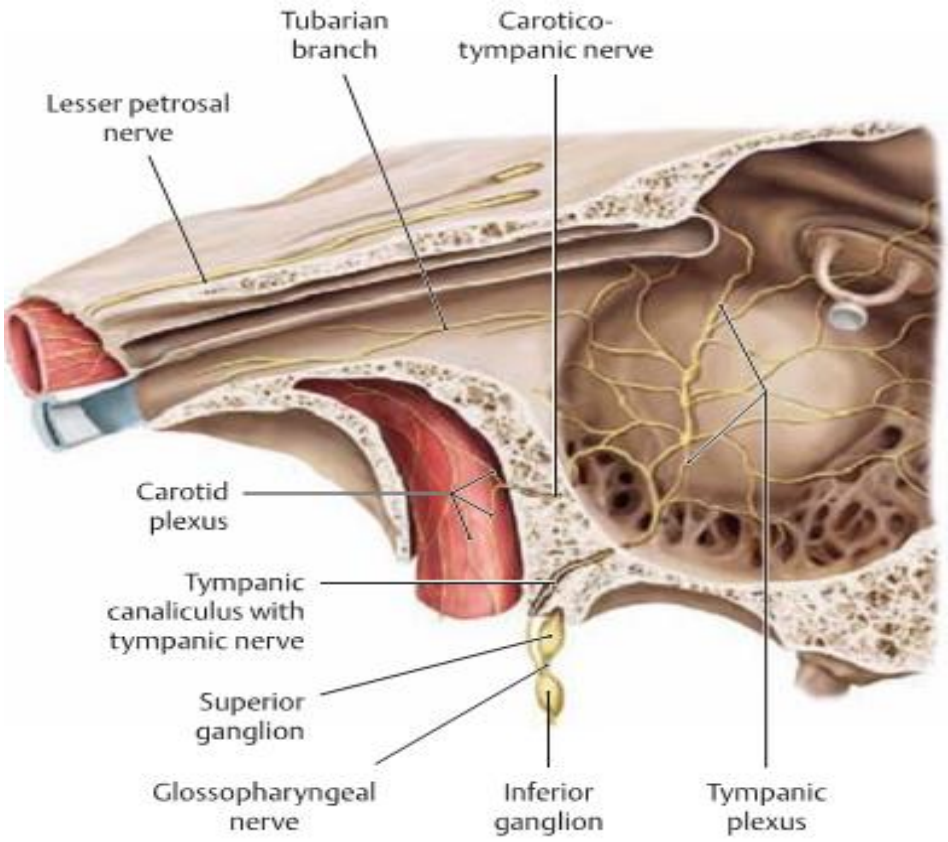


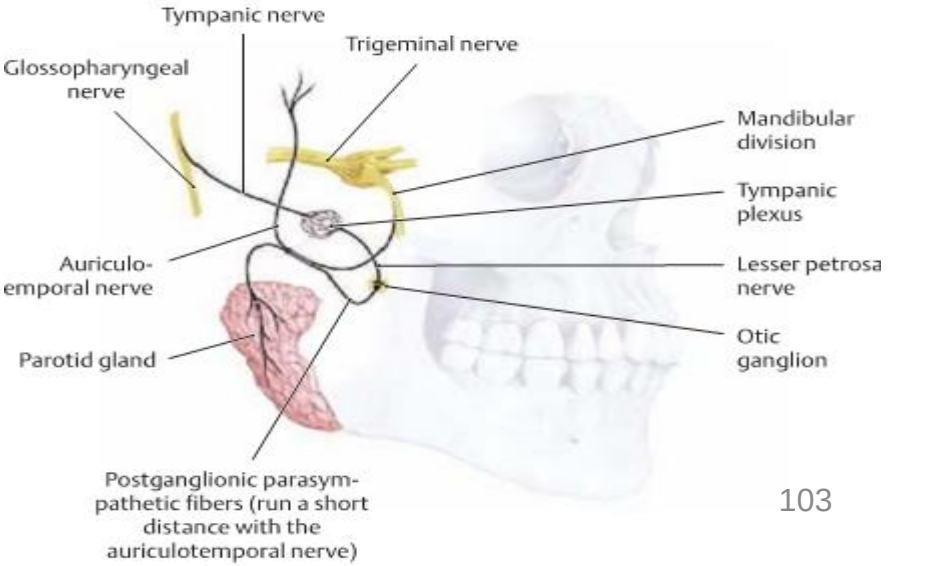
Branches

1. In the tympanic cavity :
   a. **Tympanic nerve : is the first branch.**
      - **It contain presynaptic**
        - **parasympathetic (VE) fibers to otic ganglion.**
        - **Somatic afferent for tympanic cavity and Eustachian tube.**

      Divide within tympanic cavity to form tympanic plexus.







2. Beyond the skull base :

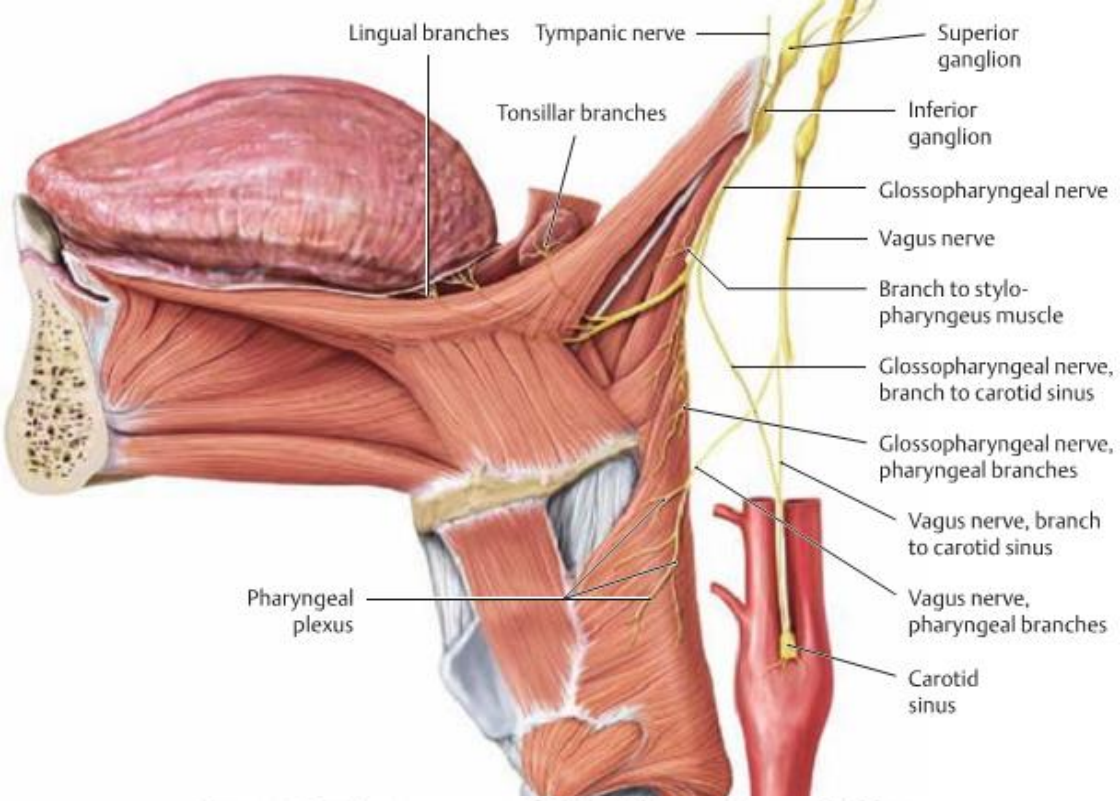
   a. **Pharyngeal branches : 3 or 4 branches.**

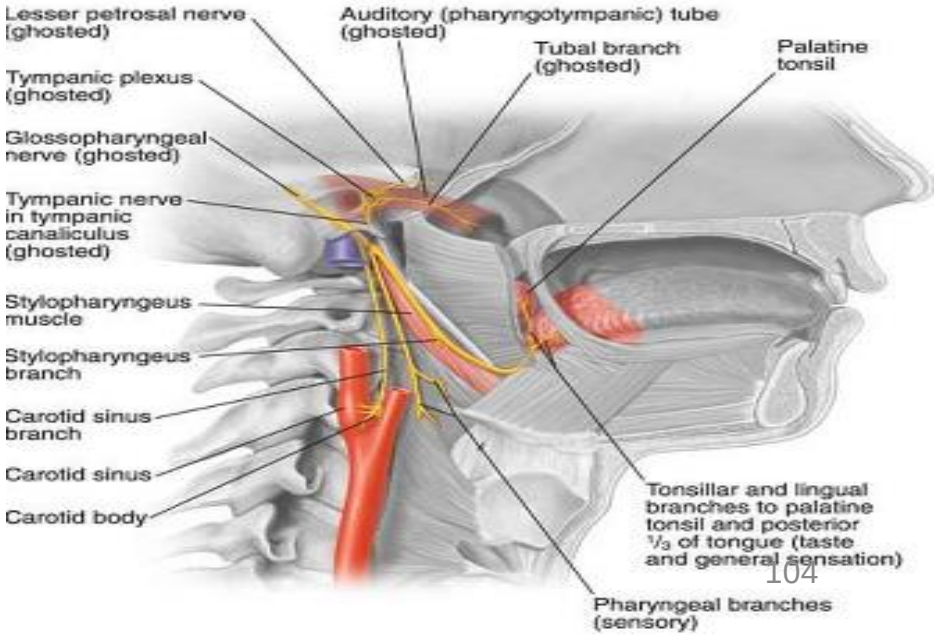
   b. Branch to **stylopharyngeus muscle.**

   c. Branch to **carotid sinus** and **body**

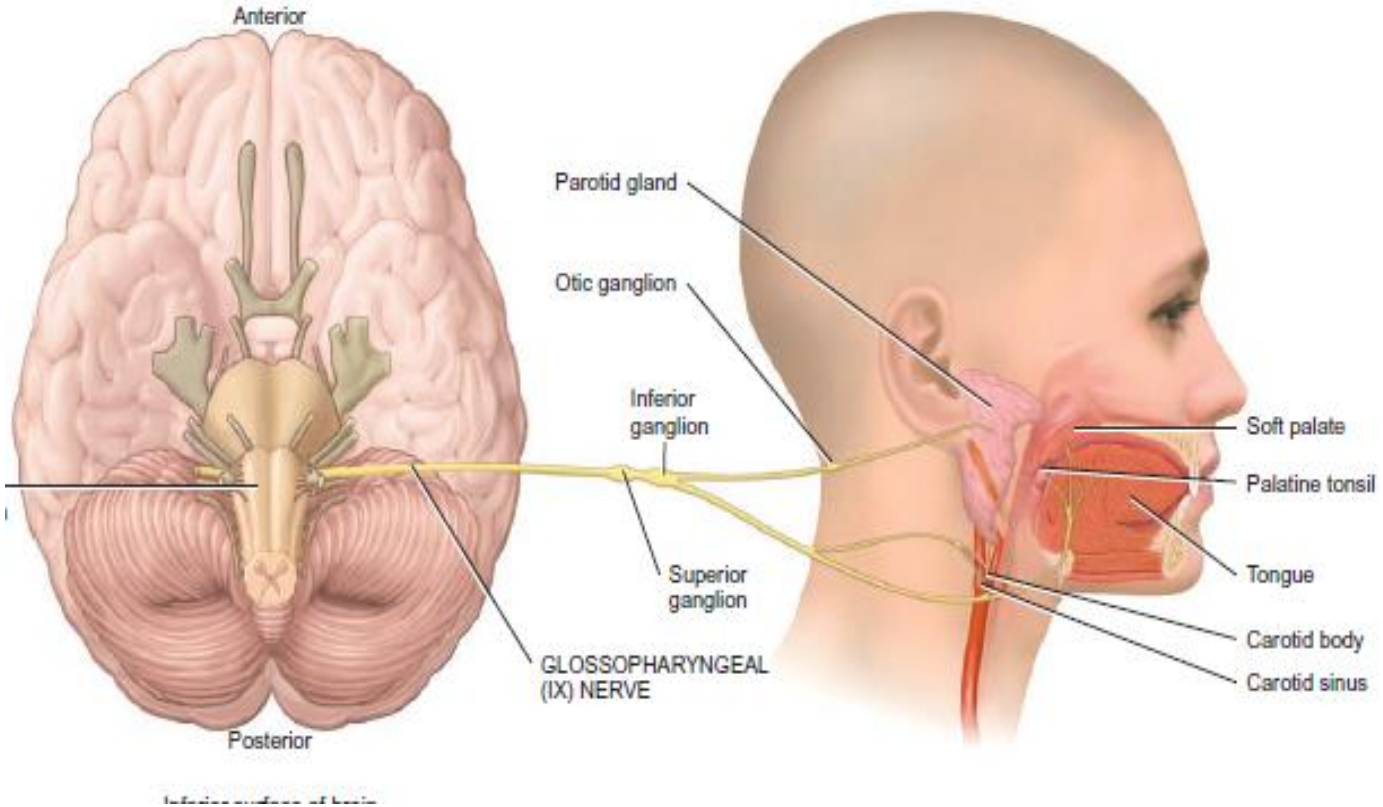
   d. Tonsillar branches **:** for the **mucosa of the pharyngeal tonsil** and its surroundings.

   e. Lingual branches **:** somatosensory fibers and gustatory fibers for the **posterior 3rd of the tongue.**



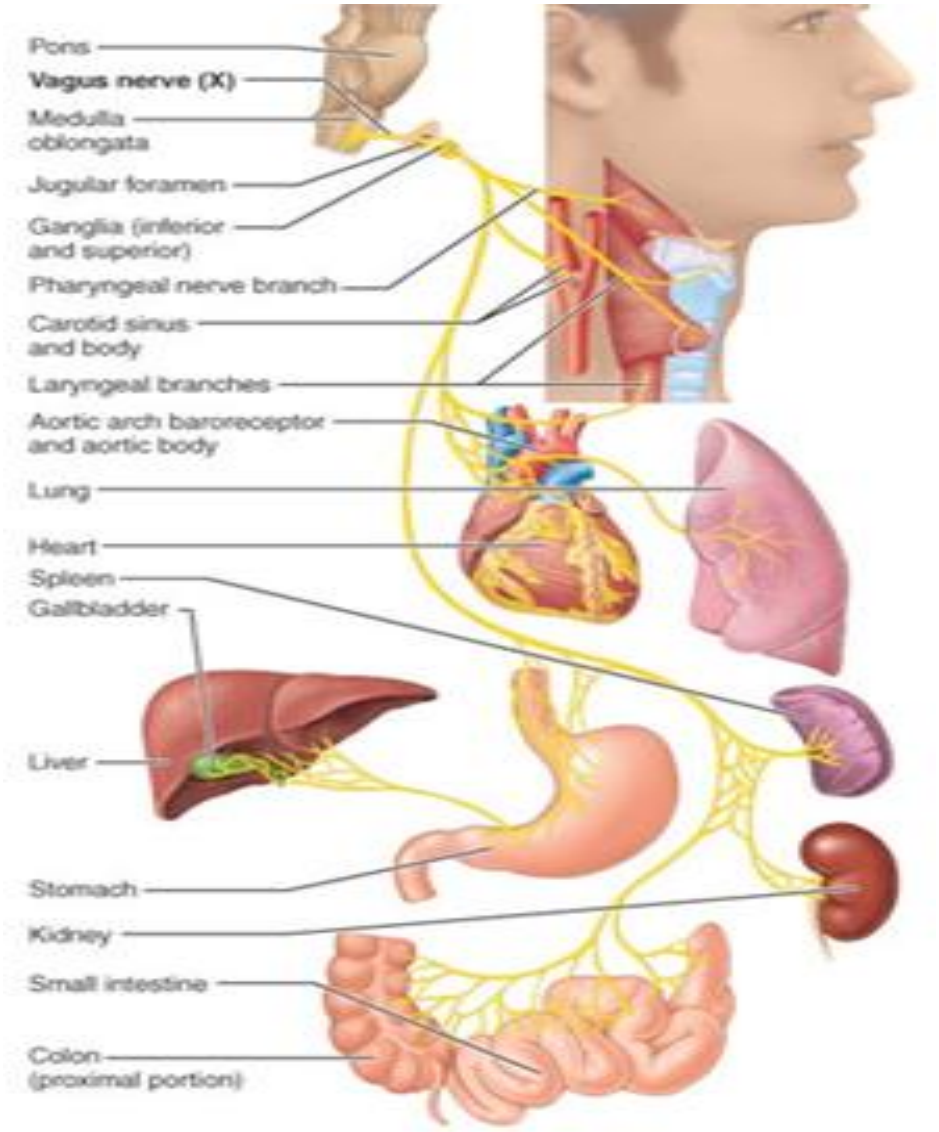


- Clinical tests: gag reflex, swallowing
- **Effects of damage**:
  - Some pharyngeal weakness/weakness in swallowing
  - Loss of salivation from the parotid gland.
  - The unilateral loss of the gag reflex



D. Vagus Nerve (Cranial Nerve X)

- Is a mixed cranial nerve.
- Originated from the posterolateral sulcus of medulla oblongata
- Exit posterior cranial fossa via jugular foramen.
- Has wide distribution and course



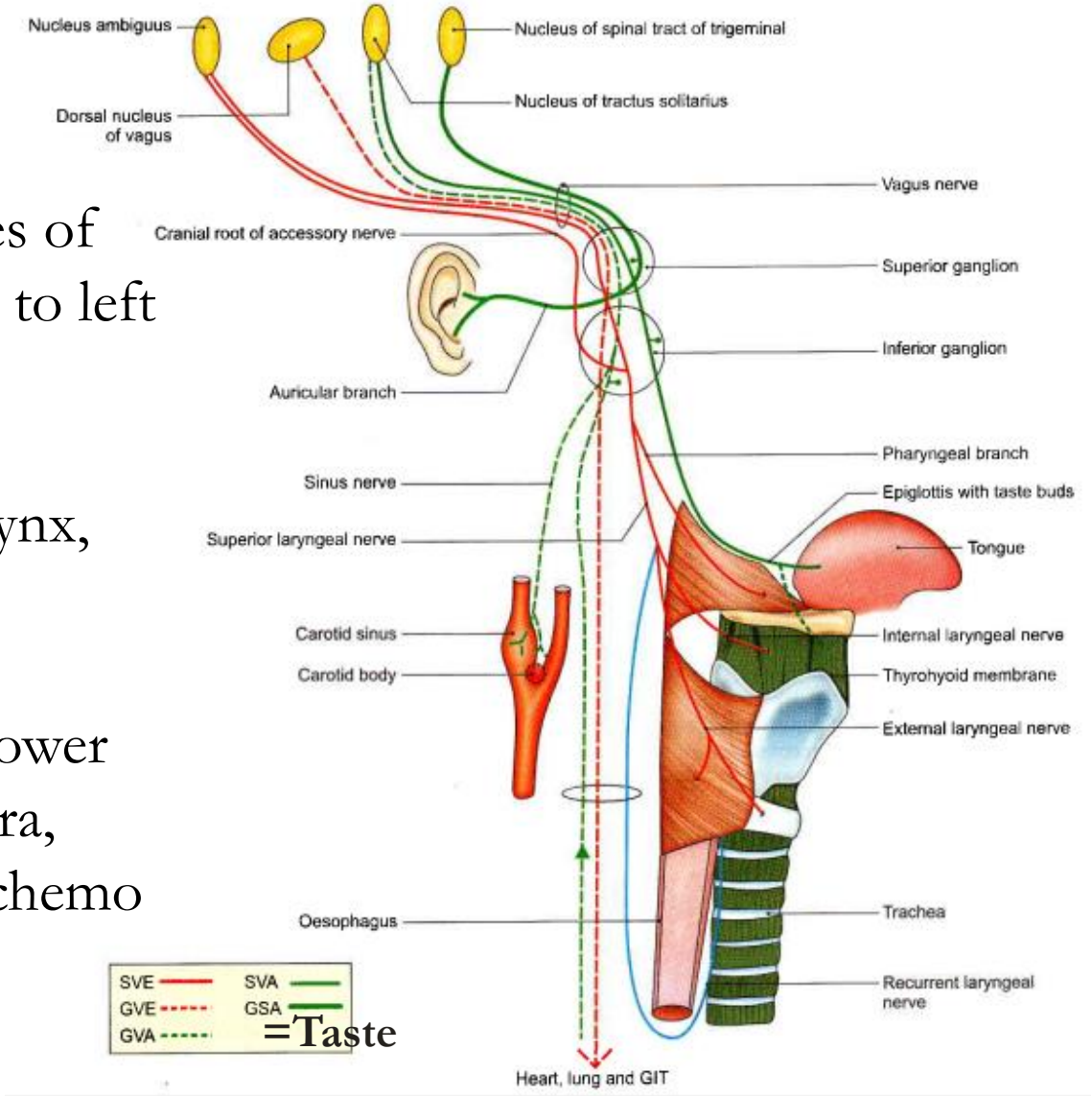
Cont.

GVE

- all autonomic structures of thorax & abdomen, up to left colic flexure (

- **SVE**= Muscles of Larynx, pharynx, & soft palate

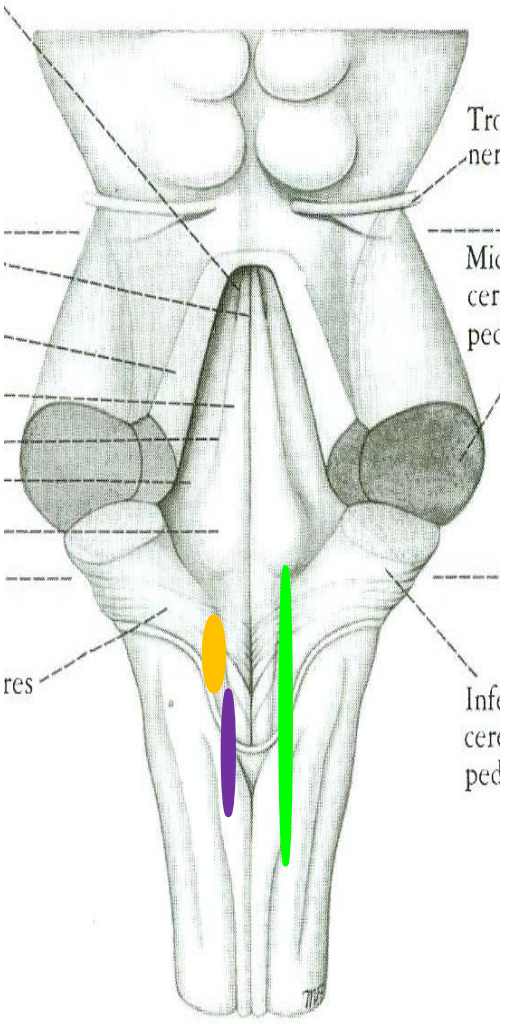
- **GVA =all** the larynx, lower part of pharynx, viscera, carotid sinus & body (chemo and baro receptor)

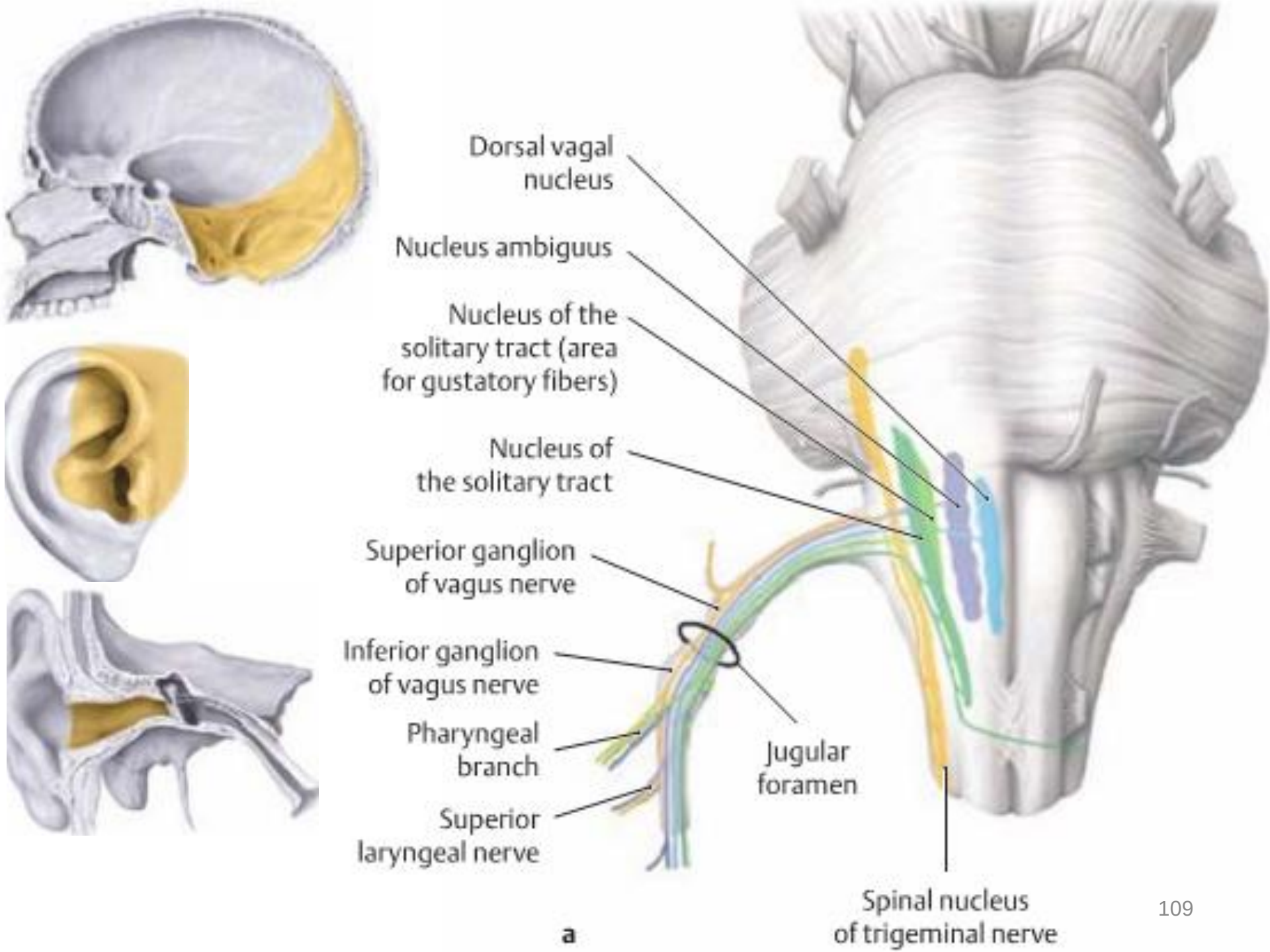


Vagus Nerve (Cranial Nerve X)

- The vagus nerve has three nuclei:

1. Main motor nucleus,
   - ❖**Nucleus ambigus**
   - ❖supplies pharyngeal constrictors
2. Parasympathetic nucleus,
   - **Dorsal motor nucleus of vagus**
3. The sensory nucleus.-
   - **Nucleus of tractus solitaries**

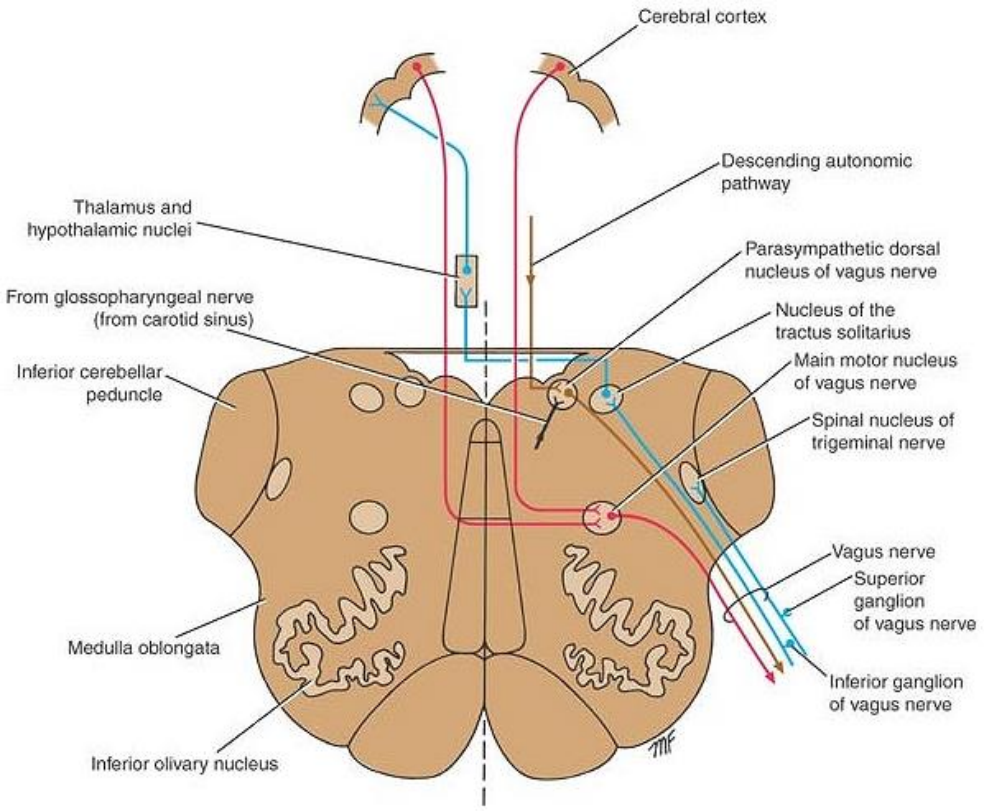



Dorsal vagal nucleus
Nucleus ambiguus
Nucleus of the solitary tract (area for gustatory fibers)
Nucleus of the solitary tract
Superior ganglion of vagus nerve
Inferior ganglion of vagus nerve
Pharyngeal branch
Superior laryngeal nerve
Jugular foramen
Spinal nucleus of trigeminal nerve
a

Mixed Cranial Nerves : C.N. X

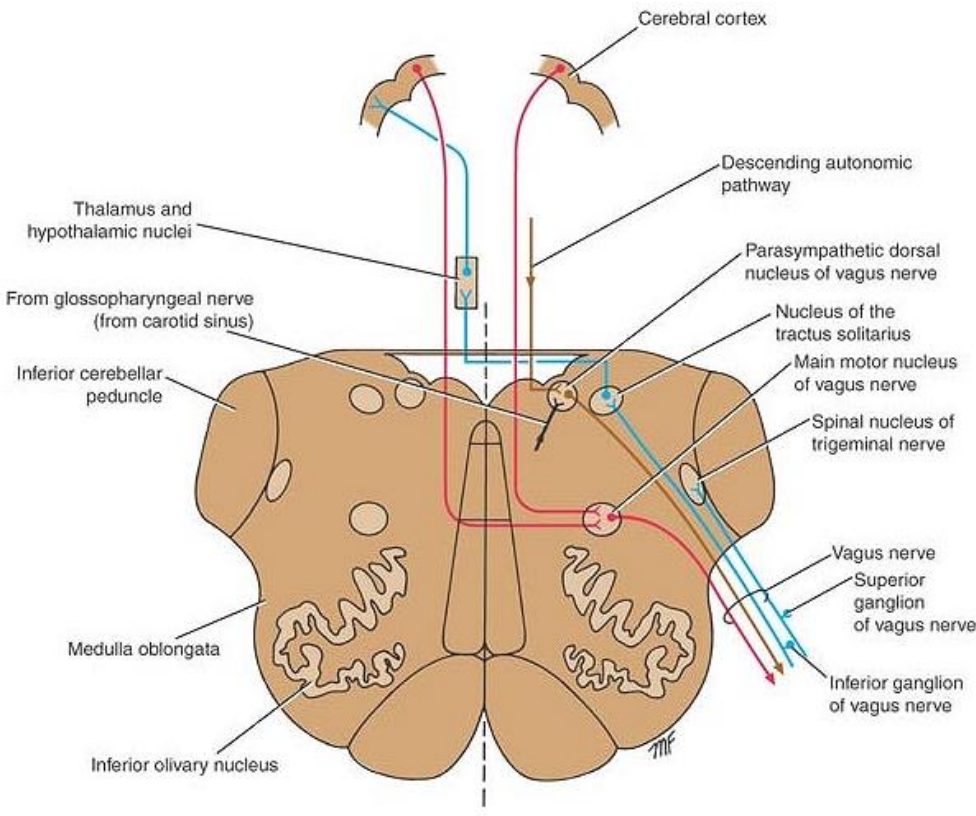
1. Main Motor Nucleus:

- Lies deep in reticular formation of MO
- Formed by nucleus ambiguous
- Receive corticonuclear fibers from both hemispheres
- Efferent fibers supply constrictor muscles of pharynx & intrinsic muscle of larynx

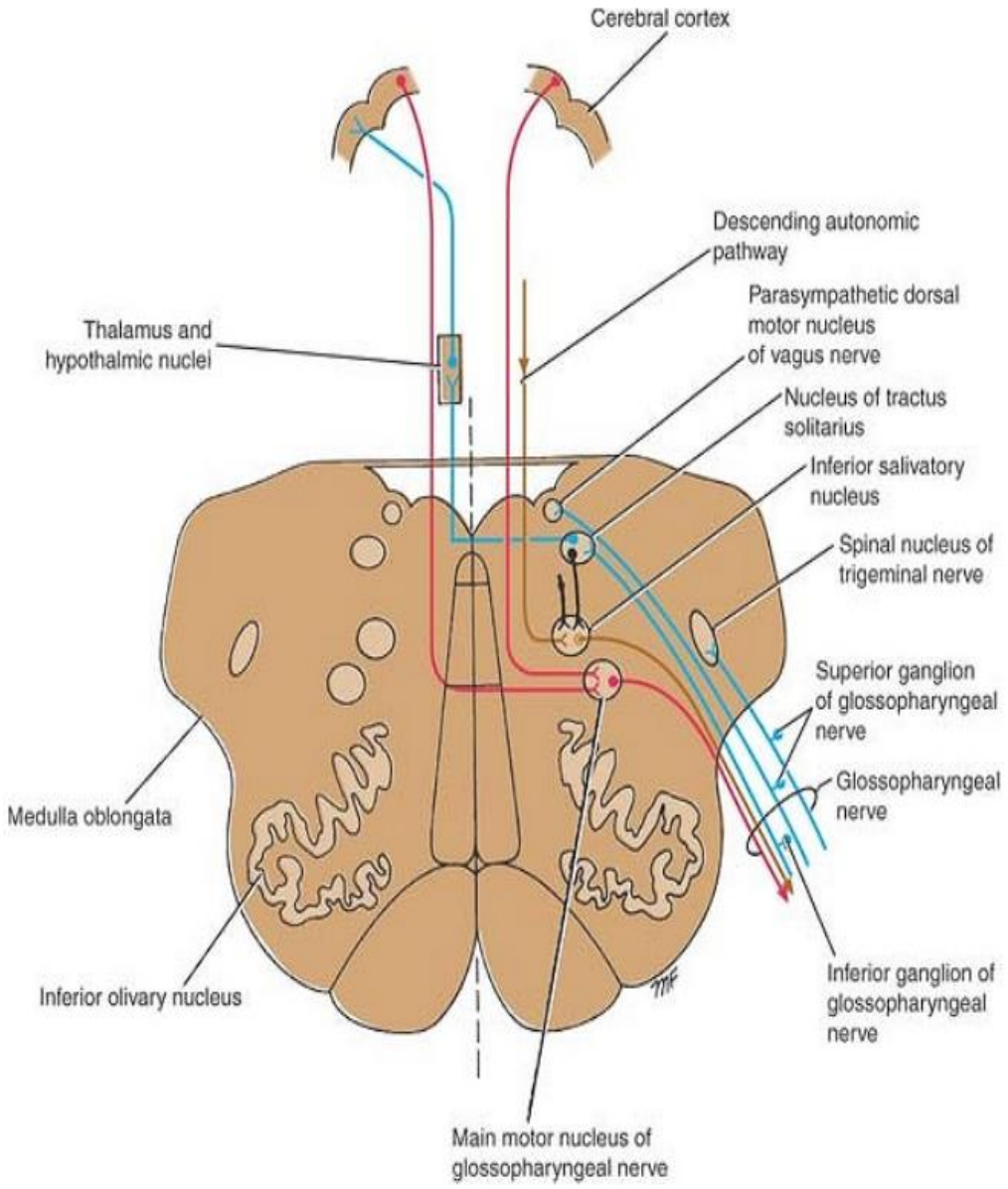


2. **Parasympathetic Nucleus:** dorsal motor nucleus of vagus

- Lie below floor of 4th ventricle, just posterolateral to hypoglossal nucleus
- Receive afferent fibers from hpothalamus & glossopharyngeal nerve /carotid sinus/.
- Efferent fibers to thoracic & abdominal viscera: ***bronchi, heart, esophagus, stomach, small intestine, & large intestine as far as left colic flecture.***

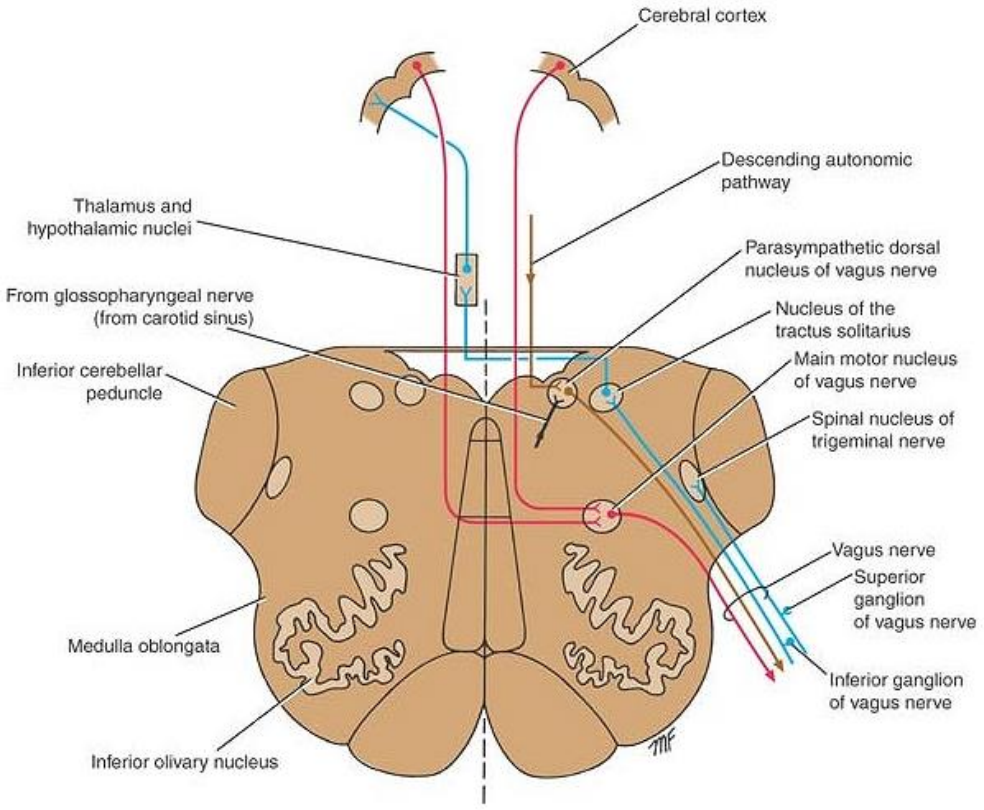


- Afferent impulses from the carotid sinus also travel with the glossopharyngeal nerve.
- They terminate in the nucleus of the dorsal motor nucleus of the vagus nerve.
- The **carotid sinus reflex** that involves the *glossopharyngeal and vagus nerves* assists in the regulation of arterial blood pressure.



3. Sensory Nucleus:

- Lower part of nucleus of tractus solitarius
- Sensation of taste pass via **inferior ganglion** of CN X
- Common sensation via **superior ganglion** & end in spinal nucleus of CN – V.



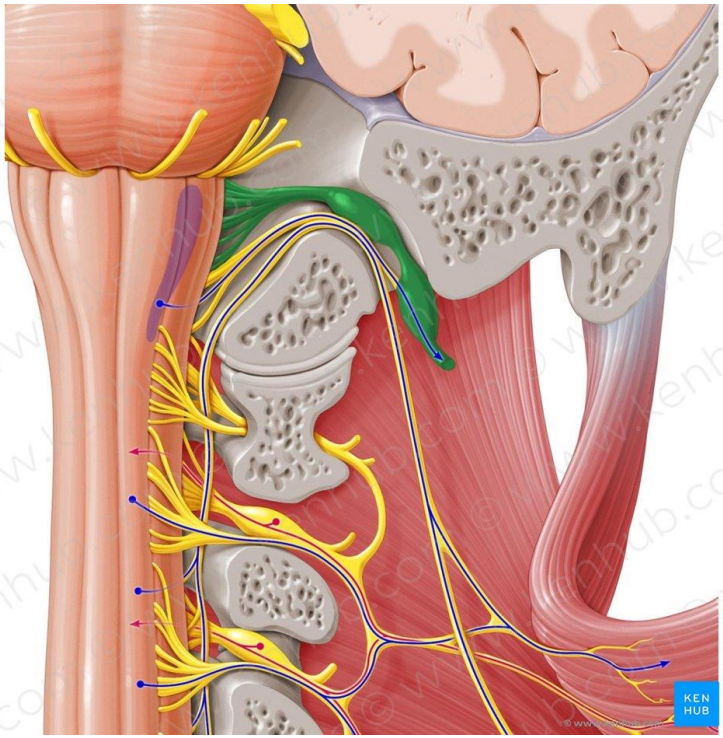
- Superior ganglion located in jugular foramen
- Inferior ganglion is outside jugular foramen

Vagus…

- Afferent fibers cross the median plane and
- ascend to the ventral group of nuclei of the opposite thalamus as well as to a number of hypothalamic nuclei.
- From the thalamus, pass through IC corona radiata to end in the postcentral gyrus.
- Afferent information concerning general somatic sensation enters the brainstem through the superior ganglion of the vagus nerve but ends in the spinal nucleus of the trigeminal nerve.

Course of vagus nerve

- leaves the anterolateral surface of the upper part of the medulla oblongata as a series of rootlets in a groove between the **olive and the inferior cerebellar peduncle**



- Passes laterally through the posterior cranial fossa

- Leaves the skull through the jugular foramen.

- The vagus nerve possesses two sensory ganglia
- The vagus nerve descends vertically in the neck within the **carotid sheath**

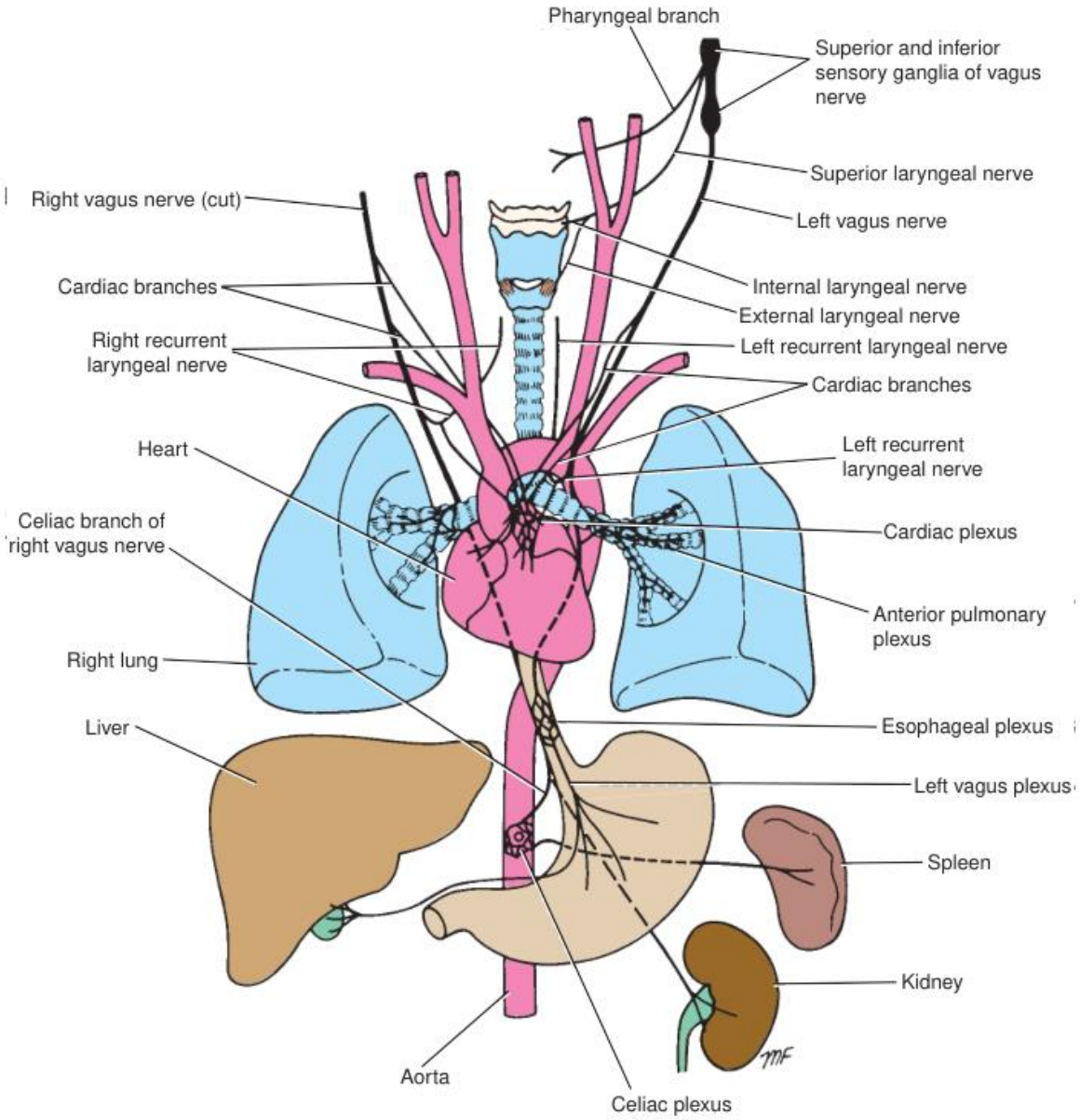


Figure 11-19 Distribution of the vagus nerve.

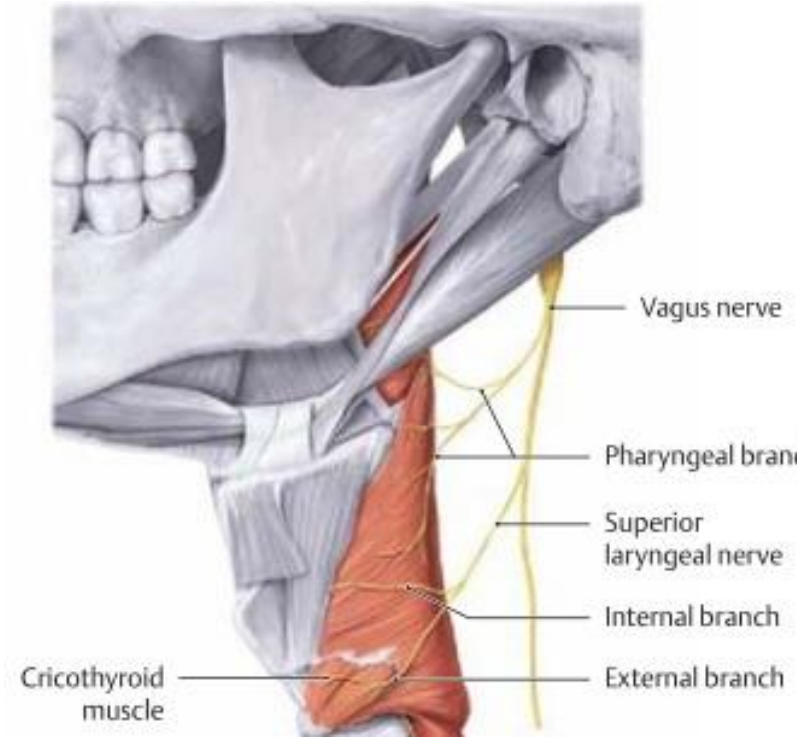
Divisions (parts) of vagal nerve.

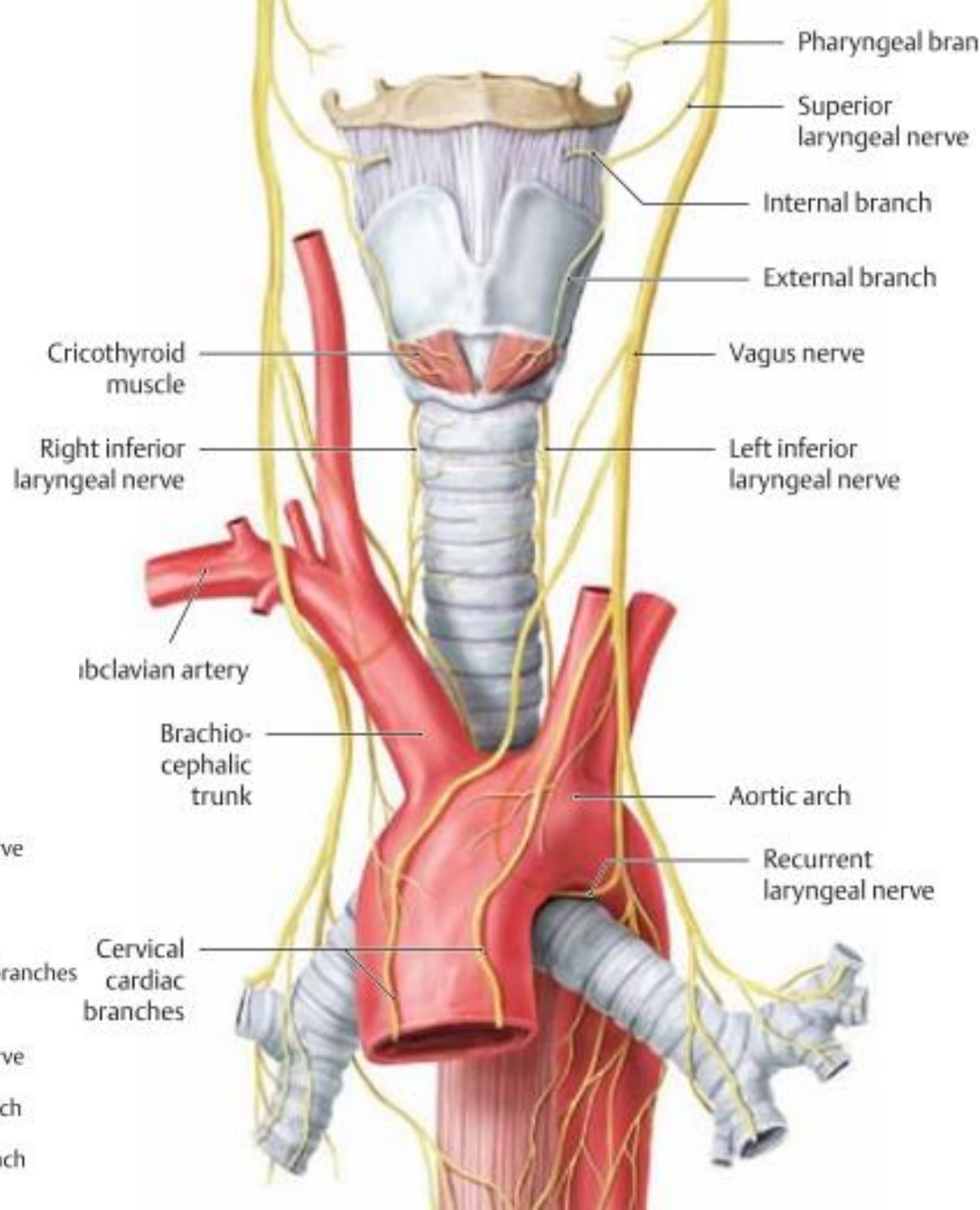
1. Cranial
   - Meningeal branch to dura mater
   - Auricular branch
2. Cervical : right and left vagus nerves enter carotid sheaths and continue to root of neck.
   - Branches
     - Pharyngeal branches to pharyngeal plexus (motor)
     - Cervical cardiac branches (parasympathetic, visceral afferent)
     - Superior laryngeal nerve (mixed) internal (sensory) and external (motor) branches
     - Right recurrent laryngeal nerve (mixed)

3. Thoracic

- enter thorax through superior thoracic aperture;
- The left and right vagal nerves form anterior and posterior vagal trunks.

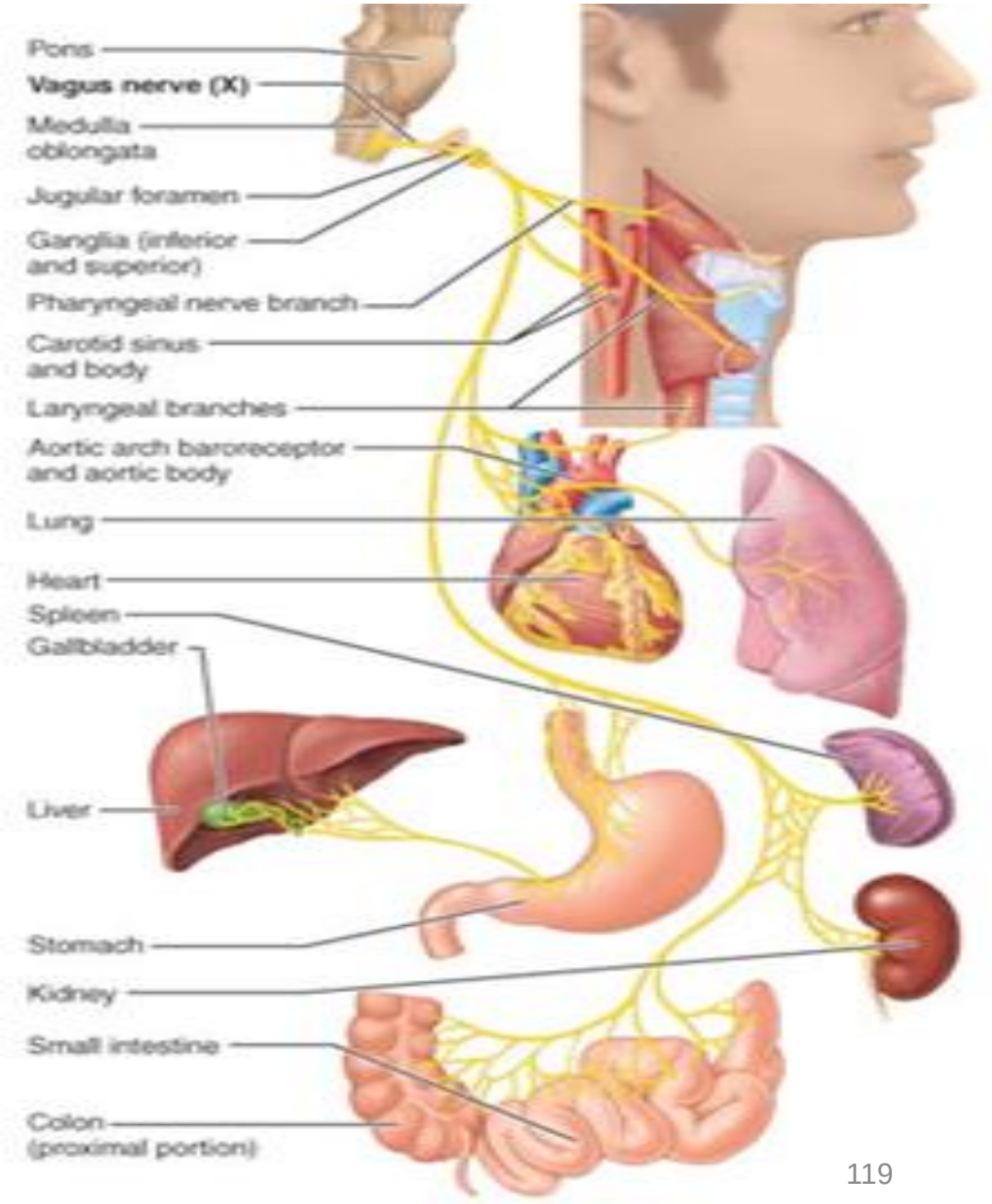
- Branches in thorax
  - Left recurrent laryngeal nerve
  - Thoracic cardiac branches
  - Pulmonary branches
  - Esophageal plexus



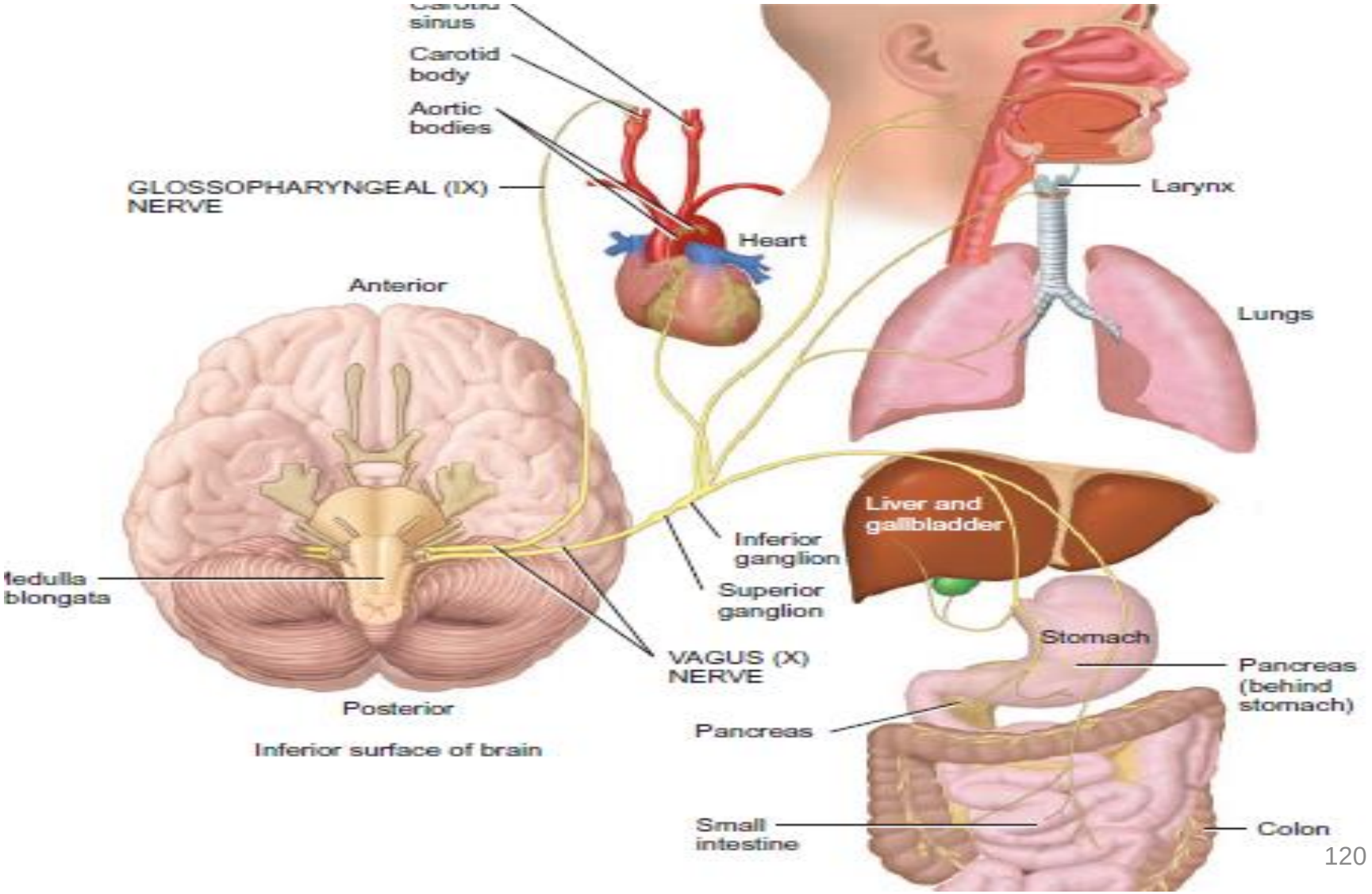


4. Abdominal

- Vagal trunks enter abdomen through esophageal hiatus in diaphragm;
  - Branches
    - Esophageal branches
    - Gastric branches
    - Hepatic branches
    - Celiac branches (from posterior vagal trunk)
    - Pyloric branch (from anterior vagal trunk)
    - Renal branches
    - Intestinal branches (to colic flexure)



- Clinical tests: test with cranial nerve IX
- Effects of damage: hoarseness or loss of voice; impaired swallowing and GI motility

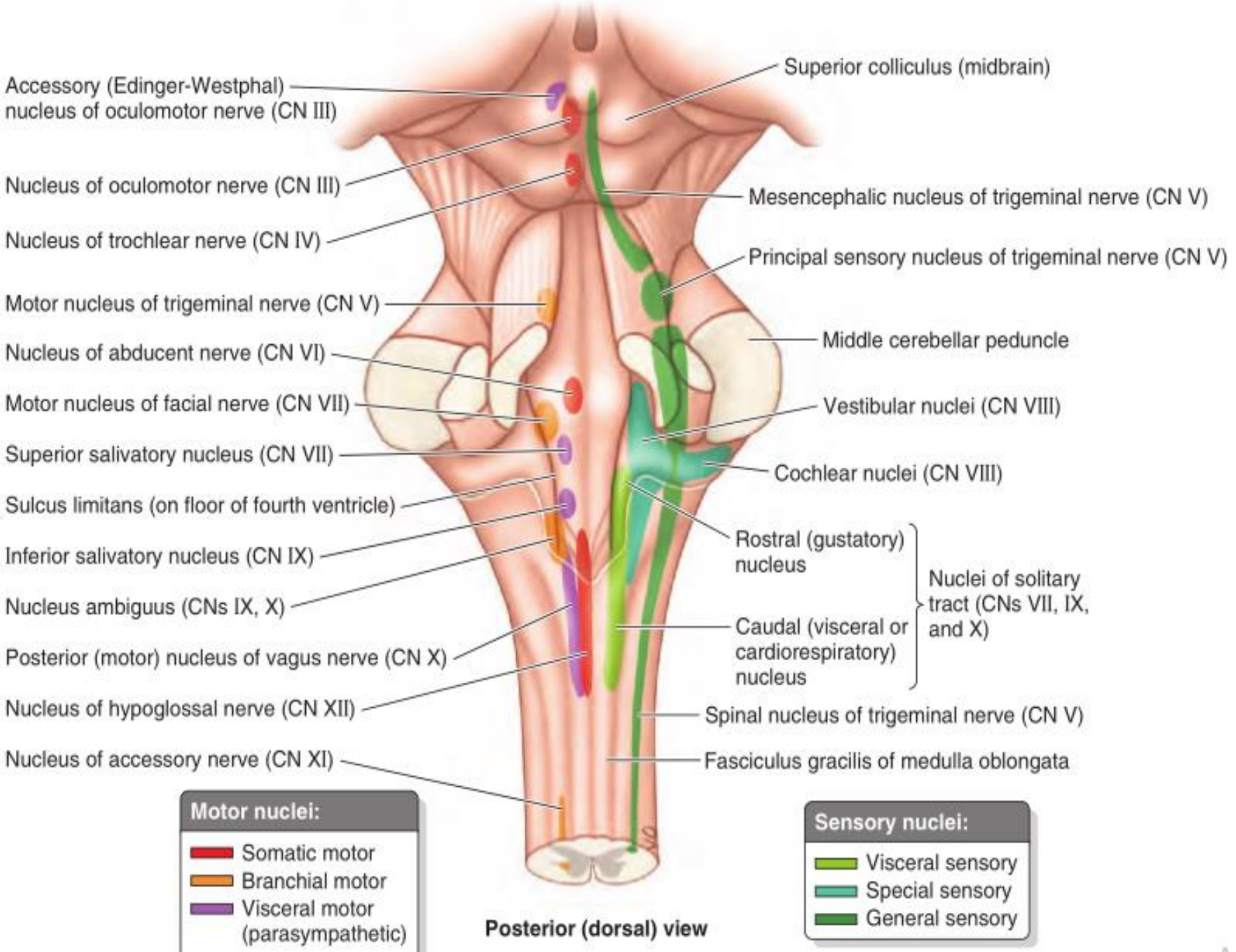


Vagus Nerve (CN-X): Clinical Aspects

- Isolated lesions of vagus nerve are uncommon.
- Injury to pharyngeal branches: ➔dysphagia (difficulty in swallowing).
- Lesions of **superior laryngeal nerve:➔** anesthesia of superior part of larynx & paralysis of cricothyroid muscle: ➔ voice is weak & tires easily.
- Injury of a **recurrent laryngeal nerve** may be caused by aneurysms of arch of aorta & during neck operations.
- Injury of **recurrent laryngeal nerve:** ➔ hoarseness & dysphonia (difficulty in speaking) because of paralysis of mm of vocal folds (cords).
- Paralysis of **both recurrent laryngeal nerves:** ➔ aphonia (loss of voice) & inspiratory stridor (a harsh, high pitched respiratory sound).

Cont.

- Because of its longer course, **lesions of left recurrent laryngeal nerve** are more common.
- Proximal lesions of CN X affect **pharyngeal & superior laryngeal nerves**, causing difficulty in swallowing & speaking.
- A simple test for integrity of the vagus relies on its innervation of muscles of soft palate.
- ➔ In unilateral paralysis, uvula deviates to the normal side when patient says 'Ahh'.


Accessory (Edinger-Westphal) nucleus of oculomotor nerve (CN III)
Nucleus of oculomotor nerve (CN III)
Nucleus of trochlear nerve (CN IV)
Motor nucleus of trigeminal nerve (CN V)
Nucleus of abducent nerve (CN VI)
Motor nucleus of facial nerve (CN VII)
Superior salivatory nucleus (CN VII)
Sulcus limitans (on floor of fourth ventricle)
Inferior salivatory nucleus (CN IX)
Nucleus ambiguus (CNs IX, X)
Posterior (motor) nucleus of vagus nerve (CN X)
Nucleus of hypoglossal nerve (CN XII)
Nucleus of accessory nerve (CN XI)
Superior colliculus (midbrain)
Mesencephalic nucleus of trigeminal nerve (CN V)
Principal sensory nucleus of trigeminal nerve (CN V)
Middle cerebellar peduncle
Vestibular nuclei (CN VIII)
Cochlear nuclei (CN VIII)
Rostral (gustatory) nucleus
Caudal (visceral or cardiorespiratory) nucleus
Nuclei of solitary tract (CNs VII, IX, and X)
Spinal nucleus of trigeminal nerve (CN V)
Fasciculus gracilis of medulla oblongata
Motor nuclei:
Somatic motor
Branchial motor
Visceral motor (parasympathetic)
Sensory nuclei:
Visceral sensory
Special sensory
General sensory
Posterior (dorsal) view

Nucleus	Pre-ganglionic	Ganglion	Post-ganglionic	Target organs
Edinger-Westphal (Oculomotor nerve)	Travels within the motor root of the oculomotor nerve	Ciliary ganglion	Travels via short ciliary nerves	Sphincter pupillae Ciliary muscles
Superior salivatory nucleus (Facial nerve)	Travels within the greater petrosal nerve and nerve of pterygoid canal	Ptergyopalantine ganglion	Hitchhikes on branches of the maxillary nerve	Lacrimal gland Nasopharynx Palate Nasal cavity
	Travels within the chorda tympani, a branch of the facial nerve	Submandibular ganglion	Fibres travel directly to target organs.	Sublingual and submandibular glands
Inferior salivatory nucleus (Glossopharyngeal nerve)	Travels within the lesser petrosal nerve	Otic ganglion	Hitchhikes on the auriculotemporal nerve	Parotid gland

FIGURE 9.4. Summary of cranial parasympathetic ganglia.