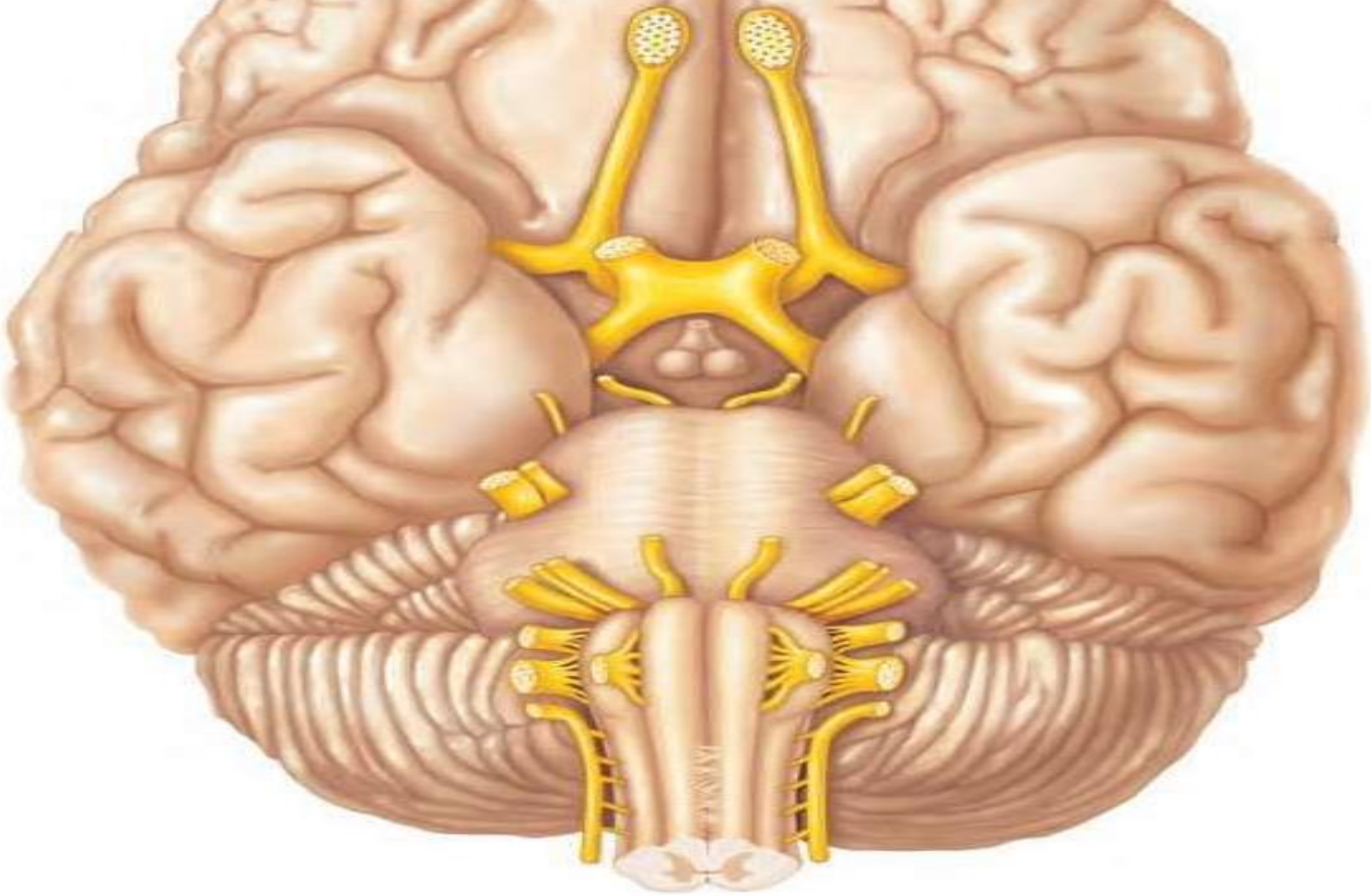
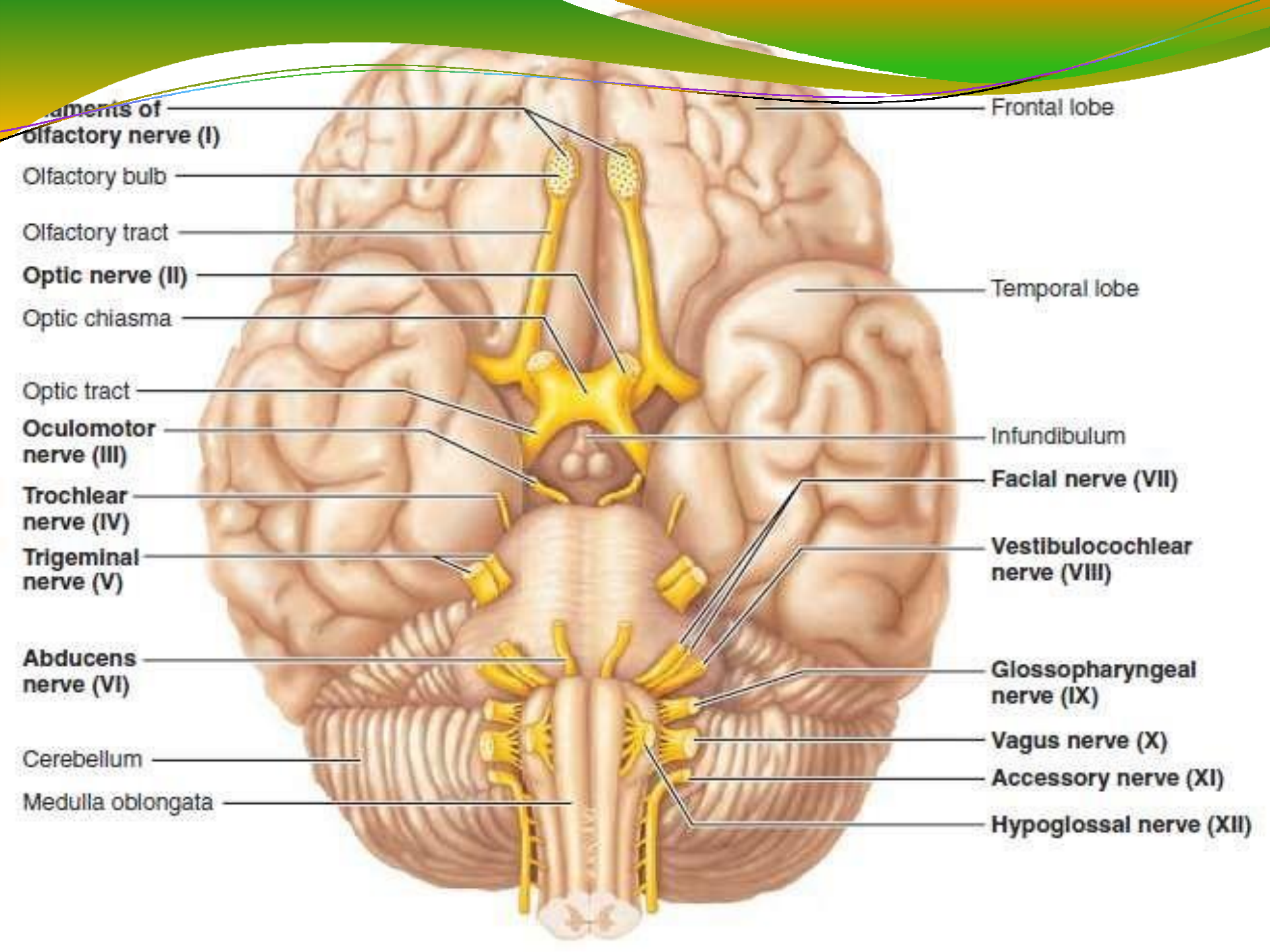
Cranial Nerves



Cranial Nerves

- Twelve pairs of **cranial nerves are associated with the brain**
- The first two pairs attach to the forebrain, and the rest are associated with the brain stem.
- Other than the vagus nerves, which extend into the abdomen, cranial nerves serve only head and neck structures.

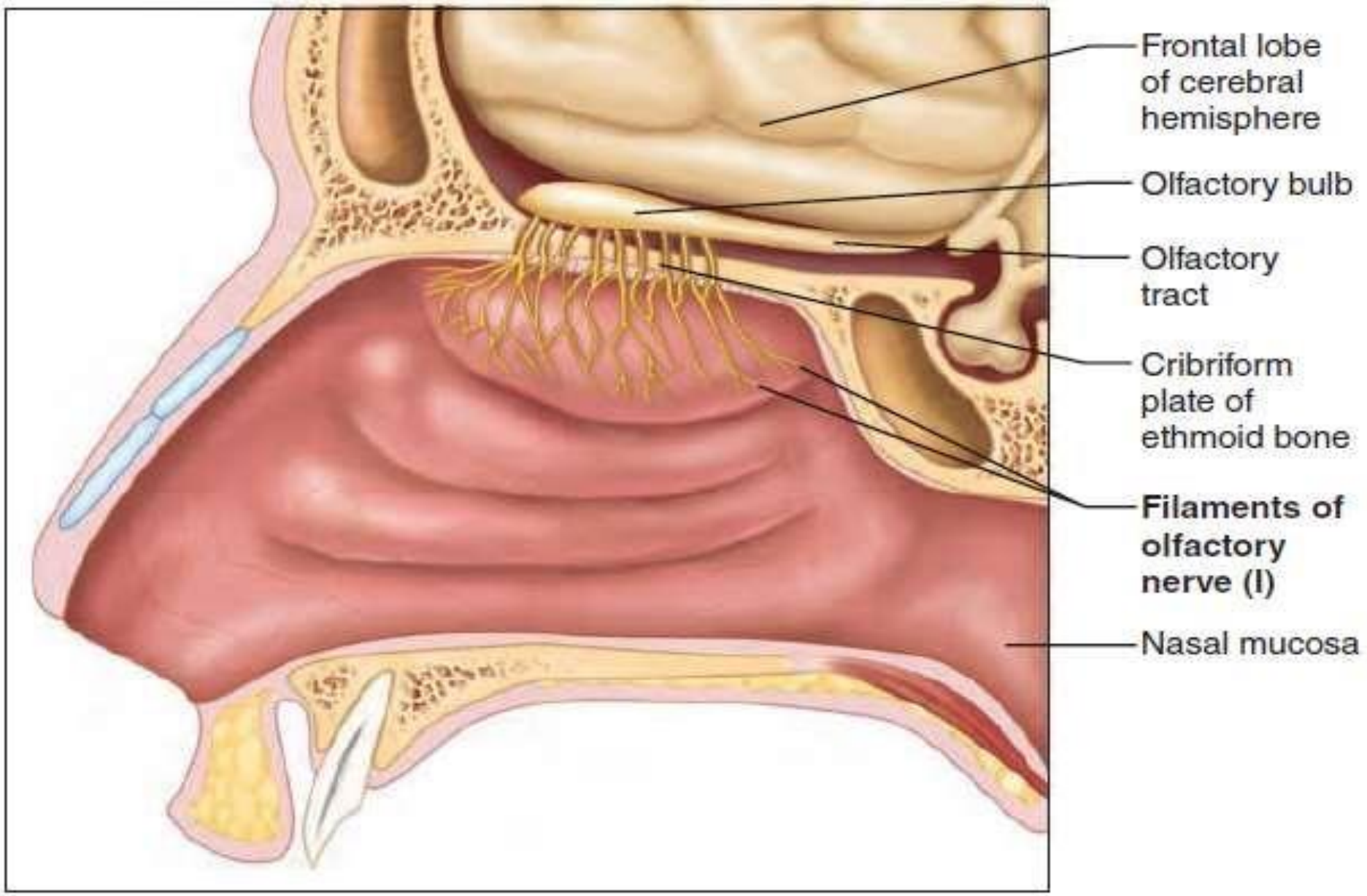

aments of
olfactory nerve (I)
Olfactory bulb
Olfactory tract
Optic nerve (II)
Optic chiasma
Optic tract
Oculomotor nerve (III)
Trochlear nerve (IV)
Trigeminal nerve (V)
Abducens nerve (VI)
Cerebellum
Medulla oblongata
Frontal lobe
Temporal lobe
Infundibulum
Facial nerve (VII)
Vestibulocochlear nerve (VIII)
Glossopharyngeal nerve (IX)
Vagus nerve (X)
Accessory nerve (XI)
Hypoglossal nerve (XII)

Cranial nerves	Sensory function	Motor function	PS* fibers
I Olfactory	Yes (smell)	No	No
II Optic	Yes (vision)	No	No
III Oculomotor	No	Yes	Yes
IV Trochlear	No	Yes	No
V Trigeminal	Yes (general sensation)	Yes	No
VI Abducens	No	Yes	No
VII Facial	Yes (taste)	Yes	Yes
VIII Vestibulocochlear	Yes (hearing and balance)	Some	No
IX Glossopharyngeal	Yes (taste)	Yes	Yes
X Vagus	Yes (taste)	Yes	Yes
XI Accessory	No	Yes	No
XII Hypoglossal	No	Yes	No

*PS = parasympathetic

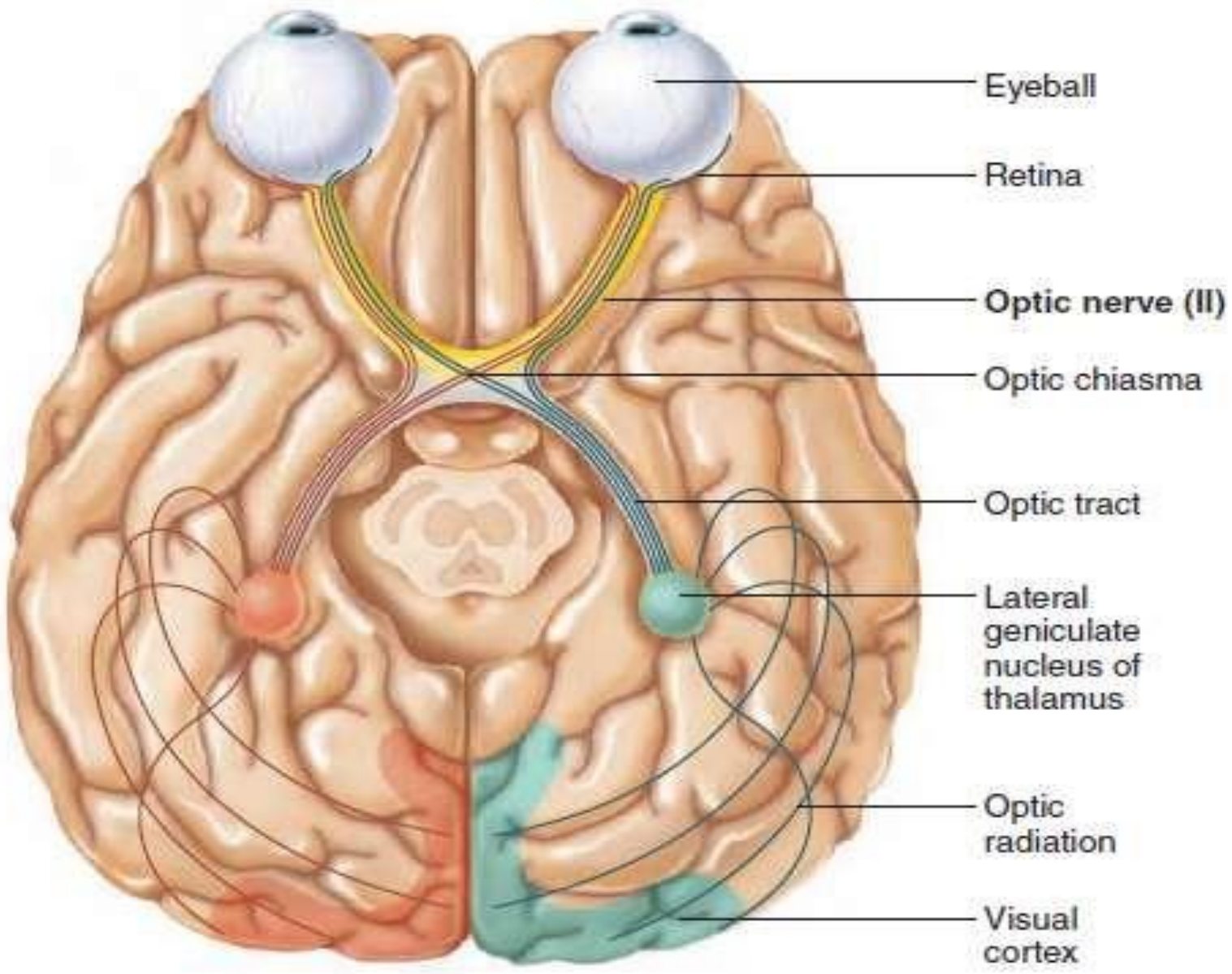
I. Olfactory

- These are the tiny sensory nerves (filaments) of smell, which run from the nasal mucosa to synapse with the olfactory bulbs.
- **Origin and course: Olfactory nerve fibers arise from** olfactory sensory neurons located in olfactory epithelium of nasal cavity and pass through cribriform plate of ethmoid bone to synapse in olfactory bulb. Fibers of olfactory bulb neurons extend posteriorly as olfactory tract, which runs beneath frontal lobe to enter cerebral hemispheres and terminates in primary olfactory cortex.
- **Function: Purely sensory; carry afferent impulses for** sense of smell.
- **Clinical testing: Ask subject to sniff and identify aromatic** substances, such as oil of cloves and vanilla.
- **Applied Anatomy:- Fracture of** ethmoid bone or lesions of olfactory fibers may result in partial or total loss of smell, a condition known as *anosmia*


Frontal lobe of cerebral hemisphere
Olfactory bulb
Olfactory tract
Cribriform plate of ethmoid bone
Filaments of olfactory nerve (I)
Nasal mucosa

II. Optic.

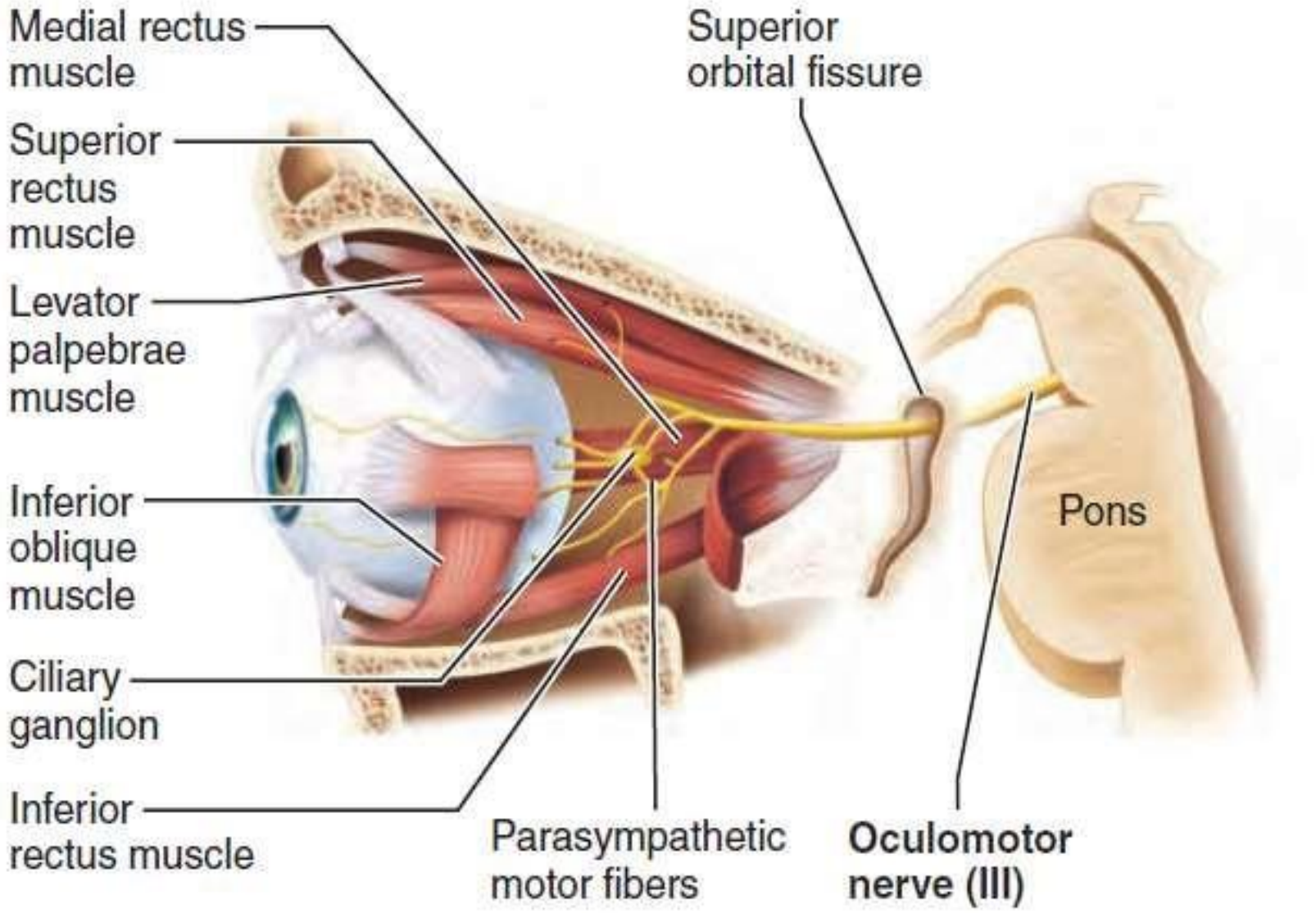
- **Origin and course:** Fibers arise from retina of eye to form optic nerve, which passes through optic canal of orbit. The optic nerves converge to form the optic chiasma where fibers partially cross over, continue on as optic tracts, enter thalamus, and synapse there.
- Thalamic fibers run (as the optic radiation) to occipital (visual)
  cortex, where visual interpretation occurs.
- **Function:** Purely sensory; carry afferent impulses for vision.
- **Clinical testing:** Assess vision and visual field with eye
- **Applied Anatomy:-** Damage to optic nerve results in blindness in eye served by nerve. Damage to visual pathway beyond the optic chiasma results in partial visual losses. Visual defects are called *anopsias*


Eyeball
Retina
Optic nerve (II)
Optic chiasma
Optic tract
Lateral geniculate nucleus of thalamus
Optic radiation
Visual cortex

III Oculomotor Nerves

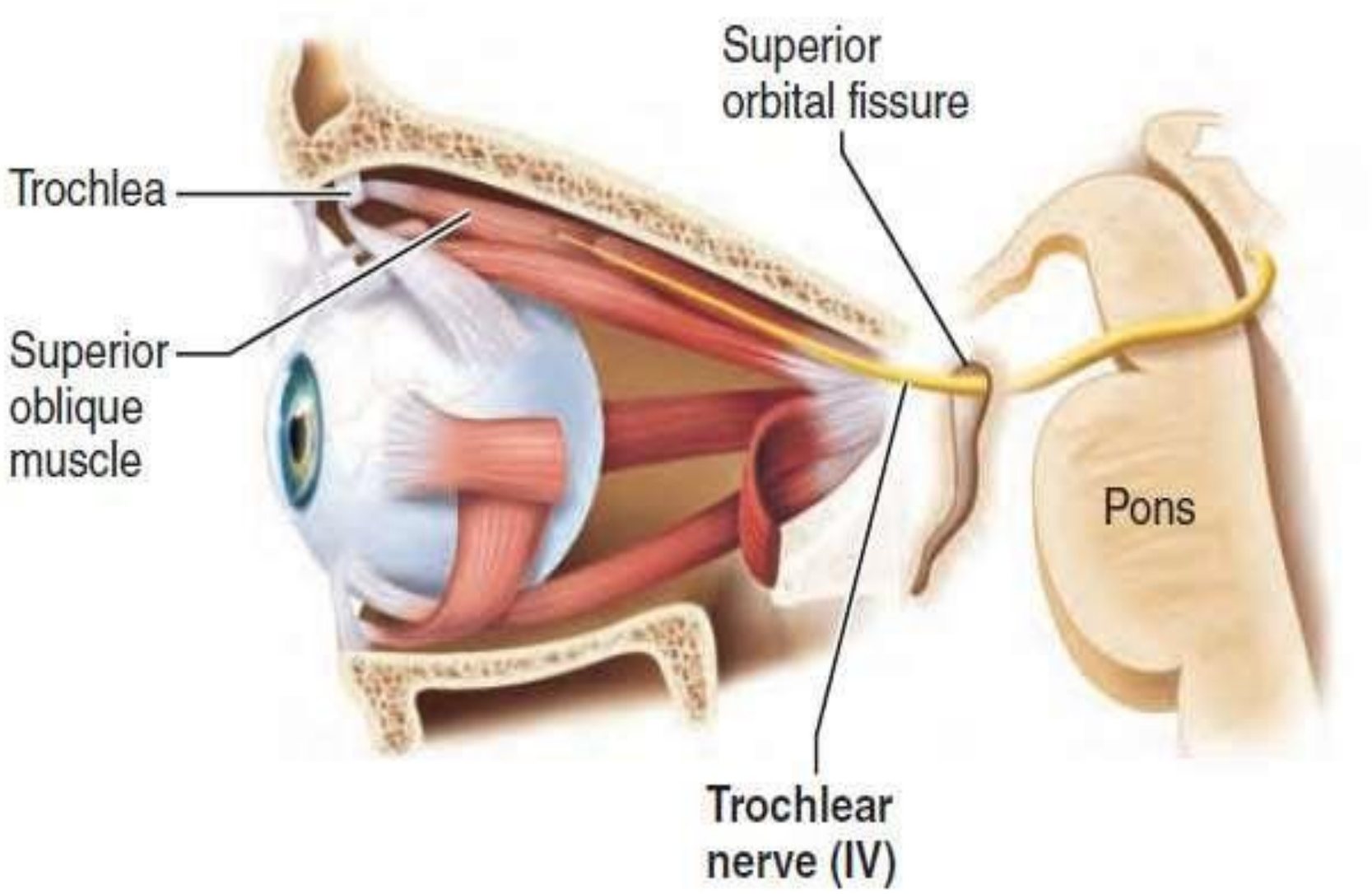
- **Origin and course:** Fibers extend from ventral midbrain and pass through bony orbit, via superior orbital fissure, to eye.
- **Function:** Each nerve includes the following:
  - Somatic motor fibers to four of the six extrinsic eye muscles (inferior oblique and superior, inferior, and medial rectus muscles) that help direct eyeball, and to levator palpebrae superioris muscle, which raises upper eyelid.
  - Parasympathetic (autonomic) motor fibers to sphincter pupillae (circular muscles of iris), which cause pupil to constrict, and to ciliary muscle, controlling lens shape for visual focusing. Some parasympathetic cell bodies are in the ciliary ganglia.
  - Sensory (proprioceptor) afferents, which run from same four extrinsic eye muscles to midbrain.

- **Clinical testing: Examine pupils for size, shape, and equality.** Test pupillary reflex with penlight. Test convergence for near vision and subject's ability to follow objects with the eyes.
- **Applied anatomy:- In oculomotor nerve** paralysis, eye cannot be moved up, down, or inward. At rest, eye rotates laterally [external strabismus] because the actions of the two extrinsic eye muscles not served by cranial nerves III are unopposed. Upper eyelid droops (ptosis), and the person has double vision and trouble focusing on close objects.


Medial rectus muscle
Superior rectus muscle
Levator palpebrae muscle
Inferior oblique muscle
Ciliary ganglion
Inferior rectus muscle
Superior orbital fissure
Pons
Parasympathetic motor fibers
Oculomotor nerve (III)

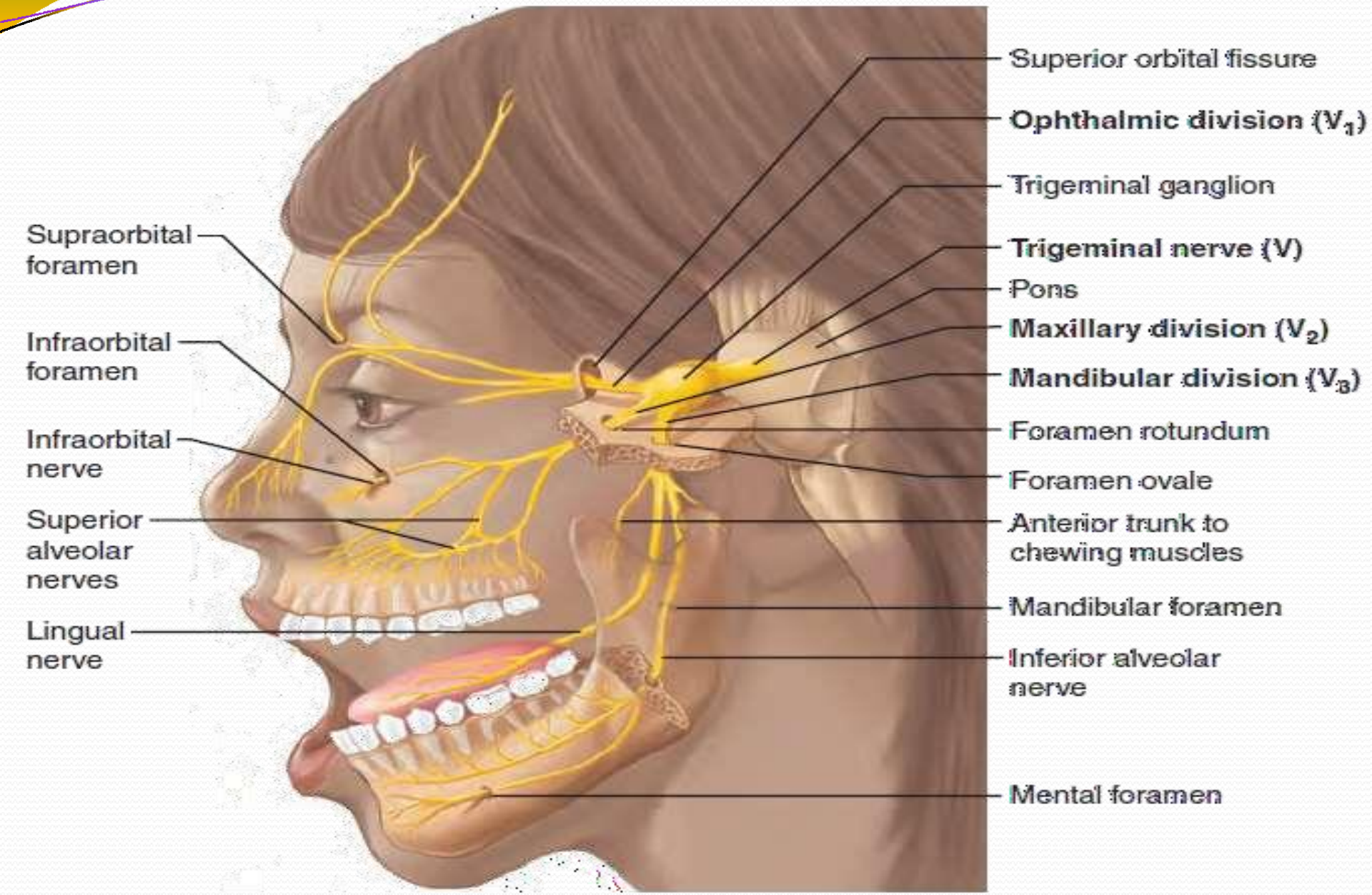
IV Trochlear Nerves

- **Origin and course: Fibers emerge from dorsal midbrain and course** ventrally around midbrain to enter orbit through superior orbital fissure along with oculomotor nerves.
- **Function:** Primarily motor nerves; supply somatic motor fibers to (carry proprioceptor fibers from) one of the extrinsic eye muscles, the superior oblique muscle, which passes through the pulley-shaped trochlea.
- **Clinical testing:** Test with cranial nerve III (oculomotor).
- **Applied Anatomy:** Damage to a trochlear nerve results in double vision and impairs ability to rotate eye inferolaterally.


Superior
orbital fissure
Trochlea
Superior
oblique
muscle
Pons
Trochlear
nerve (IV)

V Trigeminal Nerves

- Largest cranial nerves; fibers extend from pons to face, and form three divisions (*trigemina 5 threefold):*
  - *Ophthalmic*
  - *maxillary,*
  - mandibular
- As main general sensory nerves of face, transmit afferent impulses from touch, temperature, and pain receptors. Cell bodies of sensory neurons of all three divisions are located in large *trigeminal ganglion.*
- The mandibular division also contains motor fibers that innervate chewing muscles.


Supraorbital foramen
Infraorbital foramen
Infraorbital nerve
Superior alveolar nerves
Lingual nerve
Superior orbital fissure
Ophthalmic division (V_1)
Trigeminal ganglion
Trigeminal nerve (V)
Pons
Maxillary division (V_2)
Mandibular division (V_3)
Foramen rotundum
Foramen ovale
Anterior trunk to chewing muscles
Mandibular foramen
Inferior alveolar nerve
Mental foramen

Ophthalmic division (V1)

- **Origin and course:-Fibers run from face to pons** via superior orbital fissure.
- **Function Conveys:-** sensory impulses from skin of anterior scalp, upper eyelid, and nose, and from nasal cavity mucosa, cornea, and lacrimal gland.
- **Clinical testing Corneal reflex test:-** Touching cornea with wisp of cotton should elicit blinking.

Maxillary division (V2)

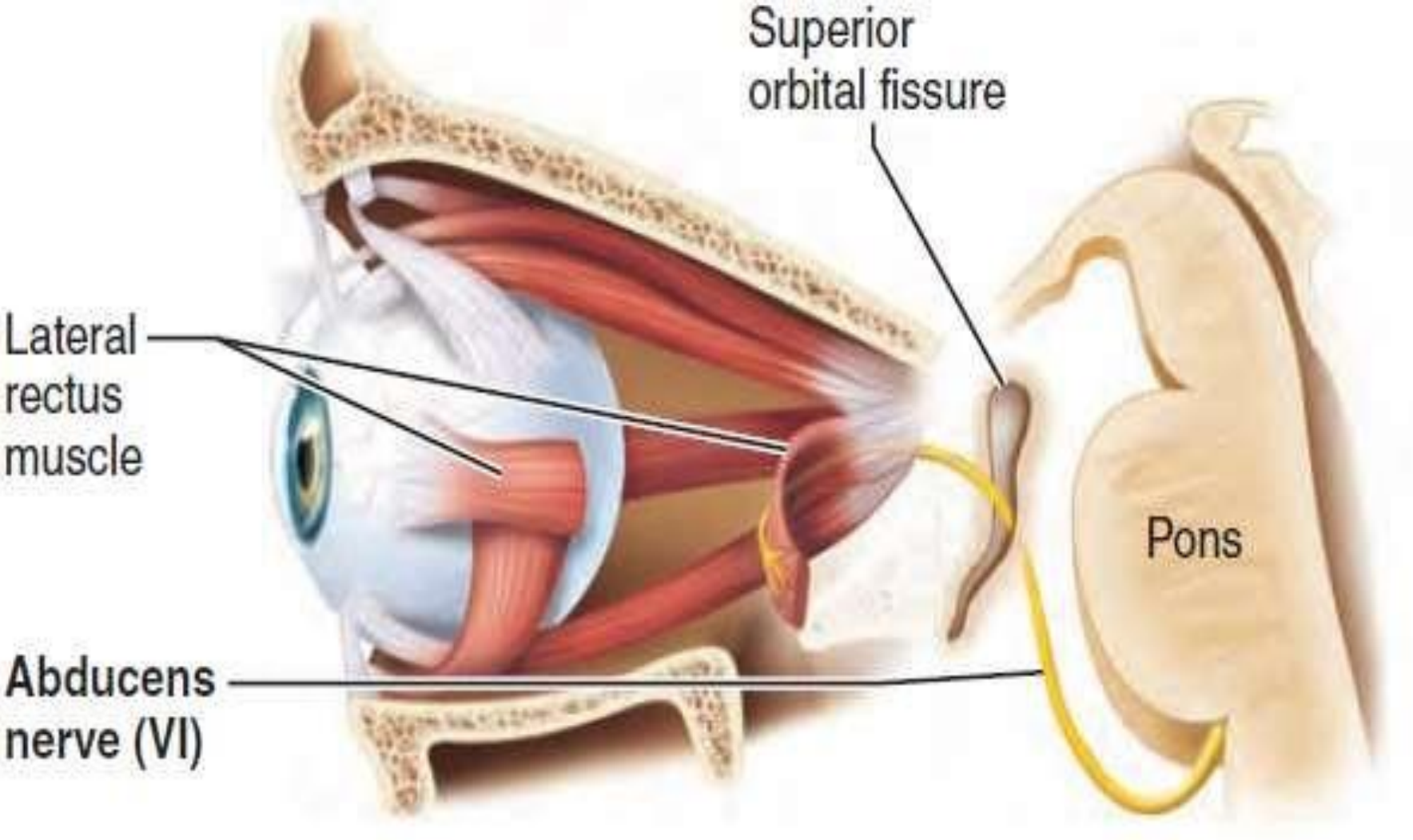
- **Origin and course:-** Fibers run from face to pons via foramen rotundum.
- **Function Conveys:-** Conveys sensory impulses from nasal cavity mucosa, palate, upper teeth, skin of cheek, upper lip, lower eyelid.
- **Clinical testing Corneal reflex test:-** Test sensations of pain, touch, and temperature with safety pin and hot and cold objects.

Mandibular division (V3)

- **Origin and course:-** Fibers pass through skull via foramen ovale.
- **Function:-** Conveys sensory impulses from anterior 2/3 tongue (except taste buds), lower teeth, skin of chin, temporal region of scalp. Supplies motor fibers to, and carries proprioceptor fibers from, muscles of mastication.
- **Clinical testing Corneal reflex test:-** Assess motor branch by asking person to clench his teeth, open mouth against resistance, and move jaw side to side.

VI Abducens Nerves

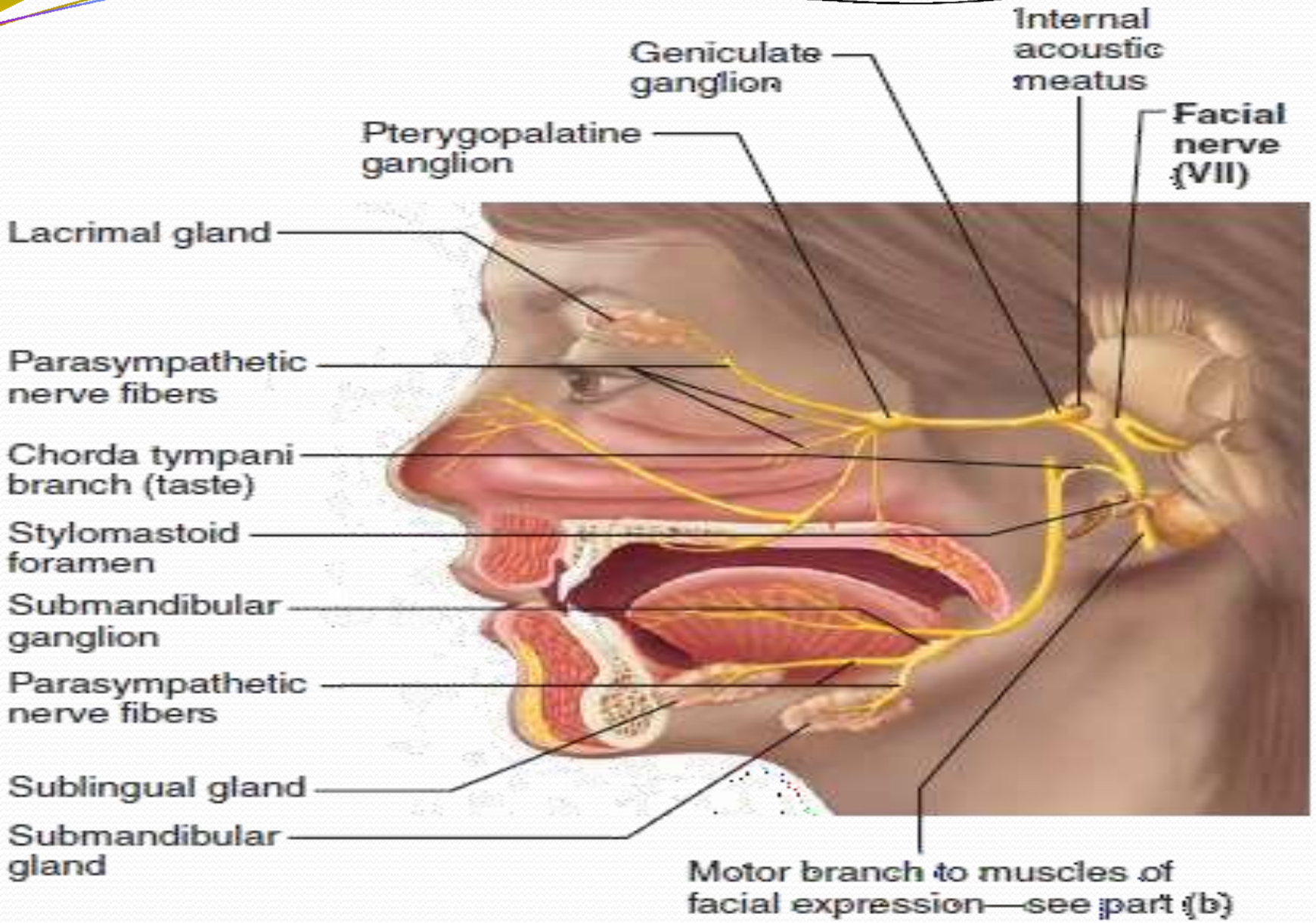
- **Origin and course:** Fibers leave inferior pons and enter orbit via superior orbital fissure to run to eye.
- **Function:** Primarily motor; supply somatic motor fibers to lateral rectus muscle, an extrinsic muscle of the eye. Convey proprioceptor impulses from same muscle to brain.
- **Clinical testing: Test in common with cranial nerve III (oculomotor).**
- **Applied Anatomy: In abducens nerve** paralysis, eye cannot be moved laterally. At rest, eyeball rotates medially *(internal strabismus).*


Superior
orbital fissure
Lateral
rectus
muscle
Pons
Abducens
nerve (VI)

VII Facial Nerves

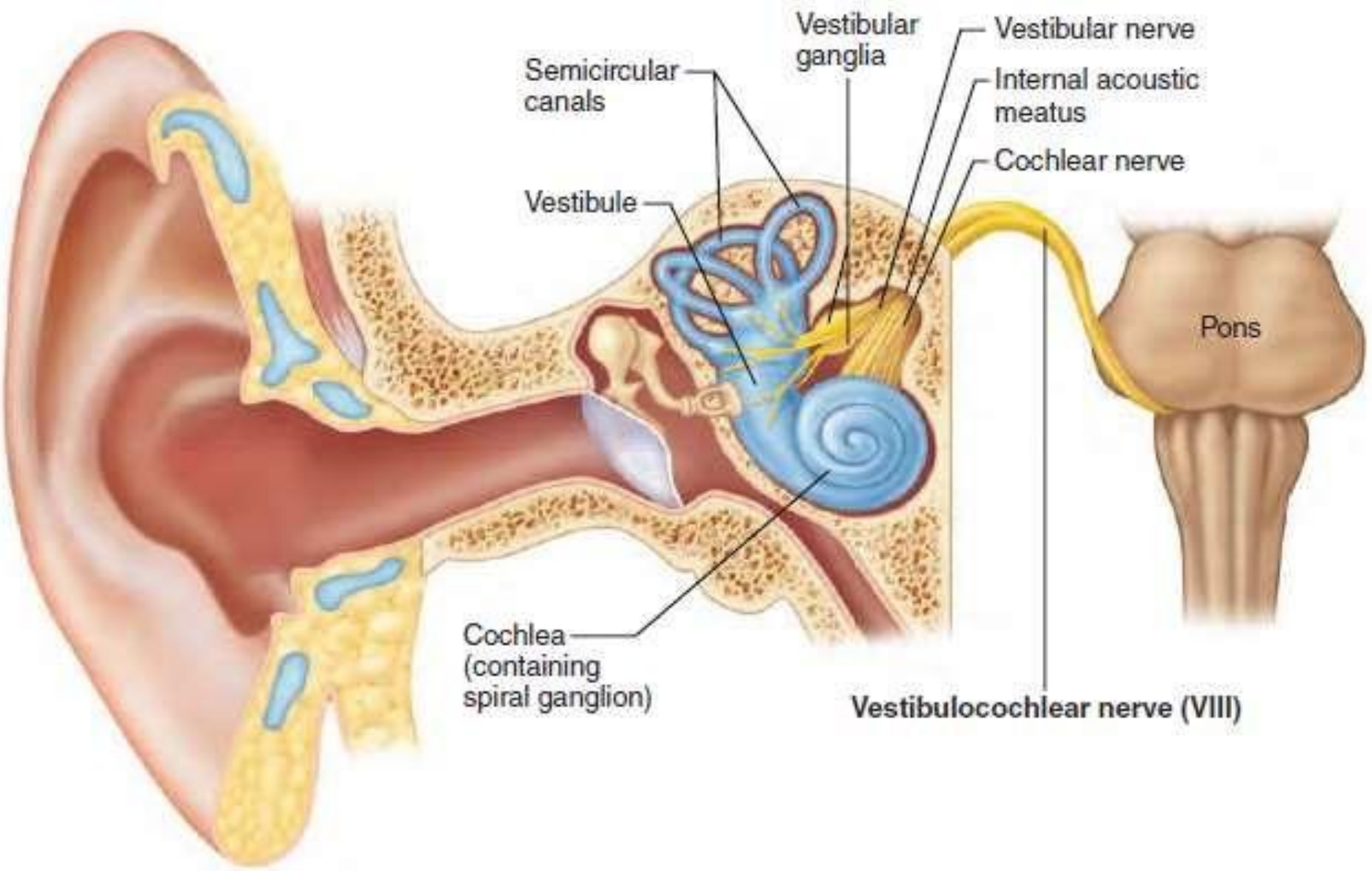
- **Origin and course:** Fibers issue from pons, just lateral to abducens nerves enter temporal bone via internal acoustic meatus, and run within bone (and through inner ear cavity) before emerging through stylomastoid foramen. Nerve then courses to lateral aspect of face.
- **Function:** Mixed nerves that are the chief motor nerves of face. Five major branches: temporal, zygomatic, buccal, mandibular, and cervical
  - Convey motor impulses to skeletal muscles of face (muscles of facial expression), except for chewing muscles served by trigeminal nerves, and transmit proprioceptor impulses from same muscles to pons.
  - Transmit parasympathetic (autonomic) motor impulses to lacrimal (tear) glands, nasal and palatine glands, and submandibular and sublingual salivary glands. Some of the cell bodies of these parasympathetic motor neurons are in pterygopalatine and submandibular ganglia on the trigeminal nerve.
  - Convey sensory impulses from taste buds of anterior two-thirds of tongue; cell bodies of these sensory neurons are in geniculate ganglion.

- **Clinical testing:** Test anterior two-thirds of tongue for ability to taste sweet (sugar), salty, sour (vinegar), and bitter (quinine) substances. Check symmetry of face. Ask subject to close eyes, smile, whistle, and so on. Assess tearing with ammonia fumes.
- **Applied Anatomy:-** Bell's palsy is characterized by paralysis of facial muscles on affected side and partial loss of taste sensation.


Geniculate ganglion
Internal acoustic meatus
Facial nerve (VII)
Pterygopalatine ganglion
Lacrimal gland
Parasympathetic nerve fibers
Chorda tympani branch (taste)
Stylomastoid foramen
Submandibular ganglion
Parasympathetic nerve fibers
Sublingual gland
Submandibular gland
Motor branch to muscles of facial expression—see part (b)

VIII Vestibulocochlear Nerves

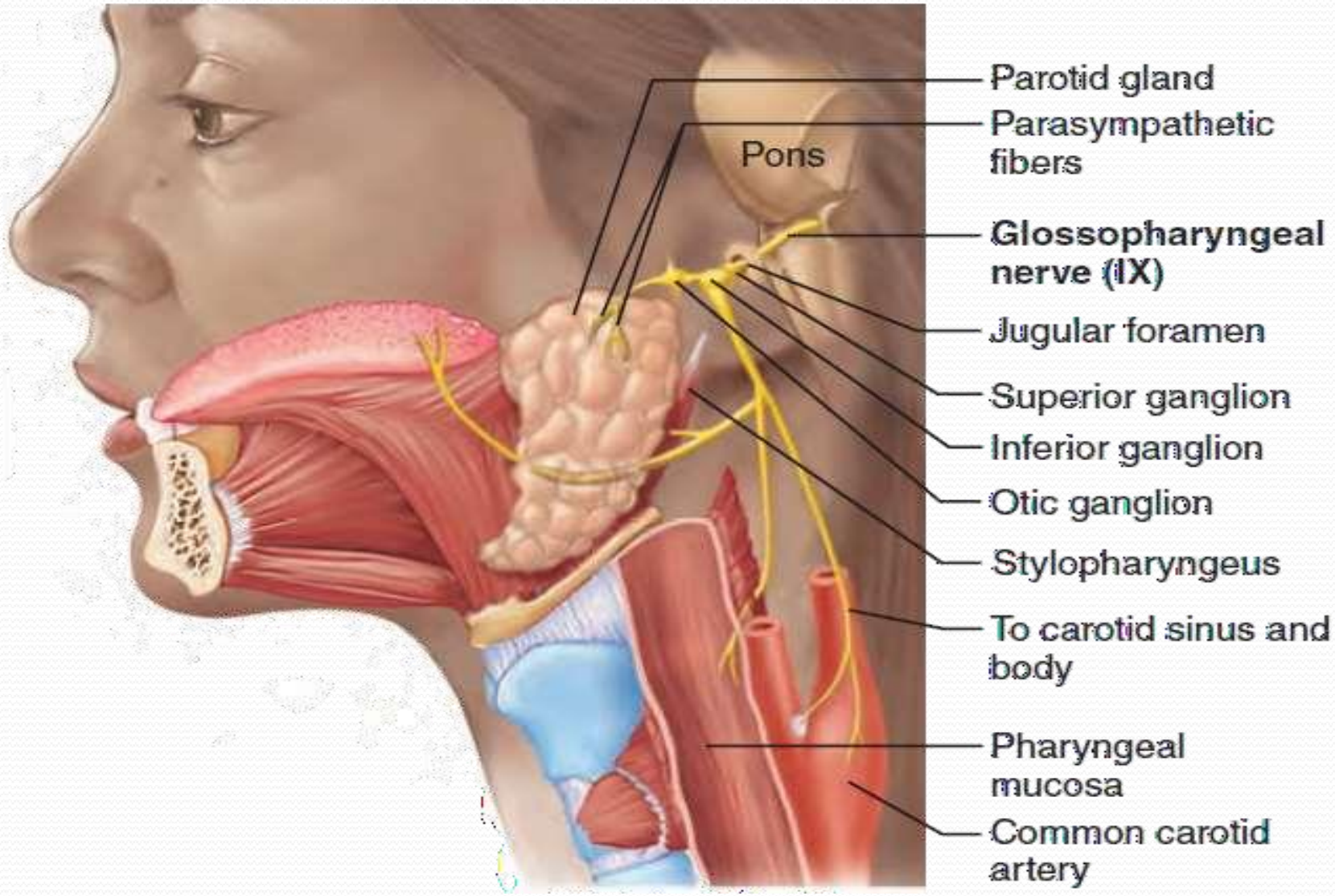
- **Origin and course: Fibers arise from** hearing and equilibrium apparatus located within inner ear of temporal bone and pass through internal acoustic meatus to enter brain stem at pons-medulla border. Afferent fibers from hearing receptors in cochlea form the cochlear division; those from equilibrium receptors in semicircular canals and vestibule form the vestibular division (vestibular nerve). The two divisions merge to form vestibulocochlear nerve.
- **Function: Mostly sensory. Vestibular** branch transmits afferent impulses for sense of equilibrium, and sensory nerve cell bodies are located in vestibular ganglia. Cochlear branch transmits afferent impulses for sense of hearing, and sensory nerve cell bodies are located in spiral ganglion within cochlea. Small motor component adjusts the sensitivity of sensory receptors.
- **Clinical testing: Check hearing by air** and bone conduction using tuning fork.
- **Applied Anatomy:- Lesions of cochlear** nerve or cochlear receptors result in central, or nerve, deafness. Damage to vestibular division produces dizziness, rapid involuntary eye movements, loss of balance, nausea, and vomiting.


Vestibular ganglia
Vestibular nerve
Semicircular canals
Internal acoustic meatus
Cochlear nerve
Vestibule
Pons
Cochlea (containing spiral ganglion)
Vestibulocochlear nerve (VIII)

IX Glossopharyngeal Nerves

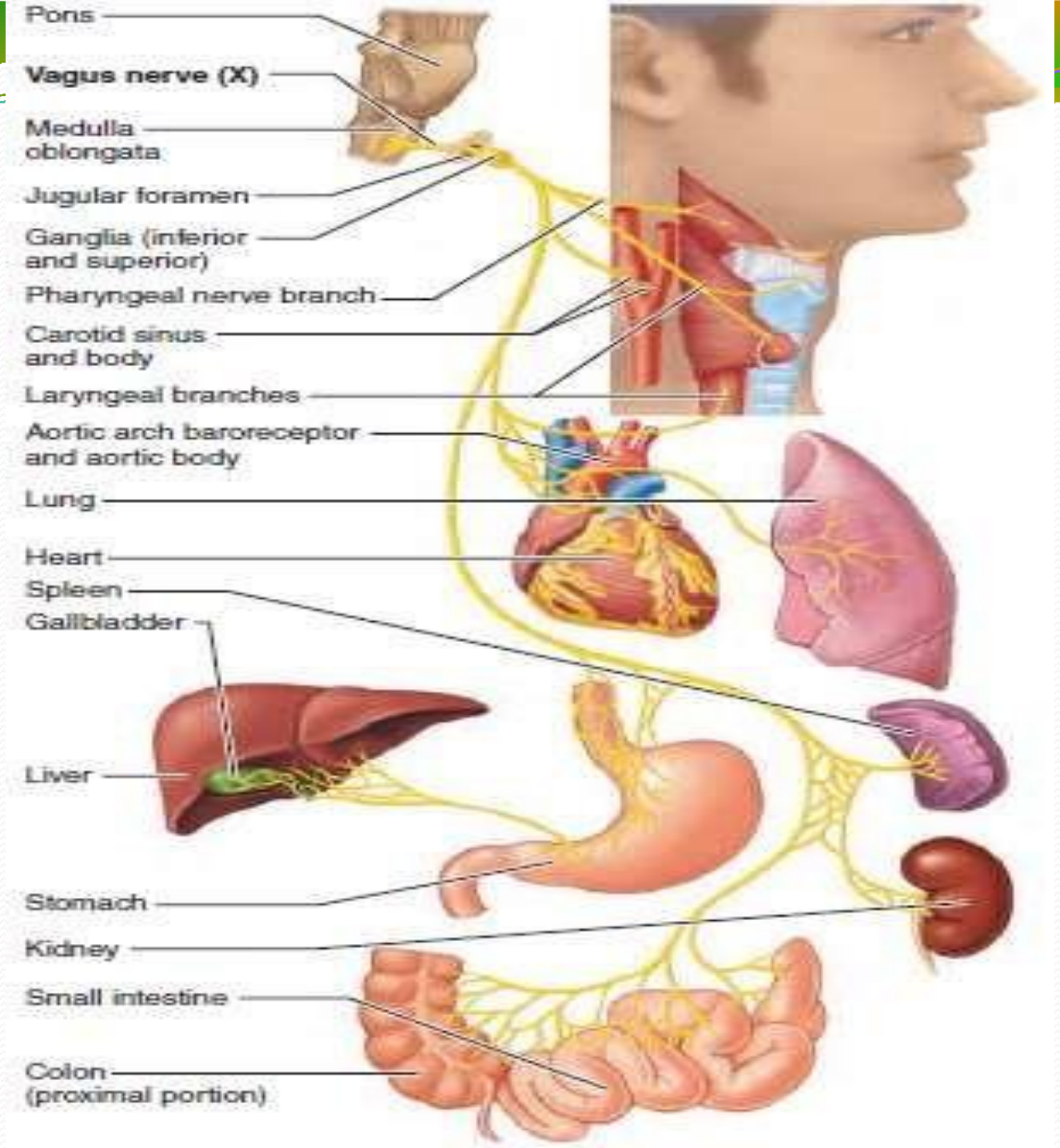
- **Origin and course:** Fibers emerge from medulla and leave skull via jugular foramen to run to throat.
- **Function:** Mixed nerves that innervate part of tongue and pharynx**.** Provide somatic motor fibers to, and carry proprioceptor fibers from, a superior pharyngeal muscle called the stylopharyngeus, which elevates the pharynx in swallowing. Provide parasympathetic motor fibers to parotid salivary glands. **Sensory fibers** conduct taste and general sensory (touch, pressure, pain) impulses from pharynx and posterior tongue, from **chemoreceptors** in the carotid body (which monitor O_2 and CO_2 levels in the blood and help regulate respiratory rate and depth), and from baroreceptors of carotid sinus (which monitor blood pressure). Sensory neuron cell bodies are located in superior and inferior ganglia.
- **Clinical testing:** Check position of uvula; check gag and swallowing reflexes.

  Ask subject to speak and cough. Test posterior third of tongue for taste.
- **Applied Anatomy:-** Injured or inflamed glossopharyngeal nerves impair swallowing and taste.


Parotid gland
Parasympathetic fibers
Pons
Glossopharyngeal nerve (IX)
Jugular foramen
Superior ganglion
Inferior ganglion
Otic ganglion
Stylopharyngeus
To carotid sinus and body
Pharyngeal mucosa
Common carotid artery

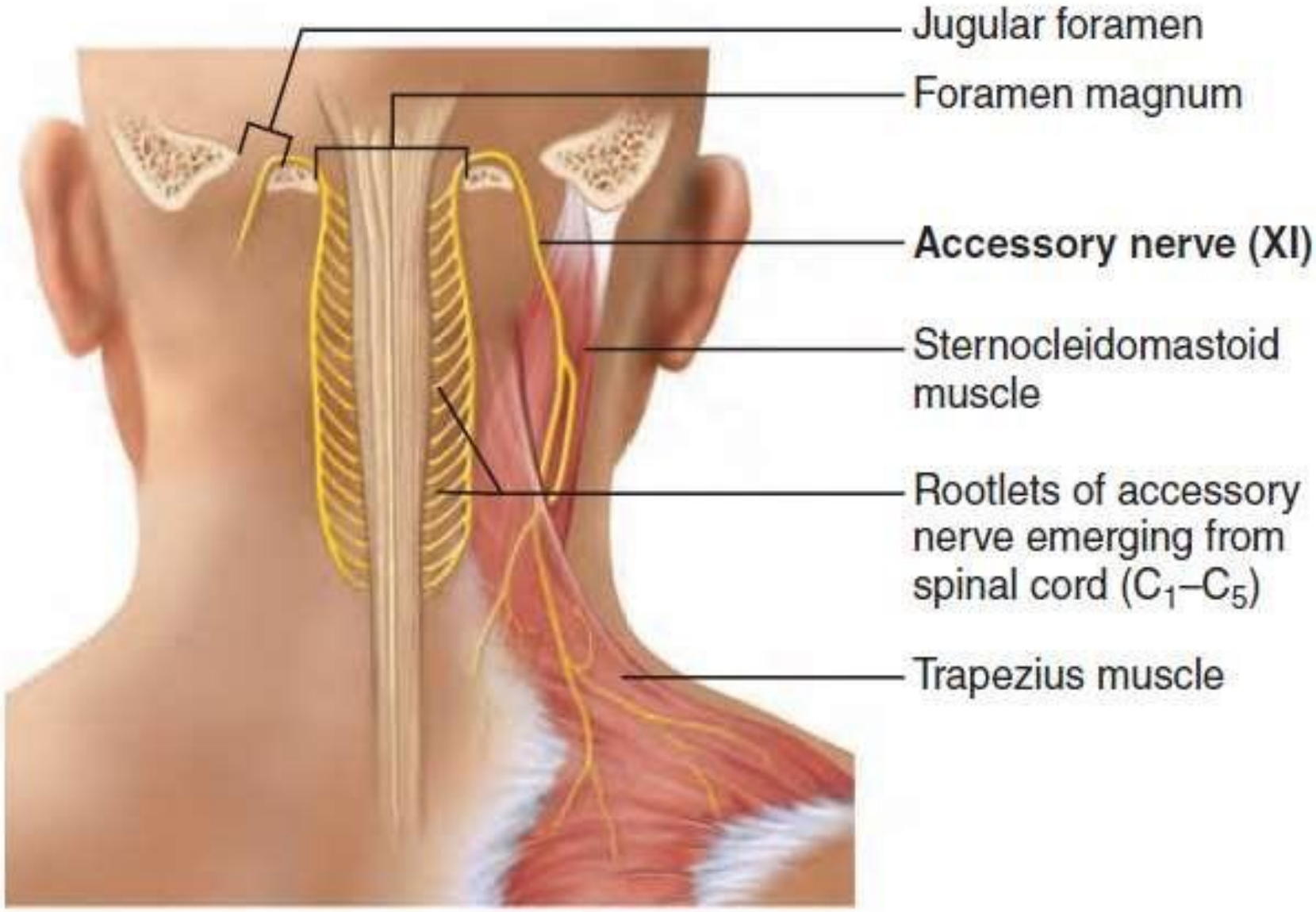
X Vagus Nerves

- **Origin and course:** The only cranial nerves to extend beyond head and neck region. Fibers emerge from medulla, pass through skull via jugular foramen, and descend through neck region into thorax and abdomen.
- **Function:** Mixed nerves. Nearly all motor fibers are parasympathetic efferents, except those serving skeletal muscles of pharynx and larynx. Parasympathetic motor fibers supply heart, lungs, and abdominal viscera and are involved in regulating heart rate, breathing, and digestive system activity. Transmit sensory impulses from thoracic and abdominal viscera, from the aortic arch baroreceptors (for blood pressure) and the carotid and aortic bodies (chemoreceptors for respiration), and taste buds on the epiglottis. Carry proprioceptor fibers from muscles of larynx and pharynx.
- **Clinical testing**: As for cranial nerve IX.
- **Applied Anatomy:- Since laryngeal branches** of the vagus innervate nearly all muscles of the larynx, vagal nerve paralysis can lead to hoarseness or loss of voice.
  - Other symptoms are difficulty swallowing and impaired digestive system motility.


Pons
Vagus nerve (X)
Medulla oblongata
Jugular foramen
Ganglia (inferior and superior)
Pharyngeal nerve branch
Carotid sinus and body
Laryngeal branches
Aortic arch baroreceptor and aortic body
Lung
Heart
Spleen
Gallbladder
Liver
Stomach
Kidney
Small intestine
Colon (proximal portion)

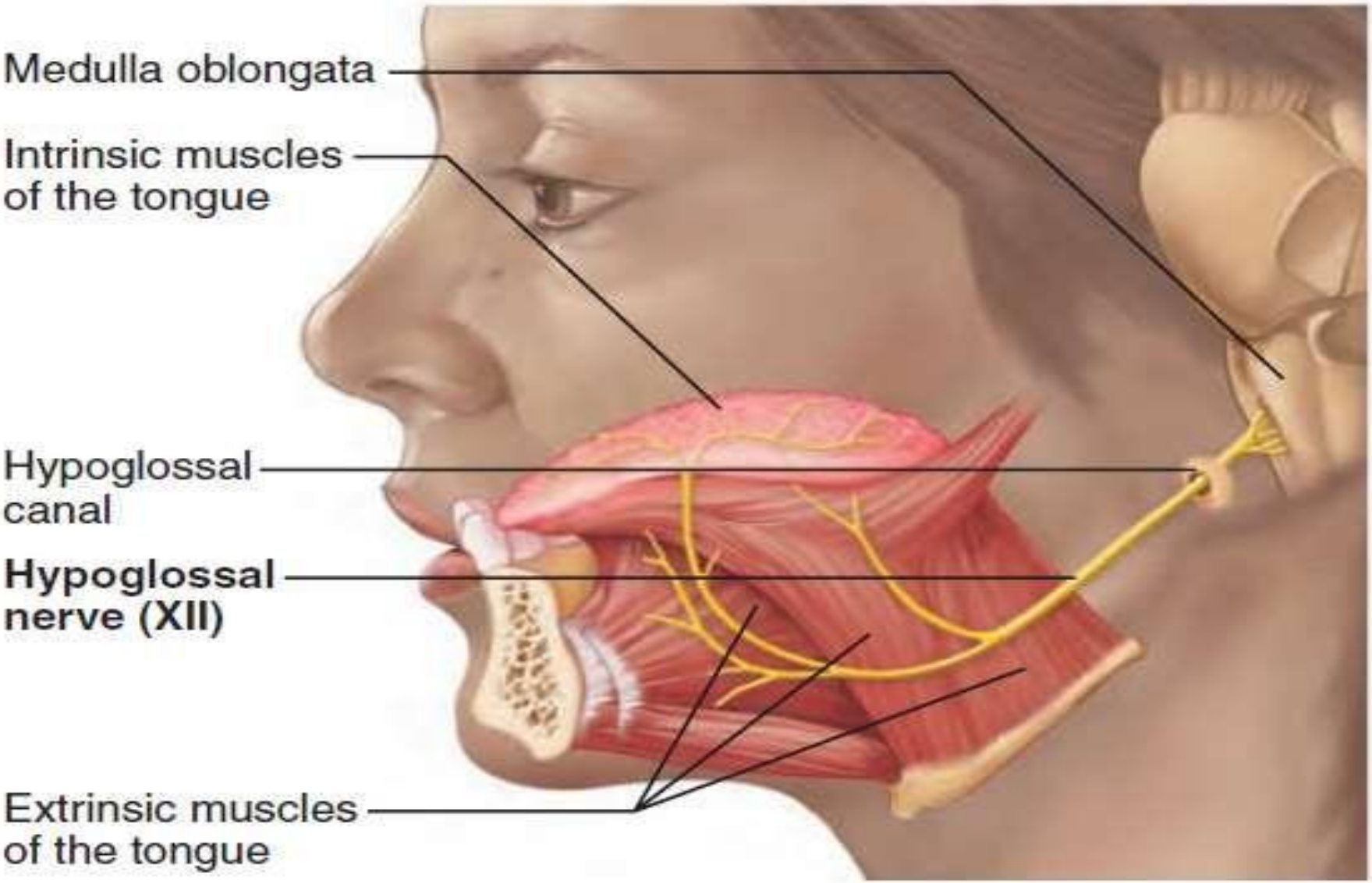
XI Accessory Nerves

- **Origin and course: Unique in that they form from rootlets that emerge** from the spinal cord, not the brain stem. These rootlets arise laterally from superior region (C1–C5) of spinal cord, pass upward along spinal cord, and enter the skull as the accessory nerves via foramen magnum. The accessory nerves exit from skull through jugular foramen together with the vagus nerves, and supply two large neck muscles.
- **Function:** Mixed nerves, but primarily motor in function. Supply motor fibers to trapezius and sternocleidomastoid muscles, which together move head and neck, and convey proprioceptor impulses from same muscles.
- **Clinical testing: Check strength of sternocleidomastoid and trapezius** muscles by asking person to rotate head and shrug shoulders against resistance.
- **Applied Anatomy:-** Injury to one accessory nerve causes head to turn toward injury side as result of sternocleidomastoid muscle paralysis. Shrugging that shoulder (role of trapezius muscle) becomes difficult.


Jugular foramen
Foramen magnum
Accessory nerve (XI)
Sternocleidomastoid muscle
Rootlets of accessory nerve emerging from spinal cord (C_1–C_5)
Trapezius muscle

XII Hypoglossal Nerves

- **Origin and course:** hypoglossal nerves mainly serve the tongue. Fibers arise by a series of roots from medulla and exit from skull via *hypoglossal canal* to travel to tongue.
- **Function:** Mixed nerves, but primarily motor in function. Carry somatic motor fibers to intrinsic and extrinsic muscles of tongue, and proprioceptor fibers from same muscles to brain stem. Hypoglossal nerve control allows tongue movements that mix and manipulate food during chewing, and contribute to swallowing and speech.
- **Clinical testing:** Ask subject to protrude and retract tongue. Note any deviations in position.
- **Applied Anatomy:- Damage to hypoglossal** nerves causes difficulties in speech and swallowing. If both nerves are impaired, the person cannot protrude tongue. If only one side is affected, tongue deviates toward affected side.


Medulla oblongata
Intrinsic muscles of the tongue
Hypoglossal canal
Hypoglossal nerve (XII)
Extrinsic muscles of the tongue

THANK YOU