Medical Academy named after S.I. Georgievsky of V.I. Vernadsky CFU
Department of Neurology and Neurosurgery

Class 4
Anatomy, physiology and pathology of the Cranial nerves VII-XII

Key points:

1. ***Brainstem:***
   - *1.1. Surface anatomy*
   - *1.2. Internal structures and organization*
   - *1.3. Cross section through the medulla*
   - *1.4. Cross section through the pons*
   - *1.5. Cross section through the rostral midbrain*
2. ***Cranial Nerves I-XII:***
   - *2.1. Anatomy*
   - *2.2. Functions*
   - *2.3. Connections*
   - *2.4. Symptoms, signs, syndromes of lesions*
   - *2.5. Clinical correlations*

Key concepts:

1) Study the transverse sections of the brain stem and localize the cranial nerve nuclei.
2) Study the ventral and dorsal surface of the brain stem and identify the exiting and entering cranial nerves.
3) Carefully study all of the figures and legends
4) Study the main information about anatomy of all cranial nerves, their functions, connections and symptoms/signs/syndromes of lesions

Define the following terms:

Brain stem, medial structures, lateral structures, dorsal structures, tegmentum, medial lemniscus, gracile and cuneate nuclei, pyramids, corticospinal fibers, inferior cerebellar peduncle, spinocerebellar tract, cuneocerebellar tract, olivocerebellar tract, lateral spinothalamic tract (spinal lemniscus), superior colliculi, inferior colliculi, oliva, medial longitudinal fasciculus (MLF), cerebral peduncle, red nucleus, substantia nigra, hypoglossal nucleus of CN XII, nucleus ambiguus (CN IX, X, and XI), vestibular nuclei (CN VIII,) spinal nucleus and tract of trigeminal nerve, abducent nucleus of CN VI, facial nucleus (CN VII), spinal nucleus and tract of trigeminal nerve (CN V), oculomotor nucleus (CN III), cranial nerves I-XII.

Literature:

Mathias Baehr, M.D., Michael Frotscher, M.D. Duus' Topical Diagnosis in Neurology. – P.116-167
Mark Mumenthaler, M.D., Heinrich Mattle, M.D. Fundamentals of Neurology. – P.16-22.

facial (mimetic) expression. CN VII includes ***the intermediate nerve***, which contains GSA, SVA, and GVE fibers. All first-order sensory neurons are found in the geniculate ganglion within the temporal bone.

1. ***Anatomy***. The facial nerve exits the brain stem in the cerebellopontine angle. It enters the internal auditory meatus and the facial canal. It then exits the facial canal and skull through the stylomastoid foramen.

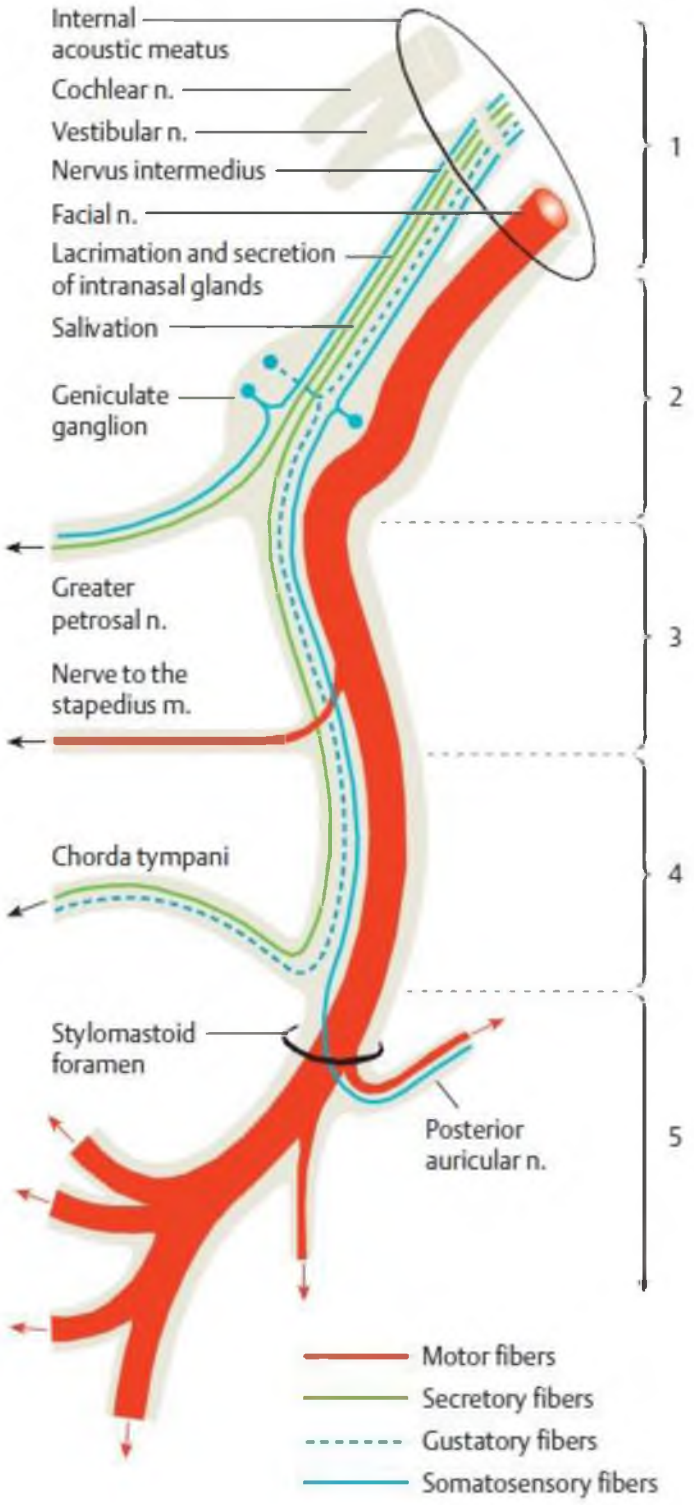


Fig. 4.35 **The components of the facial nerve and typical deficits caused by lesions at various sites along its course**

1 Peripheral weakness of the muscles innervated by the facial nerve (muscles of facial expression), hearing loss or deafness, and diminished vestibular excitability.
2 Peripheral weakness and impairment of taste, lacrimation, and salivation.
3 Peripheral weakness of the muscles of facial expression, impairment of taste and salivation, and hearing loss.
4 Peripheral weakness of the muscles of facial expression and impairment of taste and salivation.
5 Peripheral weakness of the muscles of facial expression.

2. ***The GSA component*** has cell bodies located in the geniculate ganglion. It innervates the posterior surface of the external ear through the posterior auricular branch of CN VII. It projects centrally to the spinal tract and nucleus of trigeminal nerve.

3. ***The GVA component*** has no clinical significance. The cell bodies are located in the geniculate ganglion. Fibers innervate the soft palate and the adjacent pharyngeal wall.

4. ***The SVA component (taste)*** has cell bodies located in the geniculate ganglion. It projects centrally to the solitary tract and nucleus. It innervates the taste buds from the ***anterior two-thirds of the tongue*** through:

a. The ***intermediate nerve***.

b. The ***chorda tympani***, which is located in the tympanic cavity medial to the tympanic membrane and malleus. It contains the SVA and GVE (parasympathetic) fibers.

c. The ***lingual nerve*** (a branch of CN V-3).

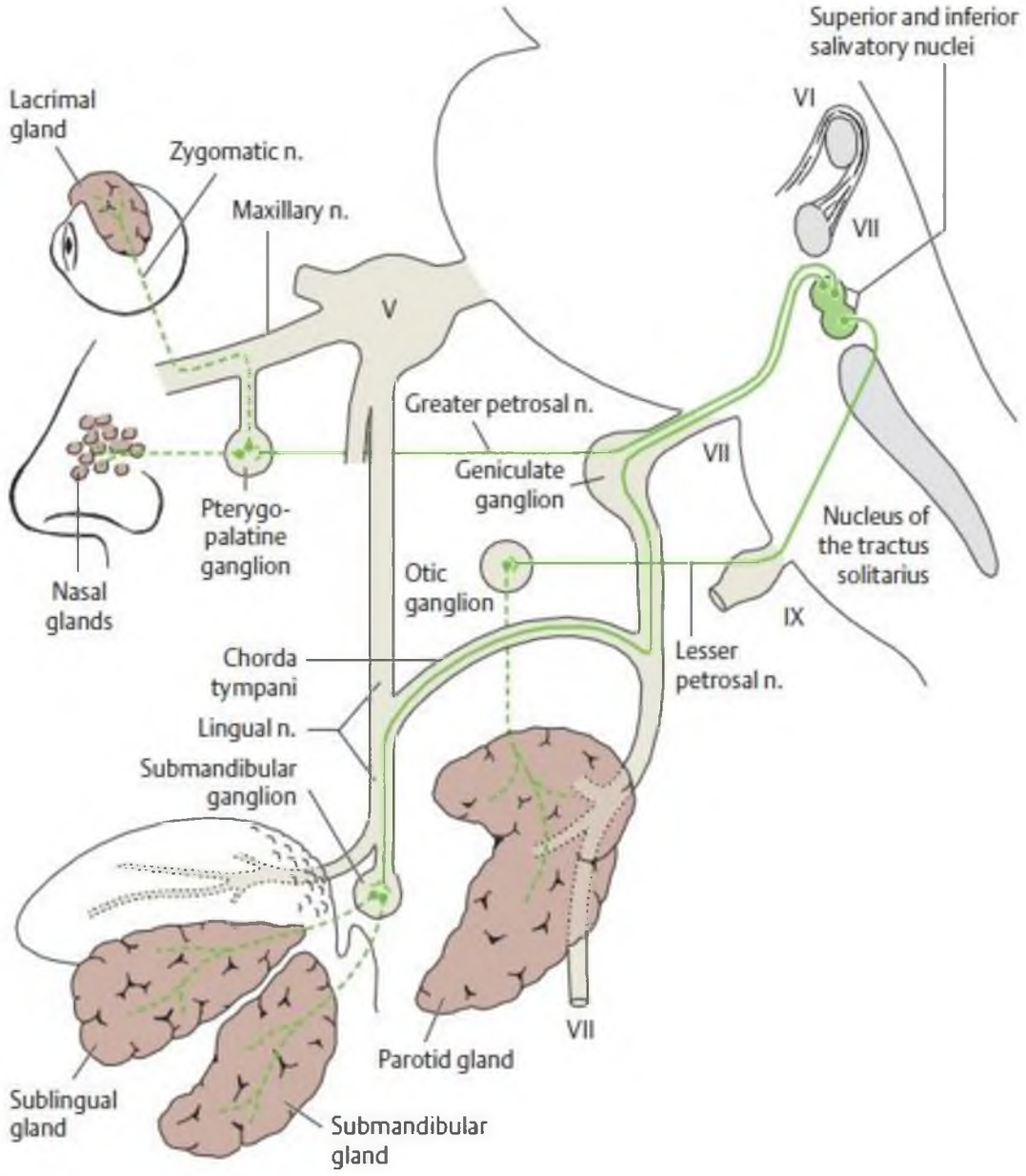
d. The ***central gustatory pathway*** (see Figure on the page 18). Taste fibers from CN VII, CN IX, and CN X project through the solitary tract to the solitary nucleus. The solitary nucleus projects through the central tegmental tract to the ventral posteromedial nucleus (VPM) of the thalamus. The VPM projects to the gustatory cortex of the parietal lobe (parietal operculum).

5. ***The GVE component*** is a parasympathetic component that innervates the lacrimal, submandibular, and sublingual glands. It contains preganglionic parasympathetic neurons that are located in the superior salivatory nucleus of the caudal pons.

a. ***Lacrimal pathway*** (see Figure below). The superior salivatory nucleus projects through the intermediate and greater petrosal nerves to the pterygopalatine (sphenopalatine) ganglion. The pterygopalatine ganglion projects to the lacrimal gland of the orbit.

b. ***Submandibular pathway*** (see Figure below). The superior salivatory nucleus projects through the intermediate nerve and chorda tympani to the submandibular ganglion. The submandibular ganglion projects to and innervates the submandibular and sublingual glands.

6. ***The SVE component*** arises from the facial nucleus, loops around the abducent nucleus of the caudal pons, and exits the brain stem in the cerebellopontine angle. It enters the internal auditory meatus, traverses the facial canal, sends a branch to the stapedius muscle of the middle ear, and exits the skull through the stylomastoid foramen. It innervates the muscles of facial expression, the stylohyoid muscle, the posterior belly of the digastric muscle, and the stapedius muscle.



B. CLINICAL CORRELATION. Lesions cause the following conditions:

1. ***Flaccid paralysis*** of the muscles of facial expression (upper and lower face).

2. ***Loss of the corneal reflex*** (efferent limb), which may lead to corneal ulceration.

3. ***Loss of taste*** (***ageusia*** - gustatory anaesthesia) from the anterior two-thirds of the tongue, which may result from damage to the chorda tympani.

4. ***Hyperacusis*** (increased acuity to sounds) as a result of stapedius paralysis.

5. ***Bell's palsy*** (peripheral facial paralysis), which is caused by trauma or infection and involves the upper and lower face.

6. ***Crocodile tears syndrome*** (lacrimation during eating), which is a result of aberrant regeneration of SVE fibers after trauma.

7. ***Supranuclear (central) facial palsy***, which results in contralateral weakness of the lower face, with sparing of the upper face (see Figure 4.34 below).

8. ***Bilateral facial nerve palsies***, which occur in Guillain-Barre syndrome.

9. ***Mobius' syndrome***, which consists of congenital facial diplegia (CN VII) and convergent strabismus (CN VI).

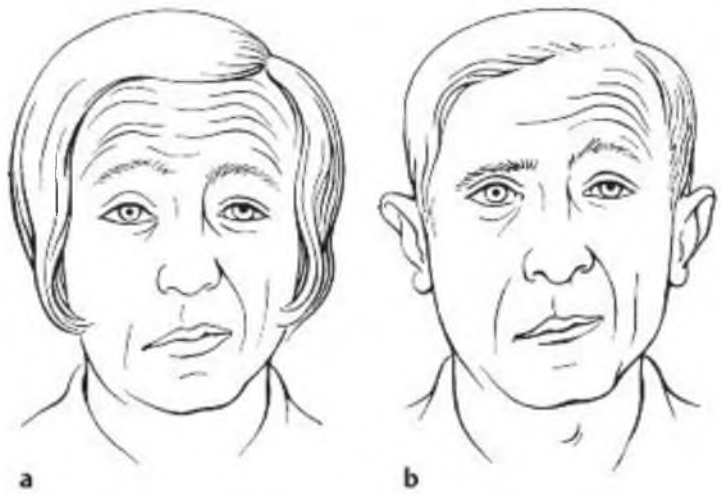


Fig. 4.34 Facial palsy
a Central facial palsy: the forehead muscles are not affected.
b Peripheral facial palsy: the forehead muscles are involved along with the rest of the face on the affected side.

VESTIBULOCOCHLEAR NERVE (CN VIII) is a special somatic afferent (SSA) nerve. It has two functional divisions: ***the vestibular nerve***, which maintains equilibrium and balance, and ***the cochlear nerve***, which mediates hearing. It exits the brain stem at the cerebellopontine angle and enters the internal auditory meatus. It is confined to the temporal bone.

A. VESTIBULAR NERVE (see Figure on the page 20)

1. GENERAL CHARACTERISTICS.

a. It is associated functionally with the cerebellum (flocculonodular lobe) and ocular motor nuclei.

b. It regulates compensatory eye movements.

c. Its first-order sensory bipolar neurons are located in the vestibular ganglion in the fundus of the internal auditory meatus.

d. It projects its peripheral processes to the hair cells of the cristae of the semicircular ducts and the hair cells of the utricle and saccule.

e. It projects its central processes to the four vestibular nuclei of the brainstem and the flocculonodular lobe of the cerebellum.

f. It conducts efferent fibers to the hair cells from the brainstem.

B. VESTIBULAR SYSTEM Like the auditory system, the vestibular system is derived from the otic vesicle. The otic vesicle is a derivative of the otic placode, which is a thickening of the surface ectoderm. This system ***maintains posture and equilibrium and coordinates head and eye movements***.

C. THE LABYRINTH

A. KINETIC LABYRINTH

1. ***Three semicircular ducts*** lie within the three semicircular canals (i.e., superior, lateral, and posterior).
2. These ducts ***respond to angular acceleration and deceleration of the head***.

a. They contain ***hair cells*** in the crista ampullaris. The hair cells respond to ***endolymph flow.***

b. Endolymph flow toward the ampulla (ampullopetal) or utricle (utriculopetal) is a stronger stimulus than is endolymph flow in the opposite direction.

B. STATIC LABYRINTH

1. The ***utricle*** and ***saccule*** respond to the position of the head with respect to ***linear acceleration*** and the pull of ***gravity***.
2. The utricle and saccule contain ***hair cells*** whose cilia are embedded in the otolithic membrane. When hair cells are bent toward the longest cilium (kinocilium), the frequency of sensory discharge increases.

D. VESTIBULAR PATHWAYS consist of the following structures:

A. HAIR CELLS OF THE SEMICIRCULAR DUCTS, SACCULE, AND UTRICLE are innervated by peripheral processes of bipolar cells of the vestibular ganglion.

B. VESTIBULAR GANGLION is located in the fundus of the internal auditory meatus.

1. ***Bipolar neurons*** project through their peripheral processes to the hair cells.
2. ***Bipolar neurons*** project their central processes as the vestibular nerve (CN VIII] to the vestibular nuclei and to the flocculonodular lobe of the cerebellum.

C. VESTIBULAR NUCLEI

1. ***These nuclei receive input from***
   a. The semicircular ducts, saccule, and utricle.
   b. The flocculonodular lobe of the cerebellum.
2. ***The nuclei project fibers to***
   a. The flocculonodular lobe of the cerebellum.
   b. CN III, IV, and VI through the medial longitudinal fasciculus (MLF).
   c. The spinal cord through the lateral vestibulospinal tract.
   d. The ventral posteroinferior and posterolateral nuclei of the thalamus, both of which project to the postcentral gyrus.

E. CLINICAL CORRELATION. Lesions result in ***disequilibrium, vertigo,*** and ***nystagmus.***

B. COCHLEAR NERVE (see Figure on the page 22)

1. GENERAL CHARACTERISTICS.

a. Its first-order sensory bipolar neurons are located in the spiral (cochlear) ganglion of the modiolus of the cochlea, within the temporal bone.

b. It projects its peripheral processes to the hair cells of the organ of Corti.

c. It projects its central processes to the dorsal and ventral cochlear nuclei of the brainstem.

d. It conducts efferent fibers to the hair cells from the brain stem.

C. THE AUDITORY SYSTEM is an exteroceptive special somatic afferent system that can detect sound frequencies from 20 Hz to 20,000 Hz. It is derived from the otic vesicle, which is a derivative of the otic placode, a thickening of the surface ectoderm.

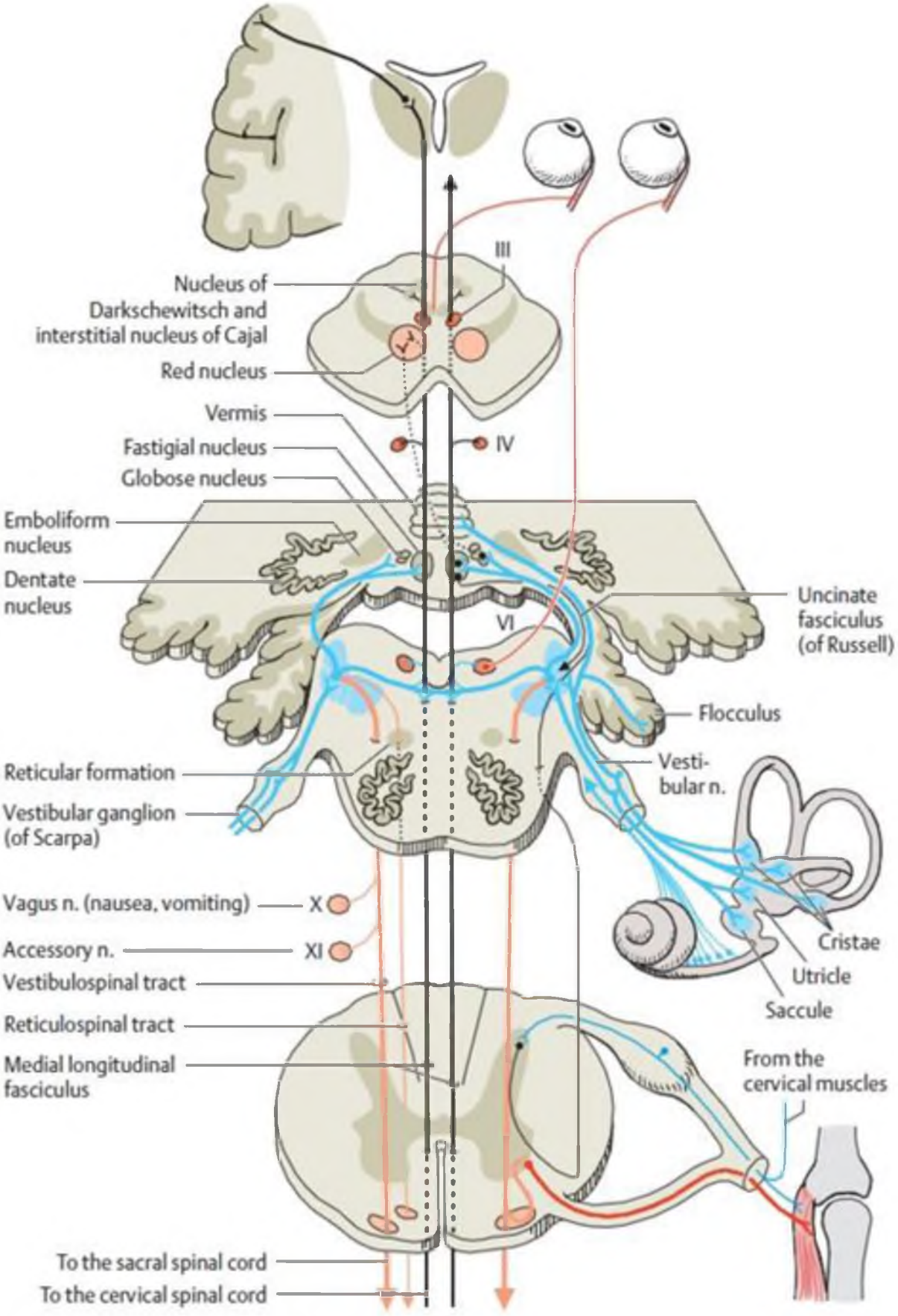


Fig. 4.47 **Central connections of the vestibular nerve**

D. THE AUDITORY PATHWAY

A. The hair cells of the organ of Corti are innervated by the peripheral processes of bipolar cells of the spiral ganglion. They are stimulated by vibrations of the basilar membrane.

1. ***Inner hair cells (IHCs)*** are the chief sensory elements; they synapse with dendrites of myelinated neurons whose axons make up 90% of the cochlear nerve.

2. ***Outer hair cells (OHCs)*** synapse with dendrites of unmyelinated neurons whose axons make up 10% of the cochlear nerve. The OHCs reduce the threshold of the IHCs.

B. The bipolar cells of the spiral (cochlear) ganglion project peripherally to the hair cells of the organ of Corti. They project centrally as the cochlear nerve to the cochlear nuclei.

C. The cochlear nerve extends from the spiral ganglion to the cerebellopontine angle, where it enters the brain stem.

D. The cochlear nuclei receive input from the cochlear nerve. They project contralaterally to the superior olivary nucleus and lateral lemniscus.

E. The superior olivary nucleus, which plays a role in sound localization, receives bilateral input from the cochlear nuclei. It projects to the lateral lemniscus.

F. The trapezoid body is located in the pons. It contains decussating fibers from the ventral cochlear nuclei.

G. The lateral lemniscus receives input from the contralateral cochlear nuclei and superior olivary nuclei.

H. The nucleus of inferior colliculus receives input from the lateral lemniscus. It projects through the brachium of the inferior colliculus to the medial geniculate body.

I. The medial geniculate body receives input from the nucleus of the inferior colliculus. It projects through the internal capsule as the auditory radiation to the primary auditory cortex, the transverse temporal gyri of Heschl.

J. The transverse temporal gyri of Heschl contain the primary auditory cortex (Brodmann's areas 41 and 42). The gyri are located in the depths of the lateral sulcus.

E. HEARING DEFECTS

A. CONDUCTION DEAFNESS is caused by interruption of the passage of sound waves through the external or middle car. It may he caused by obstruction (c.g., wax), otosclerosis, or otitis media and is often reversible.

B. NERVE DEAFNESS (sensorineural, or perceptive, deafness) is typically permanent and is caused by disease of the cochlea, cochlear nerve (acoustic neuroma), or central auditory connections. It is usually caused by presbycusis that results from degenerative disease of the organ of Corti in the first few millimeters of the basal coil of the cochlea (high-frequency loss of 4,000 to 8,000 Hz).

F. AUDITORY TESTS

A. TUNING FORK TESTS

1. ***Weber's test*** is performed by placing a vibrating tuning fork on the vertex of the skull. Normally, a patient hears equally on both sides.

a. A patient who has unilateral conduction deafness hears the vibration more loudly in the affected ear.

b. A patient who has unilateral partial nerve deafness hears the vibration more loudly in the normal ear.

2. ***The Rinne*** test compares air and bone conduction. It is performed by placing a vibrating tuning fork on the mastoid process until the vibration is no longer heard; then the fork is held in front of the ear. Normally, a patient hears the vibration in the air after bone conduction is gone. Note that a positive Rinne test means that sound conduction is normal [air conduction (AC) is greater than bone conduction (BC)], whereas a negative Rinne test indicates conduction loss, with BC greater than AC.

a. A patient who has unilateral conduction deafness does not hear the vibration in the air after bone conduction is gone.

b. A patient who has unilateral partial nerve deafness hears the vibration in the air after bone conduction is gone.

G. CLINICAL CORRELATION. Destructive lesions cause hearing loss (sensorineural ***deafness***). Irritative lesions can cause ***tinnitus*** (ear ringing). An ***acoustic neuroma (schwannoma)*** is a Schwann cell tumor of the cochlear nerve that causes deafness.

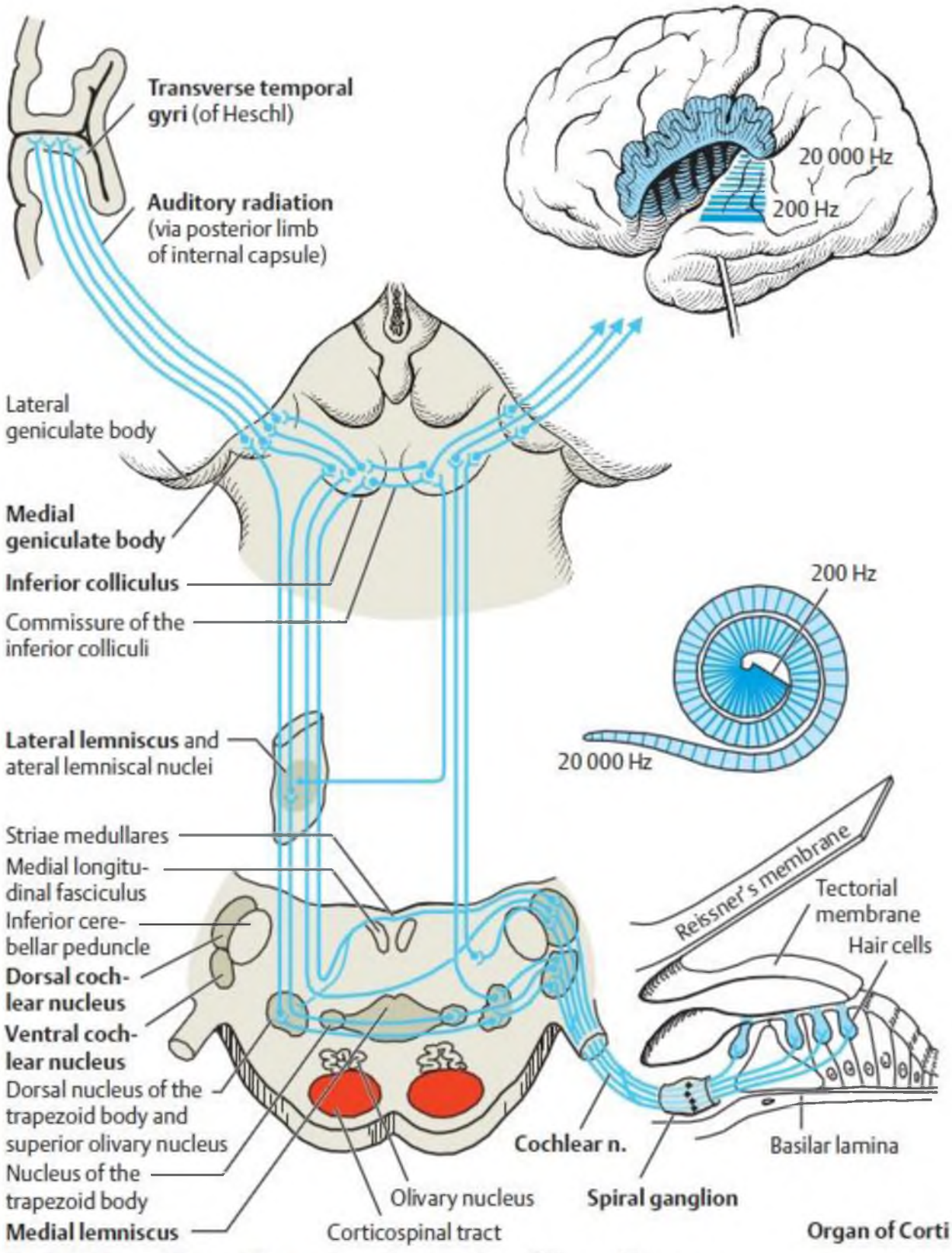


Fig. 4.43 **The auditory pathway.** Central connections of the cochlear nerve.

GLOSSOPHARYNGEAL NERVE (CN IX) is a GSA, GVA, SVA, SVE, and GVE nerve (see Figure below).

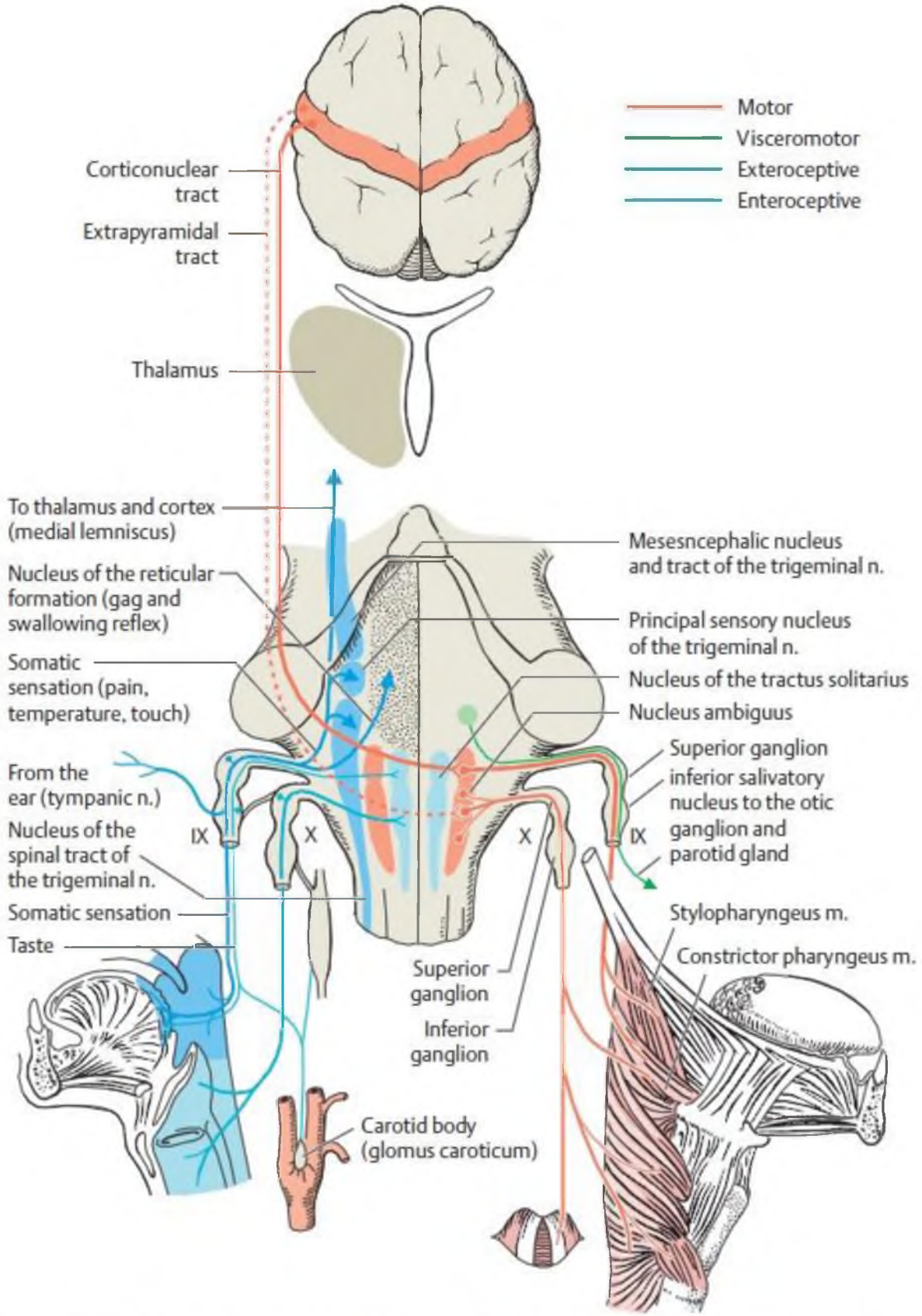


Fig. 4.48 **Distribution and central connections of the glossopharyngeal and vagus nerves**

A. GENERAL CHARACTERISTICS. The glossopharyngeal nerve is primarily a sensory nerve. Along with CN X, CN XI, and CN XII, it mediates ***taste, salivation, and swallowing***. It mediates ***input from the carotid sinus***, which contains baroreceptors that monitor arterial blood pressure. It also mediates ***input from the carotid body***, which contains chemoreceptors that monitor the CO2 and O2 concentration of the blood.

1. ***Anatomy.*** CN IX is the nerve of pharyngeal (branchial) arch 3. It exits the brain stem (medulla) from the postolivary sulcus with CN X and CN XI. It exits the skull through the jugular foramen with CN X and CN XI.

2. ***The GSA*** component innervates ***part of the external ear and the external auditory meatus*** through the auricular branch of the vagus nerve. It has cell bodies in the superior ganglion. It projects its central processes to the spinal tract and nucleus of trigeminal nerve.

3. ***The GVA*** component innervates structures that are derived from the endoderm (e.g., pharynx). It innervates the ***mucous membranes of the posterior one-third of the tongue, tonsil, upper pharynx, tympanic cavity, and auditory tube***. It also innervates ***the carotid sinus (baroreceptors) and carotid body (chemoreceptors)*** through the sinus nerve. It has cell bodies in the inferior (petrosal) ganglion. It is the afferent limb of the gag reflex and the carotid sinus reflex.

4. ***The SVA*** component innervates ***the taste buds of the posterior one-third of the tongue***. It has cell bodies in the inferior (petrosal) ganglion. It projects its central processes to the solitary tract and nucleus.

5. ***The SVE*** component innervates only the ***stylopharyngeus muscle***. It arises from the nucleus ambiguus of the lateral medulla.

6. ***The GVE*** component is a parasympathetic component that innervates ***the parotid gland***. Preganglionic parasympathetic neurons are located in the inferior salivatory nucleus of the medulla. They project through the tympanic and lesser petrosal nerves to the otic ganglion. Postganglionic fibers from the otic ganglion project to the parotid gland through the auriculotemporal nerve (CN V-3).

B. CLINICAL CORRELATION. Lesions cause the following conditions:

1. Loss of the gag (pharyngeal) reflex (interruption of the afferent limb).
2. Hypersensitive carotid sinus reflex (syncope).
3. Loss of general sensation in the pharynx, tonsils, fauces, and back of the tongue.
4. Loss of taste from the posterior one-third of the tongue.
5. Glossopharyngeal neuralgia, which is characterized by severe stabbing pain in the root of the tongue.

VAGUS NERVE (CN X) is a GSA, GVA, SVA, SVE, and GVE nerve.

A. GENERAL CHARACTERISTICS. The vagal nerve mediates ***phonation***, ***swallowing*** (with CN IX, CN XI, and CN XII), ***elevation of the palate***, ***taste***, and ***cutaneous sensation from the ear***. It innervates ***the viscera of the neck, thorax, and abdomen***.

1. Anatomy. CN X is the nerve of pharyngeal (branchial) arches 4 and 6. Pharyngeal arch 5 is either absent or rudimentary. It exits the brain stem (medulla) from the postolivary sulcus. It exits the skull through the jugular foramen with CN IX and CN XI.

2. The GSA component innervates ***the infratentorial dura, external car, external auditory meatus, and tympanic membrane***. It has cell bodies in the superior (jugular) ganglion, and it projects its central processes to the spinal tract and nucleus of trigeminal nerve.

3. The GVA component innervates ***the mucous membranes of the pharynx, larynx, esophagus, trachea, and thoracic and abdominal viscera*** (to the left colic flexure). It has cell bodies in the inferior (nodose) ganglion. It projects its central processes to the solitary tract and nucleus.

4. The SVA component innervates ***the taste buds in the epiglottic region***. It has cell bodies in the inferior (nodose) ganglion. It projects its central processes to the solitary tract and nucleus.

5. The SVE component innervates t***he pharyngeal (brachial) arch muscles of the larynx and pharynx, the striated muscle of the upper esophagus, the muscle of the uvula, and the levator veli palatini and palatoglossus muscle***s. It receives SVE input from the cranial division of the spinal accessory nerve (CN XI). It arises from the nucleus ambiguus in the lateral medulla. The SVE component provides the efferent limb of ***the gag reflex***.

6. The GVE component innervates ***the viscera of the neck and the thoracic (heart) and abdominal cavities as far as the left colic flexure***. Preganglionic parasympathetic neurons that are located in the dorsal motor nucleus of the medulla project to the terminal (intramural) ganglia of the visceral organs.

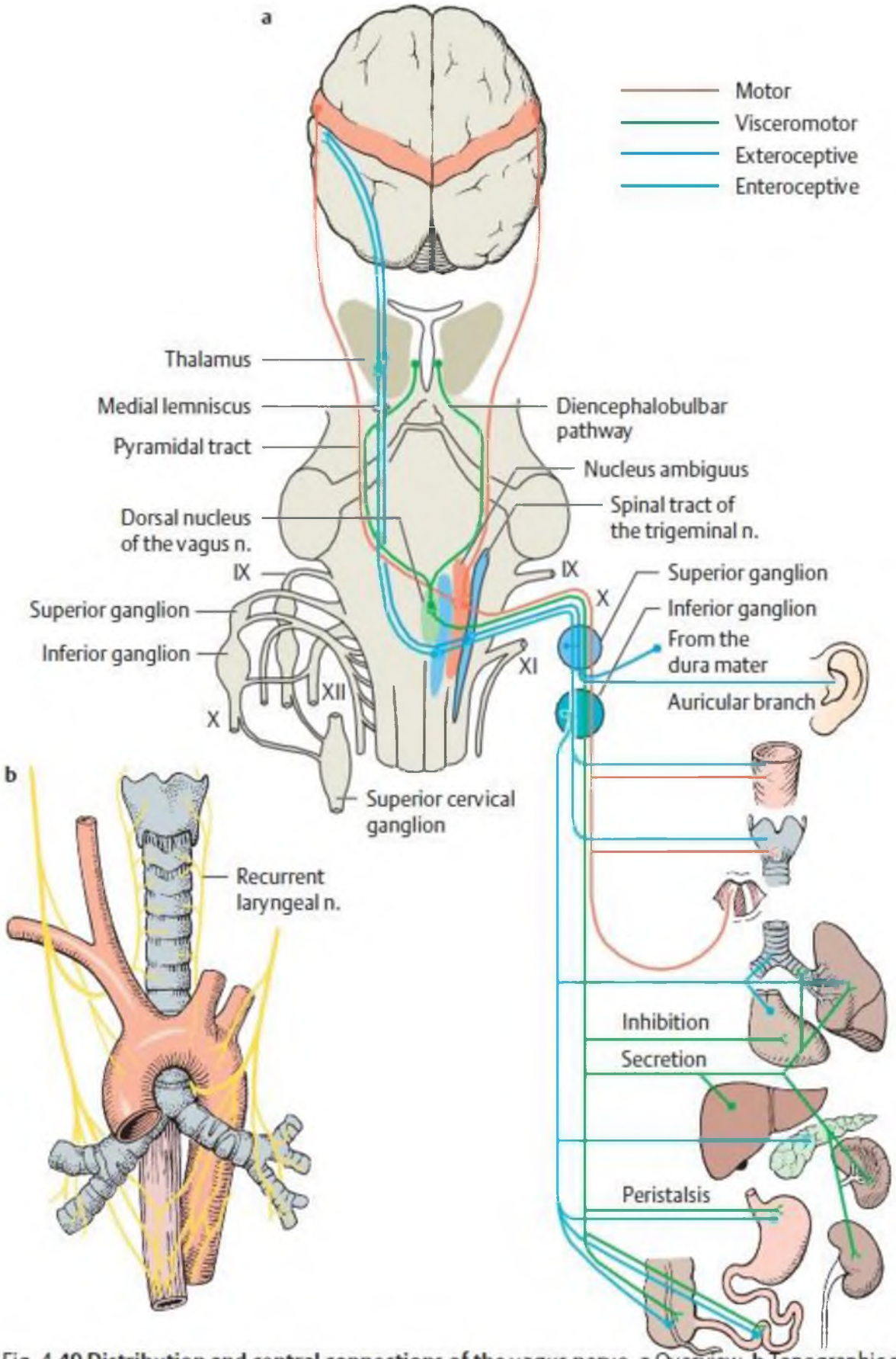
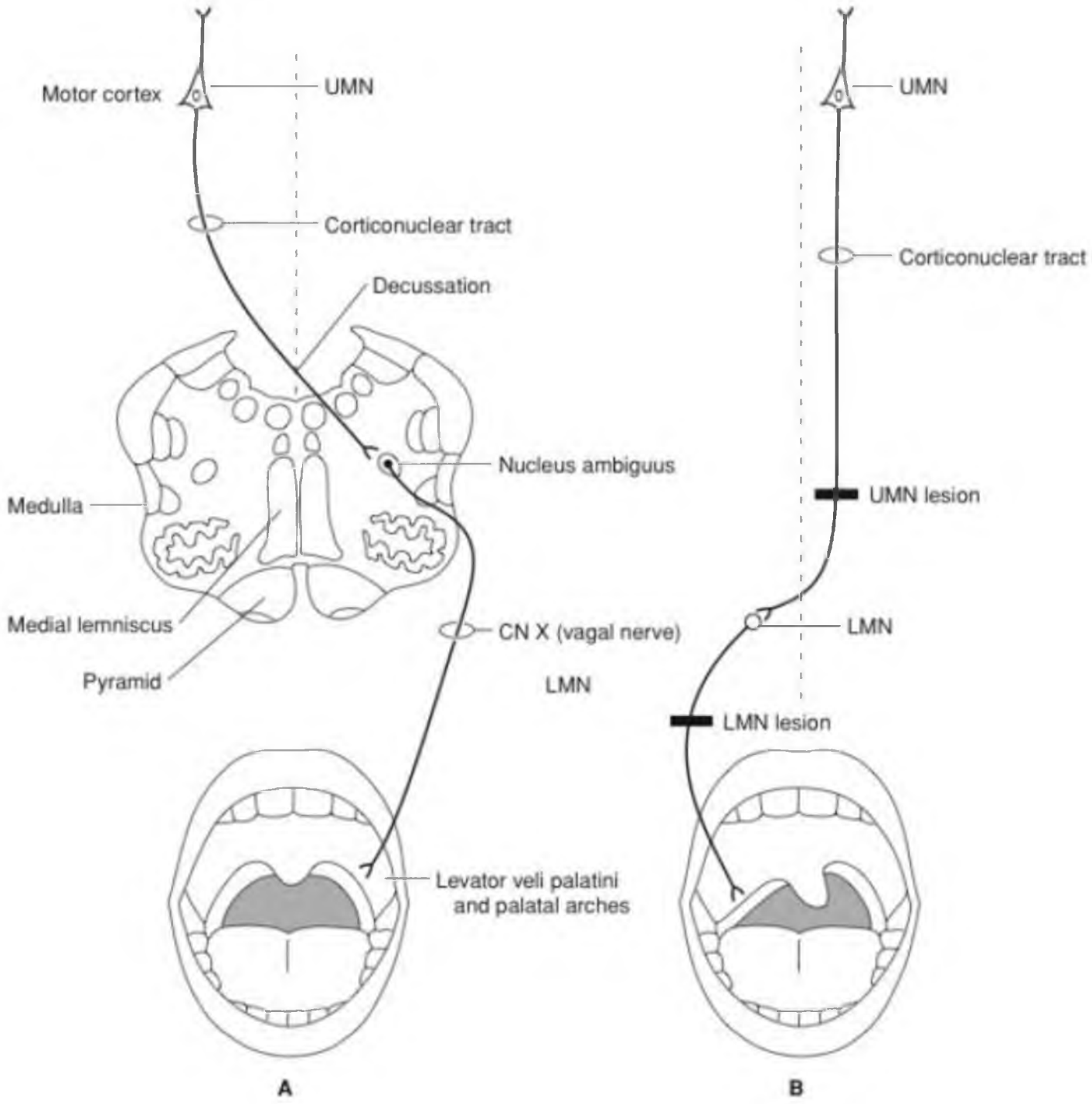


Fig. 4.49 **Distribution and central connections of the vagus nerve. a** Overview. **b** Topographic relations of the recurrent laryngeal nerve.



Innervation of the palatal arches and uvula. Sensory innervation is mediated by the glossopharyngeal nerve. Motor innervation of the palatal arches and uvula is mediated by the vagus nerve (CN X).
(A) A normal palate and uvula in a person who is saying "Ah."
(B) A patient with an upper motor neuron lesion (left) and a lower motor neuron lesion (right). When this patient says "Ah," the palatal arches hangs down. The uvula deviates toward the intact (left) side

B. CLINICAL CORRELATION.

1. ***Ipsilateral paralysis*** of the soft palate, pharynx, and larynx that leads to dysphonia (hoarseness), dyspnea, dysarthria, and dysphagia.

2. ***Loss of the gag (palatal) reflex*** (efferent limb).

3. ***Anesthesia*** of the pharynx and larynx that leads to unilateral loss of the cough reflex.

4. Aortic aneurysms and tumors of the neck and thorax that frequently compress the vagal nerve and can lead to cough, dyspnea, dysphagia, hoarseness, and chest/back pain.

5. ***Complete laryngeal paralysis***, which can be rapidly fatal if it is bilateral (asphyxia).

6. ***Parasympathetic (vegetative) disturbances***, including bradycardia (irritative lesion), tachycardia (destructive lesion), and dilation of the stomach.

7. The oculocardiac reflex, in which pressure on the eye slows the heart rate (afferent limb of CN V-l and efferent limb of CN X).

8. The carotid sinus reflex, in which pressure on the carotid sinus slows the heart rate (bradycardia; efferent limb of CN X).

ACCESSORY NERVE (CN XI) or spinal accessory nerve, is a SVE nerve.

A. GENERAL CHARACTERISTICS. The accessory nerve ***mediates head and shoulder movement and innervates the laryngeal muscles***. It has the following divisions:

1. ***The cranial division (accessory portion),*** which arises from the nucleus ambiguus of the medulla. It exits the medulla from the postolivary sulcus and joins the vagal nerve (CN X). It exits the skull through the jugular foramen with CN IX and CN X. It innervates ***the intrinsic muscles of the larynx through the inferior (recurrent) laryngeal nerve***, with the exception of the cricothyroid muscle.

2. ***The spinal division (spinal portion),*** which arises from the ventral horn of cervical segments Cl through C6. The spinal roots exit the spinal cord laterally between the ventral and dorsal spinal roots, ascend through the foramen magnum, and exit the skull through the jugular foramen. It innervates ***the sternocleidomastoid muscle and the trapezius muscle***.

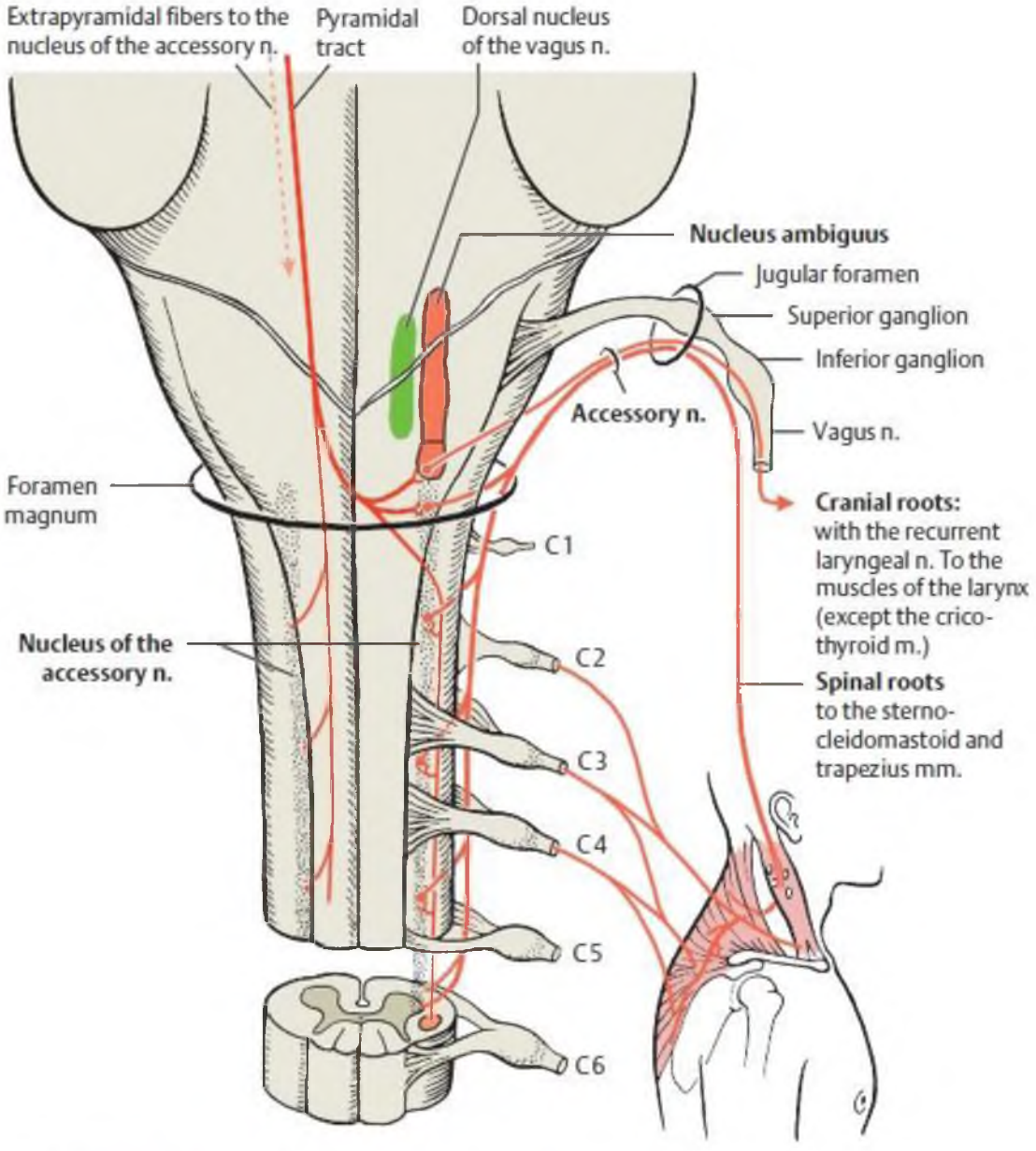


Fig. 4.50 Distribution and central connections of the accessory nerve

B. CLINICAL CORRELATION. Lesions cause the following conditions:

1. ***Paralysis of the sternocleidomastoid muscle*** that results in difficulty in turning the head to the contralateral side.

2. ***Paralysis of the trapezius muscle*** that results in shoulder droop and inability to shrug the shoulder.

3. ***Paralysis and anesthesia of the larynx*** if the cranial root is involved.

HYPOGLOSSAL NERVE (CN XII) is a GSE nerve (see Figure below).

A. GENERAL CHARACTERISTICS. The hypoglossal nerve mediates tongue movement. It arises from the hypoglossal nucleus of the medulla and exits the medulla in the preolivary sulcus. It exits the skull through the hypoglossal canal, and it innervates the intrinsic and extrinsic muscles of the tongue. Extrinsic muscles are the ***genioglossus, styloglossus, and hyoglossus***.

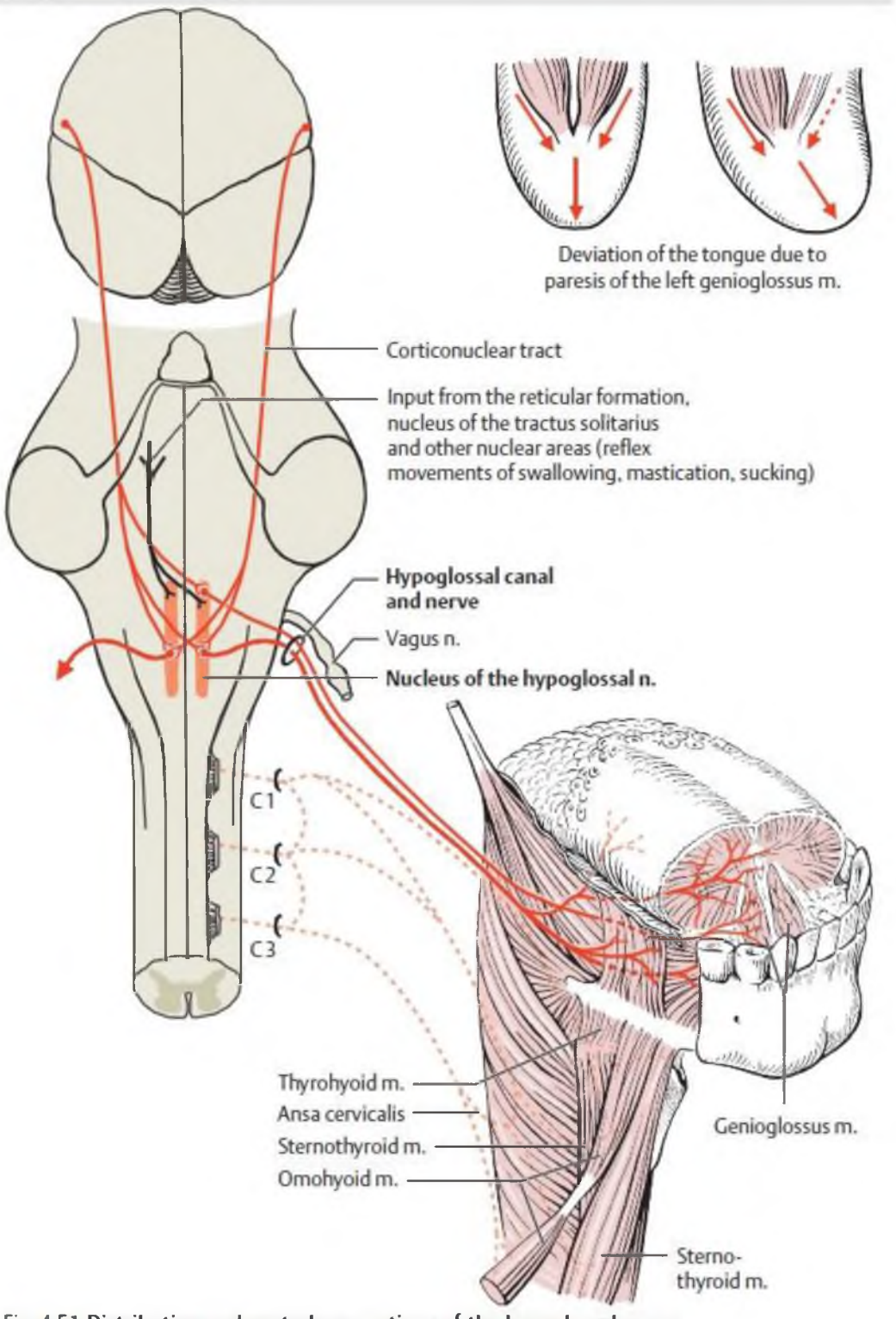


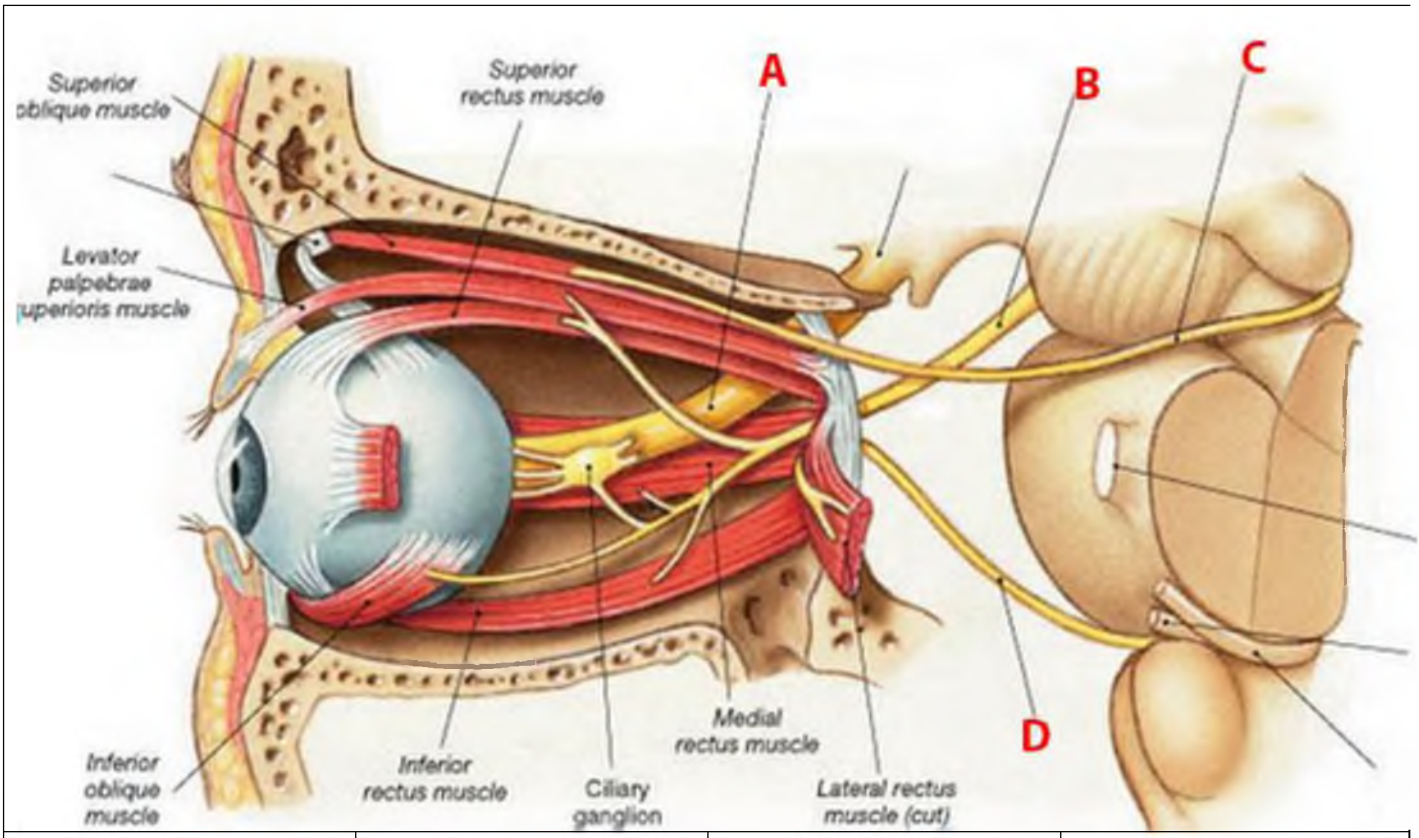
Fig. 4.51 **Distribution and central connections of the hypoglossal nerve**

B. CLINICAL CORRELATION

1. Transection results in ***hemiparalysis*** of the tongue.

2. Protrusion causes the tongue to point toward the lesioned (weak) side because of the unopposed action of the opposite genioglossus muscle.

QUESTIONS FOR SELF-EDUCATION



1. Indicate structure pointed with A:	2. Indicate structure pointed with B:	3. Indicate structure pointed with C:	4. Indicate structure pointed with D:
1. CN I	1. CN I	1. CN I	1. CN I
2. CN II	2. CN II	2. CN II	2. CN II
3. CN III	3. CN III	3. CN III	3. CN III
4. CN IV	4. CN IV	4. CN IV	4. CN IV
5. CN V	5. CN V	5. CN V	5. CN V
6. CN VI	6. CN VI	6. CN VI	6. CN VI
7. CN VII	7. CN VII	7. CN VII	7. CN VII
8. CN VIII	8. CN VIII	8. CN VIII	8. CN VIII
9. CN IX	9. CN IX	9. CN IX	9. CN IX
10. CN X	10. CN X	10. CN X	10. CN X
11. CN XI	11. CN XI	11. CN XI	11. CN XI
12. CN XII	12. CN XII	12. CN XII	12. CN XII

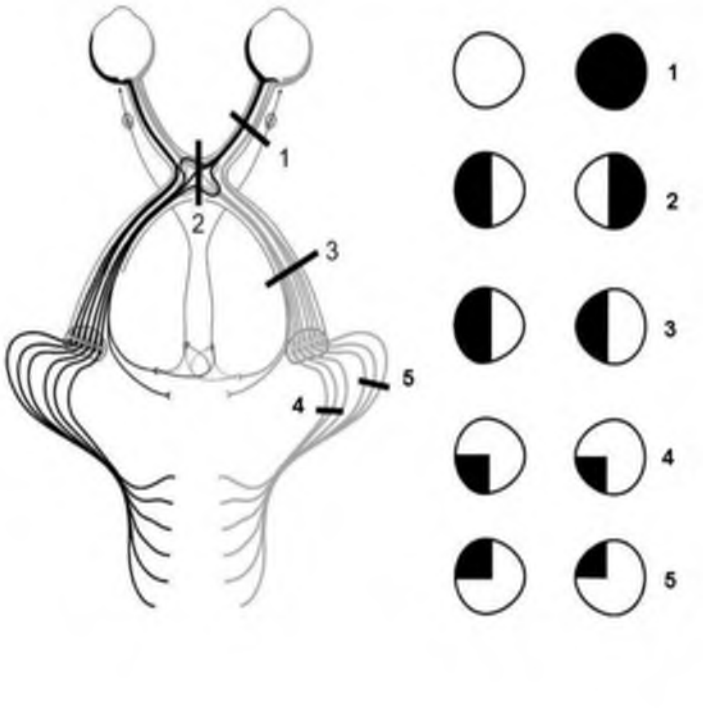
5. Indicate components of the visual pathway:
   1. Optic nerve
   2. Optic chiasm
   3. Gasser's ganglion
   4. Optic tract
   5. Optic ganglion
   6. Lateral geniculate body
   7. Medial geniculate body
   8. Trapezoid body

9. Lateral lemniscus
10. Optic radiation
11. Superior colliculi
12. Visual cortex
13. Meyer's loop
14. Superior salivatory nucleus
15. Entorhinal cortex

6. Which of the following statements are true:
    1. The right visual field of the left eye is perceived by the left temporal retina
    2. The right visual field of the left eye is perceived by the right temporal retina
    3. The left visual field of the left eye is perceived by the right nasal retina
    4. The left visual field of the left eye is perceived by the left nasal retina
    5. The superior visual field of the left eye is perceived by the left inferior retina
    6. The superior visual field of the left eye is perceived by the left superior retina
    7. The inferior visual field of the left eye is perceived by the left superior retina
    8. The left half of the visual field is projected to the left nasal retina and the left temporal retina
    9. The left half of the visual field is projected to the right nasal retina and the left temporal retina
    10. The left half of the visual field is projected to the right nasal retina and the right temporal retina
    11. The right half of the visual field is projected to the right temporal retina and the right nasal retina
    12. The right half of the visual field is projected to the right temporal retina and the left nasal retina
    13. The right half of the visual field is projected to the left temporal retina and the left nasal retina
    14. The left visual field projects to the right visual cortex
    15. The left visual field projects to the left visual cortex

7. Define the term “homonymous hemianopsia (hemianopia)”:
    1. Abnormal corneal shape that prevents light from coming to focus in one plane
    2. Axes of eyes are not parallel to each other
    3. Loss of vision in the same half of the visual field on each side
    4. Very sluggish constriction to light and return to normal size
    5. No constriction of pupil to light, but does constrict with accommodation
    6. Loss of vision in different halves of the visual field on each side
    7. Loss of vision in the same quadrant of the visual field on each side, can be superior or inferior

8. Which cranial nerve's main functions include facial muscle regulation and taste:
    1. CN I
    2. CN II
    3. CN III
    4. CN IV
    5. CN V
    6. CN VI
    7. CN VII
    8. CN VIII
    9. CN IX
    10. CN X
    11. CN XI
    12. CN XII



9. Indicate type of blindness (dark coloured) related to 1:

1. Heteronymous bitemporal hemianopsia
2. Heteronymous binasal hemianopsia
3. Homonymous bitemporal hemianopsia
4. Homonymous binasal hemianopsia
5. Homonymous upper quadrantanopsia
6. Homonymous lower quadrantanopsia
7. Heteronymous upper quadrantanopsia
8. Heteronymous lower quadrantanopsia
9. Monocular blindness
10. Central scotoma
11. Homonymous hemianopsia

10. Indicate type of blindness (dark coloured) related to 2:

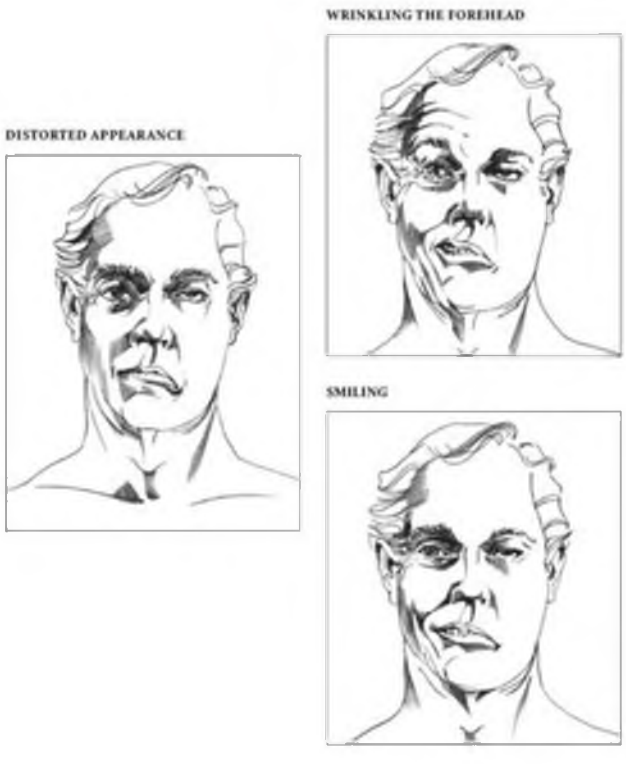
1. Heteronymous bitemporal hemianopsia
2. Heteronymous binasal hemianopsia
3. Homonymous bitemporal hemianopsia
4. Homonymous binasal hemianopsia
5. Homonymous upper quadrantanopsia
6. Homonymous lower quadrantanopsia
7. Heteronymous upper quadrantanopsia
8. Heteronymous lower quadrantanopsia
9. Monocular blindness
10. Central scotoma
11. Homonymous hemianopsia

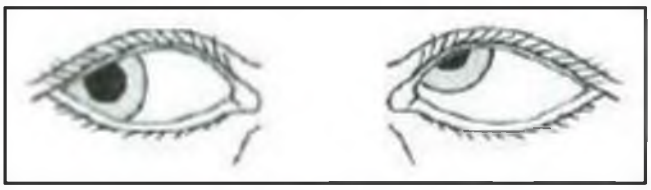
11. Indicate type of blindness (dark coloured) related to 3:

1. Heteronymous bitemporal hemianopsia
2. Heteronymous binasal hemianopsia
3. Homonymous bitemporal hemianopsia
4. Homonymous binasal hemianopsia
5. Homonymous upper quadrantanopsia
6. Homonymous lower quadrantanopsia
7. Heteronymous upper quadrantanopsia
8. Heteronymous lower quadrantanopsia
9. Monocular blindness
10. Central scotoma
11. Homonymous hemianopsia

12. Indicate type of blindness (dark coloured) related to 4:

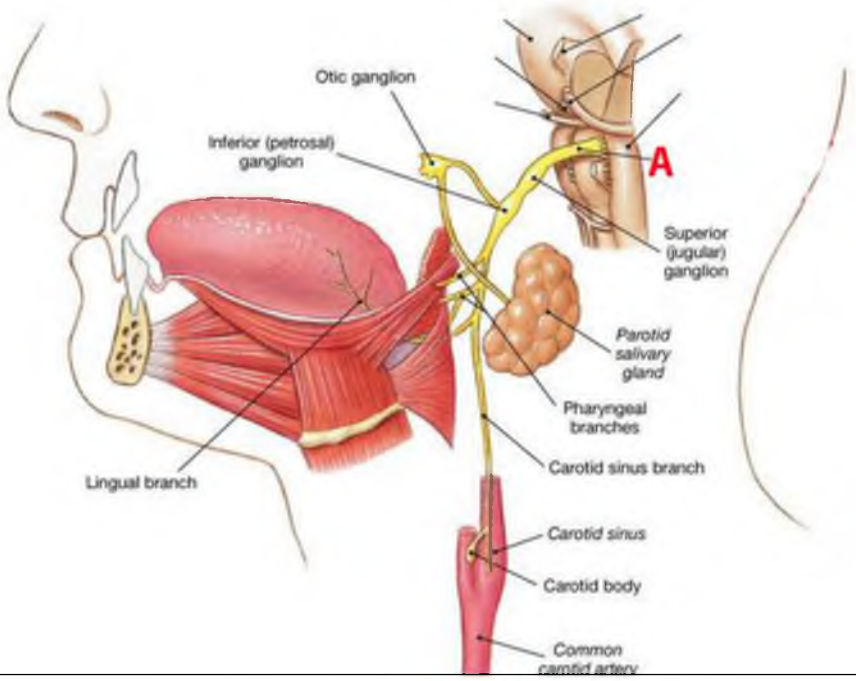
1. Heteronymous bitemporal hemianopsia
2. Heteronymous binasal hemianopsia
3. Homonymous bitemporal hemianopsia
4. Homonymous binasal hemianopsia
5. Homonymous upper quadrantanopsia
6. Homonymous lower quadrantanopsia
7. Heteronymous upper quadrantanopsia
8. Heteronymous lower quadrantanopsia
9. Monocular blindness
10. Central scotoma
11. Homonymous hemianopsia

	13. Which cranial nerve is affected: 1. CN I 2. CN II 3. CN III 4. CN IV 5. CN V 6. CN VI 7. CN VII 8. CN VIII 9. CN IX 10. CN X 11. CN XI 12. CN XII
	14. Which cranial nerve is affected: 1. CN I 2. CN II 3. CN III 4. CN IV 5. CN V 6. CN VI 7. CN VII 8. CN VIII 9. CN IX 10. CN X 11. CN XI 12. CN XII
	15. Which cranial nerve is affected: 1. CN I 2. CN II 3. CN III 4. CN IV 5. CN V 6. CN VI 7. CN VII 8. CN VIII 9. CN IX 10. CN X 11. CN XI 12. CN XII



Gaze to the right

16. Which cranial nerve is affected:
    1. CN I
    2. CN II
    3. CN III
    4. CN IV
    5. CN V
    6. CN VI
    7. CN VII
    8. CN VIII
    9. CN IX
    10. CN X
    11. CN XI
    12. CN XII



17. Indicate structure pointed with A:
    1. CN I
    2. CN II
    3. CN III
    4. CN IV
    5. CN V
    6. CN VI
    7. CN VII
    8. CN VIII
    9. CN IX
    10. CN X
    11. CN XI
    12. CN XII

18. What is true about the oculomotor nerve (CN III):
    1. It emerges from the midbrain and serves four extrinsic eye muscles
    2. It emerges from the pons and serves five extrinsic eye muscles
    3. It carries motor and proprioceptor impulses to and from superior oblique muscle of the eyeball
    4. It emerges from the pons and serves the motor and proprioceptive functions of the lateral rectus muscle of the eyeball
    5. Oculomotor nerve is a mixed cranial nerve
    6. It's function is raising of eyelid, eye movements (up, down, medial gaze), regulation of size of the pupil
    7. Enters/exits brainstem dorsally
    8. There are two nuclei for the oculomotor nerve
    9. There are four nuclei for the oculomotor nerve (ventral, dorsal, inferior, superior)
    10. One of the nuclei supplies parasympathetic fibers to the eye via the ciliary ganglion
    11. It controls the sphincter pupillae muscle and the ciliary muscle
    12. It also innervates skeletal muscle of the superior oblique muscle
    13. It enters the orbit via the superior orbital fissure
    14. Oculomotor nerve palsy is resulted in a characteristic down and out position in the affected eye
    15. Oculomotor nerve palsy is also characterized with presence of ptosis and mydriasis

19. What is true about the trochlear nerve (CN IV):
    1. It emerges from the midbrain and serves four extrinsic eye muscles

2. It emerges from the dorsal aspect of the brainstem at the level of the caudal mesencephalon, below the inferior colliculus
3. It emerges from the junction of the pons and the medulla, medially to the facial nerve
4. It serves the motor function of the lateral rectus muscle of the eyeball
5. It's function is raising of eyelid, eye movements (up, down, medial gaze), regulation of size of the pupil
6. It innervates the superior oblique muscle of the eye
7. Enters/exits brainstem dorsally
8. There are two nuclei for the trochlear nerve
9. There are four nuclei for the trochlear nerve (ventral, dorsal, inferior, superior)
10. There is only one motor nucleus for the trochlear nerve
11. It controls the sphincter pupillae muscle and the ciliary muscle
12. It also innervates skeletal muscle of the inferior oblique muscle
13. It enters the orbit via the superior orbital fissure
14. Injury to the trochlear nerve cause weakness of downward eye movement with consequent vertical diplopia (double vision)
15. Injury to the trochlear nerve causes diplopia (double vision), due to the unopposed action of the medial rectus muscle, the affected eye is pulled medially

20. What is true about the abducens nerve (CN VI):
    1. It emerges from the midbrain and serves four extrinsic eye muscles
    2. It emerges from the dorsal aspect of the brainstem at the level of the caudal mesencephalon, below the inferior colliculus
    3. It emerges from the junction of the pons and the medulla, medially to the facial nerve
    4. It serves the motor function of the lateral rectus muscle of the eyeball
    5. It's function is raising of eyelid, eye movements (up, down, medial gaze), regulation of size of the pupil
    6. It innervates the superior oblique muscle of the eye
    7. Injury to the abducens nerve causes diplopia (double vision), due to the unopposed action of the medial rectus muscle, the affected eye is pulled medially
    8. It enters the orbit via the inferior orbital fissure
    9. There are four nuclei for the abducens nerve (ventral, dorsal, inferior, superior)
    10. There is only one motor nucleus for the abducens nerve
    11. It controls the sphincter pupillae muscle and the ciliary muscle
    12. It also innervates skeletal muscle of the inferior oblique muscle
    13. It enters the orbit via the superior orbital fissure
    14. Injury to the abducens nerve cause weakness of downward eye movement with consequent vertical diplopia (double vision)
    15. Abducens nerve palsy is also characterized with presence of ptosis and mydriasis

21. What is true about the trigeminal nerve (CN V):
    1. Trigeminal nerve is a sensory cranial nerve
    2. It has three major branches (ophthalmic, maxillary and mandibular nerves)
    3. It emerges from the pons
    4. The ophthalmic branch leaves the skull through the inferior orbital fissure
    5. The maxillary branch leaves the skull through the foramen ovale
    6. The mandibular branch leaves the skull through the foramen rotundum
    7. Injury to the trigeminal nerve causes loss of bitter and sour taste, and impaired swallowing
    8. The ophthalmic branch carries sensory information from the scalp and forehead, the upper eyelid, the conjunctiva and cornea of the eye, the nose, the nasal mucosa, the frontal sinuses and parts of the meninges
    9. The mandibular branch is mixed and also innervates the posterior belly of the digastric muscle, the stylohyoid muscle, and the stapedius muscle of the middle ear
    10. The cell bodies for the afferent nerves are found in the Geniculate ganglion

11. The main motor function of the nerve is motor control of most of the muscles of facial expression
12. The sensory function of the trigeminal nerve is to provide tactile, proprioceptive, and nociceptive afference to the face and mouth
13. The spinal trigeminal nucleus represents pain/temperature/light touch sensation from the face
14. Trigeminal neuralgia is a neuropathic disorder characterized by episodes of intense pain in the face, originating from the trigeminal nerve
15. Dysfunction of the nerve causes an inability to control facial muscles on the affected side

22. What is true about the facial nerve (CN VII):
    1. Facial nerve is a mixed cranial nerve
    2. The nucleus of the motor component of the facial nerve is located in the ventrolateral portion of the pontine tegmentum
    3. The cell bodies for the afferent nerves are found in the geniculate ganglion
    4. The facial nerve has three major motor branches: the ophthalmic nerve, the maxillary nerve and the mandibular nerve
    5. The facial nerve emerges from the anterior portion of the medulla oblongata
    6. The nerve leaves the skull through the central part of the jugular foramen
    7. The facial nerve has the following intracranial branches: tympanic, stylopharyngeal, tonsillar, nerve to carotid sinus, branches to the posterior third of tongue and lingual branches
    8. The facial nerve has the following extracranial branches: posterior auricular nerve, branch to posterior belly of digastric muscle and stylohyoid muscle, five facial branches
    9. The cell bodies for muscular efferent nerves are found in the facial motor nucleus
    10. The cell bodies for the parasympathetic efferent nerves are found in the inferior salivatory nucleus
    11. The main motor function of the nerve is motor control of most of the muscles of facial expression
    12. The sensory function of the facial nerve is to provide tactile, proprioceptive, and nociceptive afference to the face and mouth
    13. The facial nerve receives taste sensations from the anterior two-thirds of the tongue
    14. The facial nerve also receives general sensation from the anterior two-thirds of the tongue
    15. Dysfunction of the nerve causes an inability to control facial muscles on the opposite (contralateral to the damaged nerve) side

23. What is true about the vestibulocochlear nerve (CN VIII):
    1. The nerve transmits sound and equilibrium information from the inner ear to the brain
    2. The nerve consists mostly of bipolar neurons and splits into three large divisions: the cochlear nerve, the intermediate nerve and the vestibular nerve
    3. The cell bodies for the afferent nerves are found in the otic ganglion
    4. Scarpa's ganglion (vestibular ganglion) is the location of the primary afferent neurons associated with equilibrium
    5. Gasser's ganglion is the location of the primary afferent neurons associated with hearing
    6. Spiral ganglion is the location of the primary afferent neurons associated with hearing
    7. Central sensory processes from bipolar sensory neurons located in Scarpa's ganglion aggregate together to form the vestibular nerve
    8. Central sensory processes of primary afferent neurons associated with equilibrium enter the lower medulla
    9. Receptor cells associated with hearing are located in the organ of Corti
    10. Central sensory processes of primary afferents neurons associated with hearing have an apparent origin from the pons
    11. Damage to the vestibulocochlear nerve may cause the following symptoms: dysdiadochokinesia, intention tremor, dyssynergia, dysmetria
    12. Hearing loss is a primary symptom of impairment of the cochlear part of the nerve
    13. Impairment of the vestibulocochlear nerve often includes the following symptoms: hearing loss, vertigo, astasia/abasia, nystagmus
    14. The human cochlea contains hair cells - specialized receptor cells transduce mechanical (auditory) stimuli into electrical signals

15. The vestibular system participates in the maintenance of stance and body posture, coordination of body, head, and eye movements

24. Indicate components of the auditory pathway:
    1. Cochlear hair cells
    2. Static labyrinth
    3. Scarpa's ganglion
    4. Bipolar cells of cochlear ganglion
    5. Cochlear (CN VIII) nerve
    6. Lateral geniculate body
    7. Medial geniculate body
    8. Saccule and the utricle
    9. Lateral lemniscus
    10. Cochlear nuclei
    11. Superior colliculi
    12. Trapezoid body
    13. Inferior colliculi
    14. Medial lemniscus
    15. Heschl gyrus

25. What is true about the glossopharyngeal nerve (CN IX):
    1. The nerve is a mixed nerve that carries afferent sensory and efferent motor information
    2. The nerve exits the brainstem out from the sides of the pons
    3. The glossopharyngeal nerve passes through the jugular foramen
    4. The nerve has the following extracranial branches: posterior auricular nerve, branch to posterior belly of digastric muscle and stylohyoid muscle, five facial branches
    5. The nerve provides parasympathetic innervation of the parotid gland via the otic ganglion
    6. The glossopharyngeal nerve receives taste sensations from the anterior two-thirds of the tongue
    7. The nerve also receives general sensation from the anterior two-thirds of the tongue
    8. The nerve has the following main branches: tympanic, stylopharyngeal, tonsillar, nerve to carotid sinus, branches to the tongue and lingual branches
    9. It provides general sensory information from the skin of the external ear, internal surface of the tympanic membrane, upper pharynx, and the posterior one-third of the tongue
    10. The cell bodies for the afferent nerves are found in the geniculate ganglion
    11. The sensory function of the nerve is to provide tactile, proprioceptive, and nociceptive afference to the face and mouth
    12. The glossopharyngeal nerve carries visceral sensory information from the carotid sinus and carotid body
    13. Injury to the nerve may cause loss of bitter and sour taste, and impaired swallowing
    14. The recurrent laryngeal nerve is a branch of the glossopharyngeal nerve that supplies all the intrinsic muscles of the larynx
    15. The glossopharyngeal nerve contributes to cardiac, pulmonary, and esophageal plexuses

26. Indicate cranial nerves originating in the pons:
    1. CN I
    2. CN II
    3. CN III
    4. CN IV
    5. CN V
    6. CN VI
    7. CN VII
    8. CN VIII
    9. CN IX
    10. CN X

11. CN XI
12. CN XII

27. Indicate the motor nuclei of motor/mixed cranial nerves that receive BILATERAL motor cortical inputs:
    1. Upper part of the motor nucleus of the CN VII
    2. Nucleus ambiguus of the CN X
    3. Motor nucleus of the CN XII
    4. Motor nucleus of the CN V
    5. Lower part of the motor nucleus of the CN VII

	28. Which cranial nerve is affected: 1. CN I 2. CN II 3. CN III 4. CN IV 5. CN V 6. CN VI 7. CN VII 8. CN VIII 9. CN IX 10. CN X 11. CN XI 12. CN XII

29. As a result of an infection, a 56-year-old woman experiences a loss of taste affecting the front of her tongue and the ability to smile. If the sensory loss involves damage of cell bodies, which of the following specific group of neurons would be so affected:
    1. Otic ganglion
    2. Pterygopalatine ganglion
    3. Gasser's ganglion
    4. Nodose (inferior) ganglion
    5. Superior ganglion
    6. Geniculate ganglion
    7. Ciliary ganglion
    8. Submandibular ganglion
    9. Pterygopalatine ganglion
    10. Scarpa's ganglion

30. The following test is administered to a patient: a cotton applicator is gently applied to the cornea of the eye as the patient is asked to look upward. The patient does not blink in response to stimulation of the cornea. Which of the following cranial nerves are normally involved in this reflex:
    1. Nerves II and III
    2. Nerves III and V
    3. Nerves III and IV
    4. Nerves V and VII
    5. Nerves VII and IX
    6. Nerves II and VI
    7. Nerves V and X
    8. Nerves VII and X
    9. Nerves V and IX
    10. Nerves II and X