The State Medical and Pharmaceutical University "Nicolae Testemitanu"
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Department of
Human
Anatomy

The functional Anatomy of the Cranial nerves

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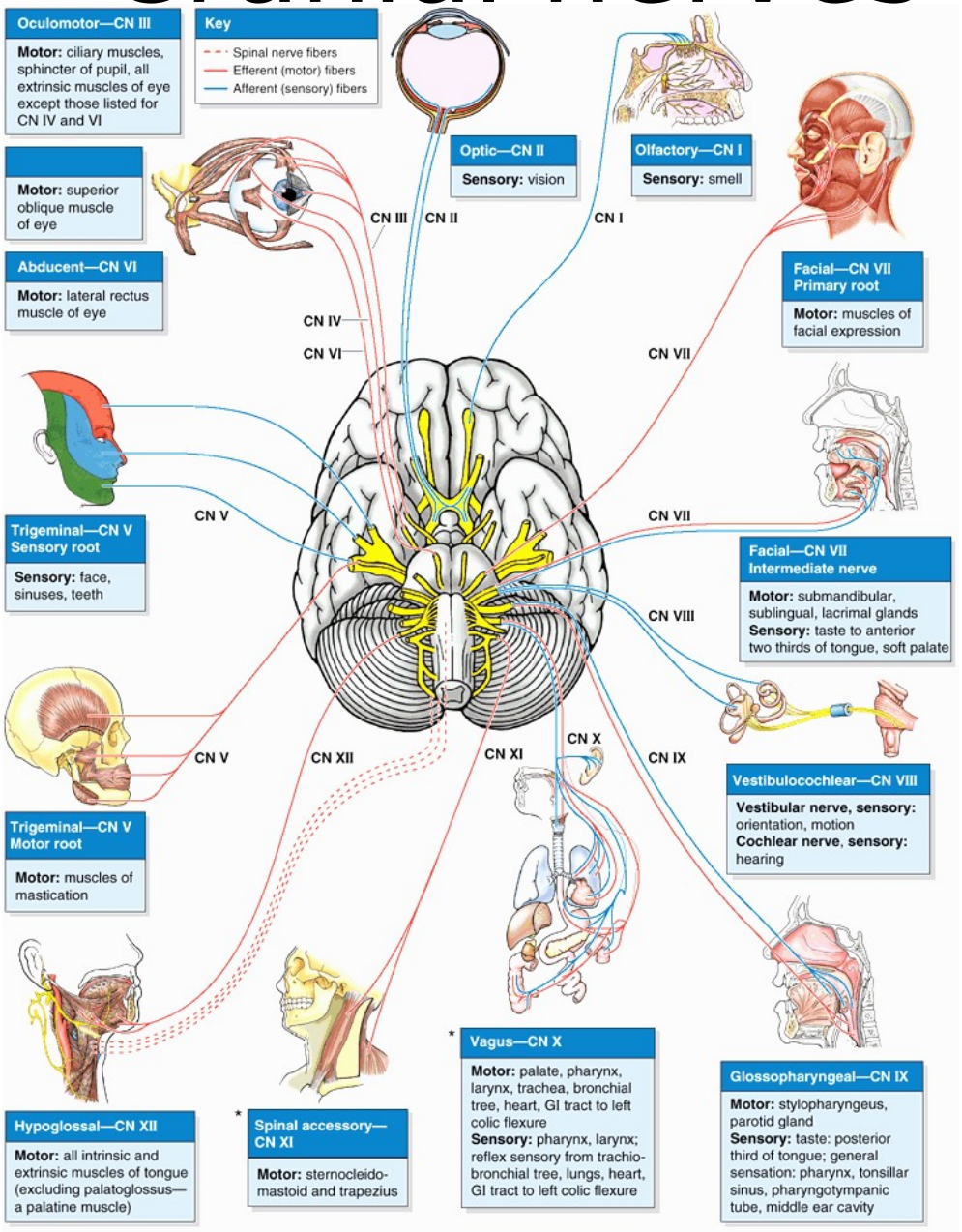
Cranial nerves

Like spinal nerves, **cranial nerves** are bundles of sensory or motor fibers that innervate muscles or glands; carry impulses from sensory receptors, or show a combination of these fiber types.

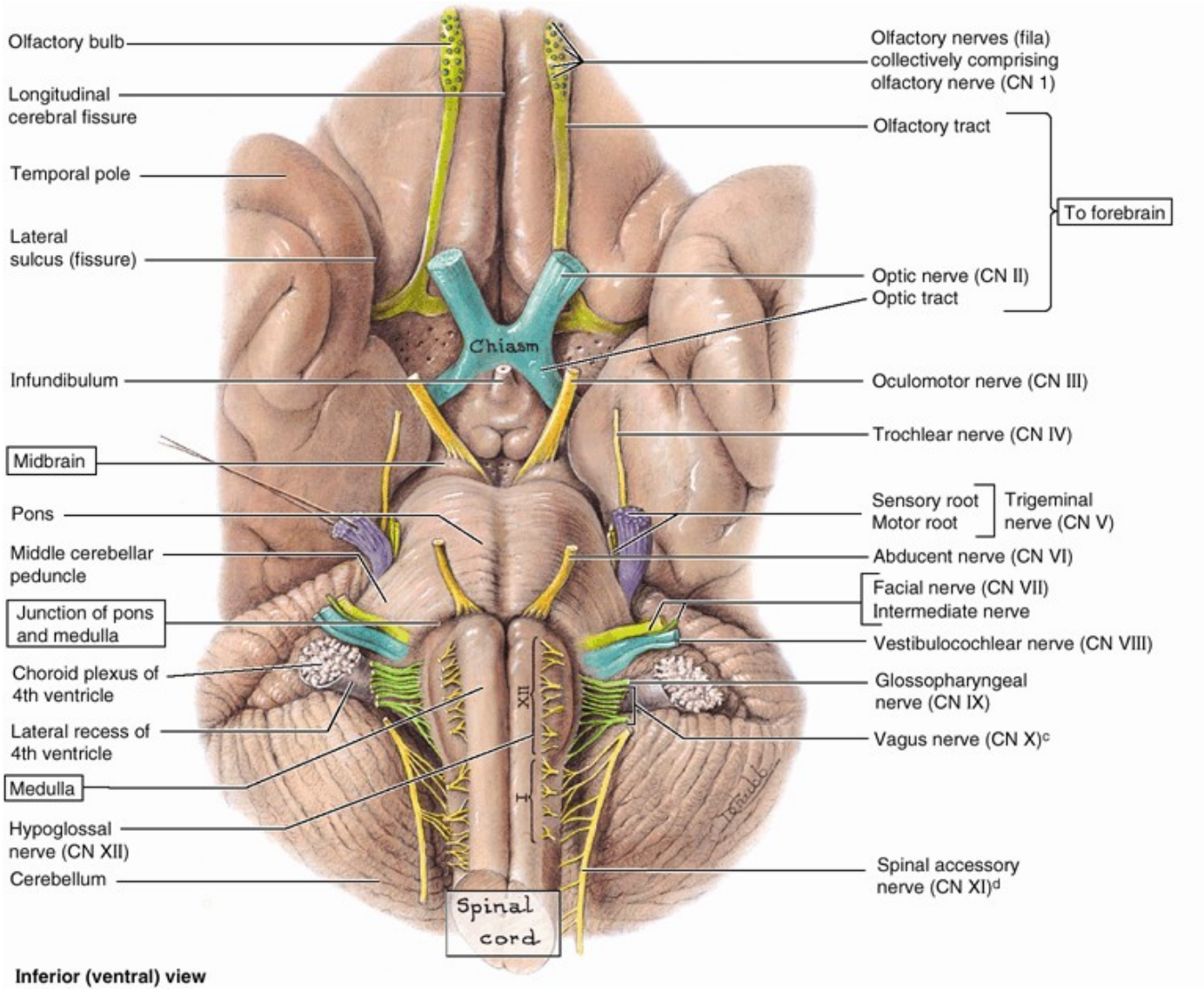
They are called **cranial nerves** because they emerge through foramina or fissures in the cranium and are covered by tubular sheaths derived from the cranial meninges.

There are **twelve** pairs of cranial nerves, which are numbered I to XII, from rostral to caudal, according to their attachment to the brain and penetration of the cranial dura. Their names reflect their general distribution or function.

Cranial nerves

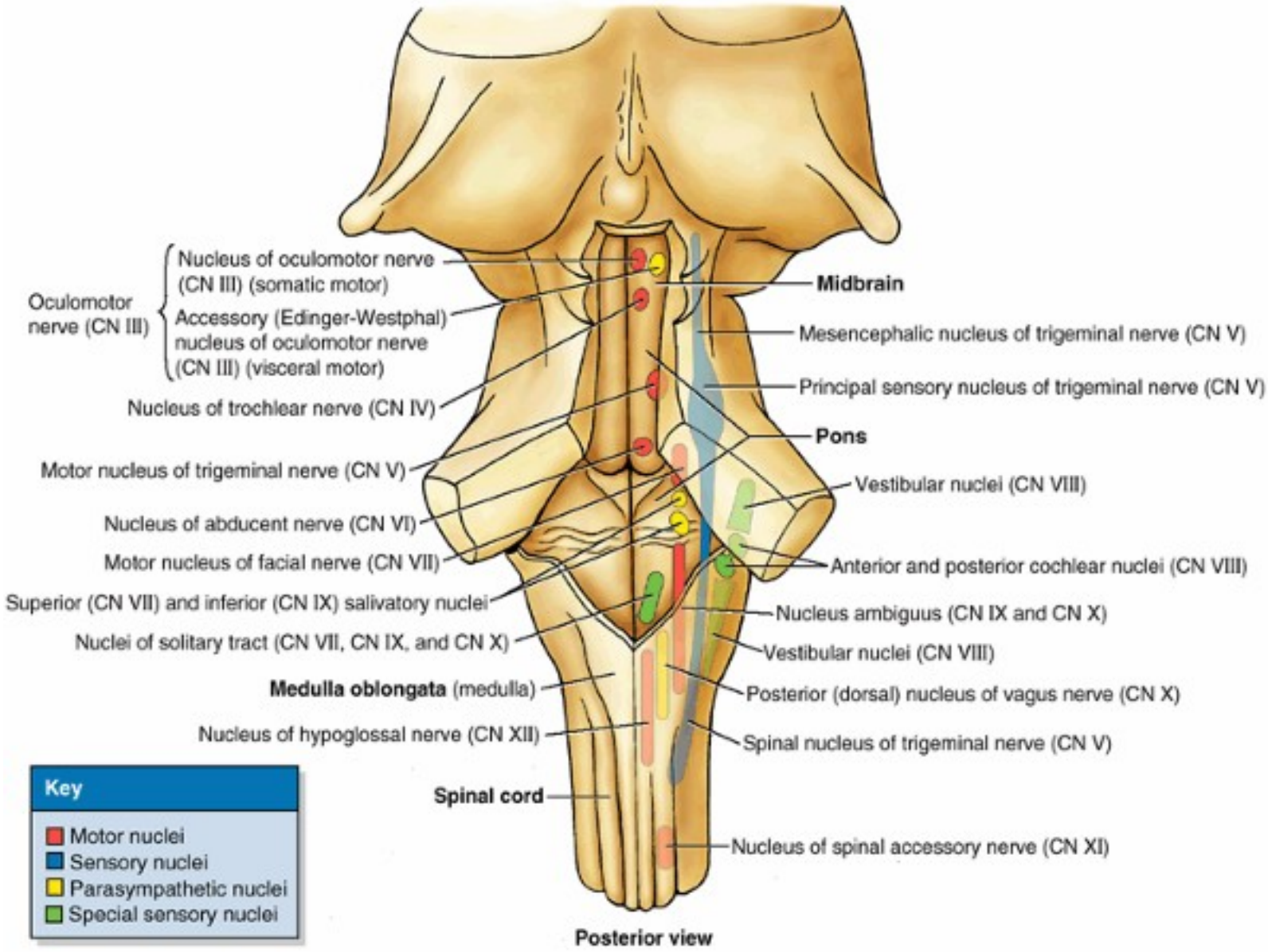


Cranial nerves



Inferior (ventral) view

Cranial nerves



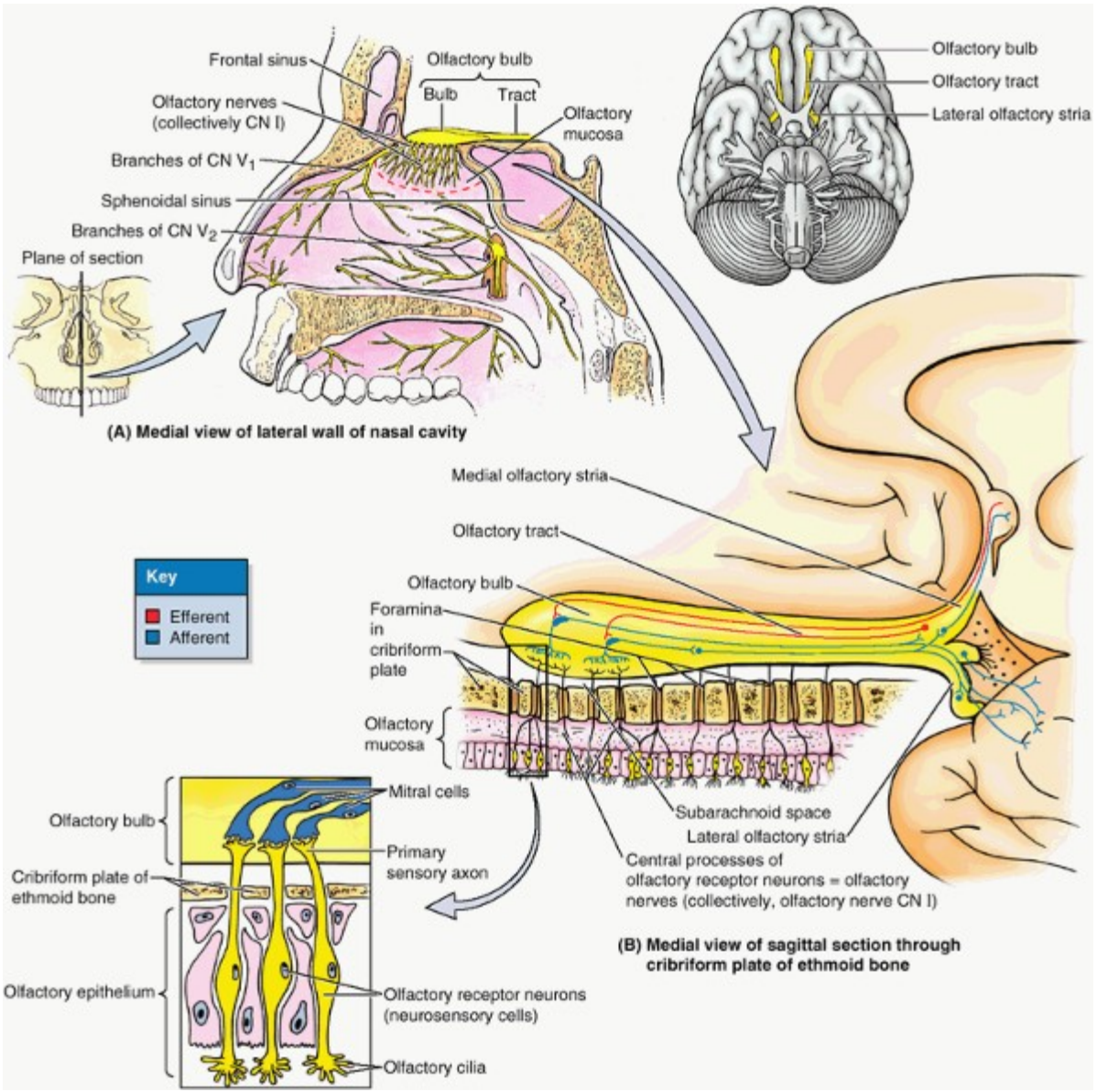
Cranial nerves

Olfactory Nerve (CN I)

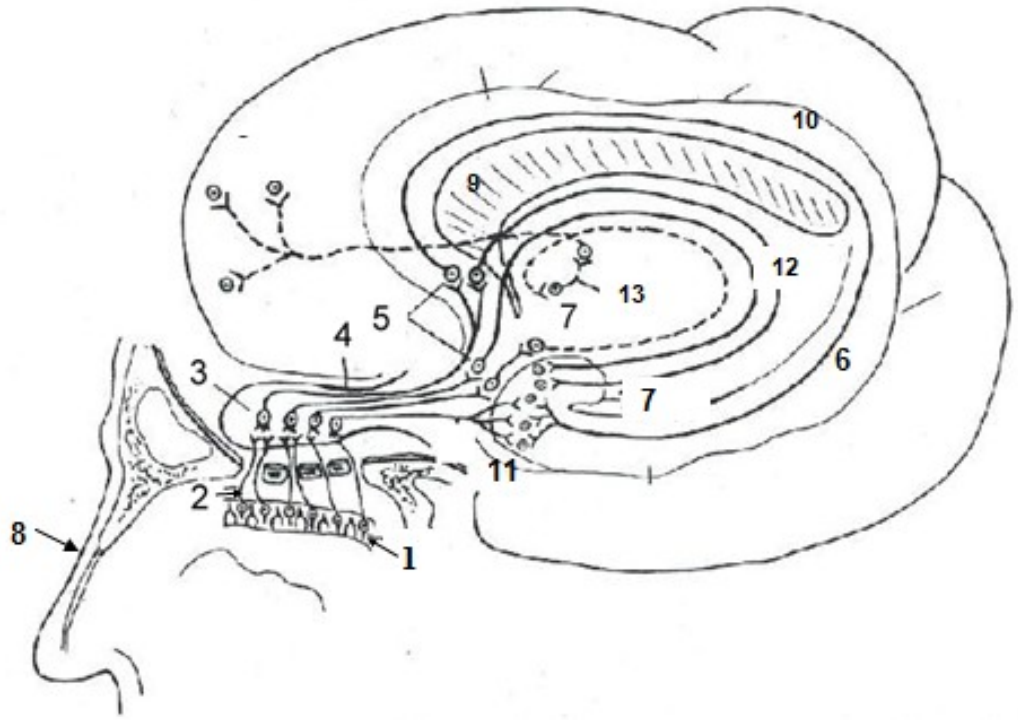
Function: Special sensory (special visceral afferent) that is, the special sense of smell. Olfaction is the sensation of odors that results from the detection of odorous substances aerosolized in the environment .

The cell bodies of olfactory receptor neurons are located in the olfactory organ (the olfactory part of the nasal mucosa or olfactory area), which is located in the roof of the nasal cavity and along the nasal septum and medial wall of the superior nasal concha. Olfactory receptor neurons are both receptors and conductors. The apical surfaces of the neurons possess fine olfactory cilia, bathed by a film of watery mucus secreted by the olfactory glands of the epithelium. The cilia are stimulated by molecules of an odiferous gas dissolved in the fluid.

Cranial nerves

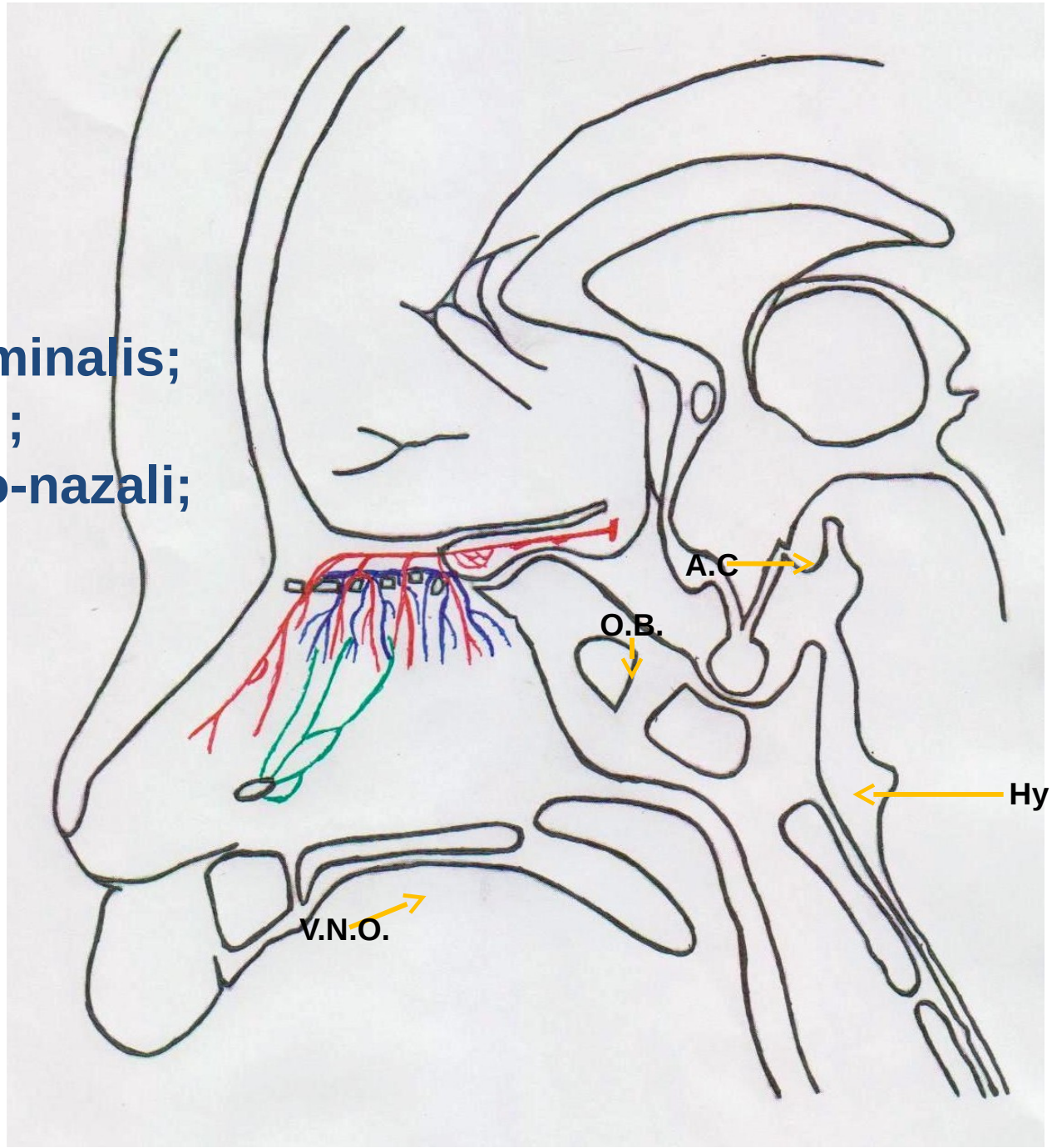


Conducting pathways of the olfactory analyzer



1 – neuronum I (cellulae bipolares neurosensoriales);
2 – filae olfactoriae;
3 – neuronum II (cellulae mitrales bulbi olfactorii);
4 – tractus olfactorius;
5 – neuronum III (trigonum olfactorium, substantia perforata anterior, septum pellucidum);
6 – gyrus parahyppocampalis;
7 – uncus, corpus amygdaloideum et area subcallosa;
8 – nasus externus;
9 – corpus callosum;
10 – gyrus cinguli;
11 – gyrus dentatus;
12 – fornix;
13 – thalamus.

- nervus terminalis;
- fila olfactoria ;
- nervii vomero-nazali;



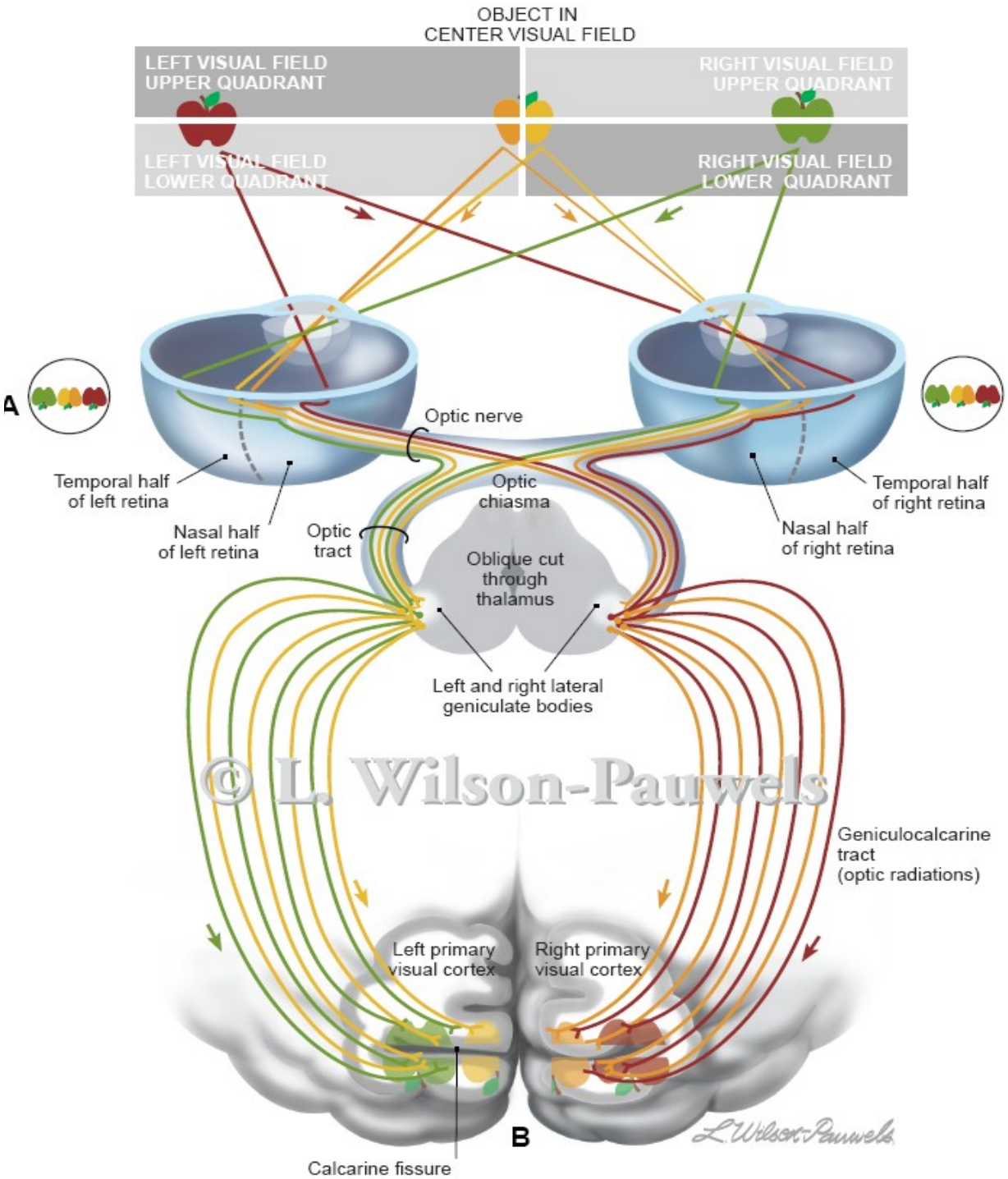
Cranial nerves

Optic Nerve (CN II)

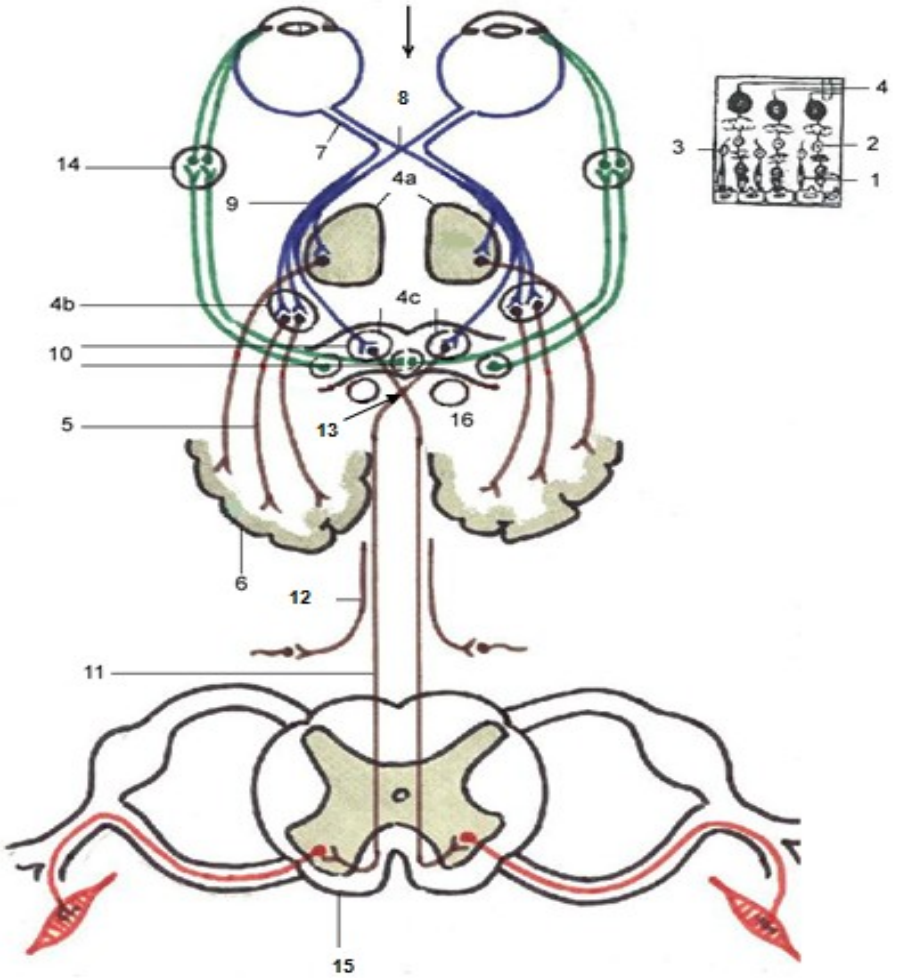
Function: Special sensory (special somatic afferent) that is, the special sense of vision.

Although they are officially nerves by convention, the optic nerves (CN II) develop in a completely different manner from the other cranial nerves. The structures involved in receiving and transmitting optical stimuli (the optical fibers and neural retina, together with the pigmented epithelium of the eyeball) develop as evaginations of the diencephalon. The optic nerves are paired, anterior extensions of the forebrain (diencephalon) and are, therefore, actually CNS fiber tracts formed by axons of retinal ganglion cells. In other words, they are third-order neurons, with their cell bodies located in the retina.

The nerve passes posteromedially in the orbit, exiting through the optic canal to enter the middle cranial fossa, where it forms the optic chiasm (Lat. chiasma opticum). Here, fibers from the nasal (medial) half of each retina decussate in the chiasm and join uncrossed fibers from the temporal (lateral) half of the retina to form the optic tract. The partial crossing of optic nerve fibers in the chiasm is a requirement for binocular vision, allowing depth-of-field perception (three-dimensional vision). Thus fibers from the right halves of both retinas form the left optic tract. The decussation of nerve fibers in the chiasm results in the right optic tract conveying impulses from the left visual field and vice versa. The visual field is what is seen by a person who has both eyes wide open and who is looking straight ahead. Most fibers in the optic tracts terminate in the lateral geniculate bodies of the thalamus. From these nuclei, axons are relayed to the visual cortices of the occipital lobes of the brain.


OBJECT IN
CENTER VISUAL FIELD
LEFT VISUAL FIELD
UPPER QUADRANT
RIGHT VISUAL FIELD
UPPER QUADRANT
LEFT VISUAL FIELD
LOWER QUADRANT
RIGHT VISUAL FIELD
LOWER QUADRANT
A
Optic nerve
Temporal half
of left retina
Nasal half
of left retina
Optic
tract
Optic
chiasma
Oblique cut
through
thalamus
Temporal half
of right retina
Nasal half
of right retina
Left and right lateral
geniculate bodies
© L. Wilson-Pauwels
Geniculocalcarine
tract
(optic radiations)
Left primary
visual cortex
Right primary
visual cortex
B
Calcarine fissure
L. Wilson-Pauwels

Conducting pathways of the optic analyzer



1 – epitheliocyti (neurosensorii) coniferi et bacilliferi;
2 – neuronum I (neuron bipolare);
3 – neuronum II (neuron ganglionare multipolare);
4 – neuronum III:
4a – pulvinar thalami;
4b – corpus geniculatum laterale;
4c – colliculi superiores;
5 – radiatio optica (Gratiolet);
6 – regio sulci calcarini;
7 – nervus opticus;
8 – chiasma optica;
9 – tractus opticus;
10 – nuclei n. oculomotorii;
11 – tractus tectospinalis;
12 – tractus tectobulbaris;
13 – decussatio dorsalis tegmenti (Meynert);
14 – ganglion ciliare;
15 – medulla spinalis;
16 – colliculi inferiores.

Cranial nerves

Oculomotor Nerve (CN III)

Functions: Somatic motor (general somatic efferent) and visceral motor (general visceral efferent parasympathetic).

Nuclei: There are two oculomotor nuclei, each serving one of the functional components of the nerve. The somatic motor nucleus of the oculomotor nerve is in the midbrain. The visceral motor (parasympathetic) accessory (Edinger-Westphal) nucleus of the oculomotor nerve lies dorsal to the rostral two thirds of the somatic motor nucleus.

The oculomotor nerve (CN III) provides the following:

Motor to the striated muscle of four of the six extraocular muscles (superior, medial, and inferior recti and inferior oblique) and superior eyelid (L. levator palpebrae superioris); hence the nerve's name.

Proprioceptive to the muscles listed above.

Parasympathetic through the ciliary ganglion to the smooth muscle of the sphincter of the pupil (L. sphincter pupillae), which causes constriction of the pupil and ciliary body, which produces accommodation (allowing the lens to become more rounded) for near vision.

CN III is the chief motor nerve to the ocular and extraocular muscles. It emerges from the midbrain, pierces the dura lateral to the sellar diaphragm roofing over the hypophysis, and then runs through the roof and lateral wall of the cavernous sinus.

CN III leaves the cranial cavity and enters the orbit through the superior orbital fissure. Within this fissure, CN III divides into a **superior division** (which supplies the superior rectus and levator palpebrae superioris) and an **inferior division** (which supplies the inferior and medial rectus and inferior oblique). The inferior division also carries presynaptic parasympathetic (visceral efferent) fibers to the ciliary ganglion, where they synapse. Postsynaptic fibers from this ganglion pass to the eyeball in the short ciliary nerves to innervate the ciliary body and sphincter of the pupil.

Cranial nerves

Trochlear Nerve (CN IV)

Functions: Somatic motor (general somatic efferent) and proprioceptive to one extraocular muscle (superior oblique).

Nucleus: The nucleus of the trochlear nerve is located in the midbrain, immediately caudal to the oculomotor nucleus.

The trochlear nerve (CN IV) is the **smallest** cranial nerve. It emerges from the **posterior surface of the midbrain** (the only cranial nerve to do so), passing anteriorly around the brainstem, running the **longest** intracranial (subarachnoid) course of the cranial nerves. It pierces the dura mater at the margin of the cerebellar tentorium (L. tentorium cerebelli) and passes anteriorly in the lateral wall of the cavernous sinus.

CN IV continues past the sinus to pass through the superior orbital fissure into the orbit, where it supplies the superior oblique the only extraocular muscle that uses a pulley, or trochlea, to redirect its line of action (hence the nerve's name).

Cranial nerves

Abducent Nerve (CN VI)

Functions: Somatic motor (general somatic efferent and proprioceptive) to one extraocular muscle (lateral rectus).

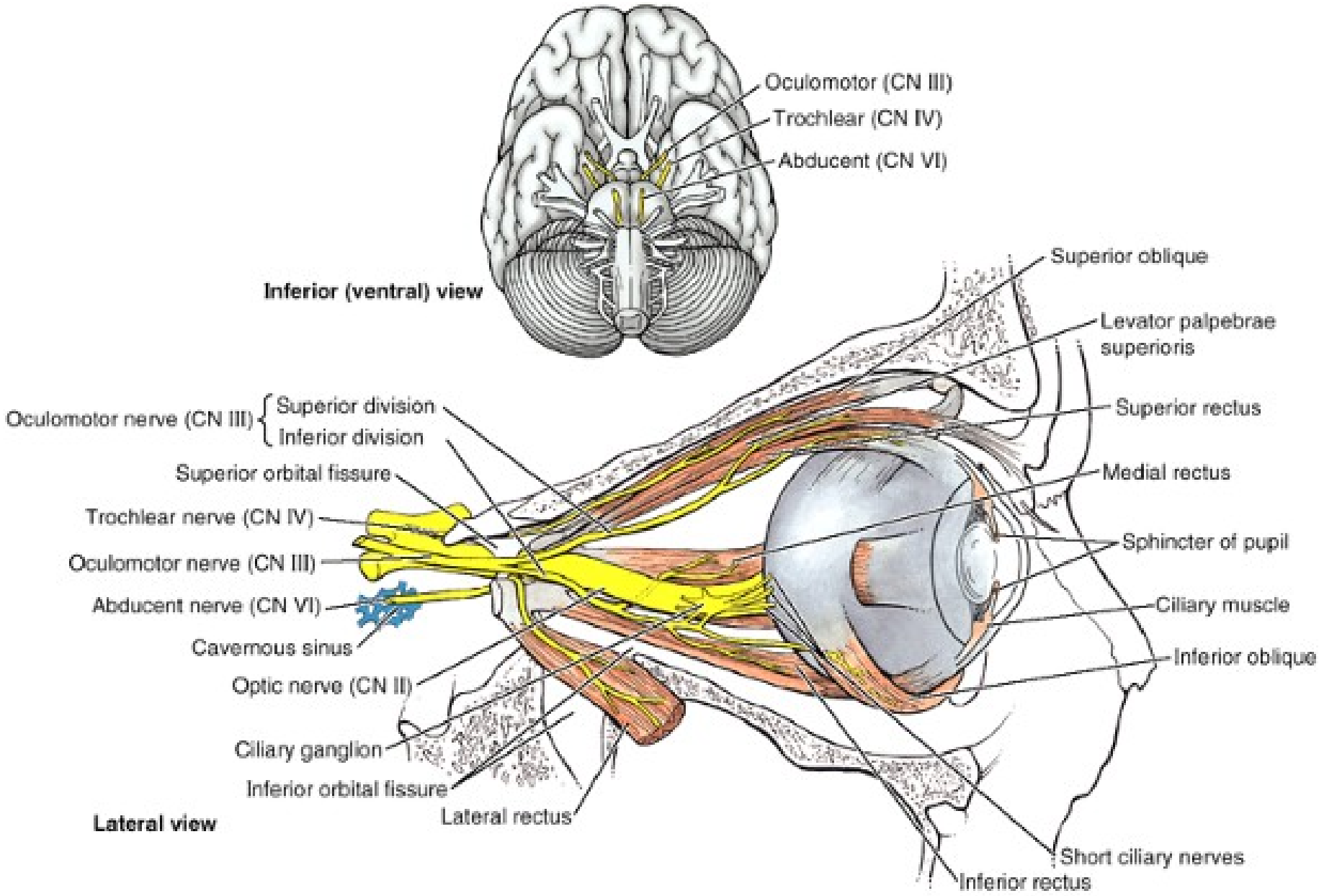
Nucleus: The abducent (L. abducens) nucleus is in the pons near the median plane.

The abducent nerves (CN VI) emerge from the brainstem between the pons and the medulla and traverse the pontine cistern of the subarachnoid space, straddling the basilar artery. Each abducent nerve then pierces the dura to run the longest intradural course within the cranial cavity of the cranial nerves that is, its point of entry into the dura covering the clivus is the most distant from its exit from the cranium via the superior orbital fissure.

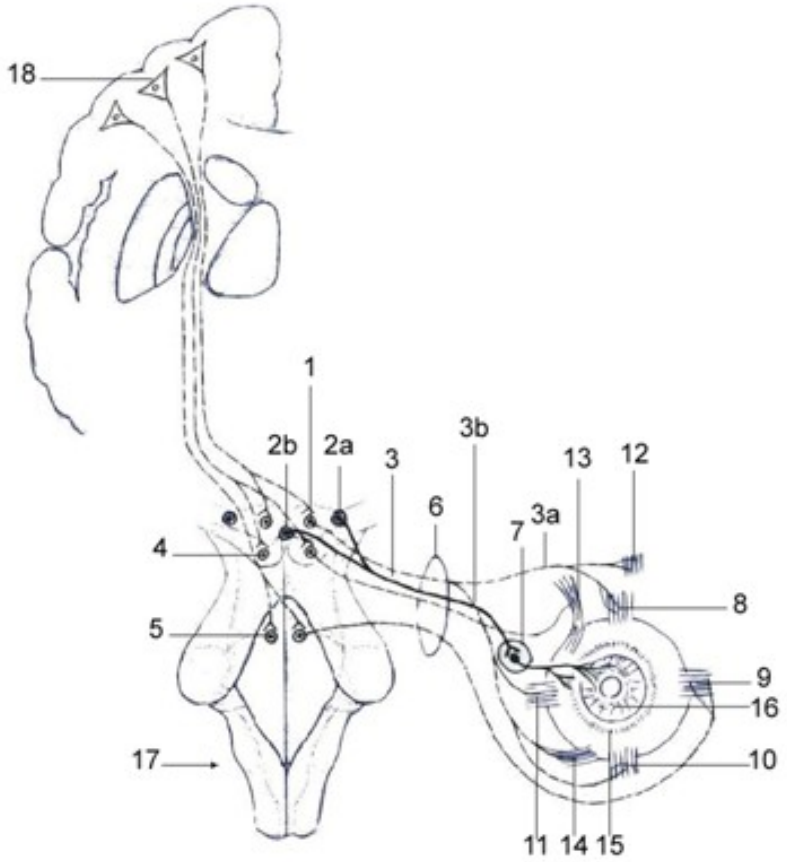
During its intradural course, it bends sharply over the crest of the petrous part of the temporal bone and then courses through the cavernous sinus, surrounded by the venous blood in the same manner as the internal carotid artery, which it parallels in the sinus.

CN VI traverses the common tendinous ring (L. anulus tendineus communis) as it enters the orbit (see Chapter 7), running on and penetrating the medial surface of the lateral rectus, which abducts the eye (this function being the basis for the name of the nerve).

Cranial nerves



Innervation of the muscles of the eyeball



1 – nucl. n. oculomotorii (III);
2a – n. accessorius (Якубович-Edinger-Westfal);
2b – nucleus impar (Perl) (III);
3 – nervus oculomotorius:
3a – ramus superior;
3b – ramus inferior;
4 – nucl.n. trochlearis (IV);
5 – nucl.n. abducentis(VI);
6 – fissura orbitalis superior;
7 – ganglion ciliare;
8 – m. rectus superior;
9 – m. rectus lateralis;
10 – m. rectus inferior;
11 – m. rectus medialis;
12 – m. levator palpebrae superioris;
13 – m. obliquus superior;
14 – m. obliquus inferior;
15 – m. ciliaris;
16 – m. sphincter pupillae;
17 – truncus cerebri;
18 – neurocytus pyramidalis magnus (Betz).

Cranial nerves

Trigeminal Nerve (CN V)

Functions: General sensory (general somatic afferent) and branchial motor (special visceral efferent) to derivatives of the 1st pharyngeal arch.

Nuclei: There are four trigeminal nuclei one motor and three sensory.

The trigeminal nerve (CN V) is the **largest** cranial nerve.

It emerges from the lateral aspect of the pons by a large sensory root and a small motor root. The roots of CN V are comparable to the posterior and anterior roots of spinal nerves.

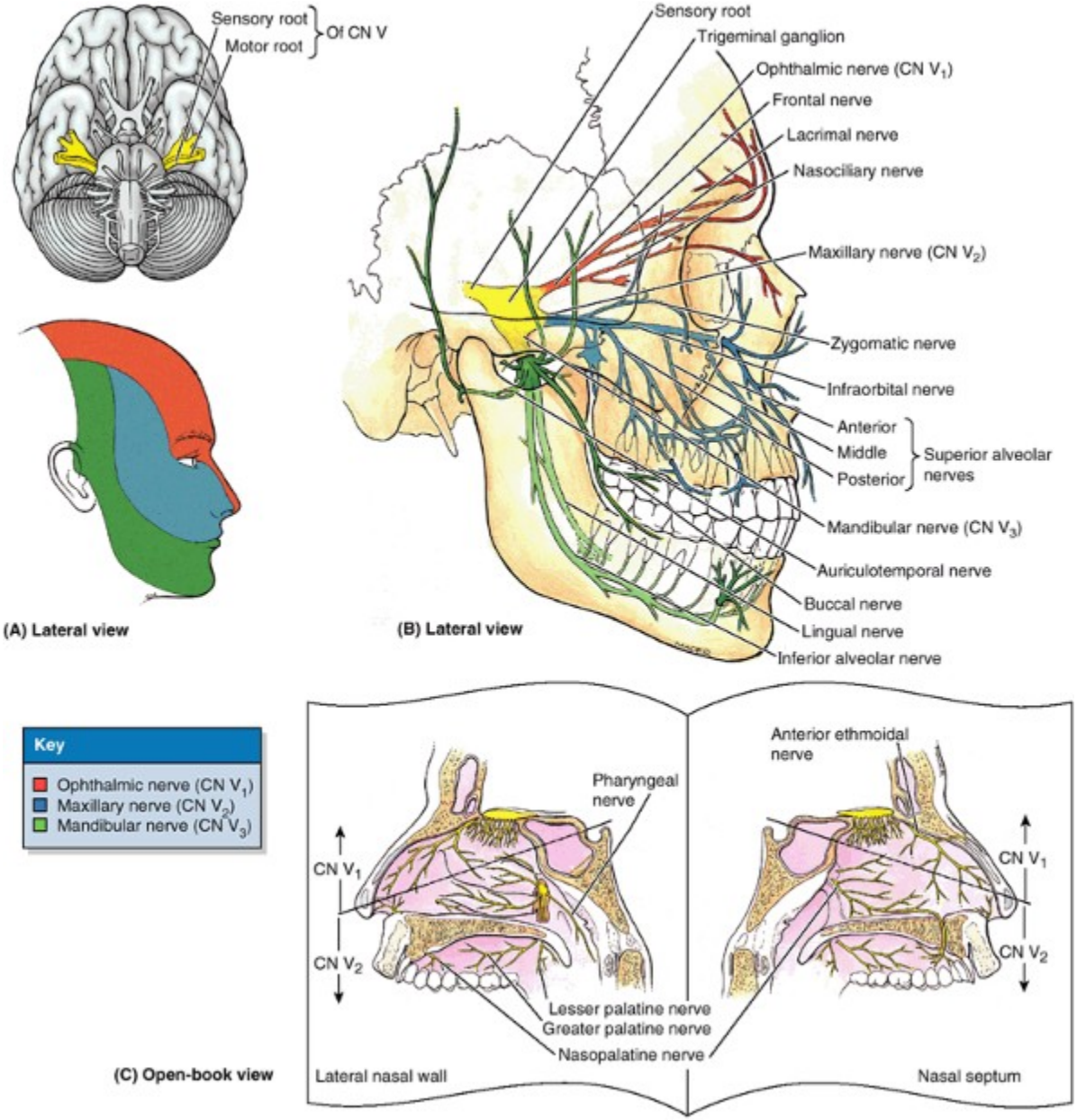
CN V is the principal general sensory nerve for the head (face, teeth, mouth, nasal cavity, and dura of the cranial cavity). The large **sensory root** of CN V is composed mainly of the central processes of the pseudounipolar neurons that make up the trigeminal ganglion. The trigeminal ganglion is flattened and crescent shaped (hence its unofficial name, semilunar ganglion) and is housed within a dural recess (trigeminal cave) lateral to the cavernous sinus. The peripheral processes of the ganglionic neurons form three nerves or divisions:

ophthalmic nerve (CN V1), maxillary nerve (CN V2), and sensory component of the mandibular nerve (CN V3). Maps of the zones of cutaneous innervation by the three divisions resemble the dermatome maps for cutaneous innervation by spinal nerves. Unlike dermatomes, however, there is little overlap in innervation by the divisions; lesions of a single nerve result in clearly demarcated areas of numbness.

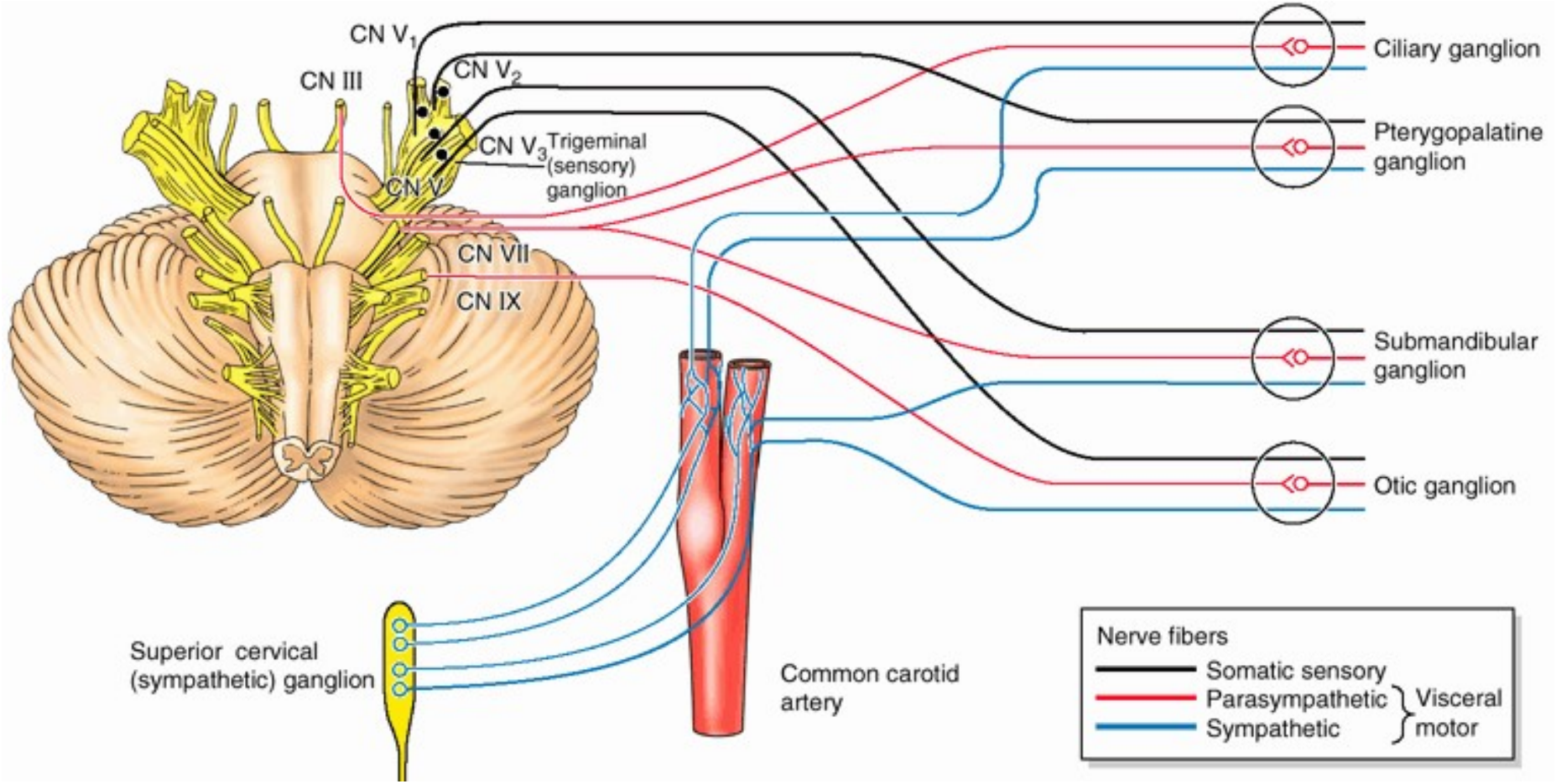
The fibers of the **motor root** of CN V pass inferior to the trigeminal ganglion along the floor of the trigeminal cave, bypassing the ganglion just as the anterior roots of spinal nerves bypass the spinal sensory ganglia. They are distributed exclusively via the mandibular nerve (CN V3), blending with the sensory fibers as the nerve traverses the foramen ovale in the cranium; entering branches pass to the muscles of mastication, mylohyoid, anterior belly of the digastric, tensor veli palatini, and tensor tympani, which are derived from the 1st pharyngeal arch.

Although CN V conveys no presynaptic parasympathetic (visceral efferent) fibers from the CNS, all four parasympathetic ganglia are associated with the divisions of CN V. Postsynaptic parasympathetic fibers from the ganglia join branches of CN V and are carried to their destinations along with the CN V sensory and motor fibers.

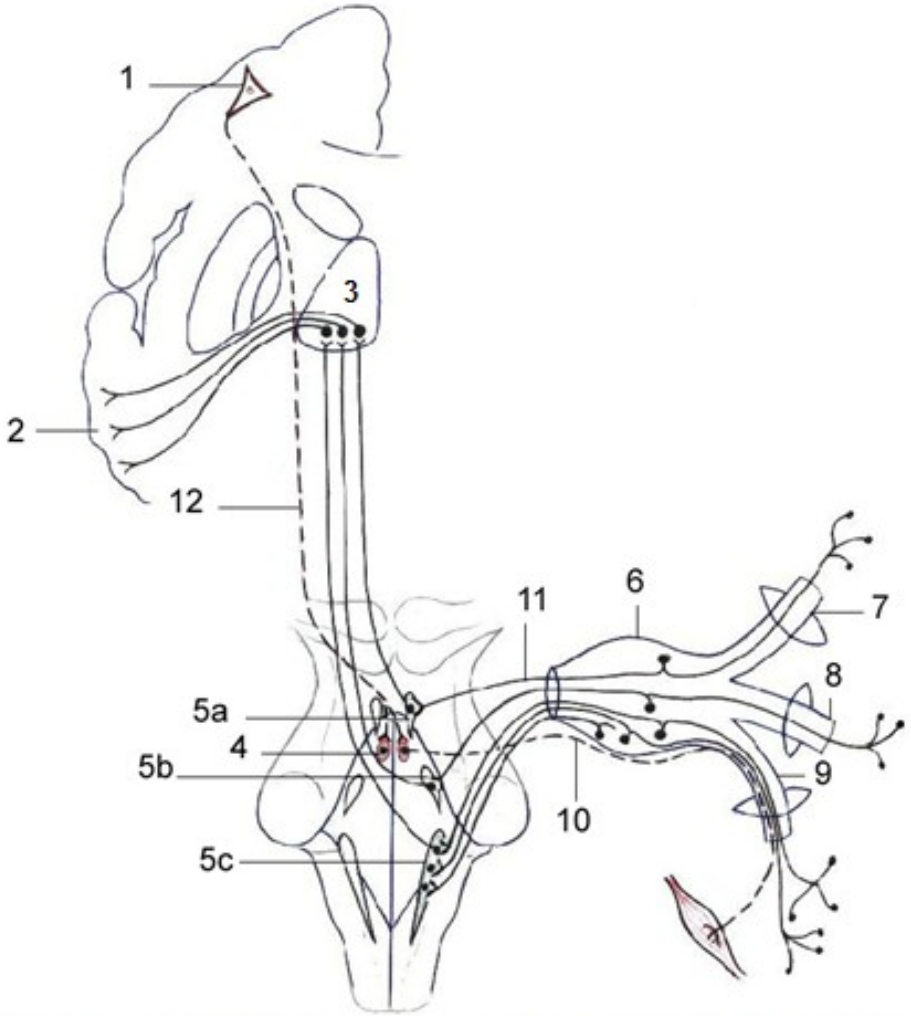
Cranial nerves



Cranial nerves



Conducting pathways of the trigeminal nerve (V)



1 – neuronum I (neurocytus pyramidalis magnus, Betz) (gyrus precentralis);
2 – gyrus postcentralis;
3 – neuronum III (thalamus opticus):
4 – nucl. n. trigemini (V);
5 – nuclei sensoriales n. trigemini (V);
5a – nucl. mesencephalicus n. trigemini (V);
5b – nucl. pontinus (V);
5c – nucl. spinalis nervi trigemini (V);
6 – ganglion trigeminale (Gasser);
7 – n. ophthalmicus;
8 – n. maxillaris;
9 – n. mandibularis;
10 – radix motoria n. trigemini;
11 – radix sensoria n. trigemeni;
12 – tractus corticonuclearis.

Cranial nerves

Facial Nerve (CN VII)

Functions: Sensory (special visceral afferent and general somatic afferent), motor (branchial motor or special visceral efferent), and parasympathetic (general visceral efferent). It also carries proprioceptive fibers from the muscles it innervates.

Nuclei: The motor nucleus of the facial nerve is a branchiomotor nucleus in the ventrolateral part of the pons. The cell bodies of the primary sensory neurons are in the geniculate ganglion. The central processes of those concerned with taste end in the nuclei of the solitary tract in the medulla. The processes of those concerned with general sensations (pain, touch, and thermal) from around the external ear end in the spinal nucleus of the trigeminal nerve.

The facial nerve (CN VII) emerges from the junction of the pons and medulla as two divisions, the motor root and the intermediate nerve. The **larger motor root** (facial nerve proper) innervates the muscles of facial expression, and the **smaller intermediate nerve** (L. nervus intermedius) carries taste, parasympathetic, and somatic sensory fibers. During its course, CN VII traverses the posterior cranial fossa, internal acoustic meatus, facial canal, stylomastoid foramen of the temporal bone, and parotid gland. After traversing the internal acoustic meatus, the nerve proceeds a short distance anteriorly within the temporal bone and then turns abruptly posteriorly to course along the medial wall of the tympanic cavity. The sharp bend is the geniculum of the facial nerve (L. genu, knee), sometimes called the external genu of CN VII, the site of the geniculate ganglion (sensory ganglion of CN VII). While traversing the temporal bone within the facial canal, CN VII gives rise to the: **Greater petrosal nerve. Nerve to the stapedius. Chorda tympani nerve.**

Then, after running the longest intraosseous course of any cranial nerve, CN VII emerges from the cranium via the stylomastoid foramen; gives off the posterior auricular branch; enters the parotid gland; and forms the **parotid plexus**, which gives rise to the following five terminal motor branches: **temporal, zygomatic, buccal, marginal mandibular, and cervical**.

Branchial Motor As the nerve of the 2nd pharyngeal arch, the facial nerve supplies striated muscles derived from its mesoderm, mainly the muscles of facial expression and auricular muscles. It also supplies the posterior bellies of the digastric, stylohyoid, and stapedius muscles.

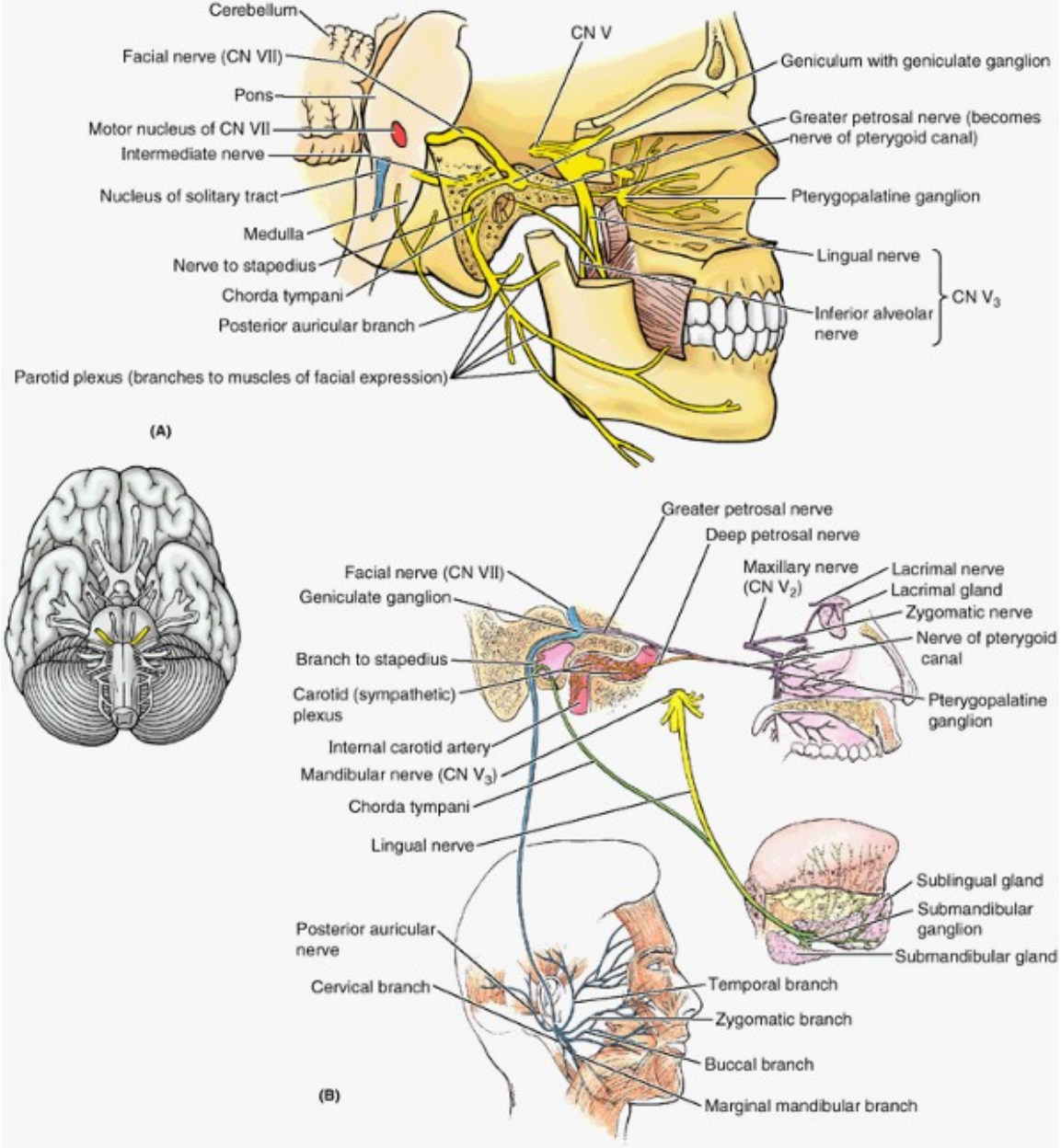
Presynaptic Parasympathetic

CN VII provides presynaptic parasympathetic fibers to the pterygopalatine ganglion for innervation of the lacrimal mucous glands and to the submandibular ganglion for innervation of the sublingual and submandibular salivary glands. The pterygopalatine ganglion is associated with the maxillary nerve (CN V2), which distributes its postsynaptic fibers, whereas the submandibular ganglion is associated with the mandibular nerve (CN V3). Parasympathetic fibers synapse in these ganglia, whereas sympathetic and other fibers pass through them.

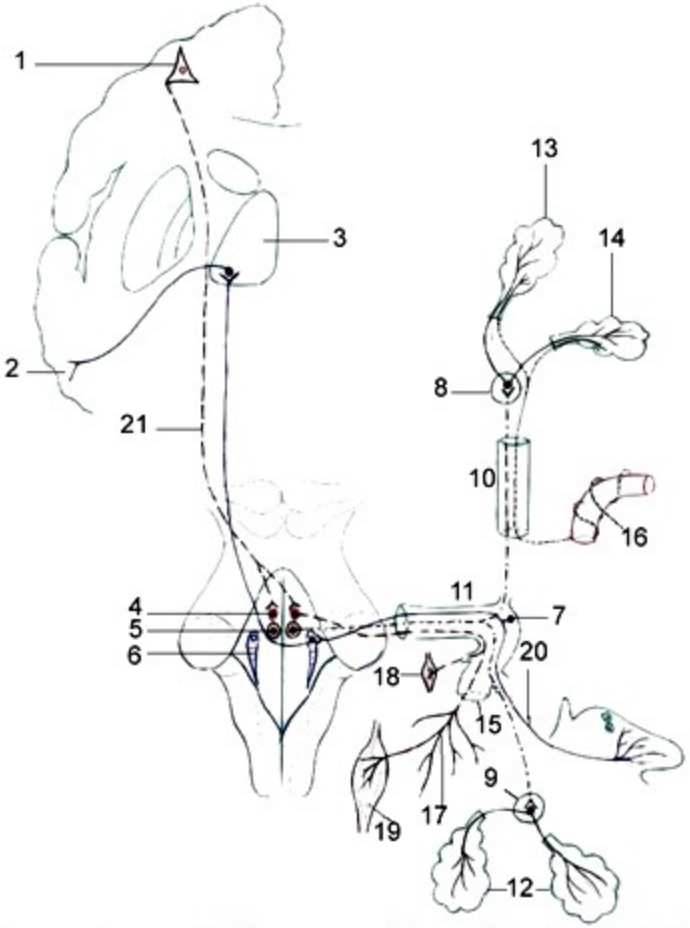
General Sensory Some fibers from the geniculate ganglion supply a small area of the skin of the concha of the auricle, close to external acoustic meatus.

Taste (Special Sensory) Fibers carried by the chorda tympani join the lingual nerve to convey taste sensation from the anterior two thirds of the tongue and soft palate.

Cranial nerves

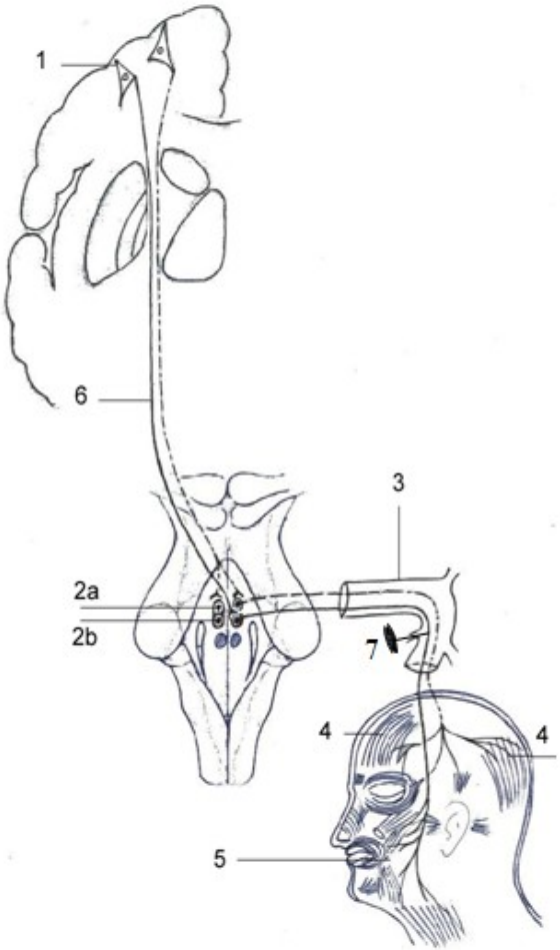


Conducting pathways of the facial nerve (VII)



1 – neuronum I (neurocytus pyramidalis magnus, Betz) (gyrus precentralis);
2 – girus parahipocampalis et uncus;
3 – thalamus opticus;
4 – nucl. n. facialis (motorius) (neuronum II) (VII);
5 – n. salivatorius superior (VII);
6 – n. tractus solitarii (VII);
7 – ganglion geniculi;
8 – ganglion pterygopalatinum;
9 – ganglia submandibularia et sublingualia;
10 – canalis pterygoideus;
11 – canalis n. facialis (Fallopius);
12 – glandulae sublingualis et submandibularis;
13 – glandula lacrimalis;
14 – glandulae nasales;
15 – foramen stylomastoideum;
16 – plexus caroticus internus;
17 – plexus parotideus;
18 – m. stapedius;
19 – mm. faciei;
20 – chorda tympani;
21 – tractus corticonuclearis.

Efferent, motor pathways of the facial nerve (VII)



1 – neuronum I (neurocytus pyramidalis magnus, Betz) (girus precentralis);
2 – neuronum II (nucl. n. facialis, motorius) (VII);
2a – pars superior;
2b – pars inferior;
3 – canalis n. facialis;
4 – mm. faciei superiores;
5 – mm. faciei inferiores;
6 – tractus corticonuclearis;
7 – m. stapedius.

Cranial nerves

Vestibulocochlear Nerve (CN VIII)

Functions: Special sensory (special somatic afferent) that is, special sensations of hearing and equilibrium.

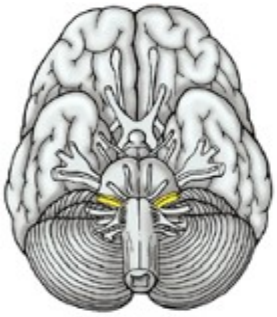
Nuclei: Four vestibular nuclei are located at the junction of the pons and medulla in the lateral part of the floor of the 4th ventricle; two cochlear nuclei are in the medulla.

The vestibulocochlear nerve (CN VIII) emerges from the junction of the pons and medulla and enters the internal acoustic meatus. Here it separates into the vestibular and cochlear nerves.

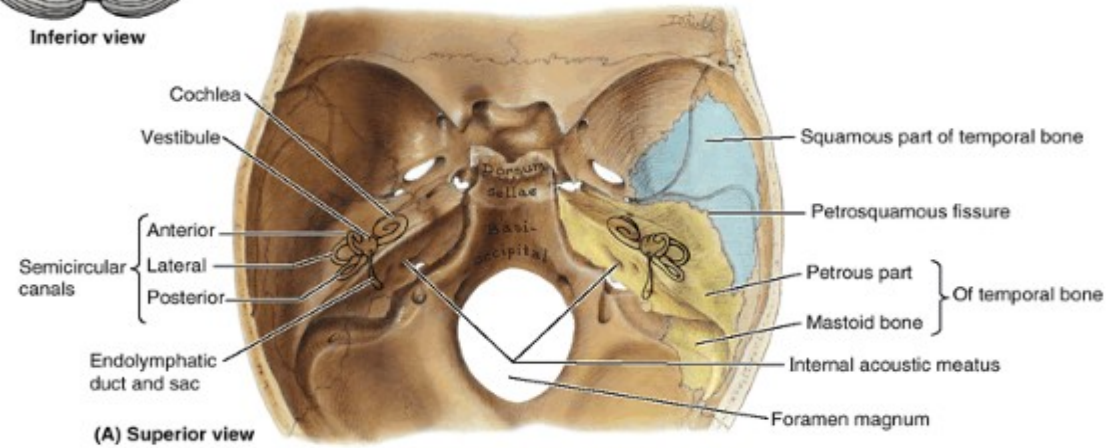
The **vestibular nerve** is concerned with equilibrium. It is composed of the central processes of bipolar neurons in the vestibular ganglion; the peripheral processes of the neurons extend to the maculae of the utricle and saccule (sensitive to the line of linear acceleration relative to the position of the head) and to the ampullae of the semicircular ducts (sensitive to rotational acceleration).

The **cochlear nerve** is concerned with hearing. It is composed of the central processes of bipolar neurons in the spinal ganglion; the peripheral processes of the neurons extend to the spiral organ.

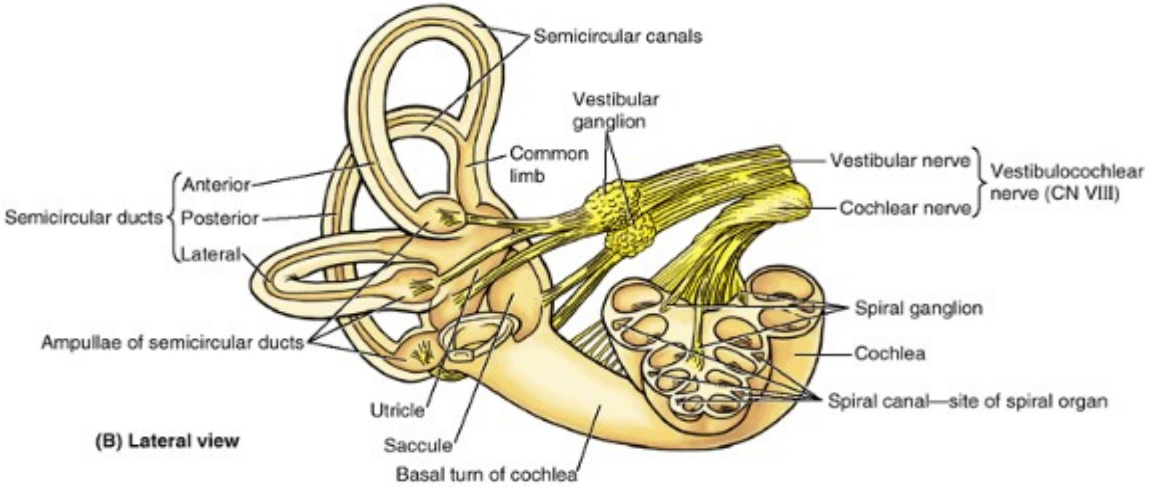
Cranial nerves



Inferior view

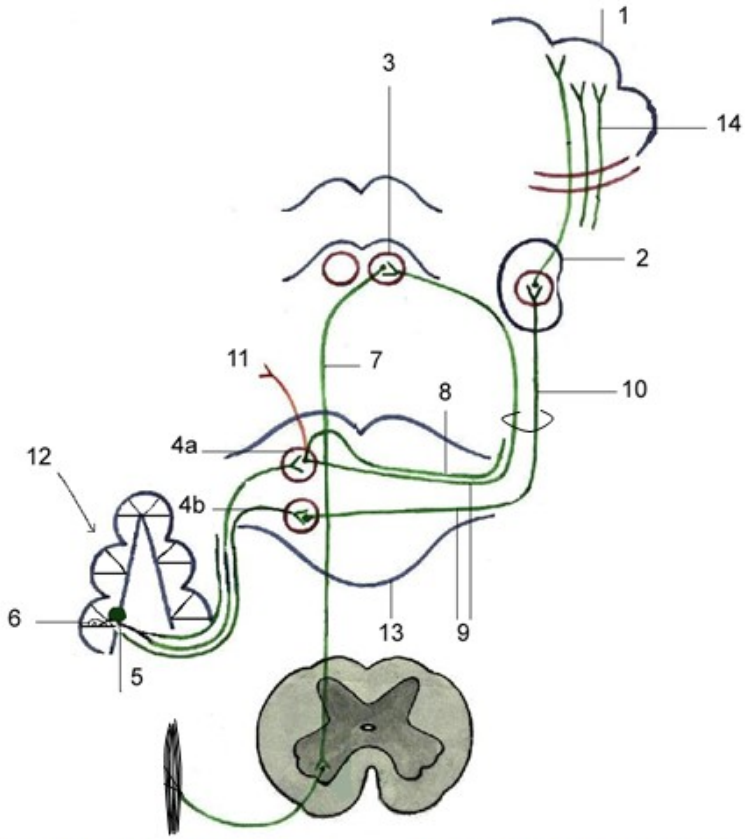


(A) Superior view



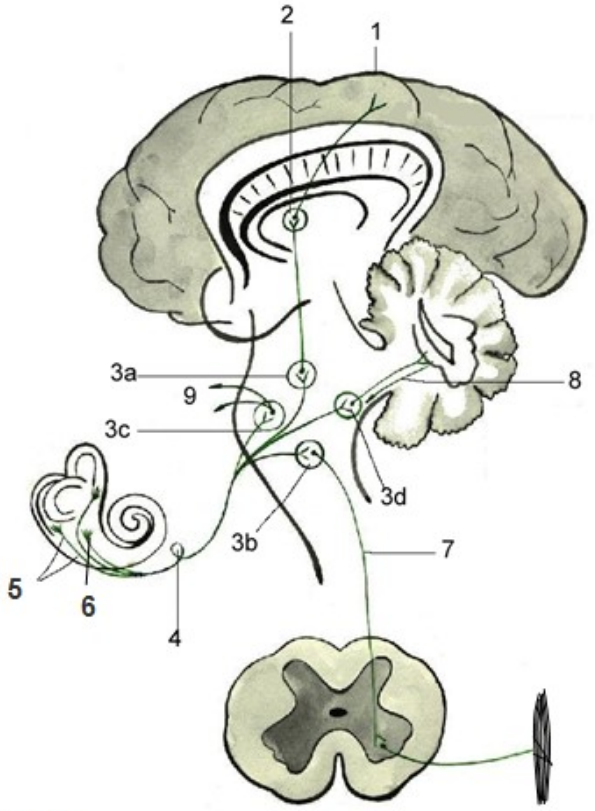
(B) Lateral view

Conducting pathways of the auditory analyzer



1 – gyri temporales transversi (Heschl) (gyrus temporalis superior);
2 – neuronum III (corpus geniculatum mediale);
3 – neuronum III (colliculus inferior tecti mesencephali);
4 – neuronum II (nuclei partes cochlearis n. vestibulocochlearis);
4a – nucleus dorsalis;
4b – nucleus ventralis;
5 – neuronum I [ganglion spirale (Corti)];
6 – organum Corti (epitheliocytus neurosensorius);
7 – tractus tectospinalis;
8 – striae medullares;
9 – corpus trapezoideum;
10 – lemniscus lateralis;
11 – conexiones ad nervos III, IV, VI;
12 – cochlea (labyrinthus osseus);
13 – pons Varolio;
14 – radiatio acustica.

Conducting pathways of the vestibular analyzer



1 – lobus temporalis;
2 – neuronum III (thalamus opticus);
3 – neuronum II (nuclei vestibulares n. vestibulocochlearis):
a – superior (Бехтерев);
b – inferior (Roller);
c – lateralis (Deiters);
d – medialis (Schwalbe);
4 – ganglion vestibulare (Scarpa) (neuronum I);
5 – cristae ampullares ductuum semicircularium;
6 – macula utriculi et macula sacculi;
7 – tractus vestibulospinalis (Levental);
8 – tractus vestibulocerebellaris et tractus cerebellovestibularis;
9 – conexiones ad nervos craniales IX, X et III, IV, VI.

Cranial nerves

Glossopharyngeal Nerve (CN IX)

Functions: Sensory (general somatic afferent, special visceral afferent, general visceral afferent), motor (special visceral efferent), and parasympathetic (general visceral efferent) for derivatives of the 3rd pharyngeal arch.

Nuclei: Four nuclei in the medulla send or receive fibers via CN IX: two motor and two sensory. Three of these nuclei are shared with CN X.

The glossopharyngeal nerve (CN IX) emerges from the lateral aspect of the medulla and passes anterolaterally to leave the cranium through the anterior aspect of the jugular. At this foramen are **superior and inferior (sensory) ganglia**, which contain the pseudounipolar cell bodies for the afferent components of the nerve. CN IX follows the **stylopharyngeus, the only muscle** the nerve supplies, and passes between the superior and the middle constrictor muscles of the pharynx to reach the oropharynx and tongue. It contributes sensory fibers to the pharyngeal plexus of nerves.

CN IX is afferent from the tongue and pharynx (hence its name) and efferent to the stylopharyngeus and parotid gland.

Branchial Motor Motor fibers pass to one muscle, the stylopharyngeus, derived from the 3rd pharyngeal arch.

Parasympathetic (Visceral Motor)

Following a circuitous route initially involving the tympanic nerve, presynaptic parasympathetic fibers are provided to the otic ganglion for innervation of the parotid gland. The otic ganglion is associated with the mandibular nerve (CN V3), branches of which convey the postsynaptic parasympathetic fibers to the parotid gland .

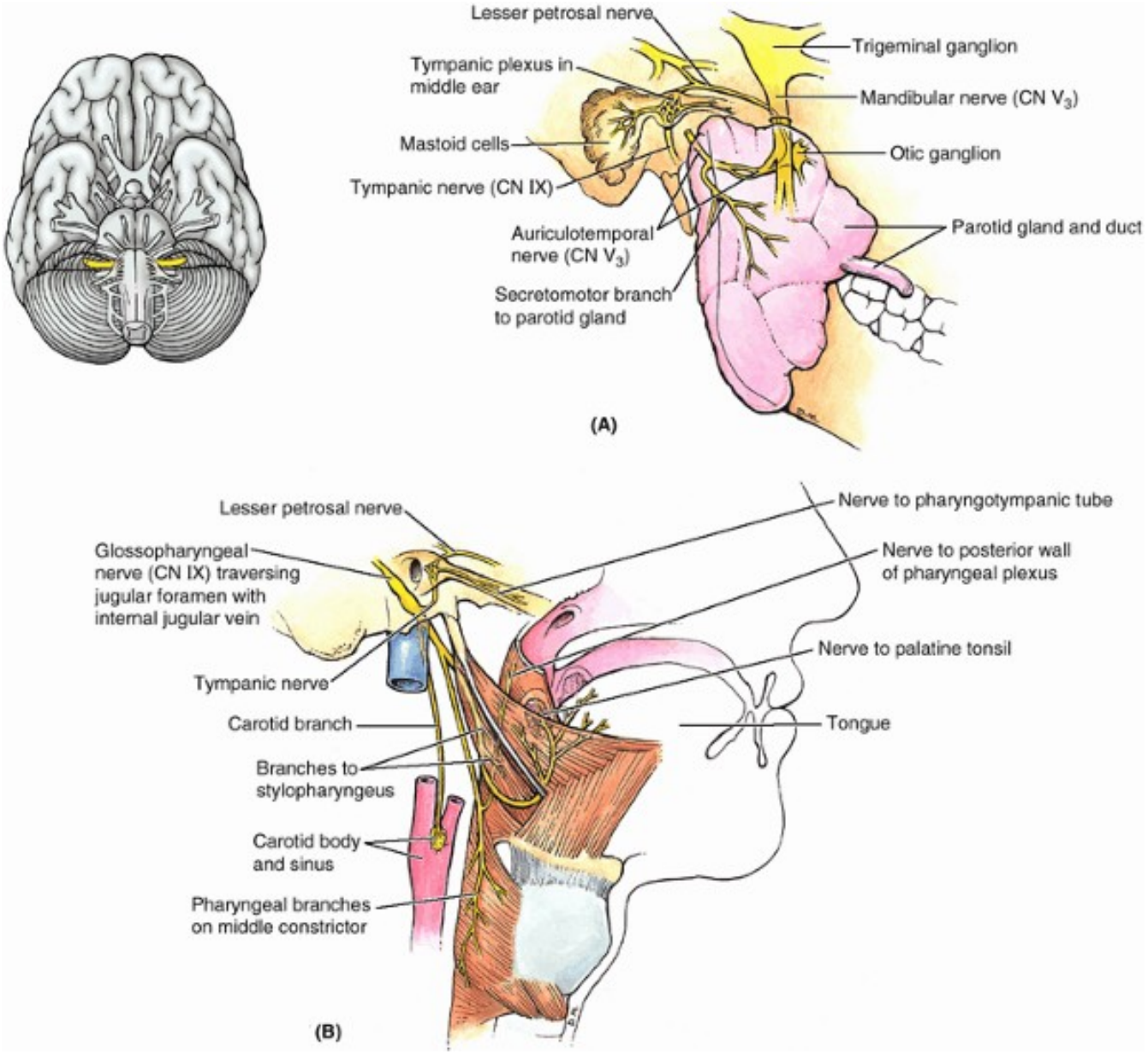
Sensory (General Sensory)

The general sensory branches of CN IX are as follows : **The tympanic nerve**. **The carotid sinus nerve** to the carotid sinus, a baro- (presso) receptor sensitive to changes in blood pressure, and the carotid body, a chemoreceptor sensitive to blood gas (oxygen and carbon dioxide levels).

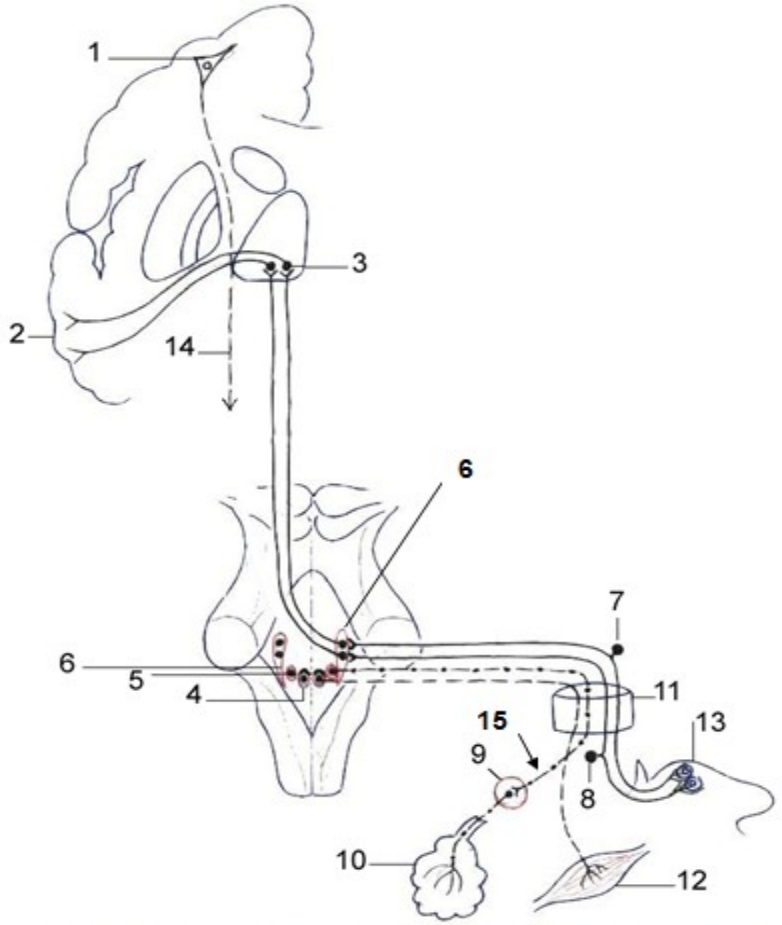
The pharyngeal, tonsillar, and lingual nerves to the mucosa of the oropharynx and isthmus of the fauces (L. throat), including palatine tonsil, soft palate, and posterior third of the tongue. In addition to general sensation (touch, pain, temperature), tactile (actual or threatened) stimuli determined to be unusual or unpleasant here may evoke the gag reflex or even vomiting.

Taste (Special Sensory) Taste fibers are conveyed from the posterior third of the tongue to the sensory ganglia.

Cranial nerves



Conducting pathways of the glossopharyngeal nerve (IX)



1 – neuronum I (motorium) (gyrus precentralis, neurocytus pyramidalis magnus, Betz);
2 – uncus et gyrus postcentralis;
3 – neuronum III (thalamus opticus);
4 – neuronum II (motorium) (nucleus ambiguus);
5 – nucleus salivatorius inferior (neuronum I);
6 – neuronum II (sensitivum) (nucleus tractus solitarii);
7 – neuronum I (sensitivum) (ganglion superius);
8 – neuronum I (sensitivum) (ganglion inferius, nodosum);
9 – ganglion oticum (neuronum II);
10 – glandula parotis;
11 – foramen jugulare;
12 – ramus musculi stylopharyngei;
13 – 1/3 posterior linguae (papillae valatae);
14 – tractus corticonuclearis;
15 – nervus tympanicus.

Cranial nerves

Vagus Nerve (CN X)

Functions: Sensory (general somatic afferent, special visceral afferent, general visceral afferent), motor (special visceral efferent), and parasympathetic (general visceral efferent).

Sensory from the inferior pharynx, larynx, and thoracic and abdominal organs.

Sense of taste from the root of the tongue and taste buds on the epiglottis. Branches of the internal laryngeal nerve (a branch of CN X) supply a small area, mostly general but some special sensation; most general and special sensation to the root is supplied by CN IX.

Motor to the soft palate; pharynx; intrinsic laryngeal muscles (phonation); and a nominal extrinsic tongue muscle, the palatoglossus, which is actually a palatine muscle based on its derivation and innervation.

Proprioceptive to the muscles listed above.

Parasympathetic to thoracic and abdominal viscera.

Nuclei: Four nuclei of CN X in the medulla send or receive fibers via CN IX two motor and two sensory. Three of these nuclei are shared with CN IX.

The vagus nerve (CN X) has the longest course and most extensive distribution of all the cranial nerves, most of which is outside of (inferior to) the head. The term vagus is derived from the Latin word vagari meaning **wandering**. CN X was so called because of its extensive distribution. It arises by a series of rootlets from the lateral aspect of the medulla that merge and leave the cranium through the jugular foramen positioned between CN IX and CN XI.

What was formerly called the cranial root of the accessory nerve is actually a part of CN X.

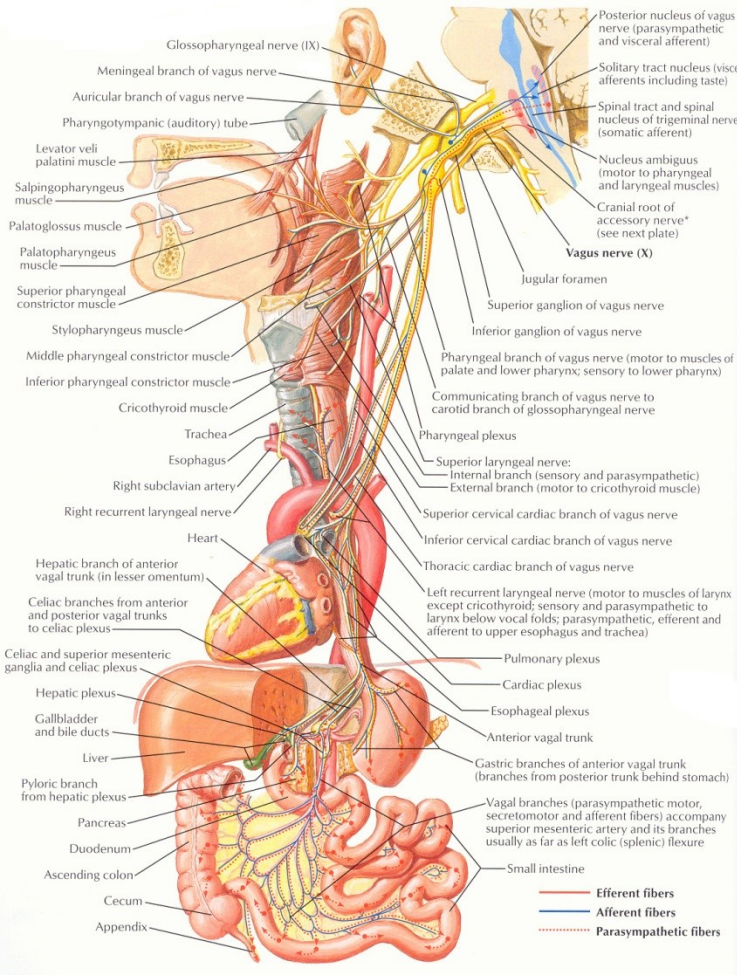
CN X has a **superior ganglion** in the jugular foramen that is mainly concerned with the general sensory component of the nerve. Inferior to the foramen is an inferior ganglion (nodose ganglion) concerned with the visceral sensory components of the nerve. In the region of the superior ganglion are connections to CN IX and the superior cervical (sympathetic) ganglion. CN X continues inferiorly in the carotid sheath to the root of the neck, supplying branches to the palate, pharynx, and .

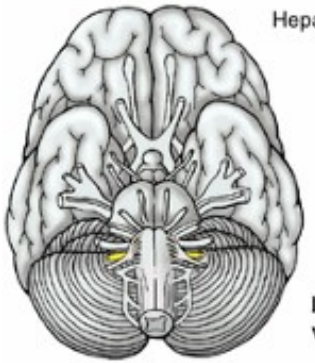
The course of CN X in the thorax differs on the two sides, a consequence of rotation of the midgut during development. CN X supplies branches to the heart, bronchi, and lungs. The vagi join the esophageal plexus surrounding the esophagus, which is formed by branches of the vagi and sympathetic trunks. This plexus follows the esophagus through the diaphragm into the abdomen, where the anterior and posterior vagal trunks break up into branches that innervate the esophagus, stomach, and intestinal tract as far as the left colic flexure.

Cranial nerves

Divisions (Parts)	Branches
Cranial Vagi arise by a series of rootlets from medulla (includes traditional cranial root of CN XI)	Meningeal branch to dura mater (sensory; actually fibers of C2 spinal ganglion neurons that hitch a ride with vagus nerve) Auricular branch
Cervical Exit cranium/enter neck through jugular foramen; right and left vagus nerves enter carotid sheaths and continue to root of neck	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)
Thoracic Vagi enter thorax through superior thoracic aperture; left vagus contributes to anterior esophageal plexus; right vagus to posterior plexus; form anterior and posterior trunks	Left recurrent laryngeal nerve (mixed; all distal branches convey parasympathetic and visceral afferent fibers for reflex stimuli) Thoracic cardiac branches Pulmonary branches Esophageal plexus
Abdominal Anterior and posterior vagal trunks enter abdomen through esophageal hiatus in diaphragm; distribute asymmetrically	Esophageal branches Gastric branches Hepatic branches Celiac branches (from posterior trunk) Pyloric branch (from anterior trunk) Renal branches Intestinal branches (to left colic flexure)

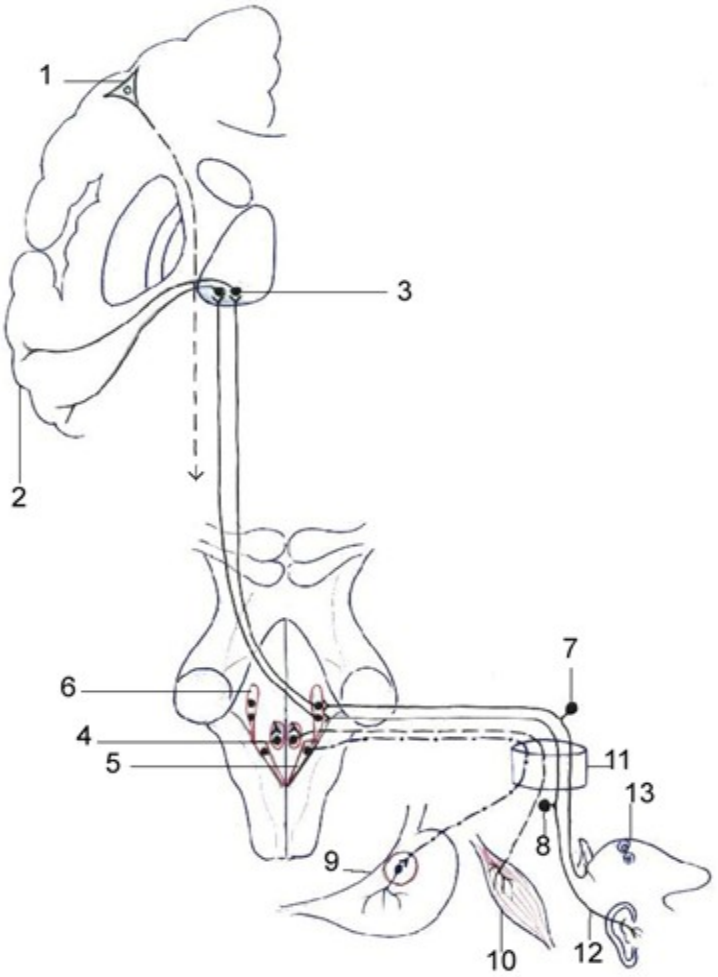
Cranial nerves





Inferior view

Conducting pathways of the vagus nerve (X)



1 – neuronum I (motorium) (gyrus precentralis, neurocytus pyramidalis magnus, Betz);
2 – uncus et gyrus postcentralis;
3 – neuronum III (sensitivum) (thalamus opticus);
4 – neuronum II (motorium) (nucleus ambiguus);
5 – nucleus dorsalis nervi vagi (neuronum I);
6 – neuronum II (sensitivum) (nucleus tractus solitarii);
7 – neuronum I (sensitivum) (ganglion superius, jugulare);
8 – neuronum I (sensitivum) (ganglion inferius, nodosum);
9 – ganglia intravisceralia et paravisceralia (neuronum II);
10 – mm. pharyngis, laryngis, palati mollis etc.;
11 – foramen jugulare;
12 – nervus auricularis posterior;
13 – radix linguae.

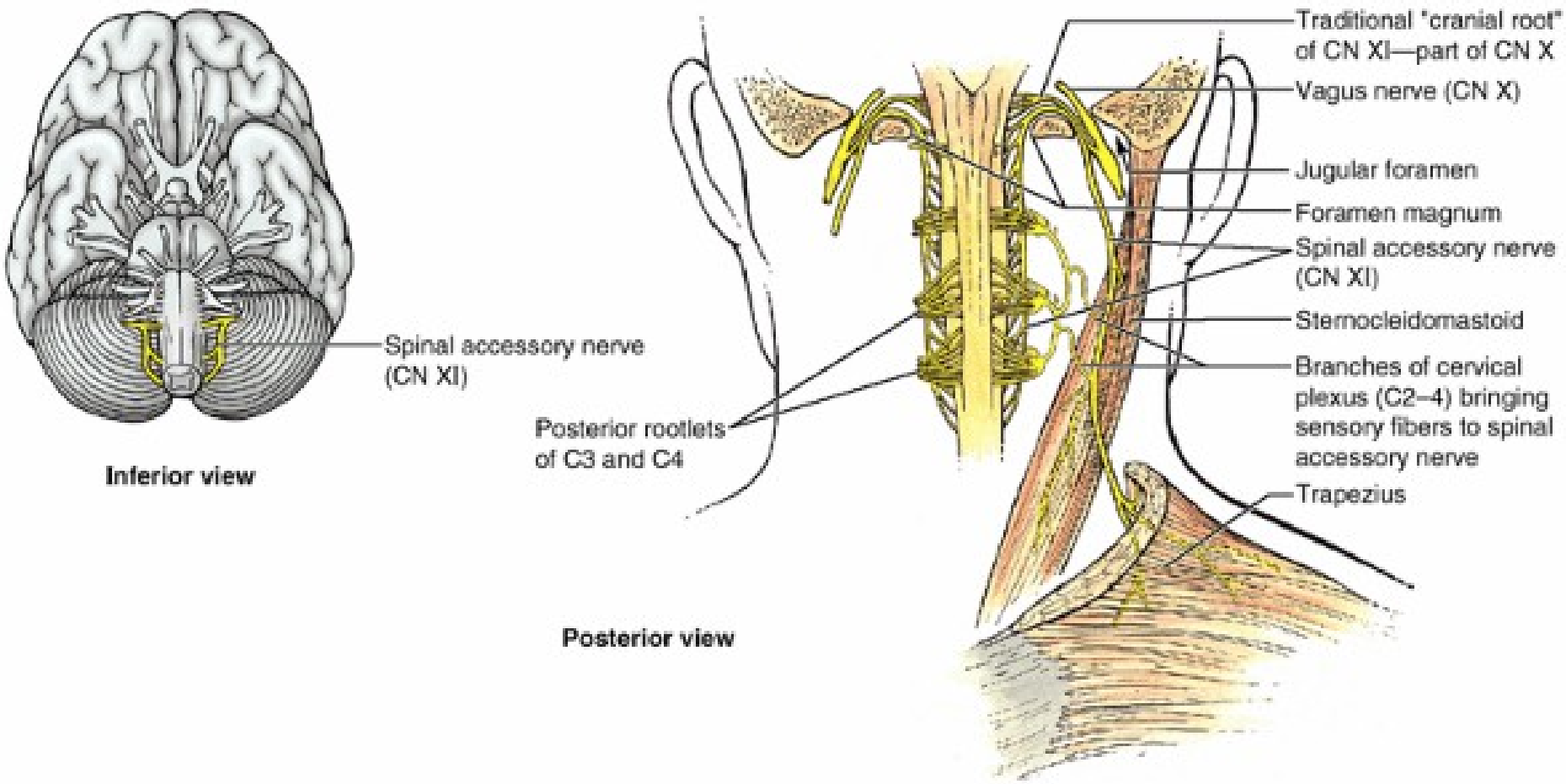
Cranial nerves

Spinal Accessory Nerve (CN XI)

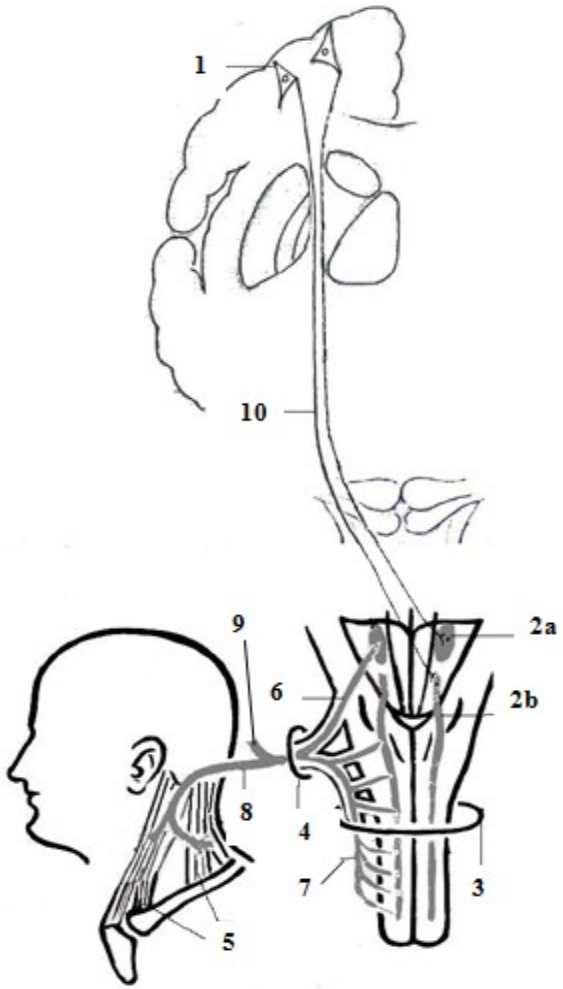
Functions: Motor to the striated sternocleidomastoid and trapezius muscles.

Nuclei: The spinal accessory nerve arises from the nucleus of the accessory nerve, a column of anterior horn motor neurons in the superior five or six cervical segments of the spinal cord .

Cranial nerves



Conducting pathways of the accessory nerve (XI)



1 – neuronum I (gyrus precentralis, neurocytus pyramidalis magnus, Betz);
2 – neuronum II [nuclei motorii n. accessorii:
a – nucleus ambiguus (IX, X, XI);
b – nucleus spinalis (XI);
3 – foramen occipitale magnum;
4 – foramen jugulare;
5 – mm. sternocleidomastoideus et trapezius;
6 – radices craniales nervi accessorii;
7 – radices spinales nervi accessorii;
8 – ramus externus;
9 – ramus internus;
10 – tractus corticonuclearis.

Cranial nerves

Hypoglossal Nerve (CN XII)

Functions: Motor (general somatic efferent) to the intrinsic and extrinsic muscles of the tongue (G. glossa) **styloglossus, hyoglossus, and genioglossus**.

The hypoglossal nerve (CN XII) arises as a purely motor nerve by several rootlets from the medulla and leaves the cranium through the hypoglossal canal. After exiting the cranial cavity, CN XII is joined by a branch or branches of the cervical plexus conveying general somatic motor fibers from C1 and C2 spinal nerves and general somatic sensory fibers from the spinal ganglion of C2. These spinal nerve fibers hitch a ride with CN XII to reach the hyoid muscles, with some of the sensory fibers passing retrograde along it to reach the dura mater of the posterior cranial fossa. CN XII passes inferiorly medial to the angle of the mandible and then curves anteriorly to enter the tongue.

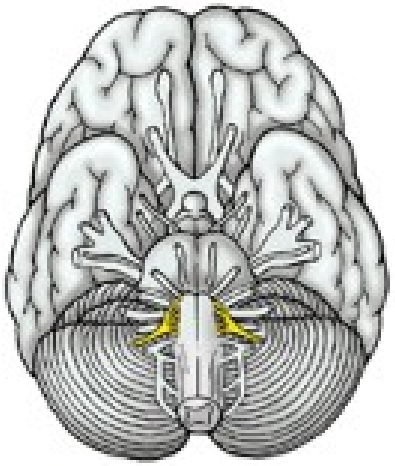
CN XII ends in many branches that supply all the extrinsic muscles of the tongue, except the palatoglossus (which is actually a palatine muscle). CN XII has the following branches:

A meningeal branch returns to the cranium through the hypoglossal canal and innervates the dura mater on the floor and posterior wall of the posterior cranial fossa. The nerve fibers conveyed are from the sensory spinal ganglion of spinal nerve C2 and are not hypoglossal fibers.

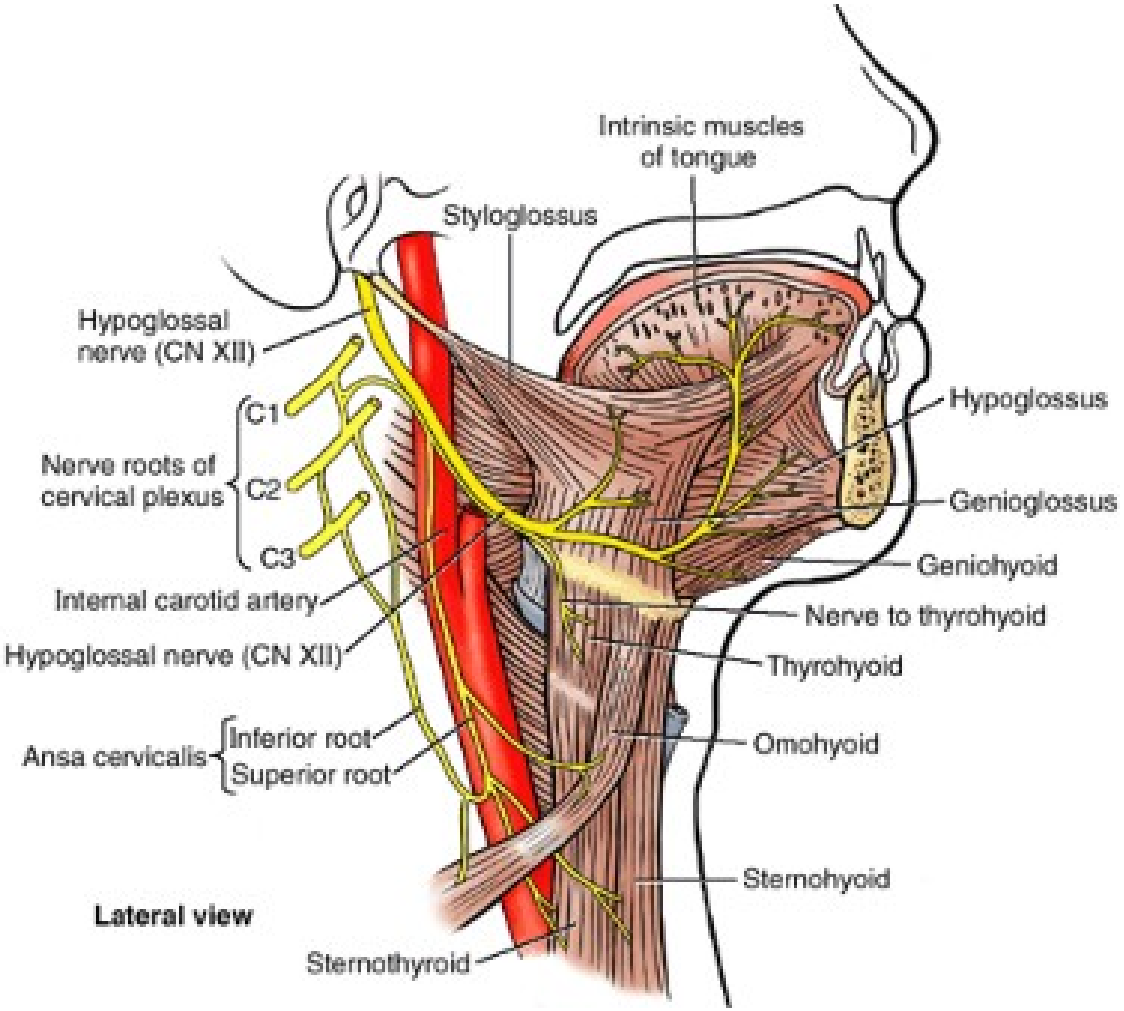
The superior root of the ansa cervicalis branches from CN XII to supply the infrahyoid muscles (sternohyoid, sternothyroid, and omohyoid). This branch actually conveys only fibers from the cervical plexus (the loop between the anterior rami of C1 and C2) that joined the nerve outside the cranial cavity, not hypoglossal fibers. Some fibers continue past the descending branch to reach the thyrohyoid muscle.

Terminal lingual branches supply the styloglossus, hyoglossus, genioglossus, and intrinsic muscles of the tongue.

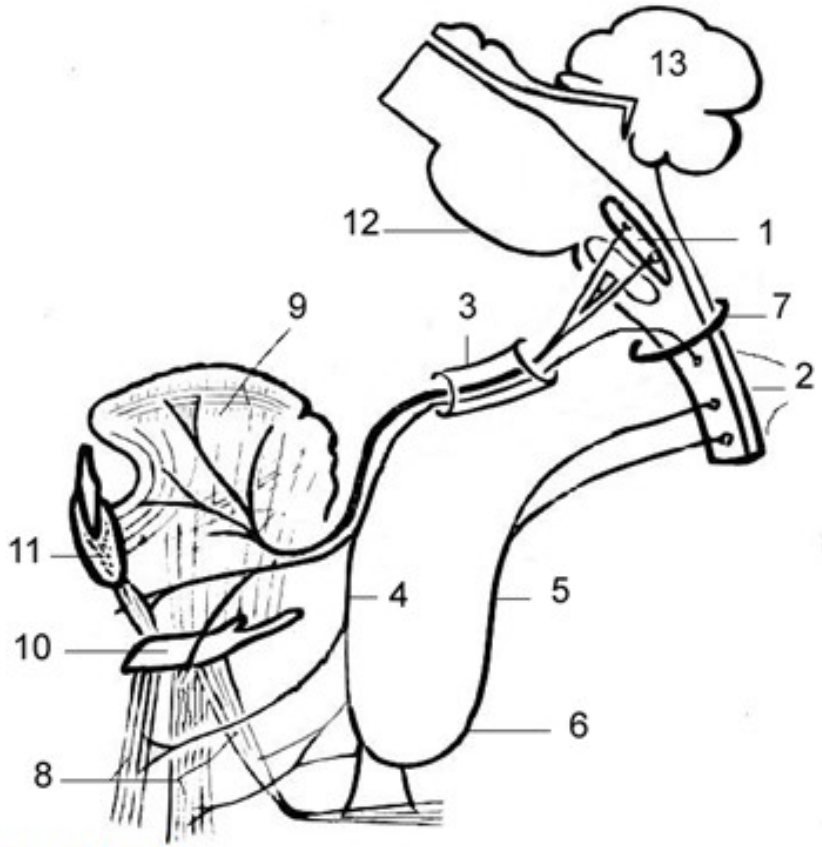
Cranial nerves



Inferior view



Conducting pathways of the hypoglossal nerve (XII)

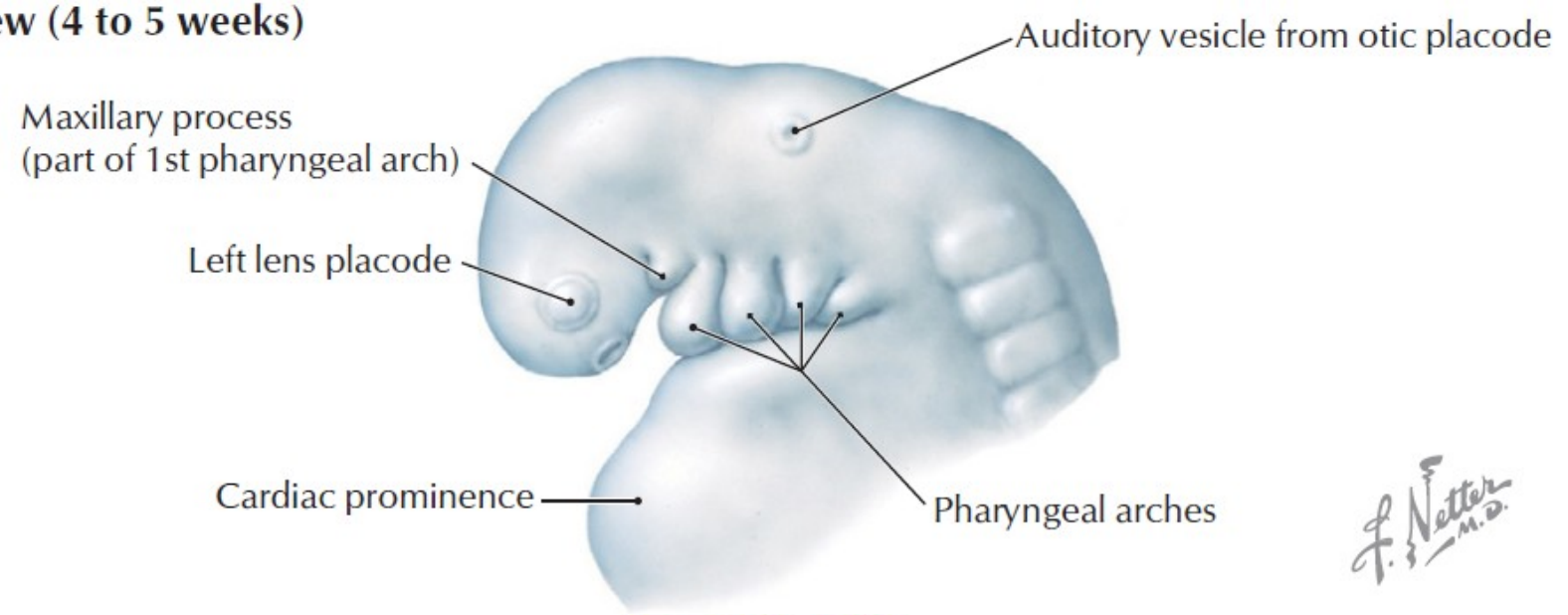


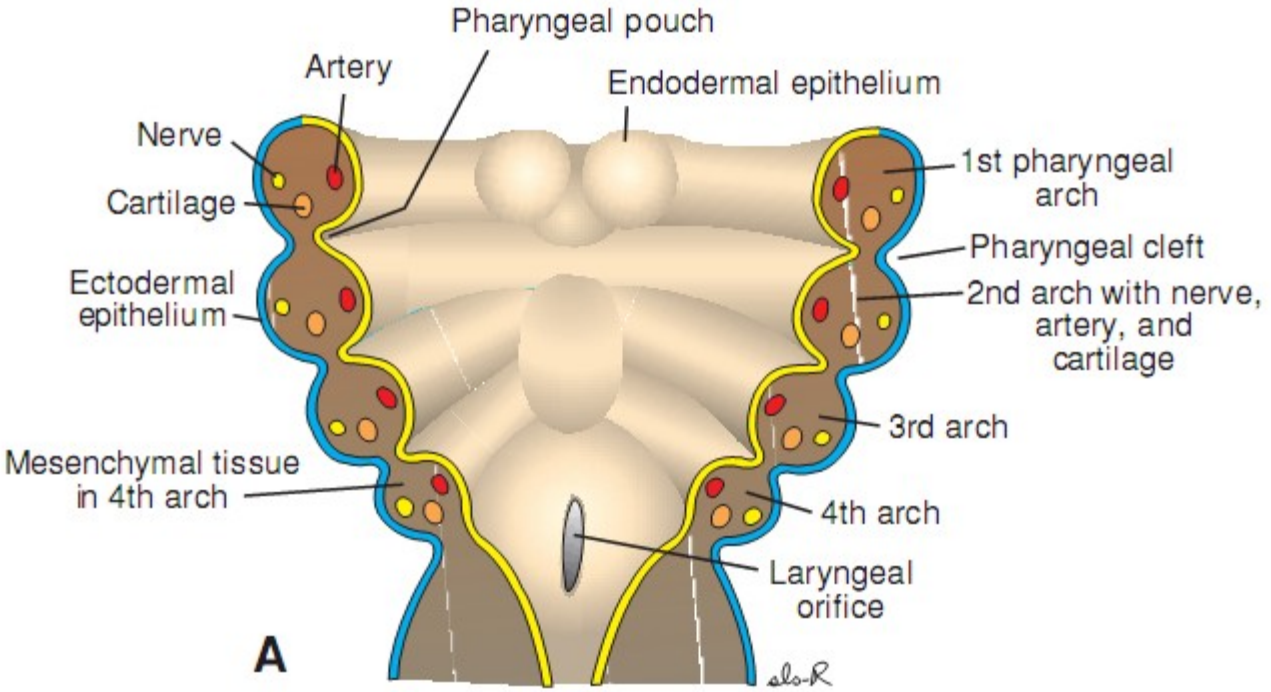
1 – nucleus nervi hypoglossi;
2 – medulla spinalis (segmenti C_1, C_2, C_3);
3 – canalis hypoglossus;
4 – radix superior ansae cervicalis;
5 – radix inferior ansae cervicalis;
6 – ansa cervicalis;
7 – foramen magnum;
8 – mm. infrahyoidei;
9 – rami linguales (musculi linguae);
10 – os hyoideum;
11 – mandibula;
12 – truncus cerebri;
13 – cerebellum.

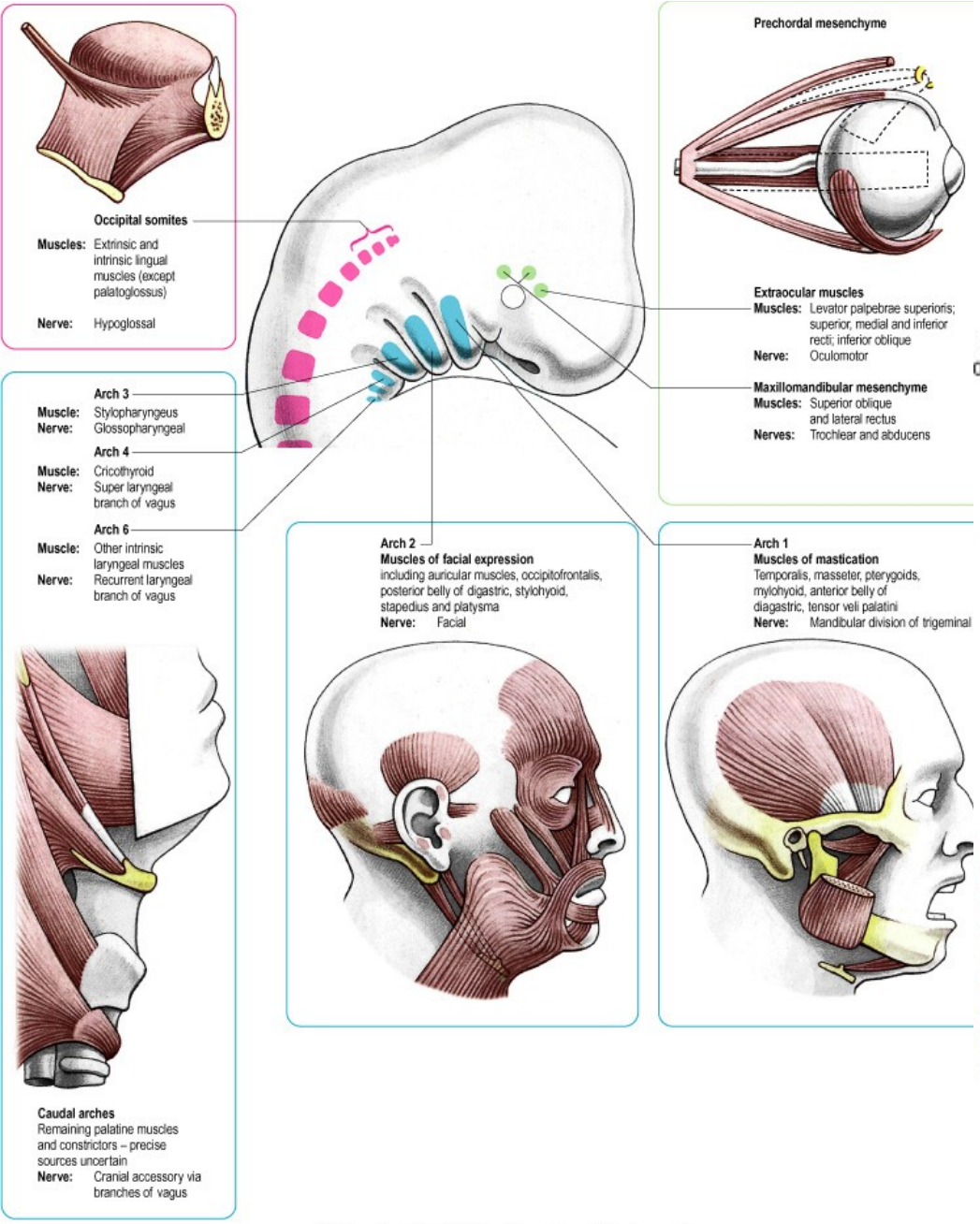
Summary of cranial nerves

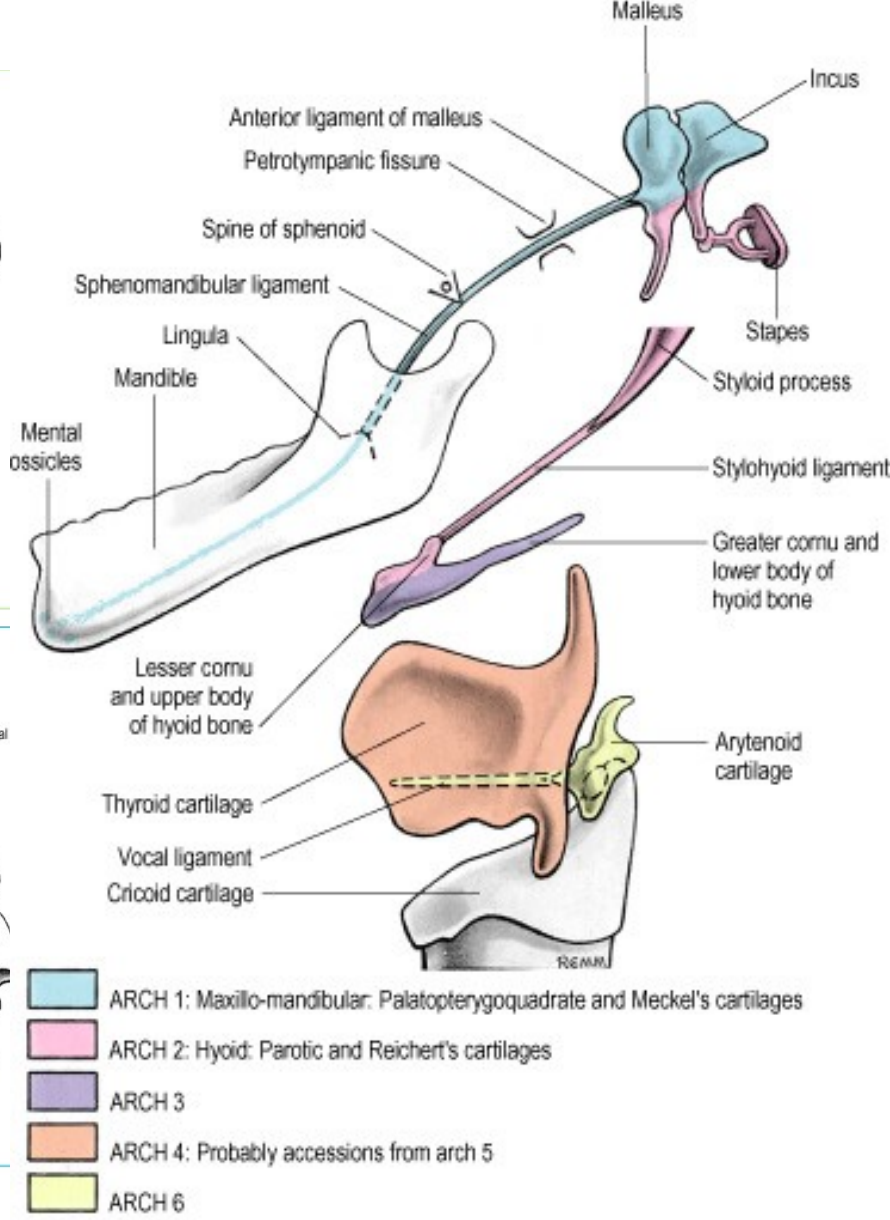
No	Name	Components	Cells of origin	Main central connections	Exit from skull	Distribution and function
I	Olfactory	Special somatic afferent	Olfactory receptor cells in nasal mucosa	To olfactory bulb, anterior perforated substance, piriform cortex	Foramena of cribriform plate	Olfaction
II	Optic	Special somatic afferent	Ganglion cells of retina	To lateral geniculate nucleus of thalamus, pretectal area of midbrain	Optic canal	Vision
III	Oculomotor	Somatic efferent	Oculomotor nucleus	From visual cortical areas, medial longitudinal fasciculus	Superior orbital fissure	Motor to medial rectus, inferior rectus, superior rectus, inferior oblique, levator palpebrae superioris
III	Oculomotor	General visceral efferent	Edinger–Westphal nucleus	From pretectal area of midbrain	Superior orbital fissure	Parasympathetic to sphincter pupillae and ciliary muscles, via ciliary ganglion, mediating pupillary constriction and accommodation
IV	Trochlear	Somatic efferent	Trochlear nucleus	From visual cortical areas, medial longitudinal fasciculus	Superior orbital fissure	Motor to superior oblique
V	Trigeminal division:					
	Ophthalmic (V_i)	General somatic afferent	Trigeminal (semilunar) ganglion	To trigeminal sensory nucleus	Superior orbital fissure	Sensation from forehead, scalp, eyelids, nose and eye, including conjunctiva
	Maxillary (V_{ii})	General somatic afferent	Trigeminal (semilunar) ganglion	To trigeminal sensory nucleus	Foramen rotundum	Sensation from mid-face, lower eyelid, nasal cavity and paranasal sinuses, upper lip, maxillary teeth and palate
	Mandibular (V_{iii})	General somatic afferent	Trigeminal (semilunar) ganglion	To trigeminal sensory nucleus	Foramen ovale	Sensation from lower face and scalp, tongue and floor of mouth, mandibular teeth and part of external ear
		General somatic afferent	Mesencephalic part of trigeminal sensory nucleus	To trigeminal sensory nucleus, cerebellum	Foramen ovale	Proprioception from muscles of mastication, temporomandibular joint
	Mandibular (V_{III})	Branchial (special visceral) efferent	Trigeminal motor nucleus	From precentral gyrus	Foramen ovale	Motor to muscles of mastication (temporalis, masseter, medial and lateral pterygoids), tensor tympani
VI	Abducens	Somatic efferent	Abducens nucleus	From visual cortical areas, medial longitudinal fasciculus	Superior orbital fissure	Motor to lateral rectus
VII	Facial	General somatic afferent	Geniculate ganglion	To trigeminal sensory nucleus, cerebellum	Internal acoustic meatus	Sensation from part of tympanic membrane, external acoustic meatus and skin behind pinna. Proprioception from facial muscles
VII	Facial	Special visceral afferent	Geniculate ganglion	To nucleus solitarius	Internal acoustic meatus	Taste from anterior two-thirds of tongue
VII	Facial	General visceral efferent	Superior salivatory nucleus	From olfactory areas, nucleus solitarius	Internal acoustic meatus	Parasympathetic to lacrimal gland and mucous membrane of nasal and oral cavities (via pterygopalatine ganglion) and submandibular and sublingual salivary glands (via submandibular ganglion) causing secretion and vasodilatation
VII	Facial	Branchial (special visceral) efferent	Facial nucleus	From precentral gyrus	Internal acoustic meatus	Motor to muscles of facial expression, stapedius, posterior belly of digastric and stylohyoid
VIII	Vestibulocochlear					
	Vestibular division	Special somatic afferent	Vestibular ganglion	To vestibular nuclei, cerebellum	Internal acoustic meatus	Sensations of equilibrium and motion
	Cochlear division	Special somatic afferent	Spiral ganglion	To cochlear nuclei	Internal acoustic meatus	Hearing
IX	Glossopharyngeal	General somatic afferent	Glossopharyngeal ganglia	To trigeminal sensory nucleus	Jugular foramen	General sensation from posterior one-third of tongue, oropharynx and middle ear
IX	Glossopharyngeal	General visceral afferent	Glossopharyngeal ganglia	To nucleus solitarius	Jugular foramen	Sensory from carotid body (chemoreceptors) and carotid sinus (baroreceptors)
IX	Glossopharyngeal	Special visceral afferent	Glossopharyngeal ganglia	To nucleus solitarius	Jugular foramen	Taste from posterior one-third of tongue
IX	Glossopharyngeal	General visceral efferent	Inferior salivatory nucleus	From olfactory areas, nucleus solitarius	Jugular foramen	Parasympathetic to parotid salivary gland (via otic ganglion), causing secretion and vasodilatation
IX	Glossopharyngeal	Branchial (special visceral) efferent	Nucleus ambiguus	From precentral gyrus	Jugular foramen	Motor to stylopharyngeus
X	Vagus	General somatic afferent	Superior (jugular) ganglion	To trigeminal sensory nucleus	Jugular foramen	General sensation from pharynx, larynx, trachea, oesophagus, part of auricle and external auditory meatus
X	Vagus	General visceral afferent	Inferior (nodose) ganglion	To nucleus solitarius	Jugular foramen	Sensory from thoracic and abdominal viscera
						Sensory from aortic arch (baroreceptors) and aortic bodies (chemoreceptors)
X	Vagus	General visceral efferent	Dorsal motor nucleus of vagus	From hypothalamus, nucleus solitarius	Jugular foramen	Parasympathetic to glands and smooth muscle in the pharynx, larynx; thoracic and abdominal viscera
X	Vagus	Branchial (special visceral) efferent	Nucleus ambiguus	From precentral gyrus, sensory nuclei of brain stem	Jugular foramen	Motor to pharyngeal, external laryngeal and oesophageal striated muscles
XI	Accessory					
	Cranial root	Branchial (special visceral) efferent	Nucleus ambiguus	From precentral gyrus, sensory nuclei of brain stem	Jugular foramen	Motor to muscles of soft palate and intrinsic muscles of larynx (distributed via vagus)
	Spinal root	Branchial (special visceral) efferent	Spinal cord segments C1–C5	From precentral gyrus	Jugular foramen	Motor to sternocleidomastoid and trapezius
XII	Hypoglossal	Somatic efferent	Hypoglossal nucleus	From precentral gyrus	Hypoglossal canal	Motor to all intrinsic and extrinsic muscles of the tongue, except palatoglossus

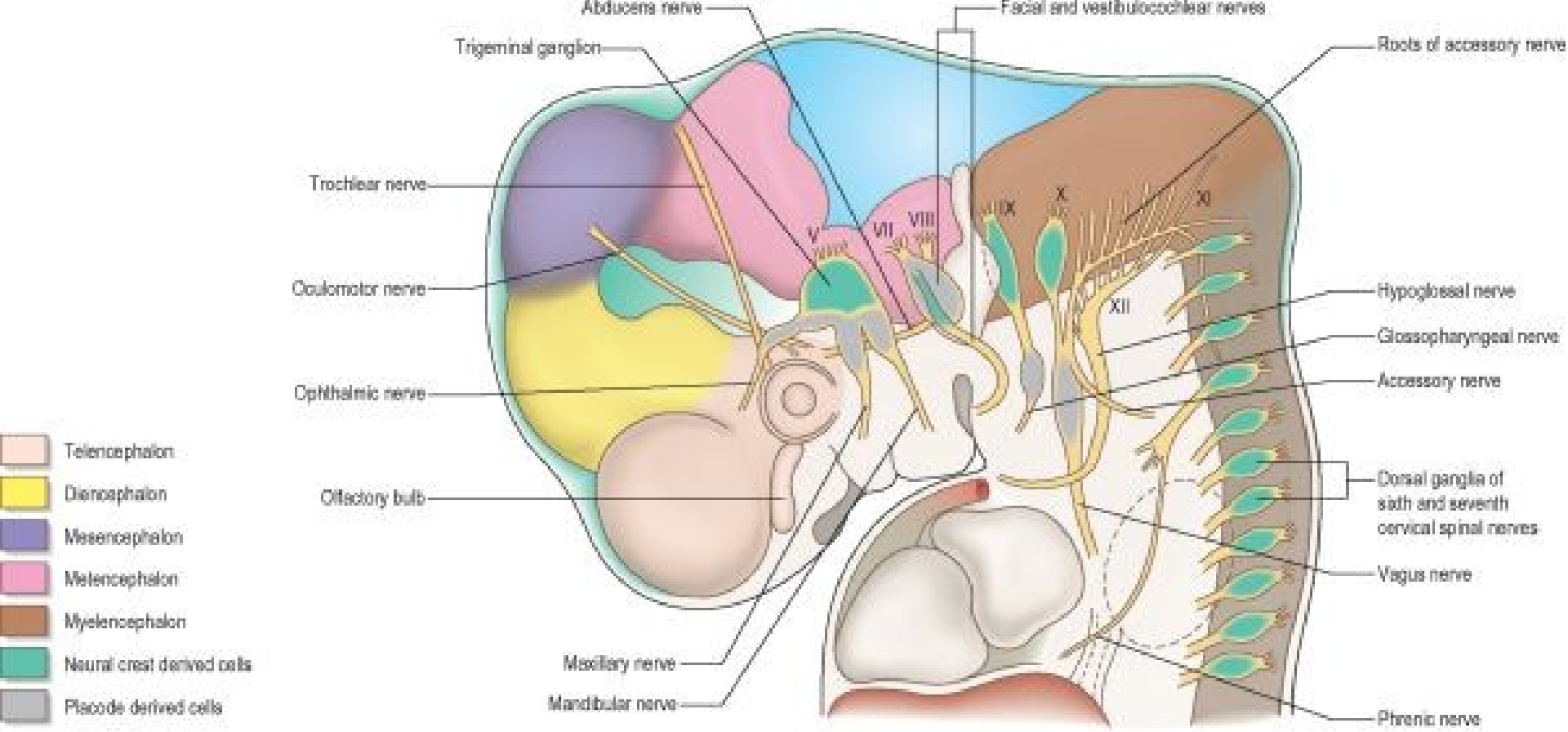
Lateral view (4 to 5 weeks)



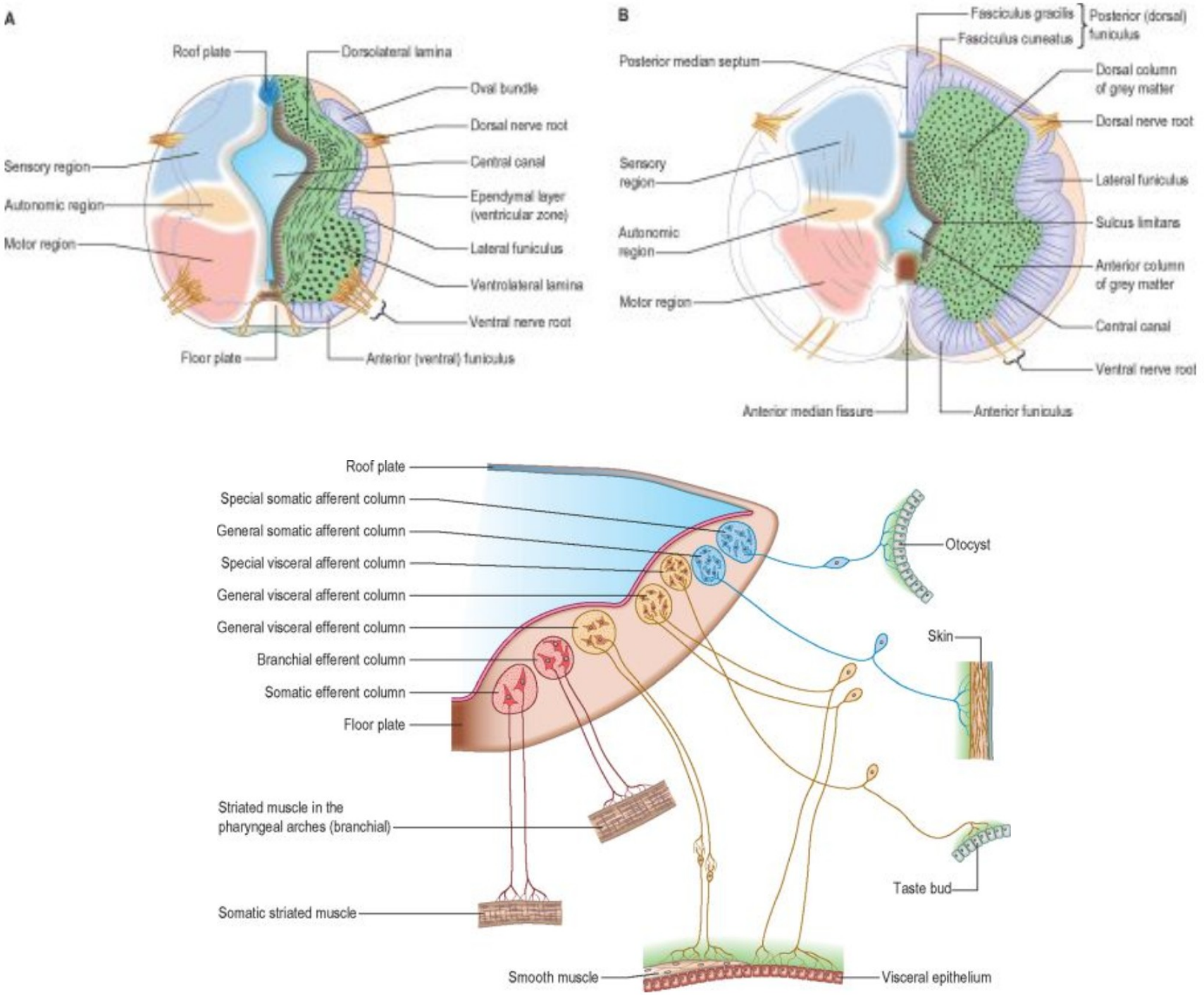








Cranial nerves may contain motor, sensory or both types of fibres. With the exception of the olfactory and optic nerves, the cranial nerves develop in a manner similar in some respects to components of the spinal nerves. The somata of motor neuroblasts originate within the neuroepithelium, while those of sensory neuroblasts are derived from the neural crest with the addition in the head of contributions from ectodermal placodes


A
Roof plate
Dorsolateral lamina
Oval bundle
Dorsal nerve root
Central canal
Ependymal layer (ventricular zone)
Lateral funiculus
Ventrolateral lamina
Ventral nerve root
Anterior (ventral) funiculus
Floor plate
Sensory region
Autonomic region
Motor region
B
Fasciculus gracilis
Fasciculus cuneatus
Posterior (dorsal) funiculus
Posterior median septum
Dorsal column of grey matter
Dorsal nerve root
Lateral funiculus
Sulcus limitans
Anterior column of grey matter
Central canal
Ventral nerve root
Anterior funiculus
Anterior median fissure
Sensory region
Autonomic region
Motor region
Roof plate
Special somatic afferent column
General somatic afferent column
Special visceral afferent column
General visceral afferent column
General visceral efferent column
Branchial efferent column
Somatic efferent column
Floor plate
Otocyst
Skin
Taste bud
Striated muscle in the pharyngeal arches (branchial)
Somatic striated muscle
Smooth muscle
Visceral epithelium