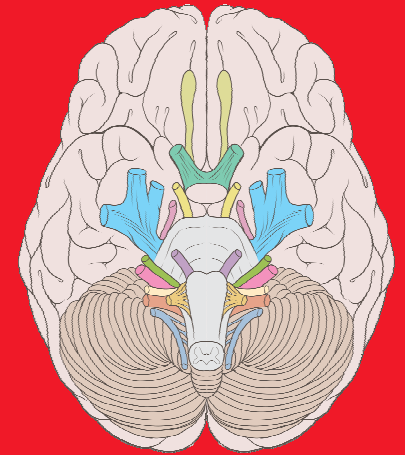


**MUNI
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Cranial nerves

Cranial nerves

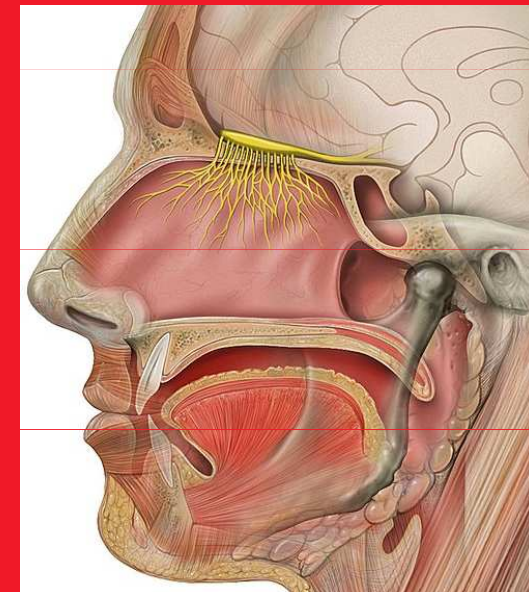
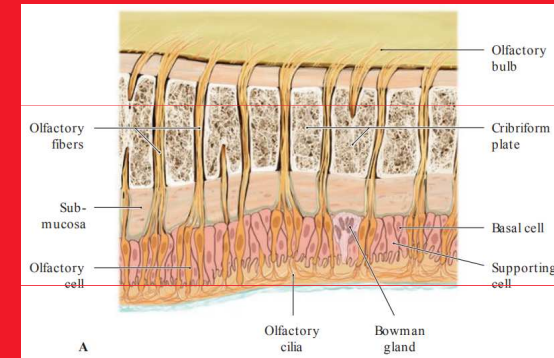


- twelve pairs of cranial nerves
- the exception is I. and II. cranial nerve, which are the protruding parts of the telencephalon and diencephalon
- generally named according to their structure or function
- numbered based on their position (rostral-caudal)
- the innervation area, as the name suggests, is the head and neck
- the exception is the X. cranial nerve, which extends into the abdominal cavity

Olfactory nerve (n. I)

- **part of the telencephalon**, not really a cranial nerve in the conventional sense
- humans have a poor sense of smell compared to animals (dogs)
- **olfactory area** is approximately **5 cm²** (10⁷ olfactory cells)
- (olfactory area in dogs up to 170 cm²)
- humans can distinguish around **10 000 smells**
- **the olfactory neurons can regenerate**

The specialized olfactory receptor neurons of the olfactory nerve are located in the olfactory mucosa of the upper parts of the nasal cavity.



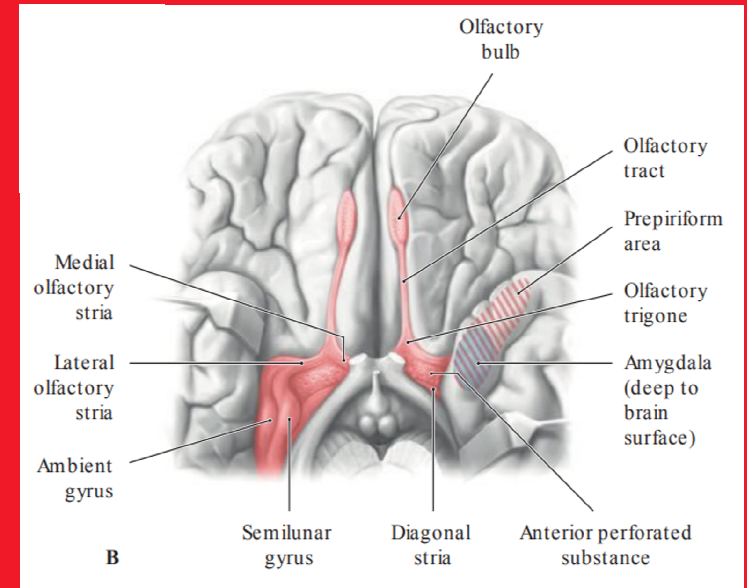
sensory nerve fibers extend from the olfactory epithelium through the many openings of the cribriform plate to reach the olfactory bulb

Olfactory pathway

1st. neuron - neuroepithelial cell of the olfactory epithelium of the upper parts of the nasal cavity (pars olfactoria cavitatis nasi)

2nd. neuron - mitral cell in the olfactory bulb

- axons continue further along the olfactory tract to the trigonum olfactorium
- the olfactory tract on both sides divides into medial and lateral olfactory striae
- the medial stria projects to the to contralateral olfactory structures
- the lateral stria continues on to structures associated with the olfactory cortex in the temporal lobe



The olfactory pathway connects to parts of the brain that control emotional responses - associating different smells with our feelings, sexual attraction and also serves as the warning system that provides us with information about the outside world (if something stinks it's probably dangerous for the body)

SYMPTOMS OF OLFACTORY NERVE LESIONS

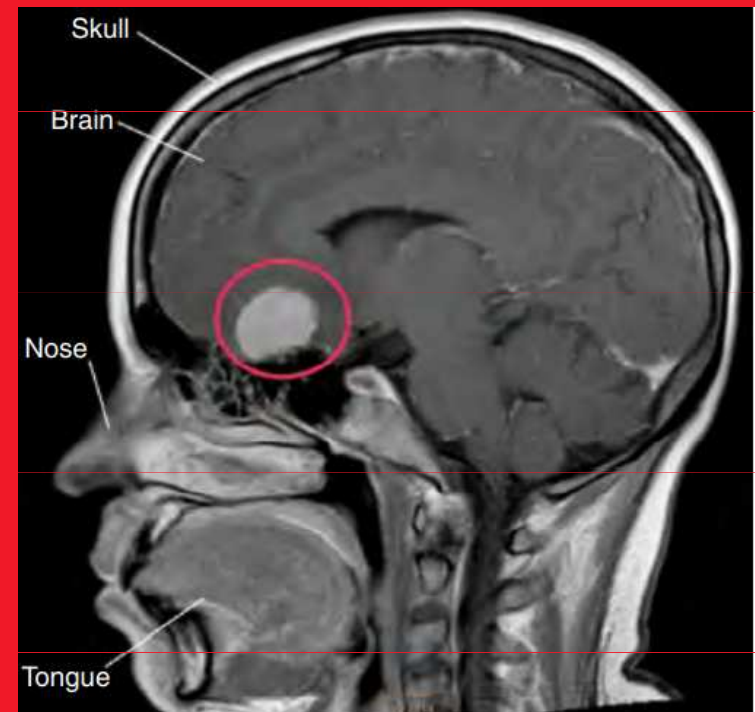
hyposmia/mikrosmia (impaired sense of smell)

Anosmia (loss of sense of smell)

parosmia (cacosmia) (normal fragrances stink, the fragrance of the flowers stink)

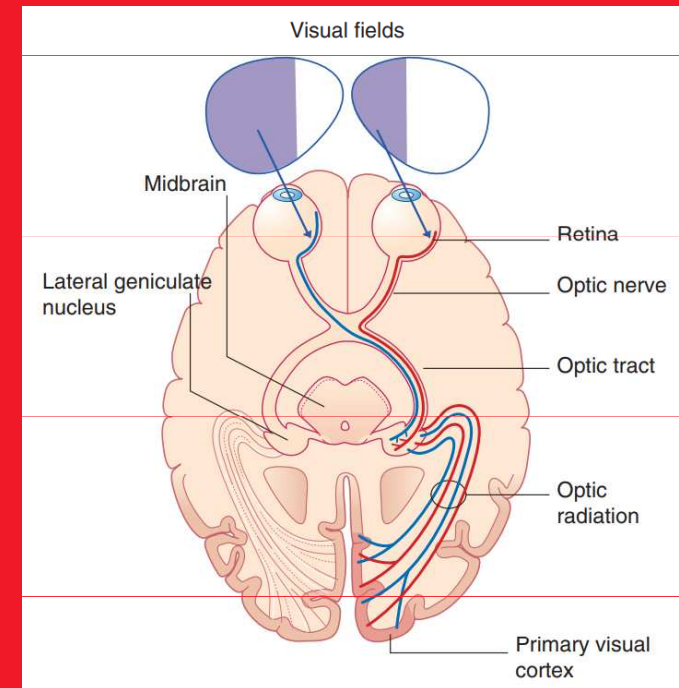
uncinate seizure (a form of epileptic seizure with olfactory hallucinations, evoked from the area of
□□the hippocampal gyrus)

- seizures often originates from temporal lobe



Optic nerve (n.II)

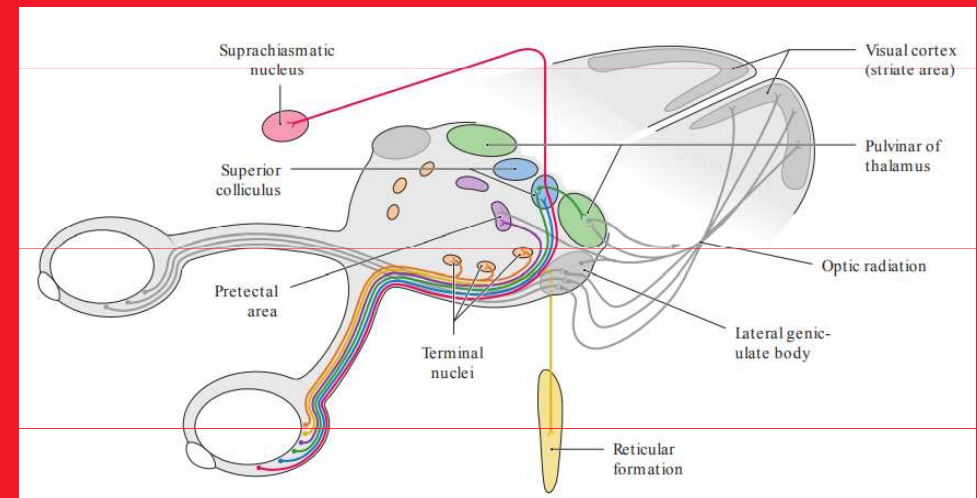
- part of the **diencephalon**, not really a cranial nerve in the conventional sense
- **doesn't regenerate** after injury
- formed from the central processes of the ganglionic cells (3th neuron of the optic pathway)
- contains approximately 1,2 millions of the afferent fibers
- 80% fibers ends in the **lateral geniculate nucleus**, remain fibers leads to the **mesencephalon** and **hypothalamus**
- 4th neurons are the cells of the lateral geniculate nucleus, their axons constitutes the **optic radiation** that ends in the **occipital cortex**
- neurons of the **occipital cortex** create a so-called cortical image of the external world



loss of left visual field

Branches of the optic tract

- composed of approximately 10-20% fibers
- branch to **area pretectalis** - pupillary reflex
- branch to the **hypothalamus** - control of vegetative functions and control of circadian rhythms (the sleep-wake cycle).



SYMPTOMS OF OPTIC NERVE LESIONS

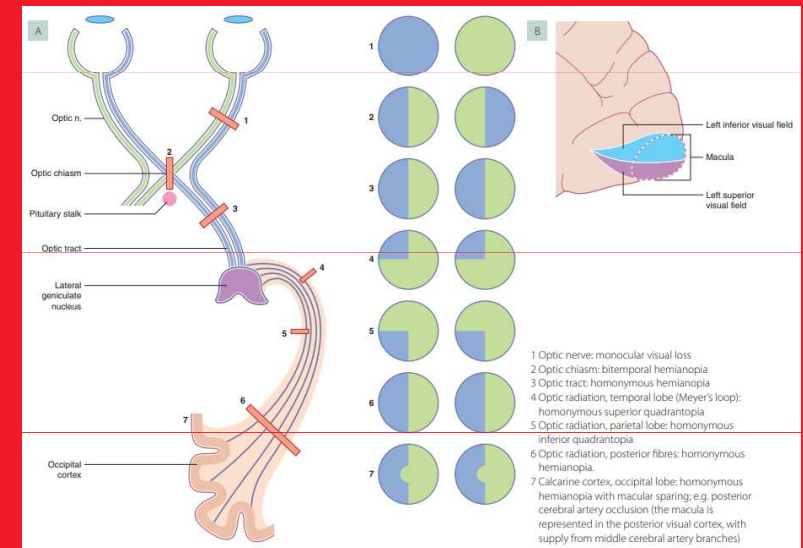
amaurosis – vision loss

hemianopsia – loss of vision or blindness (anopsia) in half of the field of vision, usually on one side of the vertical midline (cannot see the right or left side of the field of vision)

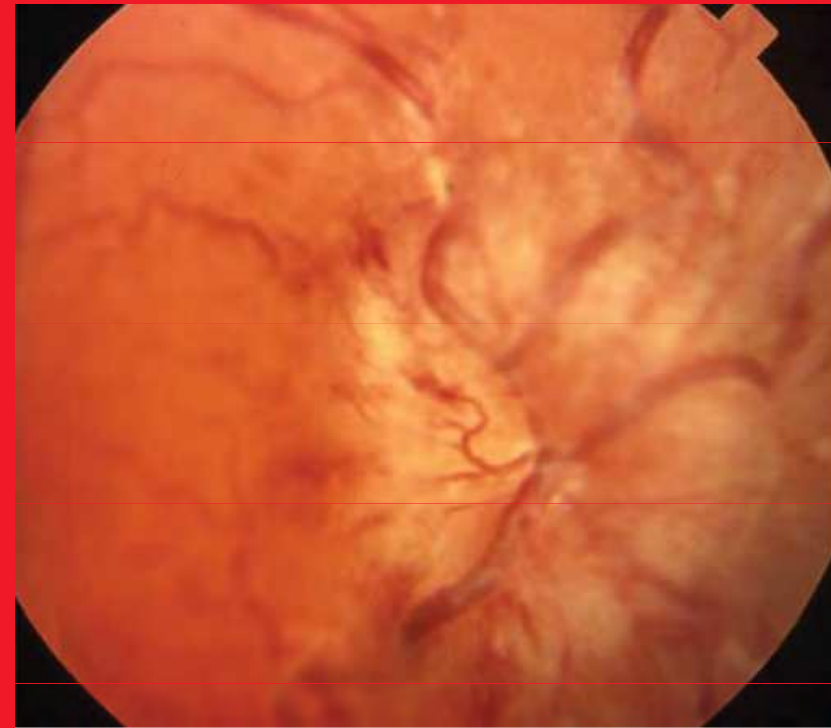
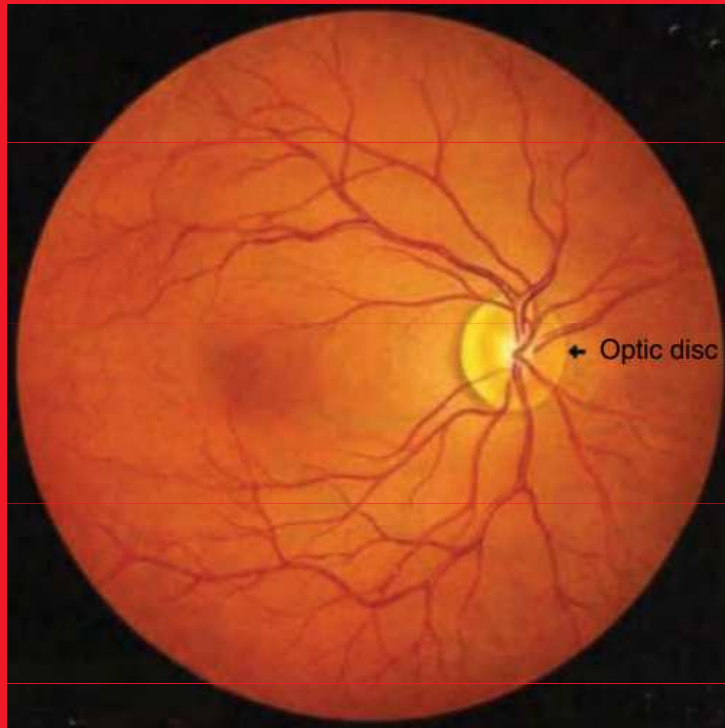
quadrantopsia - loss of vision in one quarter (one-fourth) of the field of vision

scotoma - blind spot in your field of vision (temporary or permanent)

phosphene - images of light or color that you can see while your eye is closed



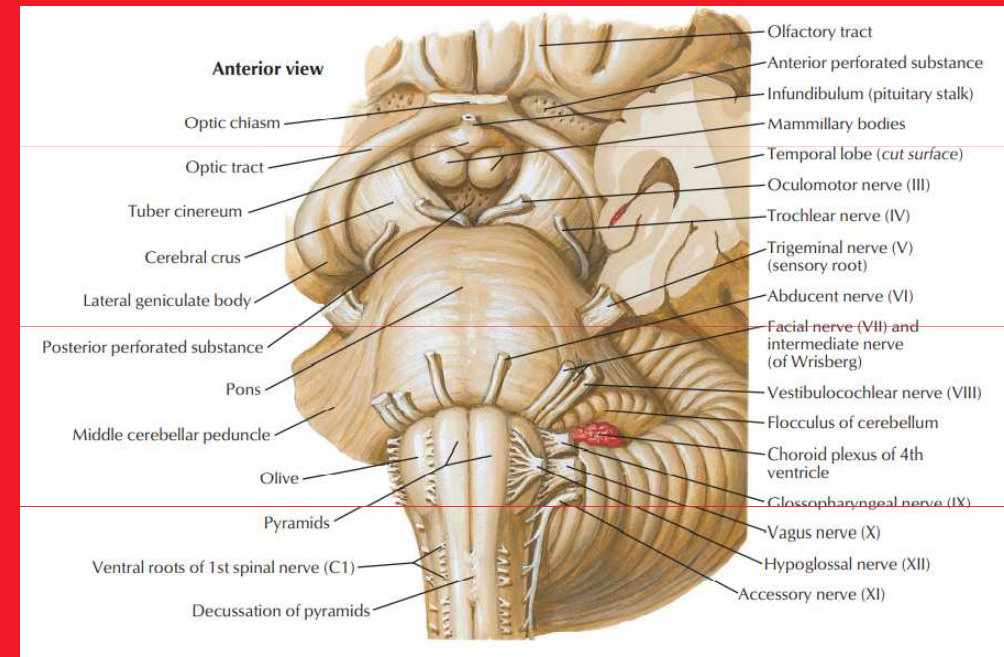
suspicion of increased intracranial pressure - fundoscopic examination is a visualization of the retina using an ophthalmoscop

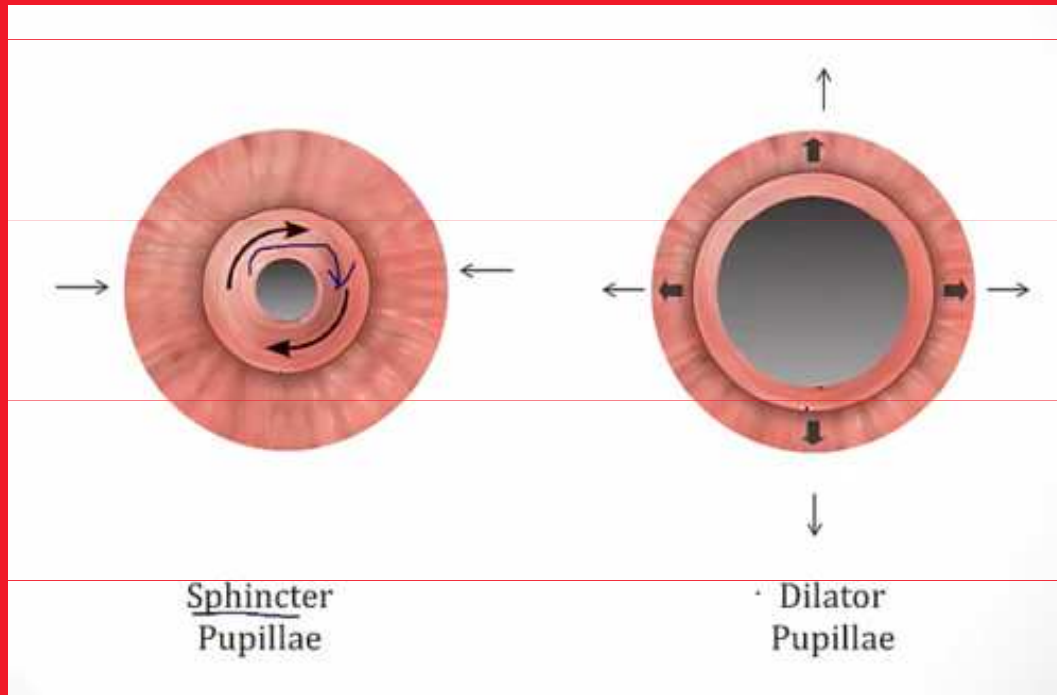


edema of the eye papilla - occurs when intracranial pressure rises, which leads to compression of nerve fibers due to increased intracranial pressure in the subarachnoid space around the optic nerve

Oculomotor nerve (n.III)

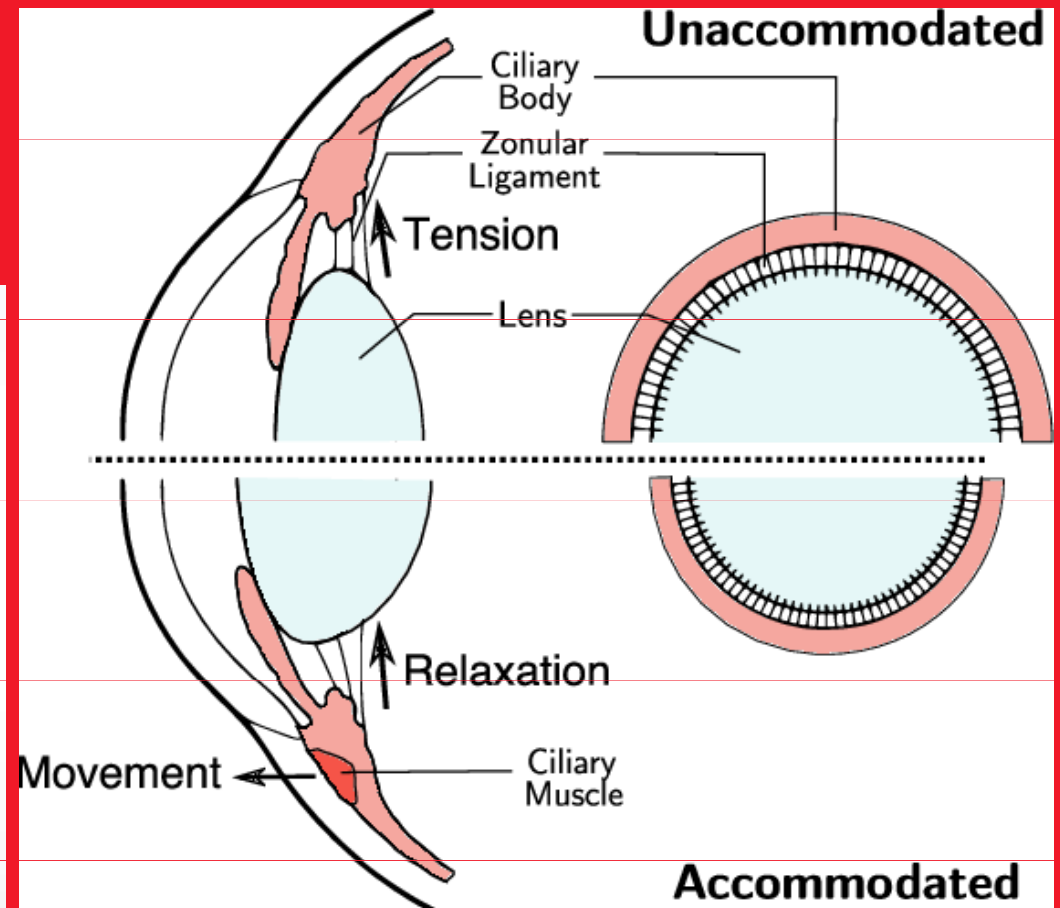
- arises from the interpeduncular fossa (sulcus nervi oculomotorii) of the midbrain
- innervates all of the extraocular muscles except superior oblique muscle and lateral rectus muscle
- brings preganglionic parasympathetic fibers from the **parasympathetic nucleus III** (Edinger-Westphali), which, after interpolation in the ciliary ganglion, innervate the **pupillary sphincter muscle** (miosis, constriction of the pupil) and **ciliary muscle** (accommodation – increasing the curvature of the lens)





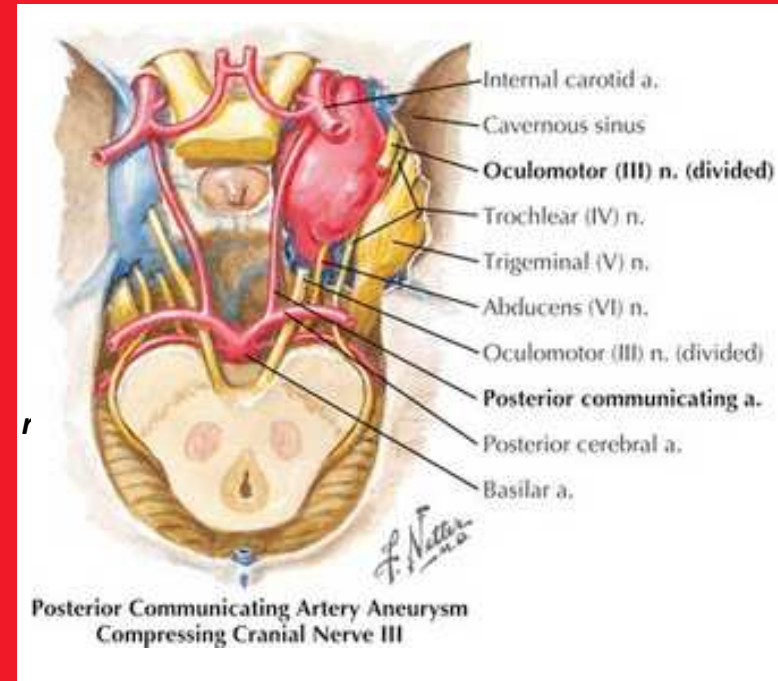
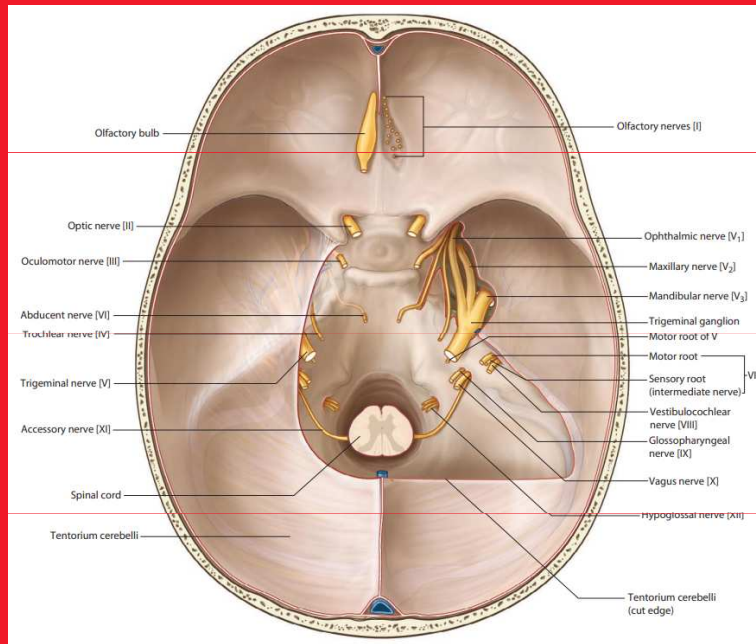
miosis (narrowed pupil)

mydriasis (dilated pupil)



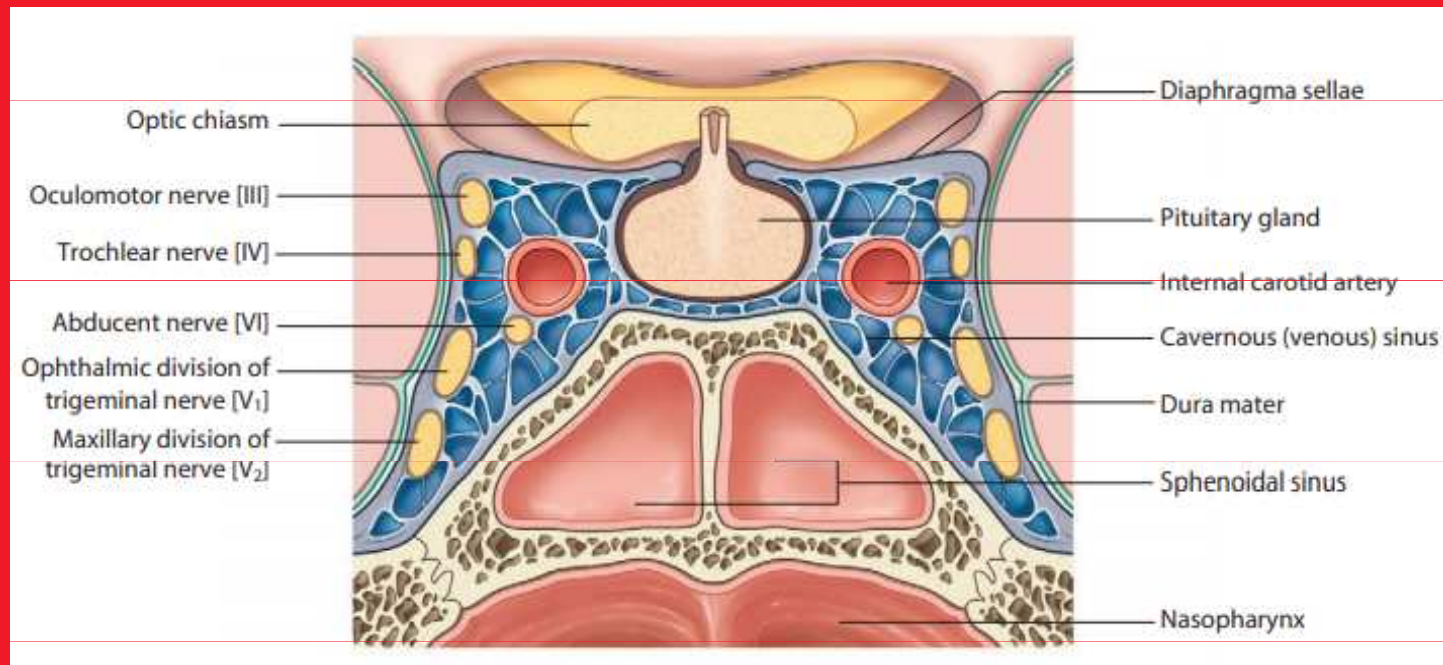
accommodation – increasing the curvature of the lens when the **ciliary muscle** is contracted, the lens becomes more spherical – and has increased focussing power

Oculomotor nerve



- passes through subarachnoid space (interpeduncular cistern) lateral to the posterior communicating artery
- pierces *dura mater* lateral from the posterior clinoid process and enters the cavernous sinus

CAVE: oculomotor nerve palsy caused by posterior communicating artery aneurysm!



- oculomotor nerve is located uppermost, above the trochlear nerve in the lateral wall of the cavernous
- In the cavernous sinus:
receives sympathetic branches from internal carotid plexus for innervation of superior tarsal muscle
(ncl. intermediolateralis Th1-Th5 → ganglion cervicale superius → n. caroticus internus → plexus caroticus internus)

SYMPTOMS OF OCULOMOTOR NERVE LESION

- **ptosis** (drooping or falling of the upper eyelid, weakening of the levator palpebrae superioris muscle)
- **strabismus** (eyes do not line up in the same direction)
- **diplopia** (double vision)
- **miosis** (constriction of the pupil)
- **mydriasis** (dilation of the pupil)

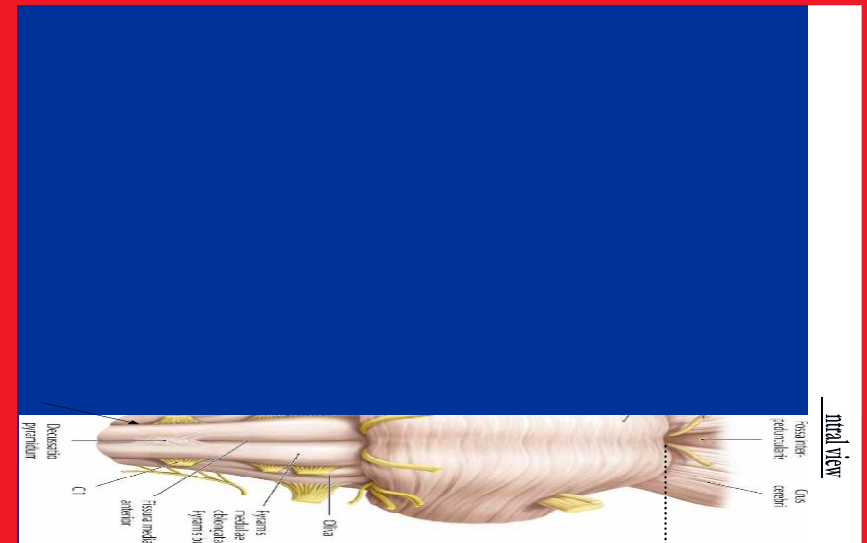


M U N I

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Trochlear nerve (n.IV)

- the trochlear motor nucleus in the midbrain
- fibers decussate within the brainstem
- arises as only cranial nerve from the dorsal aspect of the brainstem
- innervates the **superior oblique muscle**



SYMPTOMS OF TROCHLEAR NERVE LESION

- inability to move the eye down and laterally – paresis of the **superior oblique muscle** (the eye is moved medially)
- **diplopia** (double vision)



M U N I

M E D

Trigeminal nerve (n.V)

- the biggest cranial nerve
- mixed nerve with large nuclear complex

1. Motor nucleus of trigeminal nerve (masticatory)

- **branchiomotor nucleus** supplies muscles derived from 1th pharyngeal arch (muscles of mastication, *m. mylohyoideus*, *venter anterior m. digastrici*, *m. tensor tympani*, *m. tensor veli palatini*)

2. Principal sensory nucleus of trigeminal nerve (pontine)

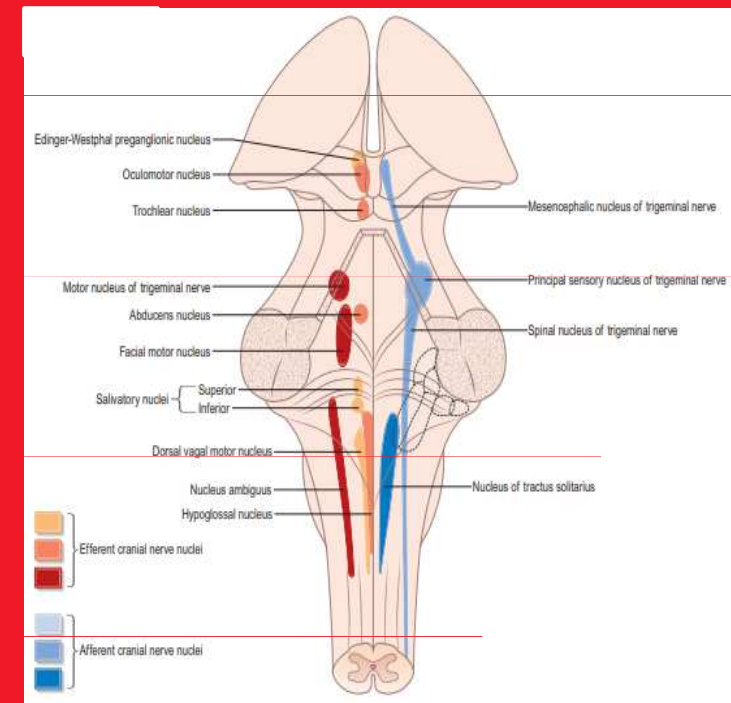
- **somatosensory nucleus**, receives discriminative sensations, proprioception, light touch and vibration in areas of face and mouth

3. Spinal nucleus of trigeminal nerve

- **somatosensory nucleus** for perception of cold, heat, pain (pain in or around your teeth and jaws) and partial proprioception from n. V, VII, IX, X

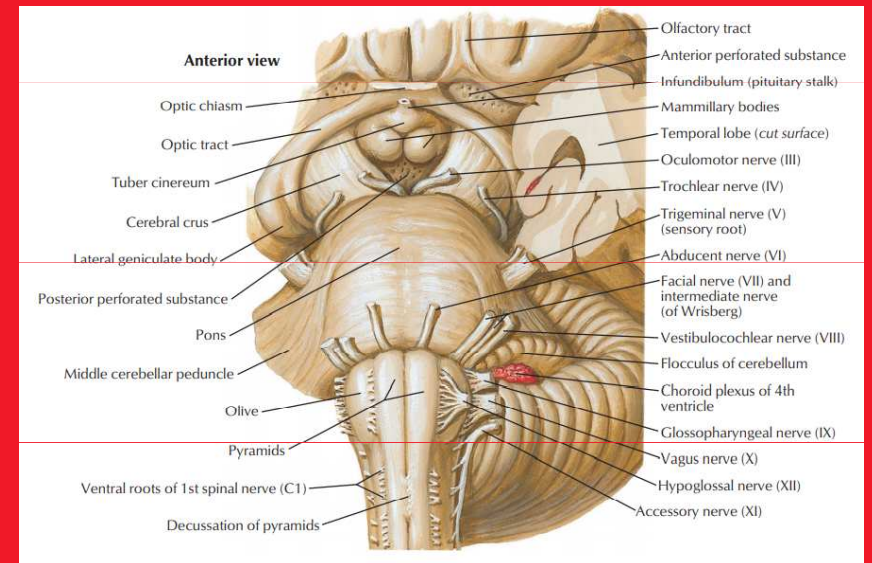
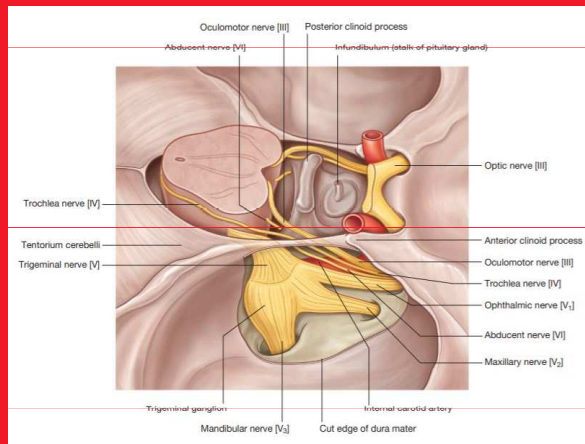
4. Mesencephalic nucleus of trigeminal nerve

- **ganglion with pseudounipolar neurons**, receives proprioception (the sense that lets us perceive the location, movement, and action of parts of the body) from **periodontium** - group of tissues that together facilitate the anchorage of teeth in jaws, hard palate, temporomandibular joint and from extraocular, masticatory, mimic and lingual muscles too



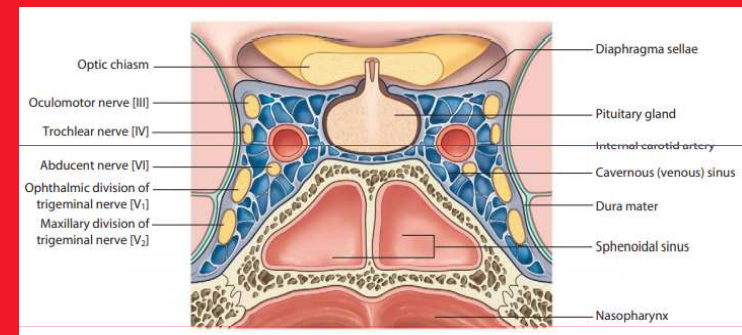
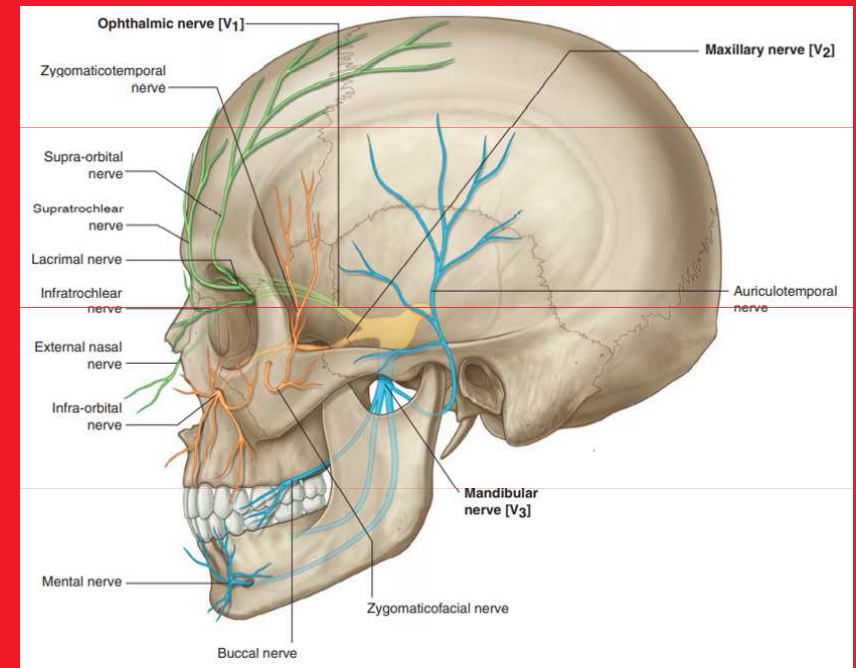
Trigeminal nerve

- arises from the middle part of pons
- enters the trigeminal cave (Meckel's cave), a dura mater pouch containing **trigeminal ganglion (*semilunare, Gasserī*)**
- **motor root (*portio minor trigemini*)** underruns the ganglion and joins the mandibular nerve directly



Ophthalmic nerve

- 1th branch of the trigeminal nerve
- counts approx. 26 000 myelinated fibers
- the most medial branch of the trigeminal ganglion
- passes through the lateral wall of cavernous sinus
- supplies (somatosensory):
 - orbit with periosteum, ocular bulb, lacrimal gland
 - conjunctiva of the upper eyelid
 - skin of nasal dorsum and tip, upper eyelid and forehead to the interauricular line
 - ethmoidal cells mucosa, *sphenoid sinus* and ventral part of nasal cavity



Ophthalmic nerve

- divides in superior orbital fissure to:
 - *nervus frontalis*
 - *nervus lacrimalis*
 - *nervus nasociliaris*

Nervus frontalis

- *n. supraorbitalis*
 - *r. medialis*
 - *r. lateralis*
- *n. supratrochlearis*

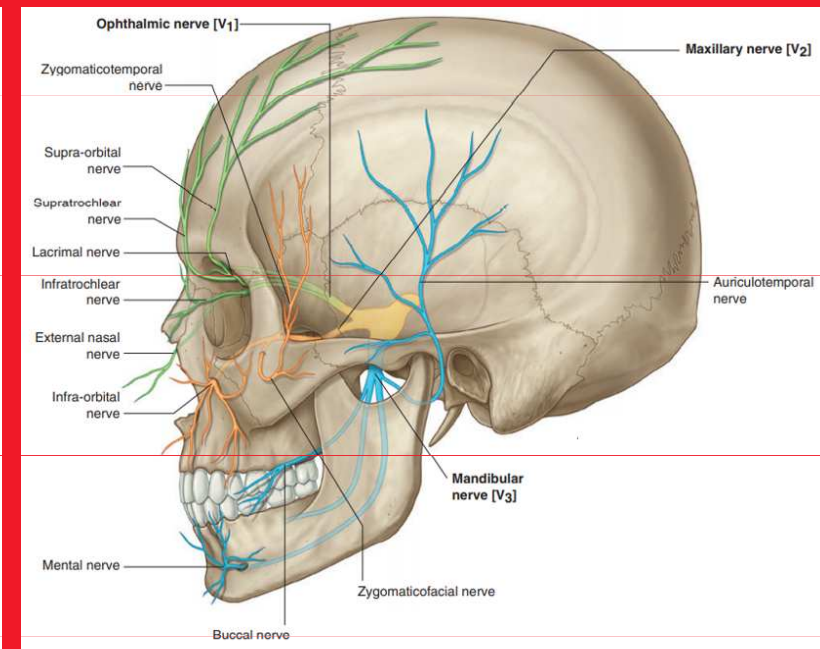
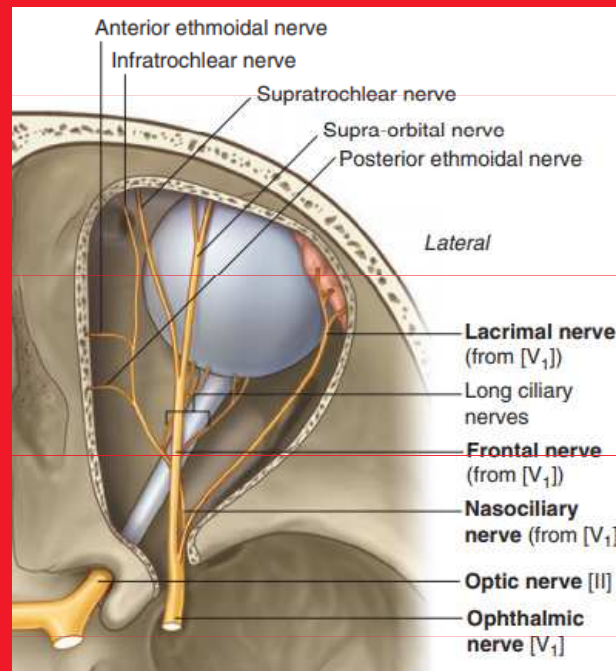
Nervus lacrimalis

- *r. communicans cum nervo zygomatico*

Nervus nasociliaris

- *r. communicans cum ganglio ciliari*
- *nn. ciliares longi*
- *n. ethmoidalis posterior*
- *n. ethmoidalis anterior*
 - *n. nasales*
 - *r. nasalis externus*

Innervates the mucosa of the upper part of the nasal cavity

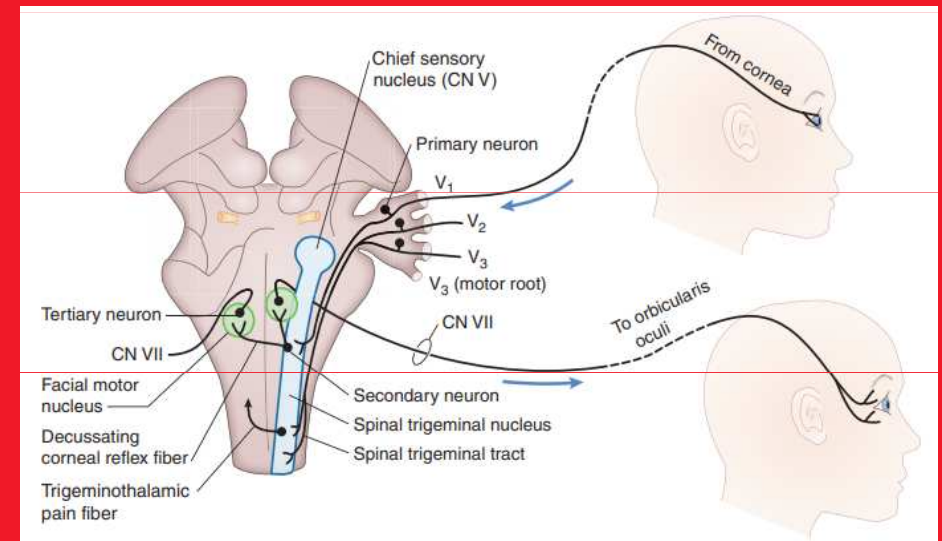


The corneal reflex

also known as the blink reflex or eyelid reflex - blinking of the eyelids elicited by stimulation of the cornea (such as by touching)

The corneal reflex is mediated by the reflex arc, which consists of corneal receptors, the afferent **ophthalmic nerve** (1st branch of the nerve) and the efferent **VII nerve** innervating the orbicularis oculi muscle (leads to tightening of the eyelids)

hypo/areflexia (loss of reflex): indicated mesencephalon or pons damage



Herpes Zoster Ophthalmicus

- a viral disease characterized by a unilateral painful skin rash or blisters in distributions of the fifth cranial nerve (ophthalmic nerve) - travel along neurons to the sensory axons of the skin to form vesicular lesions

- occurs after reactivation of latent varicella-zoster virus (VZV) present within the cerebral ganglia

antiviral drugs, corticoids, ATB for bacterial infection....

the risk of brain damage in patients with weakened immunity !!!



M U N I

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Maxillary nerve

- 2nd branch of the trigeminal nerve

- supplies (somatosensory):

dura mater in the middle cranial fossa

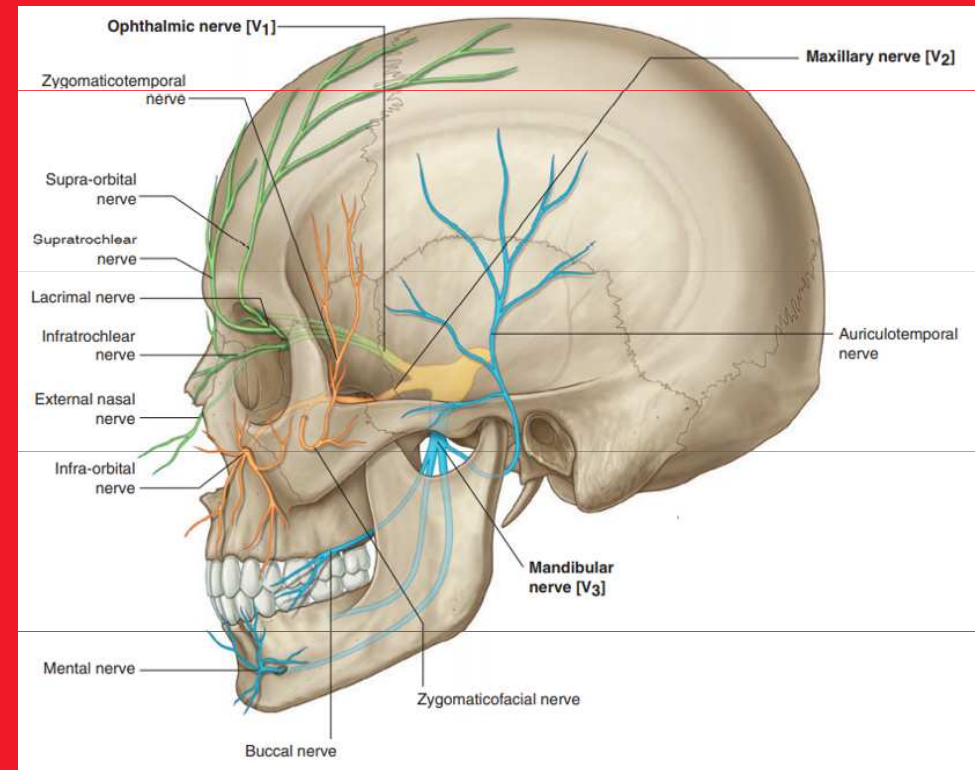
cheek skin between the palpebral and oral fissure

mucosa of the upper cheeks

mucosa of the maxillary sinus and posterior

2/3 of the nasal cavity

mucosa of the palate, nasopharynx and adjacent part of the Eustachian tube, maxilla and upper teeth

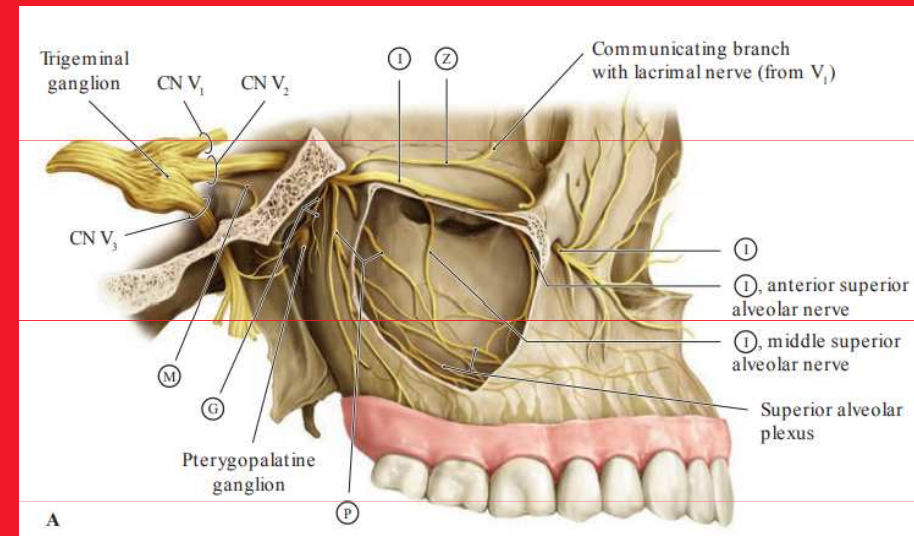


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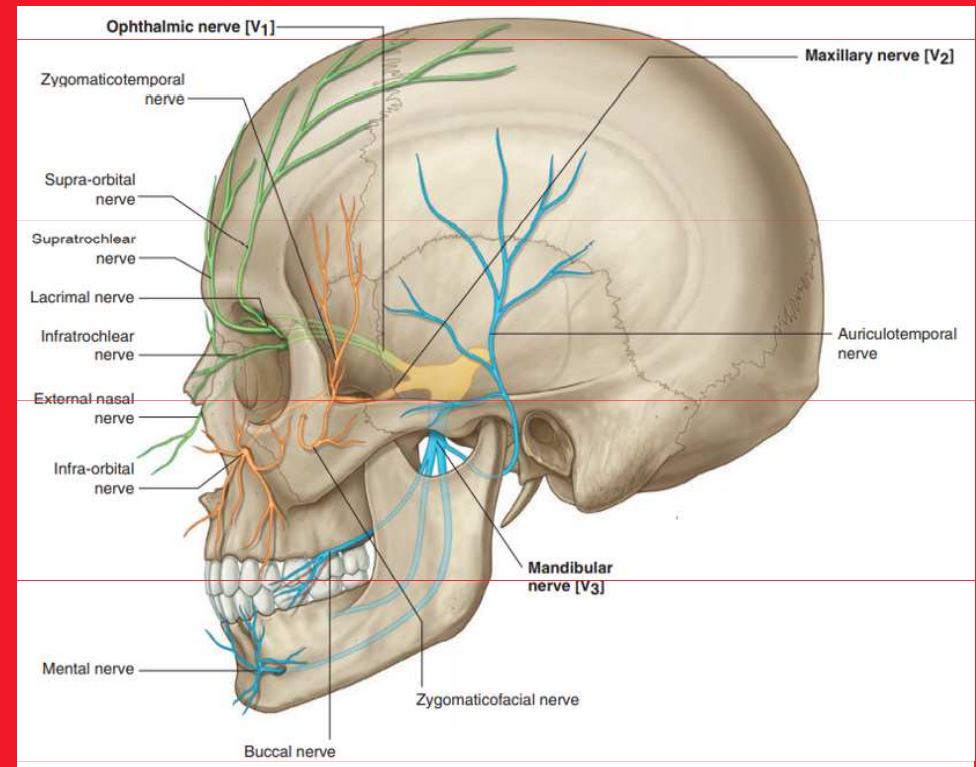
Maxillary nerve

- passes through the lateral wall of cavernous sinus,
- enters pterygopalatine fossa through the foramen rotundum
- enters the orbit through the inferior orbital fissure and runs forward on the floor of the orbit
- emerges on the face through the infraorbital foramen
- terminates by dividing into inferior palpebral, lateral nasal and superior labial branches



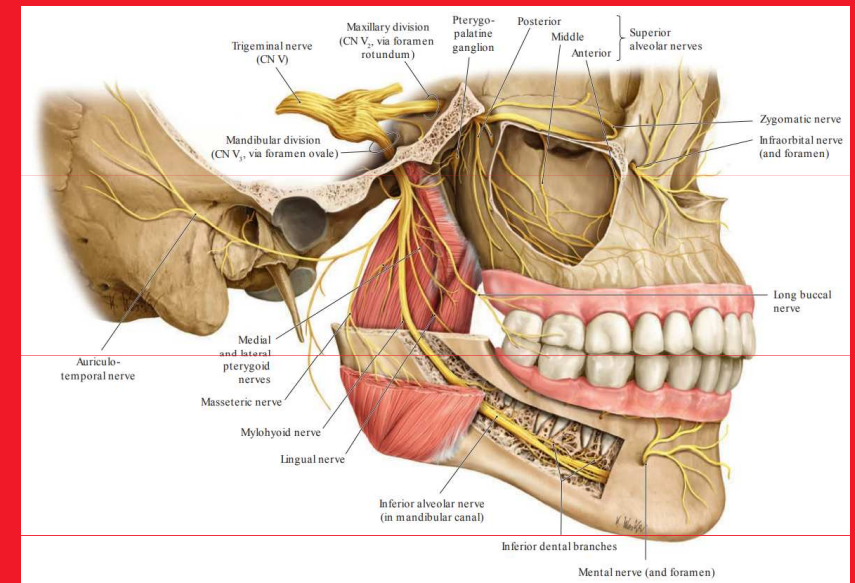
MUNI MED Mandibular nerve

- 3th branch of the trigeminal nerve
- counts approx. 26 000 myelinated fibers
- supplies (somatosensory):
 - *dura mater* near the posterior branches of middle meningeal artery
 - skin of temporal region and **around mandibula**
 - **mucosa of the lower cheeks, *isthmus faucium*, palatine tonsil and the floor of the oral cavity**
 - **mandible and lower teeth**
- innervates (branchiomotor):
 - **masticatory muscles** (*m. masseter, m. temporalis, m. pterygoideus medialis et lateralis*)
 - *m. mylohyoideus, venter anterior m. digastrici*
 - *m. tensor tympani, m. tensor veli palatini*



Mandibular nerve

- the **most lateral branch** of the trigeminal ganglion
- receives motor root
- enters to the **infratemporal fossa** through the **foramen ovale**
- enter the **mandibular canal**, a narrow tunnel running through the mandible, within this canal, the nerve provides branches to the mandibular teeth and emerges as the **mental nerve** (provides feeling of lower lip, the front of your chin, and a portion of your gums)

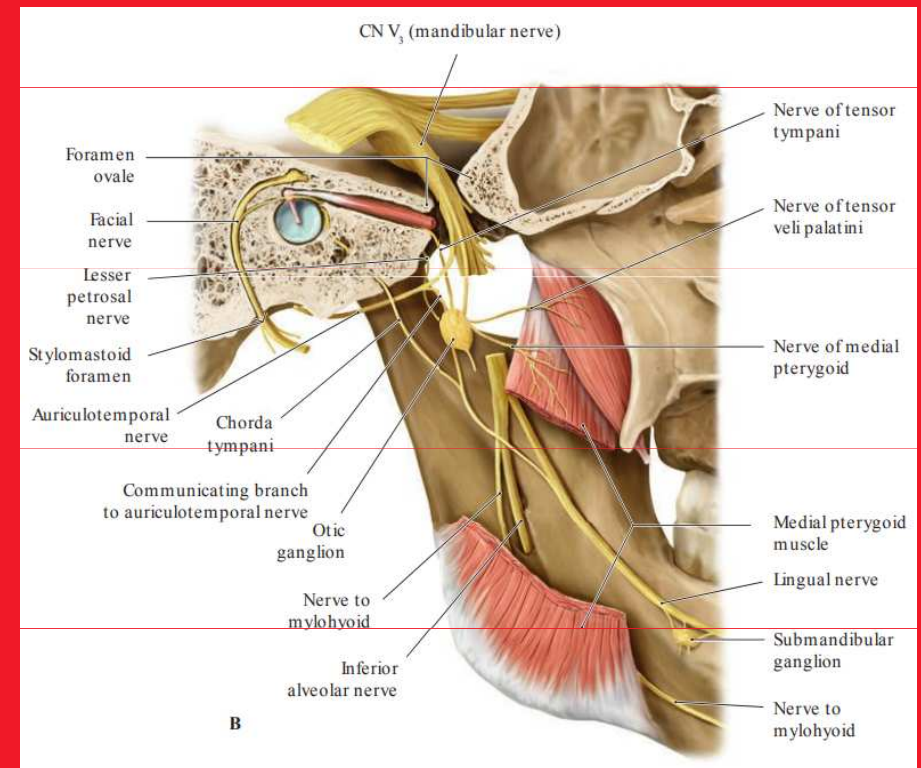


Chorda tympani

Chorda tympani branches off the facial nerve (within the facial canal) and enters the lateral wall of the tympanic cavity

- exits the skull by descending through the petrotympanic fissure into the infratemporal fossa and joins the lingual nerve, a branch of the mandibular nerve

- fibers of chorda tympani enter the sublingual space to reach the anterior 2/3 of the tongue and submandibular ganglion which innervate the submandibular and sublingual salivary glands



Jaw jerk (masseter) reflex

The mandible (lower jaw) is tapped at a downward angle just below the lips at the chin while the mouth is held slightly open

In a healthy patient, the answer is the closing of the lower jaw, which is caused by the contraction of the masseter muscle



we can test for damage to the trigeminal nerve using the masseter reflex

M U N I

M E D

Trigeminal neuralgia

type of chronic pain disorder that involves sudden attacks of severe facial pain similar to an electric shock on one side of the face

- most commonly affects the 2nd and 3rd branches of the trigeminal nerve
- usually the pain is triggered by touching the trigger zone (trigger point) for example touching the face, gums, chewing, brushing teeth, talking, cold or touch stimulus of the face

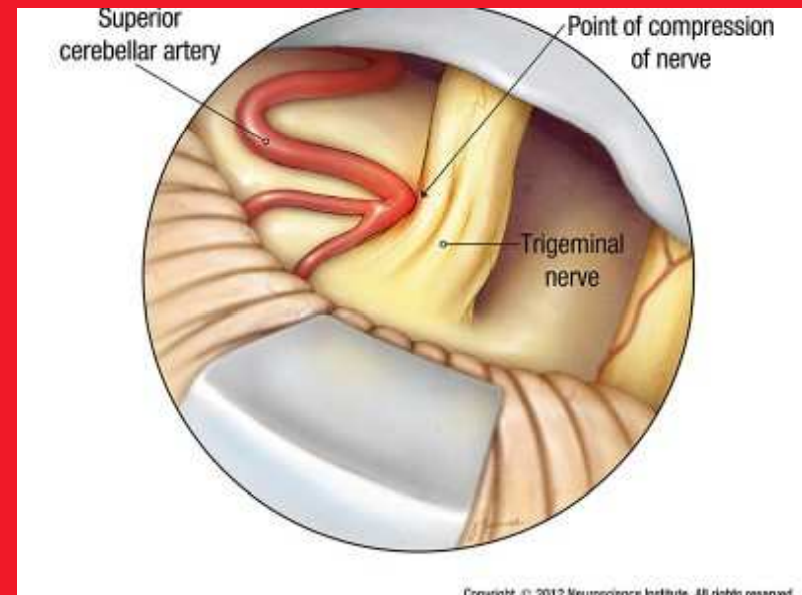
Inflammation in the oral cavity can mimic the trigeminal neuralgia by irritation of the mandibular nerve!

M U N I

M E D

Trigeminal neuralgia

the most common cause of trigeminal neuralgia is compression of the trigeminal nerve at the point of exit from the brainstem by a vessel



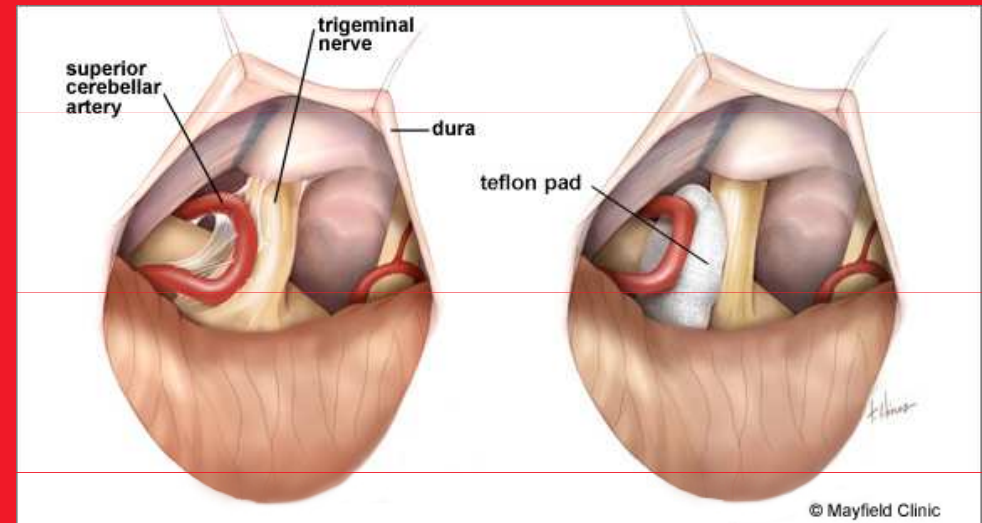
exit point of the nerve from the brainstem

Trigeminal neuralgia

treatment – surgical

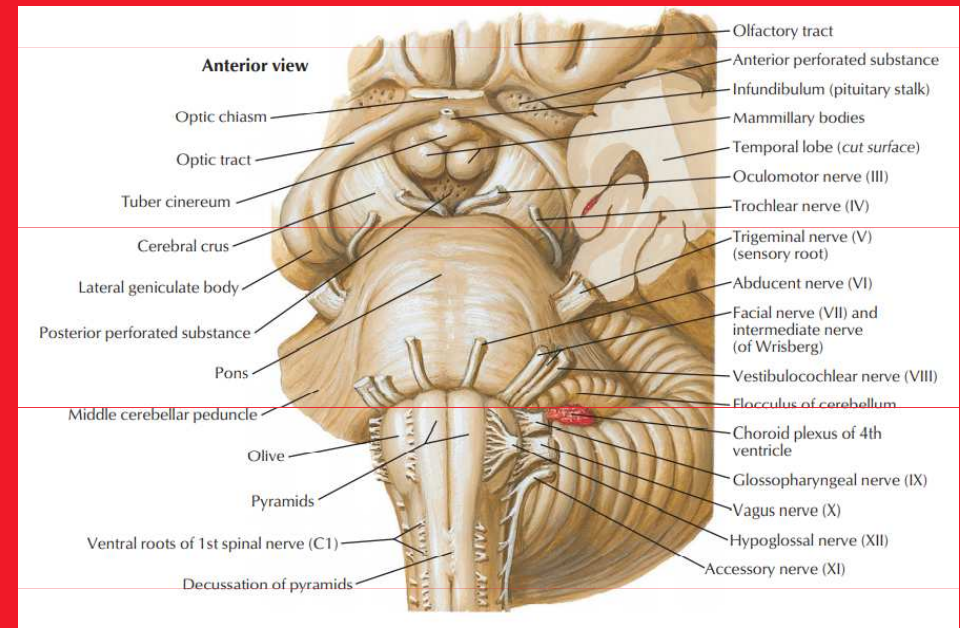
- microvascular decompression and inserting a special material between the vessel and the nerve

- the goal is to reduce the transmission of pulsations from the vessel to the nerve



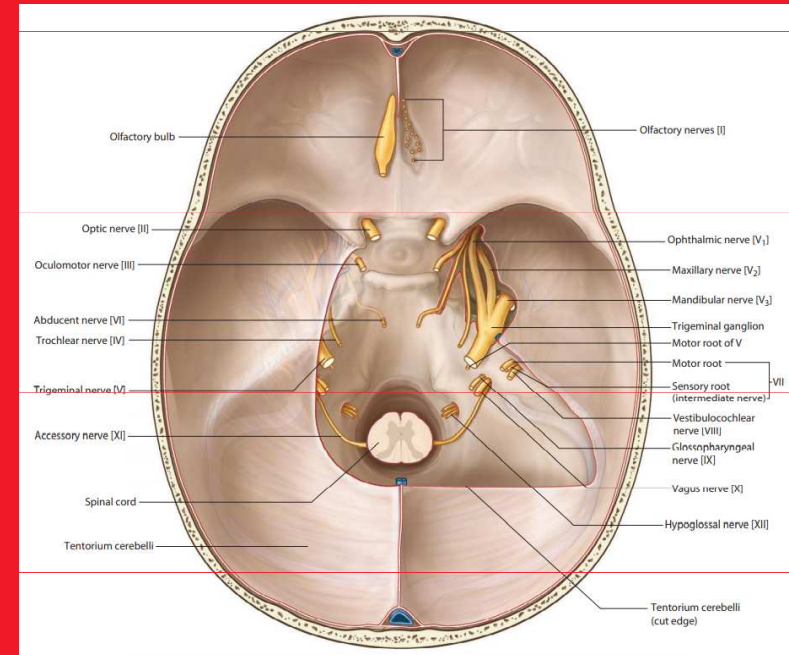
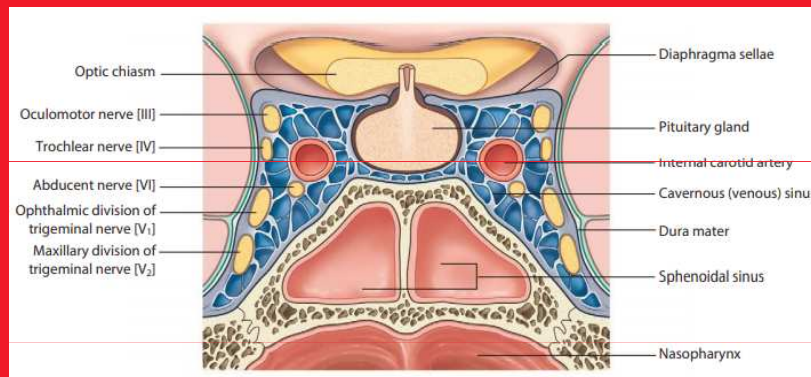
Abducens nerve (n.VI)

- the abducens motor nucleus in the pons
- arises from the **bulbopontine groove** medial to the n. VII
- innervates the **lateral rectus muscle**



Abducens nerve (n.VI)

- runs along the clivus forward and laterally
- in the cavernous sinus runs laterocaudally from the internal carotid artery – mobile and more vulnerable
- through the superior orbital fissure into the orbit



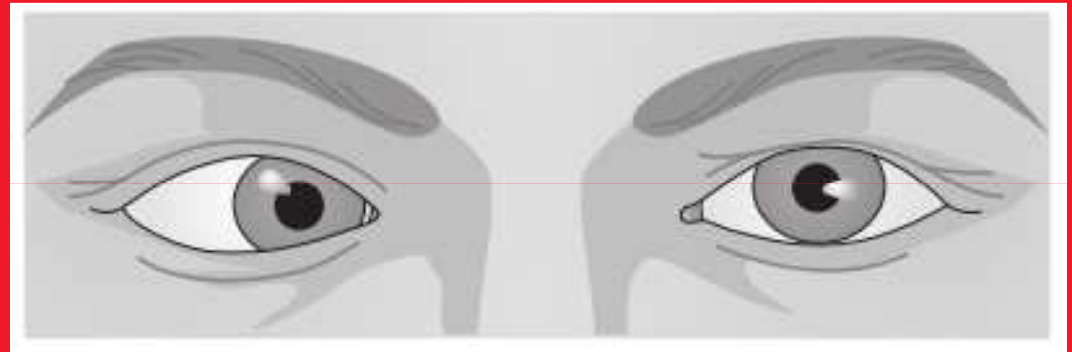
thin and mobile -can be injured by stretching or compression

M U N I

M E D

SYMPTOMS OF ABDUCENS NERVE LESION

- lateral limitation of eye movement (the lateral rectus muscle does not work)
- diplopia (double vision)



Etiology:

- trauma
- compression by the tumor
- arteriovenous fistula of the sinus cavernosus
- intracranial hypertension

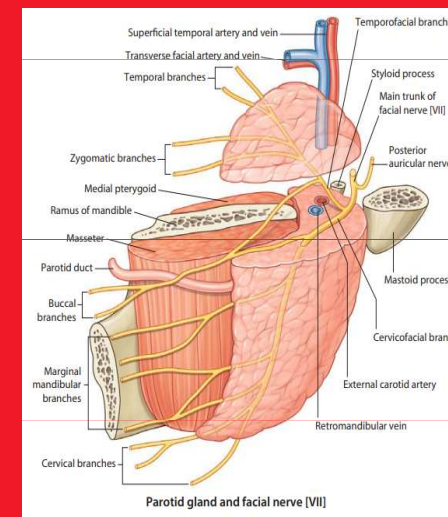
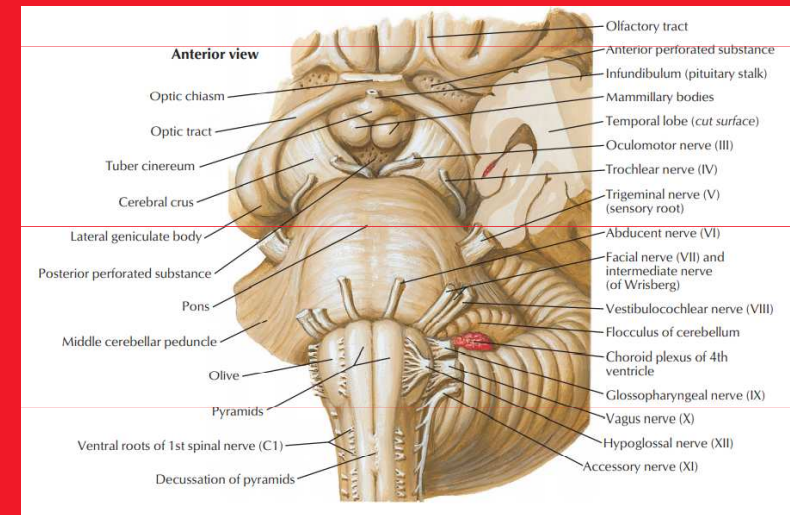


Facial nerve (n.VII)

Arising of the n. VII

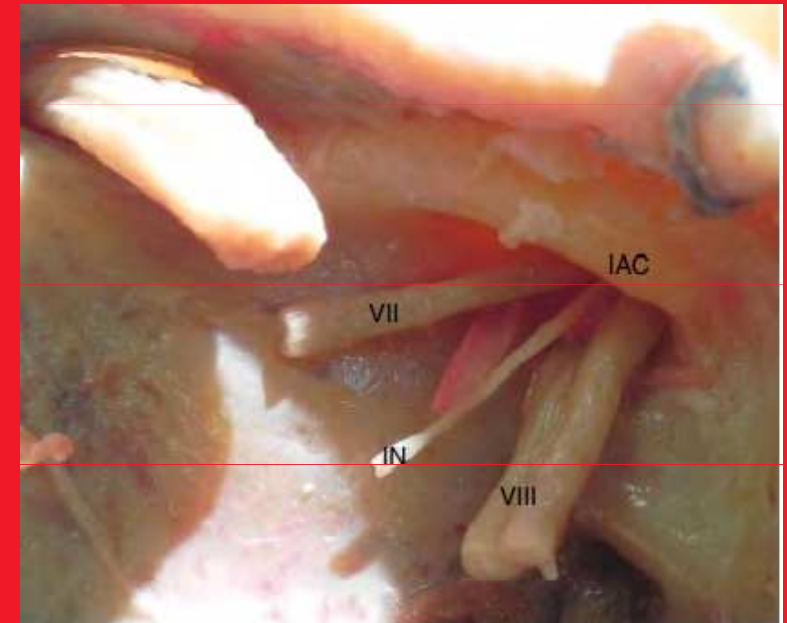
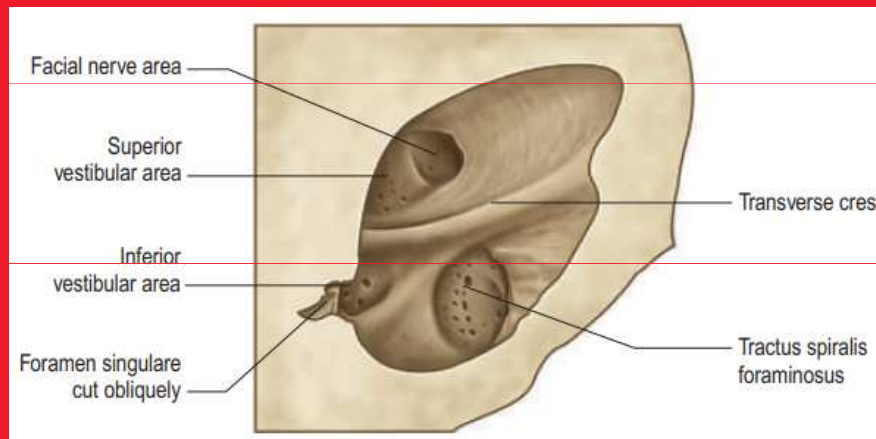
arises from the **bulbopontine groove**
lateral from the abducent nerve)

- travels from the pons through the facial canal in the temporal bone
- exits the skull at the stylomastoid foramen
- enters the parotid gland posteriorly and forms the parotid plexus
- branches for facial muscles arise from the parotid plexus

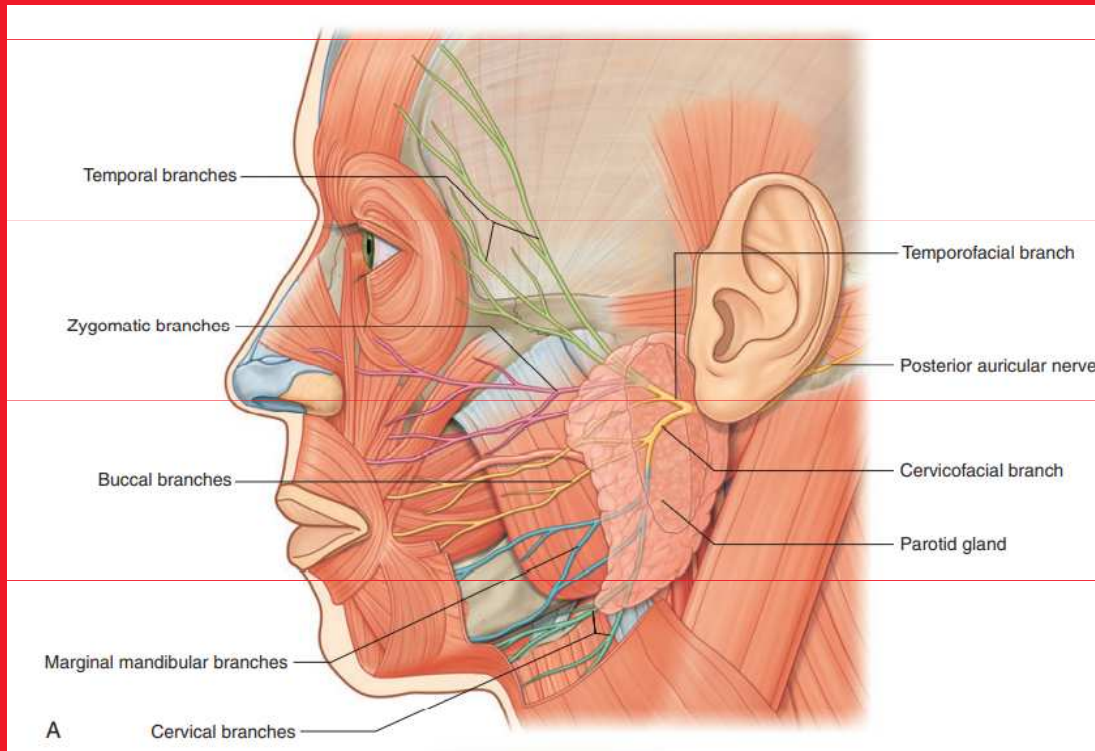


Facial nerve (n.VII)

- enters the pyramid through the fundus of internal acoustic meatus (area nervi facialis, ventrocranial part)
- before entering the pyramid, it connects with the n. intermedius, part of the facial nerve - contains the sensory fibers for taste from the front two-thirds of the tongue and parasympathetic fibers for the sublingual and submandibular salivary gland



after exiting the parotid plexus it has 5 branches for mimic muscles...



1. Temporal branches

- muscles of the frontal and temporal region

2. Zygomatic branches

- *m. orbicularis oculi*, *mm. zygomatici* and muscles of the nose

3. Buccal branches

- muscles of the upper lip and buccal region

4. Marginal mandibular branches

- muscles of the chin and lower lip

5. Cervical branches

- *m. platysma*

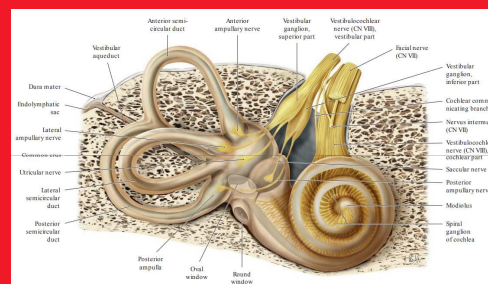
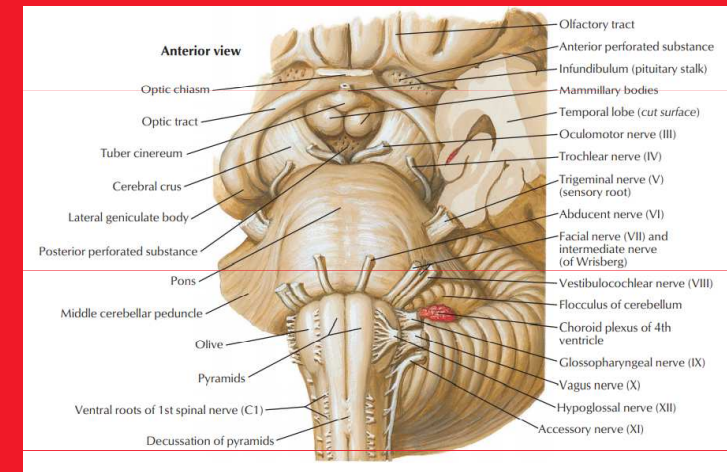
Symptoms of facial nerve lesion

- mimic muscles palsy (drooping of the corner of the mouth)
- lagophthalmos (inability to close the eyelids completely - leads to corneal drying and ulceration)
- ageusia (loss of taste functions of the tongue)
- hyposecretion of saliva



Vestibulocochlear nerve (n.VIII)

- emerges from the brain at the cerebellopontine angle and exits the cranium via the internal acoustic meatus of the temporal bone
- splits to form the vestibular nerve and the cochlear nerve
- **vestibular nerve** innervates the vestibular system of the inner ear, which is responsible for detecting balance
- **cochlear nerve** travels to cochlea of the inner ear, forming the spiral ganglion which serve the sense of hearing



arises from the **bulbopontine groove** medial to the n. VII

Symptoms from damage to the vestibular system

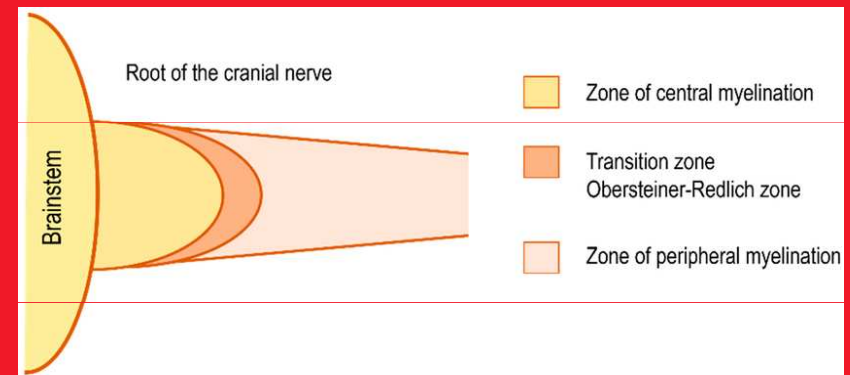
- **vertigo** (the feeling of spinning)
- **nystagmus** (rhythmic, abnormal eye movements)
- **nausea** (the feeling that you are going to vomit)
- **vomitus** (vomiting)

Symptoms from damage to the auditory system

- **hypacsis** (partial hearing loss)
- **anacosis** (the total loss of hearing)
- **tinnitus** (the sensation of hearing, commonly described as a ringing sound, noise in the ear)

Vestibular schwannoma

- benign tumor from the Schwann's cells
- develops on the vestibular nerve
- arise at the junction of **central myelin** produced by oligodendrocytes and **peripheral myelin** from Schwann cells (Obersteiner-Redlich zone)



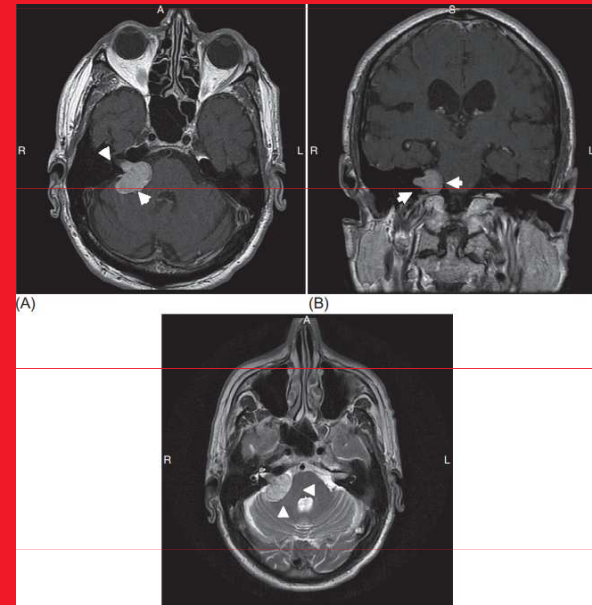
Vestibular schwannoma

Symptoms from vestibulocochlear nerve compression:

- one-sided hearing loss
- noise in the ear (Tinnitus)
- balance problems and vertigo

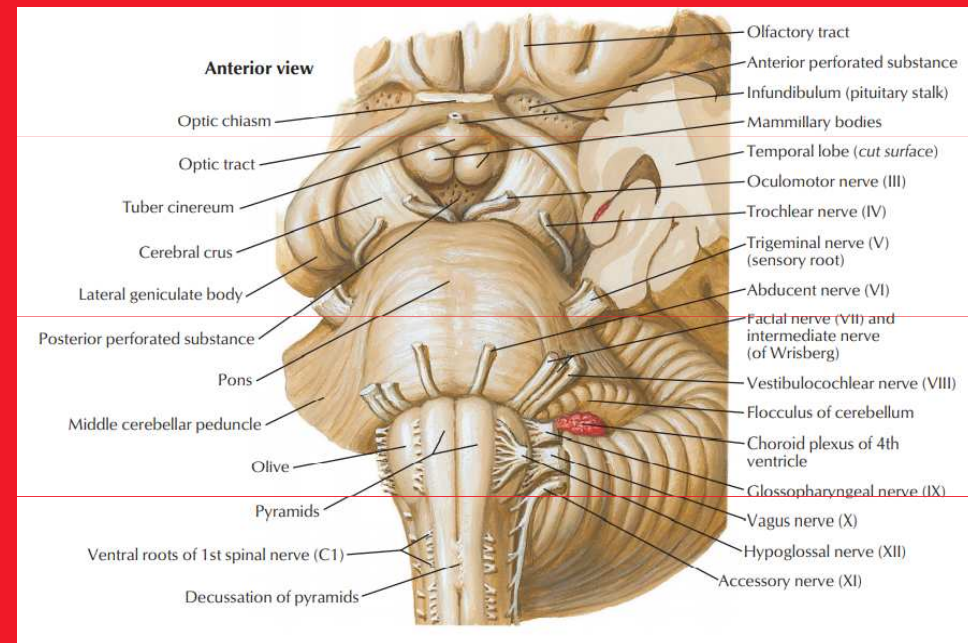
Treatment

- observations
- radiation
- surgical removal



Glossopharyngeal nerve (n.IX)

- nerve with motor, sensitive and parasympathetic (gl. parotis, parotid salivary gland) component
- sensory function - for taste perception from dorsal 1/3 of the tongue (n.VII - taste perception from the front two thirds of the tongue)
- leaves the brainstem in a form of the several rootlets from the posterolateral sulcus



Glossopharyngeal nerve

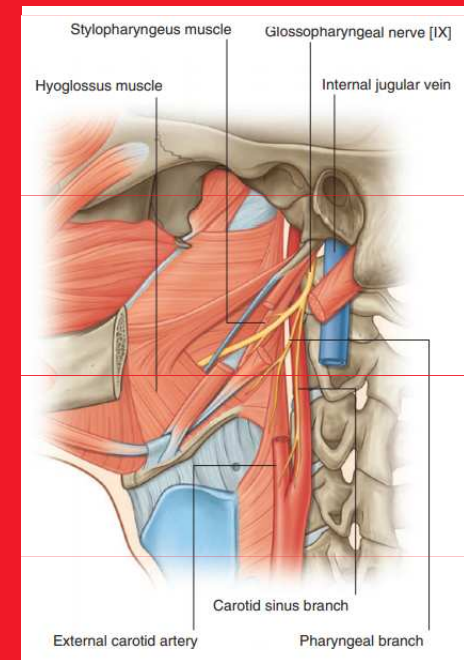
- leaves the cranium through the jugular foramen
- descends forward and inferiorly, aiming to the root of the tongue

innervation of the muscles - muscles of the pharynx, soft palate except of m. tensor veli palatini

parasympathetic innervation of the parotid gland

taste perception from dorsal 1/3 of the tongue

somatosensory information (pain, temperature, touch) from the pharynx, palatine tonsil, dorsal 1/3 of the tongue, tympanic cavity and adjacent part of the Eustachian tube

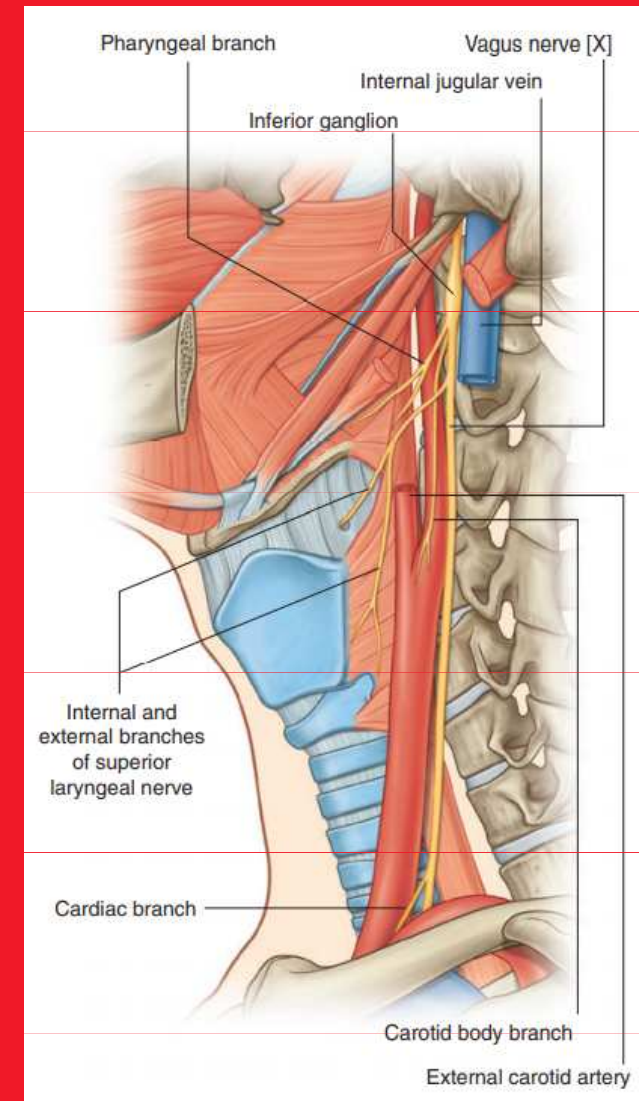


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Vagus nerve (n.X)

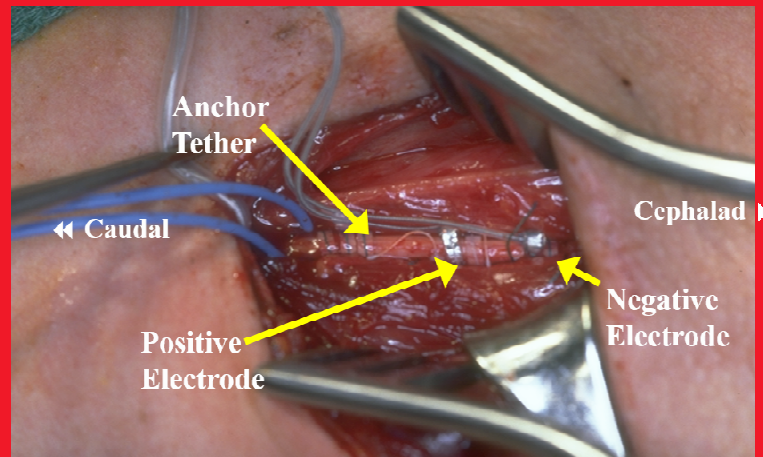
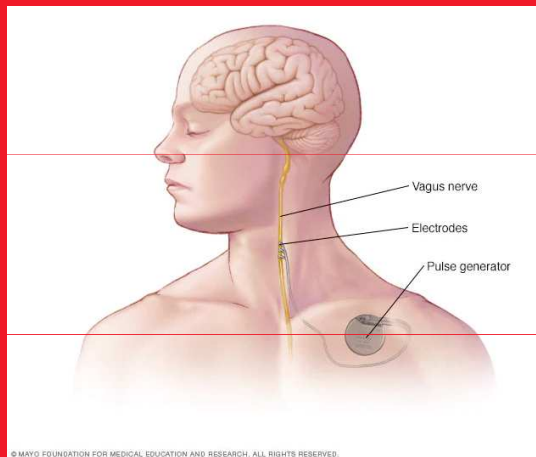
- contains parasympathetic fibres to control heart, lungs, and digestive tract
- extends through the jugular foramen, then passes into the carotid sheath between the internal carotid artery and the internal jugular vein down to the neck, chest, and abdomen



Drug-resistant epilepsy

Treatment of drug-resistant epilepsy

- implantation of electrodes to stimulate the vagus nerve with electrical impulses



connection of subcutaneous electrodes to a generator implanted below the clavicle

Accessory nerv (n.XI)

- essential for neck and shoulder movement
- innervation of the sternocleidomastoid and trapezius muscles
- palsy of the accessory nerve is most often manifested as the inability to rotate the head to the healthy side
- the arm on the affected side is lowered



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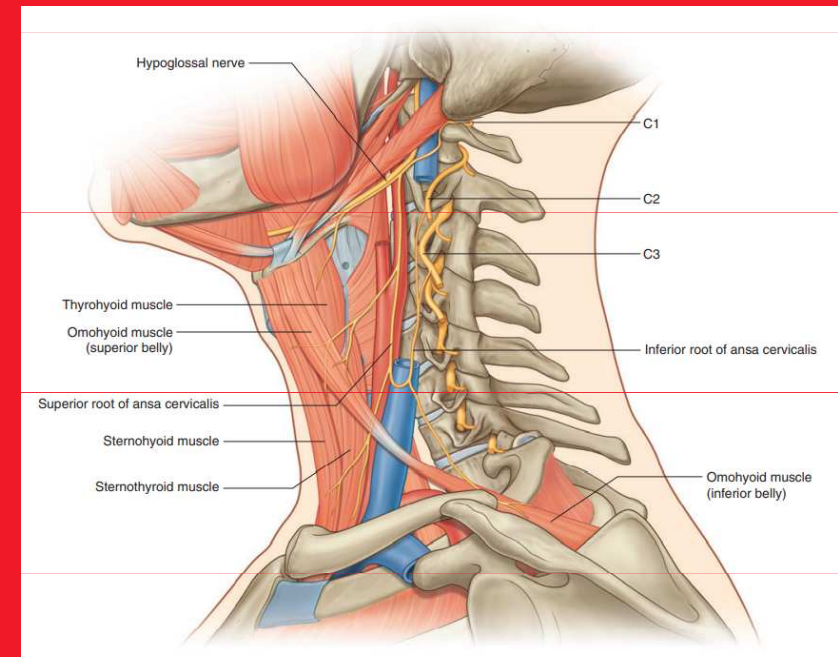
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Hypoglossal nerve (n.XII)

innervates all muscles of the tongue, except for the palatoglossus which is innervated by the vagus nerve

- exits the cranium via the hypoglossal canal of the occipital bone

- passes inferiorly to the angle of the mandible and moving in an anterior direction to enter the tongue



Symptom of hypoglossal nerve lesion

Unilateral damage to the hypoglossal nerve

hemiglossoplegia (paralysis of half of the tongue)

- the affected side of the tongue is atrophic,
- fasciculations (muscle twitching) appear
- the tongue rolls on affected side

Bilateral damage to the hypoglossal nerve

- paralysis of both halves of the tongue,
(glossoplegia) – cannot crawl out, speech is
impaired (dysarthria)



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