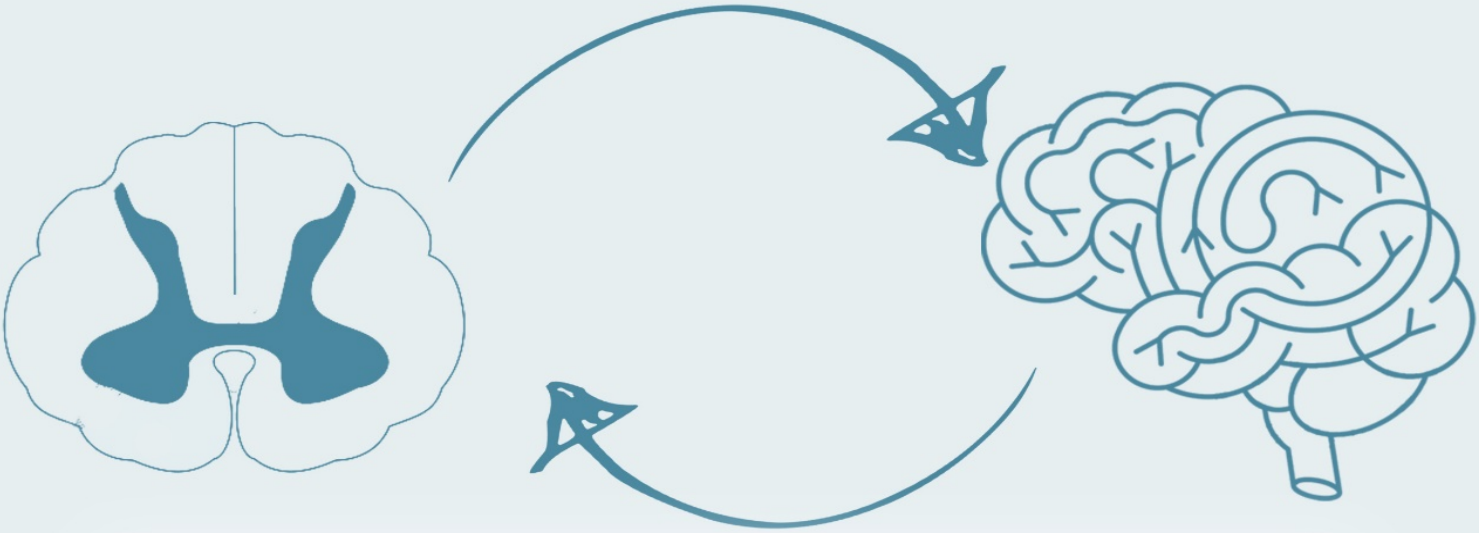

CNS

Anatomy

slides | sheets

number	10
Done by	Renad Zakaria
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We started talking about the **mid brain**,

Two transverse sections of the midbrain will be discussed:

1- The level of the inferior colliculus.

2- The level of the superior colliculus.

**** In** the previous lecture & in the LAB we talked about the trochlear nerve that innervates only a single muscle: the superior oblique muscle of the eye, the origin of it and its relation with the level of inferior colliculus, also we talked about the level of inferior colliculus.

Now we will go a level up and start talking about **the level of superior colliculus** ……

We will first consider that there are common features to see in these two levels and there are some differences:

****They have same** shape, cavity, crus cerebri, substantia nigra, medial longitudinal fasciculus (since its destination the motor nucleus of occulomotor) and cerebral aqueduct.

** **The major difference** between the two is:

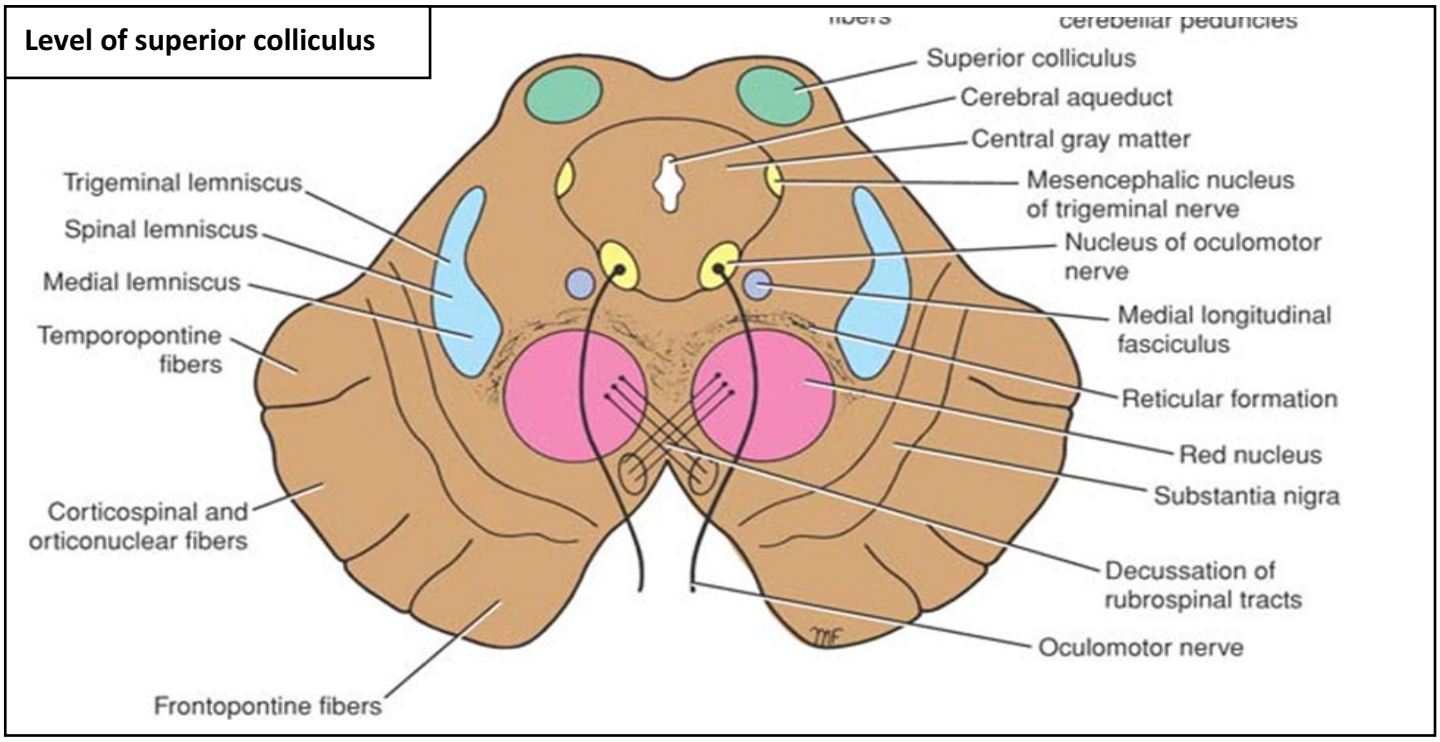
1- The presence of the **red nucleus** that found in the level of superior colliculus and if not present we will be in the level of inferior colliculus that has **Decussation of sup. cerebellar** peduncle that composed of fibers from cerebellar, cerebellothalamic tract and cerebellorubral tract.

** **NOTE:** the decussation of sup. Cerebellar is immediate, you see it at the level of the nucleus.

2- At the level of inferior coliculus Posterior to Substantia nigra there are medial, spinal, trigeminal & lateral leminisci, whereas at the level of superior coliculus you will notice that there is no lateral leminiscus, why?

We know it carries information about sound (auditory) from the cochlear nucleus to various brainstem nuclei and ultimately the contralateral **inferior colliculus** of the midbrain, and since we are at the superior level you won't found it because its fibers end in the inferior colliculus (act in auditory reflexes).

** try to identify what we were talking about, pay attention and keep refer to this picture to make sure that everything is clear:



** In this section at the level of superior colliculus there will be motor occulomotor nucleus instead of trochlear nucleus (in inferior level) since we are level above, let's talk about it:

Oculomotor Nerve (III)

- Is it pure motor?

Yes, but it has two types of motor:

a) Motor for skeletal muscles.

b) Motor for smooth muscles like ciliary and constrictor pupillae muscles, its parasympathetic regulation.

- It's the first cranial nerve to leave the brainstem.

- It has **two nuclei**: motor and parasympathetic, they are posterior to Medial longitudinal fasciculus .

Main oculomotor nucleus:

- Location: if you go postriolateral you will see the main motor nucleus of occulomotor.

- receive bilateral stimulation from the cortex, it receives from:

a) Corticonuclear fibers.

B) Tectobulbar fibers: Info from visual cortex (refer to the previous lectures).

c) Medial longitudinal fasciculus: connected to the nuclei of the IV, VI, and VIII cranial nerves.

** In some resources it's written that this motor nucleus doesn't receive from the cortex, it receives indirectly from medial longitudinal fasciculus and superior colliculus and other regions.

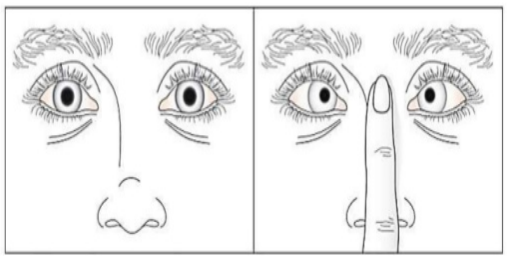
ATTENTION!

Accessory parasympathetic nucleus (Edinger-Westphal nucleus):

- Location: you will find it near the motor nucleus.

- Receives from:

a) From gaze center of the cortex through Corticonuclear fibers: it's for **accommodation reflex** which is a reflex action of the eye, in response to focusing on a near object, then looking at a distant object (and vice versa), comprising coordinated changes in vergence, lens shape and pupil size(the lens become more spherical when looking at near object) , it also named **accommodation-convergence reflex.**



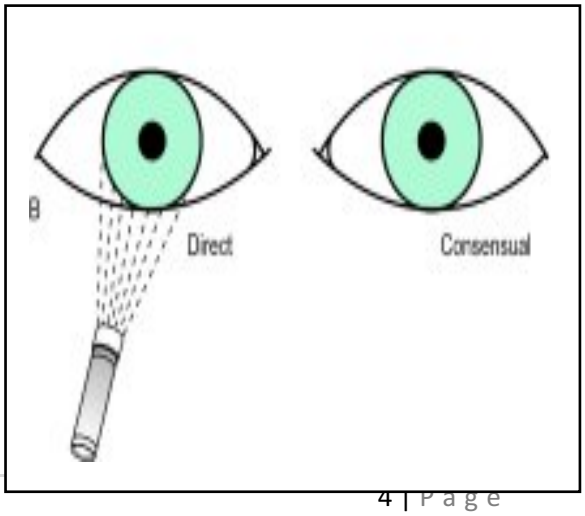
The reflex after asking this person to look at a far object then to a near one.

** *flat lens is better to recognize far objects , whereas spherical lens is better for near objects .*

b) Pretectal nucleus: direct and consensual light reflexes.

****pretectal nucleus**: close to the lateral part of the superior colliculus. These cells receive input from retinal ganglion cells (via the optic tract) and project bilaterally to the Edinger-Westphal nucleus. It's responsible for:

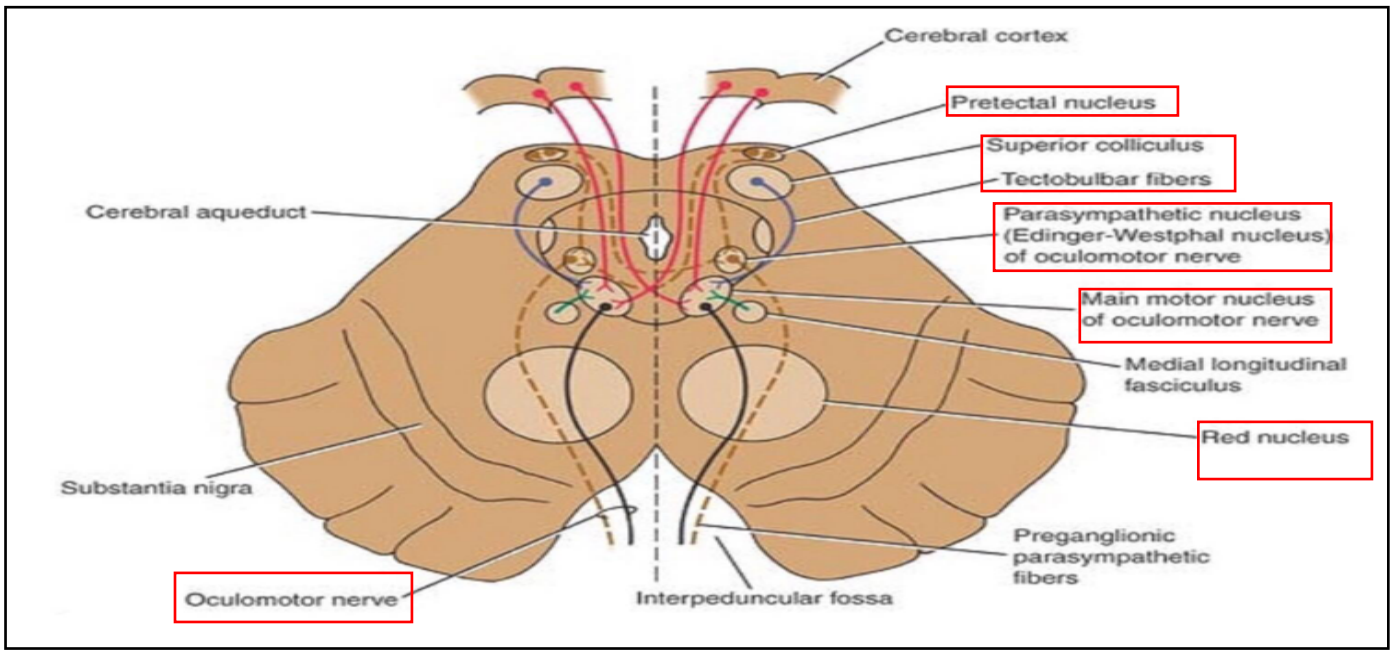
1- Direct reflex: This reflex is responsible for the constriction of the pupils by constrictor pupillae muscle upon light's entering the eye, in the eye that accept the light.



2-consensual light reflex: if an individual's right eye is shielded and light shines into the left eye,

constriction of the right pupil will occur, as well
as the left because the pretectal nucleus gives both parasympathetic nuclei .

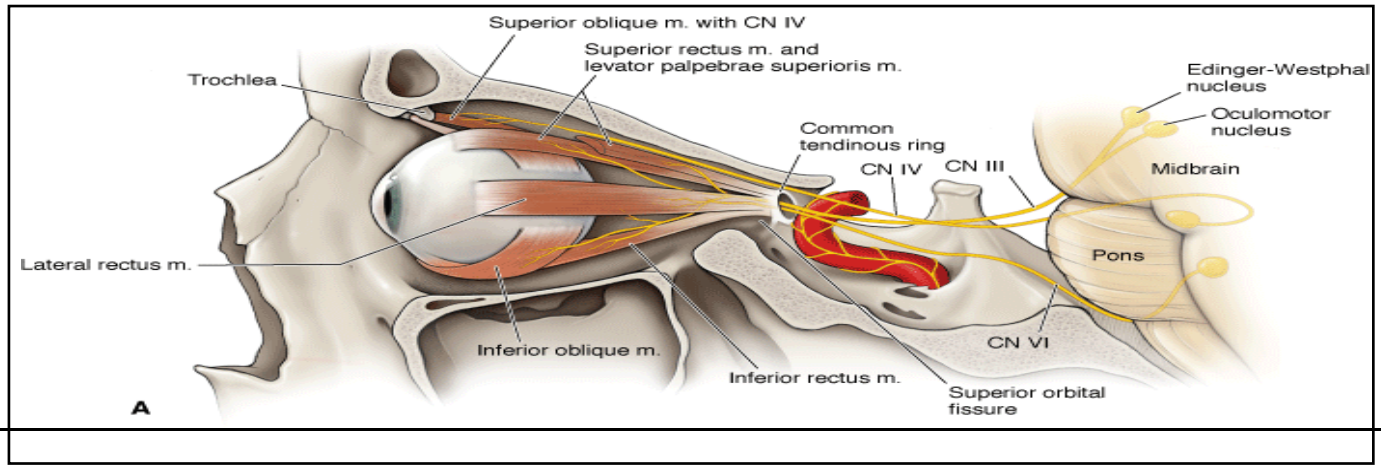
Such details on these reflexes will be discussed in physiology. **Identify** the previous structures in this figure:



**** Course of occulomotor nerve:**

The fibers from the two nuclei will pass through red nucleus without synapse. From the red nucleus fibers then pass via the substantia nigra exiting through the interpeduncular fossa. Then the nerve enters the lateral aspect of the cavernous sinus. Within the cavernous sinus, it receives sympathetic branches from the internal carotid plexus. These fibers do not combine with the oculomotor nerve – they merely travel within its sheath. The nerve leaves the cranial cavity (middle cranial fossa) via the superior orbital fissure where they divide to two remai superior and inferior, see the figure below.

NOTE: the parasympethatic fibers synapse in the ciliary ganglion, and come out as postganglionic through short ciliary nerve.



** **oculomotor nerve innervate:**

1**- Extrinsic muscles or extraoccular**(Innervated by the main motor nucleus) :

The levator palpebrae superioris, superior rectus, medial rectus,inferior rectus, and inferior oblique.

*all the muscles except superior oblique (innervated by the trochlear nerve and has lateral rotation action and downword movement)

and lateral rectus (supplied by the abducens nerve and has abduction movement)

2**- Intrinsic muscles(** innervated by the parasympathetic nucleus):

The constrictor pupillae of the iris and ciliary muscles (parasympathetic).

-**Action:** Lifting the upper eyelid; turning the eye upward, downward, and medially; constricting the pupil; and accommodating the eye.

Oculomotor Nerve injury

1- Complete lesion, lower motor neuronal lesion:

-All of the muscles are paralyzed except lateral rectus and superior oblique.

– Symptoms:

• External strabismus

• Diplopia (double vision)

• Ptosis: drooping of the upper eyelid because of levator palpebrae superioris action.

• The pupil is widely dilated and nonreactive to light, dilation is overriding.

• Accommodation of the eye is paralyzed.

This patient is at resting position, what happen here that at the affected eye the overriding muscle is the lateral rectus so it will shift to lateral aspect (diplopia)

2-Incomplete lesions:

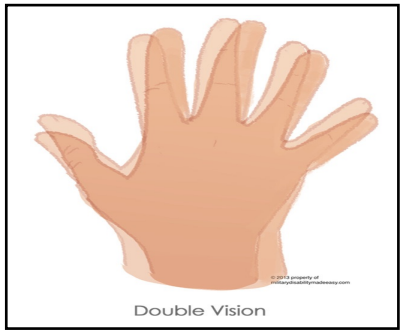
- Internal ophthalmoplegia: loss of the autonomic innervation of the sphincter pupillae and ciliary muscle (Symptoms: the pupil is widely dilated and nonreactive to light only).

- External ophthalmoplegia.: paralysis of the extraocular muscles, paralysis in motor part.(Symptoms: External strabismus, diplopa and ptosis only)

**But is there a possibility for the motor function to defect without the parasympathetic action (you know they run through same connective tissue)?

Yes it can happen, the theory imply that the parasympathetic fibers run superficial in the nerve so if a pressure applied on the nerve the parasympathetic will be affected without motor (so it's more susceptible to injury than the motor). Another possibility like In diabetic neuropathy that affect the motor fiber.

In cases of (diabetic neuropathy), the autonomic fibers are unaffected, whereas the nerves to the extraocular Muscles are paralyzed.



TO SUM UP : *you may have external ophthalmoplegia if the motor part is affected , OR internal ophthalmoplegia if the autonomic part is affected , OR both if the whole nerve is affected.*

Red nucleus

- Rounded mass of gray matter

- Situated between cerebral aqueduct and substantia nigra.

- Reddish blue in color which is attributed to the high vascularity of the structure in addition to the high level of iron pigments.

- receive Afferents from:

Cerebral cortex,cerebellum,substantia nigra, thalamic nuclei, spinal cord.

- give Efferent to:

Spinal cord, reticular formation, thalamus and substantia nigra.

- involved in motor coordination.

Substantia nigra

- Large motor nucleus.

- It is a brain structure located in the midbrain.

- plays an important role in reward, addiction, and movement.

- Substantia nigra is Latin for "black substance" due to high levels of melanin.

- It has connections with basal ganglia, cerebral cortex.

- Its Concerned with muscle tone.

- Parkinson's disease is caused by the death of neurons in the substantia nigra.

DON'T forget!! The red nucleus and substantia nigra are subcortical centers of the extrapyramidal motor system.

Trochlear nerve

- It has one nucleus, it's a motor nucleus.

- Location of the nucleus: it's found anterior to the cerebral aqueduct, just below the inferior colliculus.

- Receives from:

a) Corticonuclear fibers

b) Tectobulbar fibers: Info from visual cortex

c) Medial longitudinal fasciculus: connected to the nuclei of the III, VI, and VIII cranial nerves.

d) From both side.

- Course of the nerve:

It goes posteriorly around the central gray matter then immediately decussates, it's the only nerve that emerging from the posterior aspect of the midbrain. The nerve then moves along the lateral wall of the cavernous sinus (along with the oculomotor nerve) before entering the orbit of the eye via the superior orbital fissure to innervate the superior oblique muscle.

** Superior oblique muscle has a unique structure it's a pulley-like structure (tackle), this pulley system what gives superior oblique its actions, causing depression of the eyeball despite being inserted on the superior surface and its turn the eye laterally (downward & laterally movement of the eye) .

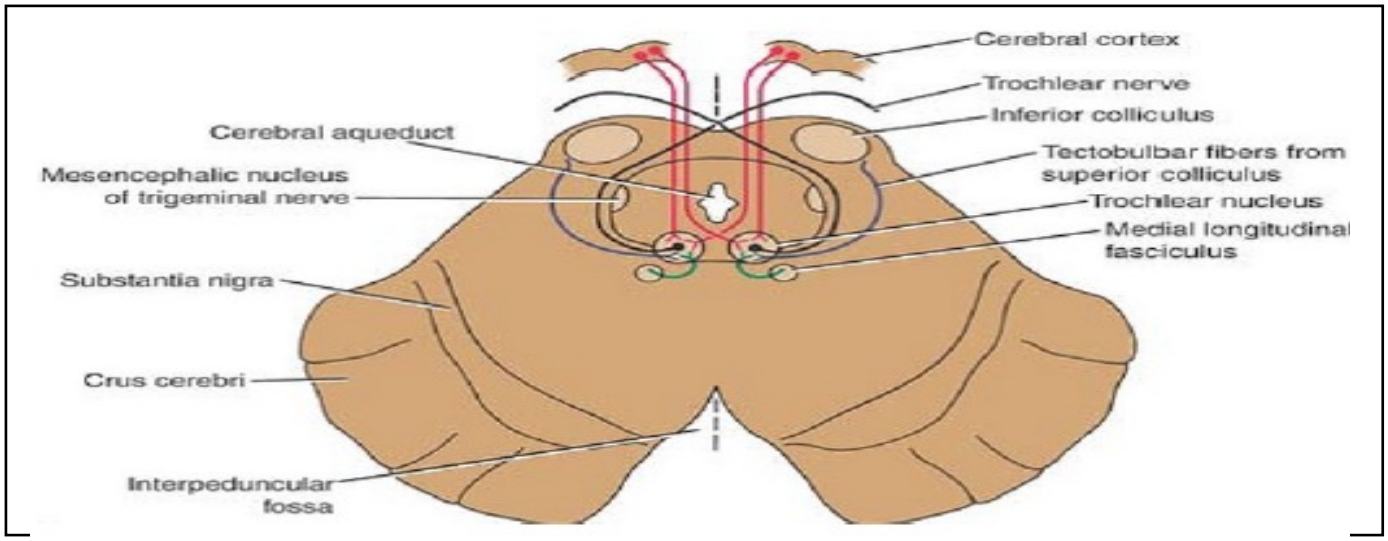
Trochlear Nerve injury:

- Symptoms: 1- Diplopia

2- Difficulty in turning the eye downward and laterally, so at resting State the patient eye will go upward & medially.

3- Difficulty in descending stairs so patient will tilt his head to the side opposite the paralyzed eye (compensatory adjustment).

** look at the figure below; try to identify the nucleus and its location:



Abducent Nerve

- has one motor nucleus found underneath the fourth ventricle, at the level of the facial colliculus. Axons from the facial nerve loop around the abducent nucleus, creating a slight bulge (the facial colliculus) that is visible on the dorsal surface of the floor of the fourth ventricle; it's close to the midline.

- Receives from:

a) Corticonuclear fibers.

b) Tectobulbar fibers: Info from visual cortex.

c) Medial longitudinal fasciculus: connected to the nuclei of the III, IV, VIII cranial nerves.

** **Course of the nerve:**

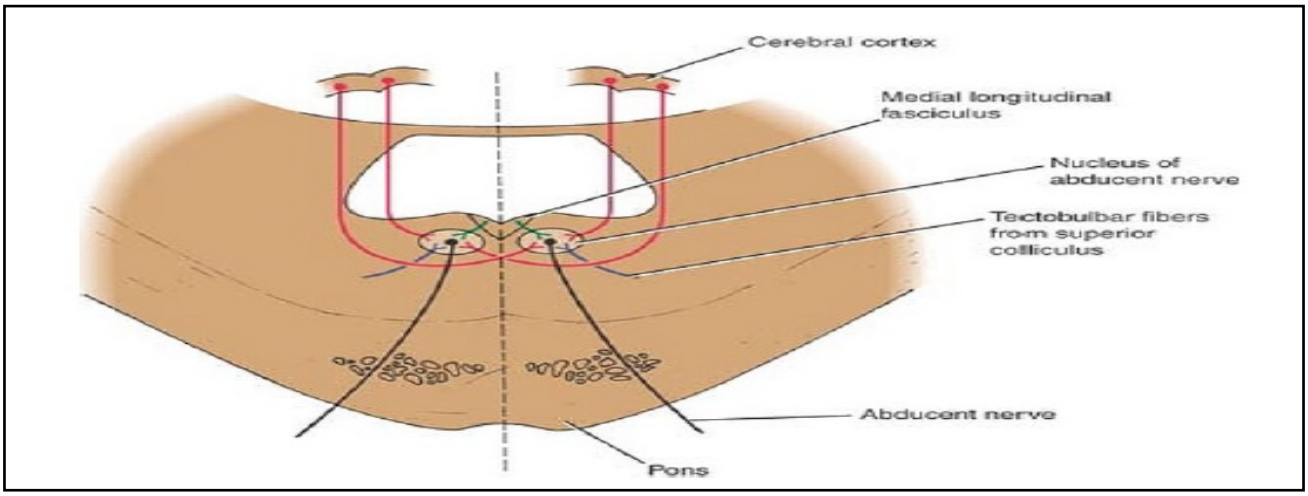
The abducent nerve leaves the brainstem anteriorly at the junction of the pons and the medulla oblangata,medial to the facial nerve. Then enter the cavernous sinus below and lateral to the internal carotid artery, then it enters the orbit through the superior orbital fissure and innervates the lateral rectus muscle of the eye that turning the eye laterally.

****Abducent Nerve injury**

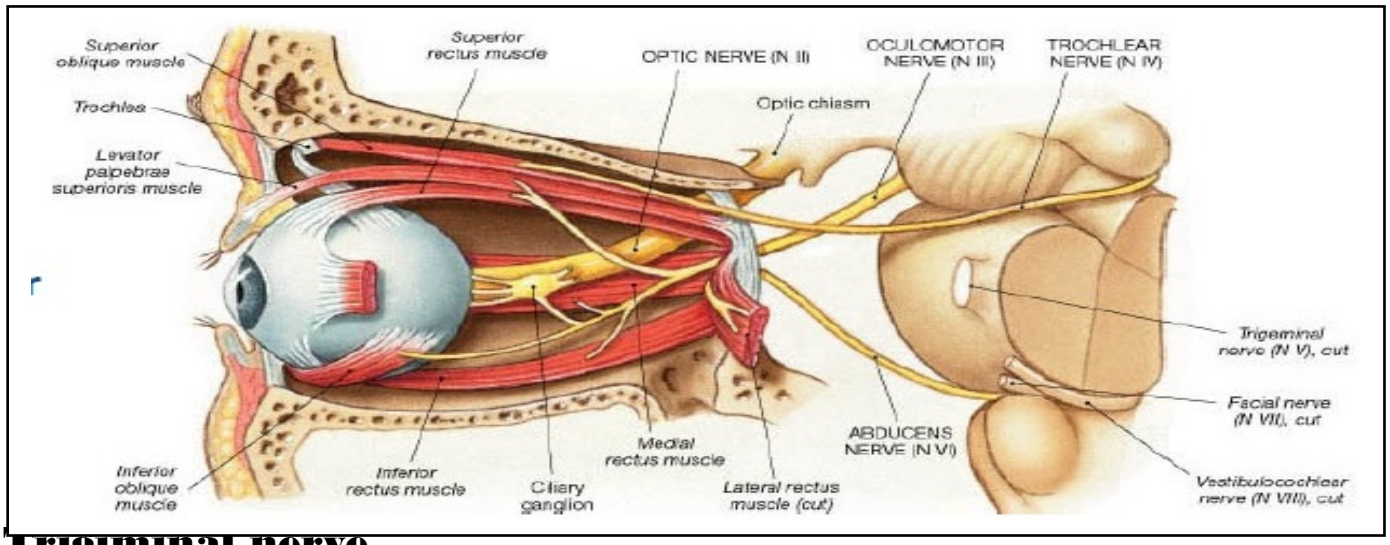
- Symptoms: 1- Diplopia.

2- Difficulty in turning the eye laterally which is called **internal strabismus** , this happens because the eye at rest is pulled medially by the overriding of medial rectus .

** Identify the nucleus & its location in this figure:



In the figure below try to identify the course of the nerves that we discussed:



Trigeminal nerve

- We talked about it before so we will just summarize it ☺ .

It has 4 nuclei, 3 sensory and 1 motor:

- **Main sensory nucleus:**
  -Found on the Posterior part of the pons (lateral).
  - Found between spinal and mesencephalic nuclei.

- **Motor nucleus:**
  Found on the Posterior part of the pons (Medial).
- **Spinal nucleus:**
  -Found the medulla.
  - Superiorly: main sensory nucleus.
  – Inferiorly: C2 segment.

- **Mesencephalic nucleus:**

  - Found in the Lateral part of the gray matter around the cerebral aqueduct.

  - Inferiorly main sensory nucleus.

Sensory Components

- Ascending branches: main sensory nucleus.

- Descending branches: spinal nucleus.

** Trigiminal nerve has three divisions from superior to inferior: ophthalmic, maxillary and mandibular. The fibers of these divisions will go to one of these nuclei so if the sensation:

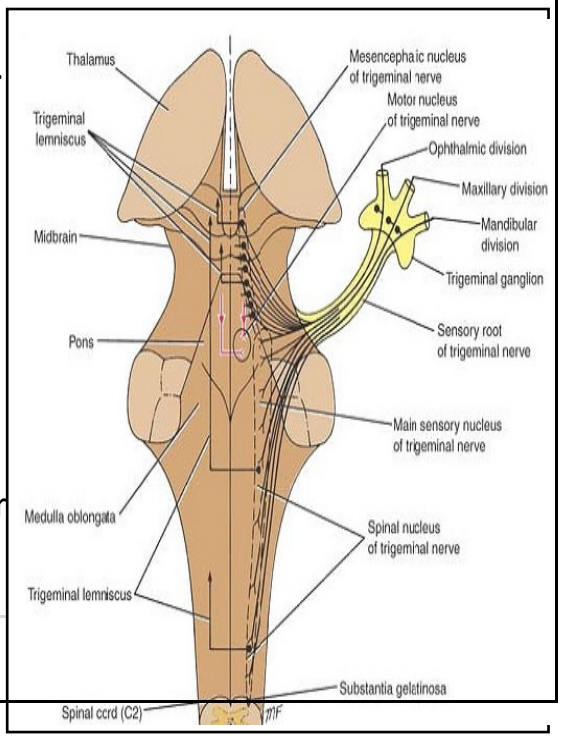
- Touch and pressure fibers will go to the Main sensory nucleus.

- Pain and temperature fibers will go to the Spinal nucleus.

- Proprioceptive impulses from the muscles fibers will go to the mesencephalic nucleus.

**But what happen to the fibers of these divisions when go to the destination nucleus that their arrangement will be different and be like:

- Ophthalmic will take inferior part of the spinal nucleus.
- Maxillary will take the middle part of the SN.
- Mandibular will take the superior part of the SN.



The location of the cell body is in the ganglia **except

For mesencephalic nucleus, where the cell body of the

1st order neuron is found , the fibers of it will just go

through the Ganglia, you won't find the cell body of Propr

Fibers in the ganglia, it's in the nucleus itself.

Note: Proprioception come from muscles of mastication in the jaw even from muscles of facial expression, its fibers runs in the trigeminal nerve. Fibers go from mesencephalic nucleus to higher centers in the cortex, you will find in other resources that this nucleus just for reflexes likes jaw jerk reflex of the mandible (normally this reflex shouldn't happen). But if there is upper motor lesion, exaggerated and the closure of the mouth will happen.

If you like this link have further information about this reflex and its test:

http://neuroexam.med.utoronto.ca/cranial_5d.htm

Motor component

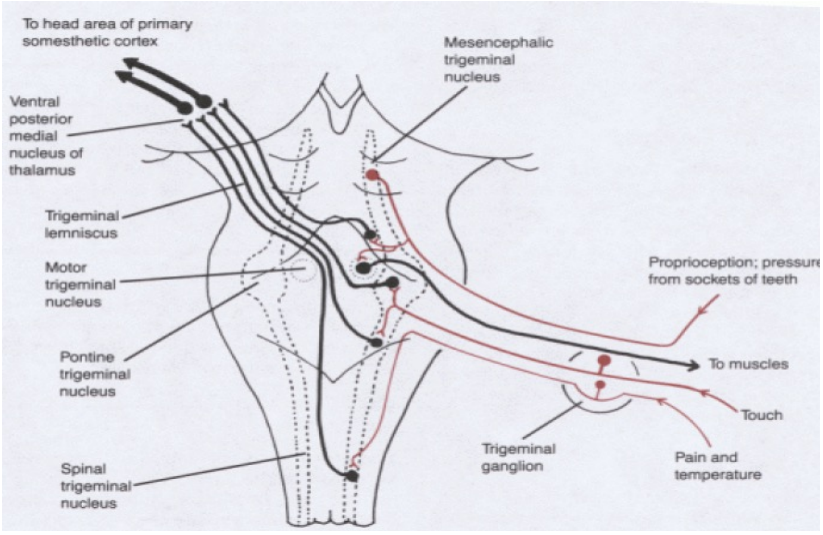
- Motor nucleus receives:

a) Corticonuclear fibers b) Red nucleus

c) Reticular formation d) Tectum

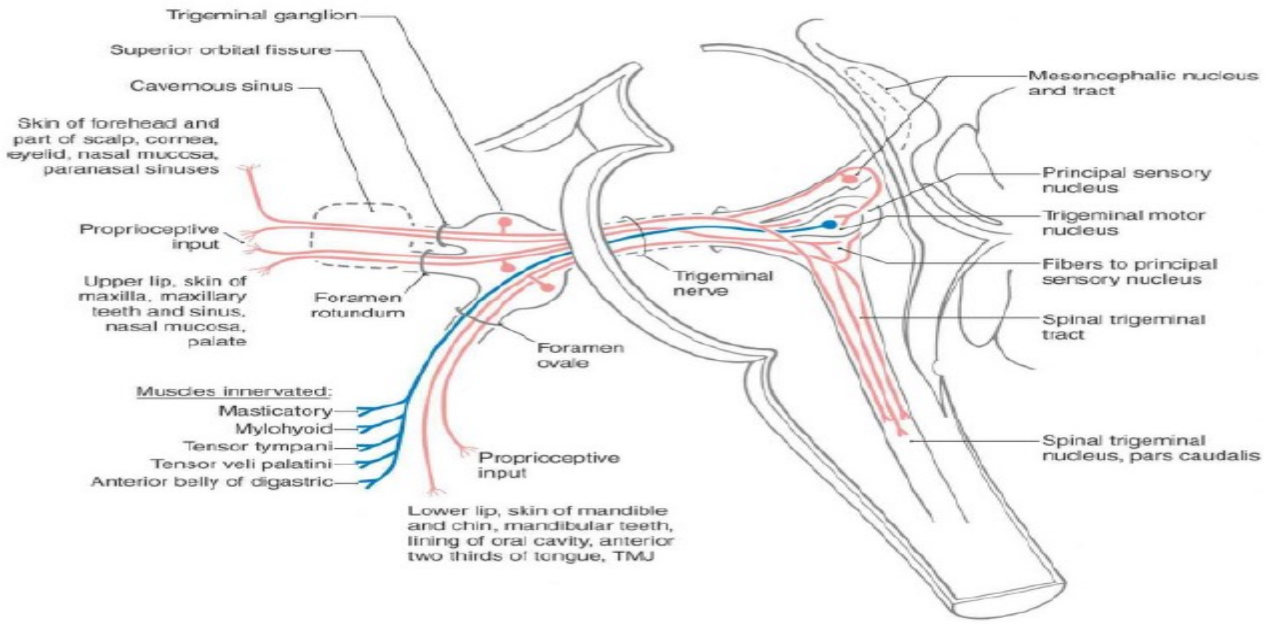
- Supplies through mandibular :

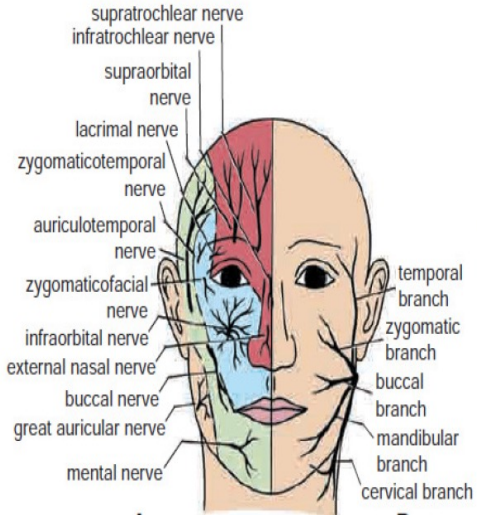
- Muscles of mastication (masseter, temporalis, medial pterygoid, and lateral pterygoid).
- Tensor tympani.
- Tensor veli palatine.
- Mylohyoid.
-Anterior belly of the digastric muscle.



This figure shows:

- Fibers and pathway of each type of sensation.
- trigeminal Ganglia and its cell bodies.
- mesencephalic nucleus & its cell body.
-2nd order neuron & trigeminal lemniscus.





This figure shows the parts of the face that supply by trigeminal sensory nerve:

Red part by ophthalmic : forehead (from the scalp as far as the vertex)

Blue part by maxillary : upper lip & zygomatic part

Green part by mandibular : lower lip & mental area .

** As you notice the angle of the mandible is the only area that not supplied by the trigeminal, it's supplied by Great auricular nerve.

**unfortunately you have to memorize them.

Course of the trigeminal nerve

The trigeminal nerve originates from three sensory nuclei and one motor, at the level of the pons anteriorly, the sensory nuclei merge to form a sensory root. The motor nucleus continues to form a motor root (motor run inferior to sensory). Then In middle cranial fossa they expand into the trigeminal ganglion.

- Trigeminal ganglion located lateral to the cavernous sinus, Upper surface of the apex of the petrous bone in a depression of the temporal bone, it has a pouch in the dura mater known as Meckel cave.

The division of this nerve will go out through:

– Ophthalmic: through superior orbital fissure.

– Maxillary: through foramen rotundum to pterygopalatine fossa.

– Mandibular: through foramen ovale to infratemporal fossa .

Facial nerve

1- **Main Motor Nucleus**

• Found Deep in the reticular formation of the lower part of the pons.

• The part of the nucleus that supplies:

– Upper part of the face receives **corticonuclear fibers from both hemispheres.**

Except that the lower part of the face receives only corticonuclear fibers from the **opposite cerebral hemisphere.**

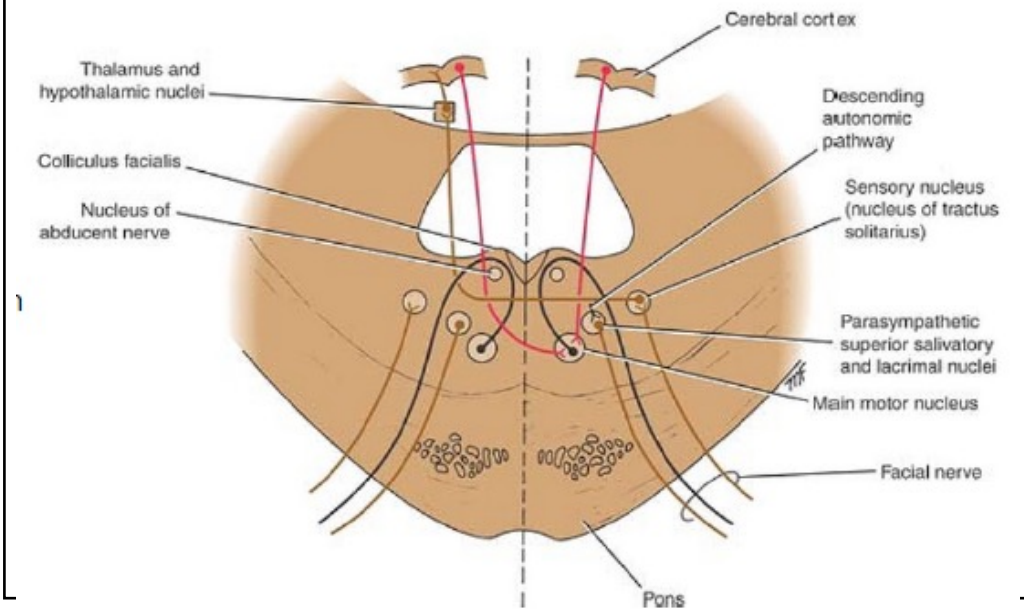
2- Parasympathetic Nuclei(superior salivatory lacrimatory):

• **Location**: Posterolateral to the main motor nucleus.
**It's also named salivatory lacrimatory nucleus because it has:
- Superior salivatory:
Mainly by submandibular and lingual, receives from the hypothalamus.
- Lacrimal nucleus:
Receives from:
– Hypothalamus (Emotional), it's the major output of limbic system that appear as responses by autonomic nervous system like if you feel sad you will cry (lacrimal gland will be stimulated to produce tears).
– Sensory nuclei of the trigeminal (reflex), like when a foreign body enter the eye as a reflex the eye start tearing (lacrimation).

3- Sensory Nucleus:
** **Remember:** there are two types of sensation in the facial nerve one is general sensory and the other related to the taste.

****Taste sensation:**

• Location: upper part of the nucleus of the **tractus solitaries**.
- The taste fibers of facial nerve will go to the nucleus of tractus solitaries.
* The Cell bodies found in geniculate ganglion.
- From the nucleus of the tractus solitaries the 2nd order neuron will make a cross and goes up to the VPM, and then it will go from ventral posteriomedial to the Primary gustatory cortex (area 43),this area found in the parital lobe just superior to the lateral fissure.



*In this figure:

- try to identify facial nerve nucleus.

- The pathway of the taste fibers.

Course of facial nerve

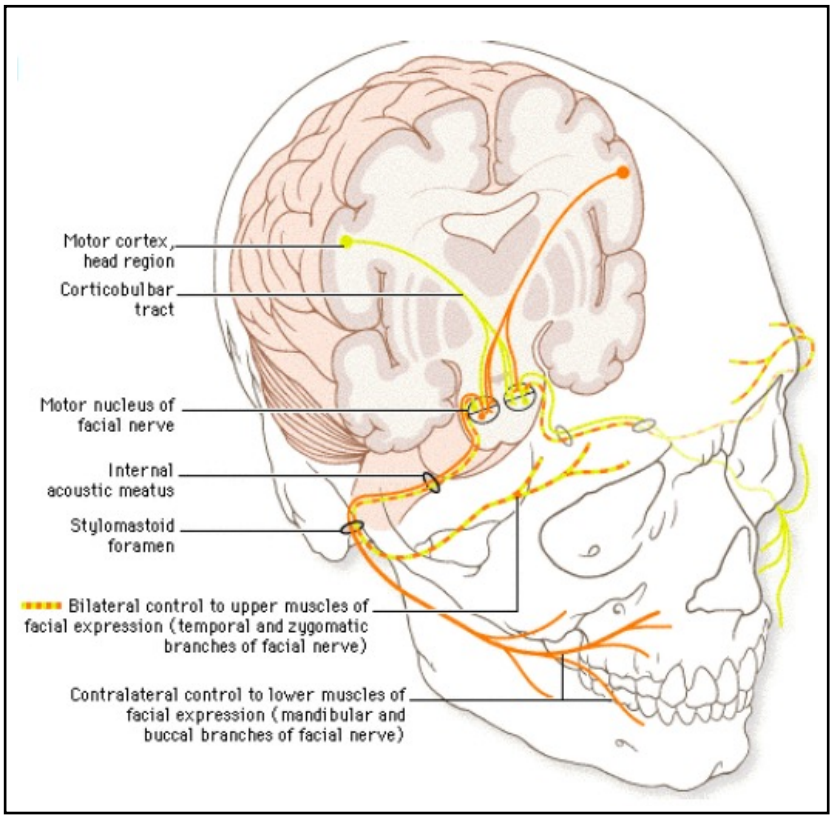
* Again we will explain the intracranial pathway.

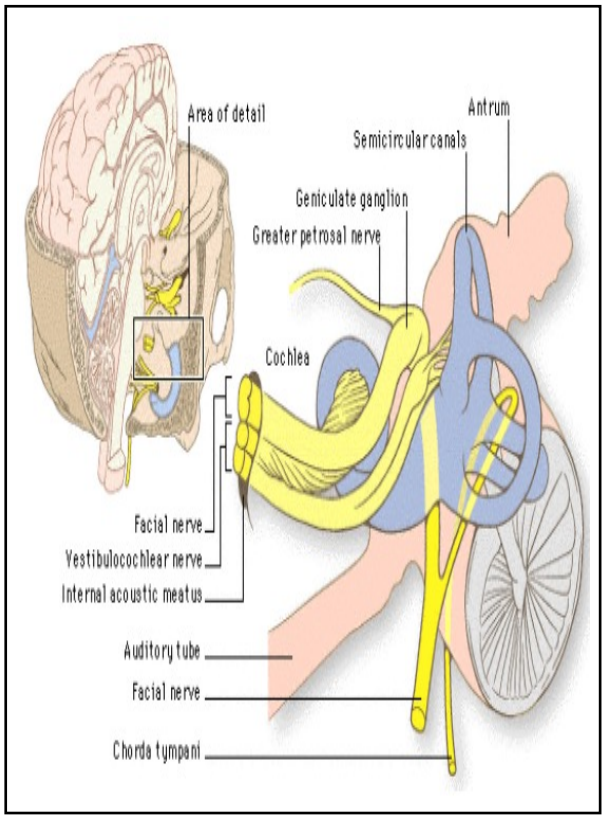
Let's talk about its general pathway then we will talk about its branches:

→ Facial nerve will go out from the anterior surface between the pons and the medulla oblongata, after coming out from the brainstem it will face a canal within the petrous part of the temporal bone of the skull which is the **internal acoustic meatus.**

- Internal acoustic meatus gives passage to two cranial nerves the facial and vestibulocochlear nerves, the facical nerve will run laterally through the cavity of inner ear on the medial wall then it goes to the posterior wall of the tympanic cavity and finally Emerges from the stylomastoid foramen.

**follow the pathway of the nerve in these figures:





Remember: from MSS we learned about the extracranial course of the nerve, where it ends in the parotid gland and within the parotid gland, the nerve terminates by splitting into five branches:

Temporal branch, Zygomatic branch, Buccal branch, Marginal mandibular branchand Cervical branch.

These branches are responsible for innervating the muscles of facial expression.

**** Now let's talk about facial nerve branches and their pathways (intracranial):**

→ When the facial nerve was in the petrous part of the temporal bone (in the cavity of middle ear), it will give two branches:

1- Greater petrosal nerve

2- chorda tympani nerve

** How about learning more about geniculate ganglion before taking the branches! ☺

→ the ganglia where the facial nerve curve called **geniculate ganglion (**geniculate mean curve)

* If you notice the facial nerve has two curves, the first where the motor fibers curve on the floor of the 4th ventricle the other in the geniculate ganglion.

geniculate ganglion is sensory ganglia, has the cell body of the sensory mainly for taste fibers (Don't say for chorda tympani, since it has fibers other than taste fibers), **Be careful!** It's not an autonomic ganglion there is no synapse.

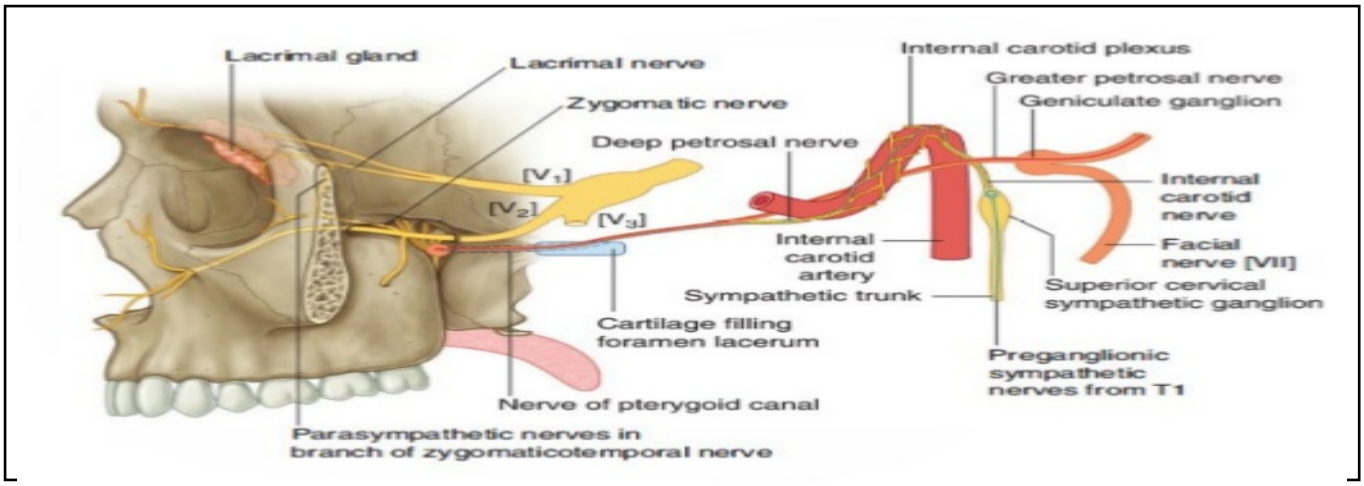
1- Greater petrosal nerve:

**It carries preganglionic parasympethatic fibers that will reach the lacrimal gland.

We said that its found in the cavity of the inner ear, then it will leave the cavity to the Middle cranial fossa through the greater petrosal foramen (or hiatus), in the middle cranial fossa it Passes over Foramen lacerum, where it joins the Postganglionic sympathetic fibers that found on the internal crotid that go to the middle cranial fossa through the carotid canal.

These Postganglionic sympathetic fibers are the **deep petrosal nerve** (they are mainly originated in the superior cervical sympathetic ganglion in the neck). Greater petrosal join the deep petrosal to form the **Vidian** nerve (nerve to pterygoid canal). Pterygoid canal is a passage way between middle cranial fossa and pterygopalatine fossa with another passageway which is the formen rotundum where maxillary nerve comes from.

So the deep and greater petrosal nerve will leave the middle cranial fossa and inter the pterygopalatine fossa where a parasympathetic autonomic ganglia found which is pterygopalatine ganglion. Follow the nerve's pathway in this figure:



Finally how these two nerves supply the lacrimal gland?

After they enter the pterygopalatine ganglion that is suspended by the maxillary nerve, the fibers of the **greater petrosal will synapse** and give postganglionic parasympethatic fibers (it enters the pterygoid canal as preganglionic parasympethatic fibers and leave the pterygopalatine ganglion as postganglionic parasympethatic fibers sfter synapse), **the deep petrosal will go through** the pterygopalatine ganglion without synapse (they already synapse in the superior cervical sympathetic ganglion and leave it as Postganglionic sympathetic fibers), these fibers then run in the maxillary nerve to the zygomatic nerve (branch from maxillary nerve), then they will go to zygomaticotemporal nerve (branch from zygomatic nerve). Zygomaticotemporal nerve will join the lacrimal nerve (**remember** lacrimal nerve is a branch from opthalmic nerve that is a branch from trigeminal nerve). And that what we mean when we said that some autonomic fibers Snoop in a branches from trigeminal which is lacrimal nerve. Then supply the lacrimal gland.

** pay more attention to pre and post, and where every nerve synapses.

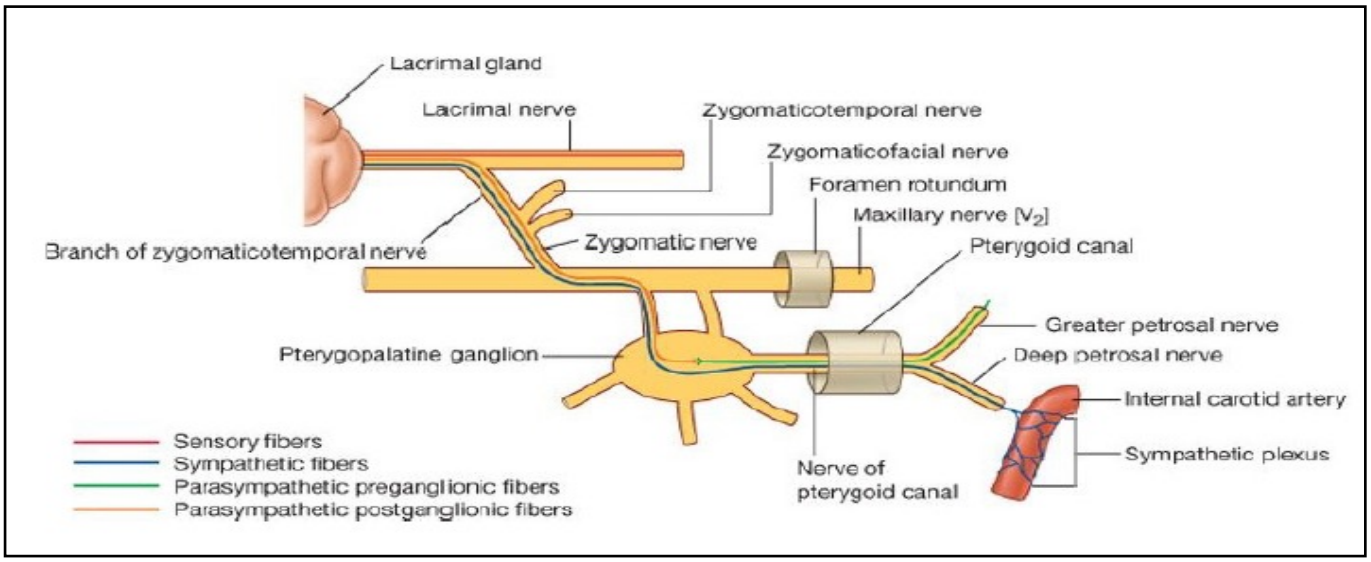
** To summarize it all:

a) The lacrimal nerve is a major general sensory branch of the ophthalmic nerve from trigeminal.

b) Parasympathetic innervation: originally from great petrosal nerve branch of facial nerve.

c) Sympathatic innervation : originally from deep petrosal nerve from carotid plexus, superior cervical ganglia.

The figure below summarizes it all:



2- chorda tympani nerve:

-Through autoscope it appears as a line, keep in mind through discussion of the nerves courses the sensory will go in and the motor will go out the brainstem.

- chorda tympani has two parasympathetic fibers and taste.

→ It Originates from the facial nerve, then it travels through the middle ear, where it runs from posterior to anterior across the tympanic membrane. It passes between the malleus and the incus, on the medial surface of the neck of the malleus. It will go out through the petrotympanic fissure (also called glaserian fissure) after which it emerges from the skull into the infratemporal fossa, it soon combines with lingual nerve.

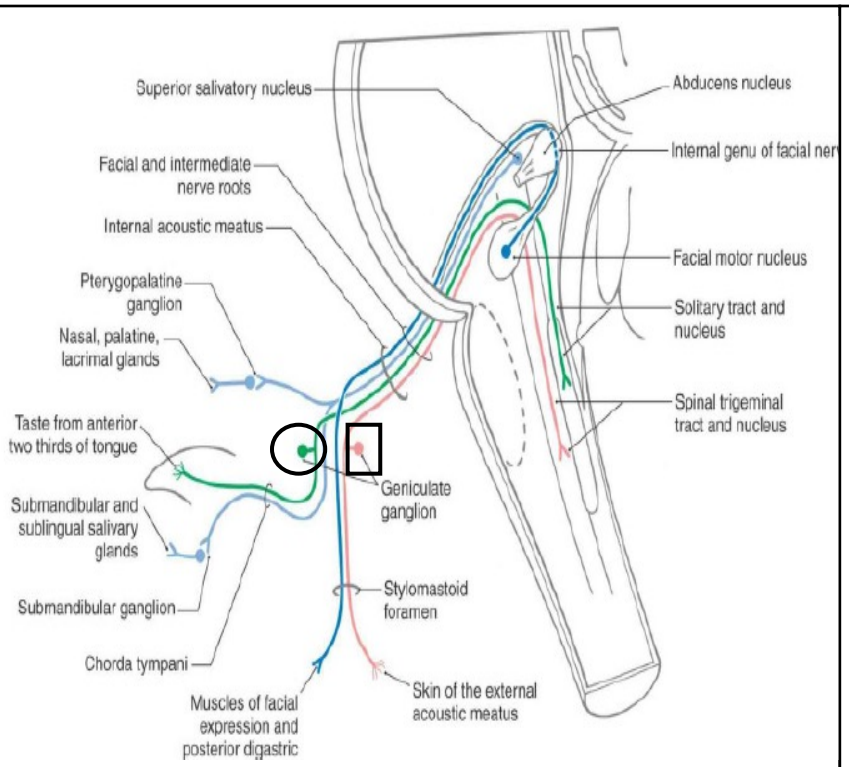
- Lingual nerve found on the posterior border of mylohyoid near the deep part of submandibular gland where the submandibular ganglion found (or you can say submaxillary ganglion), the fiber that come from **Superior salivatory nucleus** will make synapse in this ganglion (**Preganglionic parasympathetic fibers**) and the taste fibers will continue with the lingual nerve that give taste sensory to Anterior 2/3 of tongue.

** keep in mind that the chorda tympani have two fibers parasympathetic and taste.

Remember when we talked about geniculate ganglion, we said it's a sensory ganglion that has the cell body for the taste.

** we talked about taste, motor and parasympathetic but what about the general sensory that supply a small area which is the skin of the external acoustic meatus?

Actually facial nerve doesn't have a nucleus for general sensation. The fibers of this general sensation come from spinal trigeminal nucleus that its cell body located in the geniculate ganglion which give fibers carried by facial nerve to the skin of the external acoustic meatus for general sensation.



In this figure:

- follow the taste fibers and their cell body in the geniculate ganglion (green line)

*Cell body is circulated

- follow the root of the general sensation from trigeminal nucleus to the skin of the external acoustic meatus (pink line)

*Cell body of general sensation in the geniculate ganglion surrounded by square

Facial Nerve injury

* It's important to know if it lower or upper motor lesion since they differ in their symptoms.

* Remember when we talked about facial motor nucleus and we learned that it supplies the upper part and the lower part of the face differently since it gives:

- Upper part of the face receives **corticonuclear fibers from both hemispheres (**figure A**).**

-the lower part of the face receives only corticonuclear fibers from the **opposite cerebral hemisphere** (figure B**).**

* If lower motor neuron injury occur like fracture in temopral bone or injury to the nerve when it come out from stylomastoid foramen, there will be paralysis in the same side of the face upper and lower part, dropping in the angle of the mouth (sadding), difficulty in closing the eye and excessive lacrimation. (closure of the eye is done by orbicularis oculi muscle which is supplied by facial nerve .)

* If upper motor neuron injury in the left occur, the upper part will be intact since it supplied by the left and right nucleus so the right will compensate on the left so no symptom on the upper part (patient can close his eye on the left). While on the lower part the angle of the mouth will drop contralaterally (on the right).

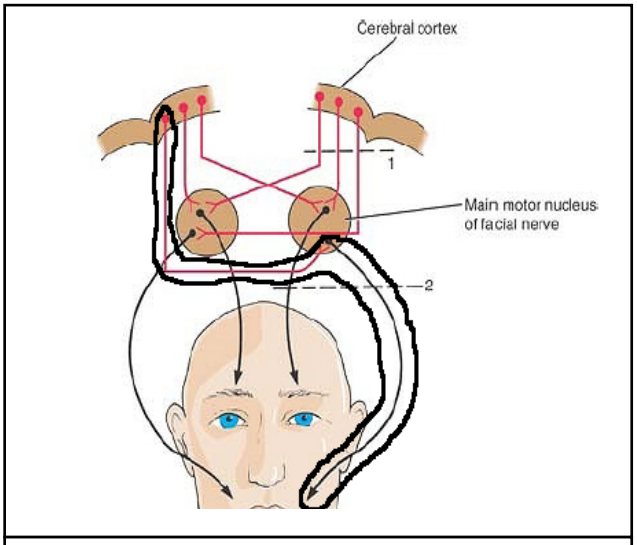


Figure B: In this figure the black line shows that the right nucleus gives one pathway to the lower part of the face in the left. (The opposite on the lower right side).

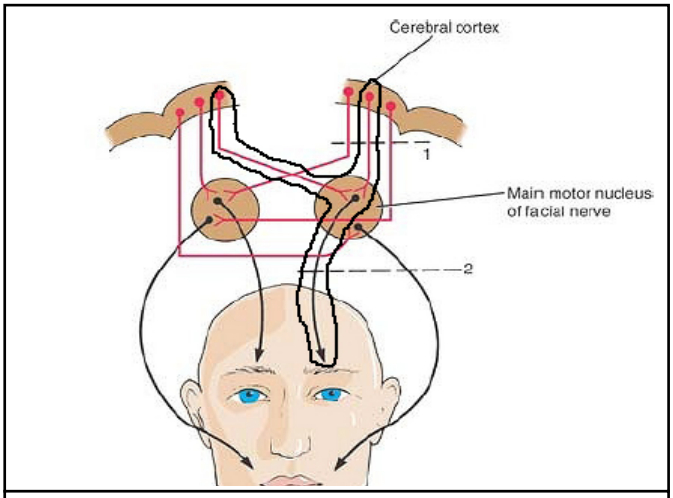
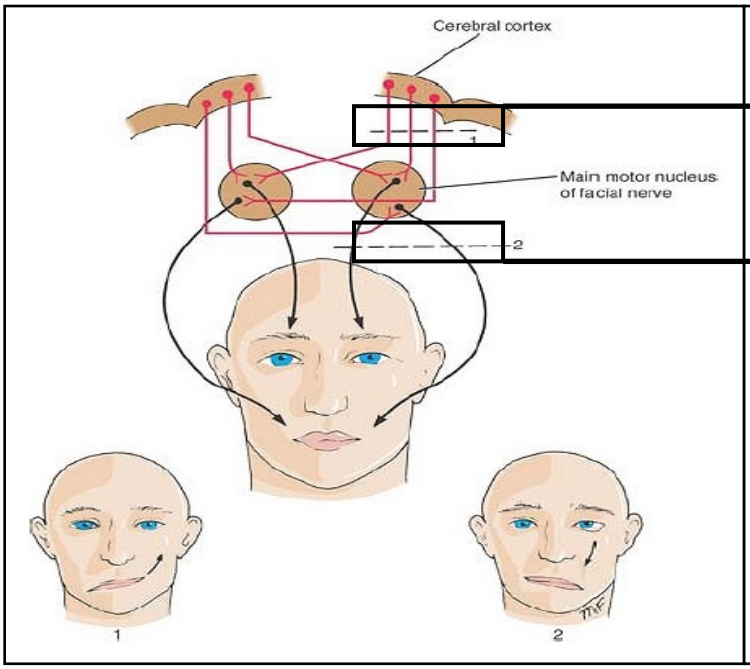


Figure A: In this figure the black line shows that the upper part of the face on the left receive 2 fibers one from the left & the other from the right.(The opposite on the upper part on the right)



This figure show:

If an injury happen here it will be upper motor lesion, symptoms will appear like we said.

If an injury happens here it will be lower motor lesion, symptoms will appear like we said.

**head NO. 1 show the symptoms of upper motor lesion.

** head NO.2 show the lesion of lower motor lesion.

Location of the lesion:

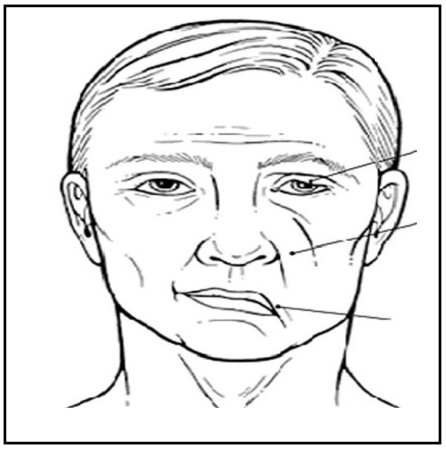
- Abducent and the facial nerves are not functioning: this means that the lesion in the pons. (*this is the place where both are found close to each other*)

- Vestibulocochlear and the facial nerves are not functioning: lesion in the internal acoustic meatus (*again here where they are found close to each other*)

- Loss of taste over the anterior two-thirds and parasympathetic of salivary glands: damaged to the chorda tympani branch.

** More details will be discussed in the LAB.

Bell's palsy



- Usually unilateral.

- Lower motor neuron type of facial paralysis.

- Cause is not known, may occur due to:

a) Exposure of the face to a cold draft?

b) Complication of diabetes?

c) Can occur as a result of tumors or AIDS?

d) if the dentist make inferior dental nerve block, and by mistake if he goes a little posterior, he may anesthetize the facial nerve and the parotid gland, symptoms of Bell's palsy it will last for 2 days maximally and recover by itself.

- In some cases it recovers without treatment.

Sorry for any mistakes

بُعد المسافة لا يهم، الخُطوة الأولى فقط هي الأكثر صعوبة.