

# CNS

## Anatomy

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▶ number

9

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# DISCLAIMER

The doctor mentioned some extra information in this lecture, however it will be thoroughly discussed in the next sheet. Therefore, you can skip it *if you want* 😊. It will be written in *italic* after the word extra.

Last time we were talking about the pons. We divide it by transversely running fibers of trapezoid body in the antero-posterior direction into:

- Basilar part (anterolateral)
- Tegmentum (posterolateral)

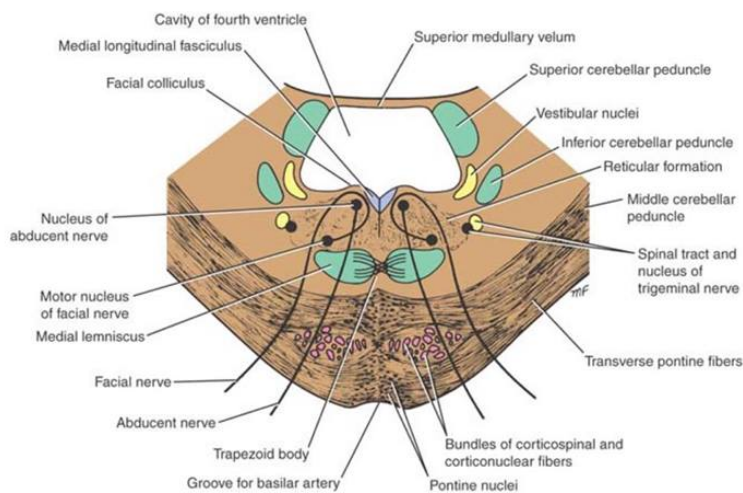
Trapezoid body is related to acoustic/auditory pathway, and it's made up of fibers derived from the cochlear nuclei.

We will study the pons in two levels:

- Caudal level – inferior (at level of facial nerve nuclei/facial colliculus)
- Level of cranial nerve (upper level), which has the Trigeminal nuclei.

However, on either levels, the cavity is *the fourth ventricle*.

## Structures underneath the floor of the fourth ventricle (through the caudal part):



- Medial longitudinal fasciculus

It's proximal to midline, exactly underneath the floor of fourth ventricle. It has a bundle of white matter connecting vestibular nuclei to nuclei of three cranial nerves: 3<sup>rd</sup>, 4<sup>th</sup>, and 6<sup>th</sup>. This will move the eyeball with the movement of the head, then goes down to upper cervical segments.

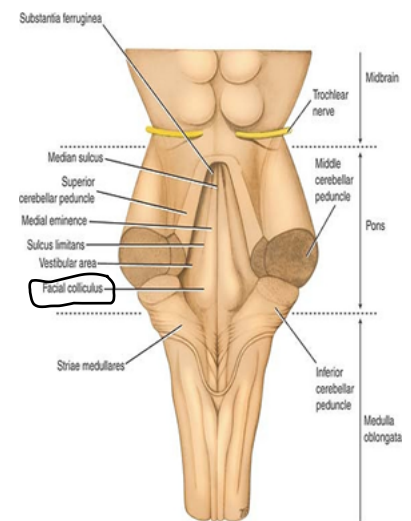
- Abducent nucleus

It is motor, beneath the floor of the upper part of the fourth ventricle. It supplies the lateral rectus only. The axons of the following nerves (from medial to lateral: the abducent, facial, then vestibulocochlear nerves) will leave pons through pontomedullary junction.

*extra: the abducent goes to the cavernous sinus then to orbital cavity through superior orbital fissure .*

- Motor nucleus of the facial nerve

It's located deeply in **reticular formation**, posterior to the lateral part of the medial lemniscus. If you look at the floor of the fourth ventricle, you will notice a protrusion, which is the facial colliculus on the posterior view of the pons (you will see the floor of fourth ventricle (rhomboid fossa) ). The facial colliculus represents motor fibers of the facial nerve. These fibers go posteriorly around the floor of the 4<sup>th</sup> ventricle, and make a U-turn around the abducent nucleus (thereby producing the facial colliculus) and then come anteriorly. *extra: This nucleus is motor for the muscles of the facial expressions and stapedius muscle in mid ear.*



If you look at the posterolateral aspect of motor nucleus, you will find the parasympathetic, superior Salivatory and lacrimatory nuclei (aka salivatory-lacrimatory nucleus) which gives parasympathetic supply for lacrimal gland and the salivary glands (submandibular-sublingual). *This nucleus represents the parasympathetic nucleus of the facial nerve.* It provides preganglionic fibers that reach their corresponding ganglia (sublingual ganglia, submandibular ganglia “submaxillary”)

*Extra: Facial nerve passes through the parotid but doesn't give it parasympathetic supply – glossopharyngeal supplies it .*

- We also have the Nucleus of Tractus Solitarius in the posterolateral aspect of the floor of the 4<sup>th</sup> ventricle. Its fibers are for sensory taste of facial nerve. But in general, it receives two kinds of sensations: taste (for facial, glossopharyngeal, and vagus) and **visceral sensation**.
- At the end, we have the spinal nucleus of trigeminal nerve on either sides of motor nucleus of the facial nerve. It senses pain and temperature for the Trigeminal, facial, glossopharyngeal and vagus nerves.
- All the previous four nuclei are for facial nerve. Their fibers will leave through pontomedullary junction a little bit distal to midline. (remember that abducent leaves proximal to midline).

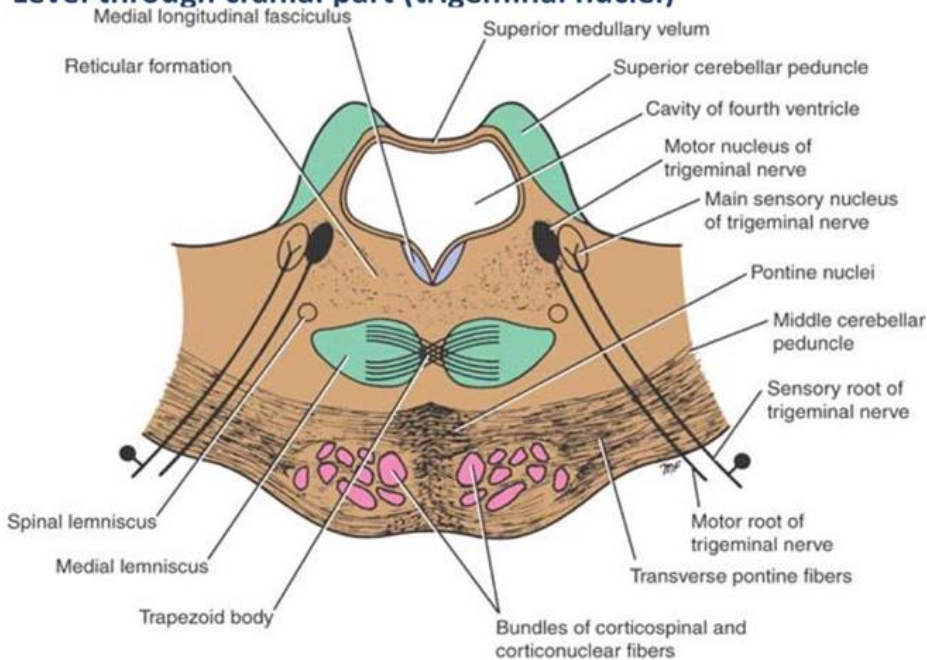
### **Trapezoid body:**

- The anterior Trapezoid body is the basilar part. The posterior trapezoid body is the Tegmentum, It's a part of auditory pathway. In the basilar part you will see scattered pontine nuclei. It is a major pathway between cerebrum and cerebellum (aka cortico-ponto-cerebellar pathway), which forms the middle cerebellar peduncle towards the cerebellum. These fibers are crossed (i.e. right hemisphere with left cerebellum and vice versa). Also, in this area you will see fibers of corticospinal pathway that will be scattered due to presence of pontine nuclei.
- You will be able to see all cerebellar peduncles: the middle cerebellar peduncle laterally (outside), and both the superior and inferior cerebellar peduncles on the inside.
- Medial lemniscus: most anterior part of the Tegmentum, long axis running transversely.
- Medial vestibular nucleus: lateral to the abducent nucleus.

- **BRIEFLY SPEAKING:**, we have the fourth ventricle, then medial longitudinal fasciculus, the nucleus of the abducent nerve, then the motor nucleus of facial nerve and its fibers (**facial colliculus**) which takes from both hemispheres except the lower part of face (from opposite sides), spinal nucleus of trigeminal, vestibular nucleus (medially) it was lateral at level of medulla oblongata , basilar part of trapezoid, and on the posterolateral you will find parasympathetic nucleus of the facial nerve and nucleus of tractussolitaris.

## Level through cranial part (Trigeminal nuclei)

### Level through cranial part (trigeminal nuclei)



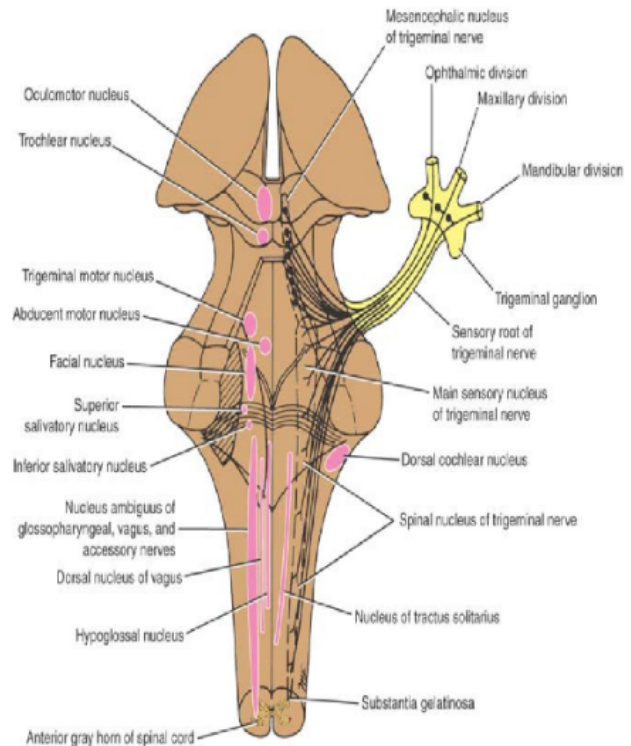
- Fourth ventricle, middle, and superior cerebellar peduncle (postero-lateral to the motor nucleus of **V**), medial longitudinal fasciculus, trapezoid body which is posterior to basilar part. Pontine nuclei and scattered corticospinal fibers are all found in the caudal part too.
- Lateral lemniscus: part of auditory pathway, it's a continuation of the basilar part. Its tract of axons in brainstem that carries information about sound from cochlear nucleus to contra-lateral inferior colliculus of the midbrain, lateral extremity of the medial lemniscus.
- Medial lemniscus: most proximal to midline (trapezoid body) around **VPL**.
- Spinal lemniscus: from anterior and lateral spinothalamic tract and spinotectal tract towards **VPL**, lateral extremity of the medial lemniscus.
- Nuclei of Trigeminal nerve:
  - Trigeminal nerve has three sensory nuclei and one motor nucleus (no parasympathetic nucleus). But if you cut these fibers outside the brainstem, you could find other parasympathetic fibers of facial "intruding". But in this section, you'll find only two nuclei (medial motor and lateral principle/ main sensory nucleus/ chief sensory nucleus/ **V nucleus** that is related to **crude touch**)
  - *Extra: Trigeminal branches: ophthalmic, maxillary ( sensory nerves ). Mandibular has motor part to muscles of mastication*
  - The spinal nucleus is below this section and the mesencephalic nucleus is above this section.
- Trigeminal lemniscus (specific to sensory innervation of head and neck. It represents second order sensory fibers that crossed after synapsing with first order fibers in sensory nuclei and leaving towards VPM, so VPM receives trigeminal lemniscus and taste fibers of nucleus of tractus solitarius ( after synapsing in the nucleus ).

Its sensory nuclei are extended along the brainstem.

Spinal nucleus from the level of C2- substantia gelatinosa- to mid pontine area, then the main sensory nucleus.

*Extra: Trigeminal nerve is the biggest cranial nerve. It has a ganglia that is found in Meckel's cave in the cranial cavity*

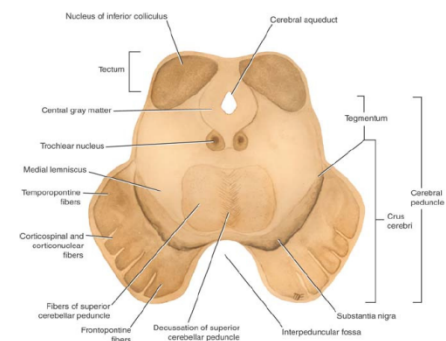
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## MID BRAIN:

We will discuss it into two sections:

- level of inferior colliculus (see motor nucleus of trochlear)
- level of superior colliculus (see motor nucleus of oculomotor)
- Midbrain lies between the diencephalon and the pons.



Substantia nigra is situated between the tegmentum and crus cerebri

The cavity of the midbrain is cerebral **aqueduct** which connects the 3<sup>rd</sup> ventricle to the 4<sup>th</sup> ventricle. CSF passes through it. Behind it, we have **tectum**, and in front of it we have cerebral peduncle (which is located on the ventral surface of the brain), which is divided by substantia nigra into anterior **crus cerebri** (basis peduncle of midbrain) and posterior tegmentum, which contains pyramidal

“corticospinal” tracts. Note: degeneration of substantia nigra causes Parkinson’s disease).

- Also you can notice the Superior cerebellar peduncles fibers that Connect midbrain to the cerebellum

On anterior aspect, we see that the Inter peduncular fossa is located between two peduncles, it is the site of oculomotor nerve emergence. It emerges at the level of superior colliculus.

On the posterior aspect, we find tectum which consists of four colliculi “corpora quadrigemina, the largest nuclei” -two superior and two inferior- .Trochlear nerve is the only one that emerges through from posterior aspect. It emerges below the level of inferior colliculus.

-We found piece of egg-like structure which is the thalamus (we have right and left thalamus). On the posterior aspect of the thalamus we find two bodies which are Medial and Lateral geniculate.

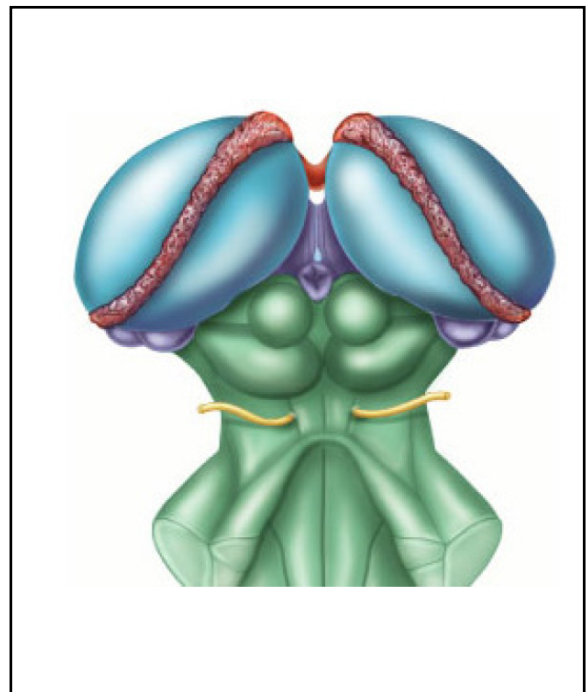
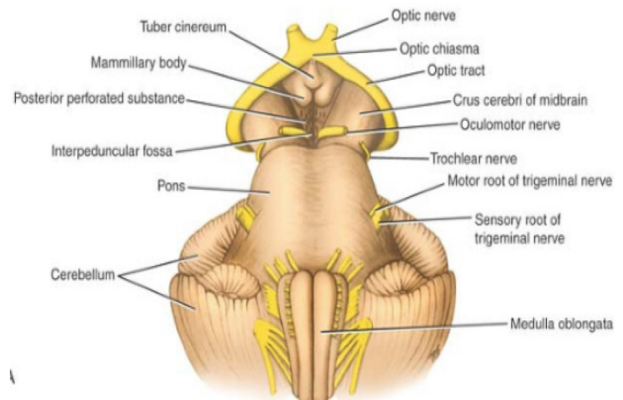
-The role of thalamus is sensory-secretory to neocortex.

-Medial geniculate body is part of the auditory pathway which projects in primary auditory area in frontal lobe.

-Lateral geniculate body is part of visual pathway that projects to occipital area (visual cortex).

-The superior colliculi is related to visual reflex but the inferior colliculi is related to auditory reflex.

Midbrain ant. View





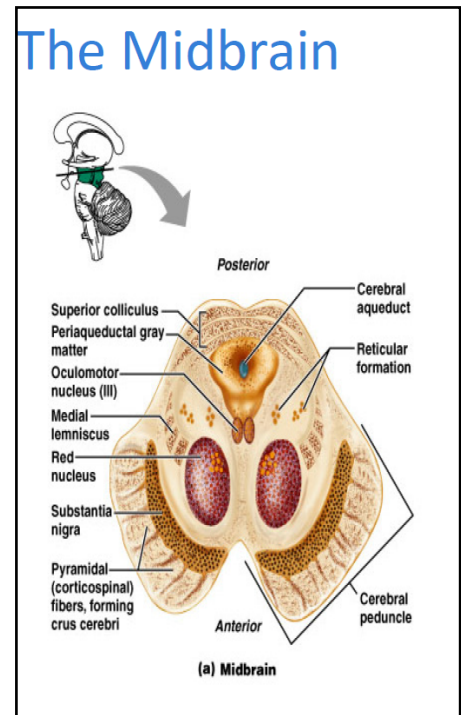
-we have a connection between inferior colliculi and medial geniculate to form inferior brachium(Auditory pathway).

Also there is a connection between superior colliculi and lateral geniculate to form superior brachium (visual pathway).

-at both levels of midbrain (at superior and inferior colliculi), you will see Substantia nigra.

Inside the white matter of midbrain, we have:

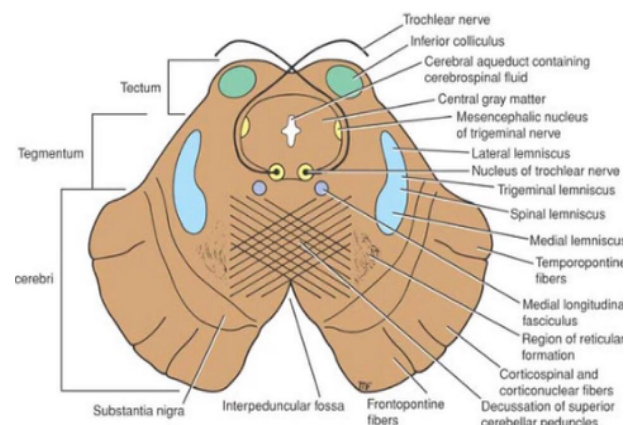
- Two pigmented nuclei.
- Substantia nigra (neuronal cell bodies containing melanin, which is functionally linked to basal nuclei).
- Red nucleus (lies deep to substantia nigra –the largest nucleus of the reticular formation-. It's seen at the level of superior colliculus from which the rubrospinal tract descends.)



**At the level of inferior colliculus :**  
**Cerebral aqueduct is the cavity**

- There is no red nucleus ,no motor nucleus, oculomotor nerves are above.
- you will see mesencephalic nucleus of trigeminal nerve(responsible for proprioception and fine touch)that is lateral to cerebral aqueduct on each side.
- Anteriorly, there is motor nucleus for

**Level of inf. colliculus**



trochlear nerve that supplies superior oblique. The course of its fiber is to pass posteriorly and turn around Cerebral aqueduct and emerge from posterior aspect contralaterally (the right from left and the left from right – the crossing at level of lower motor neuron) *Extra: then around the midbrain to lateral wall of cavernous sinus to the orbital cavity through the superior orbital fissure .*

- Anteriorly, there is medial longitudinal fasciculus. We have a crus cerebri that the corticospinal pathway passes through its middle three fifth but the medial fifth is called fronto-pontine and the lateral fifth is called temporo-pontine. Collectively, the medial and lateral fifths are called cortico-pontine which connect cerebrum with cerebellum.
- substantia nigra is the black material , dopaminergic neurons Anatomically it is related to midbrain but Functionally it is related to basal nuclei ,its function is to switch the motor system (initiation of the movement) *extra:so people who suffer from Parkinson ( symptoms: rigidity ,tremor and Slowed movement (bradykinesia)) have a difficulty in initiation due to degeneration of substantia nigra.*
- We have four lemnisci, posterior to substantia nigra from medial to lateral are: Medial lemniscus, spinal lemniscus, trigeminal lemniscus ,lateral lemniscus (proximal to inferior colliculus).
- Decussation of superior cerebellar peduncles:

We have cortical loop with basal ganglia and cortical loop with cerebellum (cortico-ponto-cerebellar tract). So, cerebellum can reply back to cortex.

Cerebellum consists of outside gray matter (cerebellar cortex). At the center we have white matter, deep within it there is a collection of four gray matter nuclei. *Don't eat greasy food: (dentatus nucleus, emboliform nucleus, globose nucleus, fastigial nucleus) respectively.*

Dentatus nucleus is lateral, then interposed nucleus “globose+ emboliform nuclei”, then the most medial is the fastigial nucleus.

Fibers that enter cerebellum like spino-cerebellar tract (mossy, climbing fibers) are always excitatory (excite nucleus then goes to cortex). But the output fibers from cerebellum are always inhibitory.

Each area of cortex makes projection to the nucleus.

Vermis cortex with fastigial nucleus, intermediate cortex with interposed nucleus, lateral hemisphere cortex with dentatus nucleus.

So, the backward tract of cerebro-ponto-cerebellar pathway => dentatus nucleus to thalamus to cortex (lateral hemisphere). This tract is called dentatothalamicocortical pathway. So, these fibers come from cerebellum and make a crossing “decussation” in superior cerebellar peduncle, then continue to opposite side cortex.

You should know that cerebral cortex controls opposite side of the body, but the cerebellum controls the same side of the body.

Globose emboliform –rubral pathway begins from interposed nucleus and crosses “decussates” in the superior cerebellar peduncle, and continues to the opposite red nucleus.

*Special thanks to Hadeel Al Khreisha ♥*