



## Lecture 05

Anatomy of  
**MIDBRAIN-I**  
(Level of Inferior  
colliculus+ 4<sup>th</sup> CN)

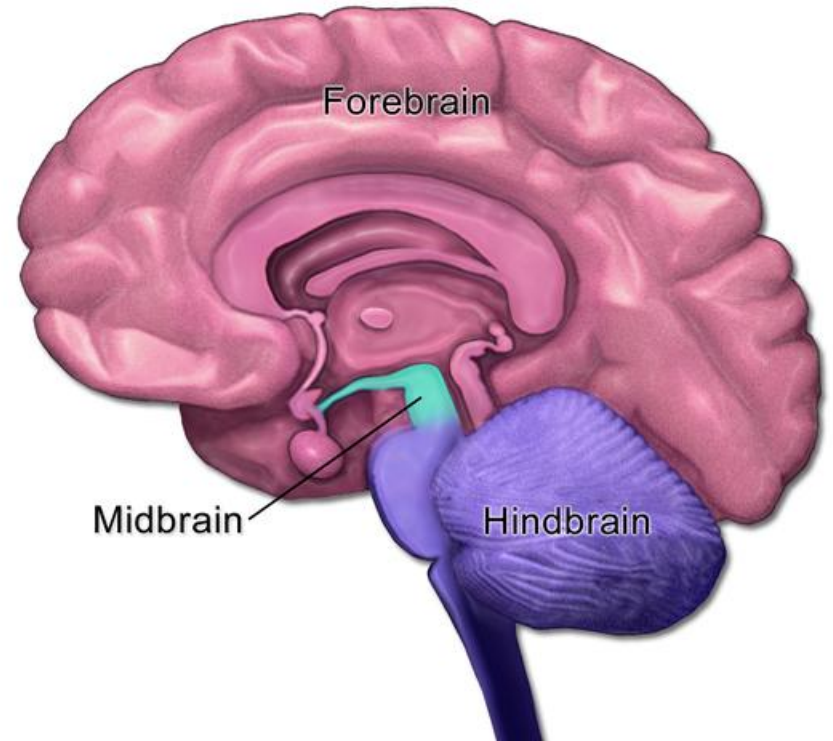
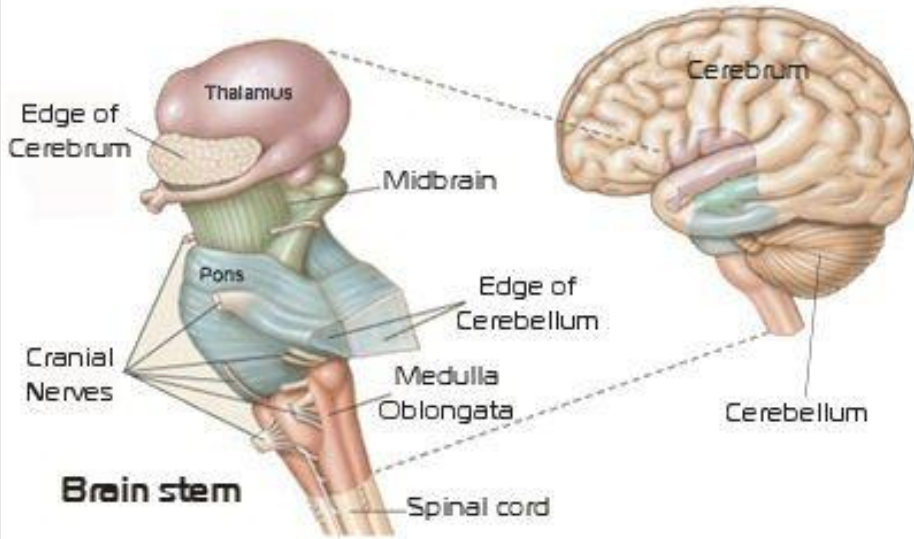
**By:**

**Dr Farooq Aman Ullah Khan**

**PMC**

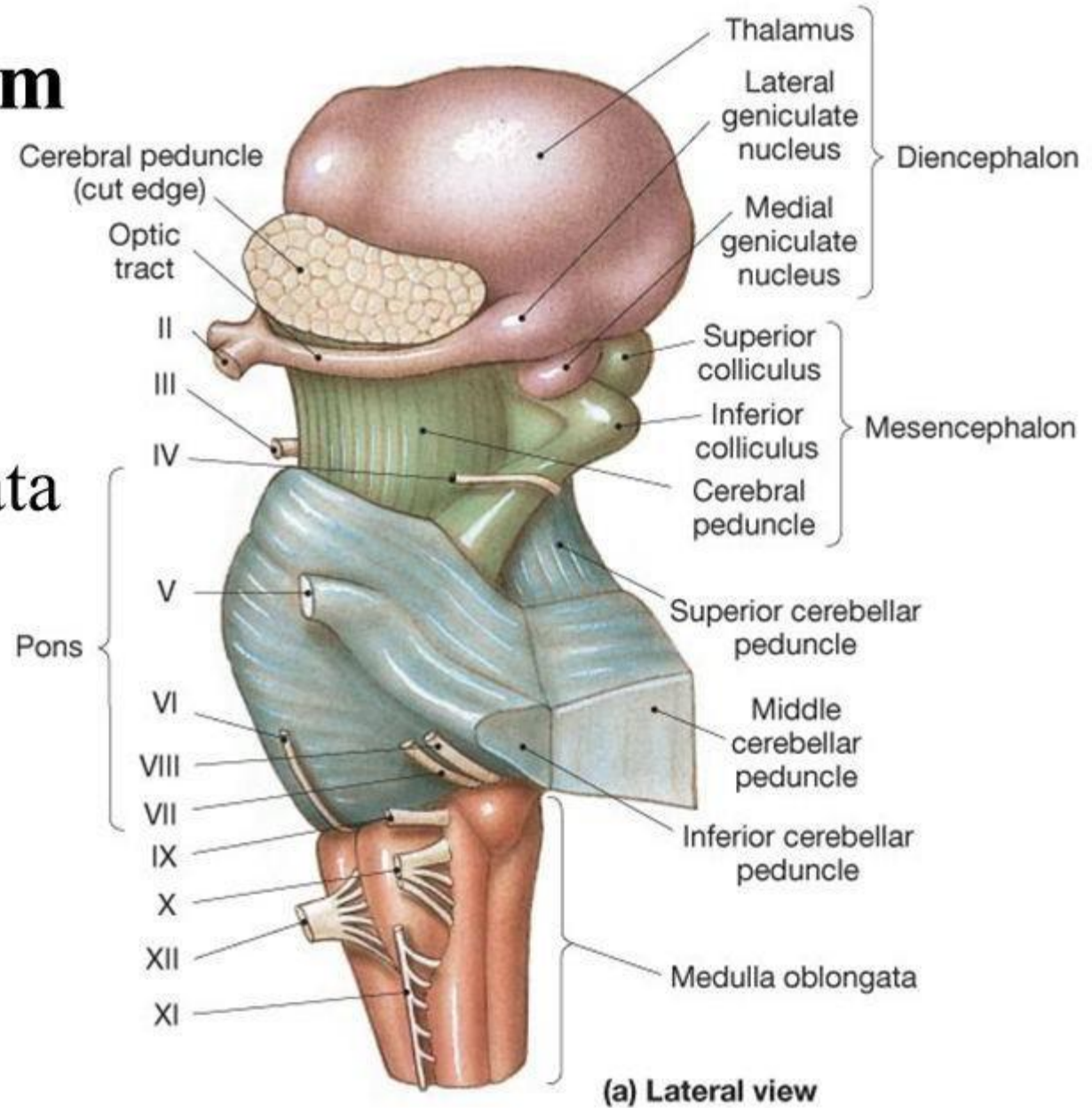
**Dated: 09.03.2022**

# BRAINSTEM Vs HIND BRAIN



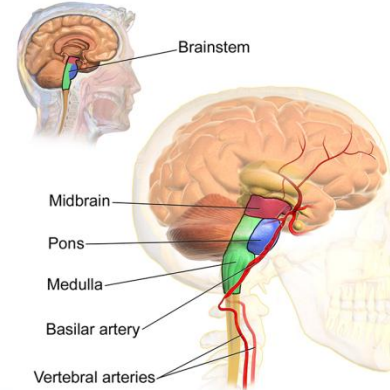
# The Brain Stem

Midbrain,  
Pons,  
Medulla Oblongata

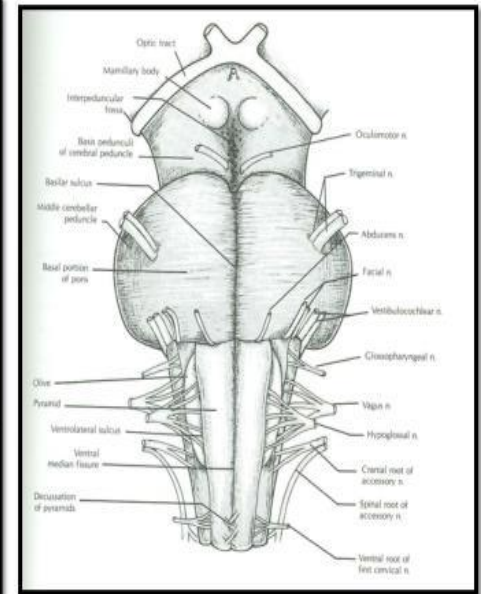
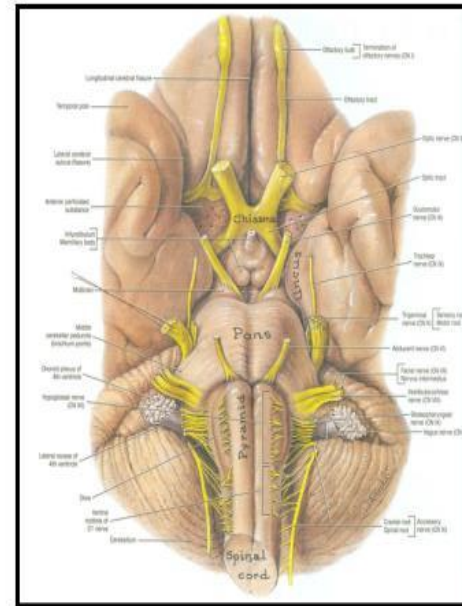


# INTRODUCTION TO MIDBRAIN

- It is the shortest segment of the brain stem.
- It is 02 cm (0.8 inch) long.
- It connects the pons and cerebellum with the forebrain.
- The **midbrain** or **mesencephalon** is a greek word consist of two parts:
  - **Mesos**, *middle*, and
  - **Enkephalos**, *brain*.
- It is the portion of the central nervous system associated with
  - Vision
  - Hearing
  - Motor control
  - Sleep/wake, arousal (alertness), and
  - Temperature regulation.

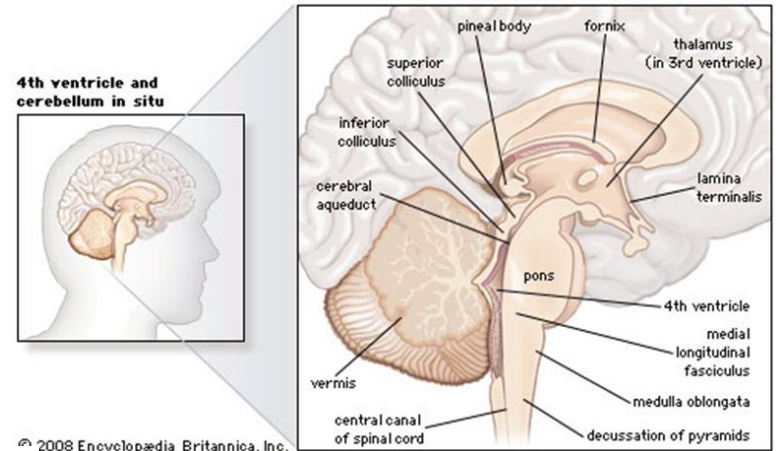


## BRAIN STEM – VENTRAL SURFACE



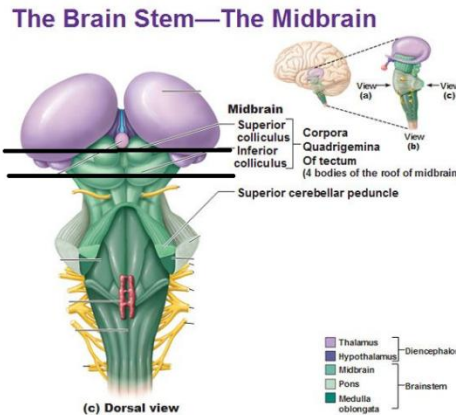
# INTRODUCTION TO MIDBRAIN.....CON'T.

- Caudally the midbrain joins the **Metencephalon** (pons and cerebellum).
- While rostrally it joins the **Diencephalon** (thalamus, hypothalamus, etc.)
- Specifically, the midbrain consists of:



## 1. Tectum

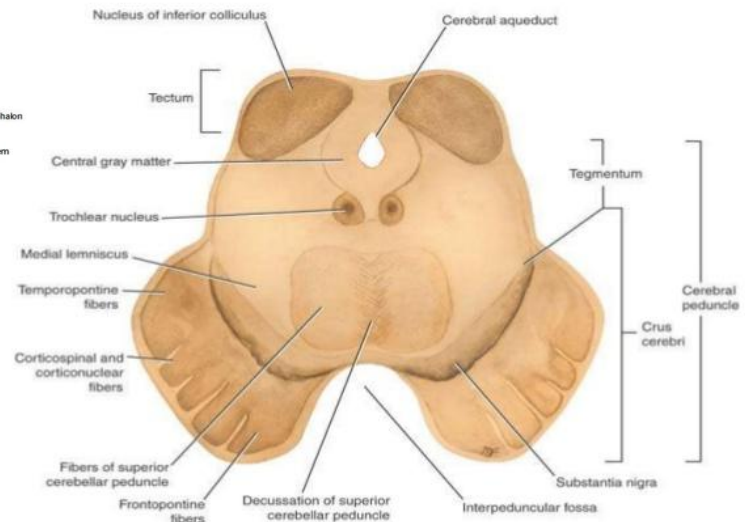
- Inferior colliculi
- Superior colliculi



## 2. Paired Cerebral padencles

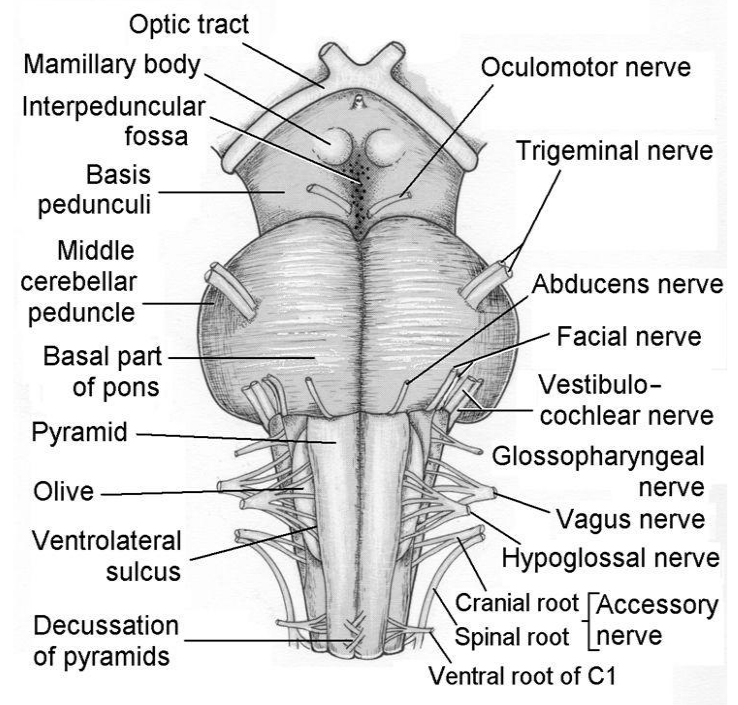
The cerebral Padeuncles consists of:

- Tegmentum
- Substantia Nigra
- Crus cerebri



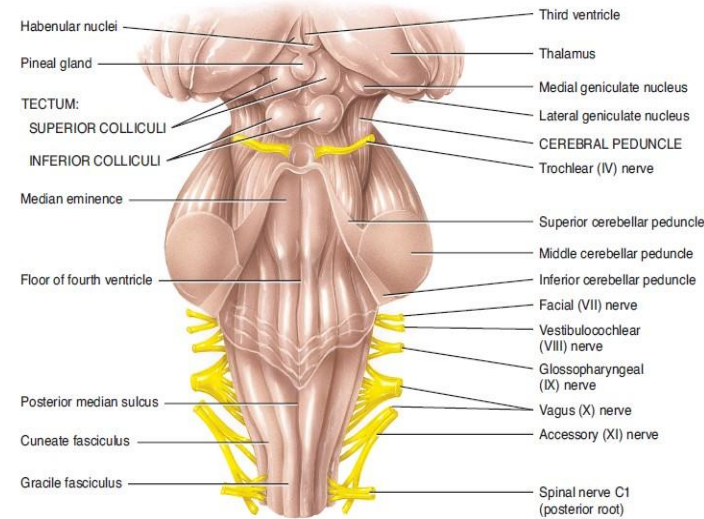
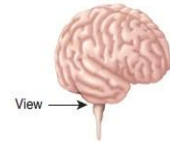
# GROSS FEATURES OF MID BRAIN.....VENTRAL SURFACE

- It is formed of a large column of descending fibres CRUS CEREBRI or Basis Pedunculi on either side.
- The two crura cerebri are separated by a depression called as interpeduncular fossa.
- Nerve emerging from anterior midbrain is one:
  - CN 03?
  - Oculomotor.
- It arises from medial aspect of the crus cerebri.

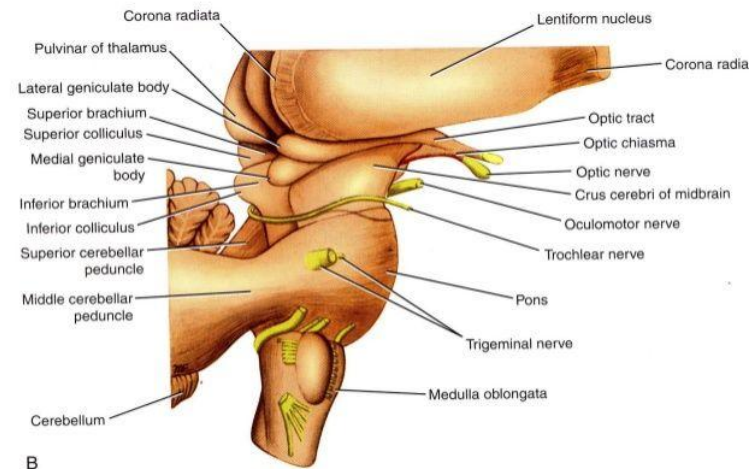


# GROSS FEATURES OF MID BRAIN.....DORSAL SURFACE

- It is marked by four elevations:
- **Two superior colliculi:**
- Concerned with visual reflexes.
- **Two inferior colliculi:**
- Forms part of Auditory pathway.
- The four elevations are collectively called the Corpora quadregemina.
- Nerve emerging from posterior Mid brain is also one:
- **Trochlear nerve CN IV:**
- It arises just caudal to inferior colliculus.
- **The only CN which arises from dorsal aspect of the Brain stem.**



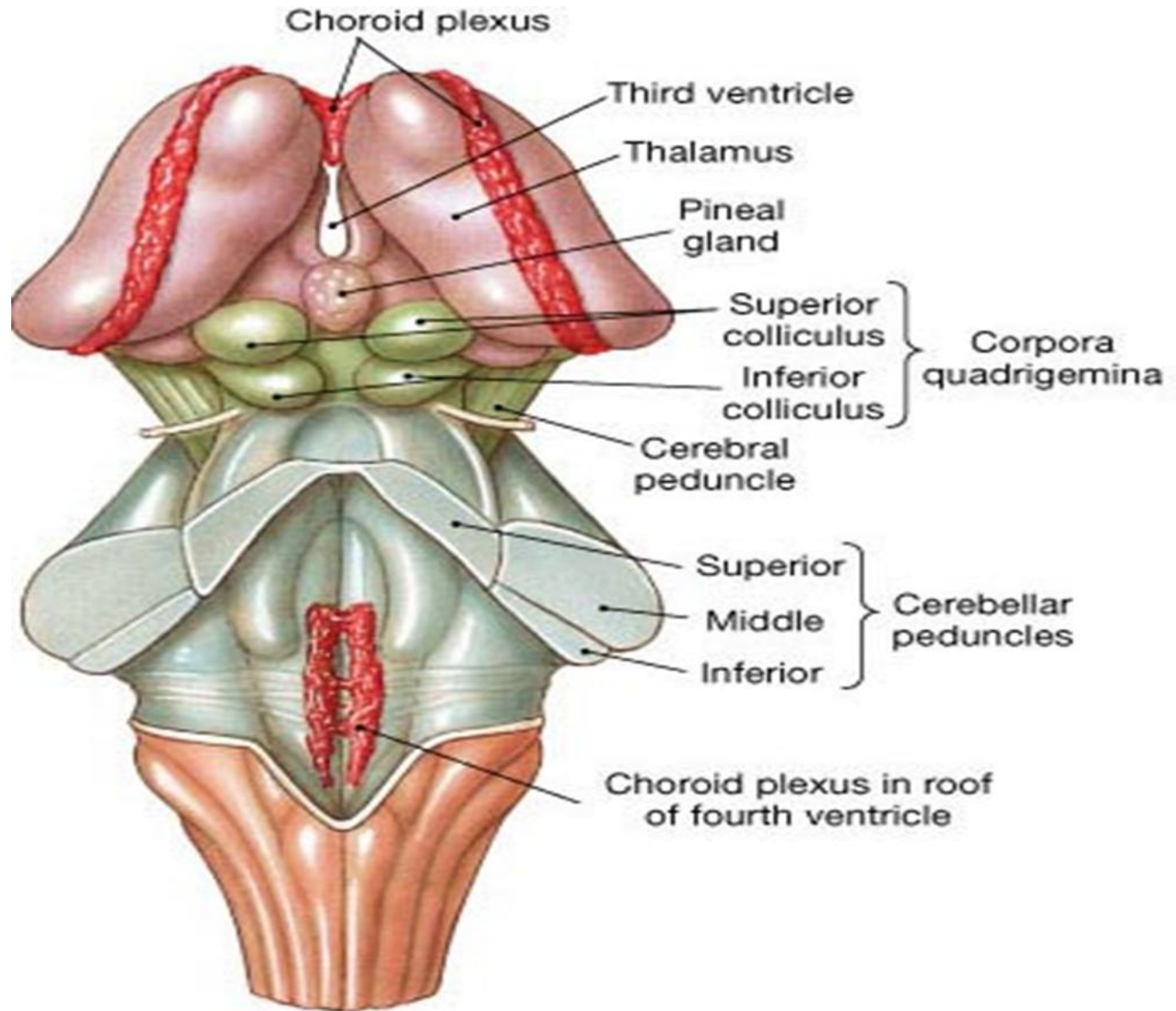
(a) Posterior view of midbrain in relation to brain stem



B

Figure 5-16 The midbrain. A. Anterior view. B. Lateral view.

Lateral view

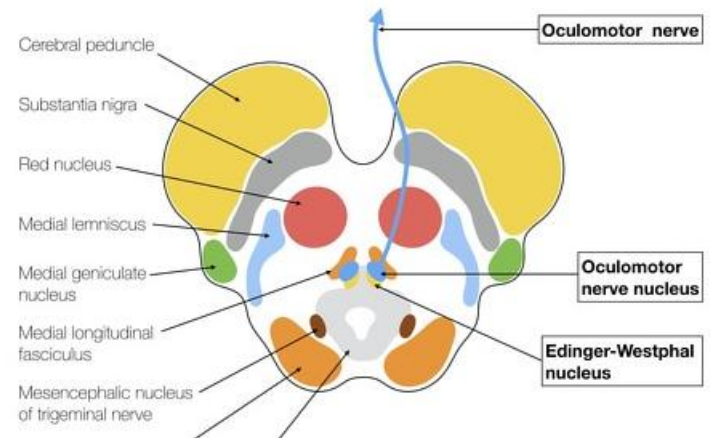
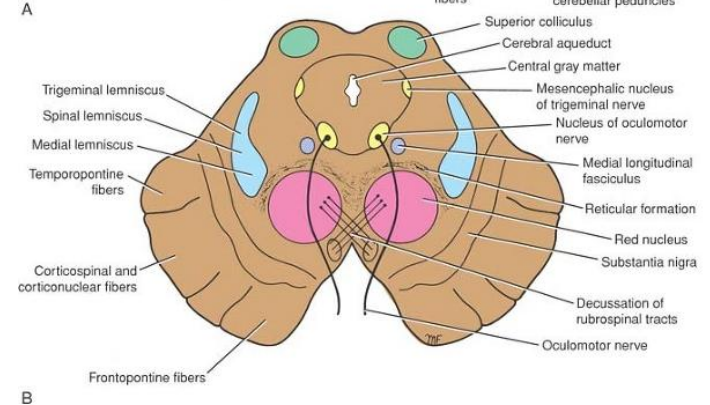
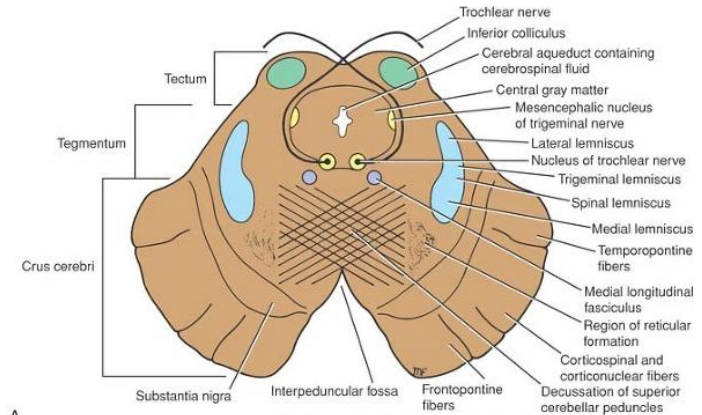


**(c) Posterior view**



# TRANSVERSE SECTION OF THE MIDBRAIN

- The midbrain is usually sectioned at the level of the:
  - Superior Colliculi, and
  - Inferior Colliculi.
- A horizontal (transverse) cross-section at the level of the **Superior colliculus** shows the:
  - Red nucleus
  - The nuclei of the oculomotor nerve (and associated Edinger-Westphal nucleus).
  - The cerebral peduncles or crus cerebri, and
  - The substantia nigra.



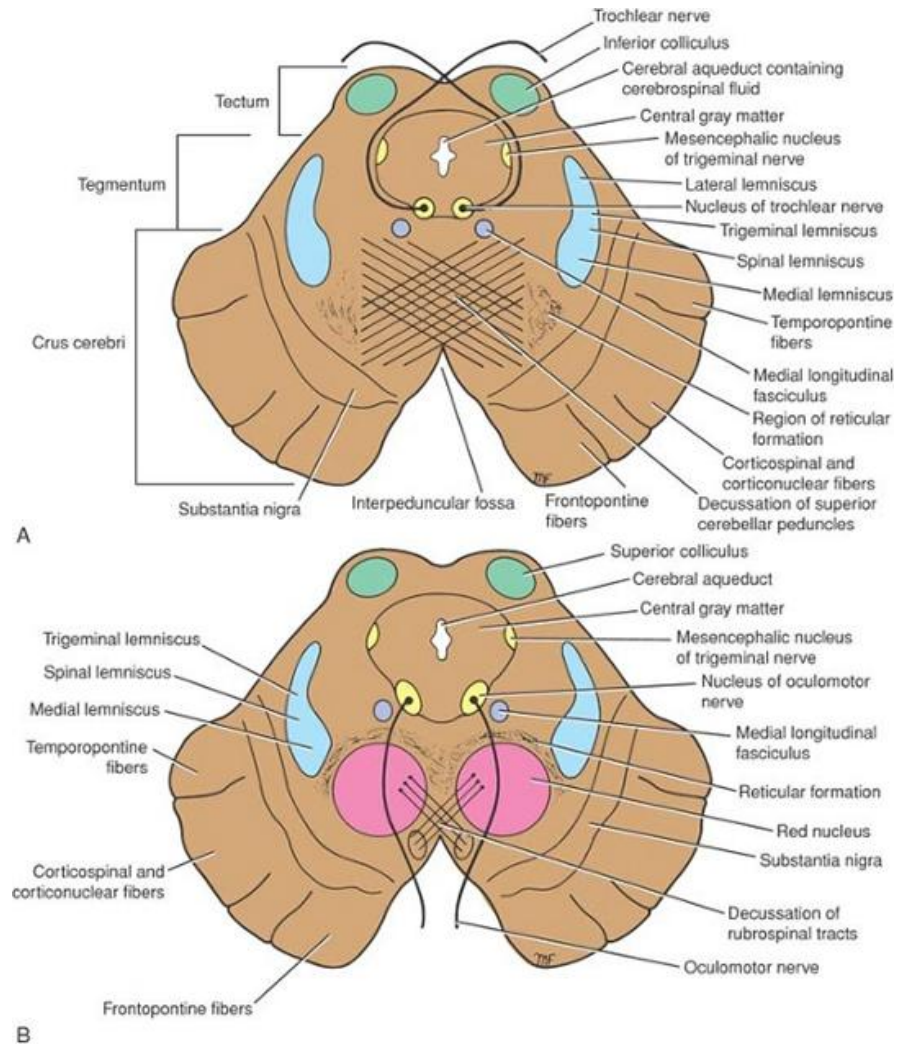
## TRANSVERSE SECTION OF THE MIDBRAIN.....CON'T

- A horizontal (transverse) cross-section at the level of the **inferior colliculus** shows the:

- Trochlear nerve nucleus, and
- The decussation of the superior cerebellar peduncles.

- **Both sections will show the:**

- A. The periaqueductal gray.
- C. Tracts (Ascending and descending)
- D. Substantia Nigra.
- D. Mesencephalic nucleus.



# INTERNAL STRUCTURE OF MIDBRAIN...DIVISION

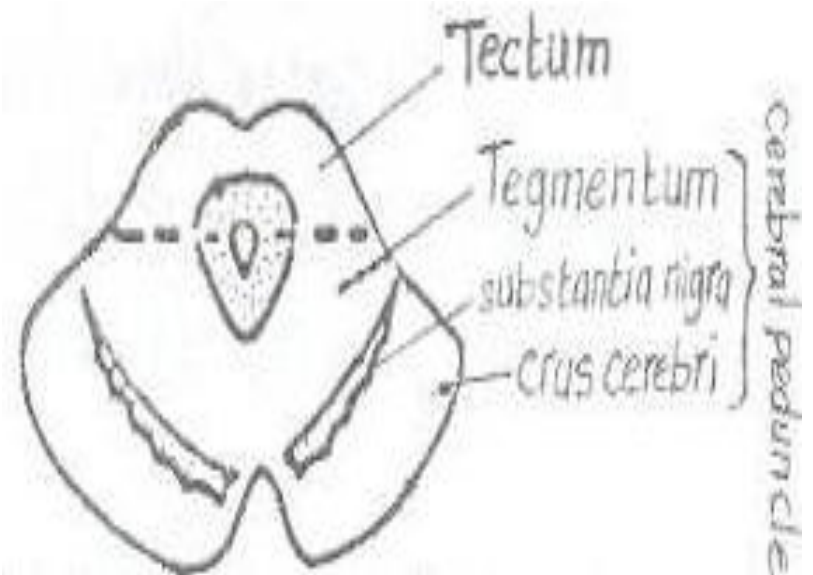
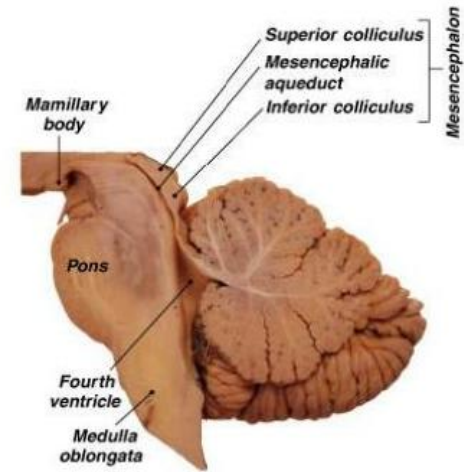
- The midbrain is divided into dorsal & ventral portions at the level of cerebral aqueduct.

## (A) Tectum :

- It is the smaller dorsal part behind aqueduct.
- It is composed of 4 rounded swellings (colliculi) :
- superior colliculi :
- inferior colliculi :

## (B) 2 Cerebral peduncles :

- It the larger ventral part in front of aqueduct.
- It consists of 3 parts :



# INTERNAL STRUCTURE OF MIDBRAIN....CON'T

## 1-CRUS CEREBRI (BASIS PEDUNCULI):

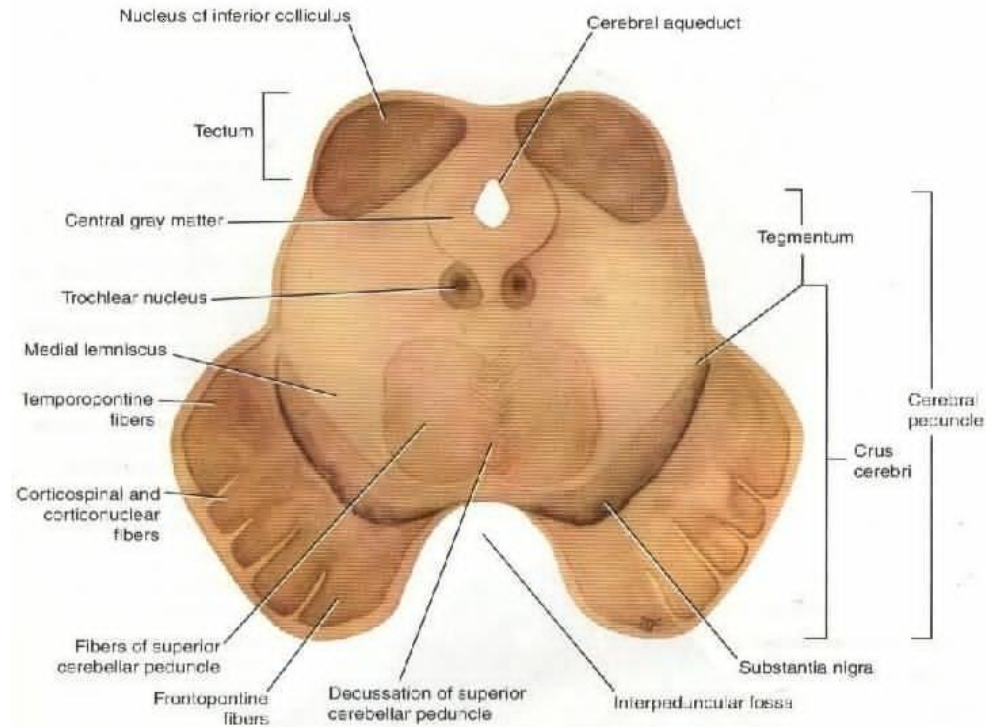
- It is the most anterior part which consists entirely of pyramidal & cortico-pontine fibres.

## 2-SUBSTANTIA NIGRA :

- It is a thick lamina of grey matter formed of deeply pigmented nerve cells lying behind the crus cerebri.
- It is an Extraparamidal motor centre.

## 3-TEGMENTUM :

- The posterior part of cerebral peduncle.
- It contains ascending tract, decussation, nuclei, & reticular formation.

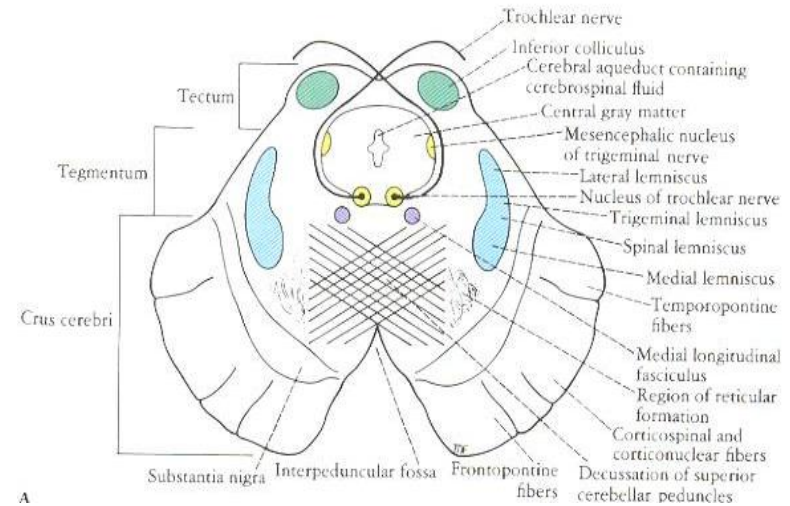


# CAUDAL MIDBRAIN AT LEVEL OF INFERIOR COLLICULUS

- The main parts of the CS of the Mid Brain at the level of IC are:

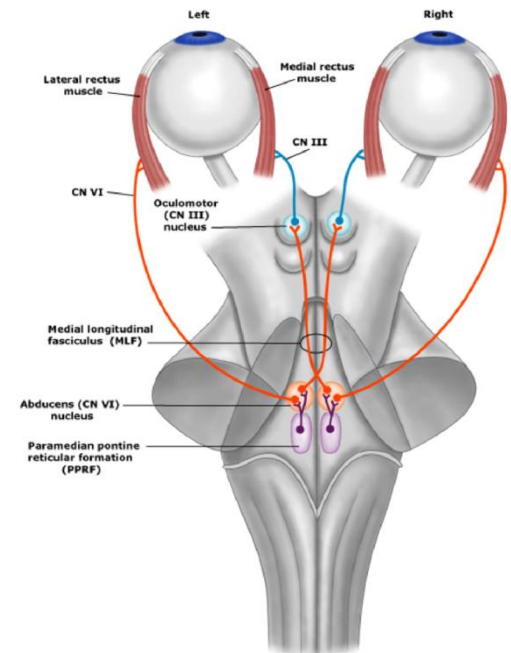
## 1-THE INFERIOR COLLICULUS.

- It is a centre of hearing reflex which receives ascending auditory pathway ,which run in lateral lemniscus.
- Its Efferent Fibers end in medial geniculate nucleus of thalamus, which projects to auditory cortex of temporal lobe.



## 2-THE CEREBRAL AQUEDUCT.

- It runs ventral to colliculi, and surrounding by area of grey matter, the peri-aqueductal (or central grey ).

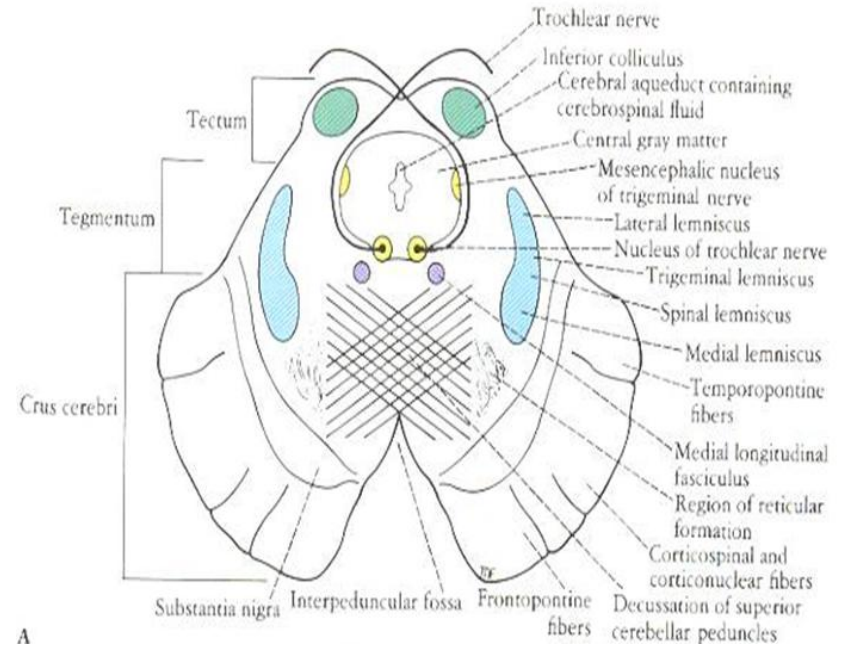


# CAUDAL MIDBRAIN AT LEVEL OF INFERIOR COLLICULUS

## NUCLEI

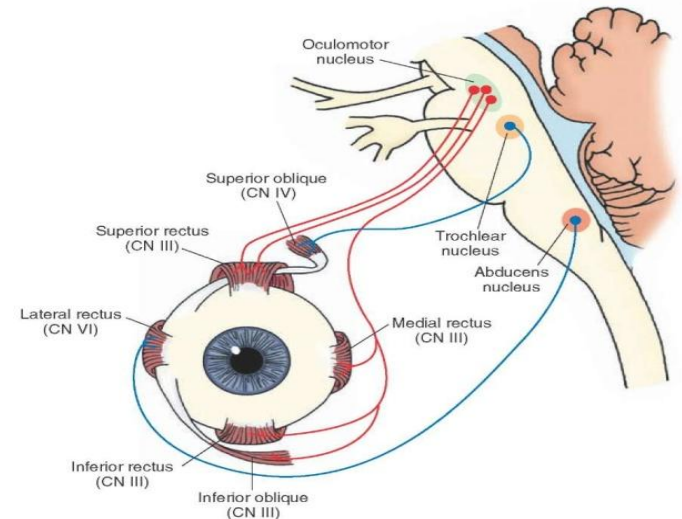
### 3-TROCHLEAR NUCLEUS :

- It lies ventral to peri-aqueductal grey, its efferent Fibres cross to opposite side to emerge from back of midbrain, .
- It then turn forwards to reach base of brain to supply extraocular muscle?
- (Superior oblique Muscle).



### 4-MESECEPHALIC NUCLEUS OF TRIGEMINAL

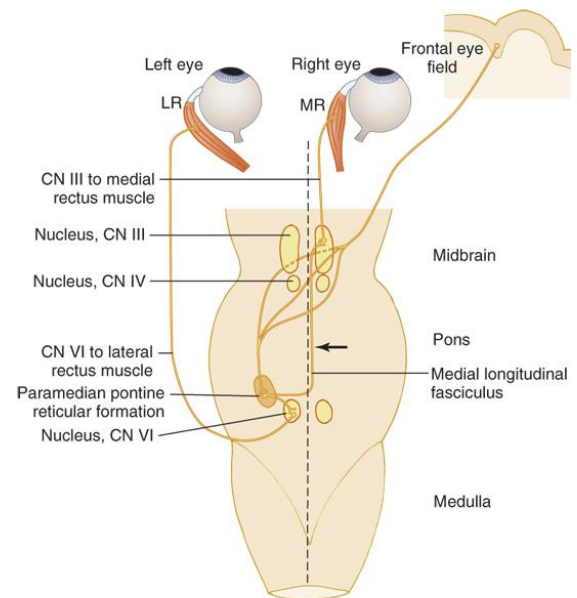
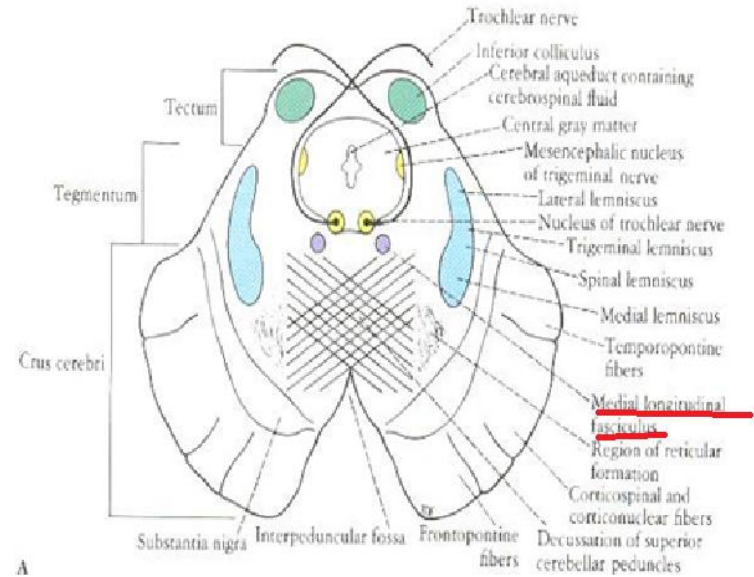
- It lies lateral to aqueduct of midbrain, at the level of inferior & superior colliculi.
- It is a Sensory nucleus receives proprioceptive sensation from muscles of mastication.



# CAUDAL MIDBRAIN AT LEVEL OF INFERIOR COLLICULUS

## 5- MEDIAL LONGITUDINAL FASCICULUS

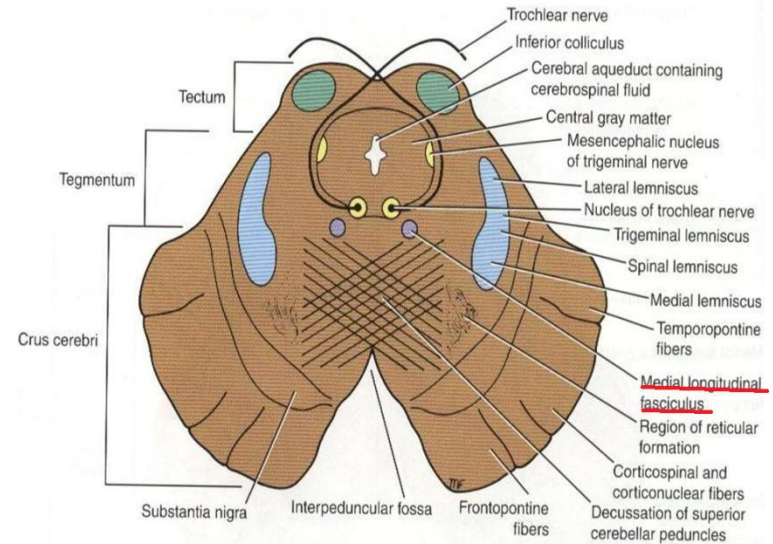
- It is a well defined bundle of association fibers lies on each side of median plane in midbrain tegmentum.
- It extends throughout the brain stem, and descends into spinal cord.
- It lies close to oculomotor, trochlear & abducent nuclei.
- It receives fibers from vestibular nuclei.
- It sends efferents to oculomotor nuclei
- Its function is coordination of eye, head & neck movements.



# CAUDAL MIDBRAIN AT LEVEL OF INFERIOR COLLICULUS

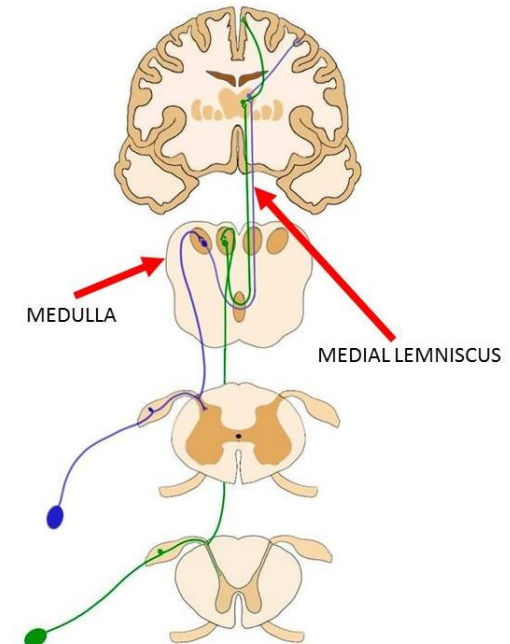
## **6-DECUSSATION OF SUPERIOR CEREBELLAR PEDUNCLES (BRACHIUM CONJUNCTIVUM) :**

- The fibres of each peduncle cross to opposite side, forming decussation in the central part of tegmentum.



## **7-MEDIAL LEMNISCUS :**

- It is a band of ascending Fibres carrying proprioceptive sensation from opposite side of body.
- It is the upward continuation of gracile & cuneate tracts of opposite side.
- It lies in tegmentum, posterior to substantia nigra.

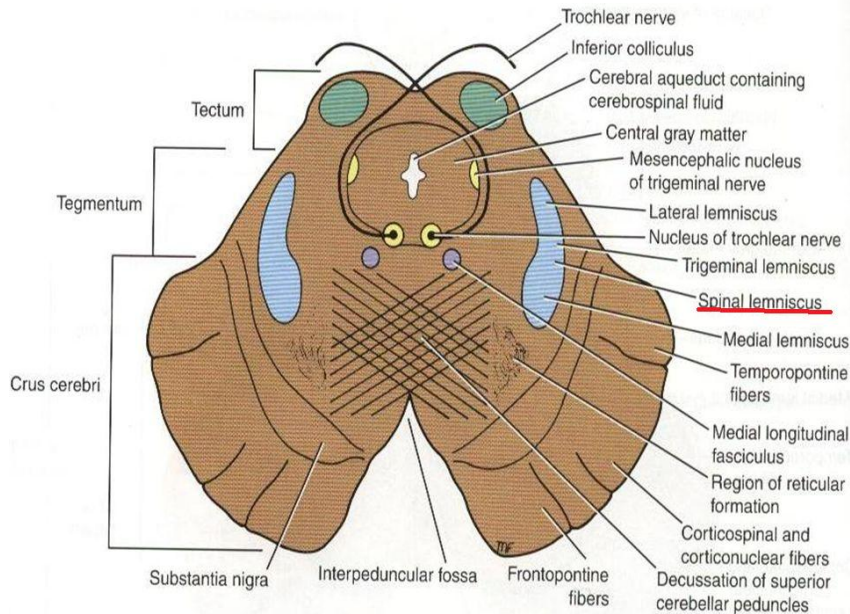




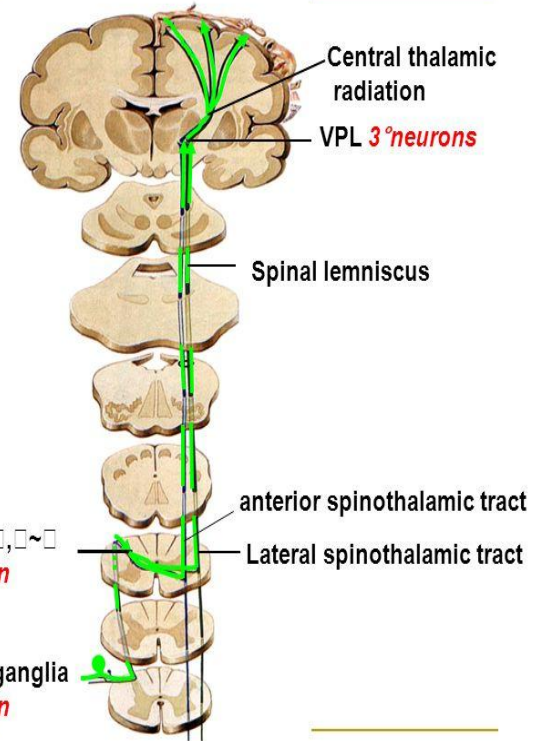
# CAUDAL MIDBRAIN AT LEVEL OF INFERIOR COLLICULUS

## 8. SPINAL LEMNISCUS

- It is the anterolateral system (anterior and lateral spinothalamic tracts).
- In older terminology, the anterior and lateral spinothalamic tracts remained discrete while ascending in the spinal cord.
- In the medulla, the two tracts merge with the spinotectal pathway and the combined tract is known as the spinal lemniscus.



Pain, temperature and crude touch pathway of trunk and limbs



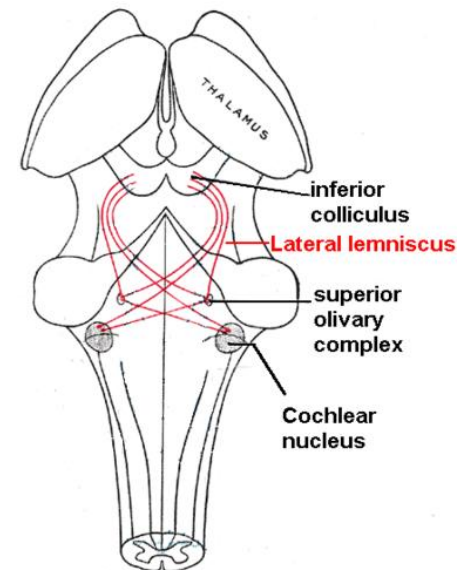
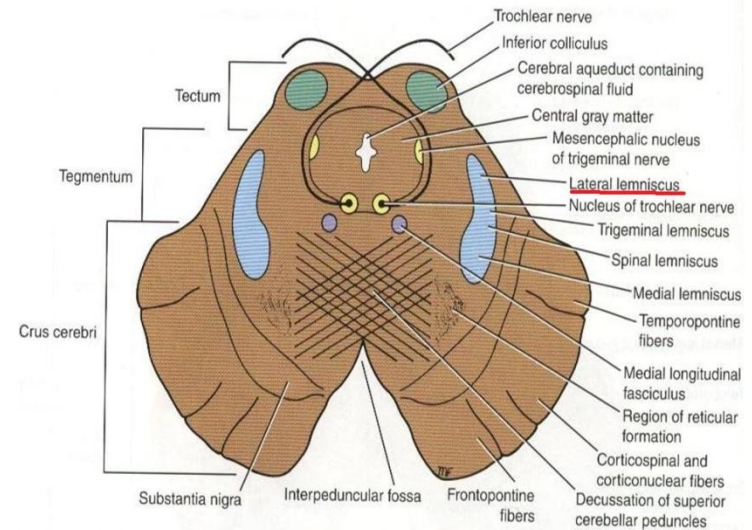
# CAUDAL MIDBRAIN AT LEVEL OF INFERIOR COLLICULUS

## 09. TRIGEMINAL LEMNISCUS,

- ALSO CALLED THE **TRIGEMINOTHALAMIC TRACT**.
- It is a part of the brain that conveys tactile,
  - Pain, and
  - Temperature impulses from the skin of the face.
- ✓ The mucous membranes of the nasal and
- ✓ Oral cavities, and the eye, as well as
- ✓ Proprioceptive information from the facial and masticatory muscles.

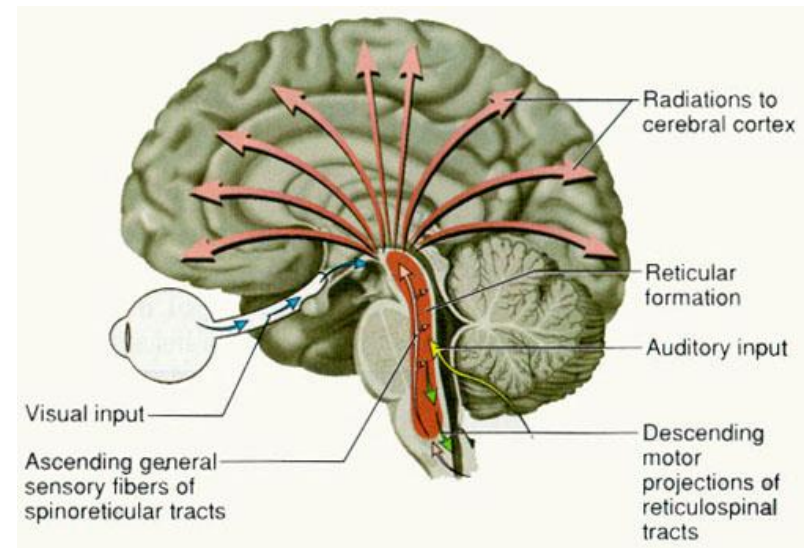
## 10. LATERAL LEMNISCUS:

- The **lateral lemniscus** is a tract of axons in the brainstem that carries **information about sound from the cochlear nucleus** to various brainstem nuclei.
- It ultimately comes to the contralateral inferior colliculus of the midbrain.



# 11. RETICULAR FORMATION

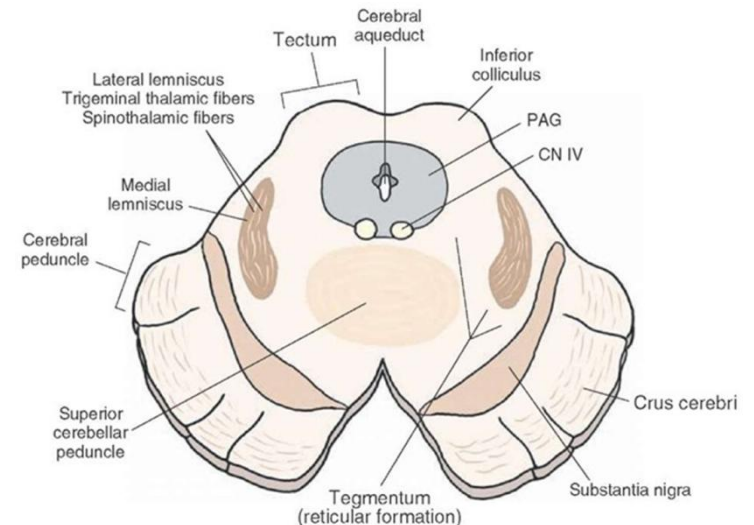
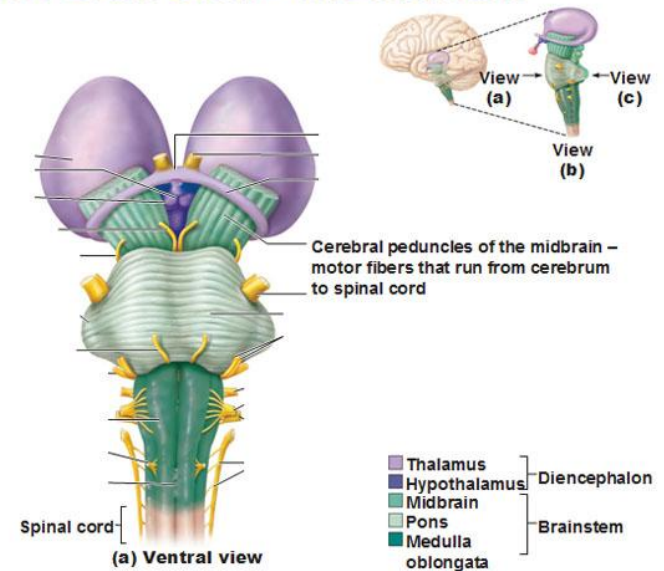
- The **reticular formation** is a set of interconnected nuclei that are located throughout the brainstem.
- The reticular formation is not anatomically well defined because it includes neurons located in diverse parts of the brain.
- The neurons of the reticular formation make up a complex set of networks in the core of the brainstem that stretches from the upper part of the midbrain to the lower part of the medulla oblongata.
- The reticular formation includes ascending pathways to the cortex in the **ascending reticular activating system (ARAS)**.
- The descending pathways to the spinal cord via the **reticulospinal tracts** of the descending reticular formation.

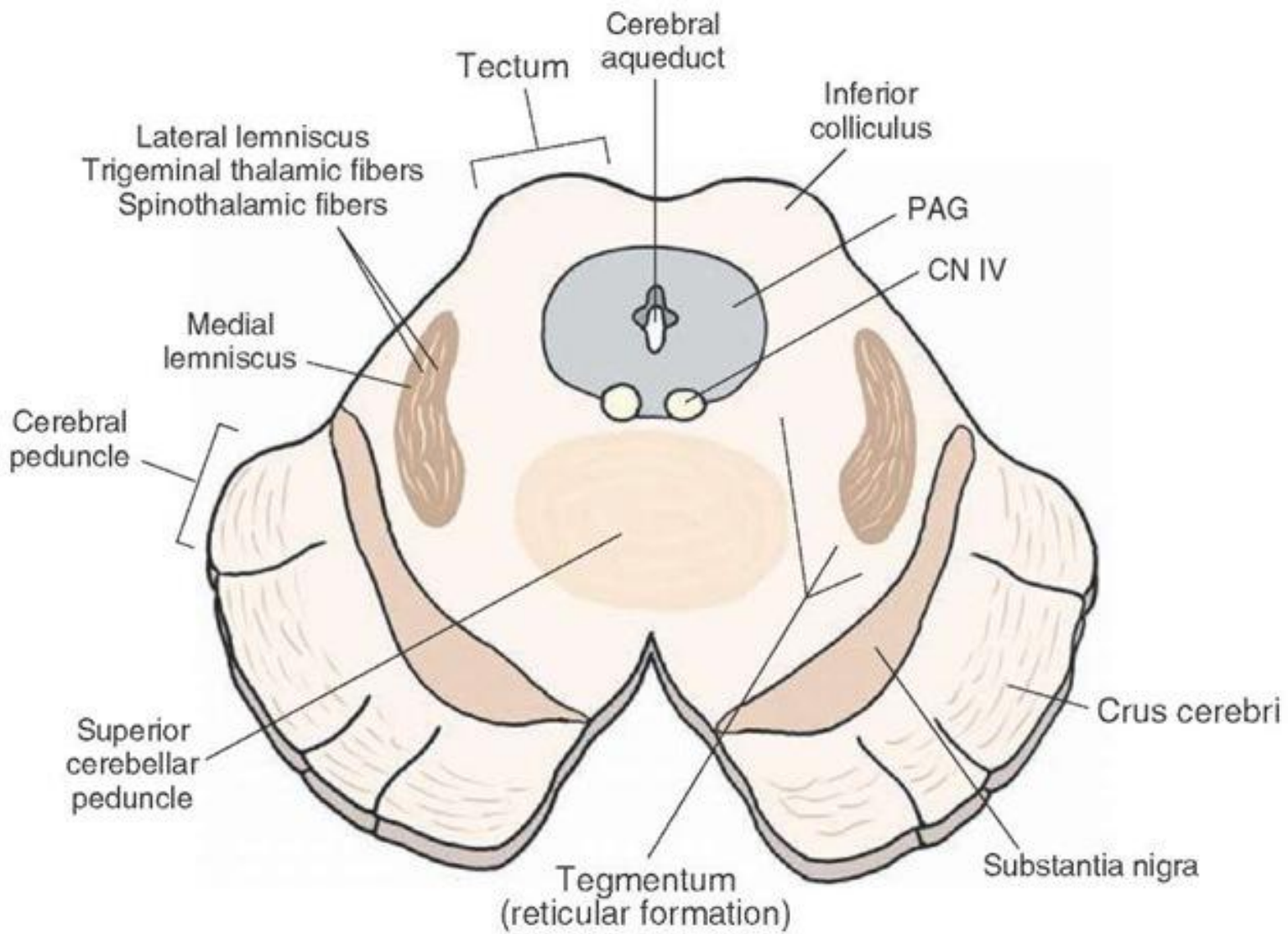


# 12. CEREBRAL PEDUNCLE

- The cerebral peduncles are structures at the front of the midbrain which arise from the front of the pons and contain the large ascending (sensory) and descending (motor) nerve tracts that run to and from the cerebrum from the pons.
- Mainly, the three common areas that give rise to the cerebral peduncles are the cerebral cortex, the spinal cord and the cerebellum.
- The **cerebral peduncle**, by most classifications, is everything in the midbrain except the tectum.
- The region includes the tegmentum, crus cerebri and pretectum.

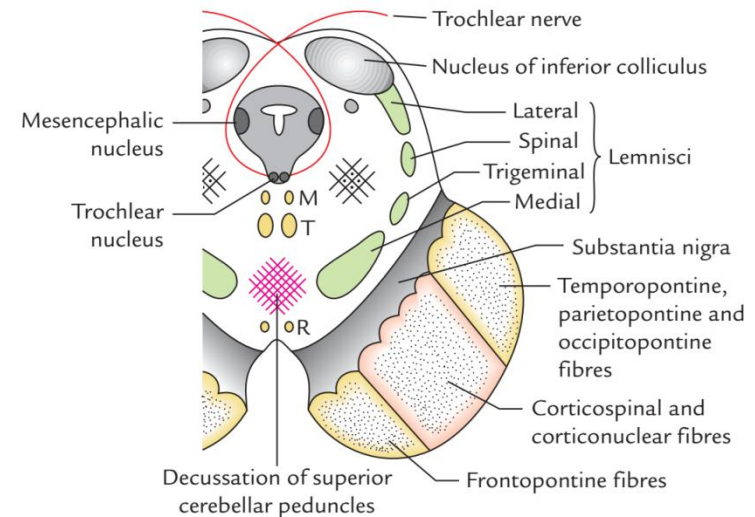
## The Brain Stem– The Midbrain





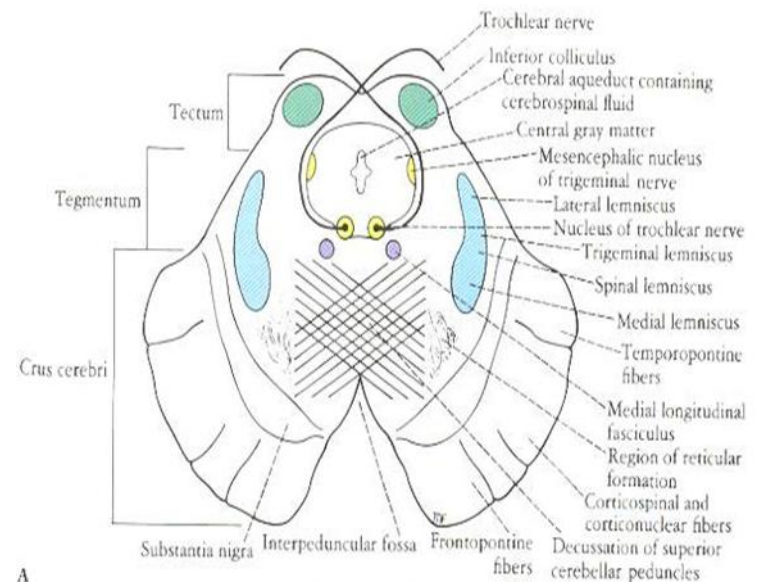
## CEREBRAL PEDUNCLE.....CON'T

- The cerebral peduncles are also known as the **basis pedunculi**, while the large ventral bundle of efferent fibers is referred to as the cerebral crus or the **pes pedunculi**.
- As a whole, the cerebral peduncles assists in refining motor movements, learning of new motor skills, and converting proprioceptive information into balance and posture maintenance.
- Important fiber tracts that run through the cerebral peduncles are:
  - Cortico-spinal,
  - Cortico- pontine, and
  - Cortico-bulbar tracts.
- Damage to the cerebral peduncles results in unrefined motor skills, imbalance, and lack of proprioception.



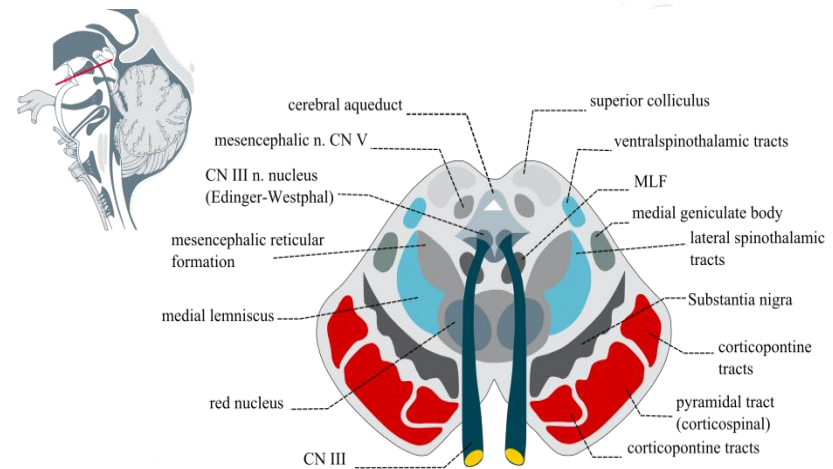
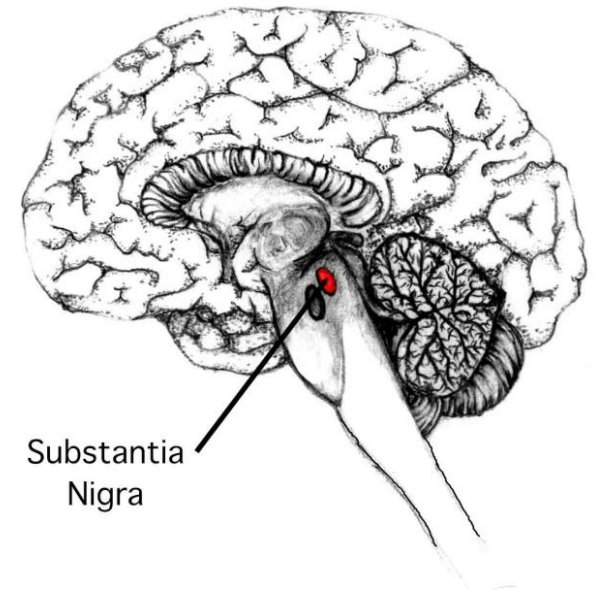
# DESCENDING FIBERS

- The descending upper fibers from the internal capsule continue on through the midbrain and are then seen as the fibers in the cerebral peduncles.
- The **cortico-pontine fibers** are found in the outer and inner third of the cerebral peduncle, these are the cortical input to the pontine nuclei.
- The **cortico-bulbar and cortico-spinal fibers** are found in the middle third of the cerebral peduncle.
- The cortico-spinal tract exits the internal capsule and is seen in the mid portion of the cerebral peduncles.



# 13. SUBSTANTIA NIGRA

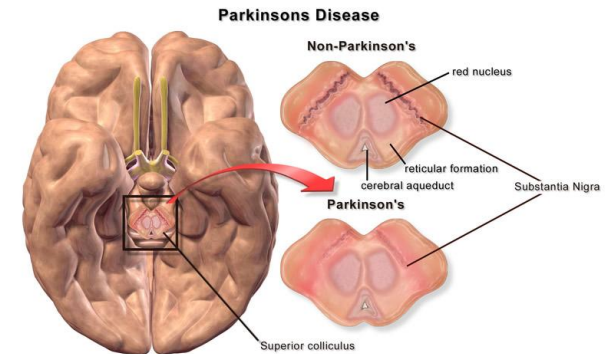
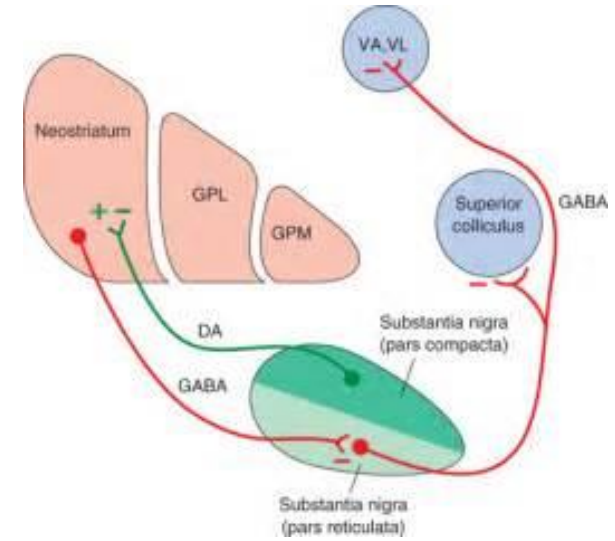
- It is a large motor nucleus.
- It is located at the border of the crus cerebri and the tegmentum.
- It is Found through out the midbrain and extend into the thalamus of diencephalon.
- **Substantia nigra** is a Latin word for "black substance".
- It reflect the fact that parts of the substantia nigra appear darker than neighboring areas due to high levels of **Neuromelanin** in dopaminergic multipolar neurons.





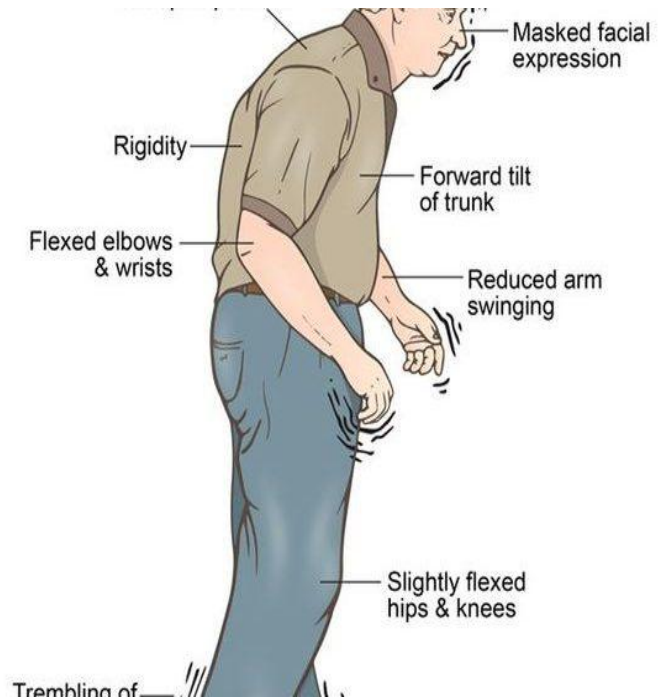
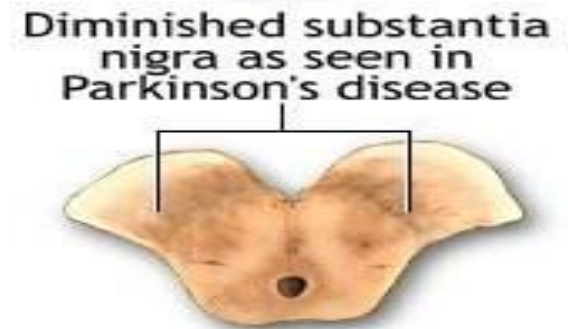
# SUBSTANTIA NIGRA

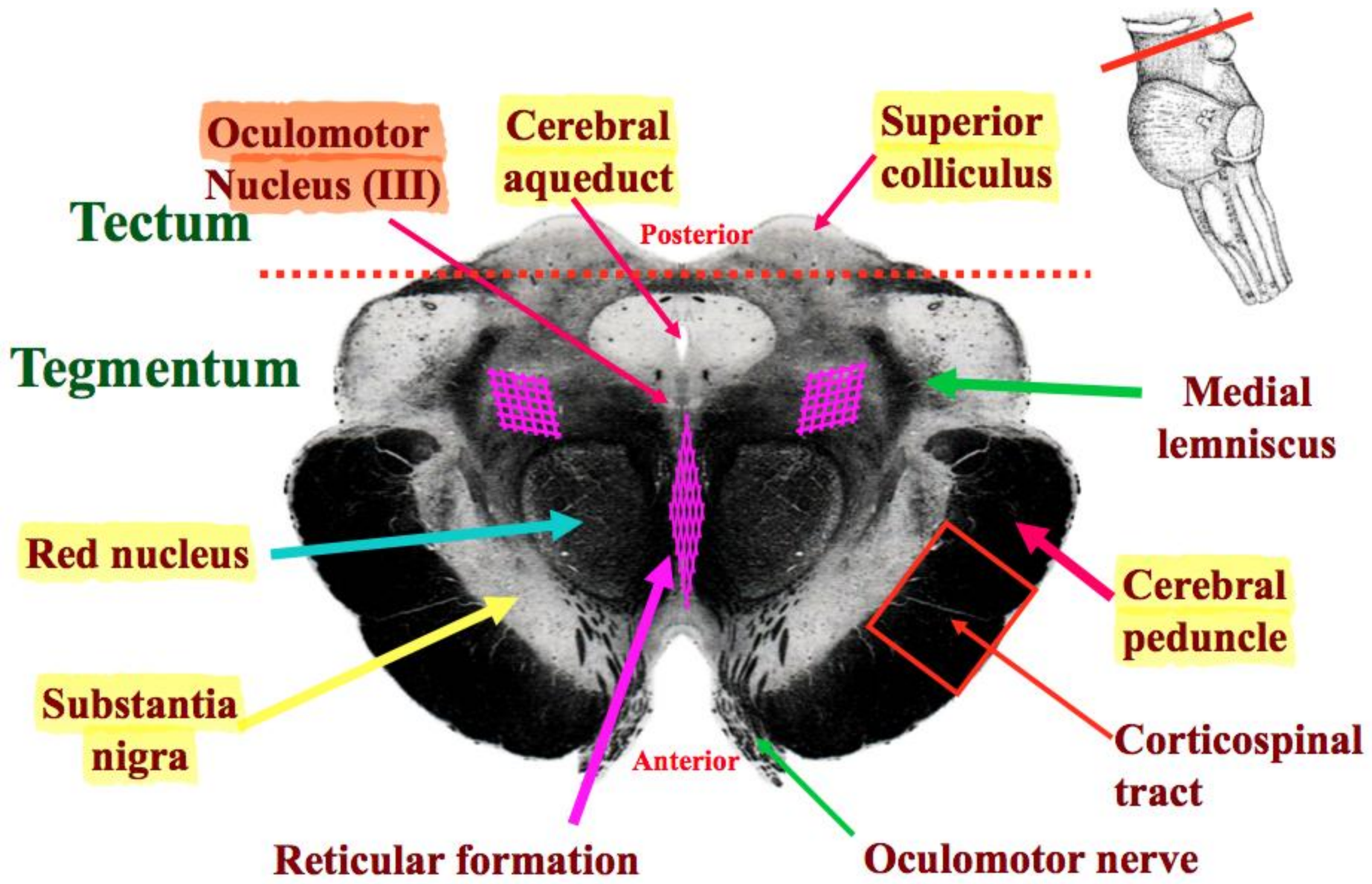
- Anatomical studies have found that it actually consists of two parts with very different connections and functions:
  - **Pars Compacta** and the
  - **Pars Reticulata**.
- The **Pars Compacta** serves mainly as an input to the basal ganglia circuit, supplying the striatum with dopamine.
- The **Pars Reticulata**, though, serves mainly as an output, conveying signals from the basal ganglia to numerous other brain structures.



# SUBSTANTIA NIGRA

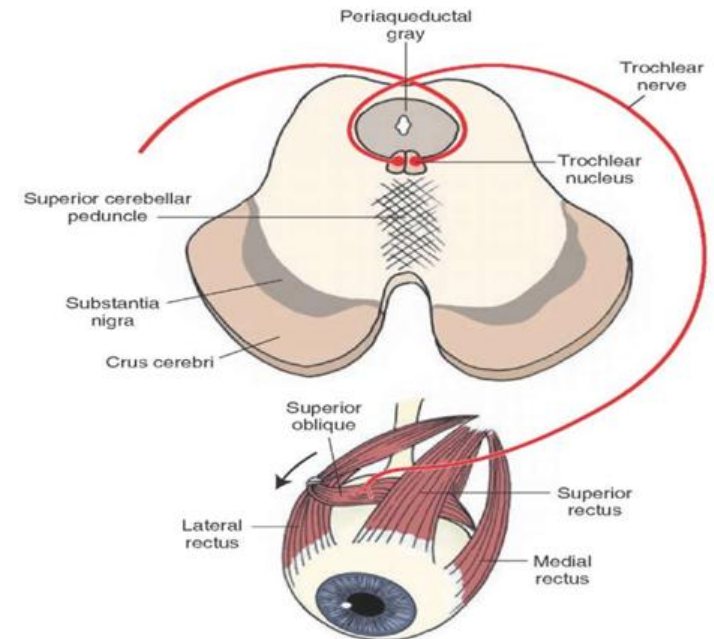
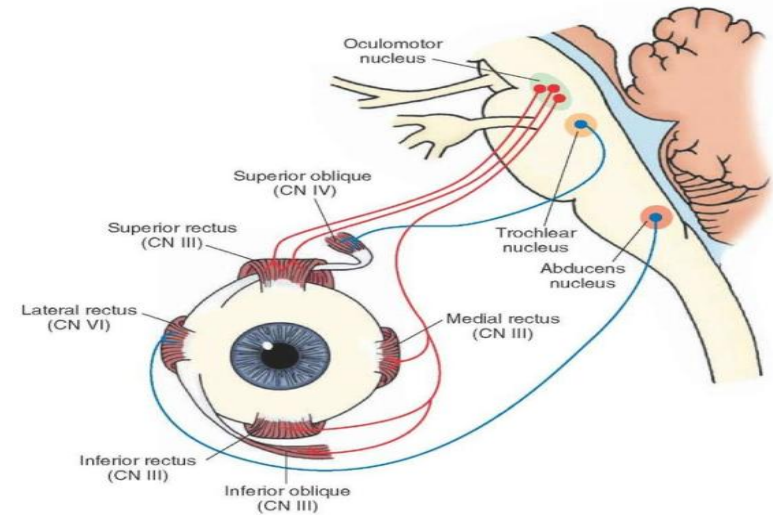
- Parkinson's disease is characterized by tremor and difficulty in initiating or termination of movement.
- It is caused due to the death of dopaminergic neurons in the substantia nigra of pars compacta.





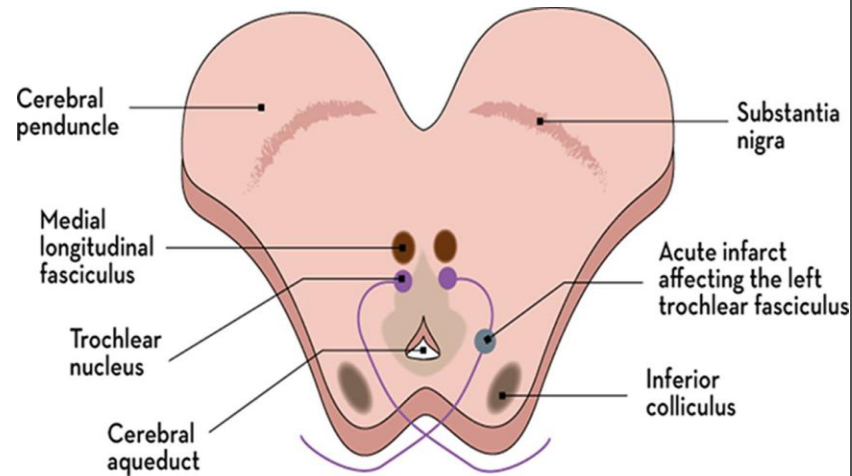
# TROCHLEAR NERVE

- It is a motor nerve (a somatic efferent nerve).
- The trochlear nerve is unique among the cranial nerves in several respects:
  1. It is the *smallest* nerve in terms of the number of axons it contains.
  2. It has the greatest intracranial length.
  3. It is the only cranial nerve that exits from the dorsal (rear) aspect of the brainstem.
- It innervates a muscle, Superior Oblique muscle, on the opposite side (contralateral) from its origin.



# TROCHLEAR NERVE NUCLEI

- The trochlear nucleus is situated in the anterior part of grey matter that surrounds the cerebral aqueduct of the midbrain.
- It lies inferior to the oculomotor nucleus at the level of inferior colliculus.
- The nerve fibers, after leaving the nucleus, pass posteriorly around the central gray matter to reach the posterior surface of the midbrain.
- The trochlear nerve receive fibers from:
  - Corticonuclear fibres.....from both cerebral hemisphere.
  - Tectobulber fibres .....visual cortex.
  - ML fasciculus.....connect to 3<sup>rd</sup>, 4<sup>th</sup>, 6<sup>th</sup> and 8<sup>th</sup> CN



# TROCHLEAR NERVE....CONT

- The nerve circles anteriorly around the brainstem and runs forward toward the eye in the subarachnoid space.
- It passes between the posterior cerebral artery and the superior cerebellar artery.
- It then pierces the dura just under free margin of the tentorium cerebelli, close to the crossing of the attached margin of the tentorium and within millimeters of the posterior clinoid process.

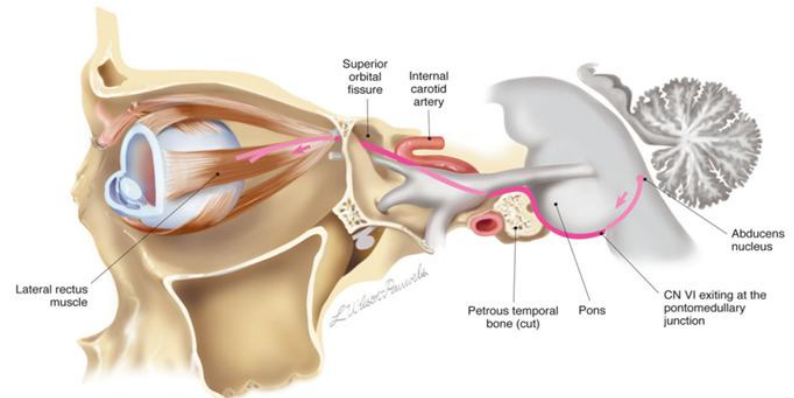
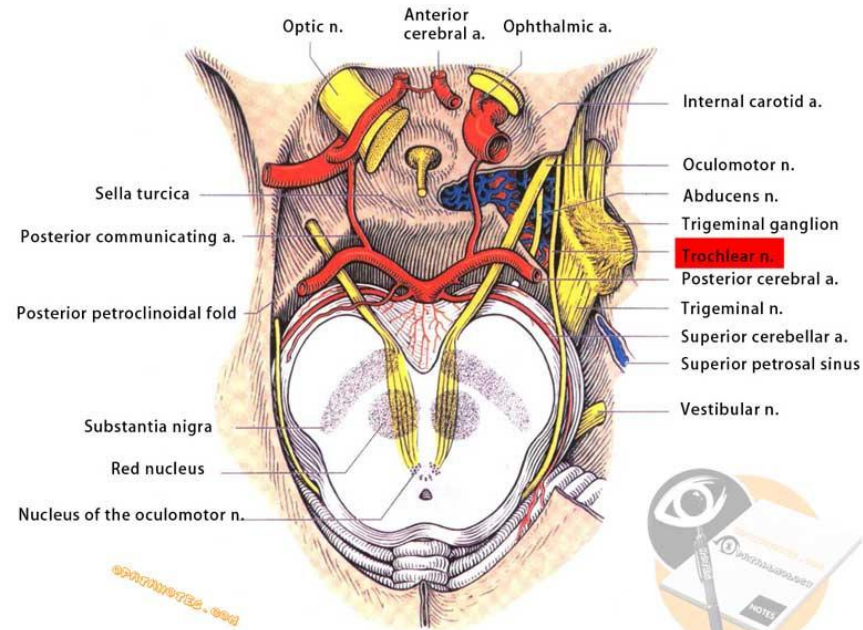
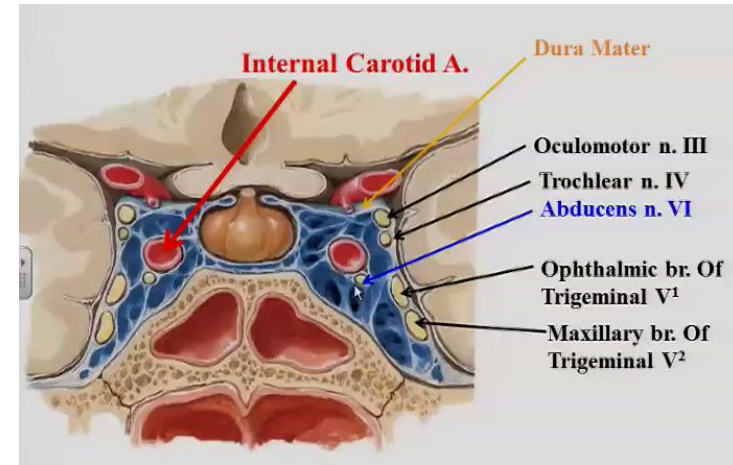


Figure VI-1 Overview of the abducens nerve.

# CAVERNOUS PART

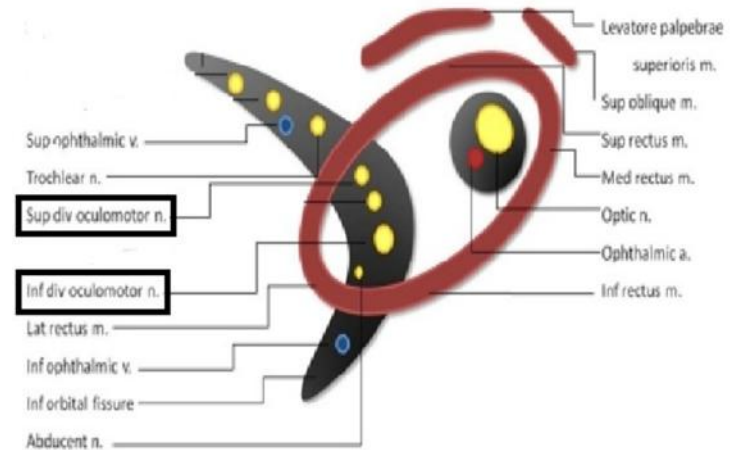
- It runs on the lateral wall of the cavernous sinus.
- Where it is joined by the other two extraocular nerves (Oculomotor - cranial nerve III and Abducent - cranial nerve VI) and,
- The first two branches of the trigeminal nerve (V), Ophthalmic (V1) and Maxillary (V2).
- The internal carotid artery also runs within the cavernous sinus.
- Finally, it enters the orbit through the superior orbital fissure and innervates the superior oblique muscle.



## Orbital segment

- The trochlear nerve enters the orbit through the superior orbital fissure outside the annular ring of Zinn.
- The orbital segment of the trochlear nerve crosses medially over levator palpebrae superioris and superior rectus muscles before entering the belly of superior oblique muscle

## Superior orbital fissure & annular ring of Zinn



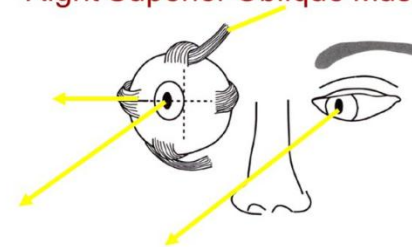
## Function of Superior Oblique Muscle

- When this muscle will contract, back of the eye ball will move upward and front will rotate downward.
- Basically it pushes the eye ball down and outside.



## Superior Oblique Muscle Function

### Right Superior Oblique Muscle

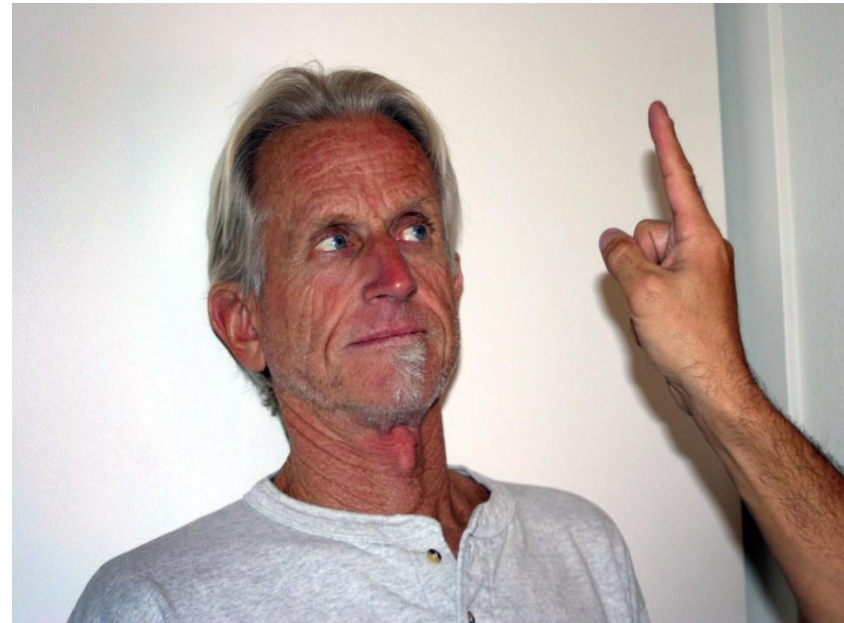


Eye ball directed down and out



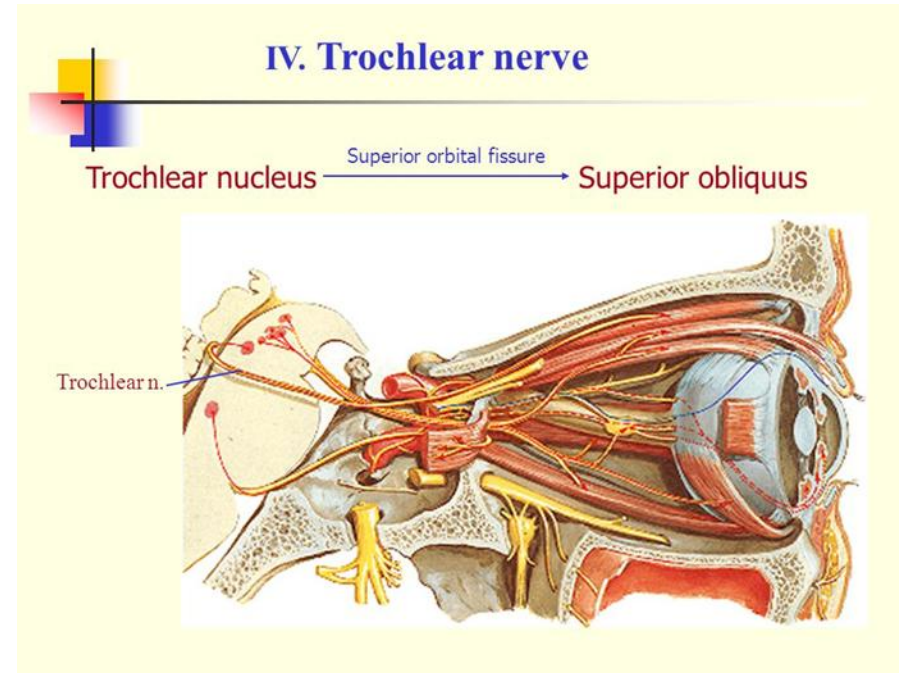
# EXAMINATION OF THE TROCHLEAR NERVE

- The trochlear nerve is examined in conjunction with the Oculomotor and Abducent nerves by testing the movements of the eye.
- The patient is asked to follow a point (commonly the tip of a pen) with their eyes without moving their head.
- The target is moved in an '**H-shape**' and the patient is asked to report any blurring of vision.



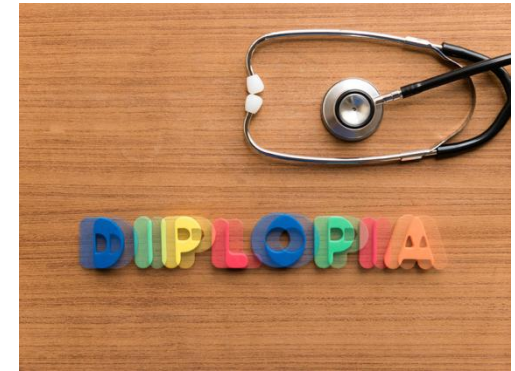
# TROCHLEAR NERVE INJURY

- **Causes of Injury:**
- Congenital (rare).
- Thrombosis in cavernous sinus.
- Aneurysm in internal carotid artery.
- Due to trochlear nerve injury superior oblique muscle will become weak,
- Weakness of depression.
- Weakness of abduction.



# PALSY OF THE TROCHLEAR NERVE

- Trochlear nerve palsy commonly presents with **vertical diplopia**, exacerbated when looking downwards and inwards (such as when reading or walking down the stairs).
- Patients can also develop a head tilt away from the affected side.
- They are commonly caused by **Microvascular damage** from diabetes mellitus or hypertensive disease.
- Other causes include:
  - A. Congenital malformation.
  - B. Thrombophlebitis of the cavernous sinus, and
  - C. Raised intracranial pressure.



Cranial nerve palsy	Exam findings – evidence of incomitance		
	Direction of gaze	Primary position	Direction of gaze
Right 3rd nerve palsy	 Smaller angle of horizontal squint	 Right eye turns downwards and outwards	 Unable to adduct right eye Larger angle of squint Double vision further apart
Right 4th nerve palsy	 No obvious squint	 Right eye turns upwards and outwards	 Right eye elevates more as it moves medially Double vision further apart
Right 6th nerve palsy	 Unable to adduct right eye Larger angle of squint Double vision further apart	 Right eye turns medially	 Able to adduct right eye No obvious squint

Interpretation of incomitance (that is, angle of squint varies with direction of gaze)

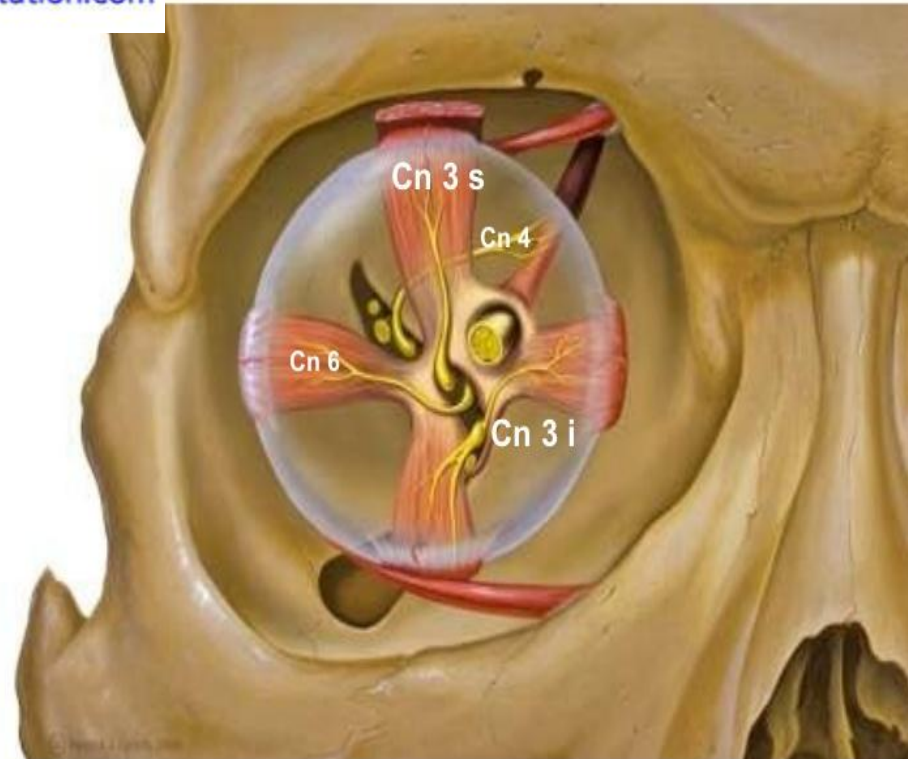
## Extraocular muscles cranial nerve innervation

### LR6-SO4-R3

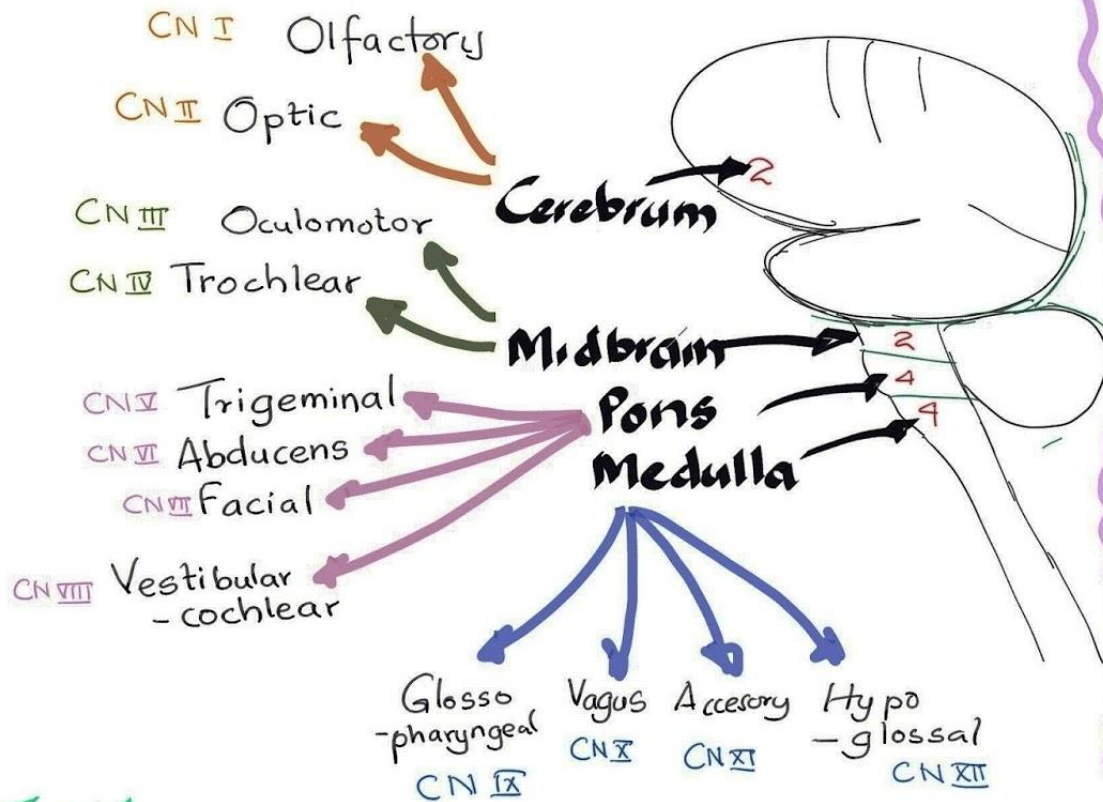
- Lateral Rectus is 6<sup>th</sup> CN
- Superior Oblique is 4<sup>th</sup> CN
- Rest are all 3<sup>rd</sup> CN



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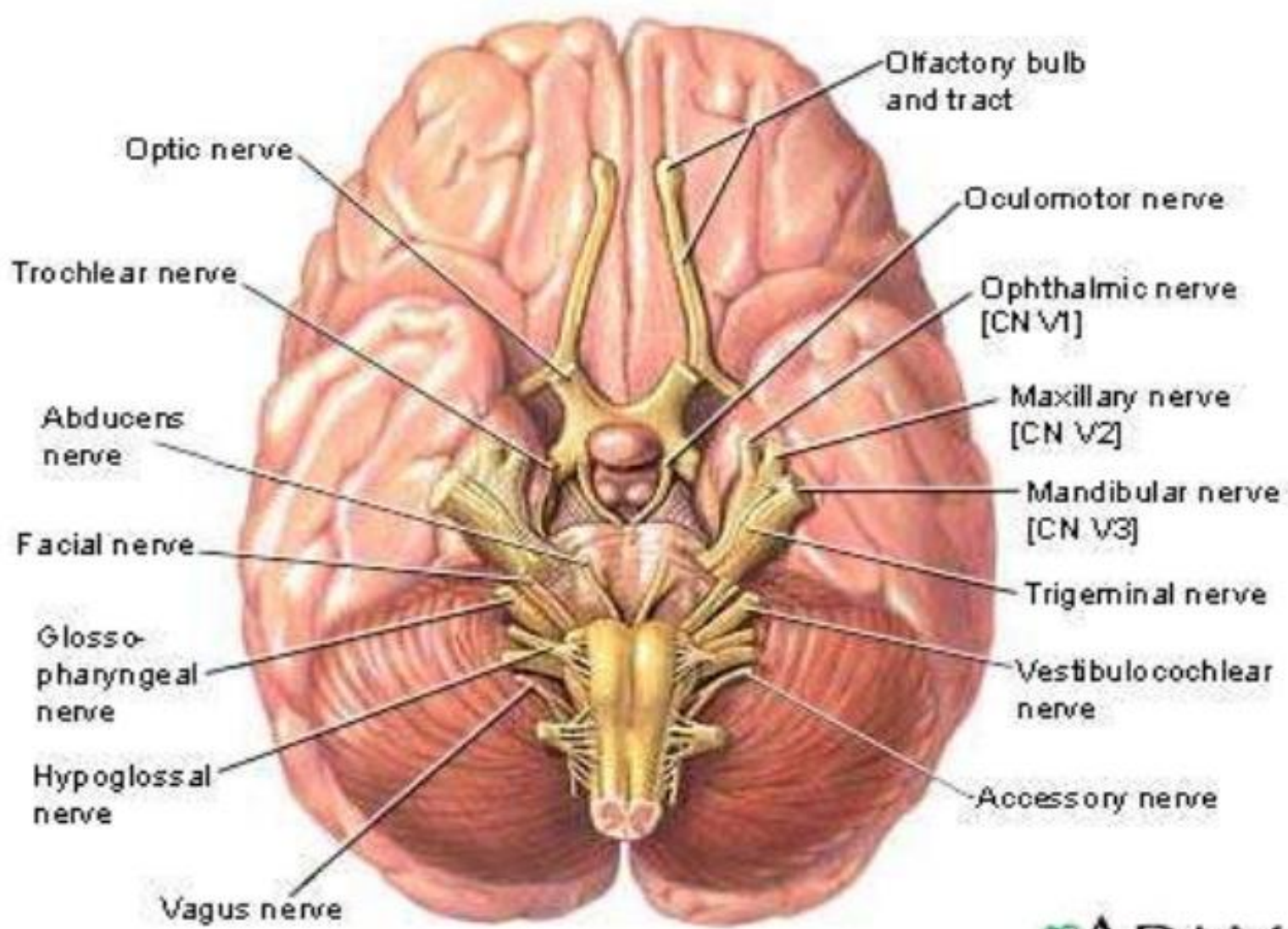


# CRANIAL NERVES EXITS



- CRANIAL NERVE EXITS**
- 2** - Cerebrum
  - 2** - Mid brain
  - 4** - Pons
  - 4** - Medulla

Jay



Thank U....

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To Be continued.....

دنیا کی ٹھوکروں سے اک سبق سیکھا ہے  
ہر مشکل کا حل سجدہ خدا میں چھپا ہے

Falah Ka Rasta