Central Nervous System

Lecture 6: Brain Stem (Internal Structure)

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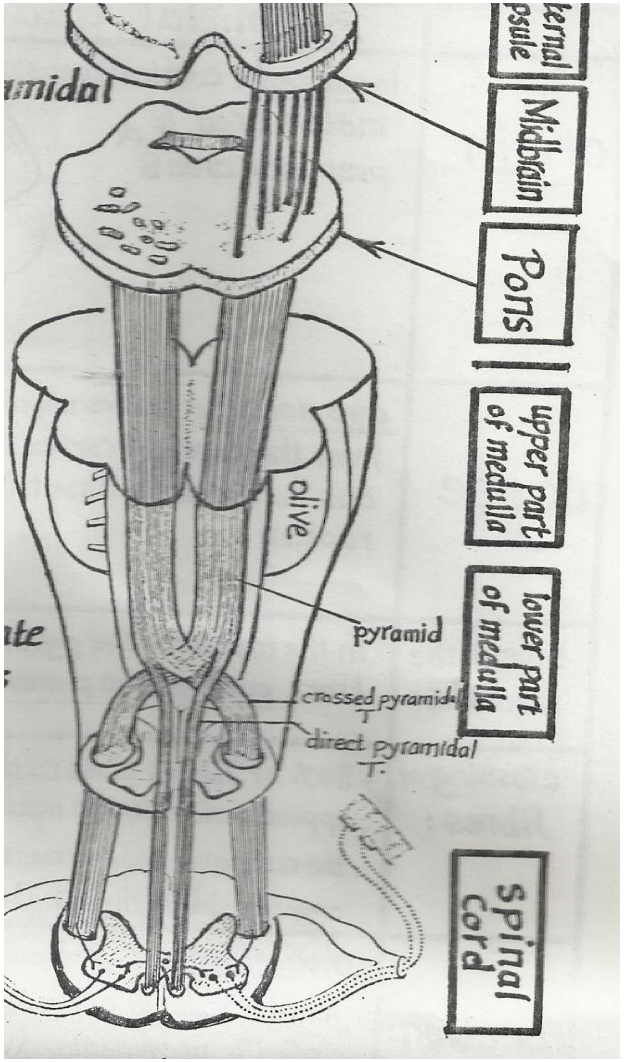
INTERNAL CONTENTS OF BRAIN STEM

A. MEDULLA OBLONGATA

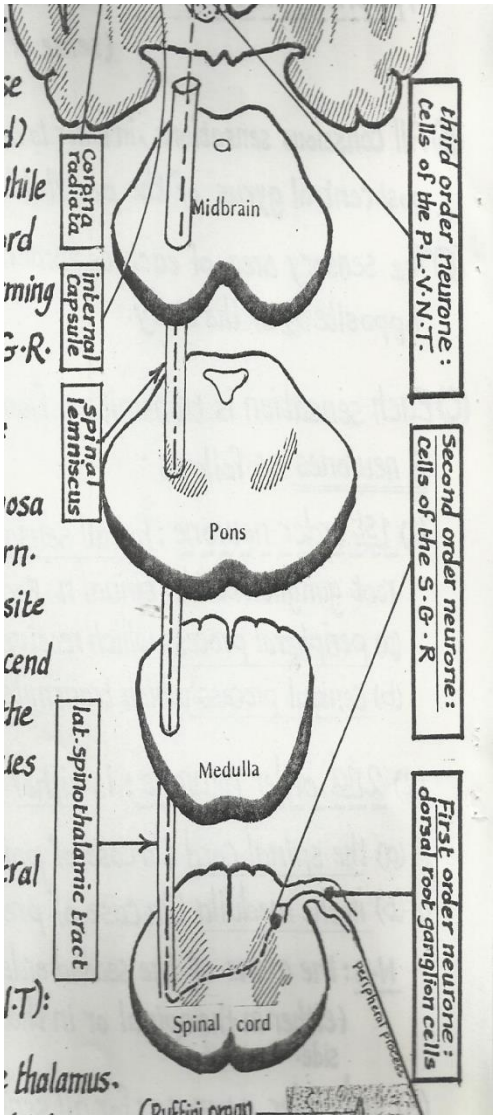
1. White matter: which includes:

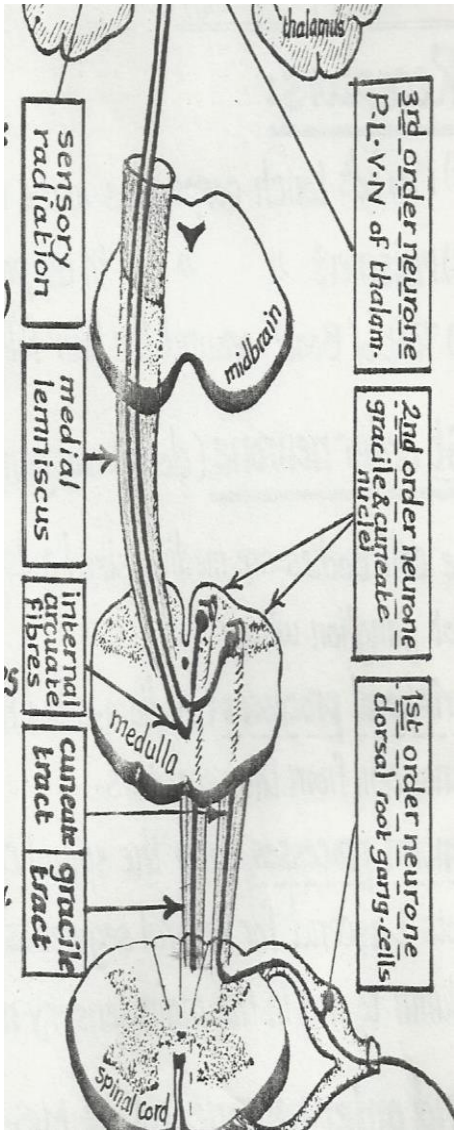
** Longitudinal fibers:

* Descending tracts: The pyramidal tract fibers collect into the pyramid in the open medulla then 80% of fibers cross in the motor decussation in the lower level of the closed medulla to form the lateral cortico-spinal tract.



* **Ascending tracts:**
* **The lateral spinothalamic tract & the ventral spinothalamic tract join to form the spinal lemniscus.**
* **Association tract: MLB**
** **Horizontal fibers:**
* **Decussations: motor & sensory decussations in medulla.**
* **Arcuate fibers: internal, ventral external & dorsal external.**





2. Grey matter: which includes:

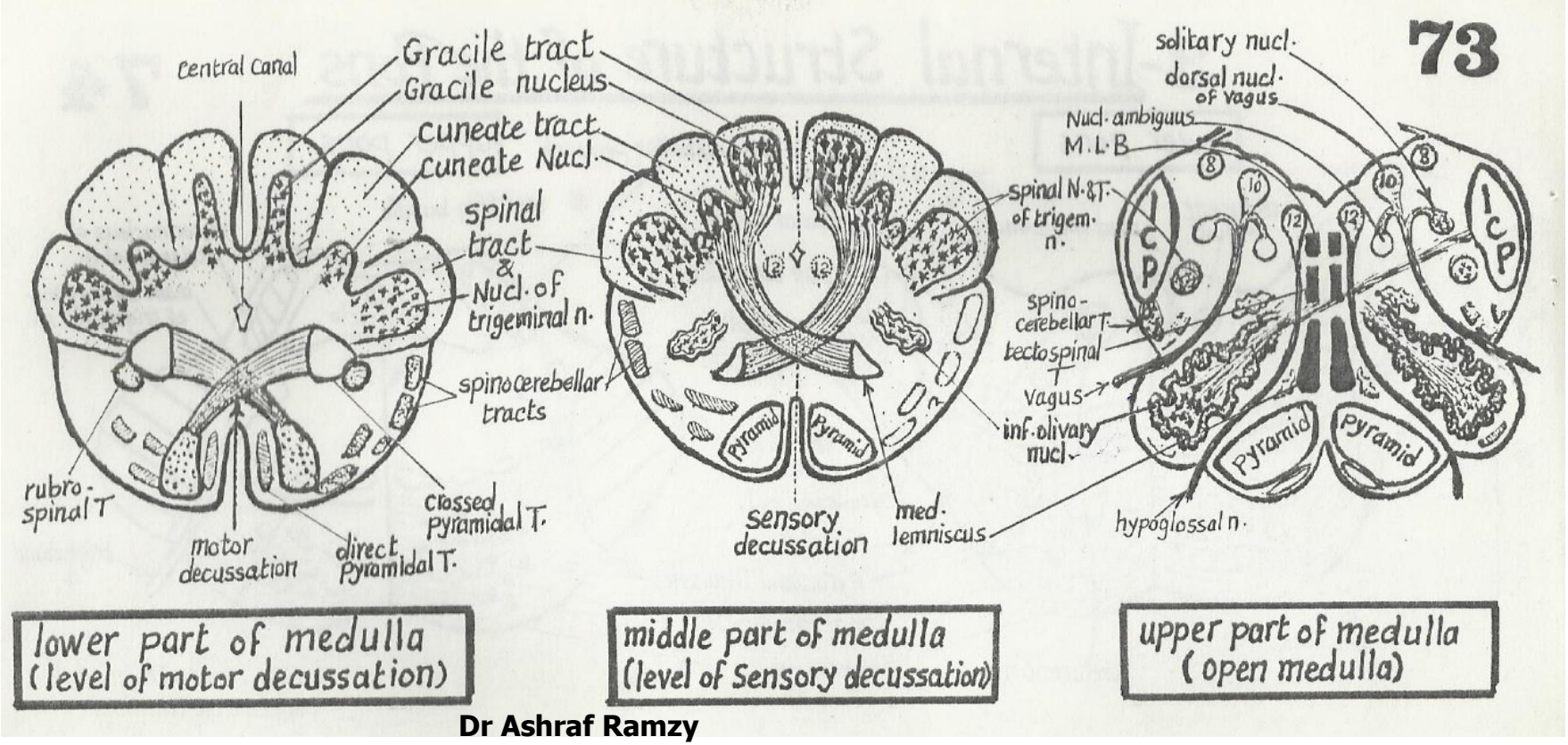
**** Cranial nerve nuclei:**

*** Nuclei of the lower 4 cranial nerves (IX, X, XI & XII).**

*** Descending nuclei from pons → spinal nucleus of trigeminal & some vestibular nuclei.**

**** Other nuclei: olivary nuclei, gracile & cuneate nuclei.**

3. Reticular formation.



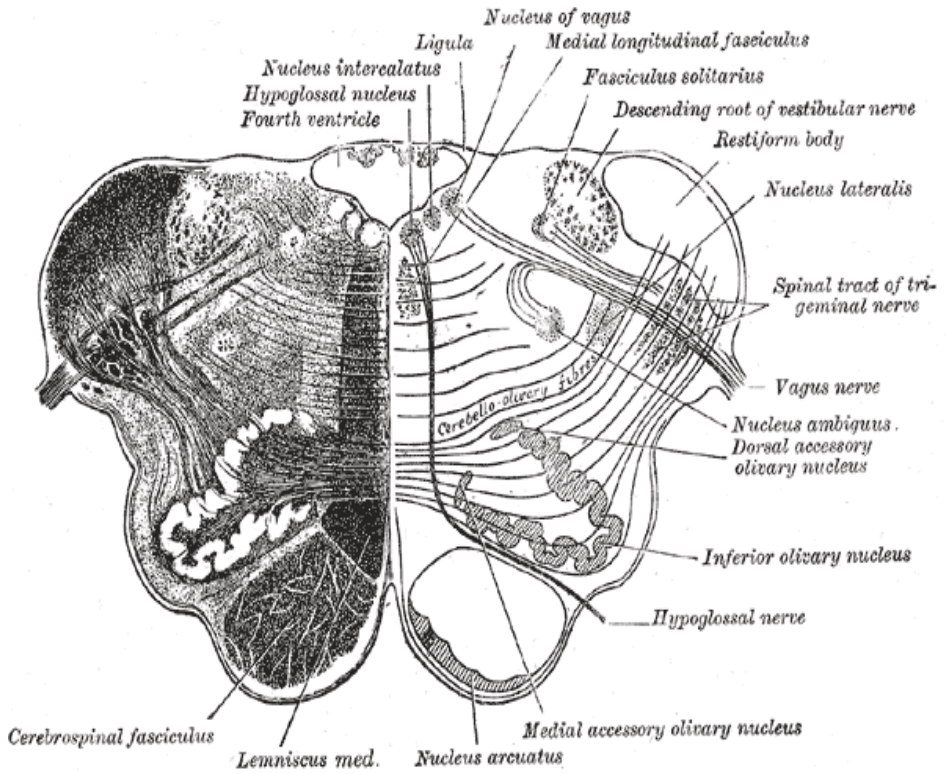
OLIVARY NUCLEI

** Four in number: inferior, superior, dorsal accessory & medial accessory olives.

1. The inferior olive:

* Is the largest.

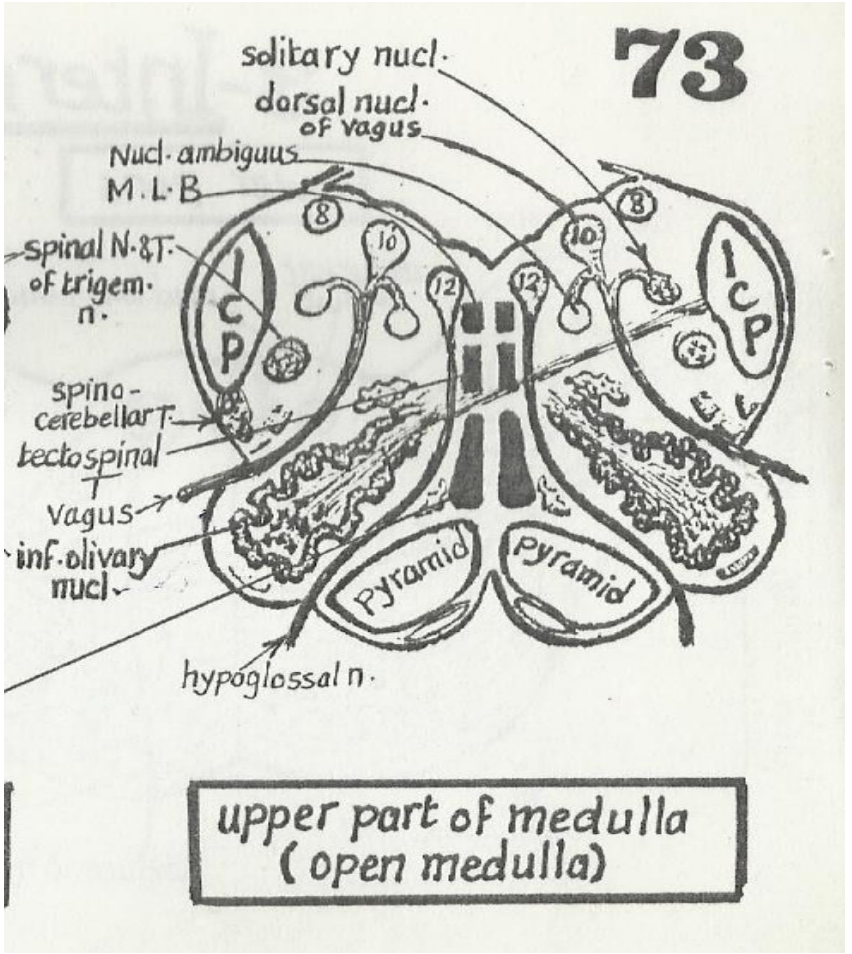
* It lies in the open medulla, lateral to the pyramid & appears corrugated with its hilus (where the fibers enter & leave) facing dorso-medially.



** Function:

1. **Relays proprioception to cerebellum:** receives proprioception via the **spino-olivary tract** & sends **olivo-cerebellar fibers** that cross & pass via the ICP.
2. **Relays newly performed motor information to the cerebellum (involved in motor learning):** receives cortico-olivary, rubro-olivary & spino-olivary inputs & sends **olivo-cerebellar output** to the cerebellum.

2 & 3. The dorsal & medial accessory olives: Lie posterior & medial to the inferior olive, close to its hilus. Both send proprioceptive fibers to the cerebellum (called parolivo-cerebellar fibers) via the ICP.

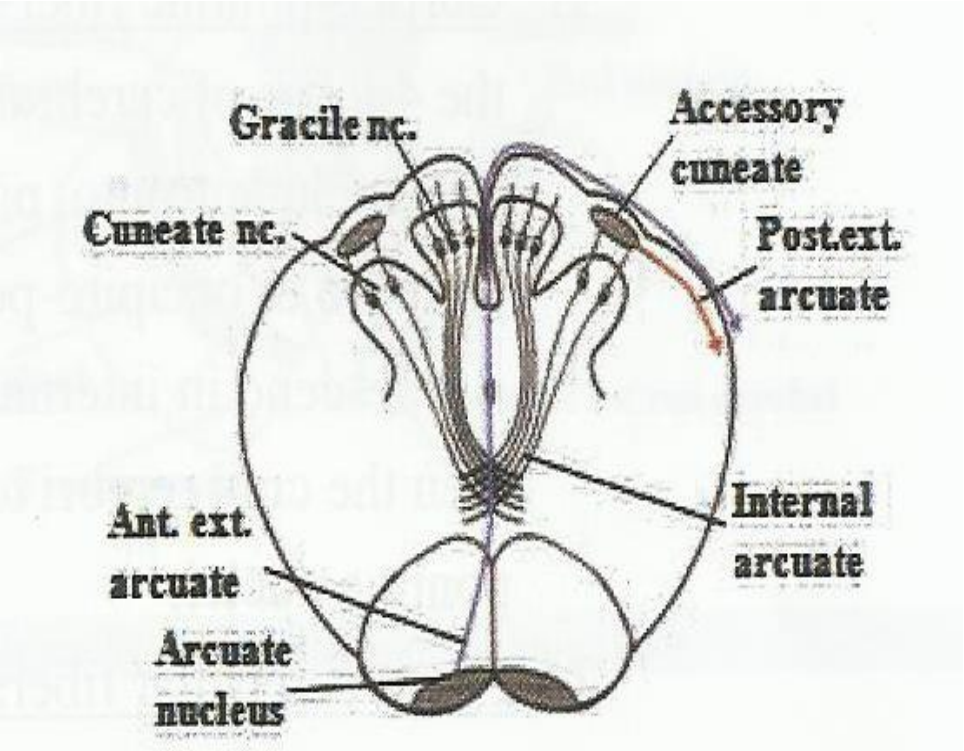


4. The superior olive: lies in the pons & forms part of the auditory pathway.

ARCUATE FIBERS

A. INTERNAL:

1. **Axons of the gracile & cuneate nuclei:** They cross to the opposite side around the central grey forming the sensory decussation, then ascend as the medial lemniscus.
2. **Axons of the inferior olivary nucleus:** They pass via the ICP to the contralateral cerebellum.

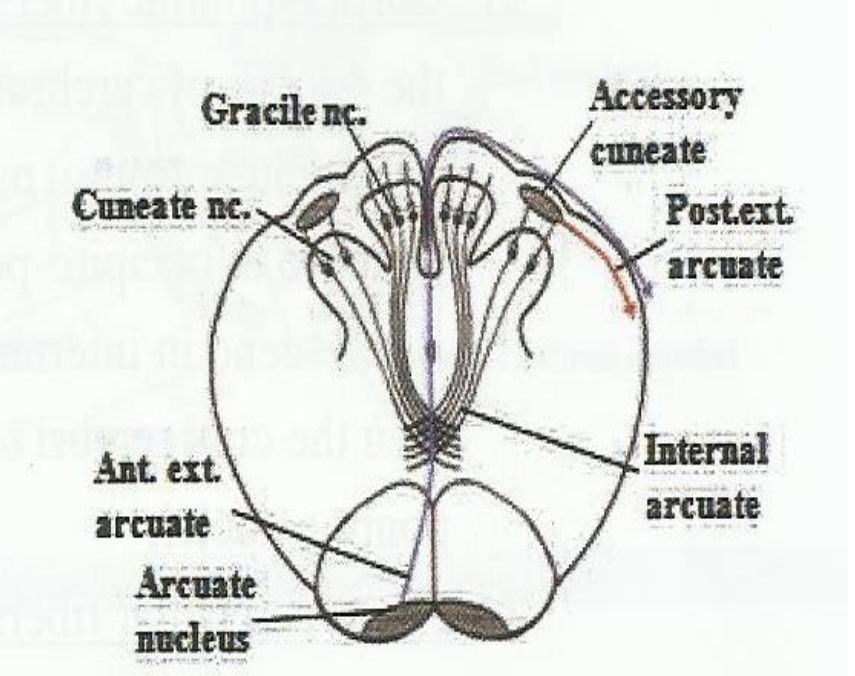


B. EXTERNAL:

1. Posterior:

** Axons of the accessory cuneate nucleus (which lies posterior to the cuneate nucleus & receives proprioceptive impulses from the upper limb).

** They pass via the ICP to the ipsilateral cerebellum.



2. Anterior:

** Axons of the arcuate nucleus (which lies anterior to the pyramid & is considered as over-descended pontine nuclei).

** They pass via the ICP to the ipsilateral cerebellum.

** They form a circumolivary bundle around the olive & the medullary stria in the floor of 4th ventricle.

B. PONS

** The pons is divided into an anterior part (basis pontis) & a posterior part (tegmentum).

I. THE BASIS PONTIS: is similar in all levels & contains:

1. Descending pyramidal fibers: collect into separate bundles that include:

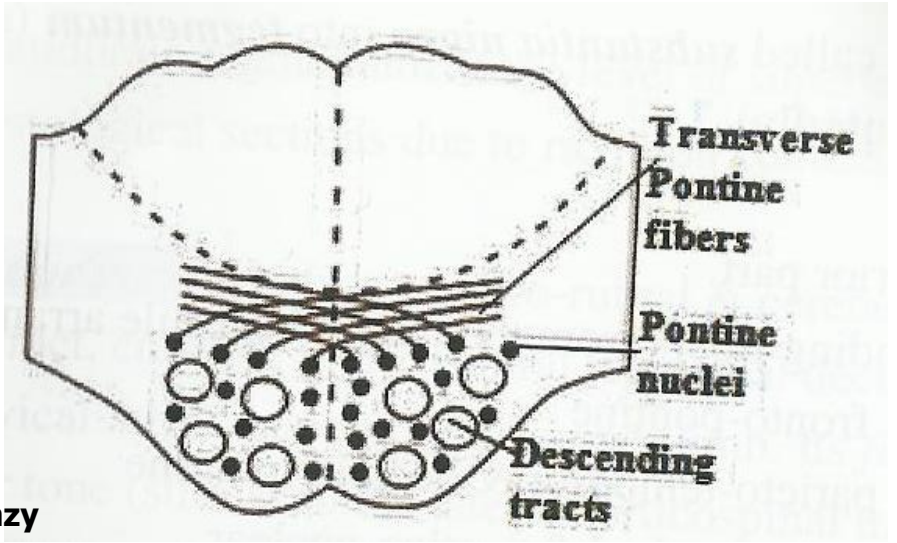
a- Cortico-spinal fibers to the AHCs.

b- Cortico-nuclear (bulbar) fibers to the cranial nerve nuclei.

c- Cortico-pontine fibers to the pontine nuclei.

2. Pontine nuclei.

3. Transverse pontine fibers: are the axons of the pontine nuclei. They pass to the MCP of the opposite side & to a little extent of the same side.

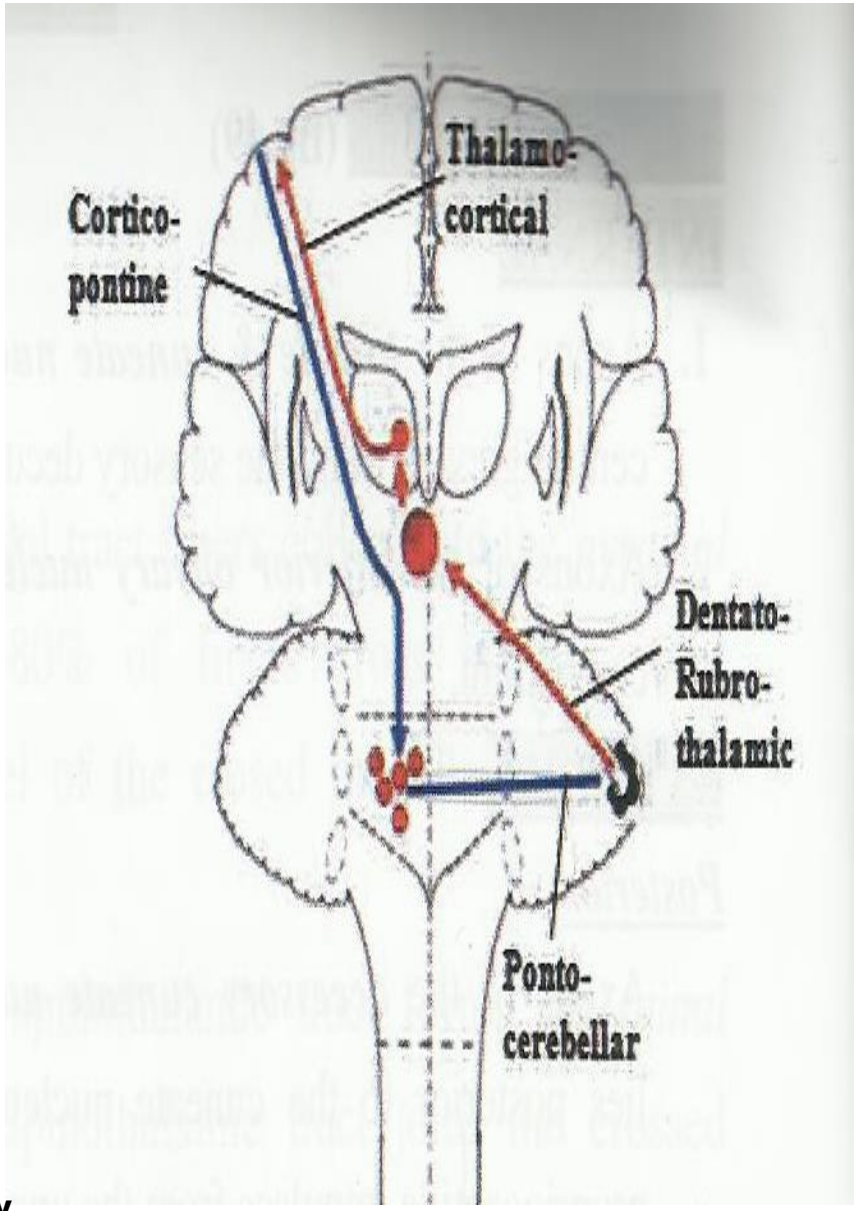


CORTICO-PONTO-CEREBELLAR PATHWAY

** The neocerebellum [responsible for coordination of voluntary movements] is connected to the contralateral cerebral cortex by a feedback circuit formed of 2 parts:

A. Afferent Part [cortico-ponto-cerebellar pathway]: includes:

1. Cortico-pontine fibers: arise from the 4 lobes of cerebral cortex & thus include fronto, parieto, temporo & occipito-pontine fibers. All descend in internal capsule, then the crus cerebri (ventral part of midbrain) to end on the pontine nuclei.

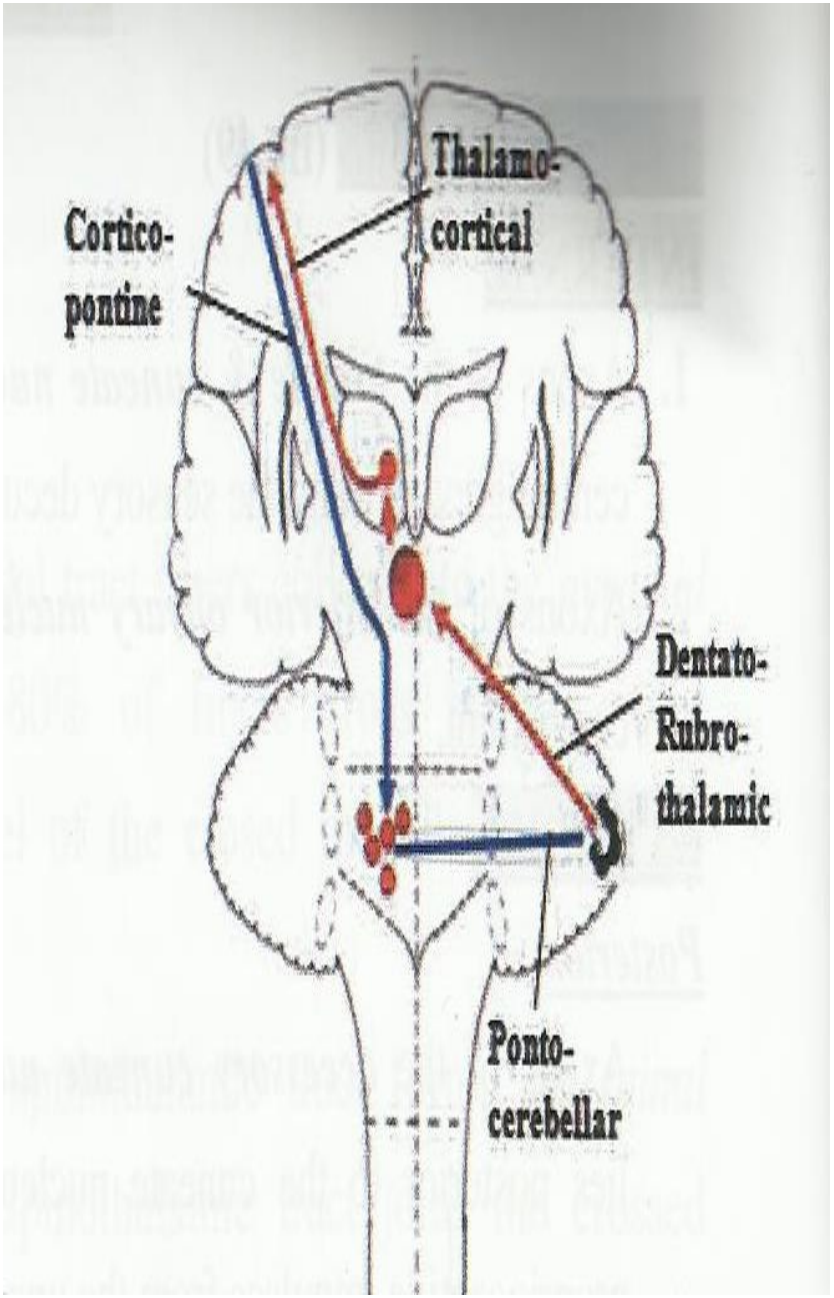


2. Ponto-cerebellar fibers: the axons of the pontine nuclei form the transverse pontine fibers which pass via the MCP to the contralateral cerebellum & to a little extent the ipsilateral.

B. Efferent Part [dentato-rubro-thalamo-cortical pathway]: includes:

1. Dentato-thalamic fibers: Arise from the dentate nucleus of cerebellum & pass via the SCP, decussate & end on the lateral anterior nucleus of thalamus either directly or after relaying on the red nucleus.

2. Thalamo-cortical fibers: projects to the cerebral cortex.



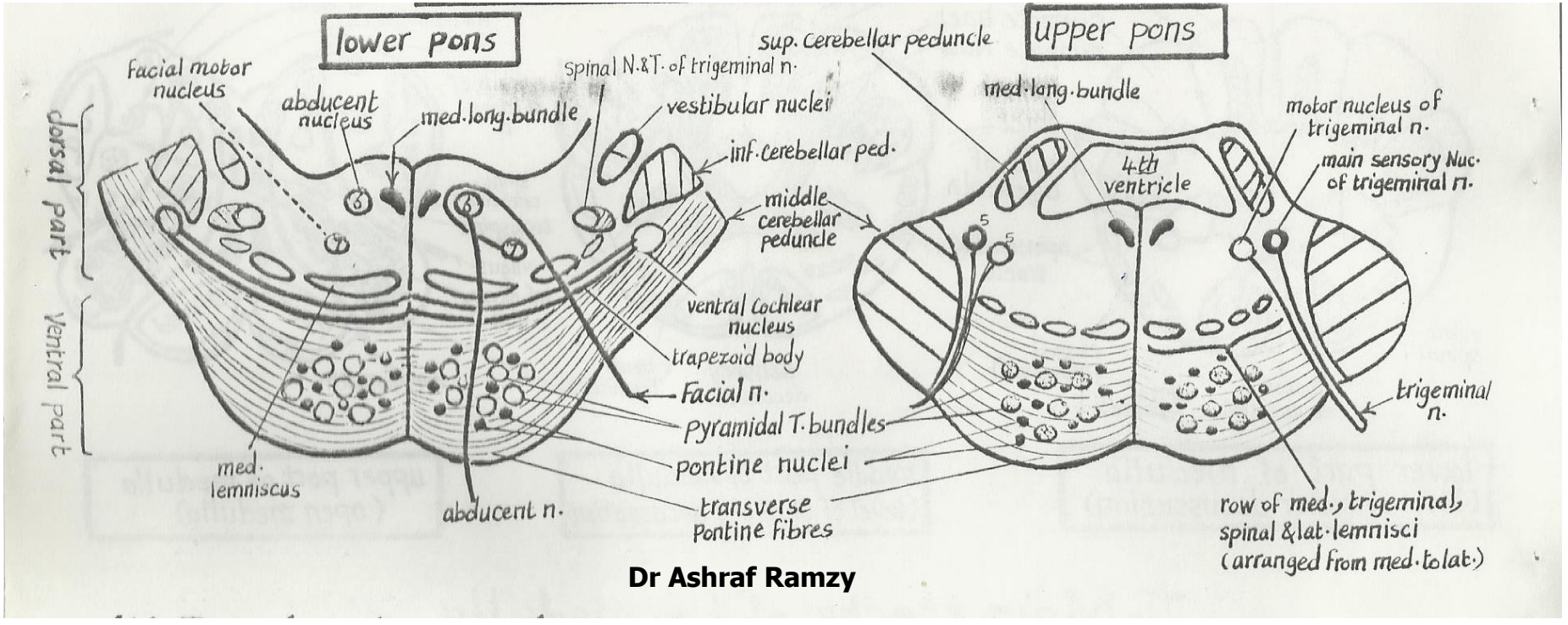
II. THE TEGMENTUM: contains:

1. White matter: including:

* Vertical fibers (MLB & ascending lemnisci: in addition to the spinal & medial lemnisci, 2 more lemnisci are added; lateral & trigeminal).
* Horizontal fibers (trapezoid body which is a part of the auditory pathway).

2. Grey matter: nuclei of the middle 4 cranial nerves + superior olive.

3. Reticular formation.



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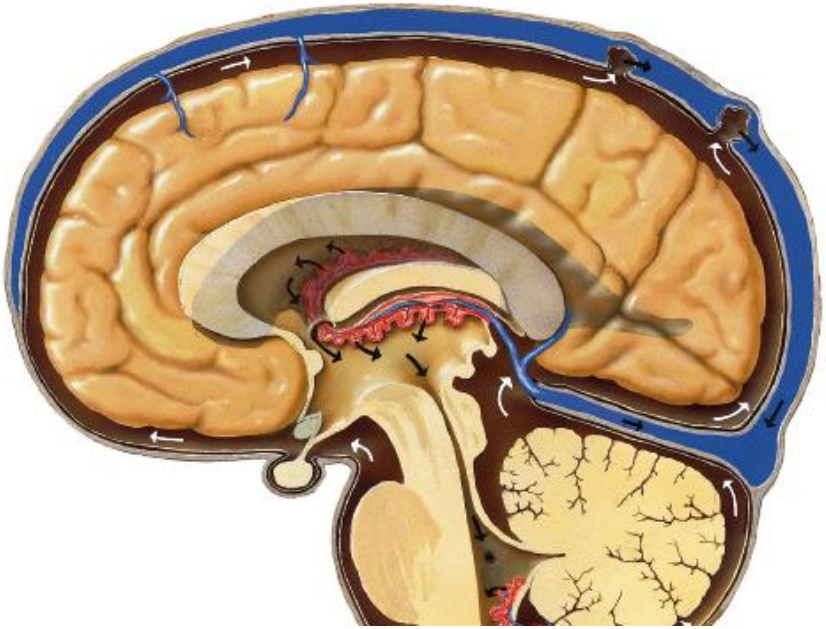
C. MIDBRAIN

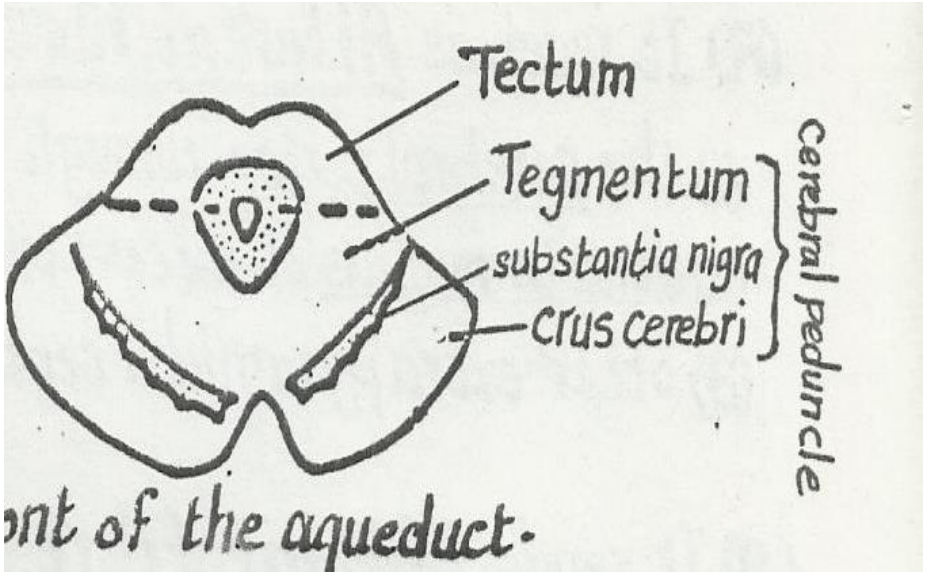
** <u>It is traversed by the cerebral aqueduct of Sylvius which divides it into</u>:

1. Tectum (dorsally).
2. 2 cerebral peduncles (ventrally).

** <u>Each cerebral peduncle is divided by a pigmented sheet of grey matter called substantia nigra into</u>:

1. Tegmentum (dorsally).
2. Crus cerebri or basis pedunculi (ventrally).





1. Crus cerebri:

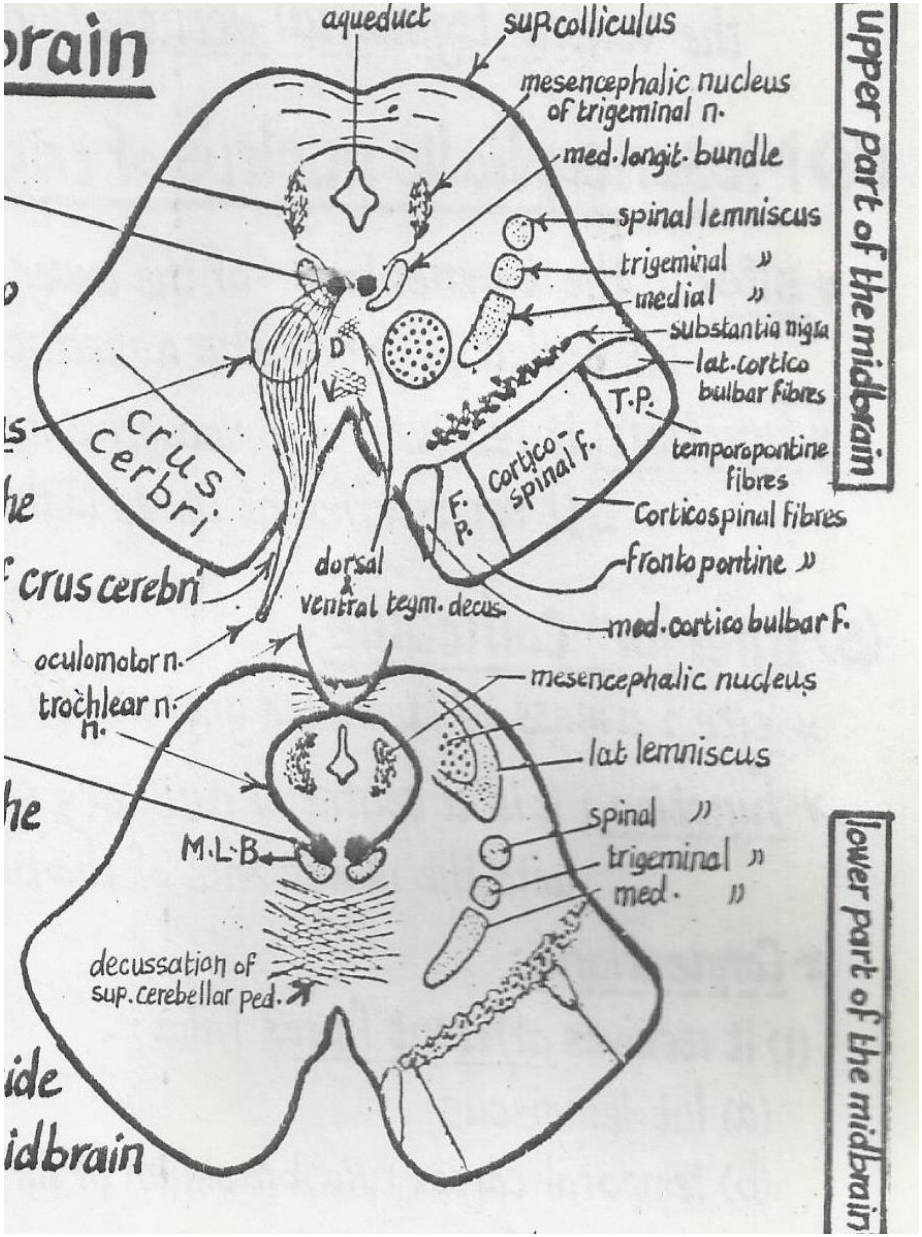
** Is the most anterior part.

** Contains descending fibers from the internal capsule arranged as follows:

* medial 1/5: fronto-pontine.

* lateral 1/5: parieto-temporo- & occipito pontine.

* middle 3/5: cortico-spinal & cortico-nuclear.



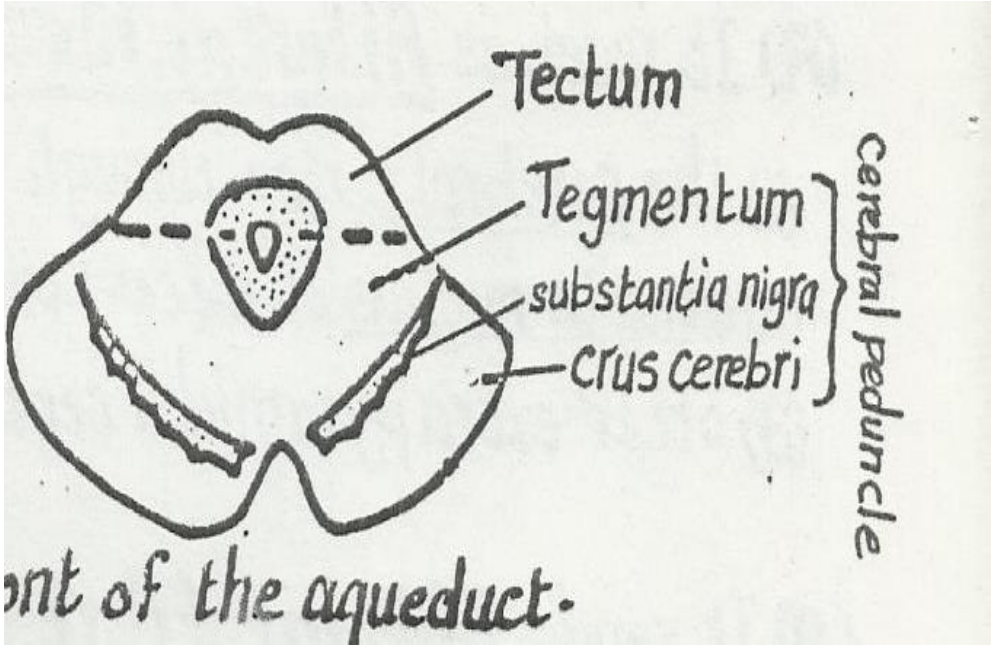
2. Substantia nigra:

** A pigmented sheet of grey matter between the crus cerebri and tegmentum.

** It is formed of neurons containing melanin pigment.

** It is connected to the corpus striatum by dopaminergic fibers;

their lesion leads to Parkinsonism.



3. Tegmentum:

** Continuous below with the tegmentum of pons & above with subthalamus.

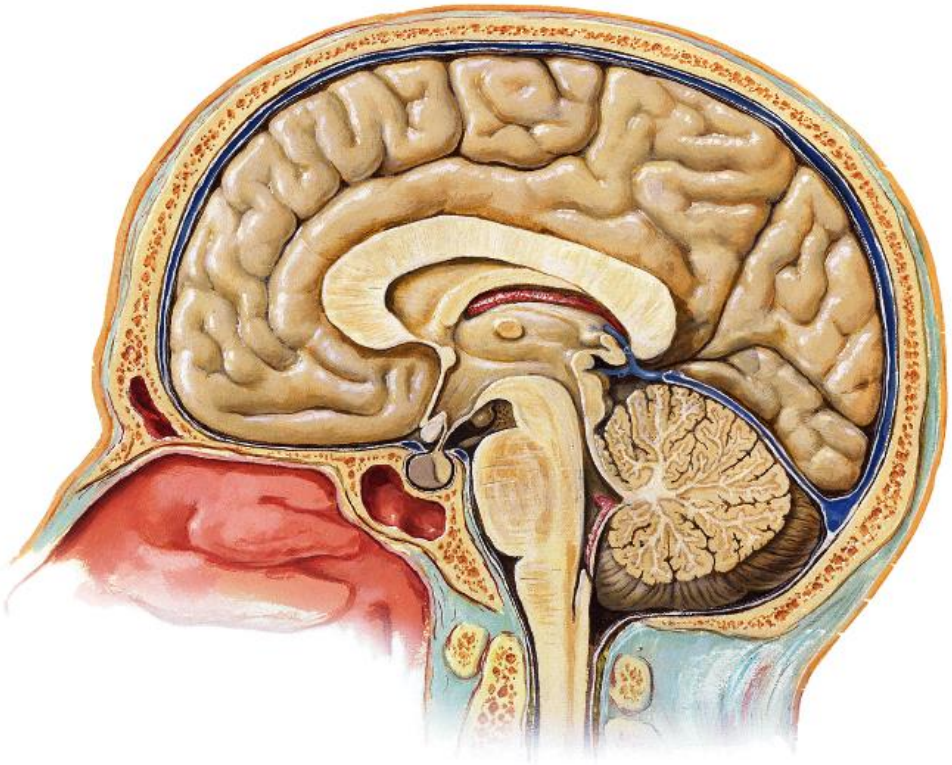
** Contains:

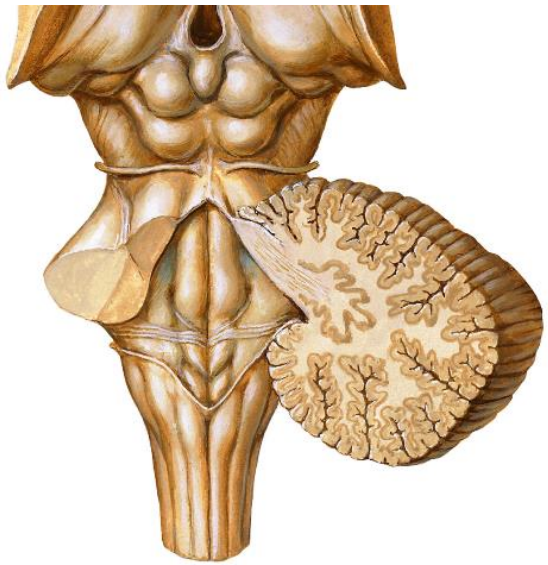
A. White matter:

@ Longitudinal fibers:

* 4 lemnisci (lateral, spinal, trigeminal & medial): present in the lower level of midbrain, but the lateral lemniscus ends in the inferior colliculus, thus is not seen in the upper level.

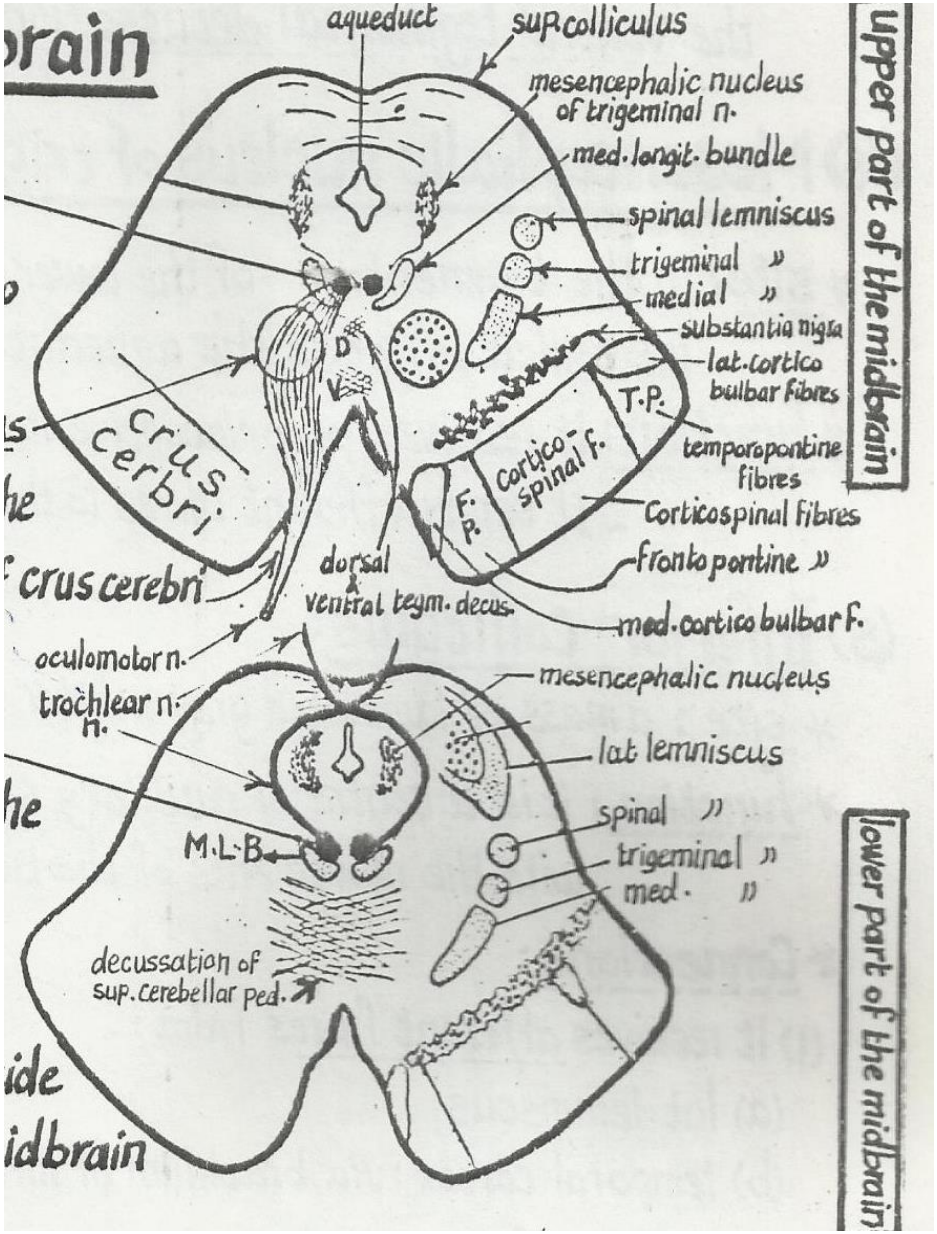
* MLB.





@ 4 Decussations:

* **2 at the level of inferior colliculus: decussation of superior cerebellar peduncle (dentato-thalamic fibers) & decussation of trochlear N.**
* **2 at the level of superior colliculus: ventral tegmental decussation (rubro-spinal tract) & dorsal tegmental decussation (tecto-spinal tract).**

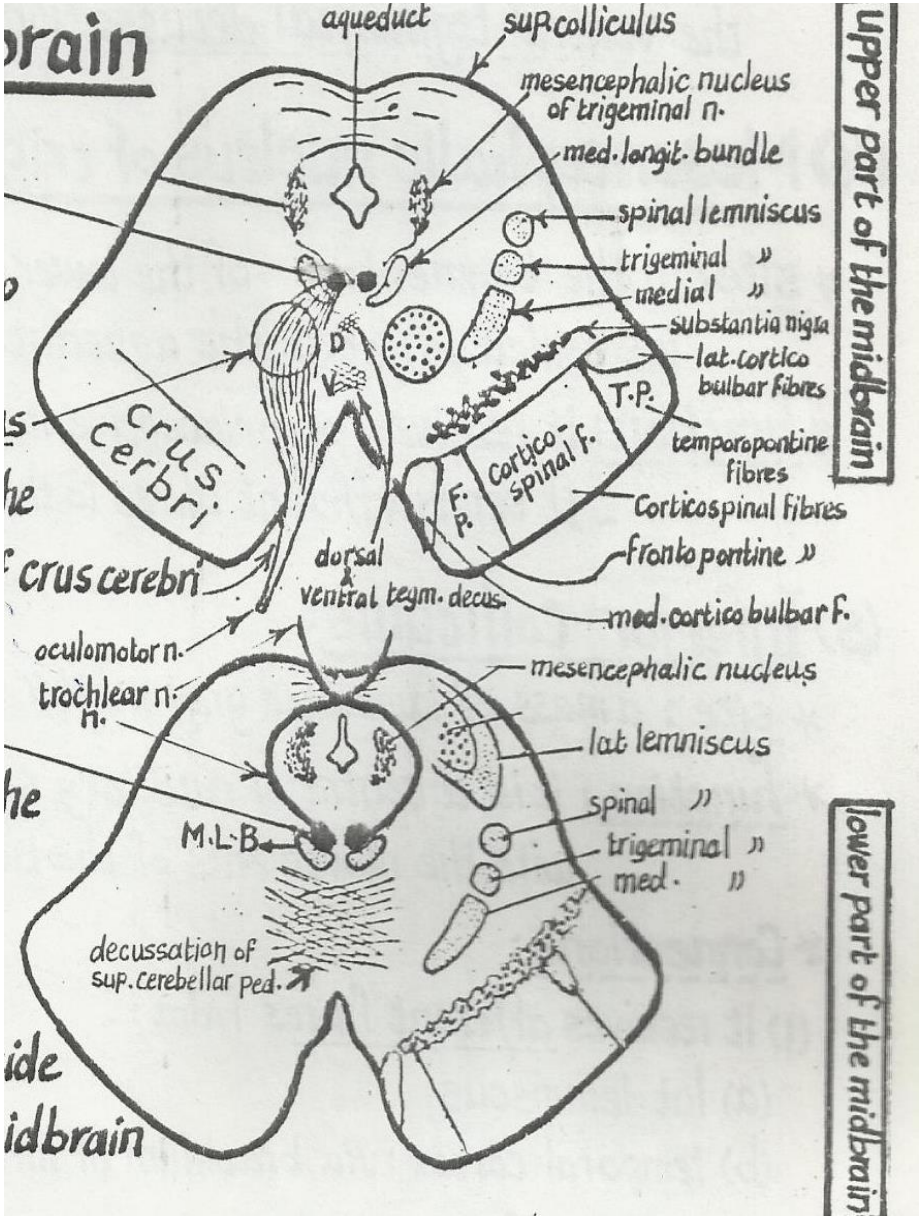


B. Grey matter:

@ 3 Cranial nerve nuclei:

1. Oculomotor nucleus (at level of superior colliculus).
2. Trochlear nucleus (at level of inferior colliculus).
3. Mesencephalic nucleus of Trigeminal (extending upwards from the pons to both levels).

@ 2 Other nuclei at level of superior colliculus: red nucleus & pretectal nucleus (concerned with light reflex)



Red Nucleus

** A large nucleus in the midbrain tegmentum at the level of superior colliculus.

** Appears red in fresh histological sections due to rich iron content.

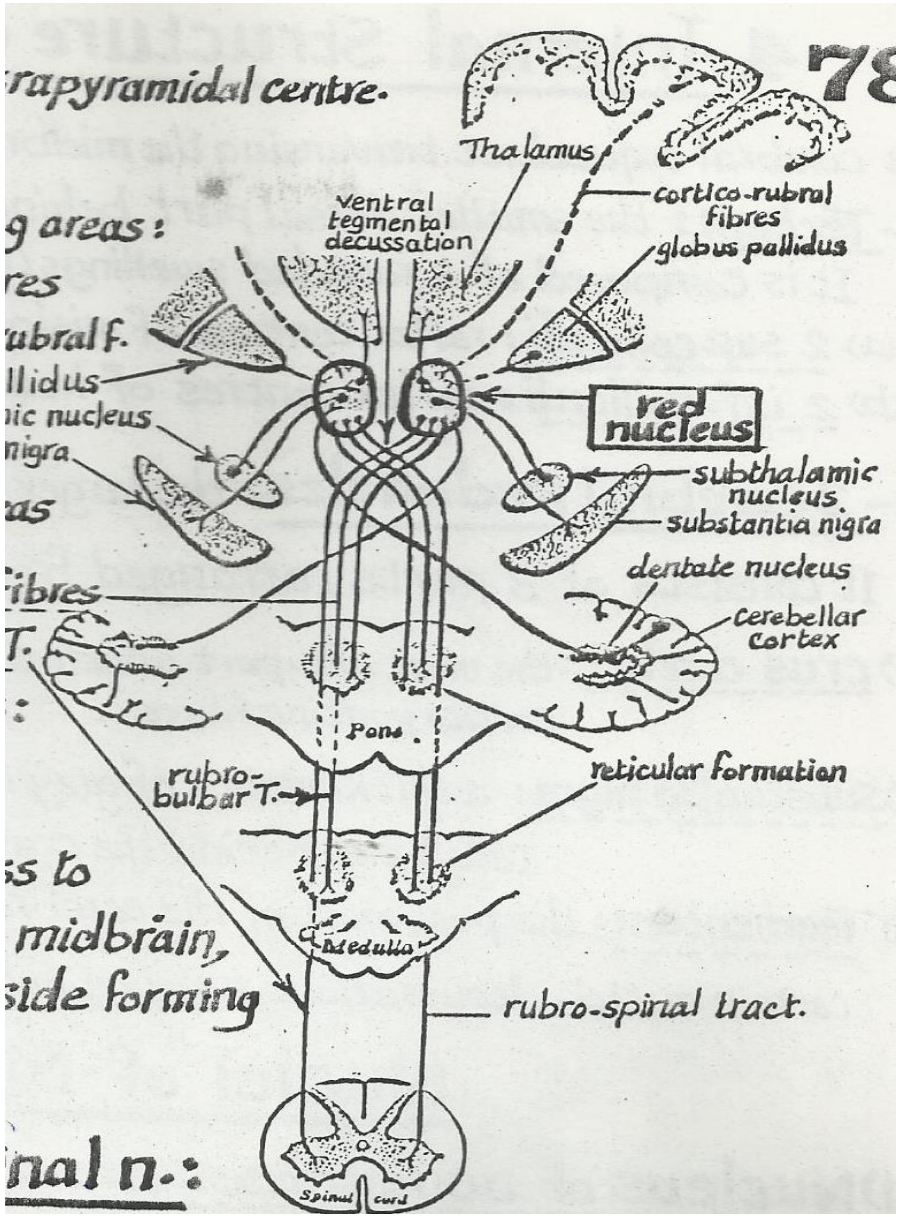
** Has 2 parts:

1. Caudal magnocellular part:

** Receives cerebro-rubral & cerebello-rubral fibers.

** Sends rubro-spinal tract, crossing in the ventral tegmental decussation, to the lateral group of cervical AHCs supplying the upper limb.

** Its function is facilitation of flexor tone (similar to the lateral corticospinal tract). May account for recovery of movement after lesion of the latter tract especially in monkeys.



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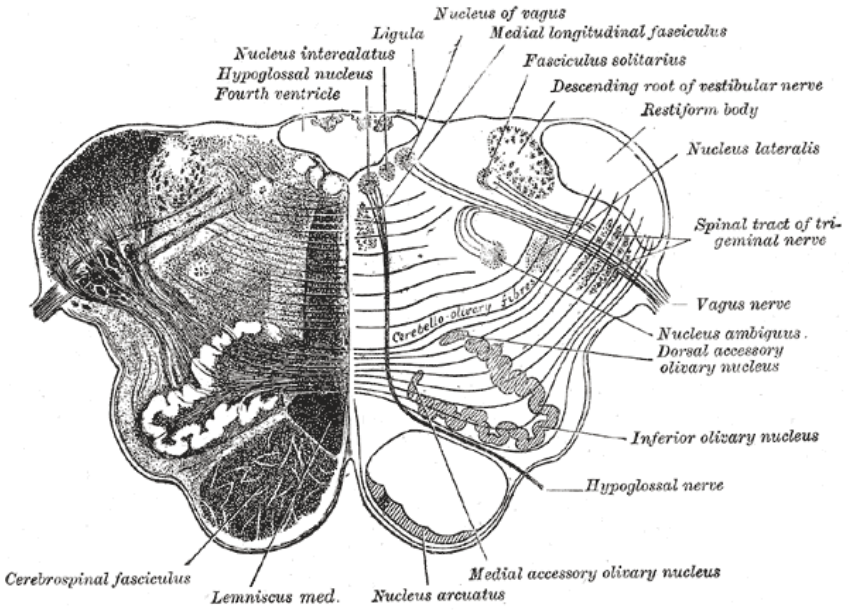
2. Cranial parvocellular part:

** connects the motor cortex with the cerebellum via the inferior olive.

** Function: motor learning



4. Tectum:

A. Inferior colliculus:

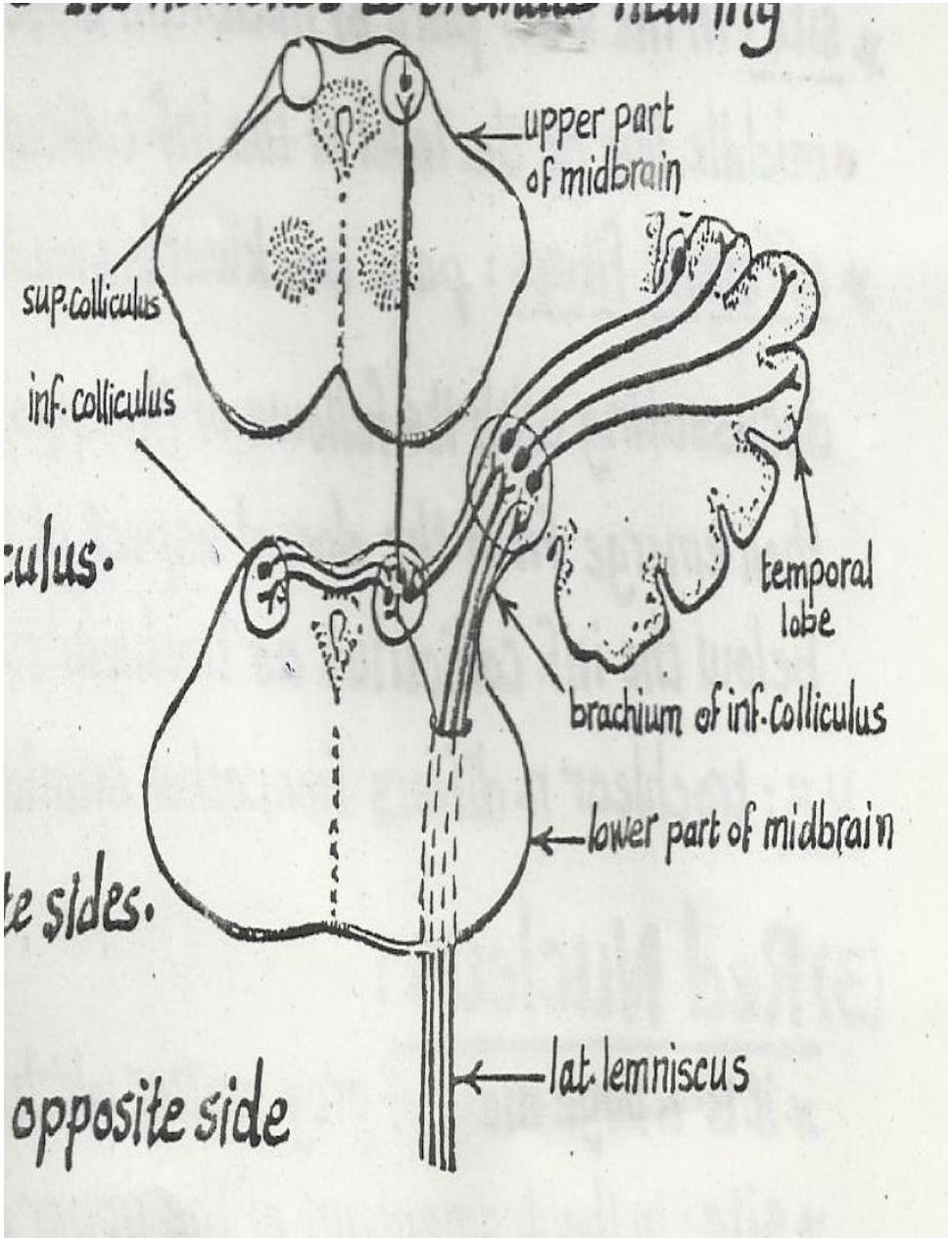
** **Structure:** a central nucleus surrounded by fibers of lateral lemniscus.

** **Function:** relays auditory pathway & auditory reflexes

** **Afferents:** lateral lemniscus

** **Efferents:**

1. **Medial geniculate body (MGB):** which projects to auditory cortex.
2. **Superior colliculus:** for reflex turning of neck & eyes via the tectospinal & tectonuclear tracts.



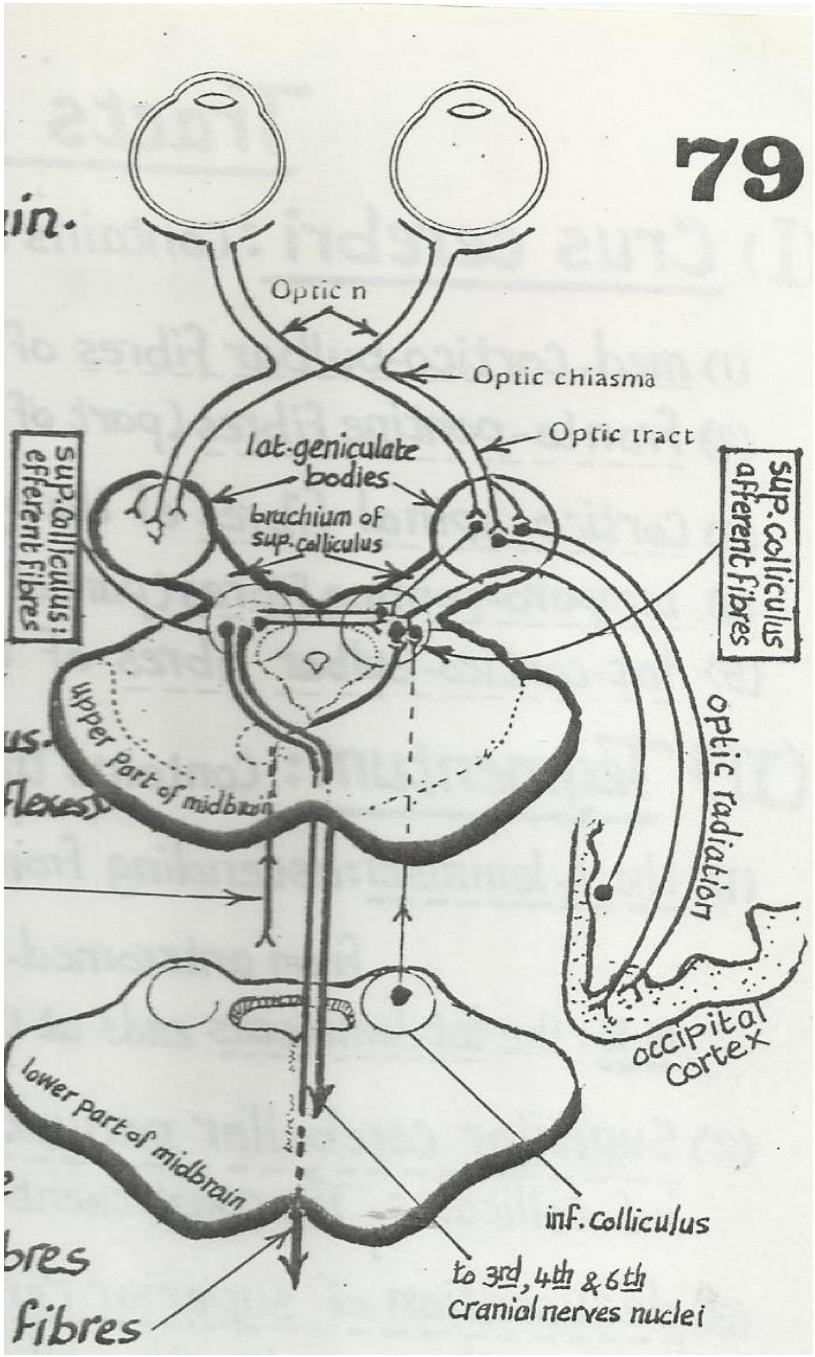
B. Superior colliculus:

** **Structure:** alternating laminae of grey & white matters.

** **Function:** reflex turning of eyes & neck in response to visual, auditory & cutaneous stimuli.

** **Afferents:** LGB (vision), inferior colliculus (auditory) & spinotectal tract (cutaneous).

** **Efferents:** tectospinal & tectonuclear (to III, IV, VI) both cross in the dorsal tegmental decussation.



LEMNISCI

** They are collections of ascending fibers in the brain stem.

** Each starts below at a decussation and ends above in the thalamus.

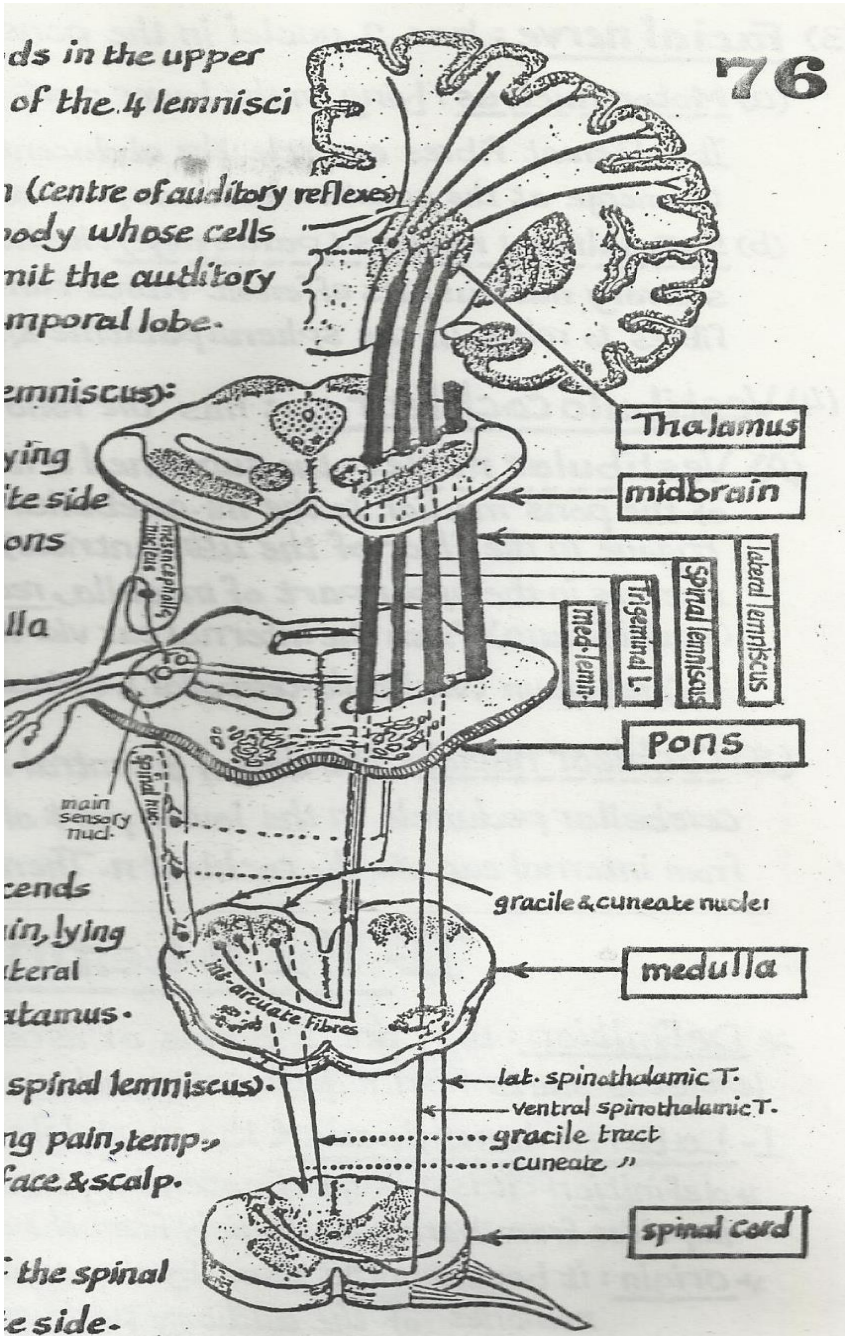
1. Medial lemniscus:

** It carries:

i. proprioception (senses of position, movement & vibration).

ii. fine touch (tactile discrimination, tactile localization& stereognosis).

** It starts by axons of gracile and cuneate nuclei of medulla oblongata which cross after forming the internal arcuate fibers then ascend in medulla oblongata, pons & midbrain close to the median plane. It ends by relaying in VPLN of thalamus.



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2. Spinal lemniscus:

** It carries:

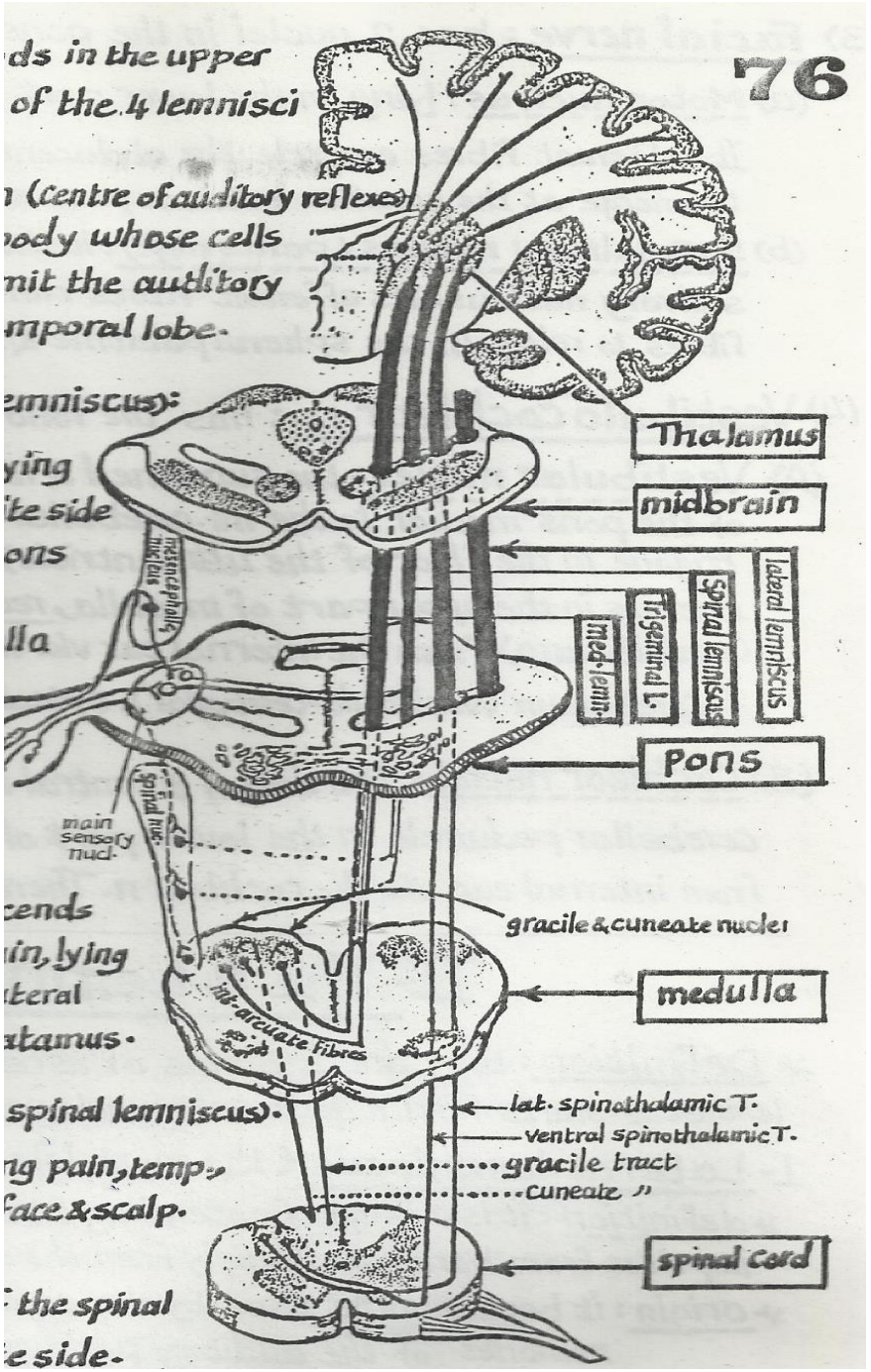
i. pain and temperature sensations from opposite side of the body.

ii. crude touch from opposite side of the body.

** Axons of laminae I,II,II & IV-VIII of grey matter of spinal cord cross the midline and ascend as the lateral & ventral spinothalamic tracts.

** They get close to other ascending tracts as they ascend in medulla oblongata to form the spinal lemniscus.

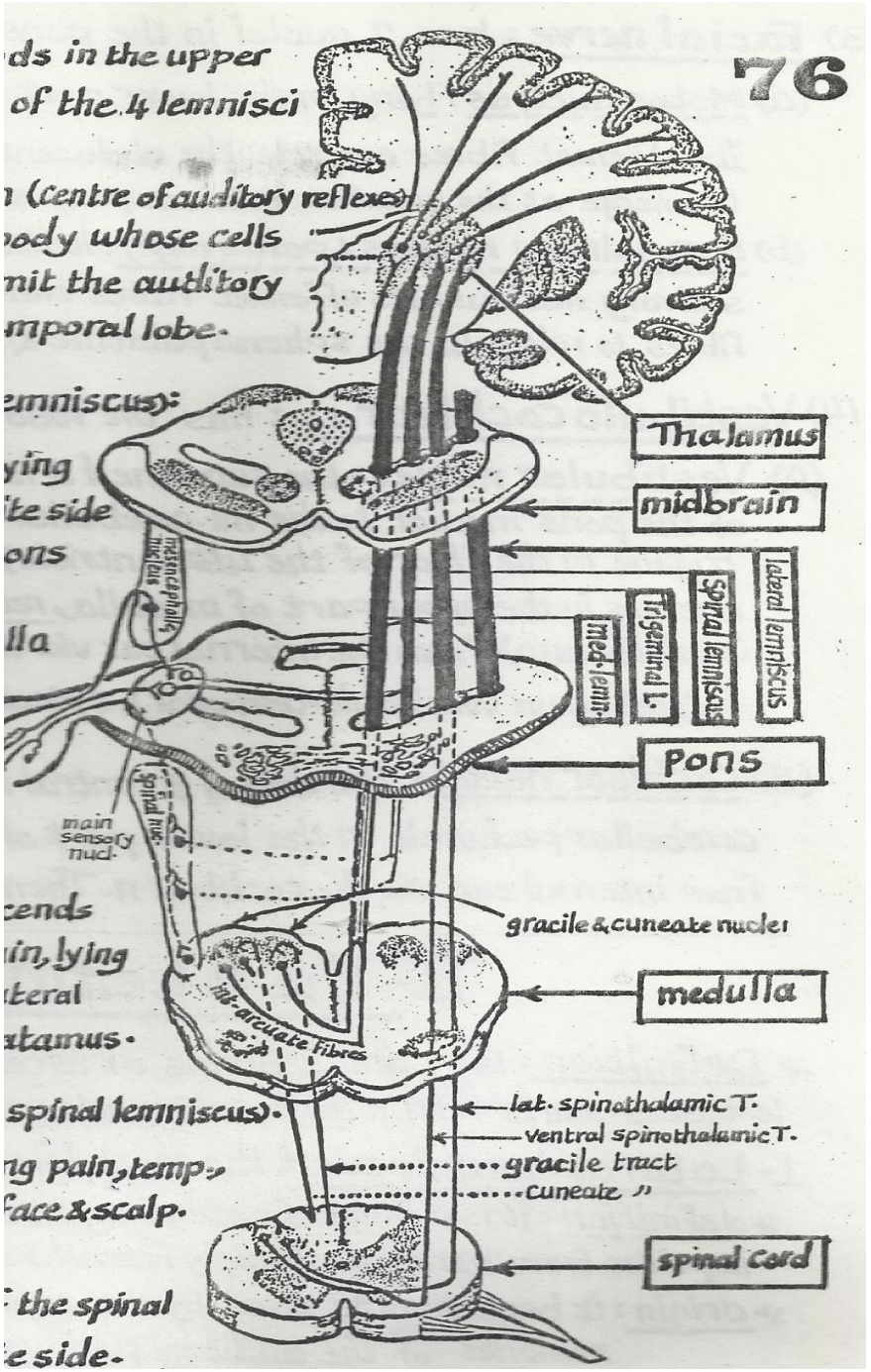
** Its fibers ascend in the pons, midbrain and end by relaying in VPLN of thalamus.



3. Trigeminal lemniscus:

** It carries pain, temperature & touch from opposite side of the face.

** Axons of the neurons of spinal and main sensory nuclei of trigeminal nerve cross the midline and ascend in the brain stem as trigeminal lemniscus. It ends by relaying in **VPMN** of thalamus.



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4. Lateral lemniscus:

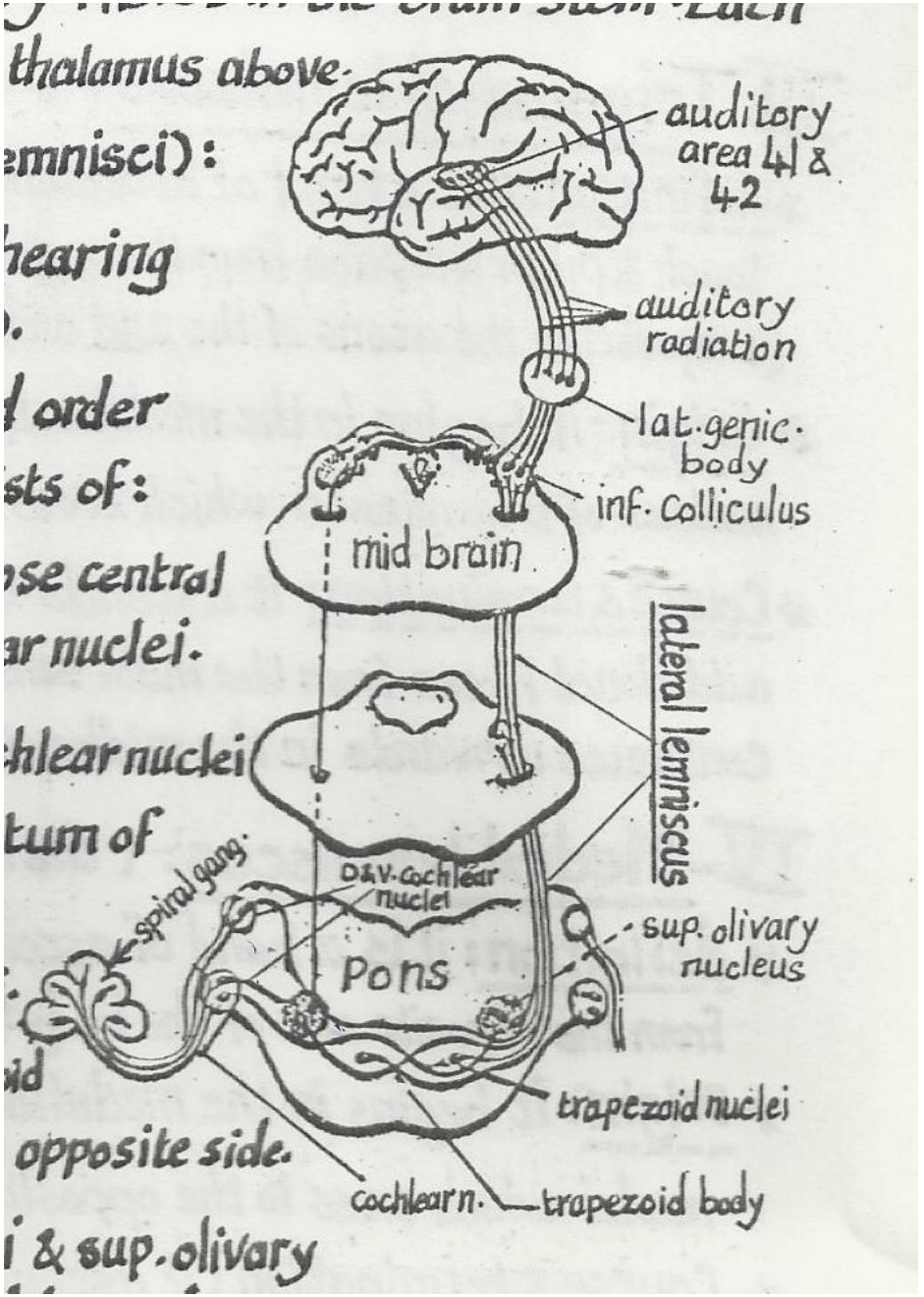
** It carries auditory impulses.

** It starts in the pons by the axons of cochlear nuclei which cross the median plane as the trapezoid body.

** As they ascend they are joined by axons of dorsal nucleus of trapezoid body & superior olive of both sides.

** It ends in the inferior colliculus or the medial geniculate body of thalamus.

** It lies most laterally.



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