BRAIN STEM II

INTERNALFEATURES

BY

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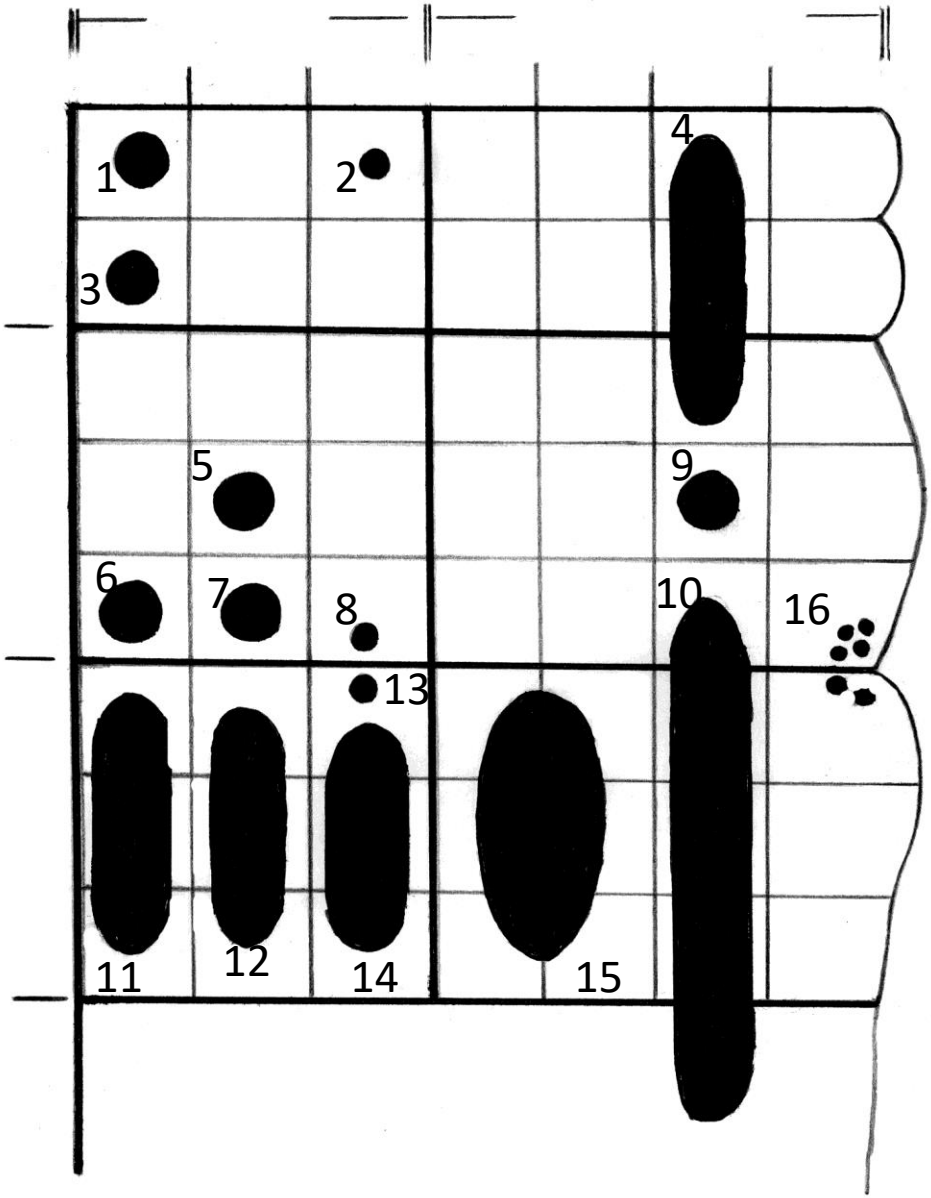
Functional classification of cranial nerve fibers & nuclei

Motor (Efferent)			Sensory (Afferent)			
Somatic	Visceral		Visceral		Somatic	
General	Special	General	General	Special	General	Special
GSE	SVE	GVE	GVA	SVA	GSA	SSA
Motor to skeletal muscles derived form somites (ms of orbit & tongue	Motor to Skeletal muscles derived from branchial arches	Motor to smooth muscles & exocrine glands (parasympathetic)	sensation from viscera (mechanicl, pain, temperature& proprioception	taste sensation & olfaction	somatic sensation as touch, pain & temperature& proprioception	vision, hearing & equilibrium

Brain stem nuclei

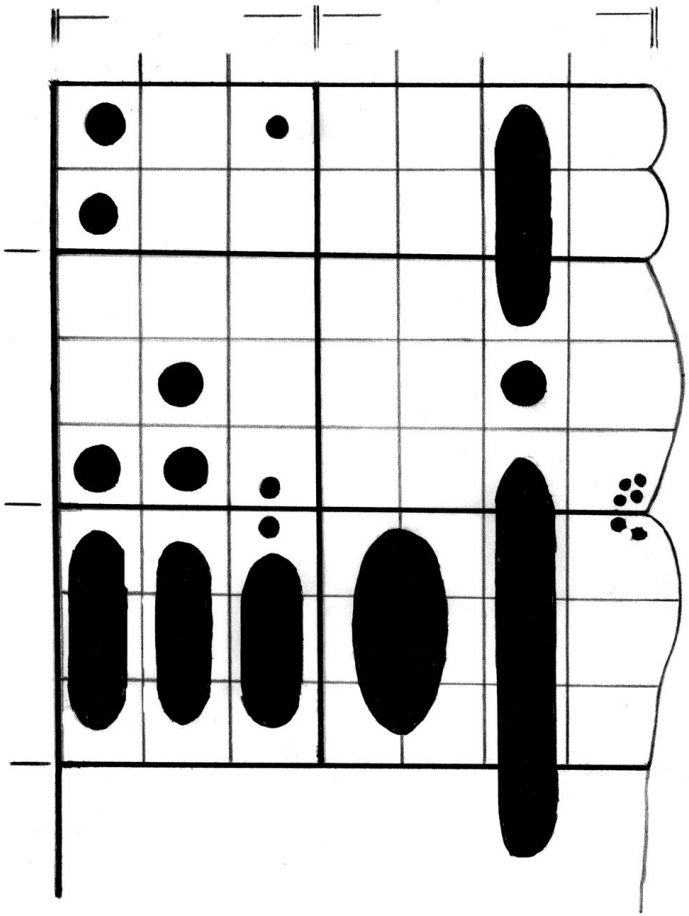
1 . Oculomotor nucleus.
2 . Edinger-Westphal nucleus.
3 . Trochlear nuclus.
4 . Mesencephalic nucleus.
5 . Motor nucleus of trigeminal.
6 . Abducent nucleus.
7 . Facial nucleus.
8 . Superior salivary nucleus.
9 . Main sensory nucleus of trigeminal.
10. Spinal nucleus of trigeminal.
11. Hypoglossal nucleus.
12. Nucleus ambiguus.
13. Inferior salivary nucleus.
14. Dorsal nucleus of vagus.
15. Solitary nucleus.
16. Vestibular and cochlear nuclei.



General Somatic Efferent (GSE) column

- **This column supplies the skeletal muscles derived from somites.** It includes the following nuclei:

1. **Oculomotor nucleus:** Supplies the extrinsic muscles of the eyeball except superior oblique and lateral rectus.
2. **Trochlear nucleus:** Supplies the superior oblique muscle of the eyeball.
3. **Abducent nucleus:** Supplies the lateral rectus muscle of the eyeball.
4. **Hypoglossal nucleus:** Supplies all intrinsic and extrinsic muscles of the tongue except palatoglossus.

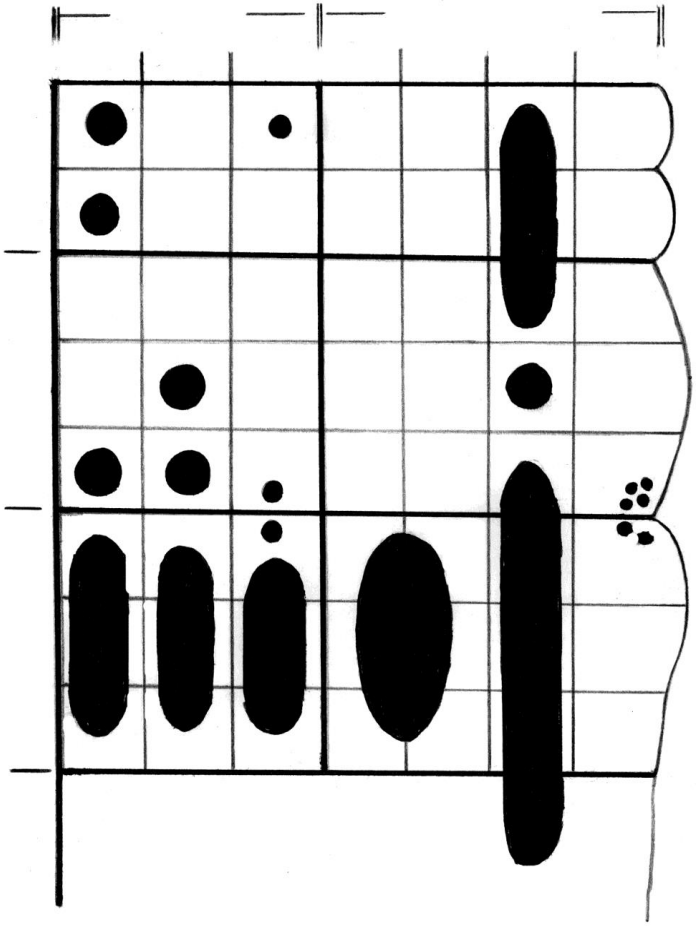


Special Visceral Efferent (SVE) column

- **This column supplies the skeletal muscles derived from branchial or arches it includes the following nuclei:**

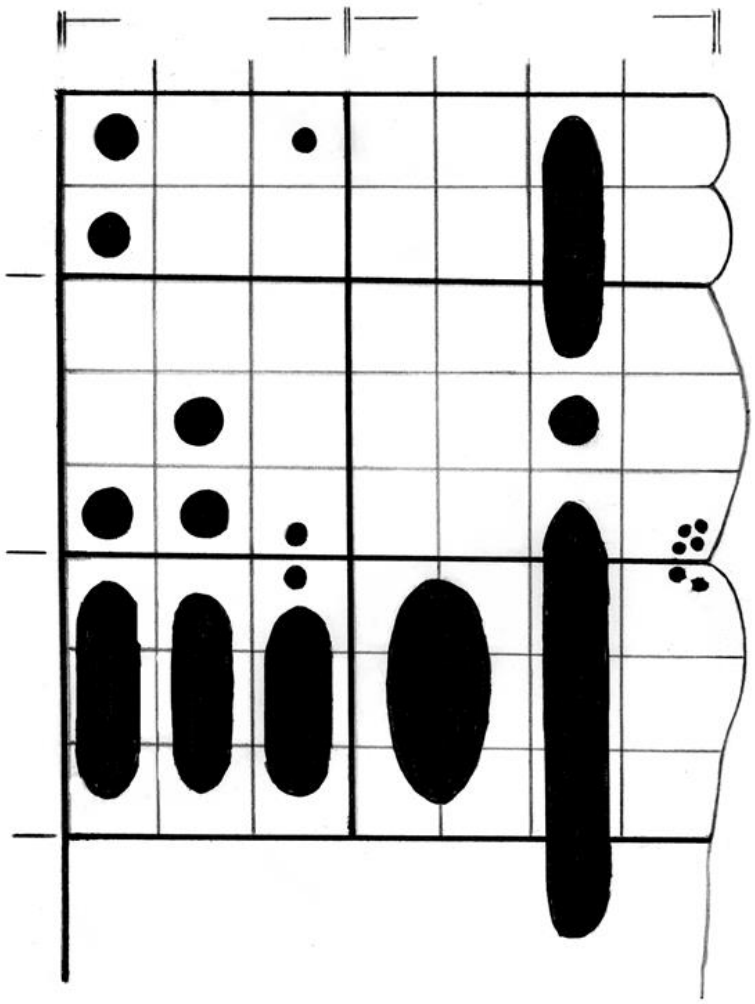
1. Motor nucleus of trigeminal nerve: Supplies the skeletal muscles derived from the first branchial arch. These are the four muscles of mastication, anterior belly of digastric, mylohyoid, tensor palati and tensor tympani.

2. Facial nucleus: Supplies the muscles of the second branchial arch. These are the muscles of the face and auricle, occipitofrontalis, platysma, posterior belly of digastric, stylohyoid and stapedius.



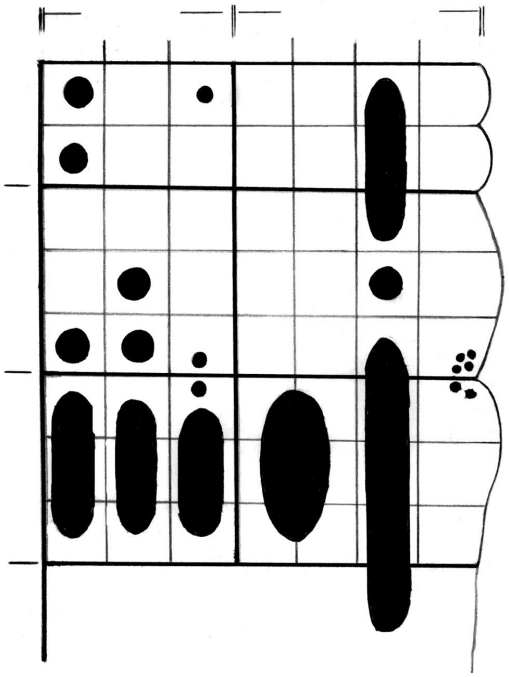
3. Nucleus ambiguus: This nucleus supplies the skeletal muscles derived from the third, fourth and sixth branchial arches. It gives fibers to three cranial nerves:

- Fibers from the upper part of the nucleus run through the glossopharyngeal nerve to supply the stylopharyngeus muscle which is the only muscle derived from the third branchial arch.
- Fibers from the greater part of the nucleus run through the vagus and cranial accessory nerves to supply the muscles of the pharynx (except stylopharyngeus), muscles of the palate (except tensor palati) and intrinsic muscles of the larynx.



General Visceral Efferent (GVE) column

- **This column supplies the smooth muscles and exocrine glands. It is called parasympathetic includes the following nuclei:**

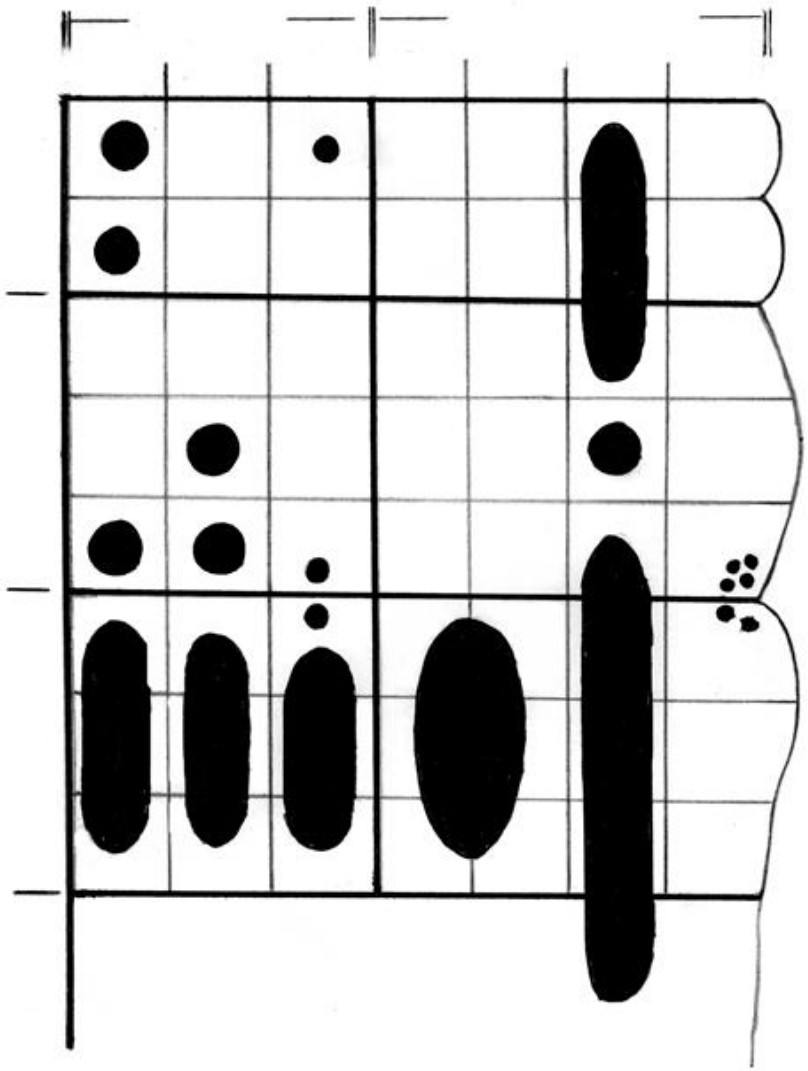


1. Edinger-Westphal nucleus: It is the parasympathetic part of the oculomotor nerve. This nucleus gives preganglionic motor fibers to the constrictor of the pupil and ciliary muscle.

2. Superior salivary nucleus: It gives preganglionic secretomotor fibers to the lacrimal, nasal, palatine, buccal, submandibular and sublingual glands. These fibers are carried by the facial nerve (its nervus intermedius part). These fibers leave the facial nerve through the greater superficial petrosal and chorda tympani.

3. Inferior salivary nucleus: It gives preganglionic secretomotor fibers to the parotid gland, which are carried by the tympanic branch of the glossopharyngeal nerve.

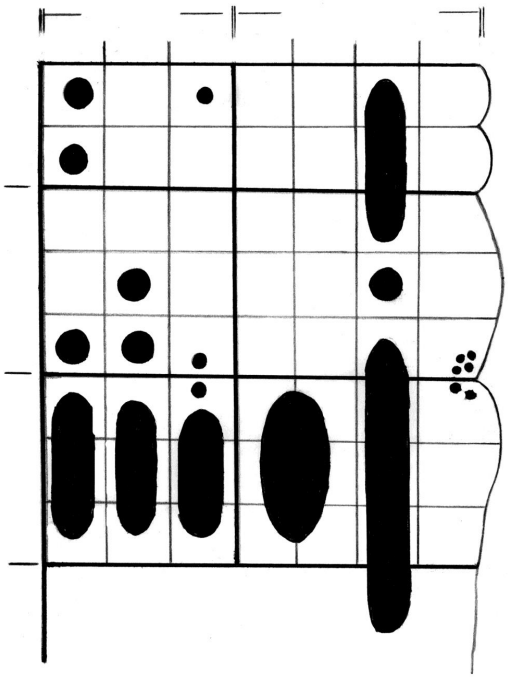
4. Dorsal nucleus of vagus: It gives preganglionic parasympathetic motor fibers to the bronchial tree, abdominal viscera, and gastrointestinal tract till the junction of the right two thirds and left third of the transverse colon. It also gives preganglionic parasympathetic inhibitory fibers to the heart. These fibers are carried by the vagus nerve; i.e. this nucleus is motor to the smooth muscles of the thoracic and abdominal viscera as well as secreto-motor to the glands of these viscera.



General Visceral Afferent (GVA) column

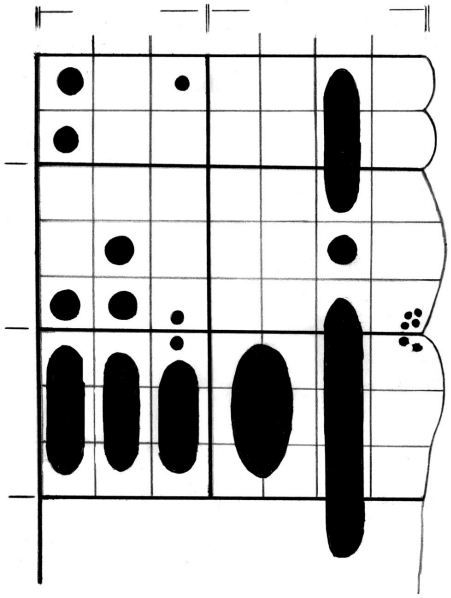
- **This column receives sensation from the viscera.**

- **This column is represented by the solitary nucleus.**
- **The upper part of this nucleus receives general sensory fibers running in the glossopharyngeal nerve which receives general sensations from the pharynx, inferior surface of soft palate, tonsil and posterior third of the tongue.**
- **The lower and greater part of the nucleus receives general visceral sensory fibers running in the vagus nerve; these fibers carry general sensation from the respiratory tract, abdominal viscera and gastrointestinal tract till the junction of the right two-thirds and left third of the transverse colon.**



Special Visceral Afferent (SVA) column

- **This column receives taste sensation from the tongue and epiglottis. It is also represented by the solitary nucleus. This nucleus receives taste fibers running through three nerves:**



- **Taste fibers from the anterior two-thirds of the tongue which are carried through the chorda tympani branch of facial nerve.**
- **Taste fibers from the posterior third of the tongue which are carried through the lingual branches of glossopharyngeal nerve.**
- **Taste fibers from the most posterior part of the tongue and epiglottis as well as vallecula which are carried through the internal laryngeal branch of vagus nerve.**

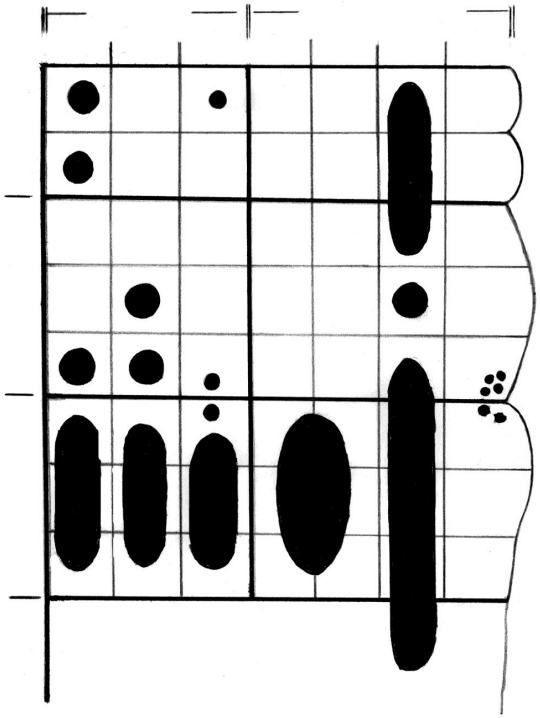
General Somatic Afferent (GSA) column

- **This column receives general somatic sensations from the head and neck. It includes the three sensory trigeminal nuclei:**

1. Mesencephalic nucleus: This nucleus is responsible for carrying proprioceptive sensation from the head.

2. Main sensory nucleus: This nucleus is responsible for receiving touch sensation from the head.

3. Spinal nucleus of trigeminal: This nucleus receives pain and temperature sensation from the head. In this nucleus the face is represented upside down. The lower part of the nucleus receives ophthalmic fibers, its middle part receives maxillary fibers while the upper part receives mandibular fibers.

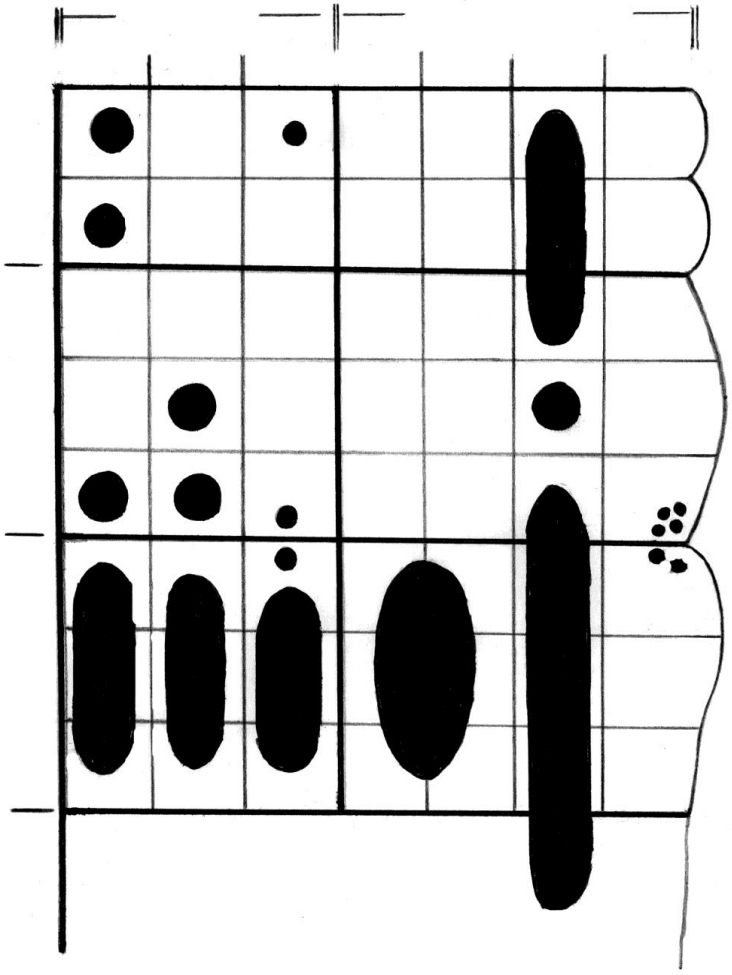


Special Somatic Afferent (SSA) column

- **This column receives special types of sensation from the head.** This column include two groups of nuclei:

1. Vestibular nuclei: Which receives vestibular impulses (responsible for equilibrium) from the utricle, saccule and semicircular canals. These impulses are carried by the vestibular nerve which is formed by axons of the bipolar cells of the vestibular ganglia.

2. Cochlear nuclei: Which receive auditory impulses from the cochlea. These impulses are carried by the cochlear nerve which is formed by axons of the bipolar cells of the spiral ganglia of the cochlea.



Functional components of cranial nerves

1 . Olfactory nerve (SVA):

It arises from the bipolar neurons located in the nasal mucosa, the olfactory epithelium.

II. Optic nerve (SSA):

It consists of axons of neurons located in the ganglion cell layer of the retina.

III. Oculomotor nerve:

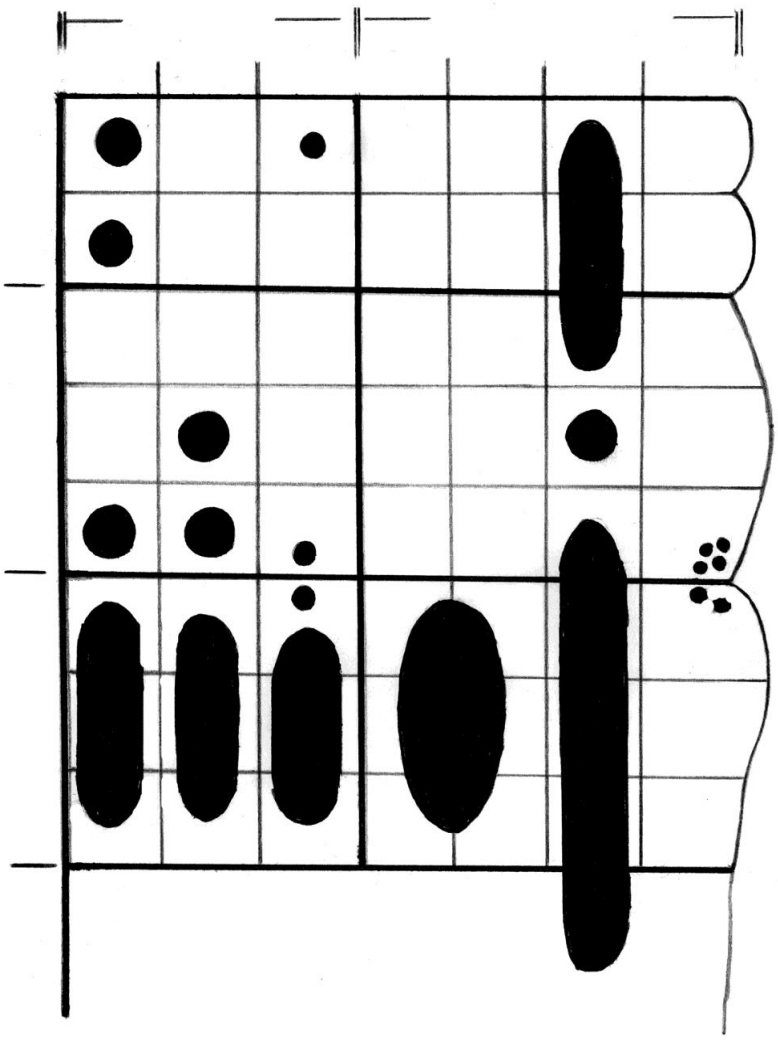
1. Oculomotor nucleus (GSE).
2. Edinger-Westphal nucleus (GVE).

IV. Trochlear nerve:

1. Trochlear nucleus (GSE).

VI. Abducent nerve:

1. Abducent nucleus (GSE).



V. Trigeminal nerve:

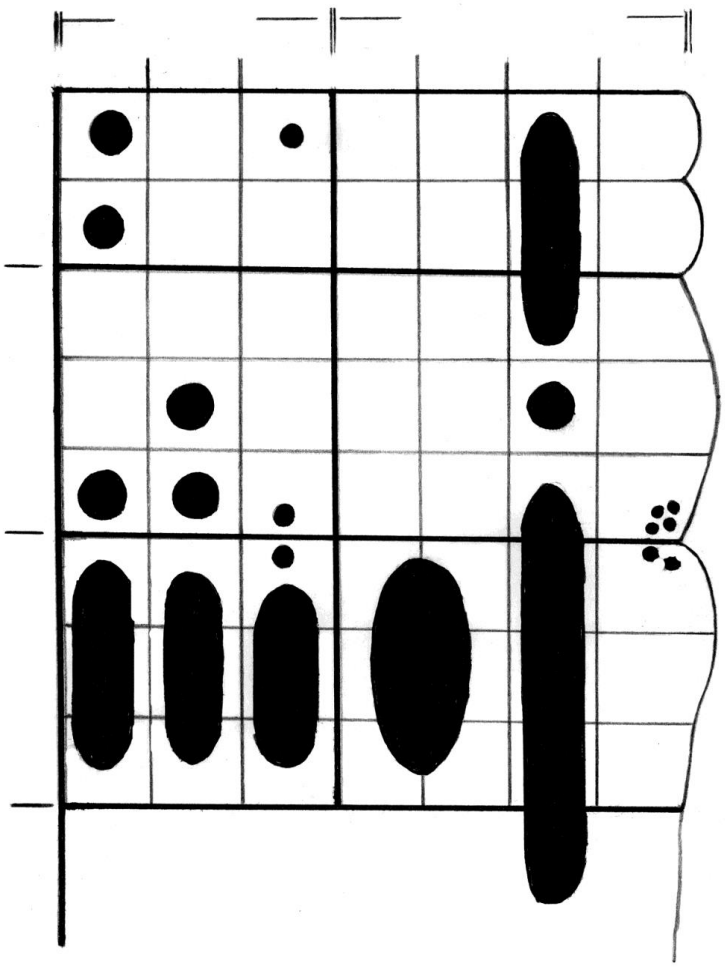
1. Motor nucleus of trigeminal (SVE).
2. Main sensory nucleus of trigeminal (GSA; touch).
3. Mesencephalic nucleus (GSA; proprioceptive).
4. Spinal nucleus of trigeminal (GSA; pain & temp.).

VII . Facial nerve:

1. Facial nucleus (SVE).
2. Superior salivary nucleus (GVE).
3. Solitary nucleus (SVA).

VIII. Vestibulocochlear nerve (SSA):

It consists of two functional divisions: the vestibular nerve and the cochlear nerve. The vestibular nerve arises from bipolar neurons in the vestibular ganglion of the internal auditory meatus. The cochlear nerve arises from bipolar neurons in the spiral (cochlear) ganglion of the cochlea.



IX. Glossopharyngeal nerve:

1. Nucleus ambiguous (SVE).
2. Inferior salivary nucleus (GVE).
3. Solitary nucleus (GVA & SVA).

X. Vagus nerve:

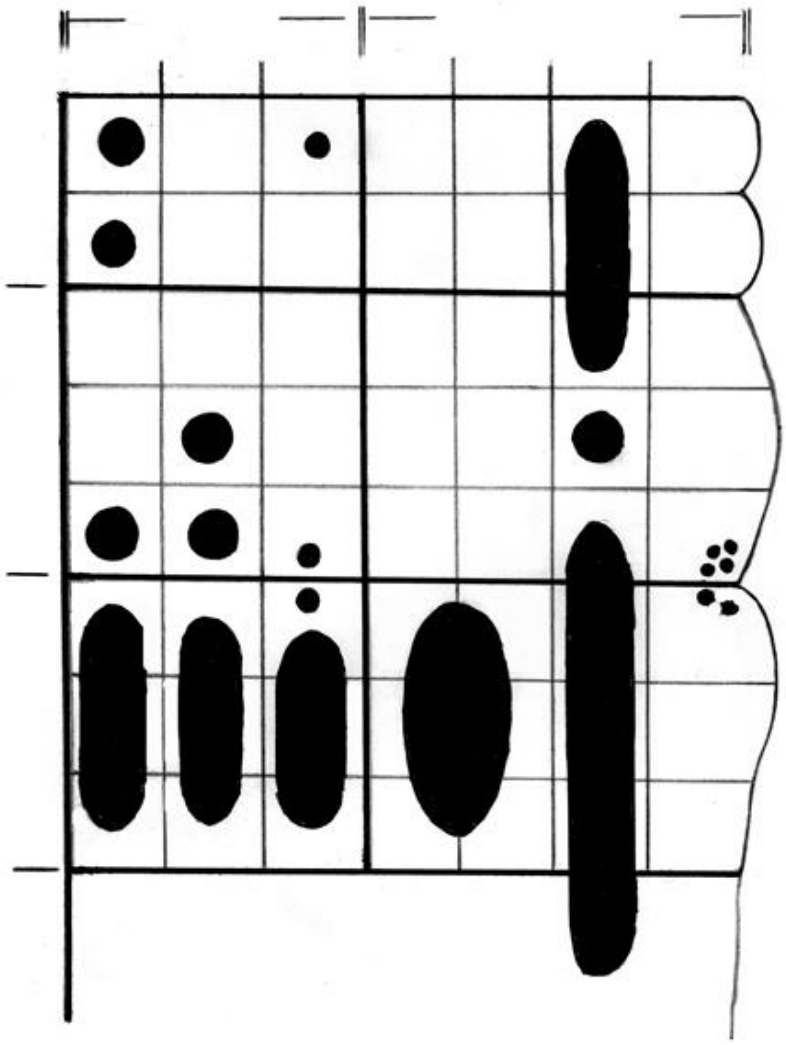
1. Nucleus ambiguous (SVE).
2. Dorsal nucleus of vagus (GVE).
3. Solitary nucleus (GVA & SVA).
4. Spinal nucleus of trigeminal (GSA).

XI. Accessory nerve:

1. Cranial part: From nucleus ambiguous (SVE).
2. Spinal part: From anterior horn cells of the upper 5 or 6 cervical spinal segments.

XII. Hypoglossal nerve:

1. Hypoglossal nucleus (GSE).



Internal structure of the medulla

- **The medulla presents the following features:**

❑ Nuclei present in the medulla

A. Cranial nerve nuclei:

1. Hypoglossal nucleus.
2. Nucleus ambiguus.
3. Dorsal nucleus of vagus.
4. Solitary nucleus.
5. Inferior salivary nucleus.
6. Spinal nucleus of trigeminal.
7. Inferior & medial vestibular nuclei.

B. Others:

1. Inferior olivary nucleus.
2. Gracile & cuneate nuclei.
3. Accessory cuneate nucleus.
4. Arcuate nuclei.

1. Infeior olivary complex:

It is The most characteristic nuclear structure in the medulla. This complex consists of 3 parts:

1) The principal inferior olivary nucleus appearing as folded bag with the opening or hilus directed medially,
2) A medial accessory olivary nucleus
3) A dorsal accessory olivary nucleus.

This complex presents the following connections:

a. Afferent: The inferior olivary complex receives fibers from:

1) The cereberal cortex.
2) The thalamus.
3) The cerebellum.
4) The red nucleus.

b. Efferent:

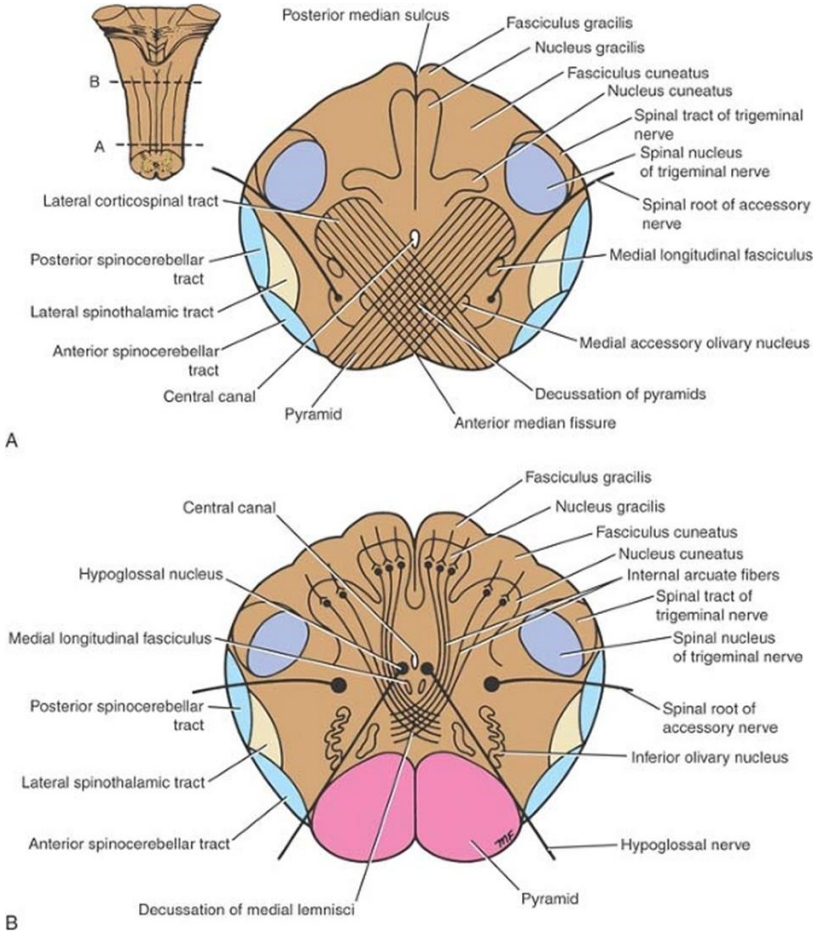
These are the olivo-cerebellar fibers.

2. Gracile and cuneate nuclei:

They receive the fibers of the gracile and cuneate tracts, and give rise to the internal arcuate fibers which cross the midline forming the sensory decussation; then ascend upwards as medial lemniscus.

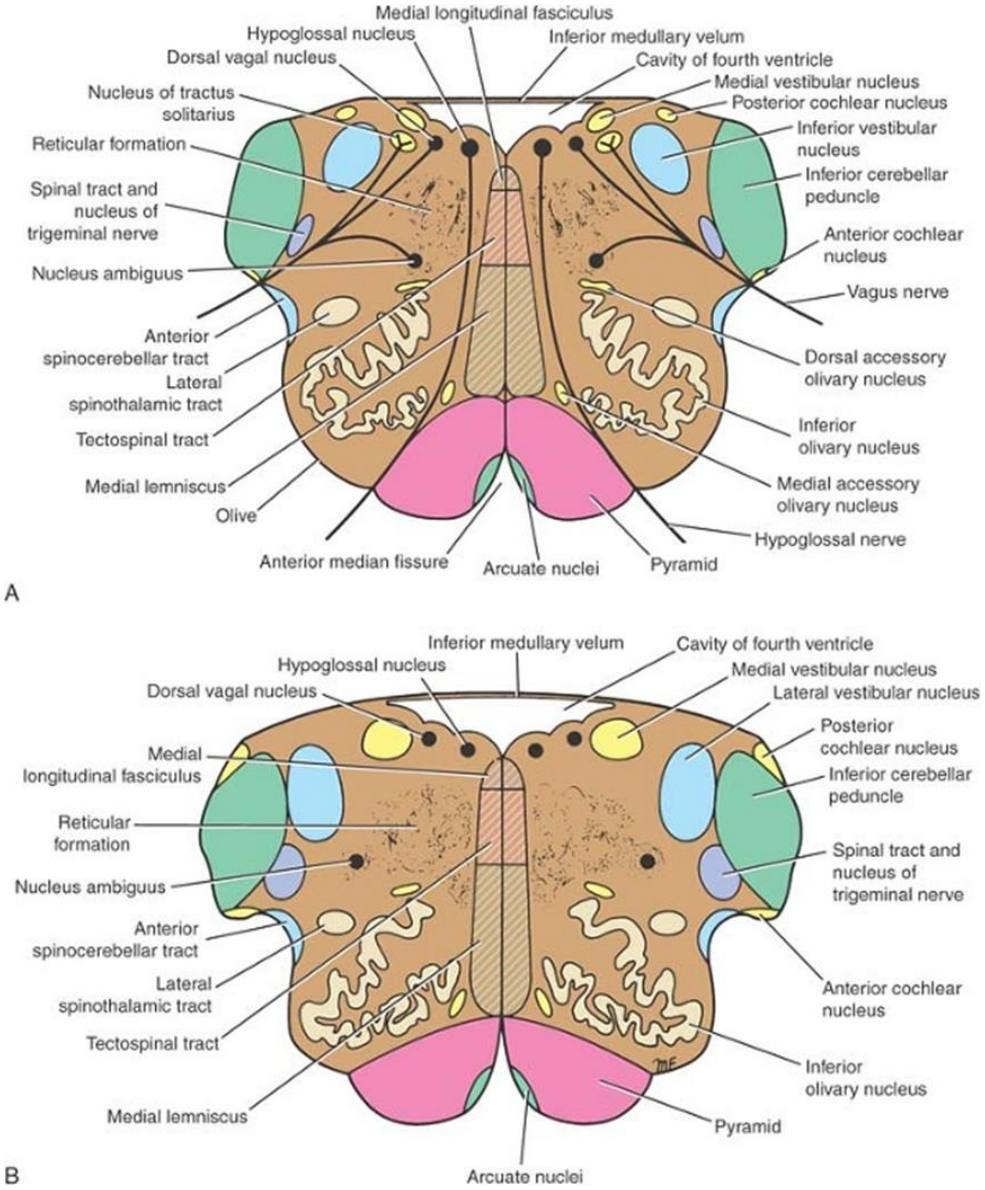
3. Accessory cuneate nucleus:

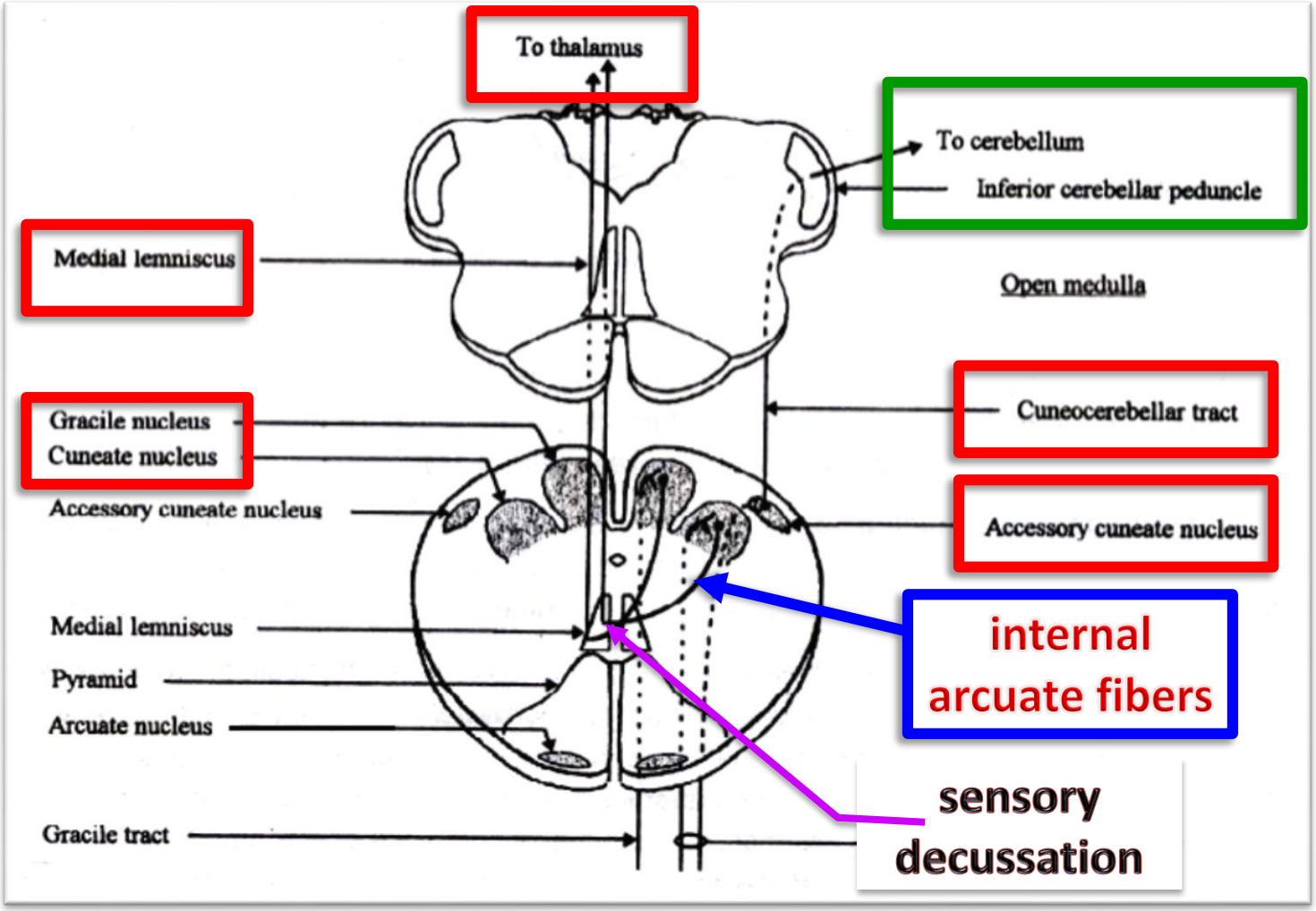
It is a small nucleus situated just lateral to the cuneate nucleus. It receive collaterals from the cuneate tract, and sends efferent fibers to the cerebellar hemisphere of the same side through the inferior cerebellar peduncle. These are called cuneocerebellar. These fibers carry proprioceptive impules from the neck and upper limb to the cerebellum.



4. Arcuate nucleus:

This nucleus lies ventromedial to the pyramid. It is suggested that the cells of this nucleus are caudally displaced cells from the nuclei pontis. Axons of its cells form the ventral (anterior) external arcuate fibers or the arcuatocerebellar fibers. These fibers run round the anterior aspect of the medulla and reach the cerebellum through the inferior cerebellar peduncle on the same side.



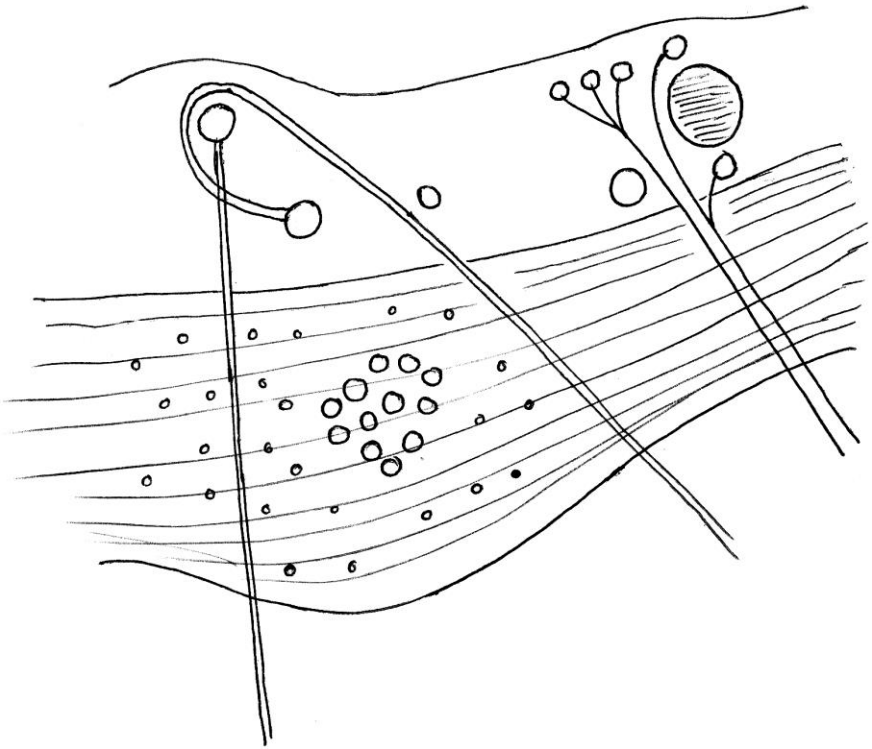

To thalamus
To cerebellum
Inferior cerebellar peduncle
Medial lemniscus
Open medulla
Gracile nucleus
Cuneate nucleus
Cuneocerebellar tract
Accessory cuneate nucleus
Accessory cuneate nucleus
internal arcuate fibers
Medial lemniscus
Pyramid
Arcuate nucleus
sensory decussation
Gracile tract

Internal structure of the pons

- **The pons is formed of 2 main parts:**

A. Ventral part called basilar part or basis pontis: **The contents of this part appears to be constant in the 3 levels.**

B. Dorsal part called tegmentum: **Which is continuous with the tegmentum of the midbrain. Its contents vary in the 3 levels of the pons.**



A. Basilar Part (basis pontis):

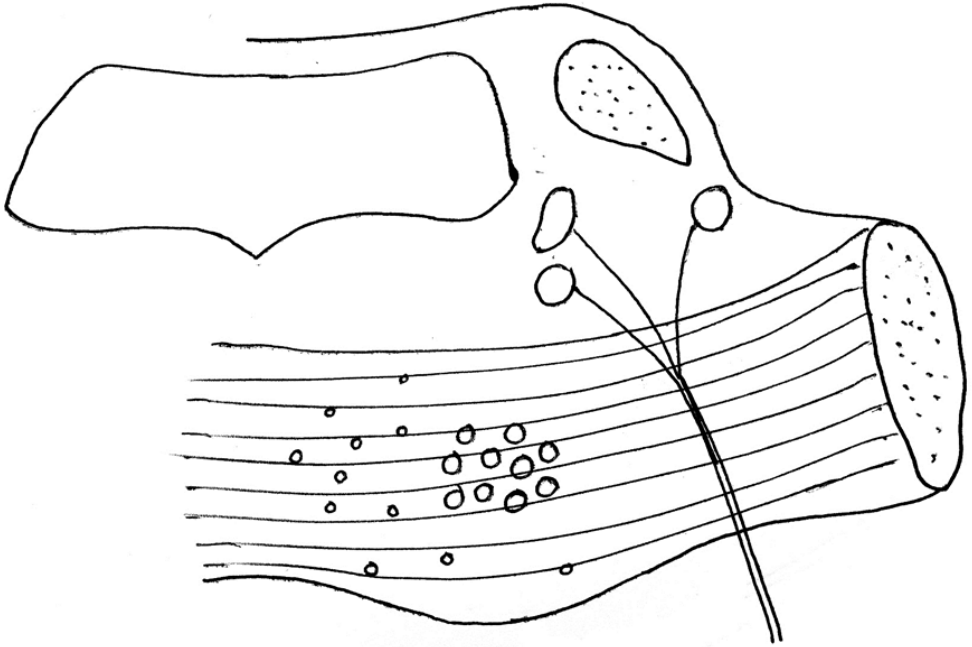
It is the larger ventral part of the pons; the contents of which are:

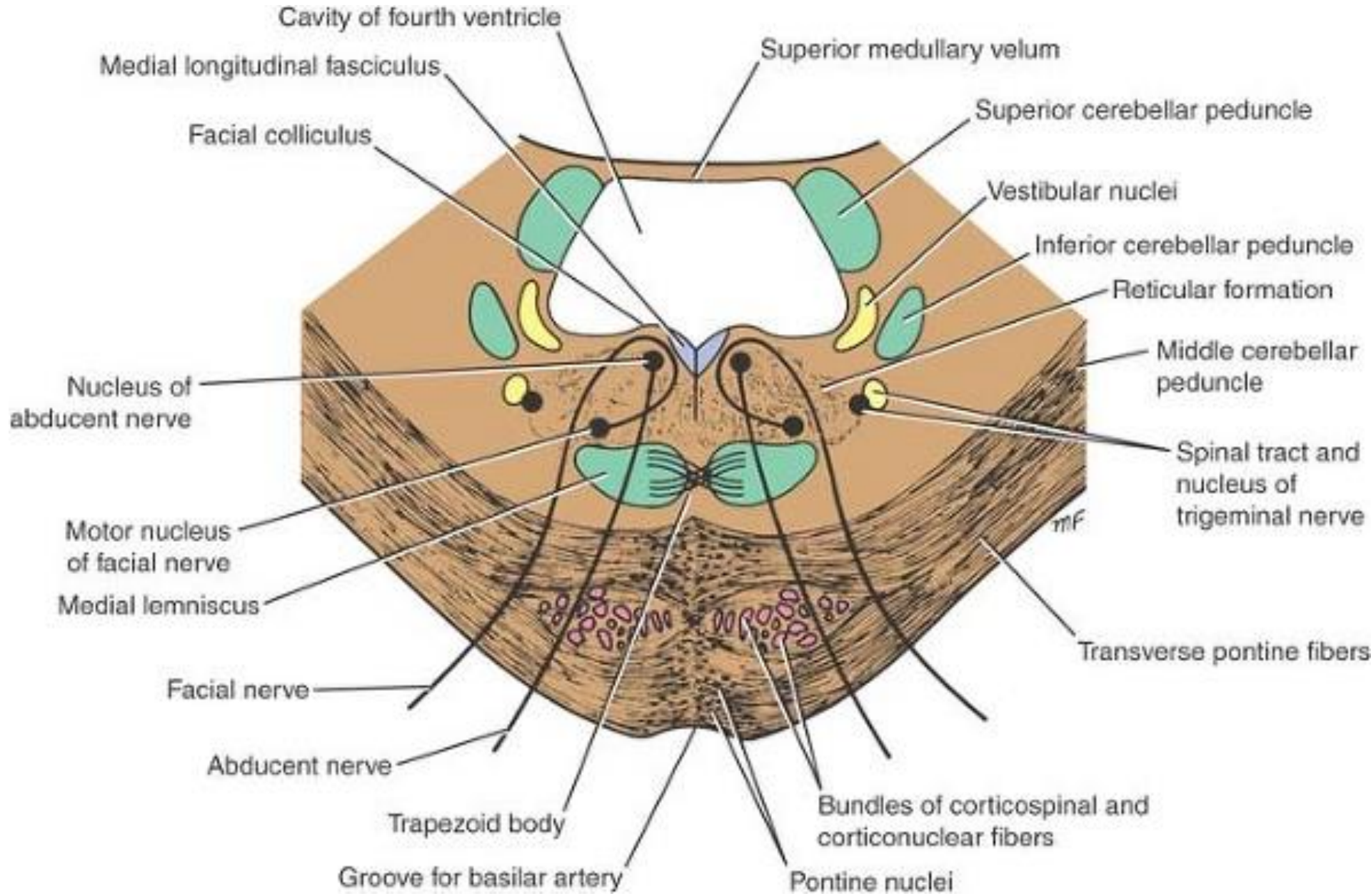
1. Bundles of the pyramidal tract.

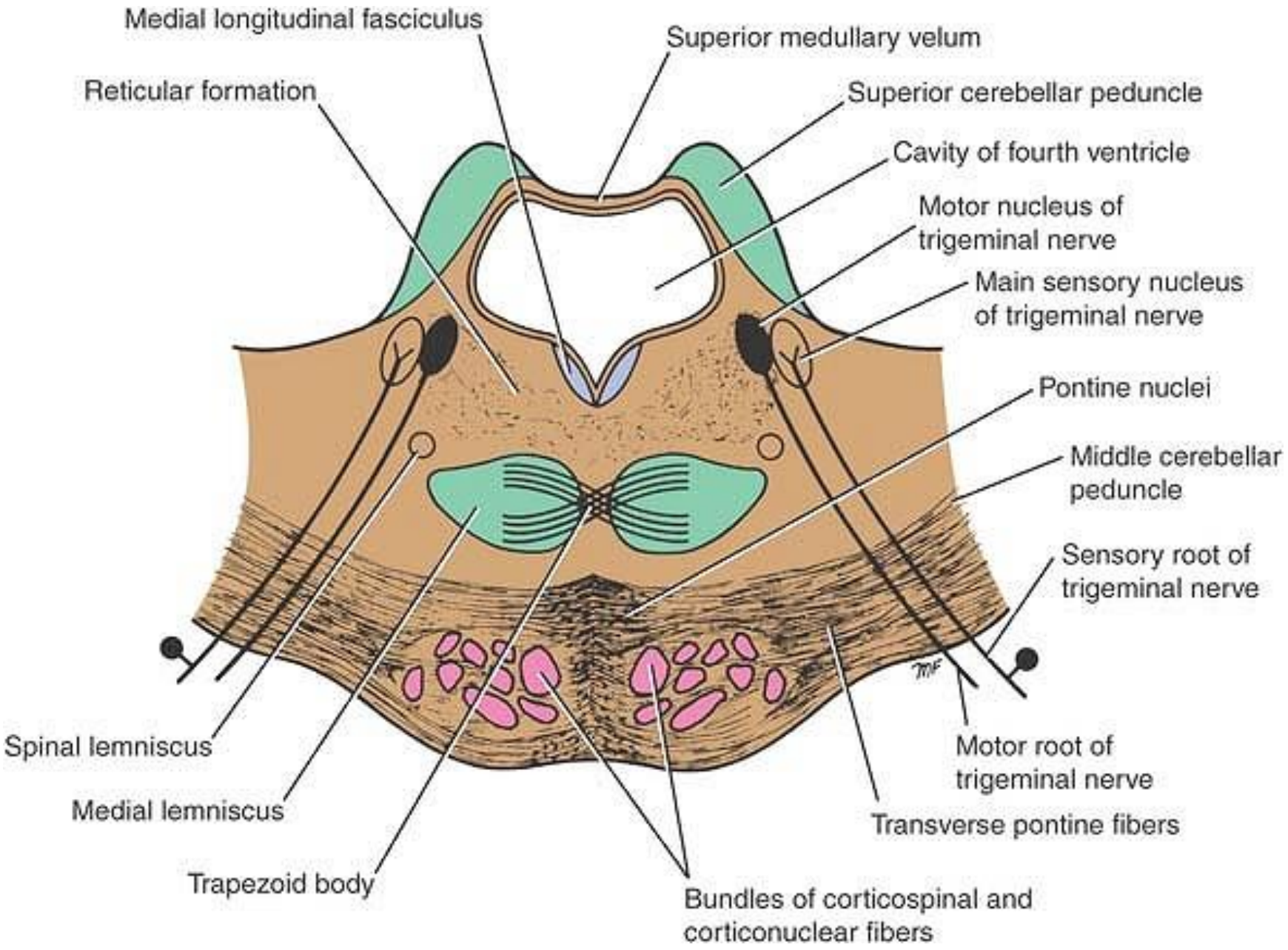
2. Corticopontine fibers: **These fibers descend from the different lobes of the cerebrum. They include frontopontine, parietopontine, occipitopontine and tempropontine fibers. They include the first neuron in the corticopontocerebellar pathway, which connect the cerebral cortex with the cerebellar cortex of the opposite side.**

3. Nuclei pontis: **These are groups of small neurons scattered in the basilar part of the pons. These neurons receive the terminations of the corticopontine fibers on the same side. Axons of the cells of the nuclei pontis cross to the opposite side, forming the transverse pontine fibers which collect into the middle cerebellar peduncle to reach the cerebellar cortex on the opposite side.**

4. Transverse pontine fibers: **These are the axons of the nuclei pontis. They cross to the opposite side and form the bulk of the middle cerebellar peduncle through which they reach the cerebellar cortex of the opposite side. These pontocerebellar fibers from the second neuron in the corticopontocerebellar pathway.**




Cavity of fourth ventricle
Medial longitudinal fasciculus
Facial colliculus
Superior medullary velum
Superior cerebellar peduncle
Vestibular nuclei
Inferior cerebellar peduncle
Reticular formation
Middle cerebellar peduncle
Nucleus of abducent nerve
Spinal tract and nucleus of trigeminal nerve
Motor nucleus of facial nerve
Medial lemniscus
Transverse pontine fibers
Facial nerve
Abducent nerve
Trapezoid body
Bundles of corticospinal and corticonuclear fibers
Groove for basilar artery
Pontine nuclei


Medial longitudinal fasciculus
Superior medullary velum
Reticular formation
Superior cerebellar peduncle
Cavity of fourth ventricle
Motor nucleus of trigeminal nerve
Main sensory nucleus of trigeminal nerve
Pontine nuclei
Middle cerebellar peduncle
Sensory root of trigeminal nerve
Spinal lemniscus
Medial lemniscus
Trapezoid body
Bundles of corticospinal and corticonuclear fibers
Motor root of trigeminal nerve
Transverse pontine fibers

B. Tegmentum:

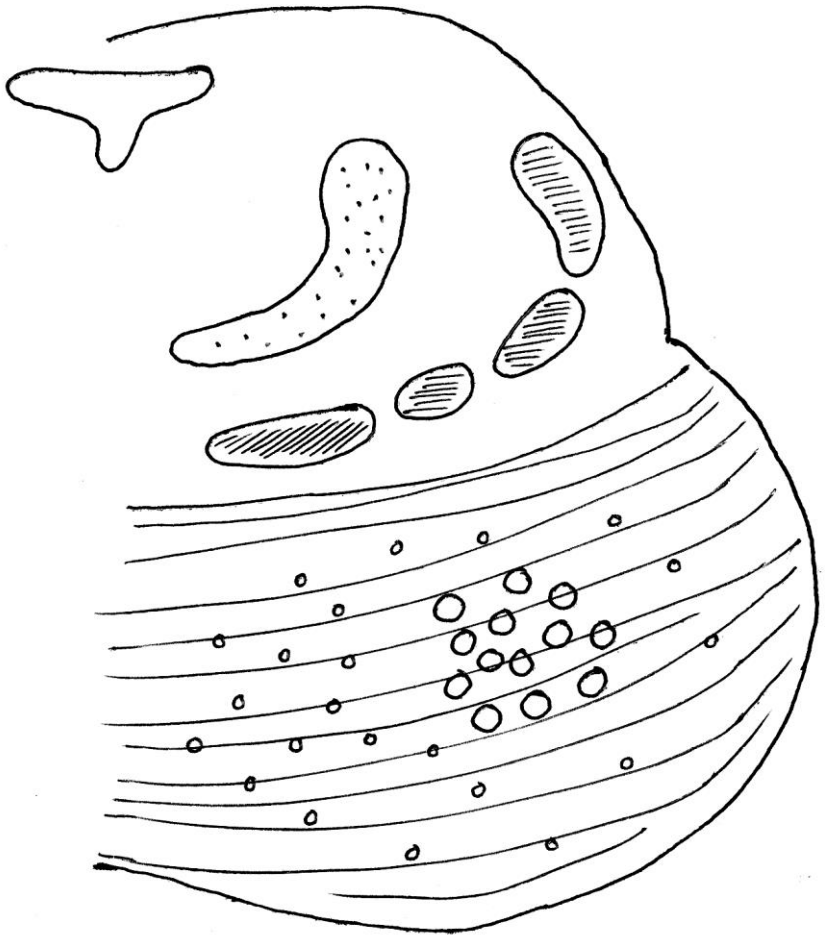
This is the smaller dorsal part of the pons. Its contents vary in the 3 levels of the pons. It contains the following structures:

I. *Tracts* (Ascending, descending & medial longitudinal bundle).

II. *Cranial nerve nuclei:* These include:

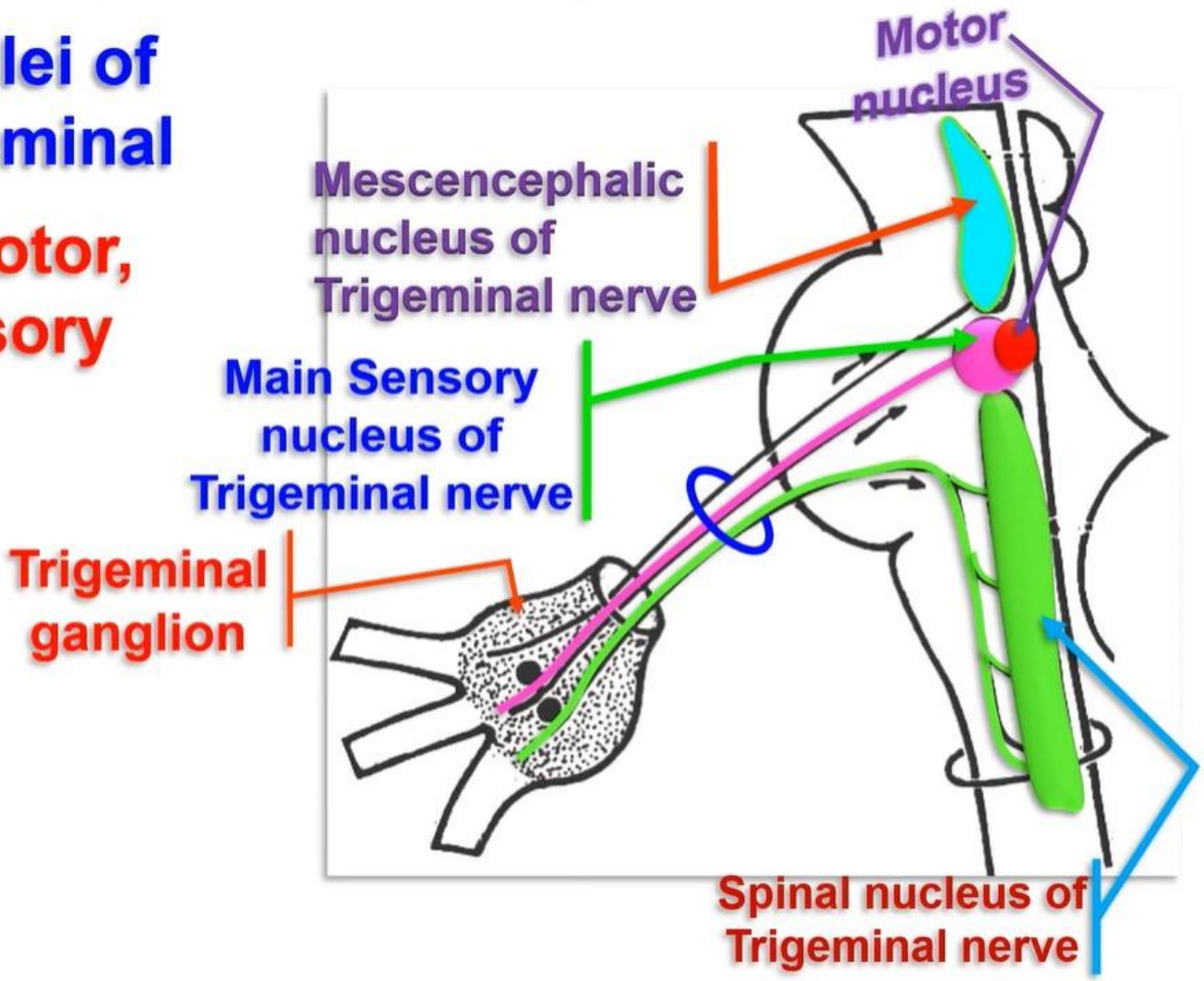
1. **Trigeminal nuclei.**
2. **Abducent nucleus.**
3. **Facial nucleus.**
4. **Superior salivary nucleus.**
5. **Vestibular nuclei.**
6. **Cochlear nuclei.**

III. *Lemnisci:* These are trigeminal, spinal, medial and lateral lemnisci (will be given later).



Nuclei of trigeminal

One motor, 3 sensory



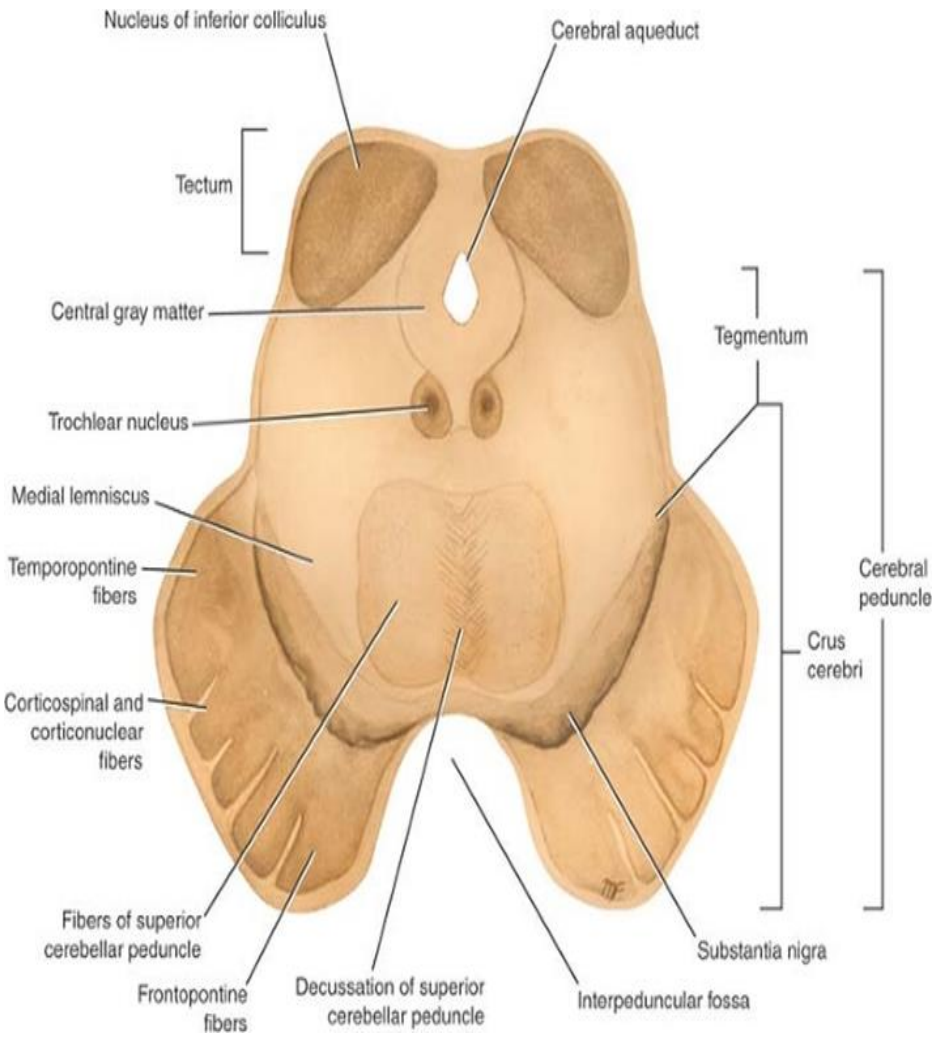
Internal structure of the midbrain

- **The midbrain is divided by a coronal plane passing through the cerebral aqueduct into two divisions:**

A. Ventral part called cerebral peduncle which is divided into 3 parts:

1. **Crus cerebri (basis pedunculi).**
2. **Substantia nigra.**
3. **Tegmentum.**

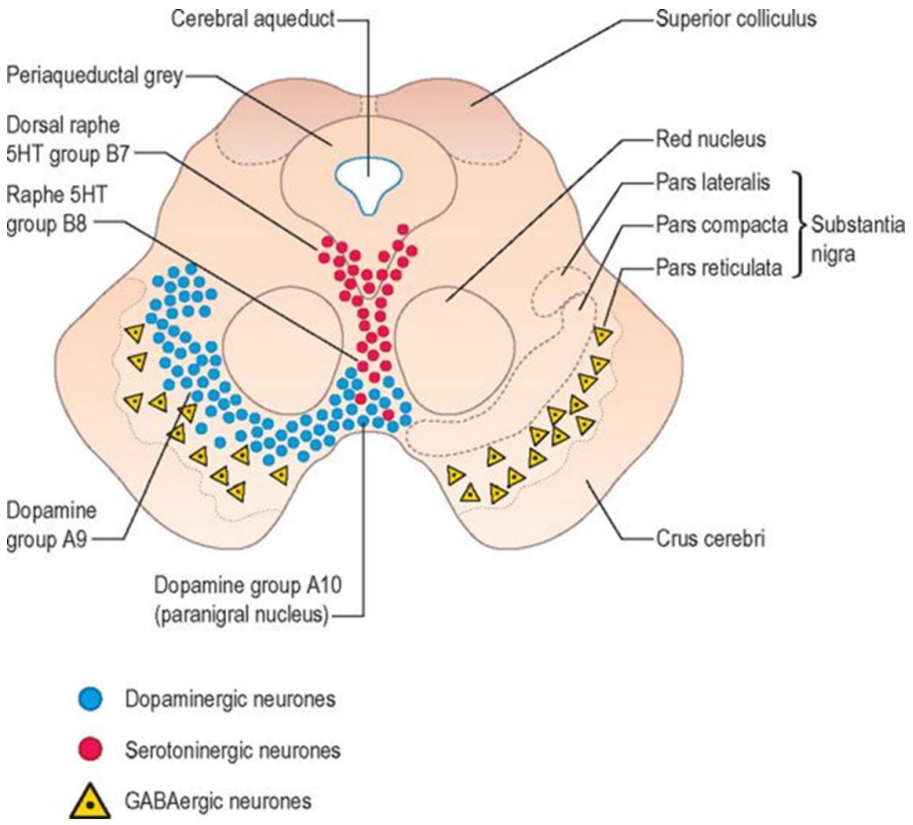
B. Dorsal part called tectum formed of 4 colliculi or corpora quadrigemina (2 superior & 2 inferior).



A . Ventral part:

1. Crus Cerebri:

Notice the fibers passing through in transverse section.



2. Substantia nigra:

It is a lamina of grey matter containing melanin pigment therefore it appears black. It is an extrapyramidal center. The substantia nigra is divided into pars compacta and pars reticularis.

Afferent = 2 C

1- From **corpus striatum** (basal nuclei**)**

2- From the **cerebral cortex**.

**** Efferent = To the corpus striatum.**

- Degeneration of the **substantia nigra** leading to absence of dopamine secretion causing **Parkinson's disease**

3. Tegmentum:

It contains a mixture of grey matter nuclei and white matter tracts scattered in the reticular formation.

a. Cranial nerve nuclei:

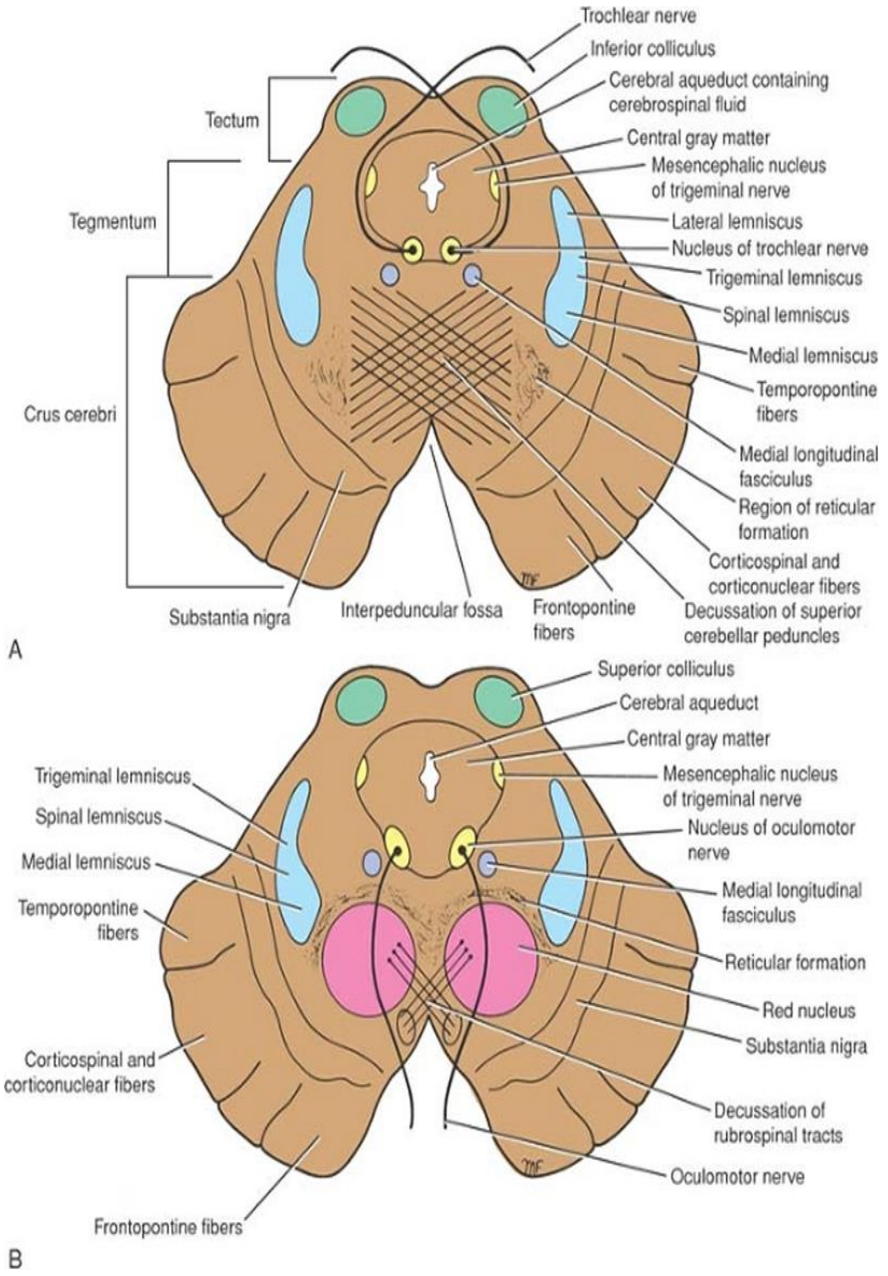
- **Oculomotor and Edinger-Westphal nuclei**
- **Trochlear nucleus.**
- **Mesencephalic nucleus.**

b. Red nucleus.

c. Decussations:

- **Decussation of superior cerebellar peduncles (at the lower level).**
- **Dorsal tegmental decussation (at the upper level).**
- **Ventral tegmental decussation (at the upper level).**

d. Tracts & bundles.



Red nucleus:

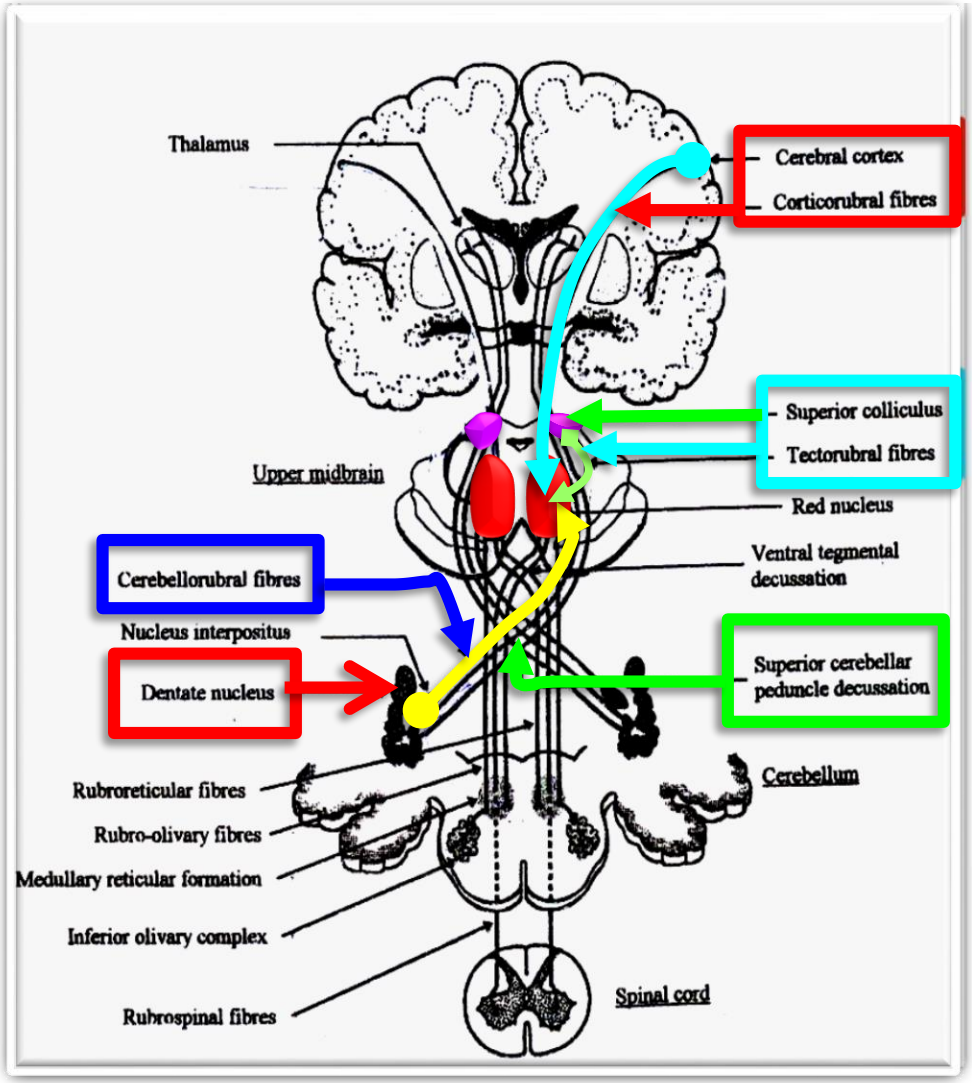
- It is so called because it has a **pink color** in fresh sections due to the presence of **iron pigment**.
- It is an important station of **extrapyramidal system**.

- **Afferent**

I- From the **cerebral cortex (same side) corticorubral**.

2- From **cerebellum** (dentate nucleus) (**opposite side**) Cerebellorubral

3- Superior colliculus (same side) Tectorubral.

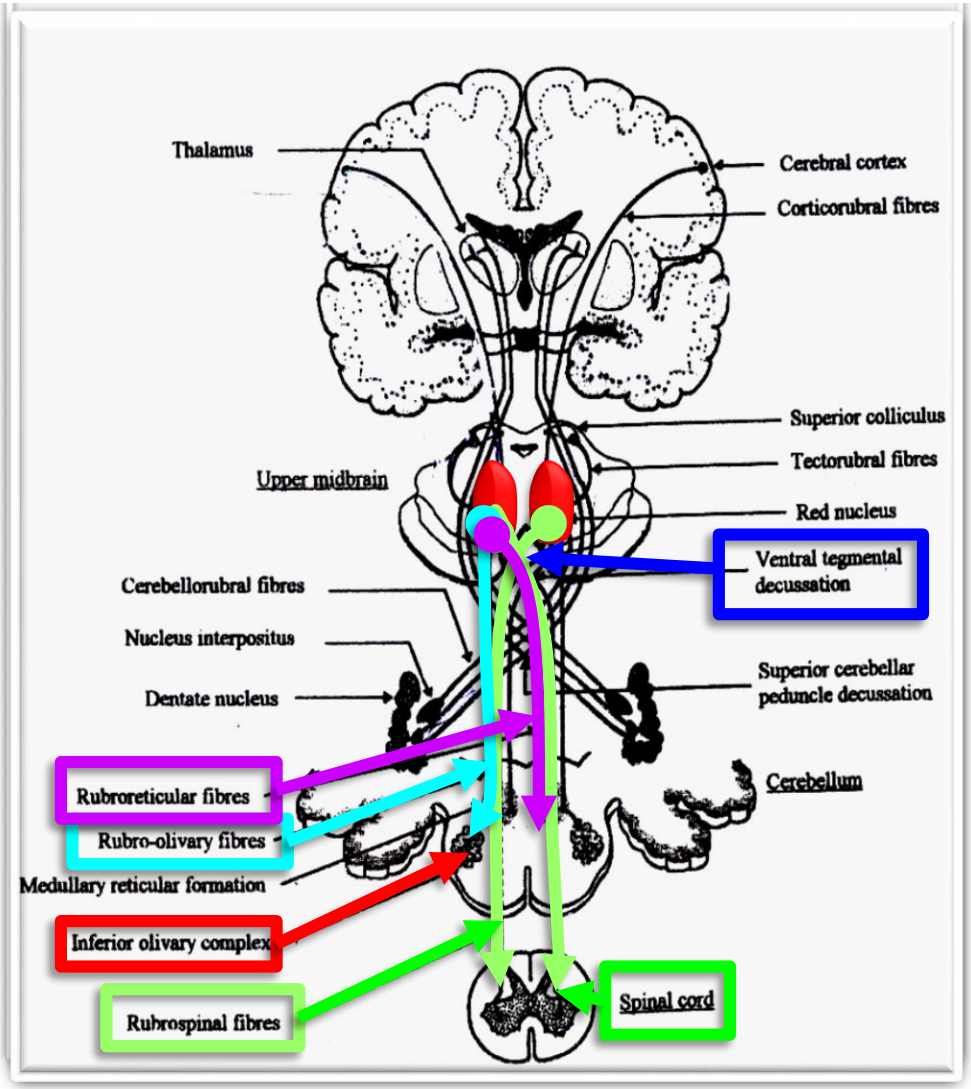


Efferent SIR

1- to the **spinal cord** (**opposite side**) Rubrospinal

2- to the **inferior olivary nucleus** (**same side**). Rubroolivary

3- to the **reticular formation** (**opposite side**). Rubroreticular



B- Tectal nuclei that lie in the tectum (posterior surface).

a- Superior Colliculus (Visual)

*** Afferent** : 1- From the optic tract.

2- From visual area of the cerebral cortex.

b- Inferior Colliculus (Auditory)

*** Afferent:** 1- From the cochlear nerve.

2- From auditory area of the cerebral cortex.

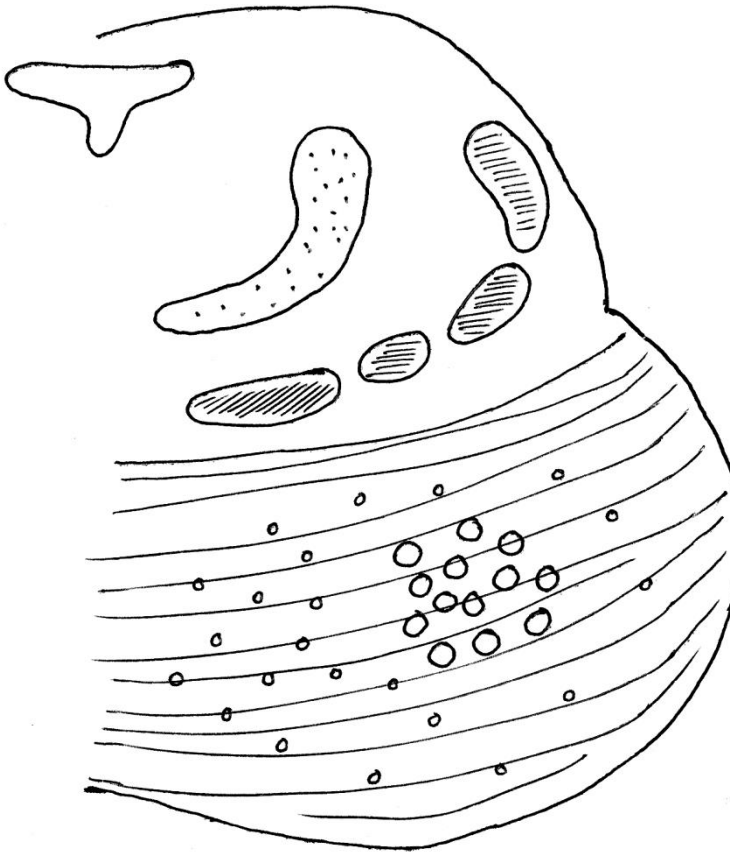
*** Efferent of superior and inferior colliculus** to:

- **Tecto-bulbar**: Ocular motor nuclei (**3rd, 4th, 6th)** responsible for movement of the eyes in relation to the visual and auditory stimuli.
- **Tecto-spinal**: **upper segments of the spinal cord** responsible for the movement of the head in relation to the visual and auditory stimuli (Spinal part of accessory nerve).

Lemnisci

- The lemnisci are formed of ascending sensory fibers as they pass through the brainstem. There are 4 lemnisci. They are arranged from medial to lateral in the pons as follows:

- **Medial lemniscus:** These are the axons of the gracile and cuneate tracts as well as the ventral spinothalamic tract.
- **Trigeminal lemniscus:** These are the axons of the spinal nucleus and the main sensory nucleus of the trigeminal.
- **Spinal lemniscus:** These are the axons of the lateral spinothalamic tract.
- **Lateral lemniscus:** These are the axons of the trapezoid and superior olivary nuclei.



Decussations

- **Motor decussation: Decussation of the corticospinal fibers at the lower level of the medulla.**
- **Sensory Decussation: Decussation of the axons of the gracile and the cuneate nuclei which form the internal arcuate fibers. They decussate at the middle level of the medulla.**
- **Decussation of the superior cerebellar peduncle: Lies at the lower level of the midbrain. These are the axons of the dentate nucleus crossing to the opposite side to reach the red nucleus and the thalamus.**
- **Ventral tegmental decussation: Lies at the upper level of the midbrain. It is formed by the decussating rubrospinal and rubroreticular tracts.**
- **Dorsal tegmental decussation: Lies at the upper level of the midbrain. It is formed by the decussating tectospinal and tectobulbar tracts.**

THANK YOU

BEST WISHES