MED437
KING SAUD UNIVERSITY

ANATOMY
Team 437

Cranial Nerve VIII (The Vestibulo-Cochlear Nerve)

Lecture (11)

- Important
- Doctors Notes
- Notes/Extra explanation

Please check our Editing File

هذا العمل مبني بشكل أساسي على عمل دفعة ٤٣٦ مع المراجعة والتدقيق وإضافة الملاحظات ولا يغني عن المصدر الأساسي للمذاكرة

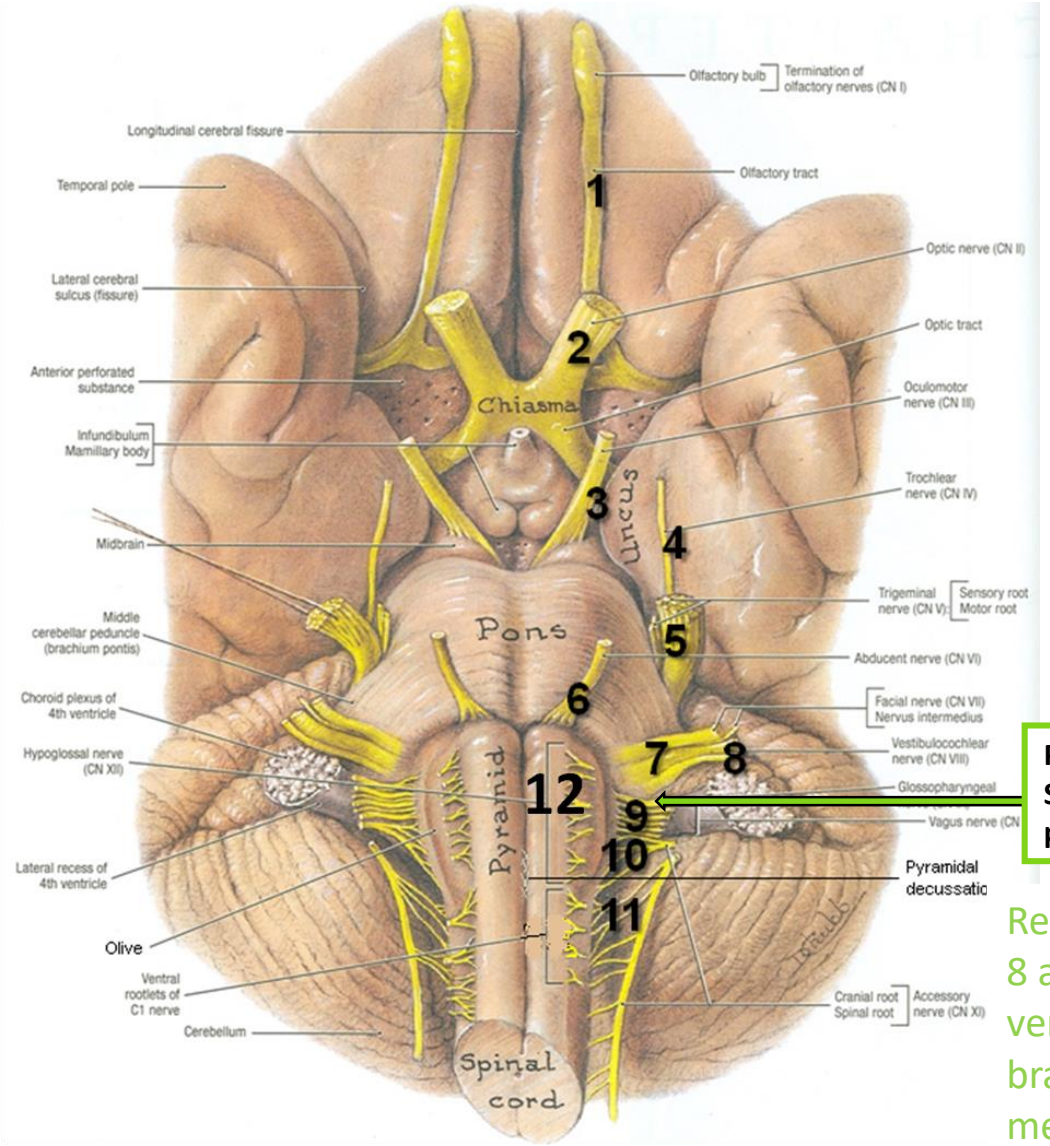
{وَمَنْ يَتَوَكَّلْ عَلَى اللَّهِ فَهُوَ حَسْبُهُ}

Objectives

At the end of the lecture, students should be able to:

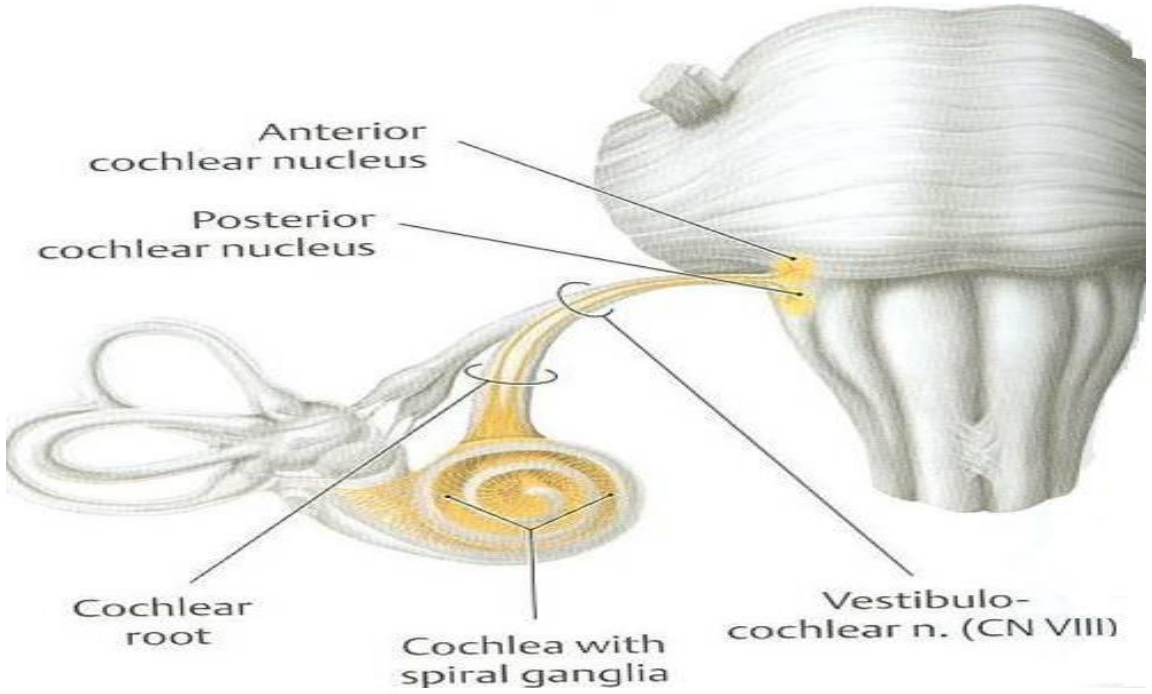
- ✓ List the **nuclei** related to **vestibular** and **cochlear nerves** in the brain stem.
- ✓ Describe the **type** and **site** of each nucleus.
- ✓ Describe the **vestibular pathways** and its main connections.
- ✓ Describe the **auditory pathway** and its main connections.

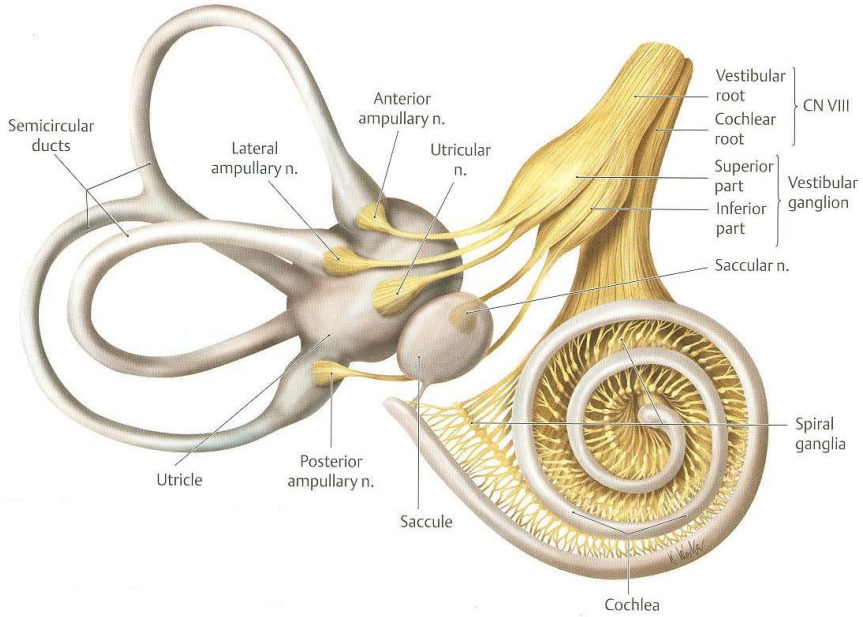
Due to the difference of arrangement of the lecture between the girls and boys slides we will stick to the girls slides then summarize the pathway according to the boys slides.



Ponto-medullary Sulcus (cerebello-pontine angle)

Recall: both cranial nerves 8 and 7 emerge from the ventral surface of the brainstem at the ponto-medullary sulcus (cerebello-pontine angle)



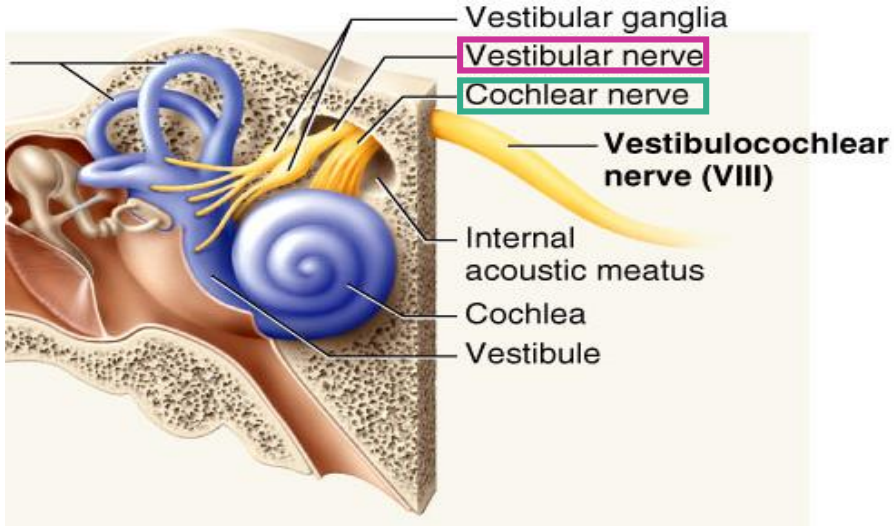


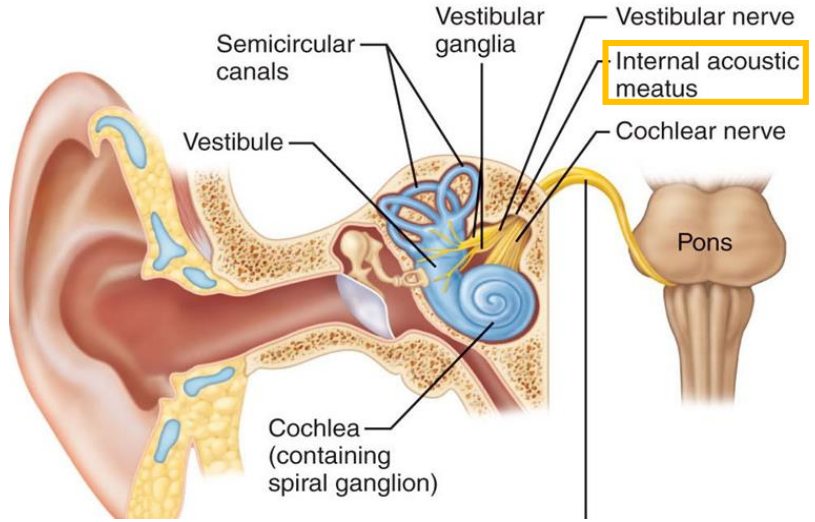
Brain – Ventral Surface

Vestibulo-Cochlear (VIII) 8th Cranial Nerve

- Type: **Special sensory** (SSA)
- Conveys impulses from inner ear to nervous system.
- Components:
  - **Vestibular part**: conveys impulses associated with body posture ,balance and coordination of head & eye movements.
  - **Cochlear part**: conveys impulses associated with hearing.
- Vestibular & cochlear parts attach to the ventral surface* of brain stem through the pontomedullary sulcus at the junction of the medulla & pons **(cerebellopontine angle)*** (**lateral to facial nerve**), run laterally in posterior cranial fossa and enter the **internal acoustic meatus** along with 7th (facial) **nerve.**

*see the previous slide





Only on the girl's slides

Auditory Pathway

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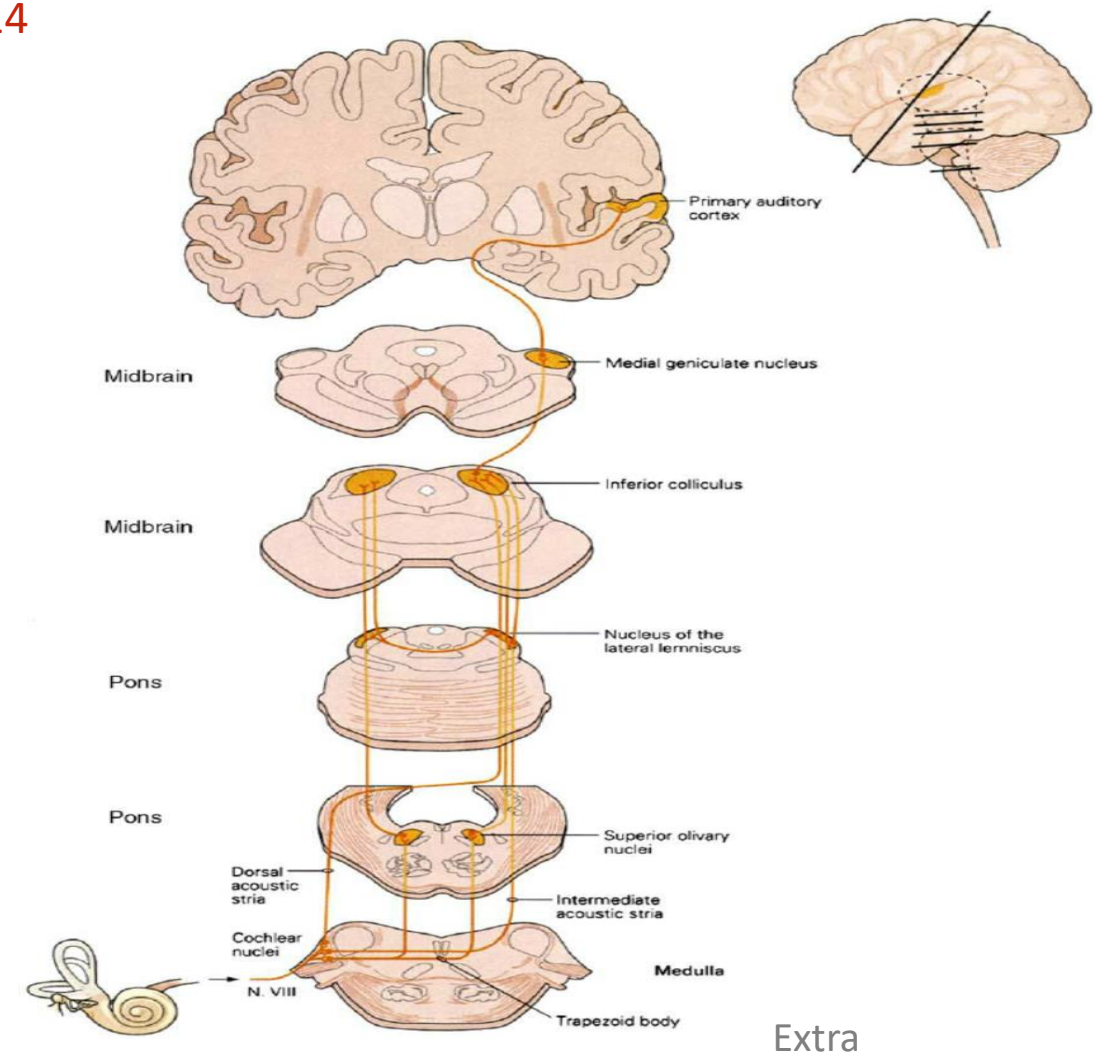
Characteristics:

- It is a **multisynaptic** pathway
- There are several locations between **medulla** and the **thalamus** where axons may synapse and not all the fibers behave in the same manner.
- Its important to know the characteristics to know what is affected when there is a lesion.



Extra

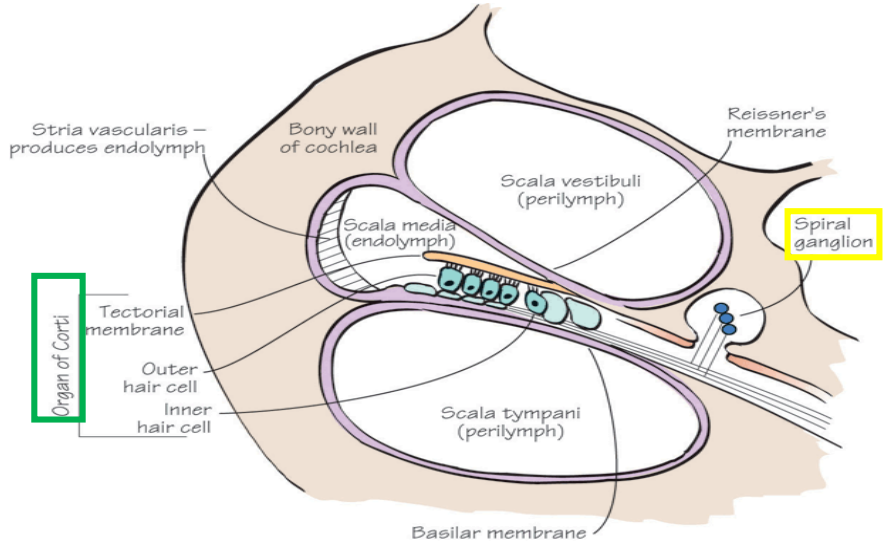
The auditory pathway involves the cochlear part of the vestibulocochlear nerve

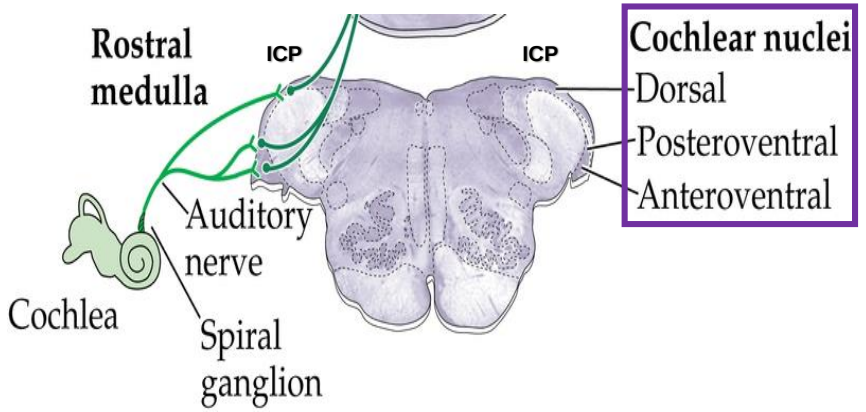
Auditory Pathway
Cochlear (Auditory) Nerve

- The Peripheral processes make dendritic contact with hair cells of the **organ of Corti** within the cochlear duct of the inner ear.

- **(1st order neurons)** The cell bodies are located in the **spiral ganglion** within the **cochlea** (organ of Corti in inner ear) axons form cochlear nerve.

- The **central processes (cochlear nerve fibers)** terminate in the **(2nd order neurons) dorsal and ventral cochlear nuclei** which lie close to the **inferior cerebellar peduncle (ICP)** in open rostral medulla.





Cochlear nuclei belong to **special somatic afferent** column in brain stem.

Auditory Pathway

From the (dorsal and ventral **cochlear nuclei**, 2nd **order neurons**, fibres ascend into the pons, where:

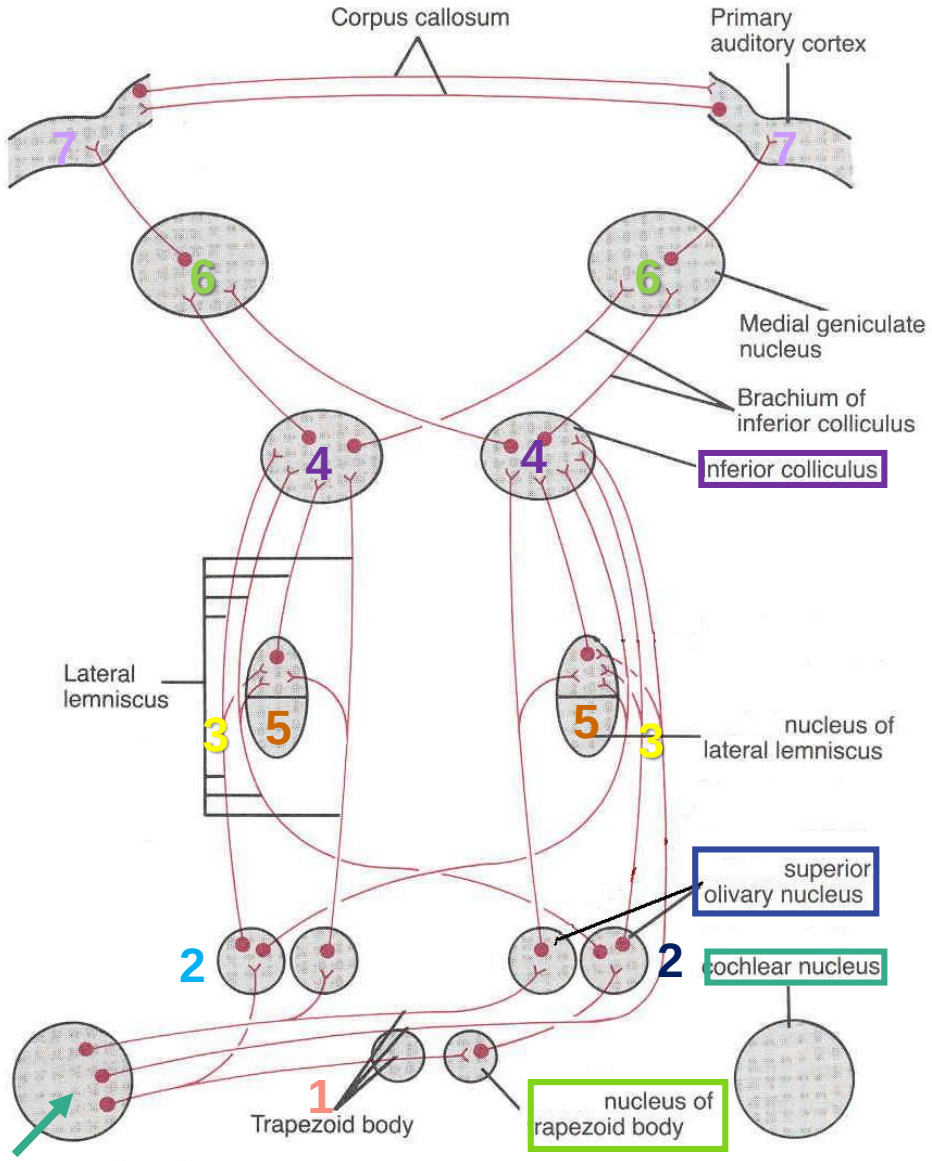
Most fibers cross the midline in **trapezoid body** (1) and terminate in:

- the **nucleus** of trapezoid body
- in the contralateral **superior olivary nucleus** (2)

Some fibers run ipsilaterally and terminate in the **superior olivary nucleus** (2).

From the superior olivary nuclei, ascending fibers comprise the **lateral lemniscus** (3) containing both crossed (mainly) and direct (few) cochlear fibres,

- Some axons within **lateral lemniscus** terminate in small nucleus of the lateral lemniscus (5)
- which runs through tegmentum of pons and terminate in the **(3rd order neurones)**: **inferior colliculus*** (4) of the midbrain



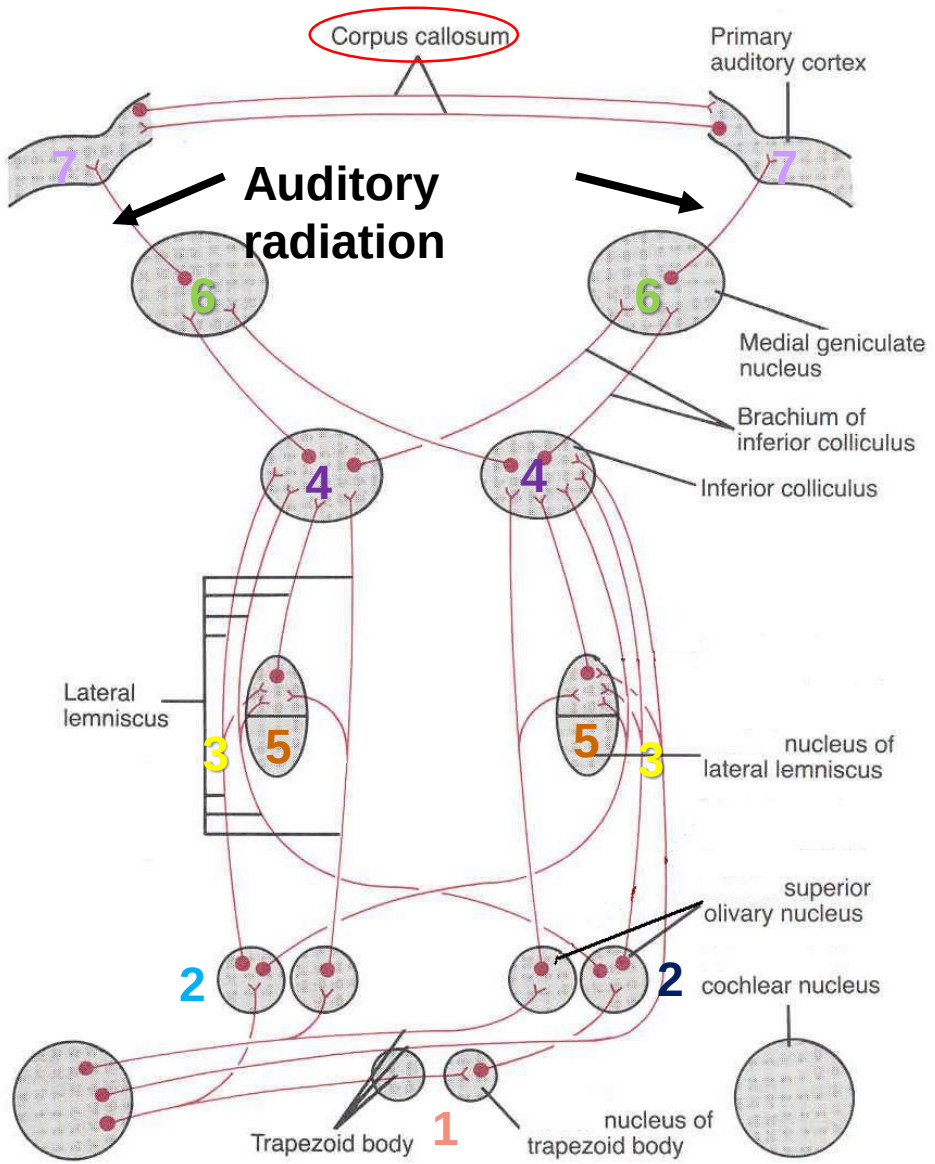
*Both colliculi are inter-connected by **commissural fibers**

Auditory Pathway

The **inferior colliculi** project to **(4th order neurons) medial geniculate nuclei** of thalamus (6)

The axons originating from the medial geniculate nucleus (auditory radiation) pass through **sublenticular part** of the **internal capsule** to:

the **primary auditory cortex** (Brodmann's areas 41, 42) located in the dorsal surface of the superior temporal gyrus (Heschl's gyrus) (7)



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Auditory Pathway

- Auditory radiation ends in primary auditory cortex (superior temporal gyrus) which is connected to auditory association cortex.
- The region surrounding the **primary auditory cortex** is known as the auditory association cortex or **Wernick's area** (**Brodmann's areas 22**) Wernick → ear
- Wernick's area is related to recognition and processing of language by the brain.

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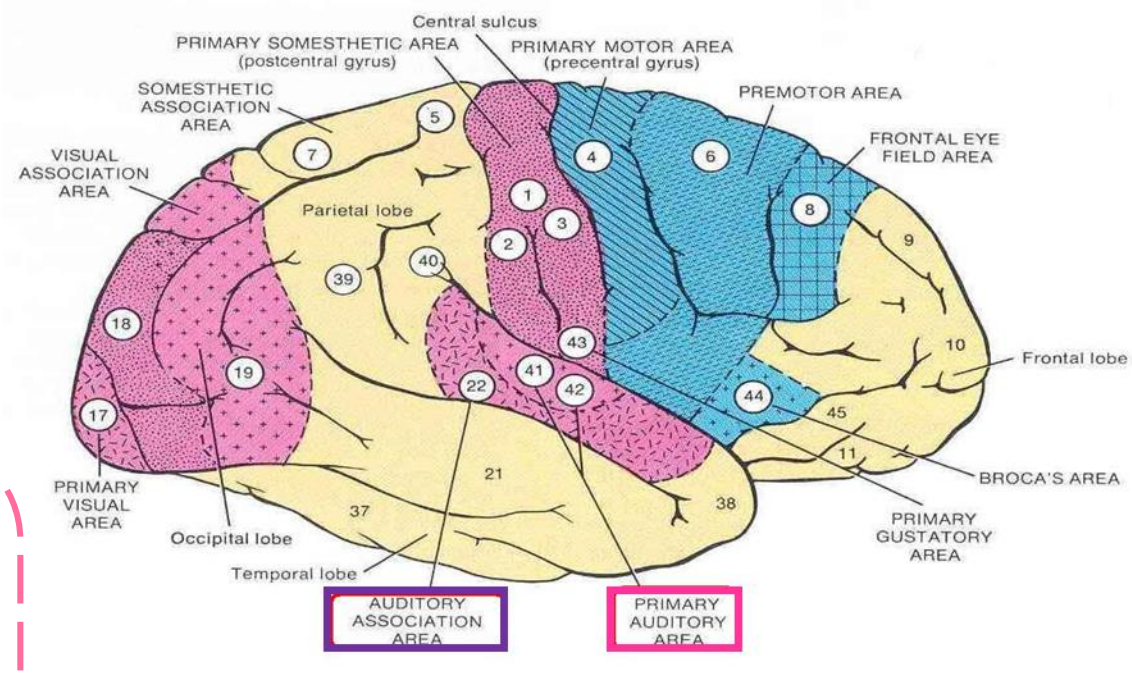

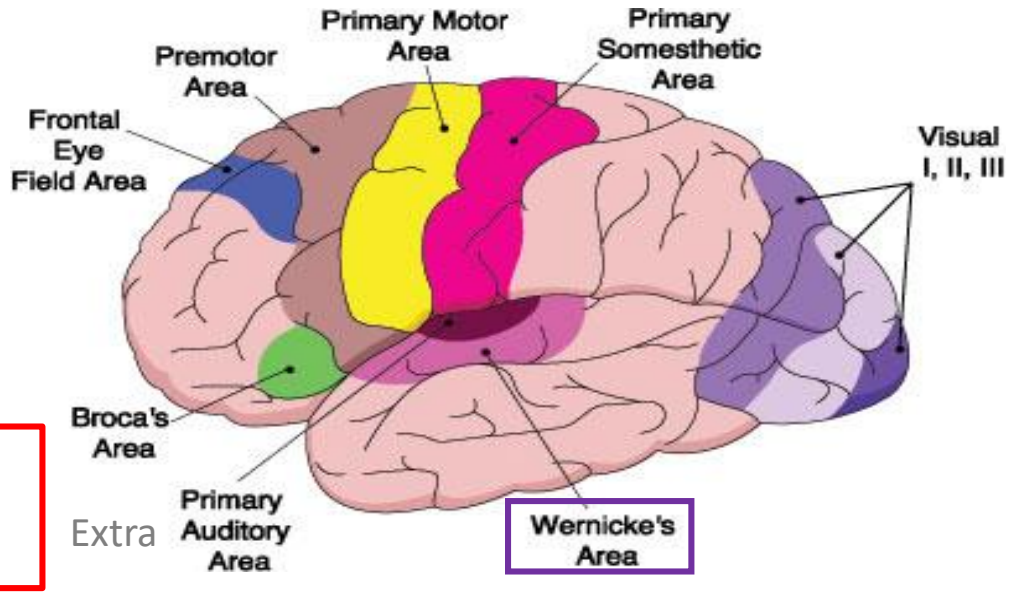

Extra

IMPPRTANT: Representation of cochlea is bilateral at all levels above cochlear nuclei.

Auditory Pathway
Other Functions of some nuclei

- **Superior olivary nucleus** sends olivocochlear fibers to end in **organ of Corti** through the vestibulocochlear nerve. These fibers are **inhibitory** in function and serve to modulate transmission of sound to the cochlear nerve.
- **Superior olivary nucleus** & the **nucleus of the lateral lemniscus** establish reflex connections with motor neurons of trigeminal and facial motor nuclei mediating contraction of **tensor tympani** and **stapedius muscles** as They reduce the amount of sound that gets into the inner ear in response to loud noise.
- **Inferior colliculi** establish reflex connections with motor neurons in the cervical spinal segments (**tectospinal tract**) for the movement of head and neck in response to auditory stimulation.

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Auditory Pathway (summary arranged according to boys slides)

First order neurons:
Cells of spiral ganglion in the cochlea.
Axons form cochlear nerve.

↓

Cochlear nerve makes dendritic contact with hair cells of organ of corti in cochlear duct.

↓

Both cochlear & vestibular nerves meet and emerge through internal auditory meatus to cranial cavity.

↓

Both cochlear & vestibular nerves enter pons through pontocerebellar angle. (lateral to facial nerve)

Second order neurons:
Cells of dorsal and ventral cochlear nuclei in pons.

↓

On ascending most axons decussate in the **trapezoid body** (in caudal pons) and form **lateral lemniscus** u can see in caudal & mid pons

Some fibers end in **superior olivary nucleus** & **nucleus of lateral lemniscus** which modulate transmission of auditory information to cochlear nerve by:

1. Sending inhibitory fibers through vestibulocochlear nerve ending in organ of corti

2. Establishing connection with motor neurons suppling **tensor tympani & stapedius muscle**

Third order neurons:
Cells of inferior colliculus (midbrain).
Both colliculi are inter-connected by **commissural fibers**

↓

Fourth order neurons:
Cells of medial geniculate nucleus (thalamus).

↓

Axons form auditory radiation that pass through retrolenticular part of internal capsule

↓

Auditory radiation ends in **primary auditory cortex** (superior temporal gyrus) which is connected to auditory association center.

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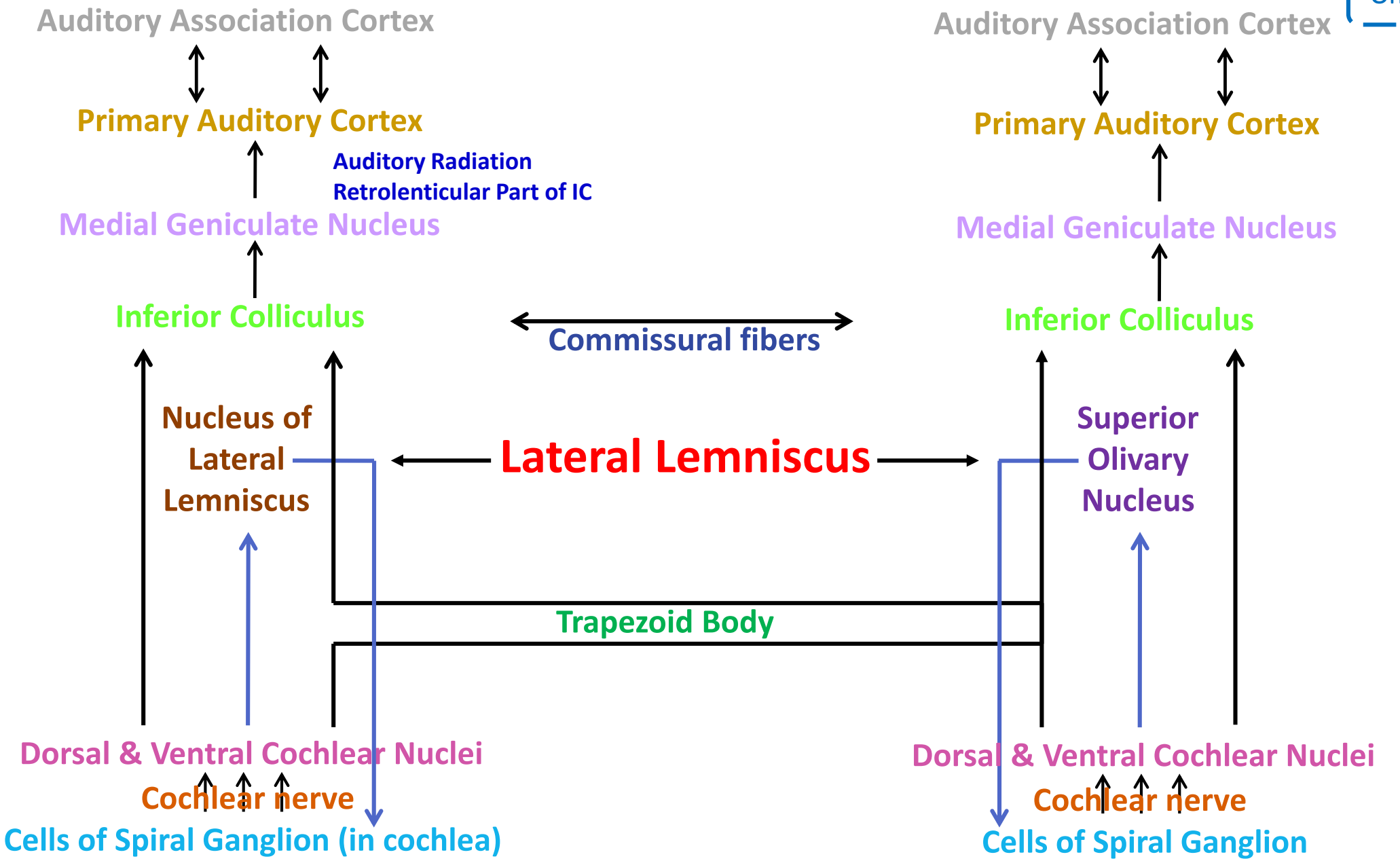

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Vestibular Pathway

Note: pay attention to form (يكون) and from (من عند)

1st order neurons

- The cell bodies are located in the **vestibular ganglion** within the internal auditory meatus.

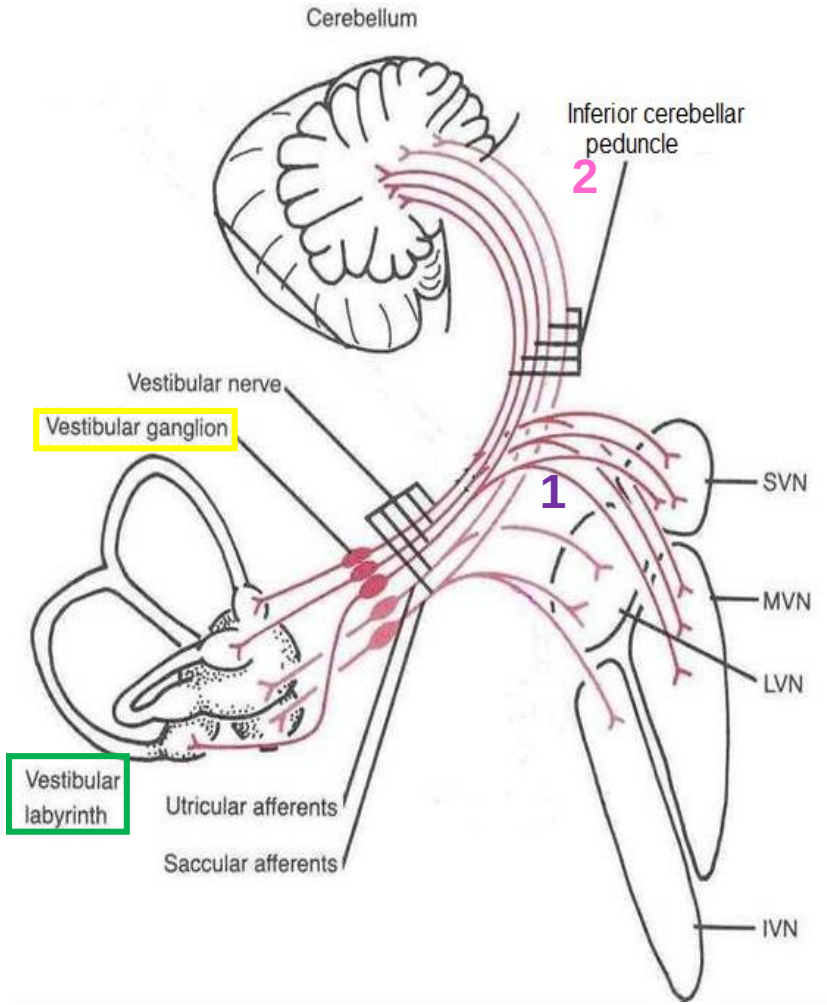
- The Peripheral processes/axons (vestibular nerve fibers) make dendritic contact with hair cells in vestibule & semicircular canals of the membranous labyrinth (inner ear).

- The central processes form the vestibular nerve and go to

2nd order neurons

1. Mostly end up in the **lateral, medial, inferior and superior vestibular nuclei** of the rostral medulla, (located beneath the lateral part of the floor of 4th ventricle)

3. Some fibers go to the cerebellum through the inferior cerebellar peduncle

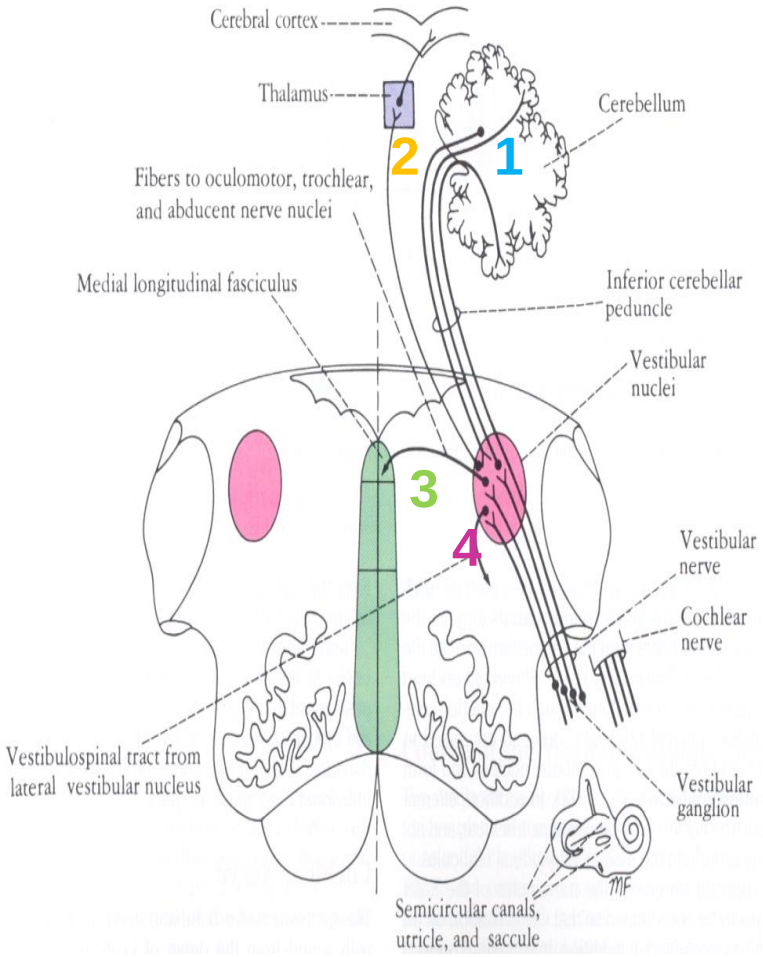


Vestibular nuclei belong to **special somatic afferent** column in brain stem.

Vestibular Pathway

Axons (Efferents) from the vestibular nuclei project to number of other regions:

1	To ipsilateral **flocculonodular lobe of cerebellum** (vestibulo-cerebellar tract)	through **inferior cerebellar peduncle**	for maintenance of equilibrium
2	Bilaterally (cross midline and ascend) to **ventral posterior nucleus of thalamus**	which in turn project to the vestibular area in **cerebral cortex**	for conscious awareness of vestibular stimulation.
3	Bilaterally to **motor nuclei of cranial nerves** (vestibulo-ocular tract)	through **medial longitudinal fasciculus**	for co-ordination of head & eye movements and the
4	To motor neurons (anterior horn cells) of the spinal cord: A. directly as **lateral** (ipsilateral), and B. join MLF (medial longitudinal fasciculus) and descend as **medial vestibulospinal** (bilateral) tracts through medial longitudinal fasciculus		for control of posture



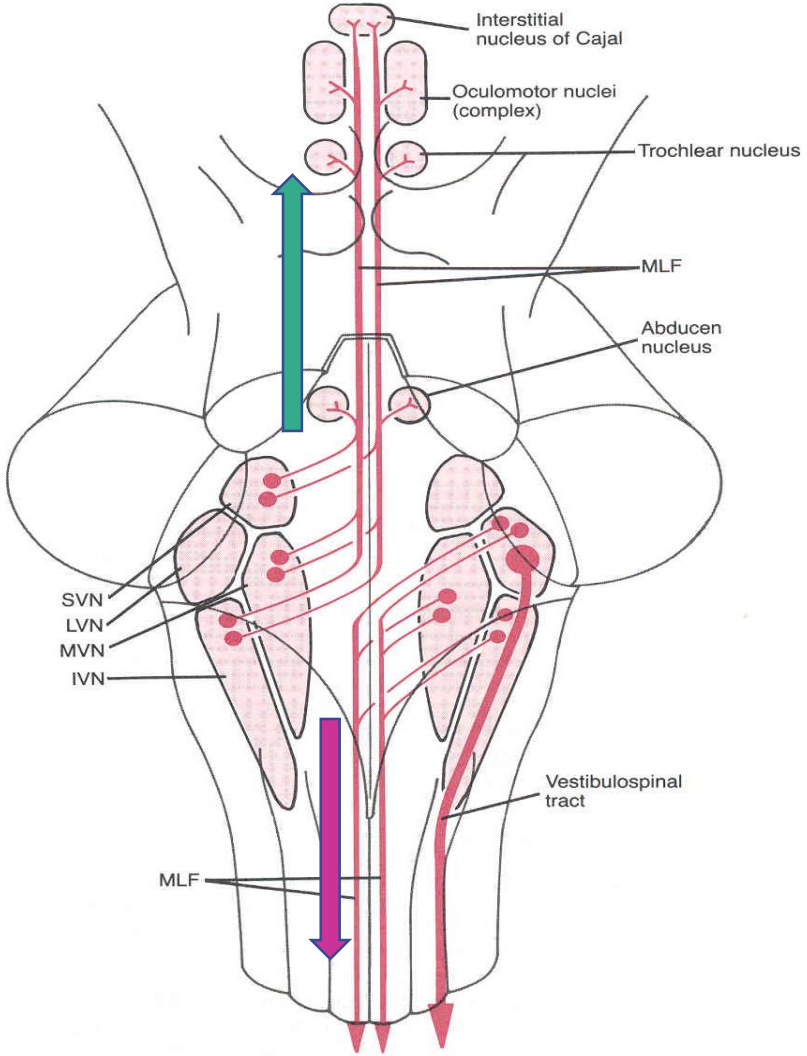
Vestibular Pathway

Medial Longitudinal Fasciculus

Also called medial longitudinal bundle

- Extends through out the brain stem and formed of both descending & ascending fibers
- Projects **bilaterally**
- Has <u>two</u> components:

The ascending component (**vestibulo-ocular**) (number 3 in previous slide)	The descending component (number 4B in previous slide)
establishes connections with the nuclei of the **Occulomotor, Trochlear & Abducent** nerves (motor nuclei for extraoccular muscles)	extends into anterior horn cells of the spinal cord as the **medial vestibulospinal tract**
for **coordination** of **head & eye movements**	for control the **body posture & balance**



Vestibular Pathway

Vestibulospinal Tracts

- Vestibulospinal fibers influence the activity of spinal motor neurons concerned with the control of **body posture** and **balance**.
- Two tracts: **lateral** & **medial**
  - **Lateral** arises from lateral vestibular (Deiter's) nucleus, descends **ipsilaterally** (efferent number 4A mentioned previously)
  - Medial is the descending part of the medial longitudinal fasciculus, projects **bilaterally**. (efferent number 4B mentioned previously)

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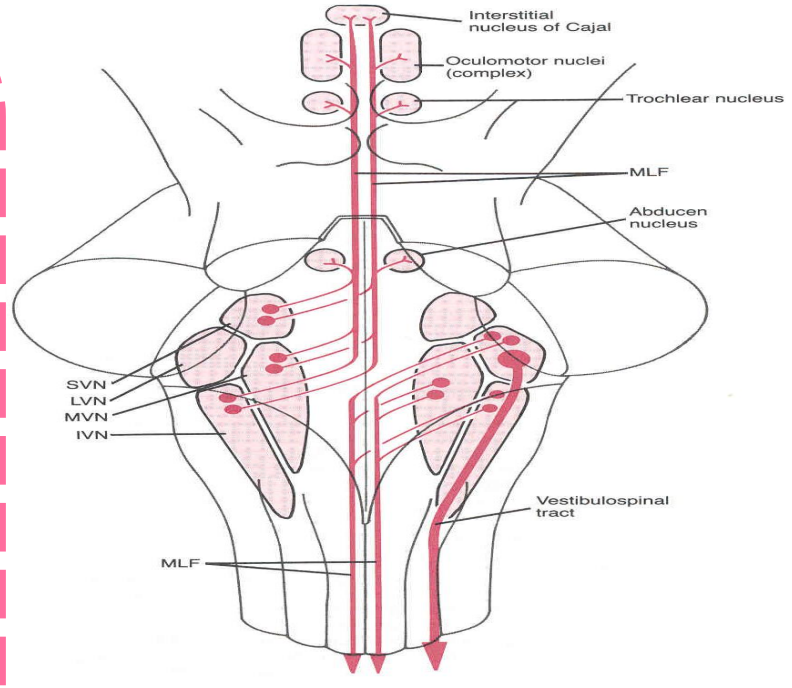
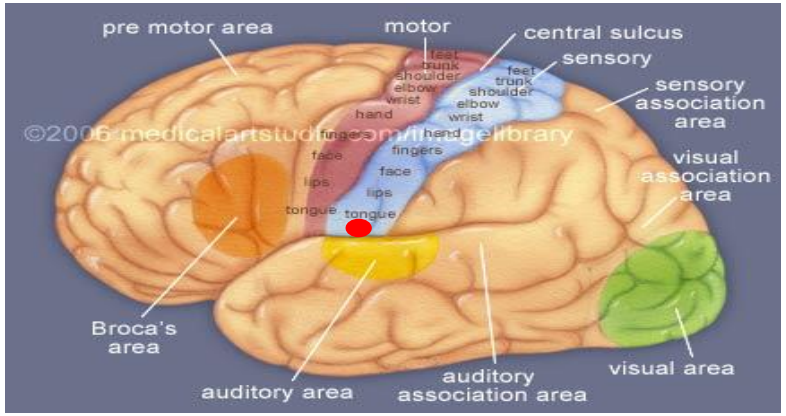


Vestibular Cortex/Area

Located in the lower part of **postcentral gyrus** (head area).

- Responsible for conscious awareness of vestibular sensation.



Vestibular Pathway (summary arranged according to boys slides)

First order neurons:
Cells of vestibular ganglion located in internal auditory meatus.

↓

Axons make dendritic contacts with hair cells in vestibule & semicircular canals.

↓

Both cochlear & vestibular nerves meet and emerge through internal auditory meatus to cranial cavity.

↓

Both cochlear & vestibular nerves enter pons through pontocerebellar angle. (lateral to facial nerve)

Second order neurons:
Cells of superior, lateral, medial and inferior **vestibular nuclei** in medulla and pons.

Axons of vestibular nuclei may:

1. Descend as **lateral vestibulospinal tract** to **anterior horn cells** of spinal cord

2. Join **medial longitudinal fasciculus** & descend as **medial vestibulospinal tract** to **anterior horn cells** of spinal cord.

3. Pass through inferior cerebellar peduncle to **flocculonodular lobe** of cerebellum

4. Cross midline & ascend to **ventral posterior nucleus of thalamus** then to vestibular area in cerebral cortex.

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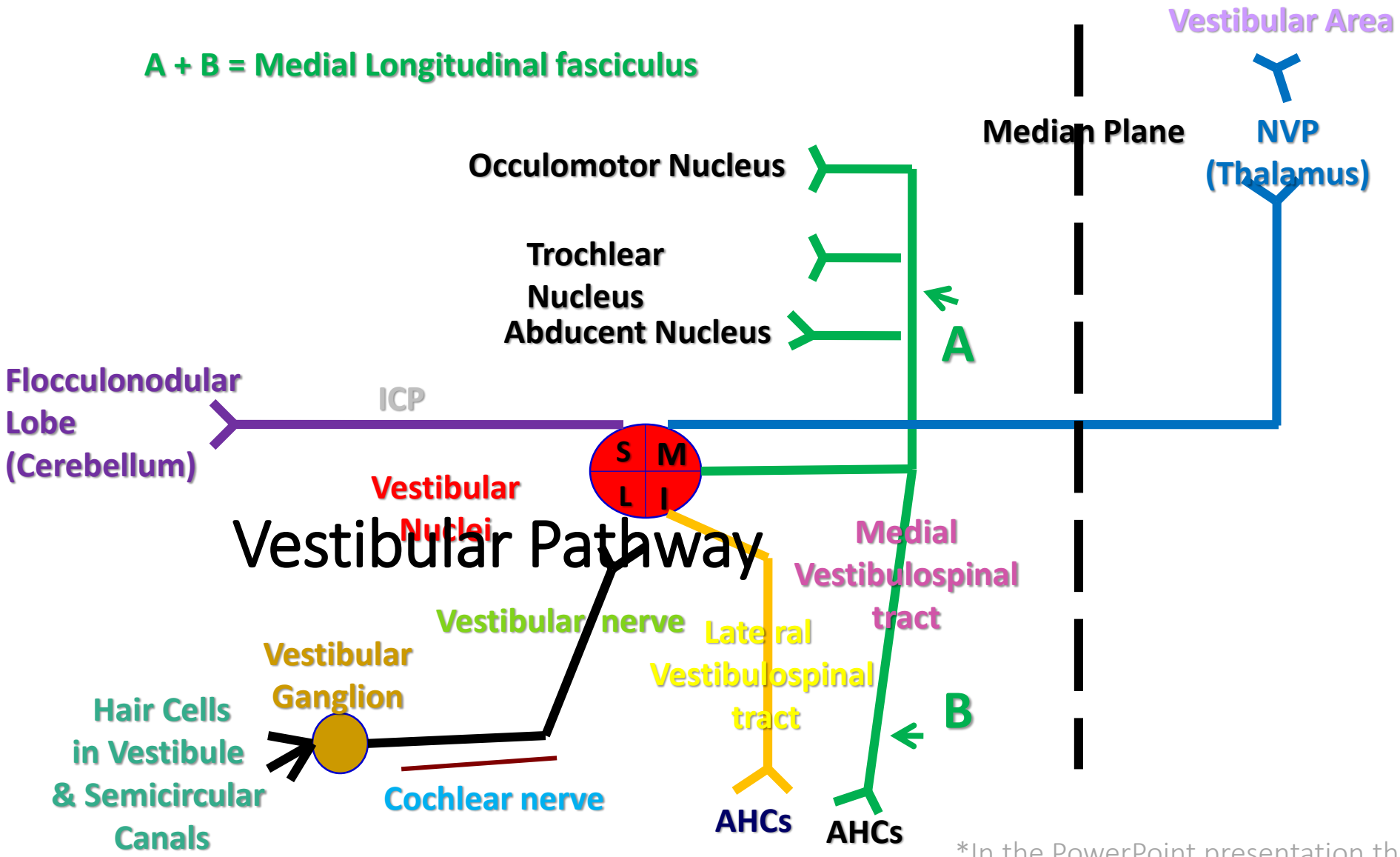
Vestibular Pathway



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Clinical Notes

- Lesion of vestibulocochlear nerve produces:
  - Deafness (Disturbance of **cochlear** nerve functions),
  - Tinnitus, vertigo, dizziness, nausea, nystagmus, loss of balance and ataxia (disturbance of **vestibular** nerve functions).
- Acoustic neuroma: a benign tumor of 8th nerve leads to compression of the nerve leading to attacks of dizziness, and profound deafness and ataxia.

- Rostral to the cochlear nuclei the representation of cochlea is essentially bilateral at all levels. (important!)
- So, Lesions anywhere along the pathway usually have no obvious effect on hearing, producing weakness of hearing in both ears but mostly in the opposite ear.
- **Complete Deafness** of the affected ear is essentially only caused by damage to the middle ear, cochlea, or auditory nerve.

*If there is damage above the level of cochlear nucleus there will be weakness in both ears
*If there is damage below the level of cochlear nucleus there will be affect the same ear

Summary

- **Ganglia** related to vestibulocochlear nerve are located in the **inner ear**.
- **Vestibular** & **cochlear nerves** pass through **internal auditory meatus** to cranial cavity, then enter pons at **pontocerebellar angle**, lateral to facial nerve.
- **Cochlear** & **vestibular nuclei** are of the **special somatic afferent** type (receiving special afferent sensation, hearing and equilibrium), and are located in pons & medulla.
- **Inferior colliculi**, **medial geniculate nucleus** and finally **auditory cortex** are stations in cochlear pathway.
- **Hearing is bilaterally represented**.
- **Vestibular** nuclei are connected to: **spinal cord** (directly or through medial longitudinal fasciculus), **flocculonodular** lobe of cerebellum and to **vestibular area of cerebral cortex**.

MCQs

(1) The third order neurons of the auditory pathway are found in?

A) Midbrain
B) thalamus
C) pons
D) cerebral cortex

(2) Regarding the vestibular pathway?

A) the vestibular ganglion is located in the middle ear
B) the vestibular nuclei are located in the midbrain
C) the vestibular nuclei are connected to the cerebellum
D) the vestibulospinal tracts are located in the lateral white column of the spinal cord

(3) The vestibular nuclei are connected to the oculomotor neuron though?

A) lateral lemniscus
B) lateral vestibulospinal tract
C) medial longitudinal fascicul
D) vestibular nerve

(4) Vestibular nuclei belong to ___ column in brain stem?

A) special somatic afferent
B) special somatic efferent
C) special visceral afferent
D) special visceral efferent

(5) The vestibular cortex is located in?

A) precentral gyrus
B) postcentral gyrus
C) post-temporal gyrus
D) pretemporal gyrus

(6) The primary auditory cortex is located in?

A) superior temporal gyrus
B) inferior temporal gyrus
C) superior frontal gyrus
D) inferior frontal gyrus

(7) The fourth order neurons of the auditory pathway are?

A) cells of spiral ganglion in the cochlea
B) cells of dorsal and ventral cochlear nuclei
C) cells of inferior colliculus
D) medial geniculate nuclei

(8) Both cochlear & vestibular nerves enter pons through?

A) inferior cerebral peduncle
B) pontocerebellar angle
C) anterolateral olivary sulcus
D) basilar sulcus

(9) The first order neurons of vestibular ganglion located in?

A) External auditory meatus
B) Internal auditory meatus
C) Middle auditory meatus
D) None of the above

(10) The central processes of cochlear nerve fibers terminate in the?

A) Dorsal and ventral cochlear nuclei
B) Dorsal cochlear nuclei
C) Dorsal and ventral cochlear nuclei
D) None of them above

Answers

(1) A
(2) C
(3) C
(4) A
(5) B
(6) A
(7) D
(8) B
(9) B
(10) A

SAQ

(1) Lesion of vestibulocochlear nerve produces?

- deafness (disturbance of cochlear nerve functions)
- tinnitus, vertigo, dizziness, nausea, nystagmus, loss of balance and ataxia(disturbance of vestibular nerve functions)

(2) Vestibular Cortex/Area Responsible for?

- conscious awareness of vestibular sensation.

(3) The difference between the lateral & medial tracts?

- Lateral arises from lateral vestibular (Deiter's) nucleus, descends ipsilaterally.
- Medial is the descending part of the medial longitudinal fasciculus, projects bilaterally.

Good luck
Special thank for team436 ❤

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- References:
  1. Girls' & Boys' Slides
  2. Greys Anatomy for Students
  3. TeachMeAnatomy.com

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