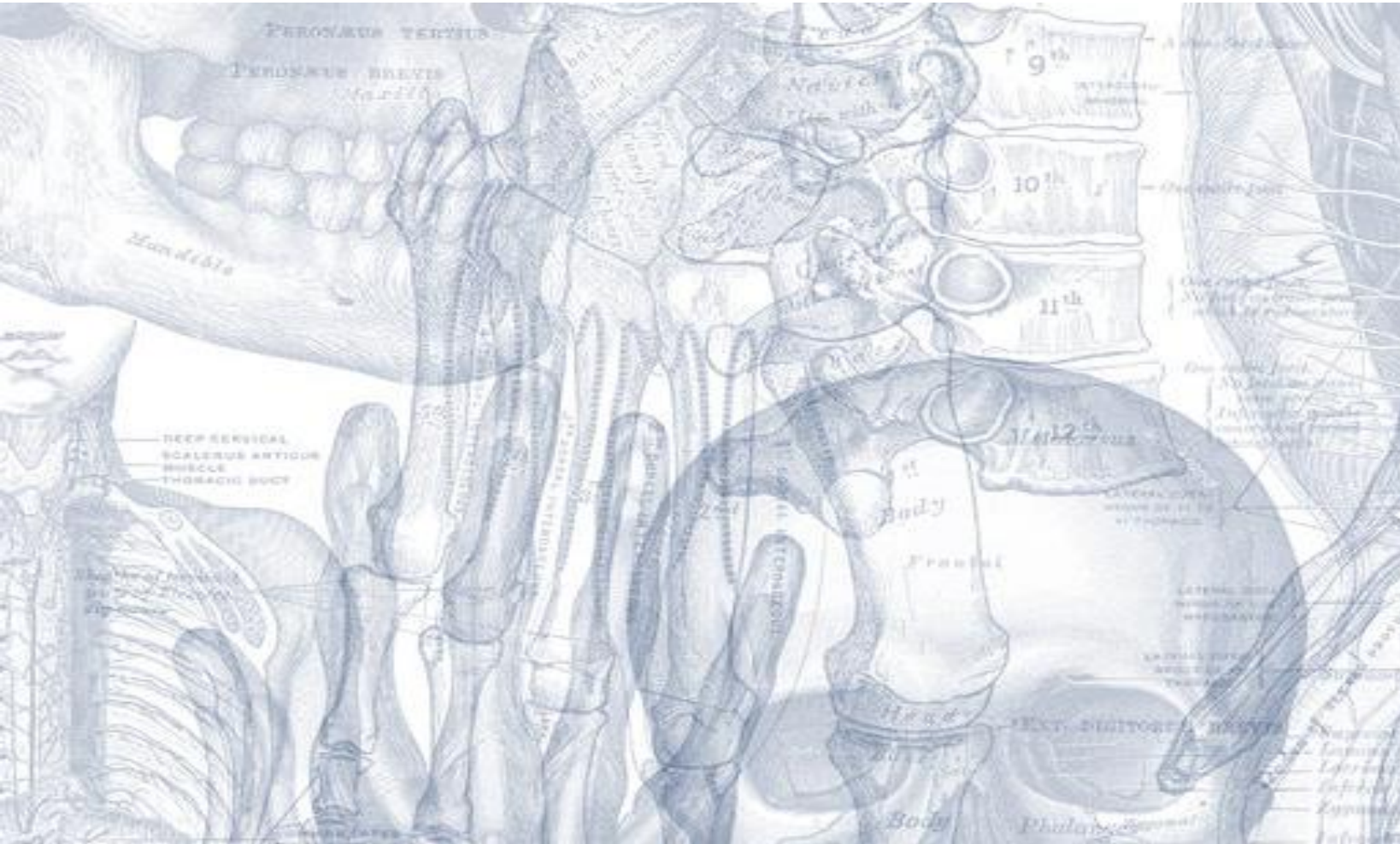


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Cranial Nerve VIII (The Vestibulo-Cochlear Nerve)

Please view our [Editing File](#) before studying this lecture to check for any changes.

Color Code

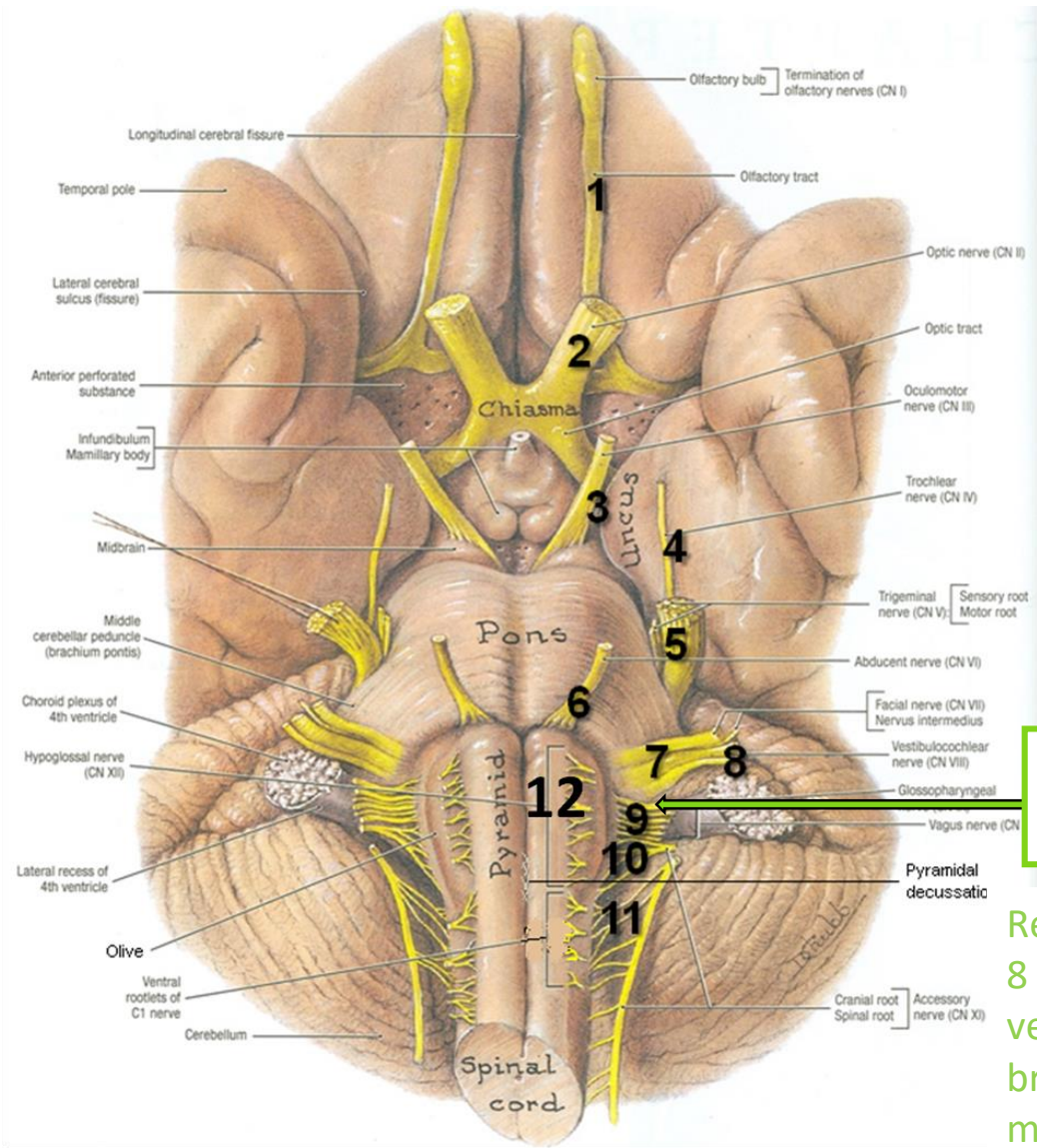
- Important
- Doctors Notes
- Notes/Extra explanation

Objectives

At the end of the lecture, the 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.

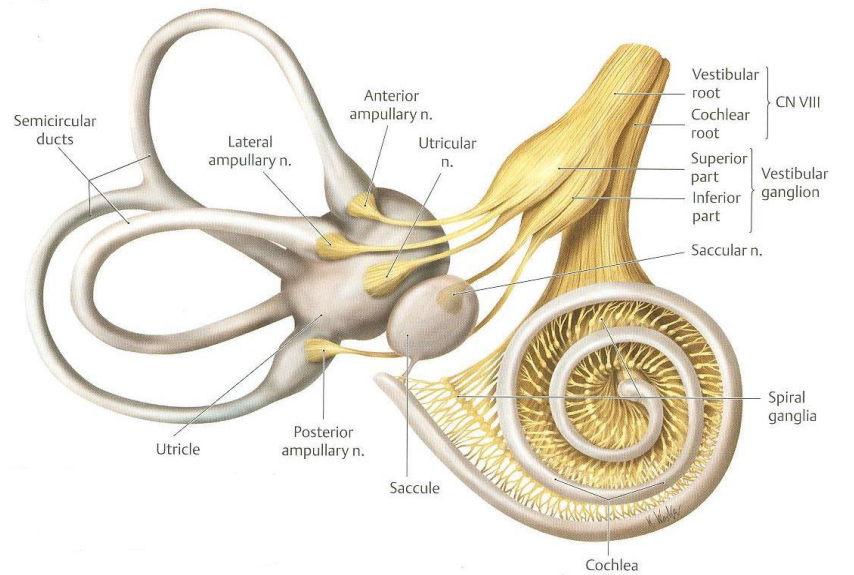
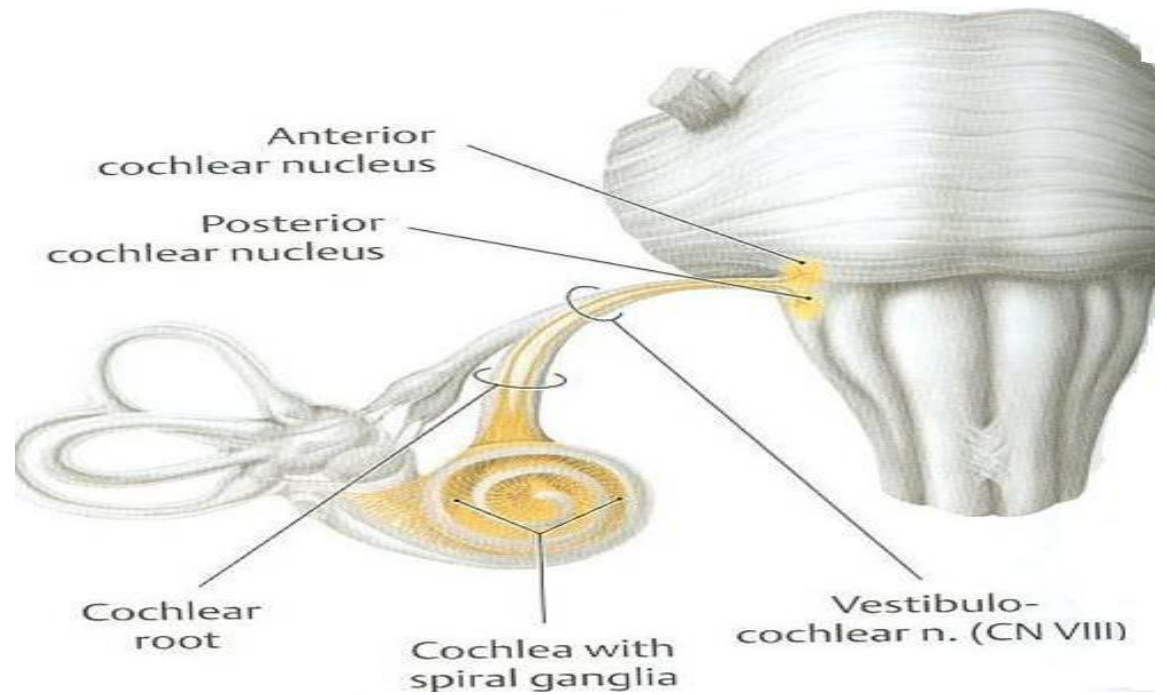
Due to the difference of arrangement of the lecture between the girls and boys slides we will stick to the girls slides then summarize the pathway according to the boys slides.



Brain – Ventral Surface

Ponto-medullary Sulcus (cerebello-pontine angle)

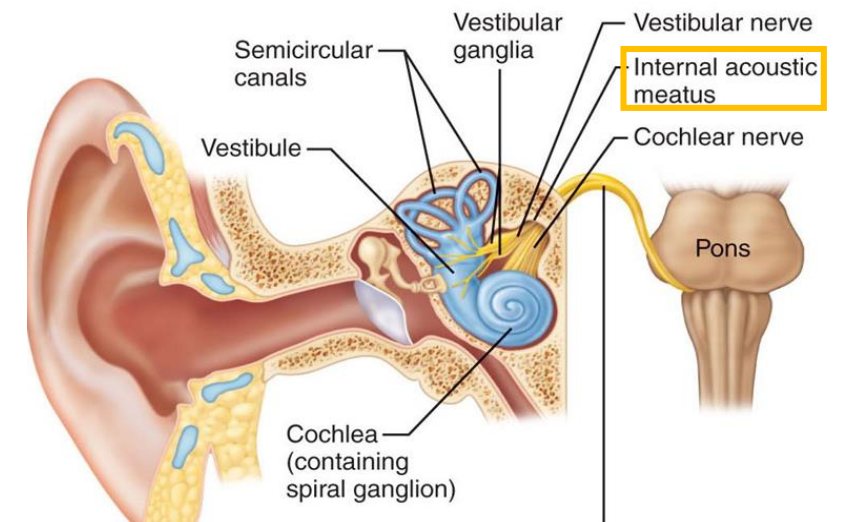
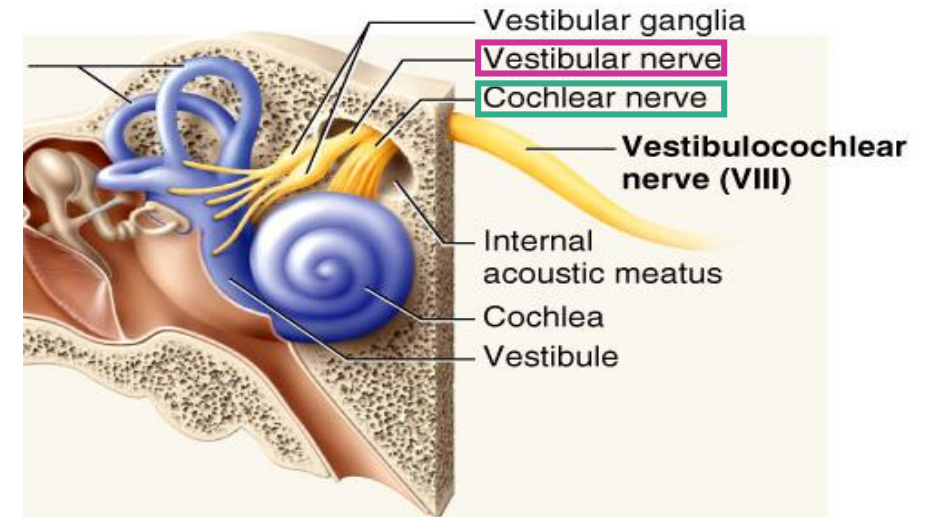
Recall: both cranial nerves 8 and 7 emerge from the ventral surface of the brainstem at the ponto-medullary sulcus (cerebello-pontine angle)



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 leave the ventral surface* of brain stem through the pontomedullary sulcus 'at 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



Auditory Pathway

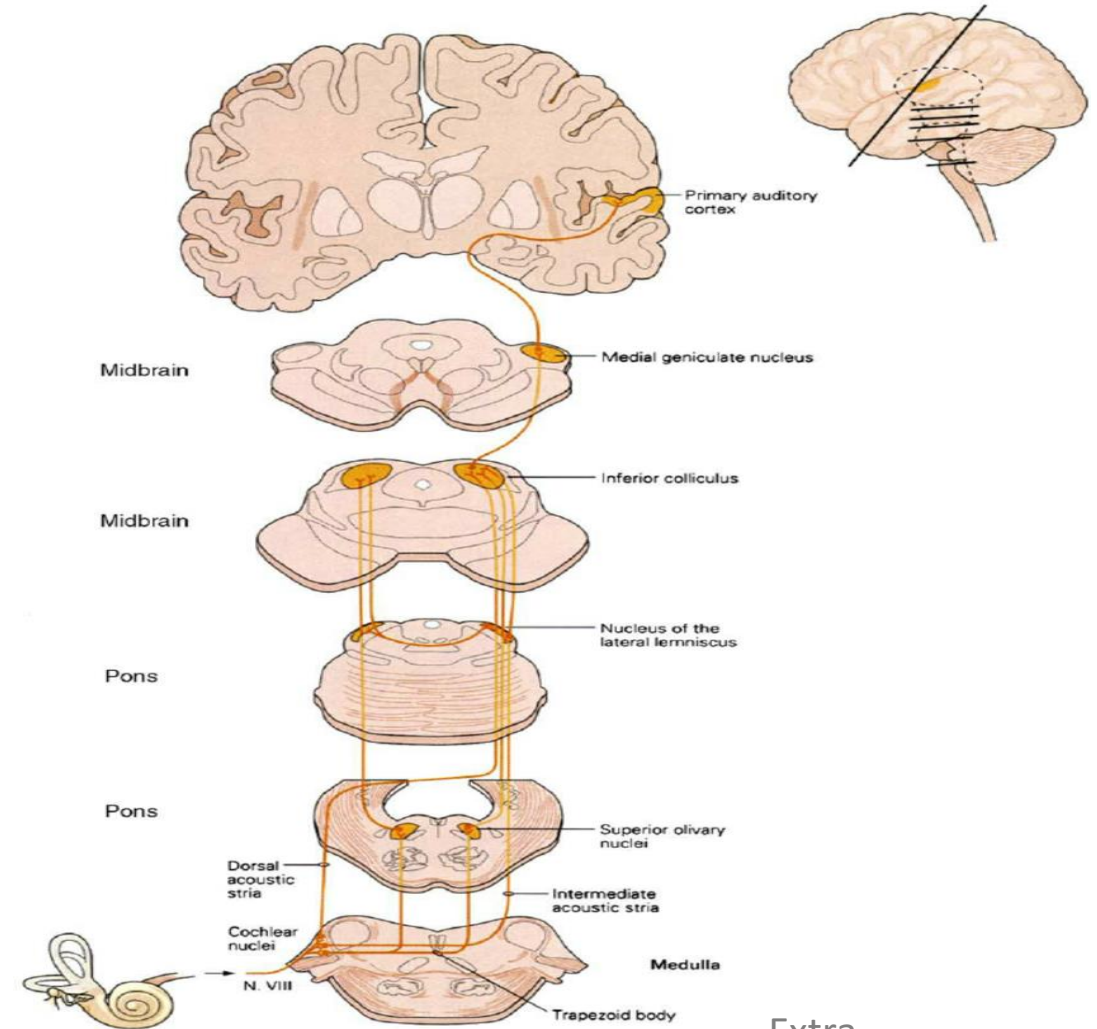


04:14

Only on the girls' slides

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.
- Representation of cochlea is bilateral at all levels above cochlear nuclei.
- Its important to know the characteristics to know what is affected when there is a lesion.



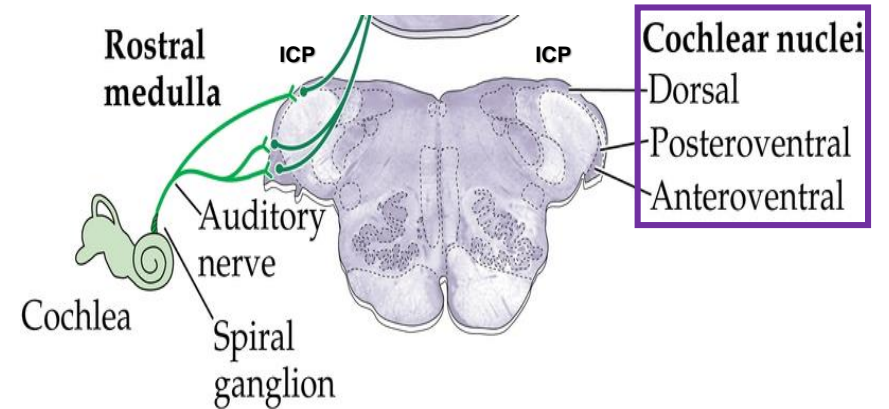
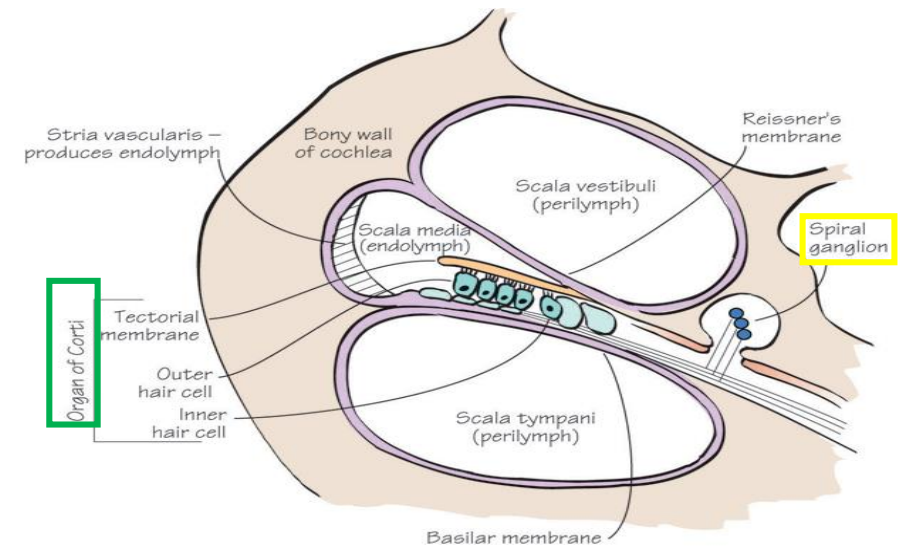
Extra

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.
- The cell bodies (**1st order neurons**) 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 **dorsal and ventral cochlear nuclei (2nd order neurons)**, 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)

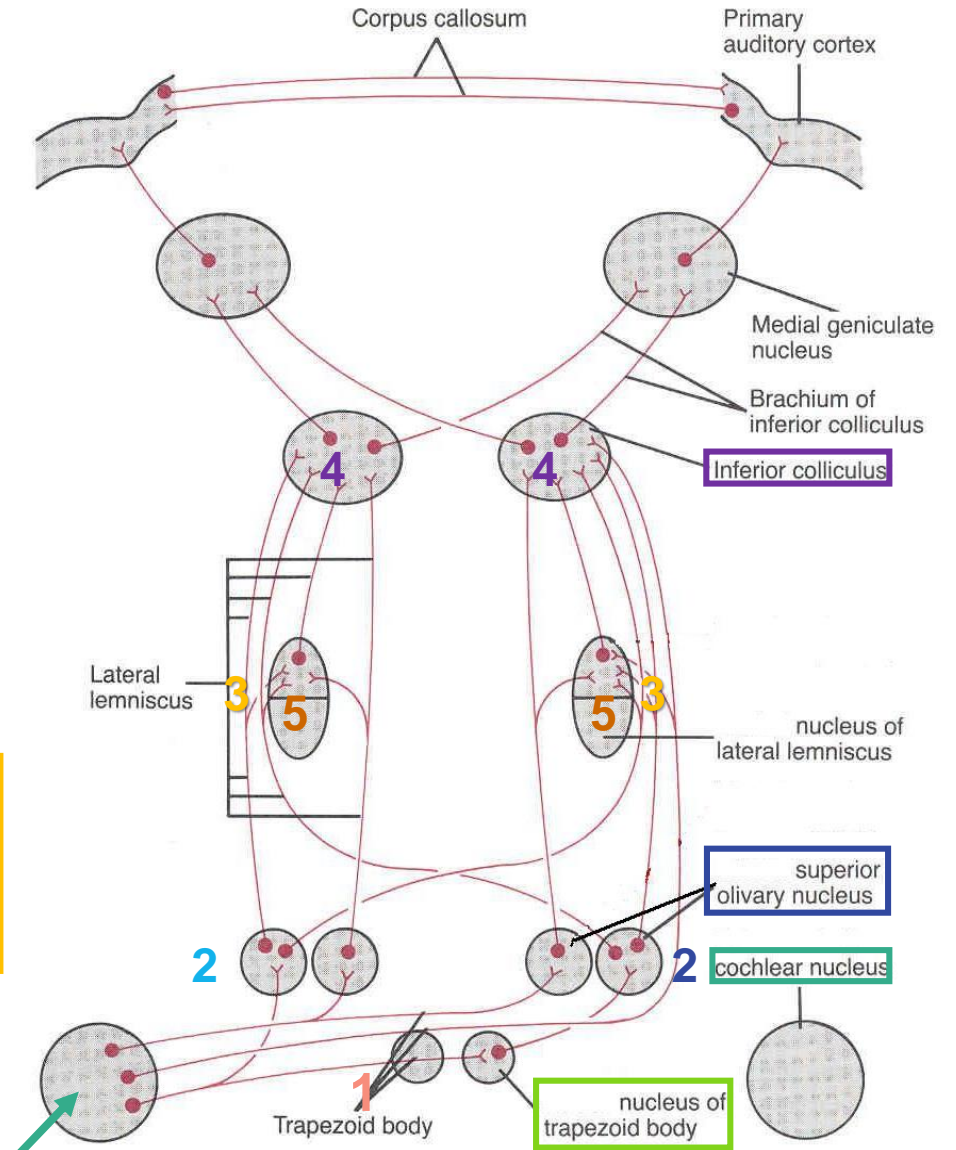
Some fibers run ipsilaterally and terminate in the **superior olivary nucleus** (2).

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 **inferior colliculus*** (4) of the midbrain (**3rd order neurones**).

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



Auditory Pathway

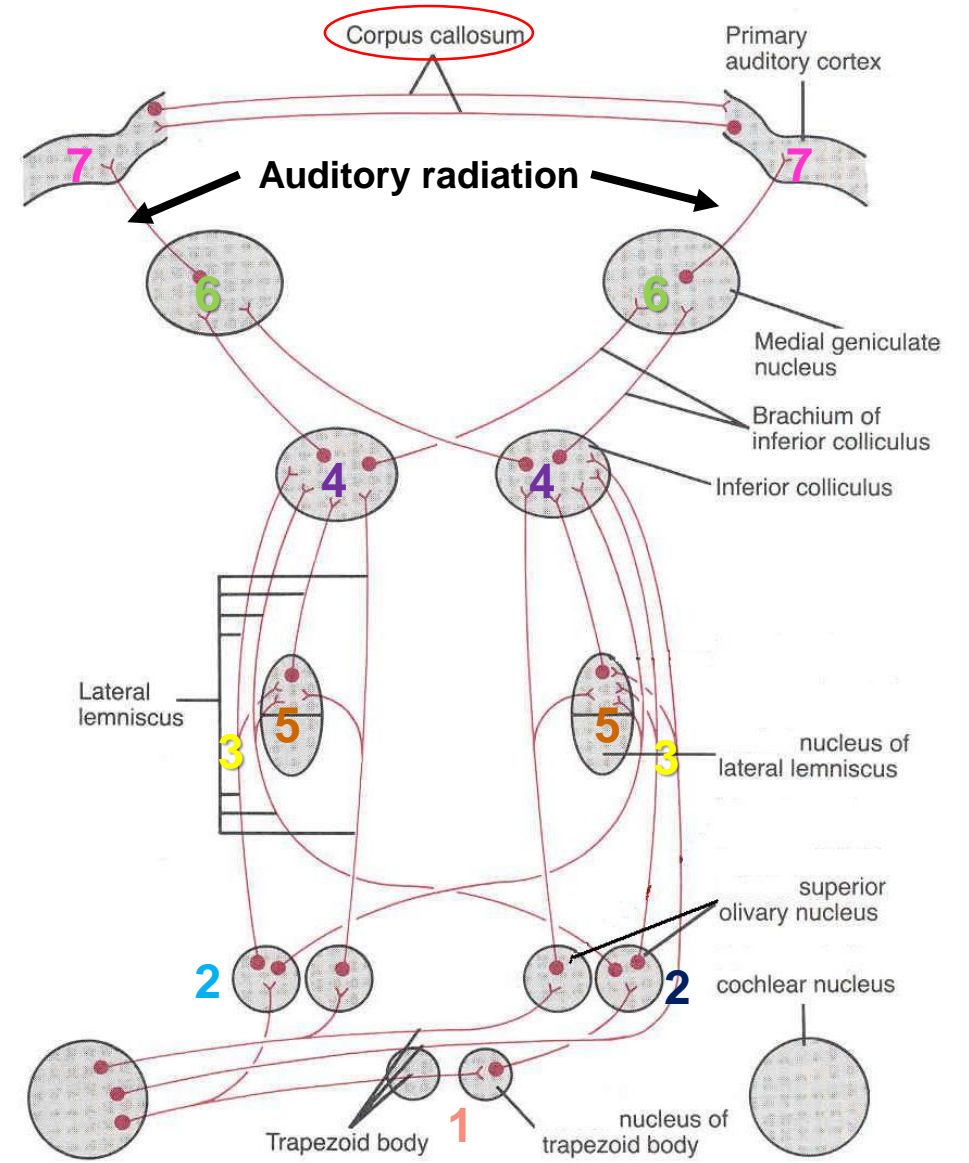
The **inferior colliculi** project to **medial geniculate nuclei (4th order neurones)** of thalamus (6)

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)

Note: brodmann's area and heschl's gyrus are only mentioned in the *girls slides*

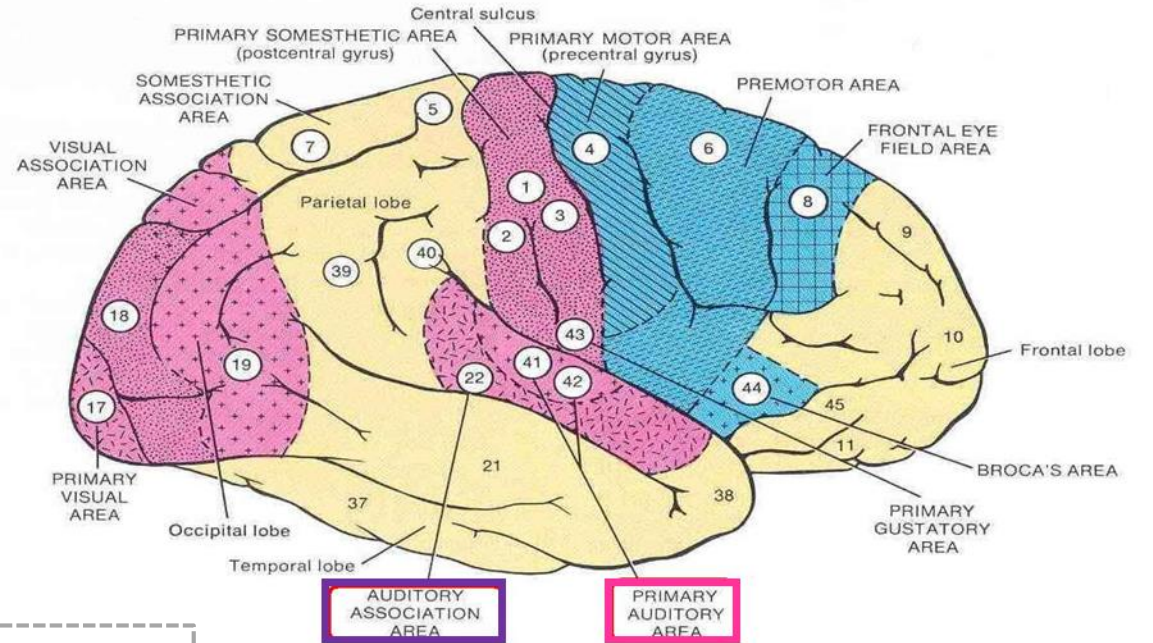
← هسكل (auditory) هشل



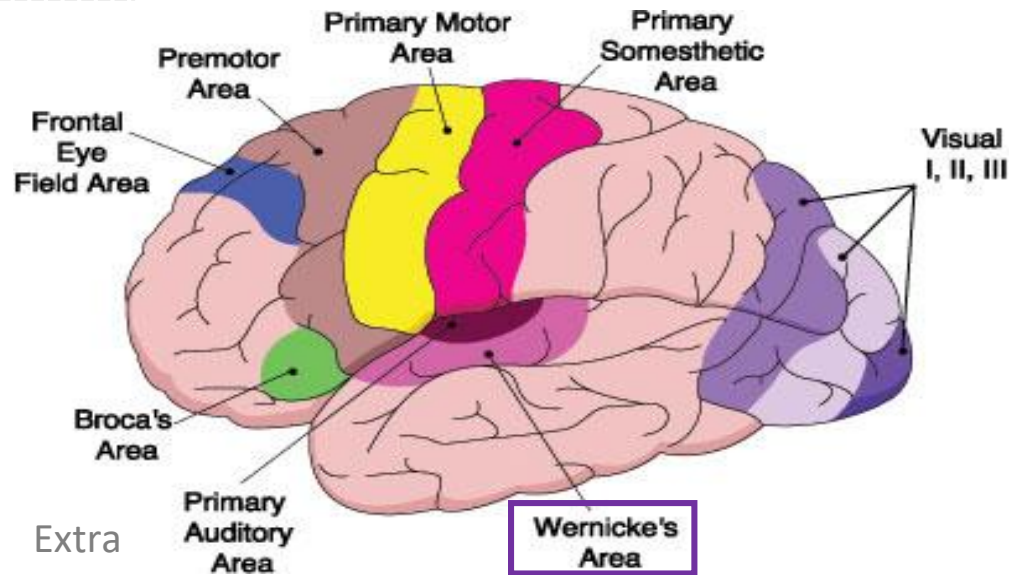
Auditory Pathway

- 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's area is related to recognition and processing of language by the brain.

Only on the girls' slides



Wernick → ear



Auditory Pathway

Other Functions of some nuclei :

- **Superior olivary nucleus & the nucleus of the lateral lemniscus**
 - 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.*
 - 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.*

Only on the girls' slides

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 and form lateral lemniscus.

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 supplying 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.

Auditory Association Cortex

Primary Auditory Cortex

Auditory Radiation
Retrolenticular Part of IC

Medial Geniculate Nucleus

Inferior Colliculus

Nucleus of Lateral Lemniscus

Dorsal & Ventral Cochlear Nuclei

Cochlear nerve

Cells of Spiral Ganglion (in cochlea)

Auditory Association Cortex

Primary Auditory Cortex

Medial Geniculate Nucleus

Inferior Colliculus

Superior Olivary Nucleus

Dorsal & Ventral Cochlear Nuclei

Cochlear nerve

Cells of Spiral Ganglion

Only on the boys' slides

Commissural fibers

Lateral Lemniscus

Trapezoid Body

In the PowerPoint presentation this slide is animated.

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*.

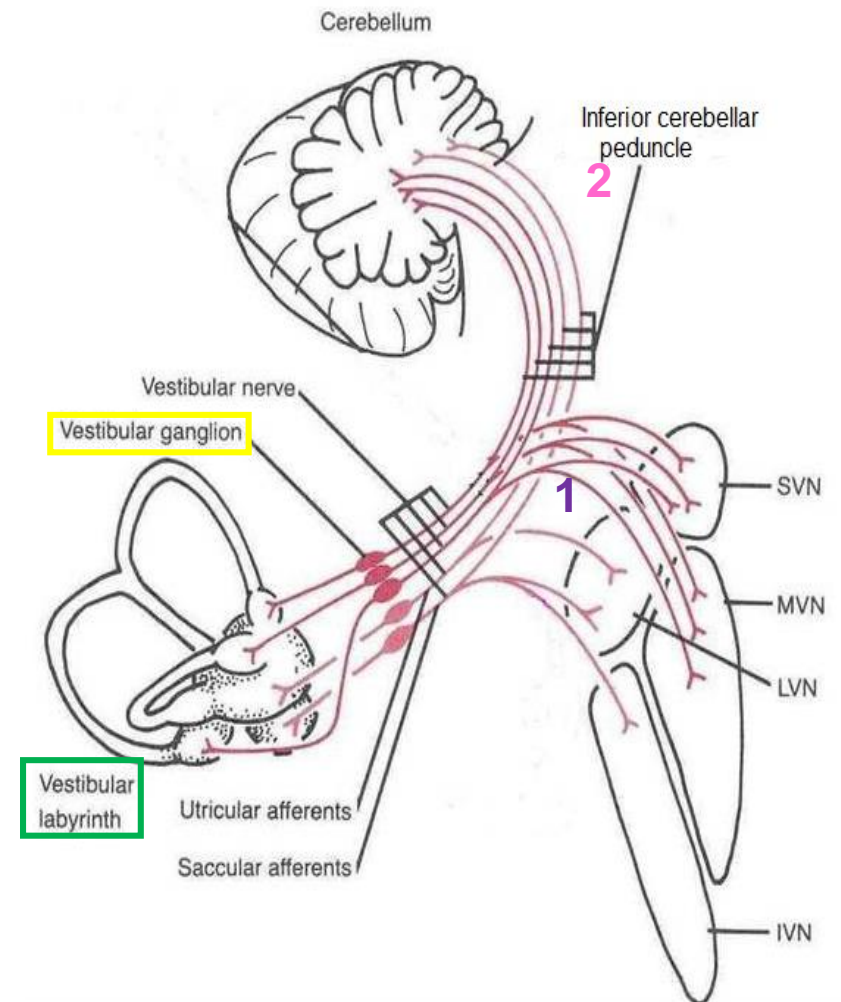
- The Peripheral processes/axons (vestibular nerve fibers) make dendritic contact with hair cells in vestibule & semicircular canals of the *membranous labyrinth* (inner ear).

- 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) and pons

2. Some fibers go to the cerebellum through the *inferior cerebellar peduncle*

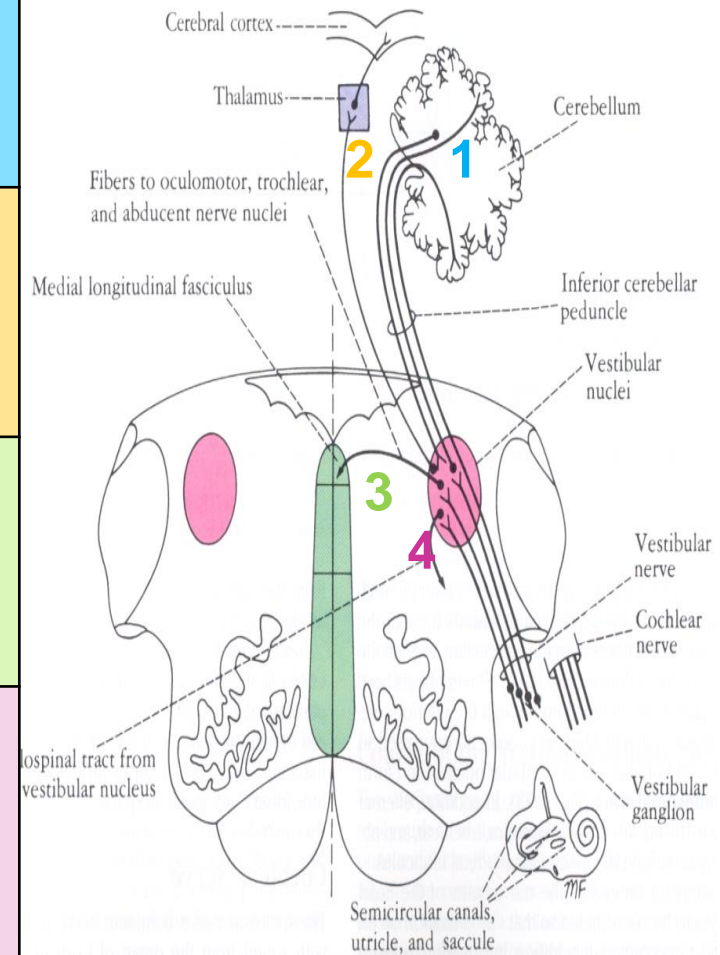


Vestibular nuclei belong to **special somatic afferent** column in brain stem.

Vestibular Pathway

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

1	To <u>ipsilateral flocculonodular lobe of cerebellum</u> (vestibulo-cerebellar tract)	through inferior cerebellar peduncle	for maintenance of equilibrium
2	<u>Bilaterally</u> (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	<u>Bilaterally</u> 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 vestibospinal (bilateral) tracts through for control the posture.		for control of posture



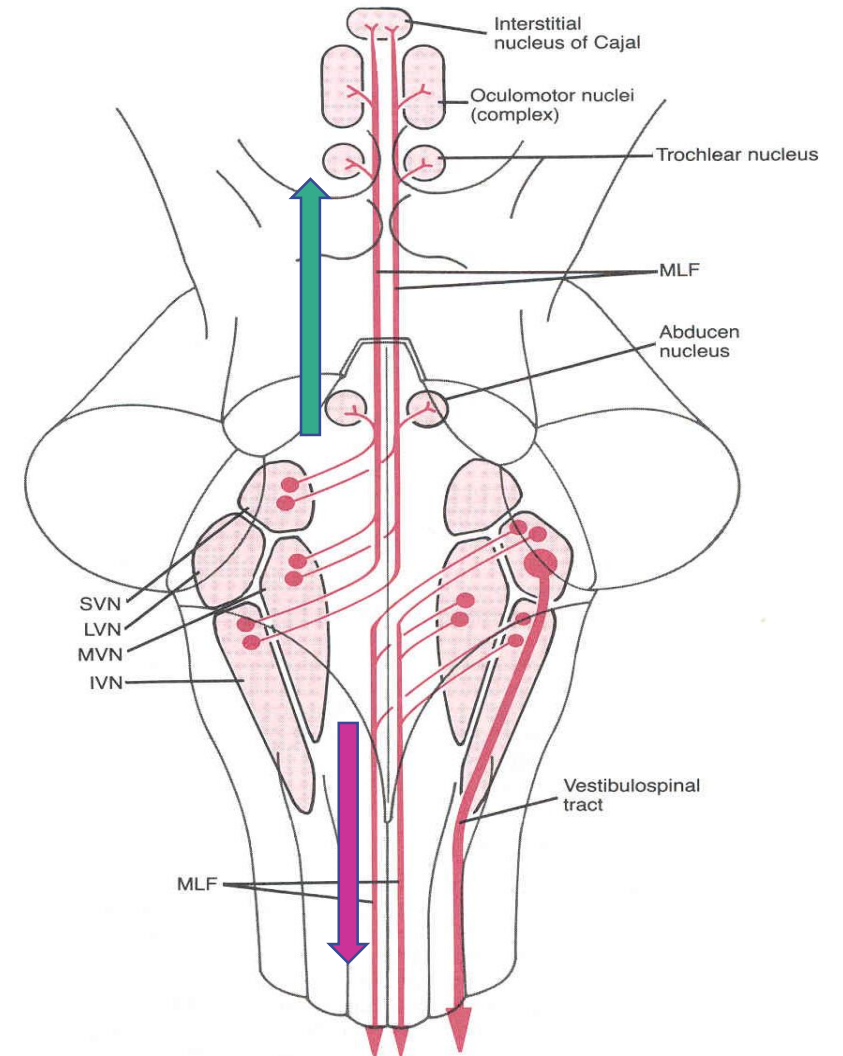
Vestibular Pathway

Medial Longitudinal Fasciculus

Also called medial longitudinal bundle

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

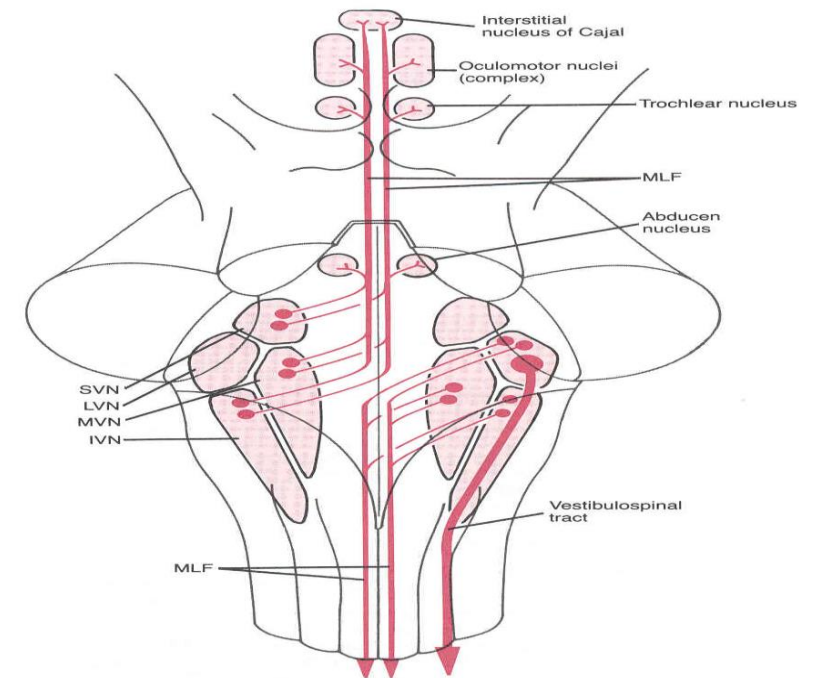
<p>The ascending component (vestibulo-ocular) (number 3 in previous slide)</p>	<p>The descending component (number 4B in previous slide)</p>
<p>establishes connections with the nuclei of the Oculomotor, Trochlear & Abducent nerves (motor nuclei for extraocular muscles)</p>	<p>extends into anterior horn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



Vestibular Pathway

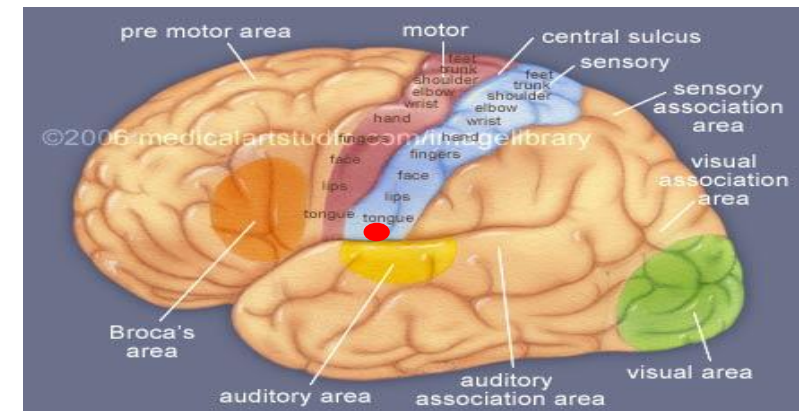
Vestibulospinal Tracts Only on the girls' slides

- 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 4A mentioned previously)



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

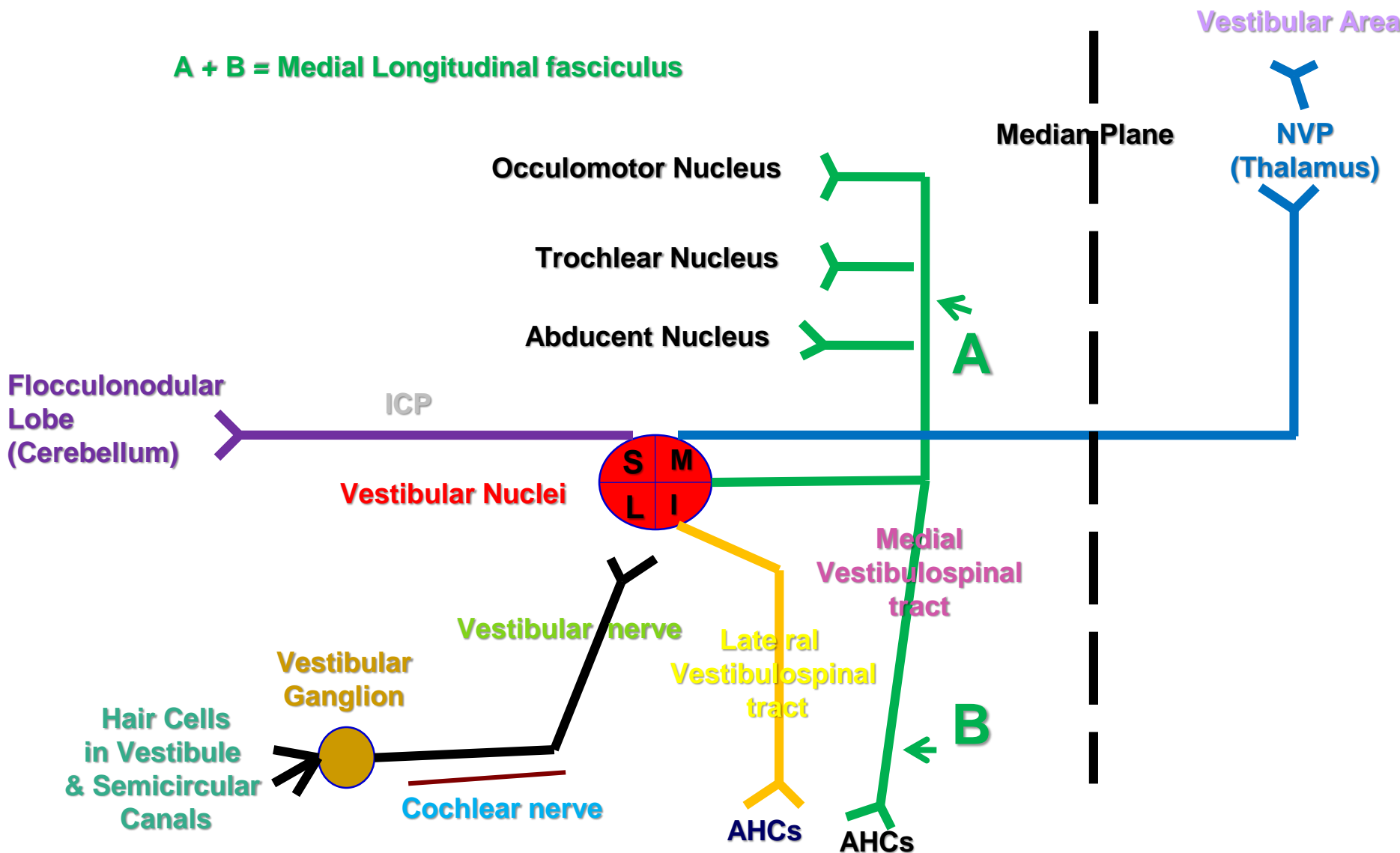
2. Join **medial longitudinal fasciculus** & descend as **medial vestibulospinal tract** to **anterior horn cells** of spinal cord.

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

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

Vestibular Pathway

Only on the boys' slides



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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.

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

Answer: A

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

Answer: C

3. The vestibular nuclei are connected to the oculomotor neuron though:

- A- lateral lemniscus
- B- lateral vestibulospinal tract
- C- medial longitudinal fasciculus
- D- vestibular nerve

Answer: C

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

Answer: A

5. The vestibular cortex is located in:

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

Answer: B

6. The primary auditory cortex is located in:

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

Answer: A

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

Answer: D

8. Both cochlear & vestibular nerves enter pons through:

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

Answer: B

