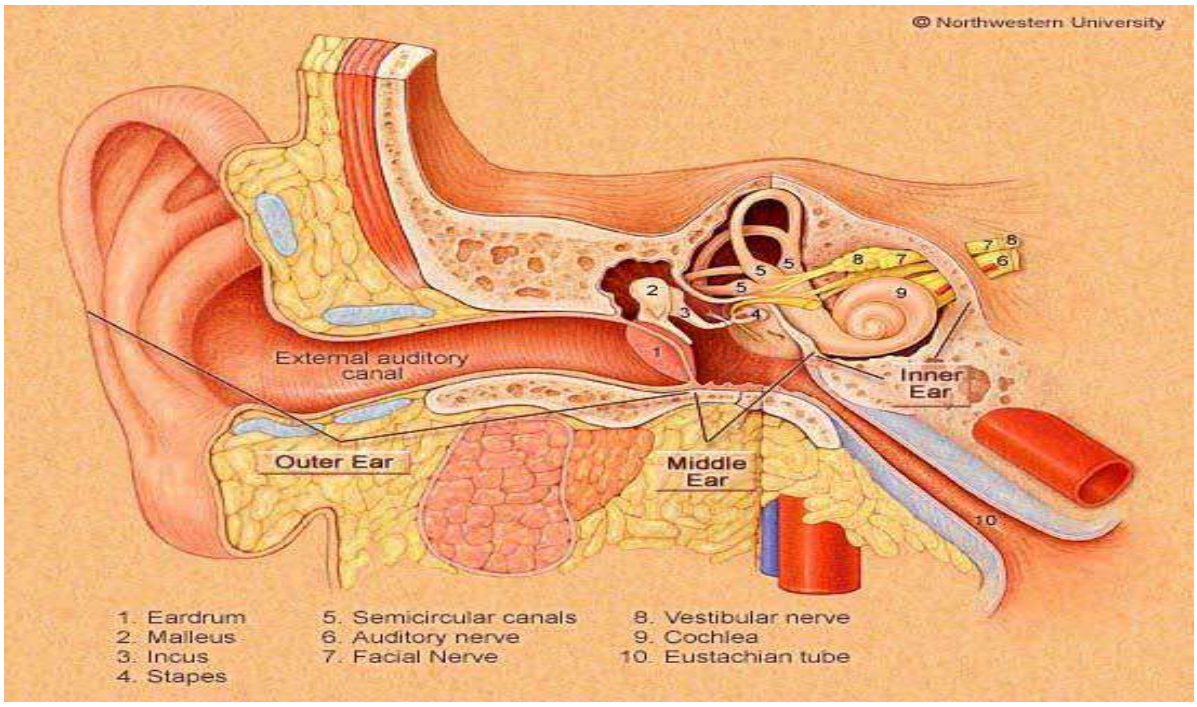
Ear I



Anatomy physiology of the ear, gross anatomy of the external, middle and inner ears, nerve supply and earache, physiology of hearing and balance.

Done by:
Mohammed Al-Harbi
Nujud Al-Hejin

Anatomy of the Ear

- **External Ear**:
  1- Auricle (Pinna)
  2- External Auditory Meatus.
  3- Outer layer of the Tympnic membrane. (Epithelial)

1- Auricle (Pinna):

- Discription :

- Formed by a fibrous elastic cartilage (not hyaline cartilage which is liable to calcification).
- This fibrous cartilage is mobile and is avascular (has no blood vessels) , it gets its blood supply from the skin covering it.
- **The cartilage is absent in:** Ear lobule + the part which between the targus & helix incisera terminalis.

- Blood supply: (From the external carotid):
  1- Posterior auricular artery.
  2- Anterior auricular branch of the superficial temporal artery.
  3- Occipital artery

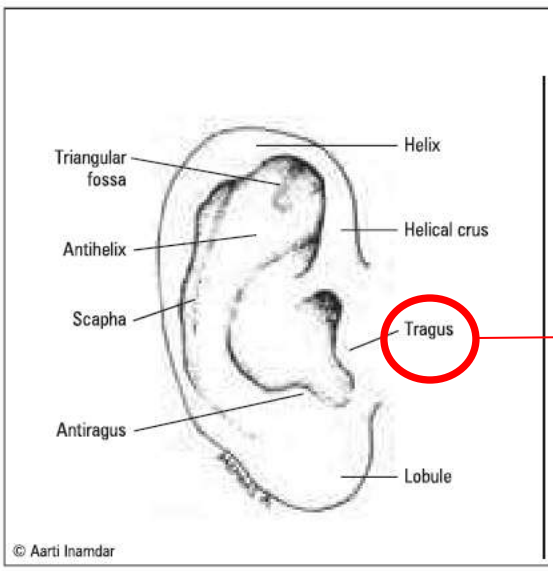
- Nerve supply:
  1- Great auricular nerve
  2- Auriculotemporal
  3- Lesser occipital nerve
  4- Auricular branch of vagus nerve

*When the auricle is diseased with inflammatory condition (perichondritis), the patient will suffer form a very sever pain due to separation of skin form fibrous cartilage. In this condition, parts of the ear without cartilage will not be affected.

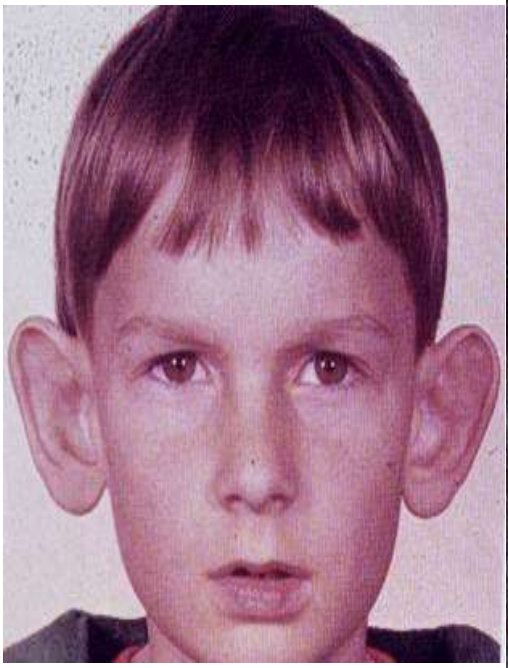
*Separation of skin form fibrous cartilage will lead to deprivation of cartilage form blood supply which will lead to necrosis.

The posterior part of the ear is usually preferred as a site of incision in surgeries because:

1- Has less blood supply.
2- Skin is looser in that area.



Can be used as a graft



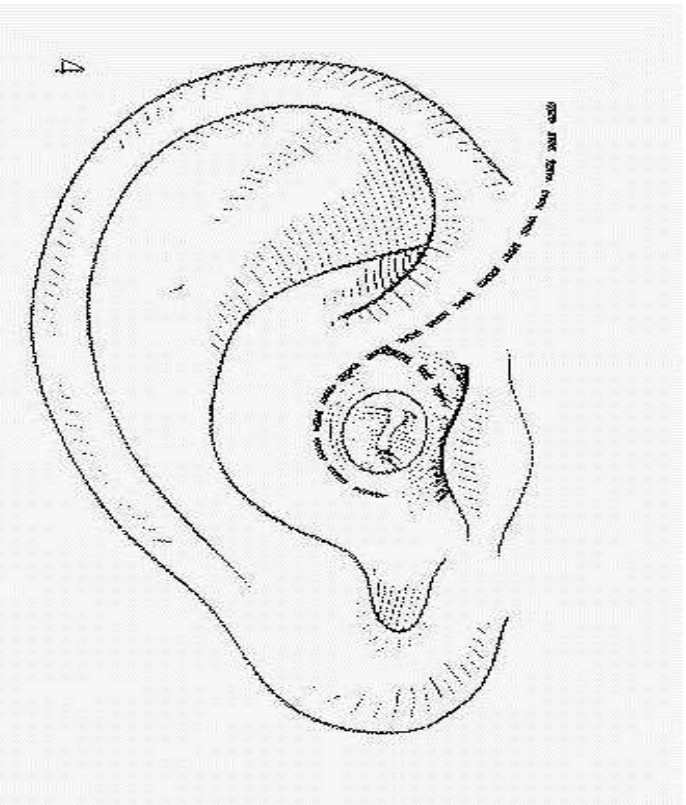
Absence of antihelix

(Protruding ear or

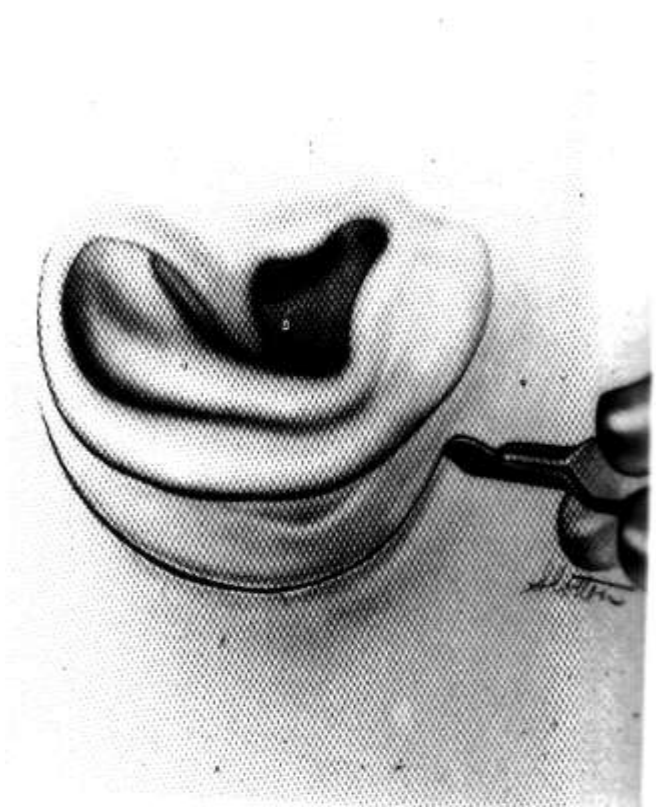
Perichondritis

Inflammation of the layer surrounding the cartilage

Erysipelas: Bacterial



Postauricular incision for external and middle ear surgery



Postauricular incision for external and middle ear surgery , why ?

1-$_3$Less bloos supply to that area

2- The skin is looser in that area

Hematoma Auris

Cauliflower ear

2- The External Auditory (Acoustic) Canal:

There's a part between the lateral and medial parts of the canal called the *Esthmus*. It's a usual site for the bacteria to grow.

Lateral Third 1/3	Medial Two Third 2/3
• Cartilaginous	• Bony • Covered by delicate skin
• Present at birth	• Develops after birth
• Hair follicles	
• Sebaceous glands	
• Ceruminous glands	

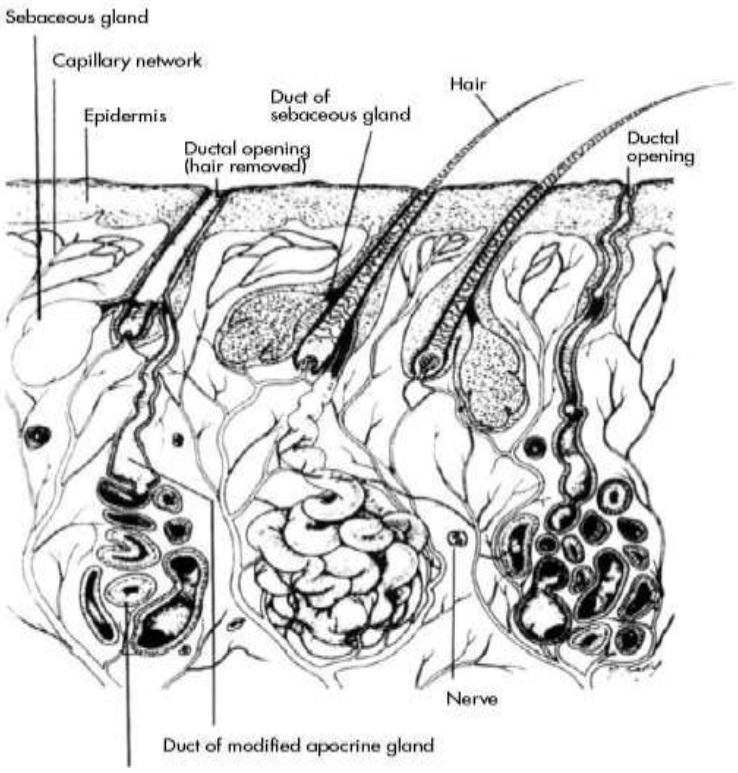
3- Outer layer of the tympanic membrane:

It's called the epithelial layer.

Type of epithelium: Stratified squamous.

Wax

Amount + color may vary from Patient to Patient



Skin of outer third of the external canal

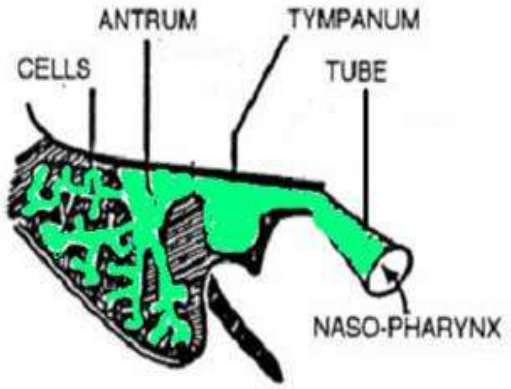
Furunclosis

Most common in Diabetic patients

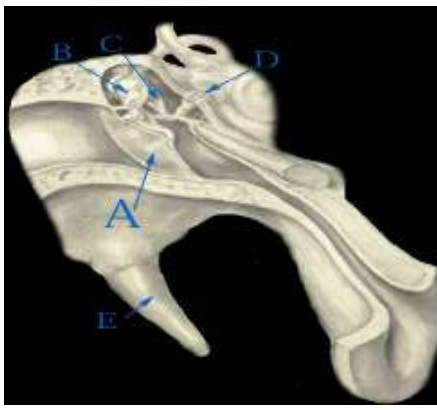
Note:
Otitis media of the middle ear cleft indicates that all parts of middle cleft are involved

• Middle Ear Cleft:

- **It consists of 3 parts:**
  1- Eustachian (Pharyngo-tympanic) Tube
  2- Tympanum (Middle Ear Cavity)
     A. Two muscles
     B. Two nerves
     C. Three bones
  3- Mastoid antrum and Air Cells



1- Eustachian Tube: [Length = 1-1.5 inch].

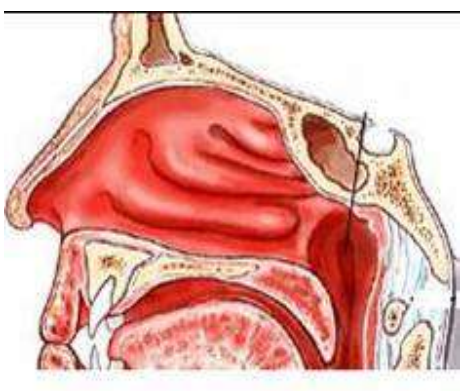


- The tube is normally closed at rest but opens during swallowing.

- Upper part is bony & the lower part is cartilaginous

- Lower. End is opening in *naso-pharynx*.
- Upper end is opening in the *anterior part of middle ear*.

- It is lined by **ciliated** epithelium.

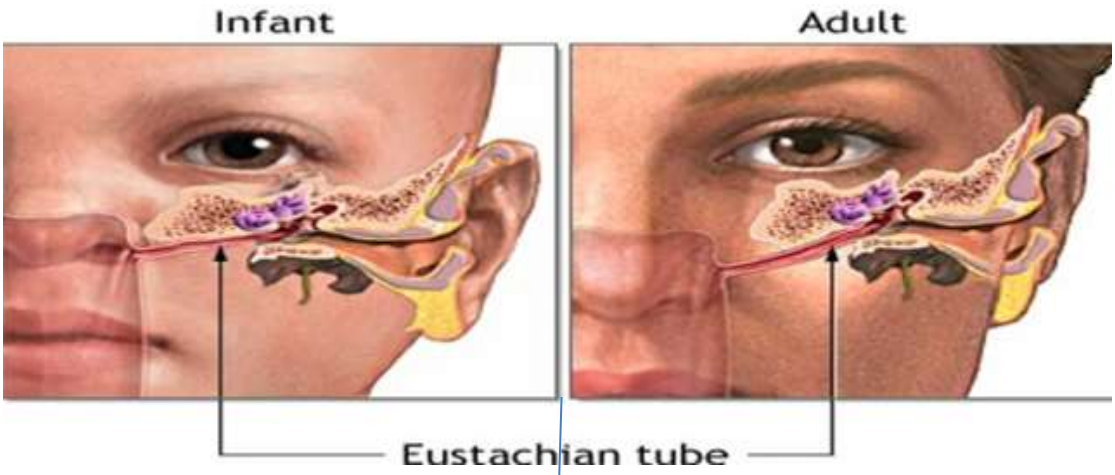


- **Functions:**
  1. It serves to equalize air pressure in the tympanic cavity & the nasopharynx.
  2. Aeration of the middle ear.
  3. Clearance of middle ear.

- **Muscles**:

There are four muscles associated with the function of the Eustachian tube:

1- Levator veli palatini. 2- Salpingopharyngeus
3- Tensor tympani 4- Tensor veli palatine

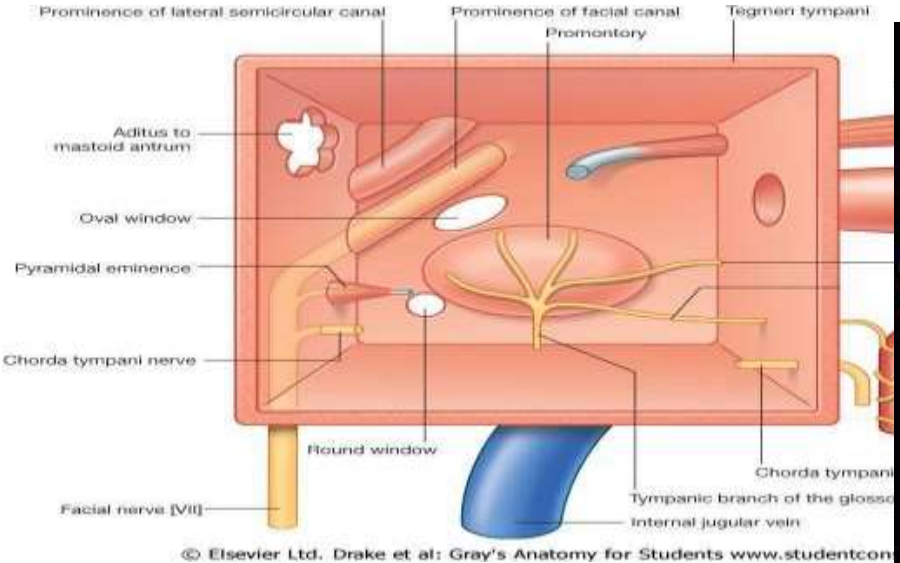


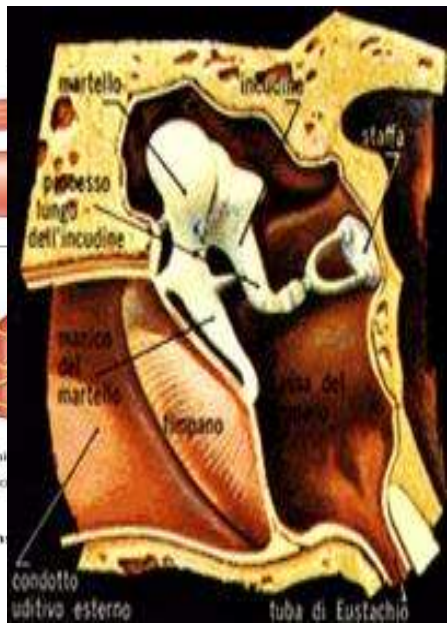
Short Tube	***Long Tube***
Horizontal	***Oblique***
Wide Tube	***Narrow***

2- Tympanum :

Also Called: (tympanic cavity) or (Middle Ear Cavity).

- It is like a box.
- It has 6 walls: anterior, posterior, medial, lateral, superior & inferior walls.





1- Roof: "see the pictures in P6"

- **Tegmen tympani :** a bone which separates the middle ear from the middle cranial fossa.
-

Sometimes unfortunately, this bone becomes very thin & the suture between 2 bones of cranium allow to infection of middle ear to be passed through this suture [intracranial complications]

2- Floor: "see the pictures in P6"

- Formed by a **thin plate of bone** which separate the middle ear from the jugular fossa.
- Jugular fossa contains:

1) Internal jugular vein.
2) Internal carotid artery.
3) Tympani branch of the 9th crania nerve (Between 1 & 2)

- *Sometimes, this thin plate of bone is absent due to congenital anomalies projection of the internal jugular vein in the middle ear surgical hazard because jugular vein is liable to severe bleeding due to surgeon's mistake.*

3- Anterior wall: "see the pictures in P6"

- Contains:

1- Eustachian tube.
2- Tensor tympani (above Eustachian tube).

4- Posterior wall: "see the pictures in P6"

- Contains **aditus to <u>mastoid antrum</u>**.
  a. Mastoid antrum is lined by mucosa & it is present in mastoid process.
  b. Mastoid antrum communicates with mastoid air cells that are very variable among individuals.

- Some individuals have **<u>no air cells</u>** → *sclerotic mastoid* (acellular mastoid). [He's liable to chronic infection rather than acute infection].
- The degree between *sclerotic mastoid* & *cellular* is called (diploid mastoid).
- Some individuals have **<u>excessive air cells</u>** → *cellular mastoid*. [He's liable to mastoid abscess].

- Posterior to mastoid antrum is sigmoid sinus.

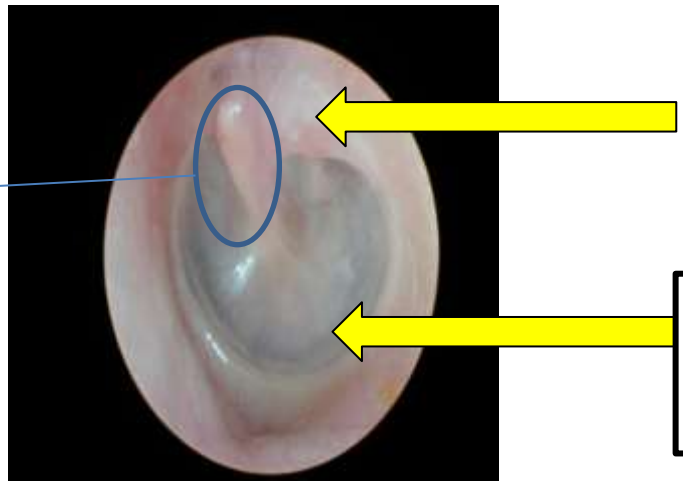
Note: If the infection is transmitted to sigmoid sinus from mastoid antrum → (sigmoid sinus thrombophlebitis).

5- lateral wall:

It consists of:

A) Tympanic membrane (ear drum), it is formed of 3 layers:

1. Outer layer stratified squamous epithelium (skin).
2. Middle layer → fibrous layer.
3. Inner layer → mucous membrane.



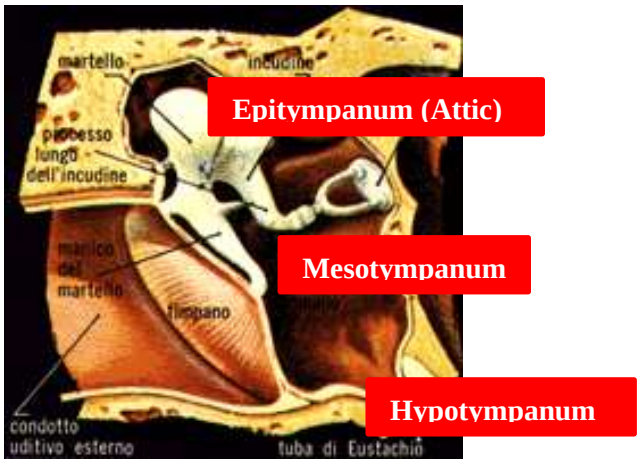
Membrane flaccida: The fibrous layer of tympanic membrane is absent in small area of tympanic membrane

(Umbo)
Handle of malleus is inserted in the middle of ear drum.

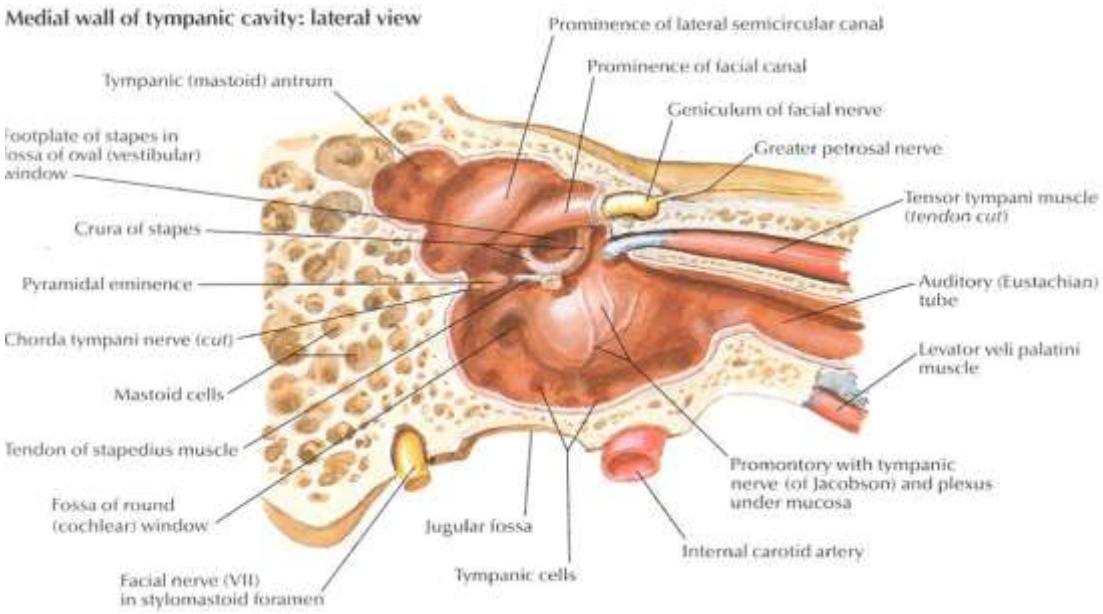
Membrane tensa: The remainder which has fibrous layer

Tympanic membrane has three parts in relation to bone:

B) Epitympanum(Attic bone): the bone which is above the ear drum.
C) Mesotympanum: The part of the lateral wall which is against ear drum
D) Hypotympanum: the bone which is under the ear drum.



6- Medial wall:



It consists of:

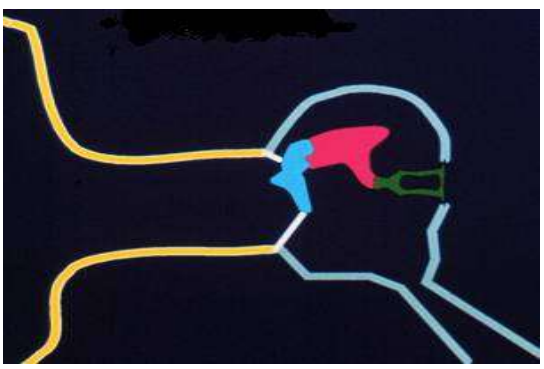
1. **Promontory:** is a rounded elevation produced by the base of the cochlea.
2. **Oval window:** just behind & above promontory, opens into the perilymph.
3. **Rounded window:** just behind & lower promontory, opens into the perilymph.
4. **Prominence of the facial nerve:** passes backward above the promontory & oval window.
5. **Lateral semicircular canal:** above facial nerve.

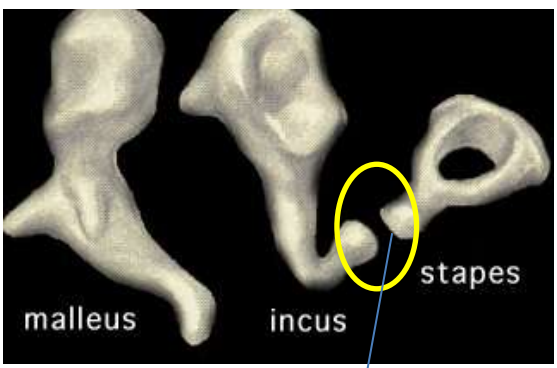
Contents of Tympanic cavity (Middle ear cleft):

1- Air: from Eustachian tube.

2- Ossicles:
   a) Malleus.
   b) Incus.
   c) Stapes.

They're connected to each other by synovial joints. So, any disease affects synovial joints in the body may involve these joints and consequently limiting their movements.

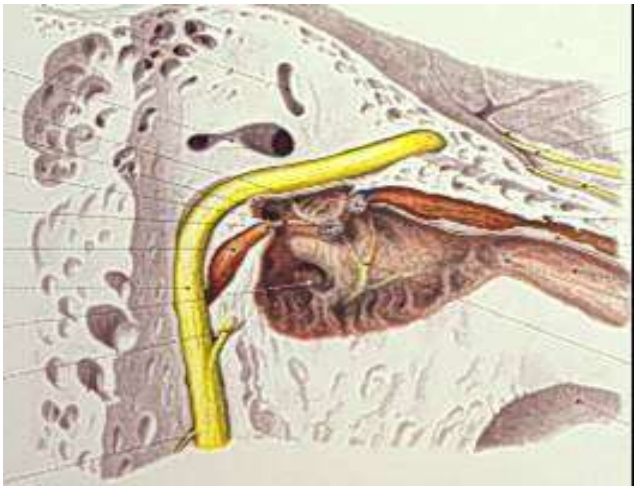




Incstapedius joint is the commonest site for infections and the 1st. why ?

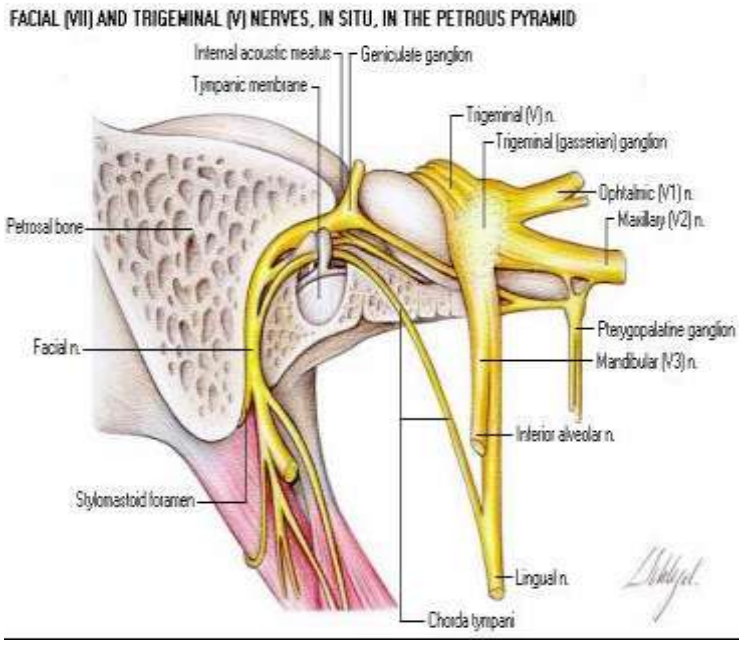
1- Thinner

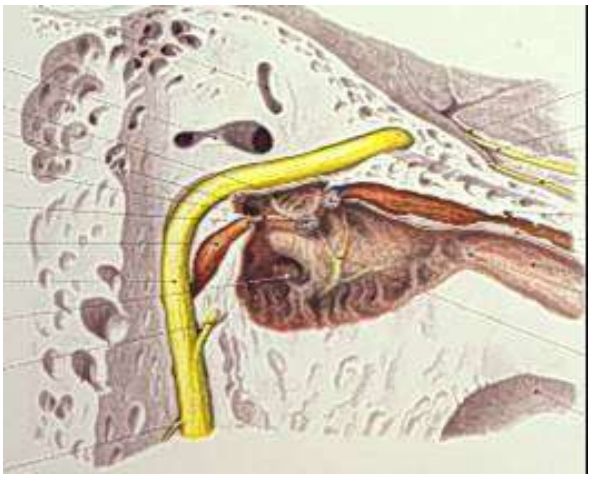
Muscles:



a- Tensor Tympani → attached to the malleus.
b- Stapedius → attached to the stapes. Contraction of the stapedius muscle restrict the movement of the stapes (this consider a physiologic reflex protects the inner ear from very loud sounds by preventing freely movements of the stapes (Attenuation reflex).

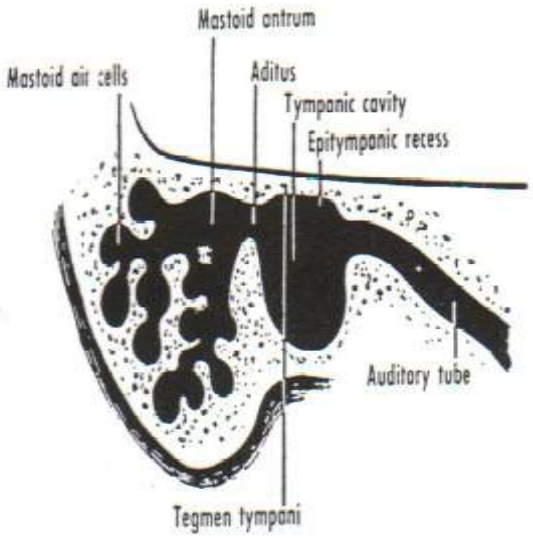
3- Nerves:

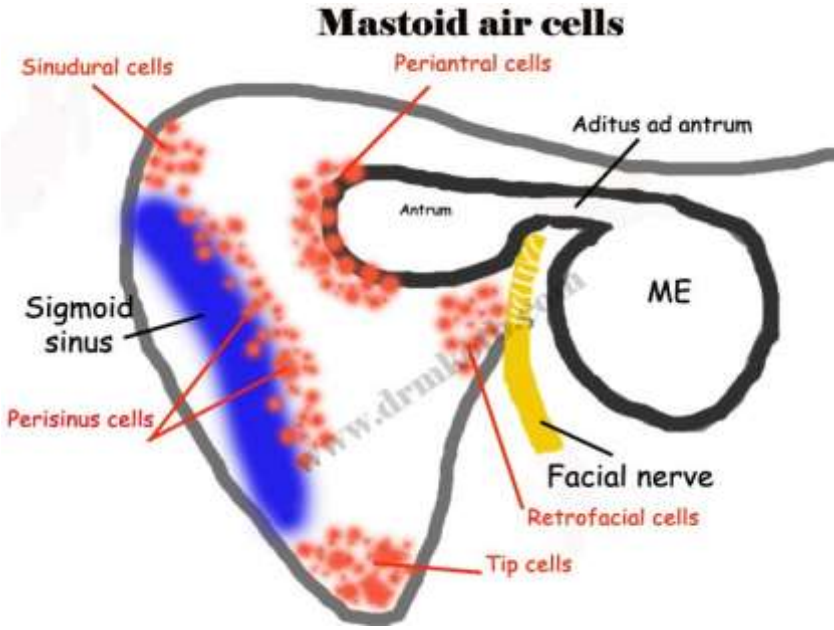




a. (facial) : Chorda Tympani: A branch from vertical part of facial nerve. They're afferent fibers that carry TASTE fibers from anterior 2/3 of the tongue. Also, they're PARASYMPATHETIC secretory fibers (efferent) that supply sublingual & submandibular glands.
b. (Glossopharyngeal): Tympanic plexus: it's found on the promontory → sensation for the middle ear. It's formed by the tympanic branch of the glossopharyngeal & branch from sympathetic plexus around internal carotid artery.

1- Mastoid Antrum & Mastoid Air cells:





At birth the mastoid is not pneumatized, but becomes aerated over the first year of life. Poor pneumatization is associated with eustachian tube dysfunction.

Clinical significance: Infections in the middle ear can easily spread into the mastoid area via the aditus ad antrum and mastoid antrum.

LINING OF MIDDLE EAR:

Mucous membrane: ciliated columnar anteriorly and cuboidal or flat elsewhere.

SENSARY SUPPLY OF MIDDLE AND EXTERNAL EAR:

- Cervical II & III (great auricular and lessor occipital).
- V cranial nerve → Mandibular → aurico-temporal.
- IX cranial nerve (tympanic or Jacobson's).
- X cranial nerve (auricular or Arnold's).
- VII cranial nerve.

Clinical importance of these nerves is referred pain where the patient may complain of otalgia although his/her external & middle ear are normal. Therefore, you have to think that this pain is referred form other site.

Referred Earache: pain in the ear due to a disease in an area supplied by a nerve that also supply the ear.

Examples:

- Cervical II & III (Cervical spondylosis, neck injury etc.)
- V cranial nerve (Dental infections, Sino-nasal diseases etc.)
- IX cranial nerve (Tonsillitis, post-tonsillectomy, carcinoma etc.)
- X cranial nerve (Tumors of hpopharynx, larynx & esophagus)

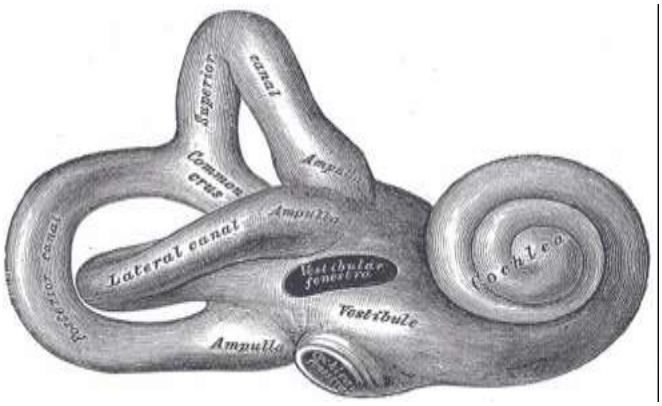
Note:
Dental pain is the most common type of pain that is referred to the ear.

- # Inner Ear:

It consists of:

A) The bony (Osseous) labyrinth: "Contains Perilymph"

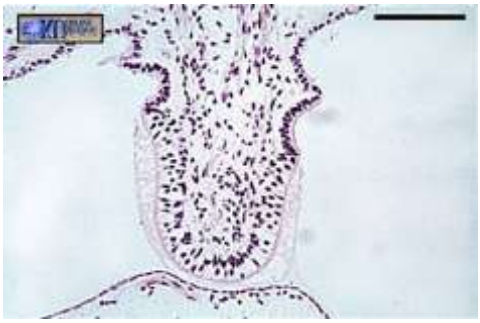
1- Bony cochlea: anterior.
2- Vestibule: middle.
3- Bony semicircular canal: posterior

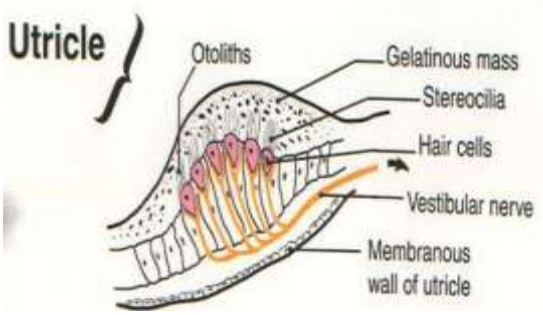


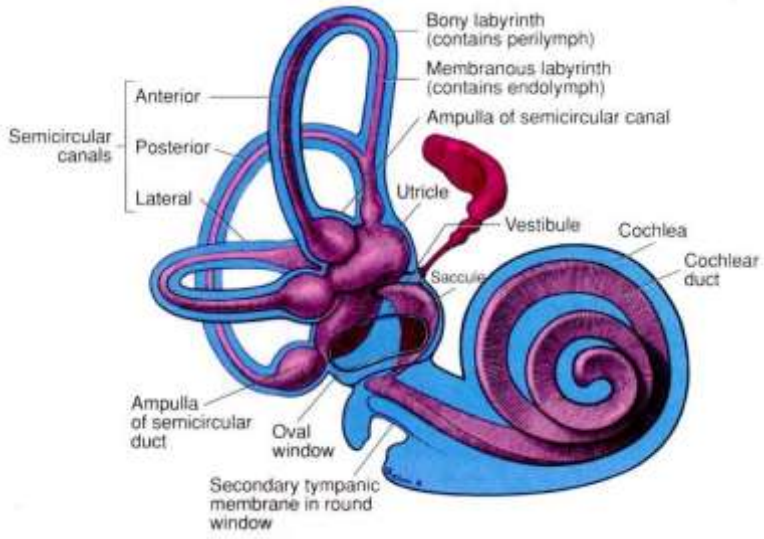
B) Membraneous labyrinth: "Contains Endolymph"

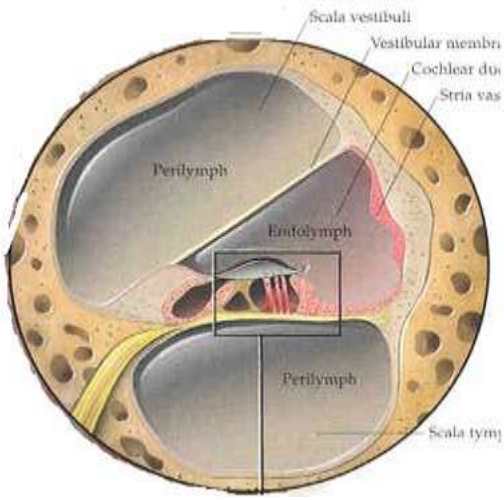
Consist of Sensory Epithelium:

1- **Cochlea**: *organ of Corti*
2- **Utricle & saccule**: *maculae* "they're located within the vestibule"
3- **Semicircular canals**: *cristae* " They are divided into: superior (anterior), posterior & transfers (lateral).





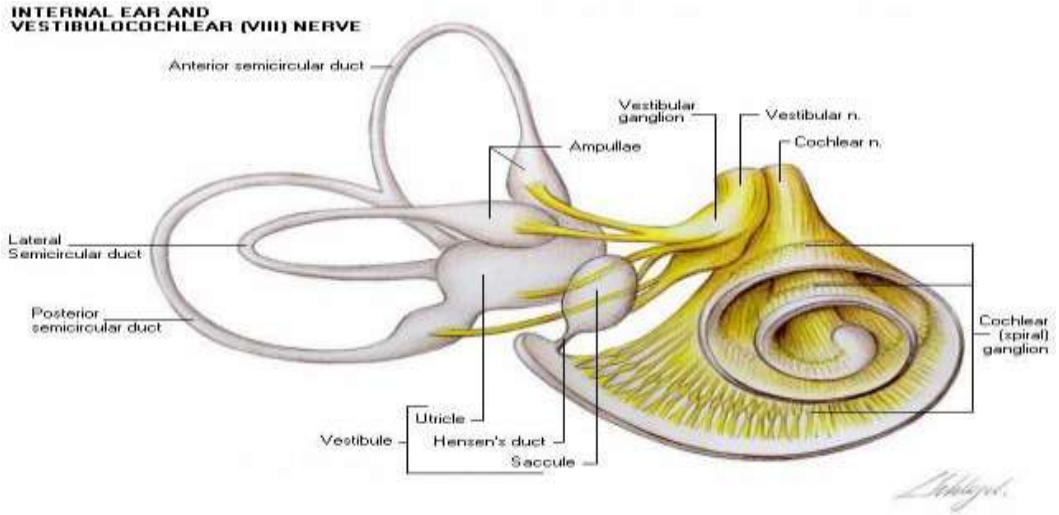


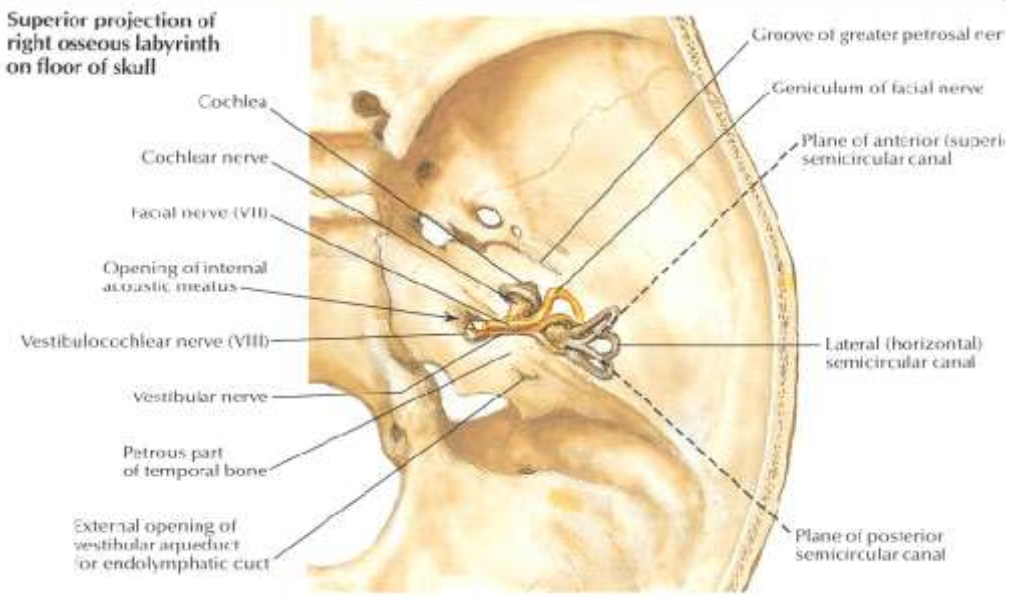


Note:

- Semicircular canals are stimulated by head motion (Angular movements)
- Sacule and utricle are stimulated by:
  1- Head motion (linear acceleration)
  2- Head position (Gravity)
- Endolymphatic duct is connected to utricle. Its action most probably is absorption of endolymph.
- Miniere's disease is characterized by accumulation of endolymph due to loss of endolymph duct action.

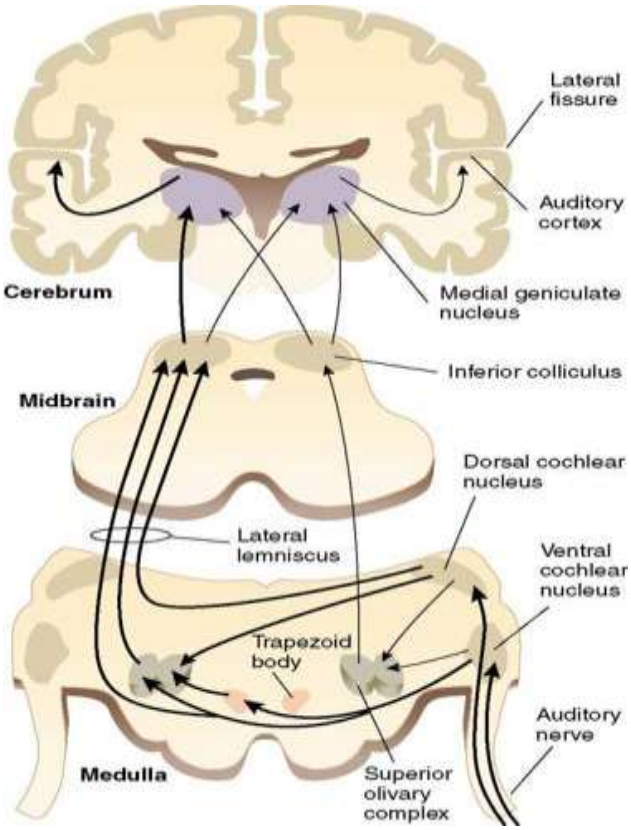
THE VESTIBULO-COCHLEAR NERVE:





Auditory Pathway:

Vestibular nerve comes out from vestibular part of labyrinth → Brain stem → Vestibular nuclei → Spinal cord, Cerebellum and cerebral cortex.



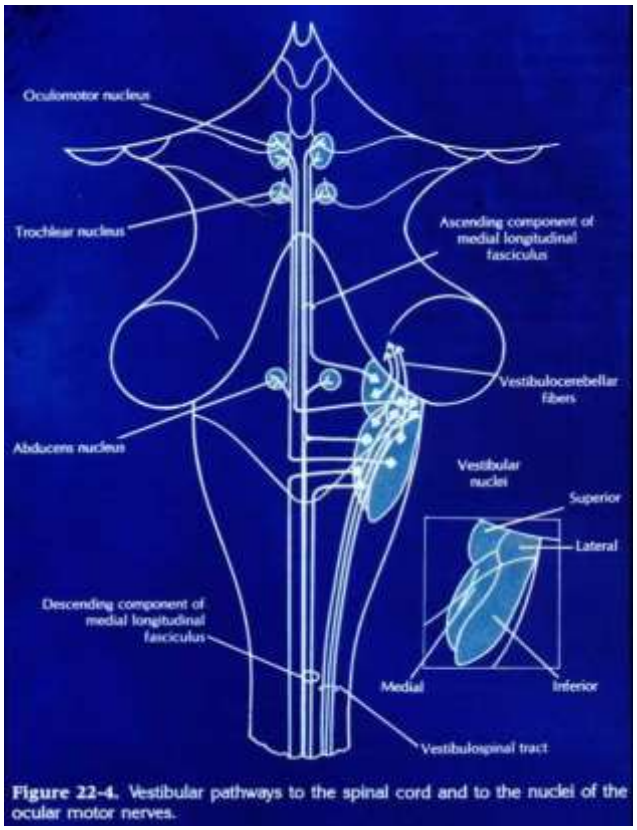
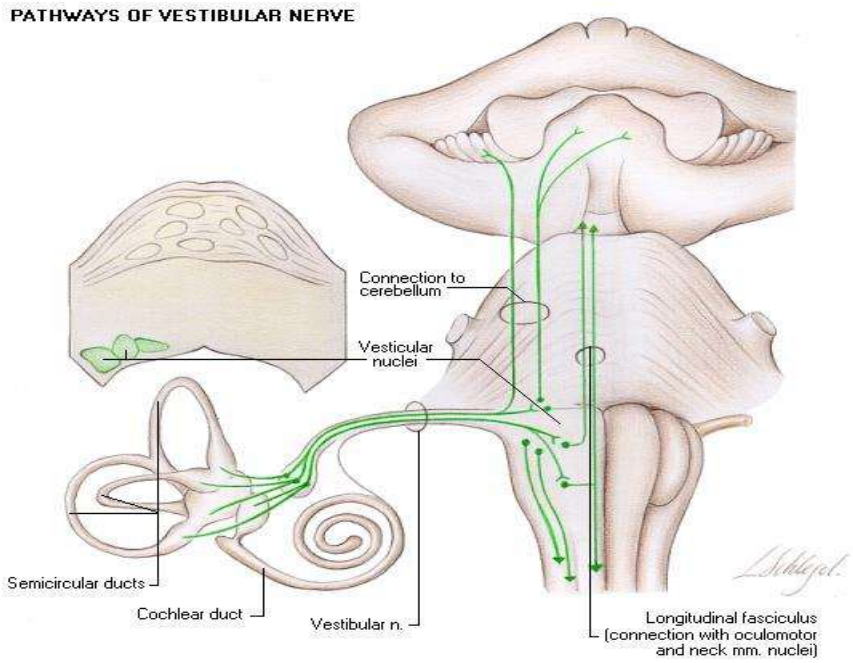


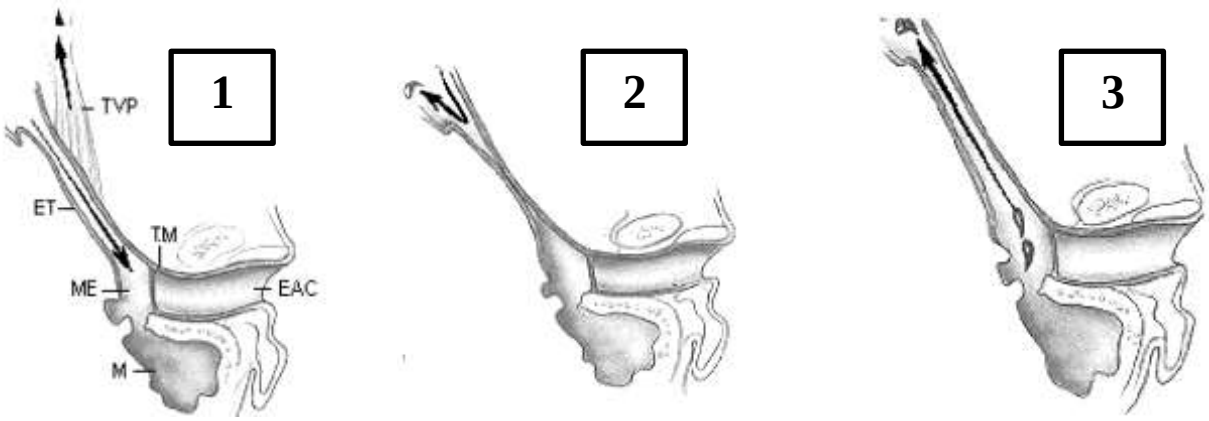
Figure 22-4. Vestibular pathways to the spinal cord and to the nuclei of the ocular motor nerves.



Physiology of the Ear

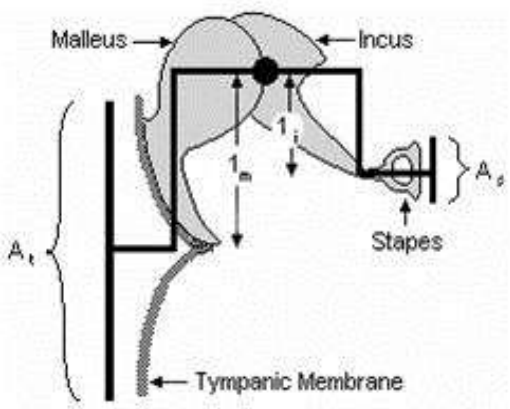
- **Functions of the external ear:**
  1- Auditory functions → Sound collection & conduction
  2- Protection of the middle ear
  - Curvature
  - Cerumen (Wax)
  - Hairs

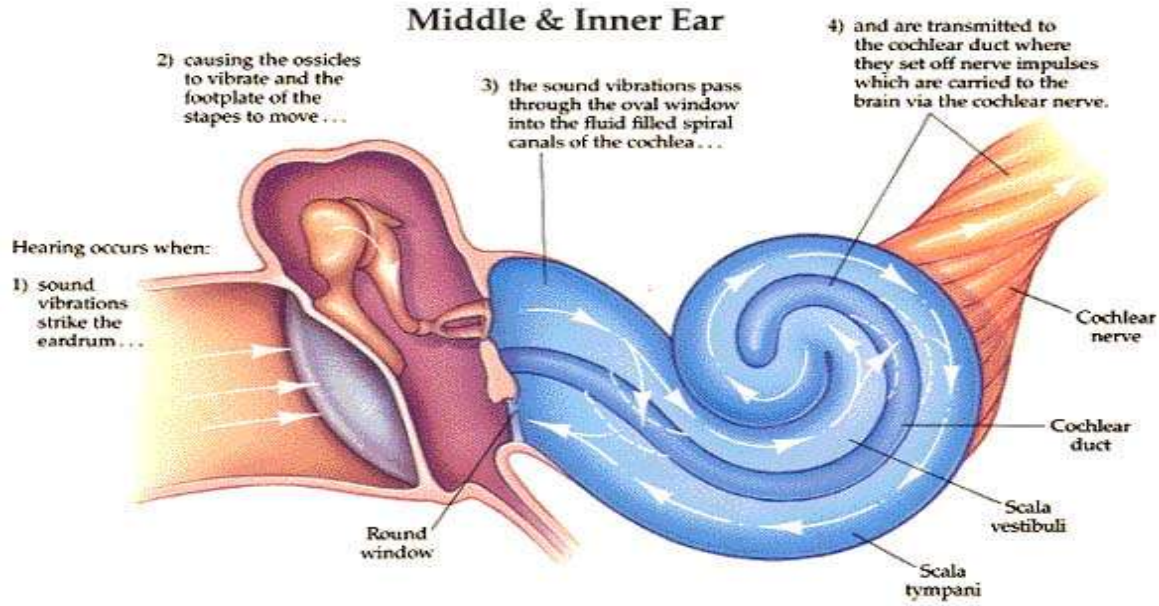
- **Functions of the Eustachian tube:**
  1. Ventilation which is the main function.
  2. Protection of the middle ear from nasopharynx.
  3. Drainage of the middle ear.



- **Functions of the middle ear:**
  1. Conduction of sound
  2. Transformer mechanism: Amplify the sound by 2 mechanisms:
     - Hydraulic action
     - Ossicular leverage

     Note: We need to amplify the sound to overcome the resistance of the fluid in the inner ear.
  3. Protection of the inner ear (Stapedius reflex)





- **Functions of the inner ear:**

1- Hearing Function:

Transduction of sound to action potentials.

2- Vestibular Function:

Participate in maintaining body balance.

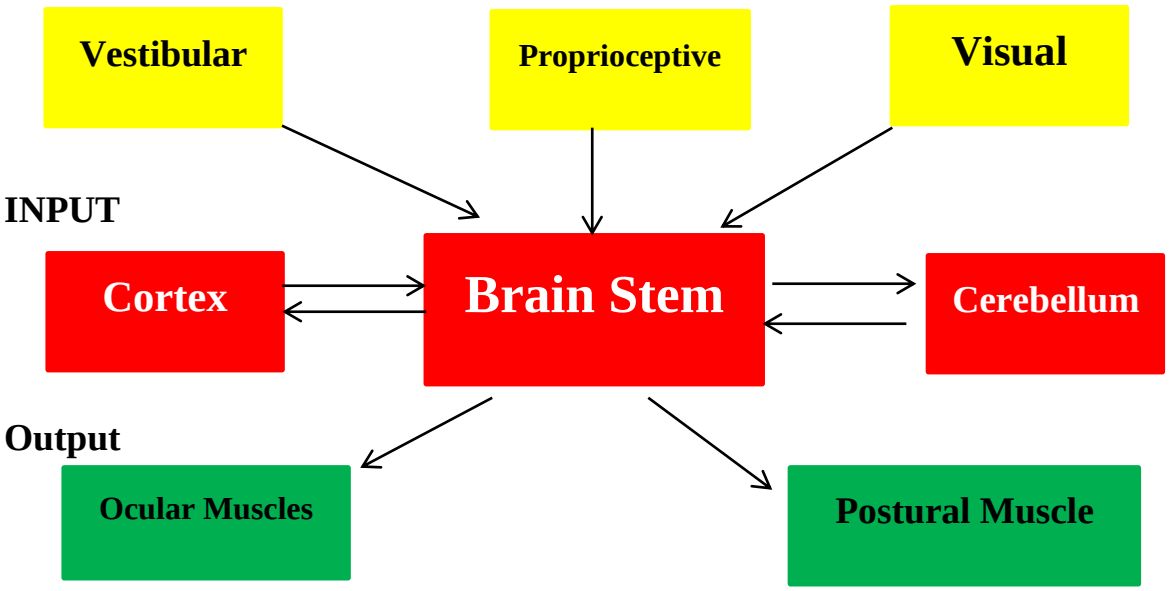
- **Maintenance of body posture:**

1- Brain stem & cerebellum.

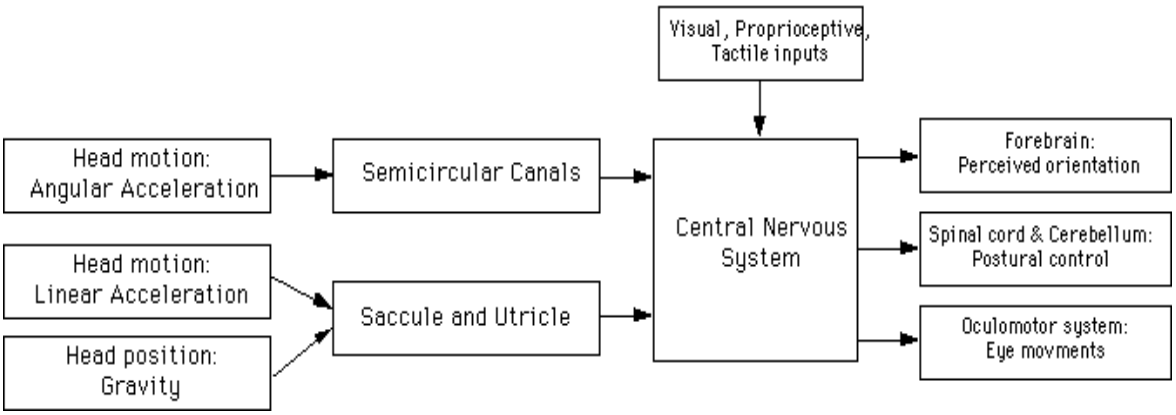
2- Vestibular function.

3- Musculoskeletal system. (Proprioception)

4- Eyes.



VESTIBULAR SYSTEM



Best wishes .....

Mohamed Al-Harbi