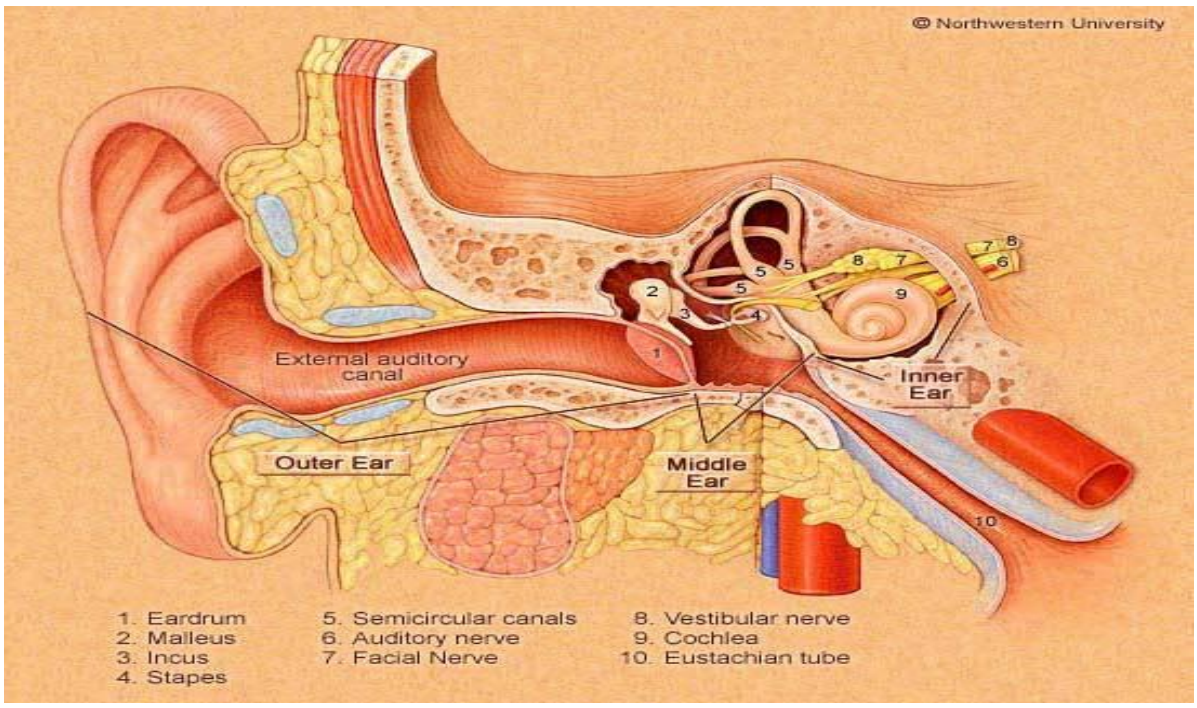
Ear I



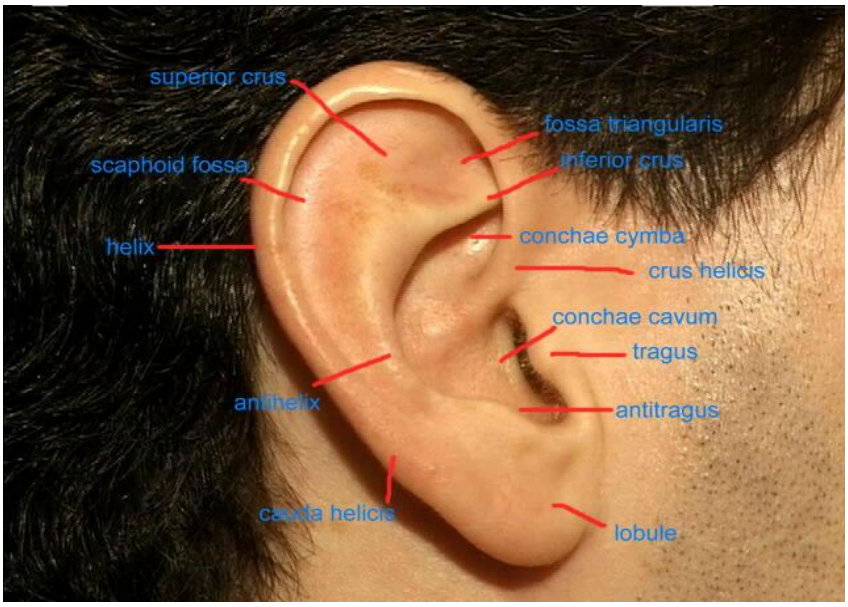
Anatomy physiology of the ear, gross anatomy of the external, middle and inner ears, nerve supply and earache, physiology of hearing and balance.

Done by:
Mohammed Al-Harbi

Anatomy of the Ear

• External Ear

1- Ear Auricle (Pinna):



- The ear pinna is formed by fibrous cartilage (not hyaline cartilage which is liable to calcification). This fibrous cartilage is mobile & covered by skin.
- The skin is adherent to fibrous cartilage. Therefore, when the auricle is diseased with inflammatory condition (called perichondritis), the patient will suffer form very sever pain due to seoaration of skin form fibrous cartilage.
- In addition to that, fibrous cartilage of auricle is avascular (no blood vessels) & it gets its blood supply from skin's blood vessels. Hence separation of skin form fibrous cartilage will lead to deprivation of cartilage form blood supply get necrosis very easily.

Blood supply: Richly supplied by branches from the external carotid.

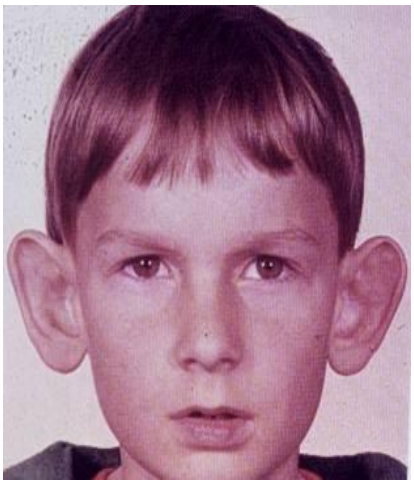
Note:

- **The cartilage is absent in:**

1- Ear lobule.
2- 2- The part which between targus & helix incisera terminalis.

- **Clinical points:**

1- In perichondritis, these 2 parts will not be affected.
2- Incisera terminal's can be used for surgical incision.

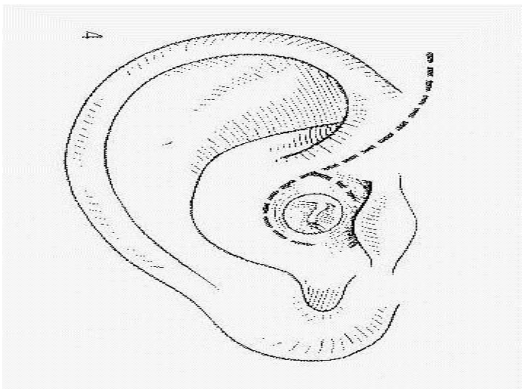


Absence of antihelix

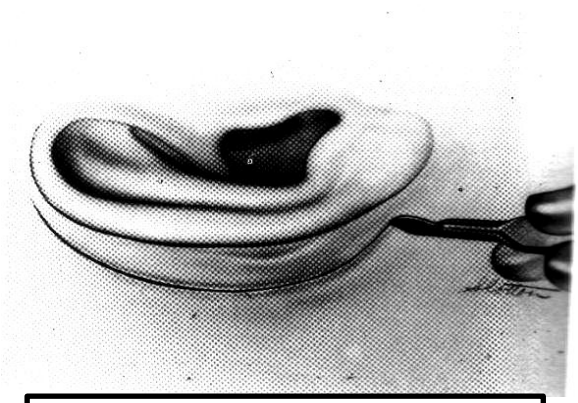
(Protruding ear)

Perichondritis

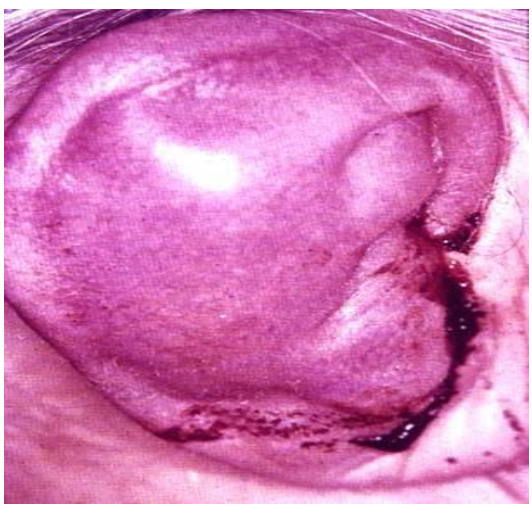
Erysipelas



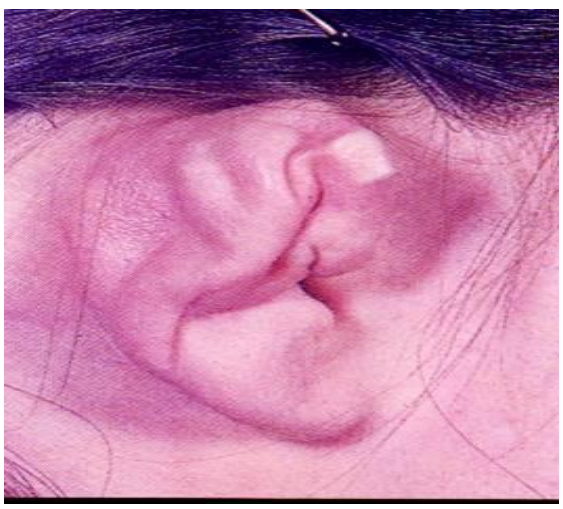
Postauricular incision for external and middle ear surgery



Postauricular incision for external and middle ear surgery

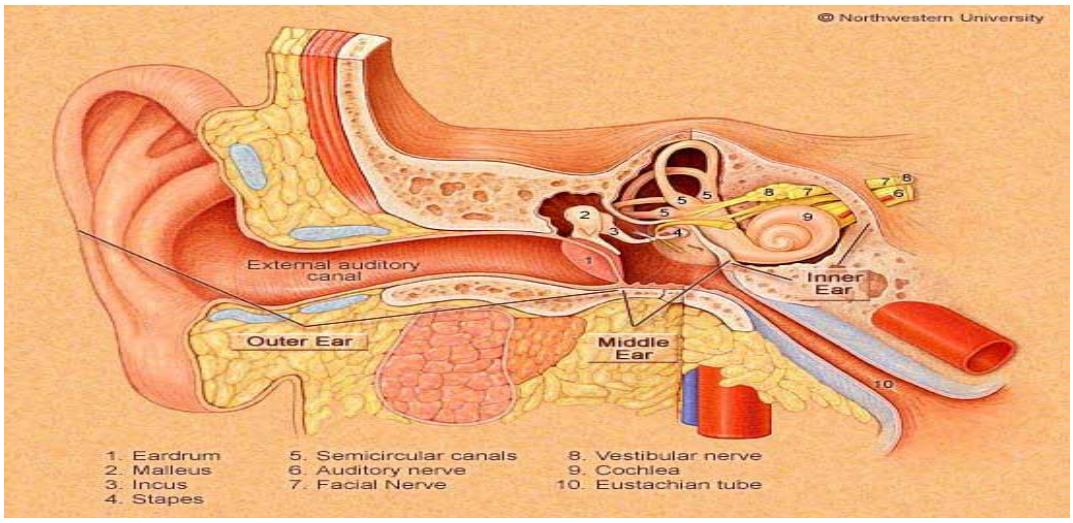


Hematoma Auris

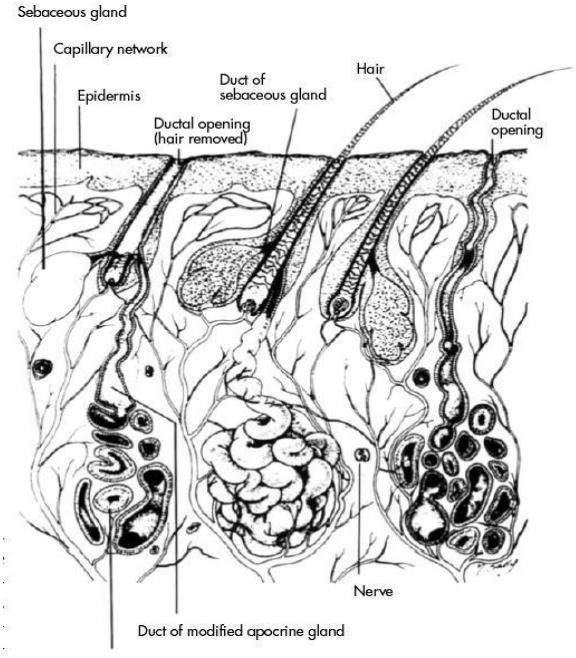


Cauliflower ear

2- The External Auditory (Acoustic) Canal:



Lateral Thirs	Medial Two Third
• Cartilaginous	• Bony
• Present at birth	• Develops after birth
• Hair follicles	
• Sebaceous glands	
• Ceruminous glands	



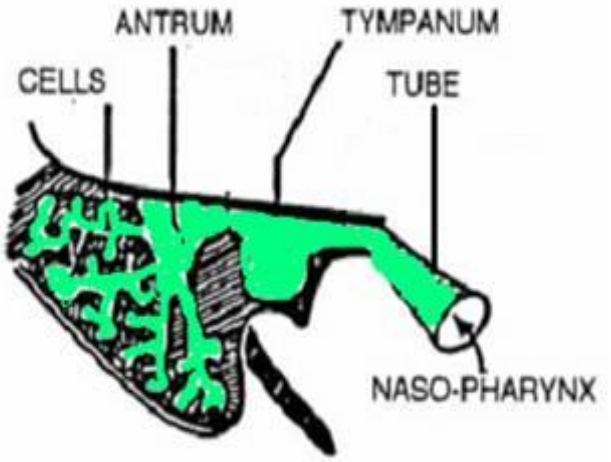
Skin of outer third of the external canal

Furunclosis

Wax

• Middle Ear Cleft:

- **It consists of 3 parts:**
  1- **Eustachian (Pharyngo-tympanic) Tube**
  2- **Tympanum (Middle Ear Cavity)**
  3- **Mastoid Antrum and Air Cells**



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

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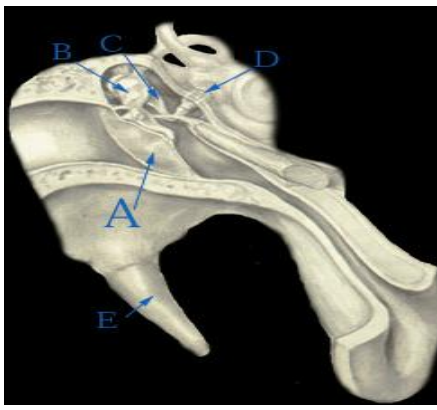
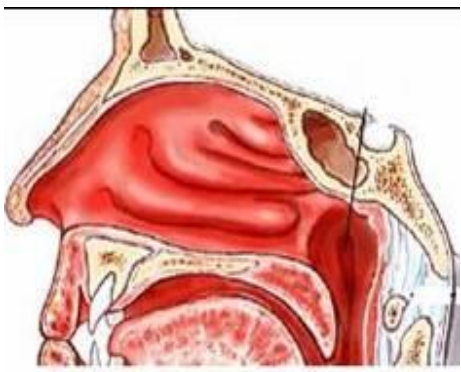
1- Eustachian Tube:

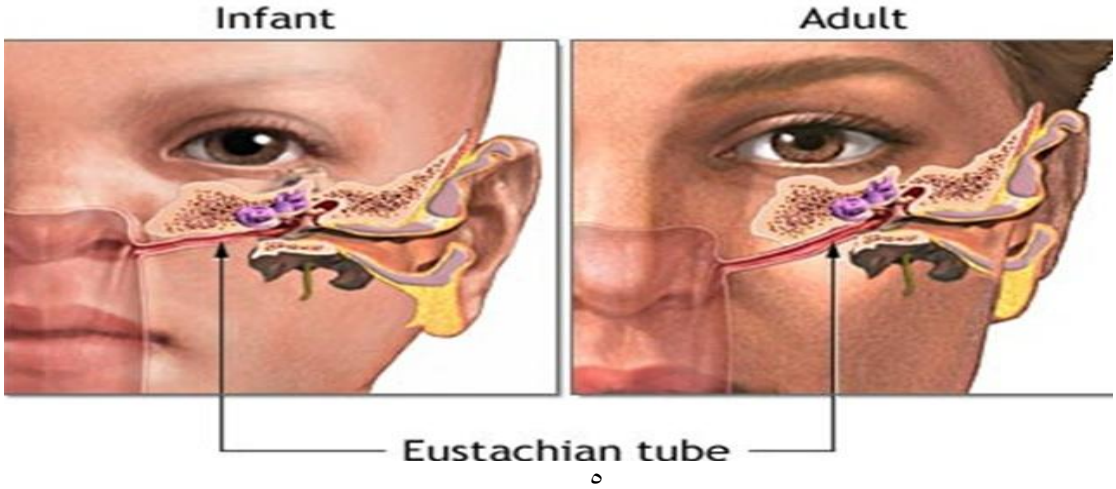


- Is a tube that is normally closed at rest but it opens during swallowing.
- Length = 1-1.5 inch.
- Upper part is bony & the lower part is cartilaginous
- Lower. End is opening in naso-pharynx.
- Upper end is opening in the anterior part of middle ear.
- It is lined by ciliated epithelium.



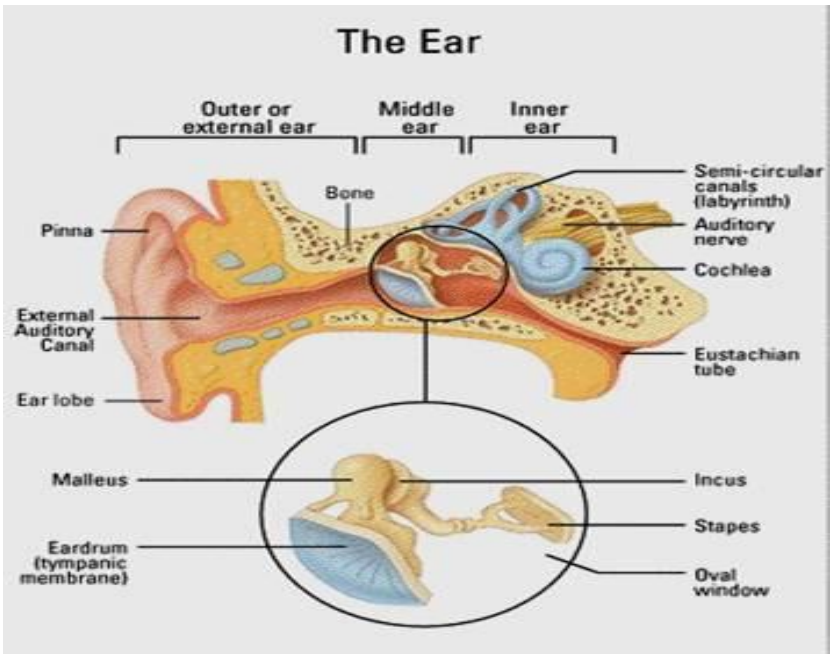
- **Muscles**: There are four muscles associated with the function of the Eustachian tube:
  1- Levator veli palatini. 2- Salpingopharyngeus
  3- Tensor tympani 4- Tensor veli palatine

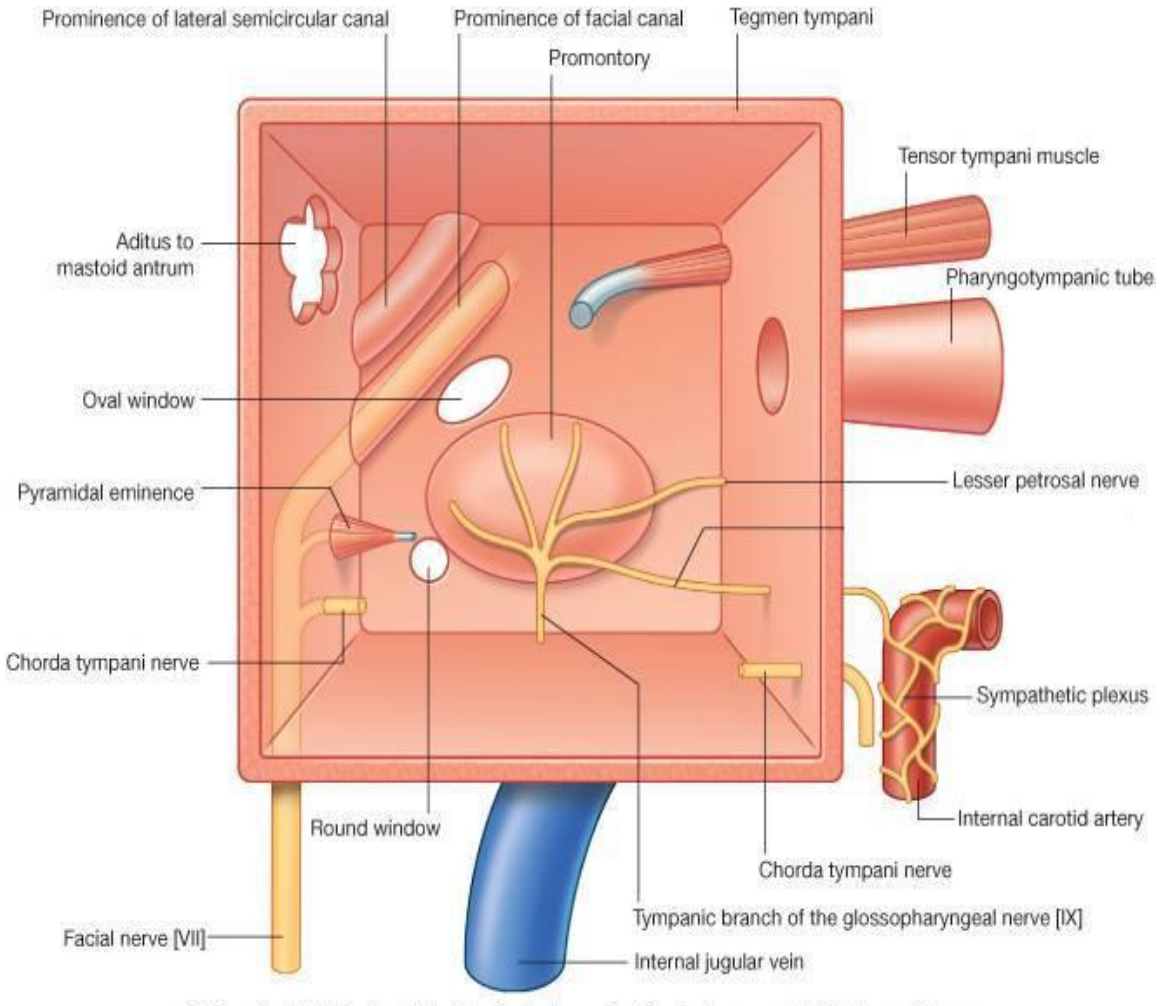
- **Functions**:
  1. It serves to equalize air pressure in the tympanic cavity & the nasopharynx.
  2. Aeration of the middle ear.
  3. Clearance of middle ear.



2- Tympanum (tympanic cavity)(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"

- It's formed of bone which separating the middle ear from the middle cranial fossa. This bone is called (tegmen tympani).
- 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 mastoid antrum.
- Mastoid antrum is lined by mucosa & it is present in mastoid process.
- Mastoid antrum communicates with mastoid air cells that are very variable among individuals. Some individuals have no air cells →sclerotic mastoid (acellular mastoid). And others have excessive air cells →cellular mastoid. The degree between sclerotic mastoid & cellular is called (diploid mastoid).
- A person with excessive air cells is liable to mastoid abscess.
- A person with sclerotic mastoid is liable to chronic infection rather than acute infection.
- Anterior to mastoid antrum is fascial nerve.
- Superior to mastoid antrum is tegmen antri.
- Inferior to mastoid antrum is mastoid tip.
- Posterior to mastoid antrum is sigmoid sinus.

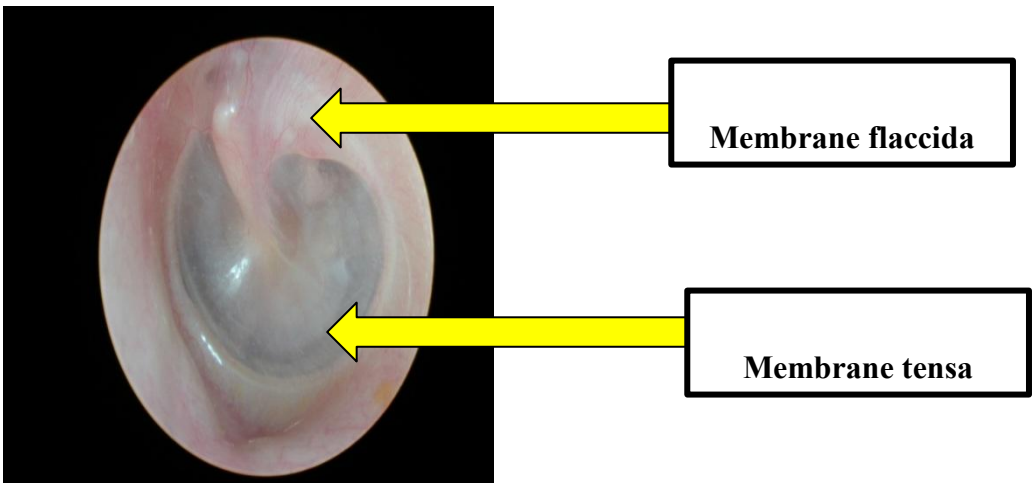
Note: If the infection is transmitted to sigmoid sinus from mastoid antrum → (sigmoid sinus thrombophlebitis).

5- lateral wall:

It consists of:

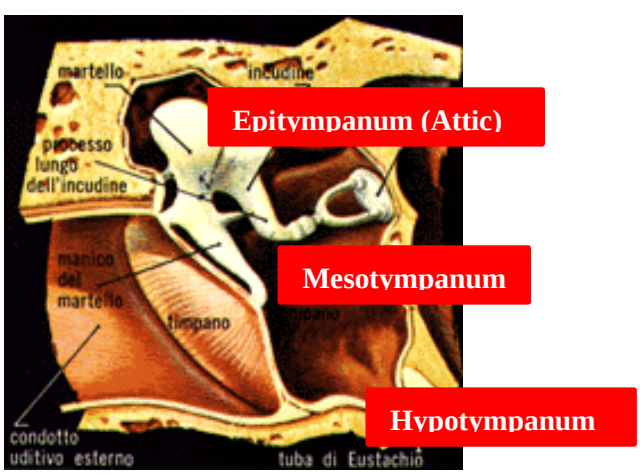
A) Tympanic membrane (ear drum), it is formed of 3 parts:

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



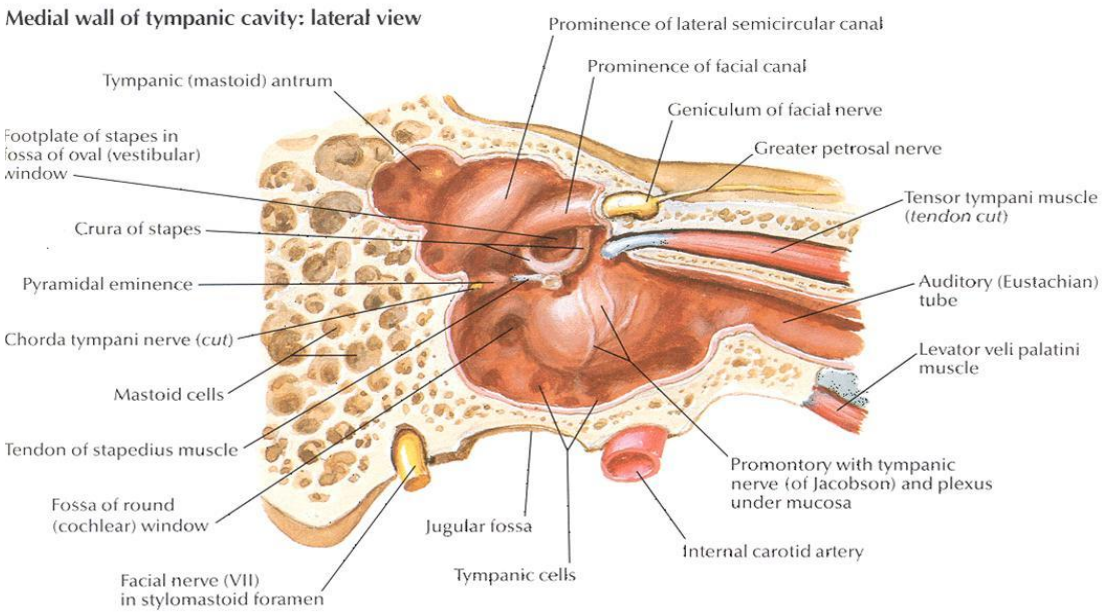
Note:

- The fibrous layer of tympanic membrane is absent in smali area of tympanic membrane called (membrane flaccida) while the remainder which has fibrous layer is called (membrane tensa).
- Handle of malleus is inserted in the middle of ear drum.
- The part of the lateral wall which is against ear drum is called mesotympanum.



B) Epitympanum(Attic bone): the bone which is above the ear drum.
C) Mesotympanum
D) Hypotympanum: the bone which is under the ear drum.

6- Medial wall:



It consists of:

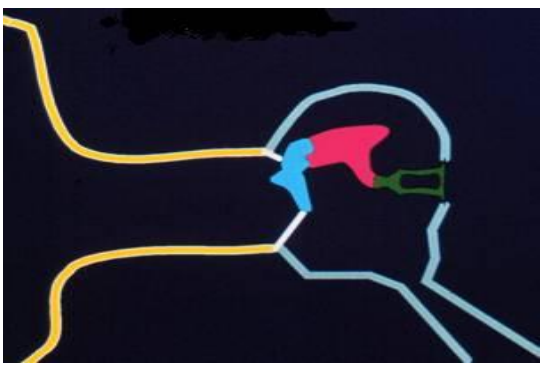
1. Promontory: is a rounded elevation produced by the base of the cochlea.
2. Oval window: just behind & above promontory.
3. Rounded window: just behind & lower promontory.
4. Prominence of the facial nerve: passes backward above the promontory & oval window.
5. Lateral semicircular canal: above facial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

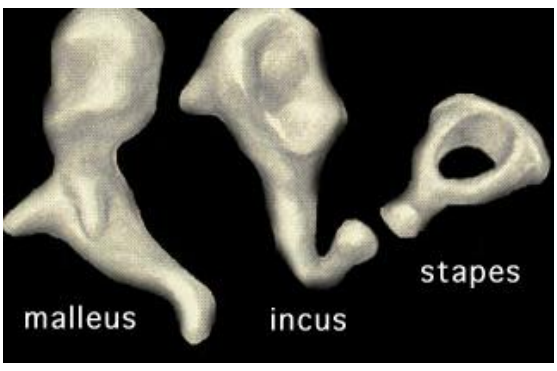
Contents of Tympanic cavity (Middle ear cleft):

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.

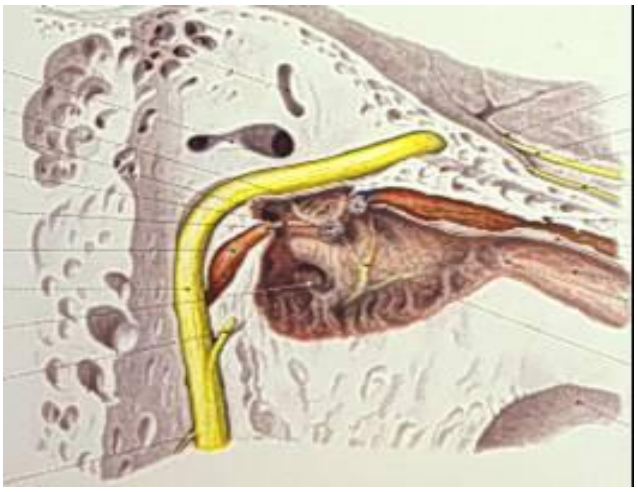




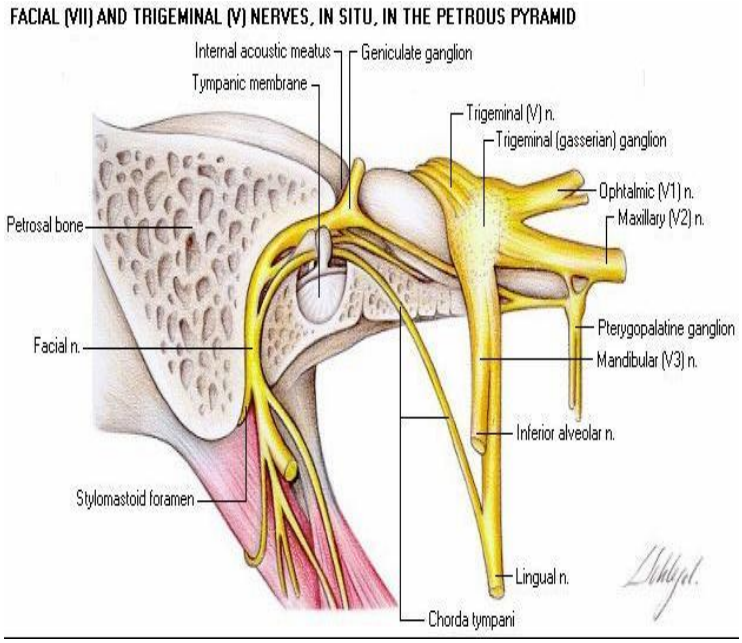
3- Muscles:

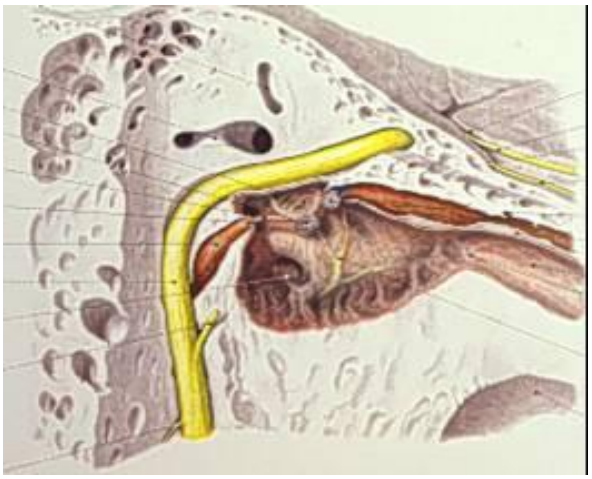
a- Tensor Tympani → attached to the malleus.

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).



4- Nerves:

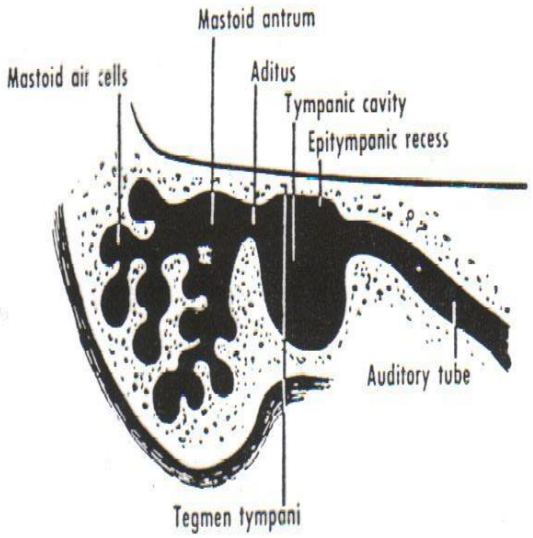


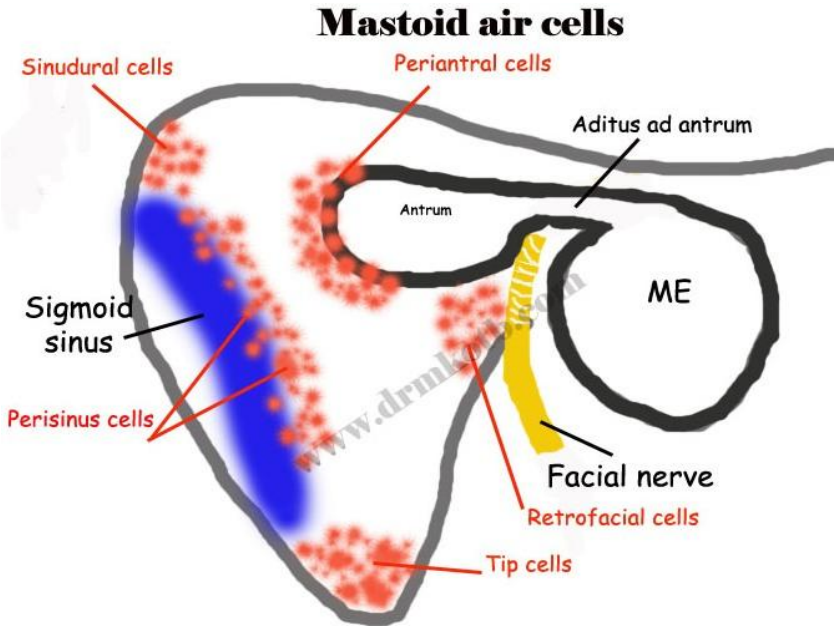


a. Chorda Tympani: A branch from vertical part of facial nerve. They're afferent fibers that carry TASTE fibers from anterior 2/3 of the tongue. Also, they're PARASYMPATHETIC secretory fibers (efferent) that supply sublingual & submandibular glands.

b. 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.

3- 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)

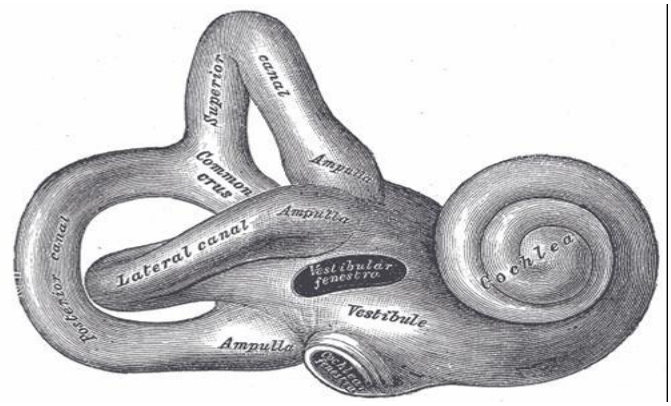
Note:
Dental pain is the most common type of pain that is referred to the ear.

- # Inner Ear:

It consists of:

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

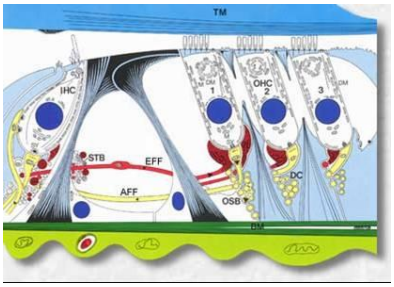
1- Bony cochlea: anterior.
2- Vestibule: middle.
3- Bony semicircular canal: posterior

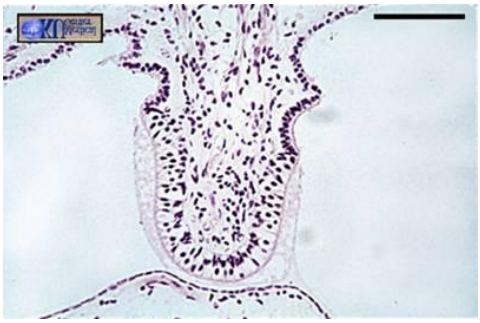


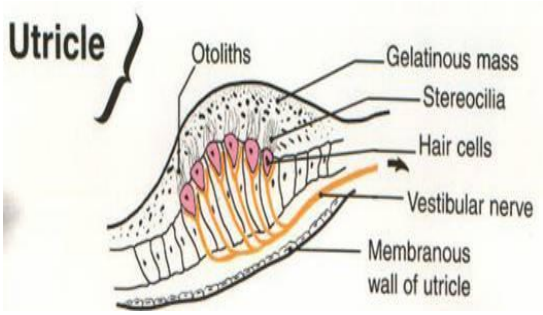
B) Membraneous labyrinth: "Contains Endolymph"

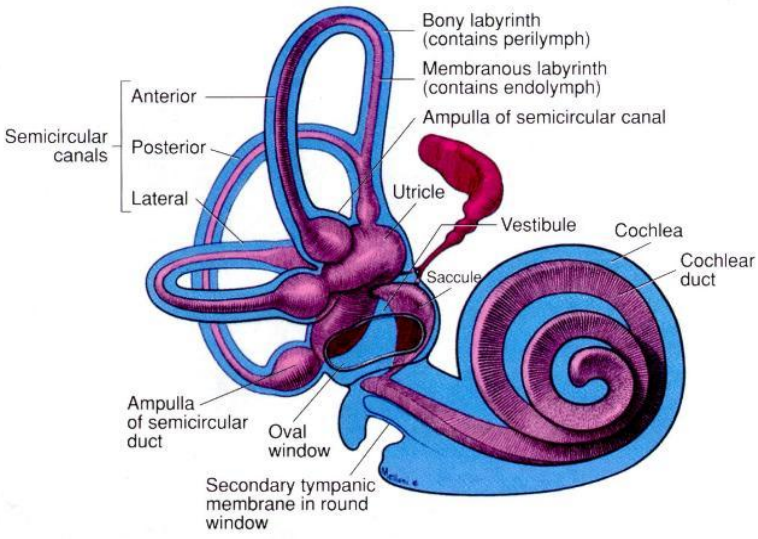
Consist of Sensory Epithelium:

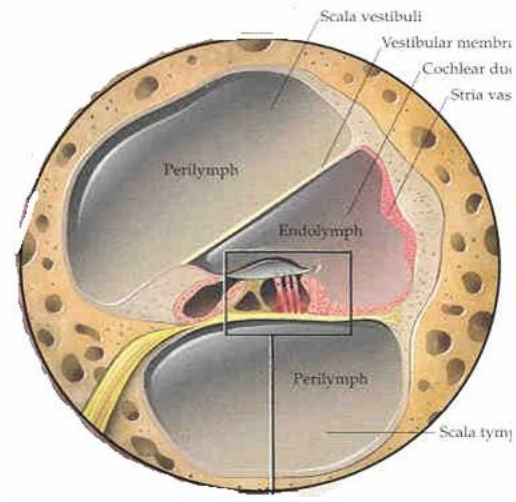
1- **Cochlea**: *organ of Corti*
2- **Utricle & saccule**: *maculae* "they're located within the vestibule"
3- **Semicircular canals**: *cristae* " They are divided into: superior (anterior), posterior & transfers (lateral).







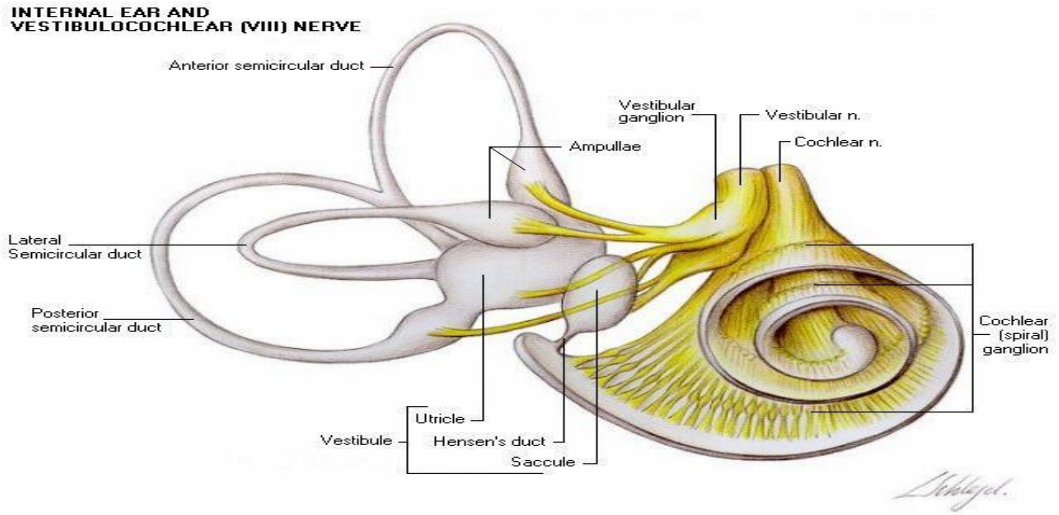


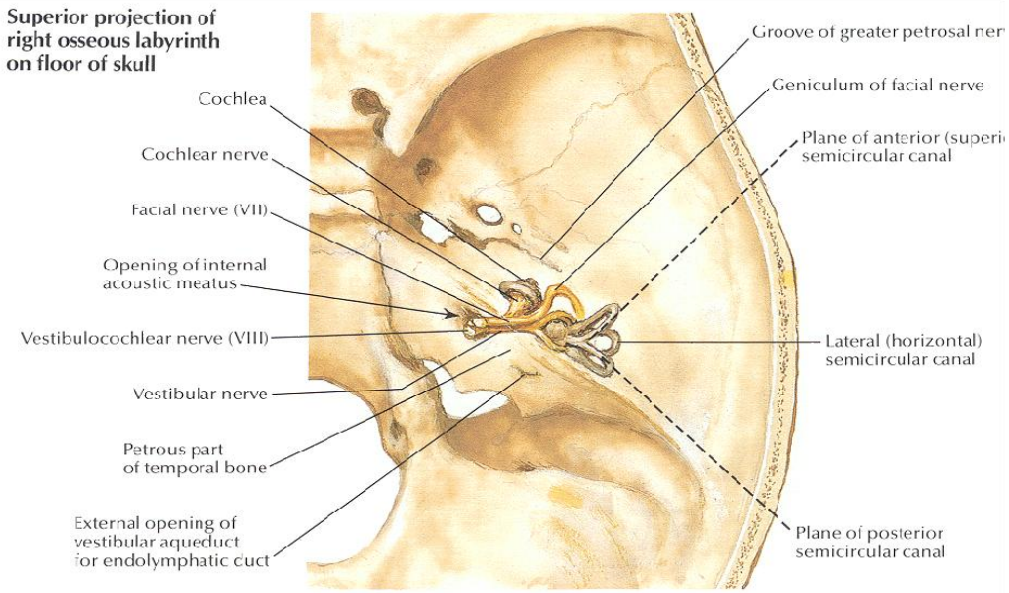


Note:

- 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.

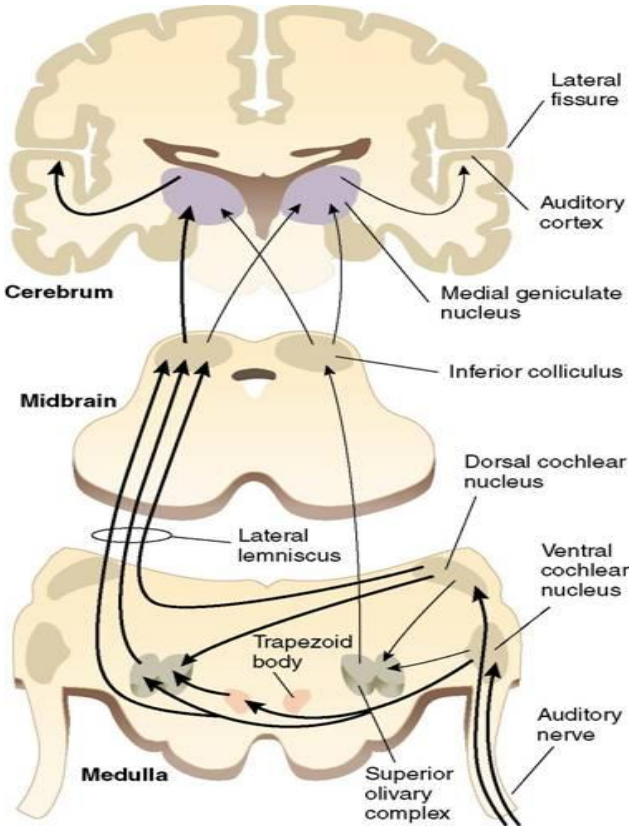
THE VESTIBULO-COCHLEAR NERVE:





Auditory Pathway:

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



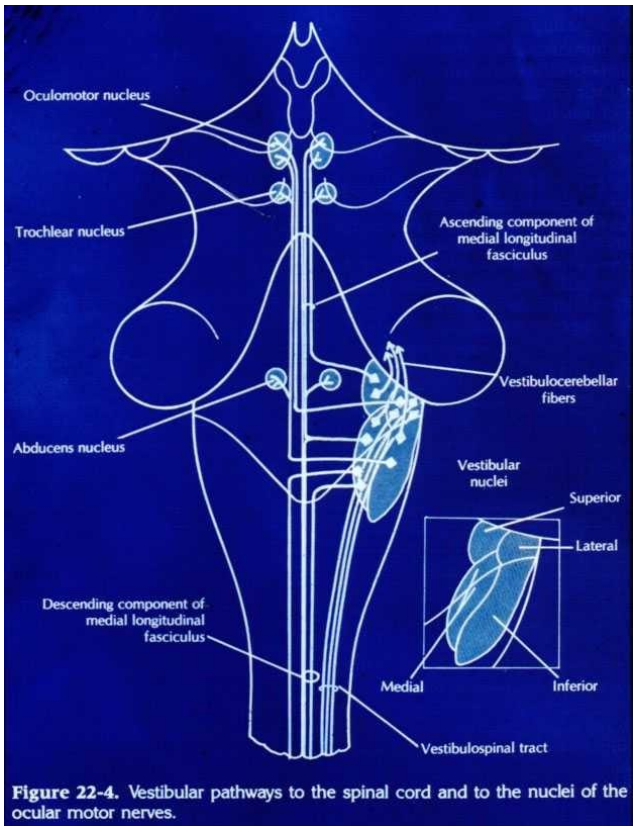
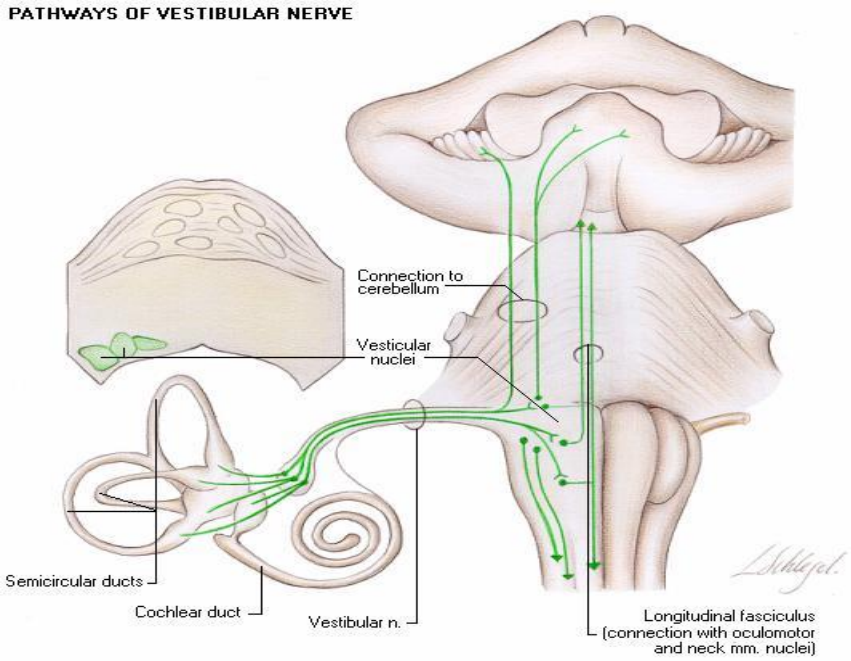


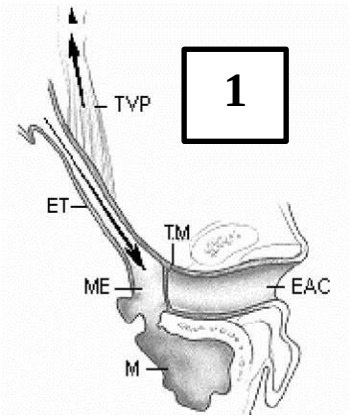
Figure 22-4. Vestibular pathways to the spinal cord and to the nuclei of the ocular motor nerves.

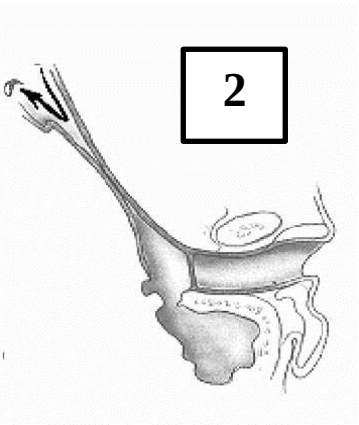


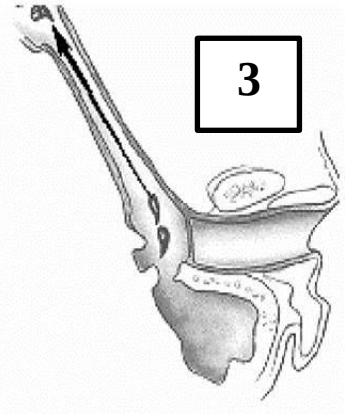
Physiology of the Ear

- **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.

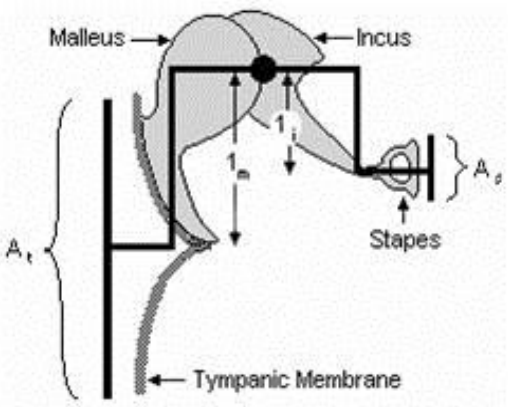


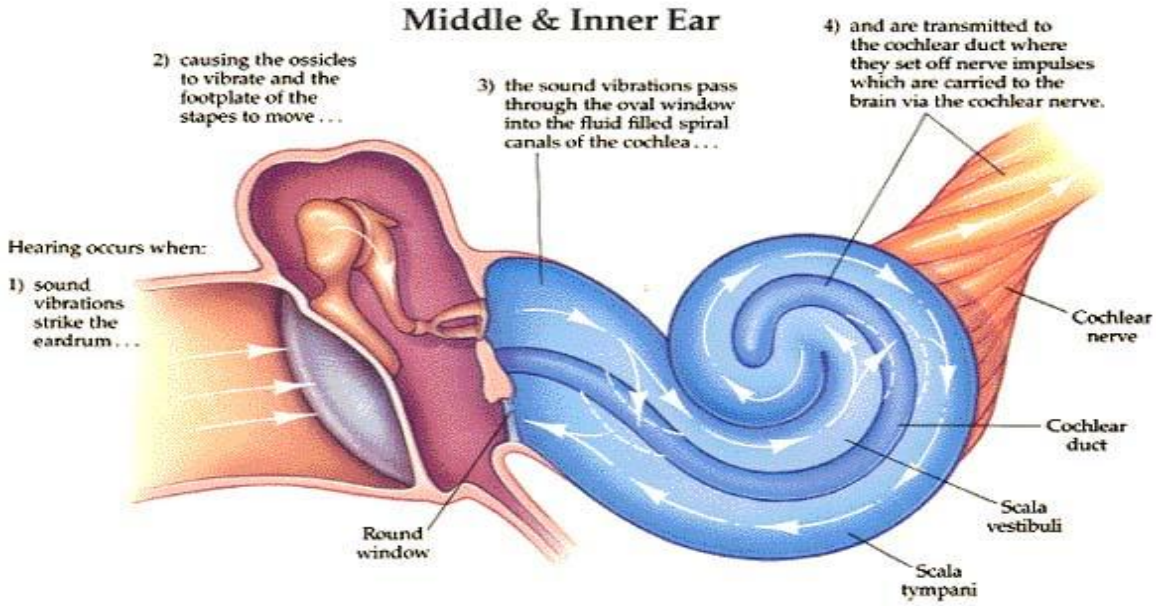




- **Functions of the middle ear:**
  1. Conduction of sound
  2. Transformer mechanism: Amplify the sound by 2 mechanisms:
     - Hydraulic action
     - Ossicular leverage

     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.

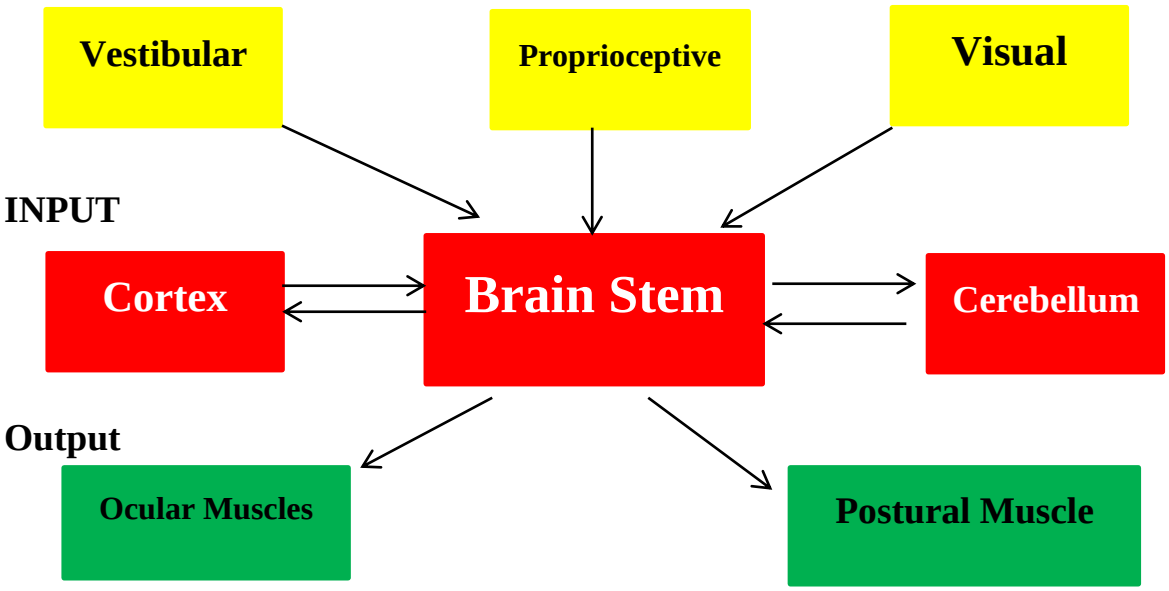
- **Maintenance of body posture:**

1- Brain stem & cerebellum.

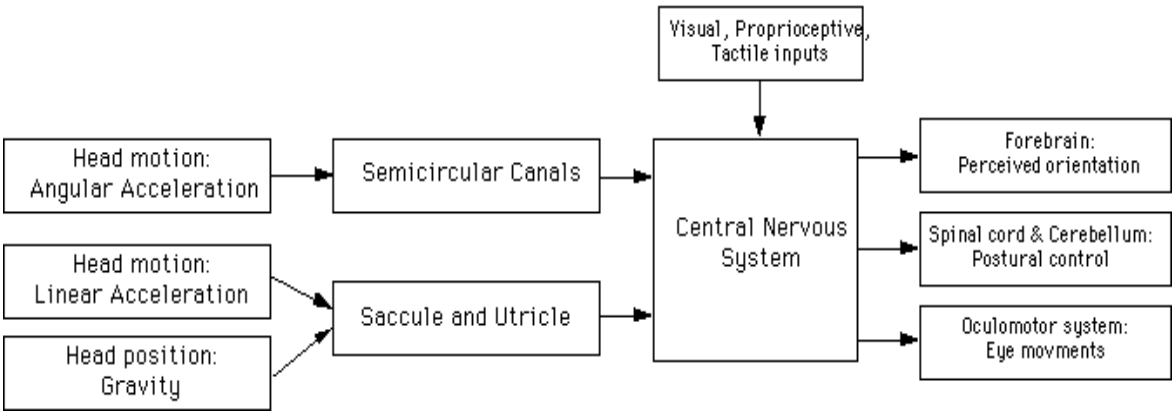
2- Vestibular function.

3- Musculoskeletal system. (Proprioception)

4- Eyes.



VESTIBULAR SYSTEM



Best wishes .....

Mohamed Al-Harbi