DEAFNESS AND TINNITUS

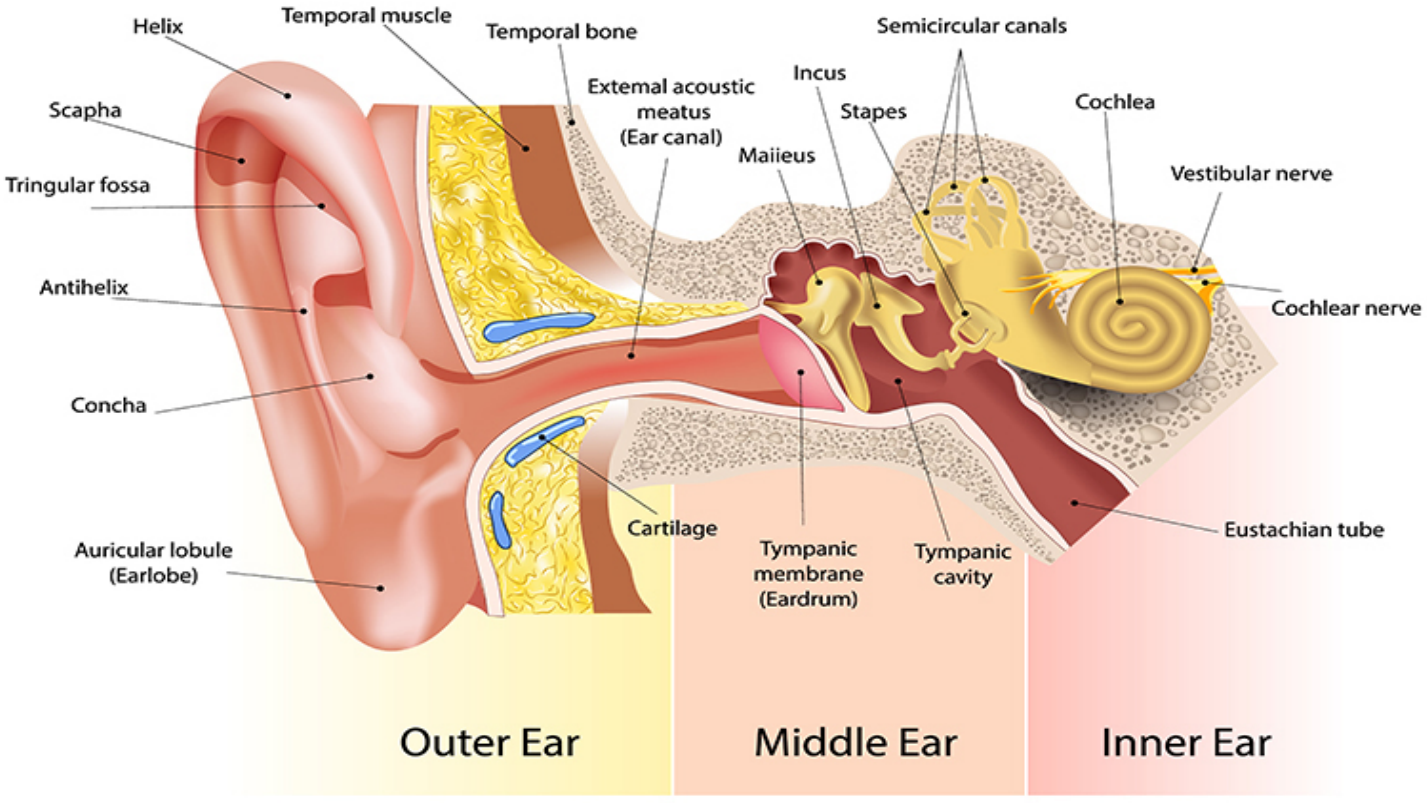
JORDAN UNIVERSITY HOSPITAL

BASIC ANATOMY

- The ear can be divided into three parts: external, middle , and inner ear.
- The external ear consists of the auricle and the external auditory canal .
- The middle ear consists of the tympanic membrane , the three ossicules { malleous , incus , stapes } , two muscle and the tendons attached to them { tensor tympani and the stapedius muscles }
- The inner ear consists of the bony and membranous labyrinth.

1. The bony labyrinth : cochlea , vestibule , semi-circular canals
2. The membranous labyrinth consist of the cochlear duct , utricle , saccule , and the semi-circular ducts .

Anatomy of the Ear



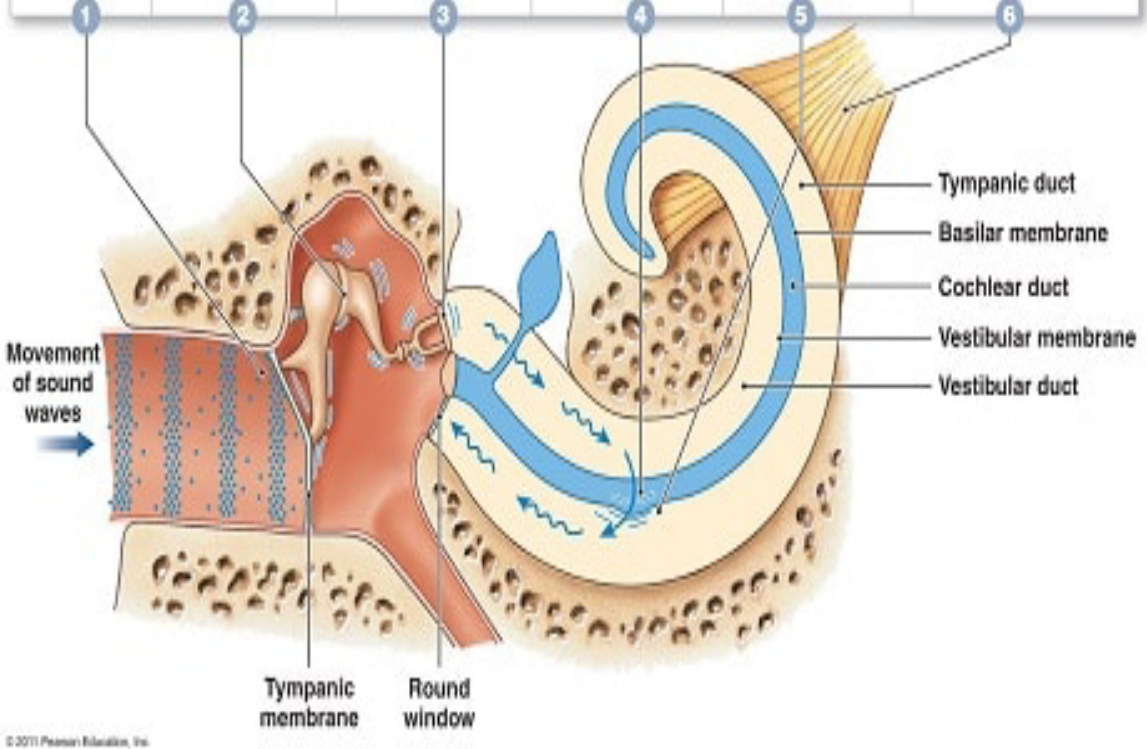
BASIC PHYSIOLOGY

- **Requirements of hearing :**

1. Source of energy sound.
2. Medium through which sound is transmitted .
3. Receptor organ { ear }.

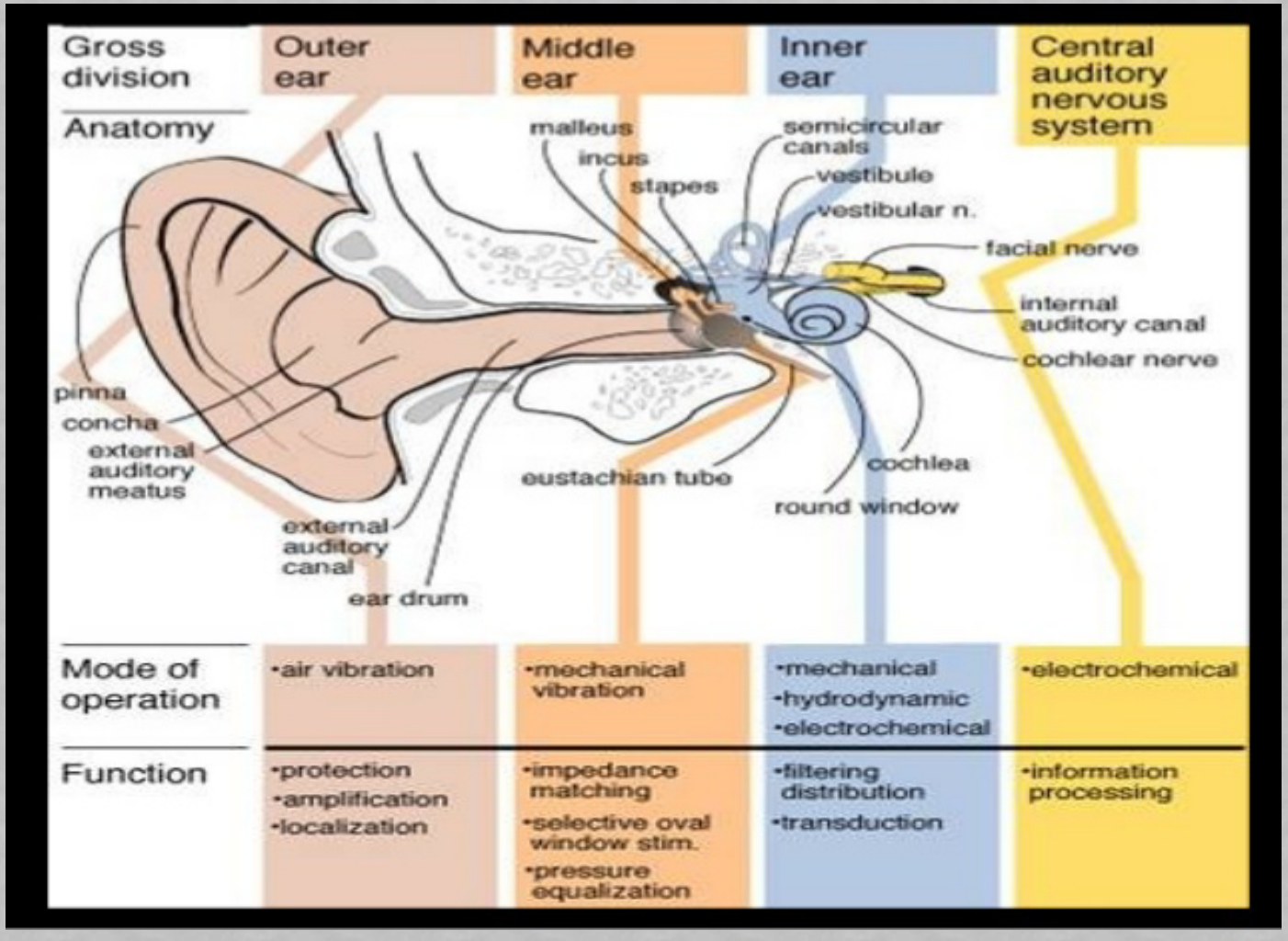
Events Involved in Hearing

1	2	3	4	5	6
Sound waves arrive at the tympanic membrane.	Movement of the tympanic membrane causes displacement of the auditory ossicles.	Movement of the stapes at the oval window establishes pressure waves in the perilymph of the vestibular duct.	The pressure waves distort the basilar membrane on their way to the round window of the tympanic duct.	Vibration of the basilar membrane causes vibration of hair cells against the tectorial membrane.	Information about the region and the intensity of stimulation is relayed to the CNS over the cochlear branch of cranial nerve VIII.



ENERGY

- Acoustic vibration (external ear(
- mechanical energy (middle ear)
- hydraulic energy (perilymph and endolymph of cochlea)
- electromechanical energy (hair cells)
- electrical energy (VIII nerve)


Gross division
Outer ear
Middle ear
Inner ear
Central auditory nervous system
Anatomy
malleus
incus
stapes
semicircular canals
vestibule
vestibular n.
facial nerve
internal auditory canal
cochlear nerve
pinna
concha
external auditory meatus
eustachian tube
cochlea
round window
external auditory canal
ear drum
Mode of operation
•air vibration
•mechanical vibration
•mechanical
•hydrodynamic
•electrochemical
•electrochemical
Function
•protection
•amplification
•localization
•impedance matching
•selective oval window stim.
•pressure equalization
•filtering distribution
•transduction
•information processing

COMMON TERMINOLOGY

- **Hearing loss:** It is an impairment of hearing, and its severity may vary from mild to severe or profound.

- **Deafness:** It is used when there is little or no hearing at all.

CLASSIFICATION

- **Conductive**: involving any cause that limits the amount of external sound from gaining access to the inner ear.
- **Sensorineural**: involving the inner ear, cochlea, or the auditory nerve.
- **Mixed loss**: which is a combination of conductive and sensorineural hearing loss

Conductive hearing loss is usually related to abnormalities of the outer or middle ear; sensorineural hearing loss is related to inner-ear pathology.

OUTER EAR CAUSES

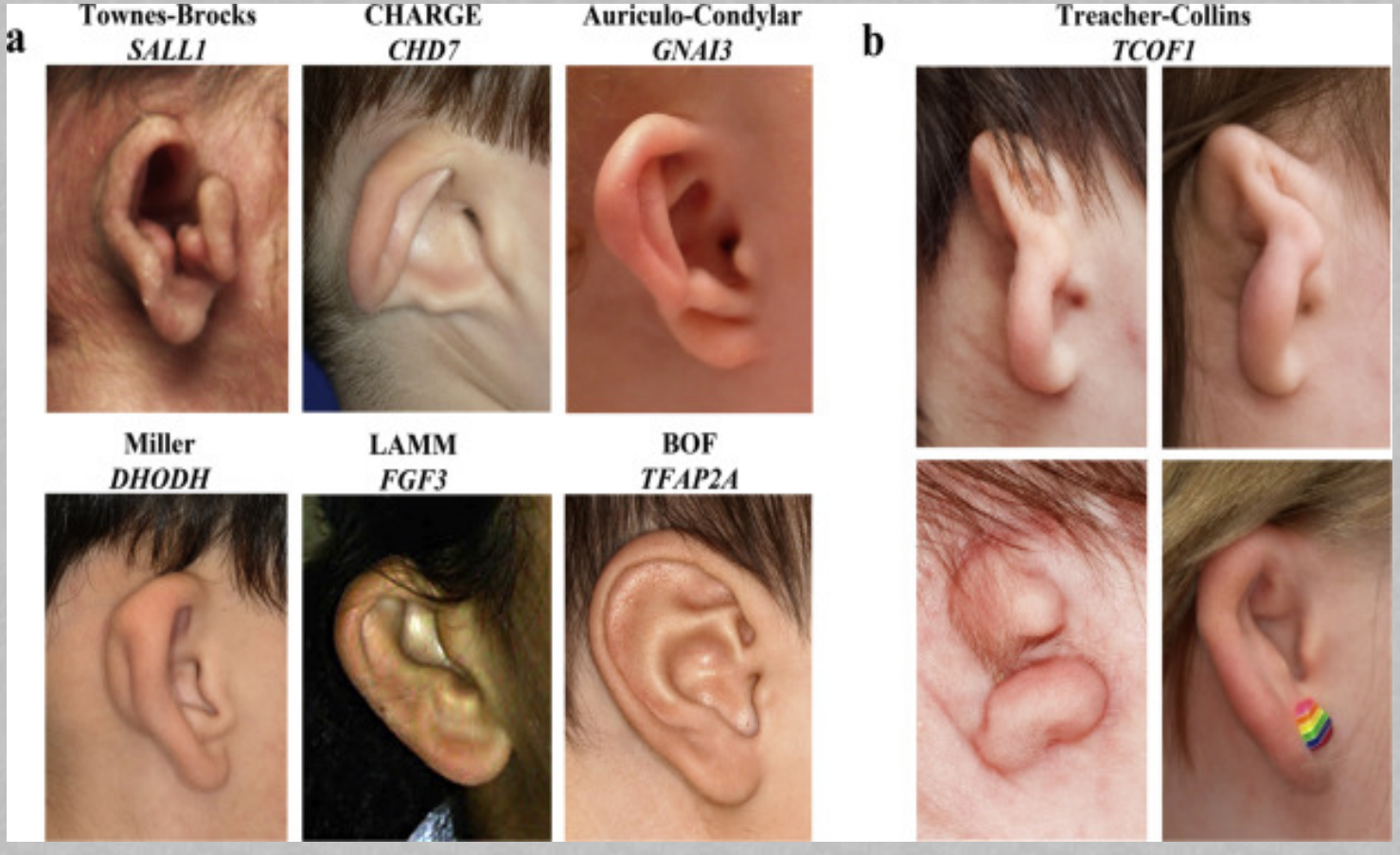
1.Congenital :

1. Microtia (the absence or malformation of the auricle) , may cause mild to moderate conductive hearing loss.

2. Atresia or significant stenosis of the EAC causes moderate to maximal conductive hearing loss.

any disease causes Conductive 1+2
→ doesn't excede 60 db

→ Not more than 55-70 db


a
Townes-Brocks
SALL1
CHARGE
CHD7
Auriculo-Condylar
GNAI3
Miller
DHODH
LAMM
FGF3
BOF
TFAP2A
b
Treacher-Collins
TCOF1

2.Infection: Infections may lead to blockage of the EAC due to the accumulation of debris, edema, or inflammation.

3.Tumor: the most common malignant tumor of the EAC is SCC, others basal cell carcinoma and melanoma, typically cause conductive hearing loss due to occlusion of the canal.

4.Benign bony growths may also occlude the EAC with a resulting conductive hearing loss. The two most common benign growths are exostosis and osteoma.

Multiple vs Single

Both from the Bone

* Both happen in cold water swimmer

Syp :- hearing loss , FB , otorrhea , ear fullness , Tinnitus , Vertigo

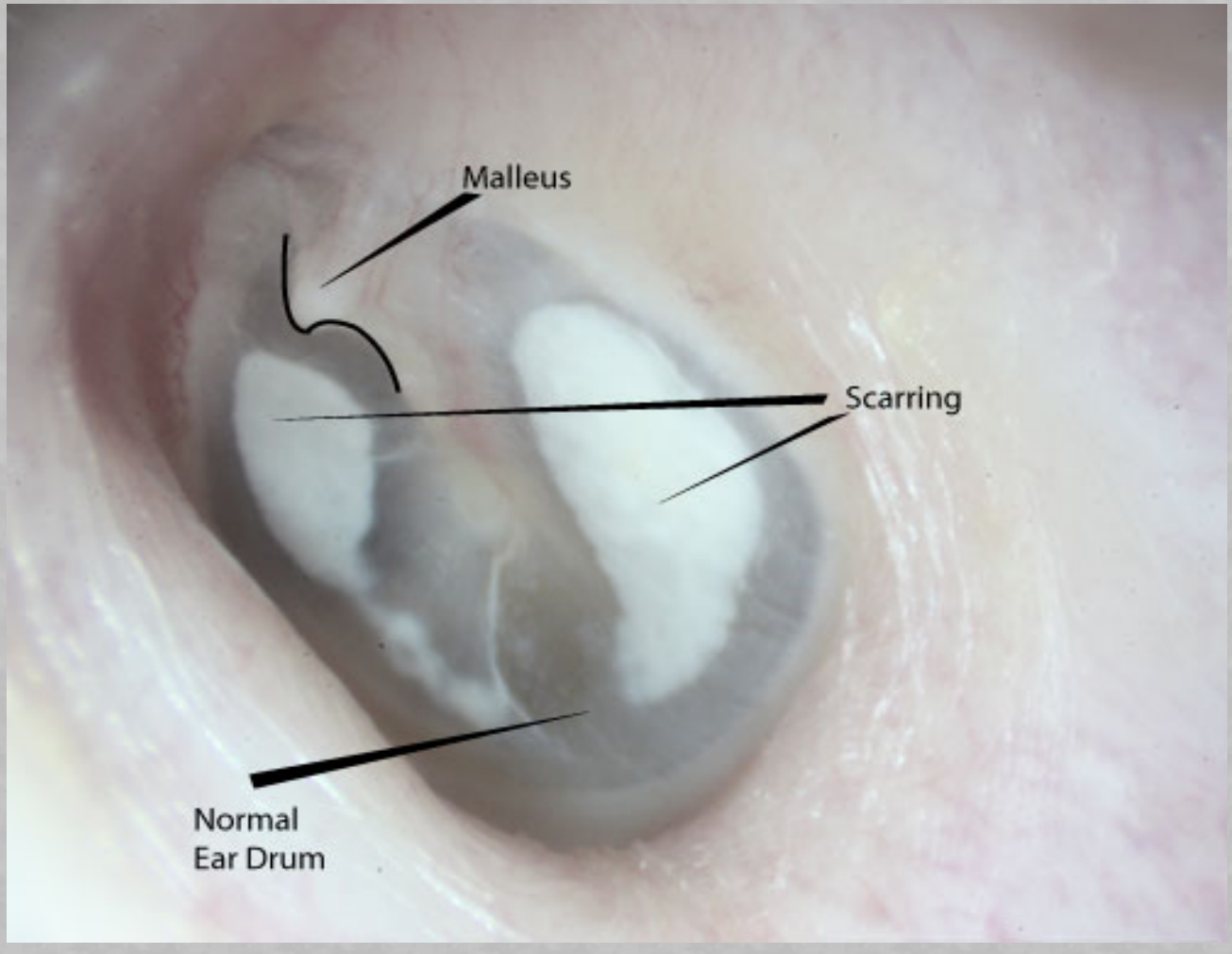
5.Wax impaction : Some patients are not able to clear wax on their own or use Q-tips that push the wax down the ear canal. These individuals may need periodic cleaning of the wax to enhance their auditory capabilities.

6.Tympanosclerosis: Between muscle's Bones. Tympanic M. or Tympanic cavity * in fibrous layer

caused by previous infection or insertion of ventilation tubes result in white or yellow scarring within the tympanic membrane.

usually It does not cause a significant reduction in hearing.

Rarely causes scarring and fixation of the ossicles, with a conductive hearing loss.


Malleus
Scarring
Normal
Ear Drum

MIDDLE EAR CAUSES

1. **Congenital** :

- atresia or malformation of the ossicular chain can cause conductive hearing loss.

- the most common ossicular abnormality observed is a missing or malalignment of the crura of the stapes others include abnormal incus or malleoincudal joint.

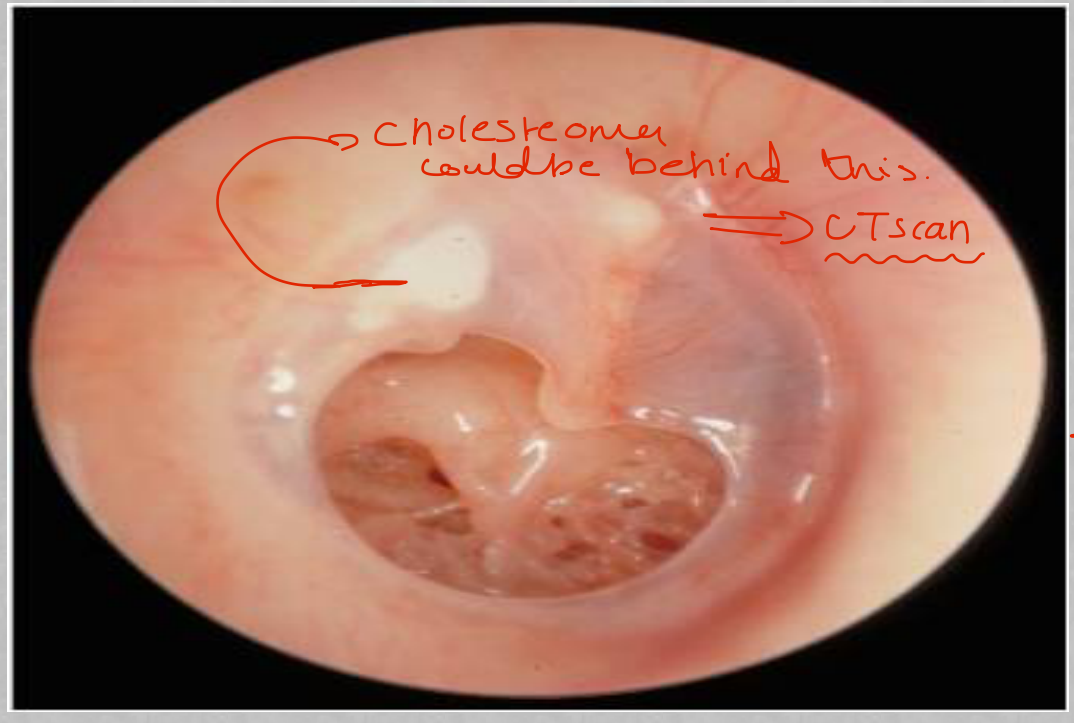
2. Infections:

- otitis media is a common childhood disorder that also frequently occurs in adults.
- it is normally associated with pain, fever, and ear fullness as well as decreased hearing.
- Conductive hearing loss occurs because fluid filling the middle ear space prevents the tympanic membrane (TM) from vibrating adequately, thereby diminishing movement of the ossicular chain.

3.Tympanic membrane perforation:

- The degree of conductive hearing loss depends upon the size and location of the perforation.

- can be caused by :
  - blast injury
  - barotrauma
  - foreign body trauma
  - temporal bone fractures
  - ear infections
  - self-inflicted trauma from a Q-tip or other object



large < subtotal.

- subtotal Perforation all except Pars ∴.

large, dry, perforation

most likely caused by → CSOM → could be safe or unsafe.

Pentorated TM.

Most acute TM perforations heal on their own or with the aid of a paper or biogenic film patch. Occasionally surgical correction is required, usually with a temporalis muscle fascia graft. Repair of the perforation often corrects the conductive hearing loss.

Middle ear barotrauma:

not always on TM.
mostly in the middle ear

- The eustachian tube needs to be closed most of the time to prevent tympanic membrane motion with respiration and it opens momentarily during swallowing or yawning for a second and allowing air flow to occur.

- Pressure within the middle ear has to match that of the outside world for the tympanic membrane to vibrate normally and for hearing to be clear.

Barotrauma: - trauma to middle ear ME + TM during rapid decend
Change

* huge diffrence Between External and Middle ear.

* NO Acend *

[severe ↓ pressure in the outer ear]

* hemotympanic → TM is Bluish, Reddish and it's still complaint

- Barotrauma occurs when a patient is exposed to a sudden, large change in ambient pressure, often during diving or flying.

- if upon descent with flying or diving this equalization is prevented by mucosal edema secondary to an URI, pregnancy, or anatomic variations, the negative relative pressure in the middle ear can lead to its filling with serous fluid or blood or to inward rupture of the TM.

- Treatment of middle ear barotrauma consists of:
  - topical and systemic decongestants
  - analgesics
  - antihistamines
  - Antibiotics should be used if purulent otorrhea is observed
  - Most TM ruptures heal spontaneously, if normal eustachian tube function is restored and infection is controlled

humidity ↑ healing ↑ Bacteria → deposit of cholesterol

4.Tumors:

- **Cholesteatoma** is a growth of desquamated, stratified, squamous epithelium within the middle ear space , As keratin desquamates from the epithelial lining of the sac, it gradually enlarges with eventual erosion of the ossicular chain, mastoid, and external auditory canal (EAC)causing hearing loss .

Malignant locally

causes →
erosion of the Bones (ossicles, Mastoide)
emergency → Surgical Removal.

5.Otosclerosis :

- Otosclerosis is a bony overgrowth that involves the footplate of the stapes bone causing fixation and a conductive hearing loss .
- The inheritance is autosomal dominant but with reduced penetrance and there maybe no family history.
- The presentation tends to occur in young and middle aged women.
- It can remain unilateral or become bilateral.

Initial treatment for otosclerosis and the accompanying hearing loss involves either hearing amplification or surgical replacement of the stapes bone with a prosthesis.

6.Eustachian tube dysfunction :

- can cause perceived hearing loss.
- occurs commonly in the setting of a viral upper respiratory infection (URI) or sinusitis, and it can also occur with allergies.

INNER EAR CAUSES

Disorders of the inner ear normally cause a sensorineural hearing loss. The etiology may be associated with the cochlea, eighth nerve, internal auditory canal, or brain.

1.congenital :

- any hearing loss that occurs at or shortly after birth.

- Hereditary : can be autosomal dominant or recessive; 90 percent is autosomal recessive, so that the children often have normal hearing parents.

- Non-hereditary: involve an insult to the developing cochlea, including viral infections such as cytomegalovirus (CMV), hepatitis, rubella, toxoplasmosis, HIV, and syphilis.

2.Presbycusis :

- age-related hearing loss, is a common cause of hearing loss worldwide. The hallmark of presbycusis is the progressive, symmetric loss of high-frequency hearing over many years in an elderly individual,

- Tinnitus is often present.

- Hearing aids are able to benefit most patients with presbycusis, and The progression of hearing loss rarely becomes so severe that hearing aids are not effective in restoring the ability to communicate

3.Infection :

- The most common infection of the inner ear in adults is viral cochleitis; in young children, it is meningitis.

- cause a profound sensorineural hearing loss by destroying the inner ear hair cells

Adult

- Viral cochleitis usually manifests as a sudden sensorineural hearing loss ; vertigo, facial paralysis, or pain occur rarely.

4.Meniere disease:

fluctuating hearing loss.

First → Affecting low frequency → late moderate

- a condition of unknown etiology, likely caused by endolymphatic hydrops of the membranous labyrinth of the inner ear.

triad.

- characterized by episodes of deafness, tinnitus, and vertigo. Typically the attacks are preceded by a sensation of fullness in the ear.

- Symptoms last for several hours and in between attacks the affected ear may return to normal.

cause recurrency

sensory not neural ?? not sure.

Cochelear.?

5.Noise exposure:

- The mechanism by which excessive noise induces hearing loss includes :

1. direct mechanical damage of cochlear structures.
2. metabolic overload due to overstimulation (including excess nitric oxide release that can damage hair cells, generation of oxygen free radicals that become toxic to membranes, and low magnesium concentrations that weaken hair cells by reducing the concentration of intracellular calcium).

6.Inner ear barotrauma:

- is a fairly uncommon injury but should be excluded In all cases of middle ear barotrauma.
- It can occur following the development of a sudden pressure differential between the inner and middle ear, leading to rupture of the round or oval window.
- The main symptoms are tinnitus, vertigo, and hearing loss, which in turn can cause disorientation and panic.

7.Tumors :

- the most common tumor that causes sensorineural hearing loss is an **acoustic neuroma** .M.C
- This is a benign tumor that usually originates from the vestibular portion of the eighth cranial nerve.
- The most common complaint is an asymmetric or unilateral sensorineural hearing loss.

8.Ototoxic substances:

- Antibiotics(oral aminoglycosides , erythromycin and tetracycline)
- chemotherapeutic agents (cisplatin) are among the most commonly used drugs that cause hearing loss.
- Any sensorineural hearing loss associated with antibiotic or chemotherapeutic drugs is permanent.

9.Neurogenic:

- Cerebrovascular accident or transient ischemic attack
- Arnold-Chiari malformations may stretch the auditory vestibular nerve,
- Multiple sclerosis

10.Iatrogenic :

- Iatrogenic inner ear injuries may occur during surgical procedures such as :

- tympanomastoidectomy or stapedectomy; following

- radiation therapy, either for intracranial or nasopharyngeal tumors; or they may be medication-related.

DEGREE OF HEARING LOSS

- Normally up to 25 db in adults and 15 in a child.
- Mild 25-40 db
- moderate 41-55 db
- Moderately severe 56-70 db
- Severe 71-85 db
- Profound >85 db

DIAGNOSIS

- Proper hx taking

- examination:
  - observe patient during conversation.
  - ability to repeat spoken words:
  - each ear, if there is profound hearing loss at one side.
  - good ear should be masked by barany noise box and deaf ear tested by shouting.

each ear.

- otoscopic examination.

- tuning fork tests.

- Investigations :
  - Audiogram
  - tympanogram
  - if needed:
  - speech audiometry
  - vestibular tests

: TREATMENT

- Congenital: counseling , hearing aids , speech therapy & special education programs , surgery in cases of cleft palate and atresia.

- ttt of underlying cause .

- idiopathic otosclerosis: hearing aids, surgery.

- Sudden hearing loss: corticosteroids

TINNITUS

- defined as the aberrant perception of sound without any external stimulation, It is thought to be due to misinterpretation of signals in the central auditory pathways of the brain.

- it consists of an intermittent or continuous ringing, hissing or buzzing noise and it may be low, medium or high-pitched.

- Quality of tinnitus varies according to origin:
  high pitch (inner ear) / crackling (middle ear) /pulsating(vascular).

- it can be unilateral or bilateral.

- **It is not a disease but a symptom.**

- described as either subjective or objective:

- Subjective tinnitus: the most common type, occurs in the absence of any physical sound reaching the ear and is audible only to the patient.

- Objective tinnitus, which affects a minority of patients(1%),is generated in the body and reaches the ear through conduction in body tissue and is audible to the patient as well as the clinician.

- Objective: rare

causes:

- palatal myoclonus, middle ear myoclonus
- vascular (aneurysm, glomus tumor, AV shunt , atheroma of cranial vessels).
- acute middle ear infection

- **Subjective:** very common

Causes:

- acute trauma
- Meniere's disease
- ototoxicity , otosclerosis
- acoustic neuroma
- systemic disease: CVS disease,blood diseases (anemia), neurological (MS, neuropathy), drugs, fever, alcohol abuse.
- middle ear effusion and chronic otitis
- psychogenic(hallucinations)
- labyrinthitis, perilymph fistula
- idiopathic (majority)

DIAGNOSIS

- proper hx taking:
  localization , pitch , duration.
  audiological : deafness ,noise exposure
  Otological : discharge
  drug hx

- examination: ENT , neck ,TMJ, auscultation

- investigations:
  audiometry, tympanometry ,vestibulometry.
  Tinnitus test (pure tone matching)
  blood test (T3, T4 , lipid profile,…)
  radiograms(x-ray , CT, MRA)

: TREATMENT

- counseling: informing the patients about the factors aggravating tinnitus which include : fatigue, anxiety, stress, depression.
- underlying cause: remove wax, tumors or aneurysms, control HTN,…
- Drugs : muscle relaxants, Antidepressants, tranquilizers, anticonvulsants.

- surgery: labyrinthectomy
- hearing aids.(if the patient is deaf)
- tinnitus maskers (white noise instrument), by producing quite noise .
- Tinnitus retraining therapy (TRT)

Thank you