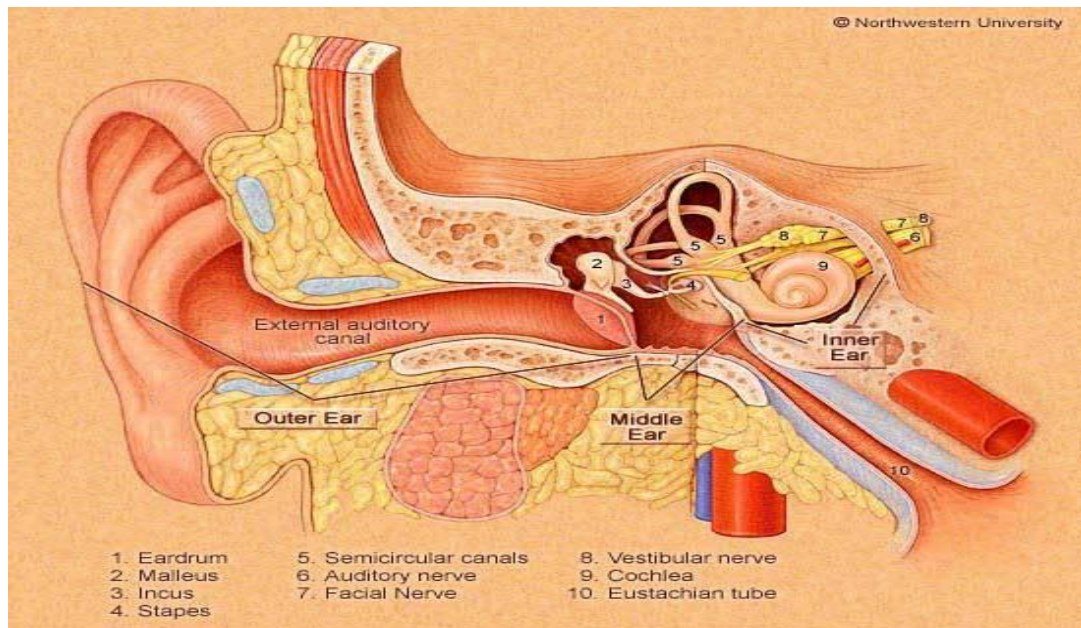


# ANATOMY OF THE EAR

**Ear is divided into 3 parts :**

- external ear
- middle ear
- inner ear



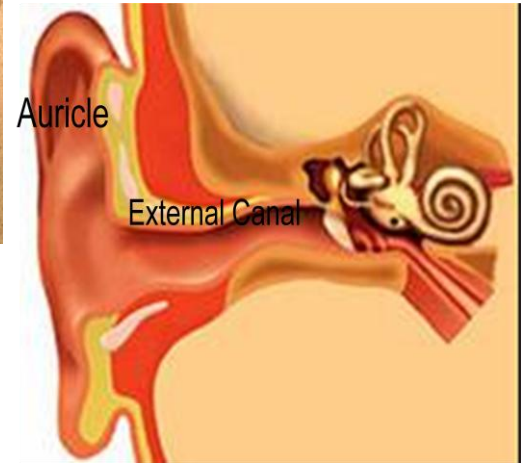
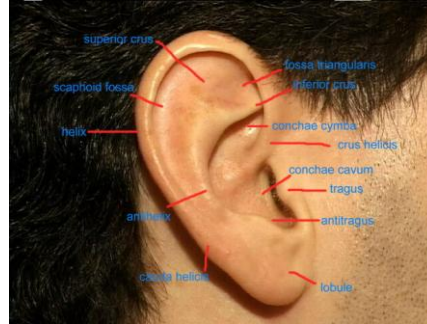
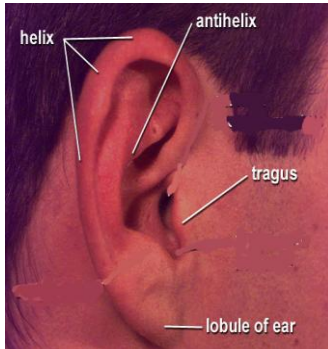
## **EXTERNAL EAR**

### **1- Ear pinna (auricle)**

- Ear pinna is formed of fibrous cartilage (not hyaline which is liable to calcification).
- This fibrous cartilage is mobile and covered by skin.
- The skin is adherent to the fibrous cartilage. Therefore, when the auricle is diseased with inflammatory condition (perichondritis) the patient will suffer from a severe pain due to separation of skin from cartilage.
- the fibrous cartilage is avascular. It gets its blood supply from overlying skin. Hence separation of skin from underlying cartilage leads to deprivation of cartilage from its blood supply which will eventually lead to necrosis.
- Cartilage is absent in :
  - 1- ear lobule
  - 2-the part between tragus and helix (incisera terminalis)
- cartilage should not be pierced it may cause infection of cartilage (perichondritis) > which may end by cauliflower deformity .
- in perichondritis these 2 parts wont be affected
- ncisera terminalis can be used for surgical incision

-parts you should know

- 1- tragus : it is a prominence
- 2-antitragus : against tragus
- 3-helix: another prominence
- 4-antihelix : against it



Perichondritis



Erysipelas

## 2-external auditory (acoustic canal)

- The external auditory canal starts from the concha of the ear auricle and ends in the tympanic membrane
- 1 inch = 2.5 cm
- It is curved which is important for tympanic membrane protection.
- you cannot see the tympanic membrane in normal ear position, you have to pull the ear upward, backward, and lateral
- in infants pull downward, backward, and lateral.
- the outer 1/3 is cartilage characterized by presence of hair follicles, sebaceous gland, and modified sweat gland (ceruminous gland) which is responsible for cerumen(wax) secretion
- frunculosis is infection of hair follicle.(only in the outer 1/3)
- If you find wax in the inner 2/3 of the canal usually it is due to wax being pushed.
- Inner 2/3 is bony, but it is cartilage in infants up to 1-2 years after birth.
- wax protects and covers skin >> if no wax (dry)>> prone to infection and injury

### MIDDLE EAR CLEFT

-it consist of the following parts:

#### 1- Eustachian tube (auditory tube):

- Connects middle ear with nasopharynx, thus any infection or mass in nasopharynx (eg:adenoid) can cause infection in middle ear
- normally it is closed at rest, it opens during swallowing and blowing
- closing is good because it is a mechanism to prevent contamination (nose and mouth are the dirtiest parts of the body)
- length is 1.5 inch
- upper part is bony , lower part is cartilaginous
- lower end opens in nasopharynx
- upper end opens in the ant part of middle ear
- It is lined by ciliated epithelium
- 4 muscles related to it:
  - Tensor palati (opens the tube)
  - Elevator palati (open the tube)
  - Tensor tympani (closes the tube)
  - Tensor veli palateni
- -function :
  - 1- Equalize pressure in tympanic cavity and nasopharynx
  - 2- Aeration of middle ear
  - 3- Clearance of middle ear

#### 2- tympanium (middle ear cavity)

- Between external and internal ear
  - Like a box
  - 6 walls :
- ##### 1- Lateral :
- Mainly tympanic membrane formed by 3 parts(.9cm)
    - outer layer (stratified squamous epithelium)
    - middle layer (fibrous)
    - inner layer (mucus mem)
  - the fibrous layer is absent in a small area called membrana flaccida
  - the reminder where fibrous layer is present is called membrana tensa
  - handle of malleous is inserted in the middle ear drum(cone of light reflection)
  - the part of the lateral wall which is against ear drum in called mesotympanium the (only part seen by otoscope)
  - Attic bone or epitympanium (bone above ear drum)
  - Hypotympanium(bone under ear drum)
- ##### 2- medial wall
- Promontory: rounded elevation produced by the base of cochlea
  - Oval window : behind and above promontory
  - Rounded window: behind and below promontory
  - Prominence of facial nerve: passes backward above the promontory and oval window

- Lateral semicircular canal : above facial nerve
- Stapes foot plate
- Nerves and blood vessels opening of eustachian tube

### 3- floor :

- Formed by thin plate of bone which separate the middle ear from the jugular fossa
- Jugular fossa (internal jugular vein- internal carotid artery- tympanic branch of 9th cranial never)
- -the tympanic branch lies between internal jugular vein and internal carotid artery
- -some time the thin plate of bone is absent due to congenital anomalies >> projection of internal jugular vein in middle ear >> surgical hazard liable to injury during surgery

### 4- roof :

- It is formed of a bone which separates middle ear from middle cranial fossa the bone is called (tegmen tympani)
- Sometimes unfortunately this bone becomes very thin and the suture between 2 bones of cranium allow infection of middle ear to be passed through the suture >> intracranial complication (cranial abscess)

### 5- anterior wall:

- Eustachian tube
- Tensor tympani (above the tube)

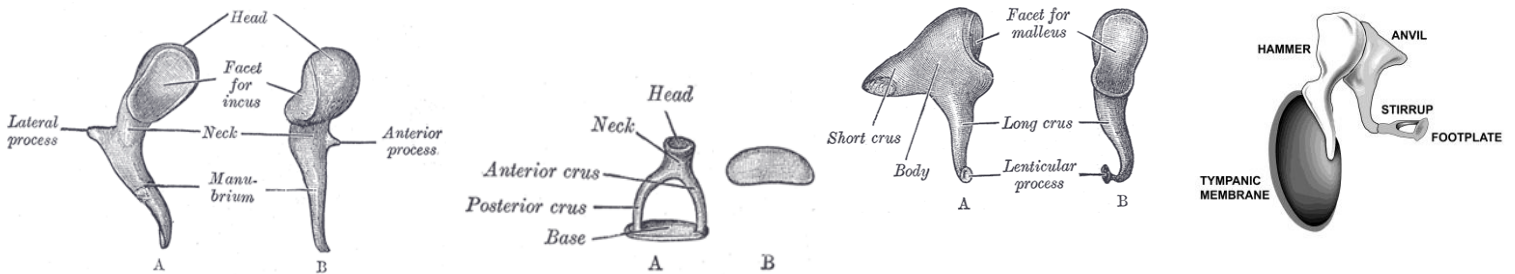
### 6- posterior wall:

- Auditus of mastoid antrum
- Mastoid antrum is lined by mucosa (present in mastoid process)
- Mastoid antrum communicates with mastoid air cells that are very variable among individuals
- if no air cells = sclerotic = acellular mastoid (prone to chronic infection)
- If excessive =cellular mastoid (prone to mastoid abcess)
- The area between sclerotic and cellular mastoid is diploid mastoid
- Anterior to mastoid antrum is facial nerve
- Superior to mastoid antrum is tegmun anti
- Inferior to mastoid antrum is mastoid tip
- Posterior to mastoid antrum is sigmoid sinus
- If infection is transmitted to sigmoid sinus from mastoid antrum (sigmoid sinus thrombophelitis)

### Content of tympanic cavity:

- Air from Eustachian tube
- Ossicles
  - Malleus (head, neck, manubrium) head connects it with the incus
  - Incus (body ,short process, and long process) the **long process** connects it to the stapes
  - Stapes (**Capitulum=head**, 2 arches anterior and posterior arch, and foot)
  - The 3 ossicles are connected by synovial joints so any disease that affects synovial joint affect these joints >> limiting movement >> affecting hearing

- Muscles :
  - Tensor tympani: attached to the malleus
  - Stapedius: attached to stapes (contraction of stapedius restrict stapes movement >> good physiological reflex, it protects the inner ear from very loud sound by preventing free movement of stapes >> attenuation reflex.
- Nerves
  - Chorda tympani: branch of vertical part of facial nerve , they are **afferent** fibers carry taste to the anterior 2/3 of tongue, they are also parasympathetic secretory fibers (efferent) that supply sublingual and submandibular glands
  - Tympanic plexus: it is found on promontory >> sensation for middle ear. Its formed by tympanic branch of glossopharyngeal and branch of sympathetic plexus around internal carotid artery



### 3-audius:

- very small opening connects the posterior part of the middle ear cavity to mastoid antrum
  - mastoid antrum and mastoid air cells
- Air cells, the largest air cell is the antrum (lots of cells)
- Important structure from medial side runs between mastoid and middle ear which is facial nerve passing through the internal auditory canal >> curves 170-180 degree >> run through middle ear >> to the mastoid >> to stylomastoid foramen
- **note** : otitis media of the middle ear cleft indicates that all parts middle cleft is involved

**SENSORY SUPPLY OF EXTERNAL AND MIDDLE EAR:**

- Branches from C2, C3 great auricular and lesser occipital nerve >> ear pinna and external canal
- Branches from trigeminal nerve >> mandibular >> auriculotemporal nerve
- Tympanic branch of glossopharyngeal
- Branch from vagus nerve
- Facial ?
- **Clinical importance:** referred pain where patient may complain of otoalgia although his/her middle ear is normal>>> think about pain coming elsewhere with a common nerve supply.
- **Example:**
  - A disease of teeth maybe presented as earache
  - A disease from oropharynx may be presented as earache
  - Cervical spondolysis may be presented as earache
  - dental pain is the most common type of referred pain to ear
  - stomach , sinuses, larynx, tounge, TMJ (Tempromandibular joint)



### INNER EAR

It contains :

#### **Osseous labyrinth:**

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

#### **Membraneous labyrinth (endolymph)**

- Cochlear ducts: it is located within the bony cochlea (connect with vestibule)
- Semicircular ducts: located within semicircular canals. They are divided into: superior (ant), posterior, and transverse (lateral)
- Saccule and utricle: located within the vestibule
- Inner ear is in the strongest bone in the body ( petrous part of temporal bone)

#### Notes:

- Endolymph is the fluid which is found in membraneous labyrinth
- Endolymphatic duct is connected to utricle and saccule. Its action most probably is absorption of endolymph
- Miniere's disease is characterized by accumulation of endolymph due to loss of endolymph duct action
- Nervous structure in membranous labyrinth:
  - Organ of corti (hearing only, the most responsible part of hearing , hair cells cochlear membrane moves with fluid
  - before organ of corti it is only transmission , the organ of corti acts as a transducer from mechanical to electrical by stimulating the hair cells
  - macula in saccule and utricle (balance)
  - cristae in semicircular ducts (balance), cristae are hair cells same material and membrane

## Important points:

#### **Vestibular pathway**

- Vestibular nerve comes out from vestibular part of labyrinth >> brain stem >> vestibular nuclei >> spinal cord, cerebellum and cerebral cortex

#### **Development of the ear**

- External and middle ear are derived from 1st pharyngeal clef and arch.(the middle ear > 1st pouch and 1st-2nd arch)
- Malleus and incus are derived from 1st pharyngeal pouch while the stapes is derived fom 2nd pharyngeal pouch
- Inner ear originates from ectoderm of hindbrain (otic vesicle) which in 4th week of development splits off from the surface ectoderm.

#### **Function of external ear (curved and wax)**

- 1- Protection of middle ear by its tortuous course, hair and wax
- 2- Sound collection and conduction to tympanic membrane >> external ear will act normally as conductor even if 90% of its lumen is obstructed (increase sound and pressure by collection sound from wide space to narrow one

#### **Function of Eustachian tube:**

- 1- Ventilation which is the main function (must have normal middle ear pressure same as outside pressure

- 2- Protection of middle ear from nasopharynx
- 3- Drainage of the middle ear of fluid and discharge
- Signals from cochlea ( nerve ending) to cochlear nerve
- Signals from vestibule ( nerve ending) to vestibular nerve (with the cochlear nerve gives the vestibulocochlear nerve VIII)

**Function of middle ear:**

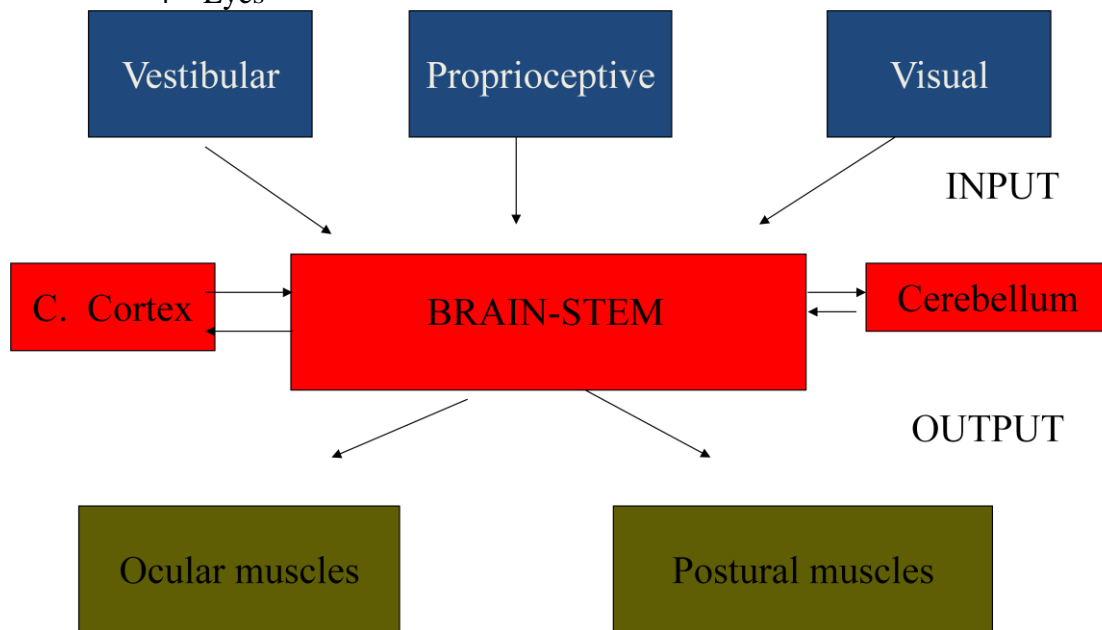
- Conduction of sound
- Transform mechanism :amplify the sound by 2 mechanism
  - 1- Hydraulic action
  - 2- Ossicular leverage
- amplification of sound is important to overcome the resistance of fluid in the inner ear
- protection of inner ear against loud sound (stapedial reflex)

**Function of inner ear:**

- 1- Hearing function (transduction of sound)
- 2- Equilibrium

**Maintenance of body posture**

- 1- Brain stem and cerebellum
- 2- Vestibular function
- 3- Musculoskeletal system proprioception
- 4- Eyes



- Semicircular canal are stimulated by head motion (angular = right and left)
- Saccule and utricle are stimulated by
- Head motion (linear acceleration, eg : elevator when walking with straight head))
- Head position(gravity)
- Both type of movement goes to the CNS along with the visual and proprioception stimuli, from CNS to forebrain (orientation), spinal cord and cerebellum (posture control), and oculomotor system(eye movement)



### Diseases of external ear

- Most common is wax (dark people more than white people)
- All surgeries are done from posterior part because the anterior part contain the blood supply and it is loose which can compromise the blood supply.

#### **a. Congenital malformation**

##### 1-Complete or partial absence of the auricle (microtia or anotia)

- Microtia : in this case the external canal and middle ear will be affected because of the common embryological origin, but the degree of the effect is according to severity of microtia usually the inner ear is normal in such cases
- Microtia is unilateral and the outer ear is functioning normally >> no need for surgical treatment of microtia.
- If microtia is bilateral you have to manage such patient because children's speech and learning is depending on hearing

##### 2- Preauricular sinus :

- Common
- Small opening around the ear usually in the anterior part (in front of the auricle)
- Problems
  - 1- Cosmetic
  - 2- Infection of the sinuses: which will be repeated once it happens
- Treatment : excision of the sinus (complete: the sinus with cartilage, its imp that the first surgeon remove it all, or the patient will need another surgery)
- You shouldn't drain because abnormality is the cause (must treat the cause not the symptom)

##### 3-Protruding ear :

- It is common, usually normal hearing
- Cosmetic
- The main problem is that there is no anti-helix
- The angle between auricle and scalp is more than 45 degree
- The wider it is the worse it gets
- Treated surgically by artificial antihelix , and the angle is fixed 35.
- It should be treated by the age of 5-6 before school age
- Techniques :
  - Permanent procedure : epithelial incision cartilage >> push ant by nylon stick
  - temporary procedure
- Abx should be given to reduce the risk of infection
- Complication : over or under correction

##### 4-Accessory auricle

- Due to incomplete fusion of the auricle
- Treated surgically by excision
- Thing you must do in case of any anomaly:
  1. Evaluate hearing
  2. Look for middle and inner ear abnormality
- If they have normal middle and inner ear with hearing problems you should do
  - Plastic repair (reform auricle from cartilage)
  - BAHA : is the best (Bone Anchored Hearing Aid)

- Sialogram : serial Xray with radioactive material usually limited to the area above auricle

**b.trauma to the auricle**

- It is an ER because blood supply may decrease >> necrosis >> cauliflower deformity
- Very common (eg: RTA)
- 1. Laceration:
  - a. Treat as any laceration
  - b. Because auricle is very vascular >> must stabilize the patient when auricle is lacerated
- 2. Hematoma auris (boxer's ear) >> drainage
  - a. due to the blunt trauma >> extravasation of blood between perichondrium and cartilage>> infection >> cauliflower ear.
  - b. Treatment:
    - i. aspiration if no OR available with Abx
    - ii. Incision and drainage (treatment of choice)
  - c. The rate of relapse is very high
  - d. Complication:
    - i. Cauliflower deformity

**c- Foreign body**

- Peanuts are the most common
- Signs and symptoms: Pain , decrease hearing ,discharge (depends on time more with congested edematous )
- Vegetarian FB : don't use water , use hook
- Before removing any FB you have to be sure that the patient is cooperative or you'll have complication such as perforated tympanic membrane, injured skin
- Sometimes especially in winter (camping in KSA) patients present with insects as FB >> you have to kill the insect before trying to remove it, by oil drops (olive oil) , then anesthetize the patient and remove the insect

**d-Perichondritis of pinna**-Etiology:

-Usually, it is secondary to trauma (hematoma, surgical trauma, burns, frostbite=too cold & furunculosis) or otitis externa.

-Often, due to pseudomonas.

-skin is adherent , all blood supply from anterior , so any inflammation in anterior part may compromise the blood supply

-Clinical picture:

A- The auricle becomes very painful, red, hot, tender & swollen in addition to fever.

B- later on deformity occurs.

-Complication:

- Infection may spread to the cartilage of the auricle -> perichondritis -> necrosis of the cartilage -> deformity (cauliflower ear).

-Treatment:

- Incision, drainage & removal of necrotic cartilage + antibiotics e.g. Gentamicin".

- use Abx that cross the BBB any infection above the lips may spread to the intracranial structure
- you have to make sure if the patient is diabetic or not, if the patient is only under oral hypoglycemic >> maybe it is not enough control.
- -sometimes you have associated skin or hair infection
- -communication between intracranial and extracranial infection>> take a swab , admit the patient for incision.

### e-Otitis externa

#### -Definition:

It is infection of the skin lining the external auditory canal.

#### -Classification according to the cause:

Causes:

A-Infective “ common will lead to Reactive”:

1. Bacterial “most common”.
2. Viral.
3. Fungal.

B-Reactive:

- 1.seborreic “excessive secretion of sebaceous glands”.
- 2.Eczematous: allergic.

#### -Causative Organisms:

##### *1.Bacterial:*

- Staph. aureus-> furunculosis.(around hair follicles)
- Pseudomonas.
- other
- management: swab +Abx

##### *2.Fungal:*

- Aspergillus niger.(black)
- Candida albican(white)
- -managemnt: antifungal sometimes with alcohol

##### *3.Viral:*

- Herpes zoster.
- management: either antiviral or subside on it is own

#### **-NOTE:-**

- before strting treatment clear ear from derbies with cotton or aural toilet , if you don't remove it >> recurrent infection
- -ersypealis is a pure dermatological presentation but present in ear >> patient thinks it is ENT related.

#### **Clinical feature of otitis externa:**

- a. Itching “ main feature”.
- b. Pain: sever pain (with localized usually) especially in furucnulosis. It is aggravated by jaw movement & touching the external ear.
- c. Tenderness & swelling “if the swelling is very huge it may be diagnosed with mastoid abscess”.(swelling if the skin involved)

- d. Otorrhea : little scanty, watery or purulent “never mucoid”.
- e. Deafness-> very rare in OE because the external canal should be obstructed completely to be causing deafness “don’t occur unless the obstruction is complete”.(prevent proper conduction of sound)
- f. Enlargement of lymph node “localized”.
- g. change in lumen and canal >> narrow

**Clinical Types:**a-Localized “ furunculosis”:

- severe pain, redness, swelling, and tenderness of the outer third of the external canal. It is due to Staph. Aureus infection.(the most common). It usually present with small boil 1 or 2 area , with scanty discharge
- **treated** by local Abx or subside alone

b-Diffused infection:

- the whole skin (follicles also but difused) is red, swollen, slight discharge “watery”. Its due Pseudomonas or Staph. Aureus.
- Usually examination is painful may cause blockage
- Aural toilet , swab >>systemic Abx
- Make sure if the patient is diabetic >>sometimes it is an early sign of diabetes

c-Otomycosis: fungal infection

1. If white -> C. Albican.
  2. if black -> Asp. Niger.
- Otomycosis may be associated with bacterial infection
  - It may maybe recurrent
  - Predisposing factor: humid area with improper cleaning
  - Management: proper cleaning with antifungal

d-Bullous myringittis “vesicle in external ear”:

- Its viral infection “ unknown virus”.
- Very painful.
- Self-limiting during 12-24 hours, may followed by blood discharge due to distribution of bullous.
- Treatment: Analgesics.

e-Herpetic:

- It is due to Herpes Zoster.
- It is called Ramsay Hunt Syndrome.
- It is due to infection of the geniculate ganglion & other cranial nerve ganglia.
- -The chief symptoms stems from painful herpetic lesion in the external auditory meatus & auricle. If the virus the 7th cranial nerve: cutaneous Herpes & ipsilateral facial paralysis “Bell’s palsy” may result. if the virus affect the 8th cranial nerve: vomiting, vertigo, nystagmus & hearing loss may result. Patient with facial paralysis and hearing loss may recover or may not but patient with vertigo will definitely recover.
- Abx local treatment is the treatment of choice

f. Eczematous & suborreic.g. Necrotizing “malignant”: (worst outcome)

- Malignant term doesn’t mean cancer, but due to aggressive course of this disease, it is called malignant.

- Acute in course. (sever pain)
- Organism: Pseudomonas
- Affect the skin of external canal then spread to the cartilage and adjacent bones.
- Dx:
  1. Uncontrolled DM.(high blood)
  2. Elderly patient.
  3. Persistent severe otalgia.
  4. Granulation tissue at the junction of the cartilage and the bone.
- Cranial nerve involvement: facial nerve paralysis.
- Can be diagnosed by X-ray & MRI.

**Treatment:**

- There is medical treatment with aural toile
- surgical
- Initially, admit the patient and give him/her I.V antibiotics & after discharge oral antibiotics.
- Antibiotics: antipseudomonas I.V. or Orally for 6 weeks minimally.
- Local treatment & debridement: remove granulation tissue.
- Control DM.
- The role of surgery is controversial.

**Management:**

- Swab for culture & sensitivity.
- Ear toilet: very important to clean the ear from the discharge. The best mean of suction of discharge under the microscope. If its not available you can use cotton wool.(the best way because if there is pus it will act as a barrier that will prevent treatment from reaching target area.
- Keep the ear dry “very imp”.
- Local medication: depends on the appearance of inflammation & symptoms of the patient.
- Systemic medication: in very selective patients e.g. diabetic patients or High recurrence patient.
- Surgery: may require in chronic case “rare”.

**f-Wax**

**Definition:** Accumulation of sebaceous and cerminous glands situated in the outer cartilaginous part of the external canal.

- Normally, the glands secrete little amount of wax and migrate by movement of the jaw, and don't accumulate in the external canal.

**Symptoms:**

- Deafness, which is sudden or decrease hearing
- Earache.
- Tinnitus (especially after shower)

**Treatment:**



- Removal of the accumulated wax by suction.
- syringe : warm water (not hot and not cold >>irritation) , you direct it toward posterior meatal canal (saline make it softer >> remove it)
- drops of oil 3-5 days (clearing)
- suction under microscope is the best , it is more careful you can see so less chance of injury to the skin and mucus membrane (may hear loud voice during this process)

## **f-Keratosis Obturans**

- Rare.
- Accumulation of desquamated epithelium in bony part of the external canal.
- Unknown cause.
- White in color.

**Symptoms:** sudden deafness and pain

May be associated with sinusitis, bronchitis or primary ciliary dyskinesia.

**Treatment:** Periodic removal.

### Acute Otitis Media

#### Definition:

It is acute infection of mucous membrane lining the middle ear cleft.

#### Predisposing factors:

1. Age: common in infant and children due to 2 reasons:
2. Lower immunity than adults.
3. Eustachian tube is wider, short, and more transverse. “most common”.
4. Maleness.
5. Bottles feeding children:
  - Lower immunity than breast-feeding children.
  - Position for bottle feeding is more transfers than breast-feeding position increase the probability of regurgitation of milk to middle ear via Eustachian tube.
6. Climate: more in winter.
7. Crowded living condition
8. Hereditary.
9. Associated condition: Cleft palate, immunodeficiency, ciliary dyskinesia, Down’s syndrome, and Cystic Fibrosis.

#### Route of infection of otitis media:

- Eustachian tube “< 90% of cases”: therefore, mostly patient with OM has suffered from acute rhinitis before developing OM.
- External auditory canal: if the eardrum is perforated.
- Blood borne □ theoretically rather than clinically.

#### Bacteriological of Otitis Media:

1. Streptococcus pneumonia.\*
  2. H. Influenza: more common in children.\*
  3. Branhameila catarrhalis .
  4. Staph. Aureus.
- Arranged from common to less common
  - These organisms are also responsible for acute sinusitis.

#### Pathology of Otitis Media:

- Eustachian tube occlusion: discomfort, autophony, and retracted drum due to negative pressure.
- Exudate inflammation: fever, earache, deafness and congested eardrum.
- Suppurative inflammation: bulging of drum due to increase pressure in tympanic cavity, increase severity of fever, congestion and bulging of the drum, deafness.
- Tympanic membrane ruptured: due to increase pressure, otorrhea, high temperature and earache will subside.
- Resolution.

#### **Note:**

- These stages are taken place if OM isn’t treated.
- The fever of OM can be raised at any stage of OM.

## **Treatment:**

### 1-Symptomatic:

- Analgesics.
- Rest.

### 2-Antimicrobial treatment “one of the following for 7 days”:

- Amoxicillin + clavulonic acid = Augmentin.
- Trimethoprim/ Sulphamethoxazole.
- Cefaclor/ cefxime.
- Erythromycin- Sulphamethoxazole.

### 3.Decongested:

- Decongestive nasal drops or spray to open Eustachian tub.

### 4.Myringotomy:

- It is used if the eardrum is bulging.
- It is used for culture sensitivity if the infection fails to resolve properly.

### 5. Ear toilet and local antibiotics

## **Recurrent Acute Otitis Media:**

- Its called recurrent if it is occurred 3 times or more over 6 months

### Treatment:

- Long-term low dose antimicrobial half of the therapeutic dose for 3 months or 6 weeks.
- Ventilation tube insertion:
  1. Minimize the incidence of the acute infection.
  2. Extruded by it self.
  3. Provide drainage if the infection occurred.
  4. Better than long-term antibiotics.
  5. Recurrent acute otitis media is not the only indication for it.