

# **Ear**

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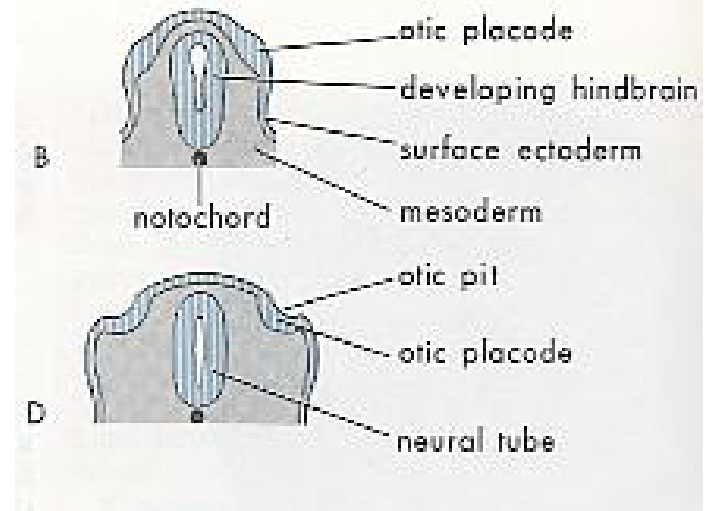
# Ear

- **Embryology**
- Congenital anomalies
- Anatomy
- Physiology
- Disease of external ear
- Acute Otitis media

# The Ear

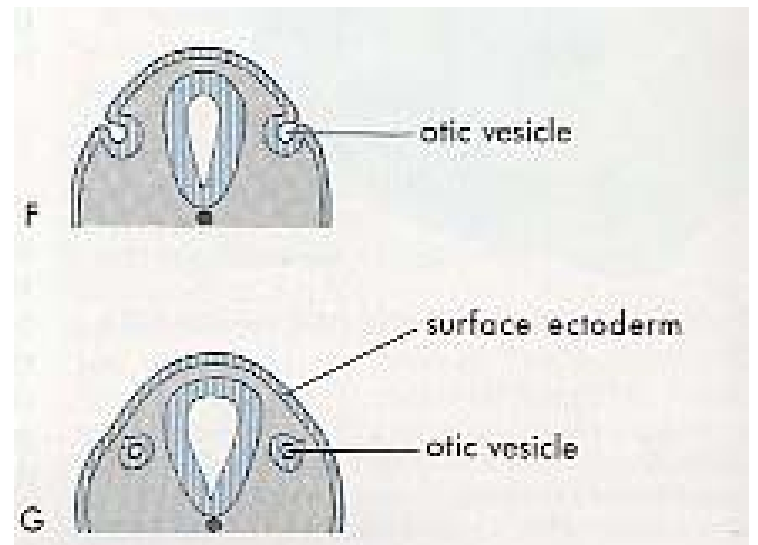
## Otic placode

- 4<sup>th</sup> week
- Thickening in surface ectoderm
- Otic vesicle

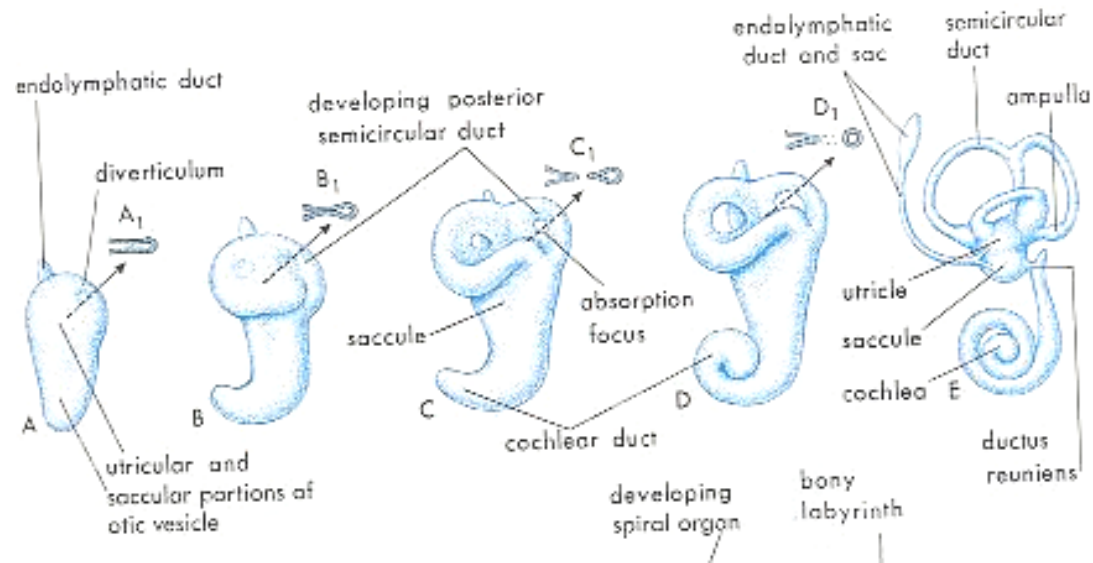


# The Ear

- Otic vesicle
  - Invaginates of mesenchyme
  - Detaches from ectoderm
  - divides into 2 regions:
- **Utricular portion**
  - Utricle
  - Semicircular canals
- **Saccular portion**
  - Saccule
  - cochlea



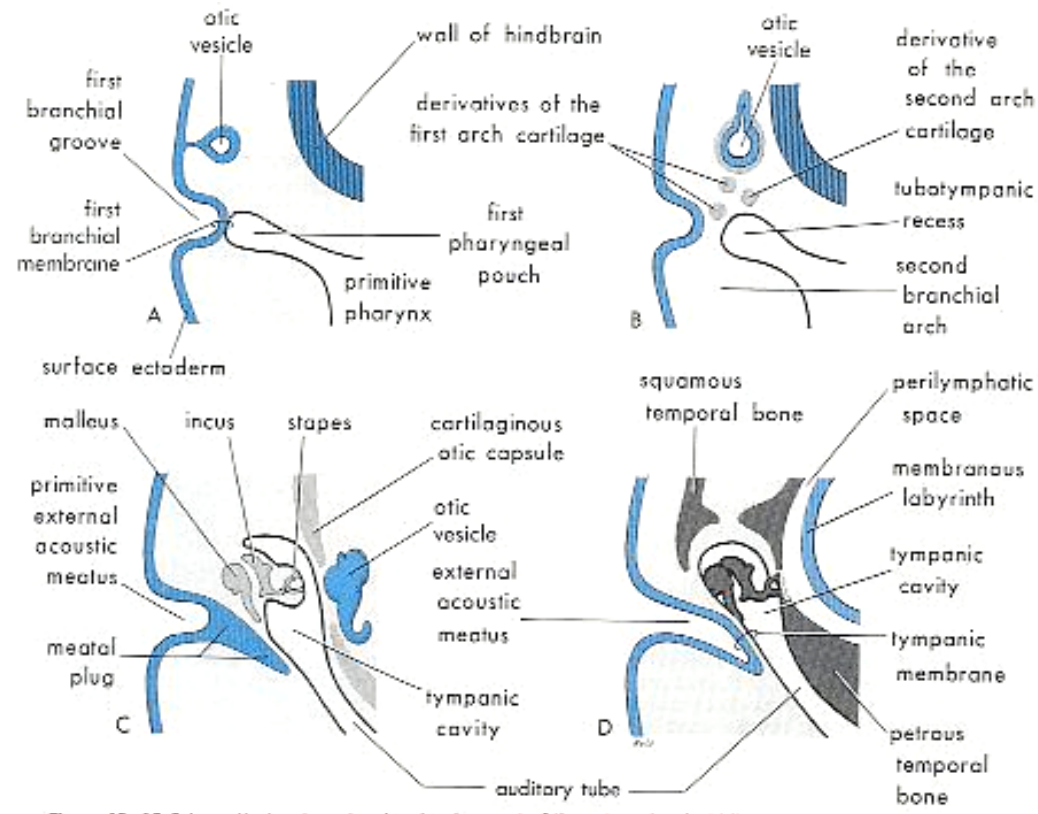
# Inner Ear



# 1<sup>st</sup> Pharyngeal Pouch

- Elongates into the tubotympanic recess
- The tubotympanic recess becomes the tympanic cavity and mastoid antrum
- Distally contacts the 1<sup>st</sup> pharyngeal cleft → TM
- Proximally connects the pharynx → eustachian tube

# Middle Ear

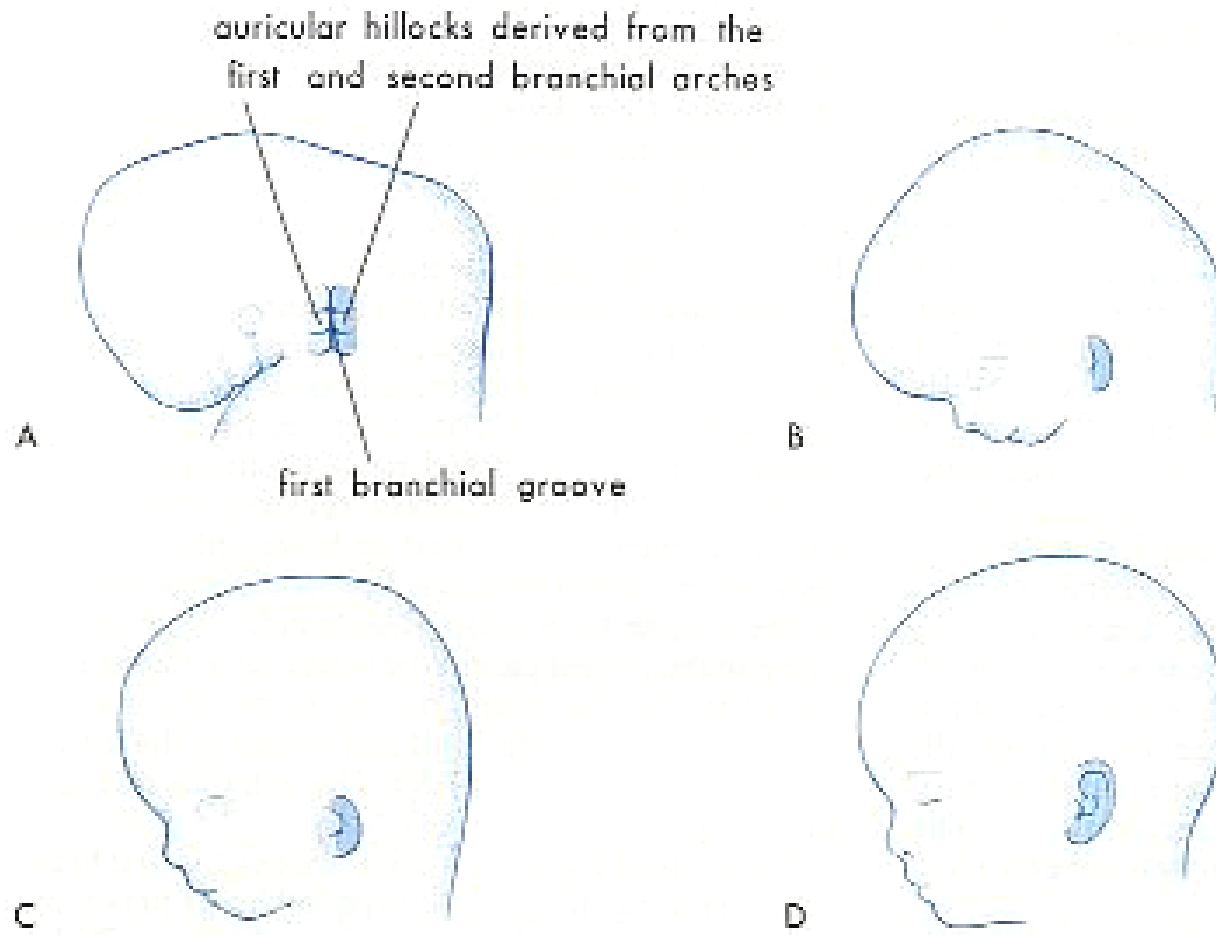


# External Ear

- 6 auricular hillocks
- The pinna
  - Initially develops in the neck.
  - Mandible grows → level of the eyes.
- Part of the auricle originating from
  - 1<sup>st</sup> branchial arch ( innervated by CN V)
  - 2<sup>nd</sup> branchial arch (innervated by CN VII )



# External Ear



# External Ear

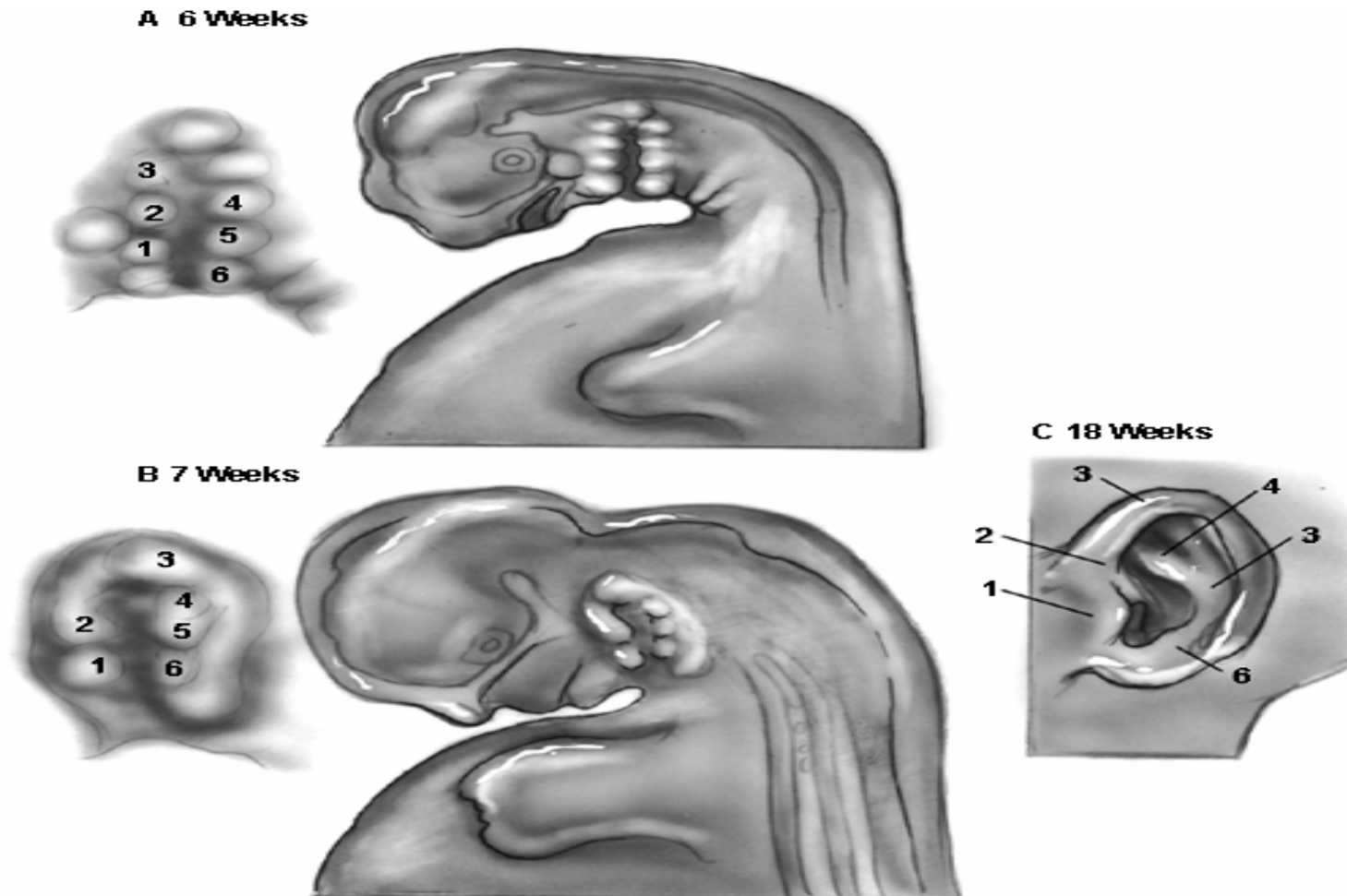


FIG. 5-1. Development of the auricle. A: Six hillocks form on the first and second branchial arches; all are identifiable at 6 weeks. B: Seven-week stage. C: By 18 weeks, the adult form is recognizable.

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# Congenital anomalies

- **Outer ear**
  - Microtia
  - Bat Ear
- **Middle ear**
  - eustachian tube dysfunction
  - Otosclerosis
- **Inner ear**
  - Aplasia (Michel Aplasia)
  - Partial Aplasia (Mondini Aplasia)

# Microtia



Grade I



Grade II



Grade III



Anotia

# ***Microtia***

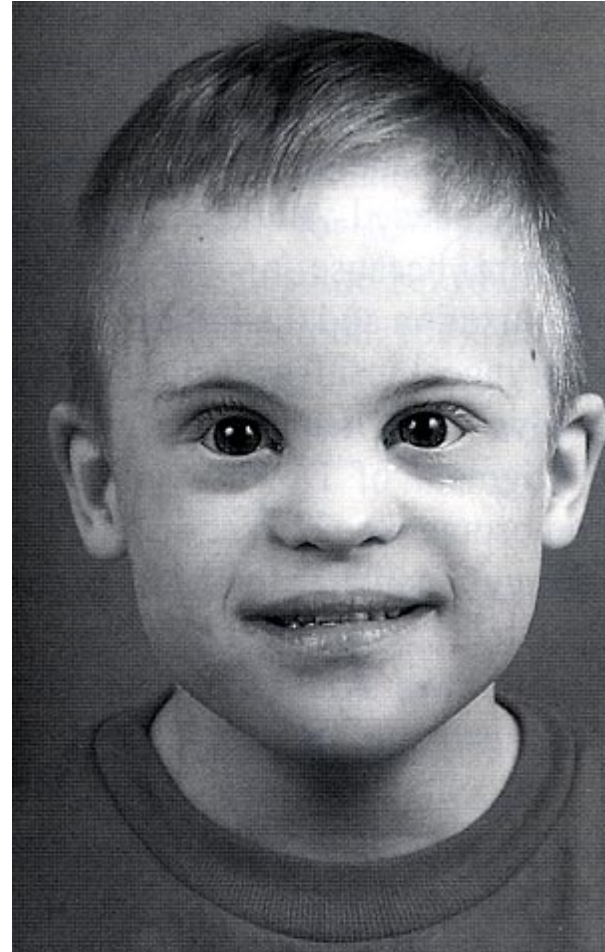


# Bat ear



# Down Syndrome

- **Trisomy 21**
- **1 in 700 births**
- **Maternal age >35**





# Hearing Concerns

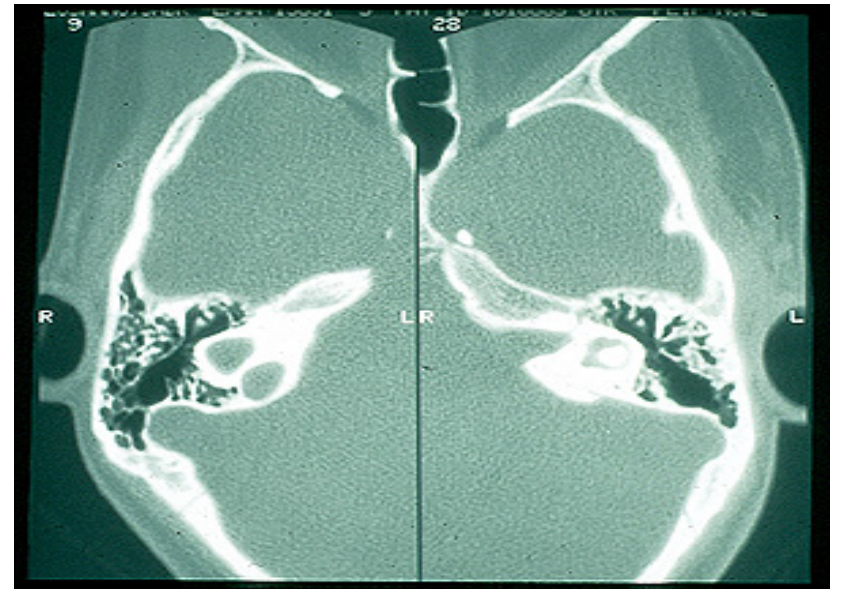
- Conductive hearing loss
  - more common
  - small pinna
  - stenotic EAC
  - eustachian tube dysfunction
  - ossicular fixation
- Sensorineural hearing loss
  - less common

# ***Michel Aplasia***

- 9 weeks gestation Cochlea fully formed
- Complete agenesis of IE
- Normal External and middle ear
- Affected ears are anacusic

# ***Mondini Aplasia***

- Only the basal coil can be identified
- Interscalar septum is absent
- enlarged endolymphatic duct

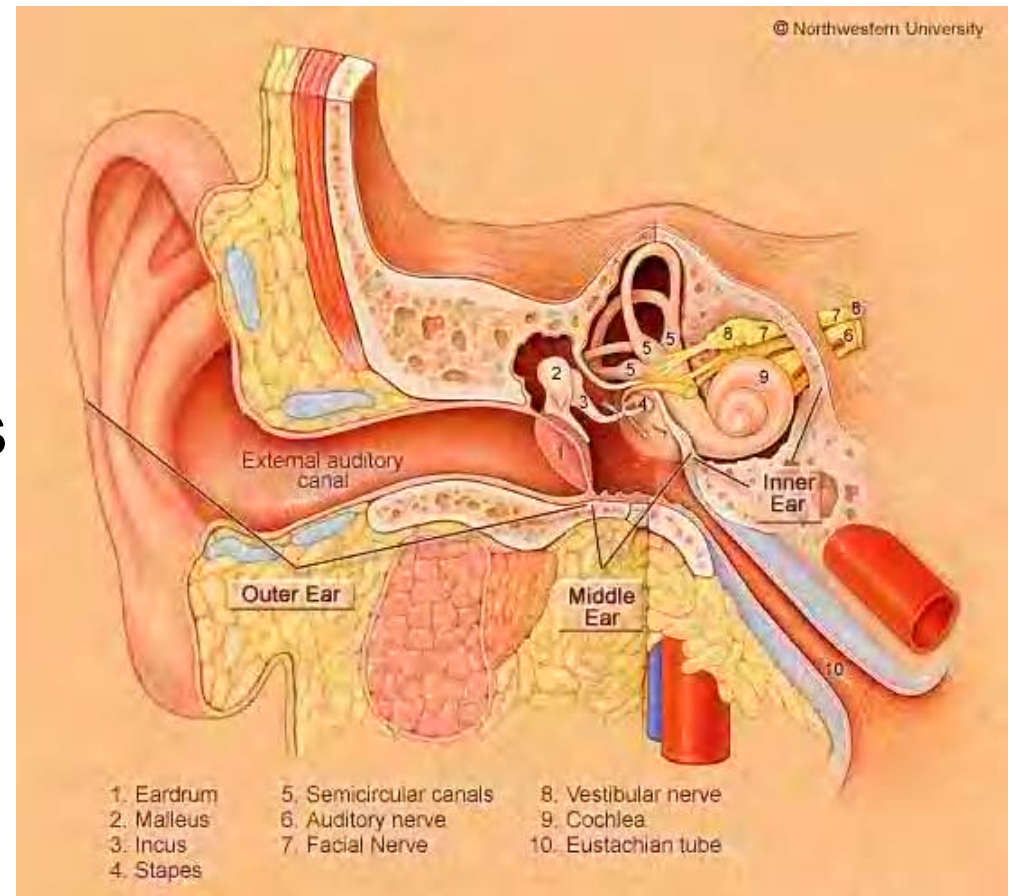


# Ear

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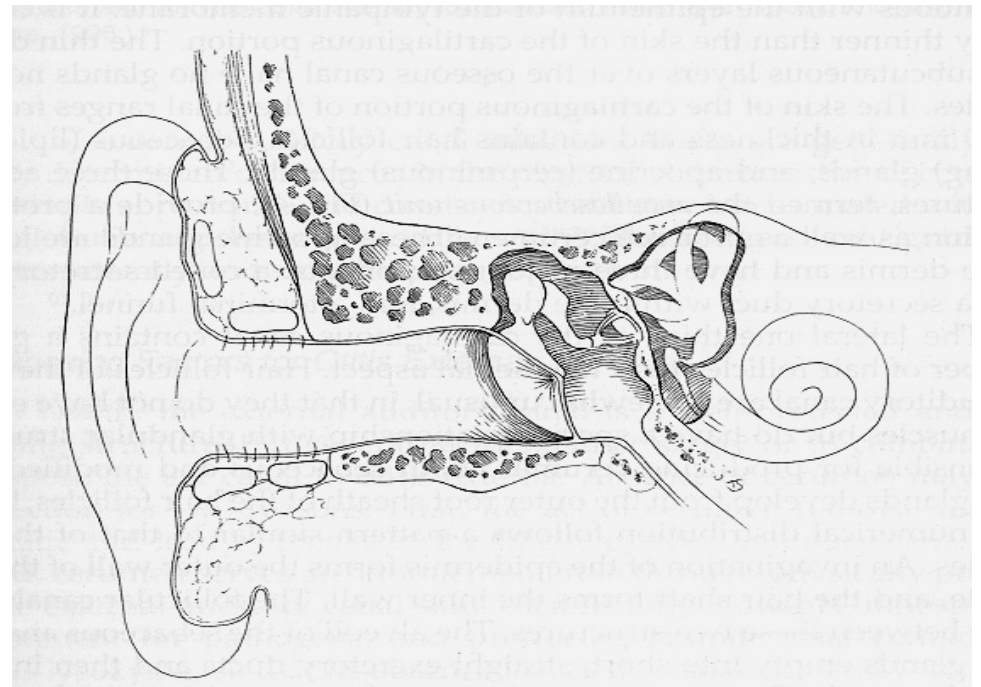
# Anatomy

- Inner Ear
  - Cochlea
  - Sacule
  - Utricle
  - Semicircular canals
- Middle Ear
  - 3 ossicles
  - Mastoid
  - Eustachian Tube



# Anatomy

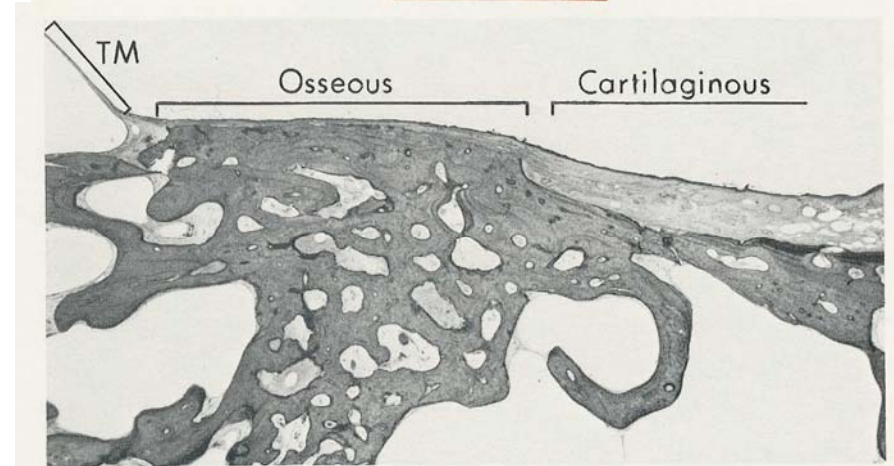
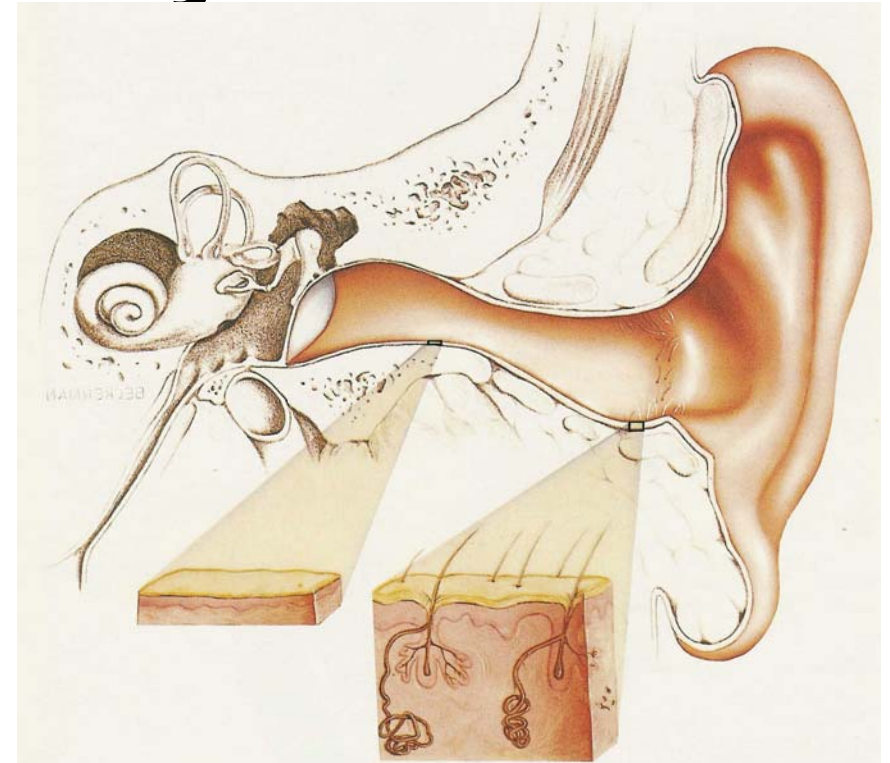
- Auricle is mostly skin-lined cartilage
- External auditory meatus
  - 2.5 cm long
  - Cartilage: ~40%
  - Bony: ~60%
  - S-shaped
  - Narrowest portion at bony-cartilage junction





# External Auditory Canal

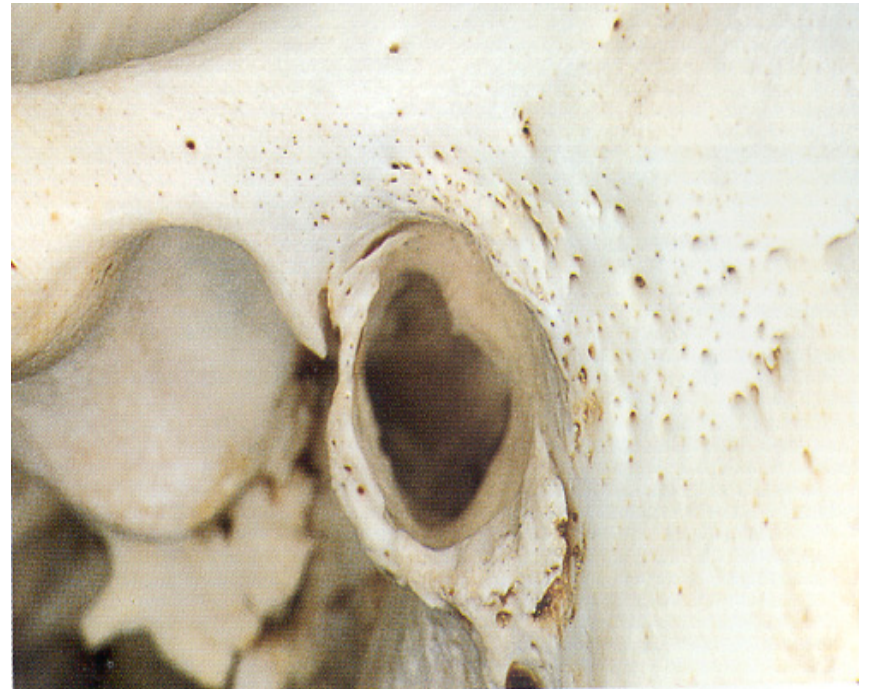
- Skin
  - Cartilage
    - 1.0 mm
    - Epidermis with papillae
    - Dermis
    - Sub-Q
  - Bone
    - 0.2 mm
    - No papillae, no sub q



# Anatomy

EAC is related to various contiguous structures

- Tympanic membrane
- Mastoid
- Glenoid fossa
- Cranial fossa
- Infratemporal fossa





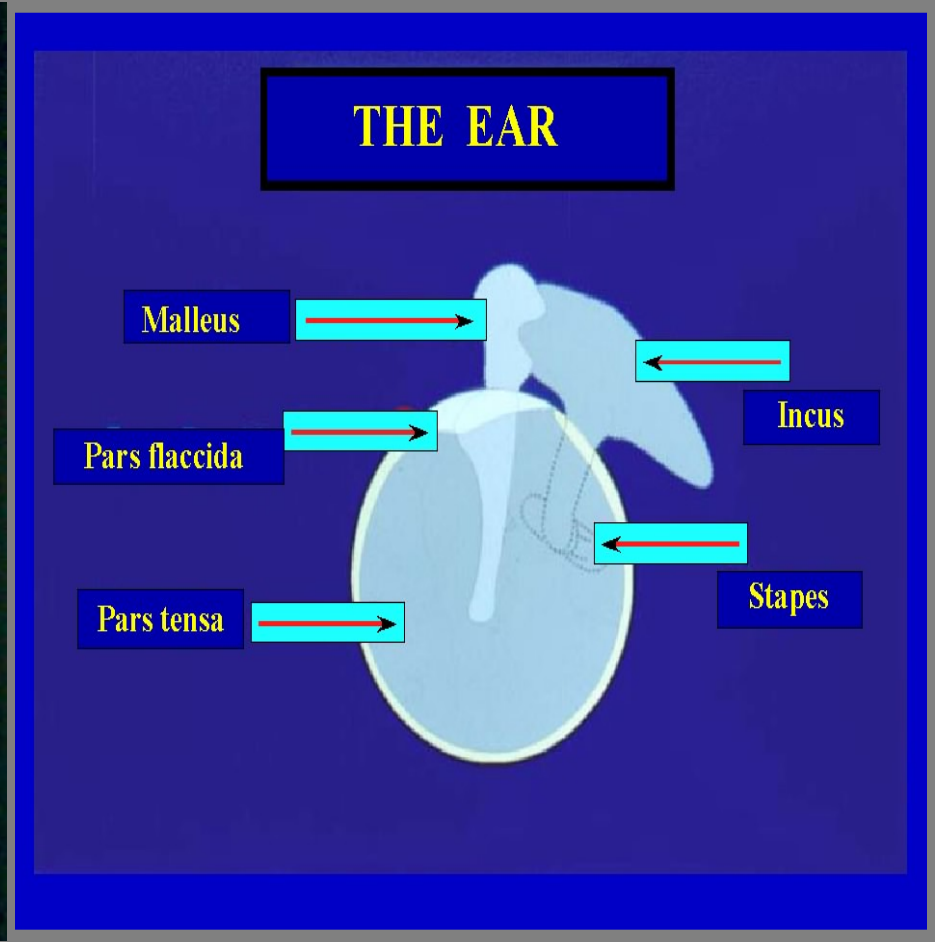
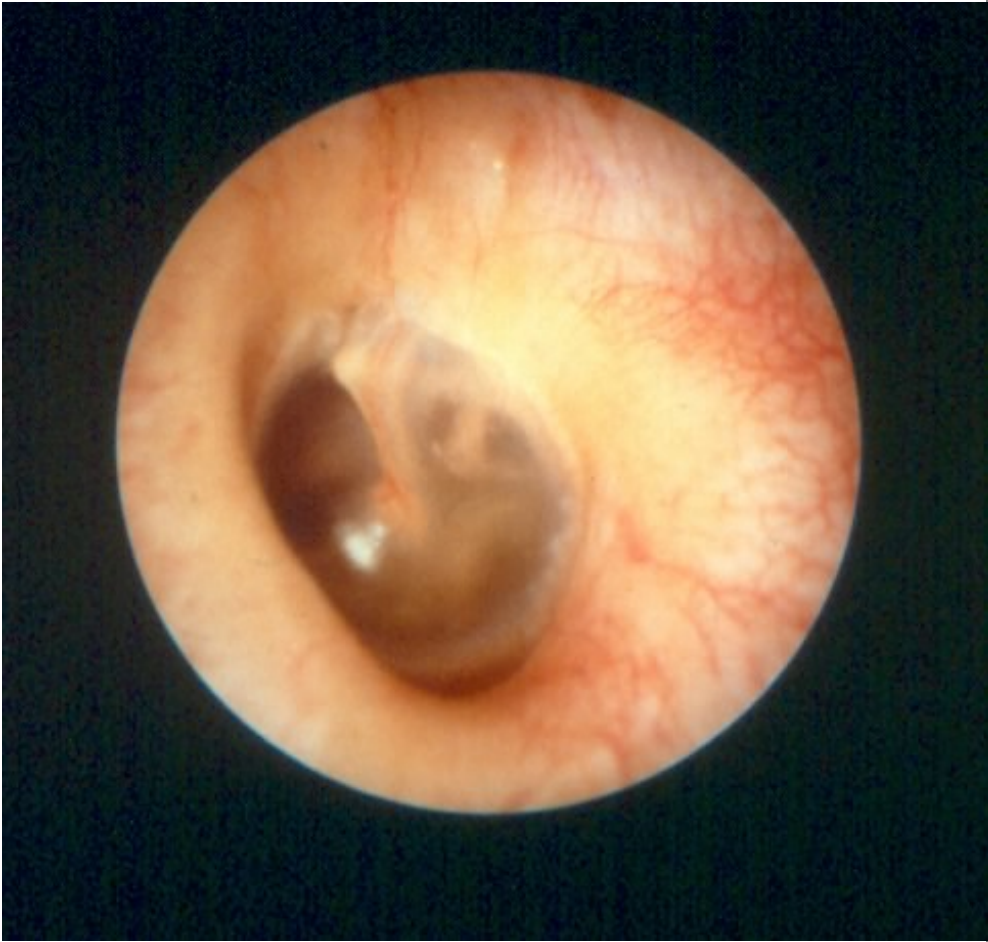
# Anatomy

## Innervation:

- Cranial nerves
  - V (Itching AR)
  - VII ( *Acoustic neuroma* sign)
  - IX (Cough)
  - X (Vaso-Vagal)
- Greater auricular nerve (Post-Parotidectomy)

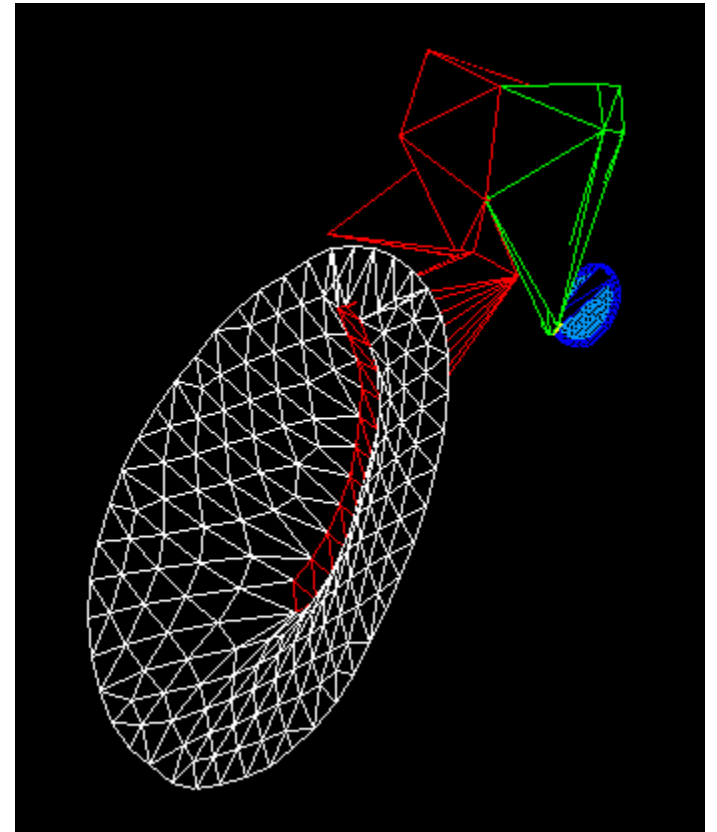
# Anatomy

- Arterial supply
  - Superficial temporal
  - Posterior auricular
- Venous drainage
  - Superficial temporal
  - Posterior auricular veins
- Lymphatics
  - External ear : Parotid, deep cervical
  - Middle ear : Retropharyngeal



# Ear

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- **Physiology**
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# ورد في القرآن الكريم

لفظي السمع و البصر معاً ( 19 ) مرةً

ذكر في (17) سبعة عشر لفظة السمع قبل البصر منها

– قوله تعالى: ( و هو الذي أنشأ لكم السمع والأبصار و الأفئدة )المؤمنون : 78

– قوله ( إن السمع و البصر و الفؤاد كل أولئك كان عنه مسؤولاً ) الإسراء :36 .

ما عدا ايتين اثنتين فقط هما

– قال تعالى : ام لهم اعين يبصرون بها ام لهم آذان يسمعون بها

– قال تعالى : ابصر به واسمع في سورة.... الكهف

فما السر؟؟

# Hearing: Mechanics

- 1 Sound waves strike the tympanic membrane and become vibrations.
- 2 The sound wave energy is transferred to the three bones of the middle ear, which vibrate.
- 3 The stapes is attached to the membrane of the oval window. Vibrations of the oval window create fluid waves within the cochlea.
- 4 The fluid waves push on the flexible membranes of the cochlear duct.
- 5 Energy from the waves transfers across the cochlear duct into the tympanic duct and is dissipated back into the middle ear at the round window.
- 6 Hair cells within the cochlear duct create action potentials in the sensory neurons of the cochlear nerve.

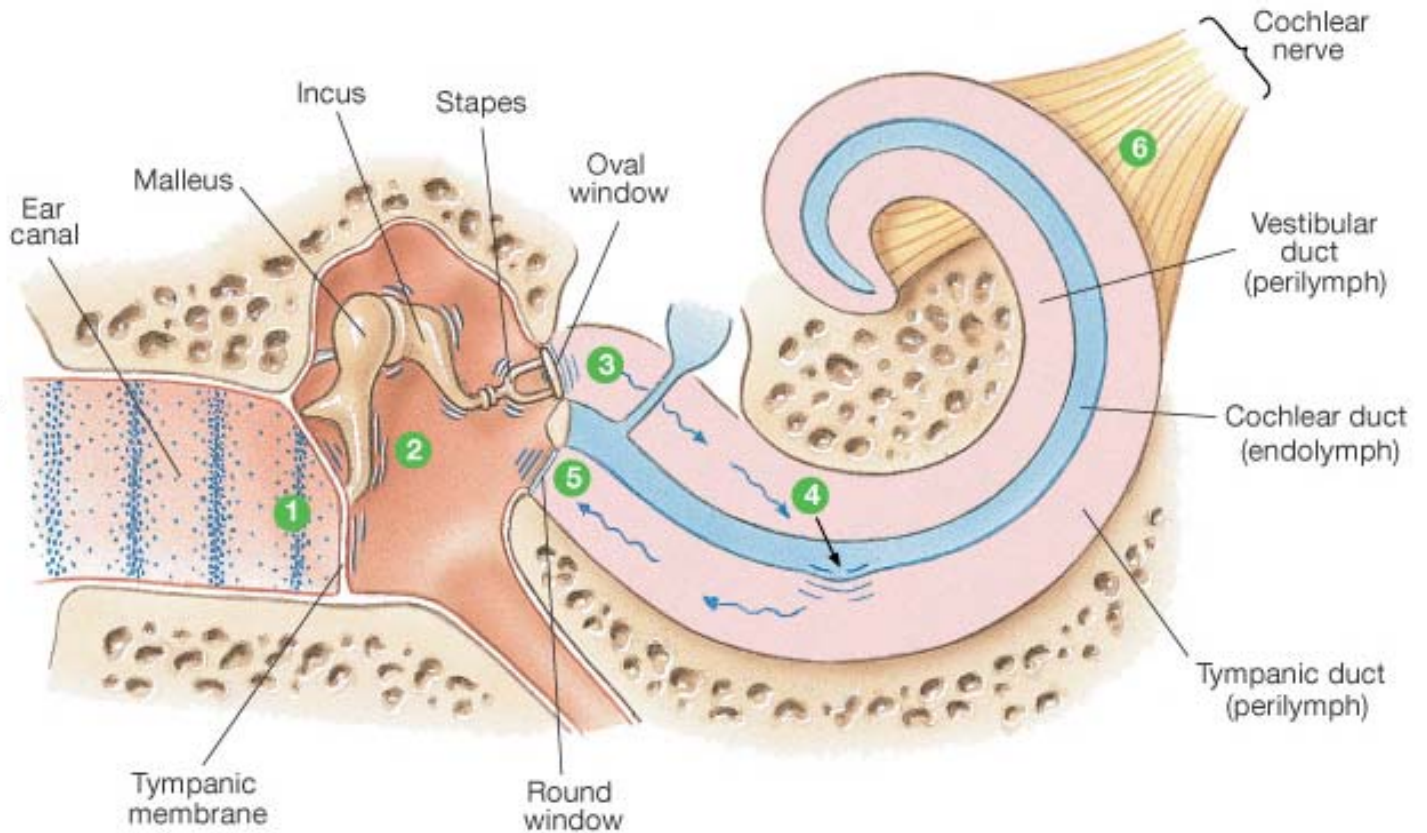


Figure 10-19: Sound transmission through the ear

# **A Little Vestibular Physiology.....**

# Why have a VOR?

1. Stabilize retina in space – fast!



On head  
movement



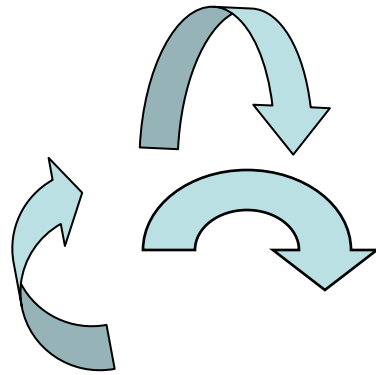
2. Posture Control

**Do finger test**



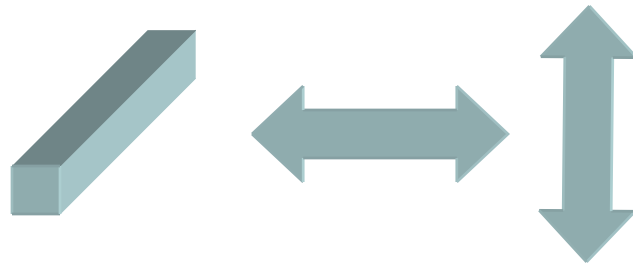
# Types of Spatial Movement

- Rotational – 3 degrees of freedom



Semicircular Canals

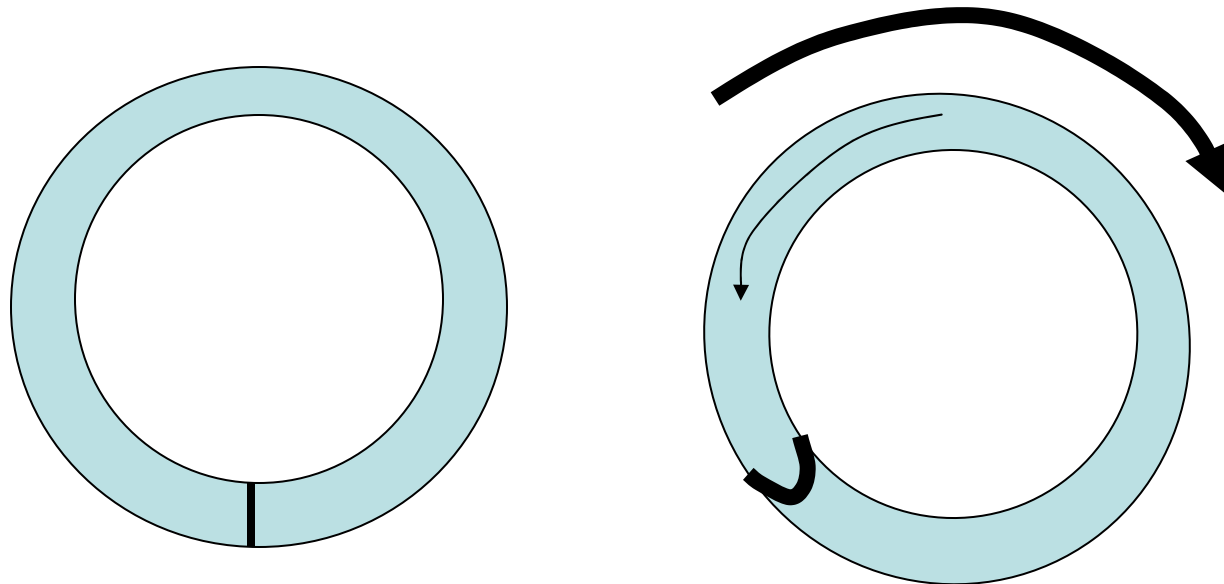
- Translational – 3 degrees of freedom



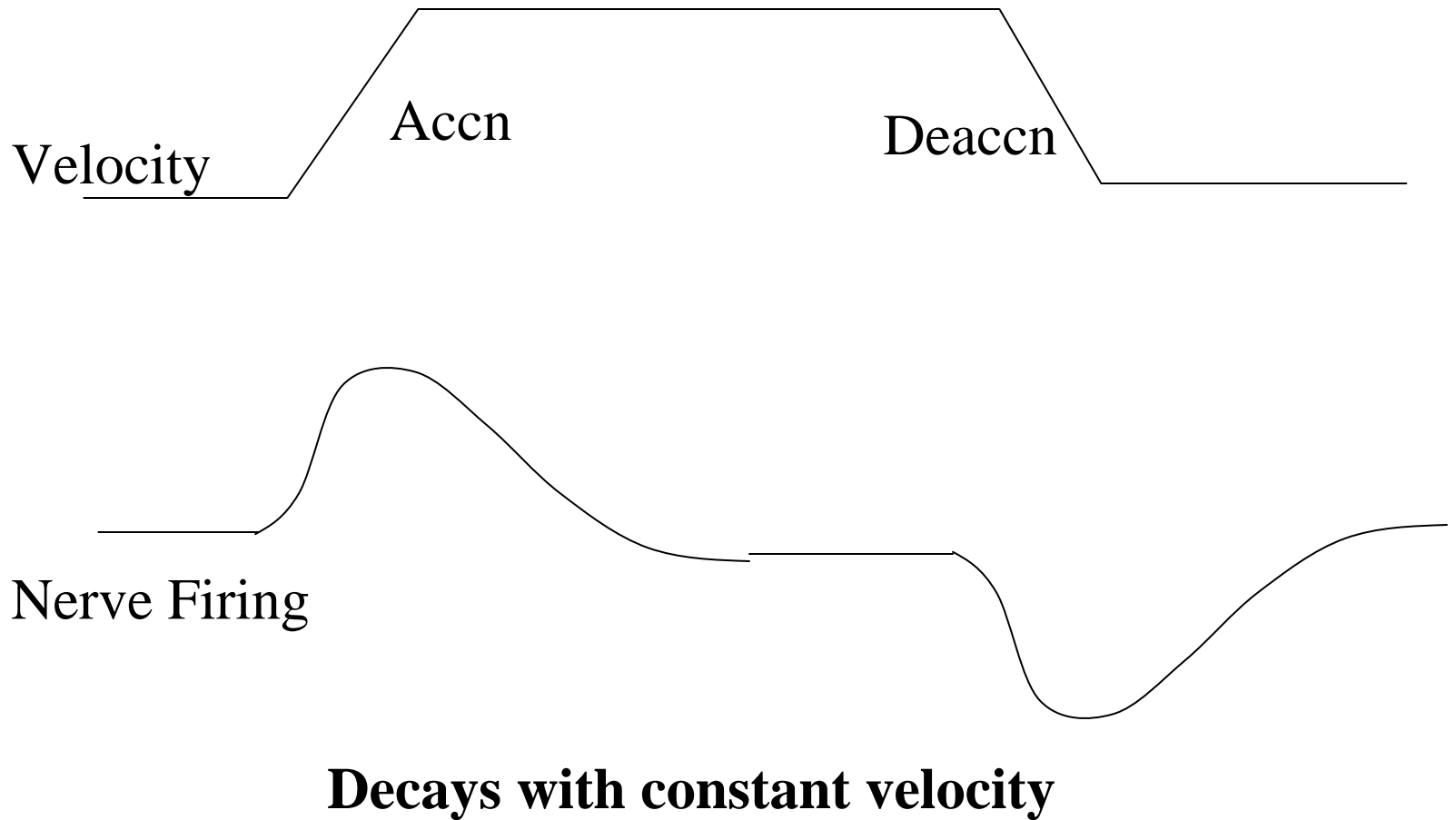
Otolith Organs

# Basic Mechanism of Detection of Rotation

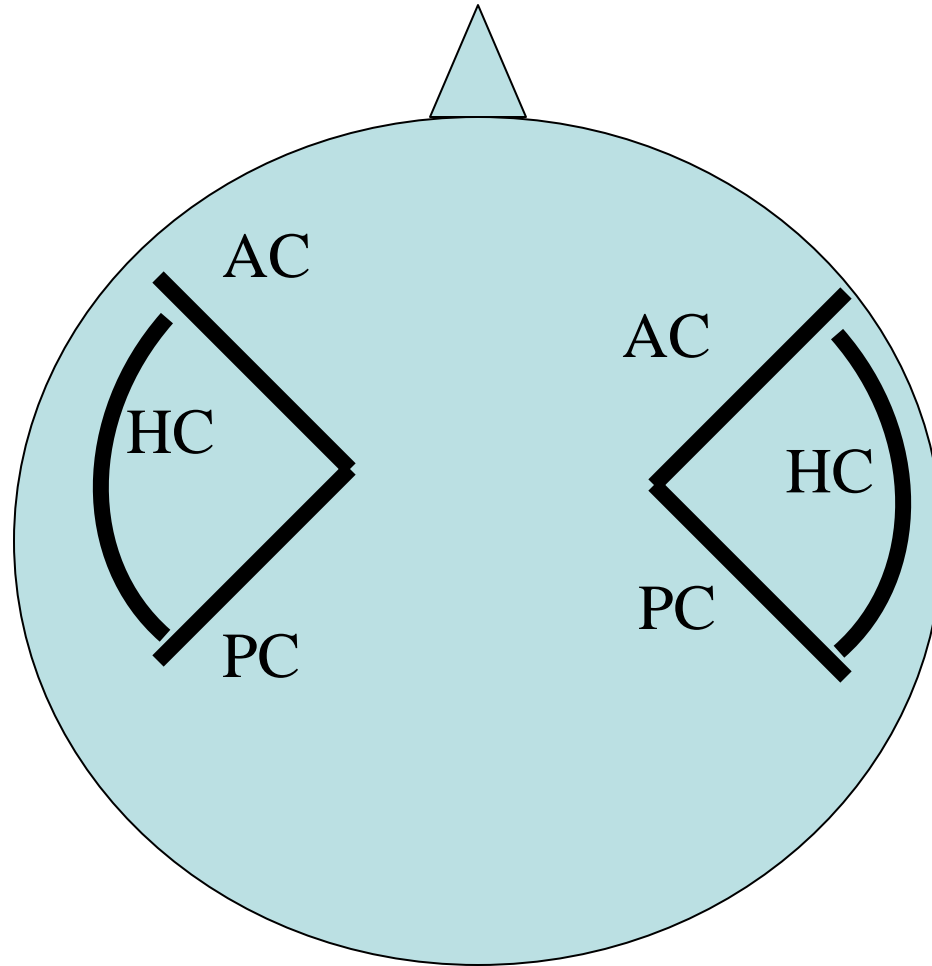
- INERTIA
- Detects head acceleration – but encodes head velocity (i.e. integrator)



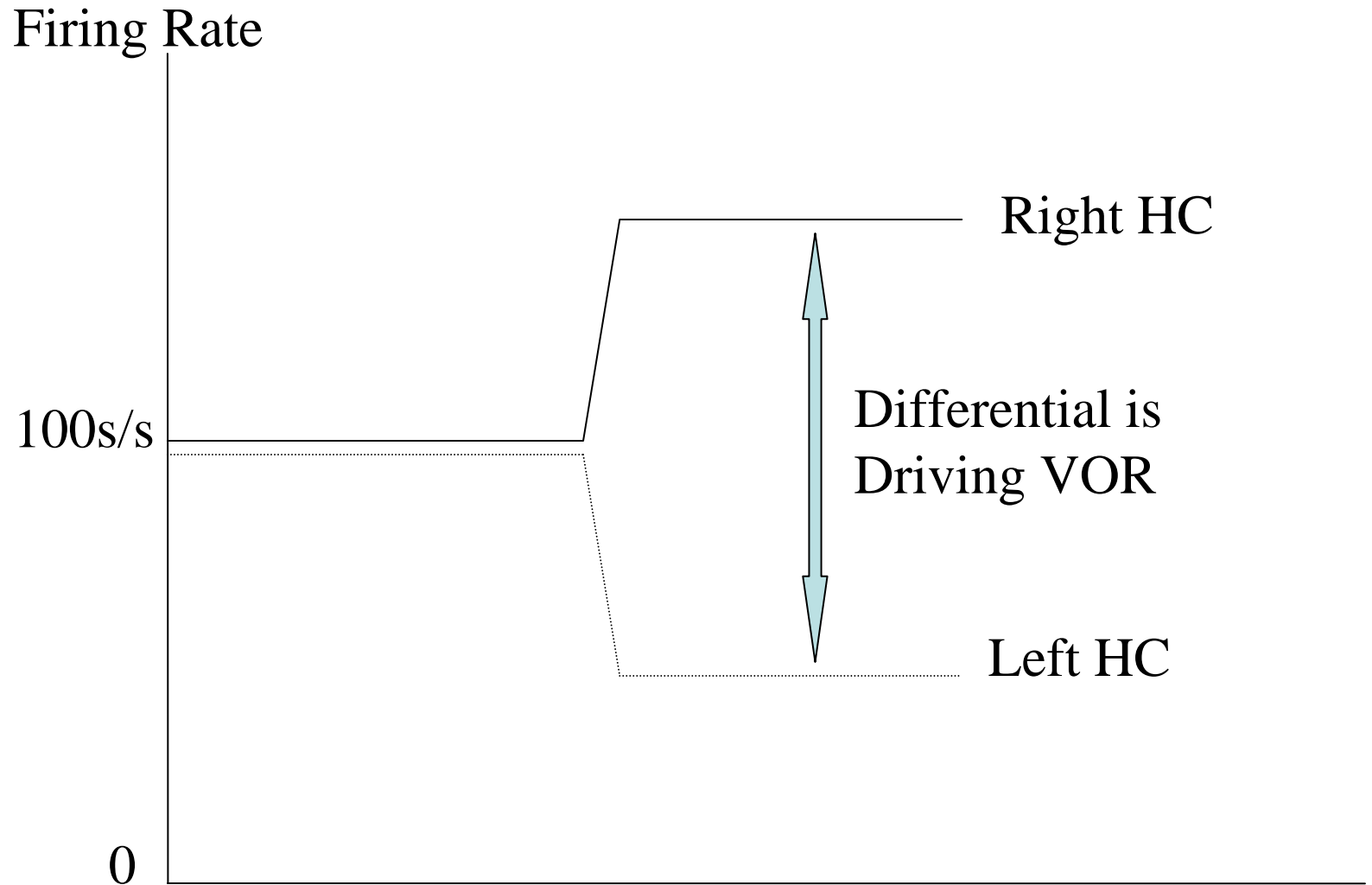
# Velocity Profile vs Signal



# Canals are Paired



# Push-Pull System



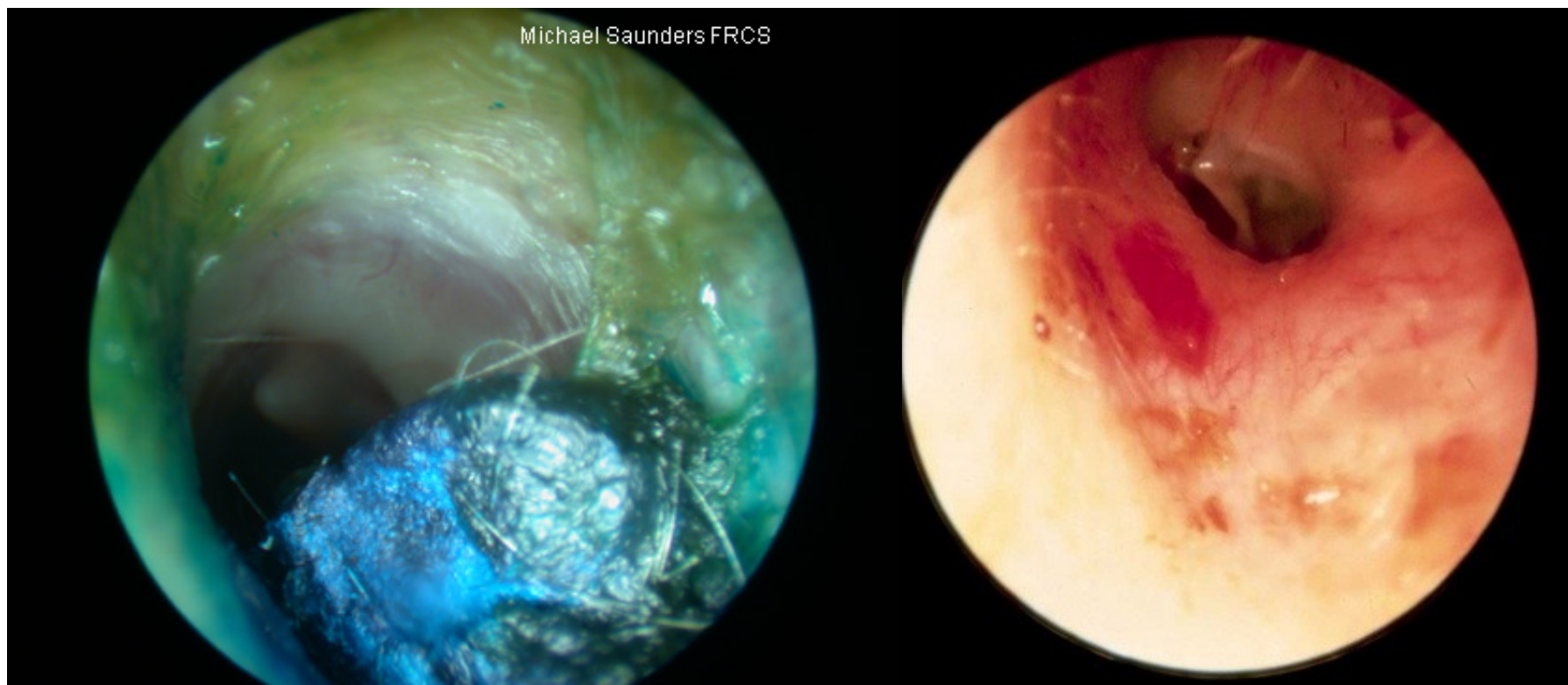
# Ear

- Embryology
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- Physiology
- **Disease of external ear**
- Acute Otitis media

# Disease of external ear

- Wax
- Tumor
  - Exostosis
  - Osteoma
- Foreign body
- Infection
- Trauma

# Wax







# Tumor

- Benign
  - Exostosis
  - Osteoma
- Malignant
  - Rare
  - Metastasis



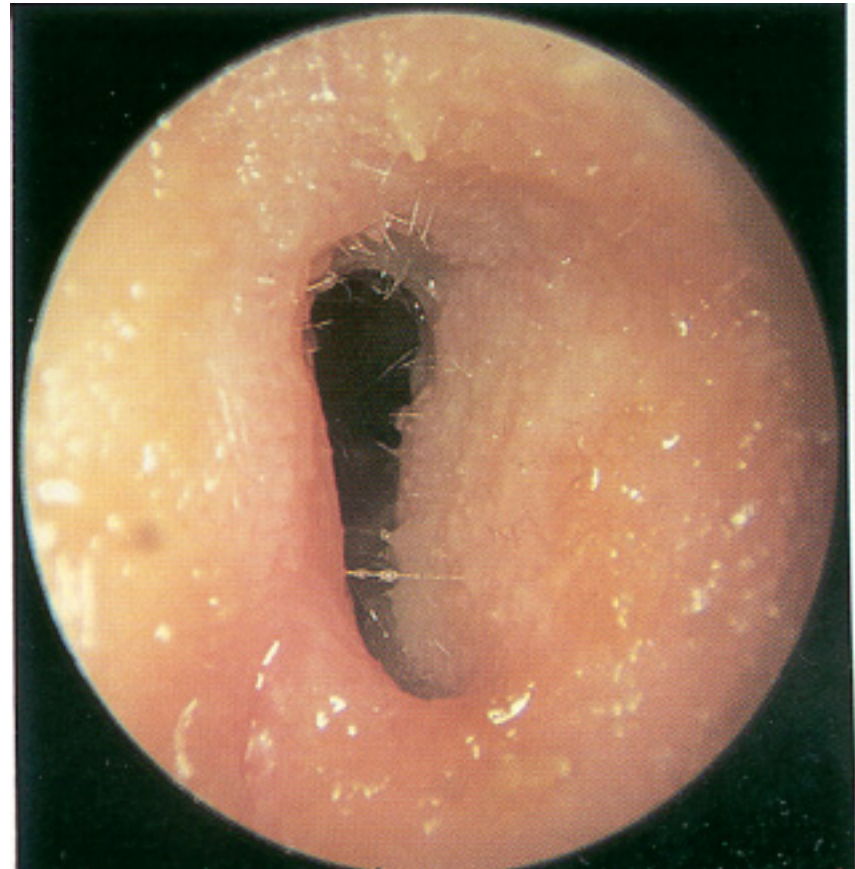
# ***Otitis Externa***

# Clinical Course

- Itching
- Progresses to:
  - Pain
  - Decreased hearing
  - Drainage (usually from bacterial infection)

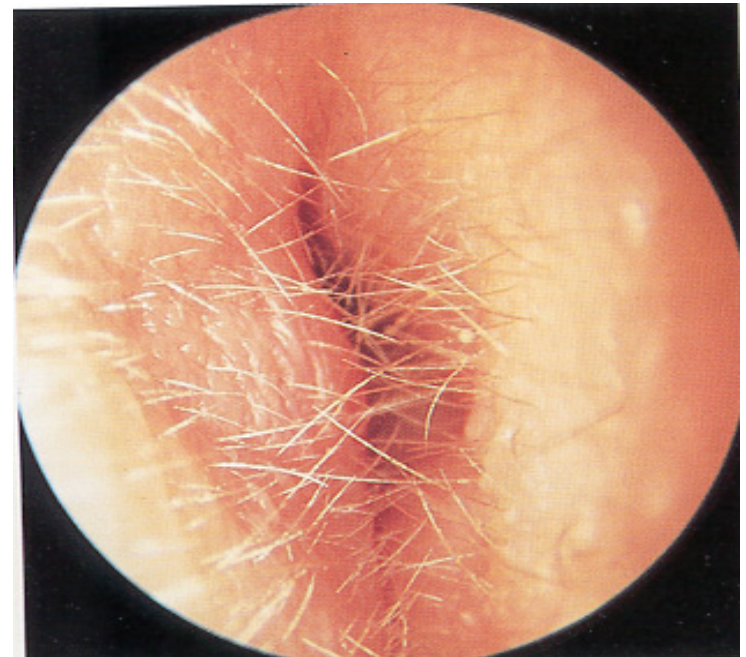
# AOE: Mild to Moderate Stage

- Symptoms
  - Pain
  - Increased pruritus
- Signs
  - Erythema
  - Increasing edema
  - Canal debris, discharge



# AOE: Severe Stage

- **Severe pain, worse with**
  - Ear movement
  - Chewing
- **Signs**
  - Lumen obliteration
  - Purulent otorrhea
  - Involvement of periauricular soft tissue

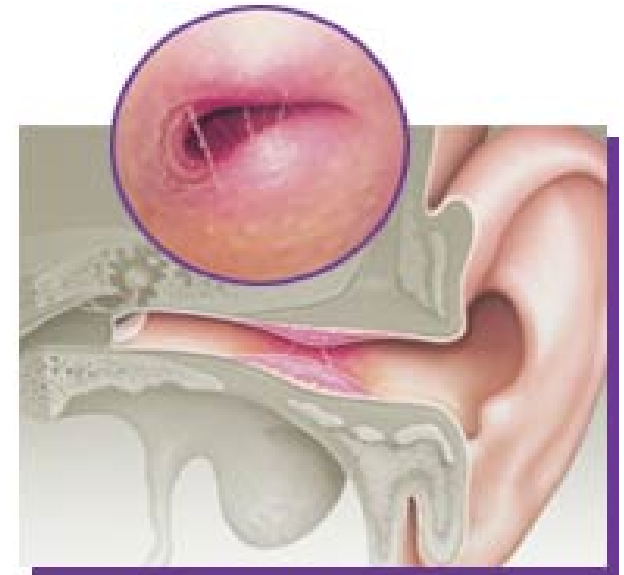


# Microbiology

- Bacteria 50% of cases
  - Staph aureus
  - Pseudomonas
  - Proteus
- Fungi
  - Aspergillus – tropical
  - Candida albicans – temperate

# Epidemiology

- Warm, humid climate
  - “swimmer’s ear”
- Poor hygiene
- Closed canal
  - Hearing aid
  - Turbans in India
- Composition of cerumen
  - pH changes from acid to alkaline (D.M)
  - Softer – washed out
  - Hard block the canal
- Instrumentation of ear canal



Swimmer's Ear (AOE)



# Diagnosis

- Persistent disease
  - Resistant
  - Fungal
  - Dermatological etiologies
  
- Cultures will be helpful

# Treatment

- meticulous cleaning
  - every 2-3 days
  - weekly
- Topical antibiotic
- Water precautions

# Furunculosis

- Acute localized infection
- Lateral 1/3 of posterosuperior canal
- Obstructed apopilosebaceous unit
- Pathogen: *S. aureus*

# Furunculosis: Symptoms

- Localized pain
- Pruritus
- Hearing loss (if lesion occludes canal)

# Furunculosis: Signs

- Edema
- Erythema
- Tenderness
- Occasional fluctuance



# Furunculosis: Treatment

- Local heat
- Analgesics
- Oral anti-staphylococcal antibiotics
- Incision and drainage reserved for localized abscess
- IV antibiotics for soft tissue extension

# Otomycosis

- Fungal infection of EAC skin
- Primary or secondary (AB)
- Most common organisms: *Aspergillus* and *Candida*

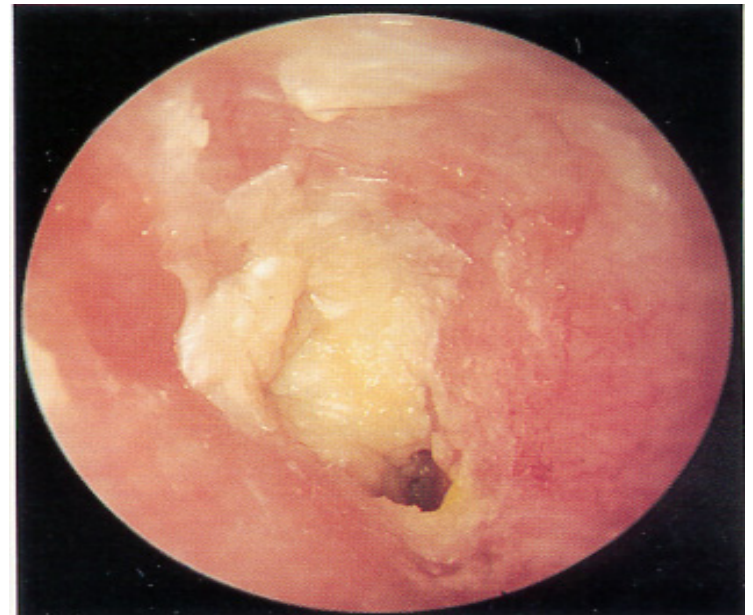
# Otomycosis: Symptoms

- Often indistinguishable from bacterial OE
- Pruritus deep within the ear
- Dull pain
- Hearing loss (obstructive)
- Tinnitus



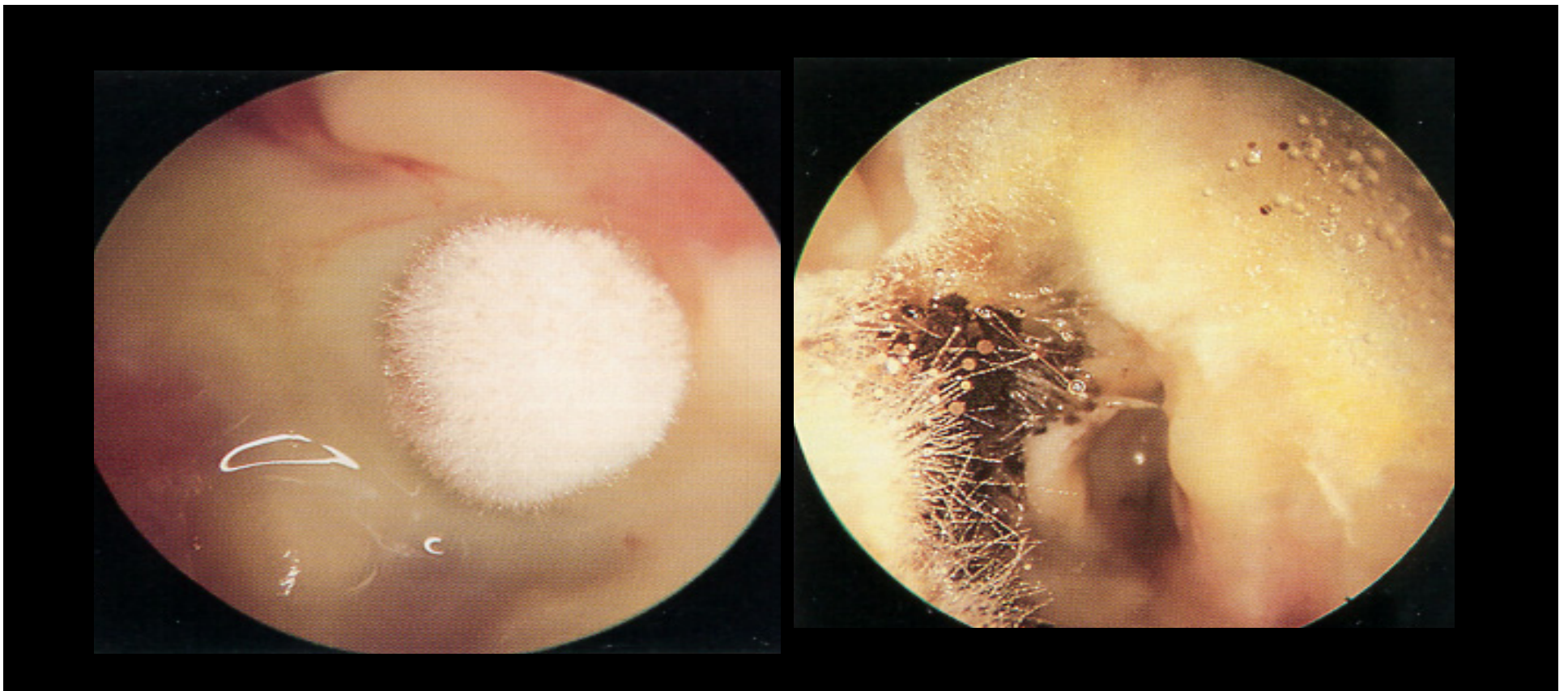
# Physical Exam

- Early
  - Normal
  - Canal erythema
  - Mild edema
- Later
  - “wet newspaper”
  - red, tender skin
  - Fungal hyphae



# Otomycosis

## Fungal hyphae



# Otomycosis: Treatment

- Thorough cleaning
- Drying of canal
- Topical antifungals

# Bullous Myringitis

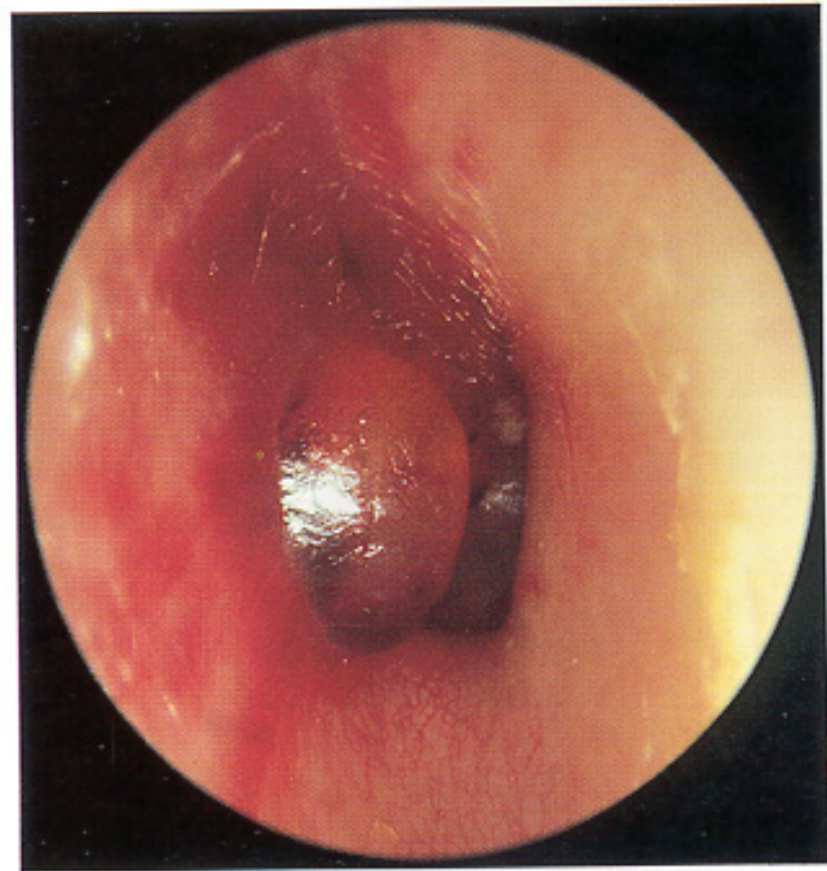
- Viral infection
- Bacteria of OM
- Confined to tympanic membrane
- Children

# **Bullous Myringitis: Symptoms**

- Sudden onset of severe pain
- No fever
- No hearing impairment
- Bloody otorrhea (significant) if rupture

# Bullous Myringitis: Signs

- Inflammation limited to TM & nearby canal
- Multiple reddened, inflamed blebs
- Hemorrhagic vesicles



# Bullous Myringitis: Treatment

- Self-limiting
- Analgesics
- Topical antibiotics to prevent secondary infection
- Incision of blebs is unnecessary

# Necrotizing External Otitis(NEO)

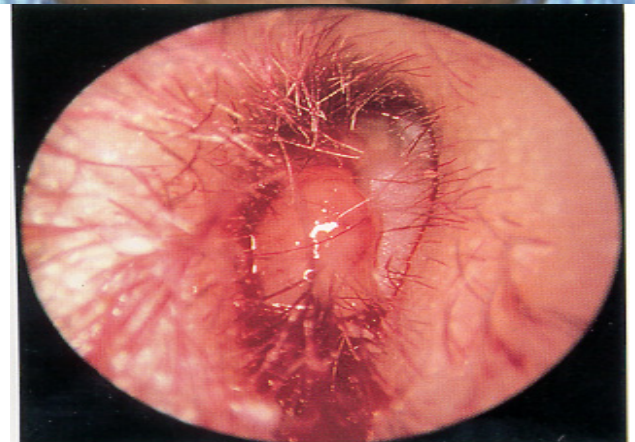
- Potentially lethal infection
- DM and immunocompromised patients
- *Pseudomonas aeruginosa*



# Malignant Otitis Externa

## 4 Ds

- **D**iabetes mellitus
  - **D**ischarge (Purulent )
  - **D**iscomfort
  - **D**ysfunction Cranial nerve
- 
- Granulation obscured TM



# NEO: Imaging

- Plain films
- Computerized tomography – most used
- Technetium-99 – reveals osteomyelitis
- Gallium scan – useful for evaluating Rx
- Magnetic Resonance Imaging

# NEO: Treatment

- Antibiotics
  - Intravenous
  - At least 4 weeks
- Local canal debridement
- DM control
- Pain control
- Hyperbaric oxygen experimental
- Serial gallium scans monthly

# NEO: Mortality

- 25 % Death rate
- 60% with multiple cranial neuropathies
- 25 % Recurrence
- May recur up to 12 months after treatment

# Perichondritis: Signs

- Tender auricle
- Induration
- Edema
- Advanced cases
  - Crusting
  - Involvement of soft tissues



# Herpes Zoster Oticus

- J. Ramsay Hunt
- Varicella zoster
- Shingles: Infection along one or more cranial nerve dermatomes
- Ramsey Hunt syndrome:
  - Herpes zoster of the pinna
  - Otalgia
  - Facial paralysis

# Herpes Zoster Oticus: Symptoms

- Early: burning pain in one ear, headache, malaise and fever
- Late (3 to 7 days): vesicles, facial paralysis



# Herpes Zoster Oticus: Treatment

- Corneal protection
- Oral steroid taper (10 to 14 days)
- Antivirals



# Erysipelas

- Acute superficial cellulitis
- Group A, beta hemolytic streptococci
- Skin: bright red; well-demarcated,
- Rapid treatment with oral or IV antibiotics if insufficient response



# Ear Trauma

# ***Auricle injuries***

- Hematomas  
separate the perichondrium (blood supply) from the cartilage  
→ excise fibrous tissue
- Apply pressure dressing , drain
- Avulsion:
  - Reimplantation
  - Microvascular anastomosis



PROSELYTE



PROSELYTE

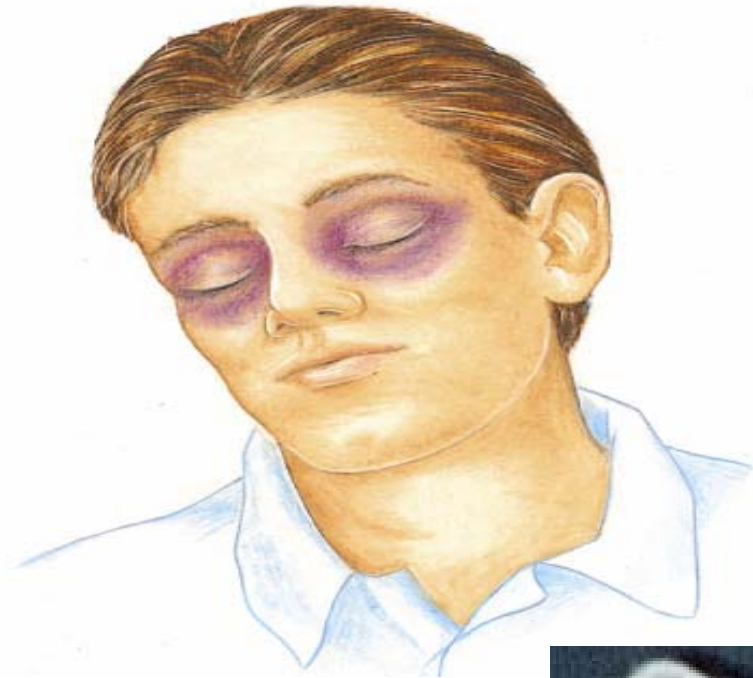


# ***Cauliflower Ear***





# Raccoon eyes sign



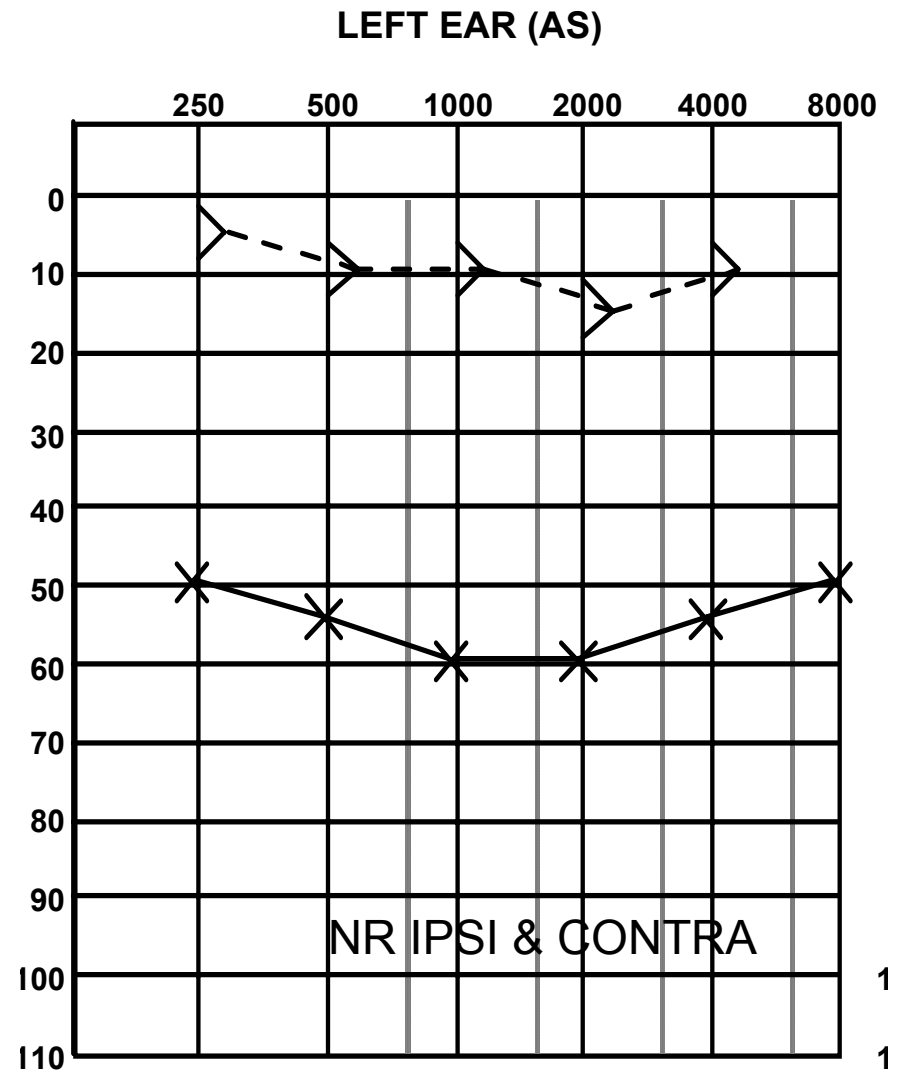
# Battle's sign





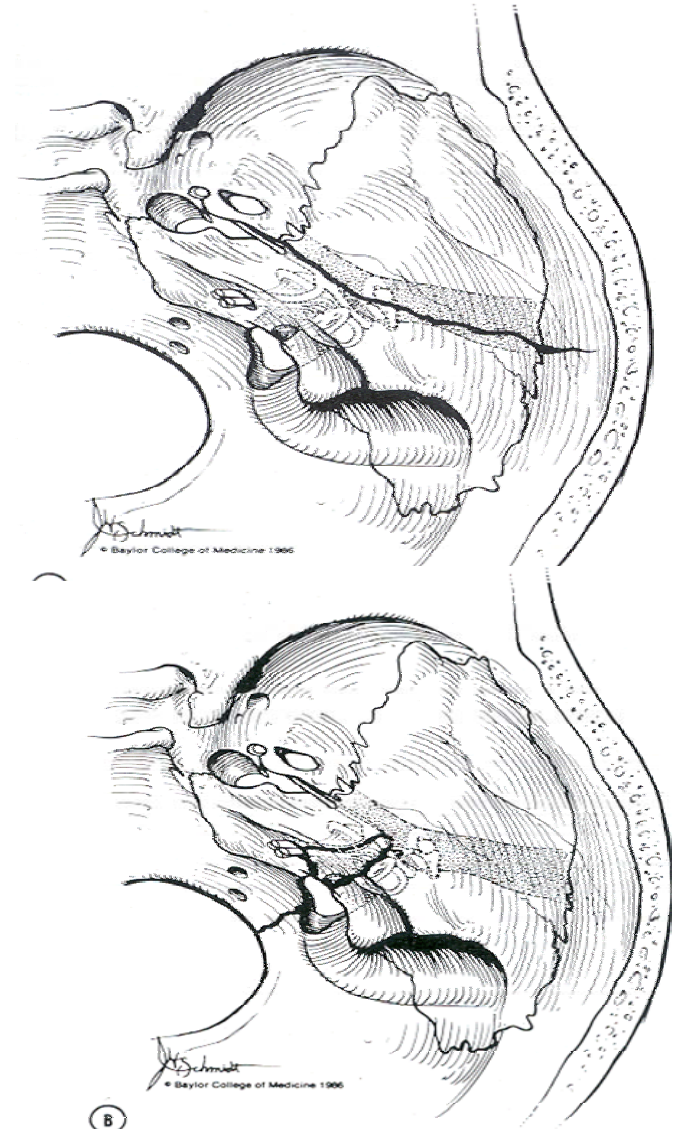


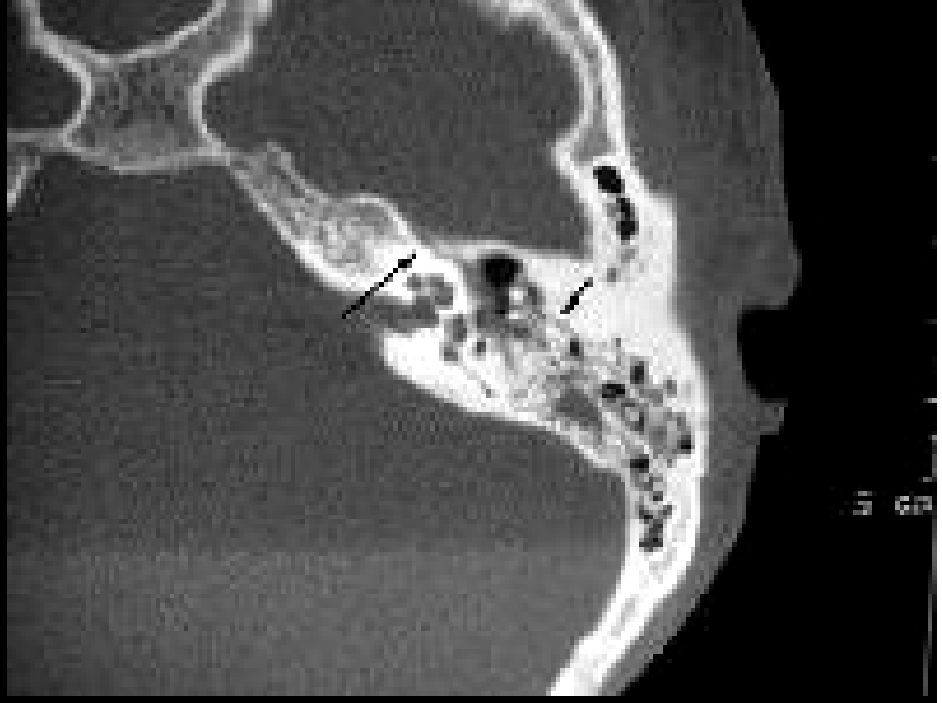
# Case

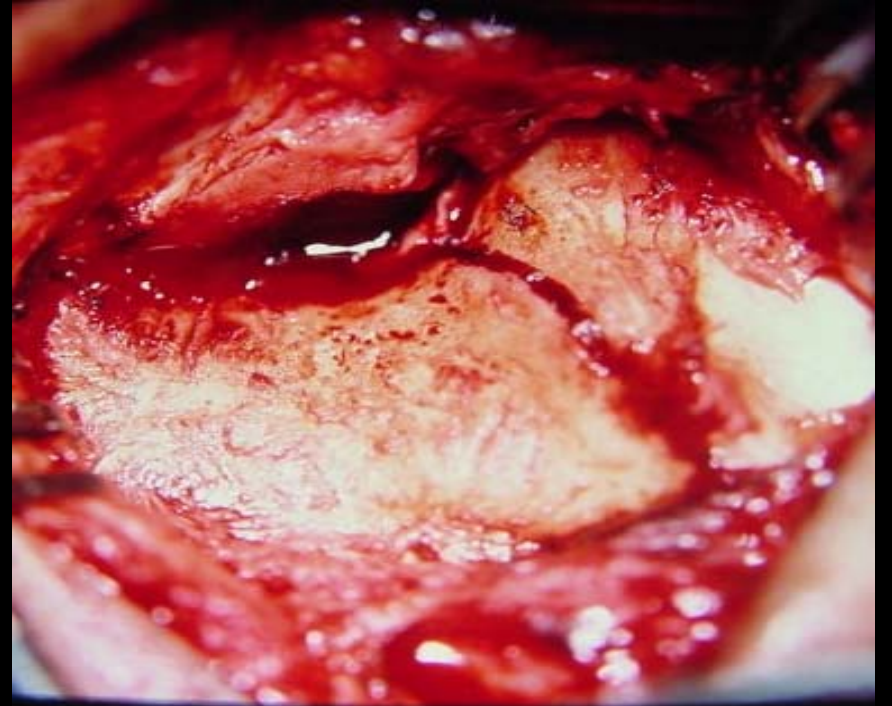
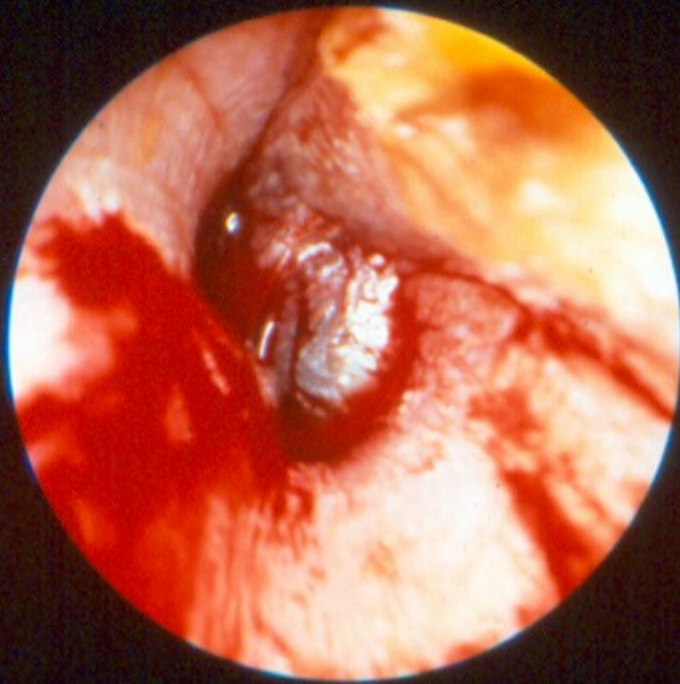
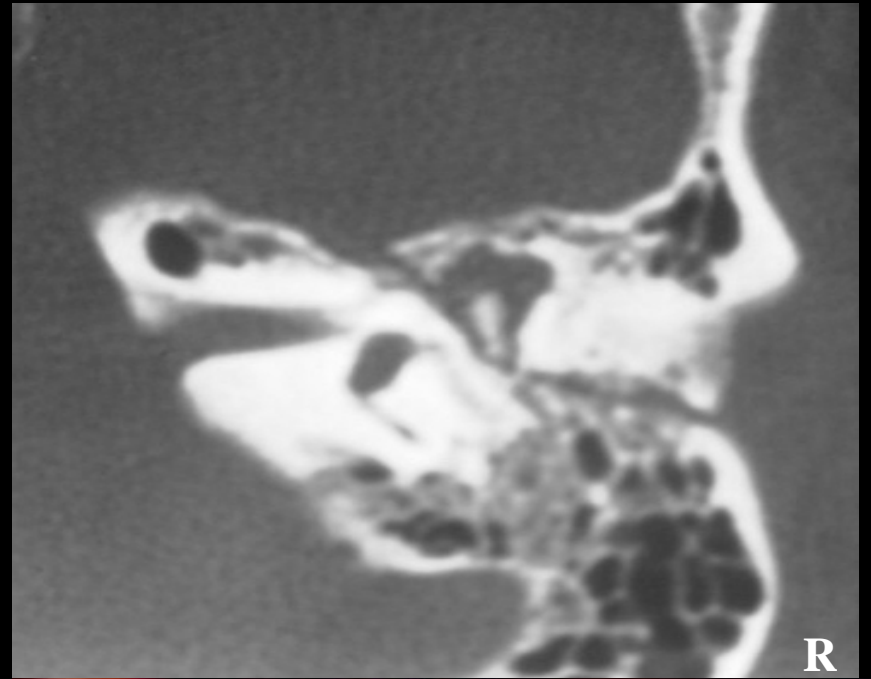


# Fractures

- **Longitudinal**
  - 80% of Temporal Bone Fractures
  - 15-20% Facial Nerve involvement
- **Transverse**
  - 20% of Temporal Bone Fractures
  - 50% Facial Nerve Involvement







# Ear

- Embryology
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- Disease of external ear
- **Acute Otitis media**

# Otitis Media

## Definition

Inflammation of the middle ear  
May also involve inflammation of  
mastoid, petrous apex, and  
perilabyrinthine air cells

# Otitis Media

- Most common reason for visit to pediatrician
- Tympanostomy tube placement is 2nd most common surgical procedure in children
- Development of multidrug-resistant bacteria

# Otitis Media - Classification

- Acute OM < 3 wk
- Subacute OM 3 wks to 3 months
- Chronic OM > 3 mos



# OM - Epidemiology

- Age
- Sex
- Day care
- Seasons
- Genetics
- Breast-feeding
- Smoke exposure
- Medical conditions

# OM - Medical Conditions

- Cleft palate
  - decreases after repair
- Craniofacial disorders
  - Treacher-Collins
- Down's syndrome
- Ciliary dysfunction
- Immune dysfunction
  - AIDS
  - steroids, chemo
  - IgG deficiency
- Obstruction
  - adenoids
  - NG tubes
  - NT intubation
  - malignancy

# OM - Epidemiology

- Increasing incidence?
- Increases after newborn period
- 2/3 with AOM by one year of age
- 1/2 with >3 episodes by three years
- most common in 6 - 11 mos

# OM - Day Care

- Greater risk of AOM in children < 3 years
- Home care best
- Day care
  - Large group
  - Exposures with wider range of flora
  - Increased URI's

# OM - Breast-feeding

- Decreases incidence of URI and GI disease
- Decreases duration of OM
- Protective factor in breast-milk?

# OM - smoke exposure

- Induces changes in respiratory tract
- Increased AOM and persistent effusion
- Increased chronic and recurrent AOM

# التدخين في المملكة

- 23 في الترتيب العالمي (نسبة استهلاك للفرد)
- المدخنين يحرقون اكثر من 5مليارات ريال
- اكثر من 40الف طن
- 30 % القطاع الصحي والتعليمي  
(الاطباء ومعلمين والطلاب)
- 600 الف مدخنة معظمهن من المراهقات.

# Eustachian Tube

- Connects middle ear and nasopharynx
- Lumen shaped like two cones
- Mucosa
  - Mucous producing cells
  - Ciliated cells



# ***Eustachian tube***

- Usually closed
- Tensor veli palatini → active opening
- Opens during
  - Swallowing
  - Yawning
  - Sneezing
- Opening involves cartilaginous portion

# Eustachian tube

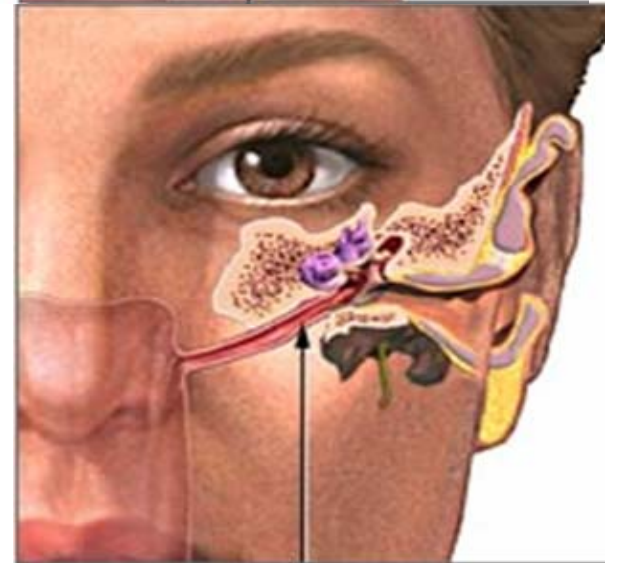
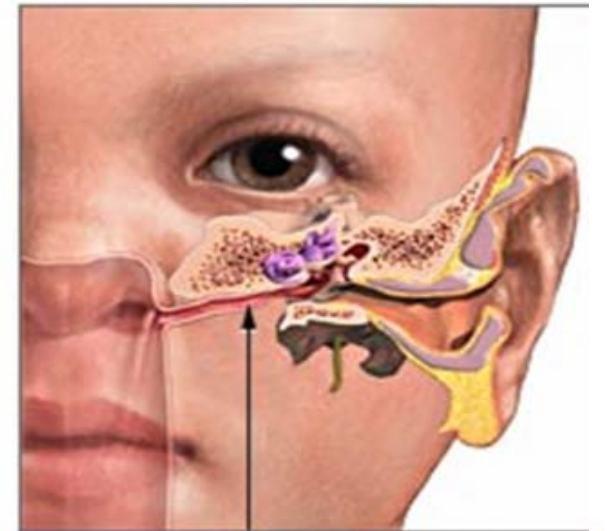
## *Functions*

- Protection from nasopharyngeal
  - Sound
  - Secretions
- Clearance of middle ear secretions
- ME Ventilation (pressure regulation)

# *Eustachian tube*

## Children

- Longer bony portion
- 10 degree angle (Horizontal)
- Larger isthmus
- Nasopharyngeal orifice
  - Relatively large
  - Obstructed by adenoid
  - Supine
  - Crying & Sniffing



# Middle ear Pathology

- Inflammation Edema
- PMN infiltration
- Epithelial ulceration
- Granulation tissue
- Fibrosis,
- influx of chronic inflammatory cells
- Increased columnar and goblet cells
- Osteitis

# Microbiology

- *S. pneumoniae* - 30-35%
- *H. influenzae* - 20-25%
- *M. catarrhalis* - 10-15%
- Group A strep - 2-4%
- Infants with higher incidence of gram negative bacilli

# Virology

- RSV - 74% of middle ear isolates
- Rhinovirus
- Parainfluenza virus
- Influenza virus

# Treatment - AOM

- Adults and older children - observation
- Antibiotics - consider drug resistance patterns

# Antibiotics

- First line
  - Amoxil –
  - Ceftin - B lactam stable
  - Bactrim
- Second line
  - Augmentin
  - Ceftin
  - Rocephin
  - Macrolides - Zithromax, Biaxin



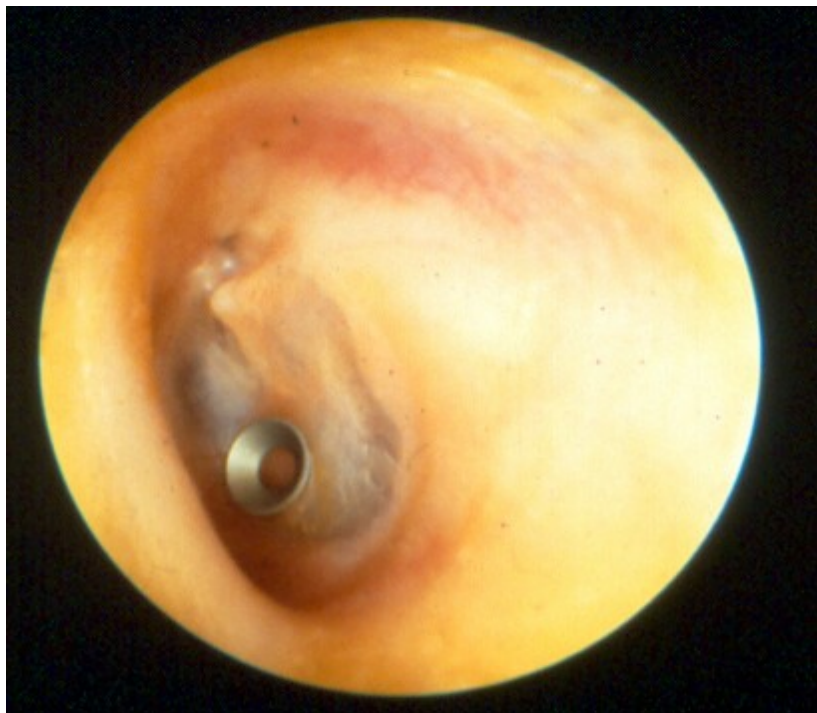
# Treatment - Recurrent AOM

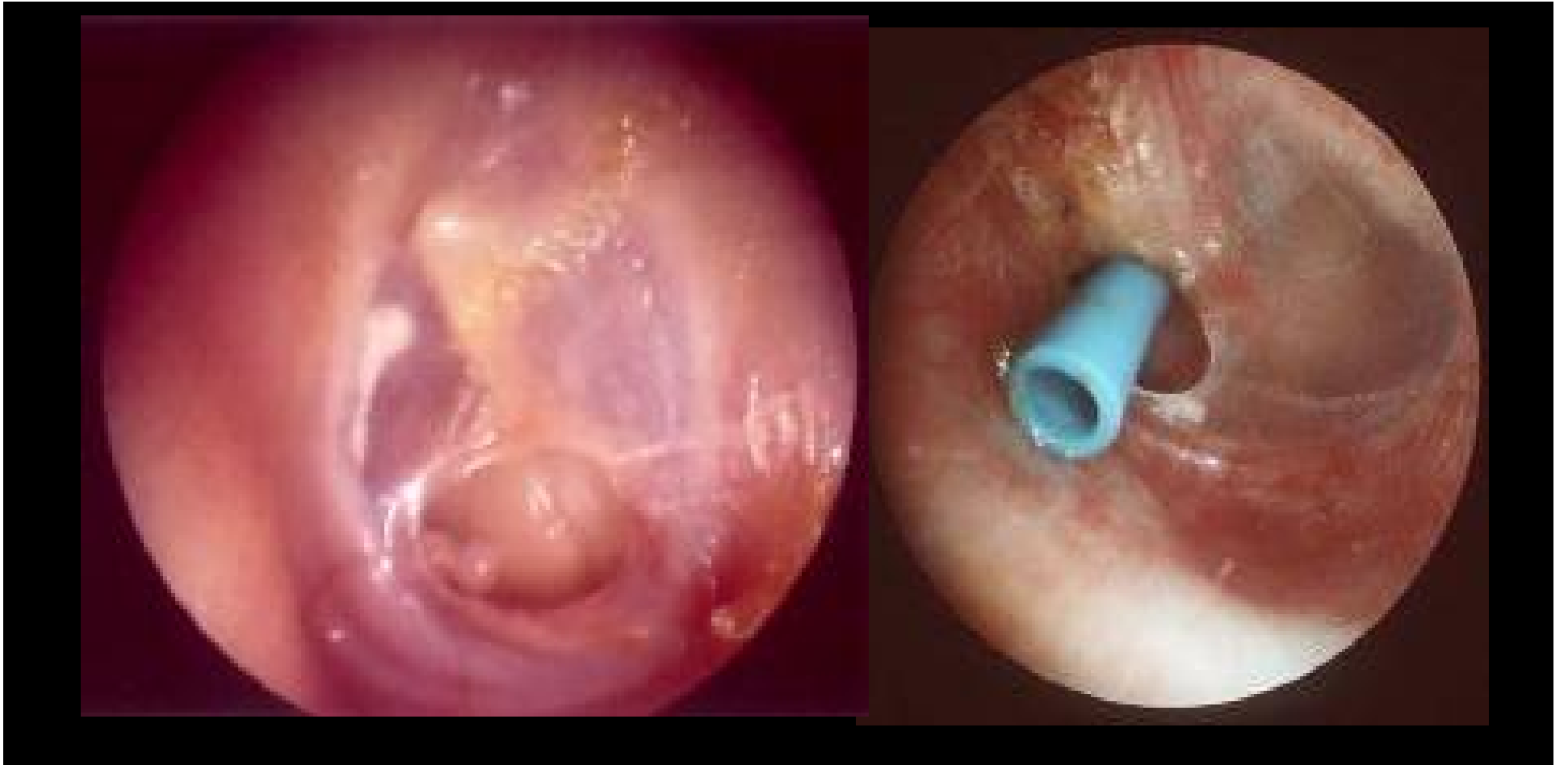
- Chemoprophylaxis
  - Sulfisoxazole, amoxicillin, ampicillin, pcn
  - less efficacy for intermittent prophylaxis
- Myringotomy and tube insertion
  - decreased # and severity of AOM
  - otorrhea and other complications
- Adenoidectomy

# Tympanostomy tube insertion

- Unresponsive OME > 3 months
- Recurrent MEE
- Suppurative complication

# Ventilating Tubes

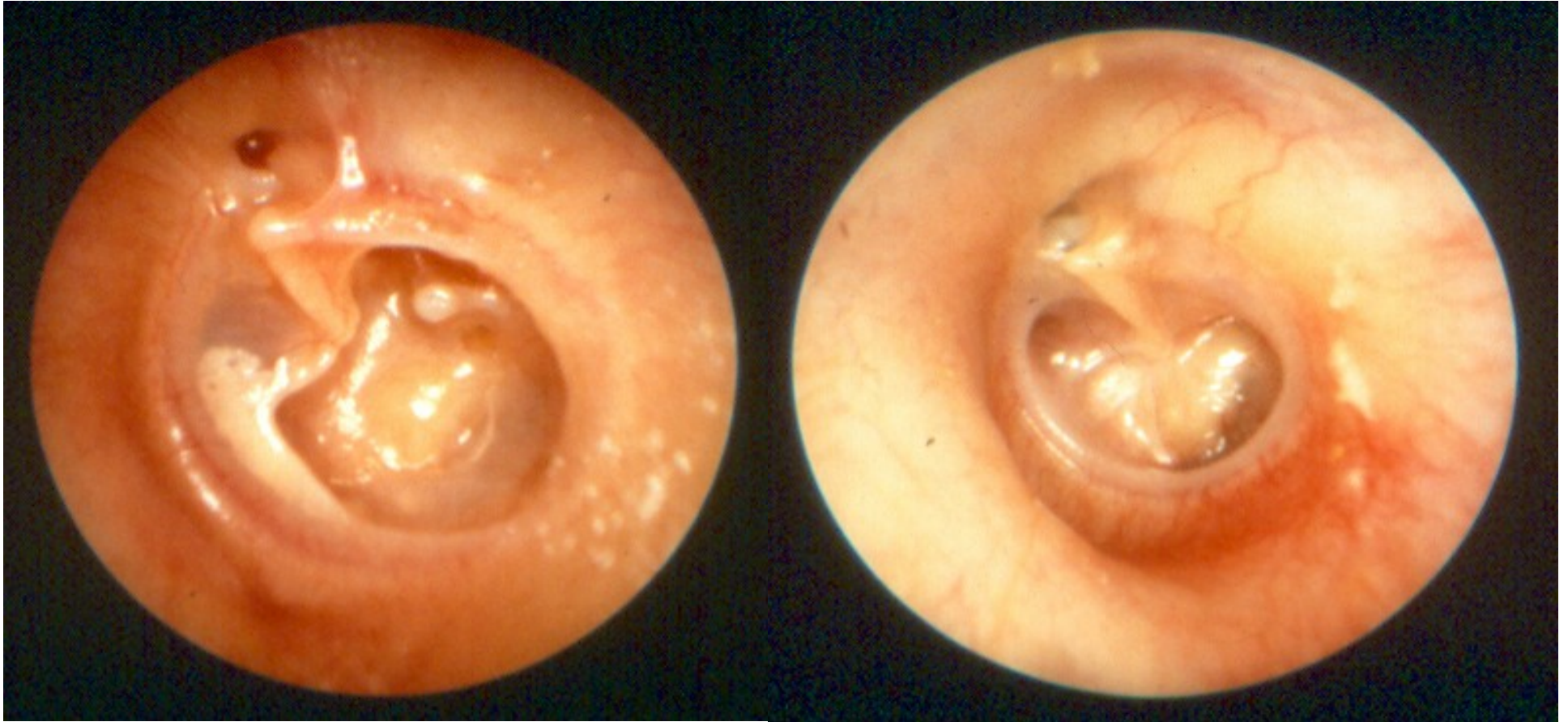




# Complications

- Intratemporal
  - hearing loss
  - TM perforation
  - CSOM
  - retraction pockets
  - cholesteatoma
  - mastoiditis
  - petrositis
  - labyrinthitis
  - adhesive OM
  - tympanosclerosis
  - ossicular discontinuity and fixation
  - facial paralysis
- Intracranial
  - meningitis
  - extradural abscess
  - subdural empyema
  - focal encephalitis
  - brain abscess
  - lateral sinus thrombosis
  - otitic hydrocephalus

# Drum Retraction (Adhesive OM)

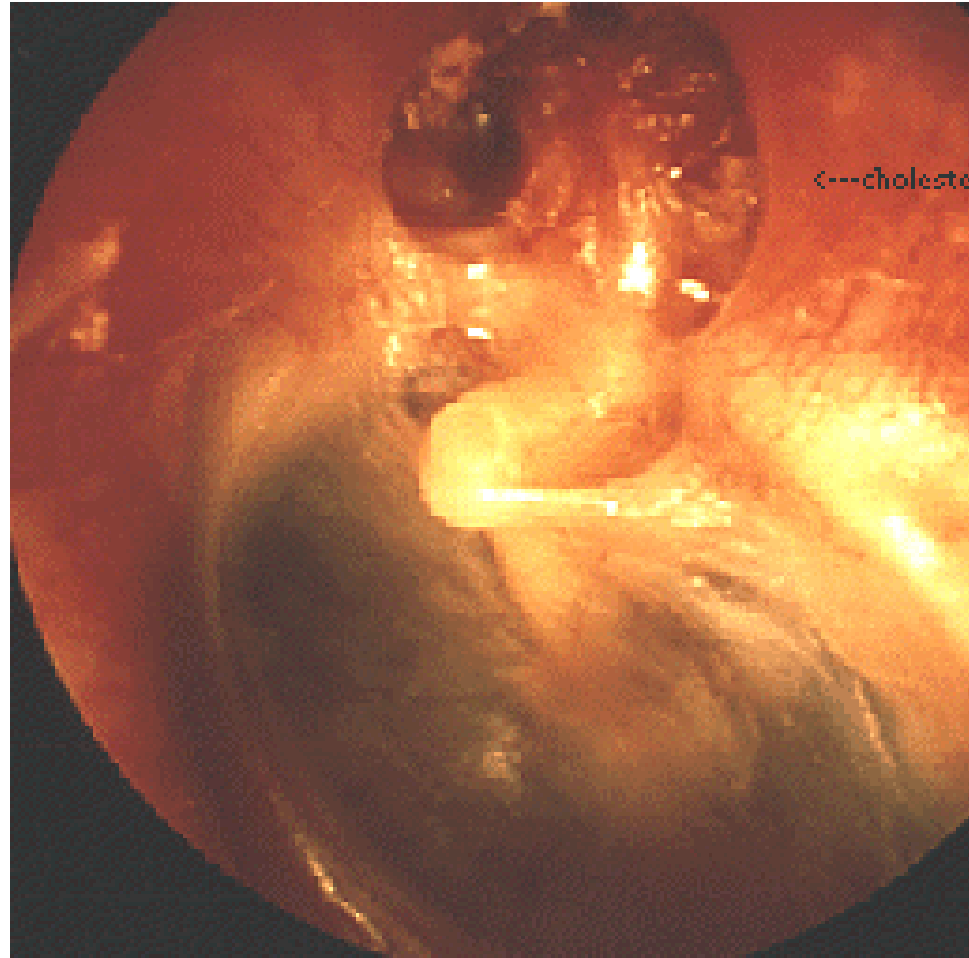




# Tympanosclerosis



# Cholesteatoma

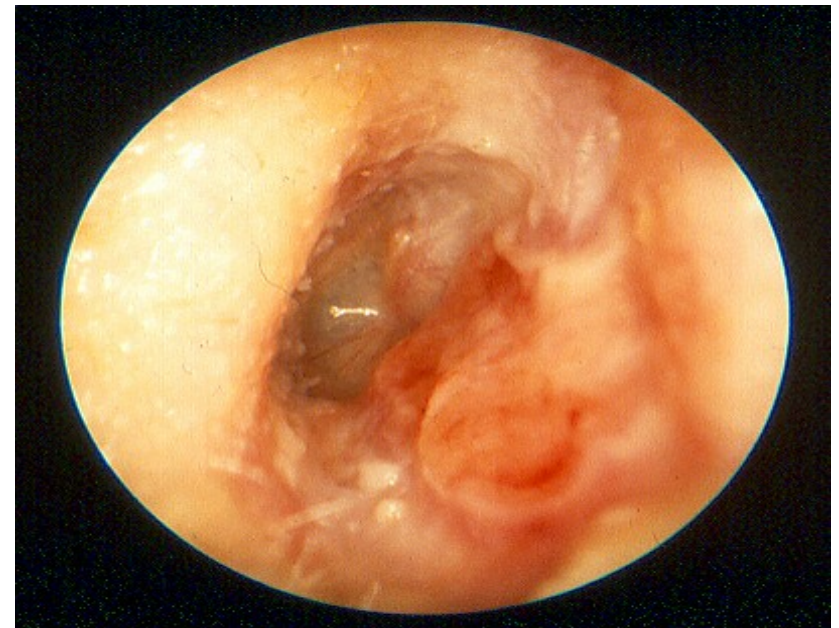




**Cases**

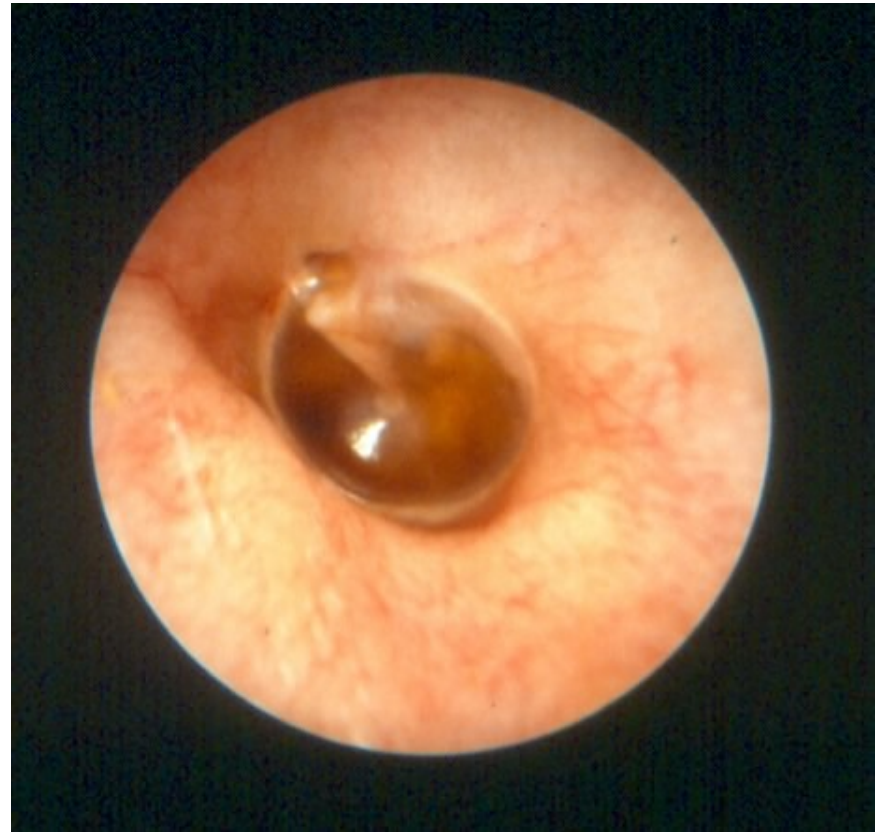
# Malignant (Necrotizing) Otitis Externa

- 55 Y
- Left ear
  - Pain
  - Discharge
- Left VII paralysis



# Secretory Otitis Media (Glue Ear)

- 3 Y
- Recurrent OM
- Hearing Loss



# Otomycosis

- 45 Y
- Severe itching
- Pain
- Hearing loss



# Fracture Base of Skull

- MVA
- Left earache
- Hearing loss



# Ramsay Hunt Syndrome

- 55 Y
- Bilateral Earache
- Facial weakness



# Mondini

- 4 Y
- Normal exam
- Rt moderate SNHL





# Otosclerosis vs Tympanosclerosis

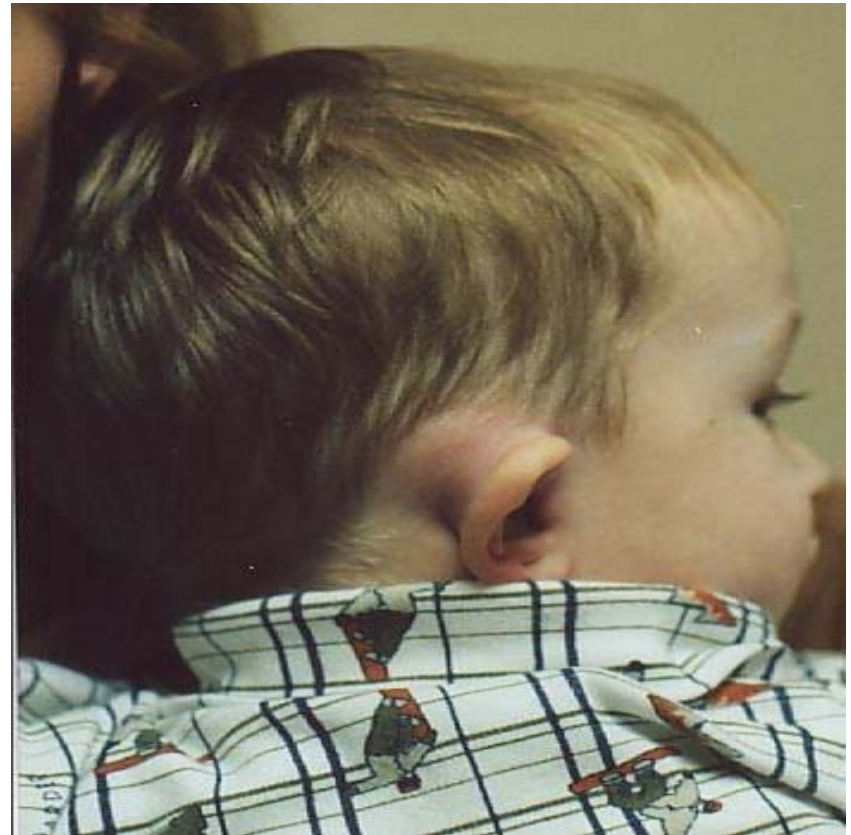
- 33 y
- No hearing loss
- Ear exam →





# Mastoiditis

- **3 Y**
- **Fever**
- **Earache**
- **Irritability**



# Bat ear

- 4 Y
- Era deformity



***Thank***

***You***