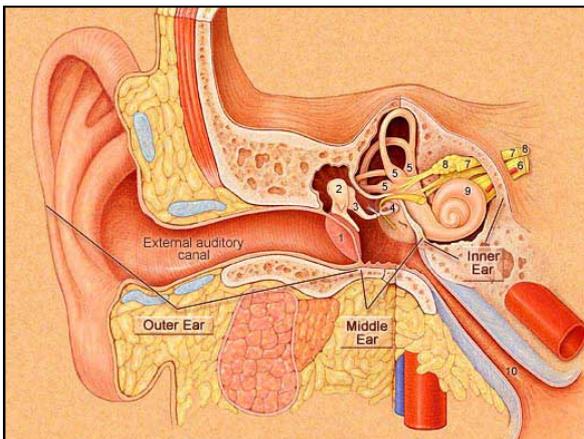
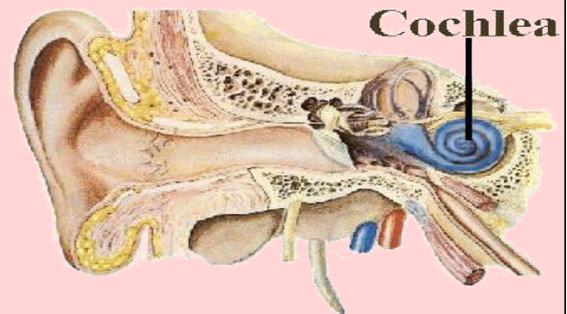


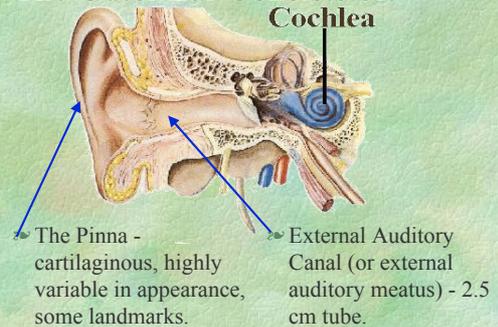
Physiology of ear

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GMC

The "Ear" is housed within the
TEMPORAL BONE



The Outer Ear Consists of:
Cochlea

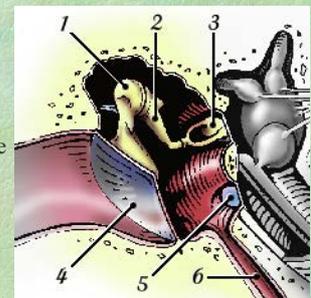


Outer Ear Functions

- Amplification / Filtering
- Protection
- Localization

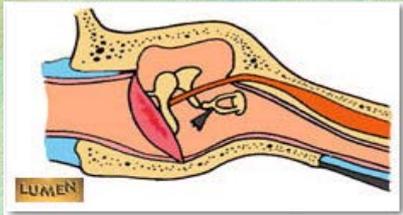
Middle Ear Structures

- 1- Malleus
- 2- Incus
- 3- Stapes
- 4- Tympanic Membrane (Eardrum)
- 5- Round Window
- 6- Eustachian Tube



Middle Ear Muscles

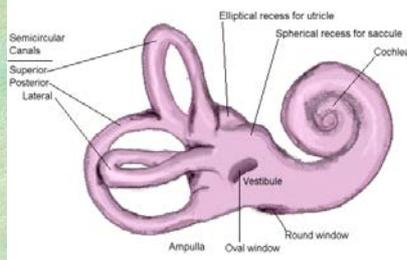
1. **The Stapedius** Attaches to Stapes, Contracts in Response to Loud sounds, chewing, speaking; Facial (VIIth cranial) nerve
2. **The Tensor Tympani** Helps open Eustachian tube



Middle Ear Functions

- Impedance Matching
- Filtering
- Acoustic Reflex

INNER EAR

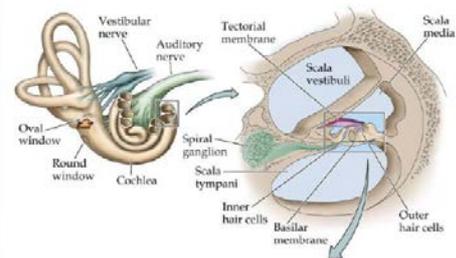


Two Halves:

- Vestibular--transduces motion and pull of gravity
- Cochlear--transduces sound energy

Sound processing in inner ear:

Structure of the inner ear



Cochlear Functions

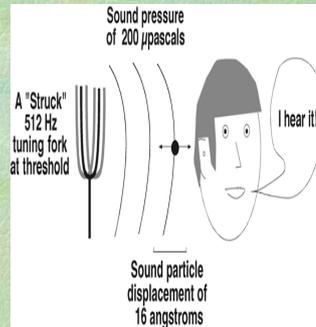
- Transduction- Converting acoustical-mechanical energy into electro-chemical energy.
- Frequency Analysis-Breaking sound up into its component frequencies
 - Active Tuning from OHCs

WHAT IS SOUND?

- Sound results when particles of a medium are set into vibration. The sounds we hear, for the most part, result from air particles being set in motion by vibrating objects.
- For example, the vibrating tines of a struck 512 Hz tuning fork produce backward and forward motions of the air particles that surround the tines.
- In general, the louder the sound, the larger the particle motions and pressure variations.

WHAT IS SOUND PRESSURE?

➤ Perception of pressure waves generated by vibrating air molecules.



Main Components of the Hearing Mechanism:

Divided into 4 parts (by function):

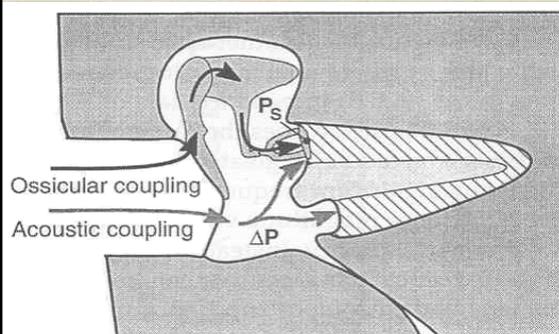
- Outer Ear
- Middle Ear
- Inner Ear
- Central Auditory Nervous System

Mechanism of hearing

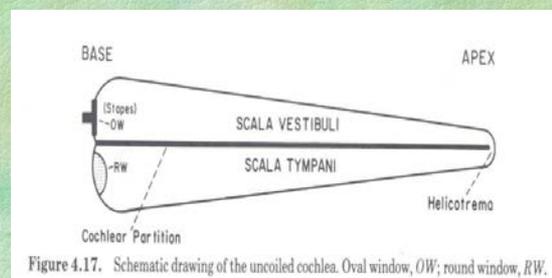
- The pinna collects sound signal from environment and directs to external auditory canal and strikes to tympanic membrane. Amplifies sound approx. 5-6 dB – Air conduction
- Head and body, has a significant influence on the sounds that reach the middle ear – bone conduction.
- Vibrations of tympanic membrane are transmitted to stapes footplate through a chain of ossicles attached to TM.

- Movement of stapes footplate cause pressure changes in the labyrinthine fluids amplifying about 20 times (approx 30 db) which move the basilar membrane.
- This stimulates the hair cells of organ of Corti these hair cells act as transducers & convert the mechanical energy to electrical impulses which travels along the auditory nerve.

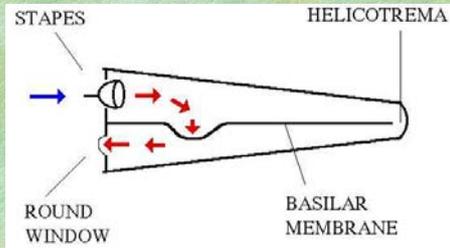
Middle Ear Transmits Energy by Two Pathways:



The Uncoiled Cochlea

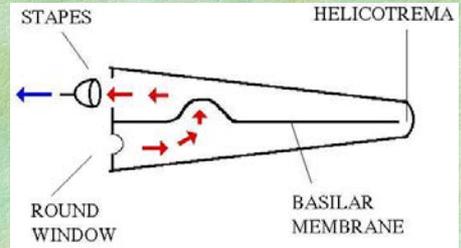


Effect of stapes insertion in cochlea



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Effect of outward movement of stapes

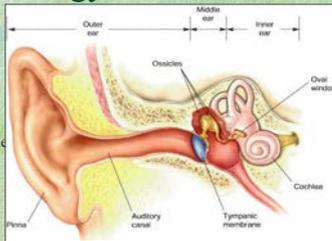


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Inner Ear Physiology

Transduction

- Tympanic membrane
 - Acoustical/mechanical
- Oval window
 - Mechanical/hydraulic
- Basilar & tectorial membrane
 - Hydraulic/mechanical
- Hair Cells (stereocilia)
 - Mechanical/electric
- Hair Cells (base)
 - Electrical/chemical
- Auditory Neuron
 - Chemical/electrical



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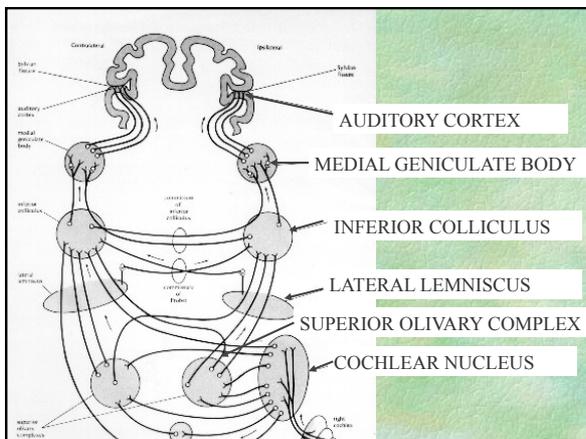
Central Auditory System

VIIIth Cranial Nerve or "Auditory Nerve"

- Bundle of nerve fibers
- Travels from cochlea through internal auditory meatus to skull cavity and brain stem
- Carry signals from cochlea to primary auditory cortex, with continuous processing along the way

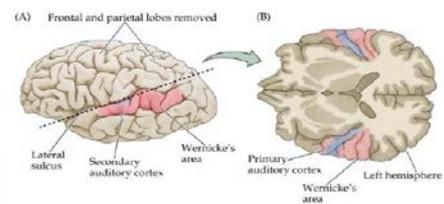
Auditory Cortex

- Wernicke's Area within Temporal Lobe of the brain
- Sounds interpreted based on experience/association



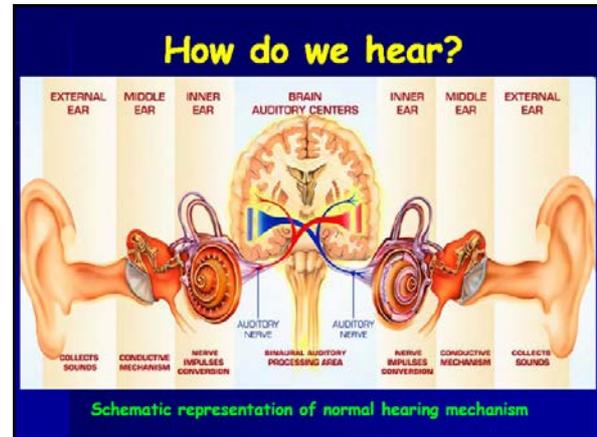
Central auditory processing:

Auditory cortical areas



Summary: How Sound Travels Through The Ear

Acoustic energy, in the form of sound waves, is channeled into the ear canal by the **pinna**. Sound waves hit the **tympanic membrane** and cause it to vibrate, like a drum, changing it into **mechanical energy**. The **malleus**, which is attached to the tympanic membrane, starts the **ossicles** into motion. The **stapes** moves in and out of the **oval window** of the **cochlea** creating a fluid motion, or **hydraulic energy**. The fluid movement causes membranes in the **Organ of Corti** to shear against the **hair cells**. This creates an **electrical signal** which is sent up the **Auditory Nerve** to the brain. The brain interprets it as sound!



Physiology of vestibular system

- Vestibular system – Peripheral- made up of membranous labyrinth – semicircular ducts, utricle & saccule.
- Central – made up of nuclei and fiber tracts in CNS to integrate vestibular impulses with other systems to maintain body balance (muscle, tendons, joints, skin, and eyes) which are connected to cerebellum and cerebrum.

- Semicircular canals are stimulated by angular acceleration because of the flow of the endolymph in canals excites the crista in their ampullae.

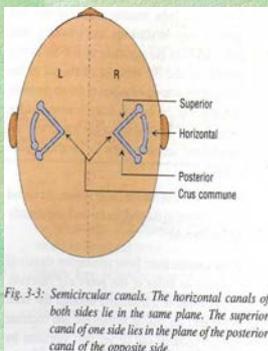
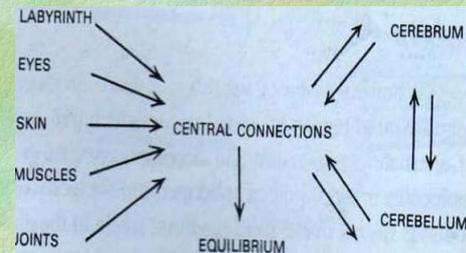


Fig. 3-3: Semicircular canals. The horizontal canals of both sides lie in the same plane. The superior canal of one side lies in the plane of the posterior canal of the opposite side.

- Utricle - responds because of stimulation of the macula by the slightest gravitational pull or linear acceleration.
- Saccule – is also similar to utricle

- Posture is maintained by labyrinthine and other proprioceptive reflexes. They are
- Static which are produced at rest
- Kinetic – are produced during movements

THANK YOU

