

# The Ear

Humans are provided with two important organs for sensing information carried by waves--- the ears and the eyes.

The ear is the organ for hearing. It is divided into three parts:

- Outer Ear (pinna/auricle, auditory canal)
- Middle Ear (eardrum, ossicles, eustachian tube)
- Inner Ear (cochlea, vestibule and semicircular canal)

# Major Divisions of the Ear

Peripheral Mechanism

Central Mechanism

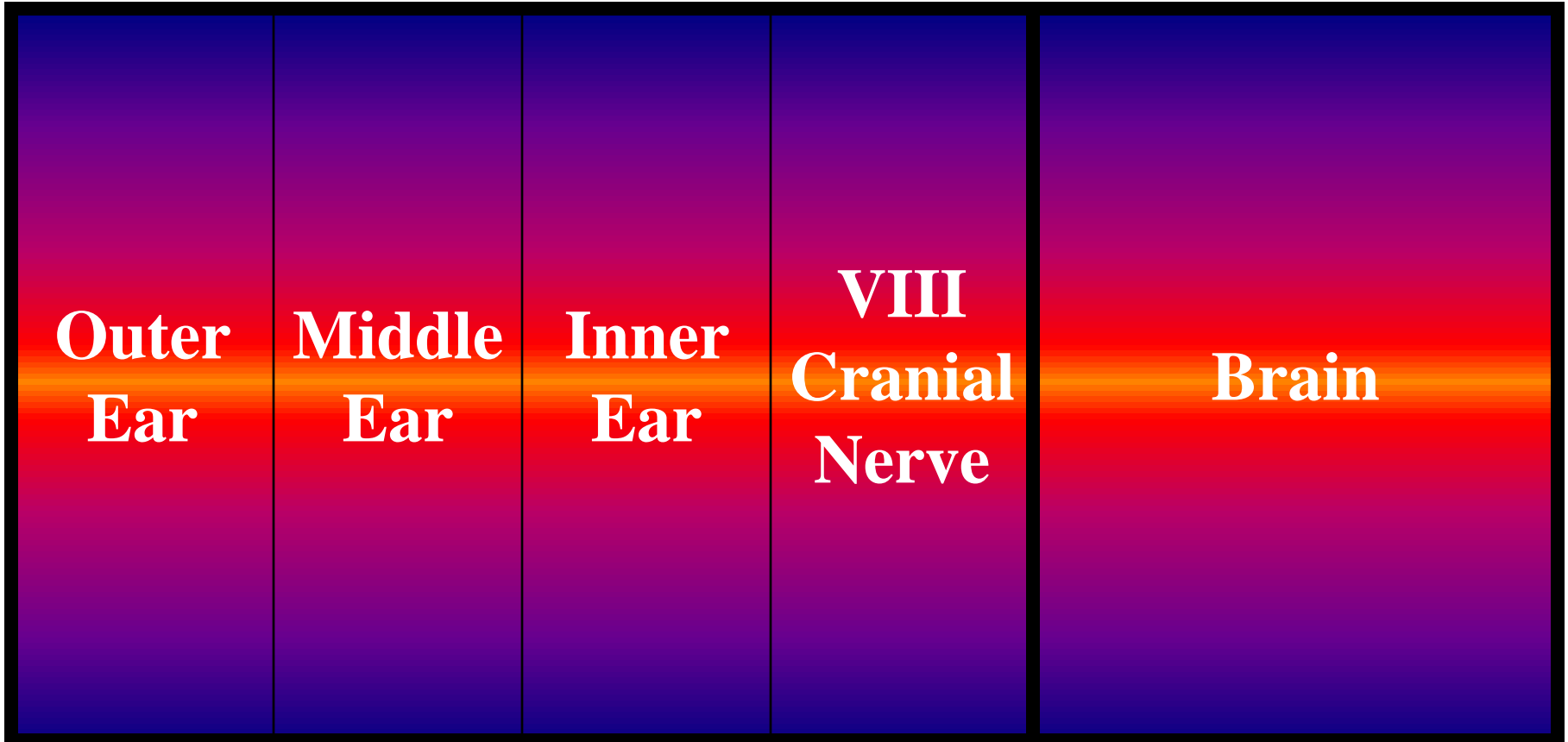
**Outer  
Ear**

**Middle  
Ear**

**Inner  
Ear**

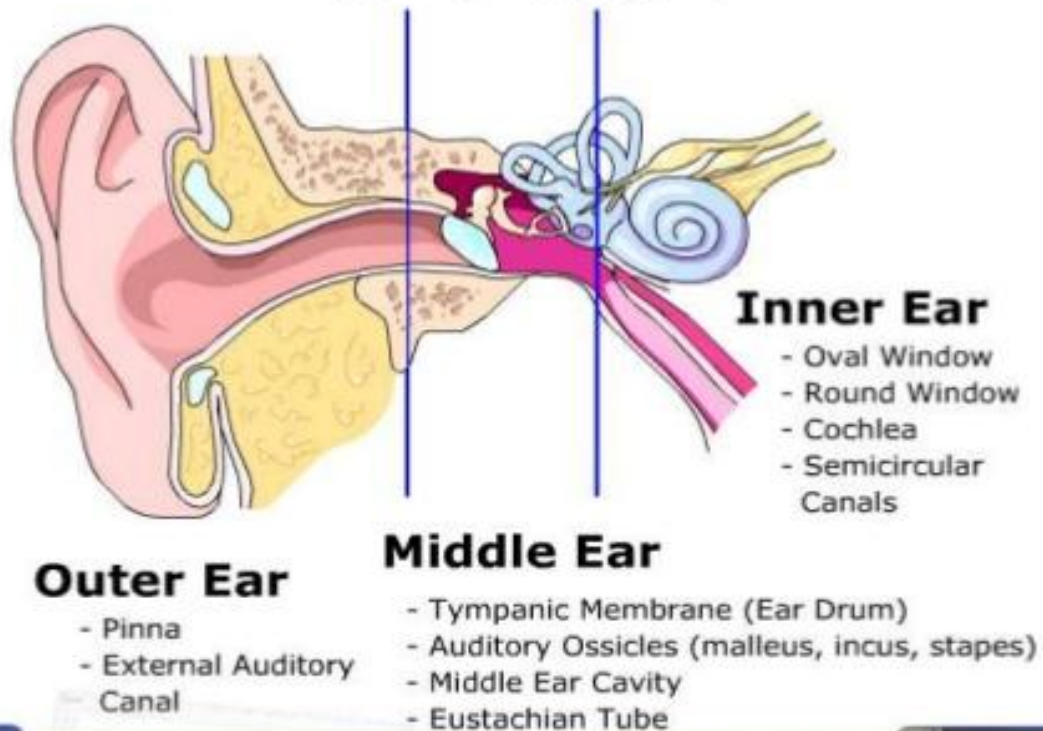
**VIII  
Cranial  
Nerve**

**Brain**

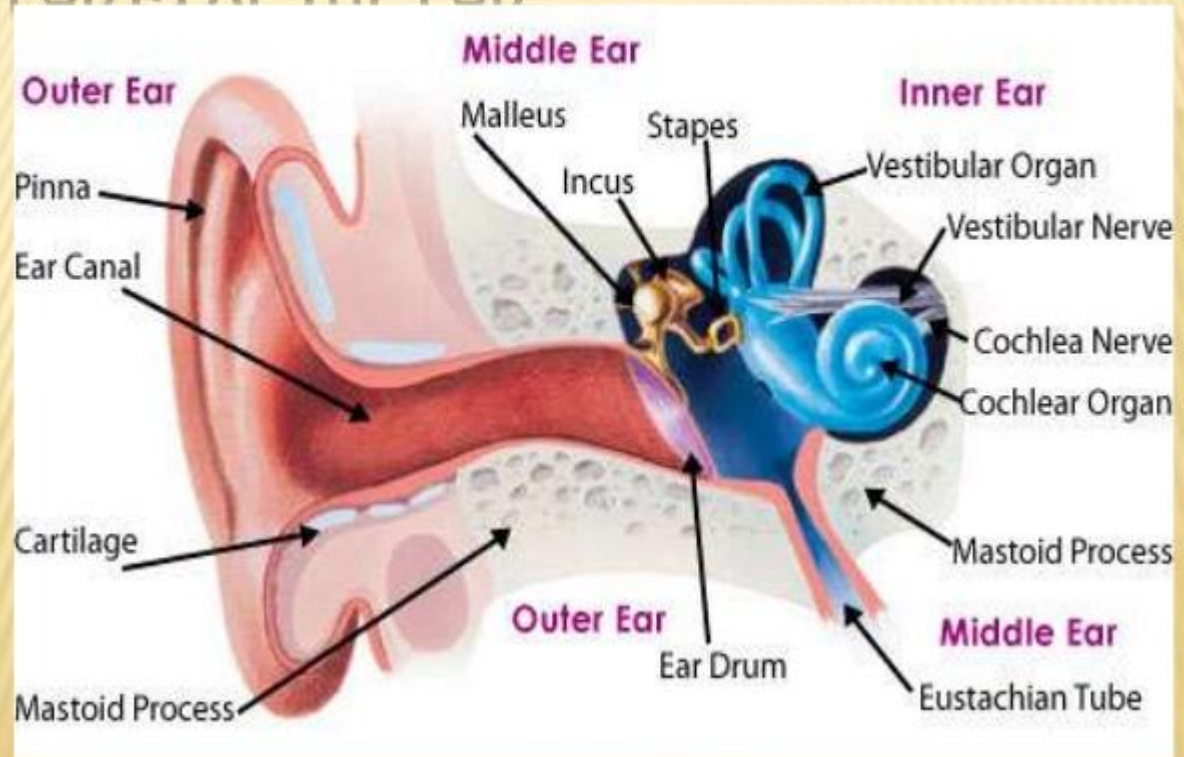


# Anatomy of the Ear

## Three Main Sections



# PARTS OF THE EAR

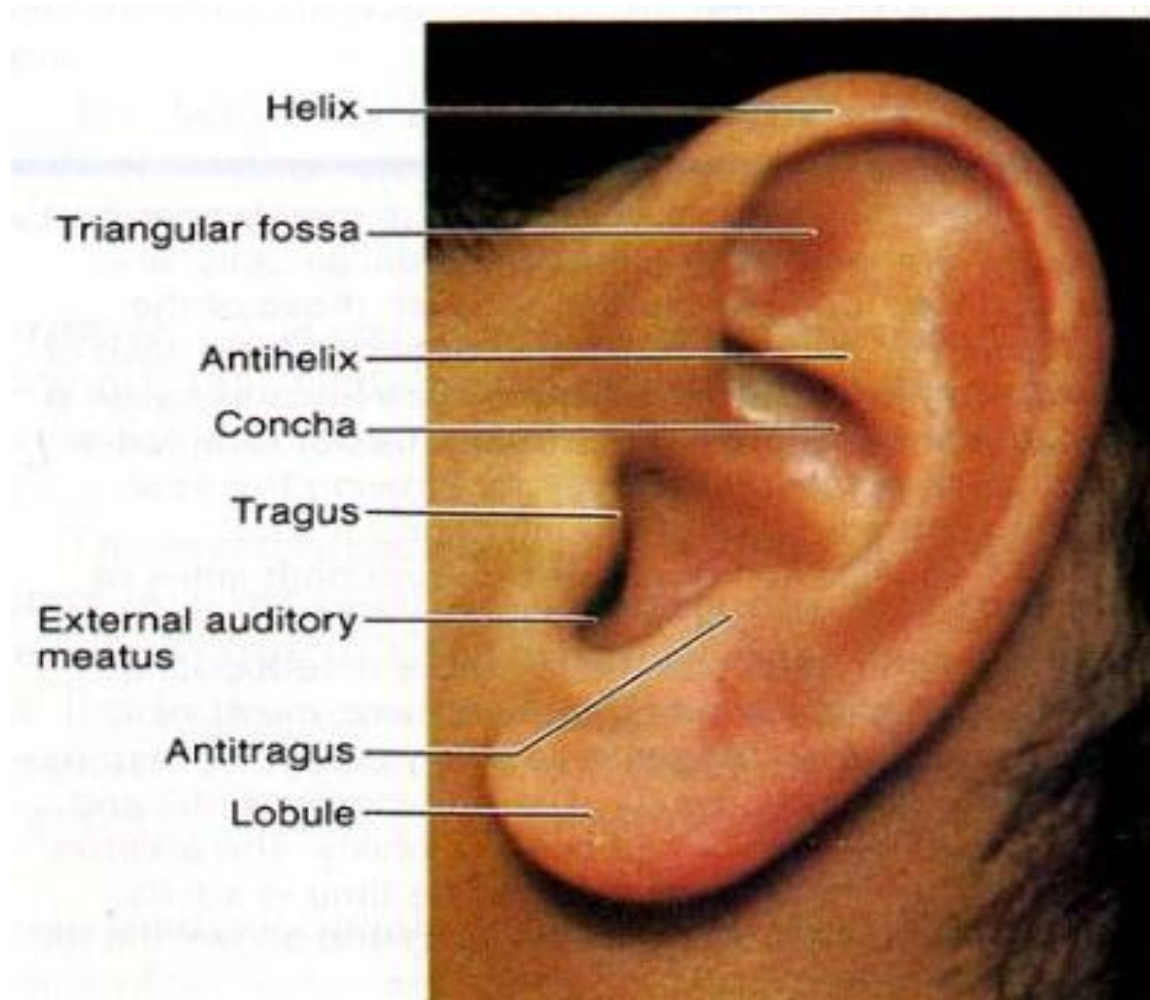


## THE OUTER EAR

**Pinna (auricle)**- receives sound waves that travel through the auditory canal or ear canal.

**Auditory canal (ear canal)**- acts as a funnel with an approximate length of 2.5cm and leads to the ear drum.  
- also protects the eardrum from shock and intrusion by external objects.

# Pinna



# Function of Outer Ear

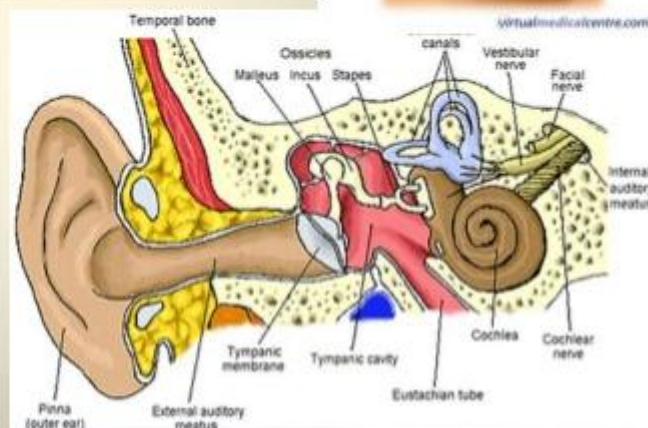
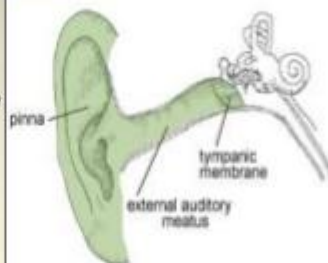
- Collect sound •
- Localization •
- Resonator •
- Protection •
- Sensitive •  
(earlobe)
- Other? •



# The External Ear

- Consists of:
  - **Auricle (pinna)**
    - Made of elastic cartilage
    - Helix (rim)
    - Lobule (ear lobe)
  - **External auditory canal**
    - Lies within temporal bone & connects to ear drum (tympanic memb)
    - Contains ceruminous glands which secrete ear wax
  - **Tympanic membrane**
    - Epithelial & simple cuboidal
    - Changes acoustic energy into mechanical energy
    - Perforated eardrum = tear

Outer Ear





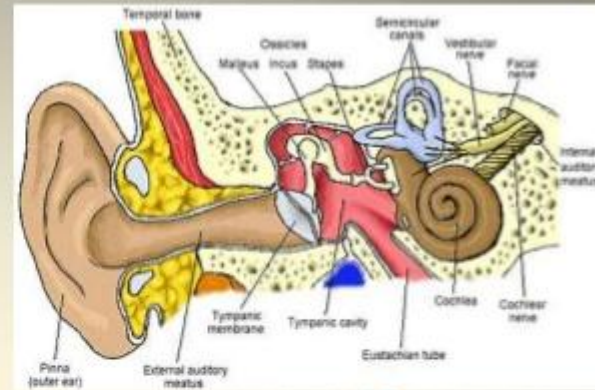
## THE MIDDLE EAR

**Eardrum-** is a cone-shaped piece of skin about 10mm wide.

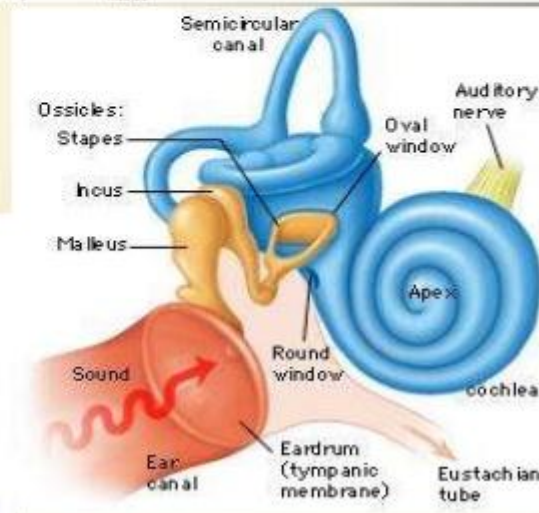
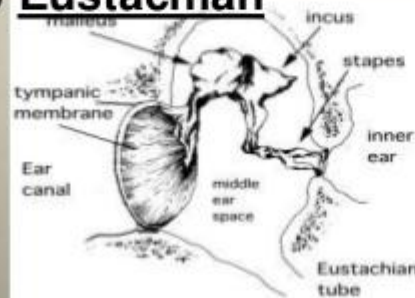
- it is very sensitive
- even the slightest pressure variation will cause it to vibrate.
- separates the outer ear from the middle ear

# The Middle Ear

- **Auditory Ossicles**  
(smallest bones in body)
  - Malleus
    - Attaches to ear drum
    - Articulates with incus
  - Incus
    - Articulates with stapes
  - Stapes (stirrup)
    - Footplate of stapes fits into oval window



- Opening to **Eustachian tube**



## **Ossicles-** smallest bones in the body

- eardrum
  - malleus (hammer)**- long handle attached to the - a tiny bone that passes vibrations from the eardrum to the anvil.
- **incus (anvil)**- a tiny bone that passes vibrations from the hammer to the stirrup.
- **Stapes (stirrups)**- a tiny, U-shaped bone that passes vibrations from the stirrup to the cochlea. -This is the smallest bone in the human body (it is 0.25 to 0.33 cm long).

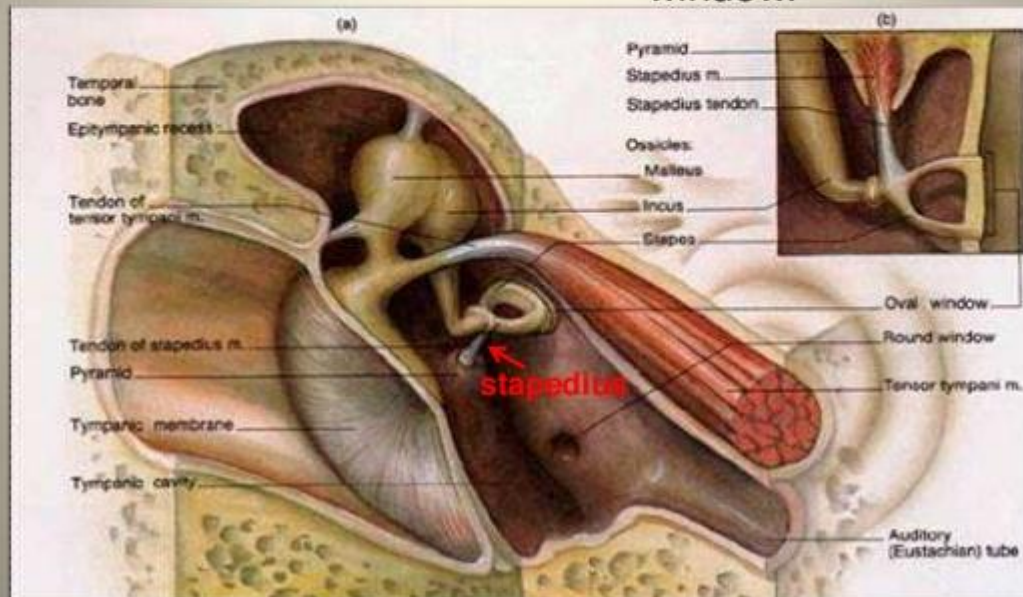
## Protection by Two Tiny Muscles

- Tensor Tympani

- Attaches to Malleus to increase tension on ear drum & prevent damage to inner ear.

- Stapedius

- Smallest skeletal muscle
- Dampens large vibrations of stapes to protect oval window.



- ✦ **Eustachian tube** - a tube that connects the middle ear to the back of the nose; it equalizes the pressure between the middle ear and the air outside.

# Eustachian Tube



The eustachian tube connects the front wall of the middle ear with the nasopharynx •

The eustachian tube also operates like a valve, which opens during swallowing and yawning •

This equalizes the pressure on either side of the eardrum, which is necessary for optimal hearing. —

Without this function, a difference between the static pressure in the middle ear and the outside pressure may develop, causing the eardrum to displace inward or outward —

This reduces the efficiency of the middle ear and less acoustic energy will be transmitted to the inner ear. •

- **Auditory Tube**  
(Eustachian tube)
  - Is a route for pathogens to travel from nose and throat to ear causing **Otitis Media**
  - During swallowing and yawning it opens to equal pressure in middle ear.



# THE INNER EAR

**Cochlea-** This is a spiral tube that is covered in a stiff membrane.

- contains thousands of hair cells attached to the end of the organ of the auditory nerve called **Organ of Corti**.



# Function of Middle Ear

## Conduction •

Conduct sound from the outer ear to the inner ear –

## Protection •

Creates a barrier that protects the middle and inner areas from foreign –  
objects

Middle ear muscles may provide protection from loud sounds –

## Transducer •

Converts acoustic energy to mechanical energy –

Converts mechanical energy to hydraulic energy –

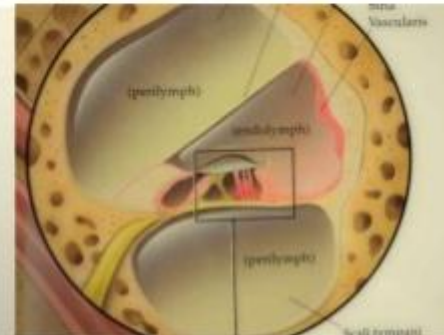
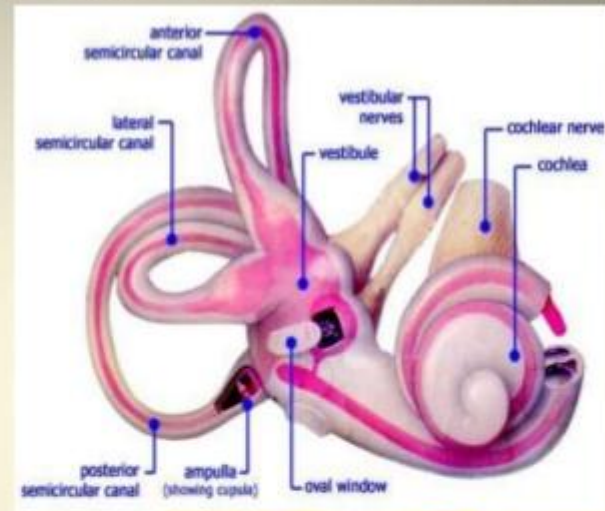
## Amplifier •

Transformer action of the middle ear –

only about 1/1000 of the acoustic energy in air would be transmitted –  
to the inner-ear fluids (about 30 dB hearing loss)

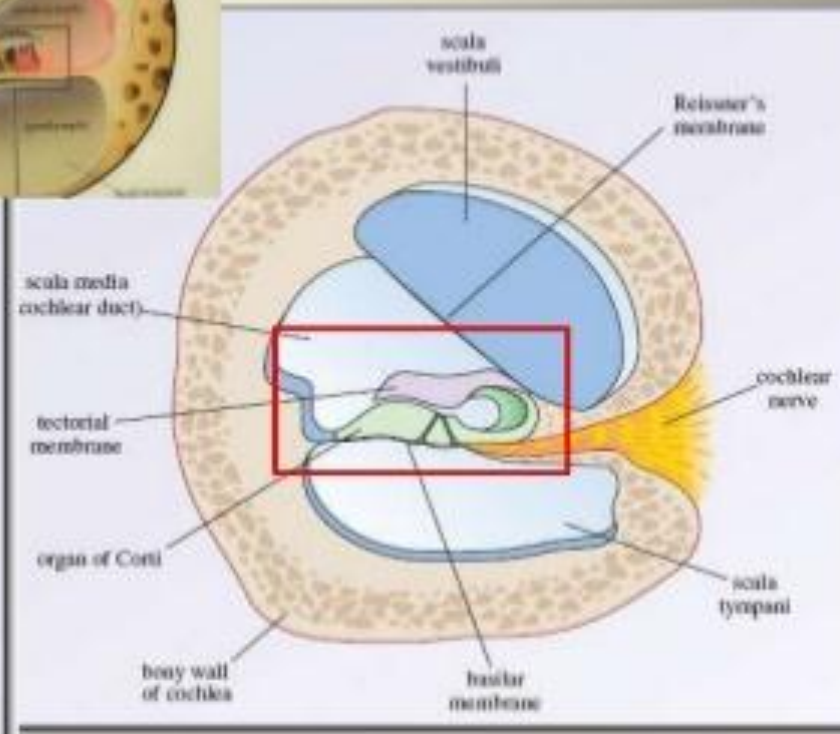
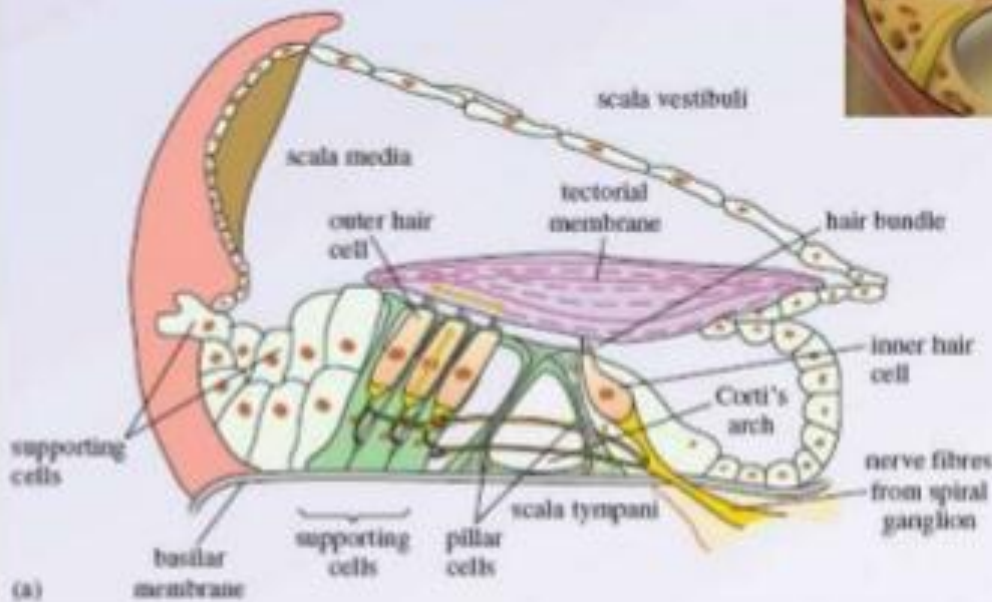
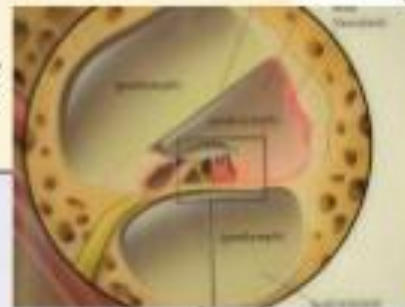
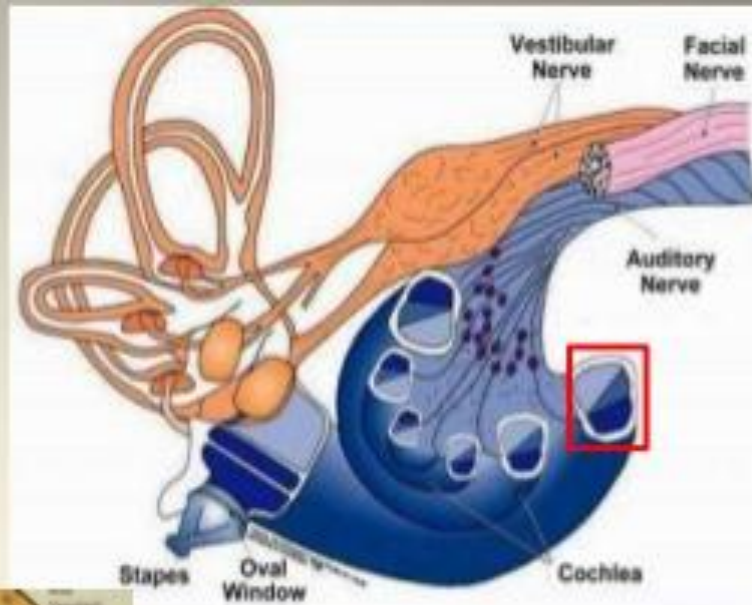
## The Inner Ear (Labyrinth)

- Bony labyrinth
  - Contains perilymph
  - Semicircular canals
    - Anterior, posterior, and lateral
    - Lie right angles to each other
  - Vestibule
    - Oval portion
  - Cochlea
    - Looks like a snail
    - Converts mechanical energy into electrical energy
- Membranous labyrinth
  - Contains endolymph,



# The Cochlea

- Divided into 3 channels
  - Cochlear duct (scala media)
    - Contains the Organ of Corti
  - Scala vestibuli
    - Ends at the oval window
  - Scala tympani



# Cochlea

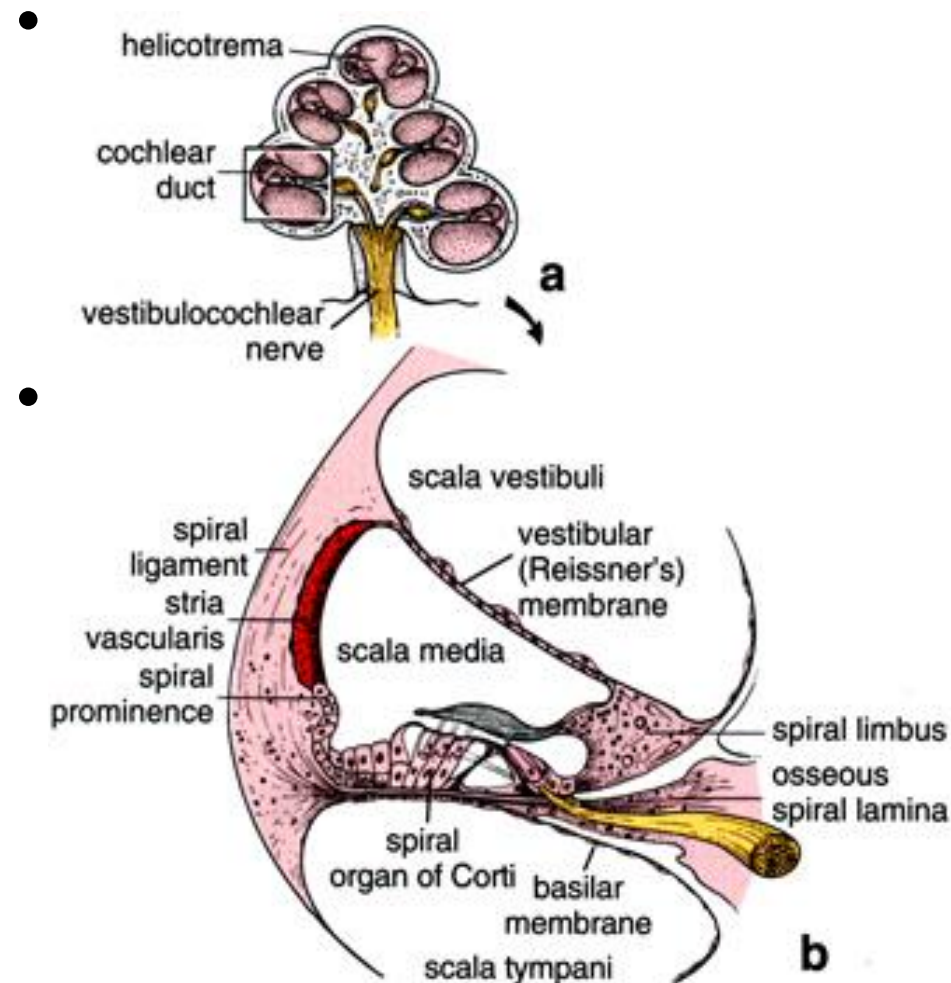
The cochlea resembles a snail shell and spirals for about 2 3/4 turns around a bony column

Within the cochlea are three canals:

Scala Vestibuli –

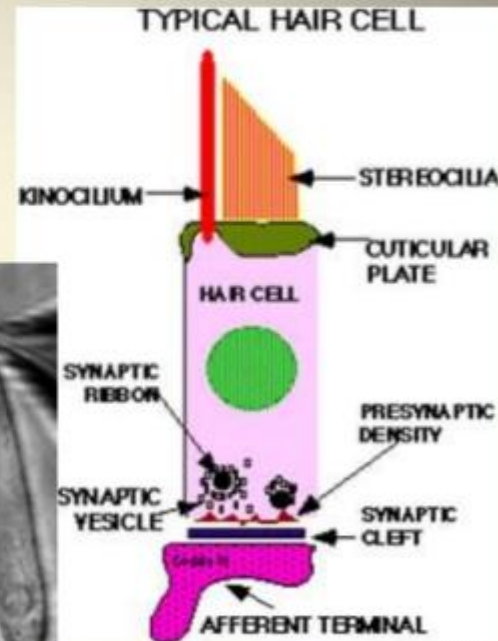
Scala Tympani –

Scala Media –



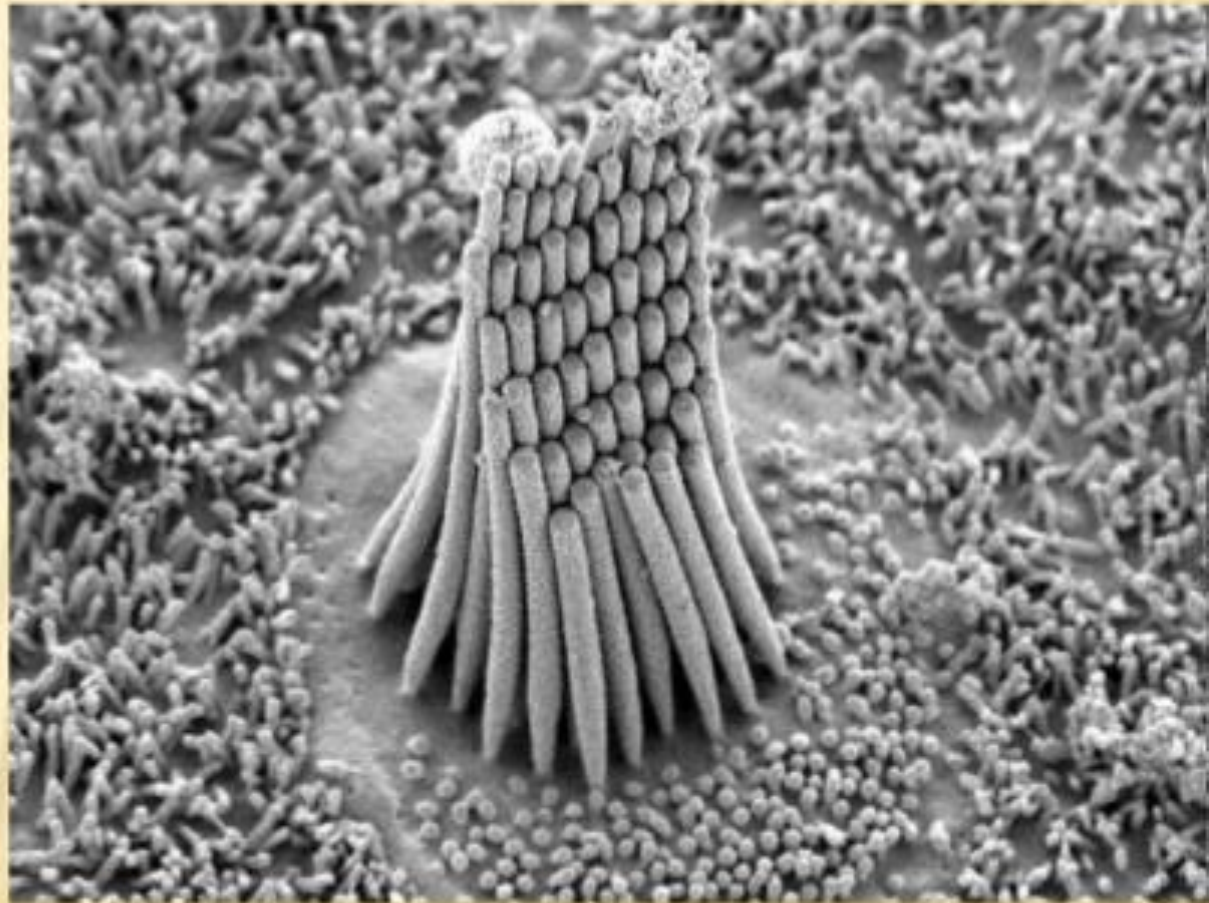
# Organ of Corti

- The end organ of hearing
  - Contains stereocilia & receptor hair cells
  - Tectorial and Basilar Membranes
  - Cochlear fluids
  - Fluid movement causes deflection of nerve endings
  - Nerve impulses (electrical energy) are generated and sent to the brain



# COCHLEAR HAIR CELLS

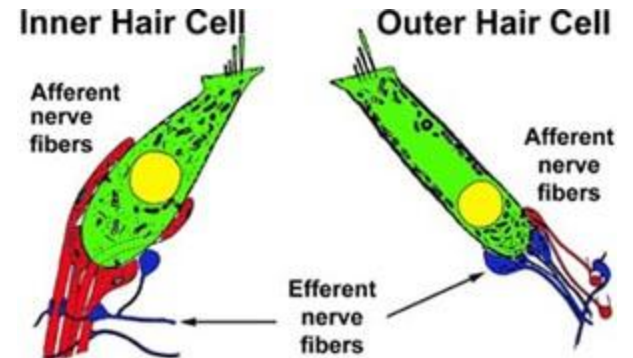
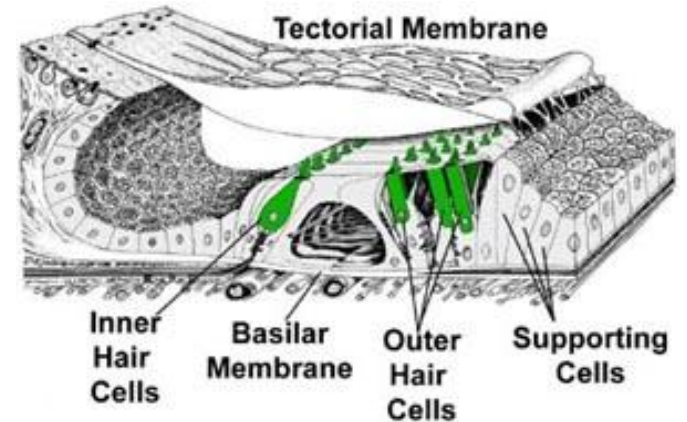
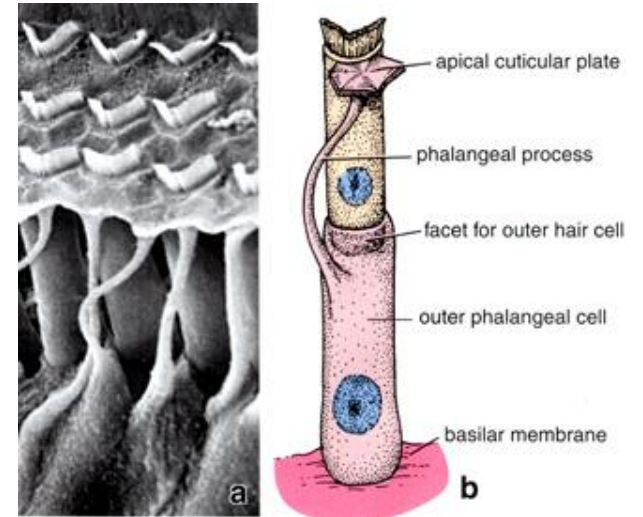
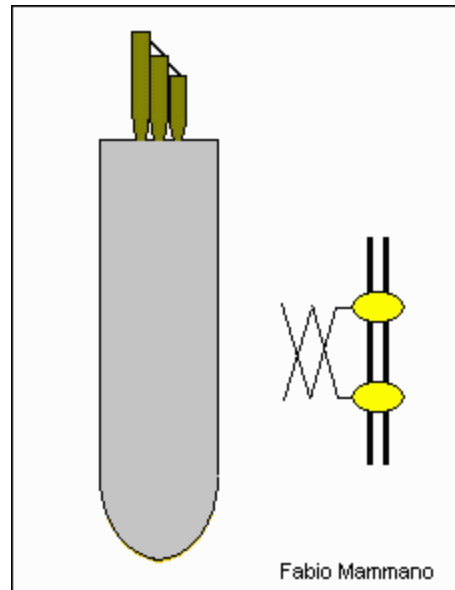
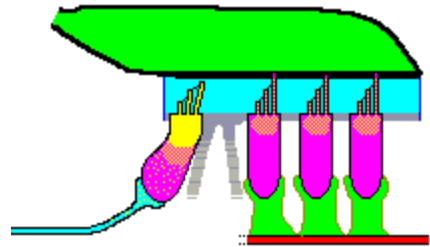
- ✦ These tiny hairs bend because of the vibrations caused by the sound waves.



# Hair Cells

- Outer Hair Cells
- Inner Hair Cells

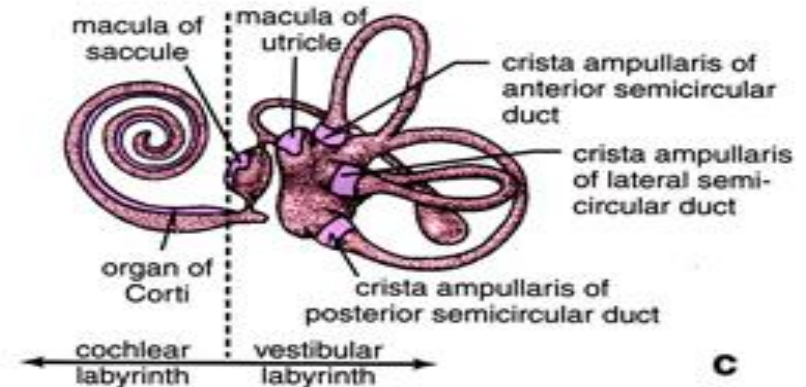
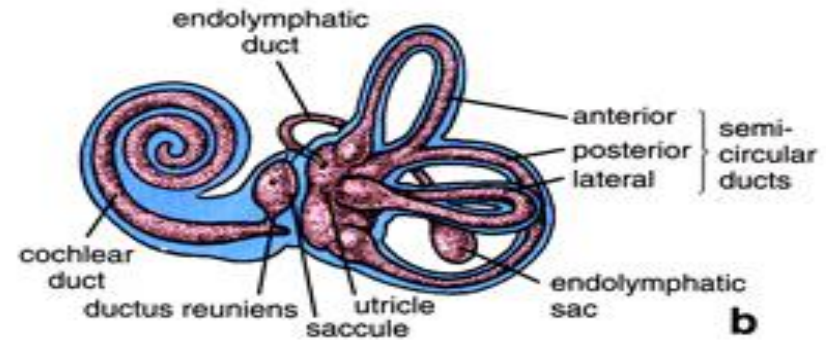
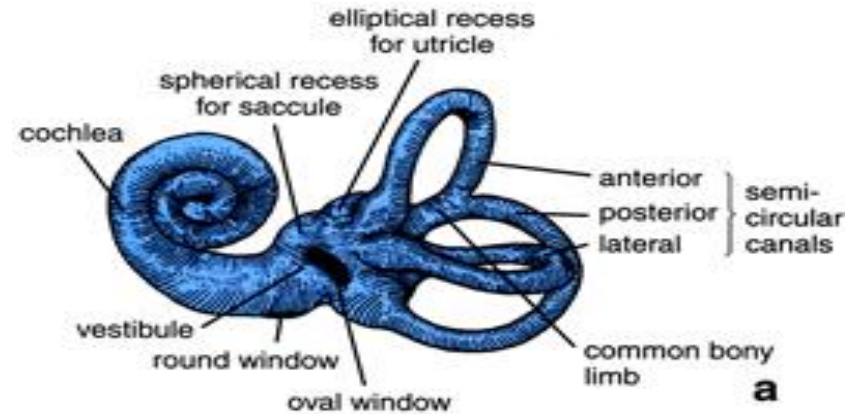
[OHC movie](#) •



# Function of Inner Ear

Convert mechanical sound waves to neural impulses that can be recognized by the brain for:

- Hearing –
- Balance –





**Auditory Nerve-** These nerves receive the electrical impulses generated by the ear and pass this information up to the brain so it can be interpreted.

- ✦ **Semicircular Canals-** three loops of fluid-filled tubes that are attached to the cochlea in the inner ear. They help us maintain our sense of balance.

# Summary of How We Hear

*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** (**cochlear nerve**) to the brain. The brain interprets it as sound!

