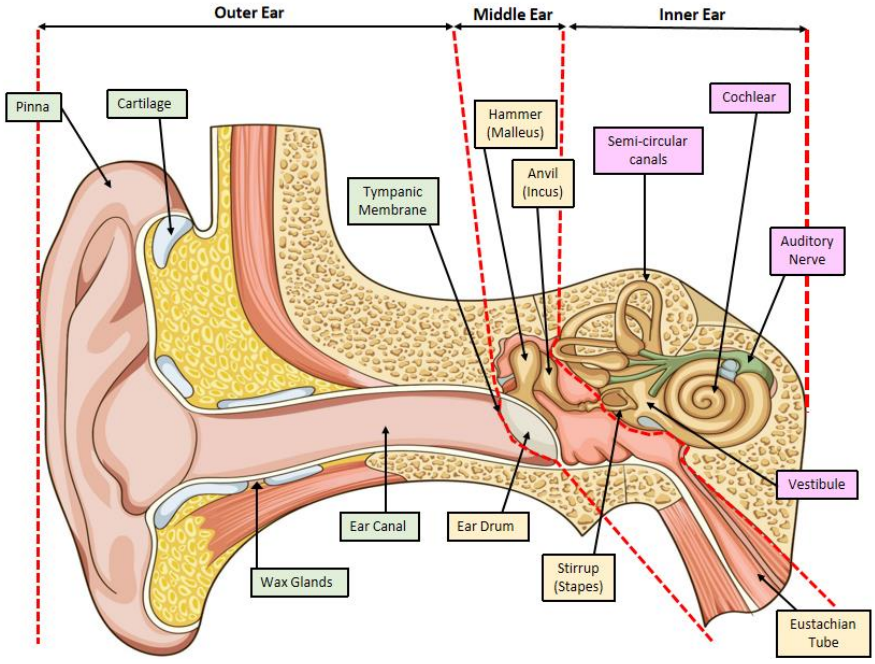
Structure and functions of Internal Ear

The **inner ear** (**internal ear**, **auris interna**) is the innermost part of the vertebrate ear. In vertebrates, the inner ear is mainly responsible for sound detection and balance. In mammals, it consists of the bony labyrinth, a hollow cavity in the temporal bone of the skull with a system of passages comprising two main functional parts:

- The cochlea, dedicated to hearing; converting sound pressure patterns from the outer ear into electrochemical impulses which are passed on to the brain via the auditory nerve.
- The vestibular system, dedicated to balance.

The inner ear is found in all vertebrates, with substantial variations in form and function. The inner ear is innervated by the eighth cranial nerve in all vertebrates.

Structure



The labyrinth can be divided by layer or by region.

Bony and membranous labyrinths

The bony labyrinth, or osseous labyrinth, is the network of passages with bony walls lined with periosteum. The three major parts of the bony labyrinth are the vestibule of the ear, the semicircular canals, and the cochlea. The membranous labyrinth runs inside of the bony labyrinth, and creates three parallel fluid filled spaces. The two outer are filled with perilymph and the inner with endolymph.

Vestibular and cochlear systems

In the middle ear, the energy of pressure waves is translated into mechanical vibrations by the three auditory ossicles. Pressure waves move the tympanic membrane which in turns moves the

malleus, the first bone of the middle ear. The malleus articulates to incus which connects to the stapes. The footplate of the stapes connects to the oval window, the beginning of the inner ear. When the stapes presses on the oval window, it causes the perilymph, the liquid of the inner ear to move. The middle ear thus serves to convert the energy from sound pressure waves to a force upon the perilymph of the inner ear. The oval window has only approximately 1/18 the area of the tympanic membrane and thus produces a higher pressure. The cochlea propagates these mechanical signals as waves in the fluid and membranes and then converts them to nerve impulses which are transmitted to the brain.

The vestibular system is the region of the inner ear where the semicircular canals converge, close to the cochlea. The vestibular system works with the visual system to keep objects in view when the head is moved. Joint and muscle receptors are also important in maintaining balance. The brain receives, interprets, and processes the information from all these systems to create the sensation of balance.

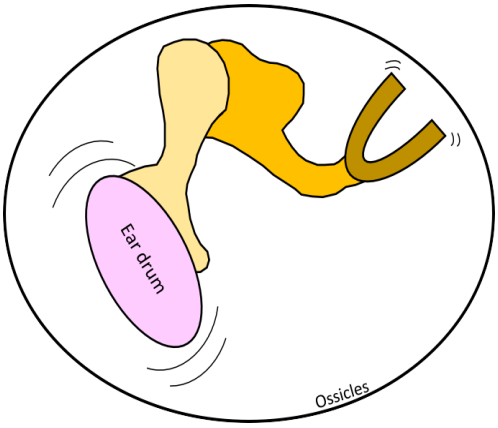
The vestibular system of the inner ear is responsible for the sensations of balance and motion. It uses the same kinds of fluids and detection cells (hair cells) as the cochlea uses, and sends information to the brain about the attitude, rotation, and linear motion of the head. The type of motion or attitude detected by a hair cell depends on its associated mechanical structures, such as the curved tube of a semicircular canal or the calcium carbonate crystals (otolith) of the saccule and utricle.

Outer Ear

- The visible part of the ear is called the Pinna or the Auricle. The pinna is made of cartilage.
- The outer ear is concerned with the transmission of sound.
- The outer ear consists of the Pinna, the ear canal and the outer layer of the eardrum, also called the Tympanic membrane.
- The ear canal is filled with air and is about 2.5cm long.
- The skin surrounding the ear canal contains glands that secrete ear wax.
- Ear wax is part of the ears protection mechanism.

Middle Ear

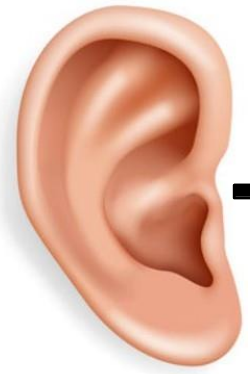
- The middle ear is a small air filled space connecting the outer and inner ear.
- The Primary function of the middle ear is to conduct sound waves through the tympanic
- membrane to the cochlear via the ear bones.
- The 3 smallest bones in the body are in the middle ear, the are called the hammer (malleus), anvil (incus) and stirrup (stapes).
- These bones are collectively known as the ossicles. Sound waves cause them to vibrate.
- The eustachian tube is also inside the middle ear. The eustachian tube controls the pressure within the ear.



Inner Ear

- The Inner Ear has 2 main functions, to convert sound waves into electrical signals for the brain and to maintain balance by detecting position and motion.
- The inner ear has 3 main parts, the cochlear, the semi-circular canals and the vestibule.
- The cochlear is filled with liquid and acts like a microphone, converting sound waves to nerve impulses that travel to your brain via the auditory nerve.
- The vestibule and semi-circular canals both help you to balance.

How Do We Hear?



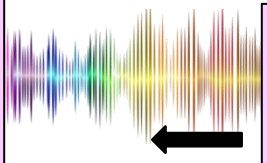
Sound waves are funnelled into our ear canal by the pinna.

The sound waves make our ear drum vibrate.

Vibrations of the ear drum cause the 3 small bones in the ear, collectively called the ossicles, to move.

As the last bone in the chain, the stapes, vibrates this causes wave like movements to be generated in the fluid inside the cochlear.

These waves stimulate microscopic hairs inside the cochlear.



The hairs in the cochlear are tuned to respond to differences in sound frequency and pitch.

When stimulated these hair cells generate nerve impulses that are

The nerve impulses travel along the

Brain

The auditory cortex converts