

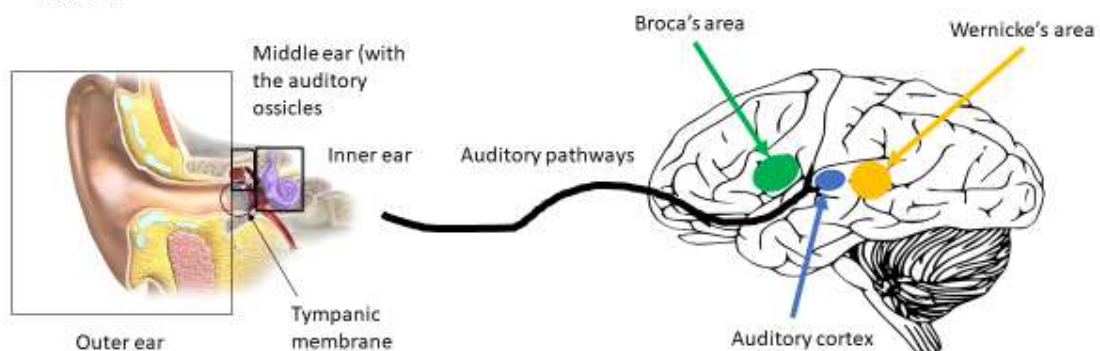
Power point Example

NEUROHEADWAY

Neuroscience Into Education

The parts of the auditory system

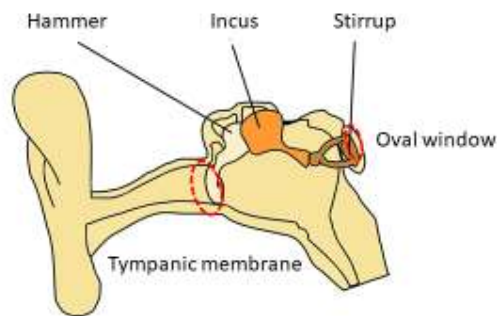
- The auditory system consists in the Ear (outer, middle and inner ear), the auditory pathways (the nerves) and the auditory cortex of the brain.



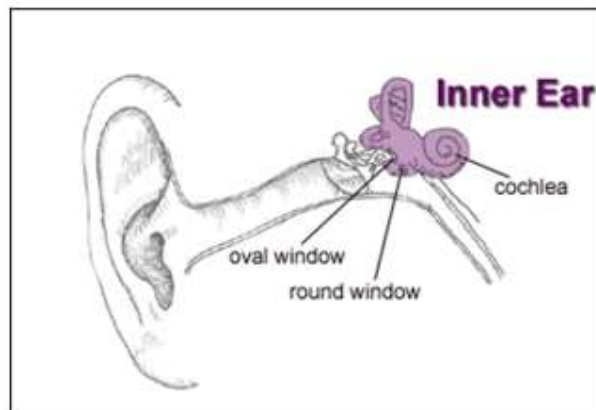
The ear

- The ear is divided in three main areas:
1. The outer ear, or auricle, or pinna. It is the visible part. It is formed by cartilage and due to this is very elastic and flexible (we can deform it very easily, and that is not painful). The main role is gathering the sound waves coming to us and conducting them all to the middle ear. All the folds of the cartilage create a canal that goes directly to the tympanic membrane.

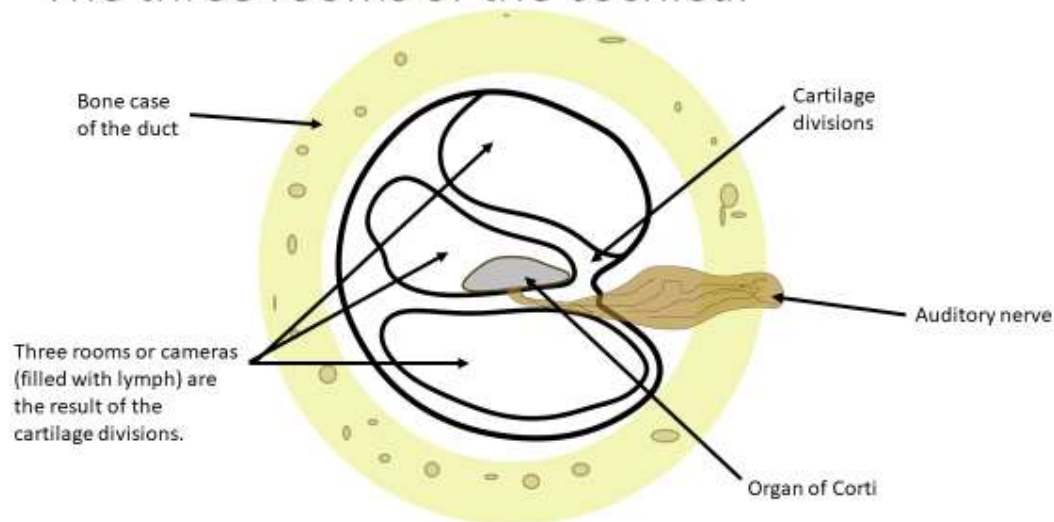
2. The middle ear. The middle ear is a small room located right after the tympanic membrane. Within this room there are three little bones, named ossicles. In contact to the tympanic membrane, there is a bone, a very small bone called the hammer (also known as malleus). Right after the hammer, there are another two bones located in line. First we find the anvil (or incus), in contact with the hammer and the third bone, the stirrup (or stapes). The stirrup is in contact as well with another membrane, much more smaller than the tympanic membrane, called oval window.



3. The inner ear. The inner ear is a very complex and delicate structure. There are many elements. The gross structures are two, the cochlea (or snail) and the labyrinth. Whereas the labyrinth is related with equilibrium and movements, the cochlea is the auditory structure of the inner ear.



The three rooms of the cochlea.



How do we hear?

- First, the sound waves travel through the air surrounding us and are gathered by the pinna. The pinna compacts them into one cartage channel that ends up at the tympanic membrane.
- The tympanic membrane vibrates with the sound waves. This sound waves "hit" the membrane and makes it vibrate.
- In the middle ear, the ossicles detect this vibration (the hammer touches the tympanic membrane) and vibrated at the same time that the tympanic membrane does.
- There is a second membrane after the ossicles, the oval window. The oval window touches the third ossicle, the stirrup. When the stirrup vibrates, the oval window vibrates too.
- This way, the middle ear little bones "pair" the vibration caused by the sound waves on the tympanic membrane with the oval window. We say that these bones transmit the mechanical vibration to the inner ear.

How do we detect the tone? And volume? And location?

- Remember that the cochlea is around 3.5 cm long. All this length is covered with Organs of Corti, but not all of them (so not all of the hair cells) are activated at the same time.
- The area activated (the part of the receptive surface) is different depending on the tone of the sound. That is due to the specific features of sound waves. We won't get into details but two sounds with different tones and pitches won't have the same shape and features (specifically, the frequency and longitude of the wave will be different). Due to this, high pitch sounds will activate different sensory areas (closer to the end of the tube) than lower pitch sounds (closer to the beginning of the tube).
- That in regards of the pitch. What about the volume? The higher the volume, the more potent the activation of the sensory area.
- The auditory cortex (or better said, the auditory system) has a property. The system has a "tonotopic organization". In other words: the nerves gather information from the sensory areas of the cochlea, and then go to the cortex. When they send this info to the cortex, they do it in the same position than the info was perceived. So the organization of the cortex is identical than the organization of the cochlea. And the sensory fields in the cochlea (detecting sound and sending information according to the tone of the wave) send information to one area only of the cortex. Due to this, the brain can understand the tone of the sound. But there are more:

Tonotopic organization.

The area where the nerves are sending/receiving the information from are maintained on the organization of the auditory cortex

