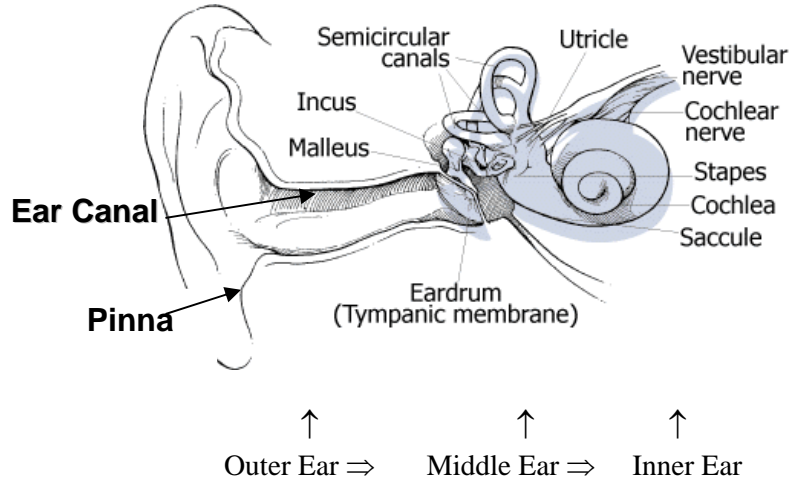


## Anatomy and Physiology of the Ear / How We Hear

Communication is receiving and giving information. We receive information in many ways. One way is hearing. We hear with our ears and we listen with our brains. This handout will explain the parts of the ear and how we hear.

### THE EAR

There are three major parts to the ear. Each part has a different purpose in moving sound to the brain. The three major parts of the ear are the outer ear, the middle ear, and the inner ear.



#### The Outer Ear

The outer ear includes the **pinna** and **ear canal**. The part of the ear you see is called the pinna. The pinna collects sound waves and directs them into the ear canal. The ear canal is a dark, waxy tube. The sound waves can travel easily to the eardrum unless the ear canal has too much wax. The eardrum divides the outer and middle ear.

#### The Middle Ear

The middle ear includes the **eardrum** and **middle ear bones**. The eardrum is very sensitive and vibrates when sound waves hit it. Attached to the eardrum are three middle ear bones. The vibration of the eardrum causes the middle ear bones to move. One of the bones, the stapes, is attached to the inner ear. The movement of the middle ear bones causes the fluid in the inner ear to move. The eardrum and middle ear bones transfer sound to the inner ear.

#### The Inner Ear

The inner ear has two parts, the vestibular part and the cochlear part. The **vestibular** part affects our balance and the **cochlear** part is for hearing, which is the focus of this handout.

##### The Cochlea

The shell-shaped cochlea is an amazing, self-contained, fluid-filled system. Scientists are still learning new things about the cochlea. As the stapes pushes on the inner ear, the fluid moves in a pattern similar to an ocean wave. The movement pattern shapes the different sounds that are heard. It is often useful to think of the

cochlea like a piano keyboard. A variety of tones will be heard depending on where you push the piano keys. The fluid movement pattern causes tiny cells (called hair cells) to be stimulated while others are not. It's just like the different sounds of a piano when some keys are pushed and others are not. So the movement pattern of the fluid stimulates the hair cells causing the auditory nerve to respond and send signals to the brain that are then understood as different sounds.

## THE BRAIN

The **auditory cortex** is the part of the brain that receives the information from the ear. It receives the signals, analyzes them, and converts them into information we understand as language. The brain can only work on the signals it receives. If a part of the ear is damaged, then the brain will receive only part of the information from the original sound.

## HOW IT WORKS

The ear picks up the sound waves in the environment and changes them to nerve pulses, then sends them to the brain. The brain understands these different signals as words.

When the sound wave passes through an ear that is intact, the complete information arrives at the brain. If a part of the ear is damaged, then part of the sound wave gets stopped or changed. For example, when the ear is blocked in the outer or middle ear the information received by the cochlea is softer than the original sound wave. The brain receives this sound as softer than the sound really is. When people say, "sounds just aren't loud enough," the damage is often in the outer or middle ear. The hearing loss is called **conductive**. Some things that can cause injury to the outer and middle ear are, repeated ear infections, genetics, punctured eardrum from foreign objects (Q-tips, bobby pins).

Hair cells and nerve fibers (which are in the cochlea) send information to the brain. If the hair cells or nerve fibers are injured, only part of the original signal is sent to the brain. If the brain only receives part of the sound, words might sound distorted or garbled. When people say, "I can hear but I can not understand the words" the damage is often at the cell level of the cochlea. The hearing loss is called **sensorineural** because the hair cells or nerve fibers are not working correctly. A common cause of hair cell damage for veterans is loud noises, such as guns, heavy equipment, power tools, and acoustic trauma.

A large part of the brain categorizes words that we have learned. When the brain receives only part of the signal, what happens? The brain relies on the memory of words to fill in the missing pieces in the signal. Words that sound alike are difficult to understand, especially when a distorted signal is received from the cochlea, or if words are spoken in a noisy background. The more complete the signal, the easier it is for the brain to accurately interpret the words.

If the ear is not able to process all the information, a hearing aid will often help fill in some of the missing pieces. Getting as much speech information as you can makes communication easier and more enjoyable. Another way to help your hearing is to protect your ears. Prevention is the best medicine. Using earplugs or earmuffs when you are around noises that are as loud as a lawn mower or louder will help prevent damage (or further damage) to your ears.

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