Hearing

Sound

Sound is an invisible vibration that begins from movement. Sound is measured in both intensity (loudness) and frequency (pitch).

Intensity is measured in decibels (dB). Frequency is measured in hertz (Hz). Most sounds are made up of a range of different frequencies.

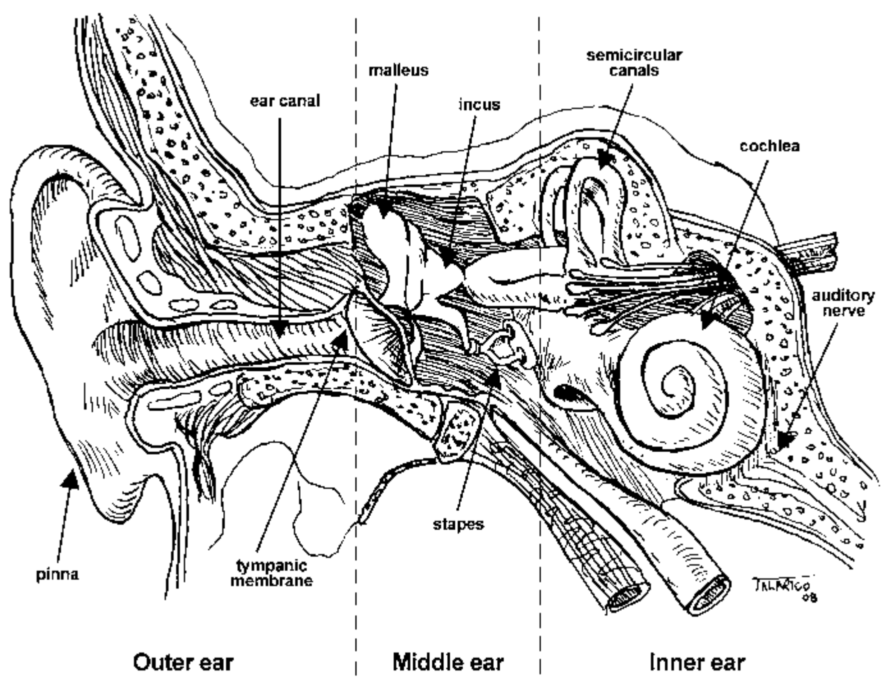
An example of a high frequency, or high-pitched sound, is the noise made by a whistle. An example of a low frequency, or low-pitched sound, is the noise made by a big drum.

Speech is usually a mix of high, middle, and low frequency sounds. Consonant sounds, like /p/, /k/, and /s/, tend to be higher in frequency than some vowel sounds, like /aa/ as in *part*.

The Ear

The ear has two main functions. It receives sound and converts it into signals that the brain can understand. It also helps us to balance. The two functions are closely connected.

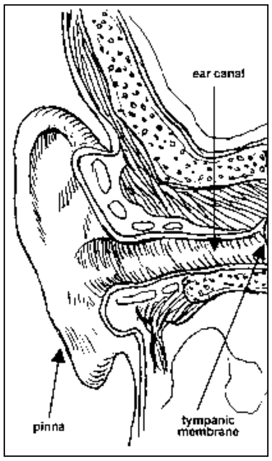
Figure 2 **The Ear**



The ear is divided into three main sections:

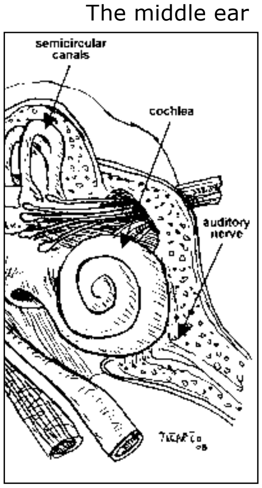
- the outer ear
- the middle ear
- the inner ear

Sound passes through all three sections of the ear before it goes to the brain. The brain interprets the sound and tells us what we are hearing. It tells us if we are hearing music, noise, a voice, a car horn, a dog, or other sounds.



The outer ear

The middle ear



The inner ear

The Outer Ear

Sound goes into the outer ear. The part of the outer ear that we can see is called the pinna.

The outer ear picks up sound waves and directs the sound down the ear canal to the eardrum.

The eardrum (tympanic membrane) is a thin membrane stretched over the end of the ear canal that separates the outer ear and the middle ear. When sound hits the eardrum, it begins to vibrate much like the membrane of a drum when it is struck with a drumstick.

The Middle Ear

The middle ear contains the three smallest bones in the body, each about the size of a grain of rice. Together these bones are called the ossicles. Individually, they are called the malleus (hammer), the incus (anvil), and the stapes (stirrup).

This chain of bones is attached to the eardrum on one end and the inner ear on the other end. The ossicles form a lever mechanism that conducts sounds from the eardrum to the inner ear.

The Inner Ear

The inner ear is housed in the bone of the skull. This part of the ear contains the semicircular canals, the cochlea, and the auditory (hearing) nerve.

The semicircular canals are fluid-filled bony structures that are responsible for balance. When you feel dizzy on a fair ride, this is because the fluid in the semicircular canals has been disturbed.

The cochlea is shaped like a snail and is filled with fluid. It is lined with thousands of tiny nerve endings called hair cells. These hair cells are tuned somewhat like the keys on a piano. Some of the hair cells respond to low-pitched sounds, and some respond to high-pitched sounds.

These hair cells are connected to the auditory nerve that connects the cochlea to the brain.

Hearing tests occur in an ideal, soundproof listening environment. Consult an audiologist to determine what the student can and cannot hear in the real world.

Audiology

Audiology is the medical term for the study and measurement of hearing and hearing loss.

An **audiologist** is a professional who is qualified to assess hearing loss and to recommend and fit amplification systems (e.g., hearing aids, wireless audio systems, cochlear implants).

An annual hearing assessment is recommended for students who are DHH because not all hearing losses are stable.

The Audiogram

The **audiogram** is a graph that represents a person's responses to sound. It is used to document the softest sound a person can detect at a variety of different frequencies (pitches).

Frequency

The frequency or pitch of sound is shown by the numbers across the top of the audiogram. Low pitches are on the left-hand side of the graph and high pitches are on the right, somewhat like the keys of a piano, which range from low pitches on one end of the keyboard to high pitches on the other end. The whistle of a bird usually has a high pitch; the growl of a dog has a low pitch.

The frequencies included on an audiogram are chosen because they are important for understanding speech.

Different speech sounds have different pitches, so it is important to know how well a person hears across the frequency range. A good example of different frequencies is the word *moose*. The /m/ sound is a low-frequency sound, the /oo/ sound is a middle-frequency sound, and the /s/ sound is a high-frequency sound. In order to hear the word completely, a person must have appropriate levels of hearing at low, middle, and high frequencies.

Intensity

The intensity or loudness of sound is shown by the numbers down the side of the audiogram. The small numbers at the top are soft sounds (–10, 0, 10 decibels [dB]), and the large numbers at the bottom are loud sounds (90, 100, 110 dB).

With a complete audiogram, an audiologist can determine the type, degree, and configuration (or shape) of the hearing loss.

Examples of Sounds on the Audiogram

The figure on the next page, "Audiogram," shows the pitch and loudness of several environmental sounds as well as typical speech sounds. Examples of sounds plotted on the audiogram include the following:

- Water dripping is a very low pitch (185 Hz) quiet sound (15 dB).
- Birds chirping is a very high pitch (6000 Hz) quiet sound (5 dB).
- People talking at a conversational level (i.e., all speech sounds) crosses all pitches at low to mid volumes (40 to 60 dB).
- A piano playing is a mid-pitch (1000 Hz) loud (80 dB) sound.
- An airplane is a high pitch (4000 Hz) extremely loud (120 dB) sound.

The shape the speech sounds make on this audiogram is commonly called the *speech banana*. The speech banana represents the area of pitch and loudness in which the majority of speech sounds will occur when a person is talking in a normal conversational voice.

Figure 3 **Audiogram**