Hearing
The structures of the ear relate to their functions.

Like light, sound is a wave.
- A wave is a vibration that transfers energy from place to place.
- Your eyes can detect light waves.
- You cannot see sound waves with your eyes.
- Instead, you “see” them with your ears!

Sound is a wave.
- Sound waves are pressure waves with alternating high and low pressure regions.
- A sound wave is created when something vibrates—like a speaker playing music.
- If you touch the surface of the speaker, you can feel the vibrations that create a sound wave.
- Those vibrations transfer energy to the surrounding air molecules.

How a sound wave is created:
- Air molecules are spread very far apart and are in constant, random motion.
- At the same temperature, higher pressure contains more molecules per unit of volume than lower pressure.

When air molecules are pushed by the vibrations, it creates a layer of higher pressure.
- That layer pushes on the next layer, which pushes on the next layer, and so on.
- The result is a traveling vibration of pressure—a sound wave.

The molecules in a sound wave are compressed in the direction that the wave travels.
- The frequency of a sound wave is the number of vibrations per second.
- Wave frequency is measured in hertz (Hz).
- A wave with a frequency of 1 hertz vibrates at one vibration per second.
Properties of Sound

Pitch
- The pitch of a sound is how we hear and interpret its frequency.
- The range of frequencies humans can hear varies from about 20 hertz to 20,000 hertz.

Loudness
- The loudness of a sound is measured in decibels (dB).
- The decibel is a unit used to express relative differences in the loudness of sounds.

A low-frequency sound has a low pitch, like the rumble of a big truck or a bass guitar.
A high-frequency sound has a high pitch, like the scream of a whistle or siren.

The decibel scale compares the loudness of sounds.
- Most sounds fall between zero and 100 on the decibel scale.

Why is it easy to recognize one person’s voice from another, even when people are saying the same word?
- The reason is that voices have different mixtures of frequencies.
A frequency spectrum is a graph showing the different frequencies present in a sound.

- Loudness is on the vertical axis and frequency is on the horizontal axis.

The human ear can be divided into sections:

1. The external ear,
2. The middle ear, and
3. The inner ear.

The outer ear helps collect sound waves and directs them into the middle ear.

- Some mammals can move their outer ears to detect the direction of sound.
- You must turn your head.
- The outer ear funnels sound waves into the ear or auditory canal which leads to the middle ear.

The middle ear is an air-filled cavity that consists of the eardrum and three tiny, interconnected bones: the maleus, incus, and stapes.

The eardrum is a tightly stretched membrane that vibrates as the sound wave reaches it.

The eardrum vibrates at the same frequency of the sound wave.

- Being connected to the maleus, the movements of the eardrum set the maleus, incus, and stapes into motion at the same frequency of the sound wave.
The inner ear

- The stapes is connected to the cochlea of the inner ear.

The inner ear has two important functions: providing our sense of hearing and our sense of balance.

Fluid moving in each of the three canals tells the brain whether the body is moving left-right, up-down, or forward-backward.

The three semicircular canals near the cochlea are also filled with fluid.

The cochlea is a tiny fluid-filled cavity in the inner ear that contains hair cells that convert sound from vibrational energy into electrical impulses.

- Which hair cells are healthy and which are damaged?

Healthy hair cell of inner ear
The stapes vibrates against the cochlea.

- Fluid in the spiral of the cochlea vibrates and creates waves that travel up the spiral.

Neurons in the cochlea convert the waves into nerve impulses and send them to an area of the brain that interprets sound.

The spiral channel starts out large and gets narrower near the end.

- The nerves near the beginning respond to lower-frequency sound.
- The nerves at the small end of the channel respond to higher frequency sound.