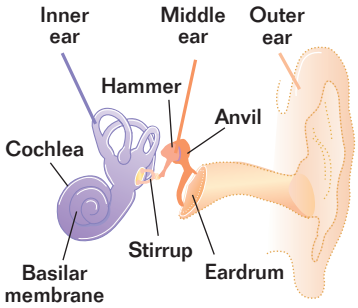

Figure 12
Sound waves travel through the three regions of the ear and are then transmitted to the brain as impulses through nerve endings on the basilar membrane.

The human ear transmits vibrations that cause nerve impulses

The human ear is divided into three sections—outer, middle, and inner—as shown in **Figure 12.** Sound waves travel down the ear canal of the outer ear. The ear canal terminates at a thin, flat piece of tissue called the *eardrum.*

The eardrum vibrates with the sound waves and transfers these vibrations to the three small bones of the middle ear, known as the *hammer,* the *anvil,* and the *stirrup.* These bones in turn transmit the vibrations to the inner ear, which contains a snail-shaped tube about 2 cm long called the *cochlea.*

The *basilar membrane* runs through the coiled cochlea, dividing it roughly in half. The basilar membrane has different natural frequencies at different positions along its length, according to the width and thickness of the membrane at that point. Sound waves of varying frequencies resonate at different spots along the basilar membrane, creating impulses in hair cells—specialized nerve cells—embedded in the membrane. These impulses are then sent to the brain, which interprets them as sounds of varying frequencies.

SECTION REVIEW

1. When the decibel level of traffic in the street goes from 40 to 60 dB, how much greater is the intensity of the noise?
2. If two flutists play their instruments together at the same intensity, is the sound twice as loud as that of either flutist playing alone at that intensity? Why or why not?
3. A tuning fork consists of two metal prongs that vibrate at a single frequency when struck lightly. What will happen if a vibrating tuning fork is placed near another tuning fork of the same frequency? Explain.
4. A certain microphone placed in the ocean is sensitive to sounds emitted by dolphins. To produce a usable signal, sound waves striking the microphone must have a decibel level of 10 dB. If dolphins emit sound waves with a power of 0.050 W, how far can a dolphin be from the microphone and still be heard? (Assume the sound waves propagate spherically, and disregard absorption of the sound waves.)
5. **Critical Thinking** Which of the following factors change when a sound gets louder? Which change when a pitch gets higher?
   - **a.** intensity
   - **b.** speed of the sound waves
   - **c.** frequency
   - **d.** decibel level
   - **e.** wavelength
   - **f.** amplitude