Section 12.3: Review Answers

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1. The middle ear is an air-filled space bordered on one side by the tympanum—a round, elastic structure that vibrates in response to sound waves. When sound waves travel through the auditory canal of the outer ear and push the tympanum, its vibrations are passed on and amplified by the neighbouring ossicles: three tiny, interconnected bones of the middle ear. Each bone vibrates more than the next so that the vibrations are amplified as they pass from the malleus (hammer), to the incus (anvil), and finally to the stapes (stirrup). The stapes concentrates vibrations onto the bony wall of the inner ear, called the oval window. The middle ear can significantly amplify and concentrate vibrations because the tympanum is 15–30 times larger than the oval window.
2. Different areas of the organ of Corti are sensitive to different wave frequencies. High frequencies, such as the shriek of a sea gull, most strongly stimulate the hair cells

closest to the oval window. Low frequencies, however, such as a low sound made by a drum, most strongly stimulate the hair cells farthest from the oval window.

Sensory neurons in the ear send information through the auditory nerve to the brain stem, thalamus, and ultimately the temporal lobes of the cerebrum for processing. Depending on which sensory neurons are stimulated, the brain can distinguish the frequency and amplitude of the sound.

3. Some people may suffer from motion sickness as they ride in an elevator. The balance required while moving the head forward and backward is called gravitational equilibrium. This equilibrium depends on the two structures called the utricle and saccule, which together make up the fluid-filled vestibule of the inner ear. Both structures contain calcium carbonate granules called otoliths. The otoliths lie in a cupula over a layer of hair cells. When the head dips forward or back, gravity pulls on the otoliths. This puts pressure on some of the hair cells, which send a neural impulse to the brain indicating the head's position. In an elevator, the inner ear may detect the motion of the elevator, as though the head is changing orientation, while the eyes do not. Motion sickness occurs when the utricle and saccule send information to the brain that conflicts with signals that the eyes send to the brain.

4. The tympanum (eardrum) separates the auditory canal from the middle ear. If air pressure in the auditory canal from outside air and air pressure in the middle ear are unequal, a feeling of pressure, pain, and even eardrum damage can result. Normally the Eustachian tube, which connects the middle ear and the throat, helps maintain equal pressure on both sides of the tympanum by allowing outside air (through the mouth) to enter the middle ear. If a person is swimming or diving, the pressure in the middle ear may become lower than the water pressure outside of the ear. The resulting stress causes a painful inward bulge of the eardrum. Plugging the nose and exhaling gently allows air to move through the Eustachian tube to equalize the pressure in the middle ear.

5. Noise is measured in decibels, and any noise over 80 decibels can damage hearing. The aunt should be wearing ear plugs or other technologies or she will likely suffer from permanent hearing loss. The amplitude of a sound wave is experienced as the intensity or volume of a sound. The louder the noise, the more the fluid within the cochlea puts pressure on the hair cells of the basilar membrane. The stereocilia of the hair cells are very delicate. Repeated or sustained exposure to loud noise destroys the stereocilia, and the resulting damage is permanent.