Answers to Questions for Comprehension

Student Textbook page 406

Q1. Sensory reception refers to the detection of sensory information by the receptors, which are the nerve endings. These sensory receptors initiate neural impulses.

Sensation occurs when the neural impulses arrive at the cerebral cortex. The resulting sensation depends on the area of the brain that has interpreted this information.

Q2. Each type of sensory receptor initiates nerve impulses that travel through the spinal cord to a certain part of the brain; the sensation that results depends on which part of the brain receives the nerve impulses. Perception, which also occurs in the cerebral cortex, occurs when the brain processes the sensations and interprets their meaning.

Student Textbook page 407

Q3. Sensory adaptation occurs when you no longer notice the ticking of a clock, feel the clothes on your skin, or notice an odour in the room. The brain filters out redundant and insignificant information. Students may recognize that constantly hearing and feeling every stimulus would be too much information for the brain to process.

Q4. To quickly process information from significant stimuli, the brain *parallels* or splits up this input to various areas of the brain—a form of neural multi-tasking. Sometimes the input information does not get reintegrated precisely, and what we sense is not necessarily what we perceive.

- proprioceptors in the muscles and tendons and at the joints—regulate body position
- hair cells in the inner ear—control balance

Answers to Questions for Comprehension

Student Textbook page 409

Q5. Students may answer with any five of the following external senses and their corresponding sensory receptors (also see Table 12.1 on page 405 of the student textbook):

- vision—rods and cones in the eyes
- taste—taste buds on the tongue
- hearing—hair cells in the inner ear
- touch/pressure/pain—receptors in the skin
- smell—olfactory receptors in the nose
- temperature—heat and cold receptors in the skin

Q6. Students may answer with any three of the following internal sensory receptors and their functions:

- osmoreceptors—regulate volume of blood
- pH receptors—regulate pH levels in the blood

Answers to Questions for Comprehension

Student Textbook page 412

Q7. Student drawings should be similar to Figure 12.7 and Table 12.2 on page 411. Consider using BLM 12.2.1: The Human Eye as an alternative way to address this question.

Q8. The process that allows the eye to adjust to various intensities of light is called light adaptation. In bright light, the iris constricts, which shrinks the pupil to let in less light. In dim light, the iris dilates, which widens the pupil and lets in more light.

Q9. Clear liquid called aqueous humour circulates inside the front portion of the eye. To maintain a healthy level of pressure within the eye, a small amount of this fluid is produced constantly while an equal amount flows out of the eye through a microscopic drainage system. (Note: This liquid is not part of the tears on the outer surface of the eye.) Because the eye is a closed structure, if the drainage area for the aqueous humour—called the drainage angle—is blocked, the excess fluid cannot flow out of the eye. Fluid pressure within the eye increases, causing damage to the blood vessels. Without proper blood circulation, the oxygen and nutrients available to the cells in the eye are limited, and the cells deteriorate.

Answers to Questions for Comprehension

Student Textbook page 414

Q10. The cornea bends light rays. The lens bends light rays and focusses them on the retina.

Q11. Astigmatism is caused when the cornea is uneven so light rays cannot be evenly focussed on the retina. The result is a fuzzy image. In people with myopia, the eyeball is elongated and the focussed light falls *in front* of the retina instead of on the photoreceptors.

In people with hyperopia, the eyeball is too short. The light rays do not meet before they reach the retina, and so the image is focussed *behind* the retina.

Q12. The ability of the lens to change shape to focus images clearly on the retina is called accommodation. If an object is near, the ciliary muscles contract and the suspensory ligaments relax, causing the lens to become more rounded. If an object is far away, the ciliary muscles relax and the suspensory ligaments become taut, causing the lens to flatten.

The iris allows light to enter the inner eye through the pupil. The iris can adjust the size of the pupil depending on the light conditions, a process called adaptation. In bright light the iris constricts, which shrinks the pupil to let in less light. In dim light, the iris dilates, which widens the pupil and lets in more light.

Answers to Questions for Comprehension

Student Textbook page 416

Q13. The two photoreceptors, rod cells and cone cells, are located at the back of the eye, within the retinal layer nearest the choroid. The rods permit vision in dim light and at night, and the cones permit vision in the bright light needed for colour vision.

Q14. Colour blindness is an inherited condition that occurs more frequently in males than in females. There are three types of cones, each of which absorbs a different wavelength of light. The combination of cones that can detect red, blue, or green wavelengths of light allows us to see a range of colours. Colour-blind individuals are actually colour *deficient*, as they lack or are deficient in particular cones, typically red or green. Thus a red-green colour-blind person may find it difficult or impossible to distinguish between these colours.

Q15. Light rays must pass through several layers of cells before reaching the photoreceptors (rods and cones). When not activated, the photoreceptors release an inhibitory neurotransmitter that inhibits nearby nerve cells. When they absorb light, however, the rhodopsin in the cells splits into retinal and opsin. This triggers a chain reaction that *stops* the release of the inhibitory neurotransmitter, thus *allowing* transmission of a neural impulse. This impulse passes through the bipolar cells to the ganglion cells, which form the optic nerve. Optic nerve fibres that emerge from the back of the eye transmit visual images through the thalamus to the cerebral cortex of the brain (specifically, the occipital lobe) for interpretation.

Q16. The blind spot is the area of the retina that does not have any rods or cones. This is the area where the optic nerve exits the eye. Without photoreceptors (rods or cones), no vision is possible.

Q17. The various aspects of an object, such as movement, colour, depth, and shape, appear to be integrated in the occipital lobe so that we can "see" it.

Answers to Questions for Comprehension

Student Textbook page 421

Q18. Sound waves encounter the following structures:

pinna → auditory canal → tympanum → ossicles (malleus, incus, stapes) → oval window → cochlea → organ of Corti

Q19. When sound waves push the tympanum, its vibrations are passed on and amplified by the neighbouring ossicles: three tiny, interconnected bones of the middle ear. The ossicles are the smallest three bones in the body. 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. Because the inner ear is fluid-filled, vibrations in the oval window are converted to pressure waves in the fluid of the inner ear.

Q20. The middle ear is connected to the throat by the thin Eustachian tube. This tube allows air pressure to equalize when there is a difference in air pressure within and without the otherwise-contained middle ear.

Answers to Questions for Comprehension

Student Textbook page 424

Q21. (a) In someone with nerve deafness, hair cells (and therefore their connections to the nerves) have been damaged.

(b) In someone with conduction deafness, damage has occurred to the sound-conduction system of the outer or middle ear.

Q22. 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. Recent research also suggests that the specific neurons stimulated in the temporal lobe depend on the sound's original source in the environment. Therefore the brain can also perceive the direction and location of the sound.

Answers to Questions for Comprehension

Student Textbook page 425

Q23. The semicircular canals contain mechanoreceptors that detect head and body rotation (rotational equilibrium). The semicircular canals are three fluid-filled loops arranged in three different planes—one for each dimension of space. The base of each canal has a jelly-like covering called a cupula. The stereocilia of hair cells in the canals stick into the cupula. When the body rotates, the fluid inside the semicircular canals moves and bends the stereocilia. Hair cells receive that rotational information and send it to the brain.

Q24. 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 communicating the head's position.

Q25. A person who is lying down is in a static position. The movement or lack of movement of fluid in the inner ear tells the brain whether a person is standing, lying down, hanging upside-down, etc. When an individual is moving around, calcium carbonate crystals in the vestibule shift position. This movement results in nerve impulses being transmitted to the brain, indicating that the individual is changing positions. When the person is in an established position, the crystals stop rolling around. The vestibule doesn't send any impulses to the brain, thereby indicating that the individual is still holding that static position. Proprioceptors are another type of mechanoreceptor involved in coordination. These receptors are in muscles, tendons, and joints throughout the body and send information about body position to the brain.

Student Textbook page 426

Q26. When we eat, saliva dissolves some of our food. Specific molecules dissolved in the saliva are detected by the taste buds, the sensory receptors in the bumps (papillae) on the tongue. The taste buds depolarize in response to particular tastes, and generate an action potential that sends a neural impulse to the brain.

Student Textbook page 427

Q27. Odours are produced from particles that fit much like a lock and key into specific chemoreceptors called olfactory cells that line the upper nasal cavity. When the particles bind to the olfactory cilia of the olfactory cells, ion channels in the cell membrane open. This generates an action potential in the olfactory cells, which travels down the nerve fibres directly linked to the olfactory bulb of the brain.

Q28. The olfactory impulses are sent from the olfactory bulb of the brain to the emotional centres of the brain and the frontal lobe where the perception of odour occurs. This is why particular odours can instantly conjure up scenes and emotions from the past.

Q29. The types of touch detected by sensory receptors in the skin include light touch, pressure, and pain.

Q30. The mechanoreceptors associated with the sense of touch occur all over the body. The skin contains more than four million sensory receptors, but they are not evenly distributed. Many of the touch receptors are concentrated in the genitals, fingers, tongue, and lips.