CHAPTER 10 READING QUESTIONS

These reading questions are designed to help you focus your reading on the most important points in the chapter. They are arranged using chapter section headers so that the file can be easily edited to reflect the material covered in class.

10.1 General Properties of Sensory Systems

1. List the special senses and the somatic senses.

2. Identify the components common to all sensory systems.

Receptors Are Sensitive to Particular Forms of Energy

3. In basic terms, describe the range of complexity seen in sensory receptors in the human body. (Fig. 10.1)

4. Name the four major groups of receptors and describe the stimuli that activate each receptor type. (Tbl. 10.2)

Sensory Transduction Converts Stimuli into Graded Potentials

5. In general terms, describe sensory transduction.

6. Identify the adequate stimulus for each of the four major sensory receptor types. (Tbl. 10.2)

7. Define threshold. What happens in a sensory neuron if a stimulus is above threshold?

8. How do stimuli create electrical signals in sensory receptors? What are receptor potentials?

A Sensory Neuron Has a Receptive Field

9. What is a receptive field? (Fig. 10.2)

10. Distinguish between primary and secondary sensory neurons.

The CNS Integrates Sensory Information

11. Name the parts of the brain that process the following types of sensory information. (Fig. 10.3)

    visual information = _____

    sound = _____

    somatic senses = _____

    smell = _____

    equilibrium = _____

    taste = _____

12. Which part of the brain is involved in the routing of all sensory information except that of smell?

13. What happens to the perceptual threshold for a stimulus when we "tune it out"? Explain the mechanism that allows us to do this.

Coding and Processing Distinguish Stimulus Properties

14. Name four attributes of stimuli that must be preserved during nervous system processing.

Sensory Modality

15. What indicates the modality of a signal?

16. Explain labeled line coding.

Location of the Stimulus

17. How does the brain determine which part of the body is sending sensory information? How can this be confirmed experimentally?

18. In contrast to other sensory information, how does the brain determine where sound stimuli originate? (Fig. 10.4)

19. Explain how lateral inhibition enhances contrast, allowing better localization of stimuli. (Fig. 10.5)

Intensity and Duration of the Stimulus

20. Name two ways stimulus intensity is coded. (Fig. 10.6)
21. Describe how population coding allows for transmission of stimulus intensity.
22. How does frequency of action potentials in the primary sensory neuron code for stimulus intensity? How is duration of the stimulus coded?
23. Compare the response of tonic receptors and phasic receptors to a constant stimulus. (Fig. 10.7)
24. Describe adaptation in phasic receptors. How is it accomplished? What are the benefits of sensory adaptation?

10.2 Somatic Senses

25. Name the four somatosensory modalities.

Pathways for Somatic Perception Project to the Cortex and Cerebellum

26. Where do primary sensory neurons synapse with secondary sensory neurons? Where do secondary sensory neurons cross the midline? Answers to these questions will vary for receptor type. (Fig. 10.8)
27. Where do secondary sensory neurons synapse with tertiary sensory neurons? Where do tertiary sensory neurons terminate?
28. How does the somatosensory cortex recognize where ascending sensory tracts originate? (Fig. 10.9)

Touch Receptors Respond to Many Different Stimuli

29. Where are touch receptors found?
30. Describe the structure and functionality of a Pacinian corpuscle. Are these receptors tonic or phasic? (Figs. 10.10, 10.1b)

Temperature Receptors Are Free Nerve Endings

31. Describe the anatomy of temperature receptors. Compare cold receptors and warm receptors.
32. Do temperature receptors adapt? Explain.

Nociceptors Initiate Protective Responses

33. What are nociceptors? How is nociceptive pain mediated? What are some of the substances that modulate nociceptor activity?
34. Why is it inaccurate to call nociceptors "pain receptors"?
35. What are the two pathways that nociceptors might activate?

Pain Modulation

36. What are the types of primary sensory fibers involved with nociception? (Tbl. 10.3)
37. Distinguish between fast pain, slow pain, and itch.
38. Where do ascending nociception pathways cross the midline? Where do they terminate in the brain? (Fig. 10.8)
39. Describe (or diagram) the ways pain perception can be modulated by the CNS. (Fig. 10.12)
40. What is referred pain and why does it occur? (Fig. 10.11)
41. What is pathological (neuropathic) pain?

10.3 Chemoreception: Smell and Taste

Olfaction Is One of the Oldest Senses

42. Sketch the olfactory system and identify these key elements: olfactory epithelium, odorant receptor, olfactory sensory neurons, secondary and higher-order sensory neurons, olfactory bulb, olfactory nerve, and olfactory cortex.
43. Diagram the mechanism for odorant receptor signal transduction.
44. Why is there such a strong link between smells and emotions?
45. What is the VNO, and what is its function? Do humans have a VNO?

Taste Is a Combination of Five Basic Sensations

46. List the five taste sensations and briefly describe the stimuli that trigger them.
47. Where are taste cells located? Diagram and describe taste buds, taste cells, and taste pores. (Fig. 10.14)
48. Distinguish between type I (support) cells, type II (receptor) cells, and type III (presynaptic) cells. Is there communication between the different cell types?

Taste Transduction Uses Receptors and Channels

49. Diagram the currently accepted mechanisms of taste transduction for the different taste sensations. Be sure to include ligands, receptors, and second messenger systems wherever appropriate. Use a question mark to identify those mechanisms where the research is still unsettled.
50. Sketch the afferent sensory pathway(s) for taste. Include specific nerves, locations of synapses with higher-order neurons, and CNS destinations.
51. What is specific hunger? Give an example.

10.4 The Ear: Hearing

52. What are the two distinct functions the ear is specialized to sense?

Hearing Is Our Perception of Sound

53. Define hearing.
54. What is sound? What three attributes of sound waves are being sensed?
55. What is pitch, and how is it measured? What is loudness, and how is it measured? (Fig. 10.16)

Sound Transduction Is a Multistep Process

56. List the transductions required for hearing sounds.
57. Trace the anatomical path followed by sound wave energy as it moves from air through the inner ear. (Fig. 10.15)
58. Diagram the steps by which the energy of sound waves in air is converted into action potentials in the sensory neuron. (Fig. 10.17)

The Cochlea Is Filled with Fluid

59. Diagram the structure of the cochlea, naming all fluids, windows, and ducts. (Fig. 10.18)
60. Compare the composition of perilymph and endolymph.
61. Describe the location and structure of the organ of Corti. (Fig. 10.18)
62. Diagram the mechanism in hair cells that converts fluid waves into action potentials. Include stereocilia, ion channels, tip links, and neurotransmitter. (Fig. 10.19)

Sounds Are Processed First in the Cochlea

63. List the three properties of sound waves used for sound discrimination. Where is each property processed?
64. Explain how the basilar membrane creates a coding system for processing pitch. (Fig. 10.20)

65. How is loudness coded by the auditory system?

Auditory Pathways Project to the Auditory Cortex

66. Trace the anatomical pathways action potentials follow from the auditory sensory neurons to their final destination(s) in the brain. Identify specific neurons, synapse locations, nerves, and CNS structures. (Fig. 10.21)
67. How does the brain localize sound? (Fig. 10.4)

Hearing Loss May Result from Mechanical or Neural Damage

68. List and briefly explain the three different forms of hearing loss.

10.5 The Ear: Equilibrium

69. Define equilibrium. What are the two components of this special sense?
70. What are the sources of sensory information that contribute to our sense of equilibrium?
71. Compare hair cells of the vestibular apparatus to hair cells of the cochlea.

The Vestibular Apparatus Provides Information about Movement and Position

72. Diagram the anatomy of the vestibular apparatus. (Fig. 10.22a)
73. Summarize the sensory functions of the semicircular canals and otolith organs.
74. Describe secretion and composition of endolymph in the vestibular apparatus.

The Semicircular Canals Sense Rotational Acceleration

75. On your diagram of the vestibular apparatus in question 72, identify which aspect of rotational acceleration is sensed by each of the semicircular canals. (Fig. 10.22a, b)

76. Diagram the structures and mechanisms that allow the semicircular canals to sense rotational acceleration. What role does endolymph play in this process? (Fig. 10.22)

The Otolith Organs Sense Linear Acceleration and Head Position

77. Diagram the structures and mechanisms that allow the otolith organs to sense linear forces and head position. (Fig. 10.22)

Equilibrium Pathways Project Primarily to the Cerebellum

78. Trace the anatomical pathways action potentials follow from the vestibular hair cells to their final destination(s) in the brain. Include specific neurons, nerves, location of synapses, and CNS structures. (Fig. 10.23)

10.6 The Eye and Vision

79. Define vision. List the three steps.

The Skull Protects the Eye

80. Trace the generalized neural pathways from the eyes to the brain. Include crossover events and CNS structures. (Fig. 10.26)

Light Enters the Eye through the Pupil

81. In what ways does the eye control the amount of light hitting the retina?
82. Describe the pupillary reflex and the associated consensual reflex. (Fig. 10.26c)
83. Explain how the eye creates depth of field.

The Lens Focuses Light on the Retina

84. What is refraction? When/where does it occur in the eye?

85. What two factors influence the angle of refraction?
86. Compare concave and convex lenses. (Fig. 10.27a)
87. Compare the focal point and the focal length (distance). (Fig. 10.27b)
88. How do you change the focal length for a lens? (Fig. 10.27c–e)
89. Define accommodation. How is accommodation achieved in the human eye? What structures and mechanisms are involved? (Fig. 10.27f–h)
90. Explain the following vision problems and tell what shape lens would correct for each. (Fig. 10.27i, j)

    presbyopia

    myopia

    hyperopia

    astigmatism

Phototransduction Occurs at the Retina

91. What is the frequency range of the EM spectrum that contains visible light? What is the wavelength range? (Fig. 10.28)
92. What is phototransduction?
93. Diagram the layers of the retinal neurons. Use arrows to show the direction of information flow in the retinal neurons. What embryonic tissue relationship explains the layered organization of the retina? (Fig. 10.29)
94. What is the function of melanin in the pigment epithelium?
95. What are photoreceptors? Compare the organization of photoreceptors in most of the retina with the organization of photoreceptors in the fovea. Why is there a difference? (Fig. 10.29d, f)

96. The image projected onto the retina is upside down. Why then do we perceive images as "right side up"? (Fig. 10.29b)
97. What is the optic disk and why is it also called the blind spot?

Photoreceptors Transduce Light into Electrical Signals

98. Distinguish between rods and cones. Describe their sensitivities.
99. Diagram the three-segment structure of rods and cones, and identify what processes occur in each segment. (Fig. 10.30)
100. What is the role of the visual pigments? Where are they located? Are visual pigments equally sensitive to all wavelengths of light, or is each type of pigment more sensitive to some wavelengths than others? (Figs. 10.30, 10.31)
101. The perceived color of an object depends on the color(s) of light that the object _____ (reflects or absorbs?).
102. What is color-blindness?

Phototransduction

103. Diagram the mechanism of phototransduction in rods. Begin with darkness, show the changes that occur upon exposure to light, and then show what happens during the recovery phase. Include in your diagram: transducin, rhodopsin, retinal, opsin, CNG channels, K^+ channels, voltage-gated Ca^{2+} channels, cGMP, Ca^{2+}, Na^+, and K^+.
104. Why do our eyes require some time to adjust to changes in light intensity?

Signal Processing Begins in the Retina

105. Explain why signal processing in the retina is an excellent example of convergence. What generalized role do horizontal cells and amacrine cells play in this process? (Fig. 10.33a)

Bipolar Cells

106. What is the neurotransmitter that is released from photoreceptors onto bipolar neurons?

107. Distinguish between light-on (ON bipolar cells) and light-off (OFF bipolar cells), and explain how one signal molecule can have opposing effects on these two cell populations.

Ganglion Cells

108. What is the organization of a visual field? What are the two types of ganglion visual fields? (Fig. 10.33)

109. Visual acuity is greatest when a ganglion cell has _____ (many or few?) photoreceptors in its visual field. Give examples of where you would find large visual fields and small visual fields.

110. The retina uses _____ (absolute light intensity or contrast?) to identify objects in the environment. Explain how this is accomplished.

111. Describe M cells, P cells, and melanopsin retinal ganglion cells.

Processing Beyond the Retina

112. The optic nerves enter the brain at the optic _____. At this point, _____ (all or some?) fibers from each eye cross to the other side of the brain. (Fig. 10.34)

113. Contrast the binocular zone with the monocular zone. Explain how binocular vision allows us to see things in three dimensions.

114. Why do some fibers project from the optic chiasm to the midbrain? (Fig. 10.26)

115. Describe the topographical organization of the lateral geniculate body. How does this topographical organization relate to the visual field, and is this organization preserved in the visual cortex?

116. Briefly highlight some of the processing of visual information that takes place in the visual cortex.