THE SPECIAL SENSES:

The body’s sensory receptors react to stimuli or changes occurring both within the body and in the external environment. When triggered, these receptors send nerve impulses along afferent pathways to the brain for interpretation, thus allowing the body to assess and adjust to changing conditions so that homeostasis may be maintained.

The minute receptors of general sensation that react to touch-pressure, pain, temperature changes, and muscle tension are widely distributed in the body. These are considered in Chapter 7. In contrast, receptors of the special senses—sight, hearing, equilibrium, smell, and taste—tend to be localized and in many cases are quite complex. The structure and function of the special sense organs are the subjects of the student activities in this chapter.

THE EYE AND VISION

1. Complete the following statements by inserting your responses in the answer blanks.

   Attached to the eyes are the a. ____________________ muscles that allow us to direct our eyes toward a moving object. The anterior aspect of each eye is protected by the b. ____________________, which have eyelashes projecting from their edges. Closely associated with the lashes are oil-secreting glands called c. ____________________ that help to lubricate the eyes. Inflammation of the mucosa lining the eyelids and covering the anterior part of the eyeball is called d. ____________________.

2. Trace the pathway that the secretion of the lacrimal glands takes from the surface of the eye by assigning a number to each structure. (Note that #1 will be closest to the lacrimal gland.)

   a. ___ Lacrimal sac          c. ___ Nasolacrimal duct
   b. ___ Nasal cavity          d. ___ Lacrimal canals

3. Identify each of the eye muscles indicated by leader lines.

   Superior rectus
   Inferior rectus
   Superior oblique
   Lateral rectus
   Medial rectus
   Inferior oblique
4. Three main accessory eye structures contribute to the formation of tears and/or aid in lubricating the eyeball. In the table, name each structure and then name its major secretory product. Indicate which of the secretions has antibacterial properties by circling that response.

<table>
<thead>
<tr>
<th>Accessory eye structures</th>
<th>Secretory product</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

5. The intrinsic eye muscles are under the control of which division of the nervous system? Circle the correct response.
   A. Autonomic nervous system  B. Somatic nervous system

6. Complete the following statements by inserting your responses in the answer blanks.

   A. ______________________ lens, like that of the eye, produces an image that is upside down and reversed from left to right. Such an image is called a b. ______________________ image. In farsightedness, the light is focused c. ______________________ the retina. The lens used to treat farsightedness is a d. ______________________ lens. In nearsightedness, the light is focused e. ______________________ the retina; it is corrected with a f. ______________________ lens.

7. Match the terms provided in Column B with the appropriate descriptions in Column A. Insert the correct letter response or corresponding term in the answer blanks.

   **Column A**
   
   a. ______________________ Light bending
   b. ______________________ Ability to focus for close vision (under 20 feet)
   c. ______________________ Normal vision
   d. ______________________ Inability to focus well on close objects; farsightedness
   e. ______________________ Reflex constriction of pupils when they are exposed to bright light
   f. ______________________ Clouding of the lens, resulting in loss of sight
   g. ______________________ Nearsightedness
   h. ______________________ Blurred vision, resulting from unequal curvatures of the lens or cornea
   i. ______________________ Condition of increasing pressure inside the eye, resulting from blocked drainage of aqueous humor
   j. ______________________ Medial movement of the eyes during focusing on close objects
   k. ______________________ Reflex constriction of the pupils when viewing close objects
   l. ______________________ Inability to see well in the dark; often a result of vitamin A deficiency

   **Column B**
   
   • Accommodation
   • Accommodation pupillary reflex
   • Astigmatism
   • Cataract
   • Convergence
   • Emmetropia
   • Glaucoma
   • Hyperopia
   • Myopia
   • Night blindness
   • Photopupillary reflex
   • Refraction
8. Using the key choices, identify the parts of the eye described in the following statements. Insert the correct term or letter response in the answer blanks.

Aqueous Humor   Cornea    Retina
Canal of Schlemm  Fovea centralis  Sclera
Choroid    Iris    Vitreous humor
Ciliary body    Lens    Ciliary zonule
Optic disk

a. _______________ Attaches the lens to the ciliary body.
b. _______________ Fluid in the anterior segment that provides nutrients to the lens and cornea
c. _______________ The “white” of the eye
d. _______________ Area of retina that lacks photoreceptors
e. _______________ Contains muscle that controls the shape of the lens
f. _______________ Nutritive (vascular) layer of the eye
g. _______________ Drains the aqueous humor of the eye
h. _______________ Layer containing the rods and cones
i. _______________ Gel-like substance that helps to reinforce the eyeball
j. _______________ Heavily pigmented layer that prevents light scattering within the eye
k. _______________ l. _______________ Smooth muscle structures (intrinsic eye muscles)
m. _______________ Area of acute or discriminatory vision
n. _______________ o. _______________ Refractory media of the eye (#n-q)
p. _______________ q. _______________
r. _______________ Most anterior part of the sclera—your “window on the world”
s. _______________ Pigmented “diaphragm” of the eye

9. Complete the following statements by inserting your responses in the answer blanks.

There are a. _______________ varieties of cones. One type responds most vigorously to
b. _______________ light, another to c. _______________ light, and still
another to d. _______________ light. The ability to see intermediate colors such as purple results
from the fact that more than one cone type is being stimulated e. _______________. Lack of all
color receptors results in f. _______________. Because this condition is sex linked, it occurs
more commonly in g. _______________. Black and white, or dim light, vision is a function of the
h. _______________.
10. Using the key choice terms, identify the structures indicated by leader lines on the diagram of the eye.

- Aqueous Humor
- Canal of Schlemm
- Choroid
- Ciliary body
- Ciliary zonule
- Cornea
- Fovea centralis
- Iris
- Lens
- Optic disk
- Retina
- Sclera
- Vitreous humor

11. In the Figure below of a Rod Cell, explain how the dark current inhibits the bipolar cell.
12. Complete the statements concerning rod photopigment and physiology by writing your responses in the answer blanks.

The bent or kinked form of retinal is combined with a protein called a. _________________ to form the visual pigment called b. _________________. When light strikes the visual pigment, it straightens out and breaks down into its two components. This event is called c. _________________ because the purple color of the visual pigment changes to d. ________________ and finally becomes e. ________________ as retinal is converted all the way back to vitamin f. _________________.

THE EAR: HEARING AND BALANCE

13. Using the key choices, select the terms that apply to the following descriptions. Place the correct letter in the answer blanks.

Anvil (incus)    External acoustic meatus    Pinna    Tympanic membrane
Pharyngotympanic tube    Hammer (malleus)    Round window    Vestibule
Cochlea    Oval window    Semicircular canals
Endolymph    Perilymph    Stirrup (stapes)

a. __________, __________, __________ Structures composing the outer ear
b. __________, __________, __________ Structures composing the bony or osseous labyrinth
c. __________, __________, __________ Collectively called the ossicles
d. __________, __________ Ear structures not involved with hearing
e. __________ Allows pressure in the middle ear to be equalized with the atmospheric pressure
f. __________ Vibrates as sound waves hit it; transmits the vibrations to the ossicles
g. __________ Contains the organ of Corti
h. __________ Connects the nasopharynx and the middle ear
i. __________, __________ Contain receptors for the sense of equilibrium
j. __________ Transmits the vibrations from the stirrup to the fluid in the inner ear
k. __________ Fluid that bathes the sensory receptors of the inner ear
l. __________ Fluid contained within the osseous labyrinth, which bathes the membranous labyrinth
14. This is a diagram of the ear. Use anatomical terms (as needed) to correctly identify all structures in the figure provided with leader lines.

15. Label diagram of the organ of corti found below. In the space below the diagram, briefly explain how the organ of corti responds to sound vibrations of various frequencies.
16. Sound waves hitting the eardrum set it into vibration. Trace the pathway through which vibrations and fluid currents travel to finally stimulate the hair cells in the organ of Corti. Name the appropriate ear structures in their correct sequence and insert your responses in the answer blanks.

Eardrum → ____________________ → ____________________ → ____________________
Oval window → ____________________ → ____________________ → ____________________ → Hair cells

17. This is a view of the structures of the membranous labyrinth. Correctly identify the following major areas of the labyrinth on the figure: membranous semicircular canals, saccule and utricle, and the cochlear duct. Next, correctly identify each of the receptor types shown in enlarged views (organ of Corti, crista ampullaris, and macula). Finally, using terms from the key choices below, identify all receptor structures provided with leader lines. (Some of these terms may need to be used more than once.)
18. Complete the following statements on the functioning of the static and dynamic equilibrium receptors by inserting the letter or term from the key choices in the answer blanks.

<table>
<thead>
<tr>
<th>Angular/rotatory</th>
<th>Gravity</th>
<th>Semicircular canals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cupula</td>
<td>Perilymph</td>
<td>Static</td>
</tr>
<tr>
<td>Dynamic</td>
<td>Proprioception</td>
<td>Utricle</td>
</tr>
<tr>
<td>Endolymph</td>
<td>Saccule</td>
<td>Vision</td>
</tr>
</tbody>
</table>

The receptors for a. __________________________ equilibrium are found in the crista ampullaris of the b. __________________________. These receptors respond to changes in c. __________________________ motion.

When motion begins, the d. __________________________ fluid lags behind and the e. __________________________ is bent, which excites the hair cells. When the motion stops suddenly, the fluid flows in the opposite direction and again stimulates the hair cells. The receptors for f. __________________________ equilibrium are found in the maculae of the g. __________________________ and h. __________________________. These receptors report the position of the head in space. Tiny stones found in a gel overlying the hair cells roll in response to the pull of i. __________________________. As they roll, the gel moves and tugs on the hair cells, exciting them. Besides the equilibrium receptors of the inner ear, the senses of j. __________________________ and k. __________________________ are also important in helping to maintain equilibrium.

19. Label the two types of tongue papillae containing taste buds. Add appropriate labels to the leader lines provided to identify the taste pore and microvilli of the gustatory cells.
20. This figure illustrates the site of the olfactory epithelium in the nasal cavity (part A is an enlarged view of the olfactory receptor area). Label the diagram using the terms below. Then add a label and leader line to identify the olfactory “hairs” and add arrows to indicate the direction of impulse transmission.

<table>
<thead>
<tr>
<th>Olfactory neurons (receptor cells)</th>
<th>Olfactory bulb</th>
<th>Olfactory nerve filaments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supporting cells</td>
<td>Cribriform plate of the ethmoid bone</td>
<td>Fibers of the olfactory tract</td>
</tr>
</tbody>
</table>

**DEVELOPMENTAL ASPECTS OF THE SPECIAL SENSES**

21. Complete the following statements by inserting your responses in the answer blanks.

The special sense organs are actually part of the a. ____________ and are formed very early in the embryo. Maternal infections, particularly b. ____________, may cause both deafness and c. ____________ in the developing child. Of the special senses, the sense of d. ____________ requires the most learning or takes longest to mature. All infants are e. ____________, but generally by school age emmetropic vision has been established. Beginning sometime after the age of 40, the eye lenses start to become less f. ____________ and cannot bend properly to refract the light. As a result, a condition of farsightedness, called g. ____________, begins to occur. h. ____________, a condition in which the lens becomes hazy or discolored, is a frequent cause of blindness. In old age, a gradual hearing loss, called i. ____________, occurs. A declining efficiency of the chemical senses is also common in the elderly.
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Special Senses

The Eye

Eye Muscles

two types

voluntary
involuntary

The Ear

major areas

dynamic equilibrium
static equilibrium

Retina

The Pathway of Light

organ of hearing

photoreceptors

sense of taste
sense of smell

5 major taste sensations

type of receptor?

21.

22.

23.

24.

25.

26.

27.

28.

29.

1.

2.

3.

4.

16.

17.

18.

19.

8.

9.

10.

11.

12.

13.

14.

15.
Chapter 8 - Special Senses
Chapter Objectives

The Eye and Vision

22. Sketch a diagram of the accessory eye structures and list the functions of each.

23. Name the layers of the wall of the eye, and indicate the major function of each.

24. Explain how the functions of rod and cones differ.

25. Describe image formation on the retina.

26. Trace the pathway of light through the eye to the retina.

27. Discuss the importance of an ophthalmoscopic examination.

28. Define the following terms: accommodation, astigmatism, blind spot, cataract, emmetropia, glaucoma, hyperopia, myopia, and refraction.

29. Trace the visual pathway to the optic cortex.

30. Discuss the importance of the pupillary and convergence reflexes.
31. Identify the structures of the external, middle, and internal ear, and list the functions of each.

32. Describe how the equilibrium organs help maintain balance.

33. Explain the function of the organ of Corti in hearing.

34. Define sensorineural and conductive deafness and list possible causes of each.

35. Explain how one is able to localize the source of a sound.

**Chemical Senses: Taste and Smell**

36. Describe the location, structure, and function of the olfactory and taste receptors.

37. Name the four (five?) basic taste sensations and list factors that modify the sense of taste.

**Developmental Aspects of the Special Senses**

38. Describe changes that occur with age in the special sense organs.
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