Chapter 15: The Special Senses

I. Olfaction

A. Olfactory Epithelium and Bulb

1. Structurally olfactory neurons are classified as _____
2. Axons of olfactory neurons pass through holes of the _____ to the _____
3. The olfactory tracts _____
4. What is an olfactory vesicle? _____
5. Where are olfactory hairs found? _____
6. Functionally odorants enter the nasal cavity:
   a. Dissolve in _____
   b. Bind to _____
   c. Cilia of the olfactory neurons react by _____
7. How often is the olfactory epithelium lost? _____
8. What is the source of new olfactory neurons? _____

B. Neuronal Pathways for Olfaction

1. Axons from the olfactory neurons enter the _____
2. They synapse with _____ or _____
3. These cells pass olfactory information to the brain through _____ & synapse with _____
4. How is olfactory information modified before leaving the olfactory bulb?

   _____

   _____
5. Olfaction is the only major sensation that does not first go to _____
6. Where is the olfactory cortex located? _____
7. Functionally the lateral olfactory area _____
8. Functionally the medial olfactory area _____
9. The intermediate olfactory area has axons that extend to _____ where they synapse with _____
   a. This is a major mechanism for _____

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II. Taste

A. Papillae

1. In addition to papillae, taste buds are located on:
    a. Other areas of _____
    b. _____
    c. Even _____
2. Vallate Papillae
    a. How numerous are the vallate papillae? _____
    b. Where are vallate papillae located? _____
    c. Do they contain taste buds? _____
3. Fungiform Papillae
    a. Where are fungiform papillae located? _____
    b. Do they contain taste buds? _____
4. Foliate Papillae
    a. Where are foliate papillae located? _____
    b. Do they contain taste buds? _____
5. Filiform Papillae
    a. How numerous are the filiform papillae? _____
    b. Where are filiform papillae located? _____
    c. Do they contain taste buds? _____

B. Histology of Taste Buds

1. What shape are taste buds? _____
2. One type of epithelial cell forms _____
3. Gustatory Cells
    a. Specialized epithelial cells that are found in the _____
    b. Live for about _____
    c. What are gustatory hairs? _____
    d. Gustatory hairs project through _____

C. Function of Taste

1. Tastants dissolve in _____ and enter the _____
2. Cause the gustatory cells to _____

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3. The gustatory cells then release _____ that stimulate _____ in associated sensory neurons
4. A person tastes salt when _____ diffuse through channels and causes _____
5. Hydrogen ions of acids cause depolarization of gustatory cells in 1 of 3 ways:
   a. _____
   b. _____
   c. _____
6. Sweet and bitter tastants bind to receptors and cause depolarization through _____
7. The new taste "umami" results when _____ bind to receptors and _____
8. The taste of food is also influenced by _____ & _____
9. Adaptation of taste may begin in _____ & be complete in _____
10. The wide variety of different tastes is the result of _____
11. Many of our sensations thought to be taste are actually _____

D. Neuronal Pathways for Taste
   1. Which cranial nerve is responsible for taste from the following locations?
      a. Anterior two-thirds of tongue _____
      b. Posterior one-third of tongue, circumvallate papillae, & superior pharynx _____
      c. Epiglottis _____
   2. These nerves extend to the _____ of the medulla oblongata
   3. Nerve fibers go from the nucleus to the _____
   4. Neurons from the _____ go to the taste area of the cortex
      a. Where is the taste area of the cortex located? _____

III. Visual System

A. Accessory Structures
   1. Eyebrows
      a. Protect the eyes by _____

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b. Help shade the eyes _____

2. Eyelids (Palpebrae)
   a. Protect the eyes from _____
   b. What is the palpebral fissure? _____
   c. What is a canthus? _____
   d. Where is the caruncle? _____
   e. What does the caruncle contain? _____
   f. What muscles are found in the eyelids?
      1. _____
      2. _____
   g. What is the function of the tarsal plate? _____
   h. Blinking helps lubricate the eye by _____
   i. What muscle closes the eyelids? _____
   j. What muscle elevates the upper lid? _____
   k. The eyelids also help regulate _____
   l. In reality a sty is an _____
   m. Where are the meibomian glands? _____
      1. What do they do? _____
3. Conjunctiva
   a. What is the conjunctiva? _____
   b. Where is the palpebral conjunctiva located? _____
   c. Where is the bulbar conjunctiva located? _____
4. Lacrimal Apparatus
   a. Where is the lacrimal gland located? _____
   b. Which cranial nerve innervates the lacrimal gland? _____
      1. Is this sympathetic or parasympathetic innervation? _____
   c. Functionally tears _____ and wash _____
   d. Tears are composed of mostly _____, with some _____, _____, and _____
      1. What is the function of lysozyme? _____

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e. Excess tears that do not evaporate:
    1. Drain at the medial canthus through an opening called _____
    2. The opening is located on _____
    3. The tears drain through the opening into small tubes called _____
    4. The small tubes open into _____
    5. The sac drains into the _____
    6. Finally the tears are emptied into _____

5. Extrinsic Eye Muscles
    a. How many extrinsic eye muscles are there? _____
    b. Structurally a rectus muscle _____
    b. Structurally an oblique muscle _____
    c. Which cranial nerve innervates the superior oblique muscle? _____
        1. How does this nerve get its name? _____
    d. Which cranial nerve innervates the lateral rectus muscle? _____
        1. How does this nerve get its name? _____
    e. All other extrinsic eye muscles are innervated by _____

B. Anatomy of the Eye
1. Fibrous Tunic
    a. What is the sclera? _____
        1. The sclera is composed of _____
        2. Functionally the sclera:
            a. Helps _____
            b. Protects _____
            c. Provides _____
        3. The visible part of the sclera is called _____
    b. Anteriorly the sclera is continuous with the _____
        1. Describe the cornea: _____ _____
        2. The connective tissue matrix of the cornea contains _____ fibers, _____ fibers, and _____

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3. Why is the cornea transparent? _____

2. Vascular Tunic
   a. The vascular tunic contains most _____
   b. The vascular tunic contains a large number of _____ and appears _____ in color
   c. Where is the choroid? _____
      1. What does choroid mean? _____
   d. The ciliary body is continuous with the _____ and attached to the _____
      1. The ciliary body consists of:
         a. Outer _____
         b. Inner _____ attached to lens by _____
      2. The ciliary body contains _____ muscle called _____
         a. The outer smooth muscle fibers are oriented _____
         b. The central smooth muscle fibers are oriented _____
         c. Ciliary muscle contraction _____ lens
      3. The ciliary processes are a complex of _____ & _____
         a. What do the ciliary processes produce? _____
   e. The iris is the _____ part of the eye
      1. The iris is composed of _____ muscle surrounding the _____
      2. Light enters through the pupil and the iris _____ the amount of light by _____ of the pupil
      3. The sphincter pupillae is composed of _____
         a. It is innervated by _____ from the _____
         b. When the sphincter pupillae contracts the pupil _____
      4. The dilator pupillae is composed of _____
         a. It is innervated by _____
         b. When the dilator pupillae contracts the pupil is _____
   f. The term "intrinsic eye muscles" refers to:
      1. _____
      2. _____

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3. _____

3. Retina
    a. The innermost layer, the nervous tunic of the eye consists of:
        1. Outer _____
            a. Which is _____
        2. Inner _____
            a. Contains photoreceptors:
                1. 120 million called _____
                2. 6 or 7 million called _____
    b. Landmarks of the retina:
        1. What is the macula lutea? _____
        2. What is the fovea centralis? _____
            a. In terms of vision, what is special about the fovea centralis?

               _____
        3. What is the optic disc? _____
            a. What is formed here? _____
            b. Why is it called the blind spot? _____
4. Compartments of the Eye
    a. The Anterior Compartment
        1. Is located in front of the_____
        2. It is subdivided into two chambers:
            a. The anterior chamber lies _____
            b. The posterior chamber lies _____
                1. The chambers are filled with _____
        3. Functionally intraocular pressure:
            a. Keeps the eye _____ &
            b. Largely _____
        4. Functionally aqueous humor also:
            a. _____ light and
            b. Provides _____ for structures such as _____
        5. Aqueous humor is produced by _____ as a _____

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6. Aqueous humor is drained by the _____
7. Production and removal of aqueous humor at the same rate:
    a. Circulates the _____
    b. Maintains _____
8. What is glaucoma? _____

b. The Posterior Compartment
1. Is the _____ compartment behind the _____
2. Surrounded almost completely by the _____
3. What is vitreous humor? _____
    a. The turnover of vitreous humor is _____
4. Functionally the vitreous humor helps maintain _____ and is involved in _____ of light in the eye

5. Lens
a. The lens is _____ and _____ with the greatest convexity (curvature) _____
b. Structurally the lens consists of:
1. Layer of _____ on the anterior surface
2. Posterior region of _____ called _____
    a. These cells lose their _____ and accumulate _____ called _____
3. Covered by a _____
c. The lens is suspended between _____
1. Suspensory ligaments are connected from _____ to _____

C. Functions of the Complete Eye
1. Light Refraction and Reflection
a. What is light refraction? _____
b. When is light refracted? _____
c. A concave lens causes light rays to _____
d. A convex lens causes light rays to _____
e. Causing light rays to converge is called _____
f. The point at which light rays cross is called the _____

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g. Where is the focused image formed? _____
h. What is light reflection? _____
i. Why is light reflection important to vision? _____

2. Focusing of Images on the Retina
   a. As light rays pass through the eye they are caused to converge by:
      1. _____
      2. _____
      3. _____
      4. _____
         a. Which of these causes the greatest convergence? _____
   b. Fine adjustment in focusing is accomplished by _____
      1. When the ciliary muscles are relaxed:
         a. Suspensory ligaments maintain _____
         b. Keeping the lens _____
         c. Allowing for _____
         d. This is the normal resting condition of the lens & is called _____
      2. When an object is closer than 20 feet, three events occur for focusing:
         a. Accommodation of the Lens
            1. Ciliary muscles _____ due to _____ stimulation
            2. Pulls the choroid toward the lens to _____
            3. Allows the lens to _____ because of _____
            4. More spherical lens causes _____
         b. Pupil Constriction
            1. The size of the pupil affects _____
               a. Small pupil diameter results in _____
               b. Large pupil diameter results in _____
         c. Convergence of the Eyes
            1. Rotation of the eyes _____ to maintain a focused image on _____ of the retina
            2. This reflex stimulates the _____

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D. Structure and Function of the Retina

1. List the three neuron layers of the sensory retina:
   a. _____
   b. _____
   c. _____
2. The pigmented retina consists of _____
   a. What is the purpose of the melanin? _____
3. Rods
   a. Rods are _____ involved in _____ and are responsible for vision _____
   b. Describe the structure of a rod _____ _____
   c. Where is rhodopsin found? _____
      1. Rhodopsin consists of a protein _____ bound to a pigment _____
4. Function of Rhodopsin
   a. As light is absorbed by rod cells _____
      1. The shape change activates _____
         a. Causes the closing of _____ resulting in _____
   b. When not exposed to light:
      1. _____ channels are open and _____ into the cell
      2. This causes the photoreceptor to release _____
      3. Glutamate acts as an _____
      4. This causes the bipolar cell to _____
   c. When exposed to light:
      1. The _____ channels _____ so fewer _____ enter the cell
      2. Therefore the amount of glutamate released _____
      3. This results in hyperpolarization of bipolar neurons _____
      4. Bipolar neurons depolarize sufficiently to release _____
      5. Stimulate ganglionic cells to _____
   d. In bright light excess rhodopsin is _____

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e. In a dark room _____

5. Cones
   a. Cones require _____ to function
   b. At night objects appear gray because _____
   c. Describe the structure of a cone _____
   d. What is the visual pigment present in cones? _____
      1. This consists of _____ and a photopigment _____
      2. List the three major types of color sensitive opsin:
         a. _____ b. _____ c. _____
   e. Iodopsin functions like rhodopsin except _____
      _____
   f. Color is interpreted in the _____ as combinations of sensory input from the various _____ stimulated
6. Inner Layers of the Retina
   a. What cells do rods and cones synapse with? _____
   b. What cells synapse with ganglion cells? _____
   c. Axons from the ganglion cells converge at the _____
   d. The point where the axons converge forms the _____
   e. How many rods connect to one bipolar cell? _____
   f. How many cones connect to one bipolar cell? _____
      a. Therefore which photoreceptor provides the sharpest vision? _____

E. Neuronal Pathways for Vision
1. Which retinal nerve fibers cross at the optic chiasma? _____
2. Most of the ganglionic axons terminate in _____
3. Some axons terminate in _____
4. What are "optic radiations"? _____
5. Where is the visual cortex in the cerebrum? _____
6. Describe a "visual field" _____
7. The _____ part of the visual field projects to the _____ retina
8. What is binocular vision? _____
9. Explain depth perception? _____

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IV. Hearing and Balance

A. Auditory Structures and Their Functions

1. External Ear
    a. Describe the auricle _____
        1. The auricle is composed of _____
    b. Functionally the auricle _____
    c. The external auditory canal contains _____ & _____
        1. What is cerumen commonly called? _____
    d. Functionally hairs and cerumen _____
    e. Describe the tympanic membrane _____
    f. Specify the composition of each layer of the tympanic membrane:
        1. Inner layer is _____
        2. Middle layer is _____
        3. Outer layer is _____
    g. Sound waves cause the tympanic membrane to _____
2. Middle Ear
    a. The middle ear is an _____ cavity
    b. It is separated on the medial side from the inner ear by the _____ and _____
    c. Two openings provide _____
        1. One passage opens into the _____
        2. The auditory or eustachian tube opens into _____
            a. Functionally this tube _____
            b. This is important because a distorted tympanic membrane _____ its vibrations and makes hearing _____
    d. The middle ear contains three auditory ossicles:
        1. _____ meaning hammer
        2. _____ meaning anvil
        3. _____ meaning stirrup
    e. Which ossicle attaches to the tympanic membrane? _____
    f. Which ossicle attaches to the oval window? _____

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g. What is the function of the annular ligament? _____

3. Inner Ear
   a. The bony labyrinth consists of _____ & _____
      1. It is lined with _____
   b. The membranous labyrinth is _____
   c. The membranous labyrinth is filled with _____
   d. The space between the membranous and bony labyrinth is filled with _____
   e. List the three parts of the inner ear:
      1. _____
      2. _____
      3. _____
   f. Which part(s) are involved in balance? _____
   g. Which part(s) are involved in hearing? _____
   h. List the three parts of the cochlea:
      1. _____
      2. _____
      3. _____
   i. What is the helicotrema? _____
   j. Which cochlear chamber extends from the oval window to the helicotrema? _____
   k. Which cochlear chamber extends from the helicotrema to the round window? _____
   l. What fluid fills the scala vestibuli and scala tympani? _____
   m. What membrane borders the scala vestibuli? _____
   n. What membrane borders the scala tympani? _____
   o. Where is the cochlear duct? _____
   p. What fluid fills the cochlear duct? _____
   q. The basilar membrane near the oval window is _____ & _____
      1. Responds to _____ vibrations
   r. The basilar membrane near the helicotrema is _____ & _____

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1. Responds to _____ vibrations

s. Hair cells and supporting epithelial cells form the _____

t. The hair cells have _____ at their apical ends

u. The hair cells are arranged in _____ extending the _____

v. The tips of the hairs are embedded in _____ called _____

w. The basilar regions of a hair cell are covered _____

x. Afferent fibers of these neurons form the _____

y. This nerve joins with the _____ to form _____

B. Auditory Function

1. External Ear

a. The auricle _____ sound waves and funnels them through the _____ to the _____

b. The brain uses the time interval between sound reaching both ears to _____

2. Middle Ear

a. When sound waves strike the tympanic membrane they cause it to _____

b. In turn this causes vibration of the _____ and the _____

c. The auditory ossicles are important in the transmission of sound waves to the oval window because the vibrations are _____

d. What is the function of the sound attenuation reflex? _____ _____

3. Inner Ear

a. As the stapes vibrates the oval window:

1. It produces _____ in the perilymph of _____

2. These are transmitted through the thin _____

3. Producing simultaneous waves in the _____

4. Vibration of the _____ causes distortion of the _____

5. This distortion causes waves in the _____
6. Ultimately causing vibration of the _____

b. Vibration of the round window acts as a _____
c. Distortion of which membrane is most important to hearing? _____
d. Depolarization of the hair cells occurs when _____
e. What determines which part of the basilar membrane will be distorted?

_____

f. The super olivary nucleus in the medulla analyzes nerve impulses from the cochlea to determine area of _____
   1. Based on this it sends nerve impulses to the cochlea inhibiting

      _____
   2. This process localizes _____
g. Action potentials from:
   1. The base of the basilar membrane are interpreted as _____
   2. The apex of the basilar membrane are interpreted as _____

C. Neuronal Pathways for Hearing
   1. Neurons from the cochlear ganglion synapse in _____
   2. These neurons synapse in or pass through the _____
   3. Neurons terminating in this nucleus may:
      a. Synapse with neurons returning to the cochlea for _____
      b. Project to cranial nerves for _____ reflex
      c. Join _____
   4. Ascending neurons from the superior olivary nucleus travel in _____
   5. All ascending fibers synapse in the _____ and from there project to _____ of the _____
   6. Where is the auditory portion of the cerebral cortex? _____
   7. The superior colliculus is involved in _____
D. Balance
   1. The static labyrinth consists of the _____ & _____
   2. The static labyrinth is primarily involved in _____
   3. The kinetic labyrinth is associated with _____

4. The kinetic labyrinth is involved in evaluating _____
5. How big is the macula?
6. What direction is the macula oriented?
    a. In the utricle _____
    b. In the saccule _____
7. Structurally a macula is composed of columnar _____ & _____
8. Hair cells have numerous microvilli called _____
9. Hair cells have one cilium called a _____
10. The hair cells are embedded in _____
11. Otoliths are composed of _____ & _____
12. The gelatinous mass moves in response to _____
13. Depolarization of hair cells results from _____
14. Hyperpolarization of hair cells results from _____
15. As the head is moved and the gelatinous mass moves the pattern of intensity _____
16. This information can be interpreted in the brain as _____
17. In response the body _____
18. The kinetic labyrinth consists of _____
    a. One in the _____ plane
    b. One in the _____ plane
    c. One in the _____ plane
19. The expanded portion of each semicircular canal is called an _____
20. The sensory structure inside the ampulla is called _____
21. What is a cupula? _____
22. What is embedded in the cupula? _____
23. Why does the cupula not respond to gravity? _____
24. The cupula is a float that is displaced by _____
25. Endolymph movements move the cupula which _____ hairs & _____
26. This system detects _____ rather

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_____

E. Neuronal Pathways for Balance
   1. Neurons from the hair cells converge to form the _____
   2. Where do these sensory fibers terminate? _____
   3. From here the axons run to _____
   4. In addition to the inner ear, the vestibular nucleus also receives input from:
      a. _____
      b. _____

V. Effects of Aging on the Special Senses

A. How much olfaction loss occurs with aging? _____

B. Gustation _____ as people age because _____ &

_____

C. The lens loses flexibility because _____
   1. There is a reduction and eventual loss in the ability to _____

D. List age related visual problems from most common to less common:
   1. _____
   2. _____
   3. _____
   4. _____

E. What happens to the number of cones as we age? _____
   1. This causes a _____ & _____

F. What happens to the number of hair cells in the cochlea? _____
   1. Since this doesn't happen equally in both ears older people may have trouble

      _____

G. What happens to the number of hair cells in the saccule, utricle, and ampullae?

_____

H. What happens to the number of otoliths? _____

I. Therefore elderly people experience a decreased sensitivity to:
   1. _____
   2. _____

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3. _____
    a. This causes elderly people to experience:
        1. _____
        2. _____

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