

The nervous system: b. the special senses

لateral (L) → Light Eye
 Medical (M) → Medicine Ear

1. Which of the following statements regarding the lateral geniculate nucleus is correct?

- A) Layer one is called a parvocellular layer
- B) Layer one receives signals from the lateral half of the retina
- C) Layer one receives signals that originate from rods
- D) Layer four receives signals from the ipsilateral retina
- E) Layer four receives signals from Y ganglion cells

Eye

2. Which of the following substances will elicit the sensation of sour taste?

- A) Aldehydes
- B) Alkaloids
- C) Amino acids
- D) Hydrogen ions
- E) Ketones

X

✓ 91.3

3. Which of the following statements regarding the refraction of light is correct?

- A) Light waves have a longer wavelength in transparent solids than in air
- B) Light waves travel at higher velocity through transparent solids than through air
- C) The refractive index of a transparent solid is the ratio of the velocity of light in air to the velocity of light in the substance
- D) The refractive index of air is zero
- E) When light waves strike a transparent solid, they always reflect away from the solid rather than travel through the solid

Eye.

4. When comparing the fovea with the periphery of the retina, which of the following statements is correct?

- A) The fovea contains an increased proportion of cones
- B) The fovea contains an increased proportion of ganglion cells
- C) The fovea contains an increased proportion of horizontal cells
- D) The fovea contains an increased proportion of rods
- E) The fovea contains an increased proportion of vasculature

Eye

5. Which of the following is the middle ear ossicle that is attached to the tympanic membrane?

- A) Columella
- B) Incus
- C) Malleus
- D) Modiolus
- E) Stapes

lateral

Ear

6. Light entering the eye passes through which retinal layer first?

- A) Inner nuclear layer
- B) Outer nuclear layer
- C) Outer plexiform layer
- D) Photoreceptor layer
- E) Retinal ganglion layer

Eye

7. Ganglion cells attached to photoreceptors located on the temporal portion of the retina project to which of the following structures?

- A) Contralateral lateral geniculate nucleus
- B) Ipsilateral lateral geniculate nucleus
- C) Ipsilateral medial geniculate nucleus
- D) Calcarine fissure
- E) Contralateral medial geniculate nucleus

Eye.

8. Which of the following best describes the “blind spot” of the eye?

- A) Located 5 degrees lateral to the central point of vision
- B) Exit point of the optic nerve
- C) Contains only rods and thus has monochromatic vision
- D) Contains no blood vessels
- E) Area where chromatic aberration of the lens is the greatest

Eye

9. When parallel light rays pass through a concave lens, which of the following will occur?

- A) Rays converge toward each other
- B) Rays diverge away from each other
- C) They maintain parallel relationship
- D) They reflect back in the direction from where they came
- E) Rays refract to one focal point

Eye

10. Which of the following regarding the attenuation reflex is correct?

- A) Can increase the intensity of low-frequency sound transmission by 30 to 40 decibels
- B) Increases the rigidity of the ossicular system, thereby reducing conduction of low-frequency sounds
- C) Masks high-frequency sounds in a loud environment so lower frequency sounds are more easily heard
- D) Occurs following a latent period of 4 to 8 seconds after the loud sound
- E) Protects the cochlea from the damaging vibrations of relatively quiet but high-frequency sounds

Eye

11. Which of the following substances will elicit the sensation of bitter taste?

- A) Aldehydes
- B) Alkaloids
- C) Amino acids
- D) Hydrogen ions
- E) Ketones

X
د. ارجو

12. Damage to the ⁶Vth cranial nerve will produce which of the following deficits in eye movement?

- A) Inability to move the eyes in a vertical up and down motion

انatomy

- B) Inability to rotate the eyes within the eye socket
- C) Inability to move the eyes laterally towards the midline
- D) Inability to move the eyes laterally away from the midline
- E) Vertical strabismus

13. Which of the following statements is correct regarding the focal length of a convex lens?

X

- A) Converging light rays passing through a convex lens will converge at a focal point farther away than the focal length of that lens
- B) Diverging light rays passing through a convex lens will converge at a focal point closer than the focal length of that lens
- C) Parallel light rays passing through a convex lens will converge at a focal point equal to the focal length of that lens
- D) The image produced by a convex lens is right side up, but its two lateral sides are reversed with respect to the object
- E) The lens with the greatest convexity will have the longest focal length

14. If a convex lens has a focal length of 1 cm (0.01 m), what is the refractive power of that lens in diopters?

X

- A) +0.01
- B) +0.10
- C) +1
- D) +10
- E) +100

15. The condition of cataracts is usually the result of which of the following processes or conditions?

- A) Denaturation of the proteins in lens of the eye
- B) Elongated eye globe
- C) Unresponsive and dilated pupil
- D) Coagulation of the proteins in the lens of the eye
- E) Increase in intraocular pressure

16. Which of the following taste sensations is the most sensitive (i.e., has the lowest stimulation threshold)?

- A) Acid
- B) Bitter
- C) Salty
- D) Sour
- E) Sweet

X

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17. Which of the following statements regarding the basilar membrane is correct?

Ear * Imp

- A) Vibrates best at high frequency near the base of the cochlea, whereas it vibrates best at low frequency at the apex of the cochlea
- B) Spiral ganglion lies on its surface
- C) Contains basilar fibers whose diameter increases from the base of the cochlea to the apex of the cochlea
- D) Contains basilar fibers whose length decreases from the base of the cochlea to the apex of the

cochlea

E) Separates the scala media from the scala vestibuli

18. Which of the following substances is responsible for the umami taste sensation?

- A) Acetic acid
- B) Potassium tartrate
- C) Long-chained organic substances containing nitrogen
- D) Fructose
- E) Glutamate

✓ 9/1.3
+
Bio 3

19. Analysis of visual detail occurs in which secondary visual area?

- A) Brodmann's area 18
- B) Inferior ventral and medial regions of the occipital and temporal cortex
- C) Frontal lobe
- D) Occipitoparietal cortex
- E) Posterior midtemporal area

X

20. Which of the following statements best describes the role of melanin in the pigment layer of the retina?

- A) Precursor of the light sensitive chemical rhodopsin
- B) Serves as nutritional component for the rods and cones in the retina
- C) Dark pigment that prevents the reflection of light inside the globe of the eye
- D) Responsible for maintaining integrity of the canal of Schlemm
- E) Light reflected off the melanin pigment is a key element used in the process of accommodation of the lens

Eye

21. Which of the following pairs of molecules combine to form rhodopsin?

- A) Bathorhodopsin and 11-cis-retinal
- B) Bathorhodopsin and all-trans-retinal
- C) Bathorhodopsin and scotopsin
- D) Scotopsin and 11-cis-retinal
- E) Scotopsin and all-trans-retinal

Eye

22. A deficiency of which vitamin prevents the formation of an adequate quantity of retinal, eventually leading to night blindness?

- A) Vitamin A
- B) Vitamin C
- C) Vitamin D
- D) Vitamin E
- E) Vitamin K

Eye

23. What is the name of the condition whereby the lens of the eye becomes almost totally unaccommodating in persons over 70 years of age?

- A) Amblyopia
- B) Emmetropia
- C) Hyperopia

! Eye X

- D) Myopia
- E) Presbyopia

24. Which compartment of the cochlea contains the organ of Corti?

- A) Ampulla
- B) Saccule
- C) Scala media
- D) Scala tympani
- E) Scala vestibuli

Ear

25. Which of the following statements regarding the transmission of taste information from the tongue to the cerebral cortex is correct?

- A) Majority of thalamic neurons in taste pathway synapse in the occipital lobe
- B) Nerve fibers carrying taste information from the tongue have no synapse in the brainstem
- C) Nerve fibers carrying taste information from the tongue synapse in the solitary nucleus
- D) Thalamic nucleus involved in the taste pathway is the dorsal medial nucleus
- E) Thalamic nucleus involved in the taste pathway is the ventral posterolateral nucleus

X
د. اولو

26. Which cells in layer IV of the primary visual cortex detect orientation of lines and borders?

- A) Border cells
- B) Complex cells
- C) Ganglion cells
- D) Hypercomplex cells
- E) Simple cells

X

27. Which of the following best describes when the transmission of sound waves in the cochlea occurs?

- A) When the foot of the stapes moves inward against the oval window and the round window bulges outward
- B) When the foot of the stapes moves inward against the round window and the oval window bulges outward
- C) When the head of the malleus moves inward against the oval window and the round window bulges outward
- D) It occurs when the incus moves inward against the oval window and the round window bulges outward
- E) It occurs when the incus moves inward against the round window and the oval window bulges outward

Ear

28. Under low or reduced light conditions, which of the following chemical compounds is responsible for the inward-directed sodium current in the outer segments of the photoreceptors?

- A) Metarhodopsin II
- B) Cyclic GMP
- C) 11-cis retinal
- D) Cyclic AMP
- E) 11-trans retinol

Eye

29. Which of the following statements regarding the cranial nerve innervation of the tongue is correct?

- A) Taste information from the anterior two-thirds of the tongue is transmitted to the solitary nucleus by the glossopharyngeal nerve
- B) Taste information from the pharynx is transmitted to the solitary nucleus by the facial nerve
- C) Taste information from the posterior third of the tongue is transmitted to the solitary nucleus by the glossopharyngeal nerve
- D) Taste information from the posterior third of the tongue initially travels with the lingual nerve
- E) Taste information from the posterior third of the tongue initially travels with the chorda tympani nerve

30. Olfactory receptor cells belong to which of the following groups of cells?

- A) Bipolar neurons
- B) Fibroblasts
- C) Modified epithelial cells
- D) Multipolar neurons
- E) Pseudounipolar neurons

X
Bio
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31. Which of the following statements regarding hair cells is correct?

- A) Hair cells depolarize when their stereocilia are bent toward the shortest stereocilium
- B) Nerve fibers stimulated by hair cells have their cell bodies in the cochlear nuclei of the brainstem
- C) The stereocilia of the hair cells are longer on the side of the hair cell nearest the modiolus
- D) There are more inner hair cells than outer hair cells in the organ of Corti
- E) Transmission of auditory signals is performed mainly by inner hair cells rather than outer hair cells

X

32. Accommodation for far vision (focusing on an object at a distance) requires which of the following processes?

- A) Constriction of the pupil of the eye
- B) Dilation of the pupil of the eye
- C) An increase in the formation of rhodopsin
- D) Causing the lens of the eye to have more curvature (making it fatter)
- E) Causing the lens of the eye to have less curvature (making it thinner)**

Eye
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33. Which of the following events occurs in photoreceptors during phototransduction in response to light?

- A) Phosphodiesterase activity decreases
- B) Transducin activity decreases
- C) Hydrolysis of cGMP increases**
- D) Neurotransmitter release increases
- E) Number of open voltage-gated calcium channels increases

Eye

34. During photoreception, all of the following increase except

- A) cGMP phosphodiesterase
- B) Transducin
- C) cAMP
- D) Metarhodopsin II

Eye

E) Sodium influx into the outer segment of the rod

35. Which of the following statements is correct regarding astigmatism?

- A) Light rays do not come to a common focal point
- B) Light rays being emitted from distant objects are focused behind the retina
- C) Light rays being emitted from distant objects are focused in front of the retina
- D) Light rays being emitted from distant objects are in sharp focus on the retina
- E) There is a cloudy or opaque area or areas in the lens

X

36. The stereocilia of hair cells are embedded in which membrane?

- A) Basilar
- B) Reissner's
- C) Tectorial
- D) Tympanic
- E) Vestibular

Ear

37. Which of the following cranial nerves is correctly paired with the extraocular muscle it innervates?

- A) Abducens nerve–medial rectus
- B) Oculomotor nerve–inferior oblique
- C) Oculomotor nerve–lateral rectus
- D) Oculomotor nerve–superior oblique
- E) Trochlear nerve–superior rectus

X

38. After olfactory receptor cells bind odor molecules, a sequence of intracellular events occurs that culminates in the entrance of specific ions that depolarize the olfactory receptor cell. Which of the following ions are involved?

- A) Calcium ions
- B) Chloride ions
- C) Hydrogen ions
- D) Potassium ions
- E) Sodium ions

X

39. For the eye to adapt to intense light, which of the following may occur?

- A) Bipolar cells will continuously transmit signals at the maximum rate possible
- B) Photochemicals in both rods and cones will be reduced to retinal and opsins
- C) The levels of rhodopsin will be very high
- D) There will be an increase in the size of the pupil
- E) Vitamin A will convert into retinal

Eye

40. The condition of myopia is usually corrected by which of the following types of lens?

- A) Compound lens
- B) Convex lens
- C) Spherical lens
- D) Concave lens
- E) Cylindrical lens

X

41. Which lobe of the cerebral cortex contains the small bilateral cortical area that controls voluntary fixation movements? X
- A) Frontal
 - B) Limbic
 - C) Occipital
 - D) Parietal
 - E) Temporal
42. Which of the following sensory systems has the smallest range of intensity discrimination? X
- A) Auditory
 - B) Gustatory
 - C) Olfactory
 - D) Somatosensory
 - E) Visual
43. Which of the following molecules moves from the ^{ok}endolymph into the stereocilia and depolarizes the hair cell? Ear
- A) Calcium ions
 - B) Chloride ions
 - C) Hydrogen ions
 - D) Potassium ions
 - E) Sodium ions
44. Which of the following events prompts the auditory system to interpret a sound as loud? Ear
- A) Decreased number of inner hair cells become stimulated
 - B) Decreased number of outer hair cells become stimulated
 - C) Hair cells excite nerve endings at a diminished rate
 - D) Amplitude of vibration of the basilar membrane decreases
 - E) Amplitude of vibration of the basilar membrane increases
45. Which of the following statements is correct concerning the elements of the retina? Eye
- A) Total number of cones in the retina is much greater than the total number of rods
 - B) Each individual cone responds to all wave lengths of light
 - C) Photoreceptors activation (rods and cones) results in hyperpolarization of the receptor
 - D) Central fovea contains only rods
 - E) Pigment layer of the retina contains the photoreceptors
46. The condition of hyperopia is usually caused by which of the following anomalies of the eye? X
- A) Decreased production of melanin
 - B) Uneven curvature of the cornea
 - C) Eyeball that is shorter than normal
 - D) Eyeball that is longer than normal
 - E) Lens system that is too powerful and focuses the object in front of the retina

47. In the central auditory pathway which of the following represents the correct sequence of structures in the pathway? Ear

A) Cochlear nuclei–superior olive–inferior colliculus via the lateral lemniscus - medial geniculate–auditory cortex

B) Cochlear nuclei–inferior olive–inferior colliculus via the medial lemniscus - medial geniculate–auditory cortex

C) Cochlear nuclei–superior olive–superior colliculus via the lateral lemniscus - lateral geniculate–auditory cortex

D) Cochlear nuclei–inferior olive–inferior colliculus via the lateral lemniscus - lateral geniculate–auditory cortex

E) Cochlear nuclei–trapezoid body–dorsal acoustic stria–inferior colliculus via the lateral lemniscus–medial geniculate–auditory cortex

48. Which of the following statements regarding the transmission of auditory information from the ear to the cerebral cortex is correct?

Ear

A) Inferior colliculus neurons synapse in the cochlear nuclei of the brainstem

B) Neurons with cell bodies in the spiral ganglion of Corti synapse in the inferior colliculus

C) The majority of neurons from the cochlear nuclei synapse in the contralateral superior olivary nucleus

D) There is no crossing-over of information between the right and left auditory pathways in the brainstem

E) Trapezoid neurons synapse in the cochlear nuclei of the brainstem

49. Which of the following statements regarding color vision is correct?

Eye

A) Green is perceived when only green cones are stimulated

B) The stimulation ratio of the three types of cones allows specific color perception

C) The wavelength of light corresponding to white is shorter than that corresponding to blue

D) When there is no stimulation of red, green, or blue cones, there will be the sensation of seeing white

E) Yellow is perceived when green and blue cones are stimulated equally

50. The function of the round window can best be described by which of the following?

Ear

A) Provides the connection point for the stapes

B) Serves to damp out low frequency sounds such as your own voice

C) Transmits the frequency information into the cochlea from the tympanic membrane

D) Serves as the pressure relief valve for the cochlea

E) Transmits amplitude information into the cochlea from the tympanic membrane

51. Which of the following muscles is contracted as part of the pupillary light reflex?

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A) Ciliary muscle

B) Pupillary dilator muscle

C) Pupillary sphincter muscle

D) Radial fibers of the iris

E) Superior oblique muscle

52. Which of the following allows the visual apparatus to accurately determine the distance of an object from the eye (depth perception)?

X

A) Monocular vision

- B) Location of the retinal image on the retina
- C) Phenomenon of stationary parallax
- D) Phenomenon of stereopsis
- E) Size of the retinal image if the object is of unknown size

53. Which of the following is the most common cause of glaucoma?

Eye

- A) Drugs that reduce the secretion of aqueous humor
- B) Increased resistance to fluid outflow through trabecular spaces into the canal of Schlemm
- C) Normal function of phagocytes on the surface of trabeculae
- D) Phagocytoses of proteins and small particles by the epithelium of the iris
- E) The activation of reticuloendothelial cells in the interstitial gel outside the canal of Schlemm

54. Which of the following statements regarding the two types of deafness is correct?

Ear

- A) An audiogram of a person with conduction deafness would show much greater loss for air conduction than bone conduction of sound
- B) An audiogram of a person with nerve deafness would show much greater loss for bone conduction than air conduction of sound
- C) Conduction deafness occurs when the cochlea or cochlear nerve is impaired
- D) Nerve deafness occurs when the physical structures that conduct the sound into the cochlea are impaired
- E) Prolonged exposure to very loud sounds is more likely to cause deafness for high-frequency sounds than low frequency sounds

55. Consider the situation in which an individual is turning their head to the left about the axis of the neck. The motion begins while the chin is directly over the right shoulder and ends with the chin directly over the left shoulder. Which of the following best describes the eye movements associated with this type of head rotation in a normal individual?

- A) While the head is turning, the eyes will be moving to the right and saccadic eye motion will be to the left
- B) While the head is turning, the eyes will be moving in the same direction as the head rotation and the saccadic eye motion will be to the left
- C) While the head is turning, the eyes will be moving to the right and the saccadic eye motion will be to the right
- D) While the head is turning, the eyes will remain stationary within the orbits and the saccadic eye motion will be to the right
- E) While the head is turning, the eyes will be moving to the left and the saccadic eye motion will be to the right

56. Horner syndrome occurs when sympathetic nerve fibers to the eye are interrupted, leading to which of the following symptoms on the affected side of the face?

N

- A) Blood vessels of the face become persistently constricted
- B) Profuse sweating occurs
- C) The superior eyelid is maintained in an open position
- D) There is an overproduction of lacrimal gland fluid
- E) There is persistent constriction of the pupil to a smaller diameter than the pupil of the opposite

eye

57. Which of the following neurotransmitters is released by both rods and cones at their synapses with bipolar cells? P
- A) Acetylcholine
 - B) Dopamine
 - C) Glutamate
 - D) Glycine
 - E) Serotonin
58. Olfactory information transmitted to the orbitofrontal cortex passes through which thalamic nucleus? X
- A) Dorsomedial
 - B) Lateral geniculate
 - C) Medial geniculate
 - D) Ventral posterolateral
 - E) Ventral posteromedial
59. Which of the following provides about two thirds of the 59 diopters of refractive power of the eye? Eye
- A) Anterior surface of the cornea
 - B) Anterior surface of the lens
 - C) Iris
 - D) Posterior surface of the cornea
 - E) Posterior surface of the lens
60. Transmission of visual signals to the primary visual cortex from the retina includes a synapse in which structure? Eye.
- A) Lateral geniculate nucleus
 - B) Medial geniculate nucleus
 - C) Pretectal nucleus
 - D) Superior colliculus
 - E) Suprachiasmatic nucleus
61. Which of the following statements regarding retinal ganglion cells is correct? Eye
- A) One W ganglion cell from the periphery of the retina typically transmits information from one rod
 - B) One X ganglion cell from the fovea typically transmits information from as many as 200 cones
 - C) W ganglion cells respond best to directional movement or vision under very bright conditions
 - D) X ganglion cells respond best to color images and are the most numerous of the three types of ganglion cells
 - E) Y ganglion cells respond best to rapid changes in the visual image and are the most numerous of the three types of ganglion cells
62. Auditory information is relayed through which thalamic nucleus? X
- A) Dorsomedial nucleus
 - B) Lateral geniculate nucleus
 - C) Medial geniculate nucleus

- D) Ventral posterolateral nucleus
- E) Ventral posteromedial nucleus

63. The phenomenon of taste preference is

- A) a central nervous system process
- B) the result of neonatal stimulation of circumvallate papilla
- C) a learned behavior in animals
- D) a result of taste bud maturation
- E) a result of taste bud proliferation following exposure to glutamic acid

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64. Of the photoreceptors listed below which one responds to the broadest spectrum of wavelengths of light?

- A) Rod receptors
- B) Green cone receptors
- C) Blue cone receptors
- D) Red cone receptors**
- E) Cells containing melanin in the pigment layer

Bio

65. Which of the following structures secretes the intraocular fluid of the eye?

- A) Ciliary processes**
- B) Cornea
- C) Iris
- D) Lens
- E) Trabeculae

Eye

66. Which type of papillae is located in the posterior part of the tongue?

- A) Circumvallate
- B) Foliate
- C) Fungiform
- D) Fungiform and circumvallate
- E) Papilla of Vater

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Bio

67. Which structure functions to ensure that each of the three sets of extraocular muscles is reciprocally innervated so that one muscle of the pair relaxes while the other contracts?

- A) Edinger-Westphal nucleus
- B) Medial longitudinal fasciculus
- C) Pretectal nucleus
- D) Superior colliculus
- E) Suprachiasmatic nucleus

Anatomy

68. Which of the following retinal cells have action potentials?

- A) Amacrine cells
- B) Bipolar cells
- C) Ganglion cells**
- D) Horizontal cells
- E) Photoreceptors

Eye

69. Which type of papillae is located in the folds along the lateral surfaces of the tongue?

- A) Circumvallate
- B) Foliate
- C) Fungiform
- D) Fungiform and circumvallate
- E) Papilla of Vater

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Bic

70. The primary auditory cortex lies primarily in which lobe of the cerebral cortex?

- A) Frontal lobe
- B) Limbic lobe
- C) Occipital lobe
- D) Parietal lobe
- E) Temporal lobe

Eye

71. The intraocular fluid of the eye flows from the canal of Schlemm into which of the following locations?

- A) Anterior chamber
- B) Aqueous veins
- C) Lens
- D) Posterior chamber
- E) Trabeculae

Eye

72. The first central synapse for neurons transmitting the sweet taste sensation is in which of the following structures?

- A) Dorsal sensory nucleus of vagus nerve
- B) Nucleus of solitary tract
- C) Nucleus of olfactory nerve
- D) Nucleus of hypoglossal nerve
- E) Nucleus of facial nerve

✓ د. الجوفية

73. Which brainstem structure plays a major role in determining the direction from which a sound originates?

- A) Cochlear nucleus
- B) Inferior colliculus
- C) Lateral lemniscus
- D) Superior olivary nucleus
- E) Trapezoid

Ear

74. Visual contrast is enhanced due to lateral inhibition by which retinal cells?

- A) Amacrine cells
- B) Bipolar cells
- C) Ganglion cells
- D) Horizontal cells
- E) Photoreceptors

X

75. Which of the following best describes the underlying basis of the dark current in the outer segment

of the photoreceptors?

Eye

- A) Dark current results from the influx of sodium ions via c-AMP–dependent sodium channels
- B) Dark current results from the influx of sodium ions via c-GMP–dependent sodium channels**
- C) Dark current results from the efflux of potassium ions via c-GMP–dependent potassium channels
- D) Dark current results from the efflux of sodium ions via c-GMP–dependent sodium channels
- E) Dark current results from the efflux of sodium ions via c-AMP–dependent sodium channels

Answers

1.C) Layers I and II of the lateral geniculate nucleus are called magnocellular layers, and receive rod input from Y retinal ganglion cells. Layers III to VI are called parvocellular layers and receive cone input from X retinal ganglion cells.

TMP12 623–624

2.D) The taste sensation of sour is proportional to the logarithm of the hydrogen ion concentration caused by acids. Sweet is caused by a long list of chemicals, including sugars, alcohols, aldehydes, ketones, and amino acids.

TMP12 645

3.C) Light rays travel through air at a velocity of about 300,000 km/sec, but much slower through transparent solids. Thus, the refractive index of air will be 1.00, and the refractive index of any transparent solid will be >1.00 .

TMP12 597

4.A) The fovea is composed almost entirely of cones. Blood vessels, ganglion cells, and other layers of cells are all displaced to one side, which allows light to pass unimpeded to the cones.

TMP12 609

5.C) The malleus is attached to the tympanic membrane, and the stapes is attached to the oval window. The incus has articulations with both of these bones.

TMP12 633

6.E) Light passes through the eye to the retina in the posterior portion of the eye. The most anterior layer of the retina, that which light passes first, is the retinal ganglion layer. Light then passes through the other cell layers of the retina until it reaches the photoreceptors in the posterior region of the retina.

TMP12 609

7.B) The axons of the ganglion cells make up the fibers of the optic nerve. The first synapse in the visual system takes place in the lateral geniculate nucleus. Ganglion cells attached to photoreceptors on the temporal side of the retina project to the same sided or ipsilateral lateral geniculate nucleus. Fibers from the nasal side of the retina cross over to the opposite or contralateral lateral geniculate nucleus in the optic chiasm. The medial geniculate nucleus is a sensory relay for the auditory system.

TMP12 623

8.B) The blind spot is located 15 degrees lateral to the central point of vision. It is the location where fibers that make up the optic nerve exit the globe of the eye. As such there are no photoreceptors in this

location.

TMP12 627

9.B) A concave lens diverges light rays; in contrast, a convex lens will converge light rays toward each other. If a convex lens has the appropriate curvature, parallel light rays will be bent so that all pass through a single point called the *focal point*.

TMP12 598

10.B) The tensor tympani muscle pulls the handle of the malleus inward, whereas the stapedius muscle pulls the stapes outward. These two forces oppose each other and thereby cause the entire ossicular system to become more rigid, reducing the intensity of low-frequency sounds by 30 to 40 decibels.

TMP12 634

11.B) The sensation of bitter is caused by many nitrogen-containing organics, as well as by alkaloids.

TMP12 645

12.D) The VIth cranial nerve is also known as the *abducens nerve*. The abducens nerve innervates the lateral rectus muscle which is attached to that lateral surface of the globe of the eye. Contracting the lateral rectus muscle results in moving the eyeball laterally away from the midline of the face in an abducting manner. Thus the name abducens nerve.

TMP12 627–628

13.C) The distance beyond a convex lens at which parallel rays converge to a common focal point is called the focal length of the lens. Thus, the focal point is equal to the focal length for a convex lens. Also, the greater the curvature of the convex lens, the shorter the focal length where these parallel rays will converge.

TMP12 597–598

14.E) The more that a convex lens bends parallel light rays, the greater its refractive power, measured in diopters. By definition, a convex lens with a focal length of 1 m has a refractive power of +1 diopter. If a convex lens can bend parallel light rays twice as much, it is said to have twice the refractive power, or +2 diopters, and a focal length of 0.5 m. Thus, there is an inverse relationship between the focal length and the refractive power. For this question, the convex lens has a focal length of 1 cm (0.01 m), and therefore has 100 times the refractive power, or 100 diopters.

TMP12 600

15.D) The condition of cataracts causes the lens of the eye to become opaque and resemble the look of water in a waterfall or rapids in a river, thus the name, cataract. A cataract results from the progressive coagulation of the proteins that make up the lens. One can think of this as similar to the white of an egg turning opaque as it is cooked. Heating the egg white results in coagulation of the proteins contained within it.

TMP12 604

16.B) The bitter taste sense is much more sensitive than the other sensations, because it is this sensation that provides an important protective function against many dangerous toxins in food.

TMP12 646

17.A) The basilar membrane (see figure) contains basilar fibers, whose length increases progressively from the base of the cochlea to the apex, whereas the overall stiffness of the basilar fibers decreases. As a result, the stiff fibers near the cochlea vibrate best at high frequency, and the less stiff fibers near the apex vibrate best at low frequency.

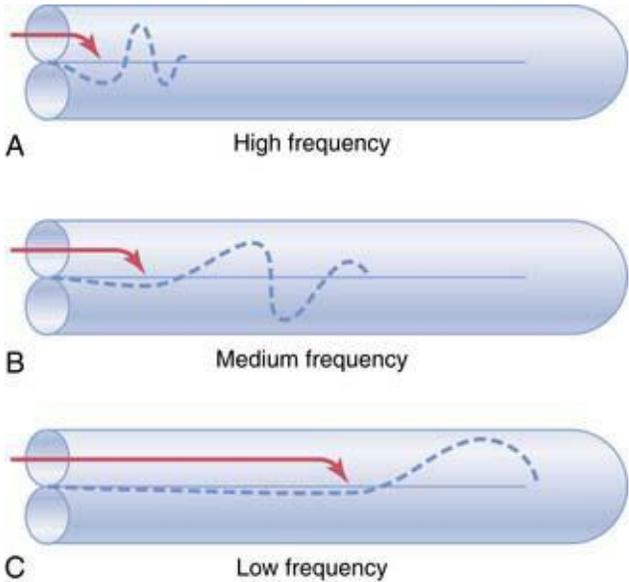


Figure for Answer 17
TMP12 635–636

18.E) The term *umami* is derived from the Japanese word for savory or delicious and is often described as similar to the taste of meat. Glutamate is the chemical believed to elicit the umami taste sensation.
TMP12 646

19.B) Visual information from the primary visual cortex (Brodmann's area 17) is relayed to Brodmann's area 18, and then into other areas of the cerebral cortex for further processing. Analysis of 3-D position, gross form, and motion of objects occurs in the posterior midtemporal area and occipitoparietal cortex. Analysis of visual detail and color occurs in the inferior ventral and medial regions of the occipital and temporal cortex.
TMP12 624,626

20.C) Melanin is the dark pigment that occurs in great abundance in the pigment layer of the retina. The pigment layer functions to limit light scattering inside the globe of the eye and increase contrast and visual acuity.
TMP12 609–611

21.D) Rhodopsin is the light-sensitive chemical in rods. Scotopsin and all-trans retinal are the breakdown products of rhodopsin, which has absorbed light energy. The all-trans retinal is converted into 11-cis retinal, which can recombine with scotopsin to form rhodopsin.
TMP12 611

22.A) One form of vitamin A is all-trans retinol, which is converted through two different pathways into 11-cis-retinal, which then combines with scotopsin to form rhodopsin. Vitamin A is stored in large

quantities in the liver. However, many months of a diet deficient in vitamin A can lead to night blindness, because rhodopsin is crucial for rod function.

TMP12 612

23.E) In presbyopia, each eye remains focused permanently at an almost constant distance. The eyes can no longer accommodate for both near and far vision. Hyperopia and myopia refer to farsightedness and nearsightedness, respectively. Emmetropia is normal vision. Amblyopia has several causes that result in either an absence or loss of binocular vision.

TMP12 601

24.C) The ampulla and saccule are part of the vestibular apparatus, not the cochlear apparatus. The cochlea has three main compartments, with fluid movement occurring in the scala vestibuli and scala media in response to sound vibrations. The organ of Corti is contained within the scala media.

TMP12 634–635

25.C) All taste fibers synapse in the solitary nucleus and send second-order neurons to the ventral posteromedial nucleus of the thalamus. Third order neurons project to the lower tip of the postcentral gyrus in the parietal cortex.

TMP12 648

26.E) The simple cells of the primary visual cortex detect orientation of lines and borders, whereas the complex cells detect lines oriented in the same direction but are not position-specific. That is, the line can be displaced moderate distances laterally or vertically, and the same few neurons will be stimulated as long as the line is the same direction.

TMP12 626

27.A) The malleus is connected to the tympanic membrane, the incus articulates with the malleus and stapes, and the stapes is connected to the oval window.

TMP12 633

28.B) In low light conditions the level of cyclic GMP is high. Cyclic GMP-dependent sodium channels in the outer portions of the rods and cones allow sodium ions to pass from the extracellular space to the intracellular space of the photoreceptor. This results in a membrane potential that is somewhat lower than the resting membrane potential of a typical neuron. The movement of the sodium ions and resulting electrical potential change as a result of this enhanced permeability is known as the *dark current*.

TMP12 612–613

29.C) Taste impulses from the anterior two thirds of the tongue pass first into the lingual nerve, then through the chorda tympani into the facial nerve, and finally to the solitary nucleus. Taste sensations from the posterior third of the tongue are transmitted through the glossopharyngeal nerve to the solitary nucleus. Taste signals from the pharyngeal region are transmitted via the vagus nerve.

TMP12 647–648

30.A) The receptor cells for the smell sensation are bipolar nerve cells derived originally from the central nervous system itself.

TMP12 649

31.E) Although there are three to four times as many outer hair cells as inner hair cells, about 90% of the auditory nerve fibers are stimulated by the inner hair cells.

TMP12 637

32.E) Light rays from a distant object do not require as much refraction (bending) as do light rays from an object close at hand. Therefore, the curvature of the lens required to focus these rays on the retina is less.

TMP12 601

33.C) In the dark state, cGMP helps maintain the open state of the sodium channels in the outer membrane of the rod. Hydrolysis of cGMP by light causes these sodium channels to close. Less sodium is able to enter the rod outer segment, thus hyperpolarizing the rod.

TMP12 613–614

34.E) During photoreception the active compound metarhodopsin is formed. This in turn activates a g-protein called transducin. The transducin activates a c-GMP phosphodiesterase which destroys c-GMP. C-GMP dependent sodium channels close and the influx of sodium ions into the outer segment of the photoreceptors decreases.

TMP12 612–614

35.A) Astigmatism most often results when there is too great a curvature of the cornea in one of its planes. Because the curvature of the astigmatic lens along one plane is less than the curvature along the other plane, light rays striking the two planes will be bent to different degrees. Thus, light rays passing through an astigmatic lens do not come to a common focal point.

TMP12 603

36.C) The scala media is bordered by the basilar membrane and Reissner's membrane, and contains a tectorial membrane. The apical border of hair cells has stereocilia that are embedded in the tectorial membrane.

TMP12 637

37.B) The abducens nerve innervates the lateral rectus muscle. The trochlear nerve innervates the superior oblique muscle. The oculomotor nerve innervates the medial rectus, inferior oblique, superior rectus, and inferior rectus muscles.

TMP12 628

38.E) Even the minutest concentration of a specific odorant initiates a cascading effect that opens extremely large numbers of sodium channels. This accounts for the exquisite sensitivity of the olfactory neurons to even the slightest amount of odorant.

TMP12 650

39.B) The reduction of rhodopsin and cone pigments by light reduces the concentrations of photosensitive chemicals in rods and cones. Thus, the sensitivity of the eye to light is correspondingly reduced. This is called light adaptation.

TMP12 614–615

40.D) In myopia the focal point of the lens system of the eye is in front of the retina. A concave lens will diverge light rays. By placing the proper concave lens in front of the eye the divergence of light rays will move the focal point from in front of the retina to a position on the retina.

TMP12 603

41.A) A bilateral premotor cortical region of the frontal lobes controls voluntary fixation movements. A lesion of this region makes it difficult for a person to “unlock” their eyes from one point of fixation and then move them to another point.

TMP12 628–629

42.C) Concentrations that are only 10 to 50 times above threshold values will evoke maximum intensity of smell, which is in contrast to most other sensory systems of the body, where the range of intensity discrimination may reach 1 trillion to 1. This, perhaps, can be explained by the fact that smell is concerned more with detecting the presence or absence of odors than with quantitative detection of their intensities.

TMP12 650

43.D) Although most cells in the nervous system depolarize in response to sodium entry, hair cells are one group of cells that depolarize in response to potassium entry.

TMP12 637

44.E) There are at least three ways that the auditory system determines loudness. First, the amplitude of vibration of the basilar membrane increases so that hair cells excite nerve endings at more rapid rates. Second, more and more hair cells on the fringes of the resonating portion of the basilar membrane become stimulated. Third, outer hair cells become recruited at a significant rate.

TMP12 636, 638

45.C) Unlike most other sensory receptors that depolarize when activated, the photoreceptors produce the opposite response, which is hyperpolarization. The total number of rods is much greater than the number of cones. Cones respond to a very specific range of wavelengths of light. The pigment layer is posterior to the retinal layer that contains the photoreceptors.

TMP12 612

46.D) In hyperopia the focal point of the eye’s lens system is behind the retina. This is usually the result of an eyeball that is too short in the anterior to posterior direction.

TMP12 602

47.A) Auditory fibers enter the cochlear nucleus. Fibers from the cochlear nucleus pass to the inferior colliculus via the lateral lemniscus. Fibers from the inferior colliculus travel to the medial geniculate nucleus and from there to the primary auditory cortex.

TMP12 639

48.C) Neurons with cell bodies in the spiral ganglion of Corti synapse in the cochlear nuclei. The majority of the cochlear nuclei neurons synapse in the contralateral superior olivary nucleus. Crossing over occurs in at least three places in the pathway, and a preponderance of auditory transmission is in the contralateral pathway. From the superior olivary nucleus, the auditory pathway then passes upward

through the lateral lemniscus, with most auditory fibers terminating at the inferior colliculus. From there, the pathway continues on to the medial geniculate nucleus and then the primary auditory cortex.

TMP12 639

49.B) Research showed that the nervous system perceives the sensation of a specific color by interpreting the set of ratios of stimulation of the three types of cones. Investigators used only red, green, and blue monochromatic lights mixed in different combinations. All gradations of colors the human eye can detect were detected using just these three colors.

TMP12 615–616

50.D) The cochlea is a structure of tubes and chambers that is filled with fluid. The fluid is non compressible. As the stapes moves back and forth against the oval window the increase and decrease in pressure caused by that in and out movement of the oval window is relieved by the opposite back and forth movement of the round window.

TMP12 635

51.C) In a normal individual, shining a light in either eye will result in both pupils constricting due to contraction of the pupillary sphincter muscles. In contrast, the pupillary dilator muscle dilates the pupil. The ciliary muscle is involved in focusing the eye (accommodation).

TMP12 632

52.D) Because one eye is a little more than 2 inches to the side of the other eye, the images on the two retinæ differ from one another. This binocular parallax (stereopsis) allows a person with two eyes far greater ability to judge relative distances when objects are nearby than a person with only one eye.

TMP12 605

53.B) Glaucoma is a disease of the eye in which the intraocular pressure becomes pathologically high, sometimes rising acutely to 60 to 70 mm Hg. Pressures above 30 mm Hg for long periods of time can lead to loss of vision. The most common cause of this higher intraocular pressure is when fluid outflow into the canal of Schlemm is obstructed.

TMP12 607–608

54.A) With nerve deafness, there is damage to the cochlea, auditory nerve, or the neural pathway. The ability to hear sound as tested by both air conduction and bone conduction is greatly reduced or lost with nerve deafness. However, with conduction deafness, the person retains the ability to hear sound by bone conduction, but not by air conduction.

TMP12 642

55.A) In the situation described the eyes will fix on an object in the visual field and remain on that object while the head is turning to the left. This will result in eye movement to the right as the head is turned to the left. When the object is no longer in the central field of vision the eyes will exhibit a quick jumping movement to the left (i.e., in the direction of the head rotation) and fix on a new object in the visual field. This jump is called a saccade. This process will repeat until the head has turned all the way to the left. During saccadic eye movement vision is suppressed.

TMP12 629–630

56.E) Horner syndrome typically occurs when the sympathetic nerve fibers that originated from thoracic spinal cord are interrupted in the cervical sympathetic chain on their way to the eye.

TMP12 632

57.C) At least eight types of neurotransmitter substances have been identified for amacrine cells. The neurotransmitters used for bipolar and horizontal cells are unclear, but it is well established that rods and cones release glutamate at their synapses with bipolar cells (pictured here).

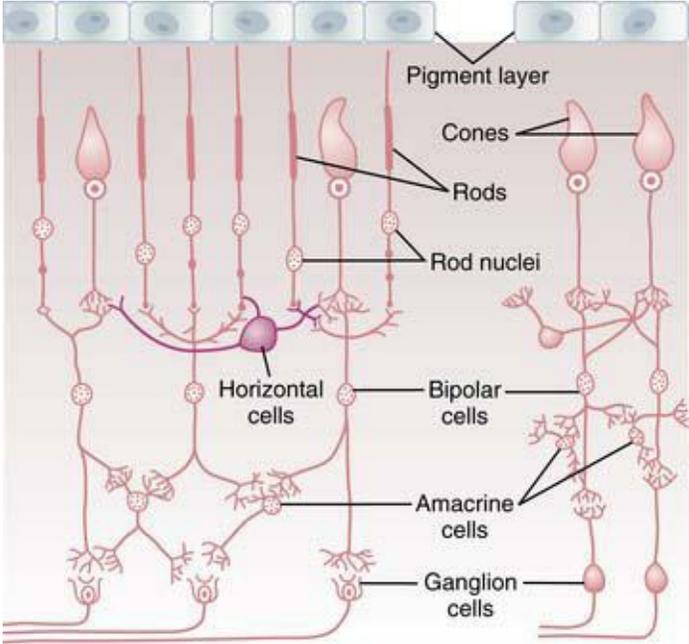


Figure for Answer 57

TMP12 617

58.A) A newer olfactory pathway has been found that projects to the dorsomedial thalamic nucleus and then to the orbitofrontal cortex. However, the older olfactory pathways bypass the thalamus to reach the cortex, in contrast to other sensory systems, which have thalamic relays.

TMP12 651

59.A) The principal reason why the anterior surface of the cornea provides most of the refractive power of the eye is that the refractive index of the cornea is markedly different from that of air.

TMP12 600

60.A) Retinal ganglion cells synapse in several locations, but those conveying information that will ultimately end up in the primary visual cortex synapse in the lateral geniculate nucleus. From there, neurons project to the primary visual cortex.

TMP12 623–624

61.D) There are three distinct groups of retinal ganglion cells, designated as W, X, and Y cells. W cells transmit rod visual signals. Y cells are the least numerous and transmit information about rapid changes in the visual image. X cells are the most numerous and receive input from cones regarding the visual image and color vision.

62.C) The medial geniculate nucleus is the thalamic nucleus that conveys auditory information from the brainstem to the primary auditory cortex.

TMP12 639

63.A) Taste preference, while not completely understood, is believed to involve a central process.

TMP12 648

64.D) Intuitively one would guess that the rod photoreceptor would have the greatest range of spectral sensitivity. However, it is the red cone that has the broadest spectral sensitivity followed by the rods, the green cones, and finally the blue cones, which have the narrowest range of spectral sensitivity.

TMP12 614

65.A) Ciliary processes secrete all of the aqueous humor of the intraocular fluid, at an average rate of 2 to 3 $\mu\text{l}/\text{min}$. These processes are linear folds that project from the ciliary muscle into the space behind the iris. The intraocular fluid flows from behind the iris through the pupil into the anterior chamber of the eye.

TMP12 606

66.A) Circumvallate papillae are located in the posterior part of the tongue, fungiform papillae in the anterior part of the tongue, and foliate papillae on the lateral part of the tongue. The papilla of Vater empties pancreatic secretions and bile into the duodenum.

TMP12 647

67.B) The medial longitudinal fasciculus is a pathway for nerve fibers entering and leaving the oculomotor, trochlear, and abducens nuclei of the brainstem. This allows communication to coordinate the contraction of the various extraocular eye muscles.

TMP12 628

68.C) Only ganglion cells have action potentials. Photoreceptors, bipolar cells, amacrine cells, and horizontal cells all appear to operate through graded potentials.

TMP12 617

69.A) Foliate papillae are located in the folds along the lateral surfaces of the tongue, fungiform papillae are located in the anterior part of the tongue, and circumvallate papillae are located in the posterior part of the tongue. The papilla of Vater empties pancreatic secretions and bile into the duodenum.

TMP12 647

70.E) Most of the primary auditory cortex is in the temporal lobe, but the association auditory cortices extend over much of the insular lobe and even onto the lateral portion of the parietal lobe.

TMP12 640

71.B) Intraocular fluid flows from the anterior chamber of the eye, between the cornea and the iris through a meshwork of trabeculae into the canal of Schlemm, which empties into extraocular aqueous veins (see figure).

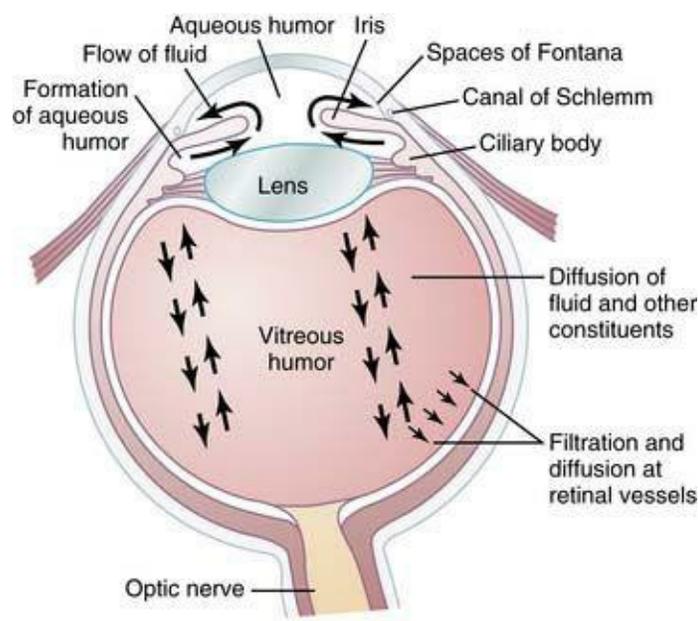


Figure for Answer 71
 TMP12 607

72.B) The termination of taste fibers for all taste sensations is in the nucleus of the solitary tract in the medulla.

TMP12 647–648

73.D) The superior olivary nuclei (see figure) receive auditory information from both ears and begin the process of detecting the direction from which a sound comes. The lateral part of the superior olivary nucleus does so by comparing the difference in intensities of sound reaching the two ears, whereas the medial part of the superior olivary nucleus detects time lag between signals entering both ears.

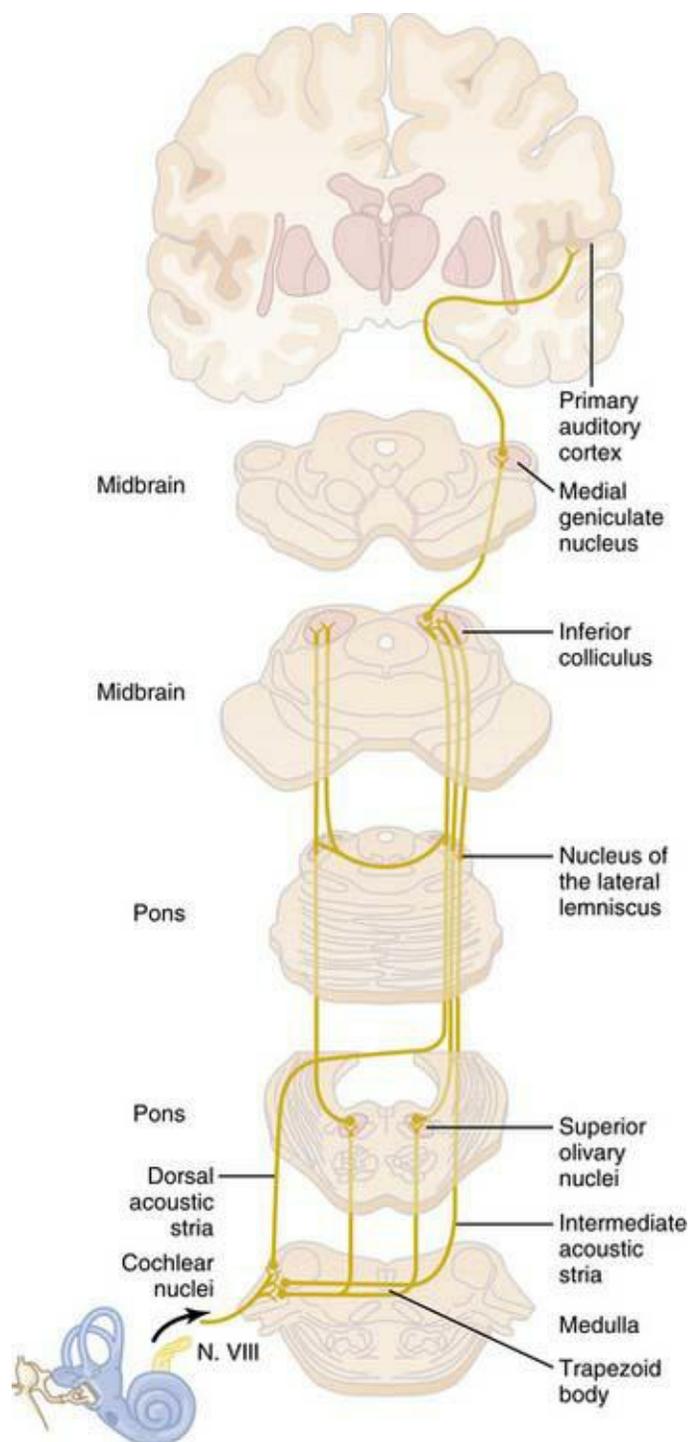


Figure for Answer 73
 TMP12 641

74.D) There appear to be many types of amacrine cells and at least six types of functions. In a sense, amacrine cells begin the analysis of visual signals before they leave the retina. However, horizontal cells, which are always inhibitory, have lateral connections between photoreceptors and bipolar cells. This lateral connection provides the same phenomenon of lateral inhibition that is important in all other sensory systems, helping to ensure transmission of visual contrast.

TMP12 618

75.B) Cyclic GMP-dependent sodium channels in the outer portions of the rods and cones allow sodium ions to pass from the extracellular space to the intracellular space of the photoreceptor. This

results in a membrane potential that is somewhat lower than the resting membrane potential of a typical neuron. The movement of the sodium ions and resulting electrical potential change as a result of this enhanced permeability is known as the *dark current*.

TMP12 612