

**NEUR0010**  
**Week 7 Practice Questions**

**2006-2**

18. The following statements about the external ear are all correct EXCEPT:

- a) the pinna reflects sounds
- b) the tragus is a secondary reflector
- c) structures of the external ear reflect multiple copies of a sound such that the copies enter the ear canal at precisely the same time
- d) the structure of the external ear is critical for determining sound elevation
- e) the shape of the external ear makes humans more sensitive to sounds in front than behind

19. The stapes

- a) is connected by an “o-ring” to the round window
- b) pulls and pushes at the oval window
- c) literally means “anvil”
- d) is attached to the tympanic membrane

20 – 22.5 From the list of structures, choose the best answer matching the following descriptions:

20. Receptor cells that send 95% of the axons to the auditory nerve

20.5 Membrane upon which the Organ of Corti sits

21. Cochlear chamber in which the Organ of Corti sits

21.5 The tips of outer hair cell stereocilia are embedded in this membrane

22. Sound enters the cochlea through this chamber

22.5 Cochlear chamber filled with endolymph

Reticular lamina	Spiral ganglion	Helicotrema
Tectorial membrane	Rods of Corti	Scala vestibule
Basilar membrane	Inner hair cells	Scala media
Stereocilia	Outer hair cells	Scala tympani
Modiolus	Dieter's cells	

23. Comparing the base and apex of the basilar membrane, the base is

- a) wider and stiffer
- b) wider and less stiff
- c) narrower and stiffer
- d) narrower and less stiff
- e) at a lower altitude

24. When sound is transduced by hair cells,

- a) K<sup>+</sup> entry depolarizes the cell causing the entry of Ca<sup>++</sup> through voltage-gated channels
- b) K<sup>+</sup> exit hyperpolarizes the cell causing the entry of Ca<sup>++</sup> through voltage-gated channels
- c) K<sup>+</sup> entry depolarizes the cell causing the exit of Ca<sup>++</sup> through voltage-gated channels
- d) K<sup>+</sup> exit hyperpolarizes the cell causing the exit of Ca<sup>++</sup> through voltage-gated channels

25. The strong driving force on K<sup>+</sup> ions in hair cells is created by

- a) the Na-K ATPase pump
- b) passive K<sup>+</sup> channels
- c) relatively higher K<sup>+</sup> concentration in the perilymph
- d) relatively higher k<sup>+</sup> concentration in the endolymph

26. The following statements about outer hair cells are all correct EXCEPT:

- a) they lack a cytoskeleton
- b) there are more of them than inner hair cells
- c) in a dead animal the piezoelectric effect involved in amplification stops working
- d) the membrane contains prestin molecules that can change shape
- e) output to the brain signals the degree of amplification they provide

27. Deafness in the left ear results from destruction of the

- a) left cochlear nucleus
- b) left superior olive
- c) right inferior colliculus
- d) a or b
- e) a, b, or c

28. Delay lines in the superior olive compute

- a) sound location in the vertical plane based on interaural delay
- b) sound location in the horizontal plane based on interaural delay
- c) sound location in the vertical plane based on phase locking
- d) sound location in the horizontal plane based on phase locking
- e) sound location in the vertical plane based on tonotopy
- f) sound location in the horizontal plane based on tonotopy

29. Tonotopy is found in the

- a) cochlear nucleus
- b) superior olive
- c) medial geniculate nucleus
- d) primary auditory cortex
- e) a and d
- f) all of the above

**2007-2**

1. All of the following cells directly participate in transduction EXCEPT
  - a) photoreceptors
  - b) nociceptors
  - c) cells with axons in the auditory nerve
  - d) cells with axons in the dorsal root of the spinal cord
  
2. The loudness of sound of a particular frequency is most closely related to the
  - a) part of the basilar membrane that is vibrated
  - b) difference in pressure between the compressed and rarefied air in the sound wave.
  - c) duration of sound waves
  - d) Duran Duran of the sound waves.
  
3. The roll of the pinna include
  - a) decreasing the movements of the ossicles during the attenuation reflex
  - b) playing a key role in the localization of sound in the vertical plane
  - c) filtering out sound waves below 20 Hz
  - d) filtering out sound waves above 20 KHz
  
4. Localizing sound in the horizontal plane includes
  - a) delay lines and coincidence detectors
  - b) the superior olive
  - c) sound intensity differences between the two ears
  - d) More than one of the above
  - e) All of the above
  
5. A high frequency sound (10,000 Hz)
  - a) vibrates the base of the basilar membrane.
  - b) vibrates the apex of the basilar membrane.
  - c) vibrates a larger percentage of the basilar membrane than a low frequency sound.
  - d) can be encoded in the auditory system through phase locking.
  
6. Different frequencies of sound waves vibrate different areas of the basilar membrane due to
  - a) the activity of inner hair cells.
  - b) selective filtering of sound waves at the oval window.
  - c) the changing physical properties of the basilar membrane.
  - d) differences in the viscosity of perilymph and endolymph.
  
7. Outer hair cells are
  - a) innervated by more spiral ganglion neurons than inner hair cells.
  - b) less numerous than inner hair cells.
  - c) found in the middle ear.
  - d) the motor for the cochlear amplifier.

8. Which of the following would cause a hair cell to depolarize

- a) opening a potassium channel exposed to endolymph
- b) opening a potassium channel exposed to perilymph
- c) opening a potassium channel exposed to the fluid of the scala media
- d) a and b
- e) a and c
- f) b and c

9. Movement of the oval window back and forth

- a) always results in the hearing of a sound.
- b) will result in movement of the round window back and forth.
- c) does not occur when high frequency sounds are heard.
- d) causes the drapes to swing back and forth.

10. Without the tectorial membrane

- a) stereocilia would not move back and forth as much when the basilar membrane moved up and down.
- b) outer hair cells would no longer be attached to the basilar membrane.
- c) fluid would leak out of the tympanic membrane.
- d) the basilar membrane could not move up and down.

11. Auditory neurons in the central nervous system that are sensitive to sound frequency

- a) only respond to sound from one ear, not both.
- b) typically respond to a single sound frequency.
- c) can be found in the lateral geniculate nucleus.
- d) are often very broadly tuned to frequency.

12. Primary auditory cortex

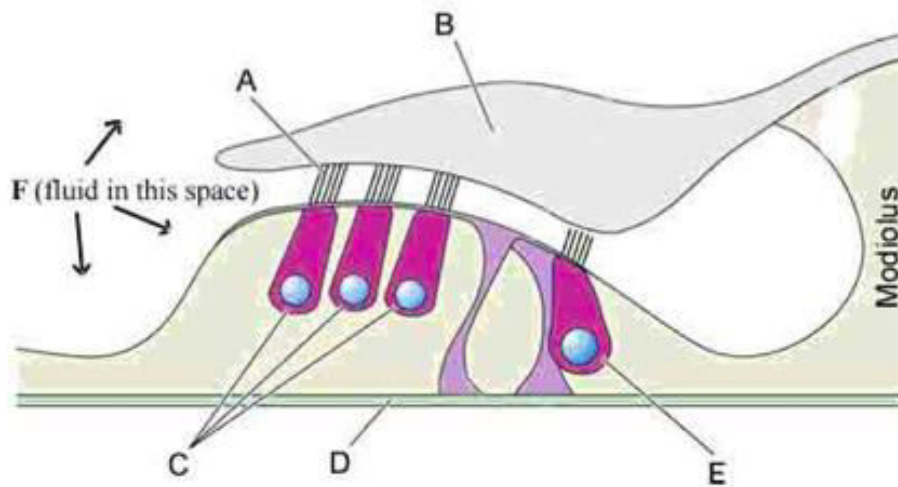
- a) is found in the same lobe of cortex as primary somatosensory cortex
- b) is organized into alternating groups of cells that are either excited by sound in both ears or excited by sound in one ear and inhibited by sound in the other.
- c) contains neurons that respond to sound in the contralateral ear only.
- d) is the only area of the brain which is capable of computing interaural time differences.

## 2008-2

18. One of the functions of the human outer ear is to
- amplify the movements of the oval window due to lever action of the ossicles.
  - play a significant role in the localization of sound in the horizontal plane.
  - play a significant role in the localization of sound in the vertical plane.
  - make humans more sensitive to sound originating from behind the head.
19. All of the following statements about sound conduction in the middle ear are true EXCEPT:
- The pressure difference between the outside and inside of the tympanic membrane is around 760mmHg for a loud sound.
  - When the oval window moves inward the round window moves outward.
  - The footplate of the stapes moves in and out at the oval window.
  - Force per square millimeter at the oval window is amplified because the window is smaller than the tympanic membrane.
20. The helicotrema
- connects the outer ear and middle ear.
  - allows low frequency sound waves to travel between the scala tympani to the scala vestibuli without moving the basilar membrane.
  - helps equalize pressure on both sides of the tympanic membrane.
  - is another word for the shockwaves felt from a low flying helicopter.
21. The APEX of the basilar membrane is \_\_\_\_\_ and vibrates most in response to \_\_\_\_\_ frequency sounds
- stiff and narrow / high
  - stiff and narrow / low
  - floppy and wide / high
  - floppy and wide / low
  - cool / techno music
22. All of the following statements about the cochlea are true EXCEPT:
- low frequency sounds vibrate a greater percentage of the basilar membrane than high frequency sounds.
  - perilymph is similar in composition to cerebrospinal fluid
  - the organ of Corti sits within the scala vestibuli
  - movement of the basilar membrane is smaller in amplitude without the activity of outer hair cells.
23. Which structure contains coincidence detecting binaural neurons used to compute sound location?
- cochlear nucleus
  - inferior colliculus
  - MGN
  - superior olive
  - spiral ganglion
24. The frequency of high frequency sounds is encoded by the nervous system through the use of
- binaural delays
  - tonotopy
  - the volley principle
  - phase locking

25. All of the following are cells that are directly involved in transduction EXCEPT
- hair cells in the cochlea
  - cones in the retina
  - nociceptors in the skin
  - bipolar cells in the retina

26-28. Label the structures (A – F) in the organ of Corti indicated in the figure below:



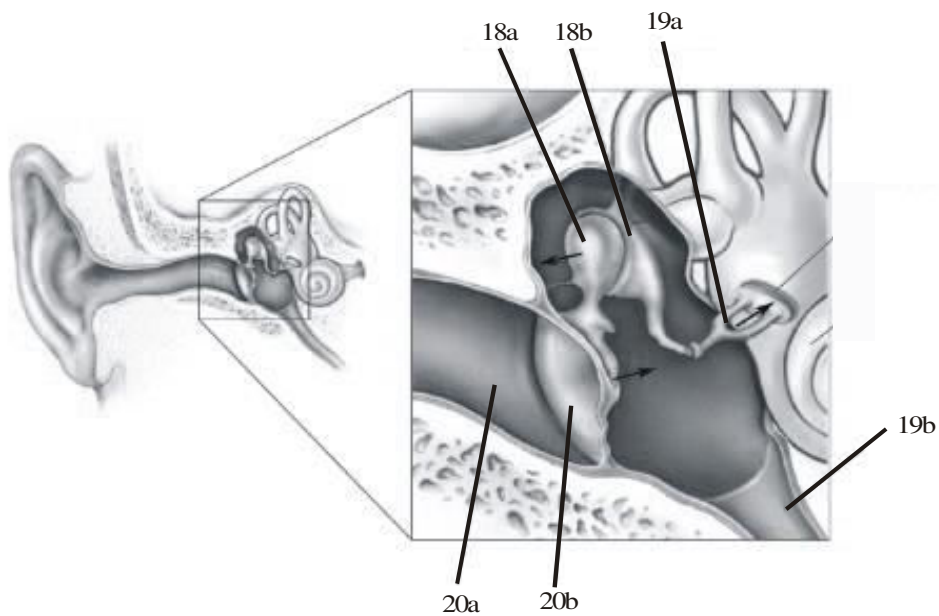
26. (A) \_\_\_\_\_  
 (B) \_\_\_\_\_
27. (C) \_\_\_\_\_  
 (D) \_\_\_\_\_
28. (E) \_\_\_\_\_  
 (F) \_\_\_\_\_

**2009-2**

17. Auditory transduction is initiated by:

- a) influx of  $K^+$  into stereocilia
- b) influx of  $Na^+$  into stereocilia
- c) efflux of  $K^+$  out of stereocilia
- d) efflux of  $Na^+$  out of of stereocilia

18 – 20. Identify the 6 structures in the figure (1 pt each)



21. When sound pushes at the oval window of the cochlea, fluid is first displaced in the

- a) scala corti
- b) scala media
- c) scala tympani
- d) scala vestibuli

22. In the cochlea

- a) there are more inner hair cells than outer hair cells and 95% of the spiral ganglion neurons communicate with inner hair cells
- b) there are more inner hair cells than outer hair cells and 95% of the spiral ganglion neurons communicate with outer hair cells
- c) there are more outer hair cells than inner hair cells and 95% of the spiral ganglion neurons communicate with inner hair cells
- d) there are more outer hair cells than inner hair cells and 95% of the spiral ganglion neurons communicate with outer hair cells

23. It is said that sound transduction involves a cochlear amplifier because

- a) outer hair cells push the basilar membrane amplifying low-intensity sounds
- b) the stereocilia on hair cells bend a distance ten times the distance the basilar membrane is displaced
- c) perilymph is similar to battery acid and it acts to push ions into the hair cells
- d) otoacoustic emissions coming out of the ear are louder than the sound going into the ear

24. Auditory signals are relayed to auditory cortex by which thalamic nucleus

- a) MGN
- b) PGN
- c) VP
- d) VPL

25. Sound localization in the horizontal plane

- a) is seriously degraded by putting tubes into the auditory canal, thus bypassing the pinna
- b) uses delay lines in the cochlear nucleus to signal interaural time delay
- c) is based on phase locking at lower sound frequencies and the volley principle at higher sound frequencies
- d) is based on interaural time delay at lower sound frequencies and interaural intensity differences at higher sound frequencies

26. All the following statements are correct EXCEPT:

- a) sound sends a traveling wave down the basilar membrane
- b) the location on the basilar membrane that moves with the highest amplitude varies with sound frequency
- c) very high frequencies go through the helicotrema which acts as a pressure relief valve
- d) fluid in the cochlea couldn't move at the oval window if it weren't for movement at the round window



27. All the following statements about hair cells in the cochlea are correct EXCEPT:
- a) stereocilia on inner hair cells are embedded in the tectorial membrane, but the cilia on outer hair cells are not embedded
  - b) cilia are moved by a shearing motion caused by the different pivot points of the tectorial and basilar membranes
  - c) outer hair cells are similar to plant cells because, unlike inner hair cells, they would collapse if punctured
  - d) inner hair cells are closer to the modiolus than outer hair cells

**2010-2**

18. The pitch of a sound is related to the \_\_\_\_\_ of sound waves and the loudness is related to the \_\_\_\_\_ of sound waves.

- a) frequency; amplitude
- b) amplitude; frequency
- c) speed; frequency
- d) frequency; speed

19. Humans cannot hear very low frequency sound (less than 20 Hz) because sound energy at this low frequency

- a) does not move the tympanic membrane
- b) maximally vibrates the very base of the basilar membrane
- c) passes through the helicotrema thereby not vibrating the basilar membrane
- d) bounces off the apex of the cochlea and is transmitted back to the oval window

20. All of the following contribute to the amplification of sound pressure waves from the outside the ear to the fluid in the cochlea EXCEPT

- a) the lever action of the ossicles
- b) contractions of the tensor tympani muscle
- c) the larger surface area of the tympanic membrane compared to the oval window
- d) the cone shape of the pinna that funnel sound energy down the ear canal

21. The fluid of the scala media

- a) has a higher concentration of potassium ions than intracellular fluid
- b) bathes the stereocilia of outer and inner hair cells
- c) is kept from surrounding the cell bodies of hair cells by the reticular lamina
- d) All of the above

22. The characteristic frequency of a spiral ganglion neuron
- a) is the only frequency that will elicit action potentials in that cell
  - b) is the frequency that will elicit the greatest number of action potentials per second in that cell
  - c) is the typical number of action potentials per second that the cell fires when activated
23. Phase locking does not work for high frequency sound waves (e.g. 10,000Hz) because
- a) Synchronization of a 1 msec action potential with sound waves that are occurring 10 times every msec is not precise enough for phase locking.
  - b) No cell is able to depolarize and repolarize 10 times every msec.
  - c) 10,000 Hz sound does not have enough energy to vibrate the basilar membrane enough to phase lock.
  - d) The tympanic membrane cannot vibrate back and forth 10,000 per second.
24. You are standing in a dark woods and someone is approaching you on foot. You are trying to use your auditory system to tell the direction from which the person is approaching by listening to the high frequency sounds of rustling leaves and the low frequency sounds of their voice humming. Which of the following mechanisms are helping you with this task?
- a) delay lines and coincidence detectors in the superior olive
  - b) the sound shadow effect of your head
  - c) the ability of your auditory system to shift attention to specific frequencies
  - d) More than one of the above
25. Your roommate brings a funny looking fluid back from his Organic Chemistry lab and accidentally spills it on your pizza. You are really hungry so you eat the pizza anyway only to realize that the compound blocks all potassium channels in outer hair cells. This would cause
- a) complete inability to hear any sound no matter how intense
  - b) difficulty hearing high frequency sounds but not low frequency sounds
  - c) difficulty hearing low frequency sounds but not high frequency sounds
  - d) difficulty hearing all but very loud sounds