

Please **blacken in** (DO NOT CIRCLE) the ***one best answer*** to each question on the answer sheet.
Please keep the questions and hand in your answer sheet. A key should be posted by 6pm tonight.

1. To disconnect the LGN from primary visual cortex, you would have to cut:

- a) optic chiasm
- b) optic nerve
- c) optic radiation
- d) optic tract

2. According to the ridiculous website toptenz.net, the most beautiful eyes in the world are the greenish-brownish ones belonging to Bollywood movie star Aishwarya Rai. Her eye color comes from pigment in which structure:

- a) aqueous humor
- b) iris
- c) pupil
- d) sclera

3. On a recent trip to your beach house in New Jersey, you sit on the sofa and extend your leg down into the 2 feet of water in the living room. As the roof on the house was blown off by hurricane Sandy, the sun gives you a good look at your leg that appears to oddly bend as it goes into the water. Your straight leg appears to bend because:

- a) water has a lower index of refraction than air and when light enters the water it bends toward a line perpendicular to the surface
- b) water has a lower index of refraction than air and when light enters the water it bends away from a line perpendicular to the surface
- c) water has a higher index of refraction than air and when light enters the water it bends toward a line perpendicular to the surface
- d) water has a higher index of refraction than air and when light enters the water it bends away from a line perpendicular to the surface

4. A trademark move of the 3 Stooges was Moe poking his fingers in Larry's eyes. For Larry to focus on Moe's fingers as they are just about to hit his eyes, he will need to:

- a) contract his ciliary muscles and stretch the zonule fibers
- b) loosen the zonule fibers to make the lens more convex
- c) relax the ciliary muscles to make the lens flatter
- d) make the lens less convex by compressing the vitreous humor

5. Which layer of the retina is the innermost in the eye?

- a) inner nuclear layer
- b) ganglion cell layer
- c) inner plexiform layer
- d) photoreceptor layer

6. The second messenger used in the transduction of light is:

- a) cGMP
- b) Na⁺
- c) rhodopsin
- d) transducin

7. As part of risky Operation Fireball, you enter a rocket based 2 miles below the earth's surface in complete darkness and launch straight toward the sun. In the dark before takeoff, your photoreceptors are dark adapted. Thirty seconds after launch you are half way to the sun facing intense light (it's a fast rocket). Before the new light adapted state is reached, all the following happen in cones EXCEPT

- a) Ca⁺⁺ influx into cones decreases
- b) inhibition of guanylyl cyclase decreases
- c) voltage-gated cation channels in the cone membrane close
- d) less cGMP is produced

8. Which type of vision is better with the peripheral retina than the fovea?

- a) color vision
- b) motion perception
- c) better visual sensitivity in low light (scotopic) conditions
- d) facial recognition

9. The receptive field surround of a retinal ganglion cell involves input from what type of neuron that is not involved in input to the receptive field center?

- a) amacrine cell
- b) bipolar cell
- c) ganglion cell
- d) horizontal cell

10. Retinal ganglion cells are best described as coding:

- a) overall light level
- b) spatial differences in light level
- c) direction of motion
- d) stimulus speed

11. The great majority of retinal ganglion cells are of which type:

- a) magno
- b) parvo
- c) nonM-nonP
- d) non sequitur

12. The Berson lab at Brown discovered an odd type of retinal ganglion cell that directly transduces light. These neurons have all the following properties EXCEPT:

- a) a different photopigment from rods and cones
- b) slow response to light
- c) project to the superior colliculus
- d) tiny receptive fields

13. On the remote island of Thalamania, the neuro-savvy natives have a ritual in which they pass a fine bamboo shoot straight downwards from the top of their head on the right side until it comes out through the bottom of their brain. In passing through the brain the bamboo glides through every layer of the right LGN. The first LGN layer the bamboo penetrates is filled with:

- a) magno cells driven by the right eye
- b) parvo cells driven by the left eye
- c) konio cells driven by the left eye
- d) magno cells driven by the left eye

14. What percentage of the input to the LGN comes from the eyes?

- a) 20%
- b) 40%
- c) 60%
- d) 80%

15. As part of an evil scientist competition sponsored by the Providence Kiwanis Club you propose to make a magno-blind person by selectively removing a single layer of primary visual cortex. The V1 layer that you would remove to cause the biggest loss of magno input from the LGN is:

- a) layer 2
- b) layer 4c alpha
- c) layer 4c beta
- d) layer 6

16. Your advisor for the evil scientist competition thinks your idea of destroying a single cortical layer to hit magno input is not evil enough. You must think bigger! She would prefer that you do your best to make a person truly motion blind. What brain structure might you destroy to satisfy your advisor and selectively abolish motion perception (i.e. leaving vision otherwise intact)?

- a) LGN
- b) V1
- c) MT
- d) IT

17. Which layer of V1 has the largest percentage of monocular neurons?

- a) layer 2
- b) layer 4c
- c) layer 5
- d) layer 6

18. In area V1, cells running from the pia to the white matter share similar receptive field properties. This is the case for all the following attributes EXCEPT:

- a) orientation tuning
- b) ocular dominance
- c) retinotopy
- d) direction of motion tuning

19. Cytochrome oxidase blobs appear most specialized for what aspect of vision?
- a) orientation selectivity
 - b) direction selectivity
 - c) color selectivity
 - d) face selectivity
20. A person is speaking at the other end of a large room and you hear the sound of their voice. Which of the following statements is true?
- a) The very same air particles displaced by the person's vibrating vocal cords travel across the room and hit your tympanic membrane.
 - b) The pressure gradient between the compressed and rarefied air in the sound wave vary from 0 to 760 mmHg in pressure.
 - c) As the person's vocal cords vibrate they generate a wave of compressed and rarefied air that travels to your tympanic membrane.
 - d) A reasonable estimate for the magnitude of such a sound is 120 decibels.
21. Don't ask how, but right before a debate the pinnae of Barack Obama are switched with those of Mitt Romney. As the candidates stand there wearing each other's pinnae, they would both
- a) have difficulty localizing sounds in the vertical plane.
 - b) be unable to hear low frequency sounds.
 - c) be unable to hear high frequency sounds.
 - d) be completely unable to hear the moderator of the debate say, "Your time is up."
22. If the tympanic membrane were the same size as the footplate of the stapes
- a) no sound could be heard.
 - b) hearing would be more sensitive to low intensity sound
 - c) balance would be disturbed
 - d) noises would not seem as loud
23. Which of the following is going to cause more perilymph to pass back and forth through the helicotrema?
- a) a loud, low frequency sound
 - b) a loud, high frequency sound
 - c) blockage of the eustachian tube
 - d) blockage of the ear canal
24. All of the following factors are essential for the proper movement of the inner hair cell stereocilia in response to sound EXCEPT
- a) stiff Rods of Corti
 - b) shortening and lengthening of outer hair cells
 - c) depolarization and repolarization of outer hair cell membranes
 - d) the insertion of inner hair cell stereocilia into the tectorial membrane
25. All of the following statements are true EXCEPT
- a) There are roughly 3 times more outer hair cells than inner hair cells.
 - b) More axons in the auditory nerve synapse with outer hair cells than with inner hair cells.
 - c) Ringing in the ears (tinnitus) can be caused by spontaneous activity of outer hair cells.
 - d) The base of the basilar membrane is narrow and stiff compared to the apex.

26. Possessing a twisted mind (and a whole lot of spare time) you decide to play a practical joke on your roommate and replace the endolymph in his scala media with perilymph. What will be the consequence of your actions as the sound of your evil laugh travels to your roommate's newly engineered auditory system?

- a) The thick perilymph will prevent all vibration of the basilar membrane.
- b) Hair cells will hyperpolarize when potassium channels on stereocilia are opened.
- c) Only outer hair cells will respond to sound waves.
- d) The membrane potential of hair cells will no longer change in the presence of sound waves.

27. You are recording from an axon in the auditory nerve and you notice that it responds best to low frequency sound. What can you conclude about this axon?

- a) It synapses with an inner hair cell located in the base of the cochlea.
- b) It will only respond to one specific frequency within the low frequency sound range.
- c) It is quite possible that the cells action potentials will be phase locked to the low frequency sound.
- d) More than one of the above

28. If a sound originates from the right side of the environment

- a) action potentials will reach the right cochlear nucleus before they reach the left cochlear nucleus.
- b) the intensity of the sound will be higher in the right ear than in the left ear.
- c) coincidence detector neurons in the left (medial) side of the right superior olive will fire.
- d) More than one of the above.
- e) All of the above.

29. Horizontal localization of sound is accomplished by

- a) delay lines and coincidence detectors
- b) sound intensity differences between the two ears
- c) the time difference in the arrival of sound at the two ears
- d) More than one of the above
- e) All of the above

30. The nucleus in the thalamus that is responsible for relaying auditory information to the cortex is the

- a) medial geniculate nucleus
- b) lateral geniculate nucleus
- c) ventroposterior nucleus
- d) intralaminar nucleus

31. The systematic organization of neurons, such as that in the primary auditory cortex, whereby neurons responding to particular sound frequencies are located in order from low frequency to high is referred to as

- a) the characteristic frequency
- b) a tuning curve
- c) tonotopy
- d) a keyboard

32. Phase locking only works for low to mid frequency sounds because

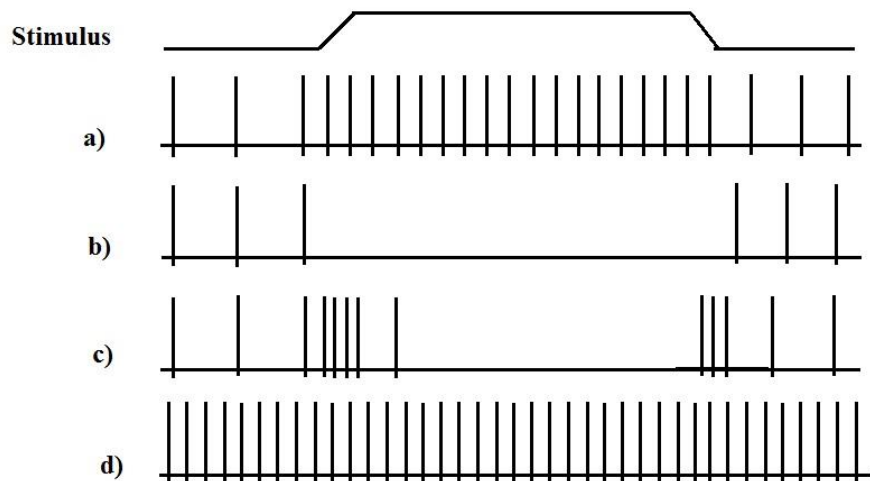
a) the timing of an action potential is not precise enough to reliably report the exact timing of the occurrence of a peak or trough within a high frequency sound.

b) high frequency sounds do not trigger action potentials in auditory neurons.

c) Phase locking requires a neuron to fire on every cycle of a sound wave so this cannot happen for frequencies above 1000 Hz.

d) these are the only sound frequencies that are easily localized in the environment.

33. Below is the time course of a somatic sensory mechanical stimulus along with four membrane potential recordings indicating action potentials aligned in time with the stimulus (a,b,c,d). Which of the following recordings demonstrates the property of adaptation? (c)



34. Compared to the response properties of Merkel's disks, Pacinian corpuscles

a) have larger receptive fields

b) demonstrate faster adaptation

c) are located closer to the surface of the skin

d) More than one of the above

e) All of the above

35. The encapsulations found around Pacinian corpuscles

a) result in a corpuscle response that is very sensitive to vibrating mechanical stimuli on the skin

b) prevent the corpuscle from responding to mechanical stimuli

c) prevent adaptation of the corpuscle response to constant stimuli

d) are very hard and solid creating a shell around the end of the axon.

36. A one-inch square patch of skin located on which part of the body will have the *smallest* representation in somatosensory cortex?

a) lip

b) finger tip

c) big toe

d) forearm

37. Information carried by the epicritic division of the somatosensory system

- a) travels through A fibers in the dorsal spinal nerve
- b) includes the modalities of pain and temperature
- c) travels through synapses in the Medial Geniculate nucleus
- d) travels through axons located in the dorsal part of the spinal cord

38. A flare-up of shingles in dermatome Sacral 5 would be a real pain in the

- a) neck
- b) chest
- c) arm
- d) ass...uming it did not spread beyond S5, pain would be limited to the area around the anus

39. A tiny little horse named Peter is galloping through your rostral medulla when it decides to start grazing on your left medial lemniscus. Destruction of the left medial lemniscus will lead to

- a) inability to feel touch and vibration on the right side of your body
- b) inability to feel pain and temperature on the right side of your body
- c) inability to feel touch and vibration on the left side of your body
- d) inability to feel pain and temperature on the left side of your body

40. All of the following are alternative names for or included within primary somatosensory cortex EXCEPT

- a) post-central gyrus
- b) Brodmann's areas 3a and 3b
- c) Area S1
- d) Brodmann's area 18

41. For 8 weeks you train to read the raised dots of braille with the third digit of your left hand. As you get more proficient, the height of the raised dots is diminished making the task more difficult. You can expect that after 8 weeks of such training the representation of

- a) digit 3 in right primary somatosensory cortex will get bigger
- b) digit 3 in left primary somatosensory cortex will get bigger.
- c) digits 2 and 4 in left primary somatosensory cortex will get smaller
- d) digits 2 and 4 in right primary somatosensory cortex will get bigger

42. You love mashed potatoes and you can't get enough of them. You plan on tricking one of your relatives into NOT eating their potatoes at Thanksgiving so you can steal them from his/her plate. You have a device that when placed on the head can temporarily inactivate underlying cortex. Which of the following manipulations has the best chance of deceiving your relative into ignoring (neglecting) their potatoes?

- a) Inactivate their right posterior parietal cortex and then place potatoes on the left side of their plate.
- b) Inactivate their left posterior parietal cortex and then place potatoes on the left side of their plate.
- c) Inactivate primary auditory cortex and put the potatoes in their water glass.
- d) Inactivate their inferior olives on both sides and then stuff the potatoes into their ear canals.

43. Which of the following would be *the best* way to decrease your perception of pain in your leg?

- a) inject substance P into your lumbar and sacral spinal cord
- b) inject capsaicin into the dorsal root ganglia of the lumbar and sacral spinal cord
- c) activate TRPV receptors in nociceptors
- d) inject morphine into the substantia gelatinosa of the lumbar and sacral spinal cord

44. One of the most interesting findings from the study on the SCN9A channelopathy that causes congenital inability to experience pain is that

- a) nociceptors express a unique subtype of voltage-gated sodium channel in their membrane.
- b) voltage-gated sodium channels are only found in nociceptors
- c) in this disease, nociceptors are lacking TRPV receptors
- d) all axons in the DCML pathway are missing in people with this disease

45. The brachialis muscle of the upper arm is:

- a) involved in arm extension AND a synergist of the triceps muscle
- b) involved in arm extension AND an antagonist of the triceps muscle
- c) involved in arm flexion AND an antagonist of the biceps muscle
- d) involved in arm flexion AND a synergist of the biceps muscle

46. All the following are properties of fast twitch muscle EXCEPT:

- a) high capillary density
- b) few mitochondria
- c) fatigues rapidly
- d) much stored energy

47. Regarding fast and slow twitch muscles:

- a) muscles can contain either fast or slow muscle, but not both
- b) fast muscle fibers can be converted into slow muscle fibers
- c) the ratio of fast and slow fibers a person has is determined before birth
- d) fast muscle is striated and slow muscle is unstriated

48. Muscles in your hands are controlled by neurons located in which portion of the spinal cord:

- a) cervical
- b) sacral
- c) lumbar
- d) thoracic

49. Fasciculations reflect spontaneous activity in one:

- a) muscle fiber
- b) motor pool
- c) gamma motor neuron
- d) alpha motor neuron

50. Golgi tendon organs

- a) send information about muscle force via Ia axons
- b) send information about muscle force via Ib axons
- c) send information about muscle length via Ia axons
- d) send information about muscle length via Ib axons

MULTIPLE CHOICE—2 pts each

- | | | |
|--------------------|----------------------|--------------------|
| 1. a b c d | 21. a b c d | 41. a b c d |
| 2. a b c d | 22. a b c d | 42. a b c d |
| 3. a b c d | 23. a b c d | 43. a b c d |
| 4. a b c d | 24. a b c d | 44. a b c d |
| 5. a b c d | 25. a b c d | 45. a b c d |
| 6. a b c d | 26. a b c d | 46. a b c d |
| 7. a b c d | 27. a b c d | 47. a b c d |
| 8. a b c d | 28. a b c d e | 48. a b c d |
| 9. a b c d | 29. a b c d e | 49. a b c d |
| 10. a b c d | 30. a b c d | 50. a b c d |
| 11. a b c d | 31. a b c d | |
| 12. a b c d | 32. a b c d | |
| 13. a b c d | 33. a b c d | |
| 14. a b c d | 34. a b c d e | |
| 15. a b c d | 35. a b c d | |
| 16. a b c d | 36. a b c d | |
| 17. a b c d | 37. a b c d | |
| 18. a b c d | 38. a b c d | |
| 19. a b c d | 39. a b c d | |
| 20. a b c d | 40. a b c d | |

wrong _____x2 _____

Grade _____