

CNS Lecture 4 – Advanced Questions

Multiple-Choice (30 questions — deep understanding)

1. Which structural feature best explains why cones provide higher spatial resolution than rods?
 - A. Cones have membranous discs separated from the cell membrane.
 - B. Cones are mostly located in the retinal periphery.
 - C. A single cone often connects to fewer second-order neurons than a rod.
 - D. Cones have greater sensitivity to light than rods.
2. The optic disc is a blind spot because:
 - A. it contains only cones but no rods.
 - B. photoreceptor outer segments are degenerated there.
 - C. axons of the neural layer exit the eyeball there and no photoreceptors are present.
 - D. it is the site of highest photoreceptor density causing signal saturation.
3. Aqueous humor accumulation causing glaucoma is most directly the result of impairment of:
 - A. vitreous humor production.
 - B. drainage through channels at the angle between iris and cornea.
 - C. ciliary muscle contraction.
 - D. lens permeability.
4. Which explanation best accounts for the difference in dark sensitivity between rods and cones?
 - A. Rods lack inner segments with mitochondria.
 - B. Cones have stacked membranous discs separated from the cell membrane which lowers sensitivity.
 - C. Rod outer segments are rod-shaped and optimized for photon capture at low intensity.
 - D. Cones are absent from the retinal periphery where low light sensing occurs.
5. The pathway of aqueous humor from production to systemic venous circulation is:
 - A. ciliary processes → anterior chamber → posterior chamber → angle channels → veins
 - B. ciliary processes → posterior chamber → through pupil → anterior chamber → angle channels → veins
 - C. lens → posterior cavity → anterior chamber → trabecular meshwork → veins
 - D. cornea → anterior chamber → posterior chamber → Schlemm's canal → veins
6. Which feature of the lens is most important for keeping the optical media avascular while maintaining lens transparency?
 - A. The lens divides the eyeball into anterior and posterior cavities.
 - B. The lens lacks blood vessels.
 - C. The lens contains abundant Golgi and polyribosomes.
 - D. The lens produces vitreous humor.
7. Damage to the stapedius muscle would most likely result in:
 - A. inability to equalize middle-ear pressure with the pharynx.
 - B. increased susceptibility to loud sounds because the stapes could not be damped.
 - C. decreased transmission of sound to the oval window.
 - D. hypermobility of the tympanic membrane only.
8. Which statement about perilymph and endolymph is best supported by the lecture content?
 - A. Endolymph lies between the bony labyrinth and membranous labyrinth.
 - B. Perilymph fills the membranous labyrinth.
 - C. Perilymph occupies the space between the bony and membranous labyrinths; endolymph is inside the membranous labyrinth.
 - D. Both fluids occupy the same cochlear compartments interchangeably.

9. The round window (secondary tympanic membrane) functions primarily to:
- A. transmit sound from the oval window into the cochlea.
 - B. equalize pressure and allow displacement of perilymph when the stapes moves in the oval window.
 - C. connect the middle ear to the pharynx.
 - D. produce endolymph.
10. Why does the organ of Corti transduce mechanical vibrations into neural signals?
- A. Because its tectorial membrane is vascularized to supply hair cells.
 - B. Because hair cell stereocilia bend relative to the tectorial membrane when the basilar membrane vibrates.
 - C. Because endolymph pressure directly activates cochlear neurons without hair cells.
 - D. Because the basilar membrane secretes neurotransmitters in response to perilymph flow.
11. A lesion that prevents communication between the cochlear duct (containing endolymph) and perilymph would most likely:
- A. abolish ossicle movement.
 - B. prevent waves from traveling between scala vestibuli and scala tympani, altering basilar membrane motion.
 - C. cause the tympanic membrane to rupture.
 - D. increase aqueous humor production.
12. Which is the best functional reason the auricle (pinna) of the ear is made of elastic cartilage?
- A. Elastic cartilage provides rigid support for ossicles.
 - B. Elastic cartilage allows shape retention while acting as an efficient directional antenna for sound.
 - C. Elastic cartilage secretes cerumen.
 - D. Elastic cartilage transmits vibrations directly to the tympanic membrane.
13. If the tensor tympani contracts reflexively, the immediate mechanical effect is:
- A. stiffening of the tympanic membrane, reducing transmission of low-frequency vibrations.
 - B. relaxation of the stapes at the oval window.
 - C. increased perilymph movement.
 - D. detachment of the ossicles.
14. Which anatomic arrangement most directly enables the cochlea to separate different sound frequencies?
- A. The oval and round windows being on opposite sides of the cochlear duct.
 - B. The basilar membrane's graded mechanical properties along its length.
 - C. The spiral shape of the cochlea ensuring equal tension across the basilar membrane.
 - D. The organization of the ossicles in a lever system.
15. The photoreceptor inner segment contains organelles necessary for photoreceptor metabolic needs. Which implication follows from this organization?
- A. Damage to inner segments would selectively impair phototransduction by removing membranous discs.
 - B. Inner segment organelles (mitochondria, Golgi) support outer segment renewal and thus photoreceptor health.
 - C. Inner segments are the primary light-sensing structures.
 - D. Inner segments absorb stray light using melanin.
16. Which of the following best explains why the vitreous humor is important for eyeball shape maintenance?
- A. It is produced by the ciliary processes and exerts outward pressure.
 - B. The gelatinous vitreous fills the posterior cavity and provides structural support.
 - C. It circulates between anterior and posterior chambers to lubricate the lens.

D. It drains via the angle between iris and cornea.

17. A patient with glaucoma due to decreased outflow drainage would show which immediate mechanical change inside the eye?

- A. decreased intraocular pressure because aqueous humor accumulation reduces pressure.
- B. increased intraocular pressure in the anterior cavity.
- C. increased vitreous humor production.
- D. displacement of the optic disc toward the cornea.

18. Which description explains the relative distribution of cones and rods and their functional consequences?

- A. Cones are mostly peripheral permitting color vision in the periphery; rods are concentrated centrally for detail.
- B. Cones are mostly in the center (foveal region) enabling high acuity and color vision; rods are mostly peripheral enabling night vision and motion detection.
- C. Rods and cones are evenly distributed; specialization arises only from downstream neural wiring.
- D. Rods are only present at the optic disc.

19. Which structural detail of the photoreceptor outer segments is correctly paired with its functional consequence?

- A. Membranous discs continuous with cell membrane in cones → higher sensitivity to low light.
- B. Rod outer segment rod-shape and membranous discs → greater photopigment surface area for low-light detection.
- C. Cone outer segments separated discs → inability to process color.
- D. Rods contain polyribosomes in outer segment → rapid protein synthesis there.

20. Considering sound transmission through the ear, which step is MOST energy-conserving and explains how air pressure waves are efficiently transferred to fluid waves?

- A. The tympanic membrane converts air pressure waves directly into neural signals.
- B. The ossicles act as a lever system that amplifies force and matches impedance between air and cochlear fluids.
- C. The oval window enlarges to allow more displacement of perilymph.
- D. The round window generates additional waves to supplement the oval window.

21. Which statement about the auditory tube (Eustachian tube) is best supported by the lecture material?

- A. It transmits sound to the inner ear.
- B. It connects the middle ear with the pharynx to equalize air pressure around the tympanic membrane.
- C. It drains perilymph from the cochlea.
- D. It is the primary site of middle ear muscle attachment.

22. A small lesion destroying the vestibule would most likely affect:

- A. hearing frequency discrimination only.
- B. equilibrium and static head position sensation more than sound transduction.
- C. production of endolymph.
- D. vibration of the tympanic membrane.

23. Why are the semicircular canals particularly suited to detect angular acceleration?

- A. They are filled with aqueous humor that changes pressure with rotation.
- B. Their membranous ducts within bony canals allow endolymph displacement relative to canal movement, stimulating hair cells.
- C. They are connected directly to the cochlea enabling frequency analysis.
- D. They are rigid and thus bend with head movement directly.

24. Which is the best mechanistic reason the tympanic membrane is convex toward the middle ear?

- A. Convexity increases the surface area for attachment of the stapes.
- B. Convex shape optimizes capture of sound energy and couples it to the malleus.
- C. Convexity prevents infection from entering the middle ear.
- D. Convex shape stores energy to be released slowly to the oval window.

25. If the membranous labyrinth is ruptured, which immediate fluid change occurs locally?

- A. Loss of perilymph into the middle ear.
- B. Mixing of endolymph and perilymph due to breach in separate compartments.
- C. Increased production of aqueous humor.
- D. Collapse of the tympanic membrane.

26. The difference between membranous and bony labyrinths is functionally significant because:

- A. the membranous labyrinth is the rigid protective shell and the bony labyrinth contains the sensory organs.
- B. the bony labyrinth houses perilymph which cushions the membranous labyrinth; the membranous labyrinth contains endolymph and the sensory epithelium.
- C. the membranous labyrinth produces perilymph and the bony labyrinth produces endolymph.
- D. both labyrinths are continuous fluid spaces with identical composition.

27. Which combination most directly reduces the risk of inner ear damage from sudden loud noises?

- A. contraction of tensor tympani and stapedius muscles to damp vibrations of tympanic membrane and ossicles.
- B. increased endolymph production and decreased perilymph absorption.
- C. closure of the auditory tube and relaxation of ossicle joints.
- D. stiffening of the basilar membrane by the tectorial membrane.

28. Considering anatomy and function together: which statement best explains why visual acuity is highest at the retinal center?

- A. The optic disc lies at the center concentrating axons there.
- B. Cones are concentrated centrally and connect in a one-to-one relationship with downstream neurons, minimizing convergence and increasing acuity.
- C. Vitreous humor focuses light more at the peripheral retina.
- D. The anterior chamber directs light preferentially to the central retina.

29. During loud sound exposure the stapedius reflex activates. The primary protective effect is:

- A. increased transmission through the ossicles to avoid damage to the tympanic membrane.
- B. reduction of stapes movement at the oval window, lowering sound energy transmitted to the cochlea.
- C. opening of the round window wider to dissipate energy.
- D. altering aqueous humor flow to reduce intraocular pressure.

30. Which structural relation most directly allows the tympanic membrane to transmit vibrations to the ossicles?

- A. The tympanic membrane is attached to the malleus which articulates with the incus and stapes.
- B. The tympanic membrane is continuous with the secondary tympanic membrane.
- C. The tympanic membrane floats in the external auditory canal transmitting vibrations through air only.
- D. The tympanic membrane connects directly to the cochlear duct.

True / False (30 statements — choose True or False; they require reasoning)

31. The retina's pigmented outer layer contains melanin that helps absorb stray light — True /

False.

32. Axons from the neural retinal layer form the optic nerve (cranial nerve II). — True / False.

33. Cones have higher sensitivity to dim light than rods. — True / False.

34. The optic disc contains a high density of rods and cones, which is why it is the most sensitive retinal area. — True / False.

35. The lens is avascular and helps separate the eyeball into anterior and posterior cavities. — True / False.

36. Aqueous humor circulates from the posterior chamber to the anterior chamber through the pupil. — True / False.

37. Glaucoma results when production of aqueous humor completely stops. — True / False.

38. Vitreous humor is a gelatinous substance that fills the posterior cavity and helps maintain eyeball shape. — True / False.

39. The external ear includes the auricle, external auditory canal, and tympanic membrane. — True / False.

40. The tympanic membrane is convex toward the external auditory canal. — True / False.

41. The middle ear contains the malleus, incus and stapes which articulate via synovial joints. — True / False.

42. The stapes fits into the secondary tympanic membrane. — True / False.

43. The tensor tympani and stapedius muscles help protect the inner ear from loud noises by modulating ossicle motion. — True / False.

44. The auditory (Eustachian) tube connects the middle ear with the pharynx to help equalize pressure. — True / False.

45. The inner ear is composed of the vestibule, cochlea, and semicircular canals; the membranous labyrinth has a matching shape inside the bony cavities. — True / False.

46. Endolymph is found between the bony membrane and the membranous labyrinth. — True / False.

47. Perilymph fills the space between the bony labyrinth and the membranous labyrinth. — True / False.

48. The cochlear duct contains endolymph and sits between the scala vestibuli and scala tympani. — True / False.

49. Movement of the stapes in the oval window sets up fluid waves in the perilymph that are transmitted through the helicotrema to the scala tympani. — True / False.

50. The basilar membrane separates the scala vestibuli and scala tympani. — True / False.

51. The organ of Corti is the sensory organ for hearing, located on the basilar membrane within the cochlear duct. — True / False.

52. The tectorial membrane is part of the organ of Corti and plays a role in bending hair cell stereocilia. — True / False.

53. Sound waves travel in sequence: external auditory canal → tympanic membrane → ossicles → oval window → perilymph → basilar membrane → organ of Corti. — True / False.

54. Semicircular ducts within the canals are part of the membranous labyrinth and are important for detecting rotational movements. — True / False.

55. The spiral organ (organ of Corti) is immersed in perilymph within the cochlear duct. — True / False.

56. The secondary (round) tympanic membrane vibrates in response to pressure changes in the cochlea. — True / False.

57. The auricle's shape serves as an antenna to collect sound waves. — True / False.

58. The stapedius is the largest skeletal muscle in the body and amplifies ossicle motion. — True / False.

59. The auditory ossicles articulate by fibrous joints rather than synovial joints. — True / False.

60. The ciliary processes produce aqueous humor. — True / False.

Answer key (answers only)

Multiple-Choice answers (1–30):

1. C

2. C
3. B
4. C
5. B
6. B
7. B
8. C
9. B
10. B
11. B
12. B
13. A
14. B
15. B
16. B
17. B
18. B
19. B
20. B
21. B
22. B
23. B
24. B
25. B
26. B
27. A
28. B
29. B
30. A

True / False answers (31–60):

31. True
32. True
33. False
34. False
35. True
36. True
37. False
38. True
39. True
40. False
41. True
42. False
43. True
44. True
45. True
46. False
47. True
48. True
49. True
50. True
51. True
52. True
53. True
54. True
55. False

- 56. True
- 57. True
- 58. False
- 59. False
- 60. True