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Vision Physiology

Study Guide — Vision

High school / pre-med / IB questions on eye optics, retina and photoreceptors, phototransduction basics, and key visual pathway concepts.

30 items — Study Guide with Answers

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1 **In a normal human eye, which structure provides the LARGEST share of the eye's refractive (focusing) power when looking at distant objects?**

A **Cornea** ✓
B Lens
C Vitreous humor
D Retina
E Ciliary body

▶ **Explanation:** Most refraction occurs at the air–cornea boundary, so the cornea provides most focusing power. The lens mainly fine-tunes focus (accommodation), while retina and vitreous do not refract significantly.

2 **The primary function of the iris is to:**

A Focus light onto the retina by changing shape
B **Regulate light entry by changing pupil diameter** ✓
C Convert light into nerve impulses
D Carry blood vessels to nourish the retina
E Produce aqueous humor for the anterior chamber

▶ **Explanation:** The iris contains muscles that constrict or dilate the pupil, controlling how much light enters. The lens focuses, and the retina converts light into neural signals.

3 **When shifting focus from a distant object to a near object, which set of changes is CORRECT?**

A Ciliary muscle relaxes → zonular (suspensory) fibers relax → lens becomes thinner

B **Ciliary muscle contracts → zonular fibers relax → lens becomes more rounded (more convex)** ✓

C Ciliary muscle contracts → zonular fibers tighten → lens becomes thinner

D Ciliary muscle relaxes → zonular fibers tighten → lens becomes more rounded

E Ciliary muscle contracts → lens flattens because tension increases

▶ **Explanation:** For near vision, the ciliary muscle contracts, reducing tension on zonular fibers so the lens rounds up, increasing refractive power. The opposite occurs for distant vision (lens flattens).

4 **In myopia (short-sightedness), images of distant objects are focused:**

A Behind the retina, and corrected with a convex lens

B On the retina, and corrected with a concave lens

C **In front of the retina, and corrected with a concave (diverging) lens** ✓

D In front of the retina, and corrected with a convex (converging) lens

E Behind the retina, and corrected with a concave lens

▶ **Explanation:** In myopia, the eye is often too long or too powerful, so light focuses before reaching the retina. A diverging (concave) lens spreads rays so the focal point moves back onto the retina.

5 **In hyperopia (long-sightedness), images of near objects are focused:**

A In front of the retina, and corrected with a concave lens

B **Behind the retina, and corrected with a convex (converging) lens** ✓

C On the retina, and corrected with a convex lens

D Behind the retina, and corrected with a concave lens

E On the retina, and corrected with no lens

▶ **Explanation:** In hyperopia, the eye is often too short or too weak, so light focuses behind the retina. A converging (convex) lens brings the focal point forward onto the retina.

6 **Why is there a 'blind spot' in each eye's visual field?**

A The lens blocks light at one point

B The retina has a region with no blood supply

C **The optic disc lacks photoreceptors because the optic nerve exits there** ✓

D The cornea is opaque in one small region

E Rods are absent everywhere in the retina

▶ **Explanation:** At the optic disc, ganglion cell axons leave the eye to form the optic nerve, and blood vessels enter/exit. There are no rods or cones there, so light hitting that spot cannot be detected.

7 **The fovea is best described as the region of the retina that:**

A Has the highest rod density for night vision

B Has no photoreceptors and forms the blind spot

C **Has the highest cone density and provides the sharpest vision** ✓

D Contains only bipolar cells and no photoreceptors

E Contains the pupil and controls light entry

▶ **Explanation:** The fovea (in the macula) is cone-rich and specialized for high visual acuity and color vision. The blind spot is at the optic disc, not the fovea.

8 **Which statement correctly compares rods and cones?**

A Rods mediate color vision; cones mediate night vision

B **Rods are more sensitive in dim light but do not provide color vision** ✓

C Cones are more sensitive than rods in very dim light

D Rods are concentrated in the fovea for high acuity

E Cones contain no photopigments

▶ **Explanation:** Rods are highly sensitive and support scotopic (low-light) vision but are essentially monochromatic. Cones require brighter light and provide color and higher acuity, especially in the fovea.

9 **You can often detect a very dim star better by looking slightly to the side of it rather than directly at it. The best explanation is that:**

A The lens focuses dim light better when the eye looks sideways

B The cornea becomes more curved when looking sideways

C **Peripheral retina has more rods, while the fovea is cone-rich and less sensitive in dim light** ✓

D The blind spot is located at the center of the retina

E Cones are more sensitive than rods in dim light

▶ **Explanation:** The fovea is optimized for acuity (cones), not dim-light sensitivity. Looking slightly away places the image on rod-rich peripheral retina, improving detection in low light.

10 **Which statement about photoreceptors in COMPLETE DARKNESS is most accurate?**

A They are hyperpolarized and release no neurotransmitter

B **They are depolarized relative to light and release neurotransmitter continuously** ✓

C They fire action potentials down the optic nerve

D They release acetylcholine instead of glutamate

E They cannot generate any electrical change without light

▶ **Explanation:** Photoreceptors are unusual: in darkness they have an inward 'dark current' and are relatively depolarized, releasing glutamate continuously. Light reduces this current, causing hyperpolarization and less glutamate release.

11 **When light hits a rod photoreceptor, the MOST direct electrical change in that photoreceptor is:**

A Opening of voltage-gated Na^+ channels causing depolarization

B **Closing of cGMP-gated Na^+ channels causing hyperpolarization** ✓

C Opening of Cl^- channels causing depolarization

D Generation of action potentials in the photoreceptor axon

E Immediate contraction of the ciliary muscle

▶ **Explanation:** Light triggers a cascade that lowers cGMP in rods, which closes cGMP-gated Na^+ channels. This reduces inward current and hyperpolarizes the photoreceptor (it does not fire action potentials).

12 **Which retinal cell type generates action potentials that propagate along the optic nerve to the brain?**

A Photoreceptors (rods and cones)

B Bipolar cells

C **Ganglion cells** ✓

D Lens epithelial cells

E Corneal endothelial cells

▶ **Explanation:** Photoreceptors and bipolar cells mainly use graded potentials. Ganglion cells are the main retinal neurons that fire action potentials; their axons form the optic nerve.

13 Which retinal wiring arrangement increases sensitivity to dim light but reduces visual acuity?

A One cone synapsing to one bipolar cell and one ganglion cell (low convergence)

✓ **B Many rods converging onto a single bipolar cell and ganglion cell (high convergence)**

C No photoreceptors connecting to bipolar cells

D Many ganglion cells converging onto one rod

E One ganglion cell connecting directly to the cornea

▶ **Explanation:** High convergence (many rods feeding into fewer downstream neurons) allows weak signals to summate, improving sensitivity in dim light. However, it blurs precise location information, reducing acuity compared to low-convergence cone pathways.

14 A bright light is shone into the right eye. In a normal pupillary light reflex, what happens?

A Only the right pupil constricts

B Only the left pupil constricts

C Both pupils constrict ✓

D Both pupils dilate

E Neither pupil changes because this reflex is voluntary

▶ **Explanation:** The pupillary light reflex is bilateral: light in one eye causes a direct response (same side) and a consensual response (opposite side). This helps regulate retinal light exposure in both eyes.

15 **Which autonomic effect on the pupil is correct?**

A Parasympathetic stimulation dilates the pupil

B Sympathetic stimulation constricts the pupil

C **Parasympathetic stimulation constricts the pupil; sympathetic stimulation dilates it** ✓

D Both sympathetic and parasympathetic always constrict the pupil

E The pupil size is controlled only by the lens

▶ **Explanation:** Parasympathetic input activates circular (sphincter) muscles causing miosis (constriction). Sympathetic input activates radial muscles causing mydriasis (dilation).

16 **Vitamin A deficiency is most likely to cause:**

A **Night blindness due to impaired rhodopsin regeneration in rods** ✓

B Permanent dilation of the pupil due to iris paralysis

C Complete deafness

D Increased lens transparency

E Enhanced color vision due to extra cone pigments

▶ **Explanation:** Vitamin A is needed to regenerate retinal (a key component of rhodopsin). Without it, rod function declines first, causing difficulty seeing in dim light (night blindness).

17 **A cataract is best described as:**

A Increased pressure in the eye that damages the optic nerve

B **Clouding of the lens that reduces transmission of light** ✓

C Loss of cones in the fovea only

D Tearing of the cornea causing bleeding

E Inability of the pupil to constrict in bright light

▶ **Explanation:** A cataract is a loss of lens transparency (clouding), which blurs vision by scattering and blocking light. Increased pressure damaging the optic nerve describes glaucoma, not cataract.

18 **Which statement about glaucoma is MOST accurate at high-school/pre-med level?**

A It is caused by clouding of the cornea

B **It often involves increased intraocular pressure that can damage the optic nerve, first affecting peripheral vision** ✓

C It is an infection of the retina by bacteria

D It is a refractive error corrected by glasses

E It always causes immediate complete blindness within minutes

▶ **Explanation:** Glaucoma commonly involves elevated intraocular pressure and progressive optic nerve damage, often reducing peripheral vision first. It is not a refractive error or a lens/cornea clouding problem.

19 **Aqueous humor is produced primarily by the:**

A Cornea

B **Ciliary body** ✓

C Optic nerve

D Retina

E Lens capsule

► **Explanation:** The ciliary body produces aqueous humor, which nourishes avascular tissues like the lens and cornea and helps maintain intraocular pressure.

20 **A blockage of aqueous humor drainage (e.g., at the trabecular meshwork/canal of Schlemm) would most directly lead to:**

A Lower intraocular pressure because fluid cannot enter the eye

B **Higher intraocular pressure because fluid cannot leave the anterior chamber efficiently** ✓

C Immediate improvement in visual acuity

D No change, because aqueous humor is irrelevant to pressure

E Loss of oxygen transport in blood

► **Explanation:** Aqueous humor is continuously produced and must drain. If drainage is reduced, pressure can rise, which can contribute to optic nerve damage (a key mechanism in many forms of glaucoma).

21 **A lesion at the optic chiasm most classically causes which visual field defect?**

A Blindness in the right eye only

B Loss of left visual field in both eyes (left homonymous hemianopia)

C **Loss of temporal (peripheral) visual fields in both eyes (bitemporal hemianopia)** ✓

D Loss of nasal visual fields in both eyes (binasal hemianopia)

E No visual deficit because the chiasm is not involved in vision

▶ **Explanation:** Nasal retinal fibers cross at the optic chiasm and carry information from the temporal (peripheral) visual fields. Damage there disrupts these crossing fibers, causing bitemporal hemianopia.

22 **A lesion of the RIGHT optic tract would most likely produce:**

A Blindness in the right eye only

B Blindness in the left eye only

C **Loss of the LEFT visual field in both eyes (left homonymous hemianopia)** ✓

D Loss of the RIGHT visual field in both eyes (right homonymous hemianopia)

E Loss of central vision only, with preserved peripheral vision

▶ **Explanation:** Each optic tract carries information from the contralateral visual field (right tract carries left visual field from both eyes). Therefore, a right optic tract lesion causes left homonymous hemianopia.

23 **Light from the RIGHT visual field falls on which halves of the retinas?**

A **Nasal retina of the right eye and temporal retina of the left eye** ✓

B Temporal retina of the right eye and nasal retina of the left eye

C Nasal retina of both eyes

D Temporal retina of both eyes

E Fovea of the right eye only

▶ **Explanation:** The image on the retina is reversed left-to-right. The right visual field projects to the left side of each retina: nasal retina in the right eye (medial side) and temporal retina in the left eye (lateral side).

24 **After walking into a dark room from bright sunlight, it takes several minutes for vision to improve. The BEST explanation is:**

A Cones slowly regenerate their pigments over hours, which mainly explains the delay

B **Rods slowly increase sensitivity as rhodopsin regenerates after being bleached by bright light** ✓

C The cornea thickens to let in more light

D The lens becomes opaque and then clears

E The retina grows new rods within minutes

▶ **Explanation:** Dark adaptation largely depends on rods becoming more sensitive again, which requires regeneration of photopigment (rhodopsin) and neural adjustments. Cones adapt faster but are less sensitive in low light.

25 **Why are colors much harder to distinguish in very dim light?**

A The iris becomes completely rigid in the dark

B The cornea stops bending light

C **Rods dominate vision in dim light and provide little/no color information** ✓

D Cones are present only in the optic nerve

E The retina cannot detect low light at all

▶ **Explanation:** Color vision mainly depends on cones, which need brighter light. In dim conditions, rods are more active and are essentially monochromatic, so color perception decreases.

26 **The fovea has very few blood vessels compared to other retinal regions. The best physiological reason is that this:**

A Prevents rods from working in daylight

B **Reduces light scattering and improves visual acuity** ✓

C Increases intraocular pressure to focus the lens

D Stops oxygen delivery to cones so they do not saturate

E Creates the blind spot

▶ **Explanation:** High acuity requires a clear optical path. Fewer blood vessels over the fovea reduce obstruction and scattering of incoming light, improving sharpness. The blind spot is at the optic disc, not the fovea.

27 **Which is NOT part of the normal 'near response' when focusing on a nearby object?**

A Accommodation (lens becomes more convex)

B Convergence of the eyes

C Pupil constriction

D **Pupil dilation** ✓

E Increased refractive power of the lens

▶ **Explanation:** The near triad is accommodation, convergence, and pupillary constriction (miosis). Dilation typically occurs in low light or sympathetic activation, not as part of near focusing.

28 **Presbyopia (common with aging) is mainly caused by:**

A **Lens losing elasticity, reducing its ability to become more convex for near vision** ✓

B Cornea becoming completely opaque

C Optic nerve swelling due to high pressure

D Rods converting into cones

E The pupil becoming permanently wide

▶ **Explanation:** With age, the lens becomes stiffer and less able to round up during accommodation, making near focusing difficult. This is why many people need reading glasses (converging lenses).

29 **The most common form of inherited red–green color blindness is typically:**

A Autosomal dominant, equally common in males and females

B **X-linked recessive, more common in males** ✓

C Mitochondrial inheritance, passed only from mothers

D Due to loss of rods, causing night blindness

E Caused by clouding of the lens

▶ **Explanation:** Red–green color blindness usually results from mutations in cone opsin genes on the X chromosome, so it is often X-linked recessive and therefore more common in males.

30 **Closing one eye most strongly reduces which aspect of vision?**

A Ability to detect any light at all

B Ability to see colors in bright light

C **Binocular depth perception (stereopsis)** ✓

D Ability to constrict the pupil in response to light

E Ability to focus using the lens

▶ **Explanation:** Stereopsis relies on comparing slightly different images from two eyes (binocular disparity). With one eye closed, you still have depth cues (size, perspective), but true binocular depth perception is reduced.