Question 1: What physical property of light is most closely related to the perception of color?

Answer: Light is electromagnetic radiation, which has three properties: wavelength, frequency, and amplitude. Wavelength is closely related to the perception of color because wavelengths of 400-700 nm are visible to the naked human eye. Within this visible spectrum, different wavelengths appear as different colors.

Question 2: Name eight structures in the eye that light passes through before it strikes the photoreceptors.

Answer: The eight structures of the eye through which light passes before striking the photoreceptors are the cornea, the aqueous humor, the lens, the vitreous humor, the ganglion cell layer, the inner plexiform layer, the inner nuclear layer, and the outer plexiform layer.

Question 3: Why is a scuba mask necessary for clear vision under water?

Answer: The refractive power of the cornea depends on the slowing down of light at the air-cornea interface. Replacing air with a medium, such as water, which allows light to pass at about the same speed as the eye eliminates the refractive power of the cornea. When you open your eyes under water, the water-cornea interface has very little focusing power and things look blurred. A scuba mask restores the air-cornea interface, and consequently, the refractive power of the cornea.

Question 4: What is myopia, and how is it corrected?

Answer: Myopia, or nearsightedness, occurs when the eyeball is too long. Parallel rays from a distant light source, which are bent by the cornea and the lens, normally converge at exactly the same plane as the retina. When the eyeball is too long, the rays of light converge and cross before the retina. As a result, the image on the retina is a blurred circle rather than a

point. This occurs because the amount of refraction that the cornea and the lens provide is too large to focus distant objects on the retina. To see distant points clearly, nearsighted people must use artificial concave lenses that help focus the image on the retina.

Question 5: Give three reasons explaining why visual acuity is best when images fall on the fovea.

Answer: Visual acuity is best when images fall on the fovea for three reasons: 1) Visual acuity improves as the ratio of photoreceptors to ganglion cells decreases. Relatively few photoreceptors feed each ganglion cell in the fovea, resulting in a low ratio, which maximizes visual acuity. 2) The fovea sits in a pit that the lateral displacement of the ganglion and bipolar cells creates above the photoreceptors. This allows light to strike the photoreceptors without passing through the other layers of retinal cells, minimizing light scatter that can blur the image. 3) Visual space is not mapped to the targets of visual input uniformly. The central few degrees of the retina are over-represented in "neural space." Signals from individual cones in the fovea are represented in a larger volume of brain tissue than input from photoreceptors in peripheral regions of the retina. This specialization contributes to high acuity in central vision.

Question 6: How does the membrane potential change in response to a spot of light in the receptive field center of a photoreceptor? Of an ON bipolar cell? Of an OFF-center ganglion cell? Why?

Answer: Photoreceptors hyperpolarize in response to light. As a result, they release less neurotransmitters at the photoreceptor/bipolar cell synapse. ON-center bipolar cells depolarize in response to light in the receptive field center. This is their response to less

glutamate release at the photoreceptor/bipolar cell synapse. ON-center ganglion cells depolarize in response to light in the receptive field center. These ganglion cells receive direct input from ON-center bipolar cells.

Question 7: What happens in the retina when you "get used to the dark"? Why can't you see color at night?

Answer: Getting used to the dark is called dark adaptation. This capability is a consequence of a duplex retina, in which cones function best at high levels of illumination and rods function best at low levels of illumination. When moving from high to low levels of illumination, the retina must be adapted to the dark before the rods are maximally sensitive. Dark adaptation is a biochemical process in which rhodopsin, the rod photopigment, regenerates after being bleached in the light. The functional circuitry of the retina also readjusts as rhodopsin regenerates. Consequently, information from more rods is available to ganglion cells. The regeneration of unbleached rhodopsin and the resulting changes in functional circuitry take about 20-25 minutes. At night, it is difficult to detect colors because the cones, which have three photopigments with different spectral sensitivities, are inactive. Only cones are capable of color vision. At low levels of illumination, only rods are active and they contain only one photopigment. Rhodopsin's peak sensitivity is 500 nm.

Question 8: In what way is retinal output *not* a faithful reproduction of the visual image falling on the retina?

Answer: The eye functions like a camera, but the retina does not function like the film. The retina is a part of the brain. The physical arrangement of photoreceptors and the interconnections among all the retinal neurons represent the beginning of visual information

processing. In other words, information about light falling on the retina is already being processed at the level of the retina, and retinal output is a result of the processing.

Question 9: In retinitis pigmentosa, early symptoms include the loss of peripheral vision and night vision. The loss of what type of cells could lead to such symptoms?

Answer: Rods are responsible for night vision. The degeneration of rod photoreceptors can lead to early symptoms, such as loss of peripheral and night vision. The density of rod photoreceptors increases in the peripheral retina.