



# SEEING

### A Photons Journey Across Space, Time and Mind

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#### INTRODUCTION

- The digital planetarium program "SEEING!" follows a photon's creation and journey across the galaxy to a young stargazer's eye. The viewer follows the photon into the girl's eye, learning the structures of the eye and their functions, prior to taking a ride on the optic nerve. Dramatic fulldome imagery from around the globe featuring humanity, landscapes, skyscapes, wildlife and space will be used to create the story of the photons journey through the eye and its conversion to the electro-chemical impulse traveling the neuro pathways of the brain to create the image we see. Along the way the program examines how the eye works, how technology has enabled us to restore vision and prevent a variety of diseases that affect sight.
- Produced by Mirage3D and Koenig Films and funded through a generous grant by Zeiss this program will bring the story of sight and vision to planetariums around the globe. "Seeing!" was directed by Robin Sip, written by Emmy Award<sup>©</sup> winning writer Kris Koenig and narrated by Dr. Neil deGrasse Tyson, Director of the Hayden Planetarium at the Rose Center for Earth and Space in New York City.
- This program is aligned to the Next Generation Science Standards (NGSS) covering the following:
  - MS-PS4-1: Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
  - MS-PS4-2: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
  - MS-LS1-8: Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.





True



2. The hydrogen atom is made up of 3 parts, a proton and two electrons. 🗆 True 🗌 False

> 3. Photons, released from the change of an electrons orbit is seen as colored light. 🗌 True 🛛 False

5. Where is the electron in this picture?

4. We see

from the interaction of the electrons from stars and energy of protons colliding.







ZEINS

UNDERWRITTEN

BY

### 6.

- The speed of light is a. 100,000 km/sec b. 200,000 km/sec c. 300,000 km/sec d. 400,000 km/sec
  - 7. What is the approximate speed of light in miles per second? (1 km = 0.62 miles)

8. How many years will the photon take to reach Earth for the star whose photon we followed from the nebula in Orion?

- a. 1300 years
- b. 560 years
- c. 75 years
- d. Uses Fedex and arrives tomorrow!

9. How did you know it was Saturn that the photon passed on its journey?





10. Do all photons that make it to the Earth's atmosphere make it all the way through to the telescope?

11. If the girl blinks, some photons will hit her eyelid and never be seen. □ True □ False















- 13. The iris adjusts to allow just the right amount of light into the eye to see.
  - 🗆 True 🛛 🗆 False
- 14. The pupil is a hard black disc that blocks light from entering the eye.
  - 🗆 True 🛛 🗆 False
- 15. The zonules and girdle of the lens help focus the light onto the back wall of the eye's retina  $\Box$  True  $\Box$  False
- 16. As we age, the difficulty warping the crystalline lens to see thing clearly up close is called a condition called
  - a. Myopia
  - b. Astigmatism
  - c. Hyperopia
  - d. Presbyopia
- 17. A lifetime exposure to ultraviolet (UV) light can cause a \_\_\_\_\_\_ in the lens of the eye.
  - a. Pimple
  - b. Cataract
  - c. Zonule
  - d. Stye
- 18. What is the final destination of the photon?
  - a. Retina
  - b. Cornea
  - c. Lens
  - d. Vitreous

- 19. The cells in the retina encode the photon's data, so that the optic nerve can interpret it 
  True
  False
- 20. Where does the crystalline lens focus the light in the retina?
  - a. Macula
  - b. Dracula
  - c. Vernacular
  - d. Spectacular
- 21. All of the following are true except
  - a. Most of the photo receptor cells are rods
  - b. Rods are very sensitive to light
  - c. Most of the photo receptor cells are cones
  - d. Rods relay only white light at low resolution
- 22. This pothole in the macula is exactly where the lens focuses light. It's called the
  - a. Macpotula
  - b. Fovea
  - c. Optic Nerve Head
  - d. Main blood vessel
- 23. All are distinct cell layers in the retina except
  - a. Ganglion layer
  - b. Bipolar cell layer
  - c. Crystalline lens, cell layer
  - d. Rods and Cones







#### **Eye Conditions**



**Eye Structures** 







24. LABEL EACH DIAGRAM









- 25. When the crystalline lens gets cloudy, it's called a
- 26. Cones detect \_\_\_\_\_\_ when photons hit them.
- 27. Ganglion cells are connected directly to the \_\_\_\_\_\_ through fibers that run back to form the optic disc.
- 28. Why is the eye called "the window to the soul"?
- 29. Observing changes to the retina by Optometrists and Ophthalmologists can detect diseases like \_\_\_\_\_ long before other methods
- 30. If you are under 40 years old, how often should you have your eyes checked?
  - a. Every year
  - b. Every two years
  - c. Only when you have a problem
  - d. Not necessary
- 31. If over 40, have your eyes checked every\_\_\_\_\_
- 32. Wear sunglasses outdoors to protect the retina and lens from
  - a. Ultraviolet light
  - b. Starlight
  - c. Red light
  - d. Moonglow

- 33. What vegetable was the girl in the film eating, as part of good nutrition? \_\_\_\_\_ Do you know why?
  - What can you research about orange and green vegetables for good eye and body health?
- 34. Rods are connected by Amacrine cells to form a scanner for \_\_\_\_\_\_ and \_\_\_\_\_.
- 35. Cone cells convert photons to electrical pulses sent to the \_\_\_\_\_ cells then to the \_\_\_\_\_ cells.
- 36. Splitting the R and L view of the retina at the optic chiasm allows our brain to see \_\_\_\_\_.
- 37. What two main sections of vision are separated in the optic radiations? \_\_\_\_\_\_ and \_\_\_\_\_ vision
- 38. The brain uses about \_\_\_\_\_% of its resources for vision?
- 39. Why should you stare out at the distance for 20 seconds about every 20 minutes when reading or using your smartphone or tablet?
- 40. Why should you wear eye protection?\_\_\_\_\_
- 41. Can you chart the path of a photon from a distant star to the image that you see, in your mind?









#### 42. THE PATH TO THE BRAIN







### Worksheet/Notes







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