**Chapter 2 Study Guide: The First Steps in Vision**

Properties of light

Light can be classified as a wave when it is traveling and as a stream of particles called protons when it is absorbed.

* Wave- an oscillation that travels through a medium by transferring energy from one particle or point to another without causing any permanent displacement of the medium.
* Absorb- taking up light, noise, or energy without transmitting it. Ex. A rock becoming warm while sitting in the sun.
* Transmit- to covey light from one place/thing to another, light that is not reflected nor refracted will be transmitted through a surface.
* Transduced- the conversion from one form of energy to another. Light energy can be transduced by the photoreceptors of the retina into neural energy that can be interpreted by the brain.
* Filter- allows passage of some frequencies of digital elements through and blocks others. This is a function of the ganglion cells.
* Contrast- difference in luminance between object and the background or light and dark parts of same object.
* Scatter- The dispersing of light irregularly.
* Reflect- when light strikes a surface, it will be redirected, usually back towards its origin point. Ex. mirrors
* Refract- as a wave passes from one medium to another (air to water or water to air), the course is altered. When talking about light, if the light passes from a fast medium such as air, to a slow medium such as water, any light rays that are not perpendicular to the surface will bend. Ex. Lenses

Anatomy of the eye

* Fundus- the back of the eye where the retina is.
* Aqueous humor- fluid inside the eyes interior and posterior chambers
* Vitreous humor- fluid between the lens and the retina
* Optic disk- this is the area where the optic nerve leaves the eye, there are no rods and cones here, and therefore it creates a blind spot.
* Lens (crystalline lens)- the shape of the lens will adjust depending on whether what you are looking at is near to you or far away. This is called accommodation which is accomplished by the contraction of the ciliary muscle. It also focuses light on the retina.
* Iris- the iris has muscles that can dilate and constrict the pupil to adjust the amount of light that is entering the eye.
* Fovea- this is the place of highest resolution in vision, it is in the center of the macula.
* Cornea- focuses light on the retina
* Retina- light sensitive membrane in the back of the eye that contains 2 photoreceptors, rods and cones. Because they have both rods and cones the retina is considered to be a duplex.
  + Rods
    - There are 90 million rods
    - They are only in the periphery
    - They have low acuity
    - Have a very high sensitivity
    - They cannot see color
    - Good for night vision
  + Cones
    - There are 5 million cones
    - They are concentrated in the fovea and drop in density with retinal eccentricity (distance from the fovea).
    - They have high acuity
    - Have a very low sensitivity
    - Color vision
    - Do not work well at night
    - Short wavelengths ~ 420 nm = blue
    - Medium wavelengths ~ 534 nm= green
    - Long wavelengths ~564 nm= red

Properties of photoreceptors

* Outer segment- part that contains photopigment molecules
* Inner segment- part that lies between outer segment and cell nucleus
* Synaptic terminal- location where the axons terminate at the synapse for transmission of information by release of a chemical transmitter. These synaptic terminals then talk to horizontal and bipolar cells.
* Chromophore- the part of the visual pigments in the retina that catch the light
* Rhodopsin- found in rods in the outer segment
* Photo activation- the activation by light
* Hyperpolarization- an increase in membrane potential where the inner membrane surface becomes more negative than the outer membrane surface.
* Graded potential- electrical potential that can vary continuously with amplitude.

Pathways of information



Lateral inhibition is, In basic terms- say the horizontal cell is connected to multiple rods and a cone, if the rods are getting an intense stimulus the horizontal cell will inhibit other cells that are not being stimulated as much. This can create a mach band effect.

Bipolar cells-

* Diffuse bipolar cell- bipolar cells whose processes are spread out to receive input from many photoreceptors at once, usually rods.
  + Good with allowing rods to function in dim lighting
  + Bad with visual acuity because the cell may fire at the same rate in response to a single point of bright light or several spots of dim light.
* Midget bipolar cells- receive input from single cones, one to one pathway. This is why cones see images so clearly. This takes place in the fovea
  + On bipolar cells, off bipolar cells.

Ganglion cells

* Midget bipolar cells send signals to small ganglion cells called P ganglion cells (parvocellular)
* Diffuse bipolar cells project to ganglion cells known as M ganglion cells (magnocellular)

Night vision

Pupil will dilate, letting in 8x more light. It takes about 25 minutes for rods to adjust to the dark by filling with rhodopsin. If light hits the eye, it only takes cones about 5 minutes to readjust.

Vision problems

* Presbyopia (“old sight”)- as we get older, the lens becomes sclerotic(harder) and loses its elasticity. This is why the elderly hold things very far away from their faces to see.
* Cataracts- irregularity of the crystalline can cause opacities of the lenses and a loss of transparency.
* Myopia (nearsightedness)- The eye is too long, so the light that enters the eye is focused in front of the retina and distance objects cannot be seen easily.
* Hyperopia (farsightedness)- the eye is too short, the light entering the eye is focused behind the retina and objects close up cannot be seen easily.
* Emmetropia- no refractive error, length of the eyeball is perfectly matched to the refractive power of the lens.
* Astigmatism- blurry vision due to irregularities (unequal curving) in the shape of the cornea