Al- mustaqbal University College
Anesthesia Techniques Department
First stage /medical physics
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***Lecture 5:***

# Physics of eyes and vision

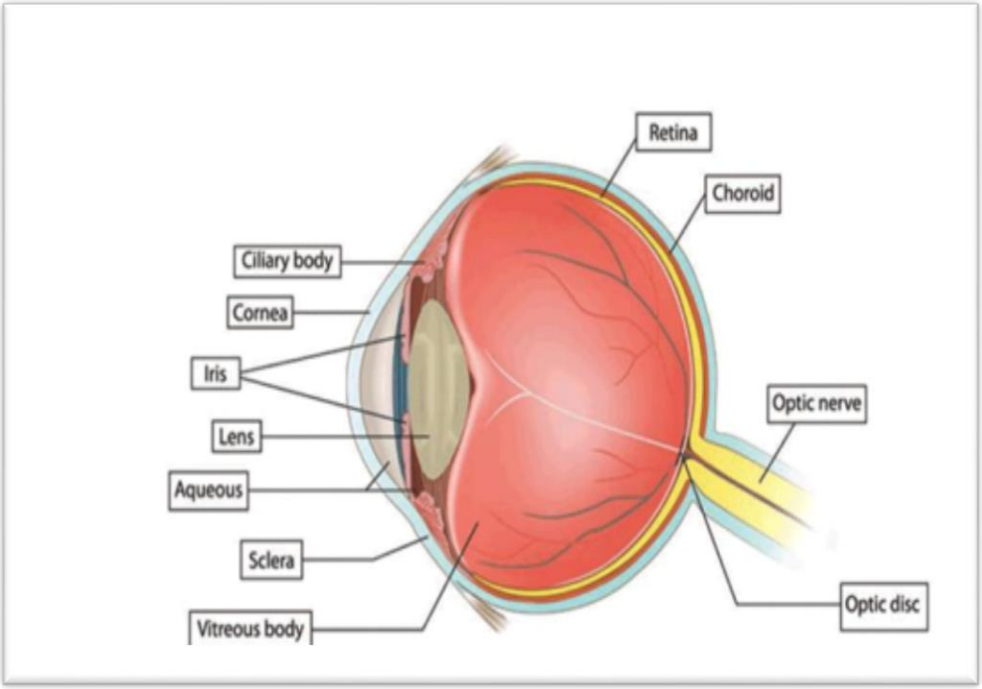
## -The sense of vision consists of three major components

1- The eye that focus image from outside world on the retina.

2- The system of millions of nerves that carries information deep into the brain.

3- The visual cortex part of brain

Blindness results if anyone of parts does not function.




## -Retina the light detector of eye

Retina the light sensitive part of eyes, converts the light images into electrical nerve impulses that are sent to the brain. The photon must be above minimum energy to cause the reaction. Infrared photons have insufficient energy and are not seen.

Ultraviolet photons have sufficient energy but they are absorbed before they reach the retina and also are not seen. There are 2 types of photo receptors in the retina: The cones 6.5 million in each eye used for day light. The rods used for night it's about 120 million in each eye.

## -Diffraction effects on the eye

All light waves undergo diffraction when it passes through small openings thus the iris produces diffraction pattern on the retina. All lenses have defects aberration

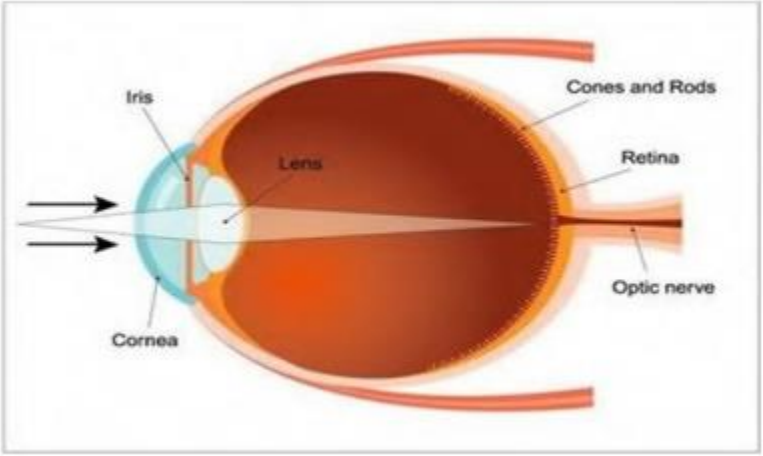



Figure 2: diffraction of light in the eye

The effect of such aberration is reduced if the lenses opening is made smaller. A point source of light will not be focused on single cone because of diffraction effects. Figure above. The angular spread (2ɵ) of the central bright spot at retina for λ= 555 m and pupil 3 mm diameter (a) is given by

$2\Theta = 2(1.22)\,\lambda/a$

$2\Theta = 2(1.22)*555*10^{-9}/3*10^{-3}$

$2\Theta = 4.5*10^{-4}$ radians

The diameter of center bright spot at retina = the effective aperture to retina distance 17mm x 2 ɵ = 17 x 4.5 x 10 -4 = 8 µm. This spot will include many cons (diameter ~ 1.1) µm. Focusing elements of the eye.

## -The eye has two major focusing components:

•the cornea which is clear transparent bump on the front of the eye. The cornea is fixed focus element.

•The lens is variable in shape and has ability to focus at various distances.

- The cornea focus by bending (refraction) the light rays, the amount of bending depends on the curvature and speed of the light in lens.

- When cornea under ware it losses most of its focusing power because the index of refraction of water (1.33) close to that of cornea (1.37). Fish have similar problem out of water.

## -Some other elements of the eye

The pupils is the openings in the center of the iris. Under average light condition the opening is about 4 mm in diameter. It can change from about 3 mm in diameter in bright light to about 8 mm in diameter in dim light about 300 sec are needed for it to fully open and about 5 sec required for it to close as much as possible.

It is believed that the iris aids the eye by increasing or decreasing incident light on the retina until the retina has adapted to the new lighting conditions.

## -Defective vision and its correction

1/F = 1/P + 1/Q basic equation of simple lenses

F = focal length P = object distance Q = image distance (F) & is measured in meter 1/F is the lens strength in diopter D

The focal length of combination of two lenses:

1/F = 1/F1 + 1/F2 and for 3 lenses: 1/F = 1/F1 + 1/F2 + 1/F3

## Example:

If FA = 0.33 m combined with FB = 0.25 m what is the focal length of combination and dioptric strength?

### Sol:

1/F = 1/FA + 1/FB

= 1/0.33 + 1/0.25 = 1/0.143

Consider the image distance Q of cornea and lens of the eye to be 2 cm or 0.02 m when normal eye focused at distance (infinity).

1/F = 1/Q = 1/0.02 m

Then eye has strength of 50 D

If eye focus on the nearest distance at P = 0.25 m

Then

1/F = 1/P + 1/Q

= 1/0.25 + 1/0.02

= 4 + 50

= 54 D

Homework:

What is the function of the cornea in the eye?