كلية المستقبل الجامعة
قسم الفيزياء الطبية
المرحلة الثانية

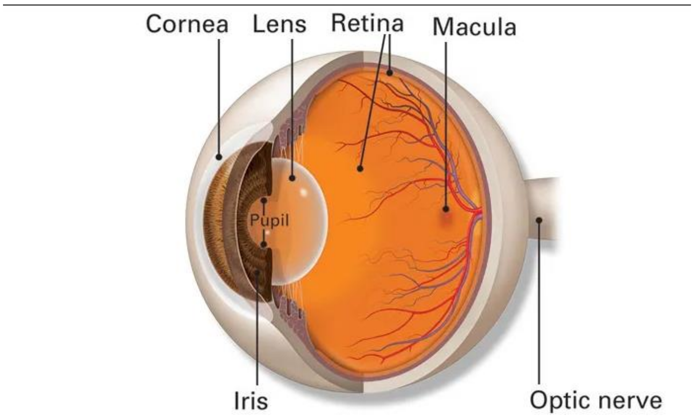
Medical Physics
Optics

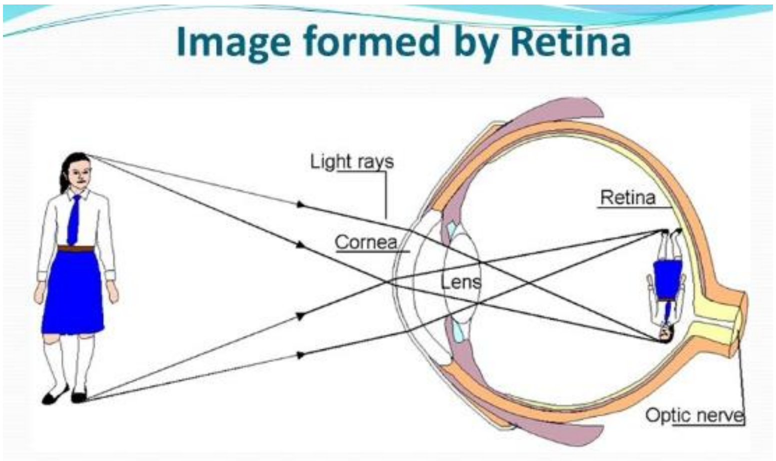
Lecture 8

Lecturer: Mohammed Salih

The Retina :

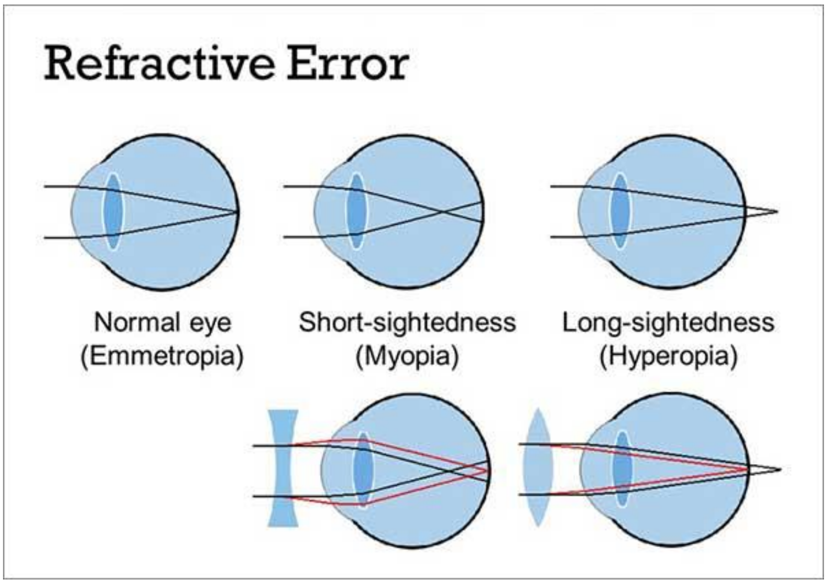
The retina is a complex part of the eye, and its job is to turn light into signals about images that the brain can understand. Only the very back of it is light sensitive: this part of the retina is roughly the area of a 10p coin, and is packed with photosensitive cells called rods and cones .





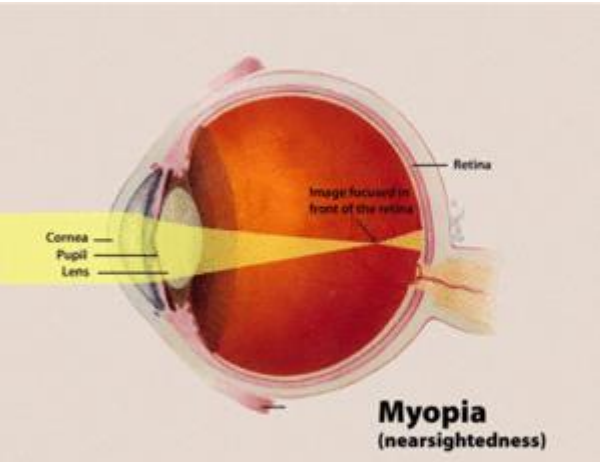
Refractive Error :

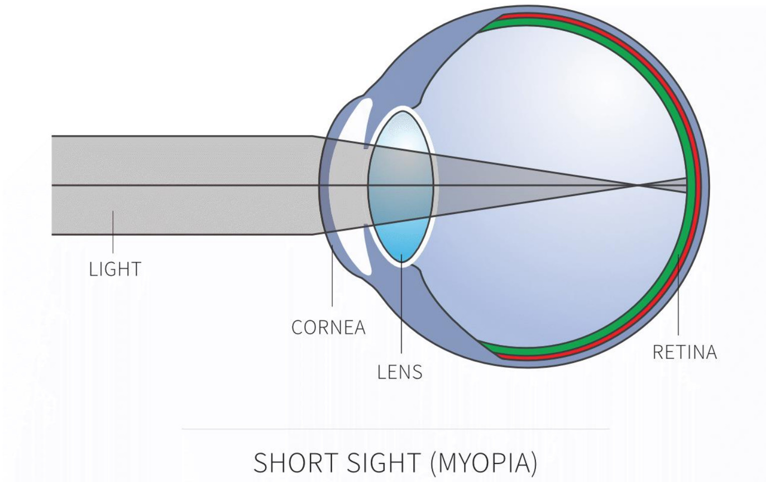
Refractive errors are eye disorders caused by irregularity in the shape of the eye. This makes it difficult for the eyes to focus images clearly, and vision can become blurred and impaired .



Myopia (short-sightedness):

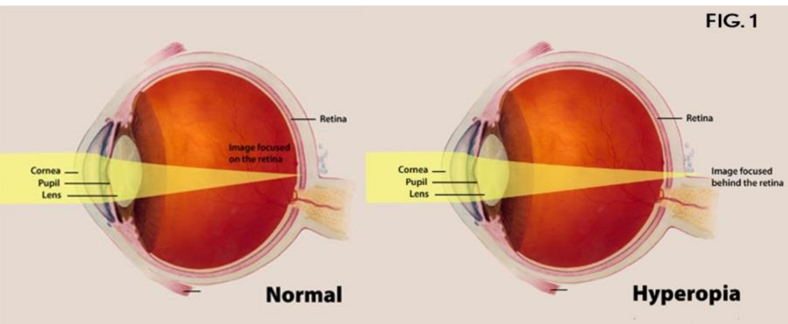
Also known as nearsightedness, is a condition where far away objects are not clear but nearby objects can be seen clearly. Due to the elongated shape of the eyeball, the image is formed in front of the retina causing far away objects to seem blurred. Myopia may increase up to the ages of 18 to 21. The symptoms include difficulty in seeing distant objects .

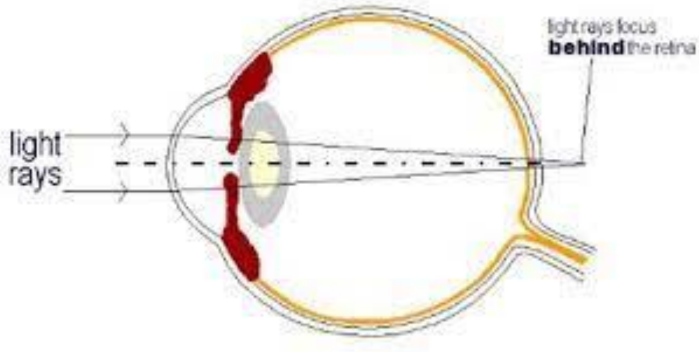




Hyperopia (long-sightedness):

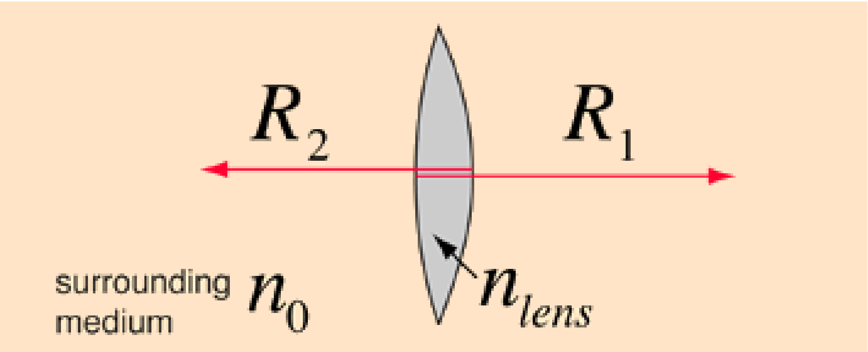
Also known as farsightedness, is caused when light rays focus behind the retina because of a shorter eyeball. Patients who are affected by this condition have difficulty in seeing nearby objects but objects far away remain clear. The signs and symptoms usually noted are difficulty in reading, headaches, eyestrain, and fatigue .





Lens-Maker's Equation :

The lens is a transparent medium bounded by two surfaces and at least one of them must be curved. A lens is said to be thin if the gap between the two surfaces is very small. A lens will be converging with positive focal length, and diverging if the focal length is negative. Therefore from this, we can conclude that a convex lens need not necessarily be a converging and a concave lens diverging. Every lens has some specific value that we can compute by using the lens makers formula .



Lens maker's equation : is the relation between the focal length of a lens to the refractive index of its material and the radii of curvature of its two surfaces. It is used by lens manufacturers to make the lenses of particular power from the glass of a given refractive index .

The lens is thin, therefore the distance measured from the poles of the two surfaces of the lens can be taken to be equal to the distances measured from the optical center .

Lens maker's equation :

$$\frac{1}{f} = (\mu - 1) \times \left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

f : The focal length of the lens .

μ : Refractive index .

$R_1 and R_2$: The radius of the curvature of both surfaces .

Example 1 :

Find out the focal length of the lens whose refractive index is 2. Also, the radius of curvatures of each surface is 20 cm and -35 cm respectively ?

Given parameters are:

$\mu = 2,$

R_1 = 20 cm

and R_2 = – 35cm

Lens maker's formula is:

$$\frac{1}{f} = (\mu - 1) \times (\frac{1}{R_1} - \frac{1}{R_2})$$

$$\frac{1}{f} = (2 - 1) \times (\frac{1}{20} - \frac{1}{-35})$$

$$\frac{1}{f} = 1 \times (0.05 + 0.028)$$

$$\frac{1}{f} = 0.078$$

Therefore, f = $\frac{1}{0.078}$

f = 12.82 cm

Example 2 :

Value of the refractive index of lens is 2.5. The curved surfaces are having the radius of curvatures 10 cm and -12 cm respectively. Find out the focal length of the lens ?

Given parameters are,

$\mu = 2.5$,

$R_1 = 10$ cm

and $R_2 = -12$ cm

Lens maker's formula is:

$$\frac{1}{f} = (\mu - 1) \times \left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

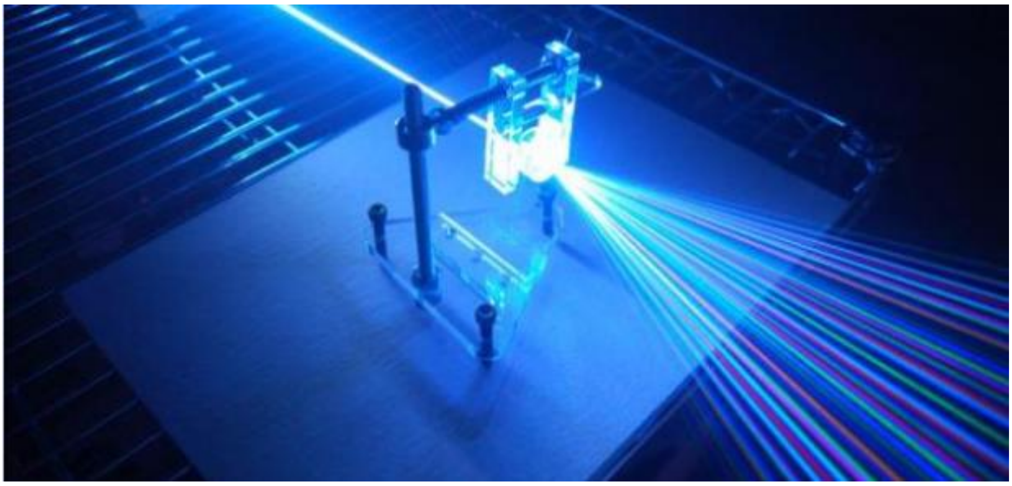
$$\frac{1}{f} = (2.5 - 1) \times \left(\frac{1}{10} - \frac{1}{-12}\right)$$

$$\frac{1}{f} = 0.274$$

So, f = 3.64 cm

Diffraction Phenomena :

The phenomenon of diffraction can be defined as the spread of waves around barriers, where diffraction can occur in sound, or in electromagnetic radiation, such as light, X-rays and gamma rays, and with very small moving particles, such as atoms, neutrons, and electrons that have properties similar to waves.



One of the results of diffraction is that sharp shadows are not created, and this phenomenon results from interference, when the waves are installed, they may enhance or cancel some of them, and they are more pronounced when the wavelength of radiation is similar to the linear dimensions of the barrier .