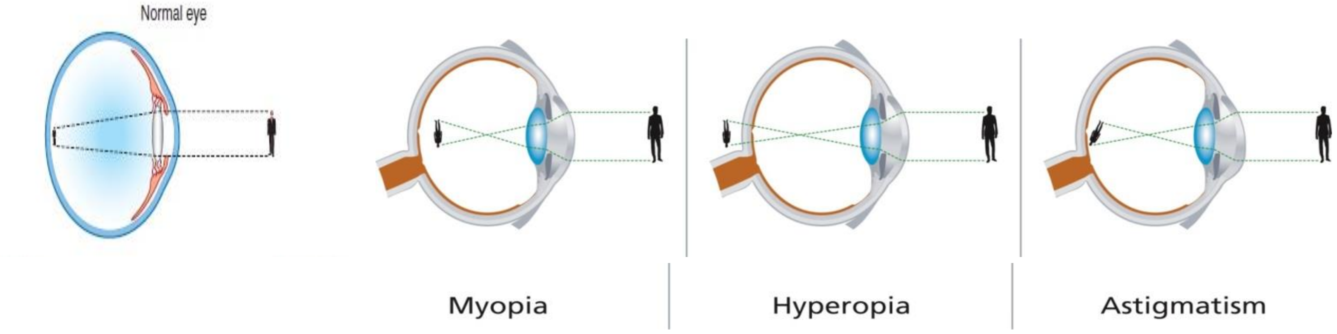
L22- Defective Vision and Its Correction

What are refractive errors?

Light rays undergo a refraction process when passing through the transparent media represented by the cornea, aqueous humor, lens and vitreous body. These light rays change their direction, so that the projection of the things we look at is placed on the retina (visual receptor). This is the normal case, of an emmetropic eye (without diopters), which sees clearly at all distances.

When the projection of the images is not placed appropriately on the retina surface, the vision is blurry.

Blurry vision can be caused by myopia (light rays focus in front of the retina), by hyperopia (light focus is behind the retina) or by astigmatism (the image is formed in several places). All these cases are refractive errors, accompanied by visual disturbances.



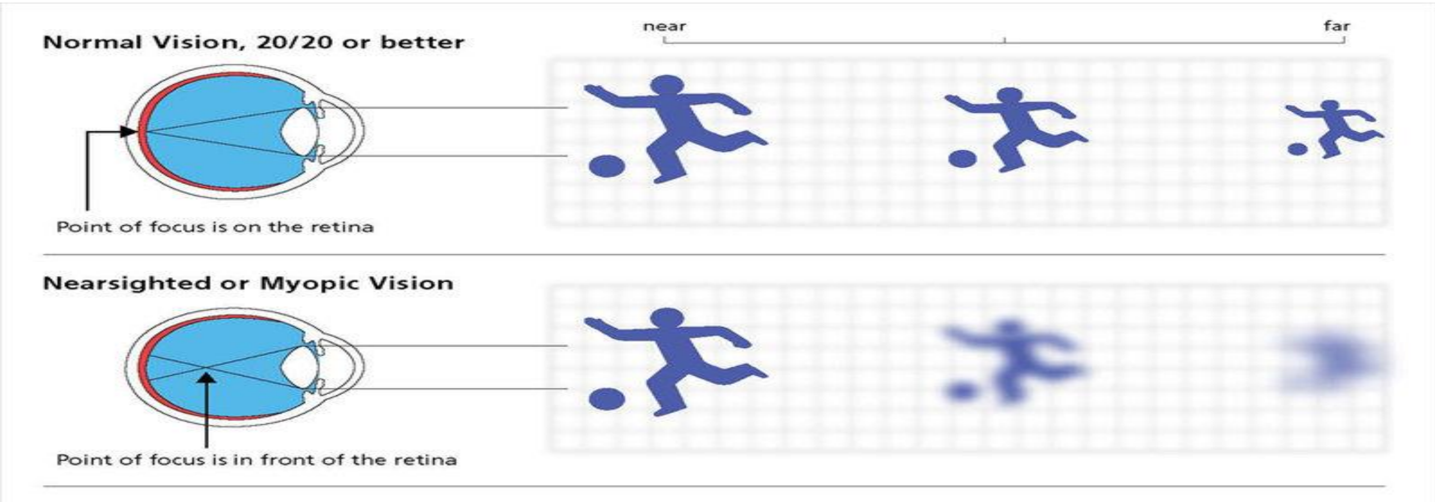
DEFECTIVE VISION AND ITS CORRECTIO

1. Myopia (near-sightedness) (short-sight)

Myopia (near-sightedness)(short-sight)

Myopia is a refractive error in which distance vision is blurry and near vision is good.

Myopia can exist at birth, can emerge during time, as the child grows, most of the time during puberty or later. Myopia increases with age. It is affects 20% to 30% of the population, but this eye disorder is easily corrected with eyeglasses, contact lenses or surgery.

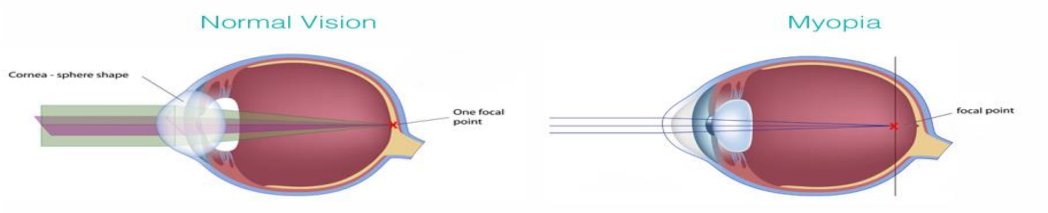


What Causes Myopia?

1. **In people with myopia, the eyeball is too long relative to the focusing power of the cornea and lens of the eye.**
2. **The cornea and/or lens being too much curvature for the length of the eyeball.**

In some cases, myopia occurs due to a combination of these factors.

Light rays of images focus in front of the retina So the light entering the eye is not correctly. Light rays of images focus in front of the retina rather than directly on the retina, causing blurred vision.



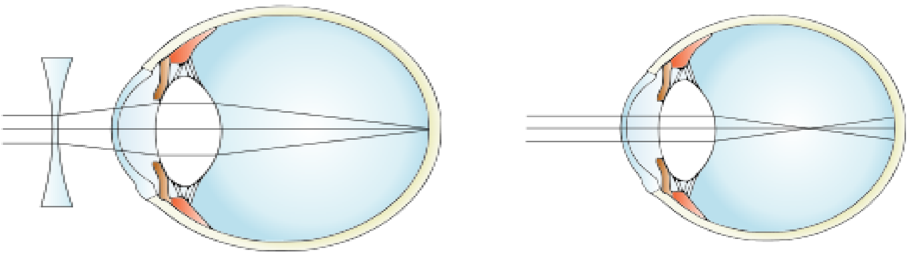
Myopia occurs when an eye cannot focus on distant objects. The uncorrected far point of the defective eye is nearer than infinity. This is because the eye muscles cannot make the eye lens thin enough to focus an image on the retina of an object at infinity. The eye can focus nearby objects hence the defect is referred to as 'short-sight'.

Correction of myopia:

To correct myopia using a lens, a diverging lens of a suitable focal length must be placed in front of the eye.

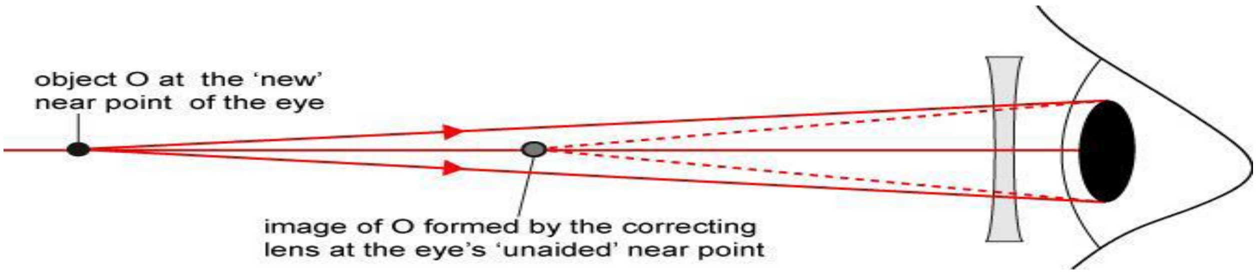
The correcting lens makes parallel rays from a distant object diverge so they appear to come from the uncorrected far point.

- **This defect can be corrected by diverging lenses. If the spectacle lens is chosen to have a focal length equal in magnitude to the distance to the far point (F), then parallel rays striking the spectacles appear to the eye to diverge from the far-point.**
- **Diverging lenses have a focal length equal to the distance from the eye to the uncorrected far point.** $F_s = (F.P)_{uncorrect}$



Note

- **The correcting lens effectively moves the far point of the uncorrected eye to infinity. It also 'moves' the near point away. The correcting lens makes the image of an object placed at the least distance of distinct vision (i.e. 'new' near point) appear at the 'unaided' near point. Therefore, the image is virtual and nearer the lens than the object as shown.**



Correction to far point

$$\left(\frac{1}{F_{f.p}}\right)_{defect\ eye} = \left(\frac{1}{F_{f.p}}\right)_{normal\ eye} - \left(\frac{1}{F_{f.p}}\right)_{correct\ eye}$$

$$\left(\frac{1}{F_{f.p}}\right)_{defect\ eye} = \left(\frac{1}{u}+\frac{1}{v}\right)_{normal\ eye} - \left(\frac{1}{u}+\frac{1}{v}\right)_{correct\ eye}$$

$$\left(\frac{1}{F_{f.p}}\right)_{defect\ eye} = \left(\frac{1}{\infty}+\frac{1}{0.02}\right) - \left(\frac{1}{f.p}+\frac{1}{0.02}\right)$$

$$\left(\frac{1}{F_{f.p}}\right)_{defect\ eye} = -\frac{1}{f.p} \quad = \text{power of the correcting lens.}$$

Example

A short-sighted eye has a far point of 5.00 m and a near point of 0.25 m.

a. State the type of lens needed to correct this defect and calculate the power of the correcting lens.

b. Calculate the distance from the lens to the near point of the eye with the correcting lens in front of the eye.

Solution

a. **A diverging lens is needed. Its focal length is (−5.0 m)(= the distance to its far point). Therefore the power of the correcting lens =1/f = 1/(-5)=−0.20 D.**

b. **Let *u* = least distance of distinct vision to an object with the correcting lens in place.**

The image of this object is a virtual image formed at 0.25 m from the eye. Hence *v* = −0.25 m

Using 1/f= 1/u + 1/v

With *v* = −0.25 m and *f* = −5.0 m gives

1/u= 1/f-1/v = 1/(-5) – 1/(-0.25) = -0.2+4 = +3.8 D Hence *u* =1/3.8 = 0.263 m

H.W

1. **What is the power of the eye when viewing an object 50.0 cm away?**
2. **Calculate the power of the eye when viewing an object 3.00 m away.**
3. **What is the far point of a person whose eyes have a relaxed power of 0.5 D?**
4. **What is the near point of a person whose eyes have an accommodated power of 3.5 D?**
5. **What power of spectacle lens is needed to correct the vision of a nearsighted person whose far point is 30.0 cm? Assume the spectacle (corrective) lens is held 1.50 cm away from the eye by eyeglass frames.**