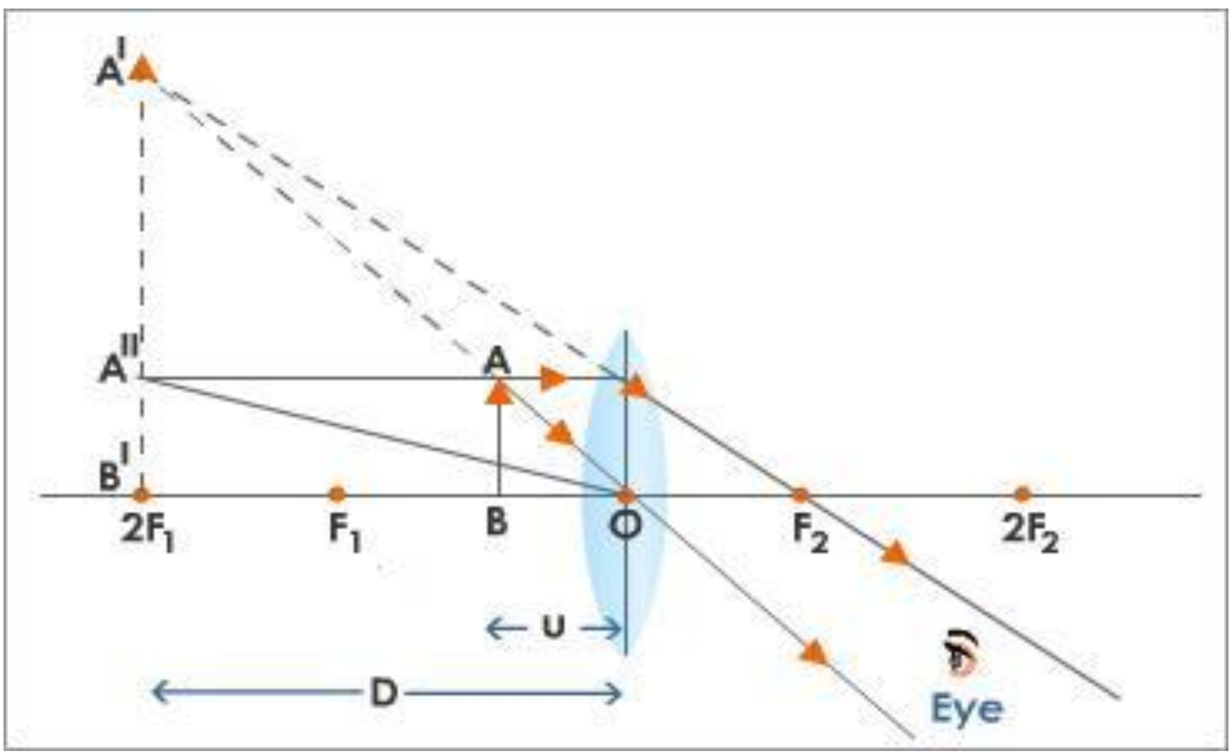
Magnifying Glass:

Principle of working of convex lens as magnifying glass:

When an object to be viewed through a double convex lens or simple microscope it is placed between the optical center and the principal focus of the convex lens and the image formed by convex lens / magnifying glass / simple microscope is erect, virtual and magnified. The image formed will lie on the same side of the object greater in size with respect to the size of object.

Ray Diagram: SLO # 12.7.1

The ray diagram showing the principle of working of simple microscope From the ray diagram it is clear that the object is placed very nearer to the convex lens or with the focal length of the lens due to this position of image the convex lens forms a virtual image which lies on the same side of the object it is erect and magnified.



Definition of Magnifying Power:

The magnifying power or angular magnification of a microscope may be defined as,

"The ratio of the angle subtended at the eye by the image formed at the distance of the distinct vision to the angle subtended by the object when placed at the distance of the distinct vision"

The ray diagram shows that the image of the object AB is formed at A^1B^1. A^1B^1 is formed at the least distance of distinct vision

Magnifying power of a Simple Microscope:

The Ray diagram shows that the angle A^1OB^1 subtended at the eye by the object in the position A^1B^1 is greater than the angle AOB subtended by it in the position AB.

From this it is clear that the eye estimates the angle subtended by an object on it and not the linear size of the object.

$$\text{Magnifying power} = \frac{\text{angle subtended at the eye by the image formed at the distance of distinct vision}}{\text{angle subtended at the eye by the object placed at the distance of distinct vision}}$$

$$= \frac{\angle A'OB'}{\angle A''OB'}$$

$$= \frac{\angle AOB}{\angle A''OB'}$$

$$= \frac{\tan \angle AOB}{\tan \angle A''OB'} \quad \left(\begin{array}{l} \text{When } \theta \text{ is small and in radian} \\ \text{measure} \\ \theta = \tan\theta \end{array} \right)$$

$$= \frac{\frac{AB}{OB}}{\frac{A''B'}{OB'}}$$

$$= \frac{AB}{OB} \times \frac{OB'}{AB} \quad (\because AB = A''B')$$

$$= \frac{OB'}{OB}$$

$$\text{Magnifying power } (m) = \frac{OB'}{OB}$$

But,

OB^1 = Least distance of distinct vision from the lens or eye = d

OB = u = distance between the lens and the object

$$m = \frac{D}{u}$$

The distance between the image and the lens is negative as the image formed is virtual

$$\therefore \; D = -v$$

The lens formula for a convex lens is

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \; ------ (1)$$

Where f is the focal length of the lens multiplying both sides of the equation (1) by v we get

$$\frac{v}{f} = \frac{v}{v} - \frac{v}{u}$$

$$\frac{v}{f} = 1 - \frac{v}{u}$$

But $m = \frac{v}{u}$

$$\frac{v}{f} = 1 - m$$

$$m = 1 - \frac{v}{f}$$

In the case of a simple microscope v = - q = - d

$$\therefore\ m = 1 + \frac{D}{f}$$

d = 25 cm Least distance of distinct vision

$$m = 1 + \frac{25}{f} \text{ - - - - - } (2)$$

Magnifying Power $= 1 + \dfrac{d}{f}$

From equation it is clear that a convex lens of short focal length has a large magnifying power.

The highest magnification which can be obtained from a simple microscope is about 20.

Uses:

A simple microscope is used as a magnifying glass.

It cannot be used to observe very tiny objects like bacteria and cells because of its low magnification.