University of Al-Qadisiyah /College of Medicine
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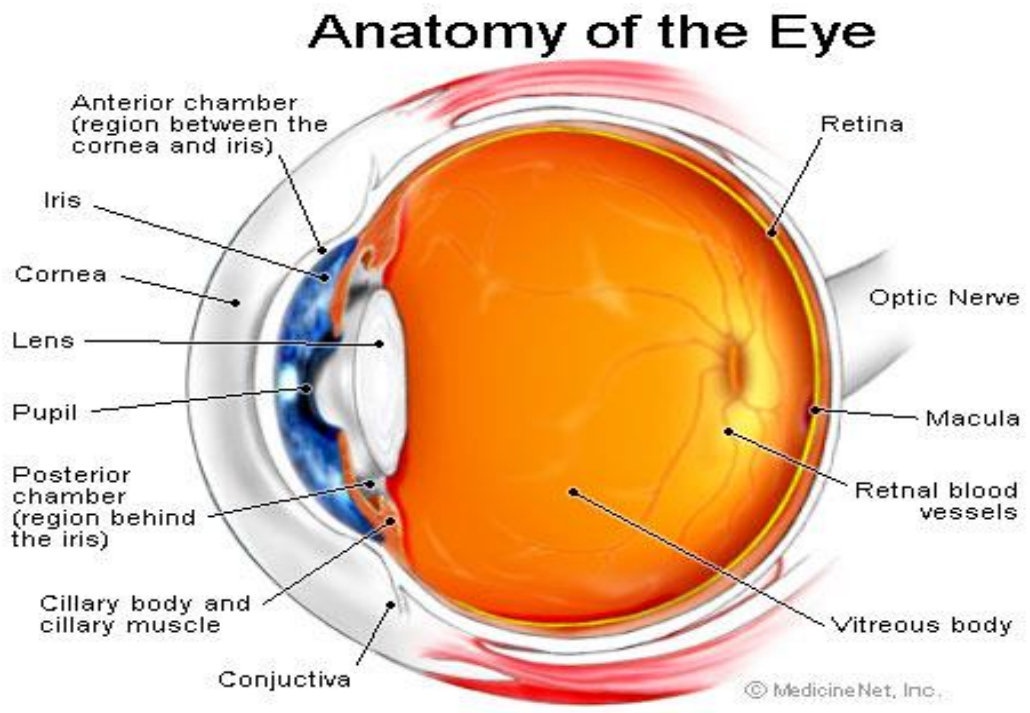
Physics of the eye and vision



Anatomy of the Eye

The human eye is a sphere of 2.3 cm in diameter, its achieves vision by forming an image that stimulates nerve endings, creating the sensation of sight. Like a camera, the eye consists of an Aperture and lens system at the front, and a light-sensitive surface at the back.

Light enters the eye through the aperture-lens system, and is focused on the back wall. The lens system consists of two lenses: the **corneal lens** on the front surface of the eye, and the **crystalline lens** inside the eye. The space between the lenses is filled with a transparent fluid called the **aqueous humor**. Cornea a clear transparent membrane covers the front part of the eye ball, and is made of living cells without blood supply. Since the living cells in the cornea are not supplied with oxygen by the blood. They must get their oxygen from the air.

Having blood vessels in the cornea would not help our vision! The nutrients for the cells in the cornea are supplied by the aqueous humor that is in contact with

its back surface. The aqueous humor contains all of the blood components except blood cells.

Also between the lenses is the **iris,** colored membrane. At the center of the iris is the **pupil,** a muscle-controlled, variable- diameter hole, or aperture, which Controls the amount of light that enters the eye, it changes from 3 mm in diameter in bright light to 8 mm in dim light, where light enters the lens. It appears black because essentially all of the light that enters is absorbed inside the eye.

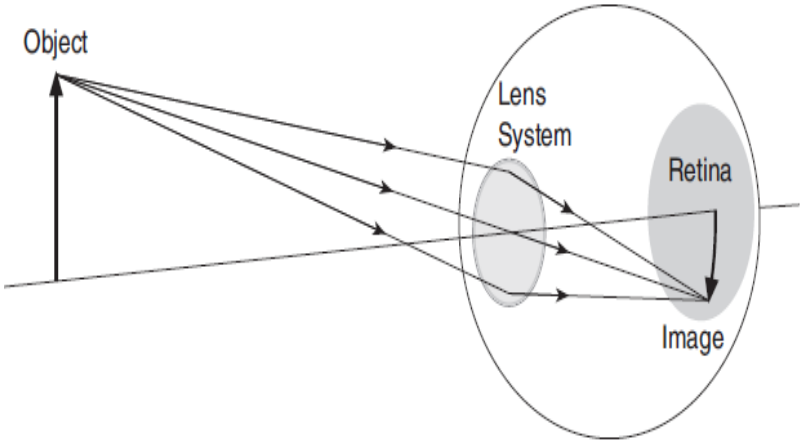
The interior of the eye behind the crystalline lens is filled with a colorless, transparent material called the **vitreous humor**. On the back wall of the eye is the **retina**, a membrane containing light-sensitive nerve cells known as **rods** and **cones**. Rods are very sensitive to low light levels, but provide us only with low-resolution, black-and-white vision. Cones allow us to see in color at higher resolution, but they require higher light levels. The **fovea**, a small area near the center of the retina, contains only cones and is responsible for the most acute vision. Signals from the rods and cones are carried by nerve fibers to the **optic nerve**, which leads to the brain. The optic nerve connects to the back of the eye; there are no light-sensitive cells at the point where it attaches, resulting in a **blind spot**. The sclera covering the entire eye except the cornea, the eye is mounted in a well-protected casing almost completely surrounded by bone.

Optics of the Eye

The corneal lens and crystalline lens together act like a single, convergent Lens. Light entering the eye from an object passes through this lens system and forms an inverted, real image on the retina but the brain automatically corrects for this.

The eye focuses on objects at varying distances by **accommodation**, or the use of muscles to change the curvature, and thus the focal length, of the crystalline lens. In its most relaxed state, the crystalline lens has a long focal length, and the eye can focus the image of a distant object on the retina. The farthest distance at which the eye can accommodate is called the **far point** for distinct vision. For a normal eye, the far Point is infinity.

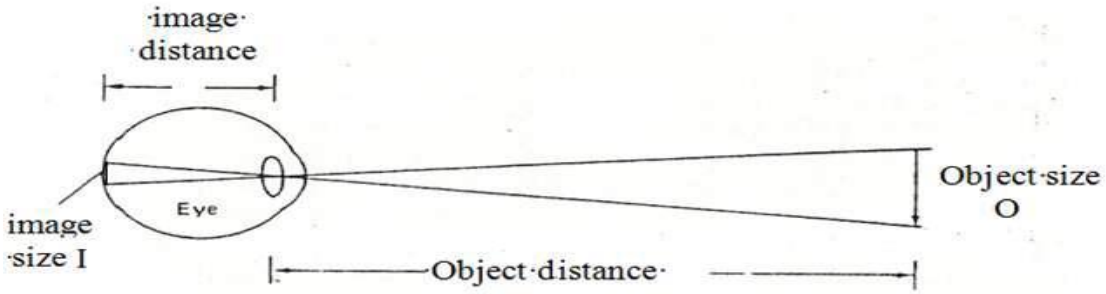
For each eye we define the near point as the closest distance at which it can see clearly; the far point is the greatest distance at which it has good vision.



•With age the lens lose some of accommodation: old sight (presbyopia).

Defective vision and its correction

Accommodation :



Retina image size I $\Longrightarrow \frac{I}{O} = \frac{V}{U}$

O = Object

V = image distance = diameter of the eye ball.

U = Object distance

The simple relation between focal length (F) of a lens, the object distance (U) and the image distance (V) is

(1/F) = (1/U) + (1/V)

•If F measured in meter 1/F = lens strength in diopter (D)

•Focal length of combination 1/F = 1/F1+1/F2+1/F3 ... etc

•Normal eye can focus on an object between infinity and 25 cm.

The variation in the focal length of the eye lens according to the image distance is called accommodation. The image distance V from the lens to retina (eye ball) diameter approximately 2cm.

The accommodation power of the normal eye is 4 D.

1. Far point

$$\frac{1}{F} = \frac{1}{\infty} + \frac{1}{0.02\ m} \quad \text{.....Eye lens strength = 50 D}$$

2. Near point

$$\frac{1}{F} = \frac{1}{0.25} + \frac{1}{0.02} = 54\ \text{D}$$

$$54 - 50 = 4\ \text{D}$$