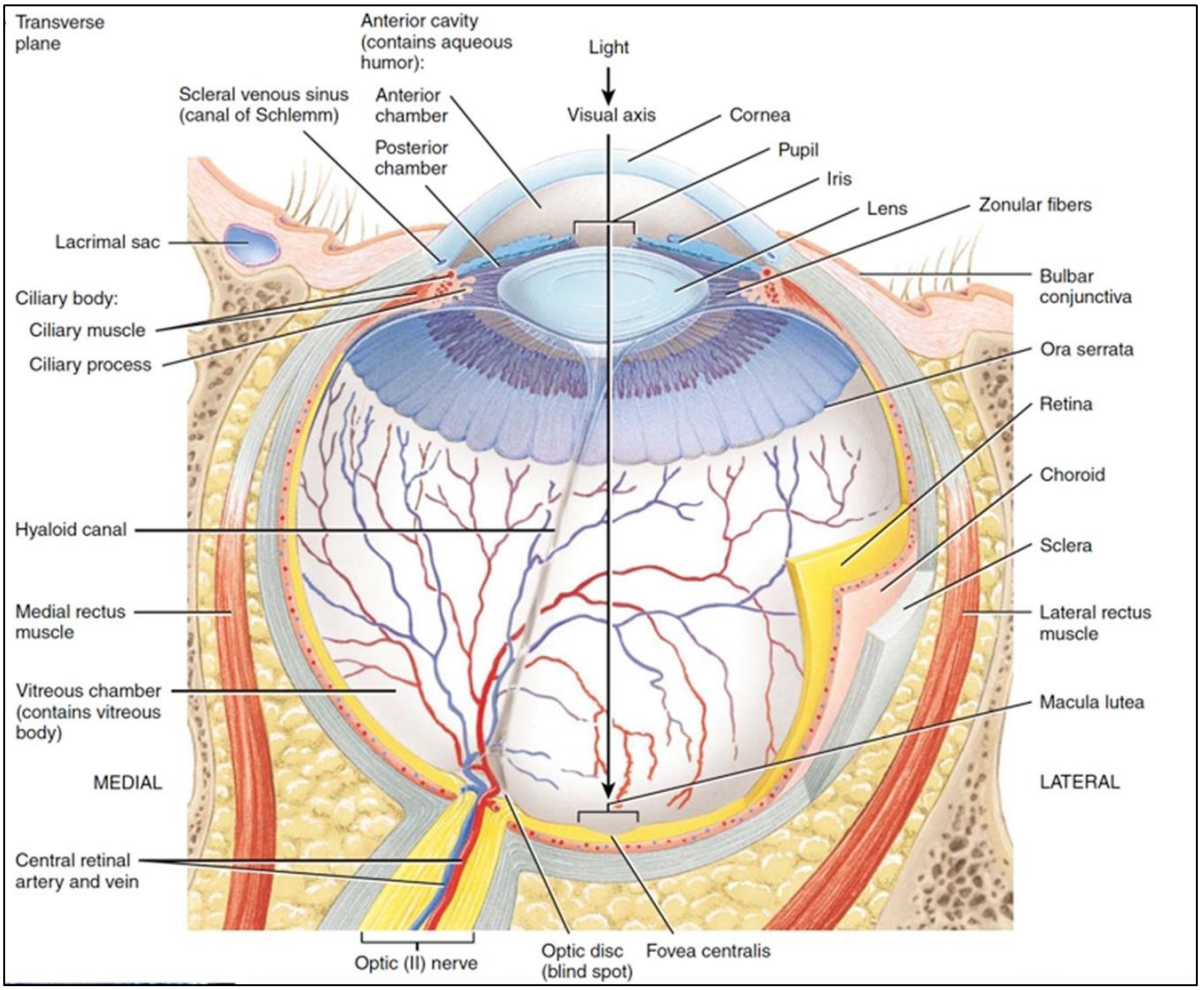
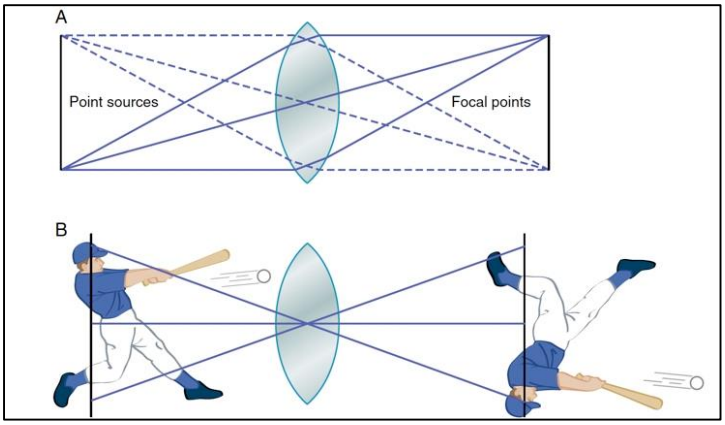
Vision-I



- The lens system of the eye can focus an image on the retina.
- The image is inverted and reversed with respect to the object.
- However, the mind perceives objects in the upright position despite the upside-down orientation on the retina because the brain is trained to consider an inverted image as normal.



When light rays traveling through a transparent substance pass into a second transparent substance with a different density, they bend at the junction between the two substances (**refraction**).

Refraction

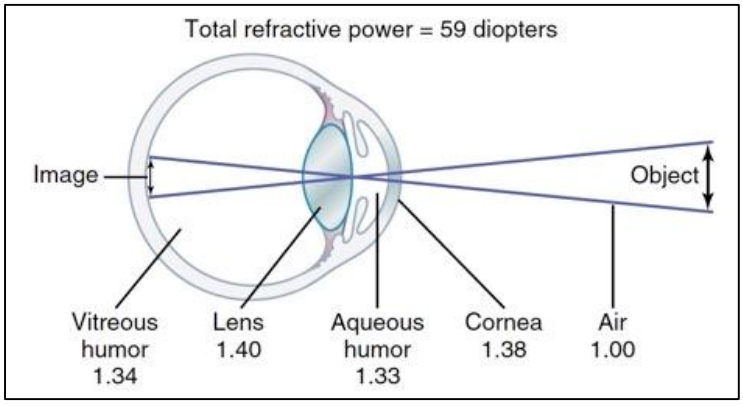
- The lens system of the eye is composed of four refractive interfaces:
  (1) the interface between air and the anterior surface of the cornea.
  (2) the interface between the posterior surface of the cornea and the aqueous humor.
  (3) the interface between the aqueous humor and the anterior surface of the lens.
  (4) the interface between the posterior surface of the lens and the vitreous humor.

Refractive index

- The refractive index of a transparent substance is the ratio of the velocity of light in air to the velocity in the substance.
- The refractive index of air is 1.00.
- The distance beyond a convex lens at which parallel rays converge to a common focal point is called the focal length of the lens.

Refractive power

- The more a lens bends light rays, the greater is its “refractive power.” This refractive power is measured in terms of diopters.
- The refractive power in diopters of a convex lens is equal to 1 meter divided by its focal length.



- Thus, a spherical lens that converges parallel light rays to a focal point 1 meter beyond the lens has a refractive power of +1 diopter.

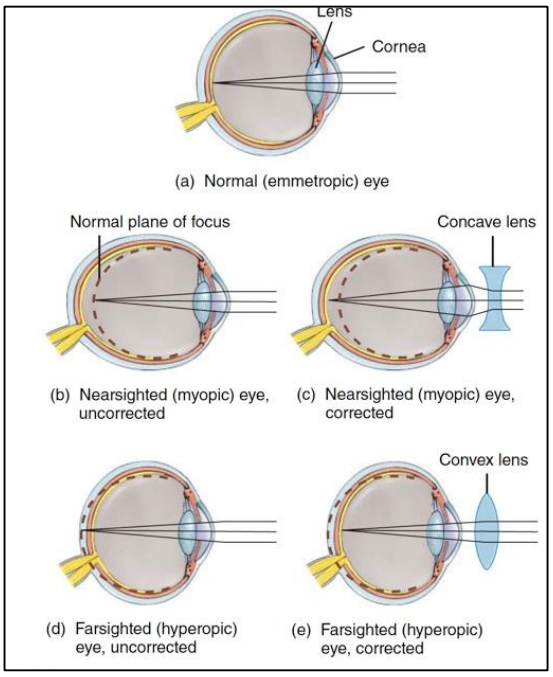
Refraction

- In the reduced eye, a single refractive surface is considered to exist, with a total refractive power of 59 diopters when the lens is accommodated for distant vision.
- About two-thirds of the 59 diopters of refractive power of the eye is provided by the anterior surface of the cornea (not the lens).
- The principal reason for this phenomenon is that the refractive index of the cornea is markedly different from that of air.
- However, the importance of the internal lens is that in response to nervous signals from the brain, its curvature can be increased markedly to provide “accommodation,”

Accomodation

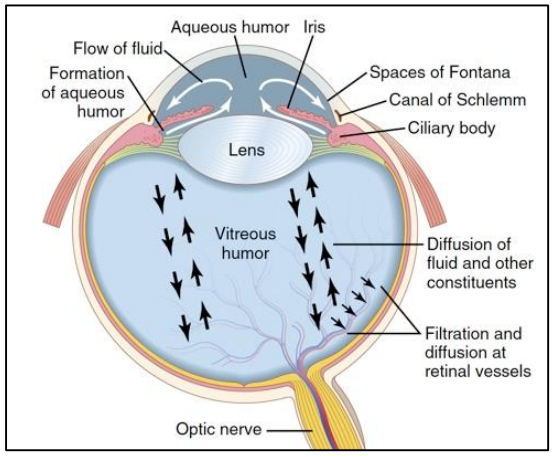
- In children, the refractive power of the lens of the eye can be increased voluntarily from 20 diopters to about 34 diopters, which is an “accommodation” of 14 diopters.
- To make this accommodation, the shape of the lens is changed from that of a moderately convex lens to that of a very convex lens.
- In a young person, the lens is composed of a strong elastic capsule filled with viscous, proteinaceous, but transparent fluid.
- However, about 70 suspensory ligaments attach radially around the lens, pulling the lens edges toward the outer circle of the eyeball.
- These ligaments are constantly tensed by their attachments at the anterior border of the choroid and retina.
- The tension on the ligaments causes the lens to remain relatively flat under normal eye conditions.
- Also located at the lateral attachments of the lens ligaments to the eyeball is the ciliary muscle, which has two separate sets of smooth muscle fibers—meridional fibers and circular fibers.
- Contraction of either set of smooth muscle fibers in the ciliary muscle relaxes the ligaments to the lens capsule, and the lens assumes a more spherical shape because of the natural elasticity of the lens capsule.
- Ciliary muscle is controlled almost entirely by parasympathetic nerve signals transmitted to the eye through the third cranial nerve from the third nerve nucleus in the brain stem.
- Stimulation of parasympathetic nerves contracts both sets of ciliary muscle fibers, which relaxes the lens ligaments, thus allowing the lens to become thicker and increase its refractive power.
- As a person grows older, the lens grows larger and thicker and becomes far less elastic, partly because of progressive denaturation of the lens proteins. The ability of the lens to change shape decreases with age.
- The power of accommodation decreases from about 14 diopters in a child to less than 2 diopters by the time a person reaches 45 to 50 years and to essentially 0 diopters at age 70 years.
- Thereafter, the lens remains almost totally nonaccommodating, a condition known as **presbyopia**.

- Once a person has reached the state of presbyopia, each eye remains focused permanently at an almost constant distance; this distance depends on the physical characteristics of each person's eyes.
- The eyes can no longer accommodate for both near and far vision. To see clearly both in the distance and nearby, an older person must wear bifocal glasses, with the upper segment focused for far-seeing and the lower segment focused for near-seeing (e.g., for reading).



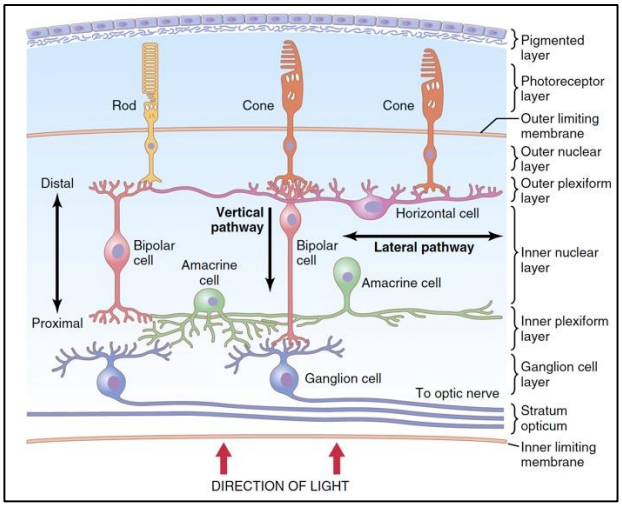
Pupillary diameter

- The major function of the iris is to increase the amount of light that enters the eye during darkness and to decrease the amount of light that enters the eye in daylight.
- The amount of light that enters the eye through the pupil is proportional to the area of the pupil or to the square of the diameter of the pupil.
- The pupil of the human eye can become as small as about 1.5 millimeters and as large as 8 millimeters in diameter.
- The quantity of light entering the eye can change about 30-fold as a result of changes in pupillary aperture.



Intraocular fluid

- The aqueous humor is a freely flowing fluid, whereas the vitreous humor, sometimes called the vitreous body, is a gelatinous mass held together by a fine fibrillar network composed primarily of greatly elongated proteoglycan molecules.
- Aqueous humor is continually being formed and reabsorbed.



- The balance between formation and reabsorption of aqueous humor regulates the total volume and pressure of the intraocular fluid.