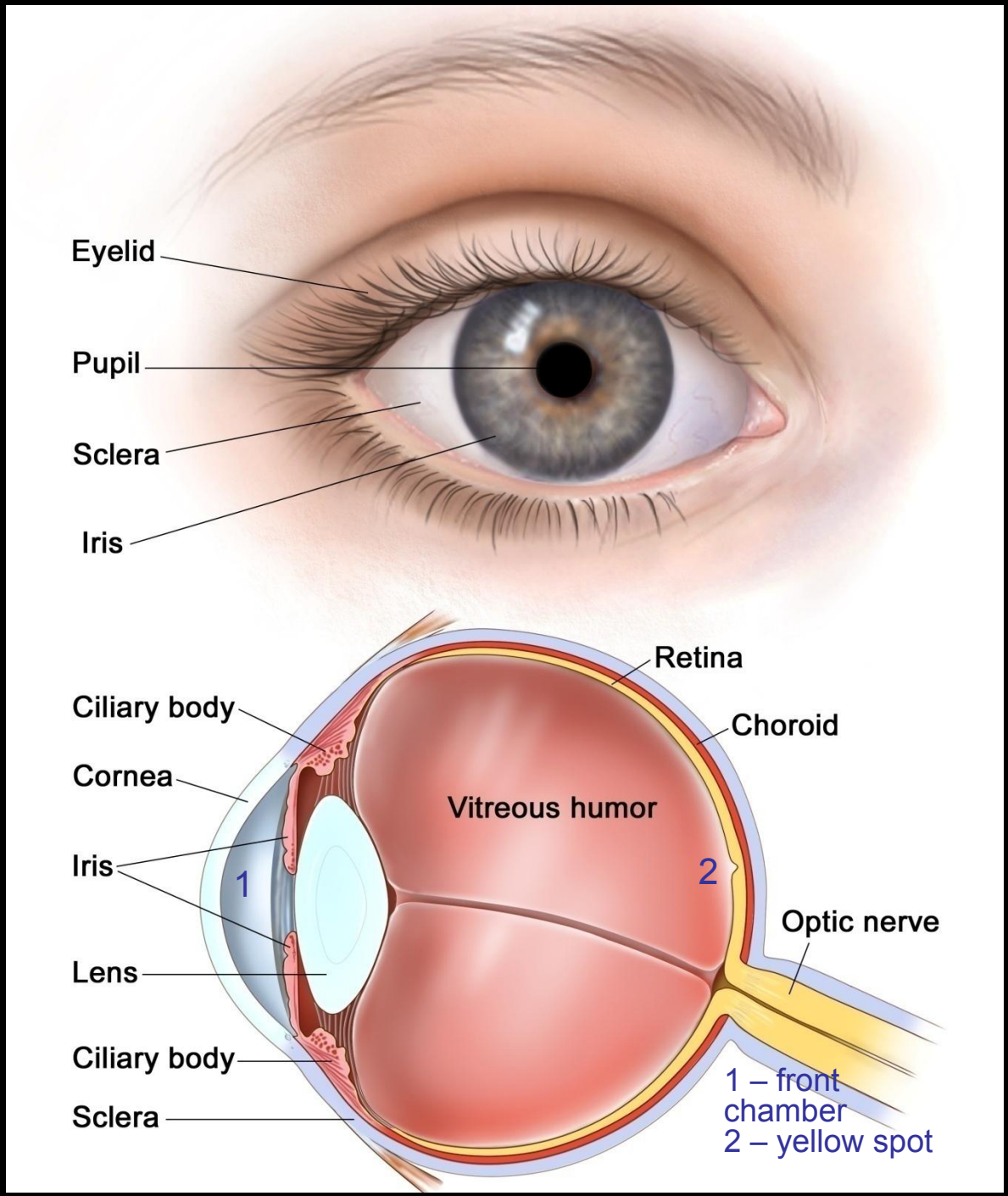
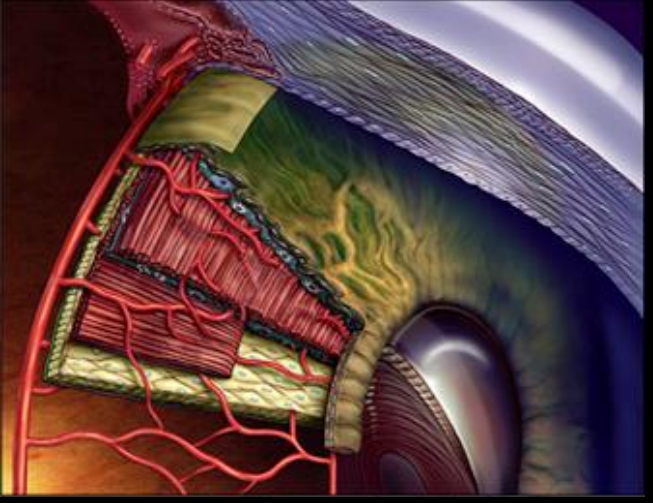
OPTICS OF VISION

EYE STRUCTURE

An eye has almost round form.
Diameter of an eye is about 2,3 cm.
It is covered with white protecting cover - **sclera**.
The front clear part of sclera is called **cornea**.
After the cornea on some distance goes **iris, colored with pigment.**
The aperture in iris is called **pupil**.
Area between cornea & iris is called **front chamber –** it is filled with liquid – **aqueous humor**.
Behind the pupil the **crystalline lens** is situated. Crystalline lens – is an elastic lens-like body.
The rest part of the eye is filled with **vitreous humor**.
Back part of an eye – the eyeground.
The eyeground is covered with **retina,** which is a complex branching of visual nerve with nerve endings – **rods & cones,** which are lightsensitive elements of an eye.

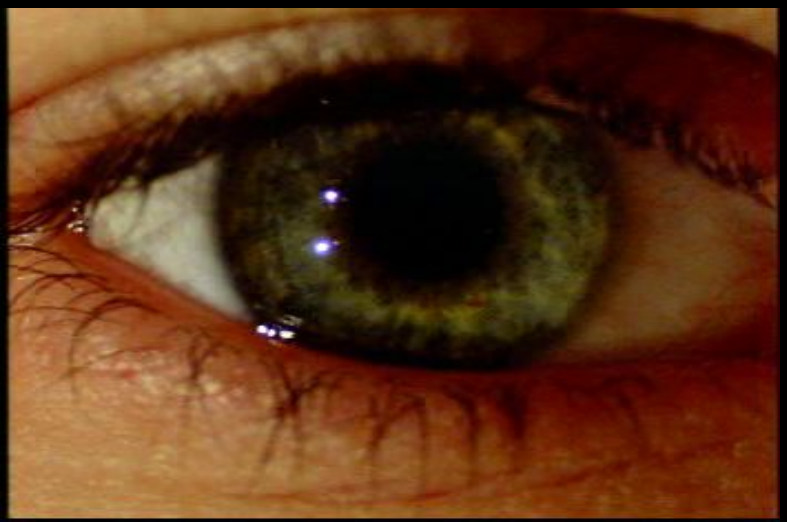




EYE ADAPTATION TO LIGHT & DARKNESS

Eye adaptation – is an eye adjustment to the lighting conditions. When an eye first was in a bright lighted conditions then it was placed in the dark, such adaptation is called **dark adaptation.**

If an eye was in the dark then it was put in the bright lighting conditions such adaptation is called **light adaptation.** During dark adaptation the sensitivity of an eye increases first very fast then more slowly.

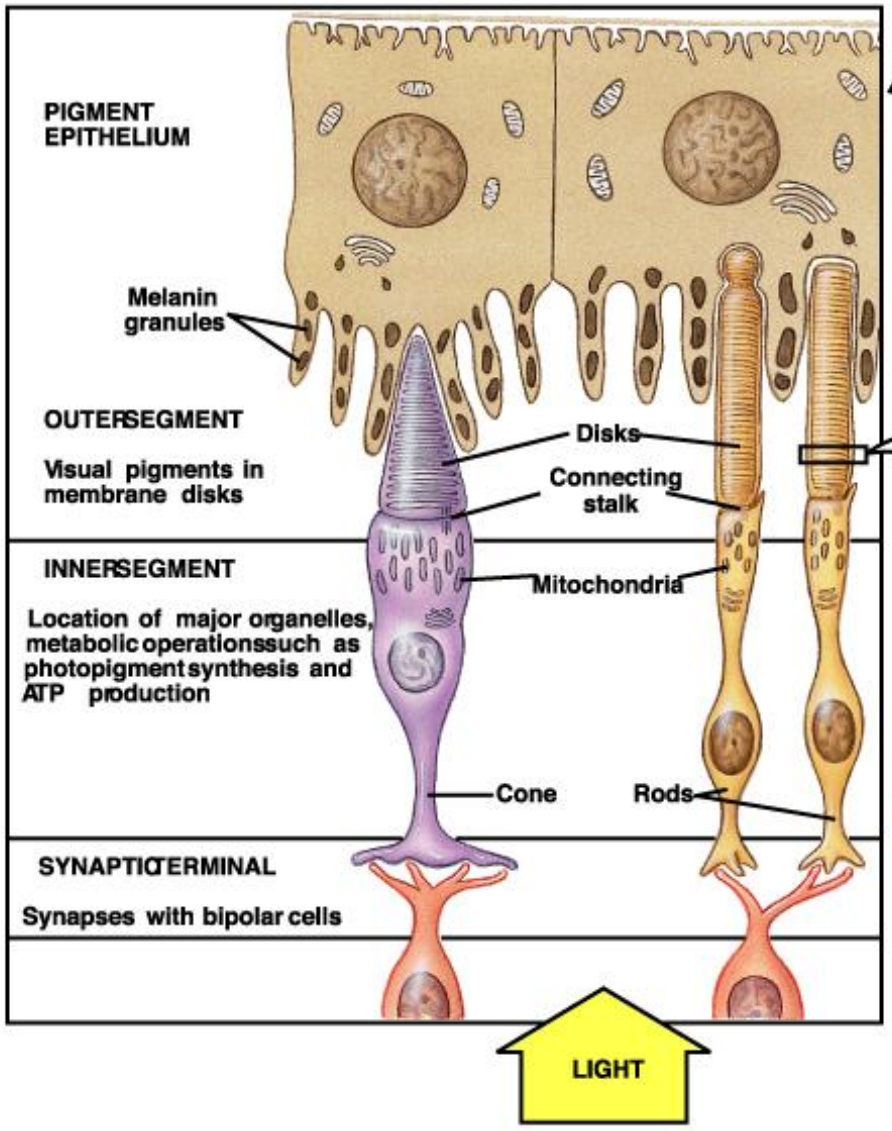


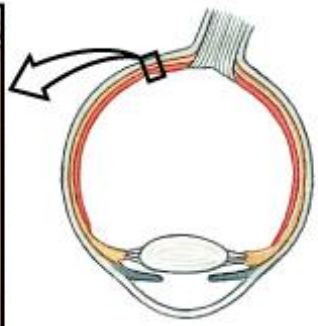
This process lasts several hours, but in the end of the first hour the sensitivity of an eye increases in many times. During light adaptation the sensitivity of an eye in the light increases more fast. Light adaptation takes 1-3 minutes in the average brightness of light.

Photoreceptors: Rods & Cones

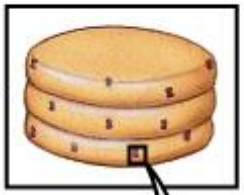
- The two types of photoreceptor cells found in the retina are rods & cones.
- Overall rods out number cones by 20:1, except at the fovea where the cones are concentrated.
- Rods function at low light levels, and are responsible for monochromic night vision.
- Cones function at higher light levels and are responsible for high acuity colour daylight vision.
- Both rods & cones have the same basic structure with an outer segment containing a light sensitive visual pigments in disks, an inner segment containing the cellular organelles and a synaptic region at the base.
- Synaptic convergence for rods is high (100:1 in the periphery) whereas synaptic convergence for cones at the fovea is low.

Rods and cones..

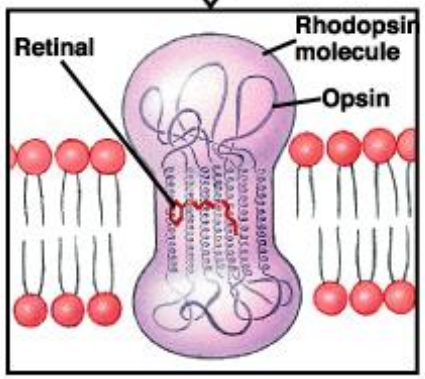




Dark pigment layer absorbs stray light & reduces reflection

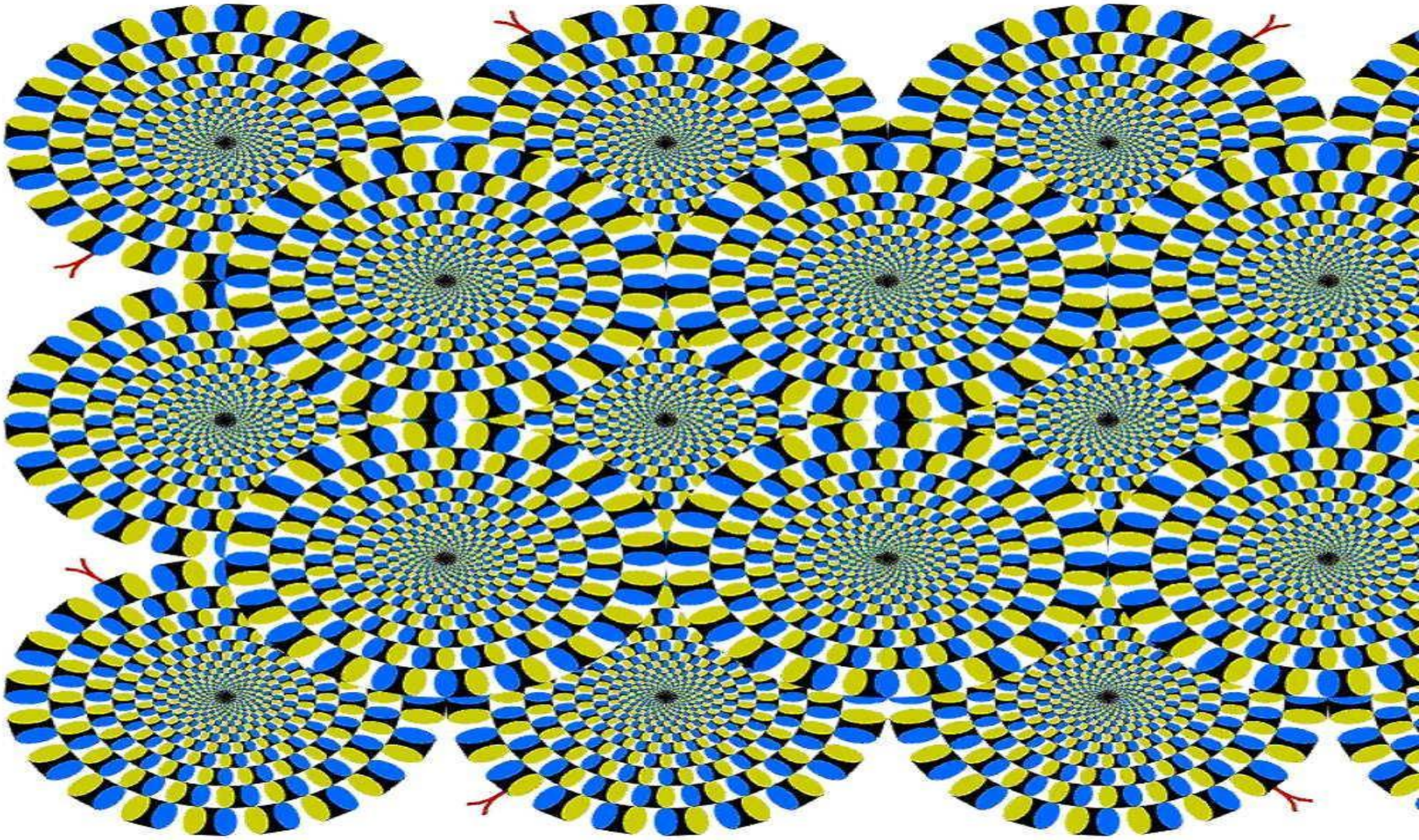


Disks in rods & cones are the site of transduction. Disks in cones are pigmented and filter light at different wavelengths



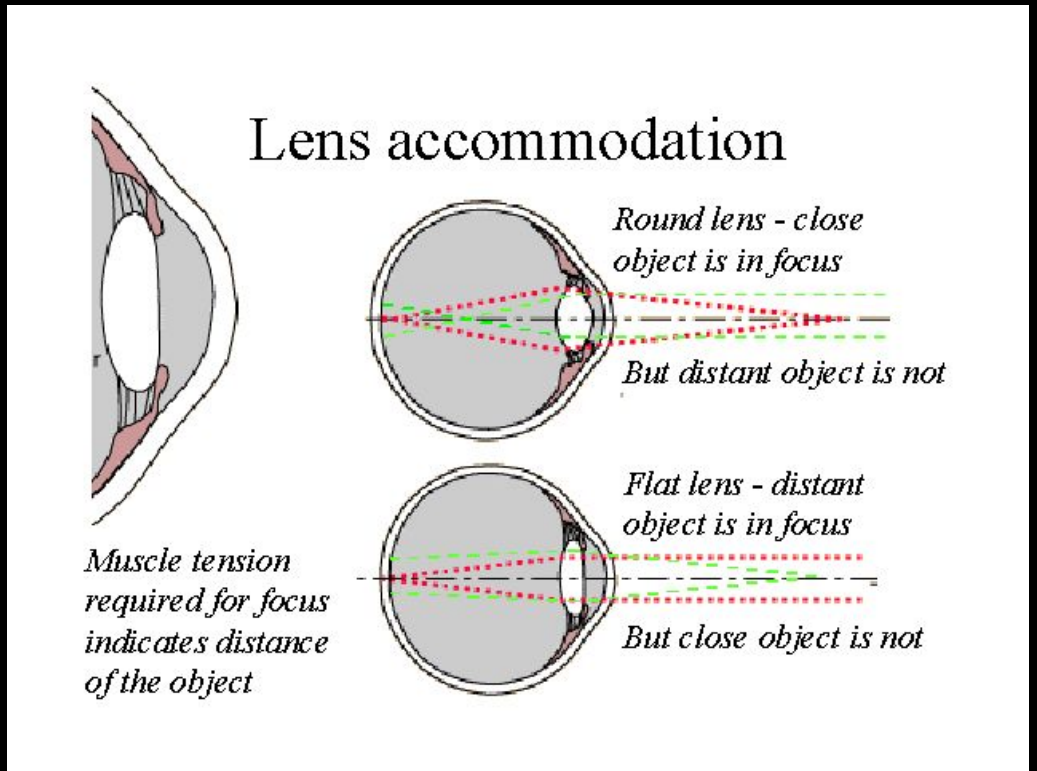
Transduction process mediated by pigments in the disks ..example is rod

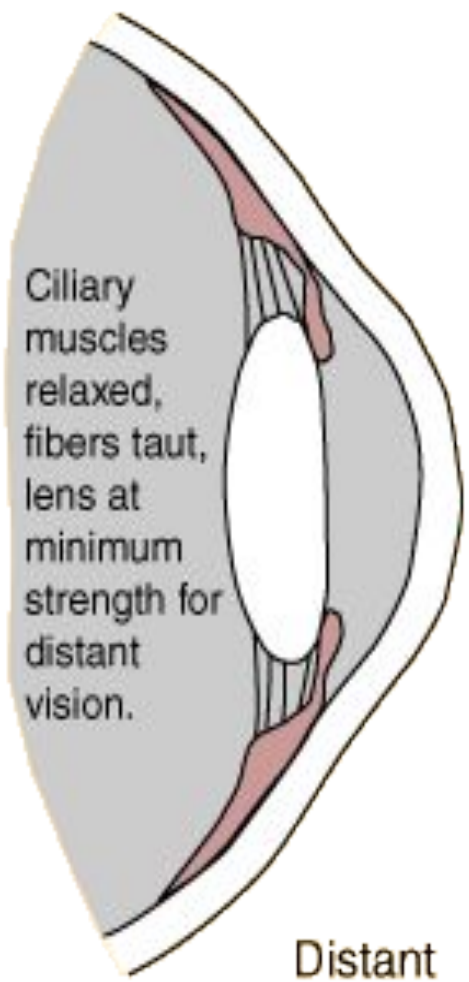
...are selective light transducers



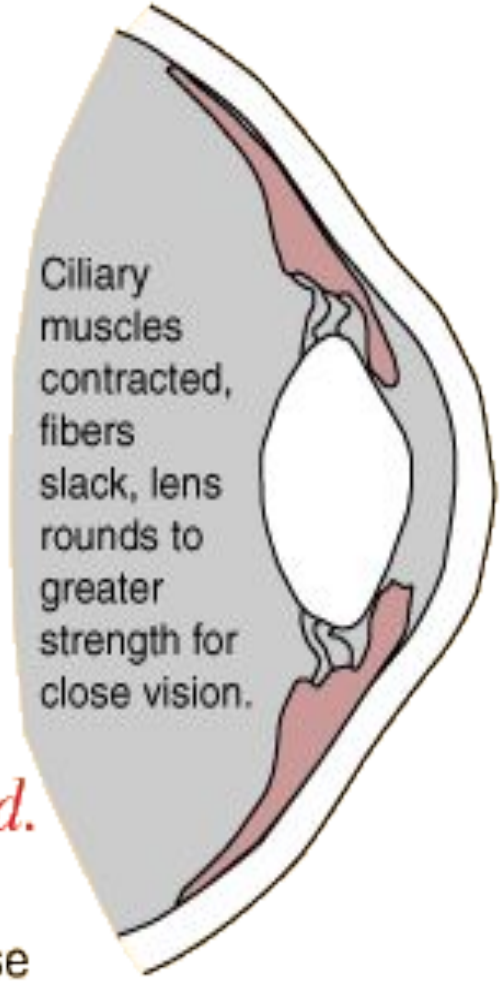
Eye accommodation

The cornea, clear liquid of front chamber, crystalline lens & vitreous humor are the optic system of an eye. The optic centre of this system is situated on a distance of about 5mm from the cornea. When the eye muscle is relaxed the optic power of an eye is equal to 59dptr, when the muscle is in maximal contraction – 70dptr. Main peculiarity of an eye as the optical system is it ability to change reflectory its optical power. This depends on what position the object the eye is focusing on is situated. Such adaptation of eye optical system to see objects on diferent distances is called **accommodation**. Accommodation goes by the mean of crystalline lens curvature change by ciliary muscles.





The eye accommodates for close vision by tightening the ciliary muscles, allowing the pliable crystalline lens to become more rounded.



Distant

Close

Presbyopia: ciliary muscles can no longer contract as well; lens cannot be made round enough for close vision

Test for Presbyopia

Measurement of 'near point':

-measure with ruler and pin

-near point increases with age

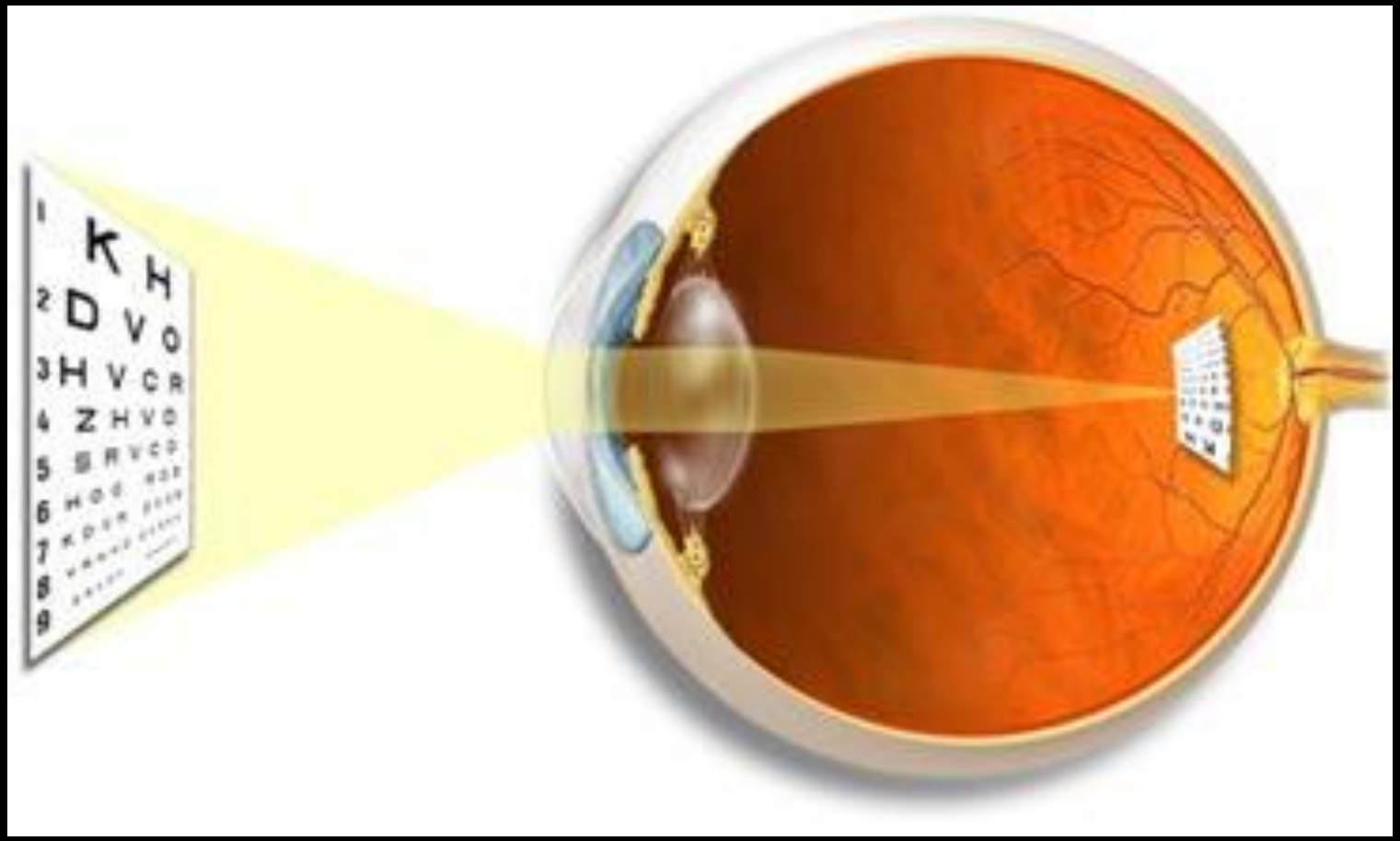
-average near points:

-10 yr. old: 7 cm

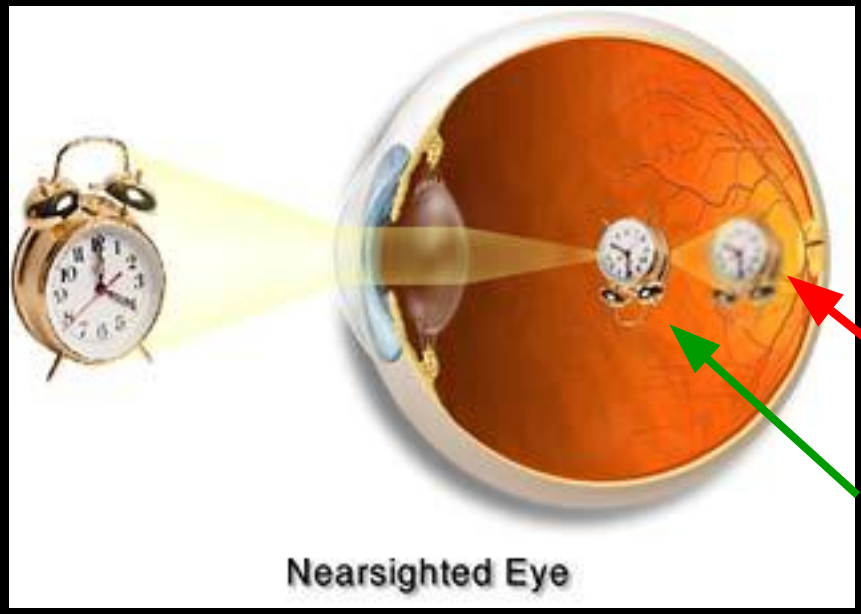
-40 yr. old: 21 cm

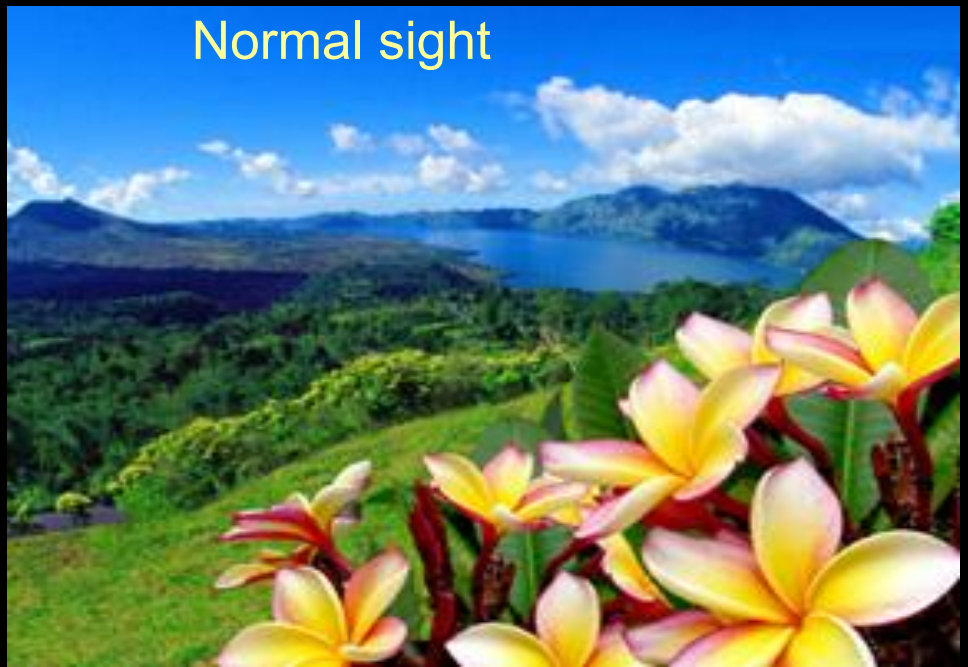
-60 yr. old: 100 cm

Emmetropia: objects focused on retina (normal)

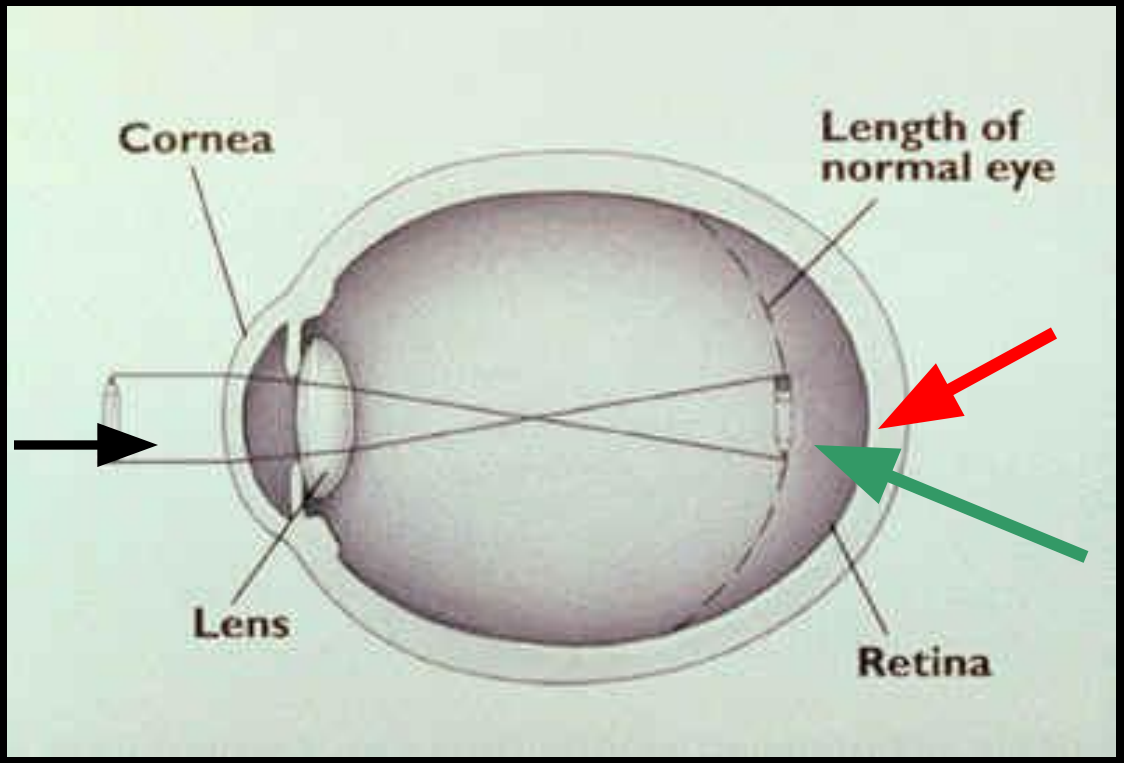


Myopia (nearsightedness): objects focused in front of retina





Myopia (nearsightedness):

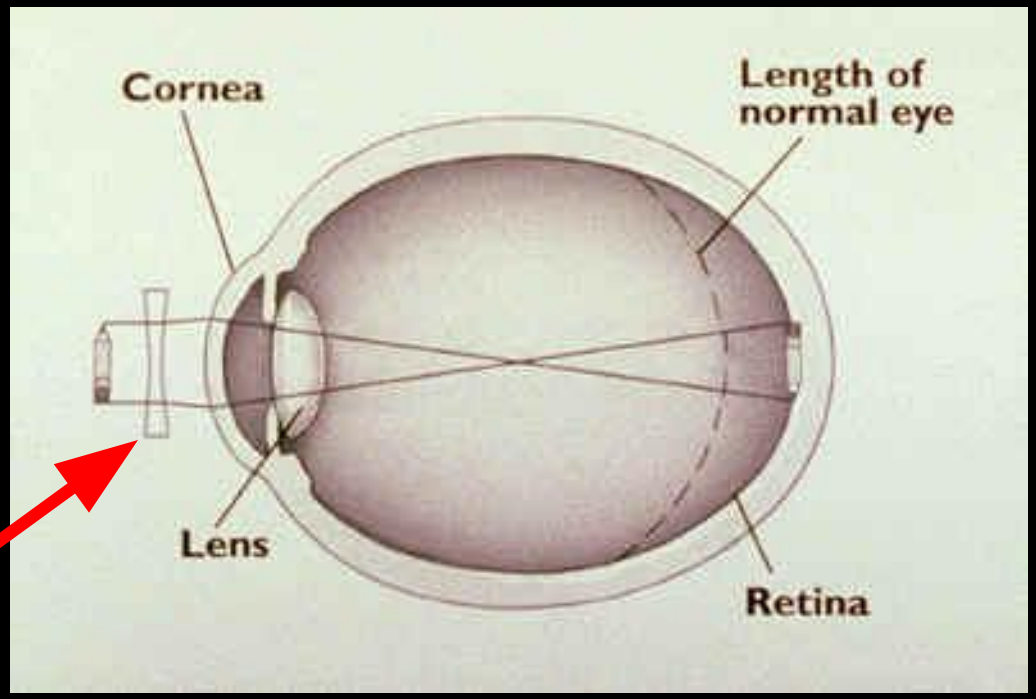


Axial myopia: eyeball too long (shown above)

Refractive myopia: cornea too curved

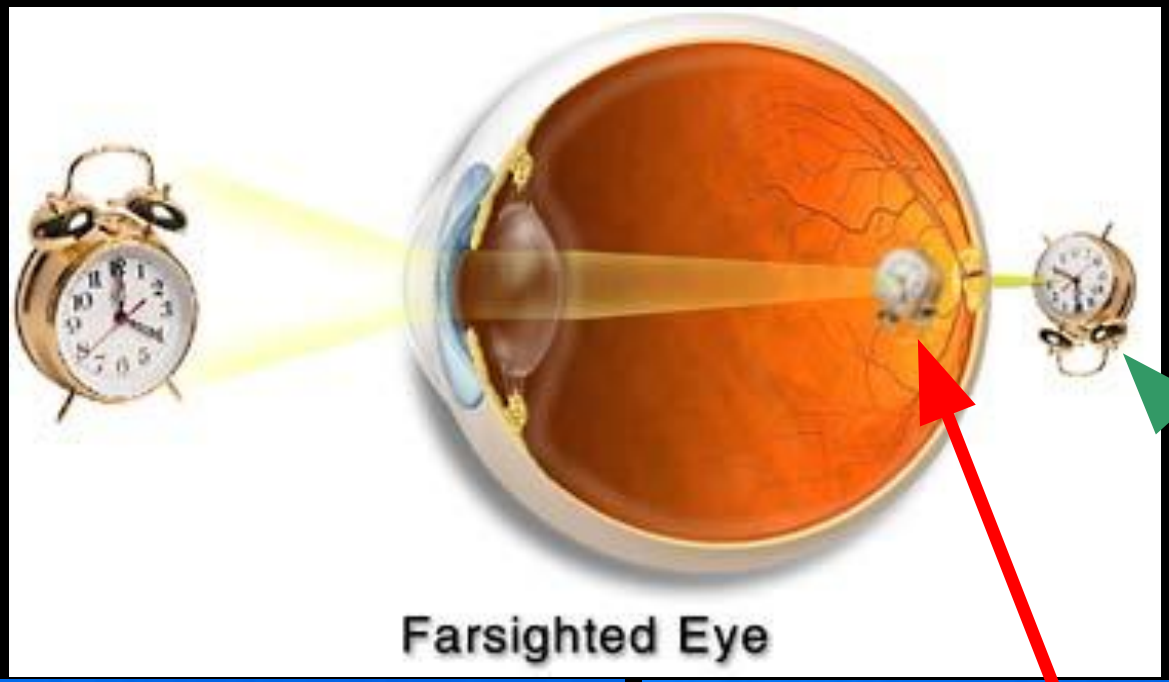
Myopia Correction

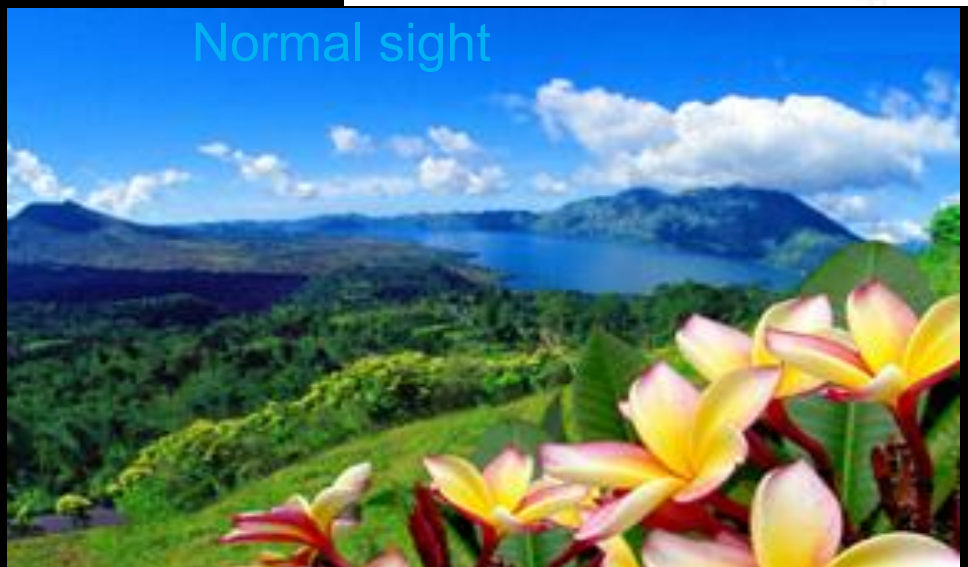
concave lens: negative diopter; diffraction

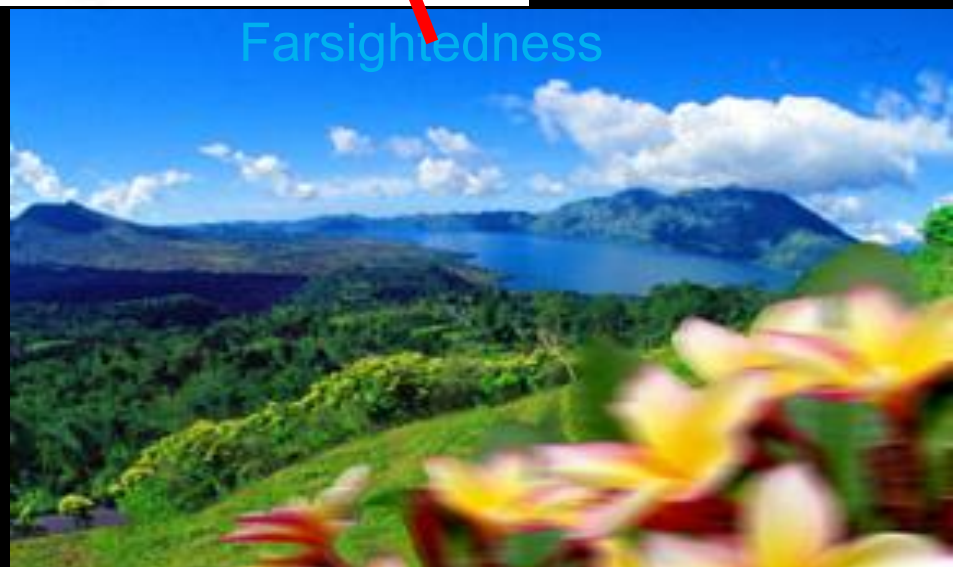


laser surgery: remove corneal tissue in center to reduce curvature

Hyperopia (farsightedness): objects focused behind retina

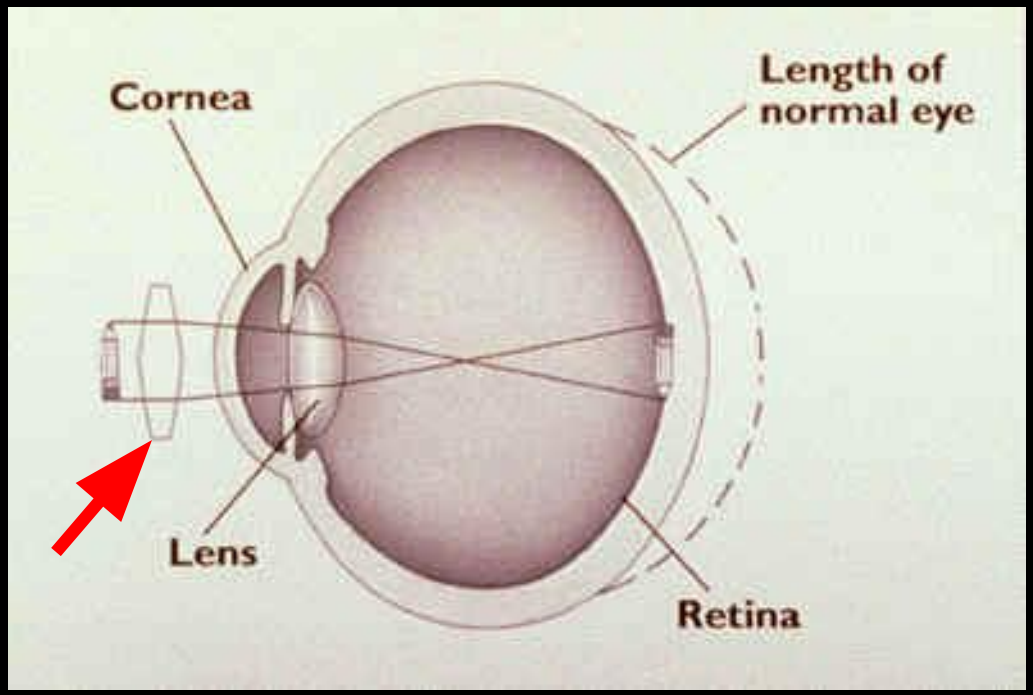






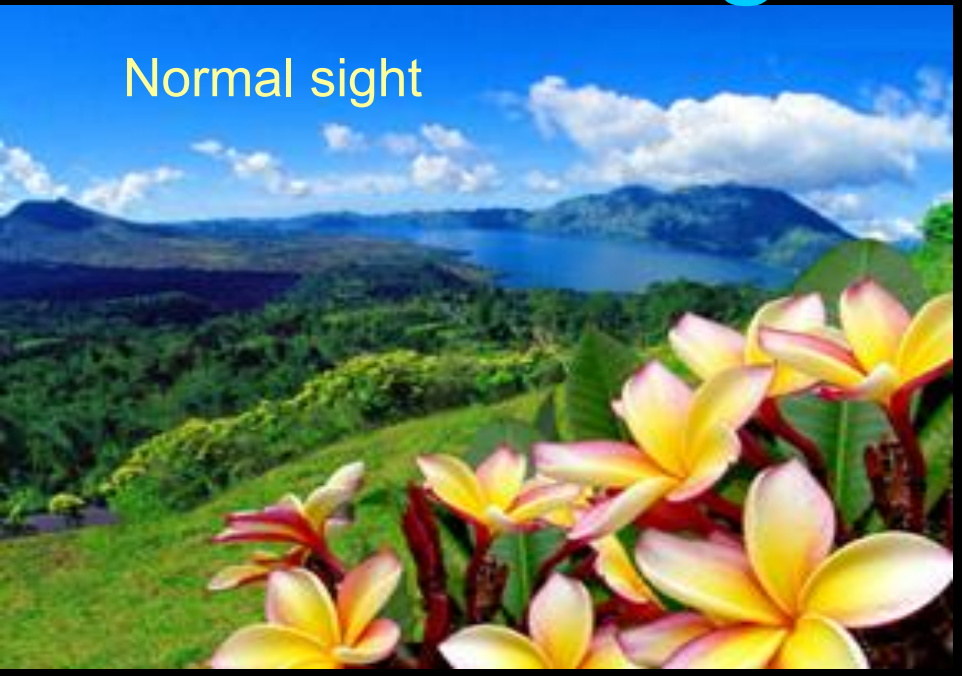
Hyperopia Correction

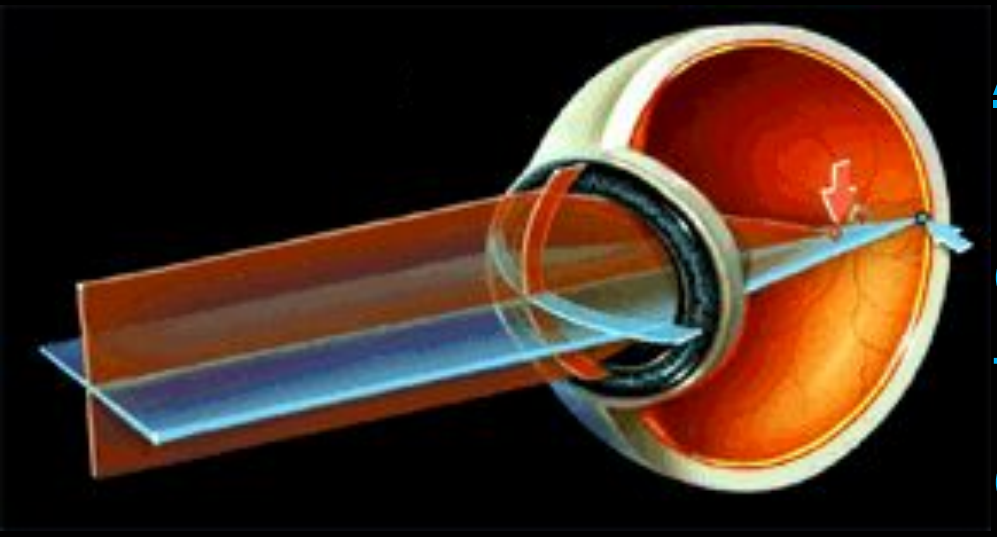
convex lens: positive diopter; refraction



laser surgery: remove corneal tissue around sides to increase curvature

Astigmatism





Aspherical cornea: light at some orientations is focused, while light at others is not

Astigmatism

LASER correction
of cornea shape