

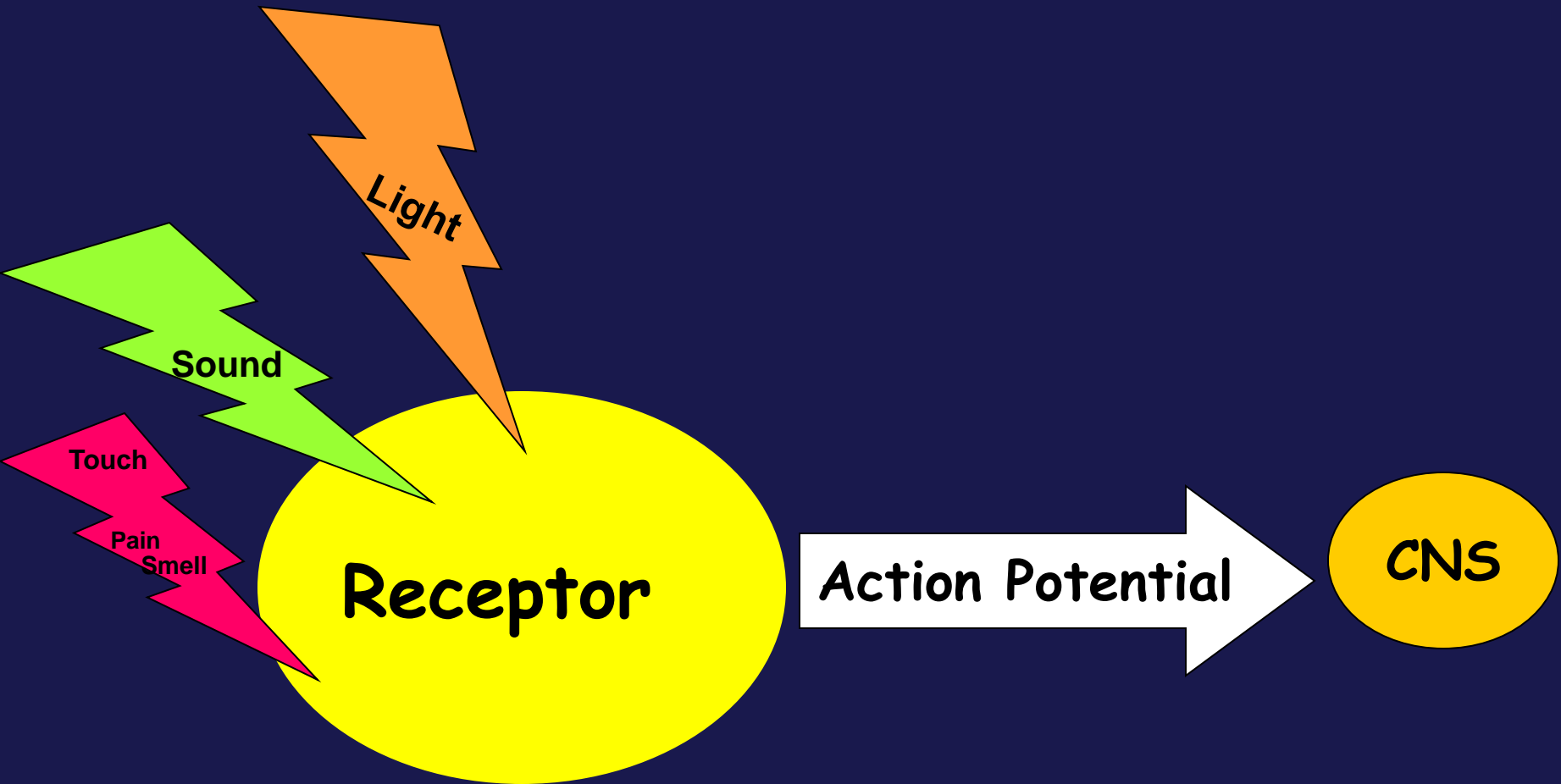
# The Special Senses

## Physiology of Vision

Lecture-1-

physiology of the eye and refraction

DR.ABDULMAJEED AL-DREES



# The Special Senses

- Vision
- Hearing
- Smell
- Taste

# Our Eyes

- The most sensitive and delicate organ we have
- We are able to see the world and our brains receive the information from the world
- The images we see are made up of light reflected from the objects we look at





Sunrise Storm Clouds, Anza Borrego State Park, California

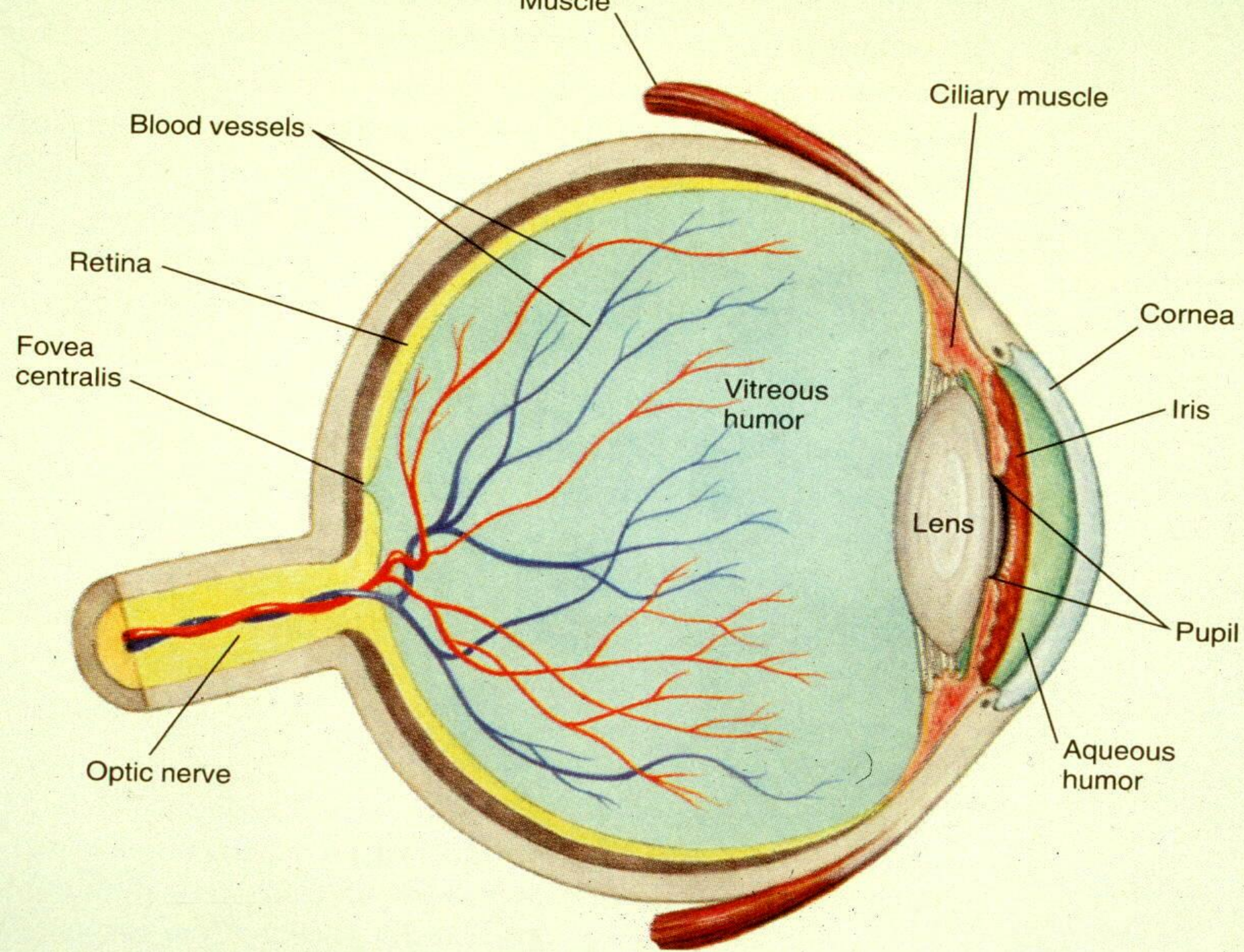


# Objectives:

At the end of these lecture the student should be able to:

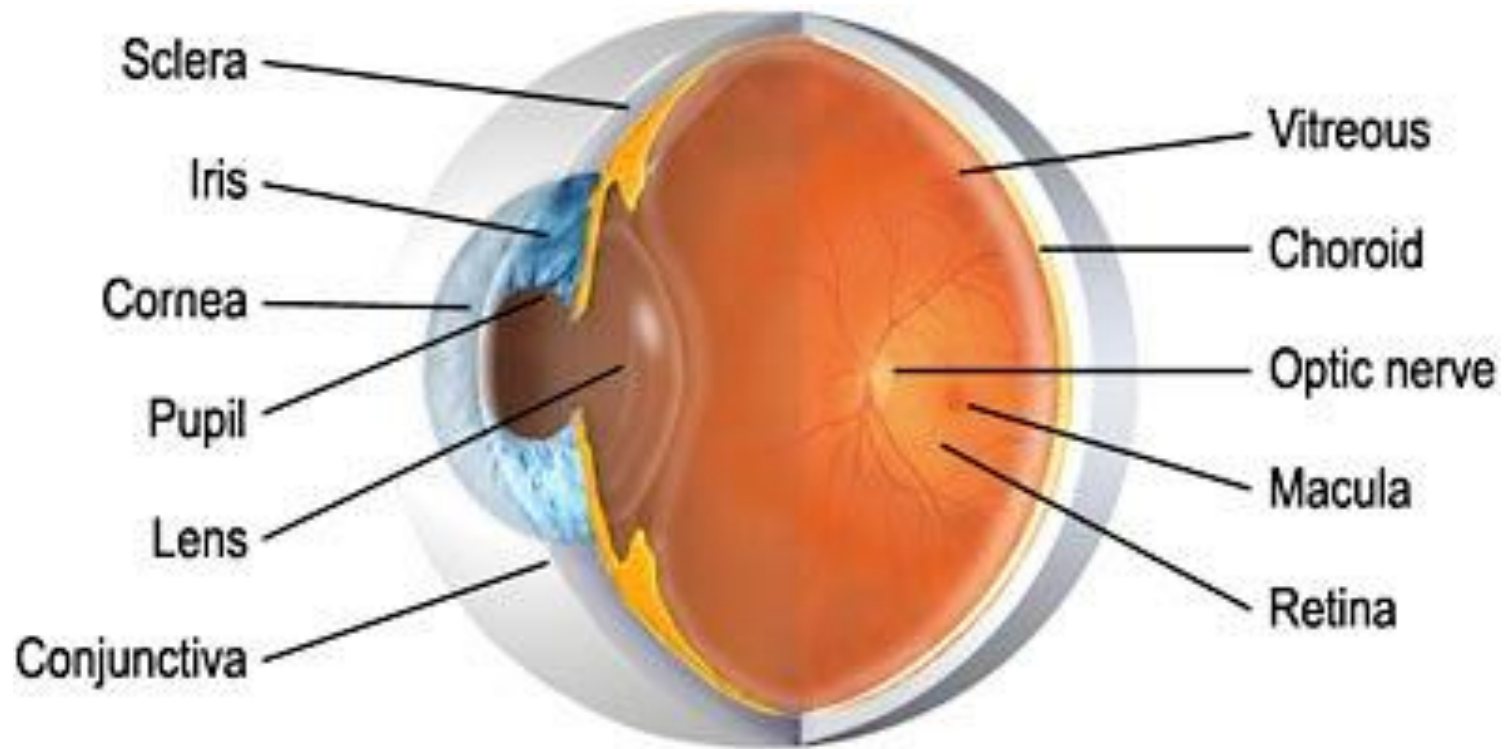
- Describe different components of the eye and function of each and understand the eye protection media –
- Describe the refraction of light as it passes through the eye to the retina, identifying the refractive media of the eye
- -Know glaucoma and binocular vision
- -Know layers of retina, blind spot, and fovea centralis –
- explain the different light sensitivities of the fovea, peripheral retina and optic disk
- - Know principles of optics and errors of refraction







# Anatomy of the Eye



## **Three concentric layers:**

### **Outer layer**

Fibrous

Cornea, corneal epithelium, conjunctiva and sclera.

### **Middle layer**

Vascular

Iris and choroid

### **Inner layer:**

Neural

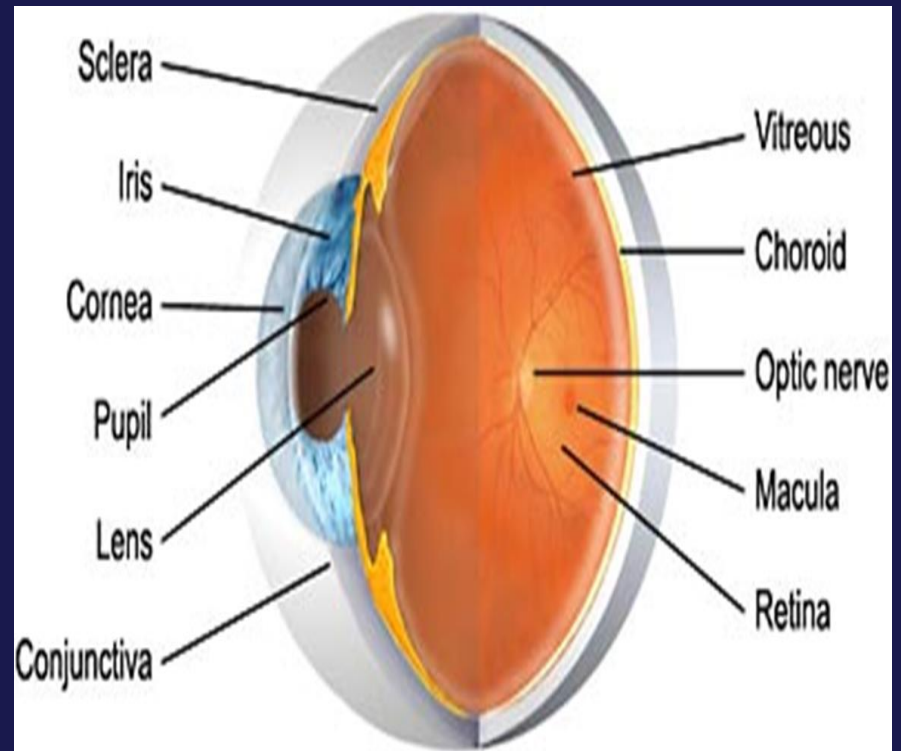
retina

- **Conjunctiva**

Transparent membrane cover -  
anterior surface of eye,  
reflected on inner surface of  
eye lids

- **Cornea**

- Protection
- Focusing





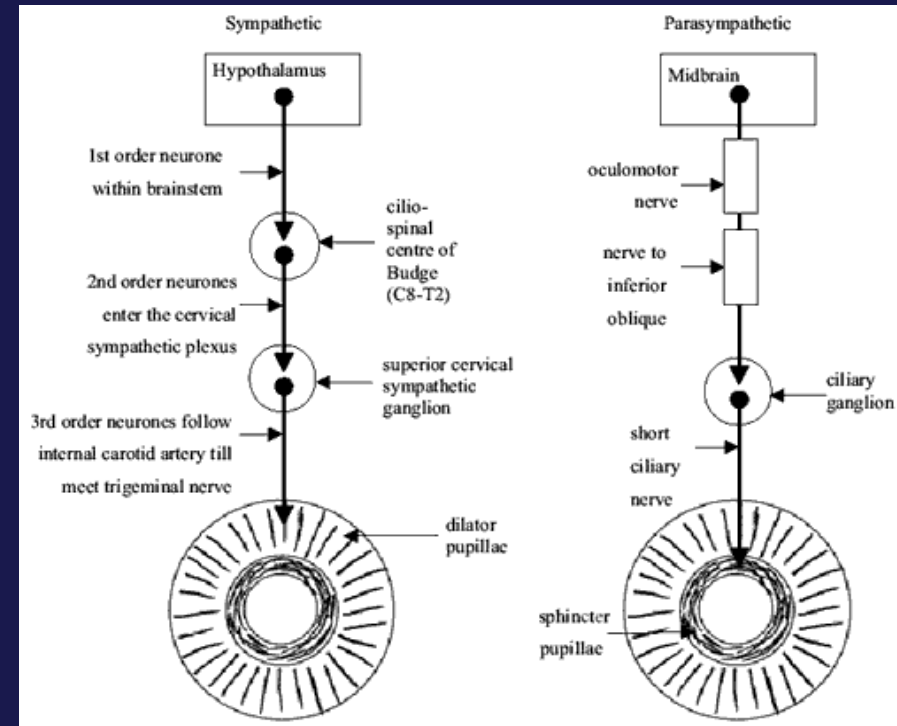
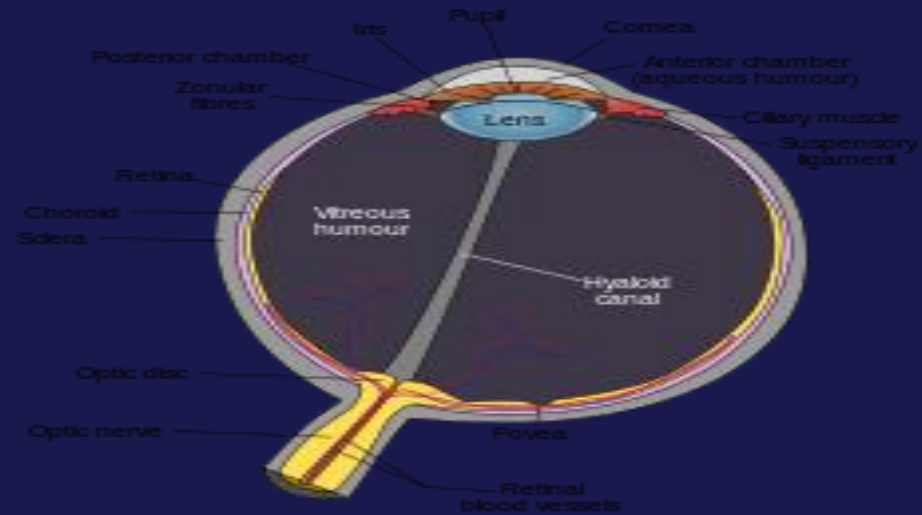
# ● Aqueous Humor

- Shape
- Nutrition

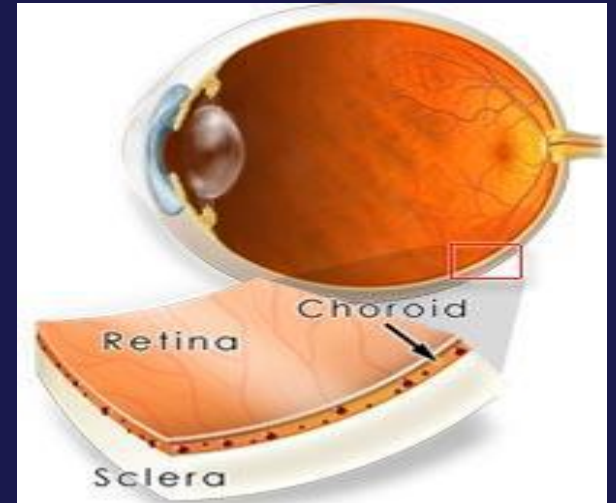
# ● Iris

- Light control
- Focusing
- colored part

(**radial muscle** Iris (supplied by sympathetic) mydriasis+ **circular muscles** (by parasympathetic) miosis



- *Choroids*
- supply retina with blood



- **Lens**

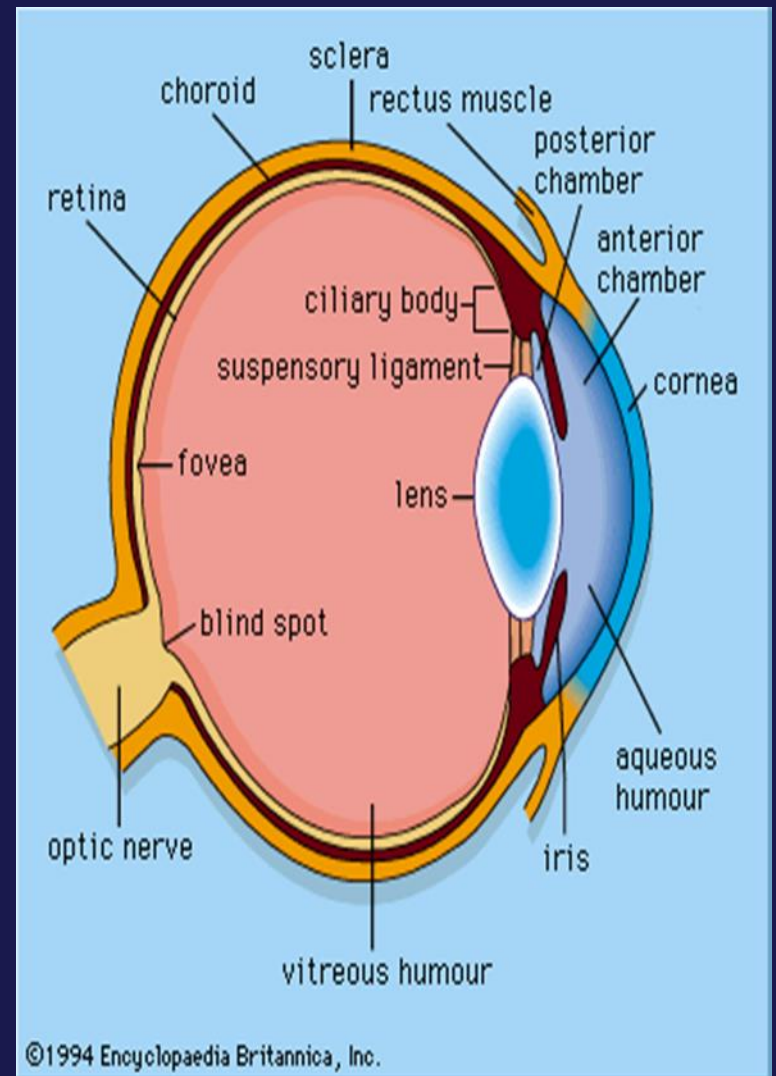
- Focusing
- Accommodation

- **Vitreous Humor**

- Shape

- **Retina**

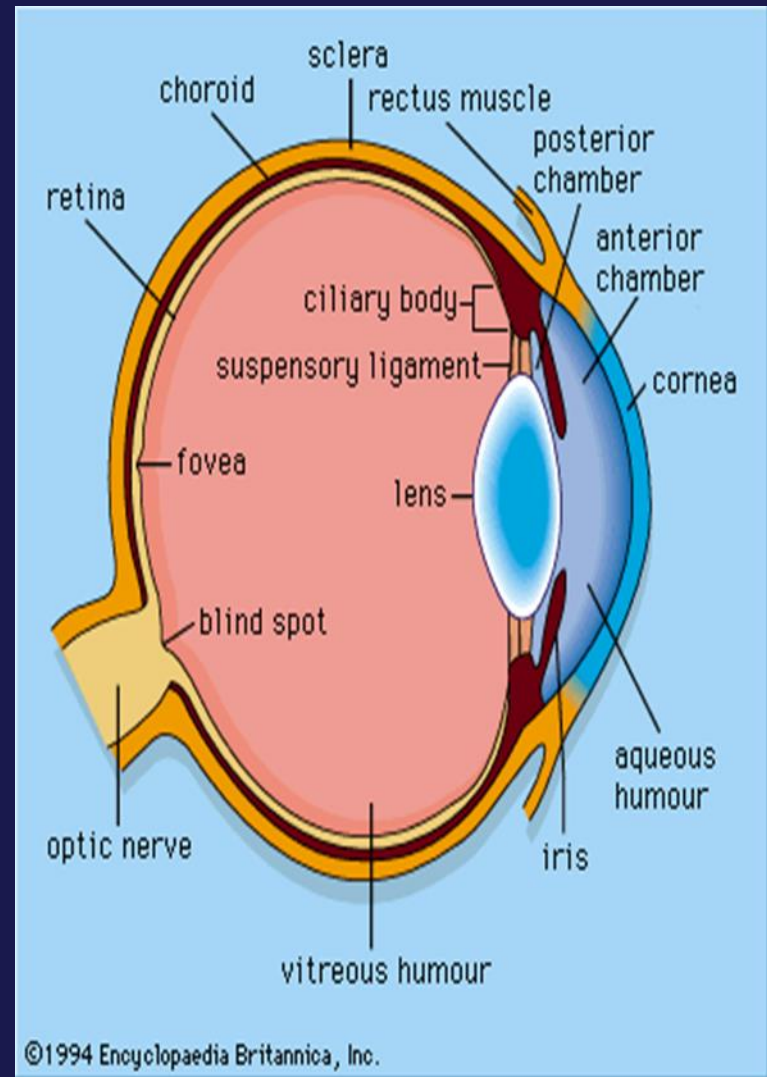
- **Rods:** black & white, night vision
- **Cones:** color, day vision
- **Fovea:** sharpest vision (concentration of cones)





## ● Optic Nerve

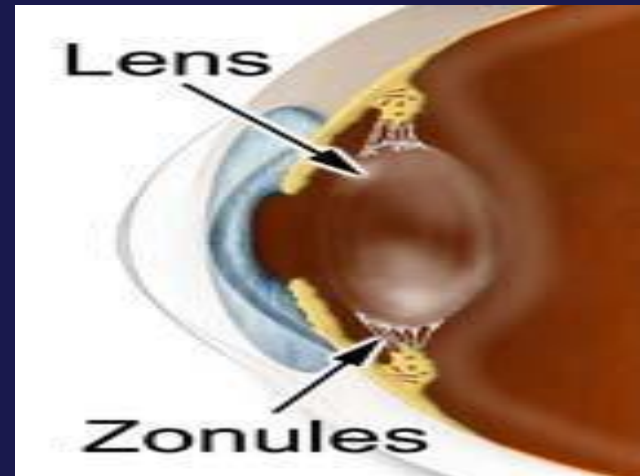
- Nerve signals to brain
- Optic Disk: blind spot



- **Ciliary muscles (body)**
- thick ant part of choroid to which attached suspensory ligaments (zonule)

- **Eye Muscles**

- Eye movement
- Convergence

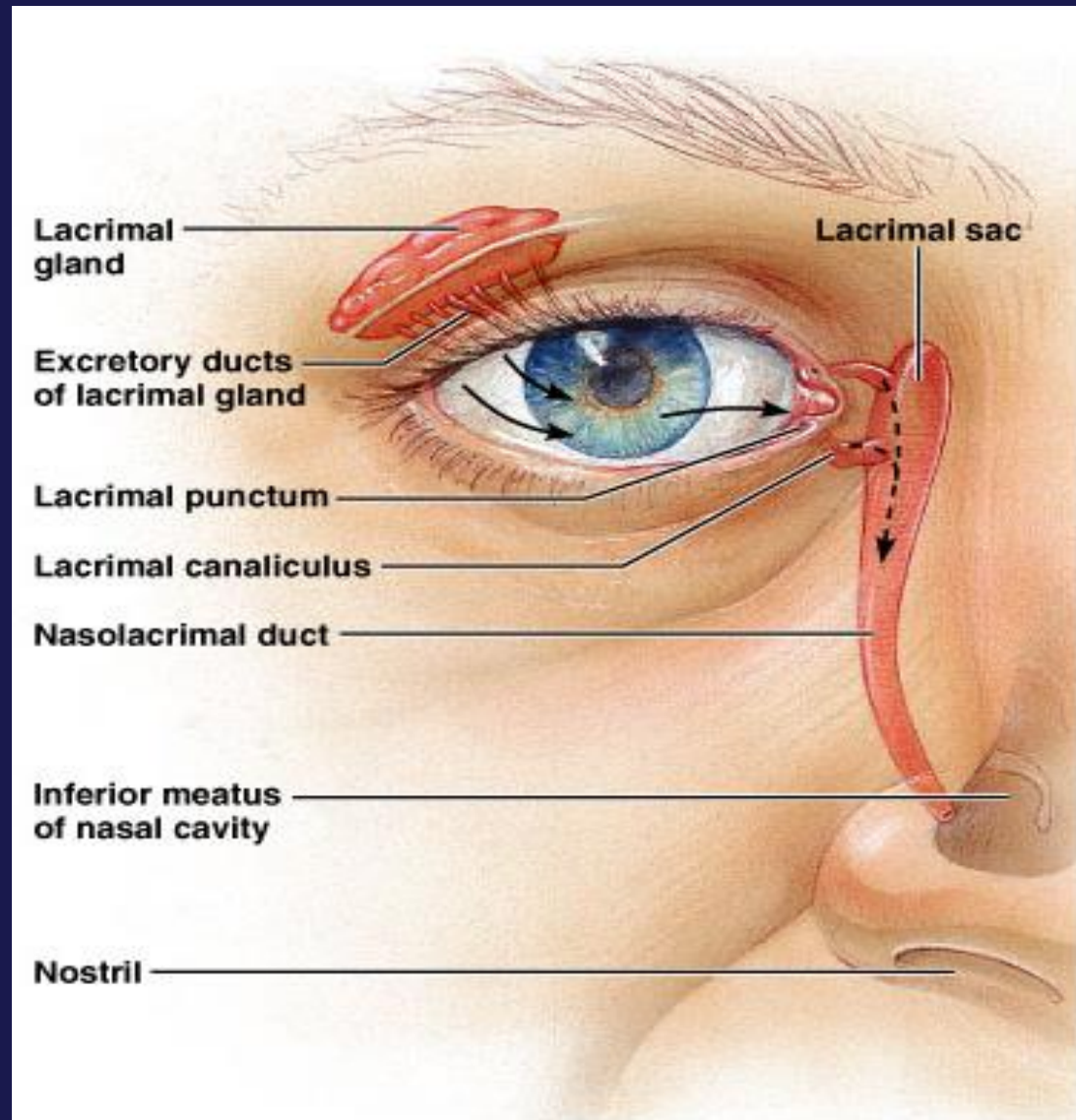


# External protection of the eye

- 1- bony orbit
- 2- lids blinking keep cornea moist
- 3 -conjunctiva
- 4-tears from lacrimal gland has antibacterial, lubricating effect ,keep cornea moist & clear.)

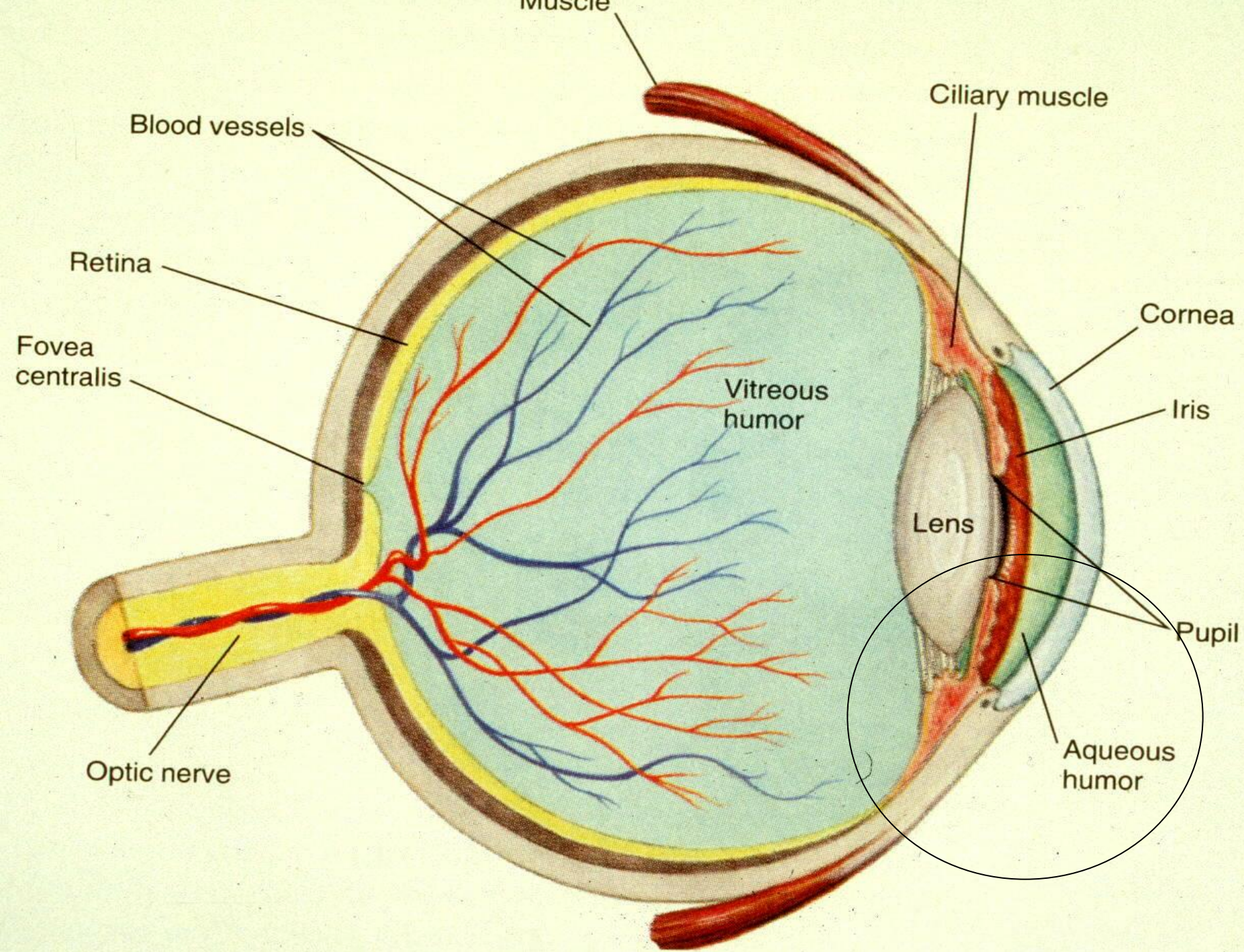


# Lacrimal gland secretion - (Tears)



(b)







# The Circulation of Aqueous Humor

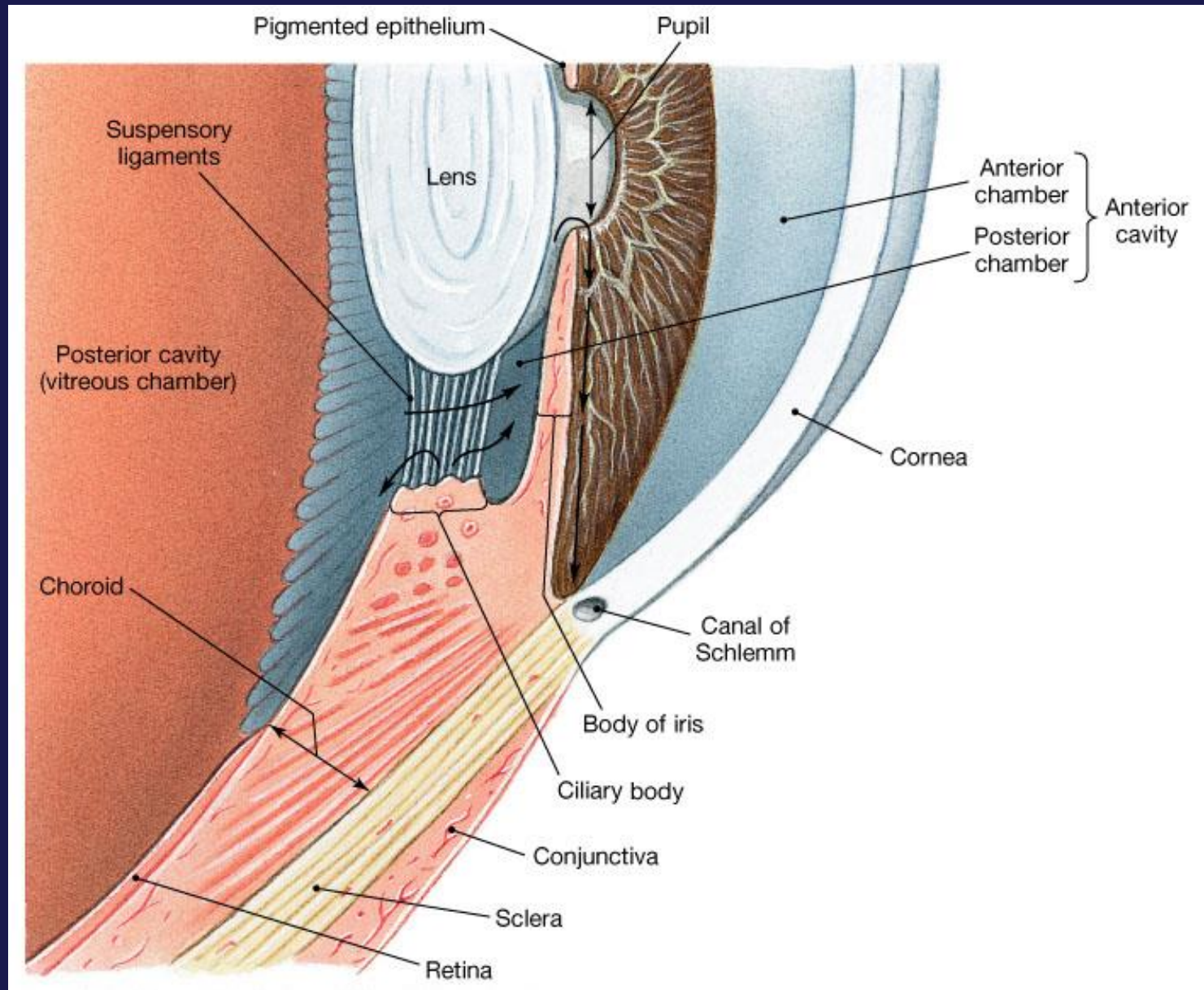
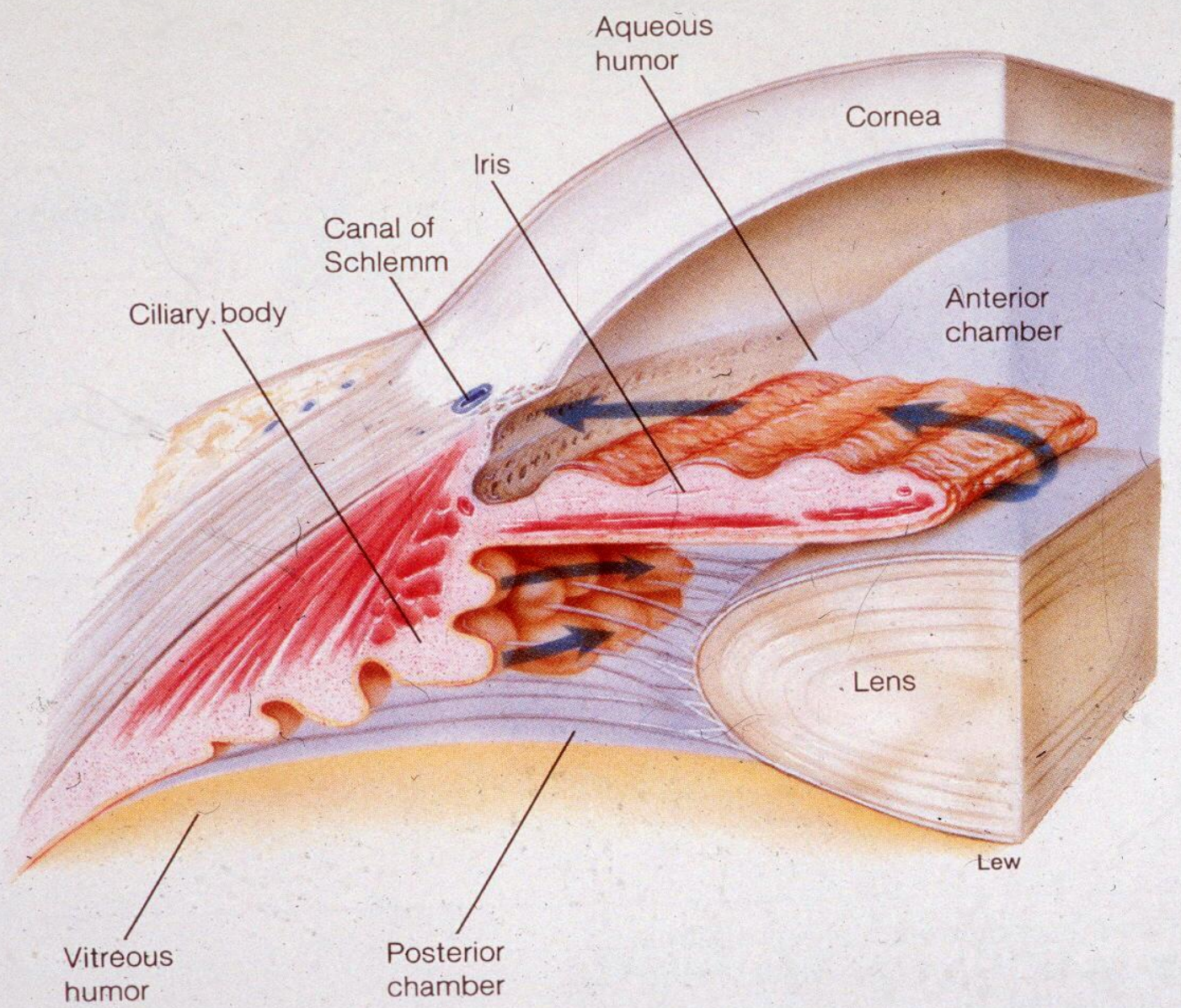


Figure 17.8





Aqueous humor

Cornea

Iris

Canal of Schlemm

Anterior chamber

Ciliary body

Lens

Lew

Vitreous humor

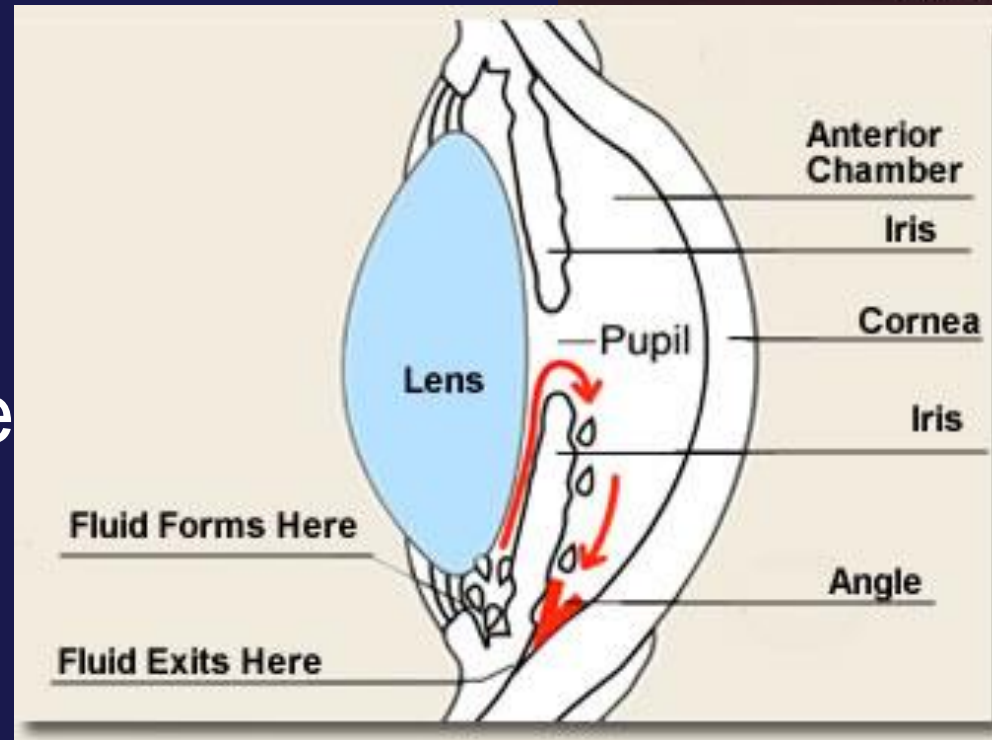
Posterior chamber



# III. L. Glaucoma



- Build up of Aqueous Humor volume
- Increases pressure in eye
- Damages nerve
- Meds/surgery

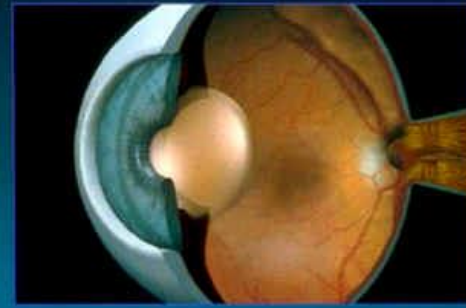
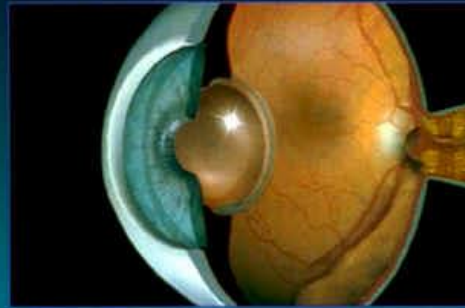




# III. L. Cataracts



- Lens clouds up
- Must be removed





## Normal Vision

## Glaucoma

Glaucoma is an eye condition that develops when too much fluid pressure builds up inside of the eye. The increased internal pressure can damage the optic nerve, which transmits images to the brain. Without treatment, glaucoma can cause blindness within a few years. Glaucoma is most often inherited, meaning it is passed from parents to children. Less common causes of glaucoma include a blunt or chemical injury to the eye, severe eye infection, blockage of blood vessels in the eye and inflammatory conditions of the eye. Glaucoma usually occurs in both eyes, but it may involve each eye to a different extent.





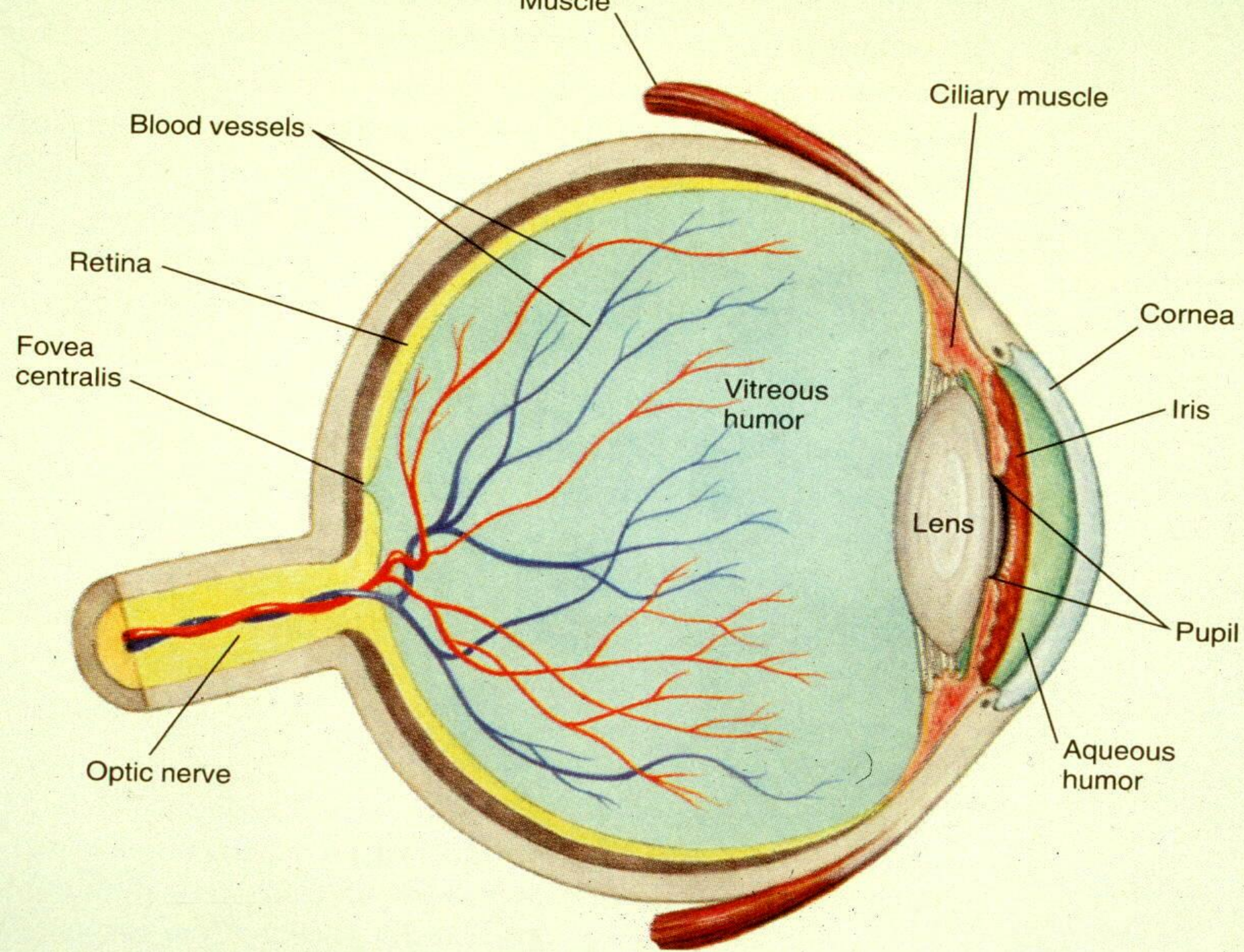
**Normal Vision**

**Cataract**

A cataract is a painless, cloudy area in the lens of the eye. A cataract blocks the passage of light from the lens to the nerves at the back of the eye, and it may cause vision problems. Changes in the lens of the eye are part of the aging process but normally do not develop into cataracts. However, cataracts are very common in older adults. Cataracts can also occur after an eye injury, as a result of eye disease, after the use of certain medications or as a result of medical conditions such as diabetes.

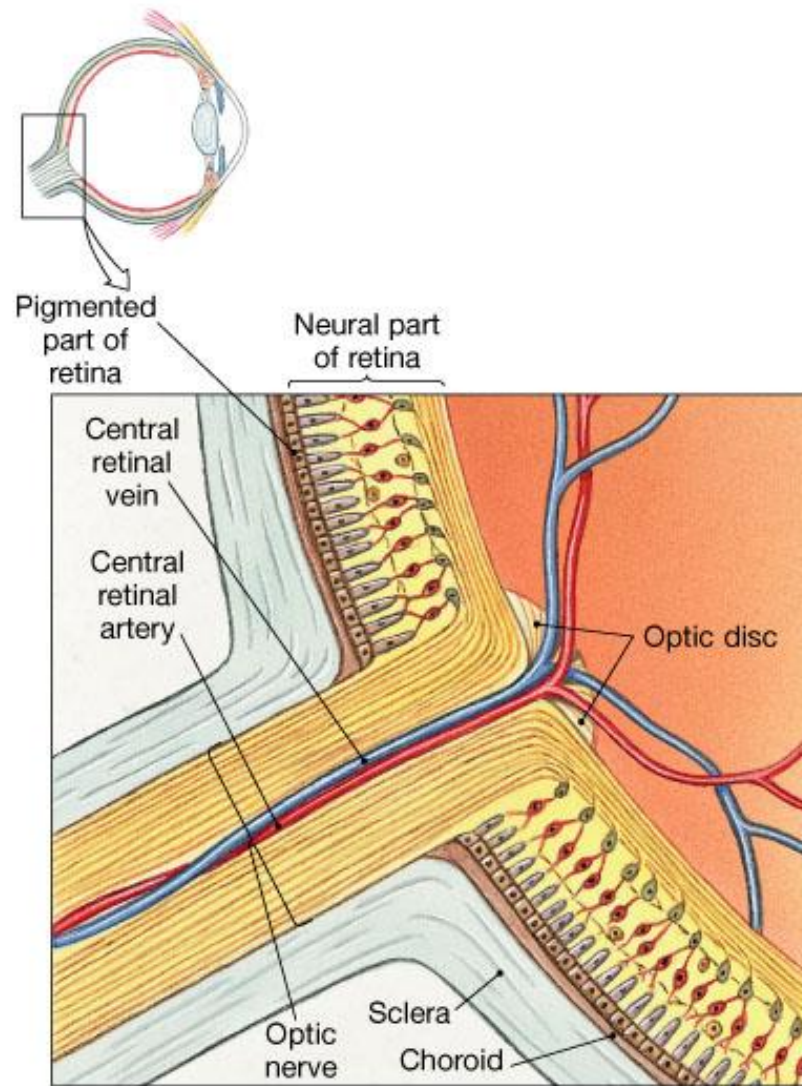




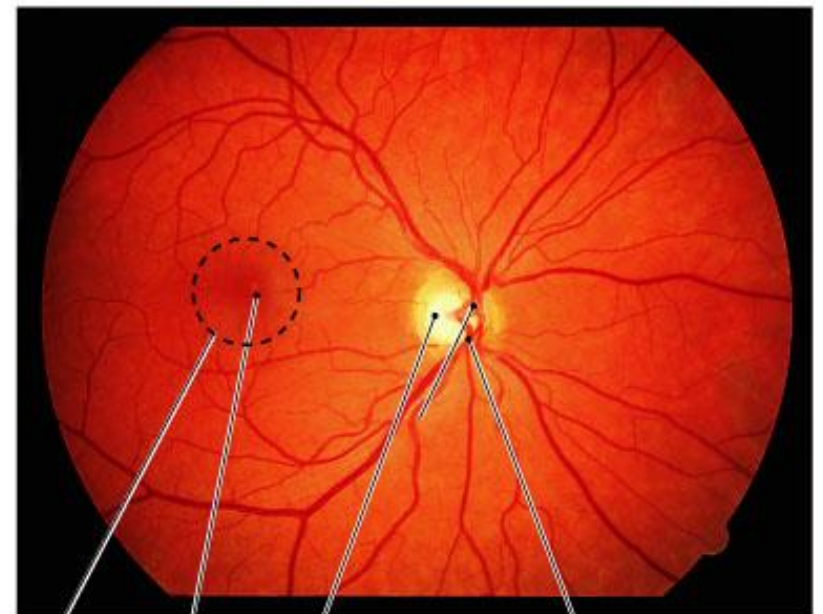




# The Organization of the Retina

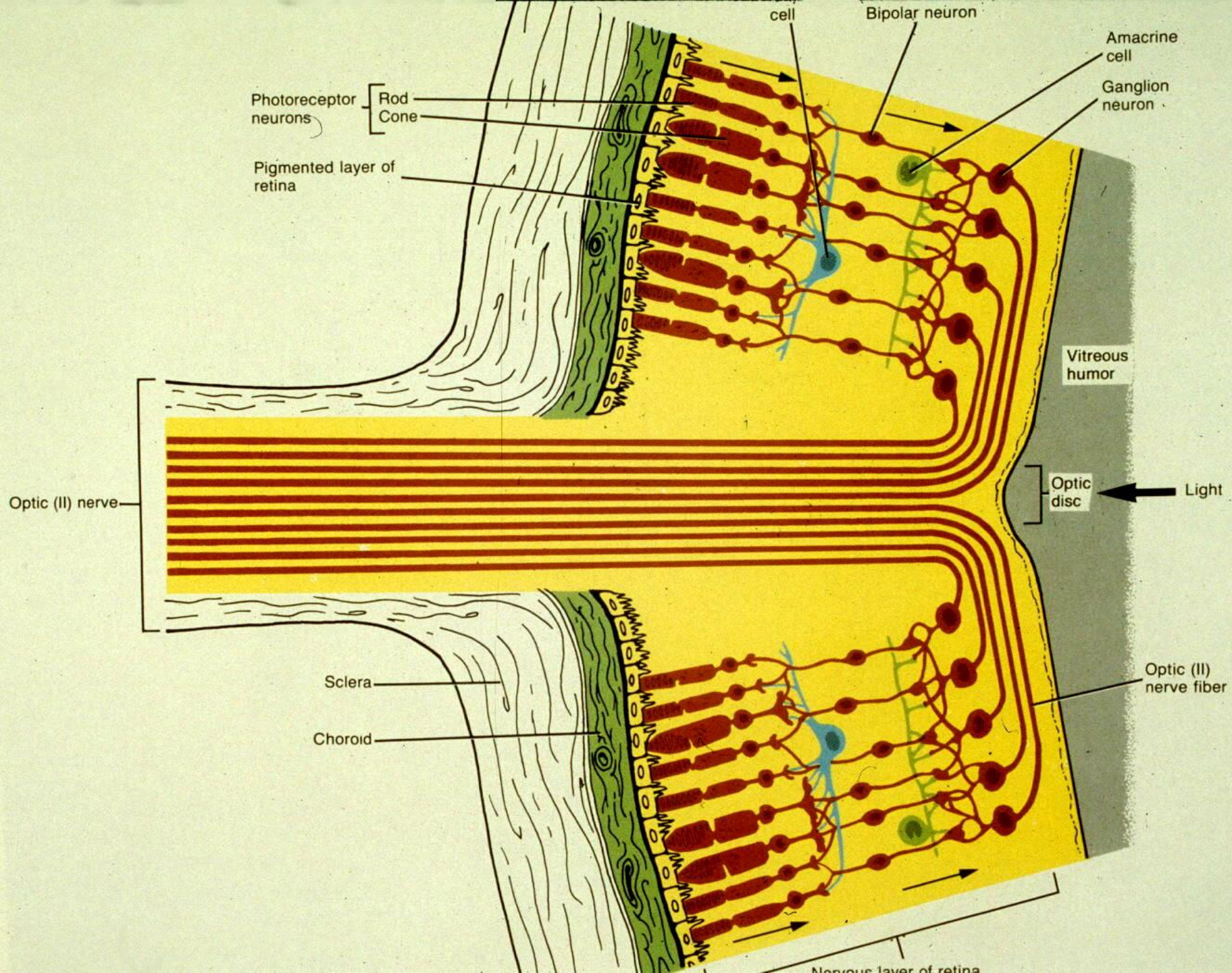


(b)



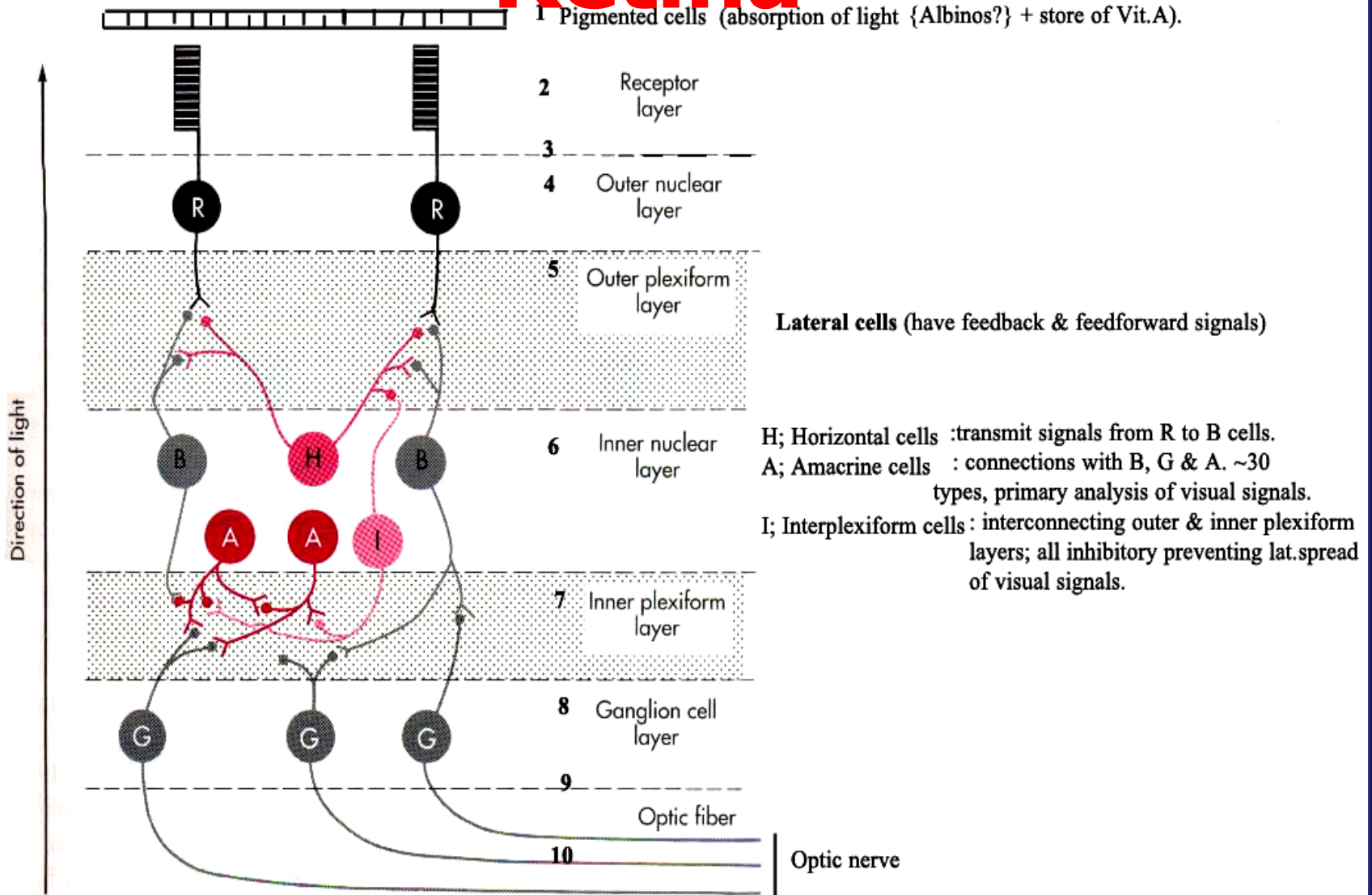
(c)

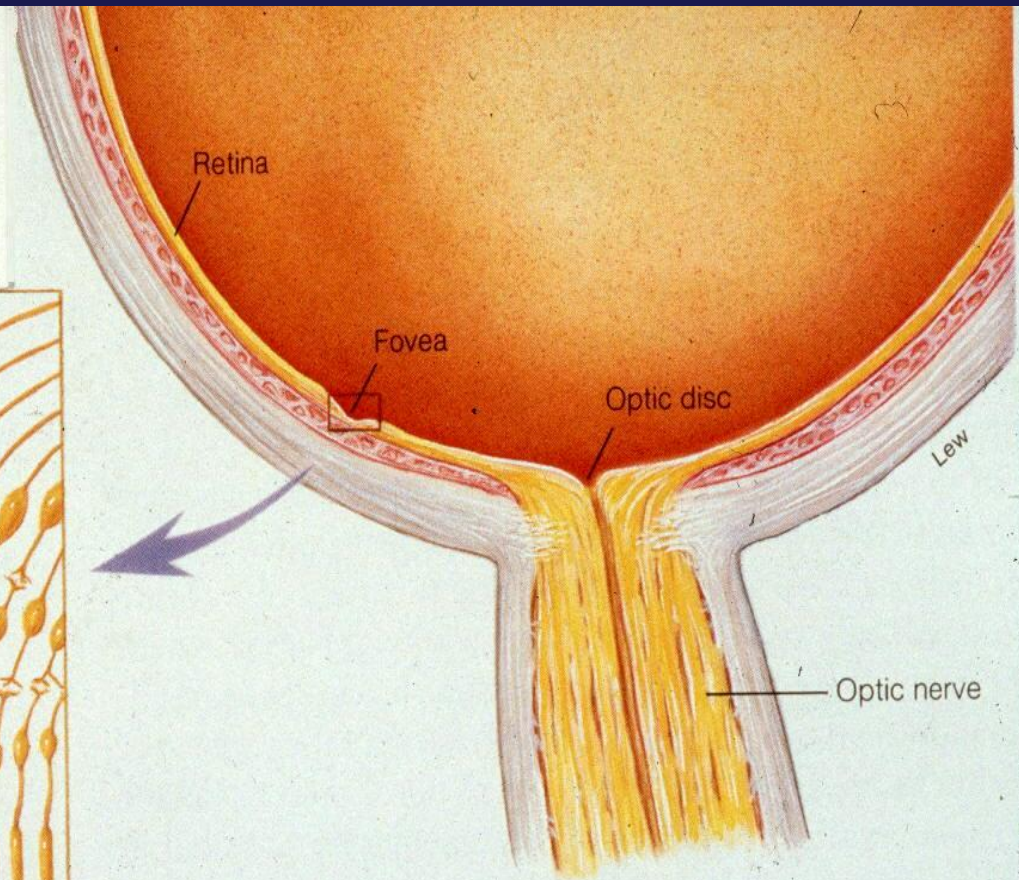
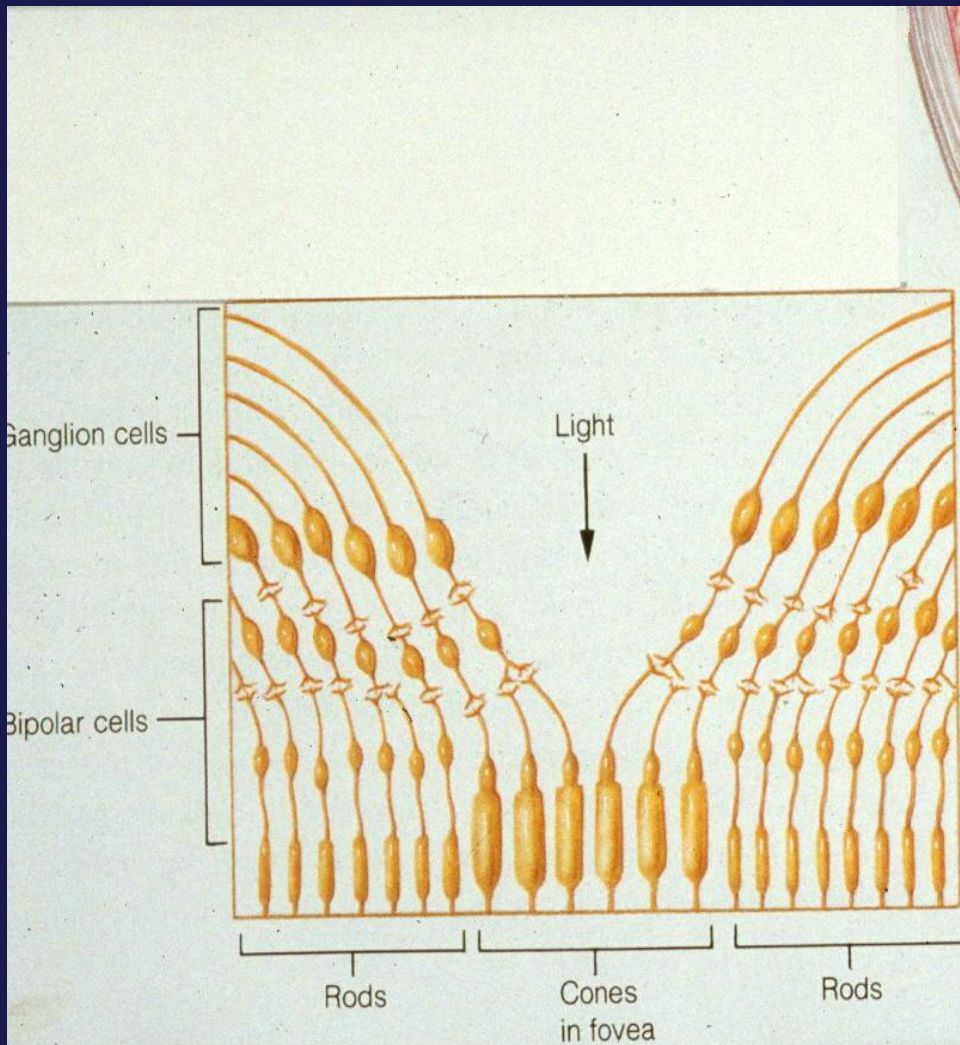




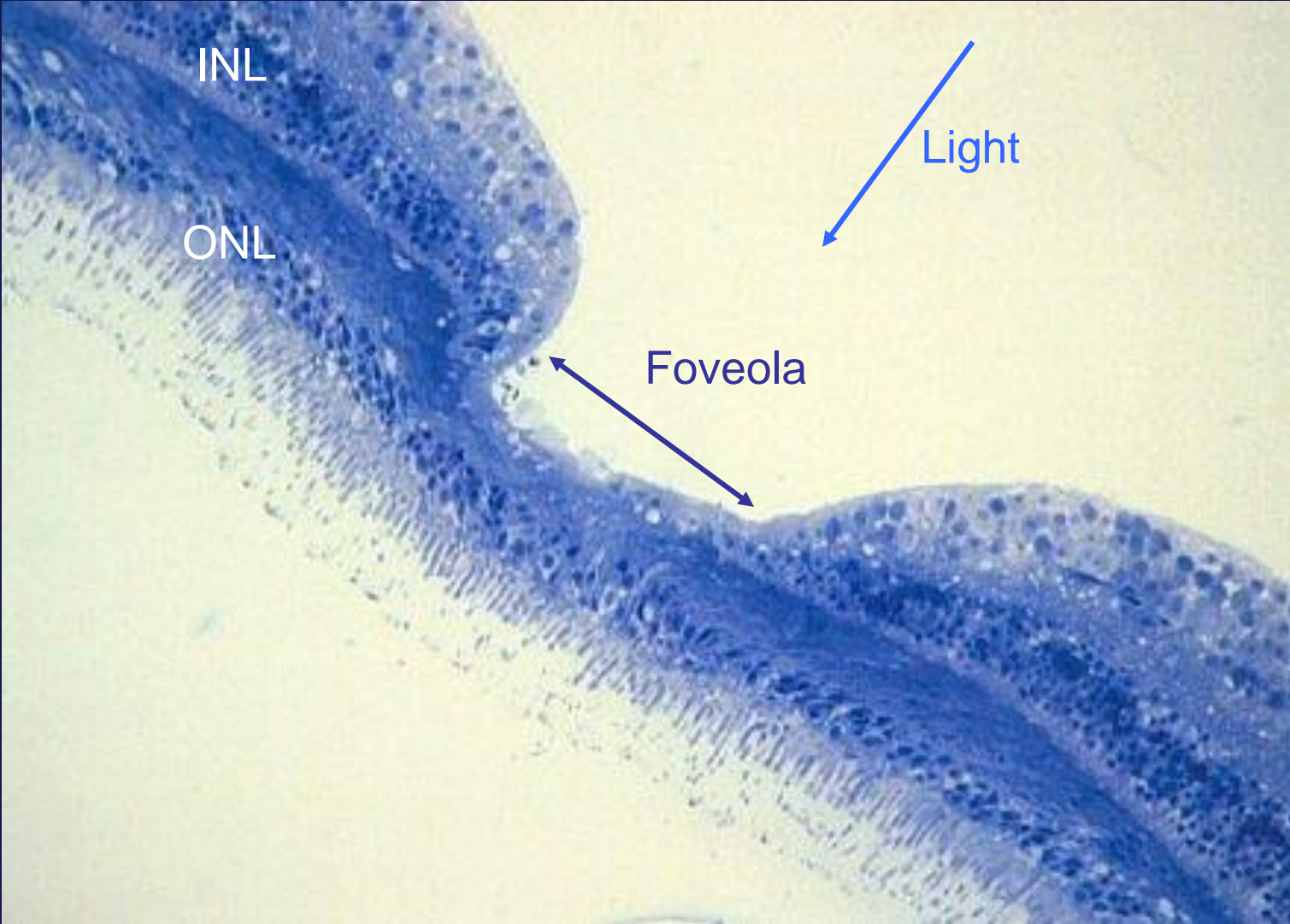


# 10 Histological Layers of the Retina









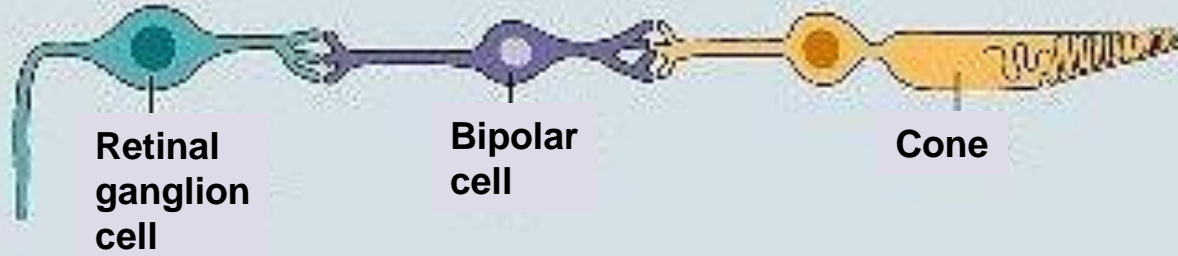
Human foveal pit

# Why Fovea is the most sensitive spot in retina?

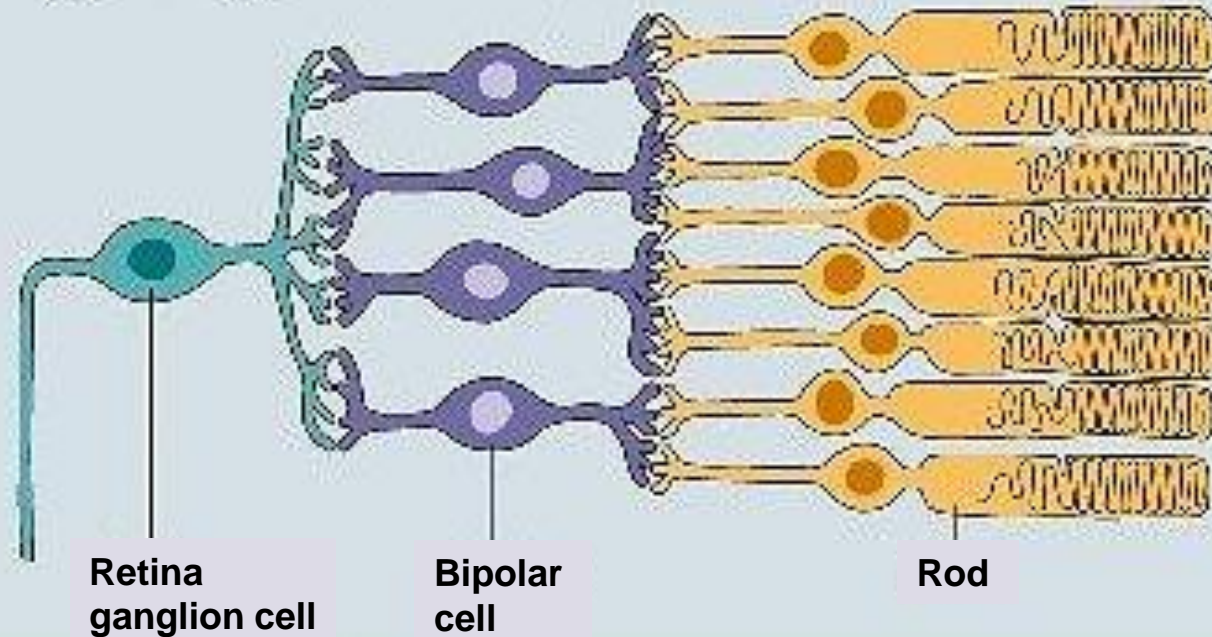
- **All layers are shifted aside leaving outer segments of photosensors to be hit directly by light**
- **High density of small diameter Cones with long outer segments**
- **1:1 convergence (cone-BC-GC)**
- **Small RF of foveal ganglion cells**
- **Wide presentation in occipital primary visual area**

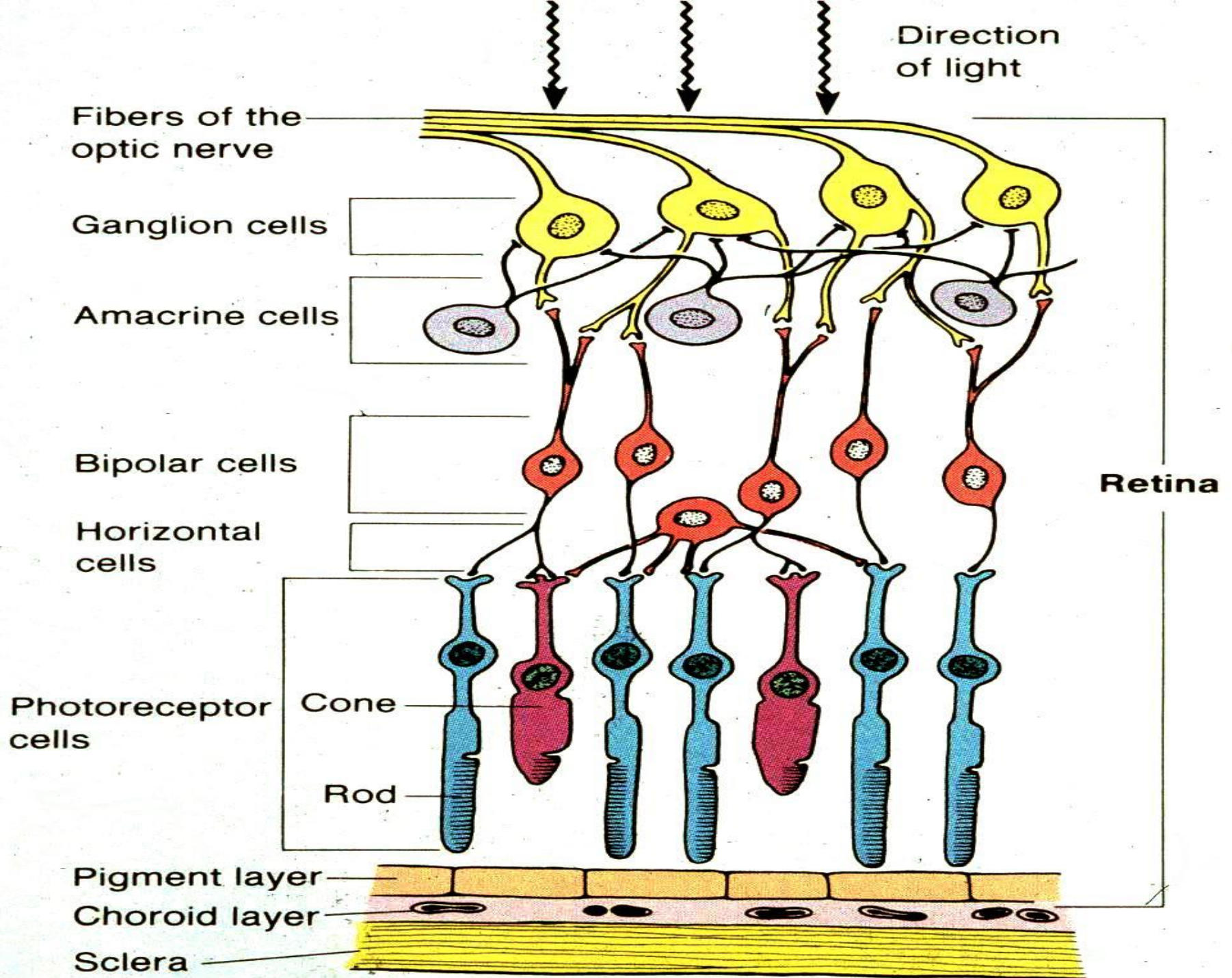


### Low Convergence Cone-Fed Circuits

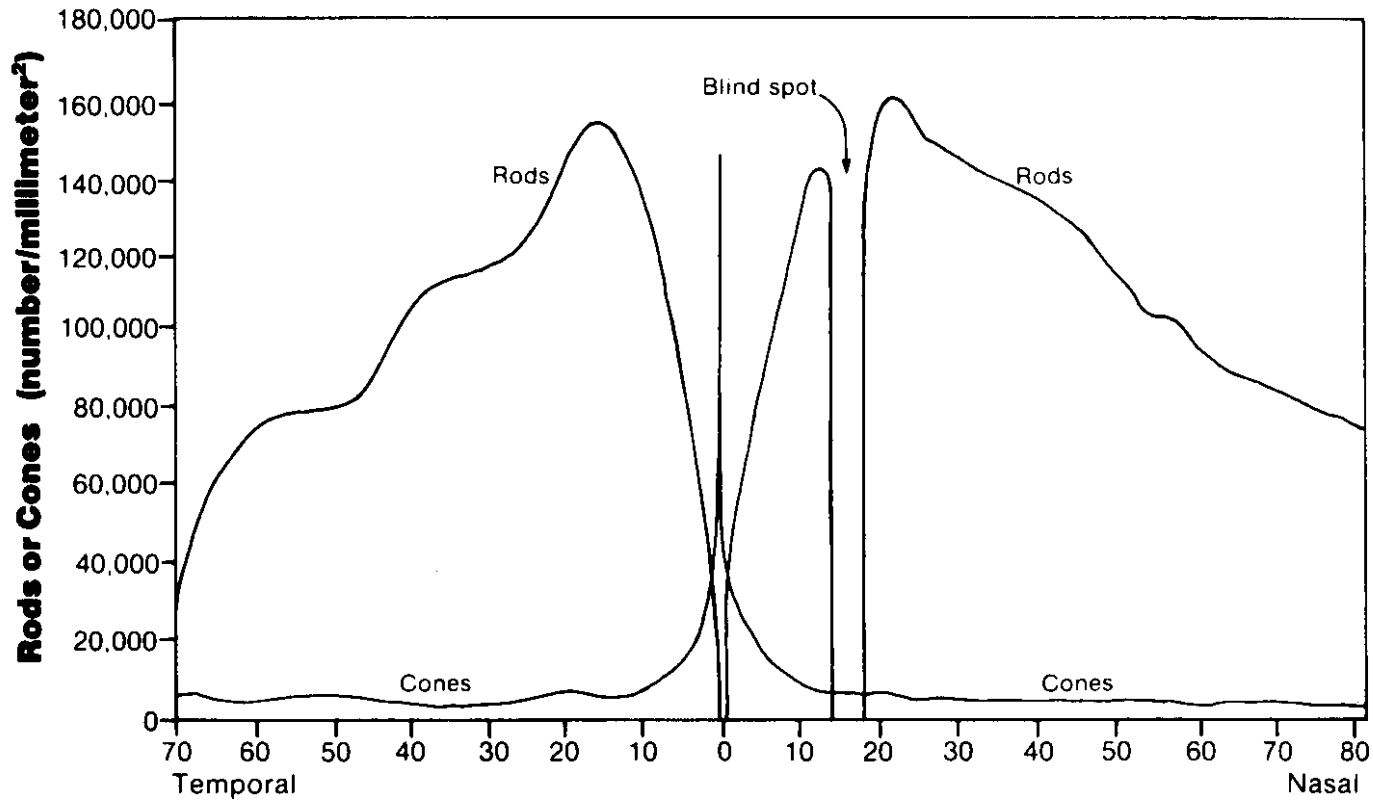


### High Convergence Rod-Fed Circuits





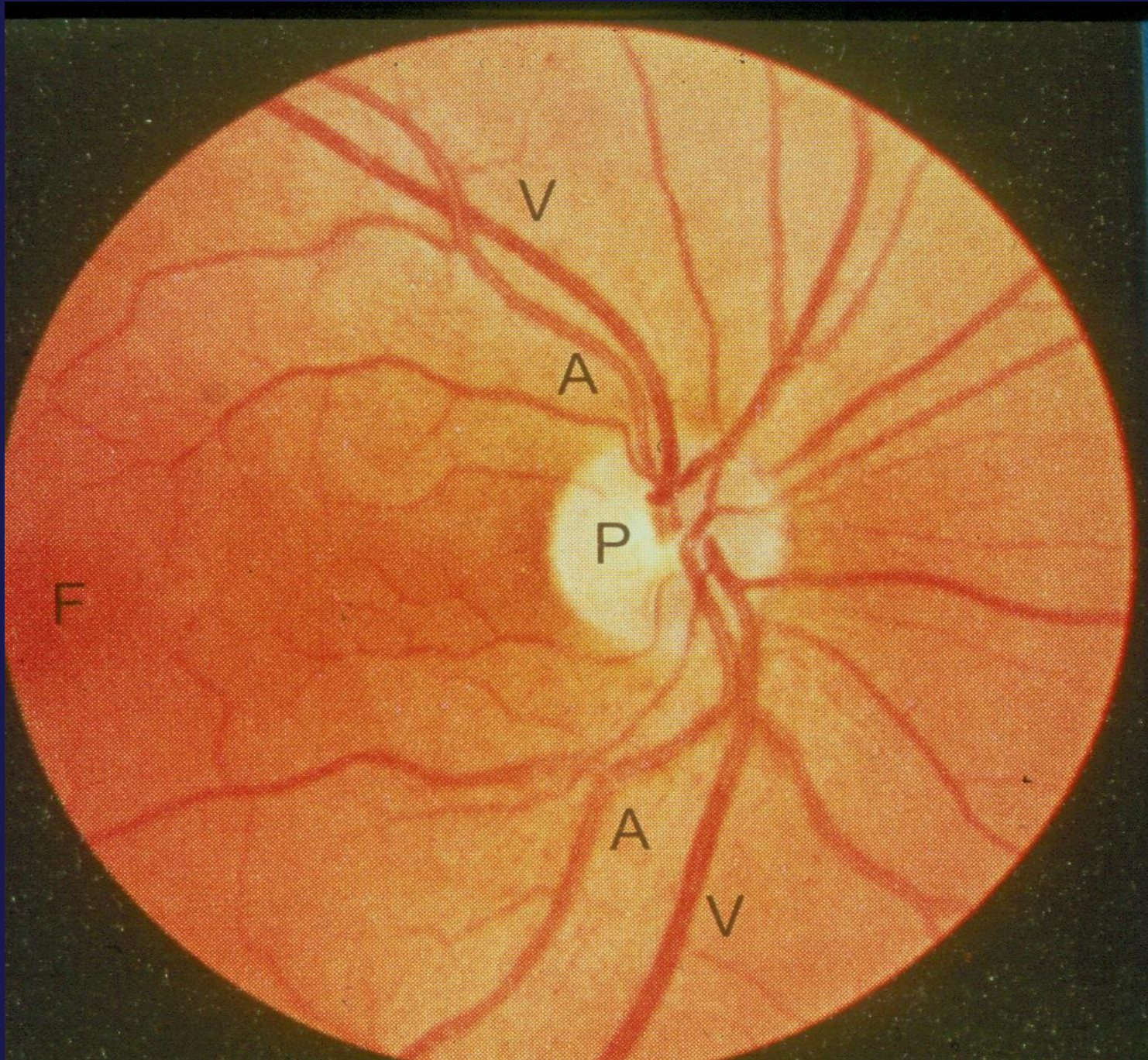
# DENSITY OF RODS AND CONES



(b)

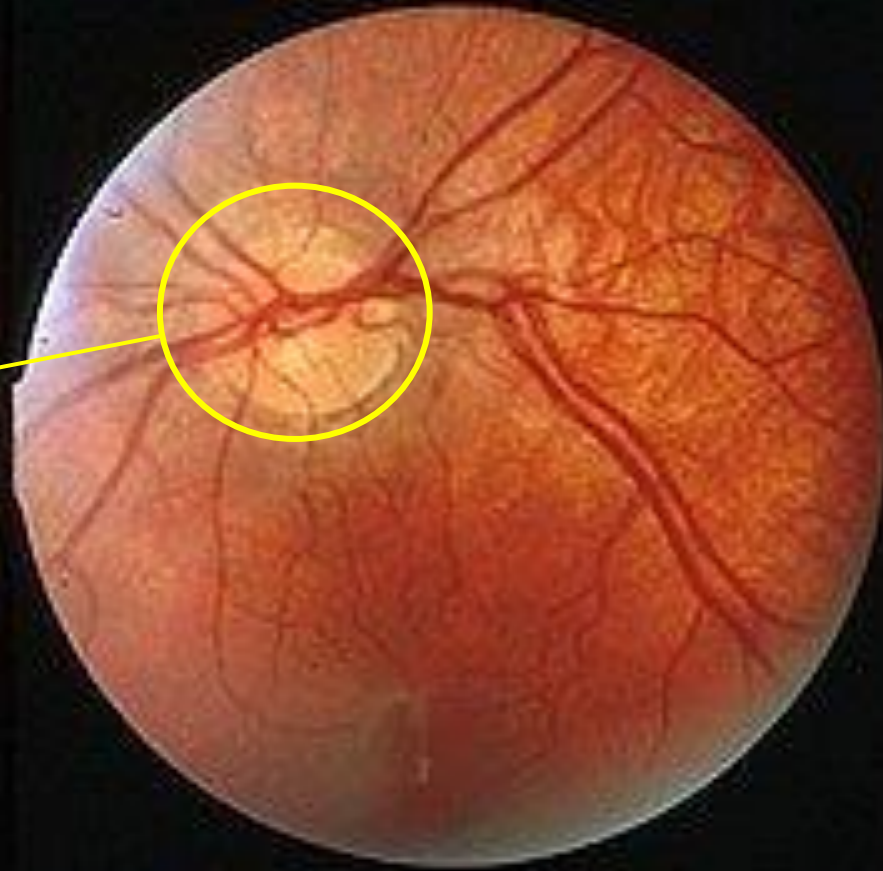
**Perimetric Angle (degrees)**







# Human Fundus



Optic disk



# The image-forming mechanism

Optics of the eye - Lenses

The image-forming mechanism - Optics of the eye -

# Lenses

Principles of Optics

# Refraction

- Light bends as it travels from one medium to another



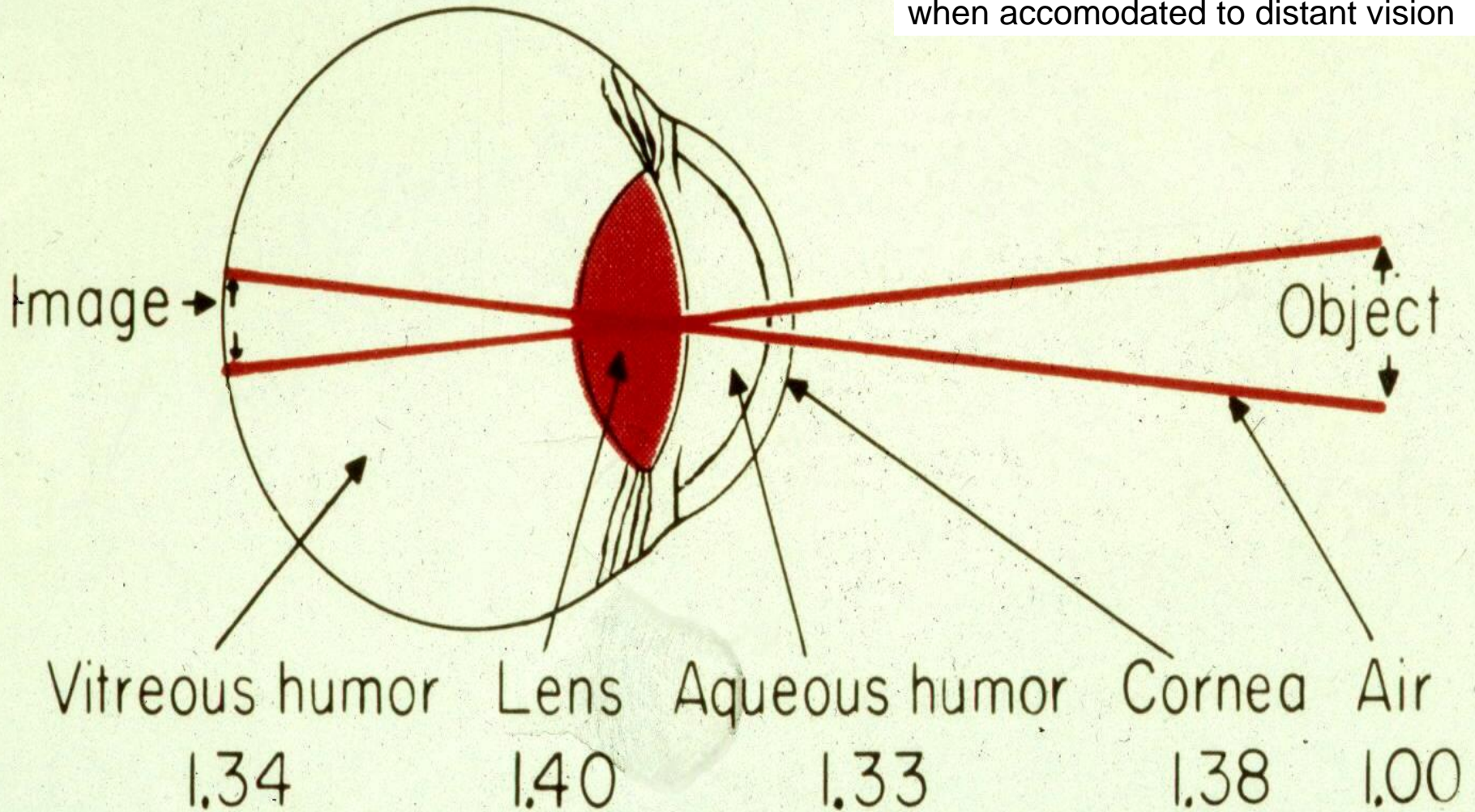
# How We See

- Light Passes through
  - Cornea
  - Aqueous Humor
  - Pupil
  - Lens
  - Vitreous Humor
  - Retina-->Phtoreceptors
  - Optic Nerve-->Brain
- Cornea refracts 70-80%
  - Change from air to cornea is largest change in index of refraction
- Lens--20%
- Ciliary Muscles/Zonule Fibers

QuickTime™ and a decompressor are needed to see this picture.

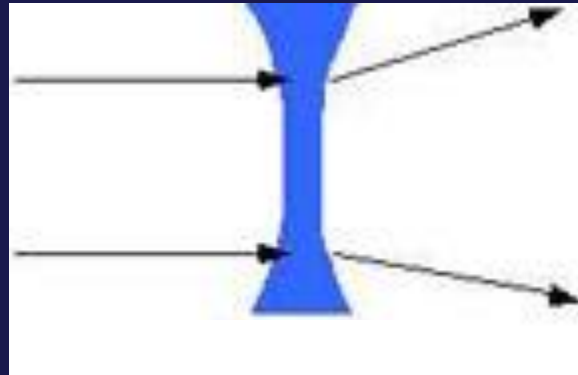
Total refractive power = 59 diopters

when accommodated to distant vision

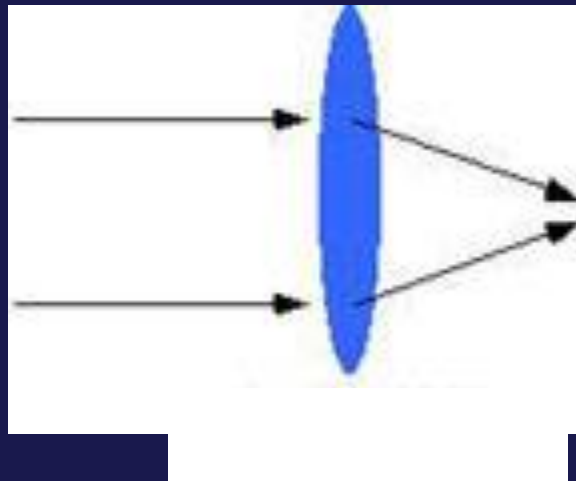


Eye and camera ... similarities and differences?

# Principles of Optics



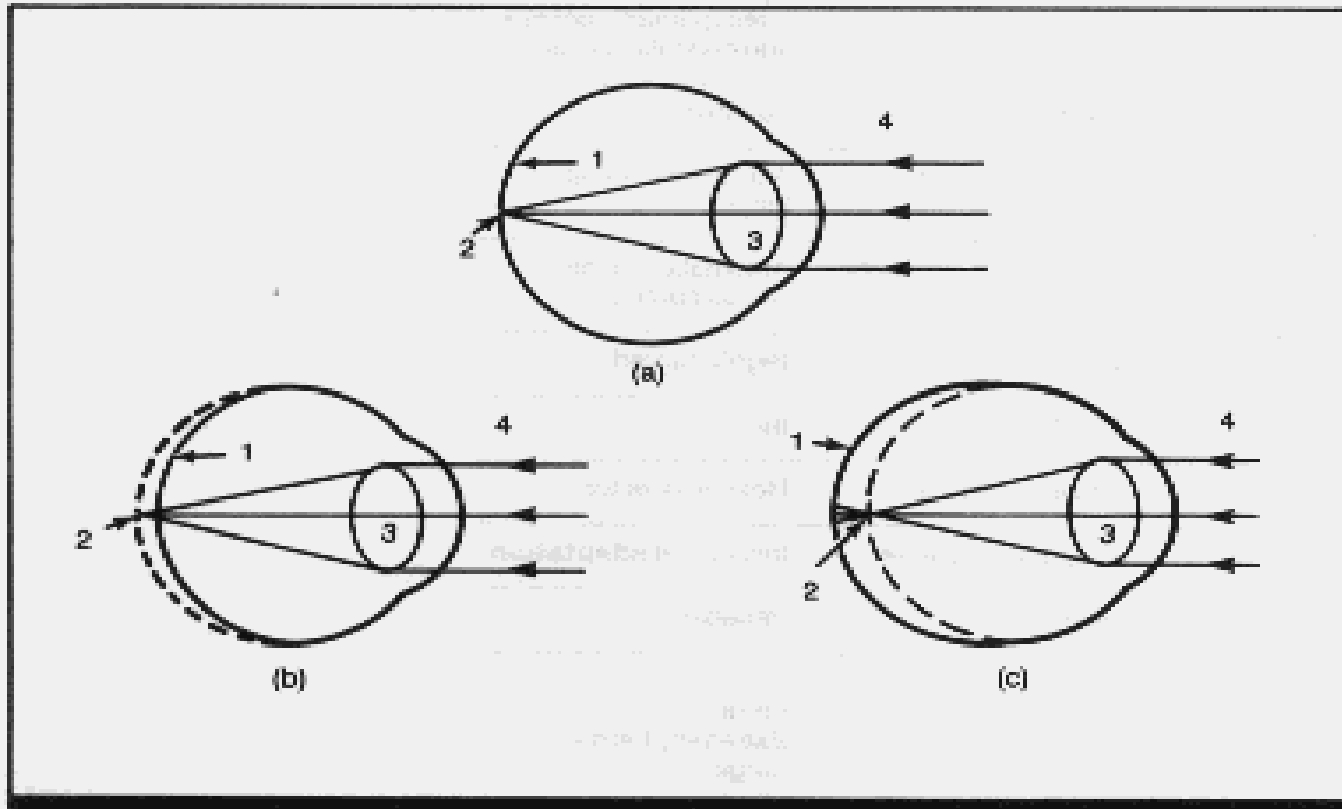
**Concave lens**



**Convex lens**

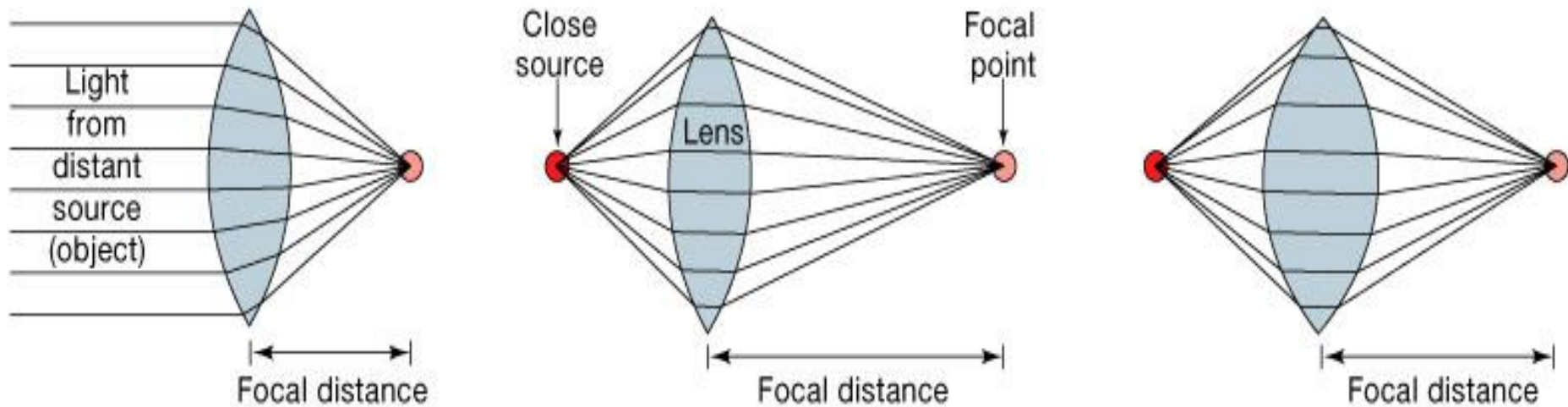


# NEAR AND FARSIGHTED EYE



**Figure 1. Refraction of light by the eye. (a) normal (emmetropic) eye; (b) farsighted (hyperopic) eye; (c) nearsighted (myopic) eye; (1 = retina; 2 = focal point; 3 = lens; 4 = incoming light). (From Ref. 3)**

# Principles of Optics - cont.



(a) The closer the light source, the longer the focal distance

(b) The rounder the lens, the shorter the focal distance

Focal distance same as focal length

# Diopetre (D)

$$\text{Diopetre (s)} = \frac{1}{\text{Focal length (m)}}$$

Distance to bring parallel rays into convergence

Dioptric power if the eye:

Cornea .....40-45 D

Lens ..... 15-20 D



# Errors of Refraction

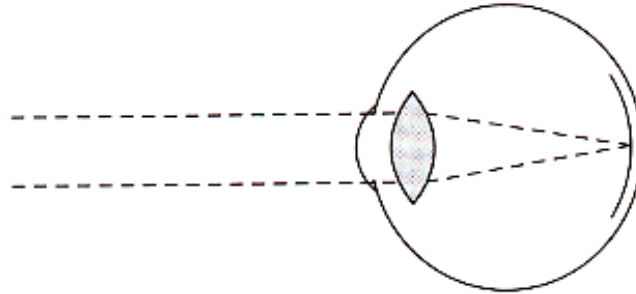
# Errors of refraction

1. Hypermetropia (long sight)
2. Myopia (Short sight)
3. Astigmatism

# Image Focusing

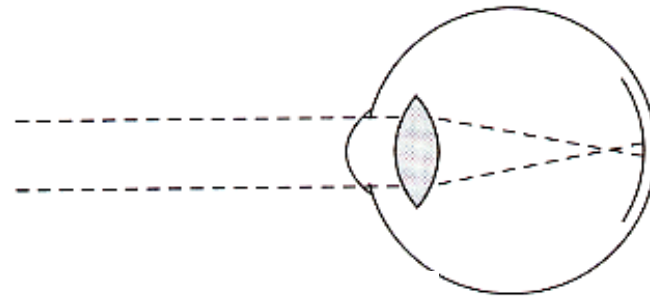
**Emmetropia**  
(normal vision)

EMMETROPIA  
(eyeball length  
just right)



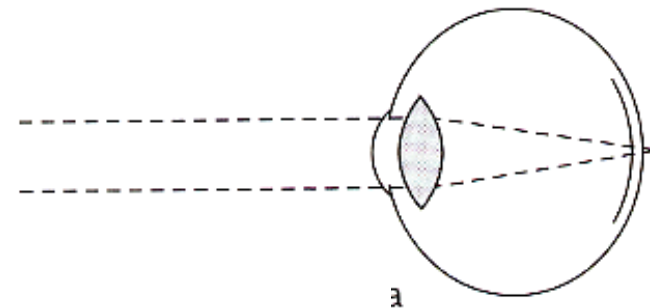
**Myopia**  
(Short sight)

MYOPIA  
(eyeball length  
too long)



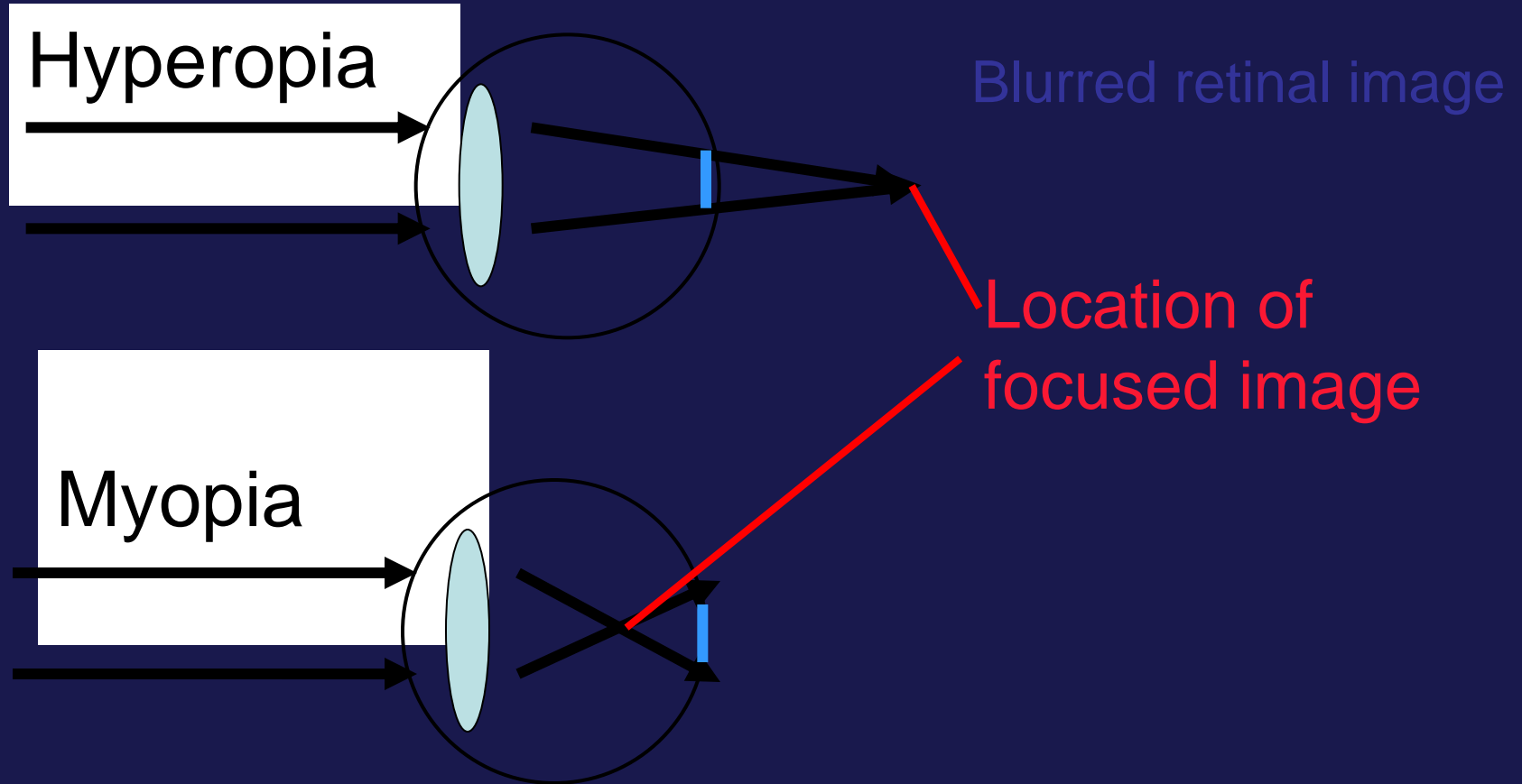
**Hyperopia**  
(long sight)

HYPEROPIA  
(eyeball length  
too short)

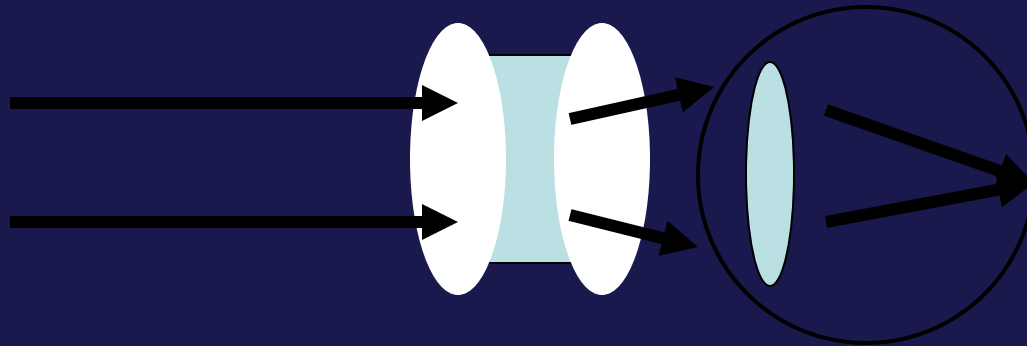
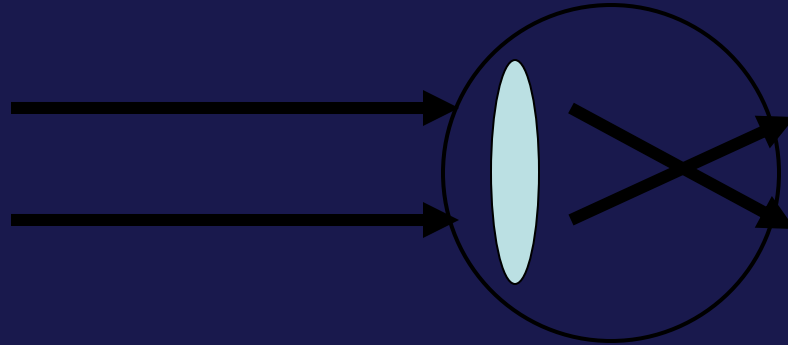




# Image Focusing

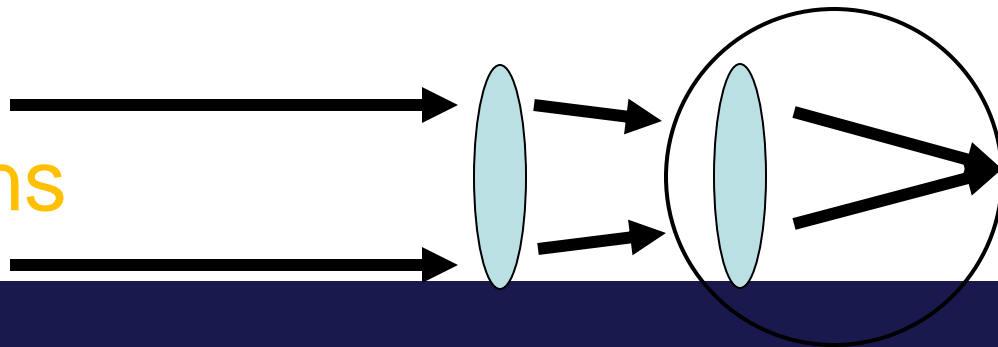
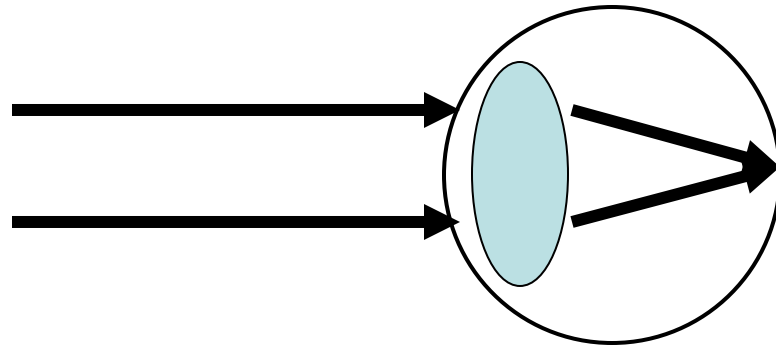
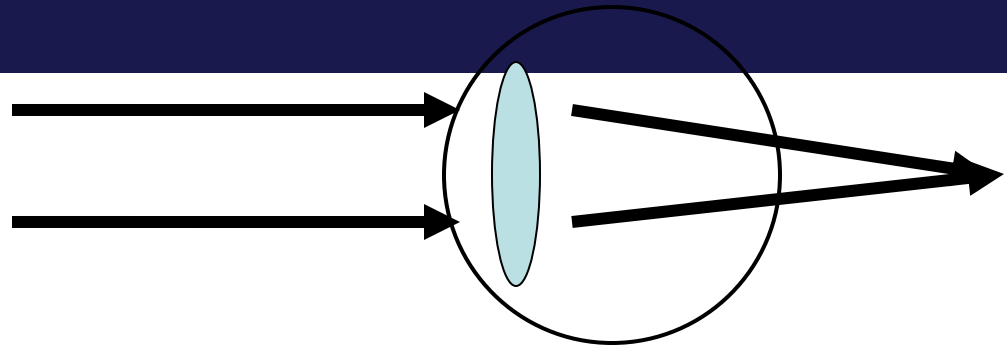


# Myopia-'short sight'



Concave corrective lens

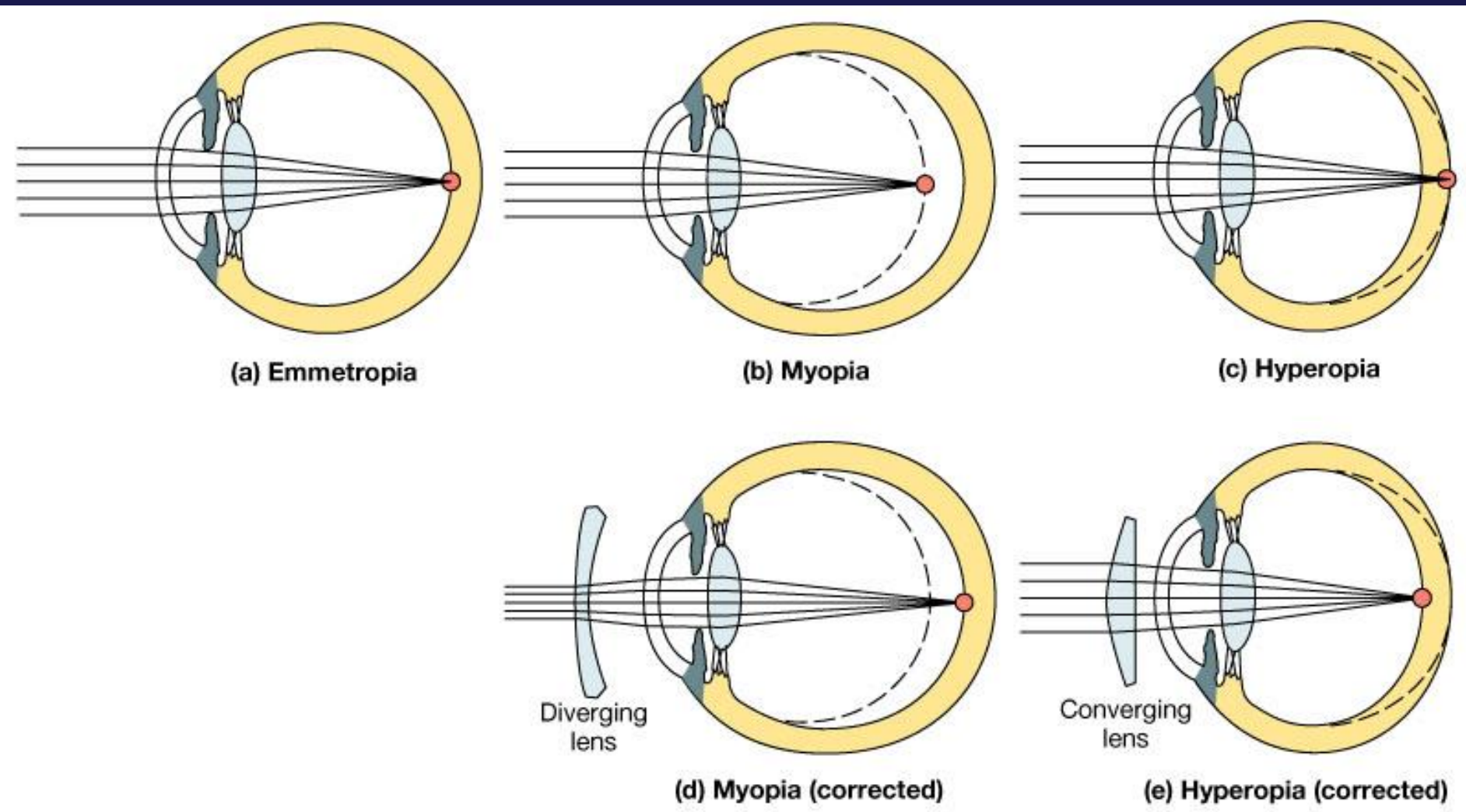
# Hyperopia - 'long sight'



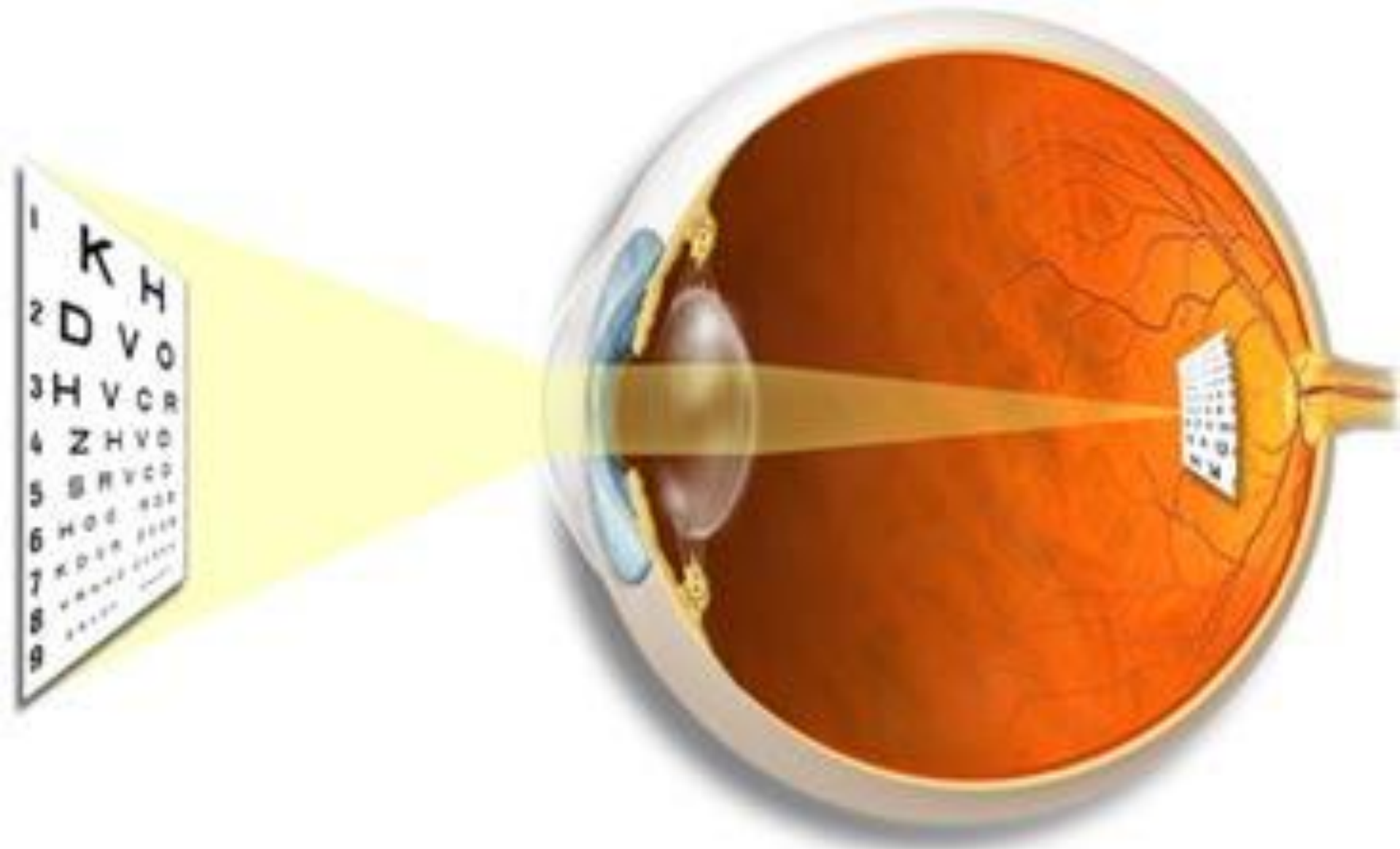
Convex lens



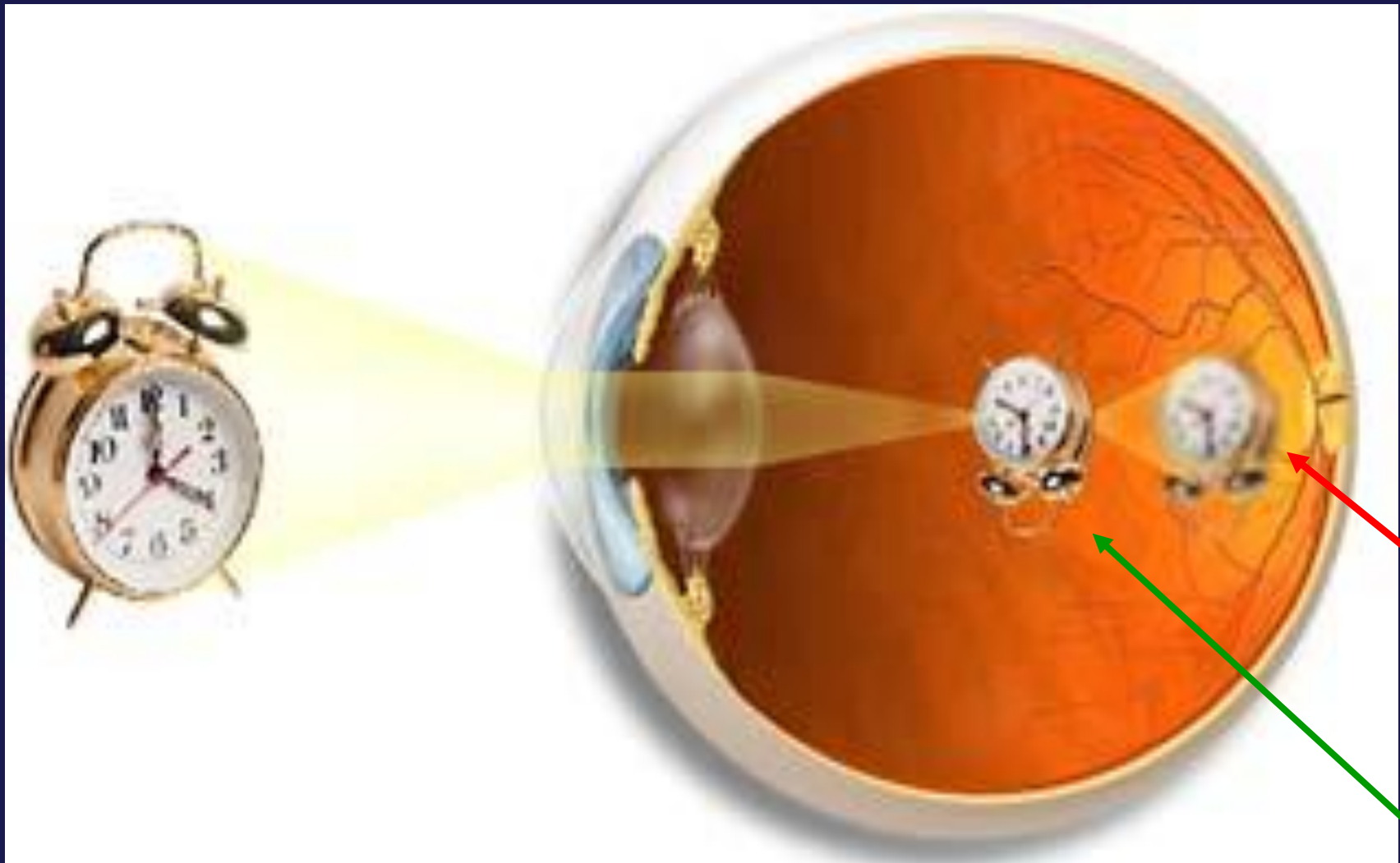
# Visual Abnormalities-cont.



# Emmetropia: objects focused on retina (normal)



# Myopia: objects focused in front of retina



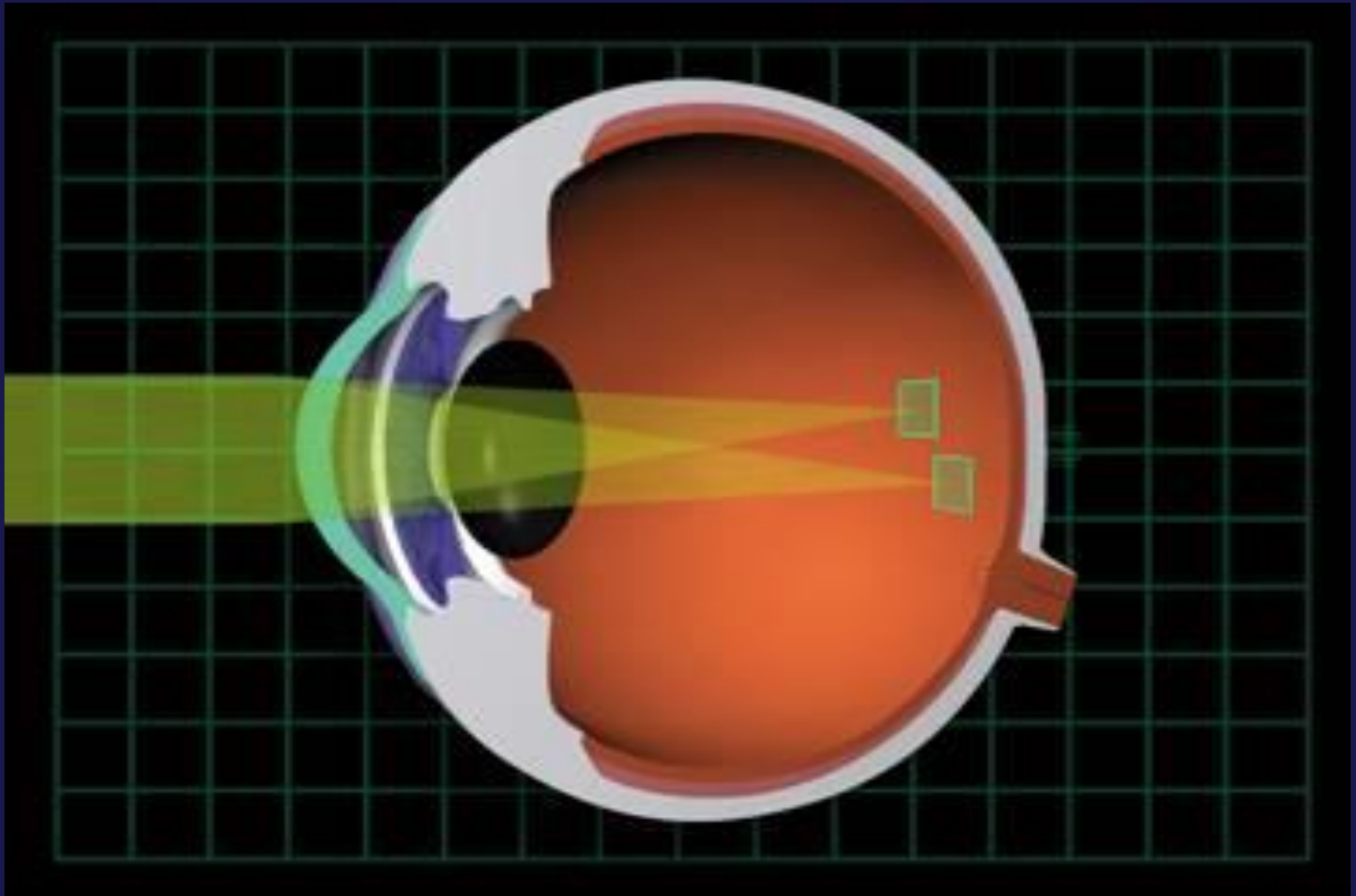
Nearsighted Eye

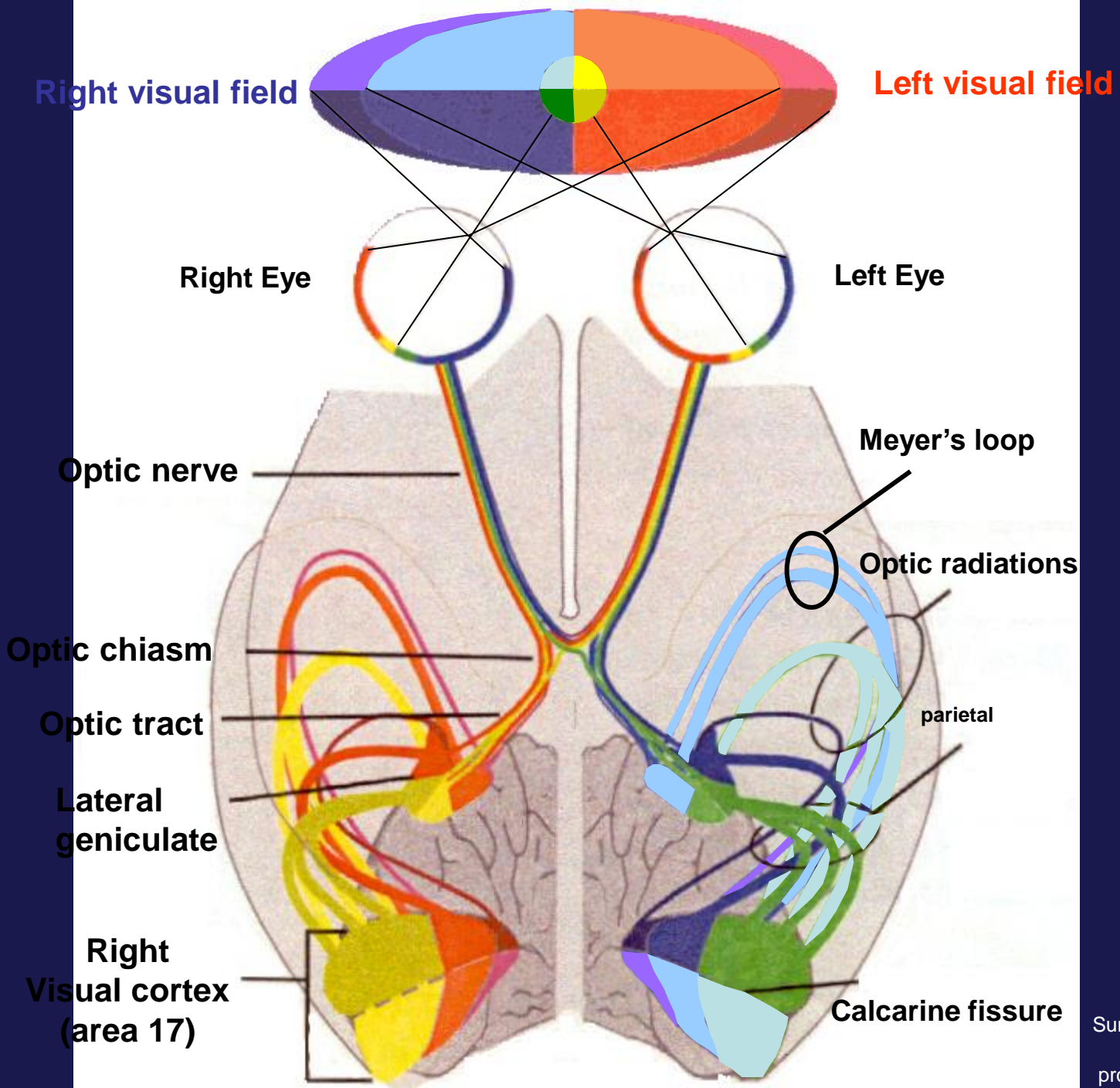


# Hyperopia: objects focused behind retina



# Astigmatism





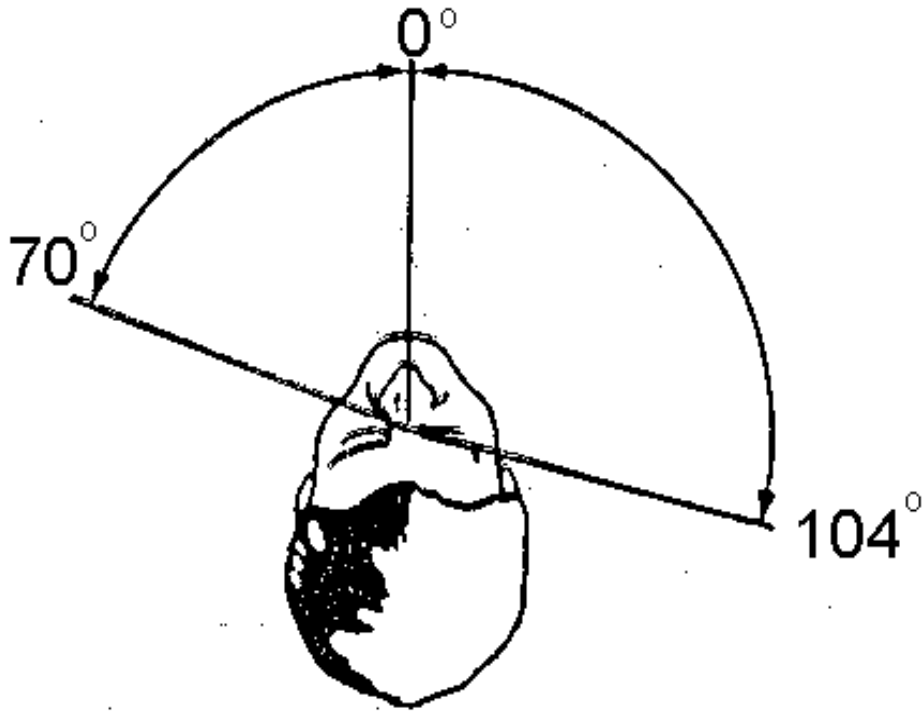
Summary of visual projections

# BINOCULAR VISION

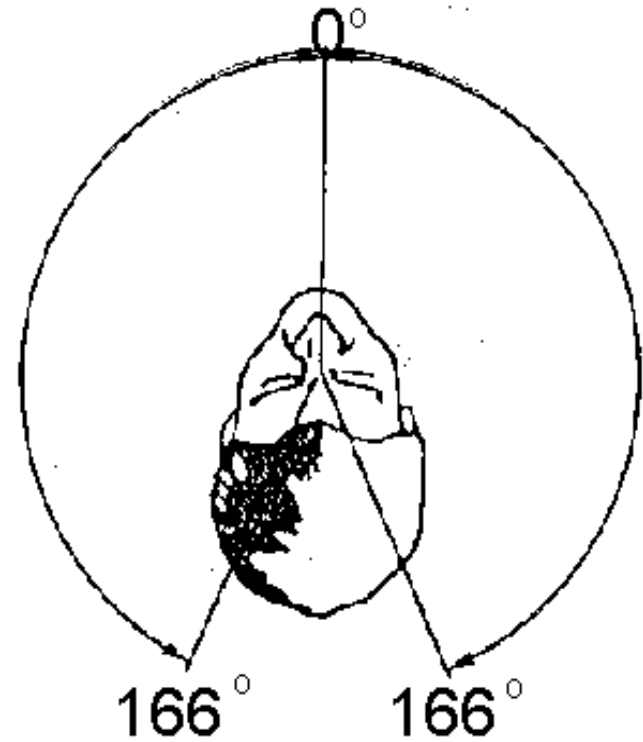
- 1- Large visual field
- 2- cancel the effect of blind spot
- 3- stereoscopic vision  
Depth of perception
- 4- one eye lesion does not affect vision



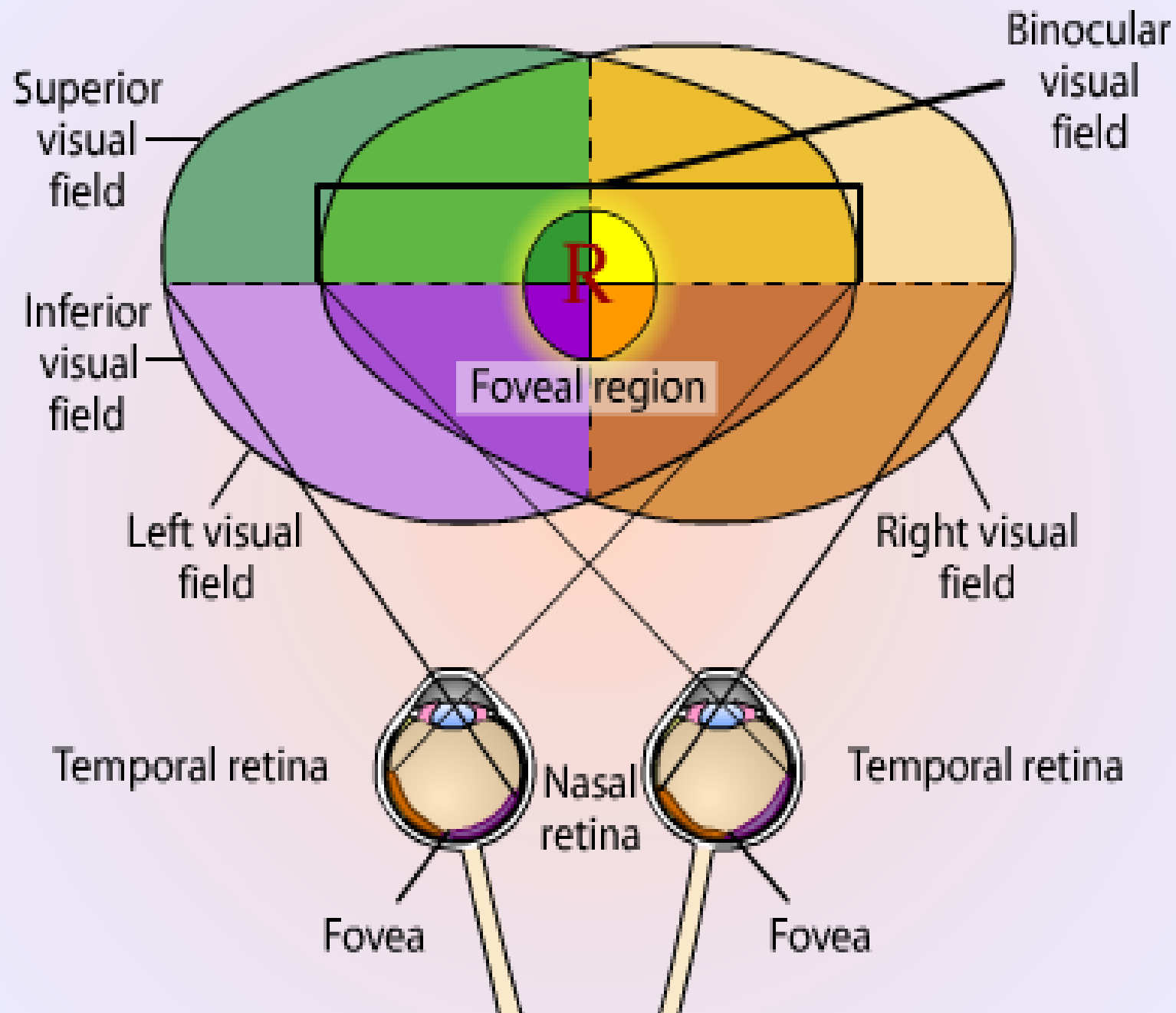
# Visual Field



Monocular vision



Binocular vision



Crescent Lake, White Mountains, Apache-Sitgreaves National Forest, Arizona





