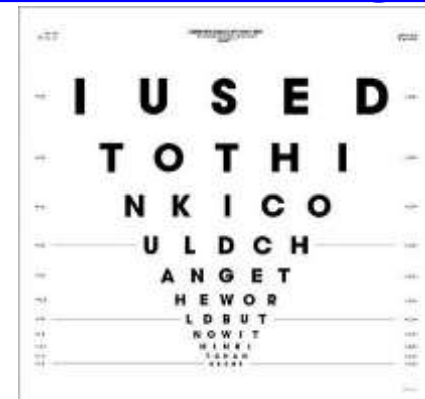


Annette Sims, MD, Ophthalmologist  
next Tuesday! Hooray!!



## **BI 358 Lecture 18**

- I. Announcements** Quiz 5, 8 – 8:30 am. Next Tues, Vision Tests & Eye Dissection Lab > Lecture by Dr. Sims! Quiz 6 next Thurs, covers Lectures 18, 19 + Eye Lab/Discussion 11! BI 358 alum+ > U of O?
- II. Physiology in the News** The sight-saving diet? *UCB*  
<http://www.berkeleywellness.com/healthy-eating/nutrition/article/can-your-diet-save-your-sight>  
*PBS News Hour* Baltimore New Vision Program 121917
- III. Eye I: Anatomy & Optics of Vision** G&H ch 50 + LS +...
- IV. Eye II: Retinal Receptor & Neural Function** G&H ch 51
- V. Eye III: Overview of Visual Pathways & Pathologies**  
G&H ch 52 + LS1 + Silverthorn +...







Microwaving,  
facts and actions, p.4

# University of California, Berkeley

# Wellness Letter®

News and expert advice from the School of Public Health

## WellnessFacts

■ **Smoking worsens the prognosis in men with prostate cancer.** In a Harvard study of 5,366 male health professionals with the disease, smokers were much more likely than nonsmokers to have a recurrence and to die from this cancer, cardiovascular disease or any cause. Men who had quit smoking had prostate cancer mortality rates similar to those who had never smoked, unless they were heavy smokers who stopped less than 10 years earlier. Previous research has suggested that smoking also increases the risk of developing prostate cancer.

■ **More bad news about television viewing: For every two hours watched daily, death rates rise by 13 percent,** according to a recent analysis in the *Journal of the American Medical Association*, which pooled data from eight large studies. That works out to about one extra death each year per 1,000 adults who watch TV two hours a day. And the risk rises with longer viewing hours. The study also found a 20 percent increased risk of diabetes for every two hours watched daily. That's not surprising, since heavy TV viewing often leads to heavy TV viewers.

## The sight-saving diet?

A look behind the eye-health claims made for foods and supplements

**N**o one knows how to prevent the eye disorders that often come with aging, though not smoking and avoiding strong sunlight may help reduce the risk of cataracts. That's why there has been so much interest in the role of nutrition in eye health, which has generated hundreds of studies in recent years—and many promising leads.

It's clear that malnutrition harms vision. A shortage of vitamin A, for example, causes night blindness and other problems. Thus, carrots really are good for your eyes, since they're rich in beta carotene, which the body converts into vitamin A. Vitamin deficiencies can also cause eye disorders such as cataracts in lab animals.

Other nutrients and plant compounds may help protect vision, perhaps by acting as antioxidants and reducing inflamma-



the progression of AMD if you do develop it (see page 2).

### Eye on research

Here are the nutrients and supplements most often promoted as ways to preserve vision in healthy people and prevent AMD and/or cataracts, along with what the research shows:

■ **Lutein and zeaxanthin.** Most (but not all) observational studies have found that people with high dietary intakes or high blood levels of these carotenoids have a reduced risk of AMD and cataracts. Some small short-term clinical trials have also suggested protective effects in people with healthy eyes, as well as benefits in those who already have AMD. More research is needed.

■ **Vitamin C and E, selenium, beta carotene and other antioxidants.** Again,



## *Sight-saving Diet?*

1. High intakes of lutein & zeaxanthin (carotenoids) may reduce risk of macular degeneration (AMD) & cataracts.
2. Consuming plant-foods rich in antioxidants including vitamins C & E, selenium &  $\beta$ -carotene also may reduce risk of macular degeneration & cataracts.
3. Older vegetarians are 30-40% less likely to develop cataracts compared to daily meat eaters.
4. The above holds for foods, but there is little evidence that anti-oxidant supplements have this effect.
5. Zinc is essential to good vision & is found in the retina & may protect eyes from light damage & inflammation. Get zinc from food (oysters, shrimp, whole grains, yogurt...)
6. High intakes of fish rich in  $\Omega$ -3 fats also reduce AMD.





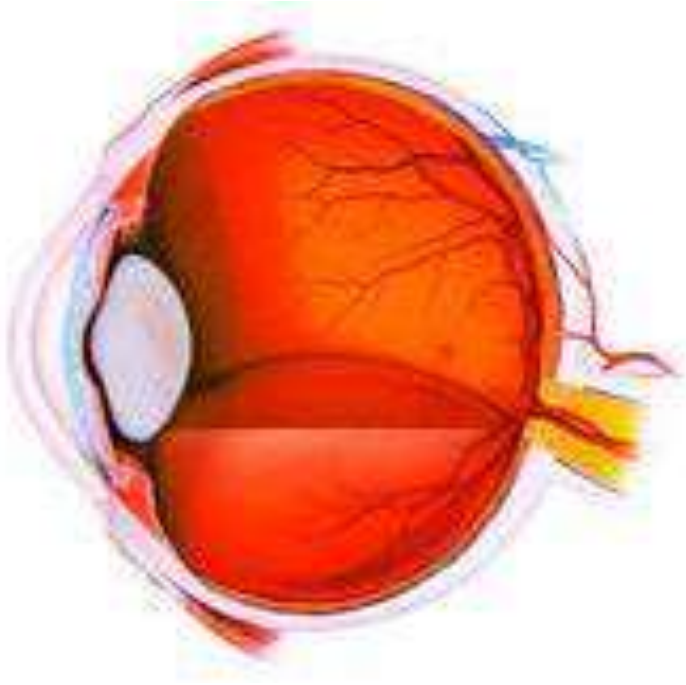
# ***Vision for Baltimore PBS News Hour***



<http://www.pbs.org/newshour/extra/daily-videos/how-this-public-private-coalition-is-providing-eyeglasses-for-poor-children/>



***Eye: Elaborate sensory receptor* ≡ Camera**

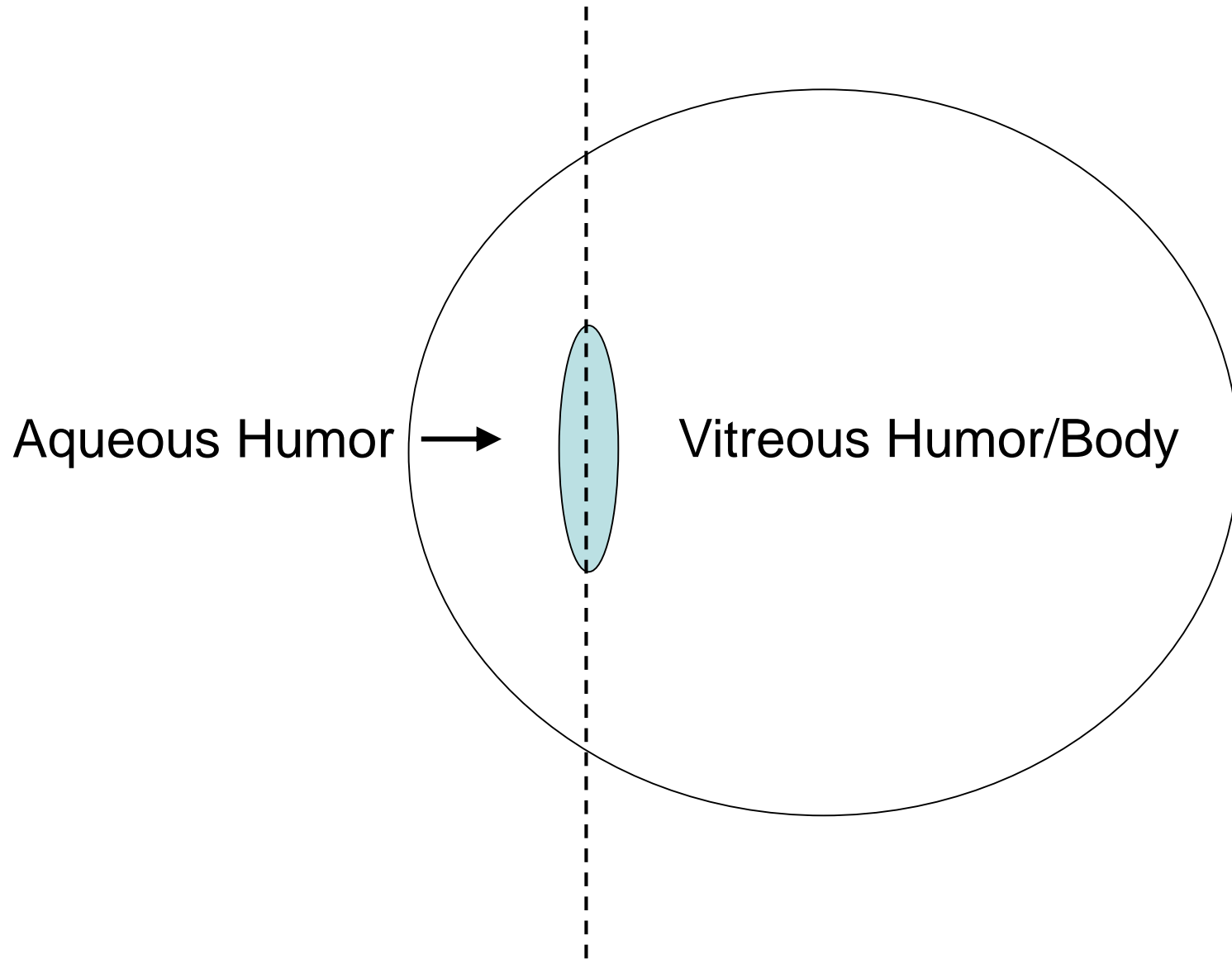


≡



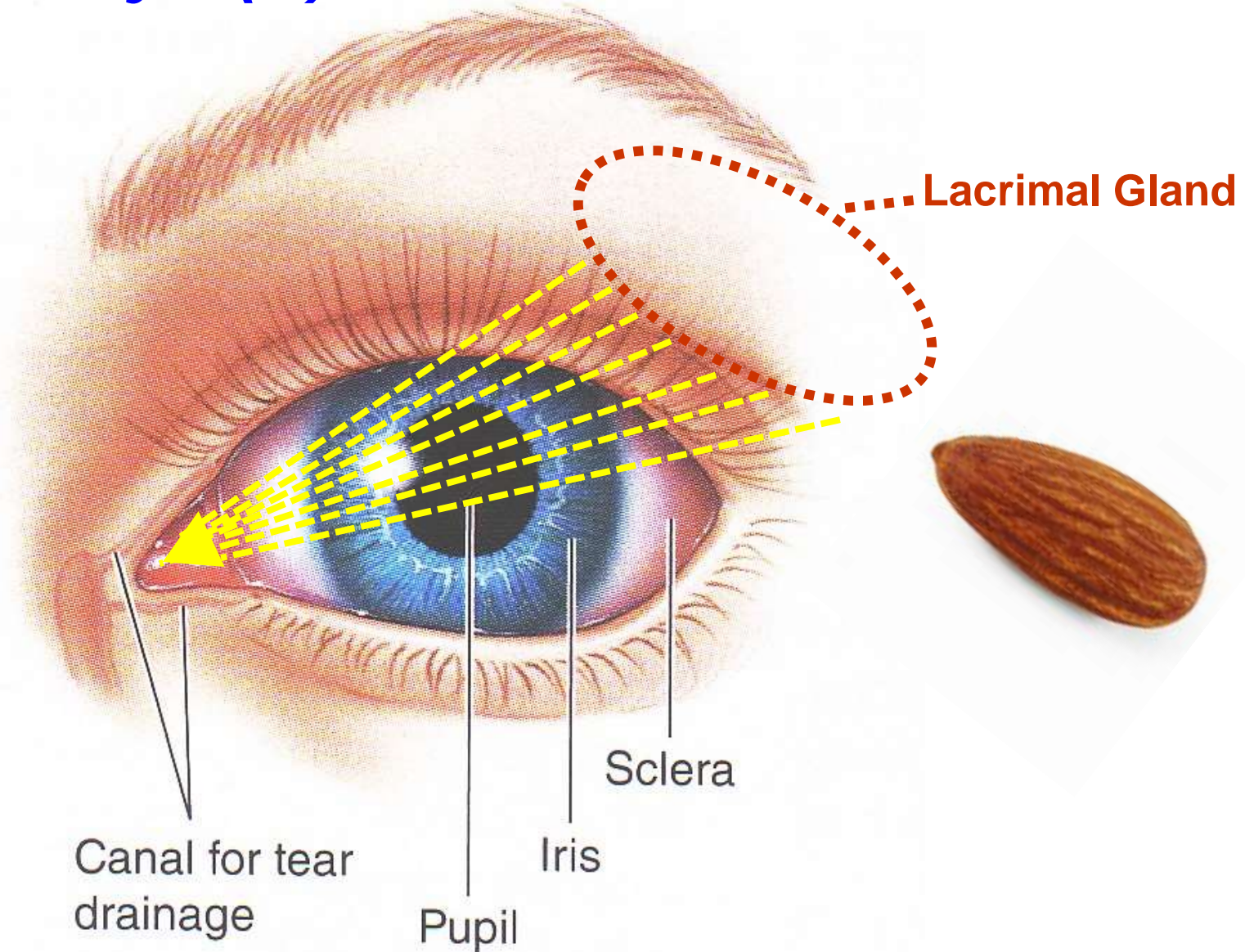
**Aperture + Lens + Film!**

# ***Lens Separates Major Compartments***





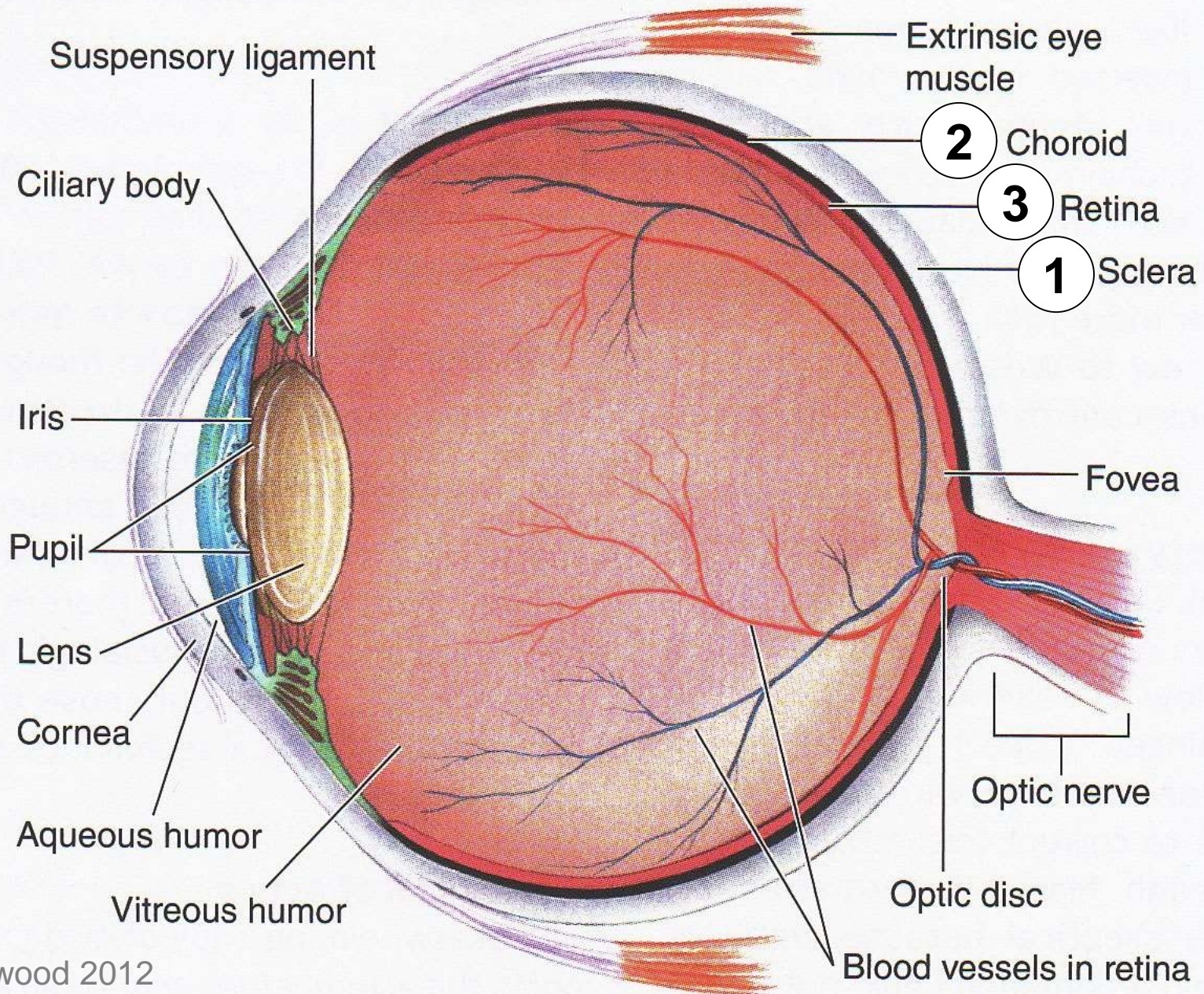
# Eye (L), Anterior View







# Eye: Saggital View





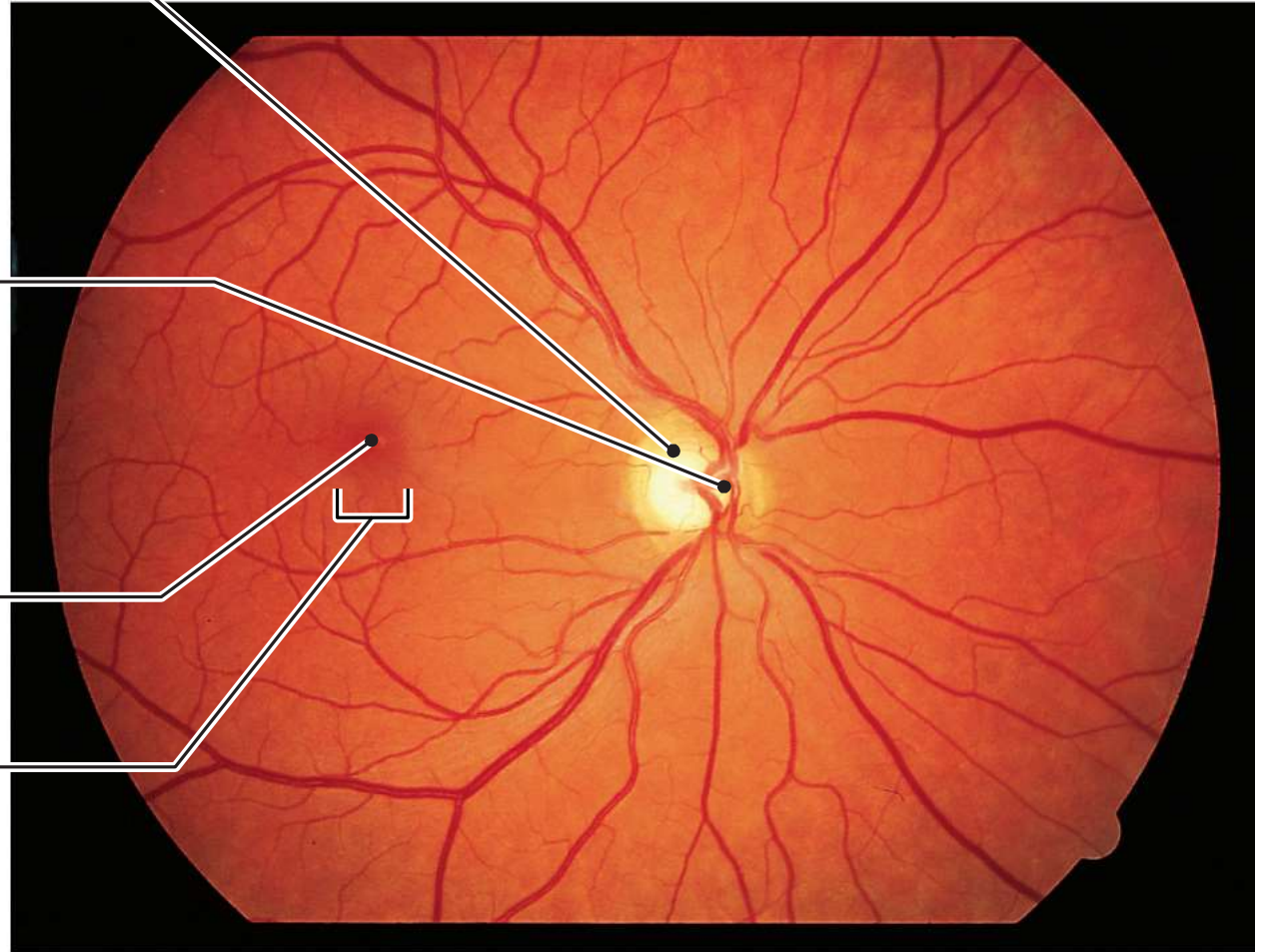
# *The Blind Spot?*

**Optic disk**  
(blind spot)

**Central retinal  
artery and vein**  
(+ optic nerve)

**Fovea**

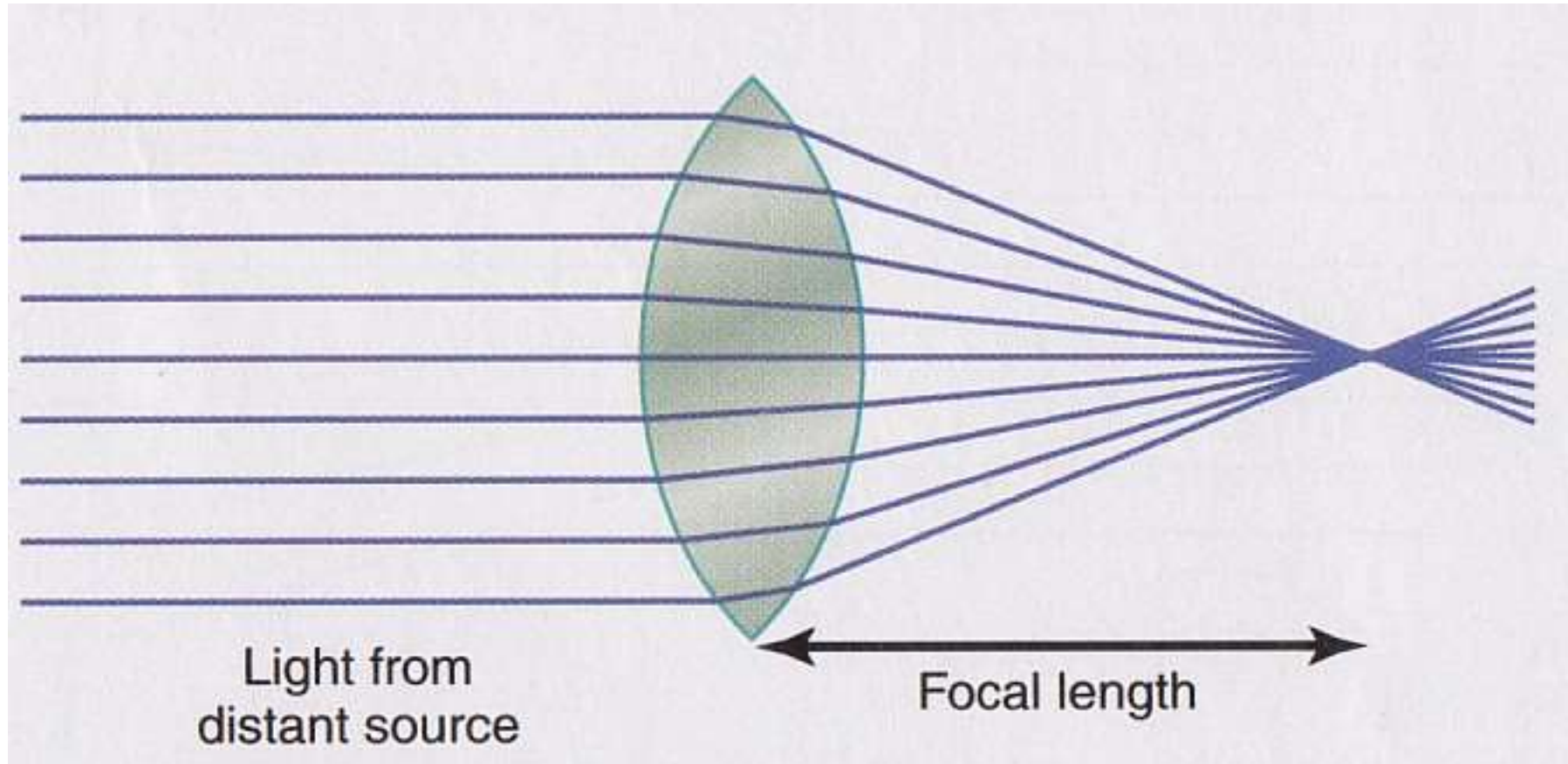
**Macula**



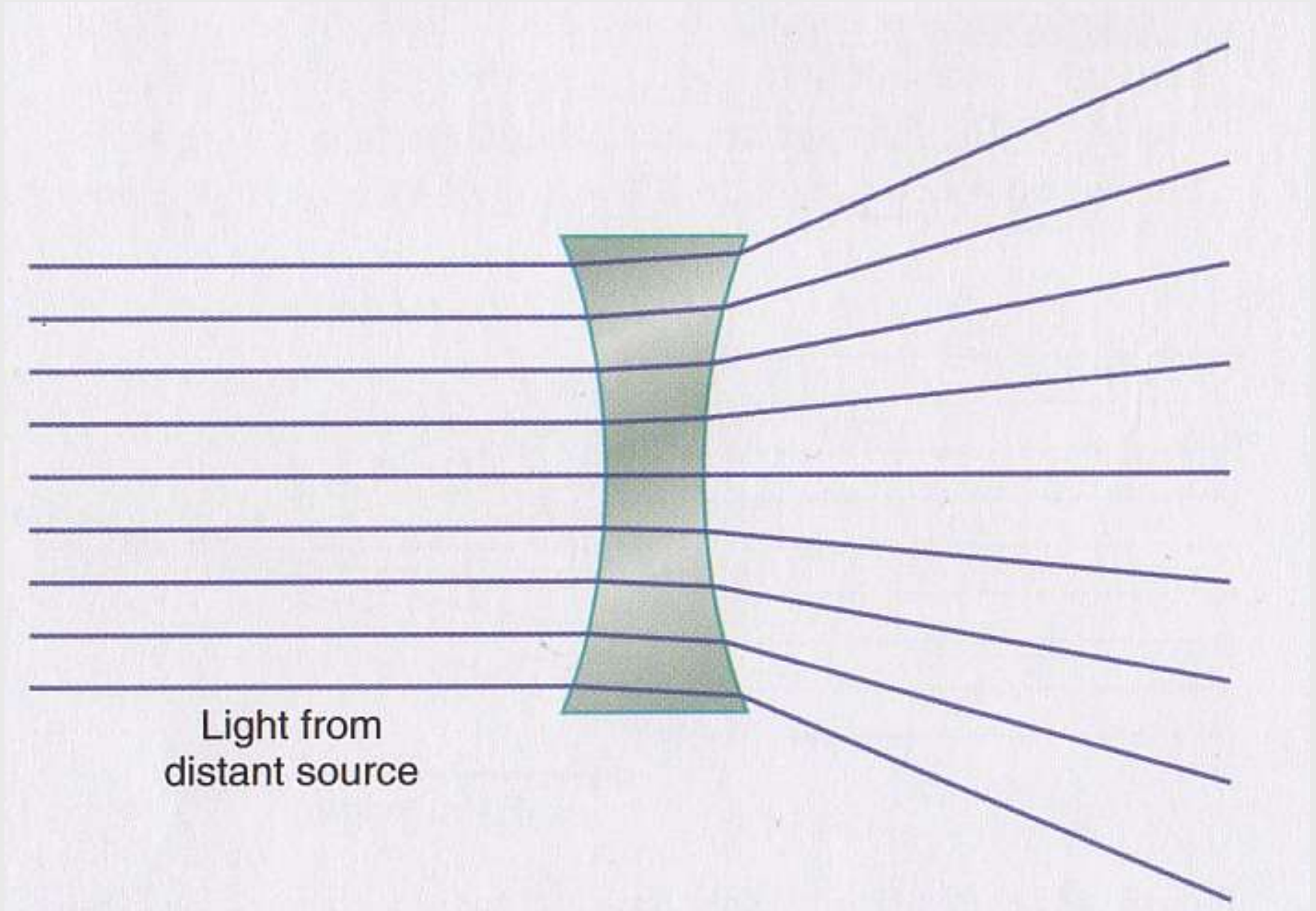
**(b)**



# *Convex lens convergence + focal length*



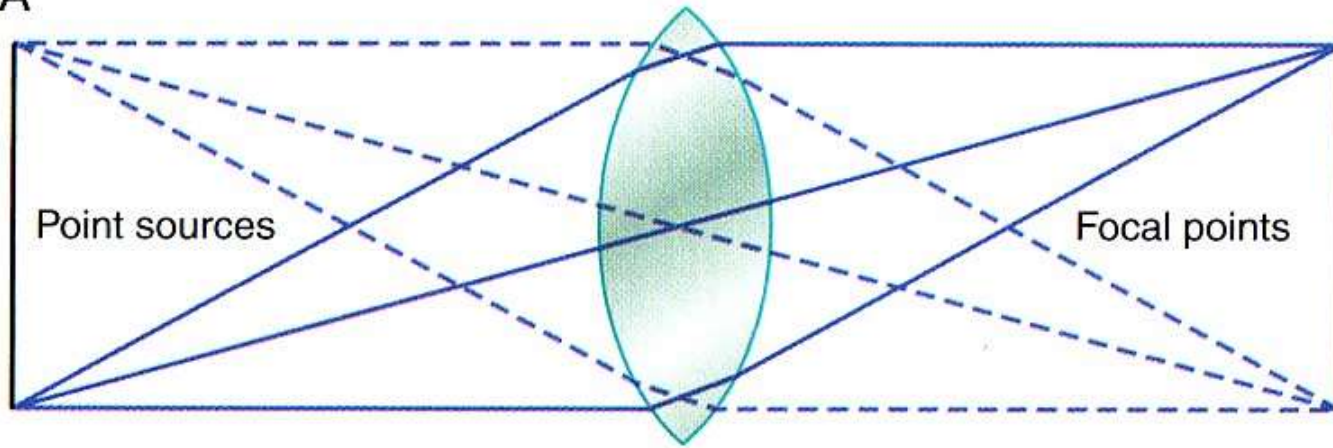
# Concave lens divergence



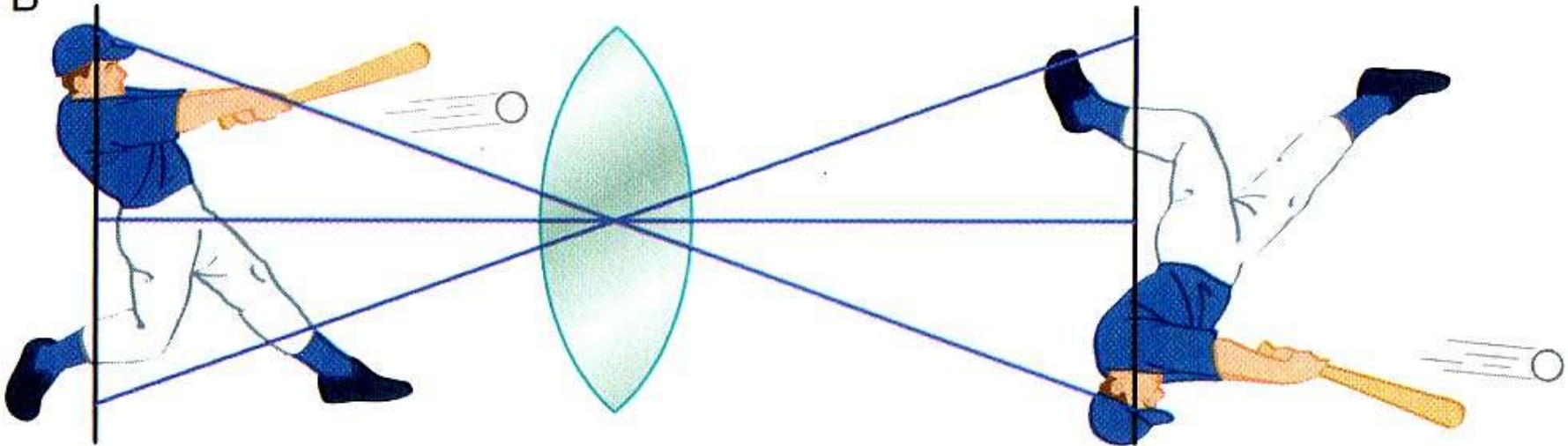


# Image formation by convex lens

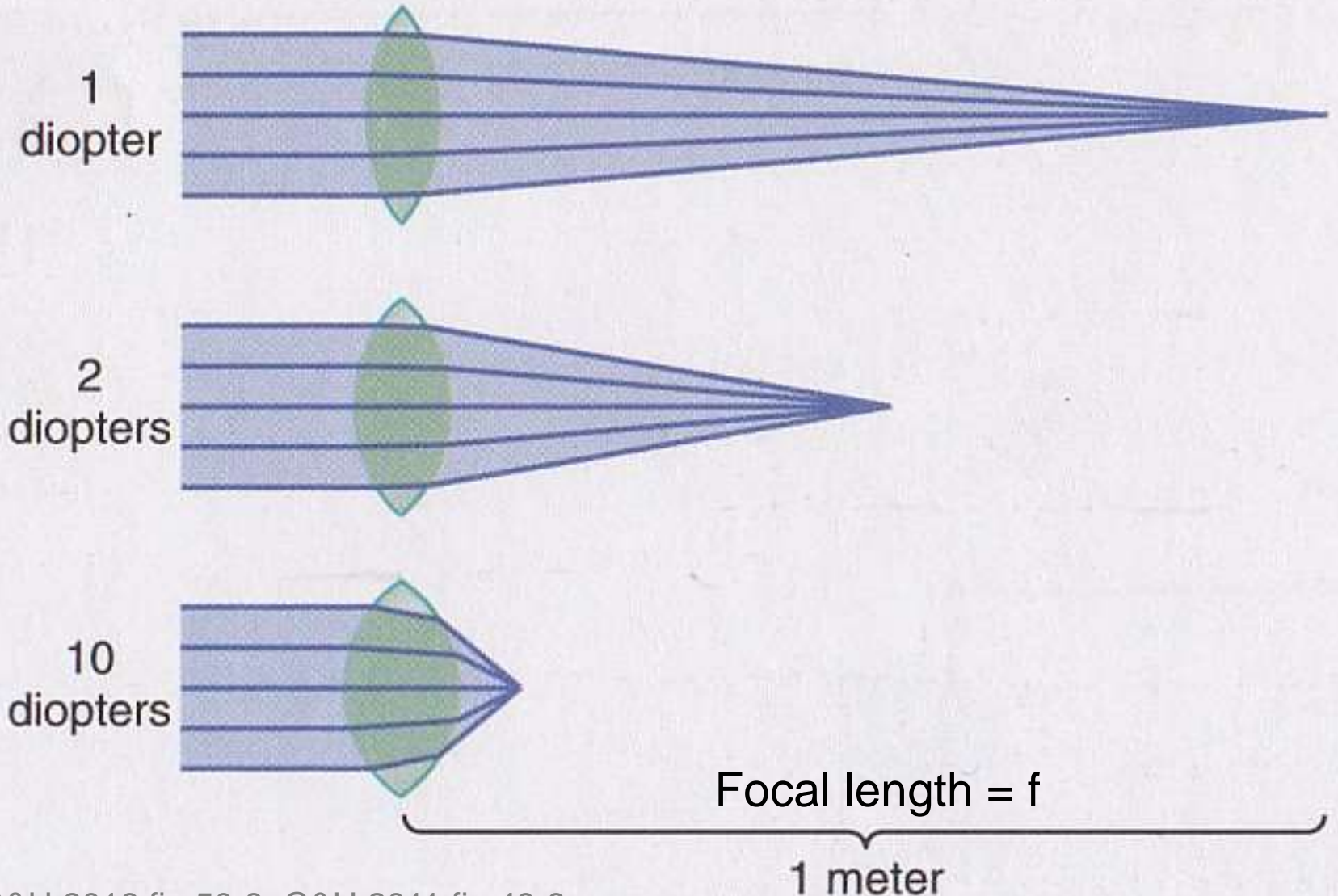
A



B



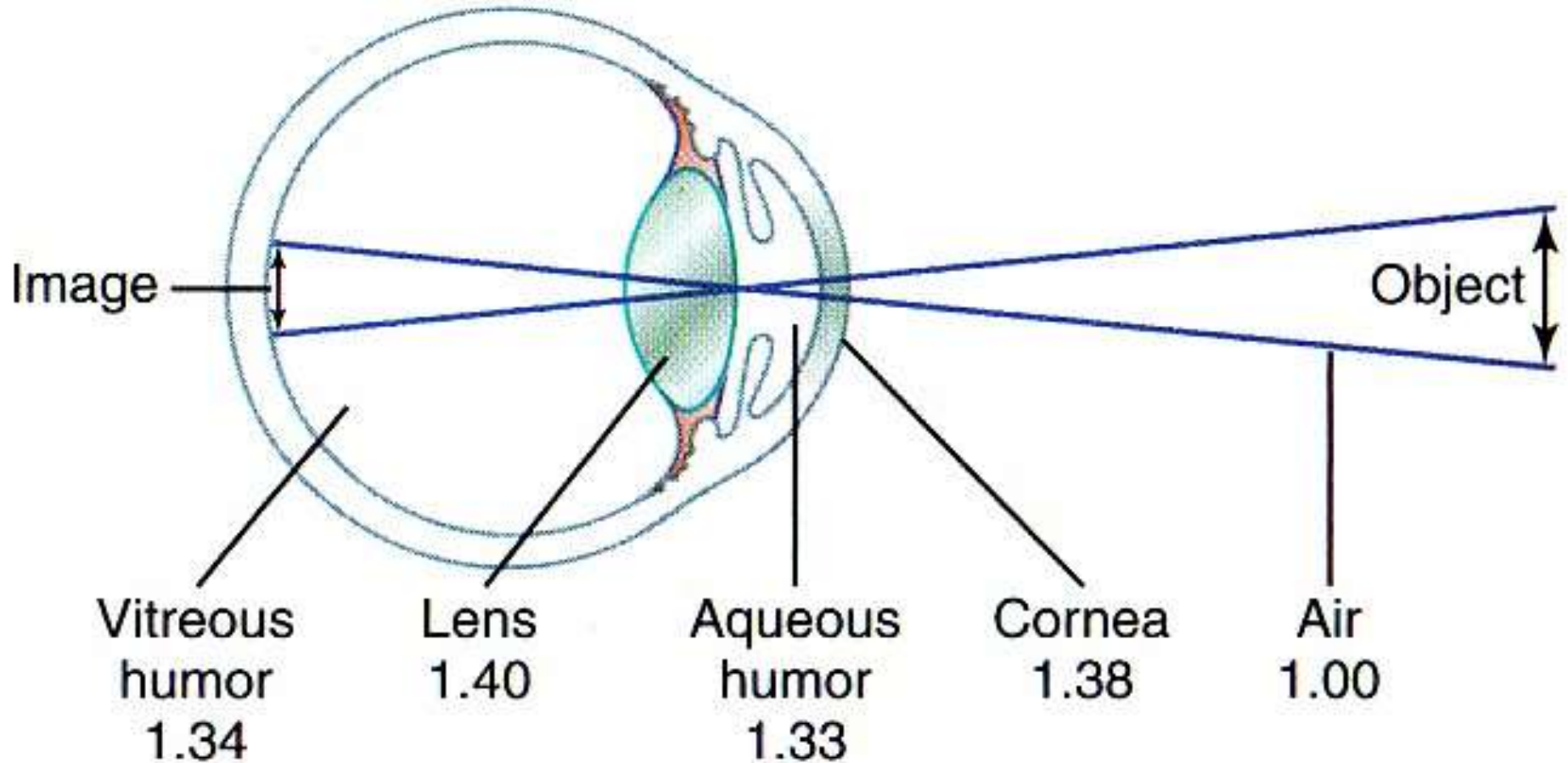
# What's a diopter? Refractive power measurement = $f^{-1}$ or 1m divide by f



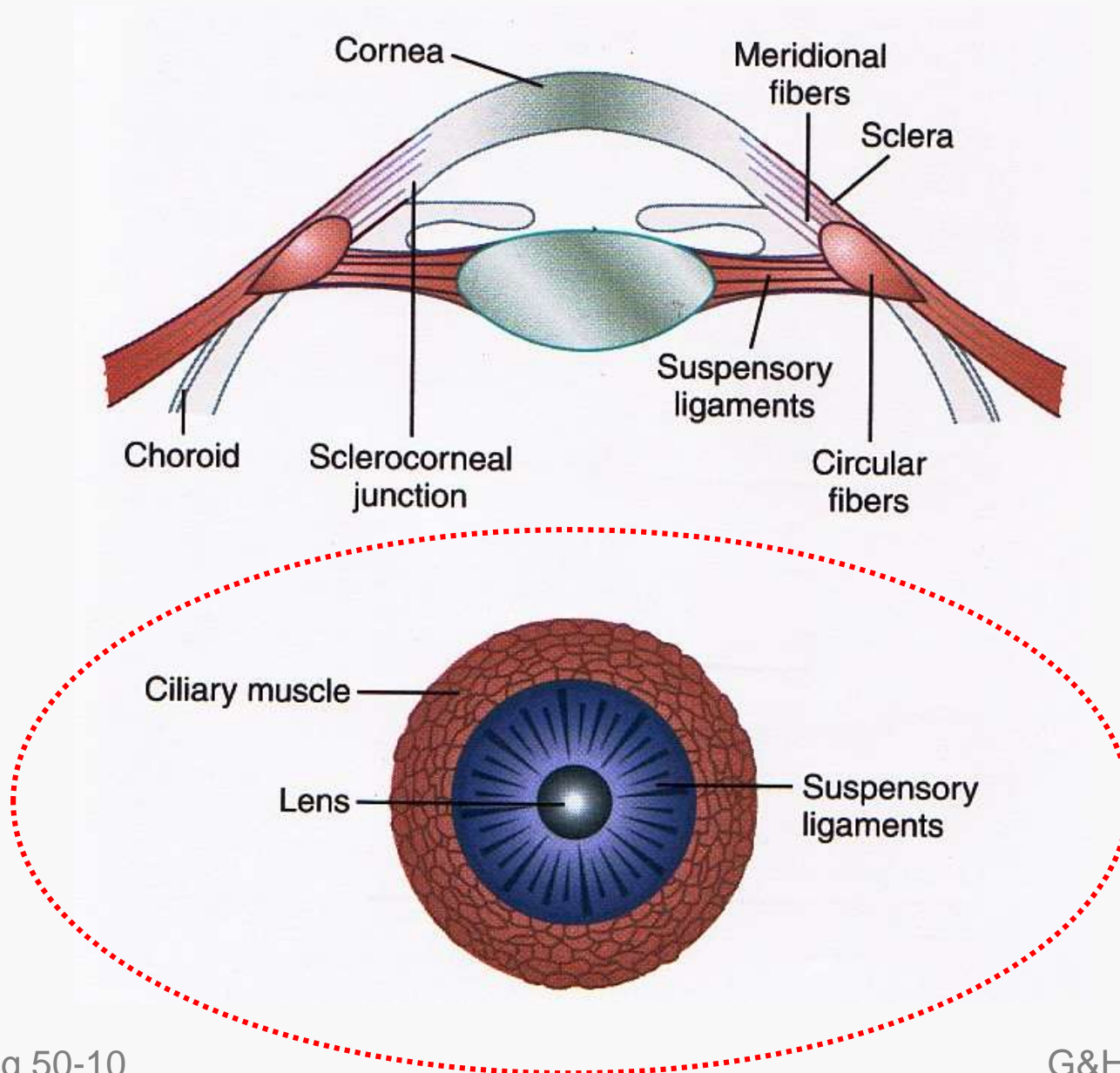


# Refractive index?

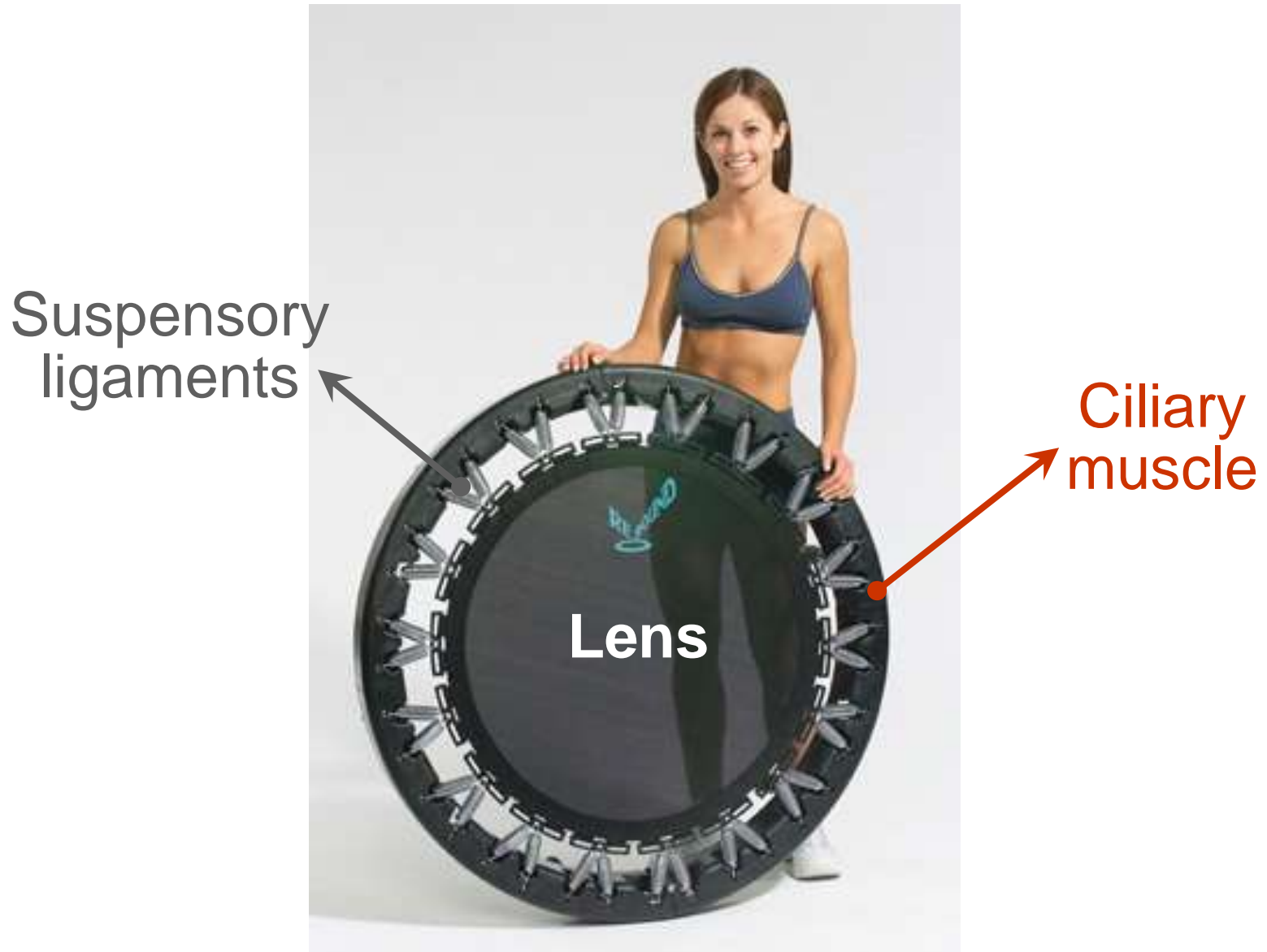
Total refractive power = 59 diopters



# ***Mechanism of accommodation***

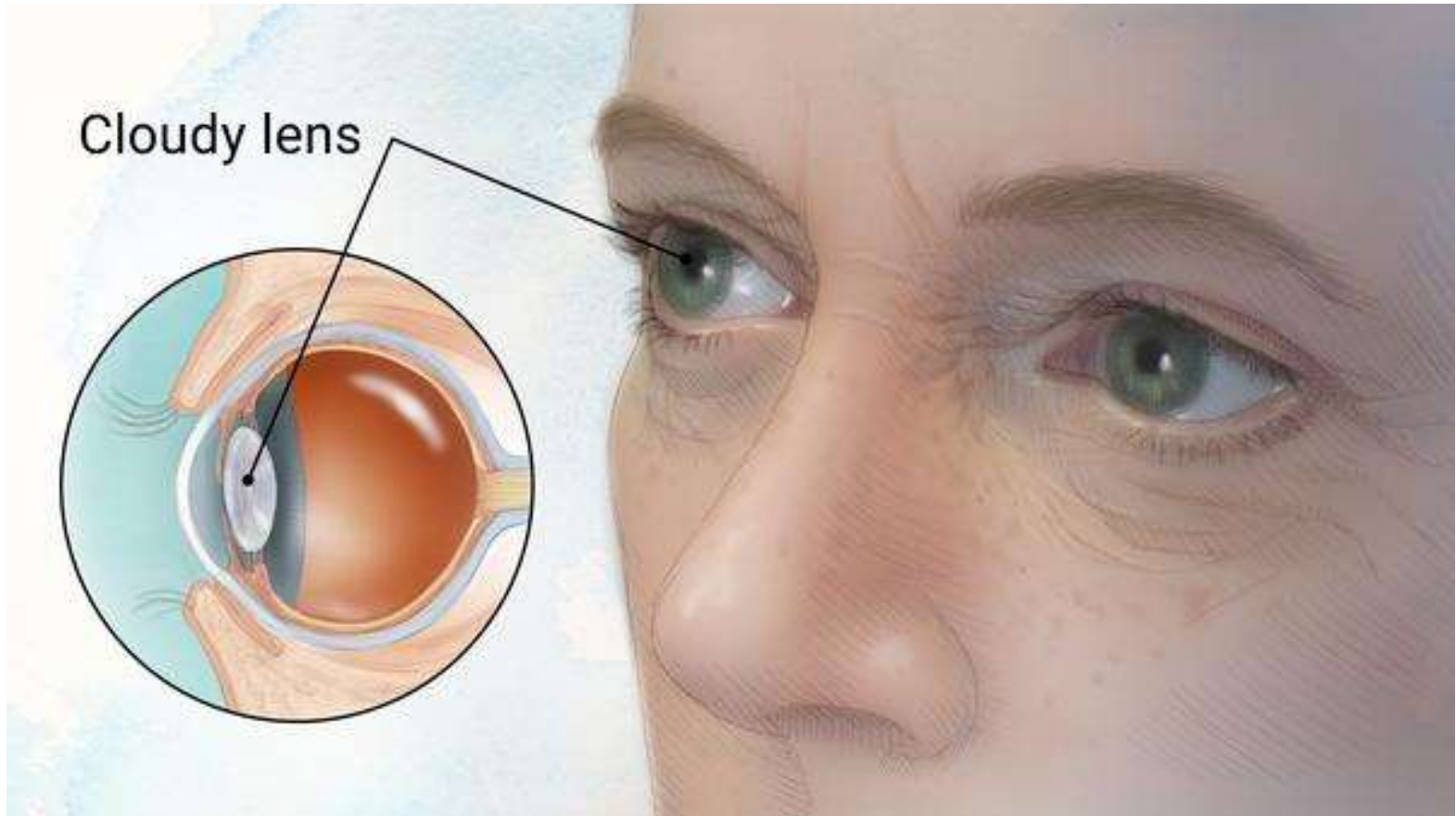


# *Mini-tramp analogy*





# Cataract: Clouding of Lens



> ½ Americans by 80 yr

SOURCES: Mayo Clinic 2019, National Eye Institute, National Institutes of Health 2019.

<https://www.mayoclinic.org/diseases-conditions/cataracts/symptoms-causes/syc-20353790>

[https://nei.nih.gov/health/cataract/cataract\\_facts](https://nei.nih.gov/health/cataract/cataract_facts)

# Cataract Staging

**MEDICAL FINDINGS** - A listing of eye health findings, relevant systemic conditions, and associated plan from your Doctor.

**Age-related nuclear cataract, bilateral** - Discussed presurgical cataract, report any change to vision/glare.

Cataract Opacification: Right eye: 1+

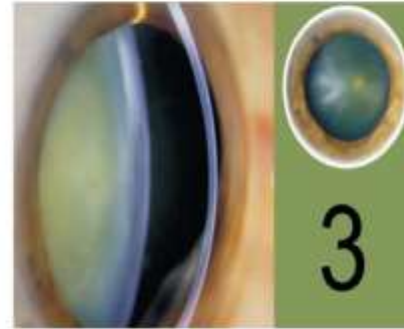
Left eye: 1+



*Minimal bother from glare, unlikely reduced vision.*



*Mild bother from glare, slightly reduced vision.*



*Vision and glare affected enough to consider surgery.*



*Very poor vision, needs surgery.*

**Medications:**

**Allergies:**

**Vitals –**

**SOURCE:** Rainbow Optics, 103018.



# *How a cataract affects vision*



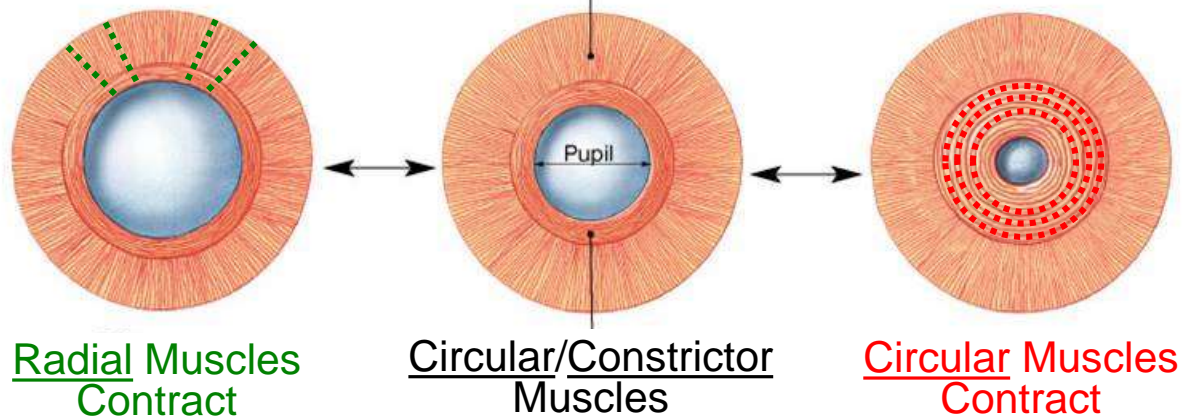
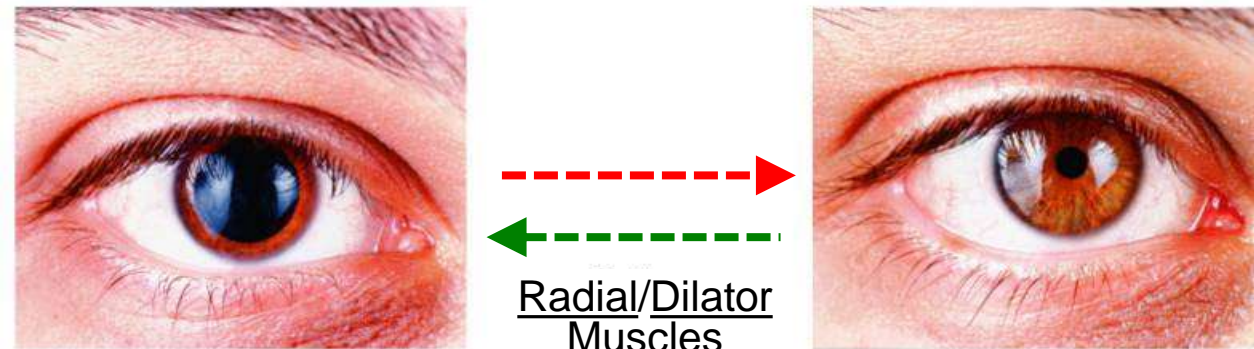
Normal



Cataract

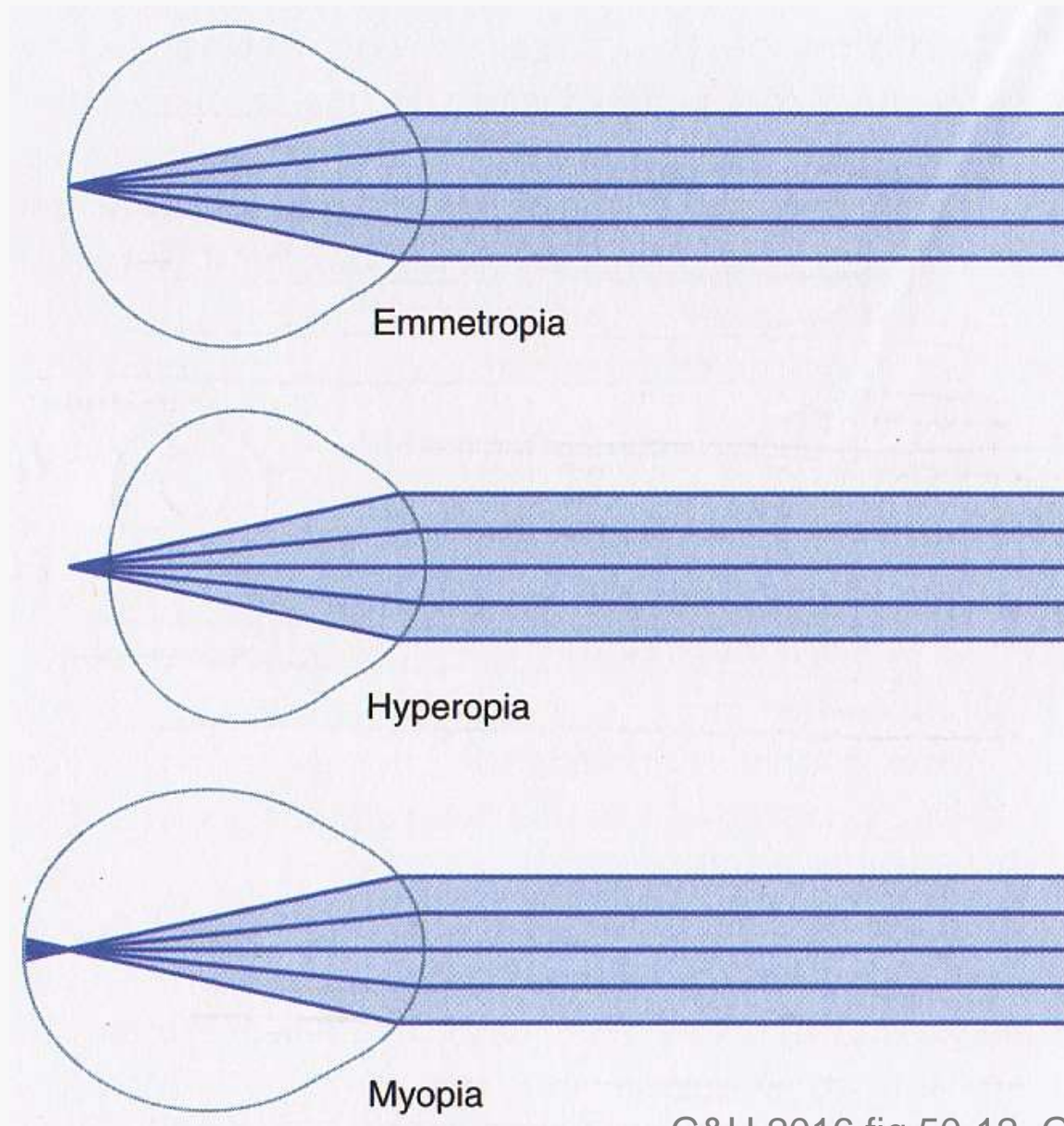
SOURCE: Mayo Foundation for Medical Education & Research 2019.

# Accommodation $\equiv$ Lens Thickens $\rightarrow$ + Pupils Constrict + Eyes Adduct!

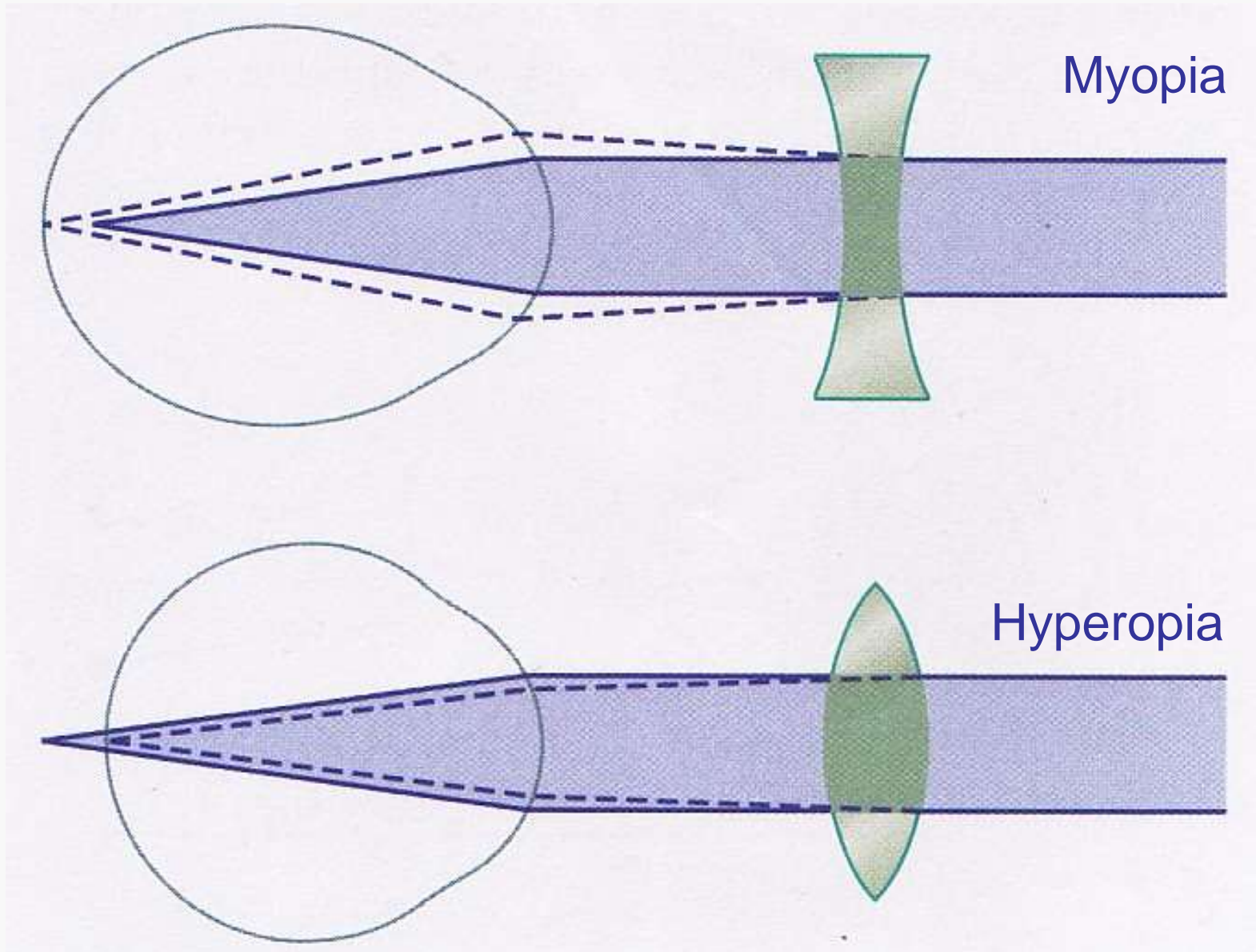




# Normal, far- & near-sighted vision

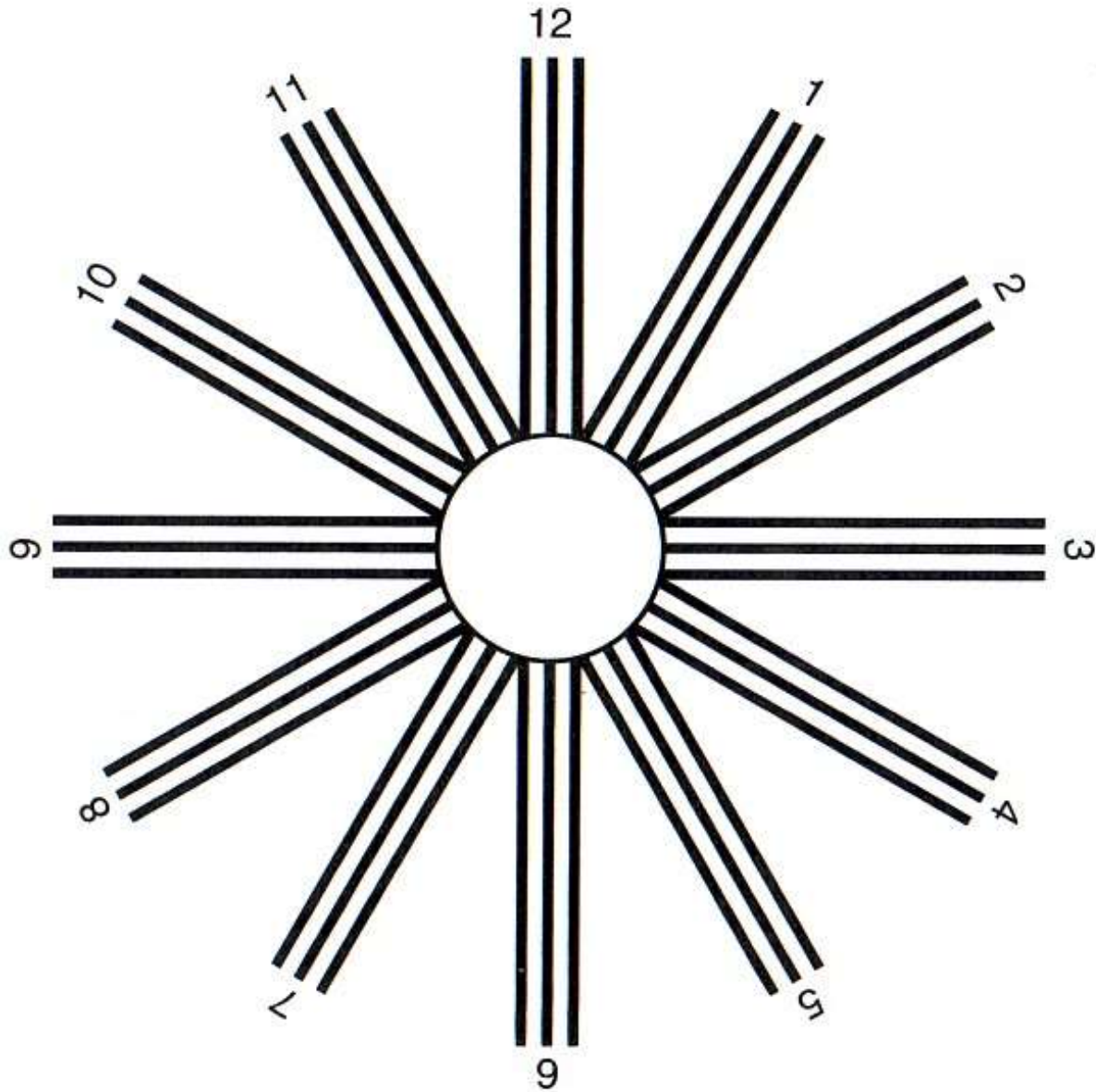


# Correcting near- & far-sightedness

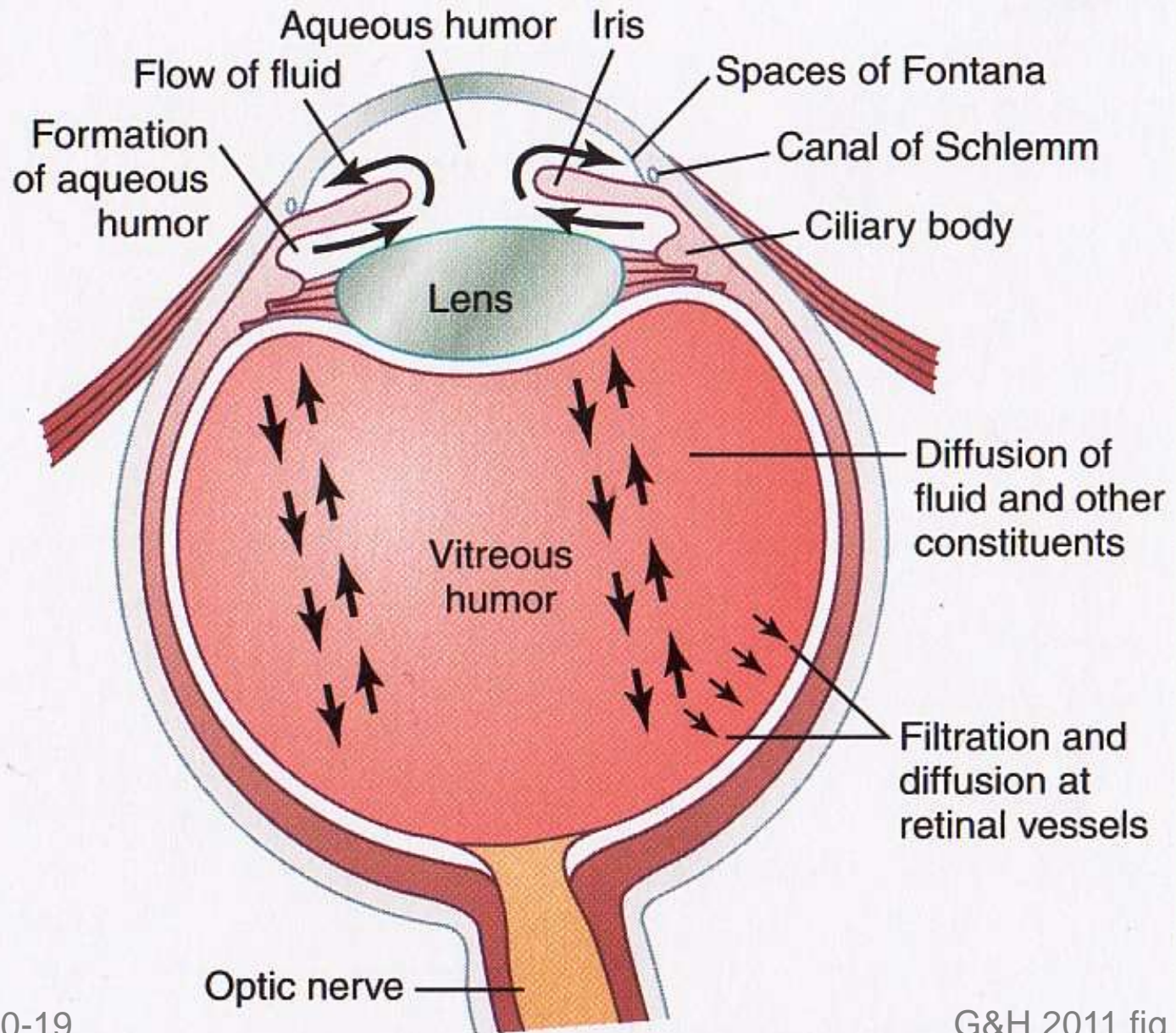




# ***Astigmatism?***

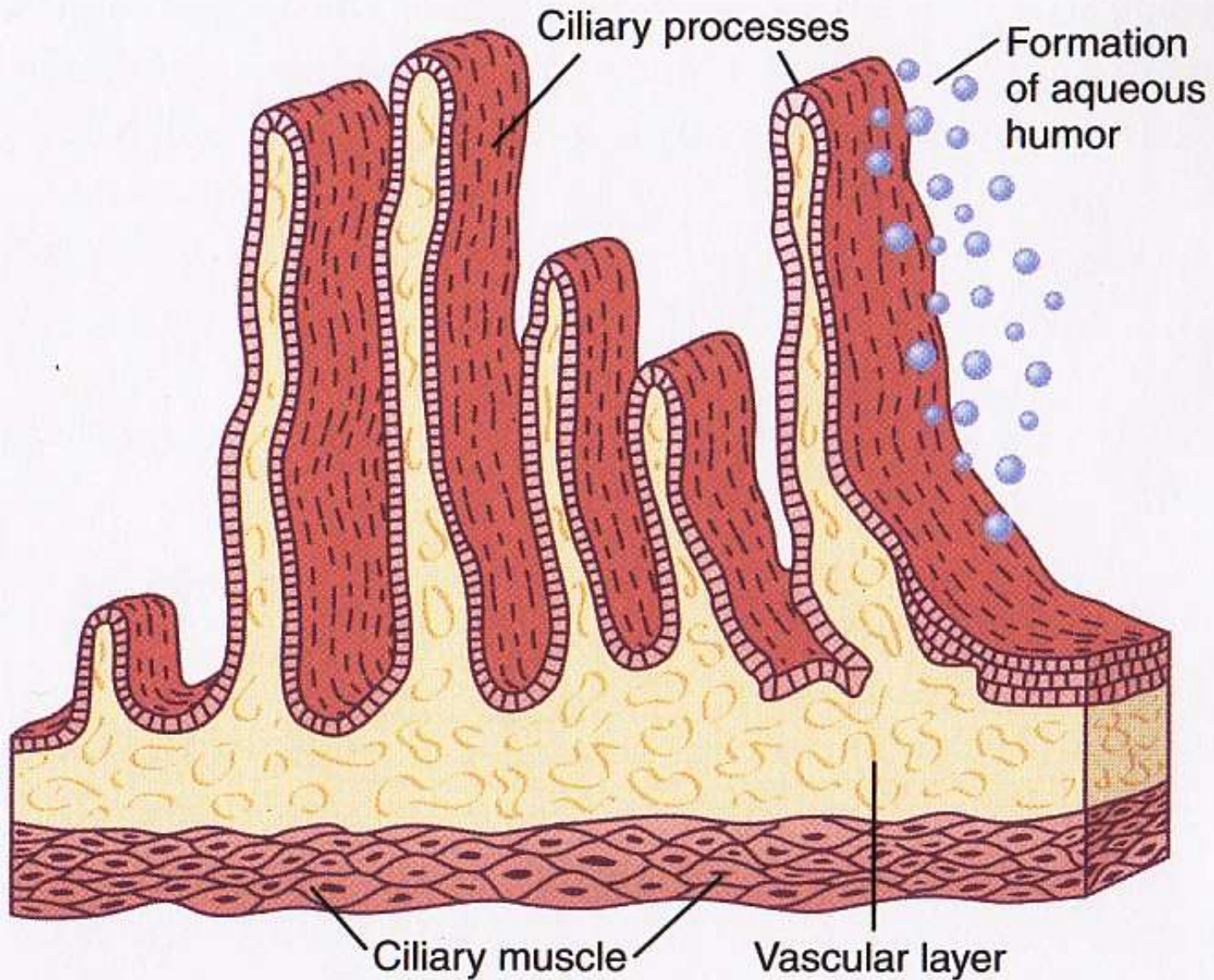


# Fluid formation & flow



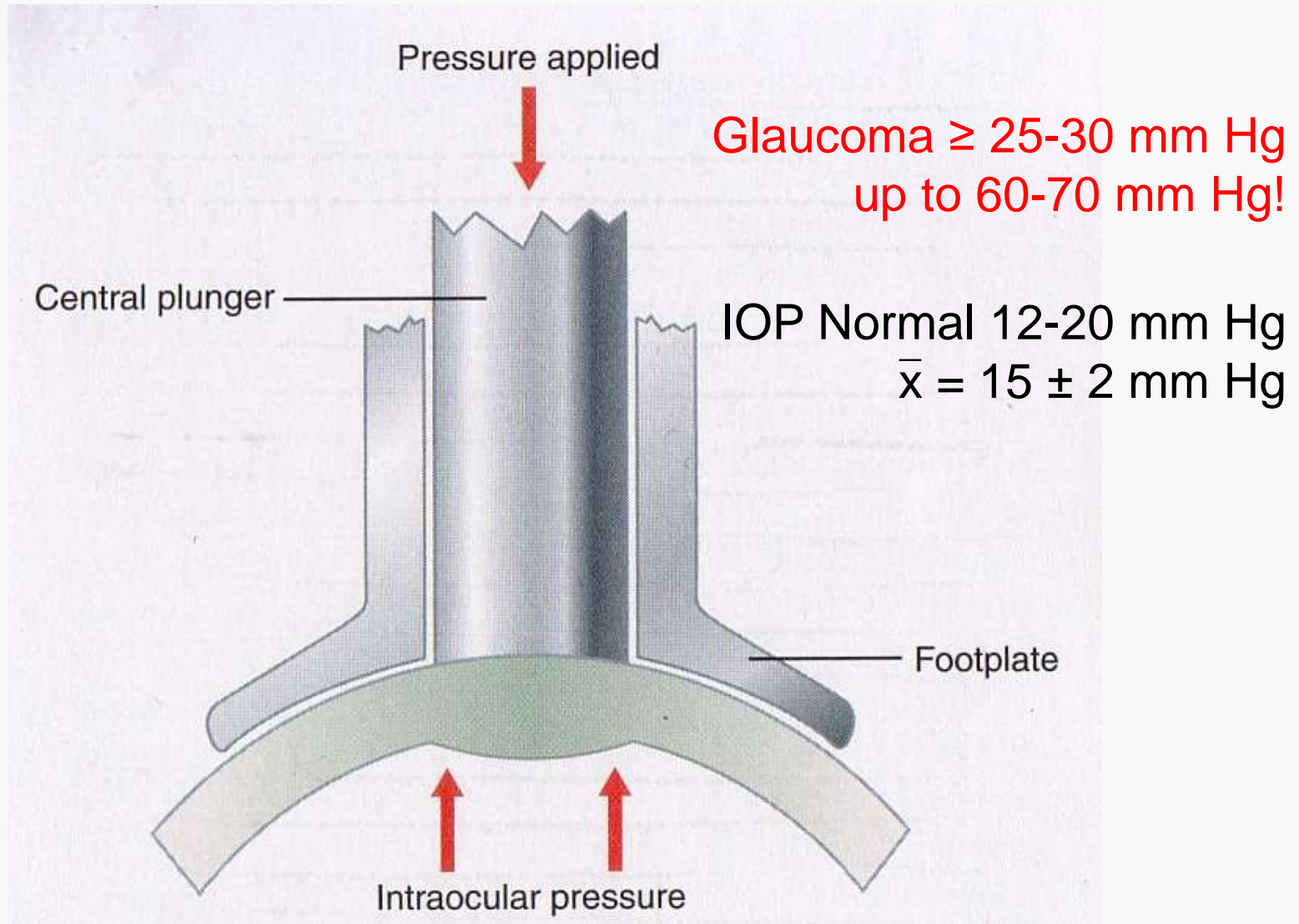


# *Aqueous humor formation*

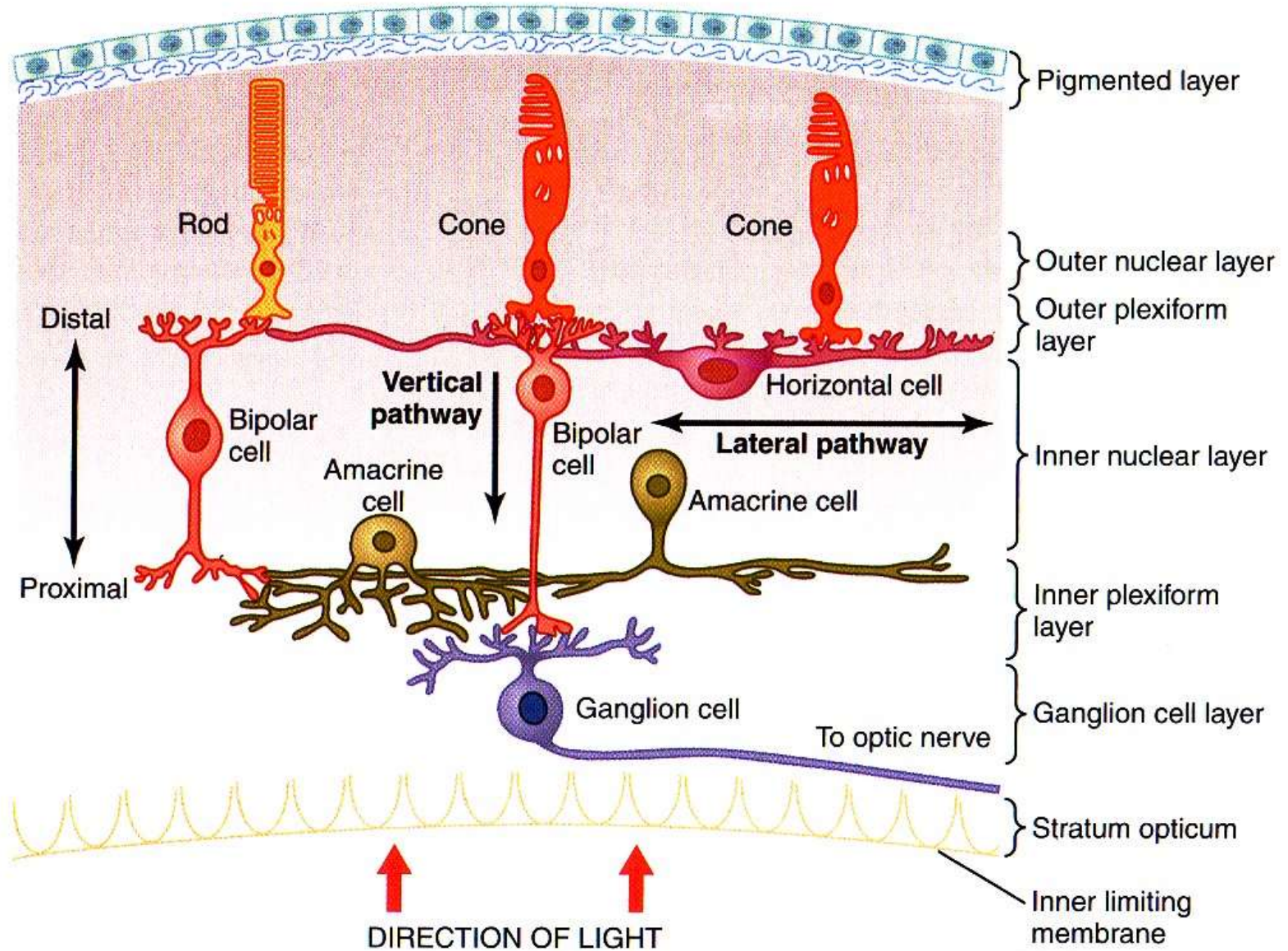




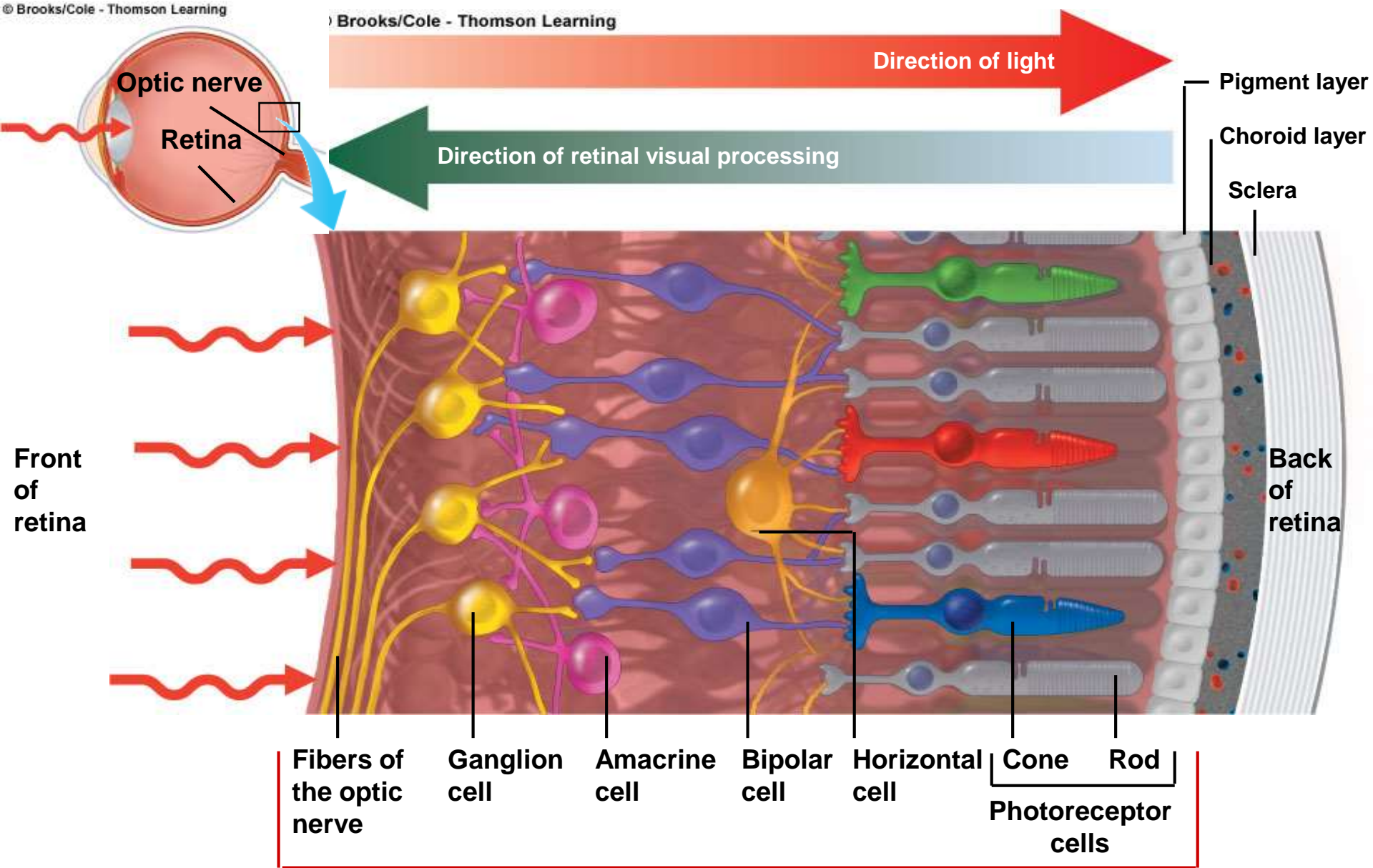
# Glaucoma & intraocular pressure (IOP)?



# Retinal layers



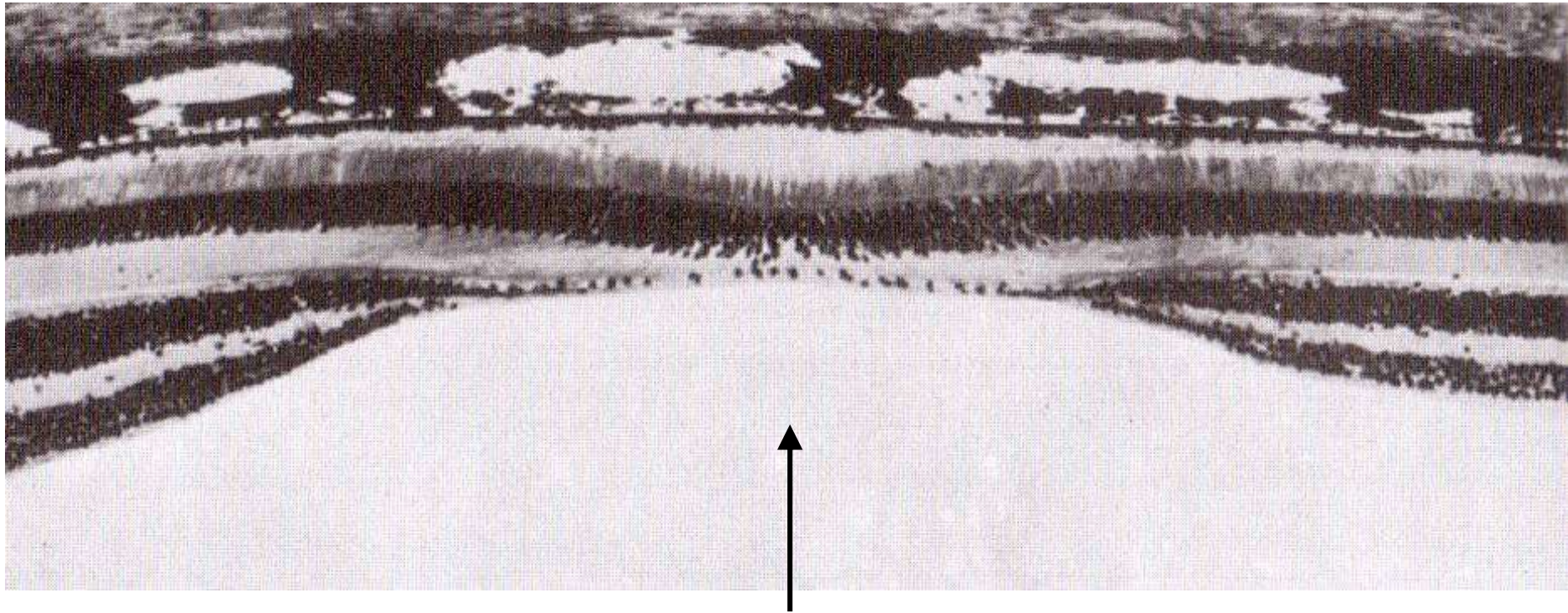




## Retina



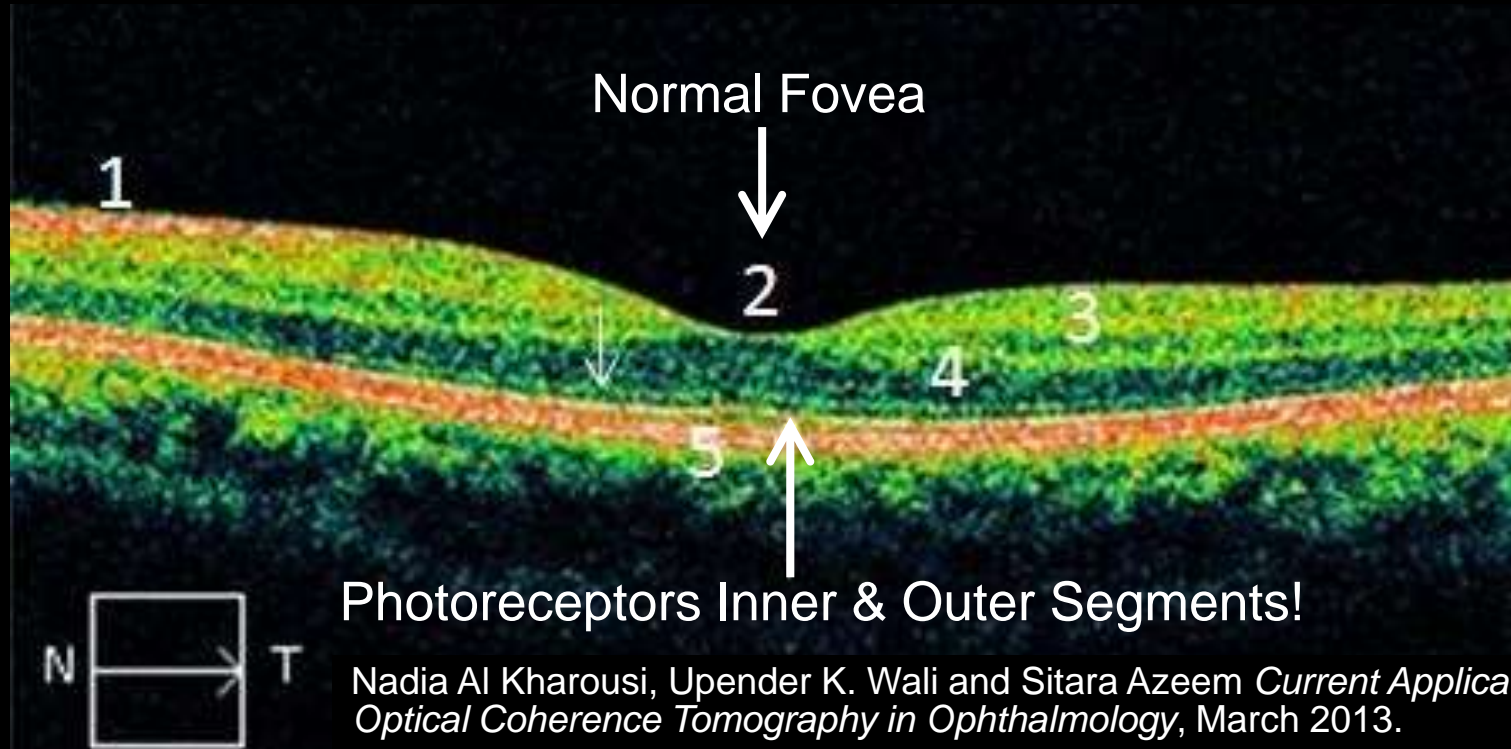
# ***Macula & fovea hot spot!***



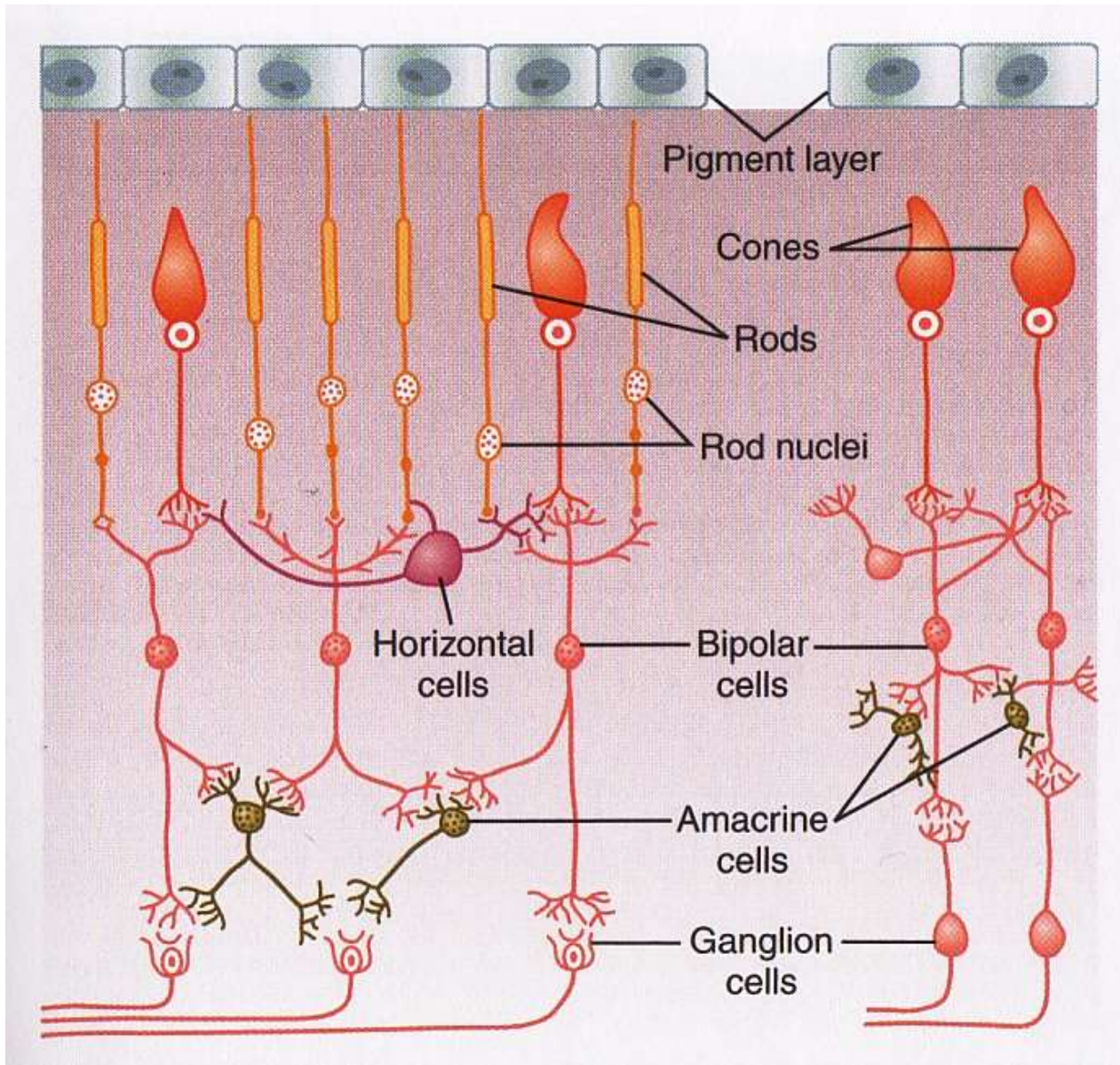
Direction of light



# Exposed Cones @ Fovea/Macular Region

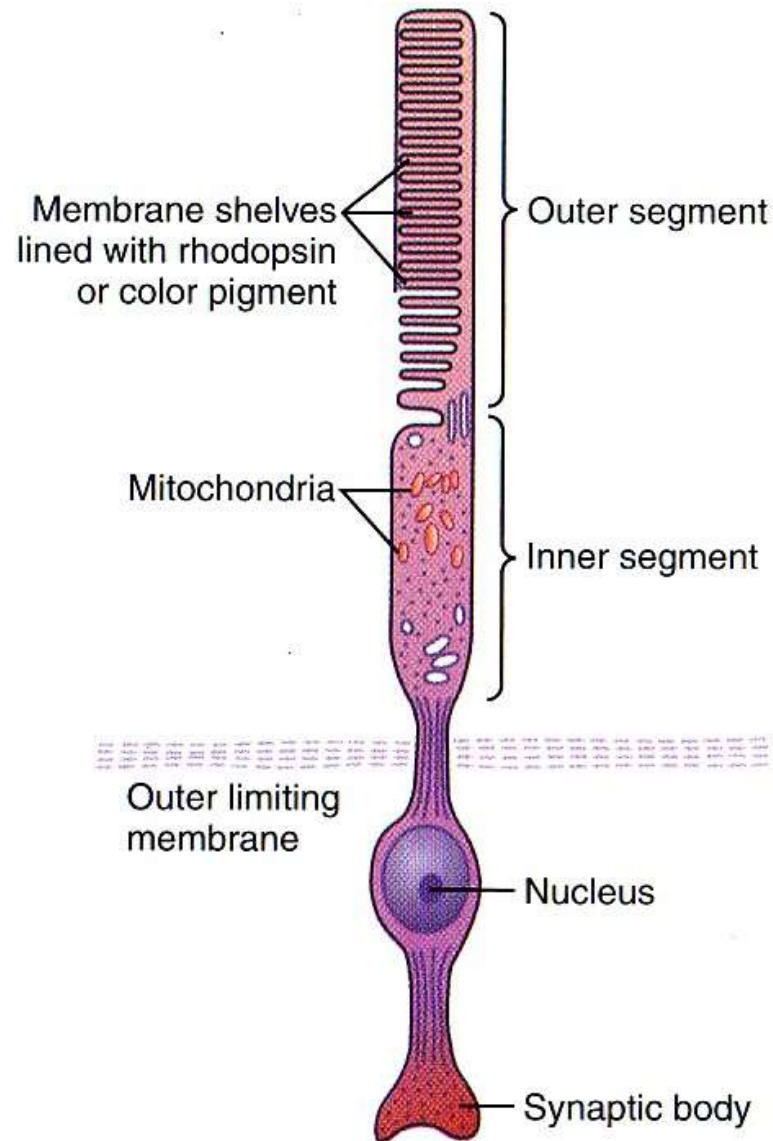


# Peripheral (L) vs. foveal (R) retina

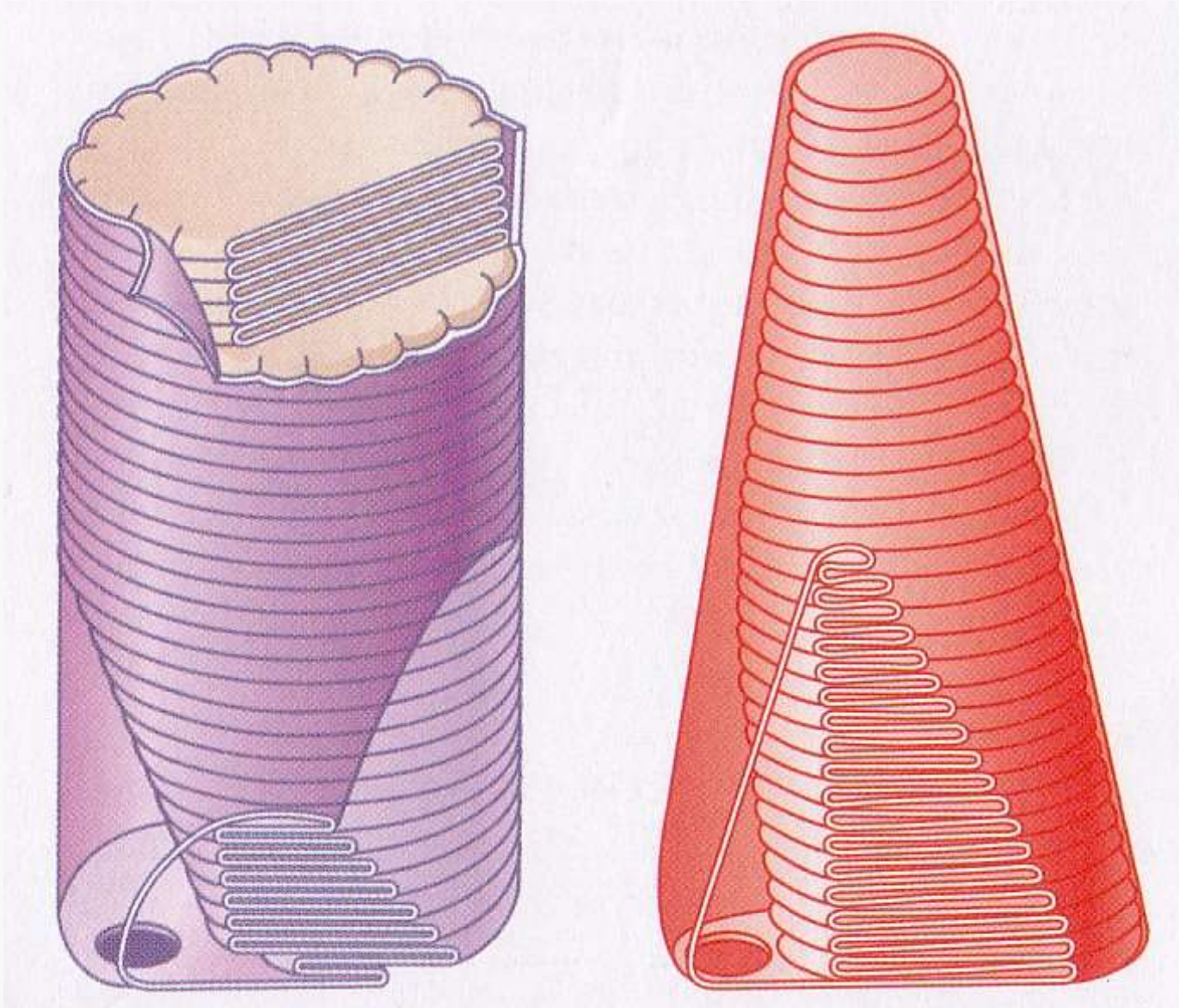




# Rod & cone functional parts

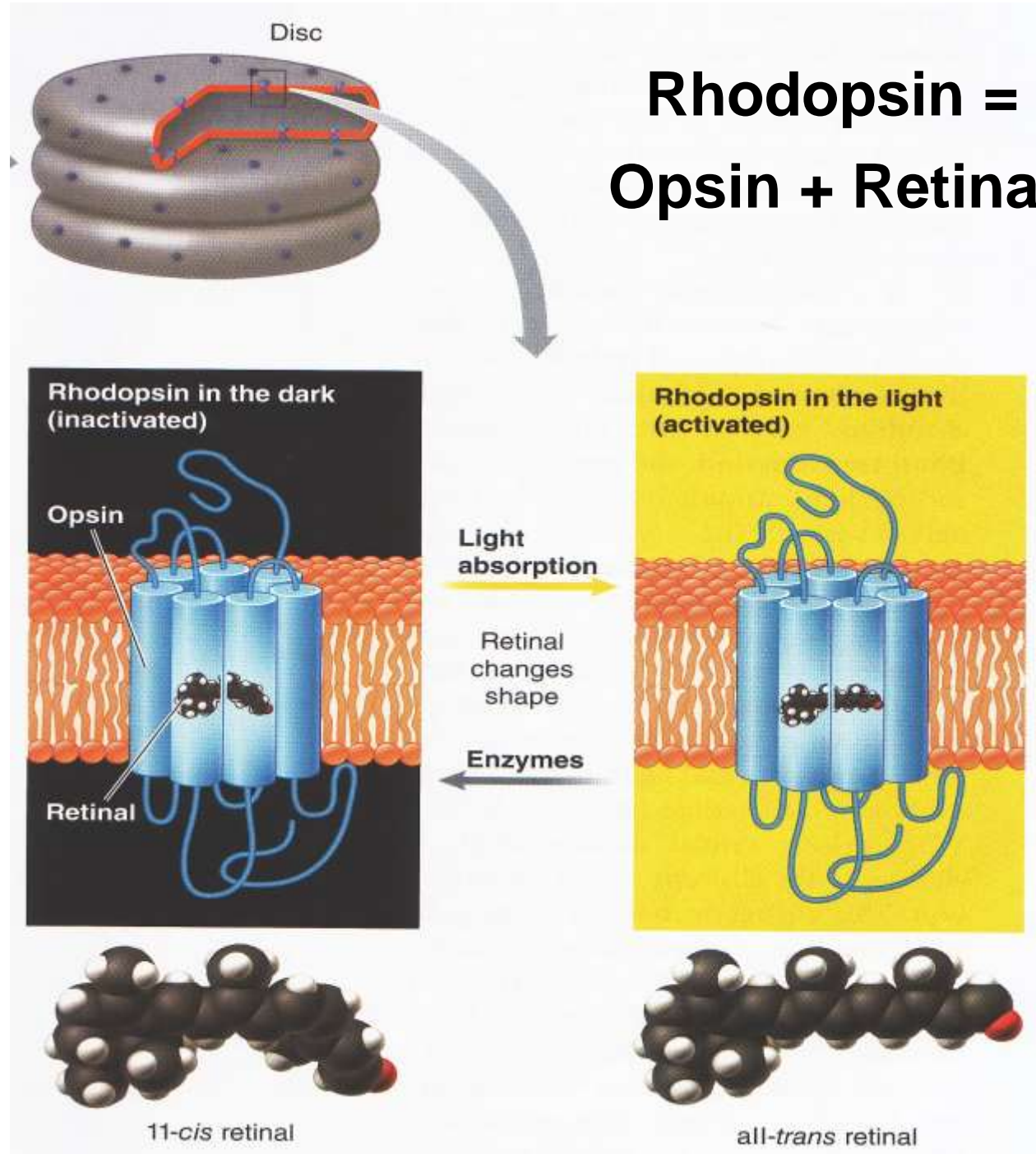


# *Rod & cone outer segments*



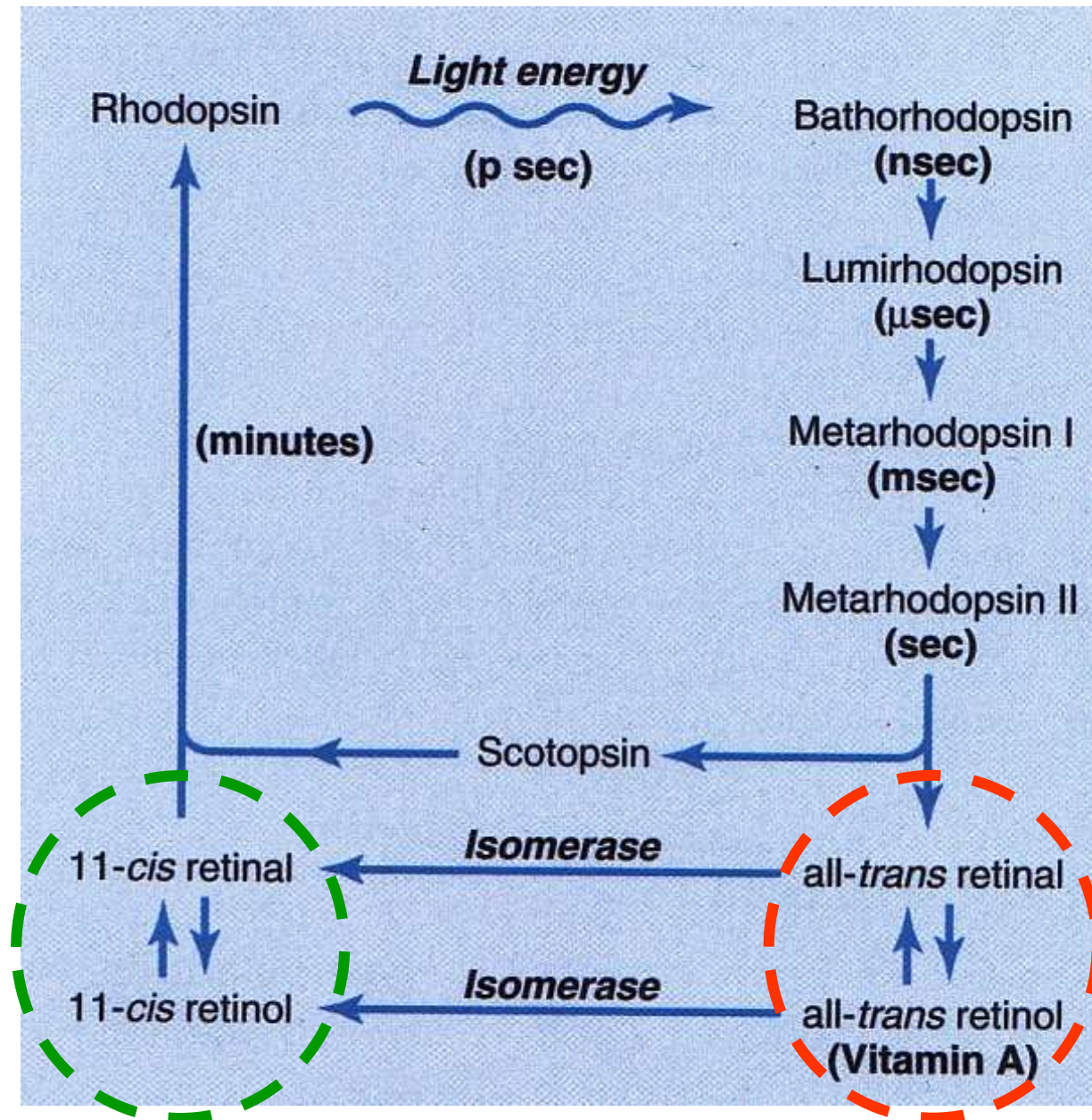
In rods,  
*light* converts  
cis to trans  
retinal

Rhodopsin =  
Opsin + Retinal





# Rhodopsin-retinal visual cycle

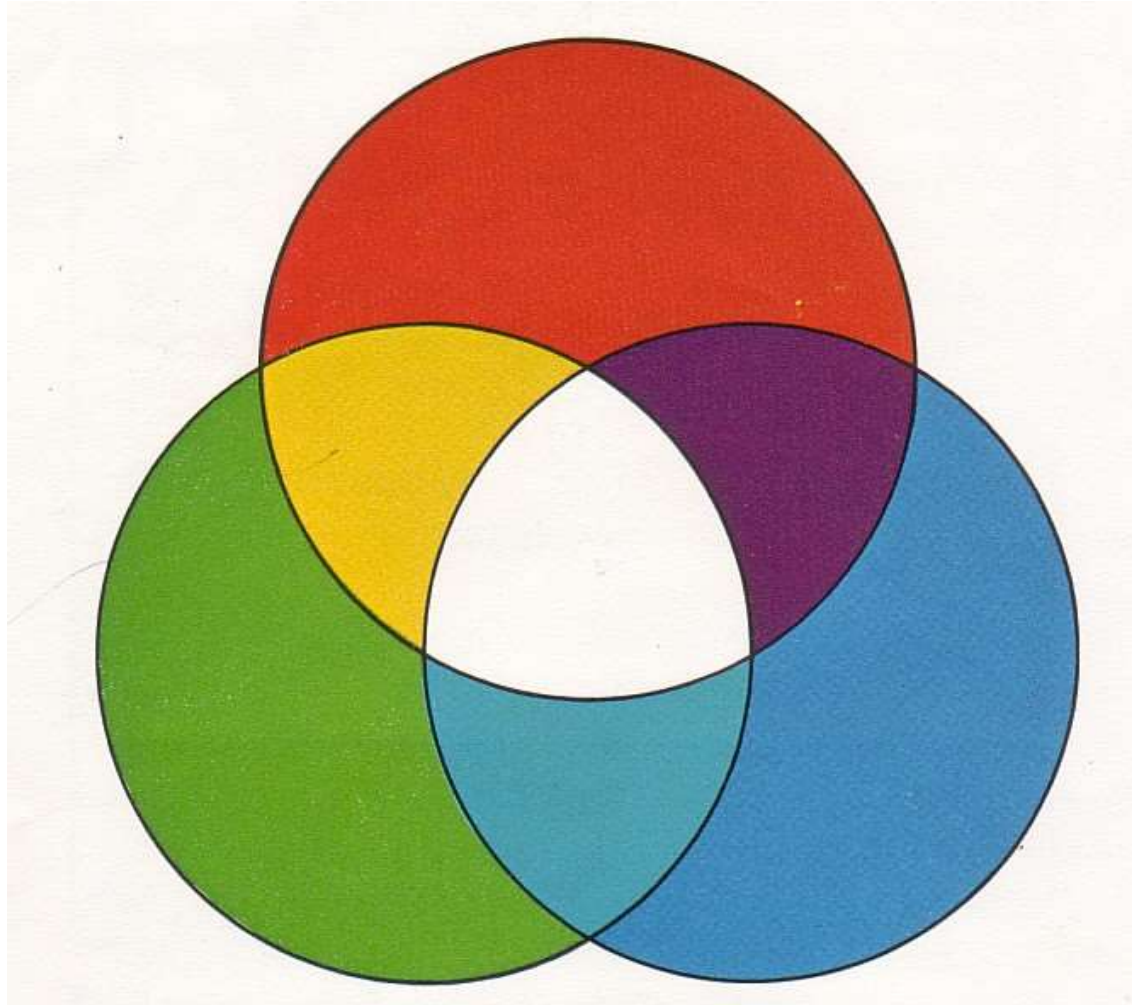


## ▲ TABLE 6-2

### Properties of Rod Vision and Cone Vision

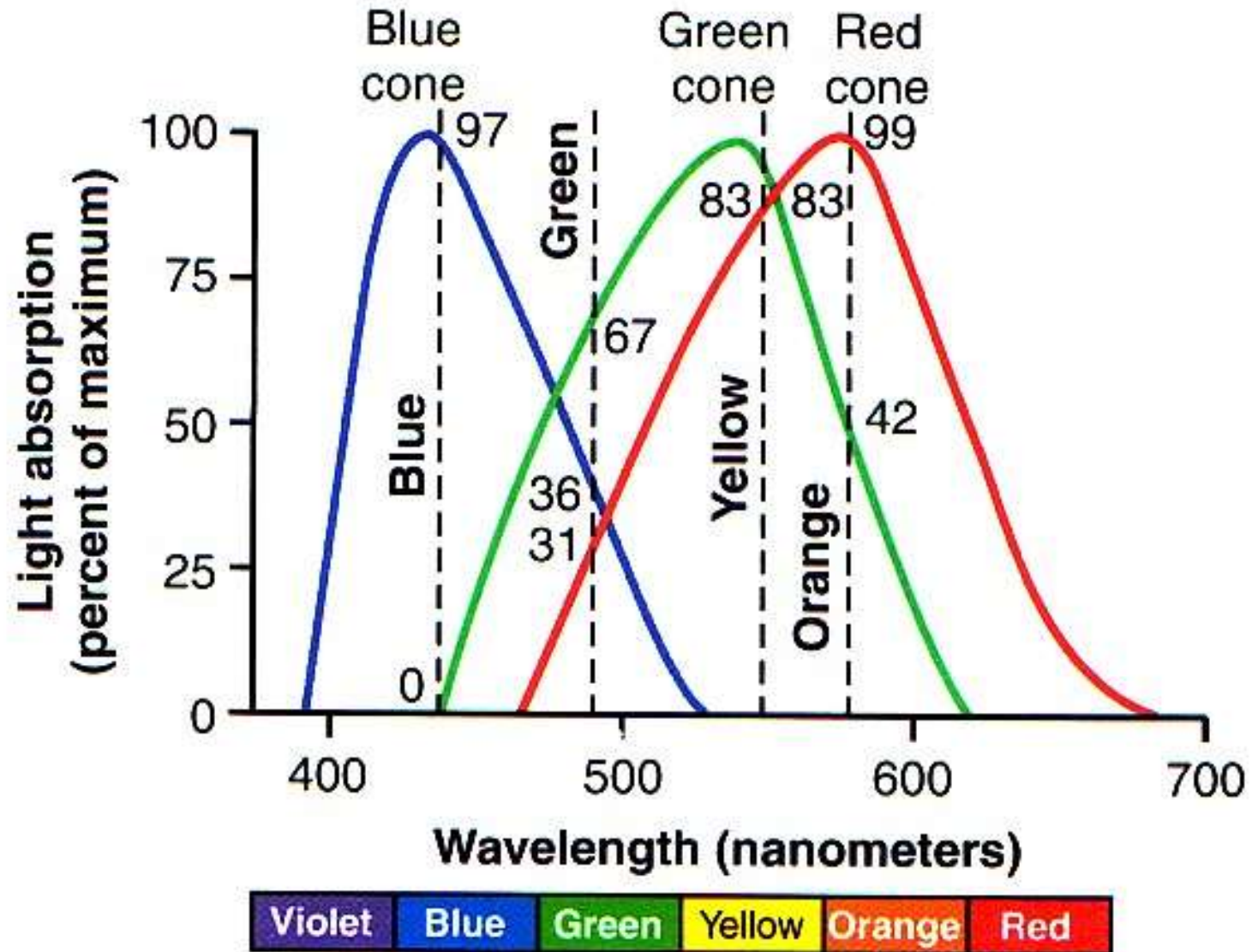
<b>RODS</b>	<b>&gt; 33 x more!</b>	<b>CONES</b>
100 million per retina	→	3 million per retina
Vision in shades of gray		Color vision
High sensitivity		Low sensitivity
Low acuity		High acuity
Night vision		Day vision
More numerous in periphery		Concentrated in fovea

***Intermediate Colors Are Produced  
When 1<sup>o</sup> Colors Are Superimposed***





# Ratios of cone stimulation determine color interpretation: orange 99:42:0

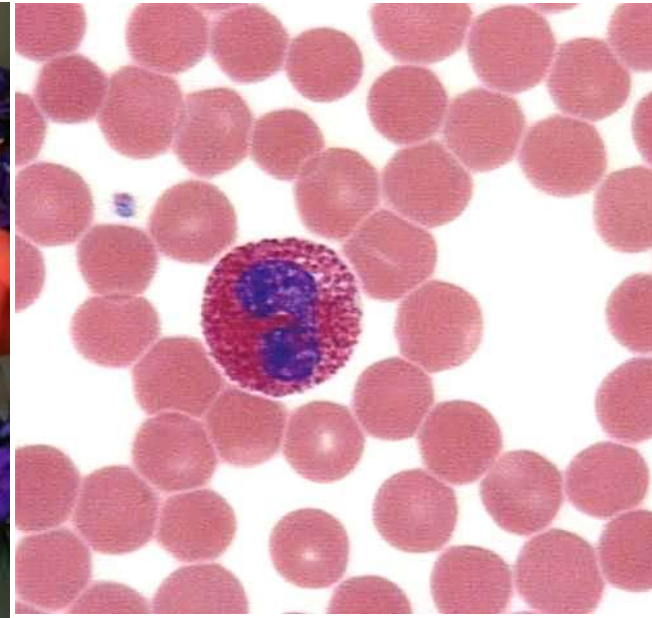


# ***Color Deficiencies Can Impact Daily Activities, Pleasure & Work!***

**Red Cone Deficiency = Protanopia**

**Green Cone Deficiency = Deuteranopia**

**Blue Cone Deficiency = Tritanopia**



<http://www.color-blindness.com/coblis-color-blindness-simulator/>

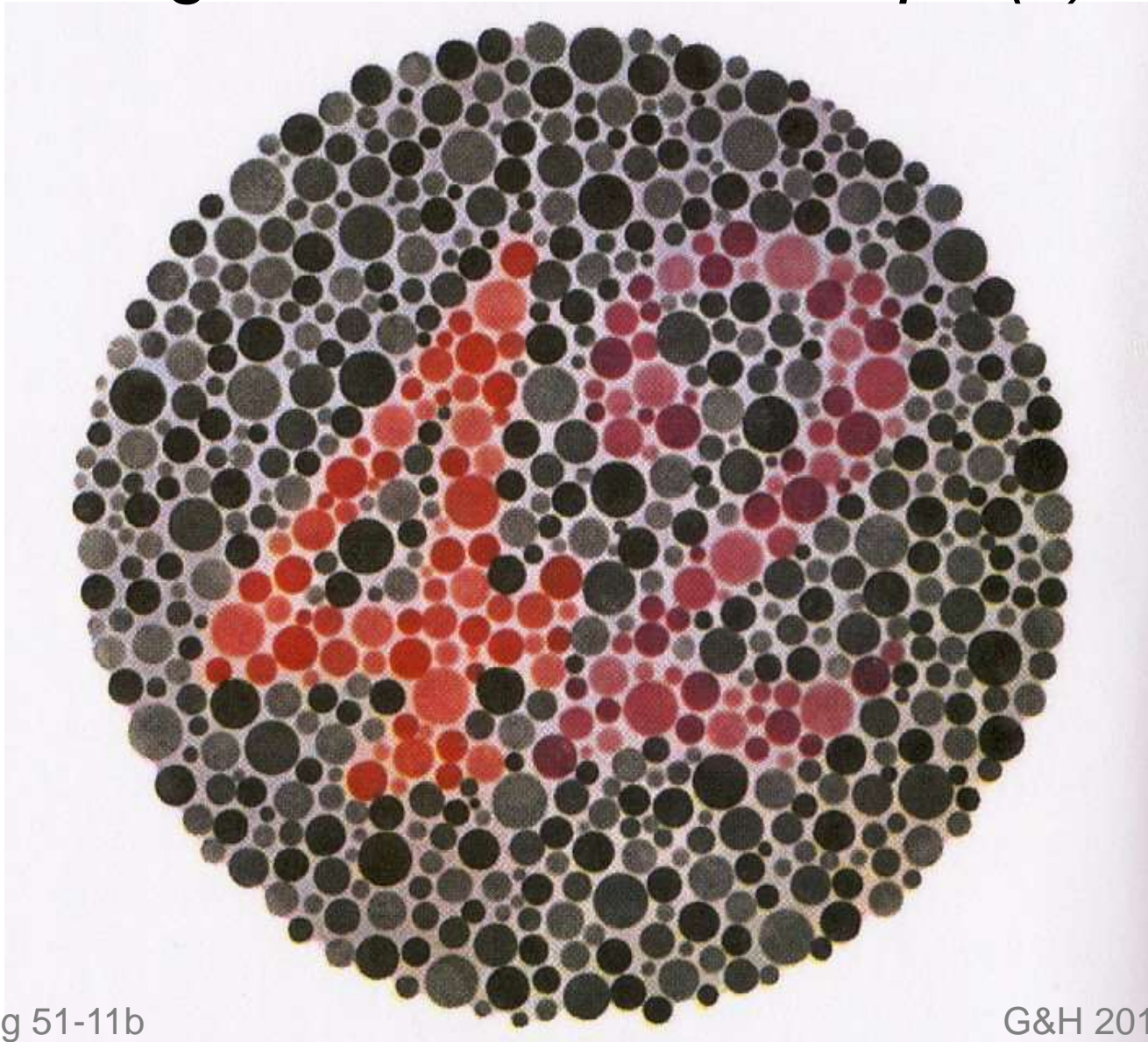


# *Ishihara Chart for Normal (74) vs. Red-Green Color Blindness (21)*





*Ishihara chart for red-blind protanope (2)  
vs. green-blind deuteranope (4)*

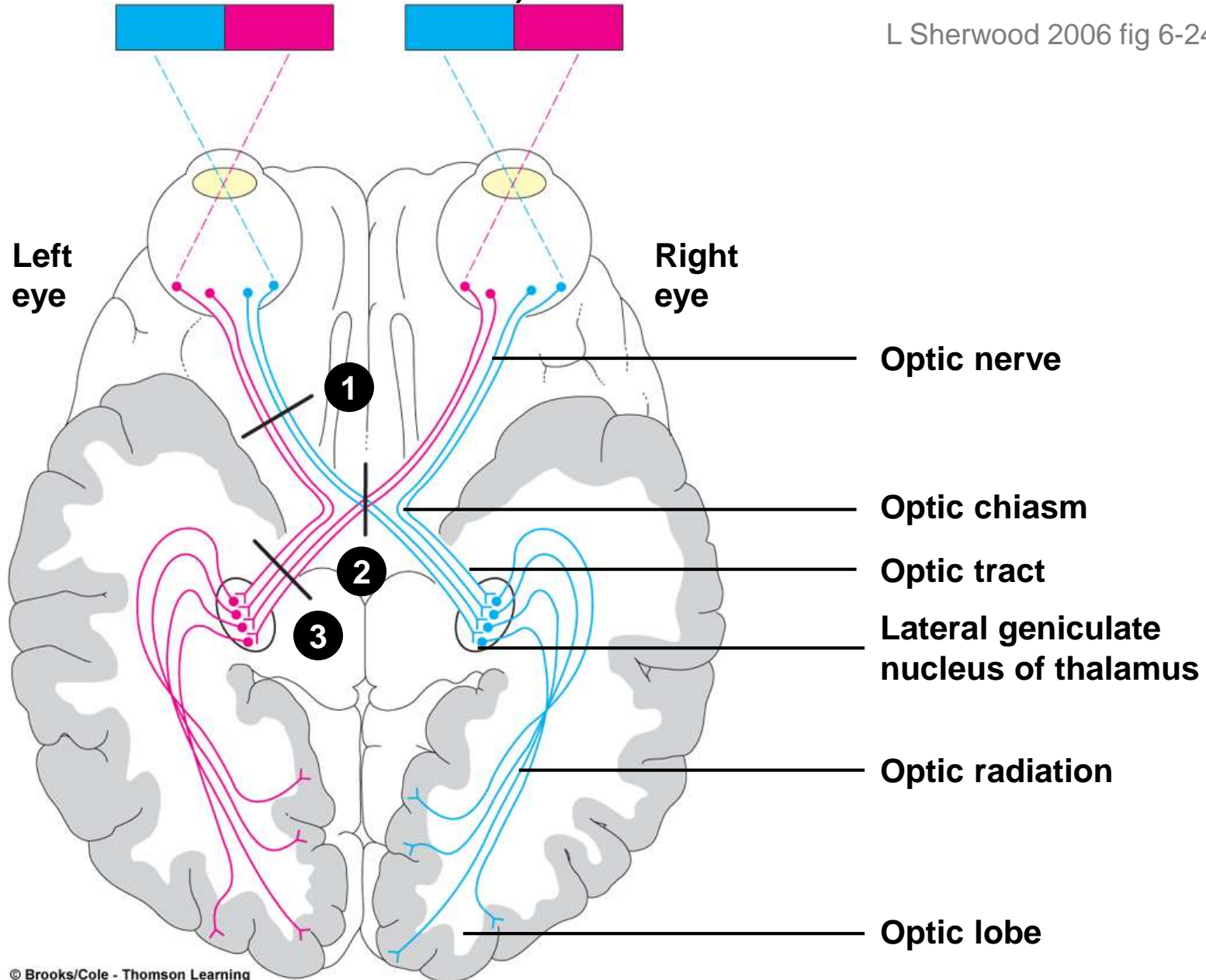


(Viewing brain from above with overlying structures removed)

Left

Right

L Sherwood 2006 fig 6-24a p 163

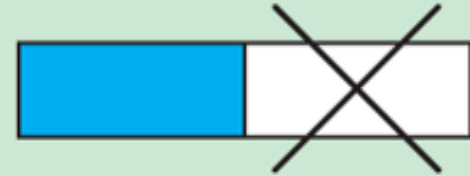
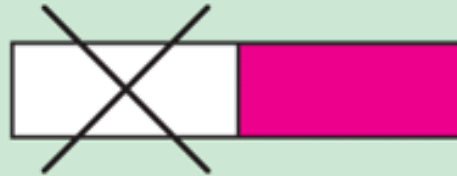


# Visual deficits with specific lesions

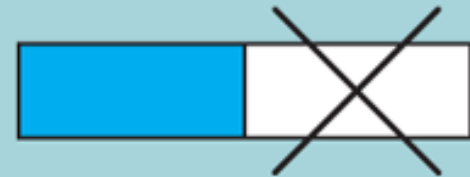
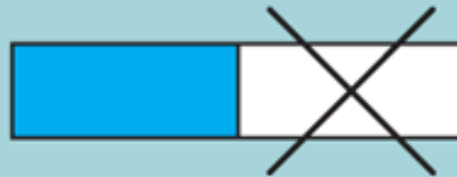
**1** Left optic nerve



**2** Optic chiasm



**3** Left optic tract (or radiation)



© Brooks/Cole - Thomson Learning

———— = Site of lesion

X = Visual deficit



# ***Rods in Darkness → Rhodopsin Not Active, cGMP High, CNG and K<sup>+</sup> Channels Open***

## ***Rods – 3 Main Cation Channels***

### **1. CNG (Cyclic Nucleotide-Gated) Channel**

Enable Na<sup>+</sup> and Ca<sup>2+</sup> entry into Rod

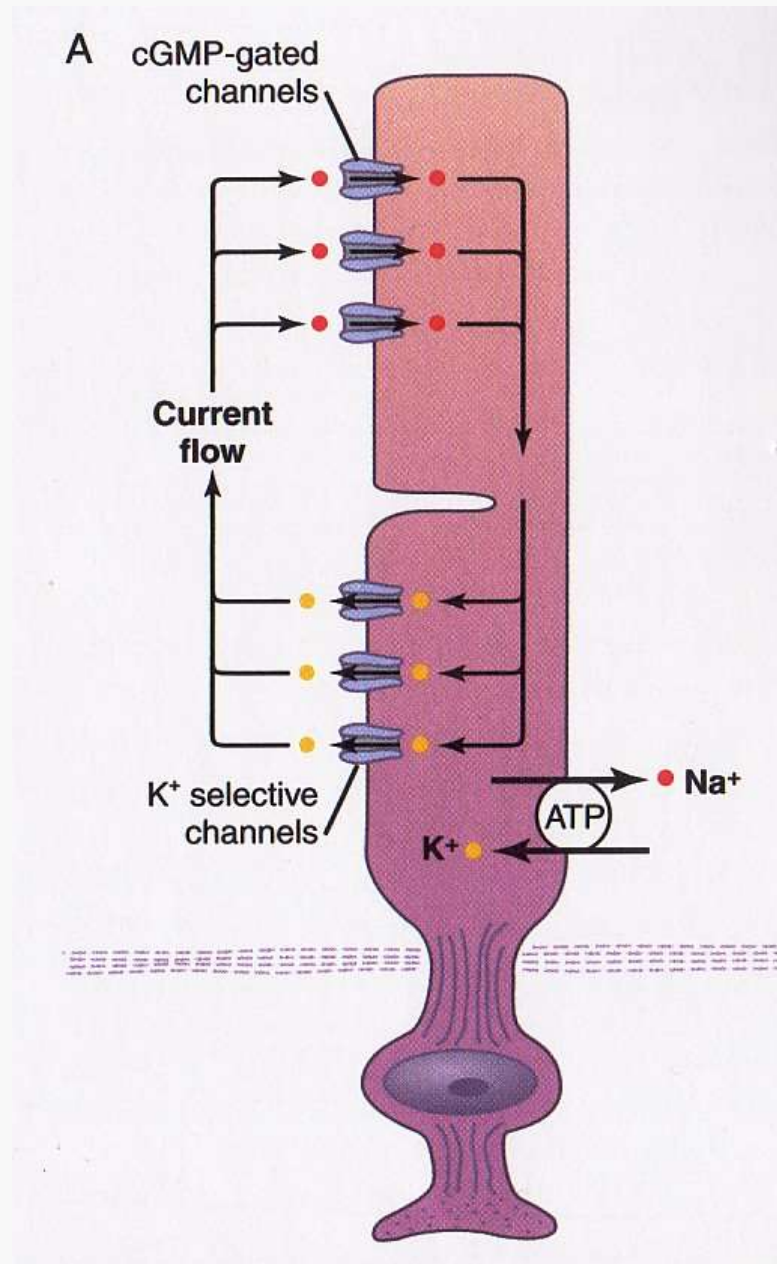
### **2. K<sup>+</sup> Channel**

Enables K<sup>+</sup> to leak out of Rod

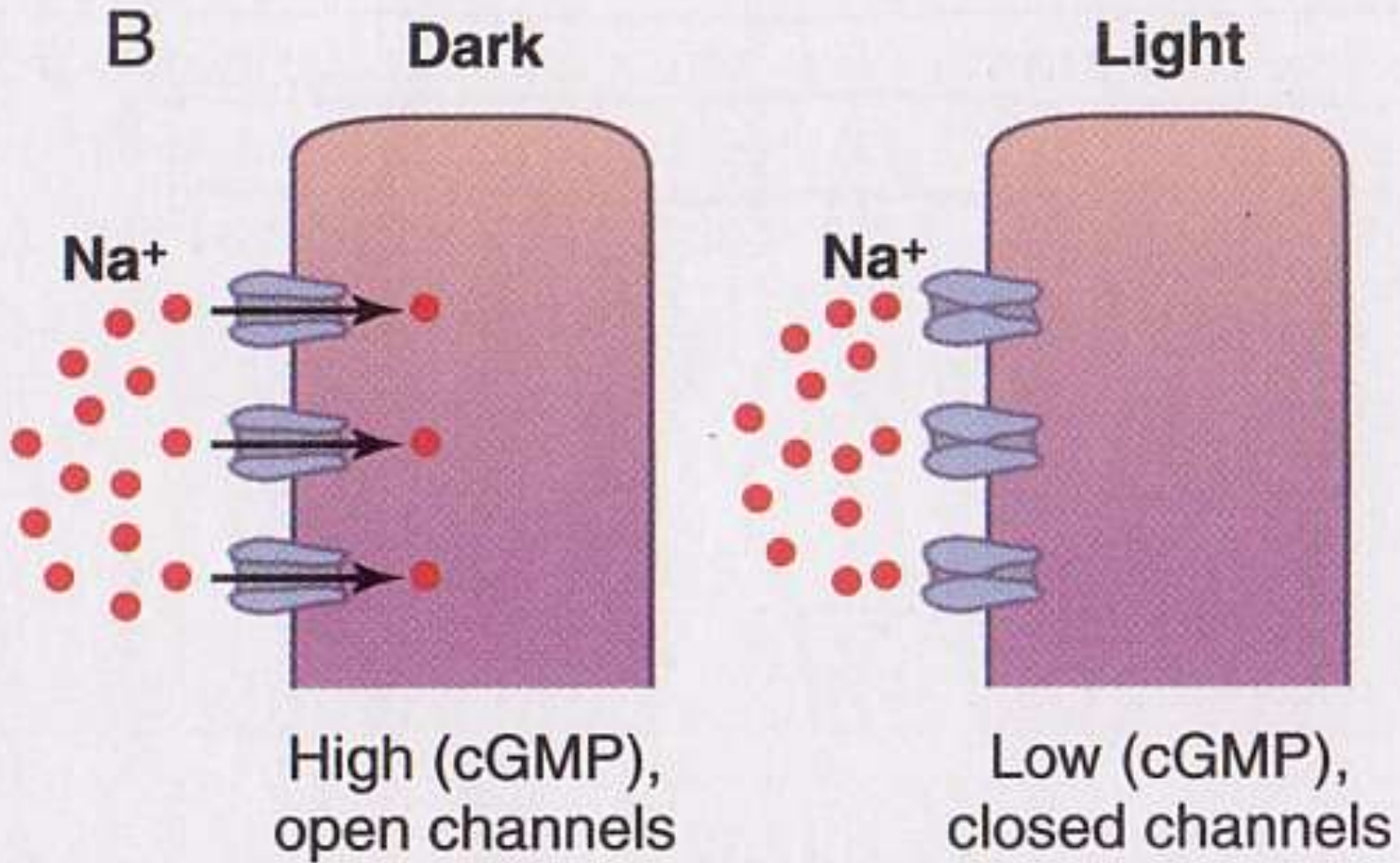
### **3. Ca<sup>2+</sup>-Voltage-Gate Channel**

Enables Ca<sup>2+</sup> Entry into Synaptic Terminal to  
Regulate Glutamate Exocytosis

# Sodium flows in photoreceptor - A

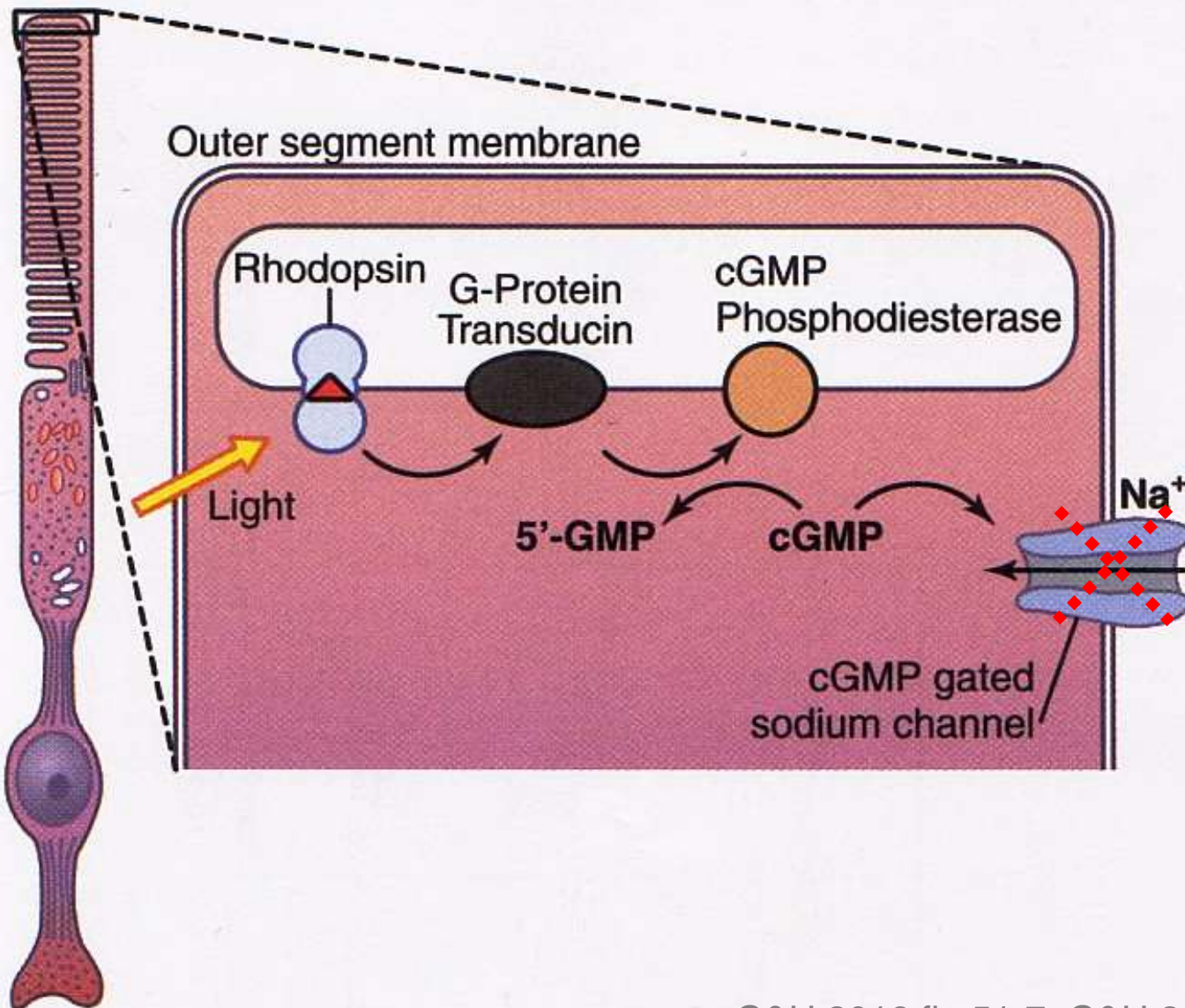


# *Sodium flows in photoreceptor - B*





# Phototransduction (outer segment)



# Summary: Let There Be Light!

