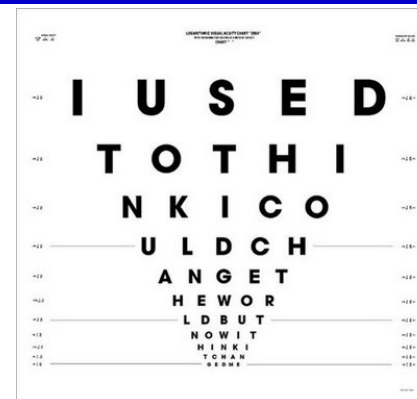


Annette Sims, MD, Ophthalmologist
next Tuesday! Hooray!!



BI 358 Lecture 18

- I. Announcements** Quiz 5 returned at end of lecture.
Eye Dissection & Vision lab next Tuesday > Lecture by Dr. Sims! Final Quiz (6) next Thursday, then thoughts on grad schools in medicine & allied health.
- II. Physiology in the News** The sight-saving diet?
UC Berkeley WellnessLetter, November 2011.
- III. Eye I: Anatomy & Optics of Vision** G&H ch 49 + LS +...
- IV. Eye II: Retinal Receptor & Neural Function** G&H ch 50
- V. Eye III: Overview of Visual Pathways & Pathologies**
G&H ch 51 + LS1 + Silverthorn +...



Microwaving,
facts and actions, p.4



WellnessLetter.com

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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

No 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.

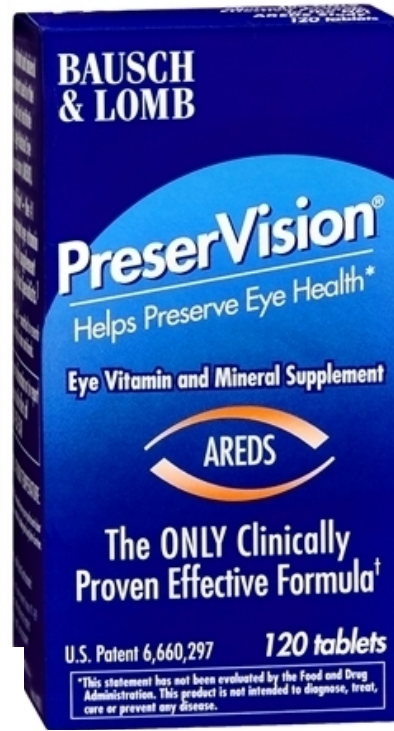
■ **Vitamin C and E, selenium, beta carotene and other antioxidants.** Again,



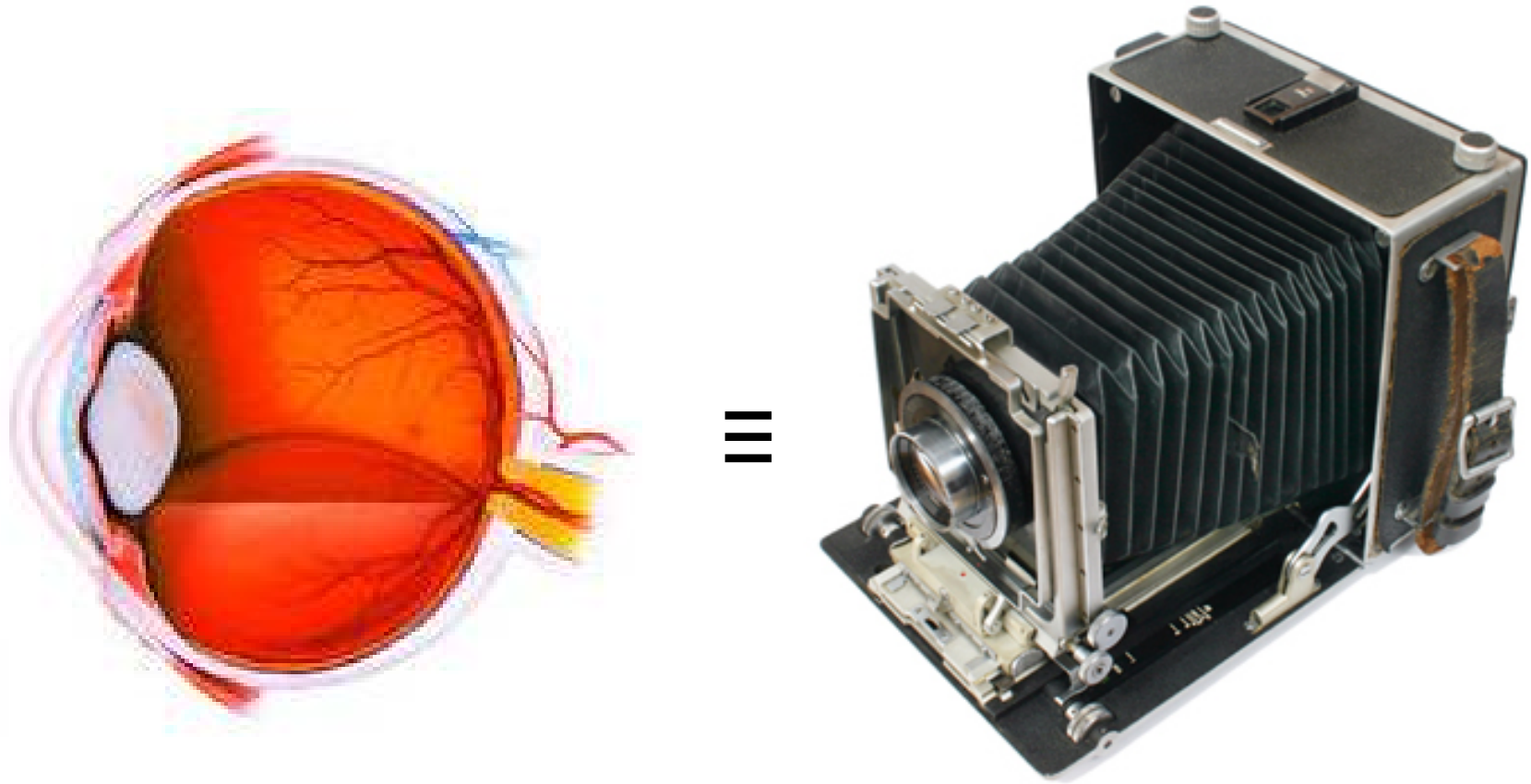
Sight-saving Diet?

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 & β -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 Ω -3 fats also reduce AMD.



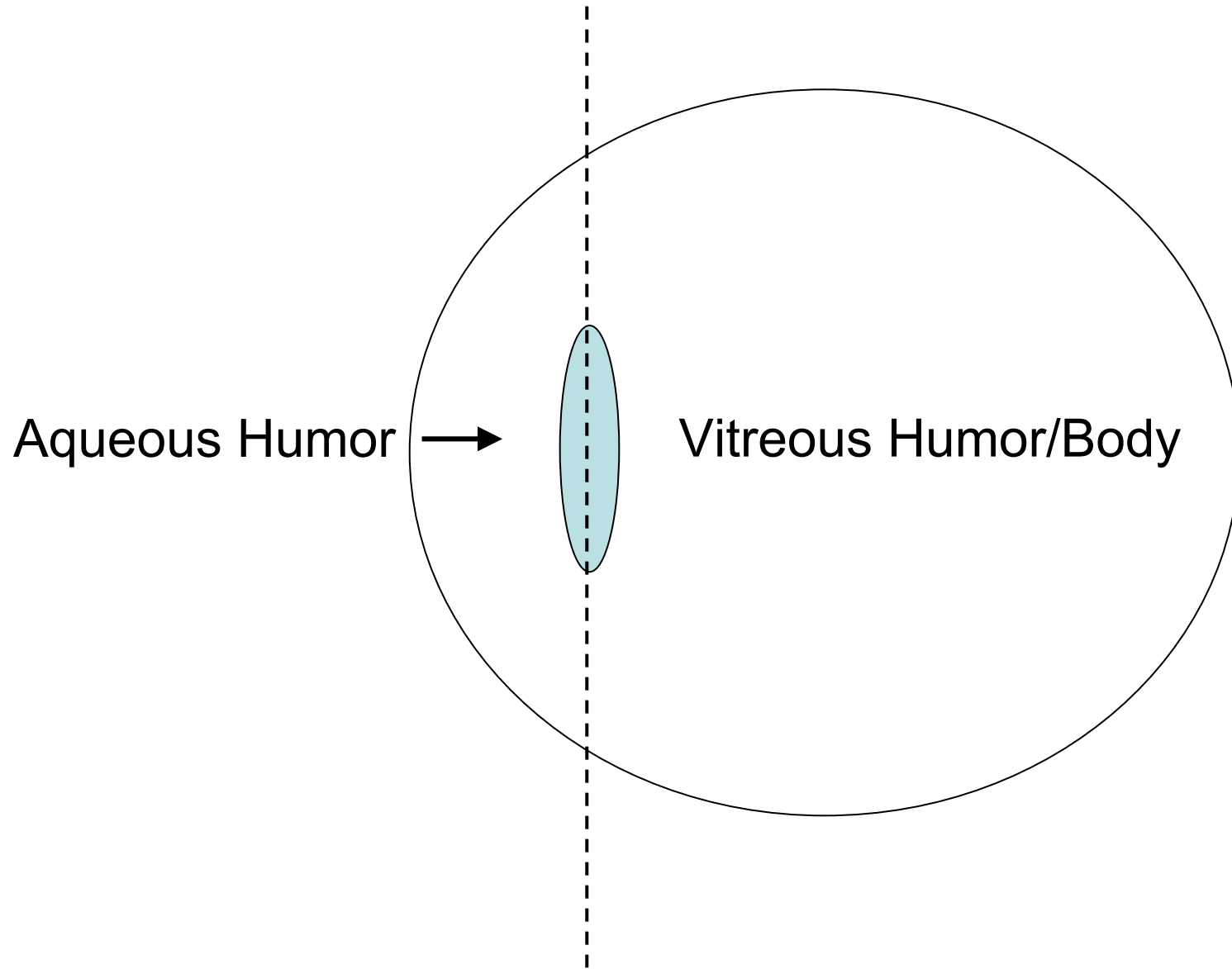


Eye: Elaborate sensory receptor ≡ **Camera**

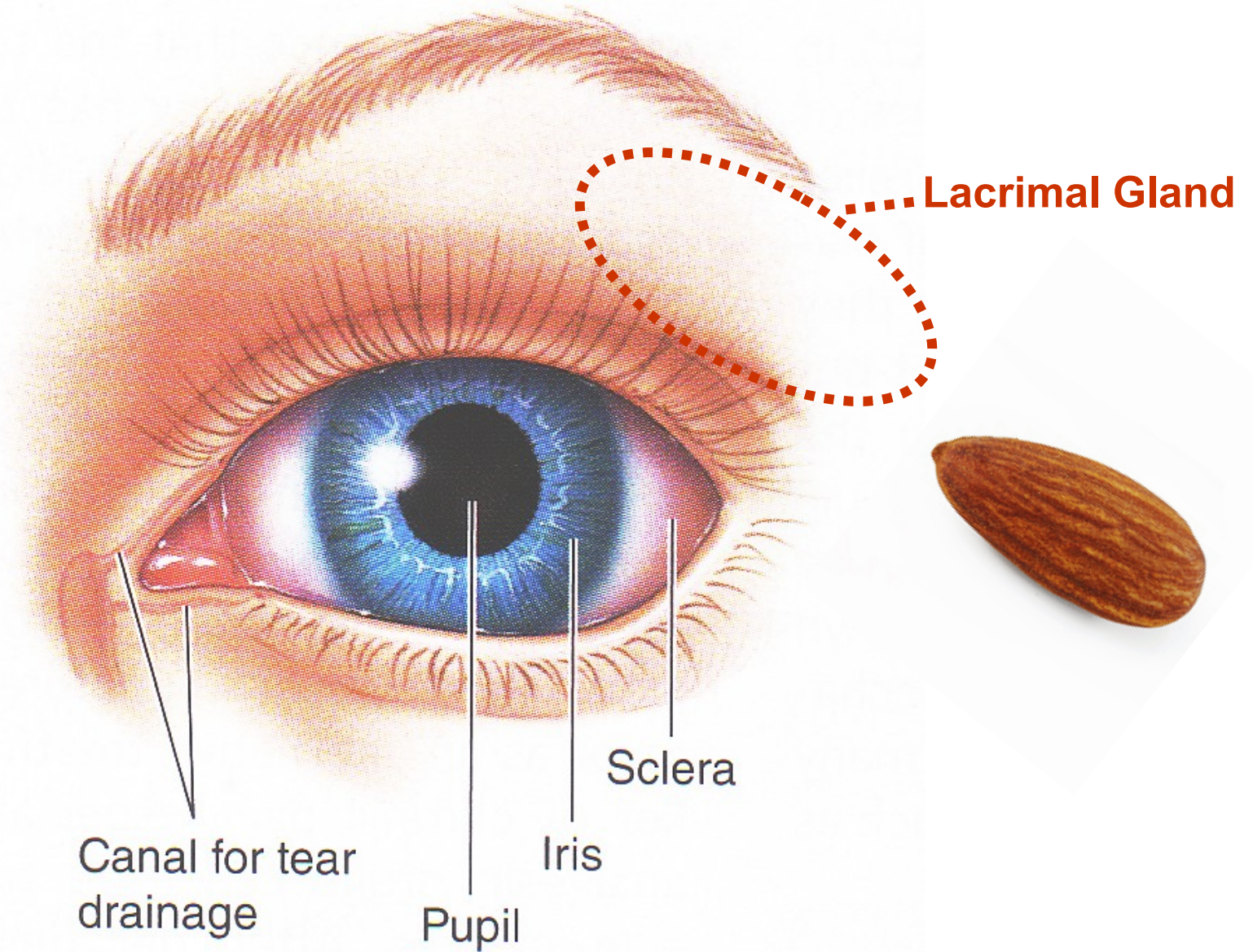


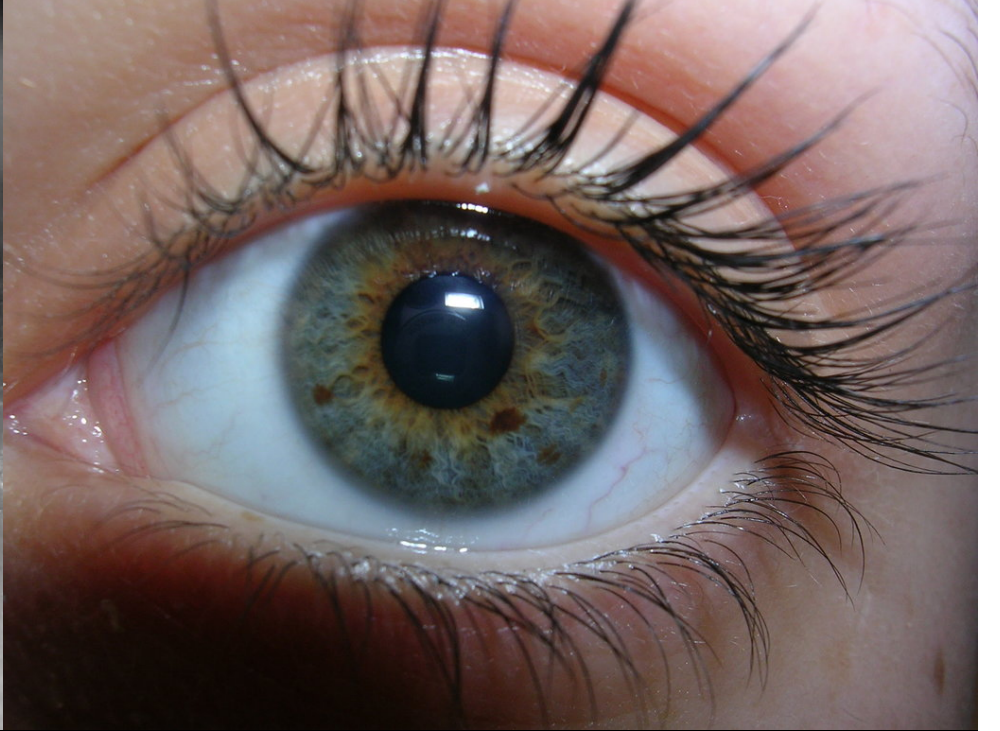
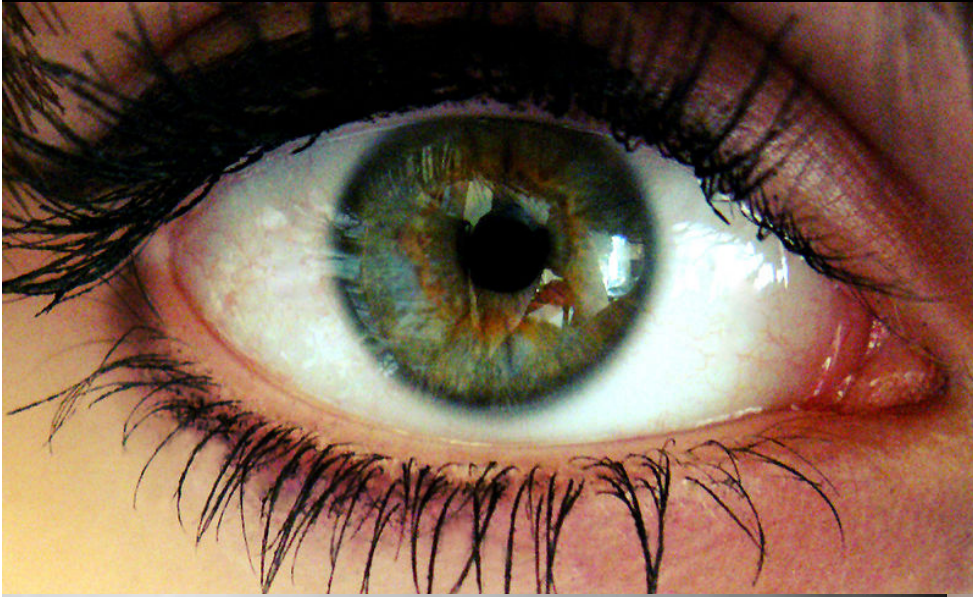
Aperture + Lens + Film!

Lens Separates Major Compartments

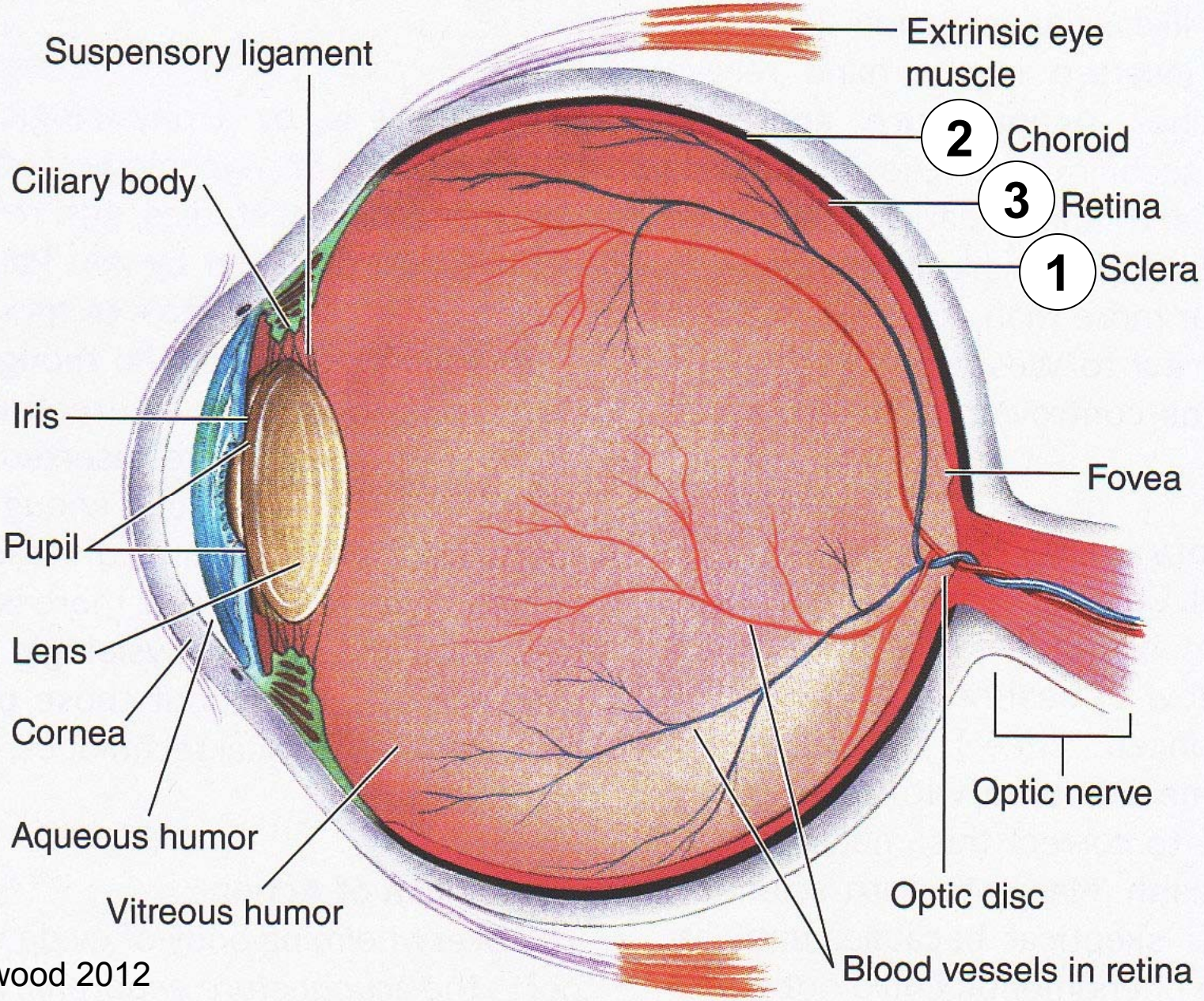


Eye: Anterior View





Eye: Saggital View



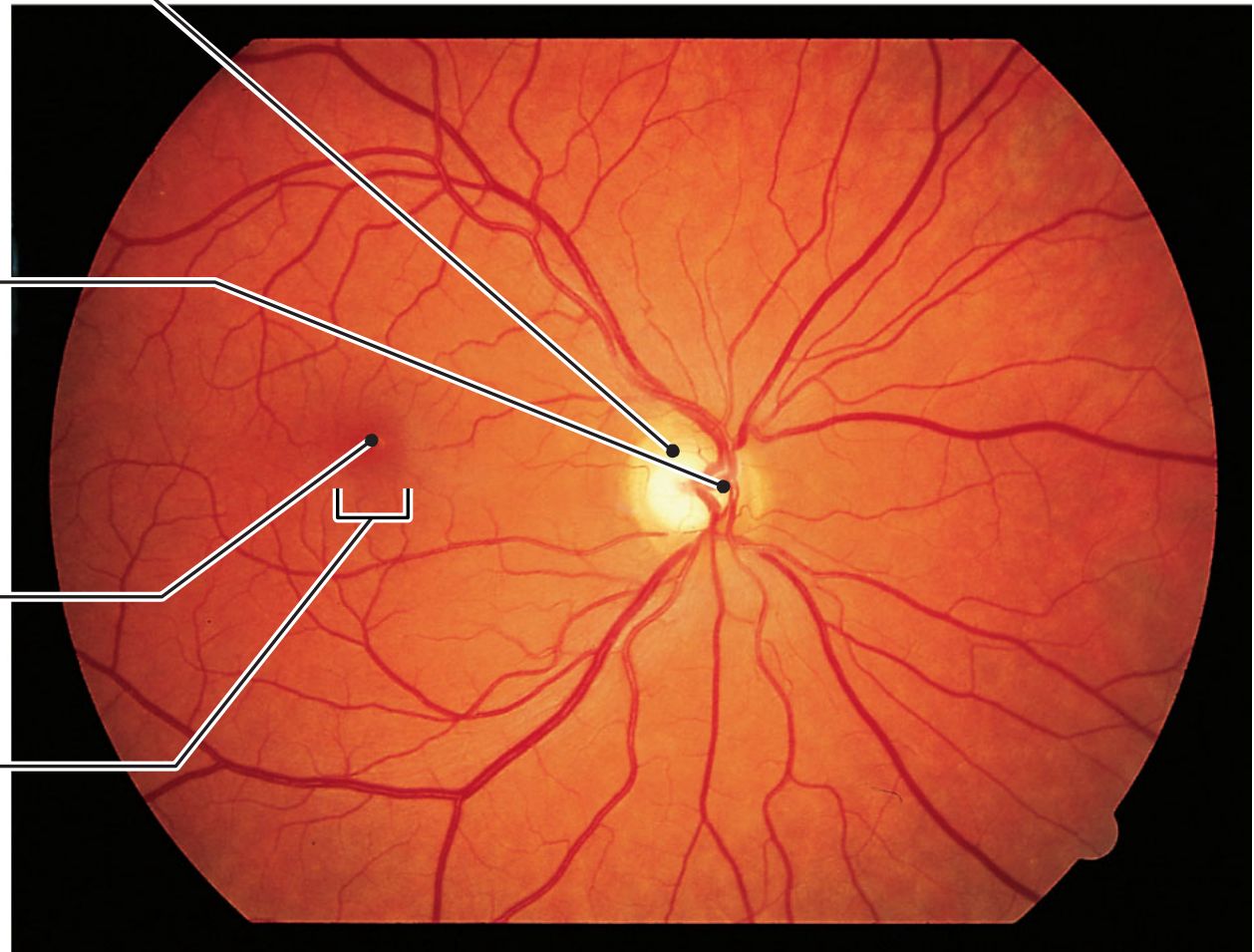
The Blind Spot?

Optic disk
(blind spot)

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

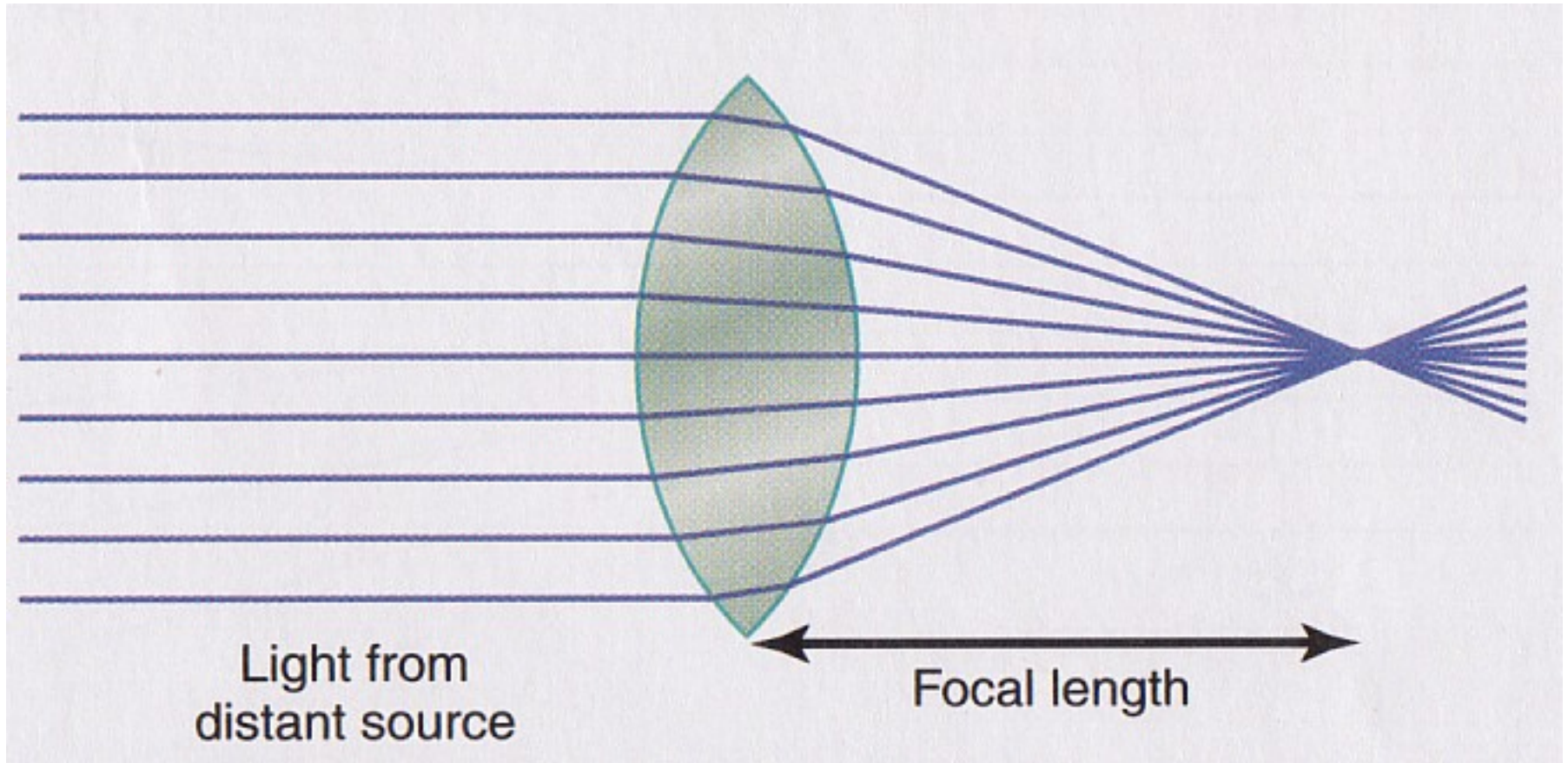
Fovea

Macula



(b)

Convex lens convergence + focal length



Concave lens divergence

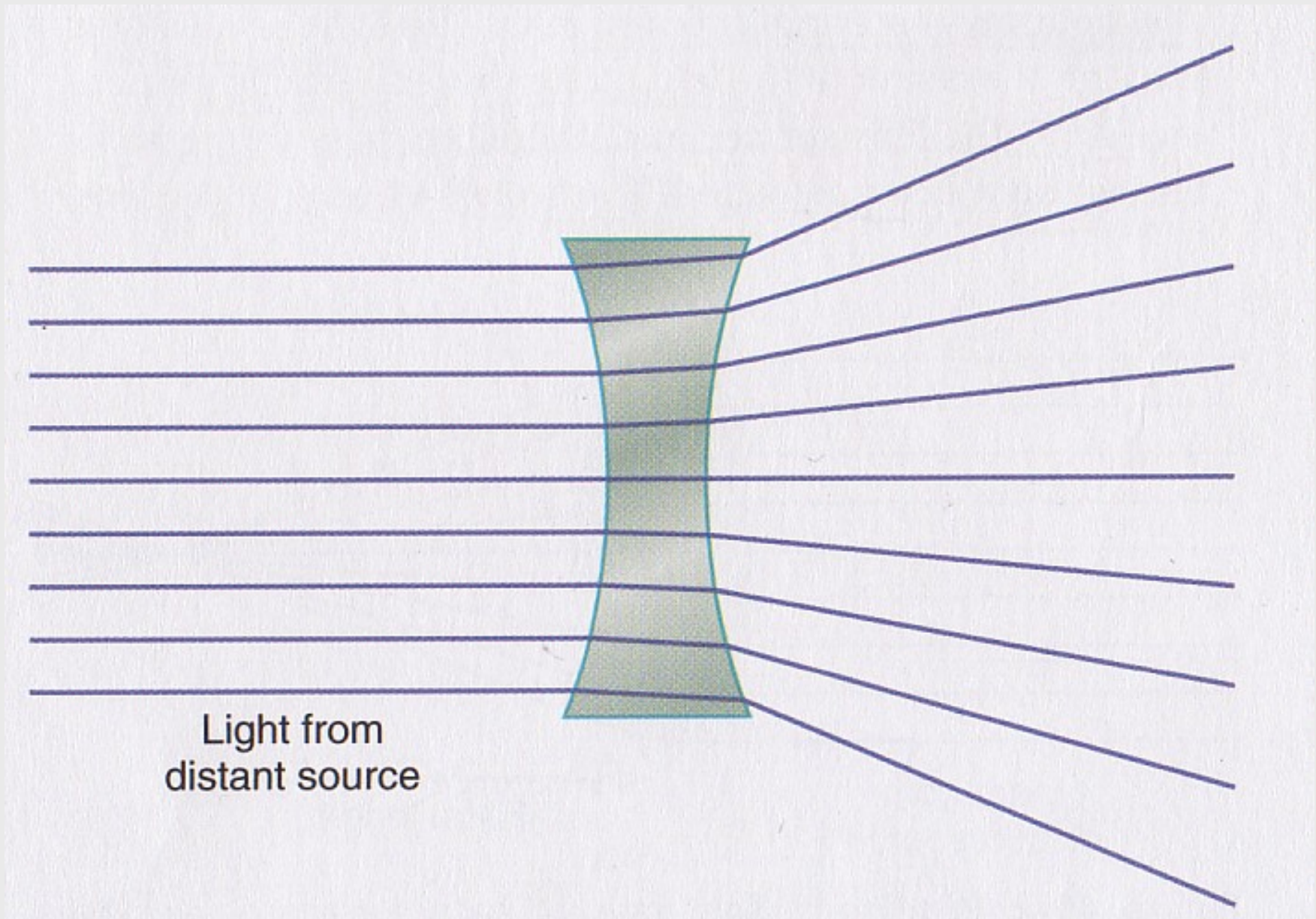
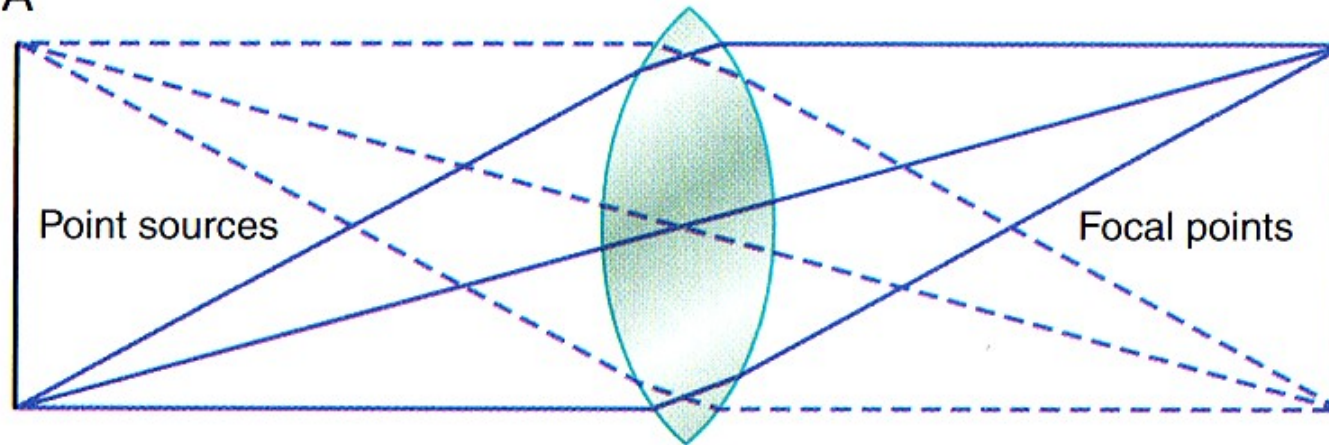
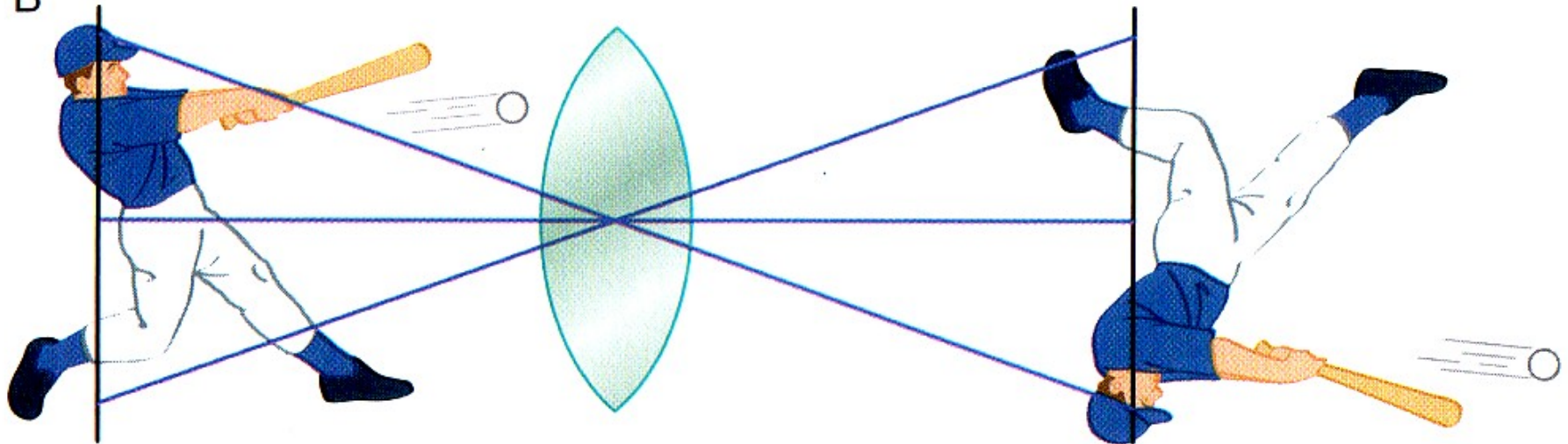


Image formation by convex lens

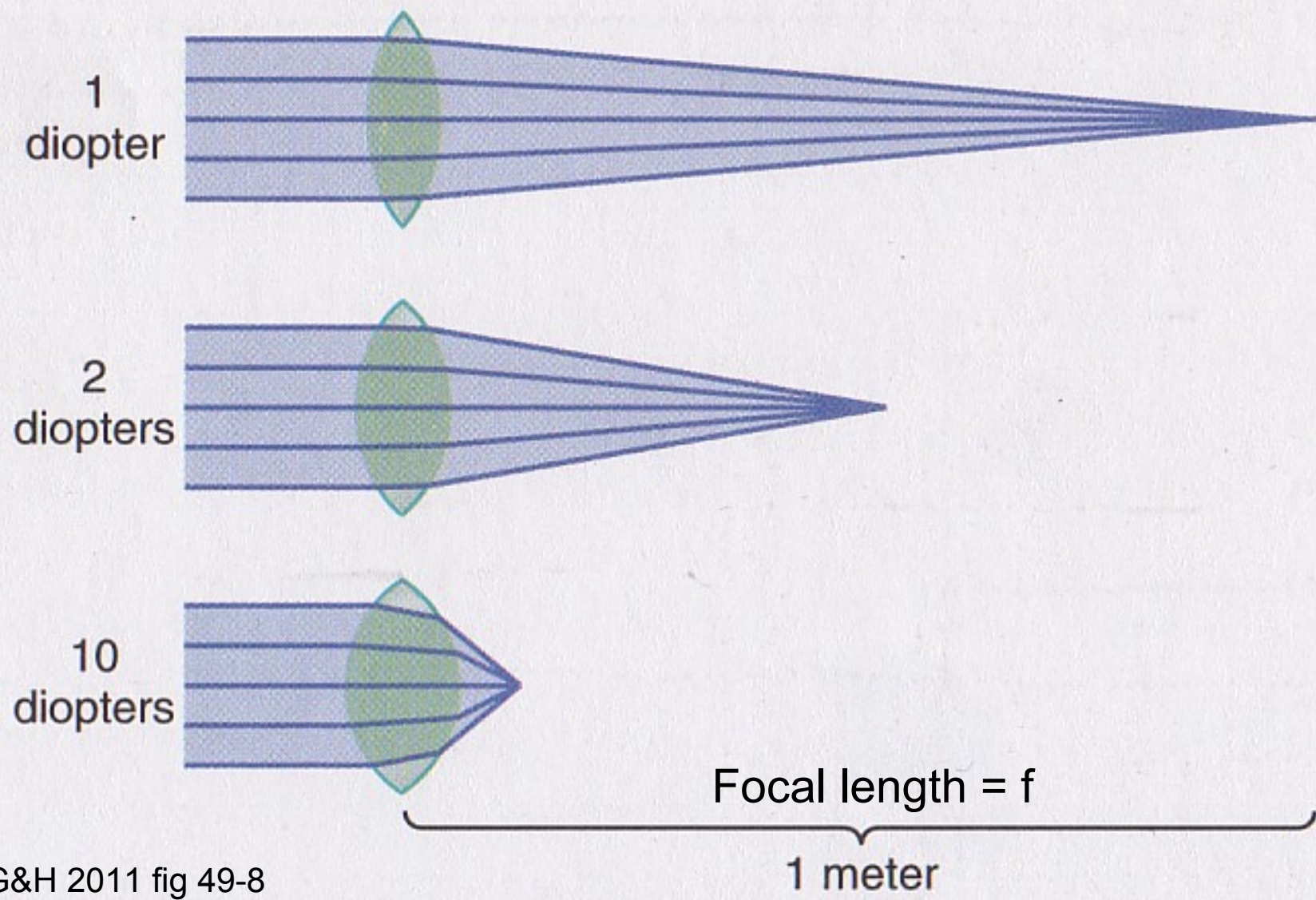
A



B

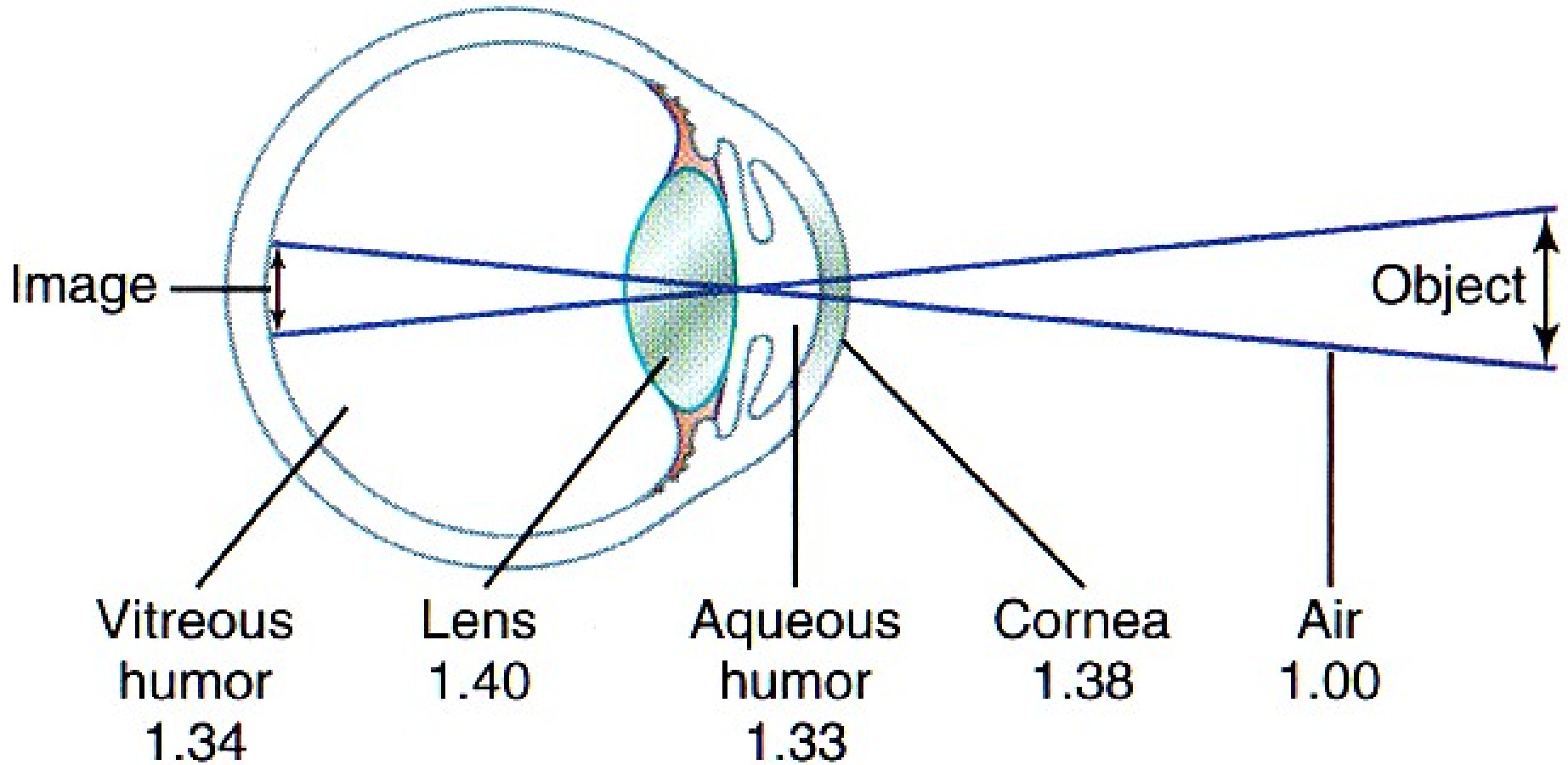


What's a diopter? Refractive power measurement = f^{-1} or 1m divide by f

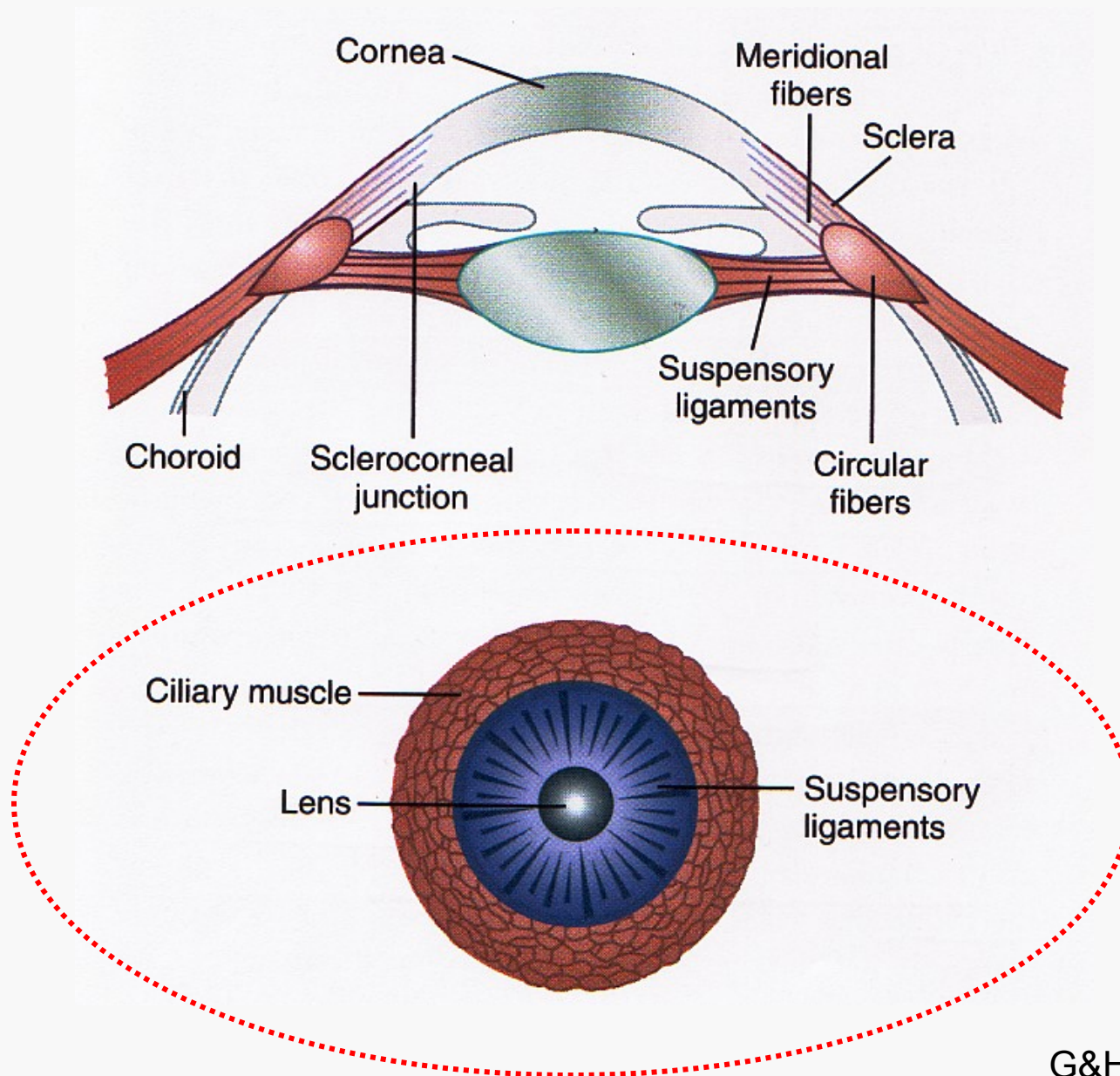


Refractive index?

Total refractive power = 59 diopters

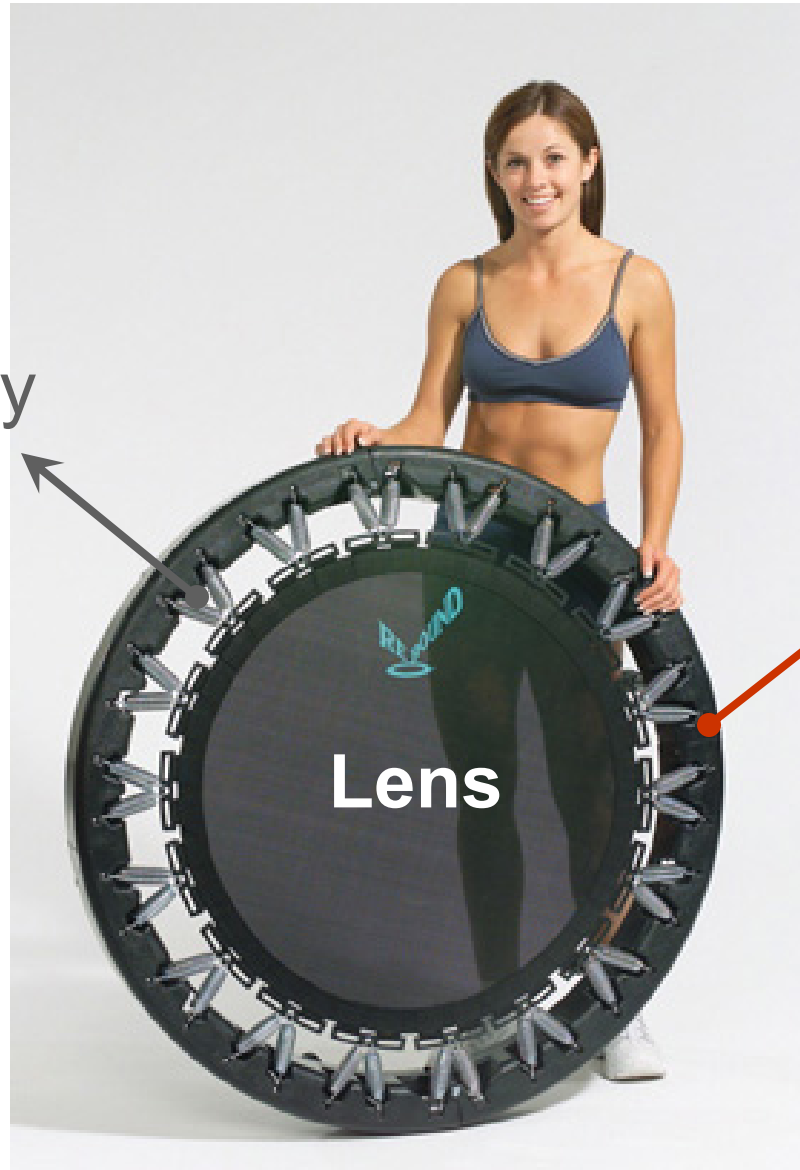


Mechanism of accommodation



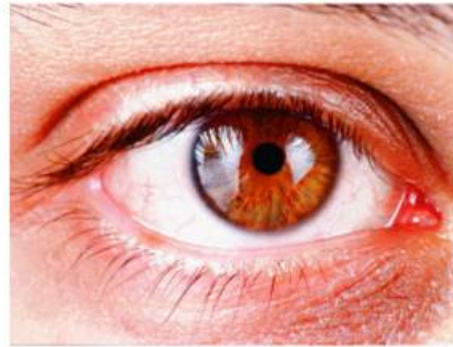
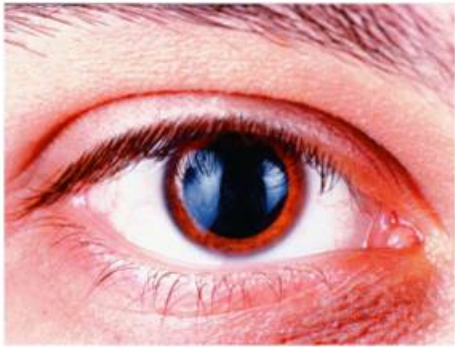
Mini-tramp analogy

Suspensory
ligaments

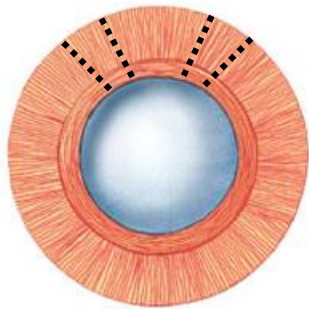


Ciliary
muscle

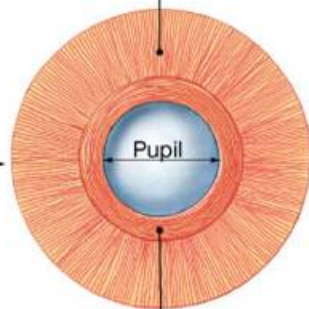
Accommodation \equiv Lens Thickens \rightarrow + Pupils Constrict + Eyes Adduct!



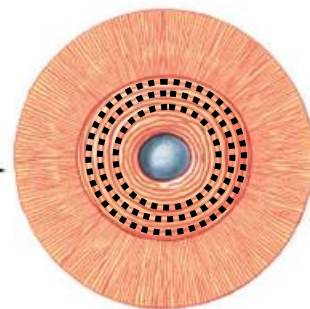
Radial/Dilator
Muscles



Radial Muscles
Contract



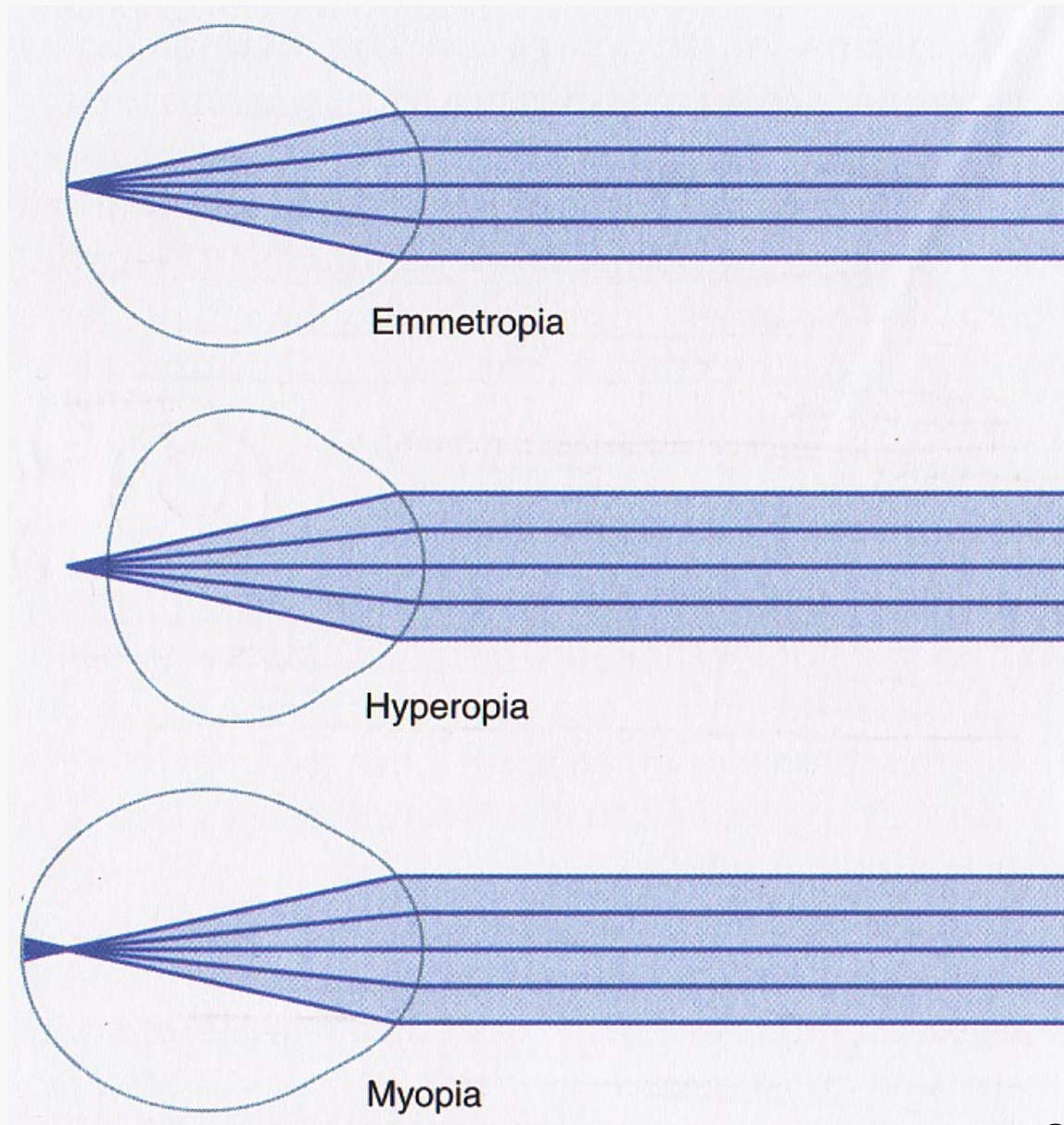
Circular/Constrictor
Muscles



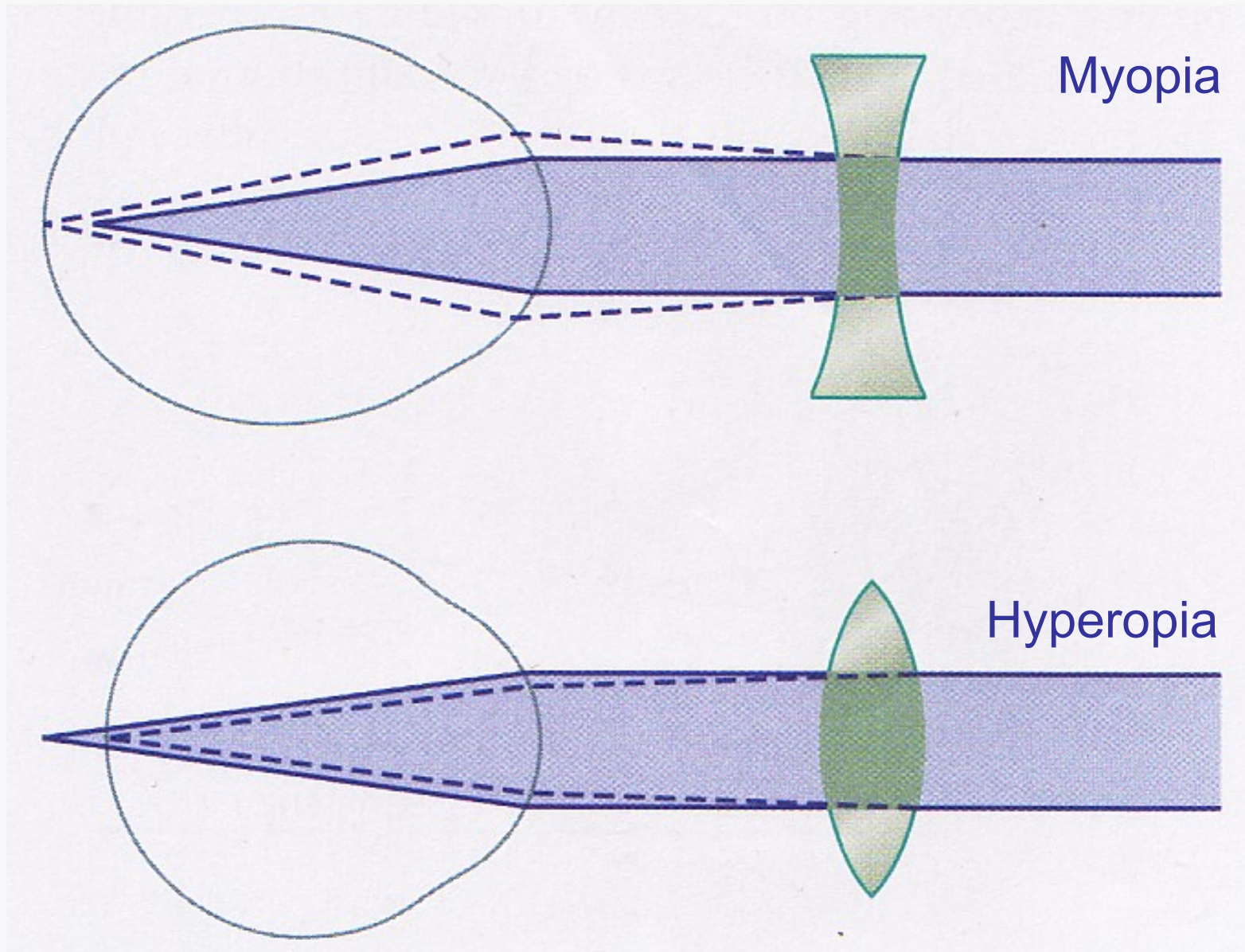
Circular Muscles
Contract



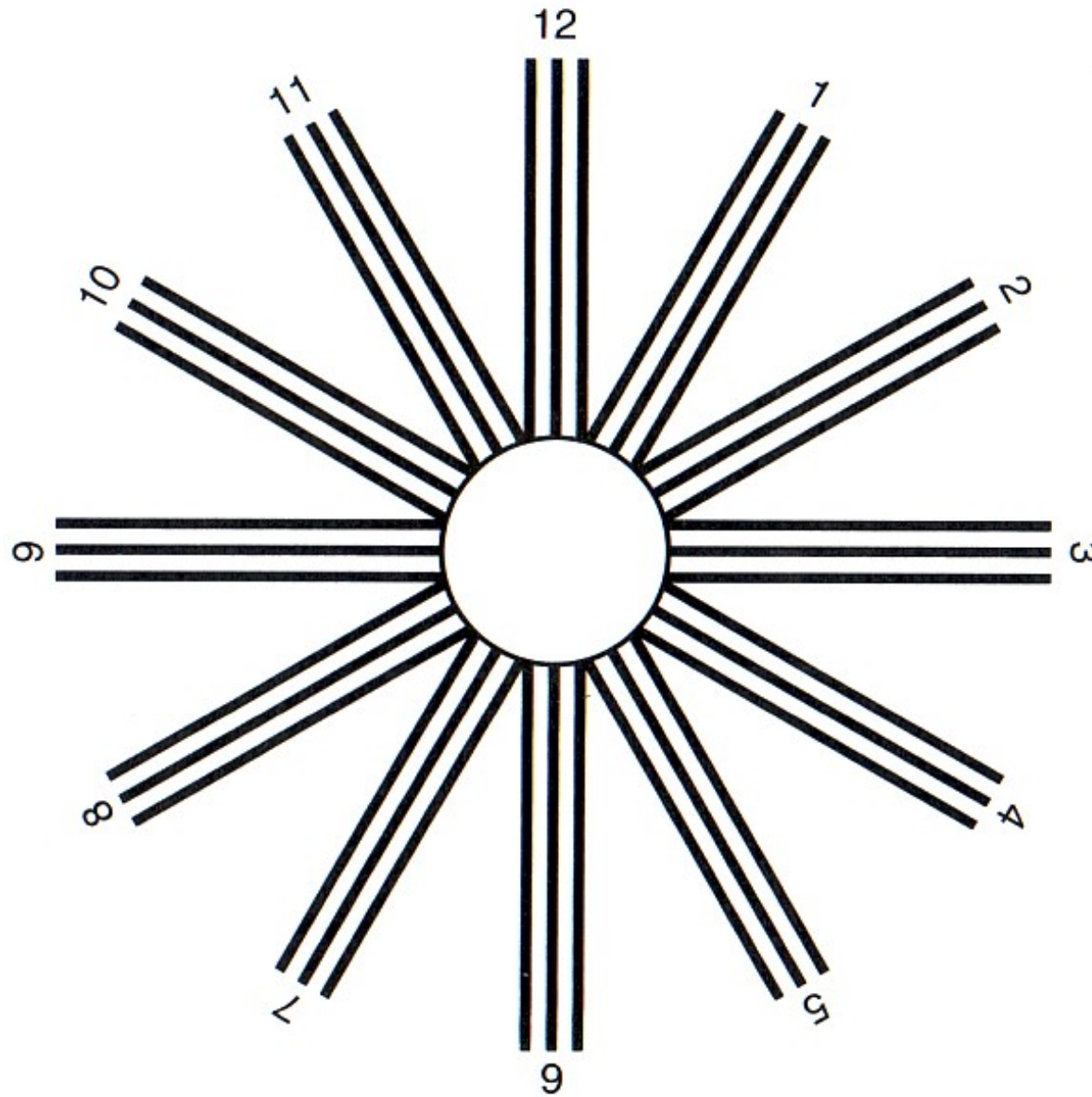
Normal, far- & near-sighted vision



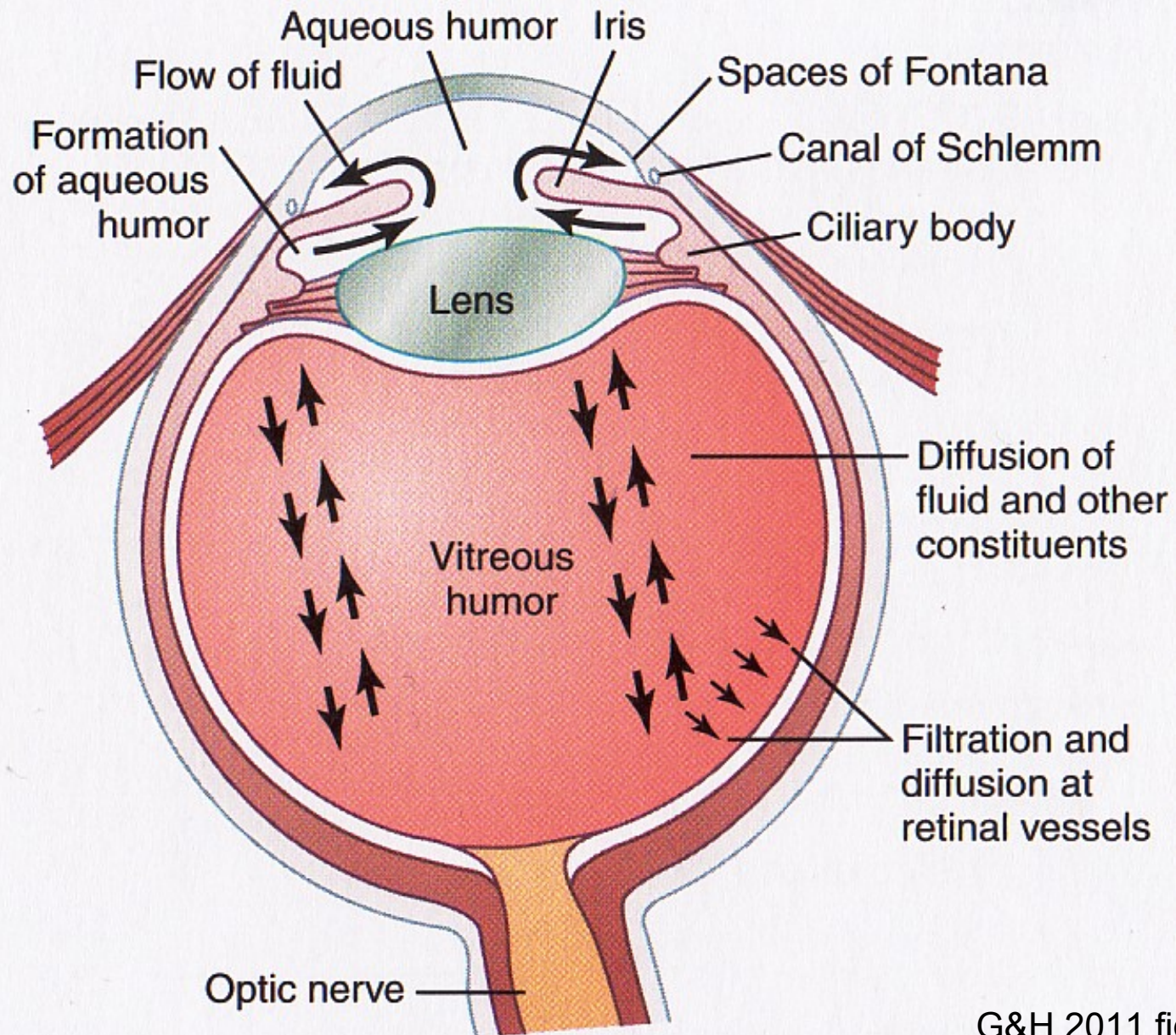
Correcting near- & far-sightedness



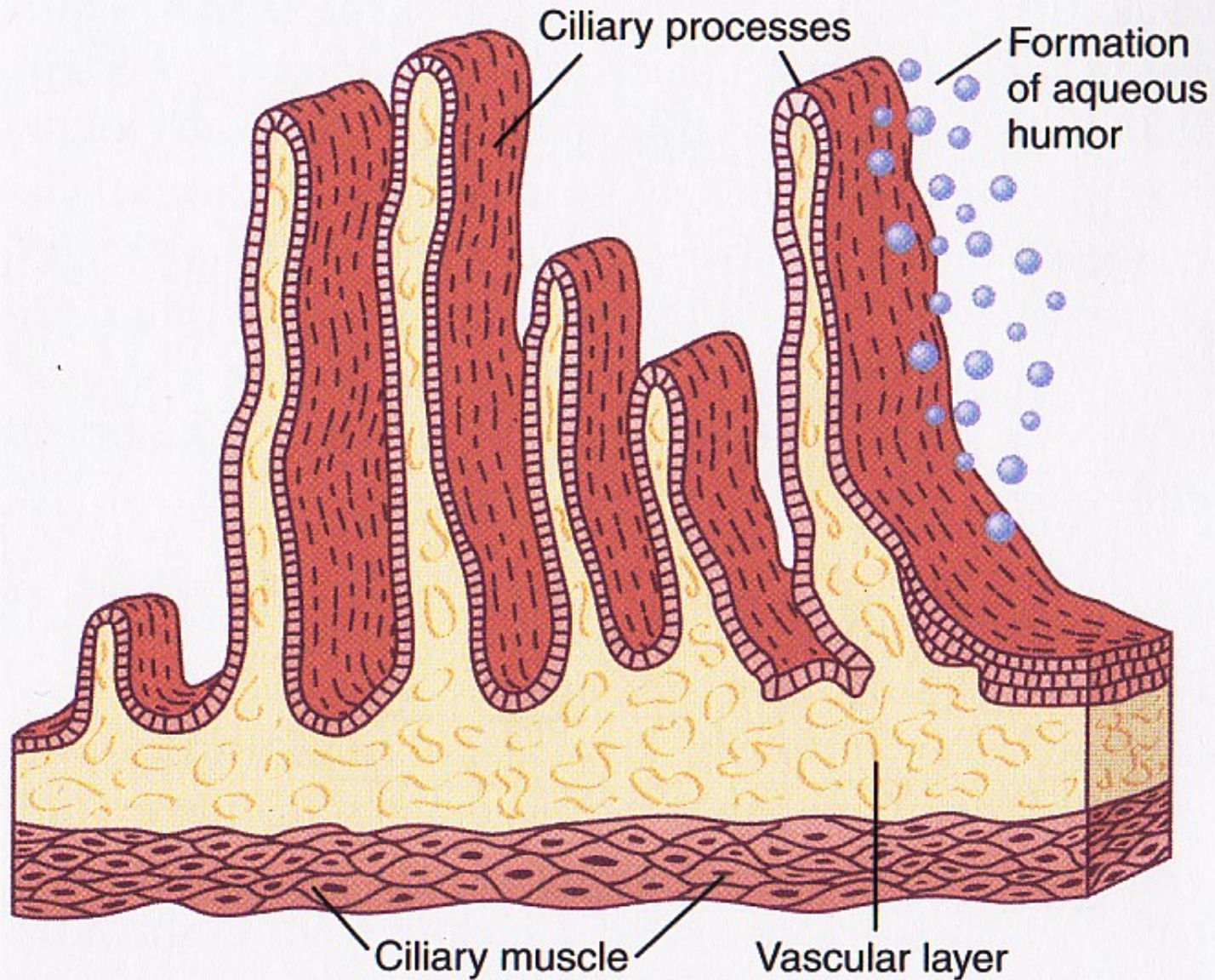
Astigmatism?



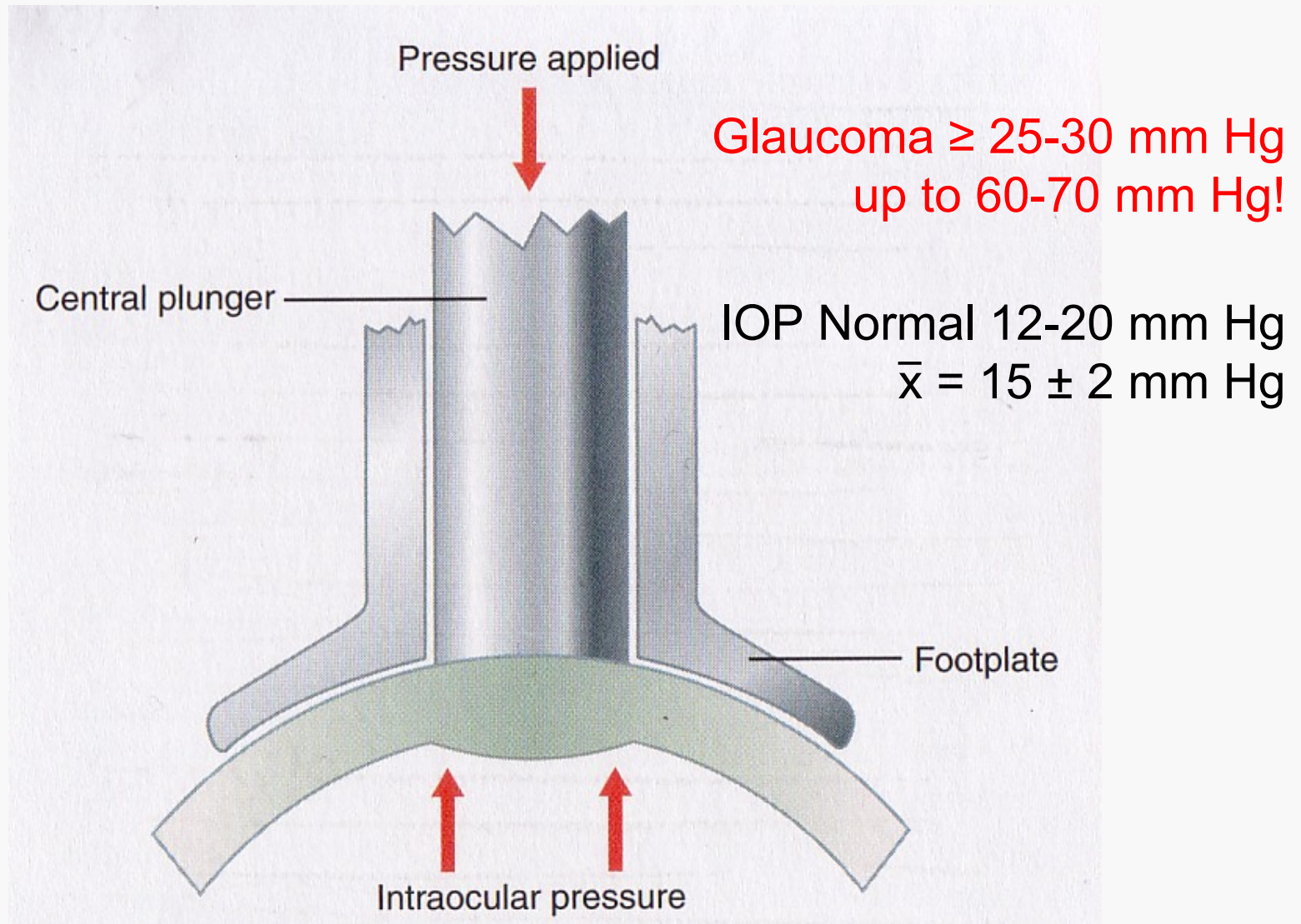
Fluid formation & flow



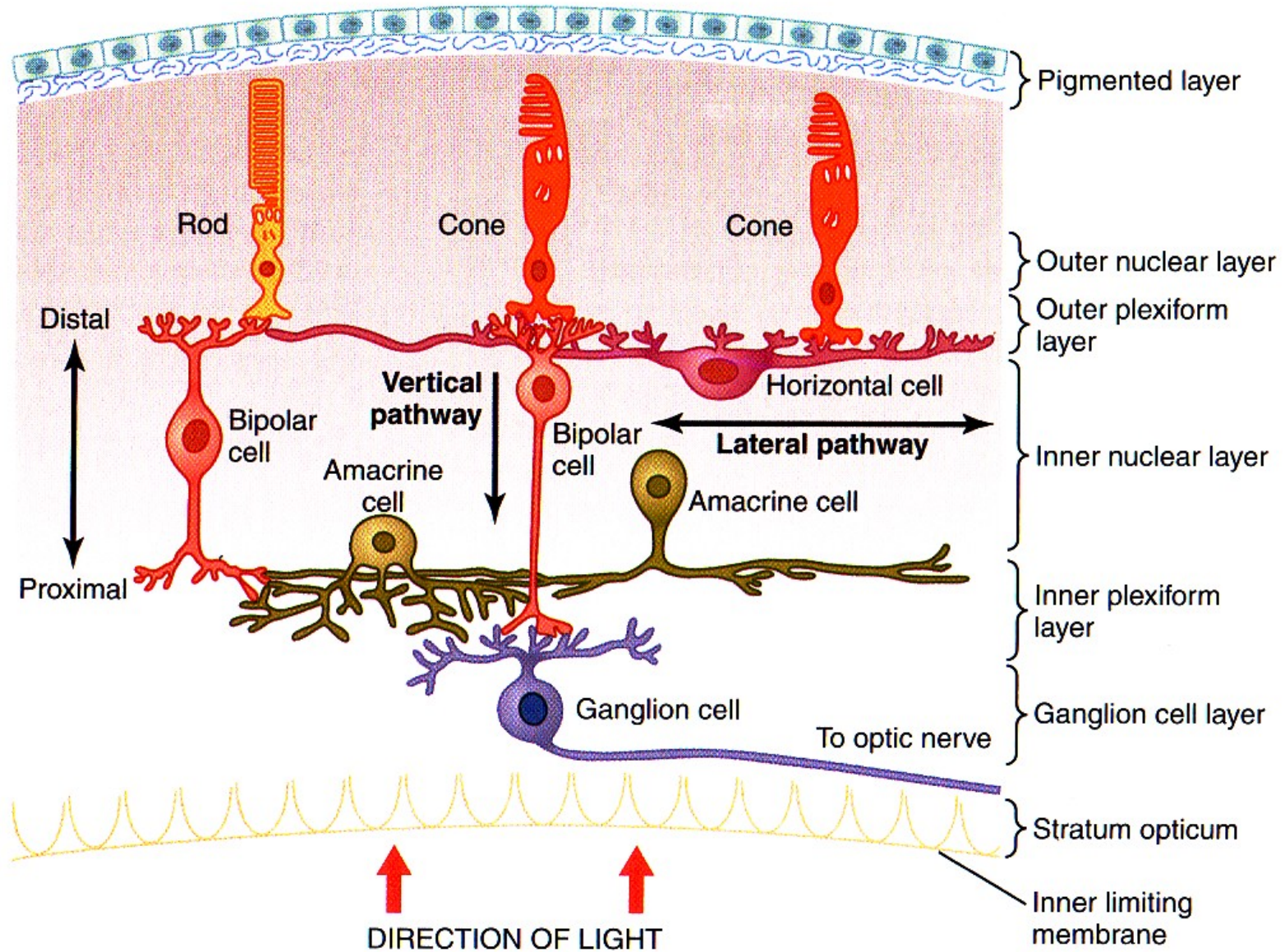
Aqueous humor formation



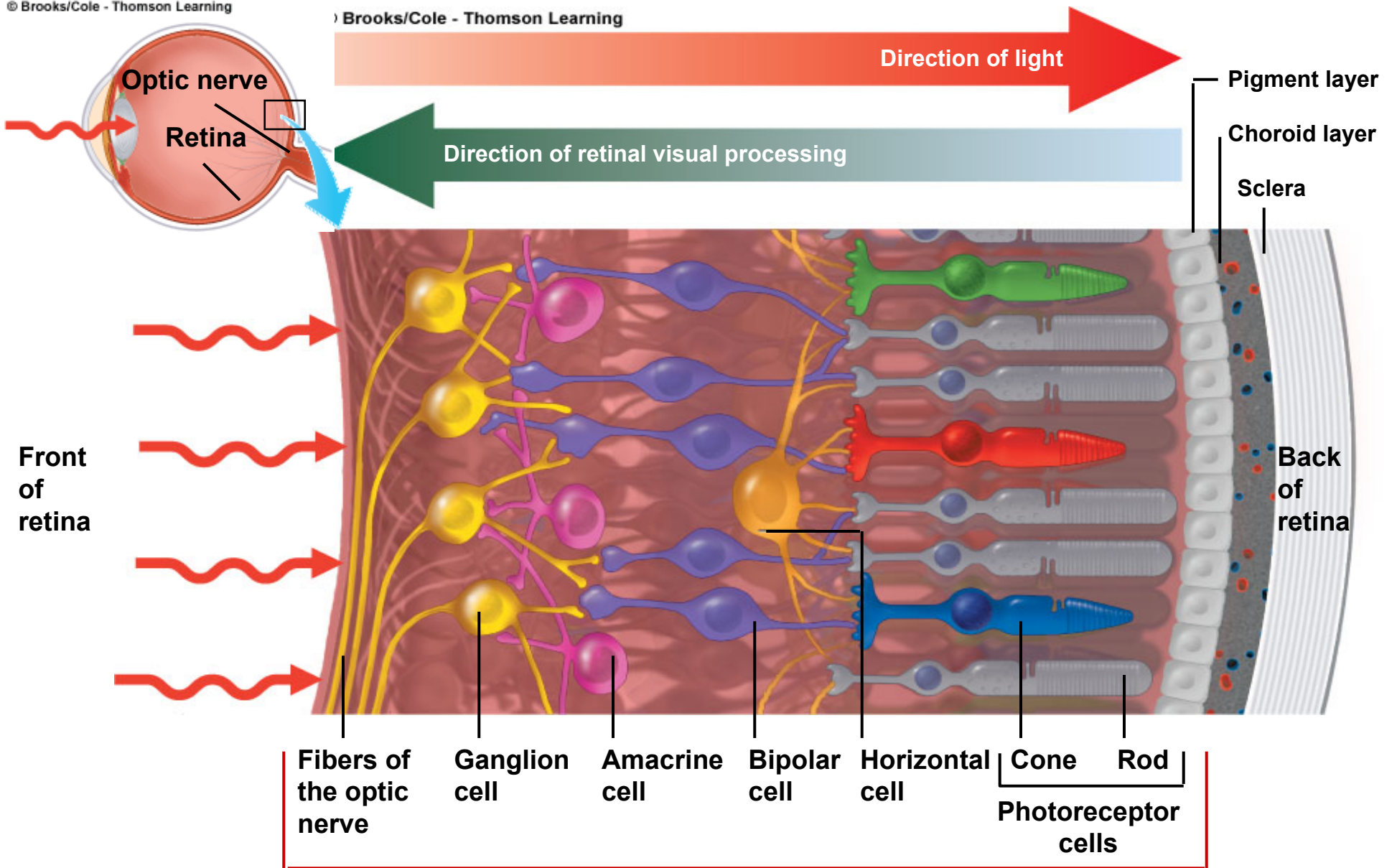
Glaucoma & intraocular pressure (IOP)?



Retinal layers

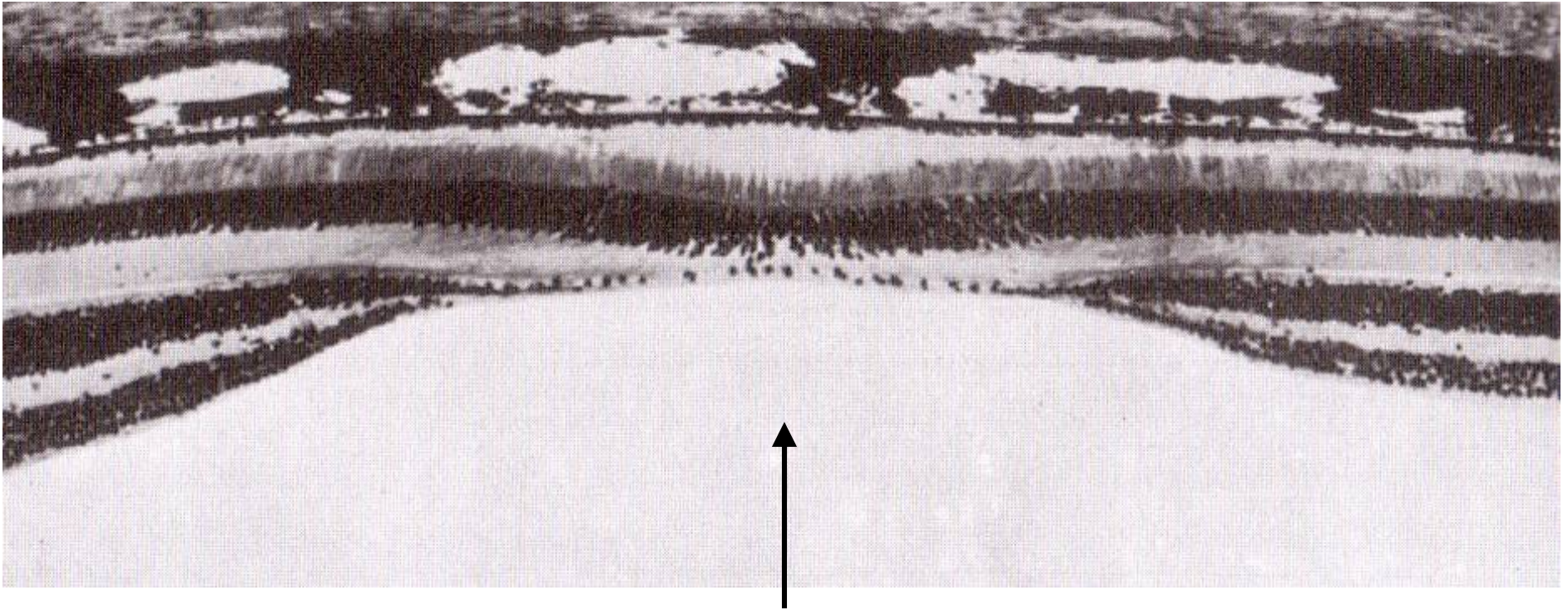


G&H 2011 fig 50-1



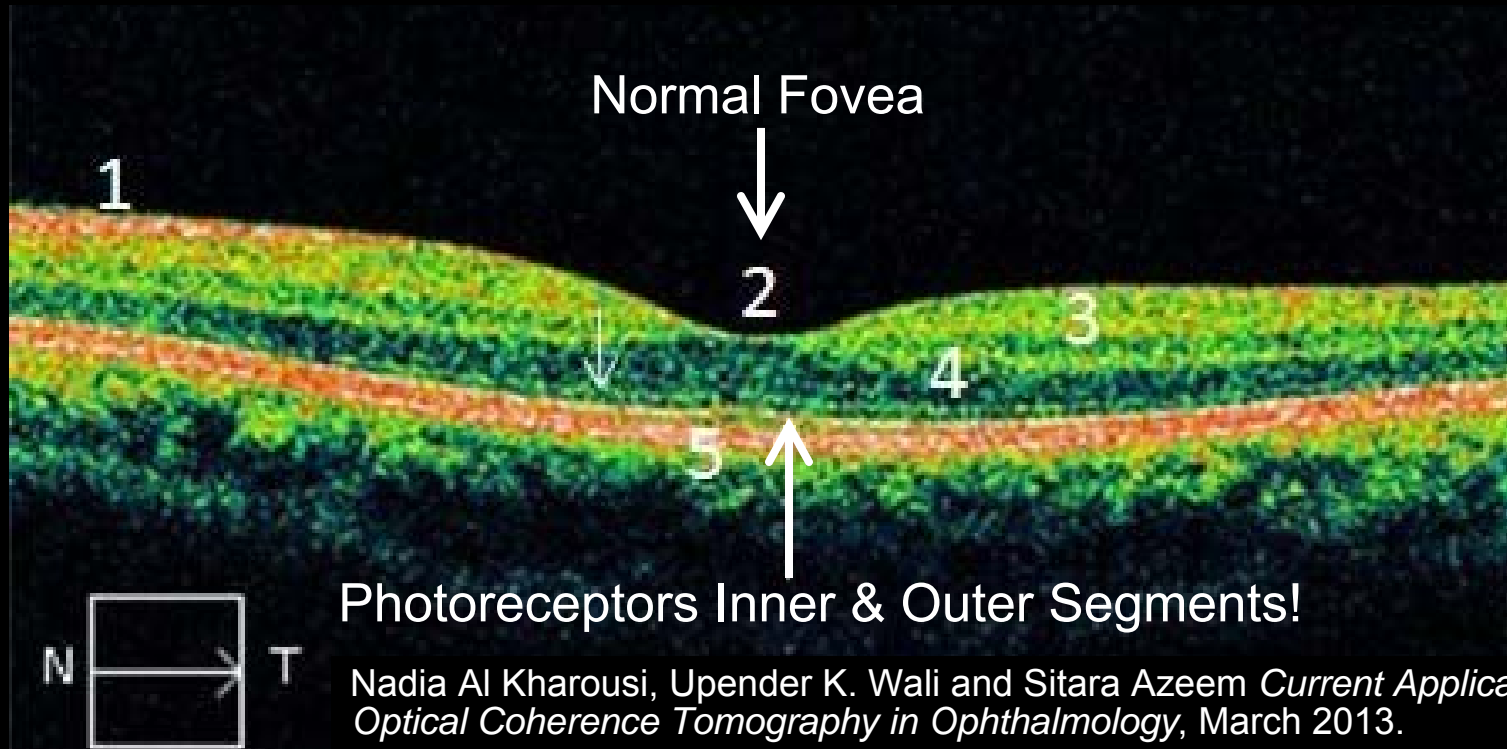
Retina

Macula & fovea hot spot!

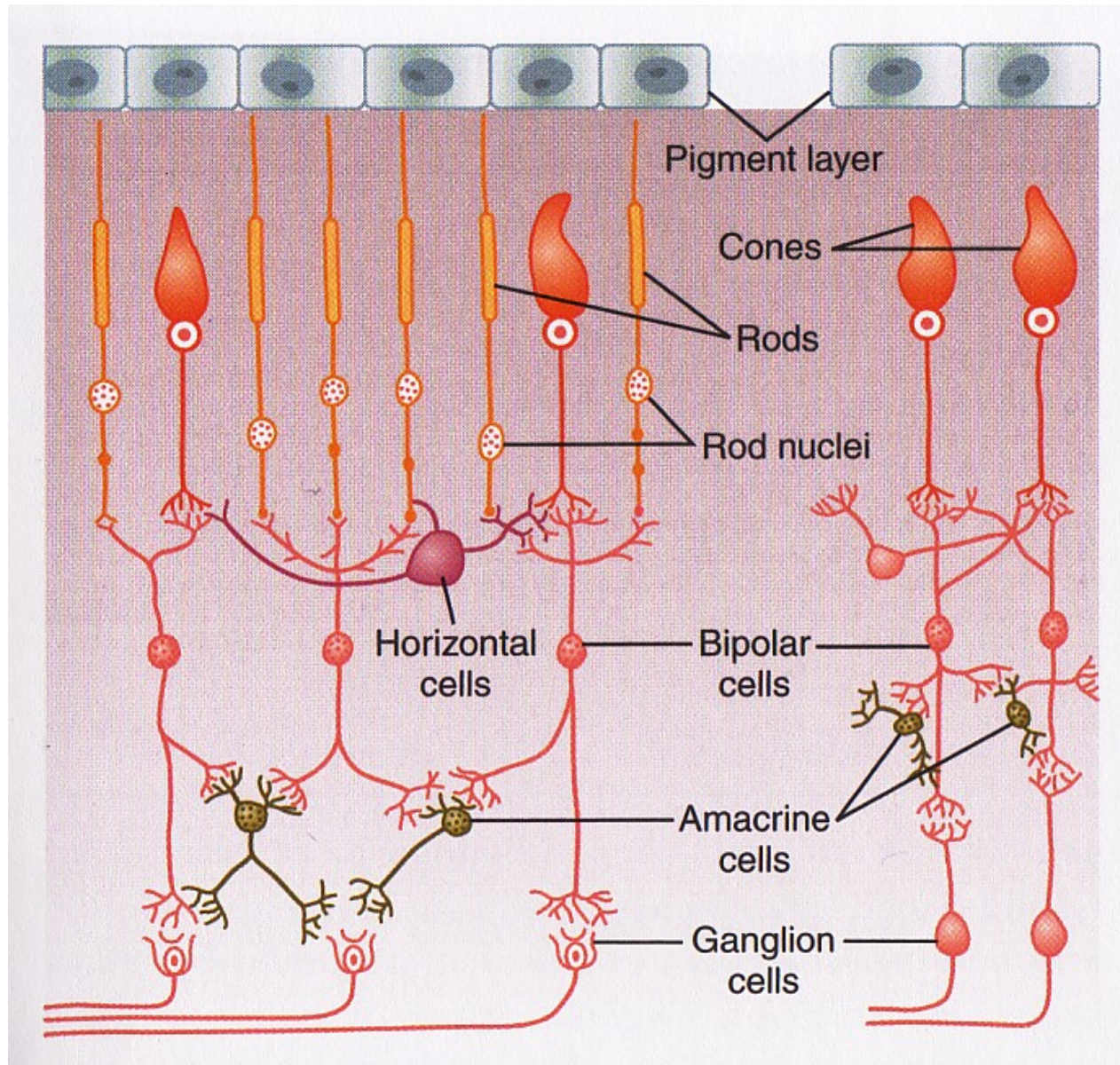


Direction of light

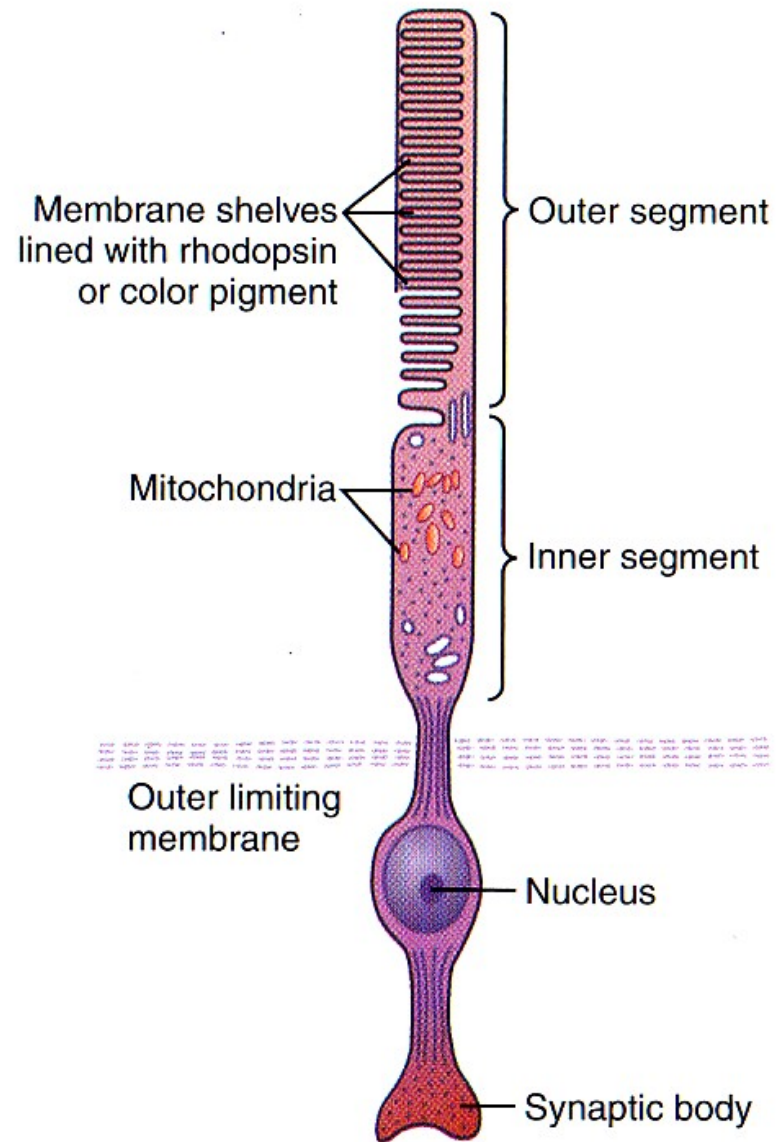
Exposed Cones @ Fovea/Macular Region



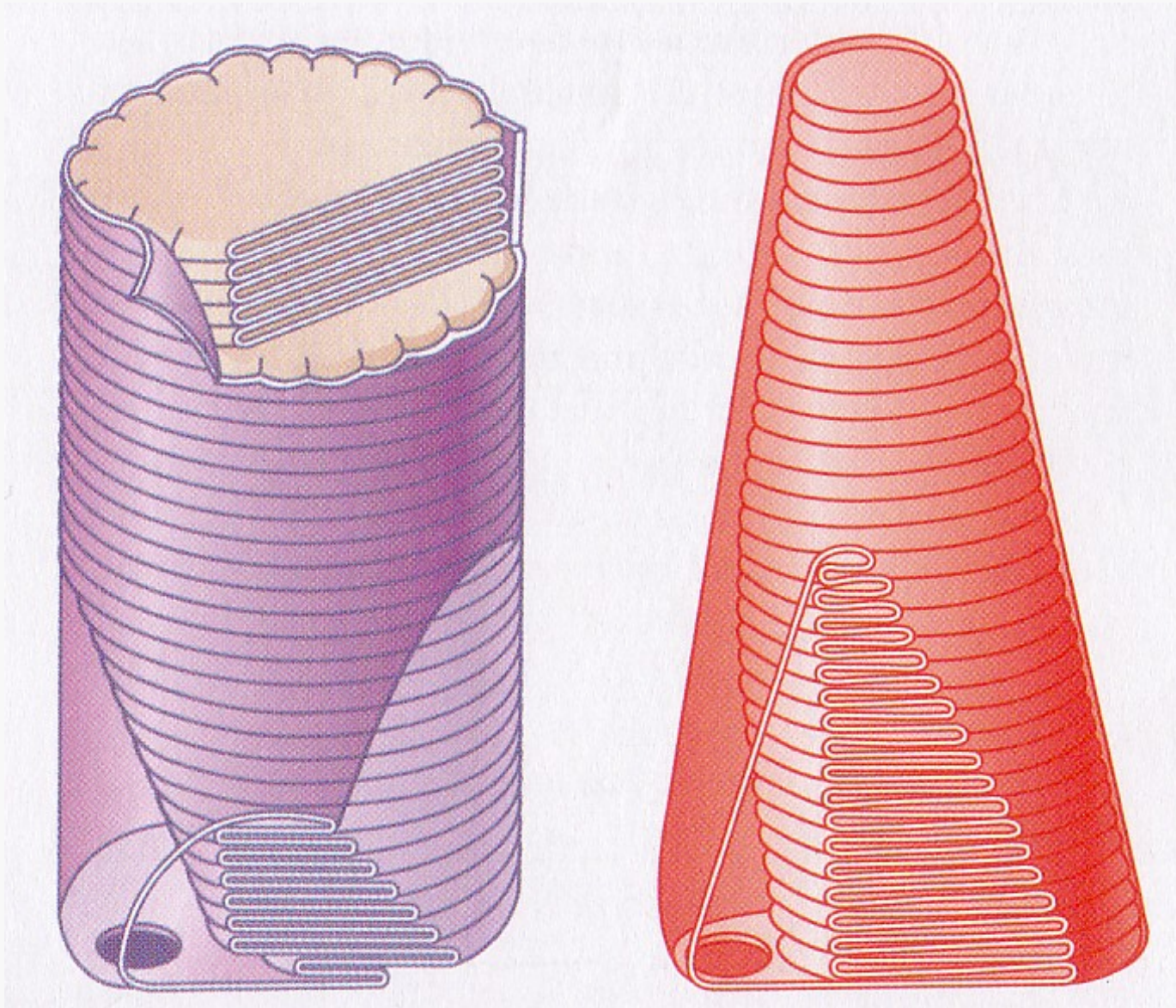
Peripheral (L) vs. foveal (R) retina



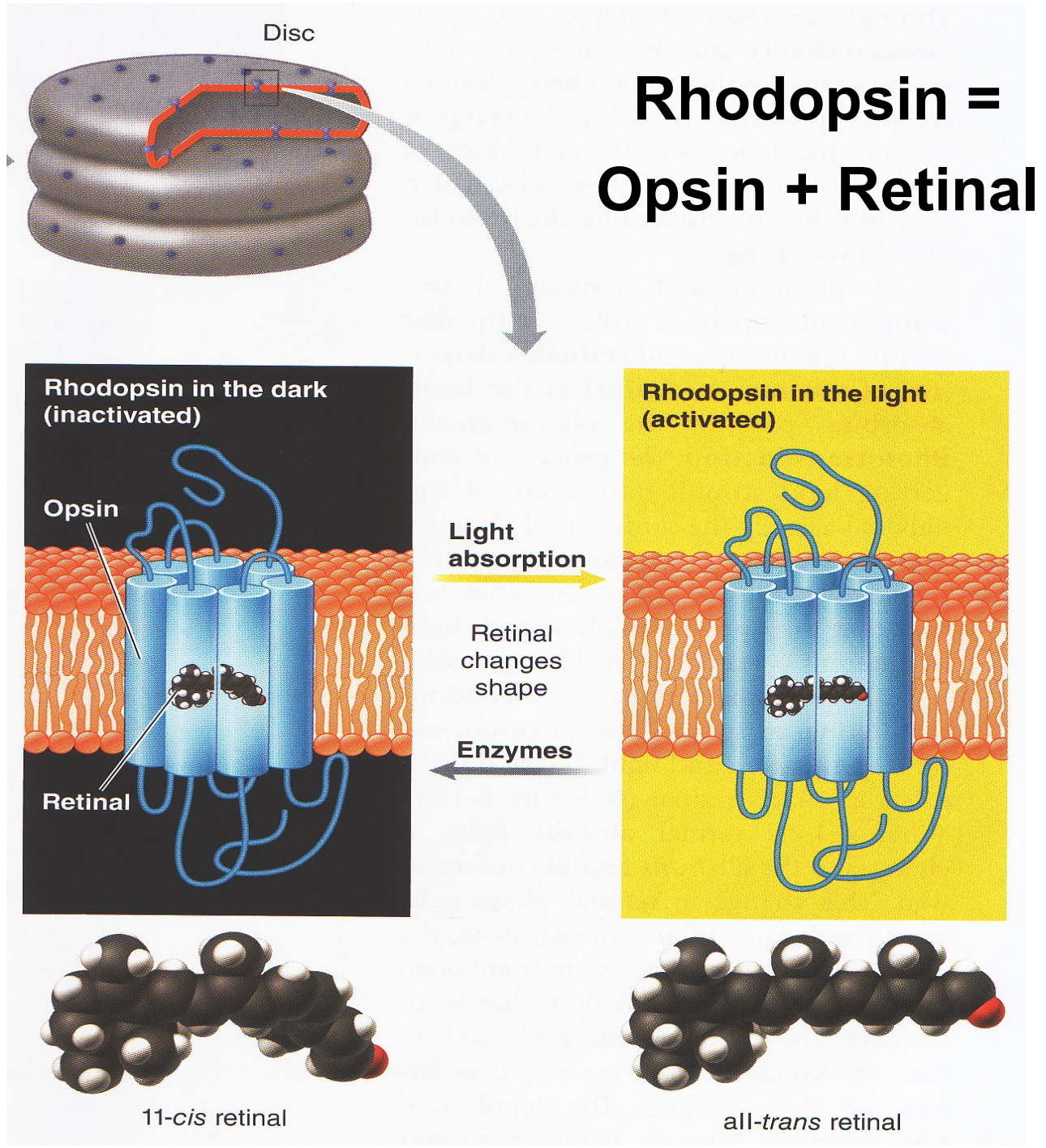
Rod & cone functional parts



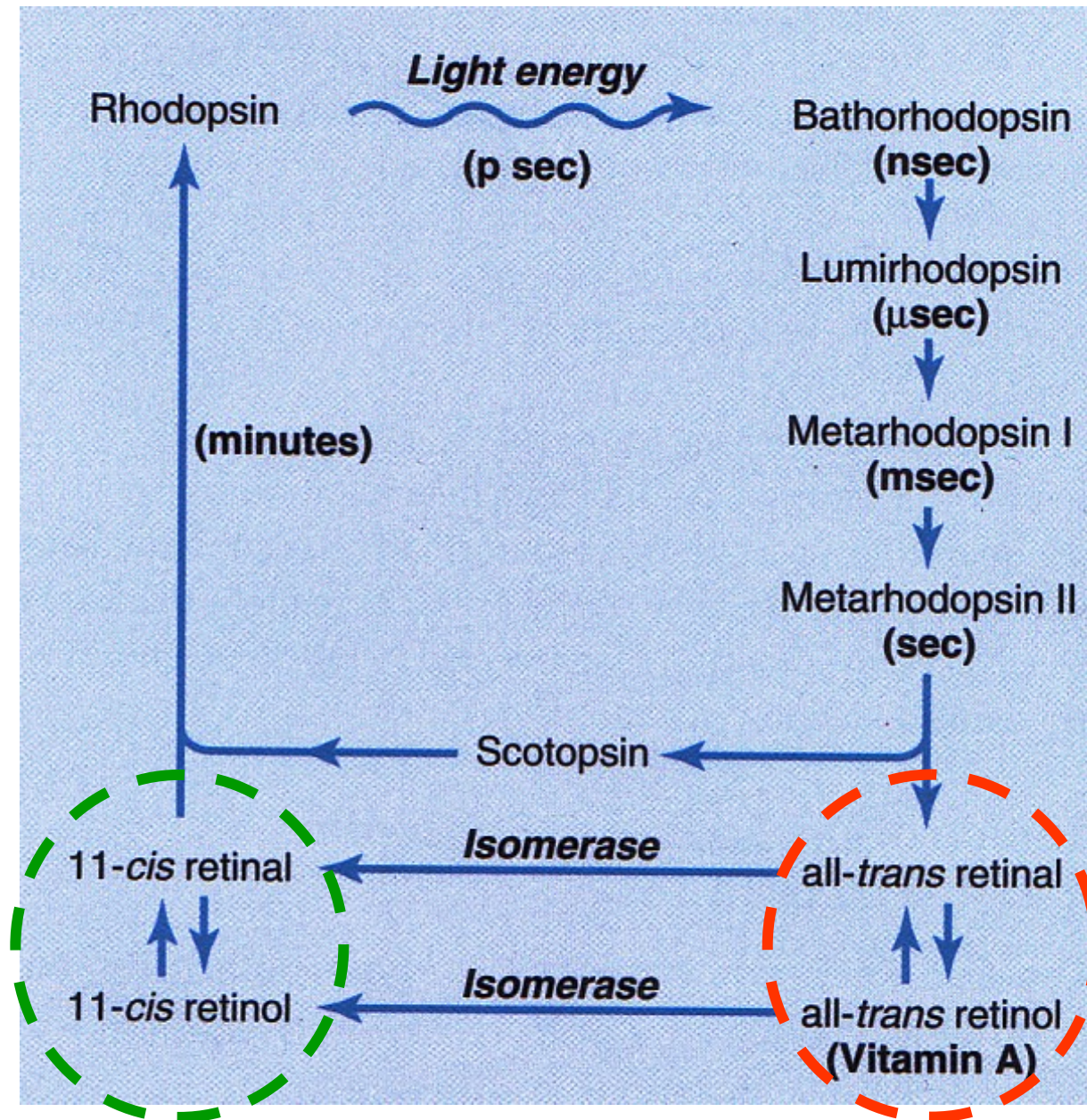
Rod & cone outer segments



In rods,
light converts
cis to trans
retinal



Rhodopsin-retinal visual cycle

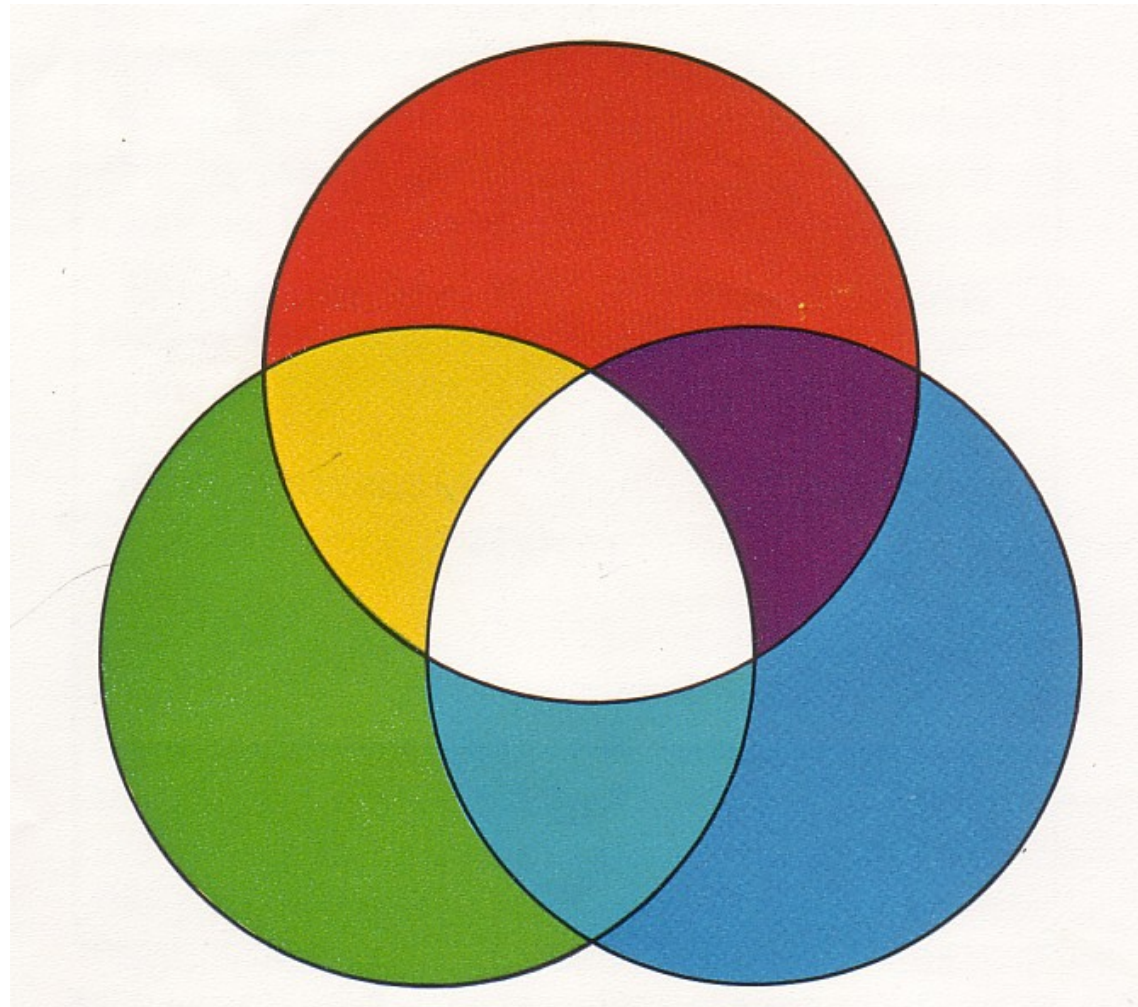


▲ TABLE 6-2

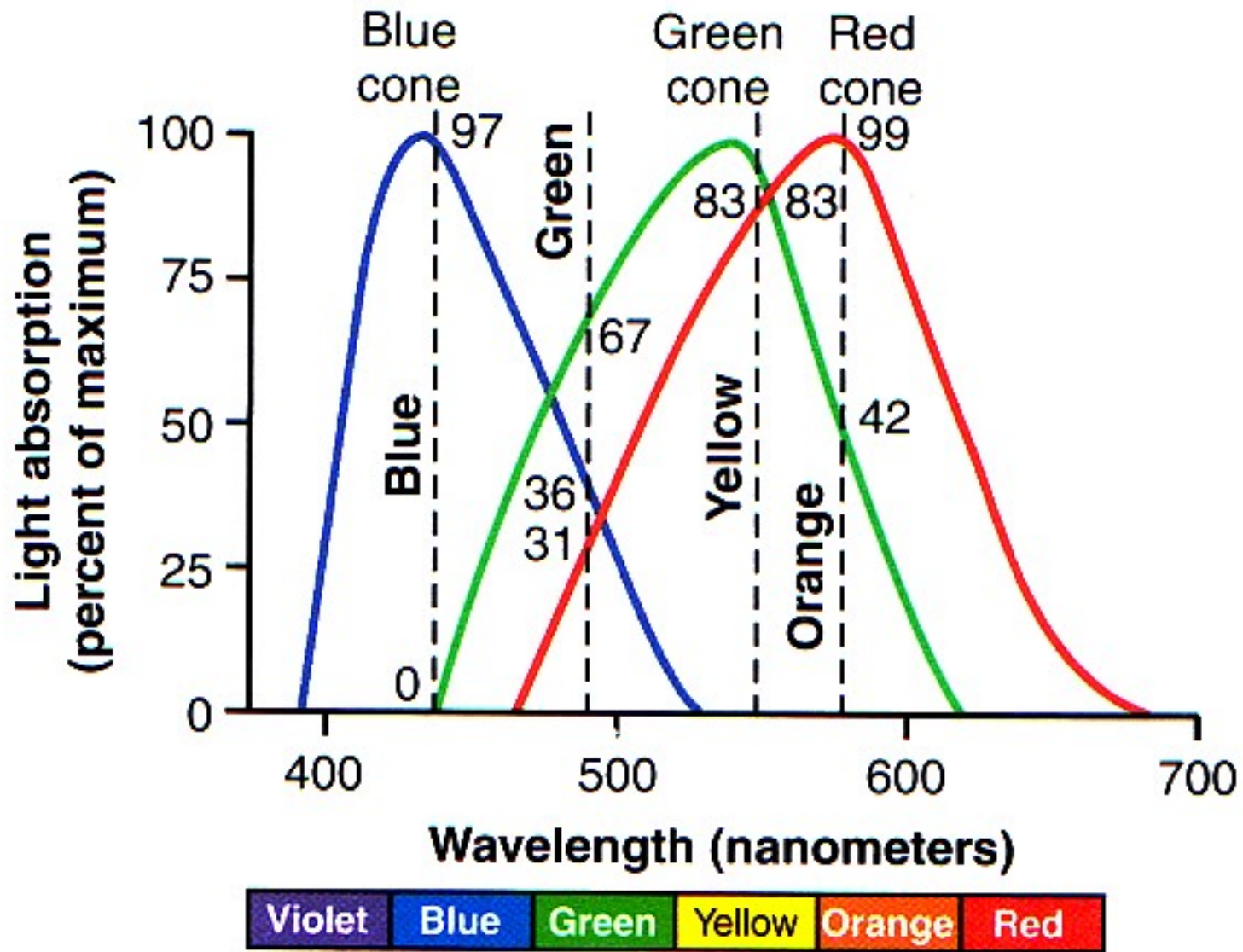
Properties of Rod Vision and Cone Vision

RODS	> 33 x more!	CONES
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^o Colors Are Superimposed***



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

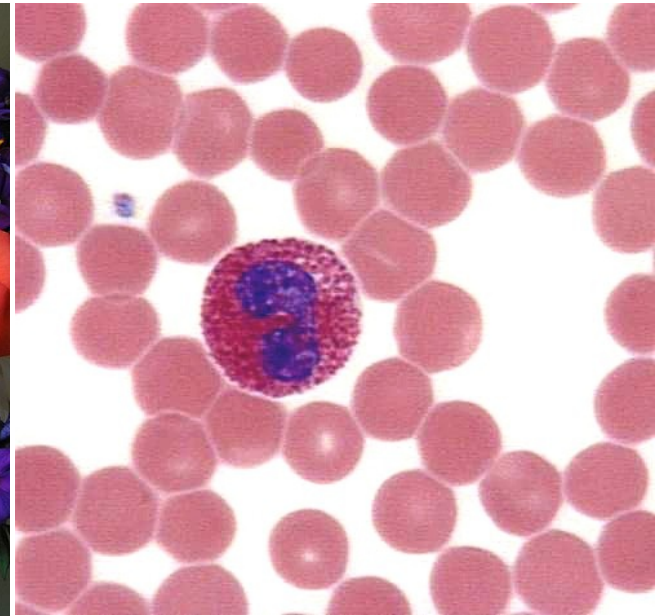


Color Deficiencies Can Impact Daily Activities, Pleasure & Work!

Red Cone Deficiency = Protanopia

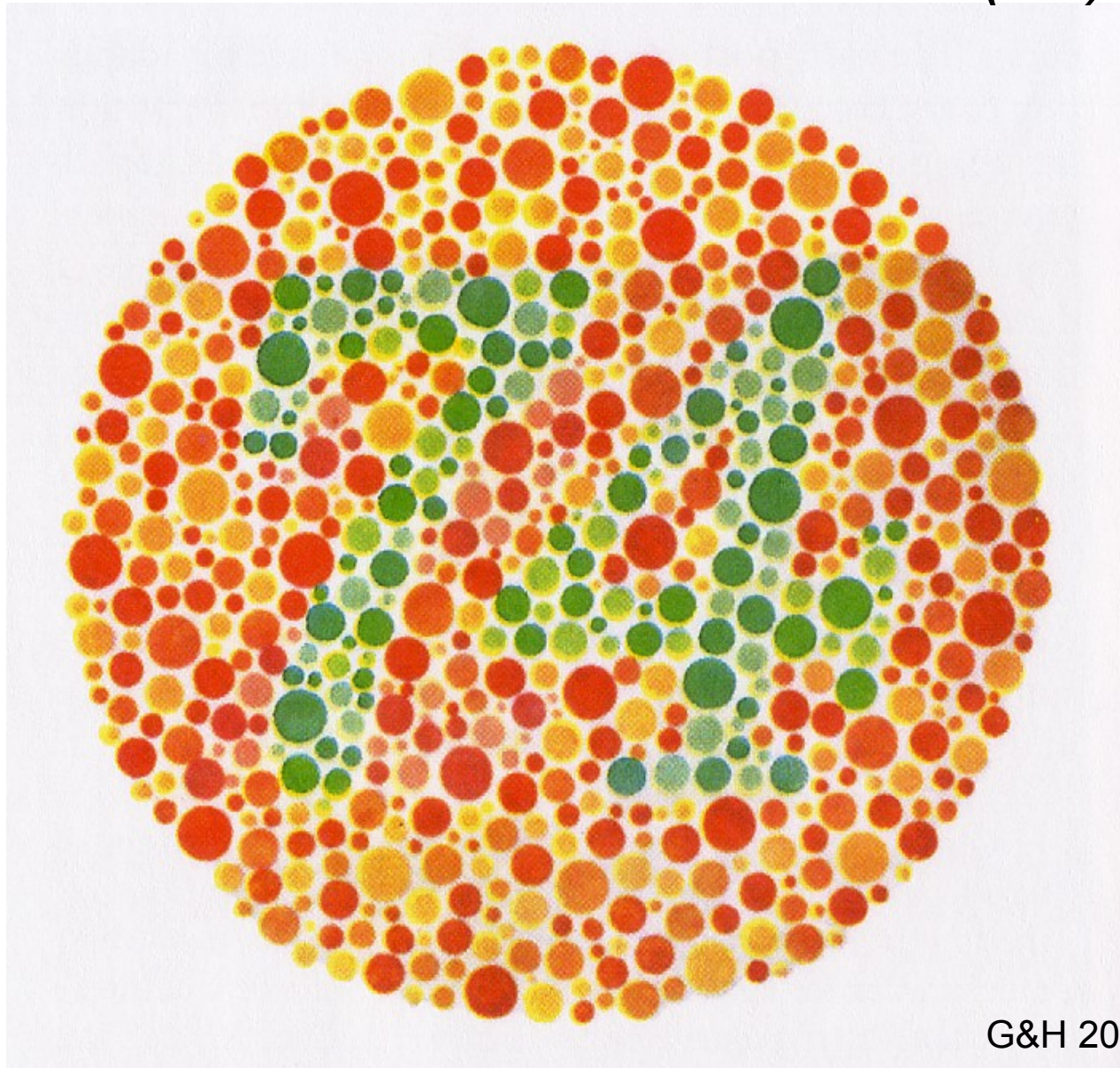
Green Cone Deficiency = Deuteranopia

Blue Cone Deficiency = Tritanopia



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

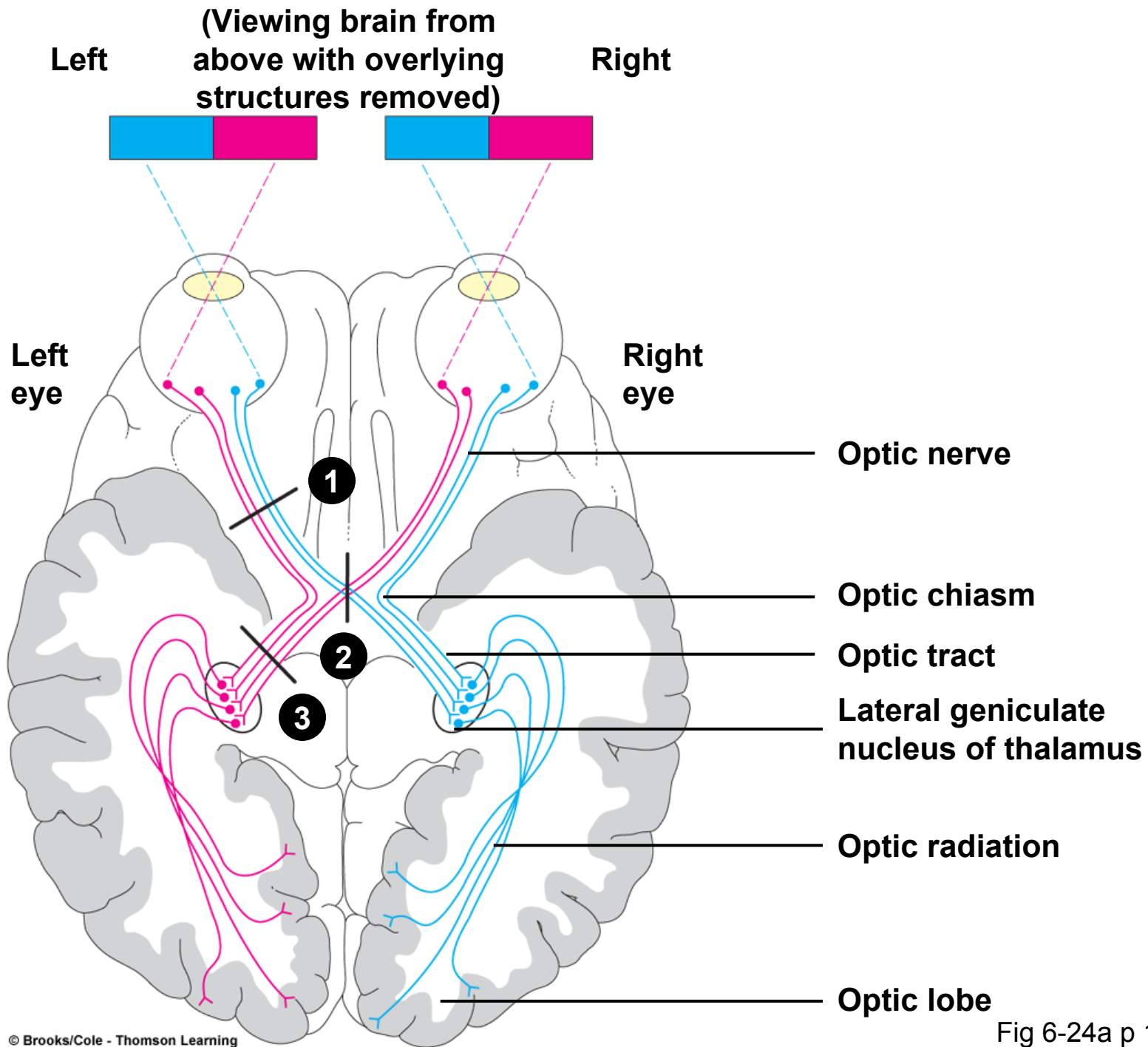
*Ishihara Chart for Normal (74) vs.
Red-Green Color Blindness (21)*



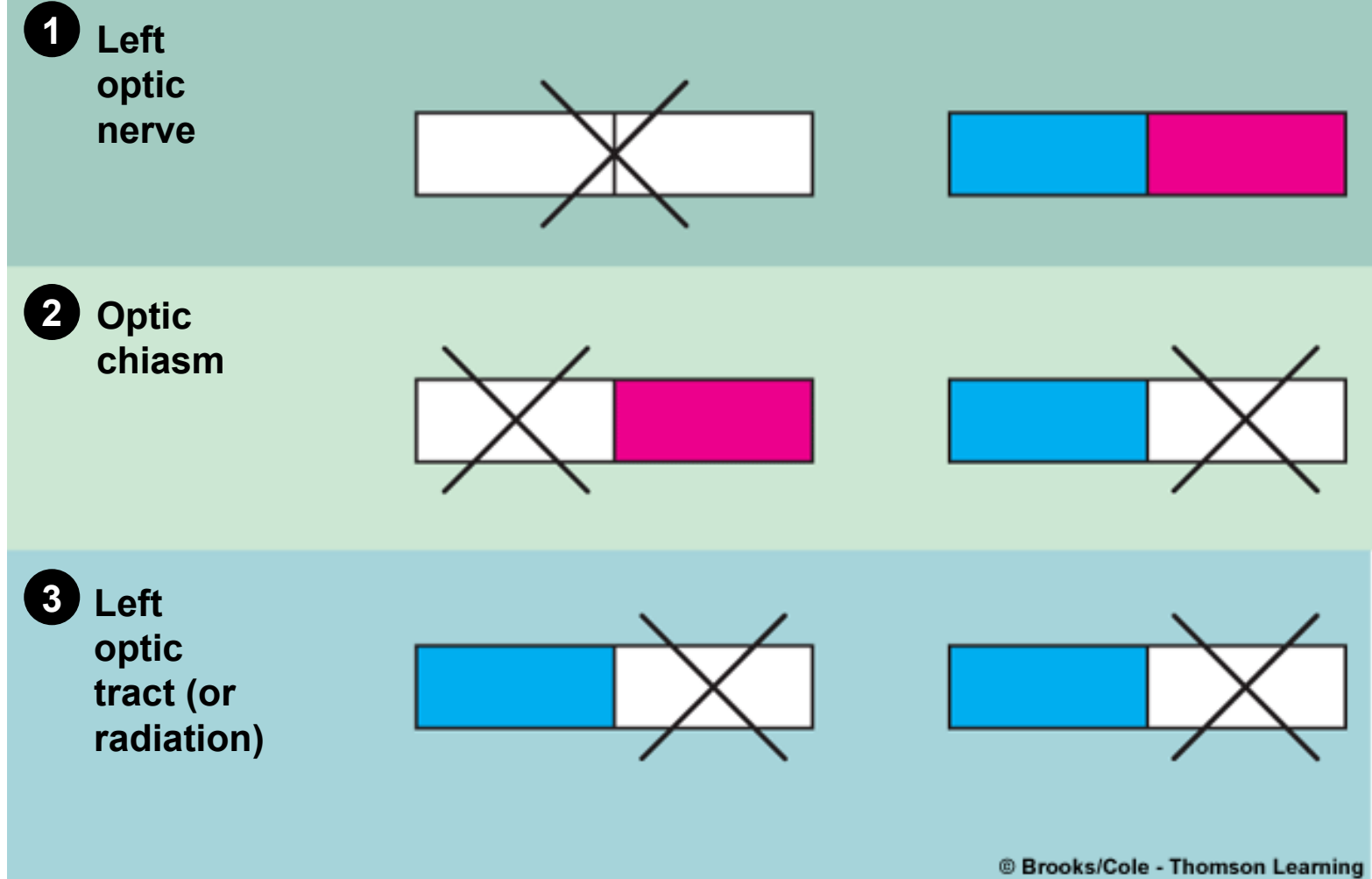
G&H 2011 fig 50-11a

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





Visual deficits with specific lesions



———— = Site of lesion X = Visual deficit

Rods in Darkness → Rhodopsin Not Active, cGMP High, CNG and K⁺ Channels Open

Rods – 3 Main Cation Channels

1. CNG (Cyclic Nucleotide-Gated) Channel

Enable Na⁺ and Ca²⁺ entry into Rod

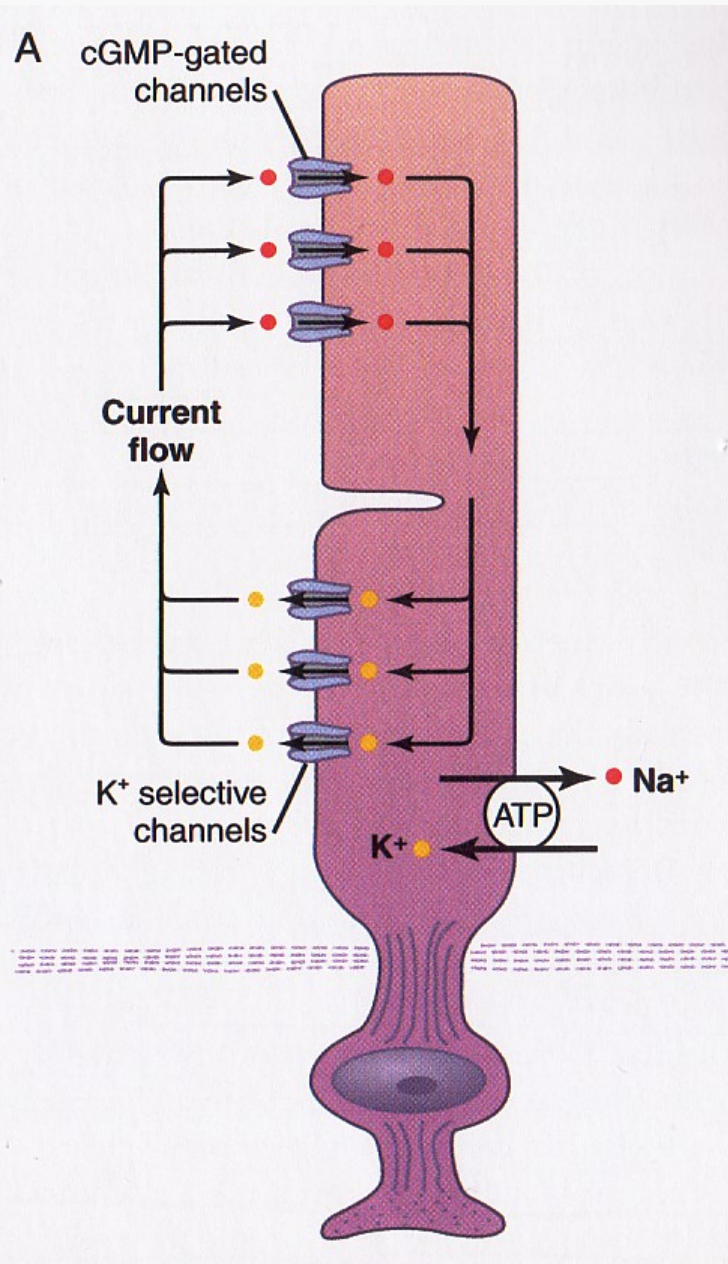
2. K⁺ Channel

Enables K⁺ to leak out of Rod

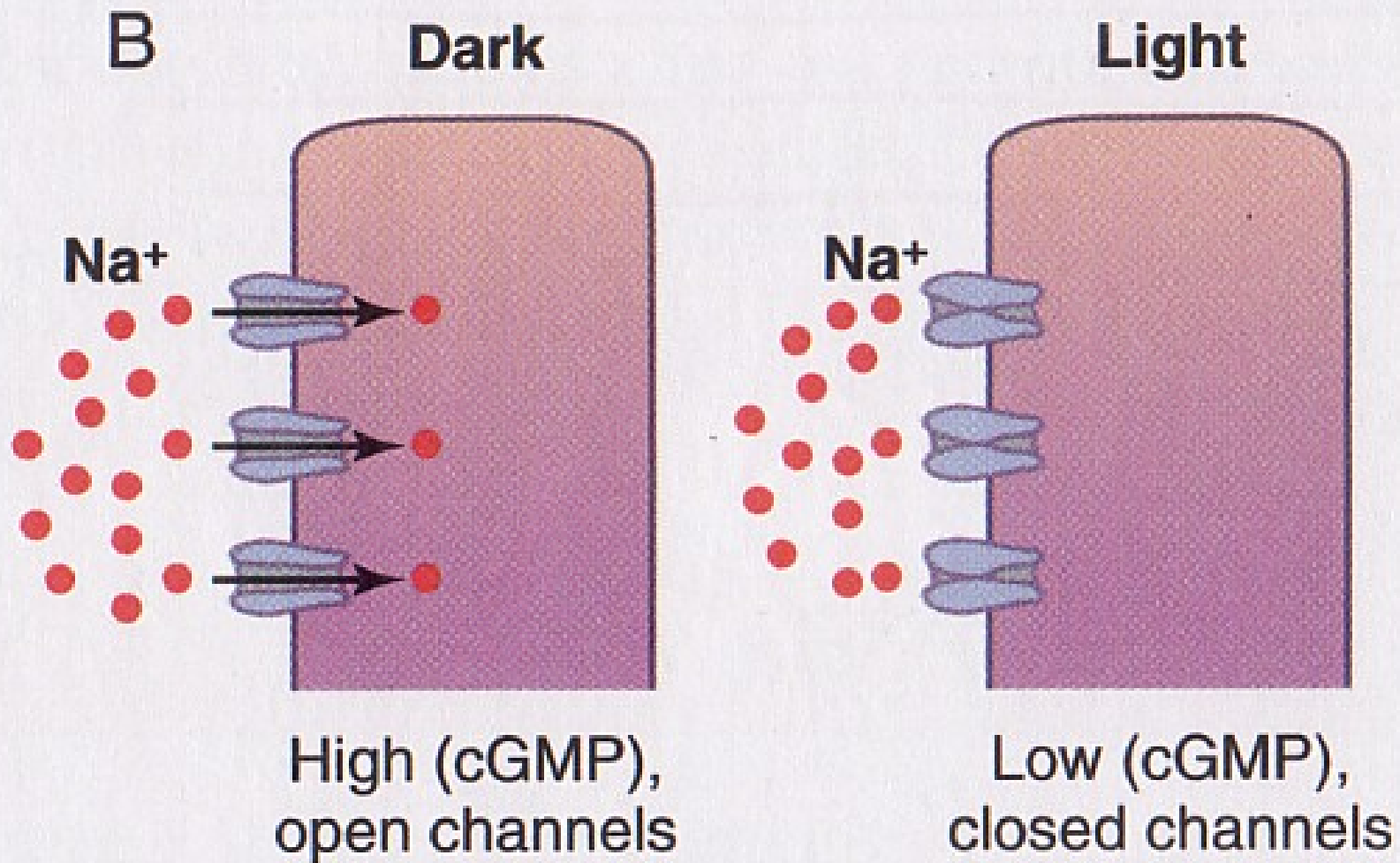
3. Ca²⁺-Voltage-Gate Channel

Enables Ca²⁺ Entry into Synaptic Terminal to
Regulate Glutamate Exocytosis

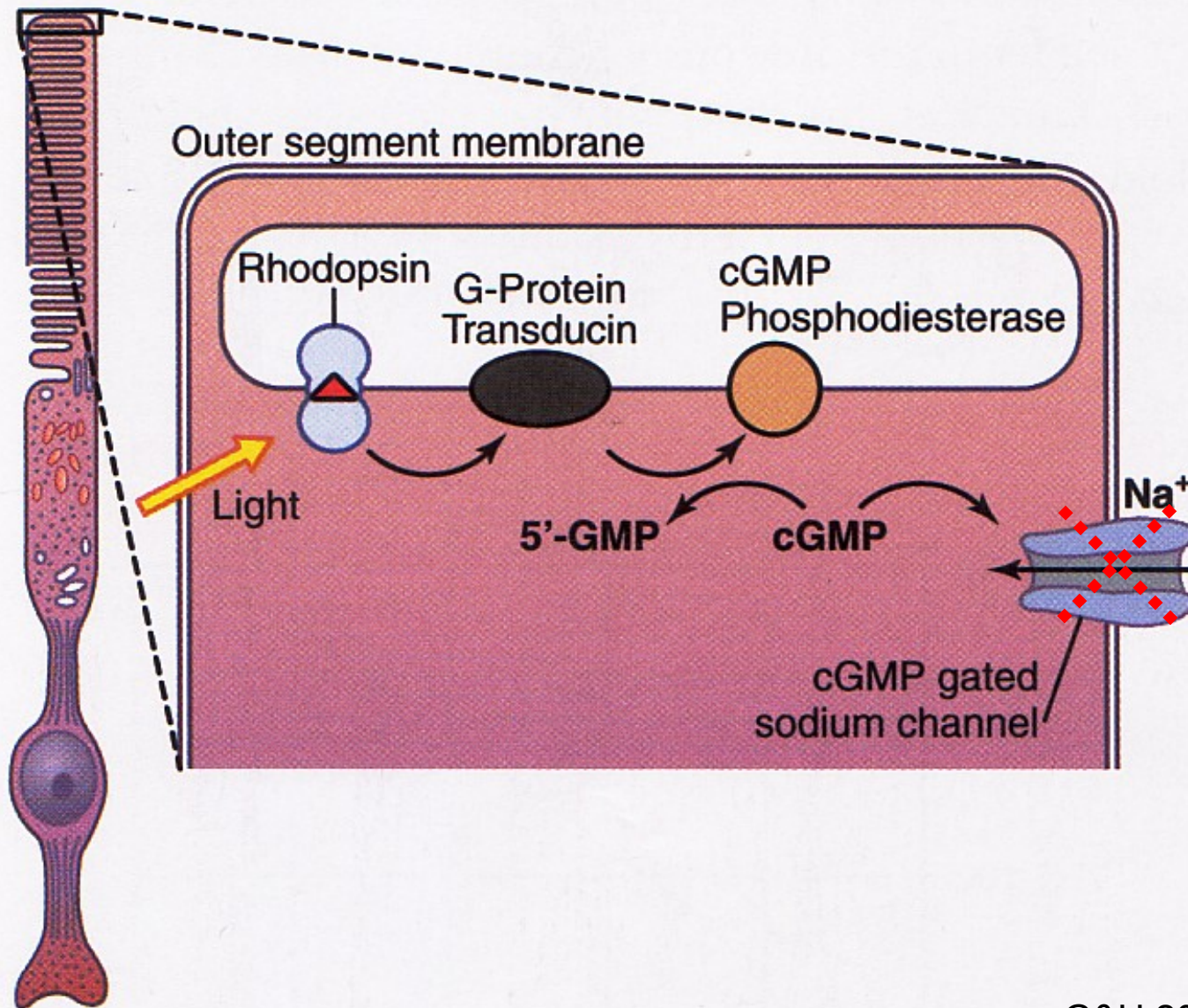
Sodium flows in photoreceptor - A



Sodium flows in photoreceptor - B



Phototransduction (outer segment)



Summary: Let There Be Light!

