

# La vision

## 1. Introduction

## 2. Mécanismes périphériques

### a) L'organe récepteur : l'œil

- Structure
- Propriétés optiques

### b) La rétine

- Données histologiques
- Structure des photorécepteurs
- La phototransduction

### c) Le message rétinien

## 3. Mécanismes centraux

### a) Le cortex visuel V1 (aire striée ou aire 17)

- Les projections géniculées
- Organisation anatomo-fonctionnelle de V1

### b) Les aires visuelles péristriées

- Inféro temporal (IT) et forme/couleur du stimulus
- Pariétal et localisation/mouvement du stimulus

## 4. Conclusion

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Modalité = Vue

3 QUALITES

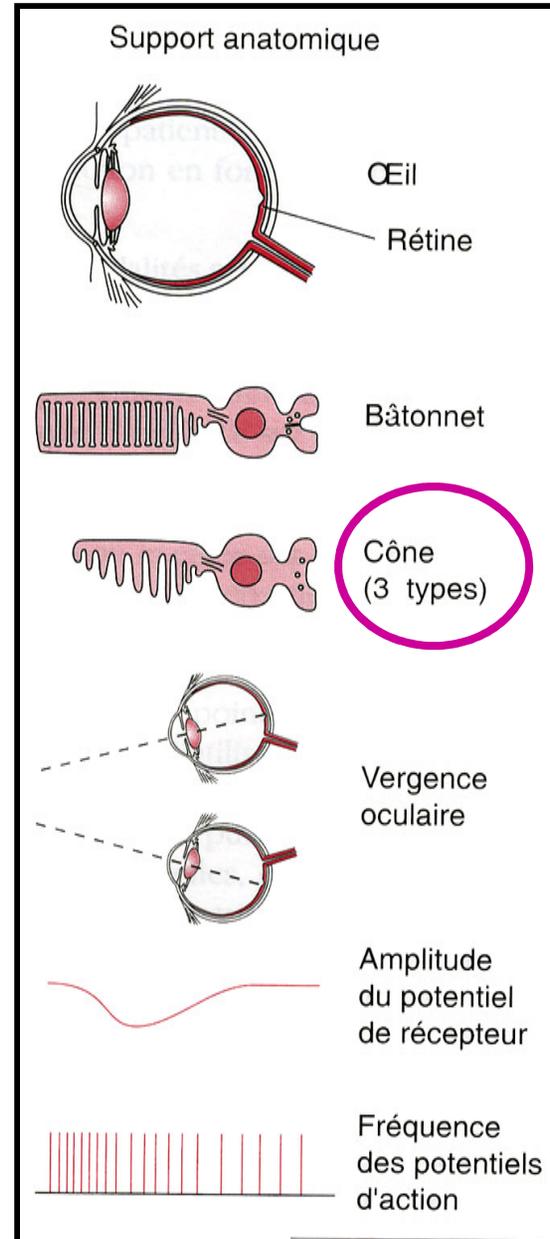
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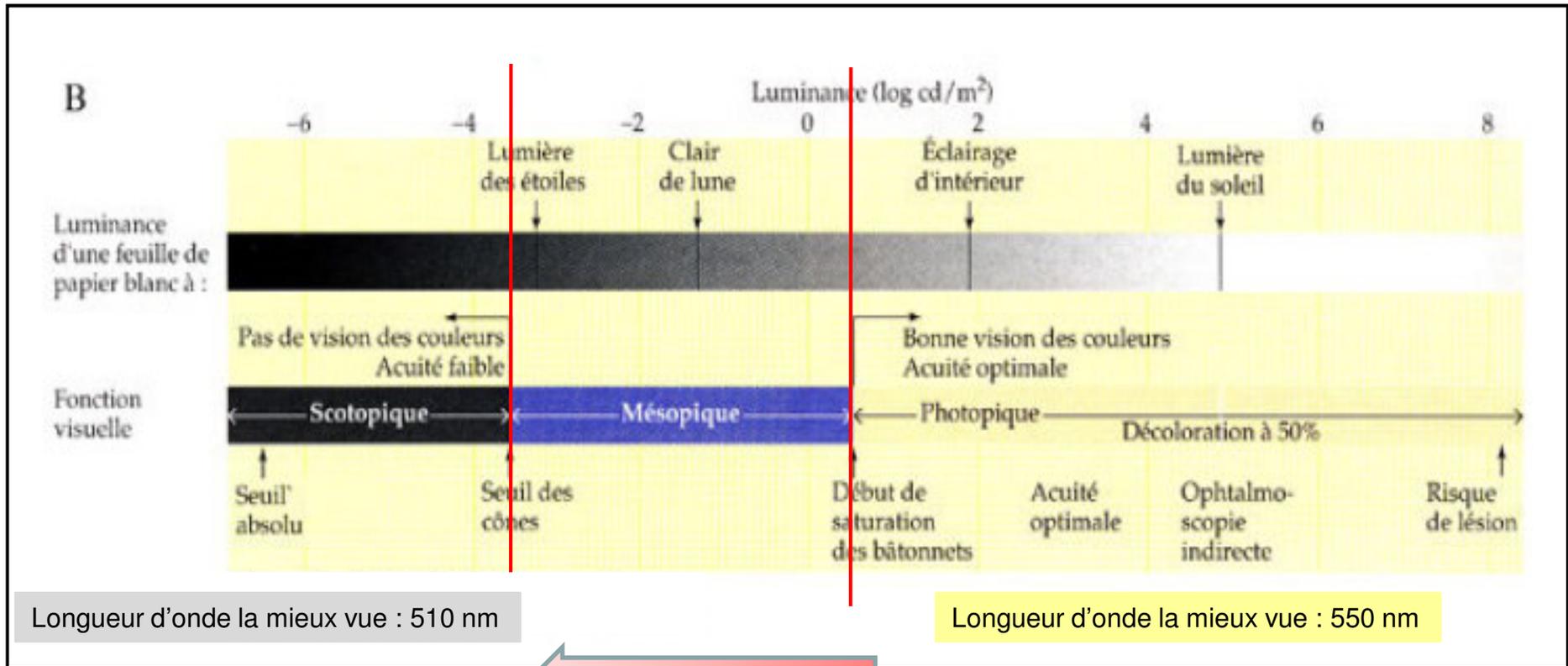
Couleur

Profondeur

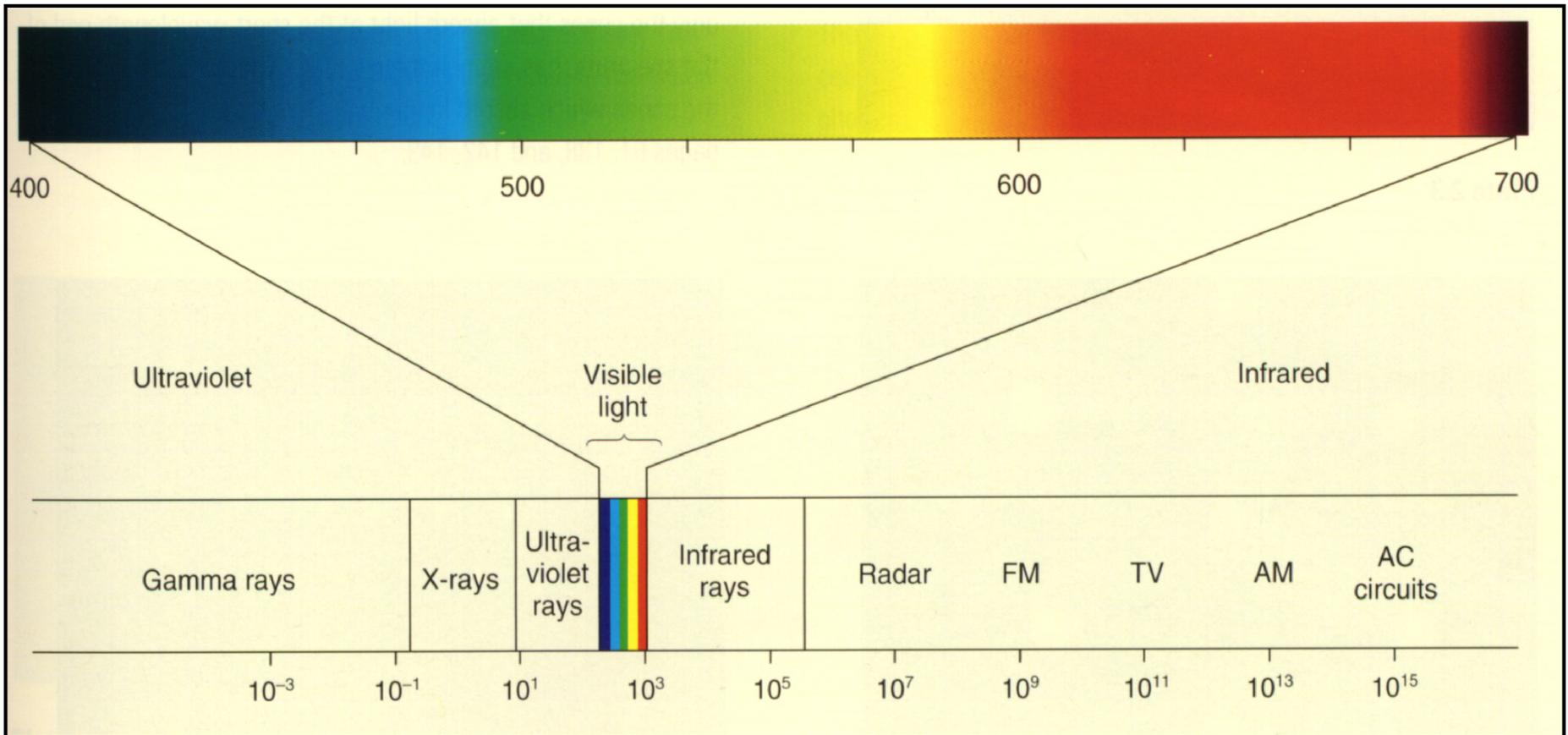
QUANTITE

Intensité  
de la sensation





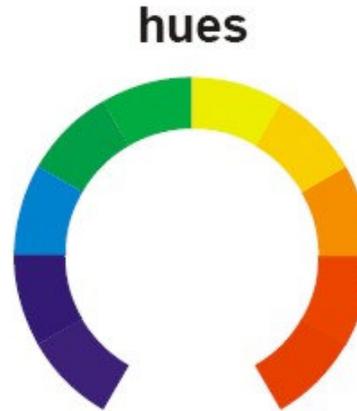
Les trois domaines de vision



**How many gradations of color can the human brain distinguish?**

a) **200 hues**

The brain transforms the single wavelengths of light seen in rainbow into a color circle. Hues on opposite sides of the circle are complementary.



b) **20 levels of saturation**

Combinations of two more wavelengths. When complementary wavelengths are combine equally one gets white.



c) **500 brightness levels**

Any color on the circle can be made brighter or darker.

Remarkably with only 3 cones types we can see  $500 \times 200 \times 20 = 2,000,000$  gradations of color



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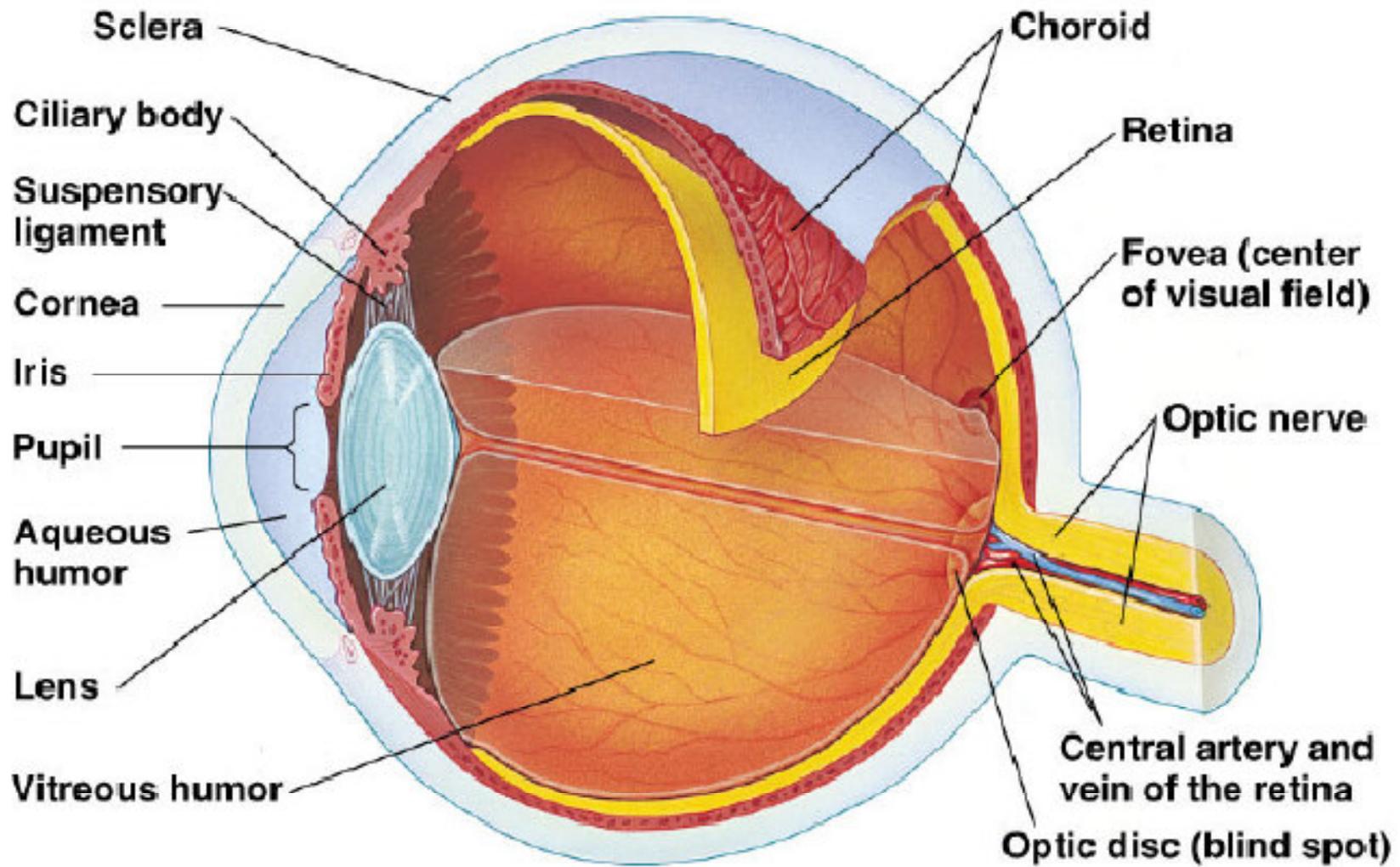
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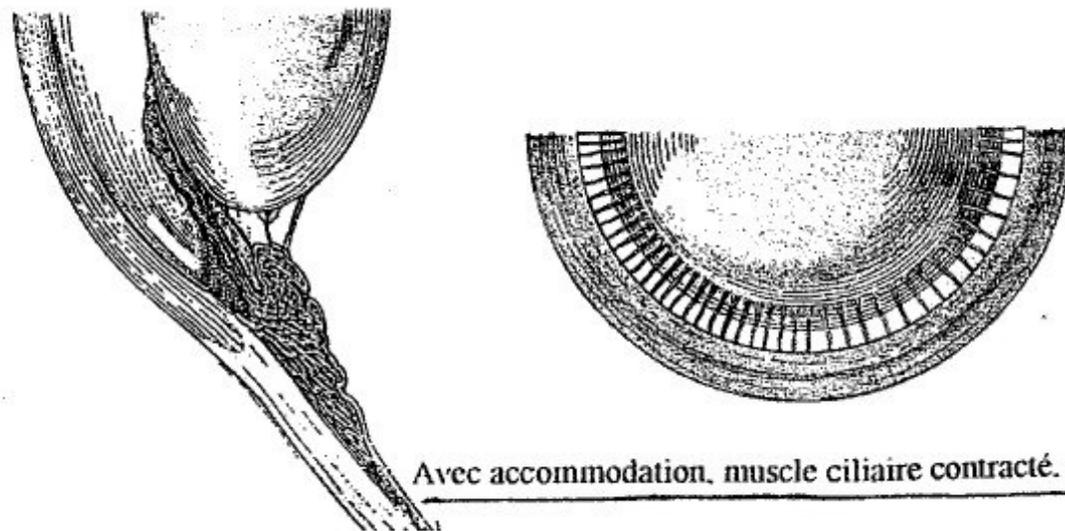
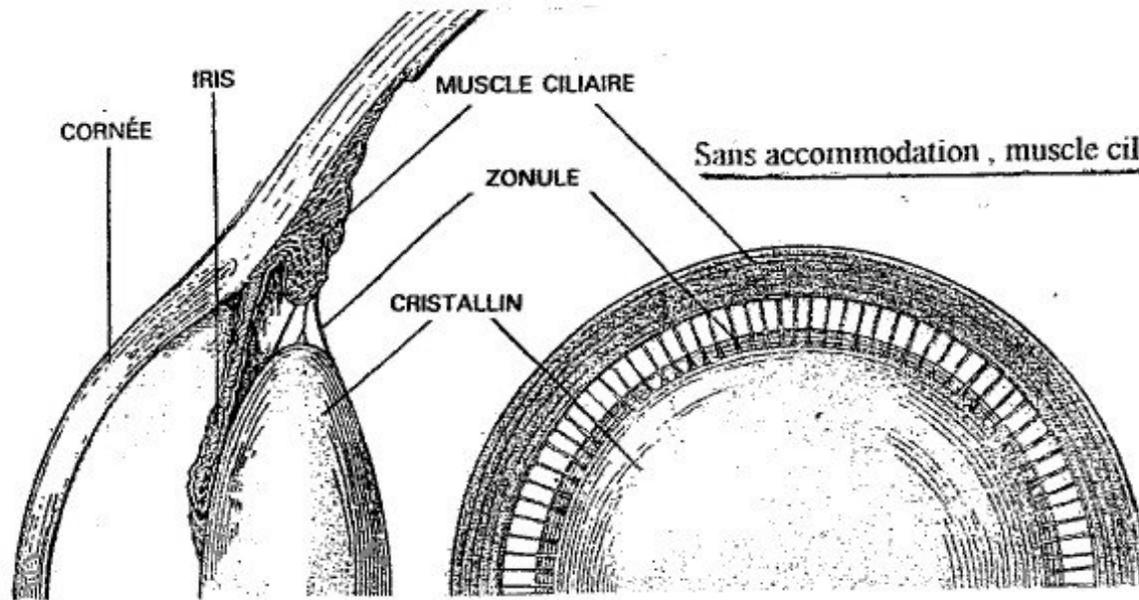
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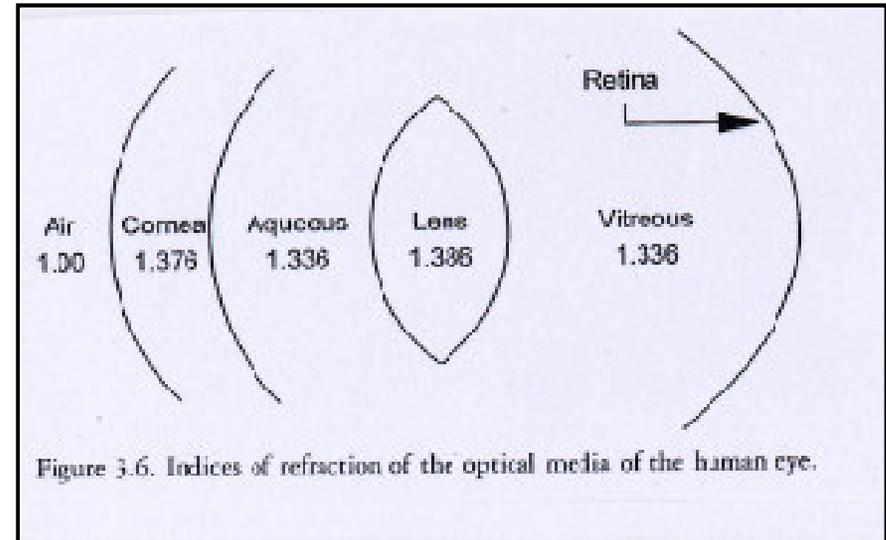
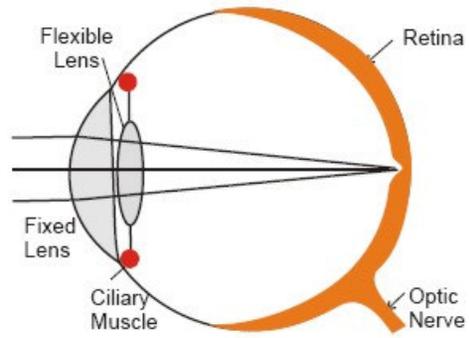
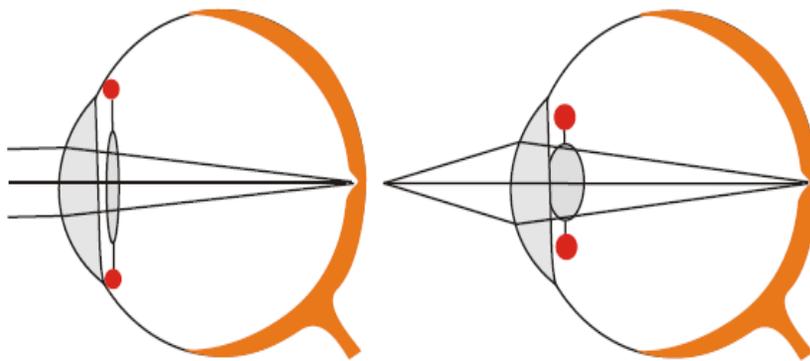
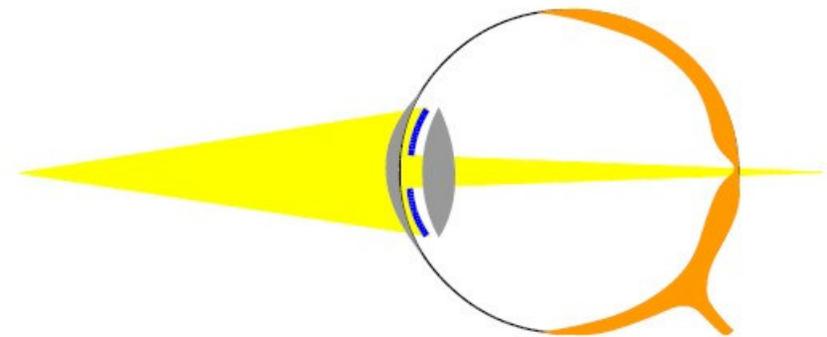


Figure 3.6. Indices of refraction of the optical media of the human eye.

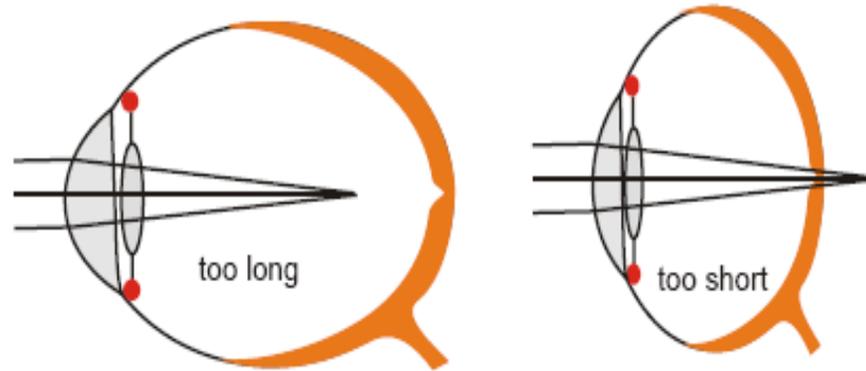


When the ciliary muscles are relaxed the lens is flat and distant objects are focused onto the retina

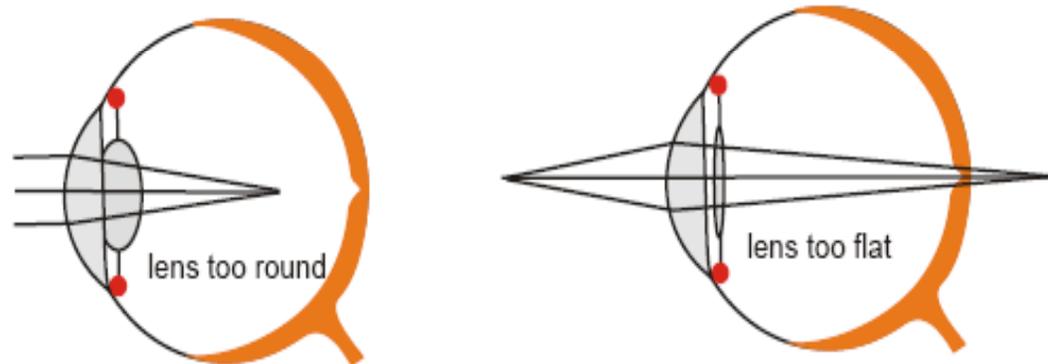
When the ciliary muscles are contracted, the lens becomes more round and a close object is focused onto the retina



a) The shape of the eye ball.



b) The shape of the lens

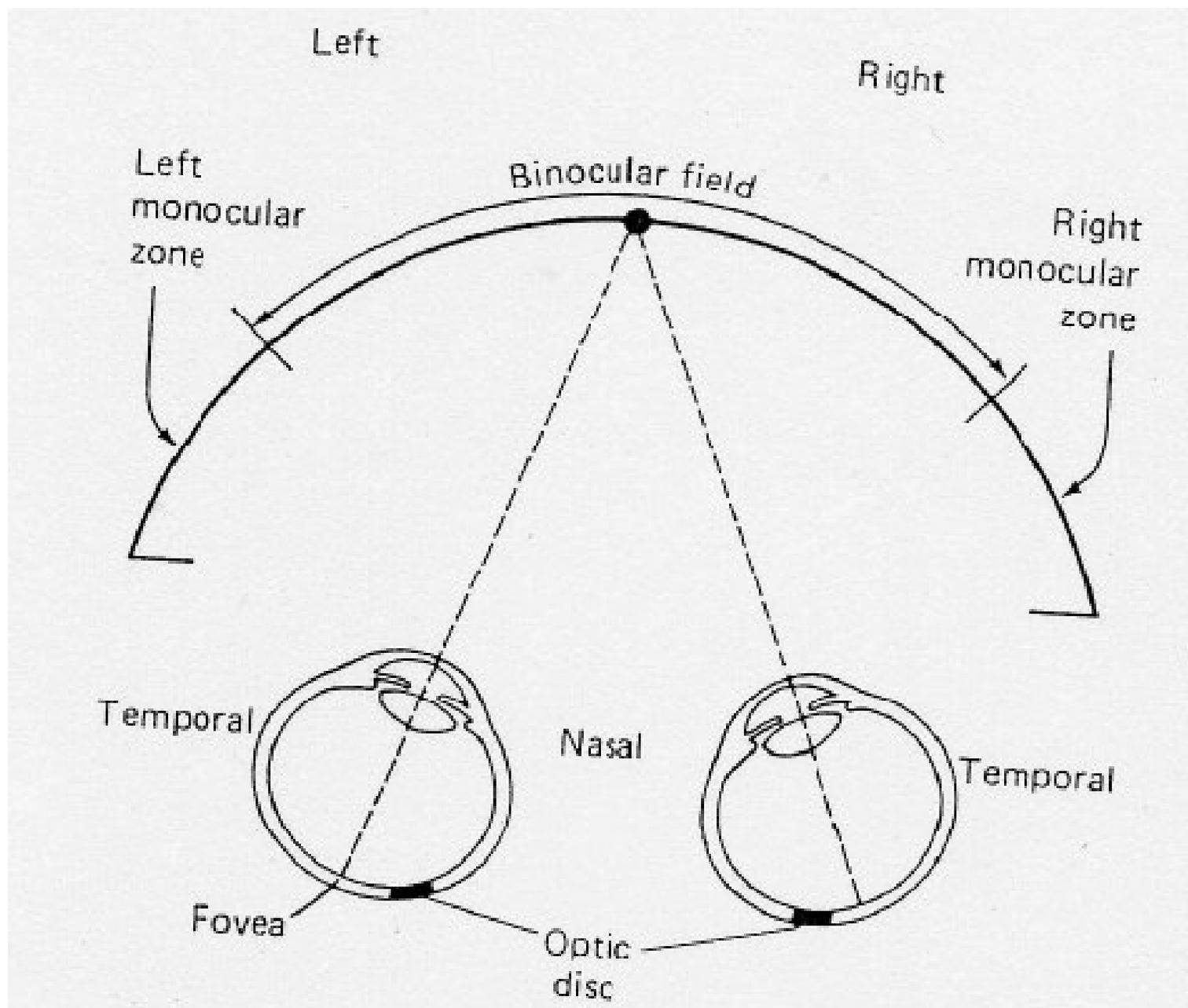


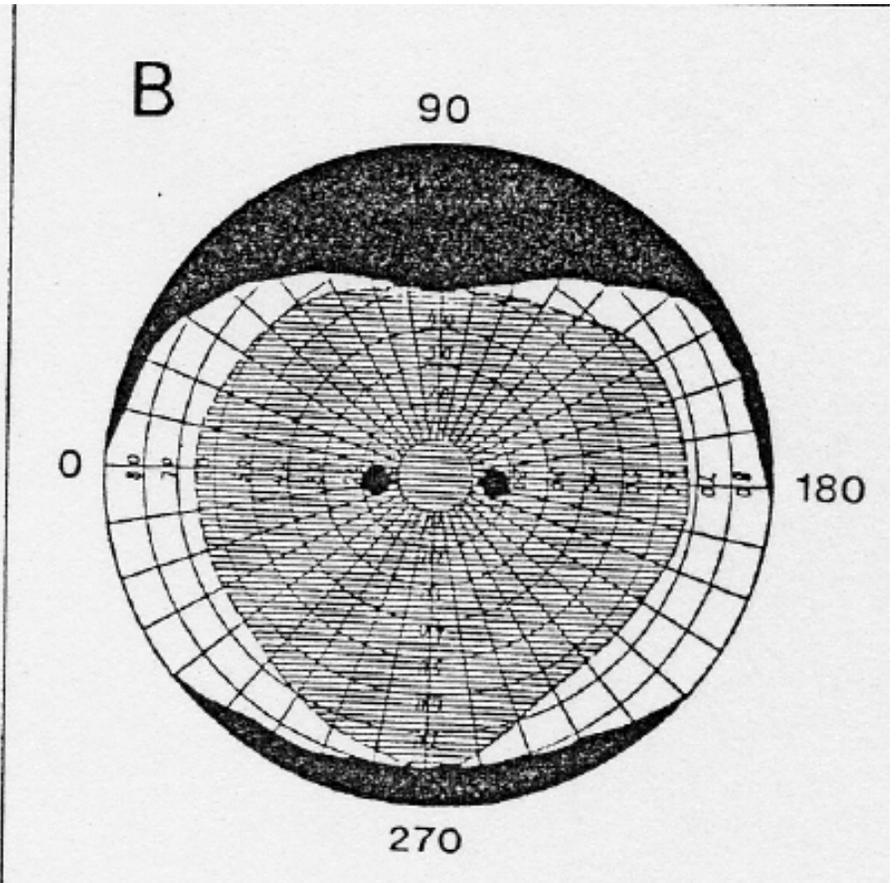
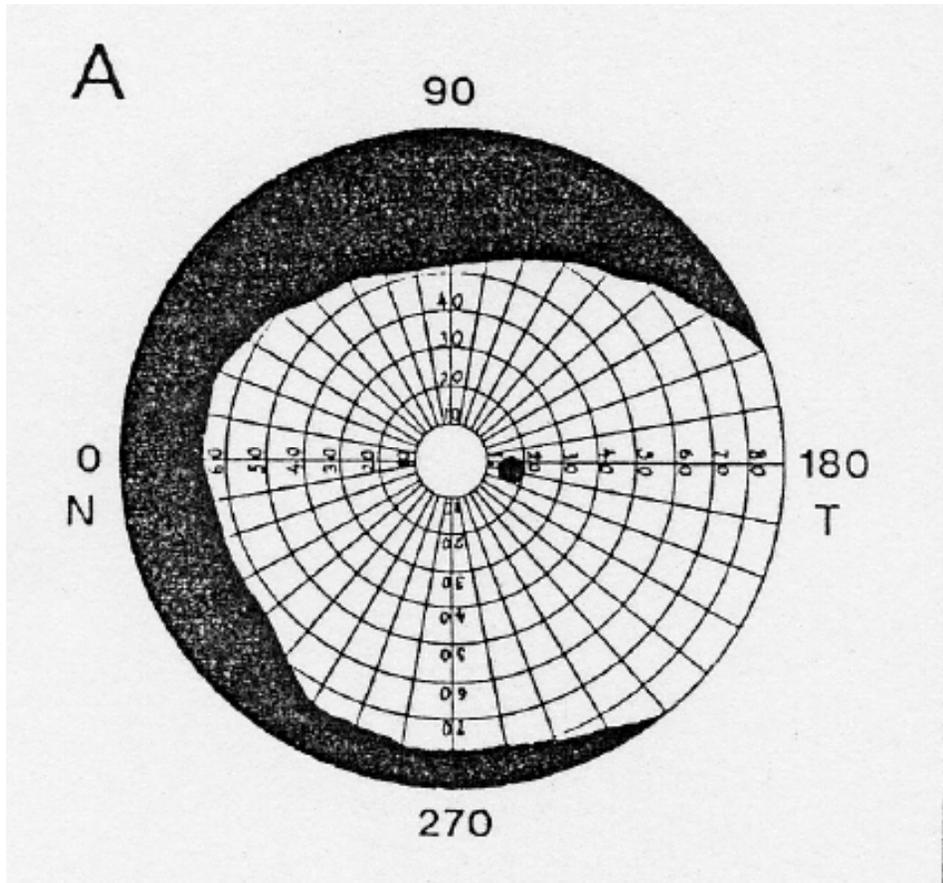
Here one cannot focus on far targets.  
One is near sighted & needs a  
concave lens.



Here one cannot focus on near targets.  
One is far sighted & needs a convex  
lens.







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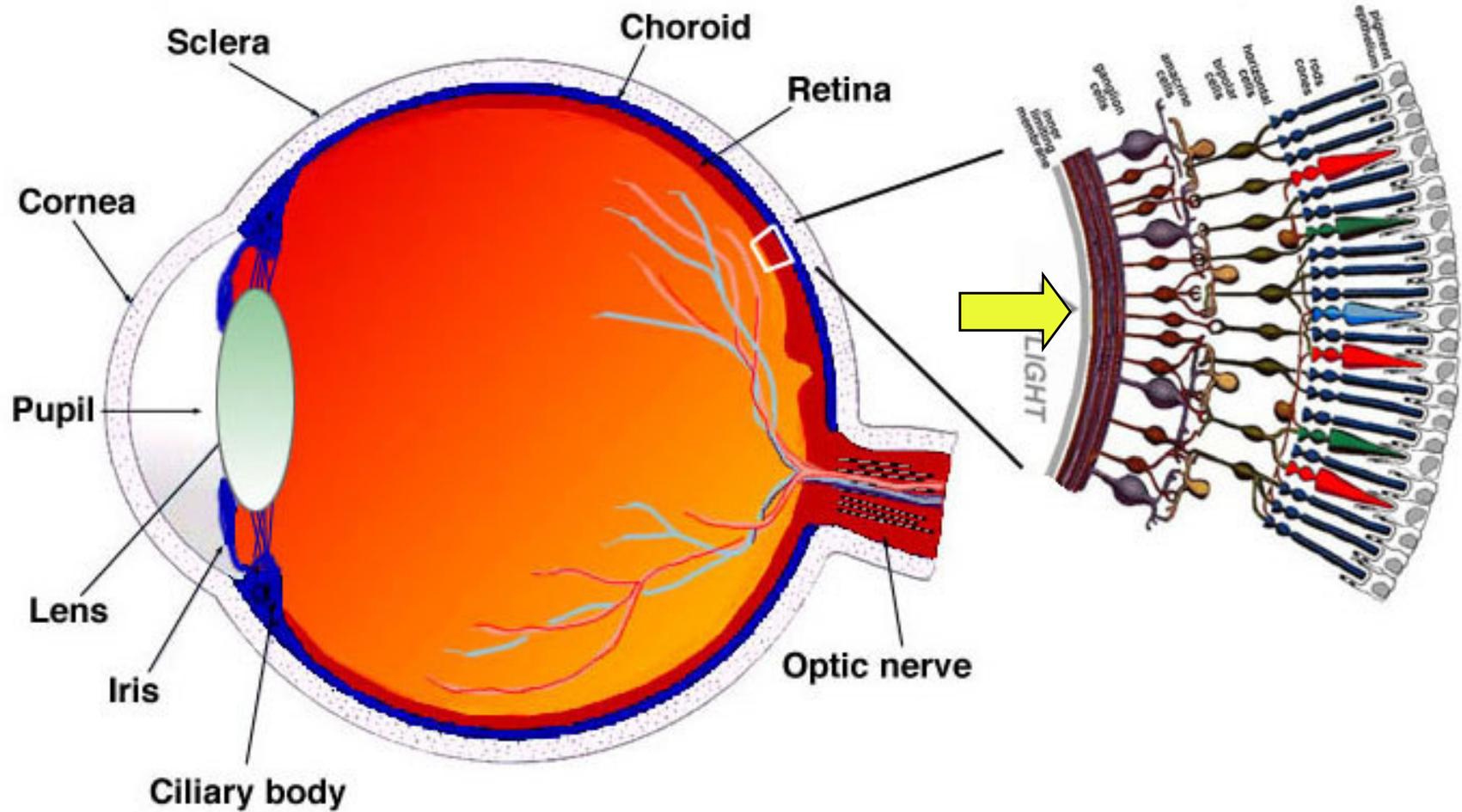
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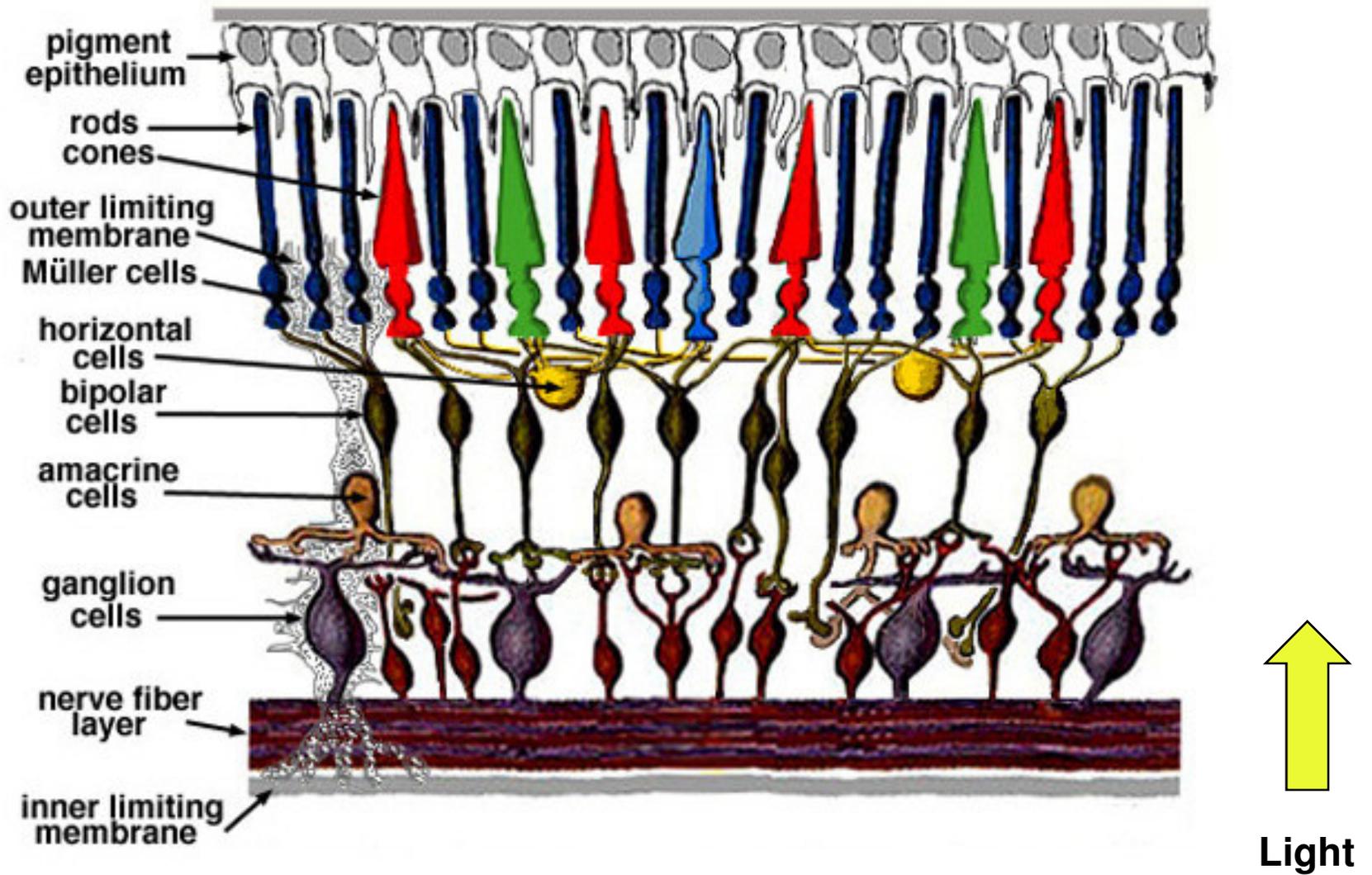
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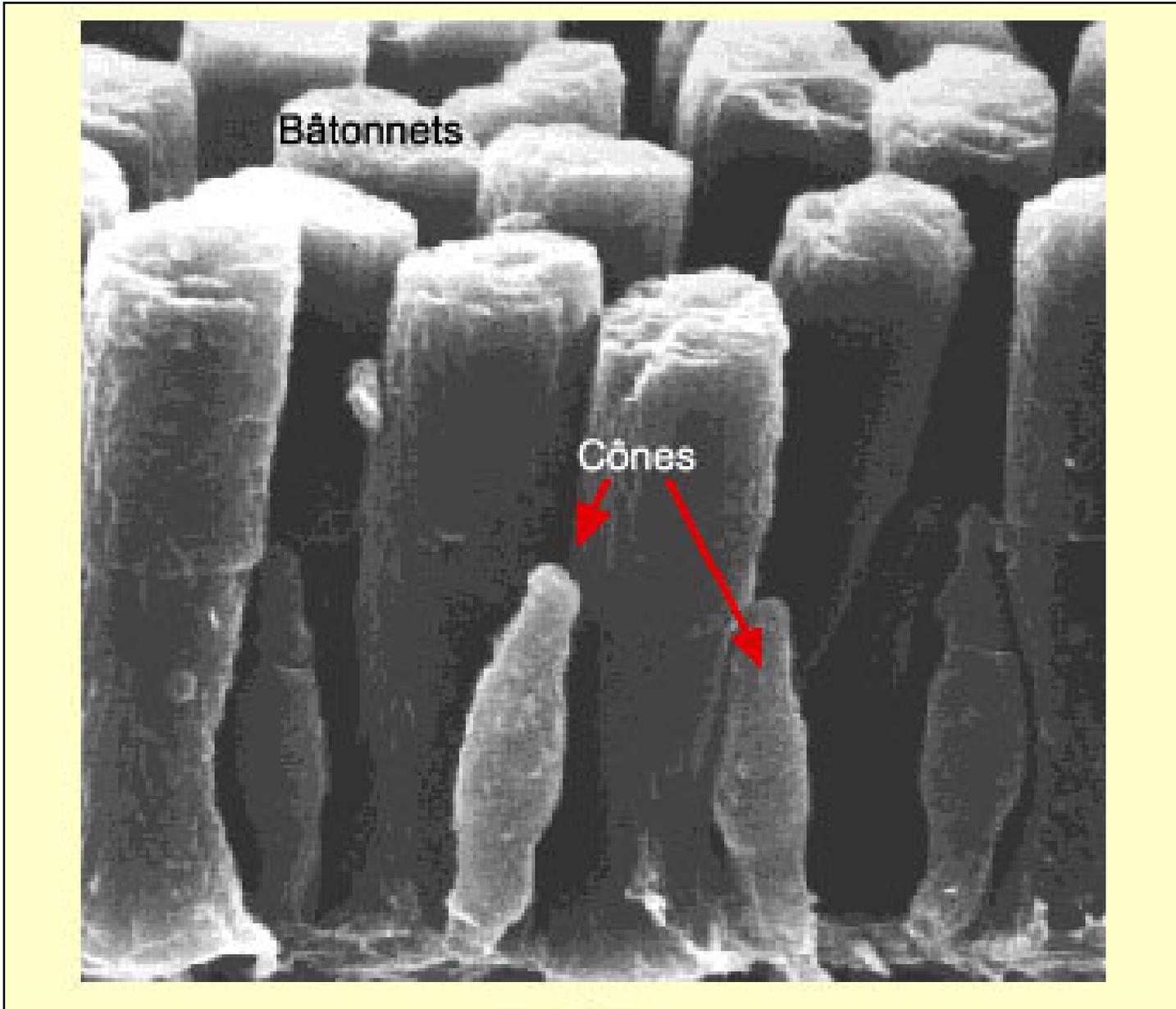
## 4. Conclusion



**Fig. 1.1.** A drawing of a section through the human eye with a schematic enlargement of the retina.



*Fig. 2. Simple diagram of the organization of the retina.*



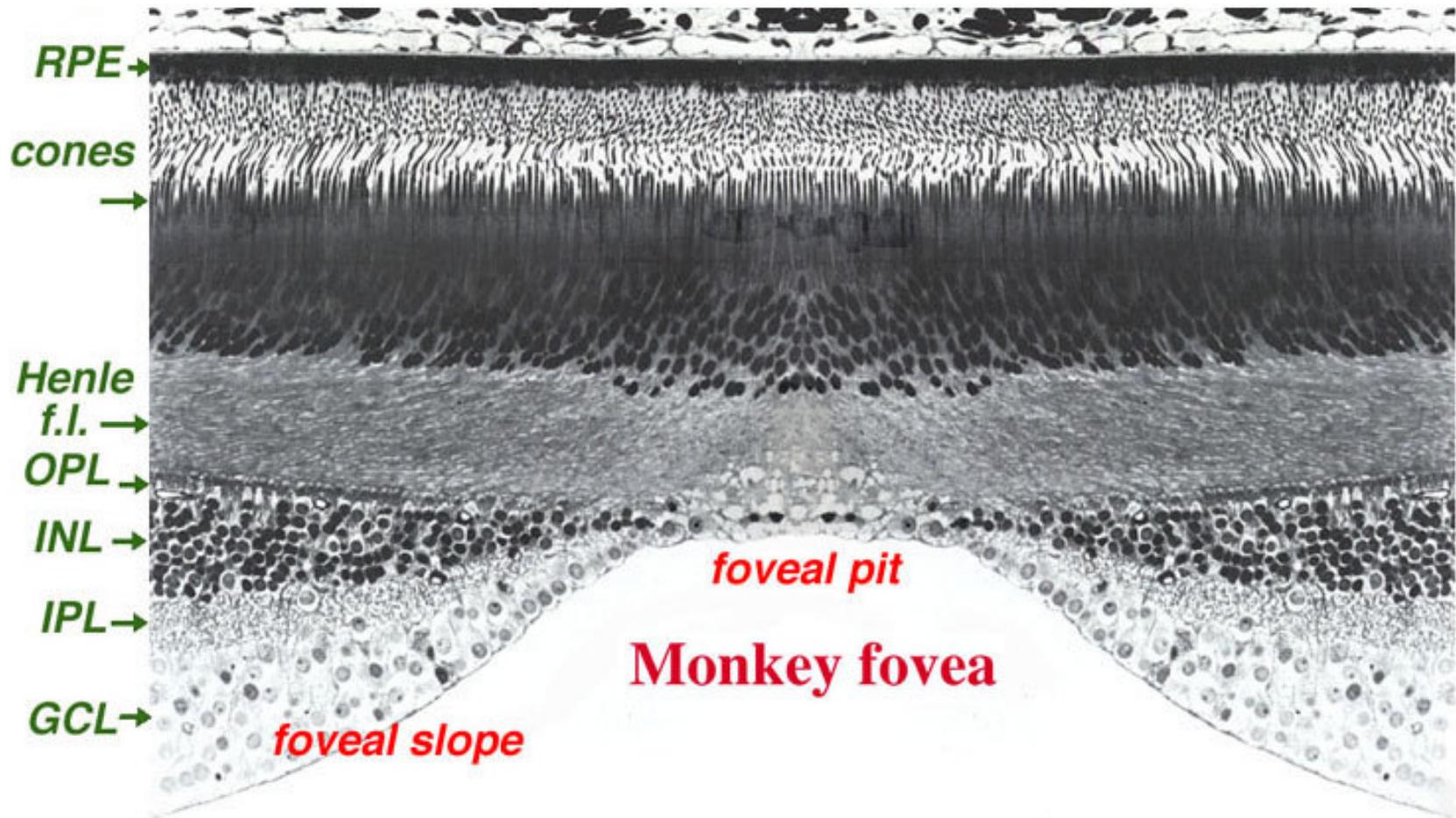


Fig. 12b. Vertical section of the monkey fovea from Hagerman and Johnson (1991).

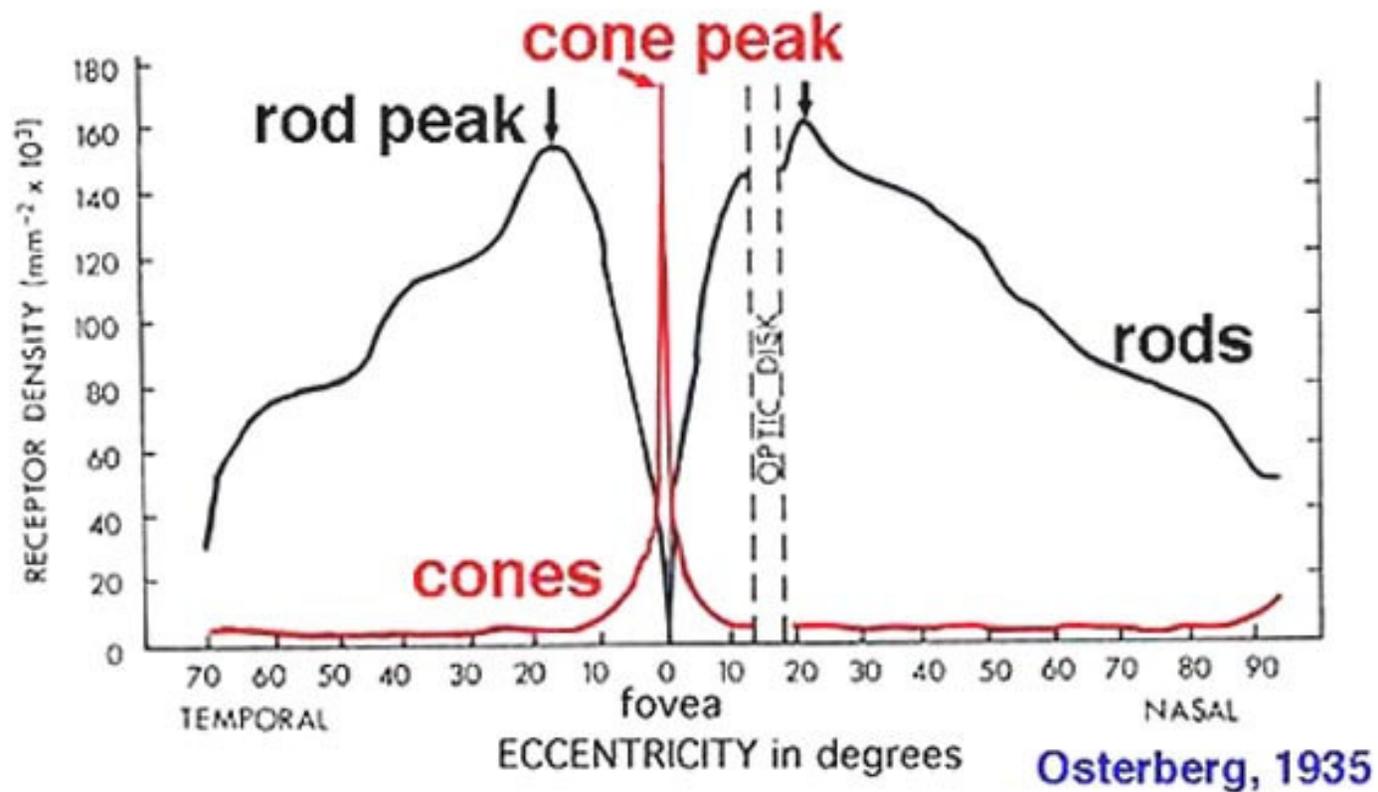


Fig. 20. Graph to show rod and cone densities along the horizontal meridian.

isodensity maps  
of cone densities (X1000)  
in the human retina

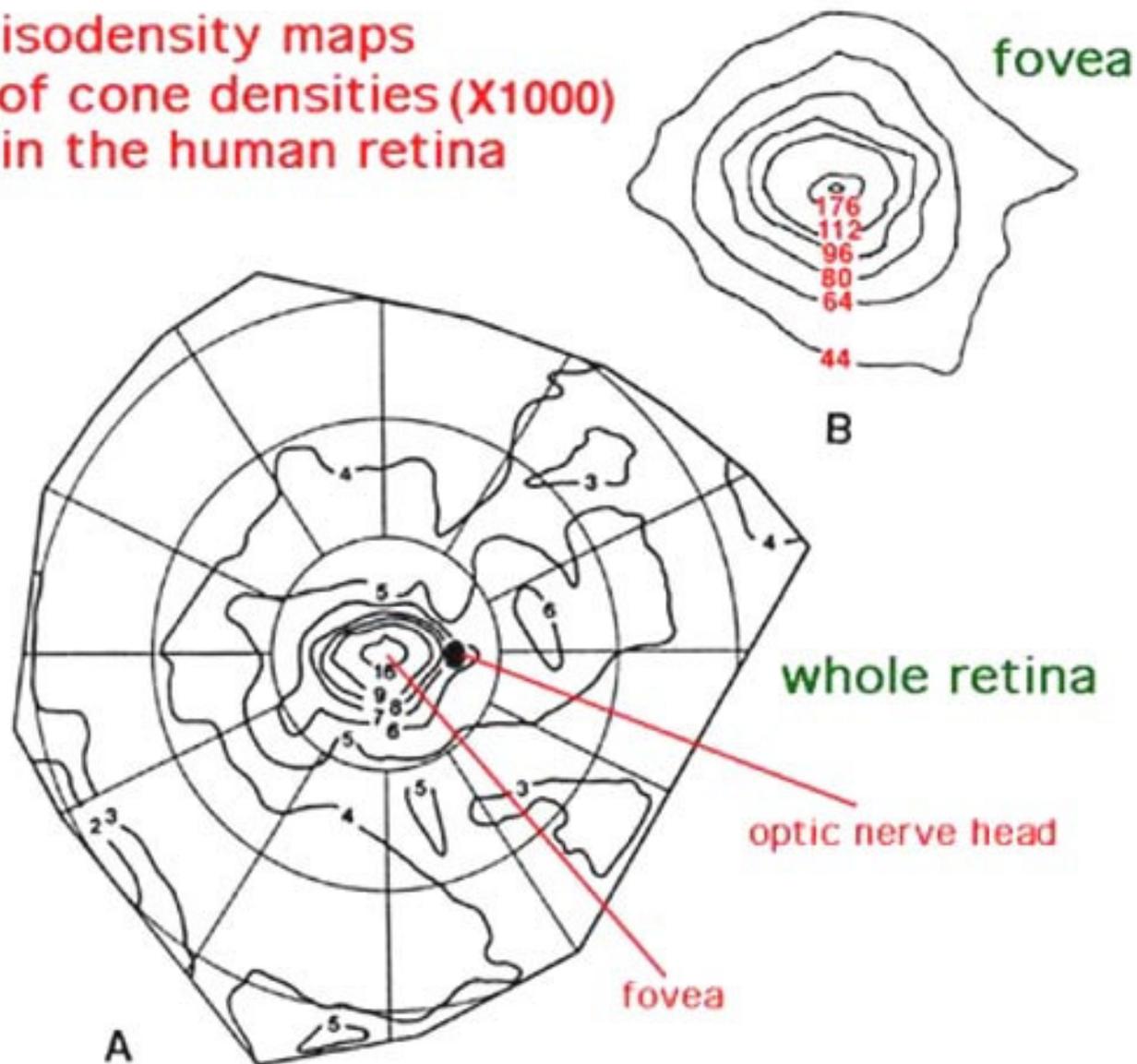
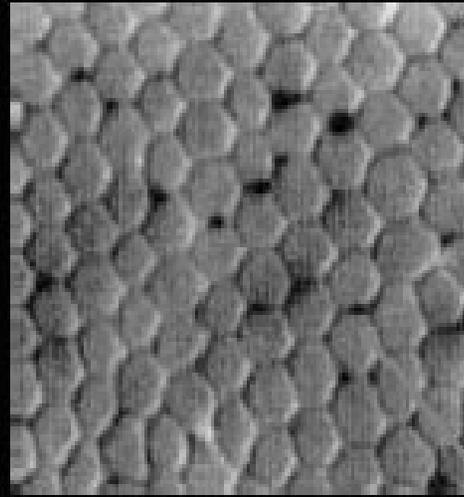
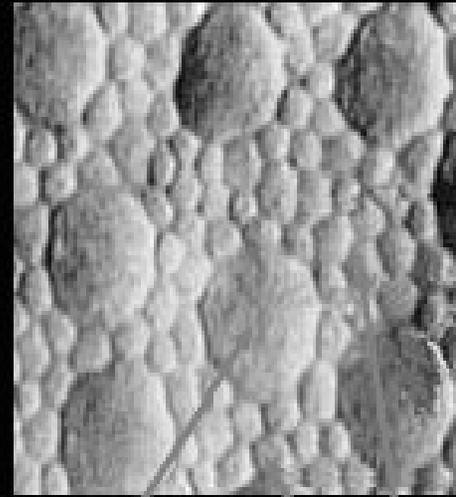


Fig. 21. Cone densities in human retina as revealed in whole mount. The foveal area is enlarged in B. (from Curcio et al., 1987).

Fovea



Periphery

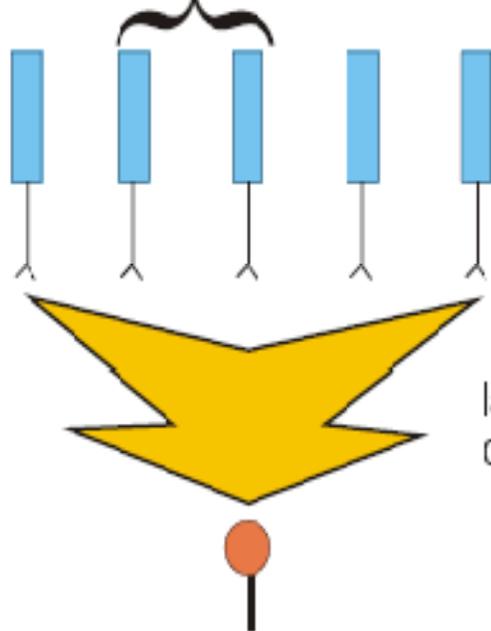


Cones

Rods

In the fovea, there are only cones (small ones) that are packed in a hexagonal pattern. In the periphery, there are large cones and lots of rods.

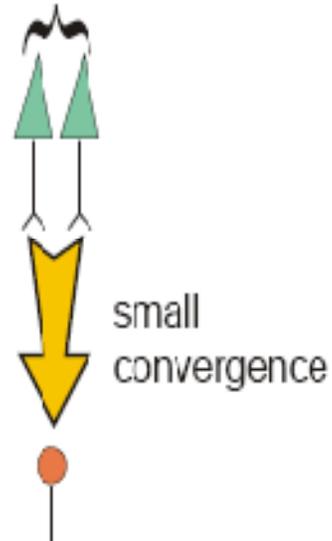
peripheral rods  
large spacing (lower density)



Ganglion cells integrate information  
from a large area of retina (3 deg)

large spacing and large convergence  
results in low acuity

foveal cones  
high density



Ganglion cells integrate information  
from a small area of retina (.03 deg)

small spacing and low convergence  
results in high acuity.

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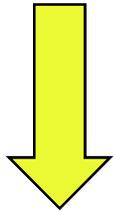
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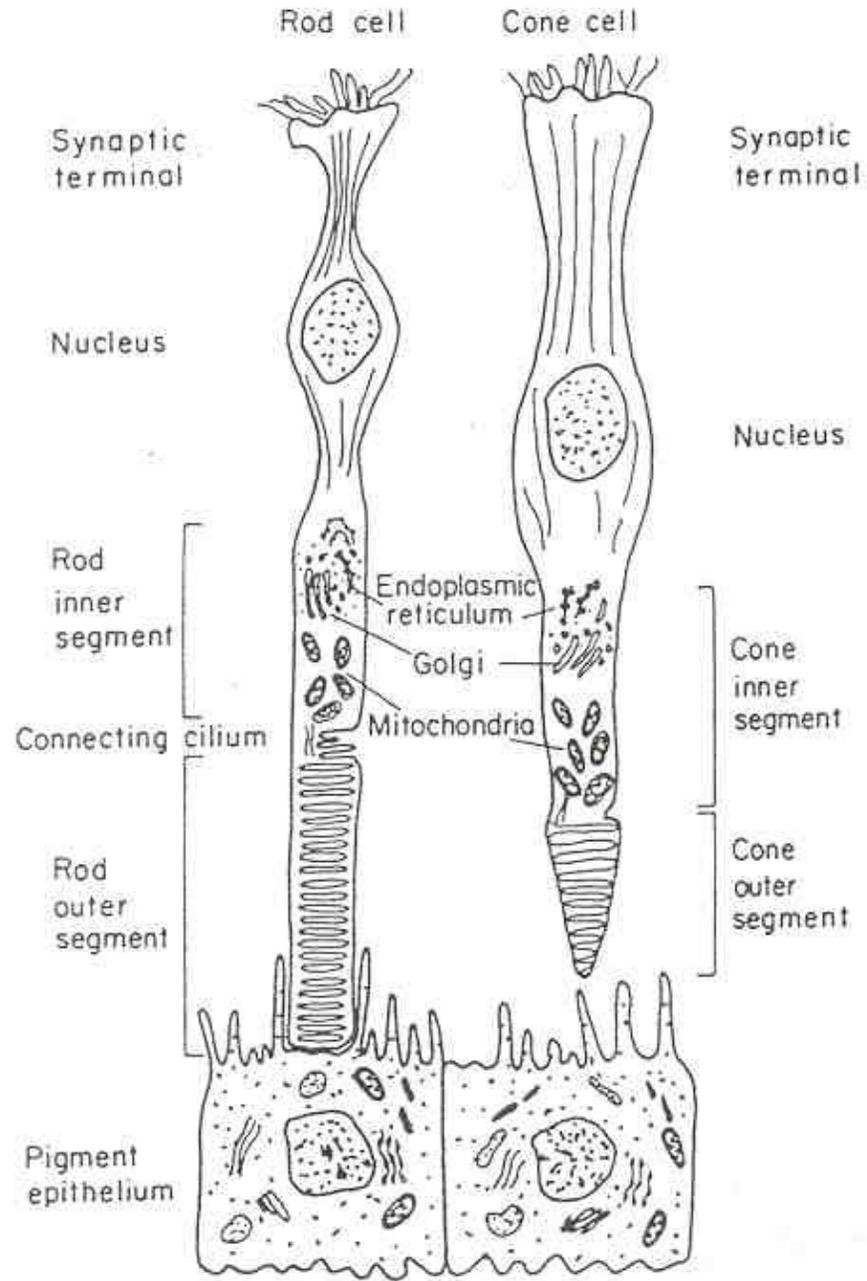
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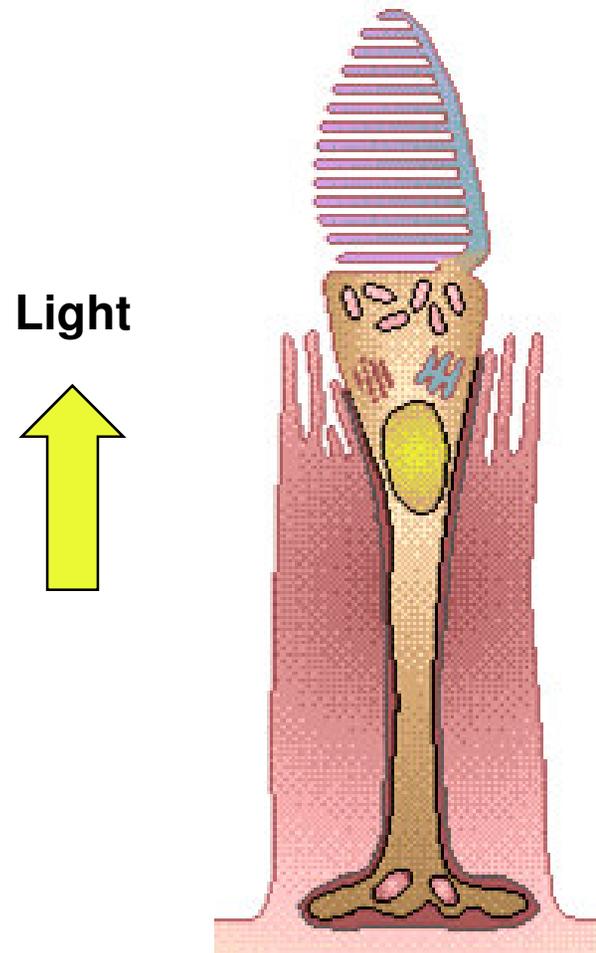
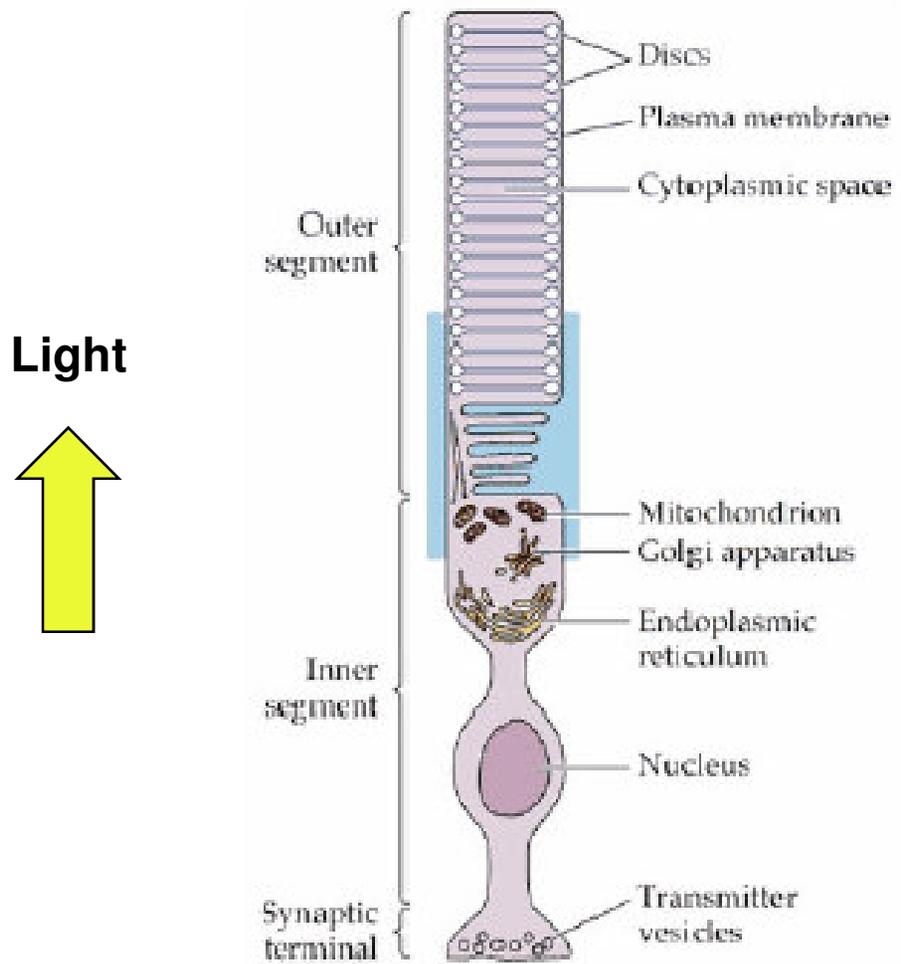
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Light





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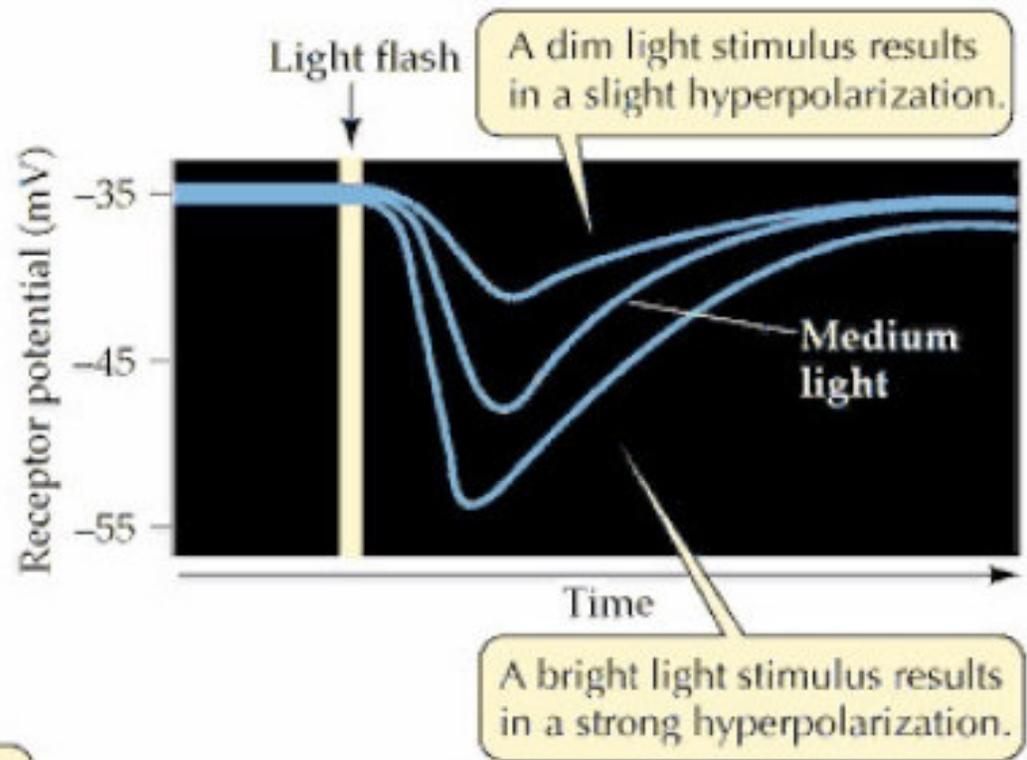
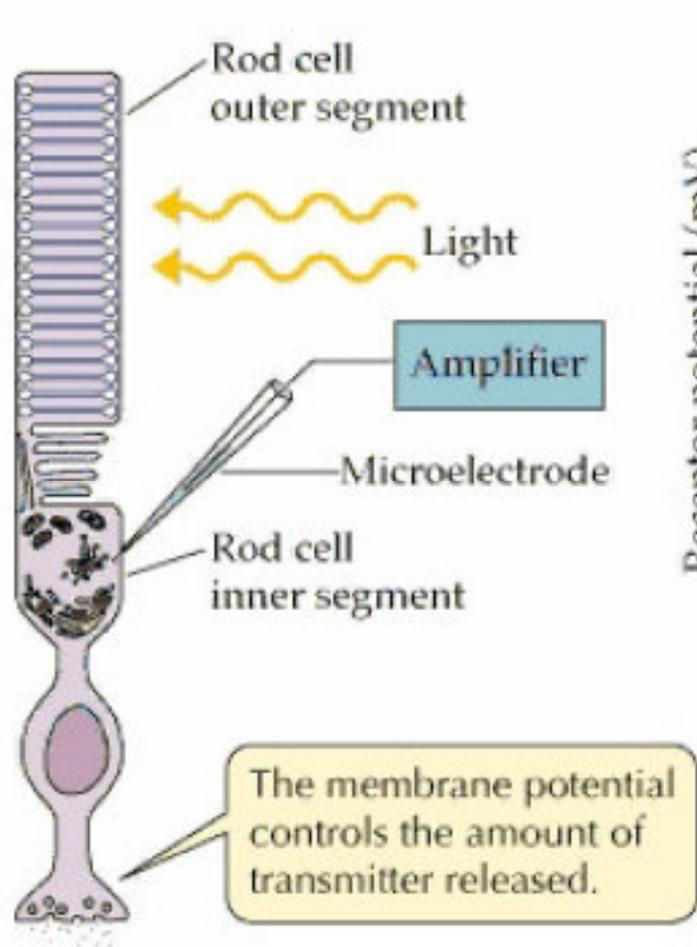
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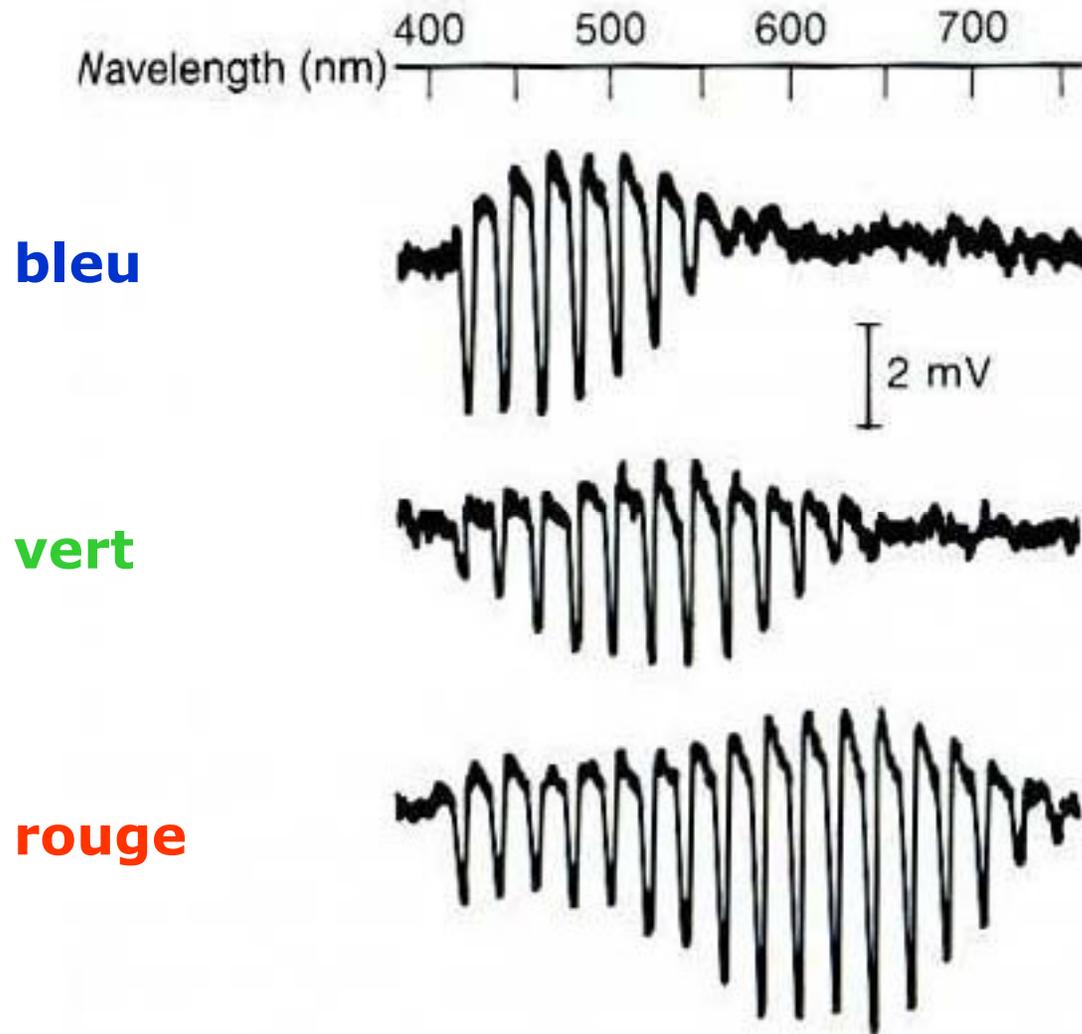
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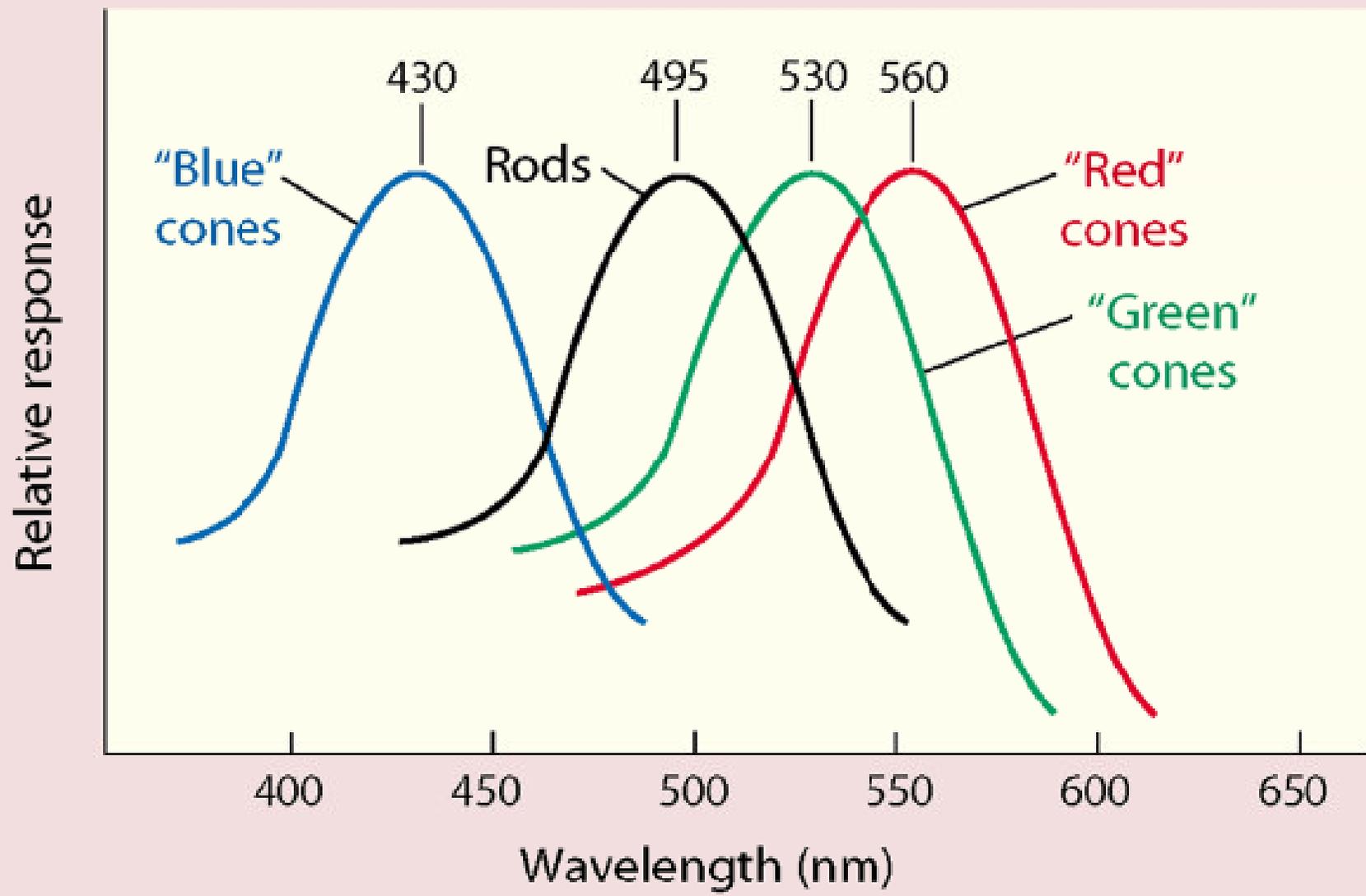
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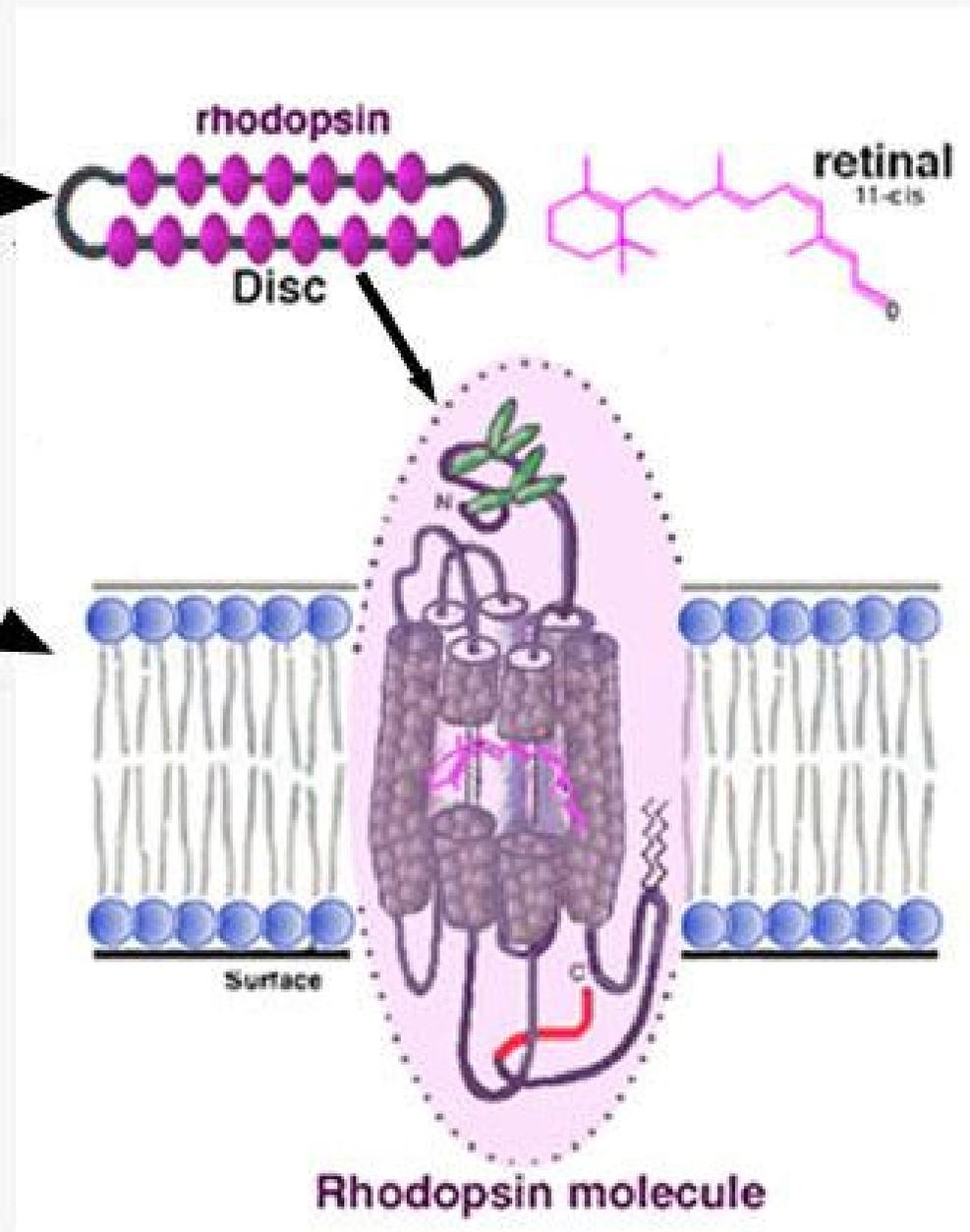
# Les cônes

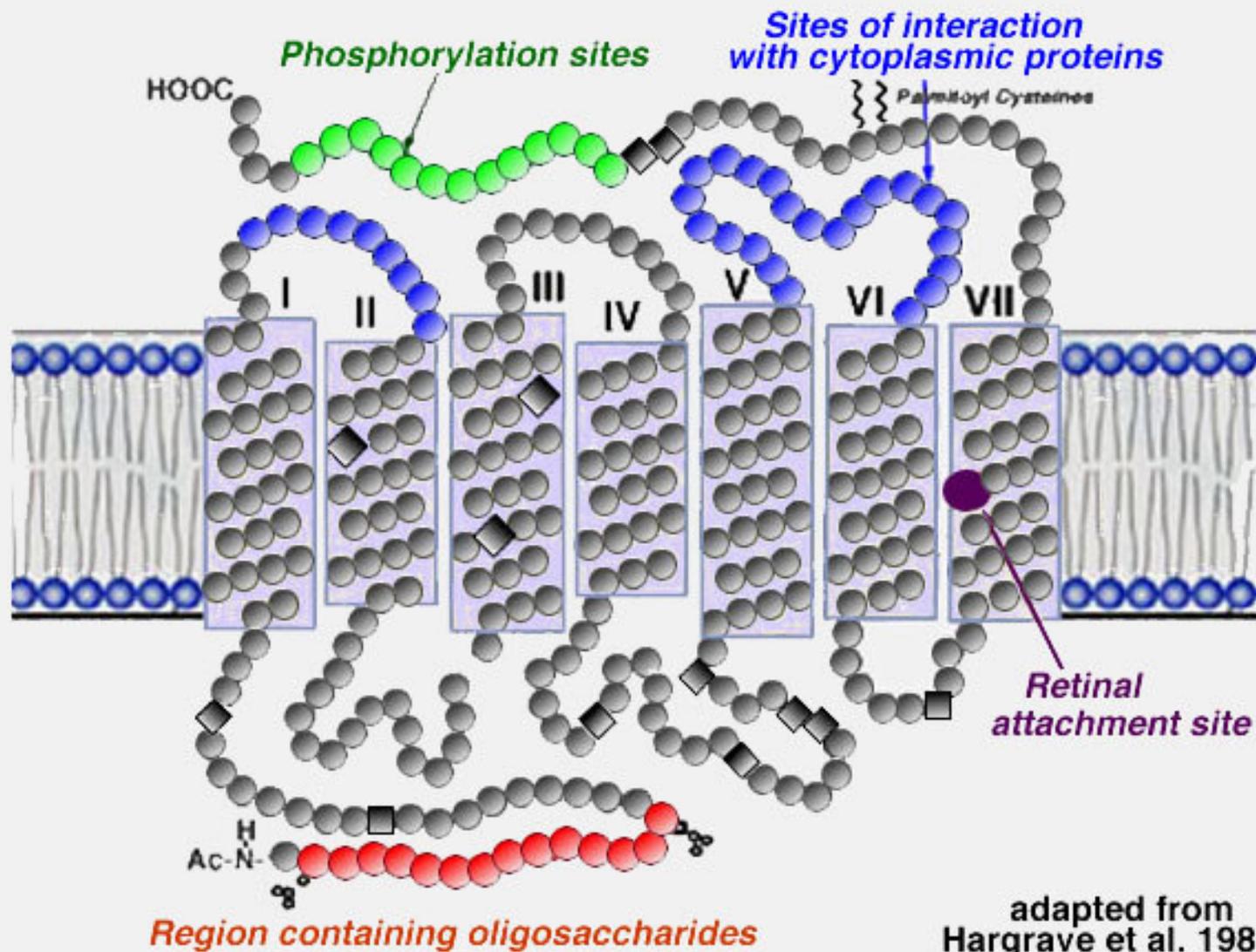




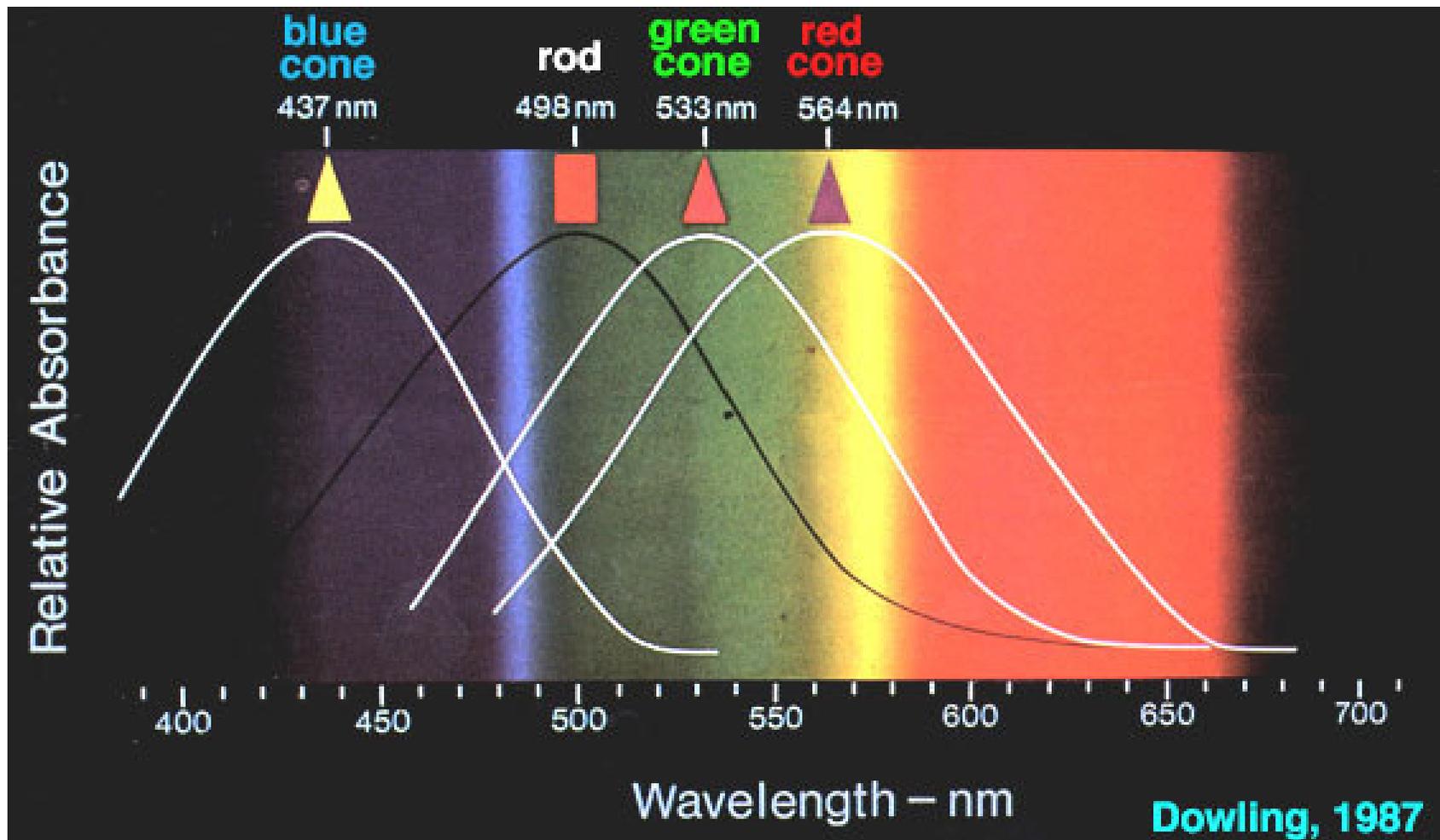


**outer segment**

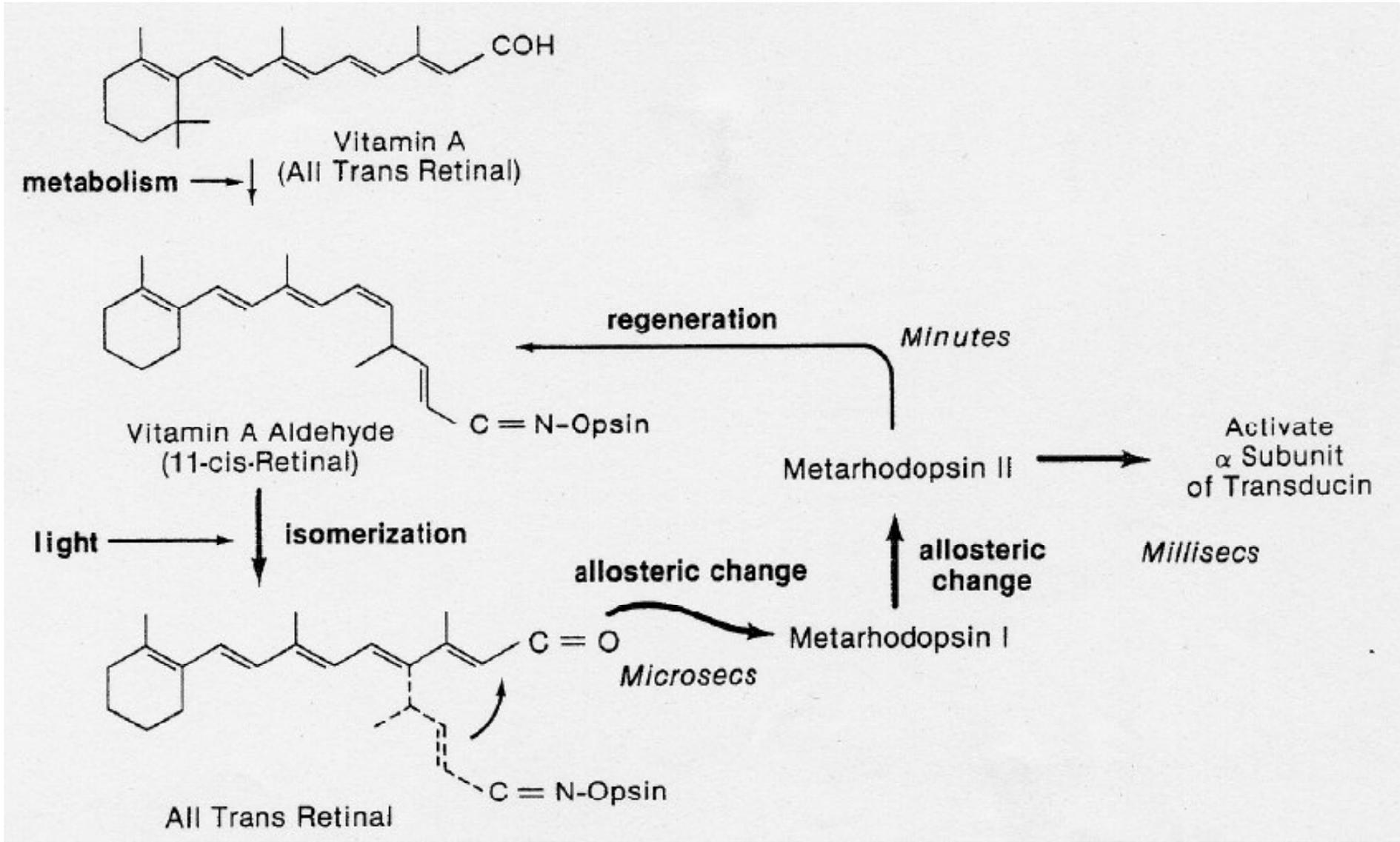


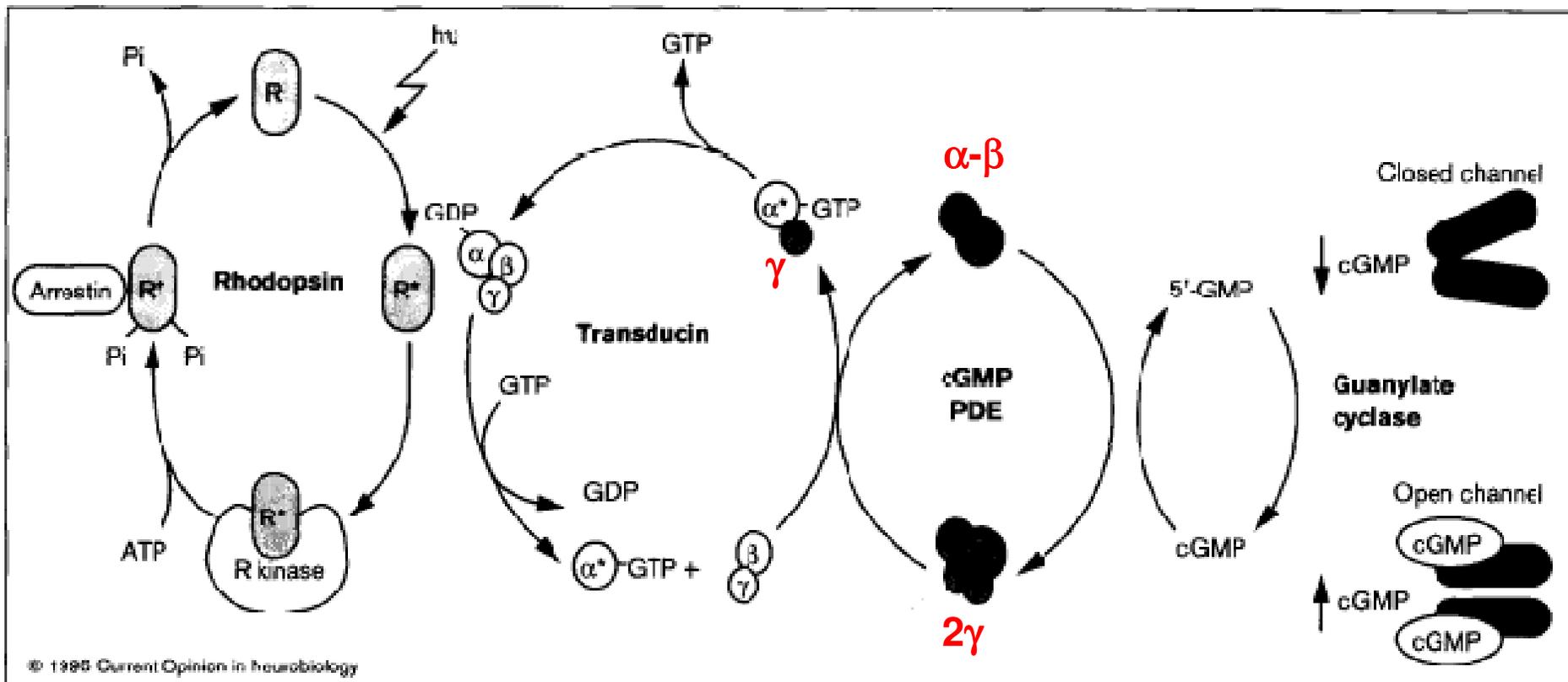


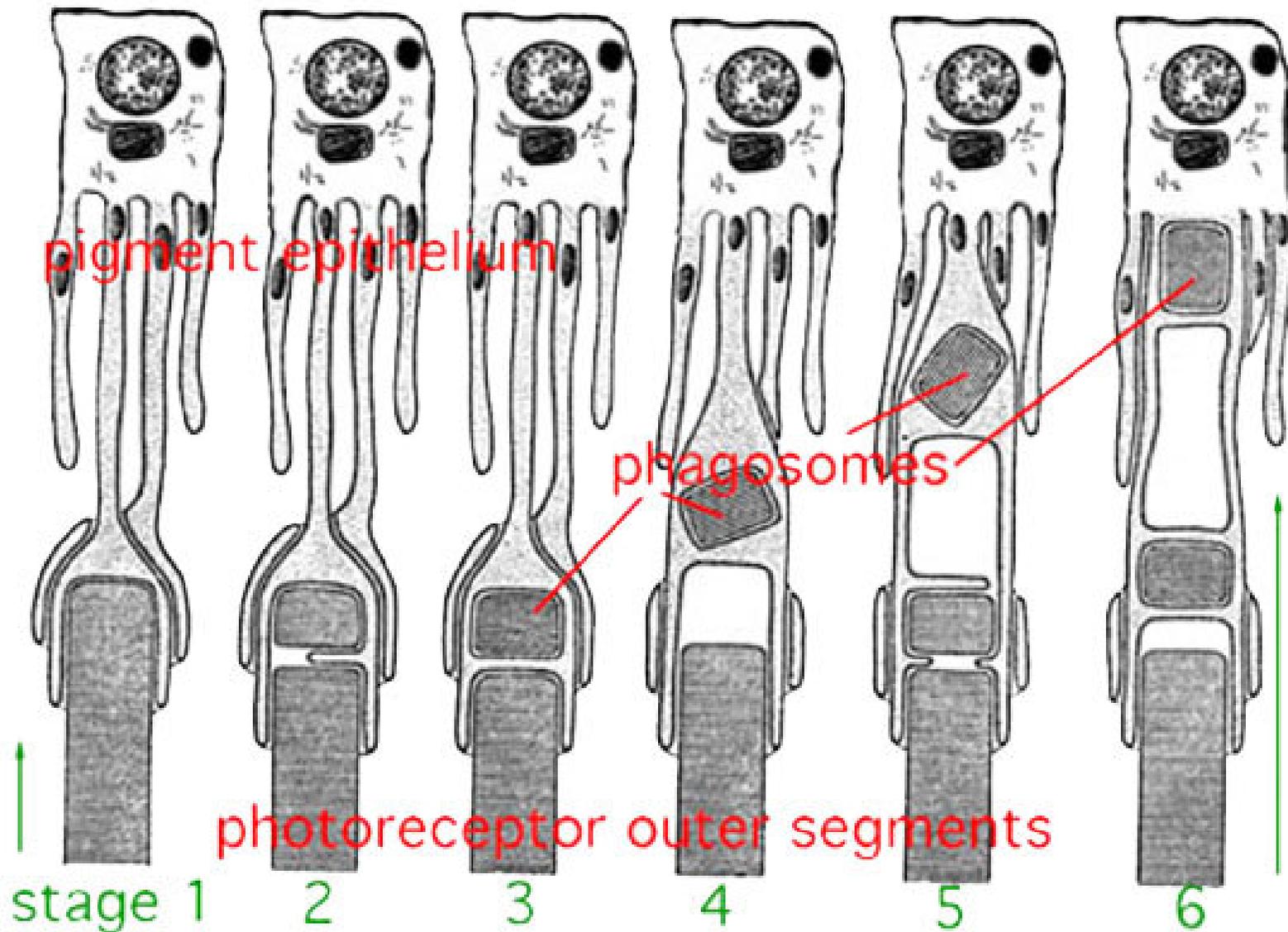
**Fig. 9. Structural model of rhodopsin showing seven transmembrane components and the attachment site for retinal.**



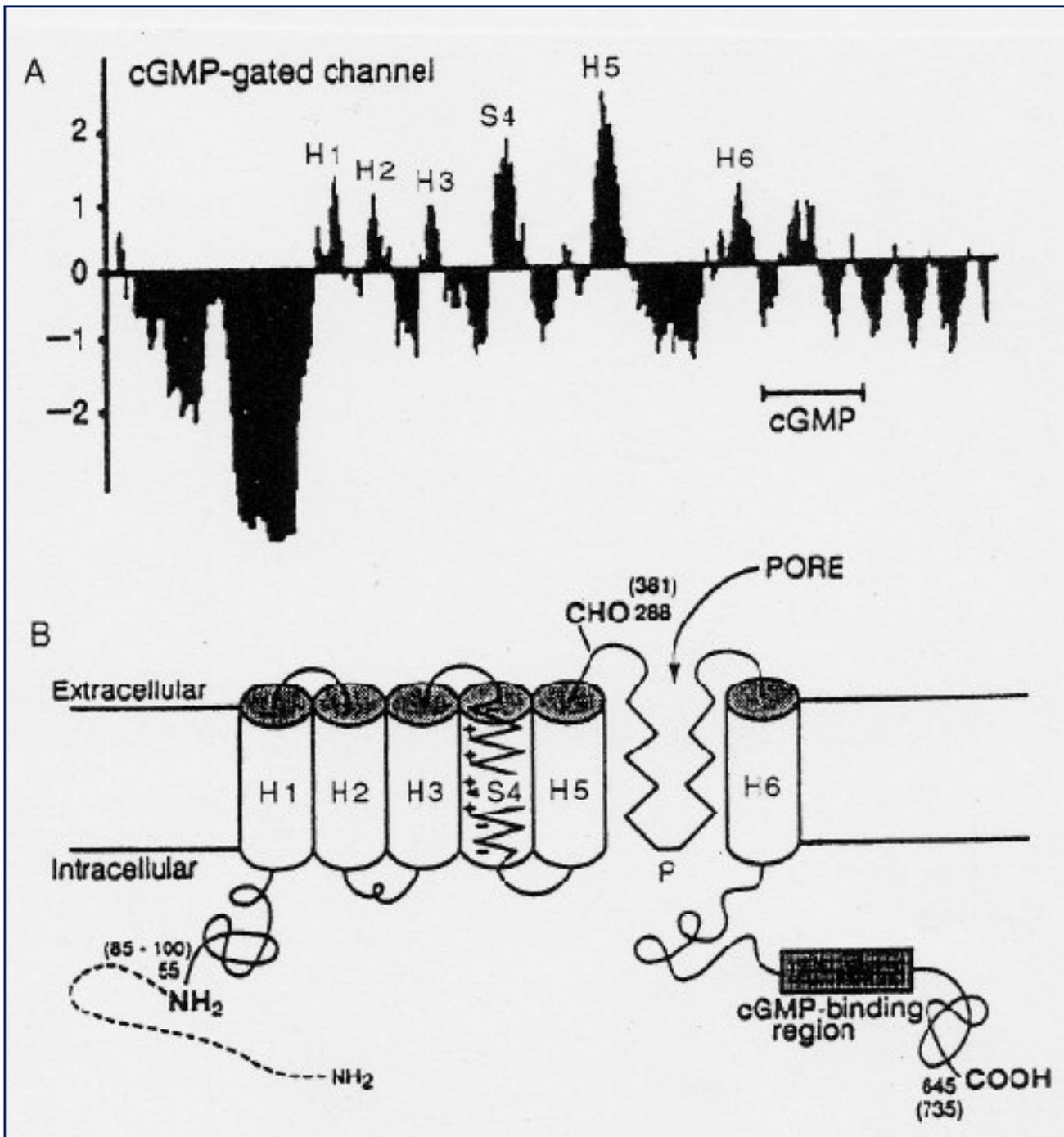
**Fig. 14.** *The peak spectral sensitivities of the the 3 cone types and the the rods in the primate retina (Brown and Wald, 1963). From Dowling's book (1987).*







**Fig. 12. Diagrammatic representation of disc shedding and phagosome retrieval into the pigment epithelial cell.**



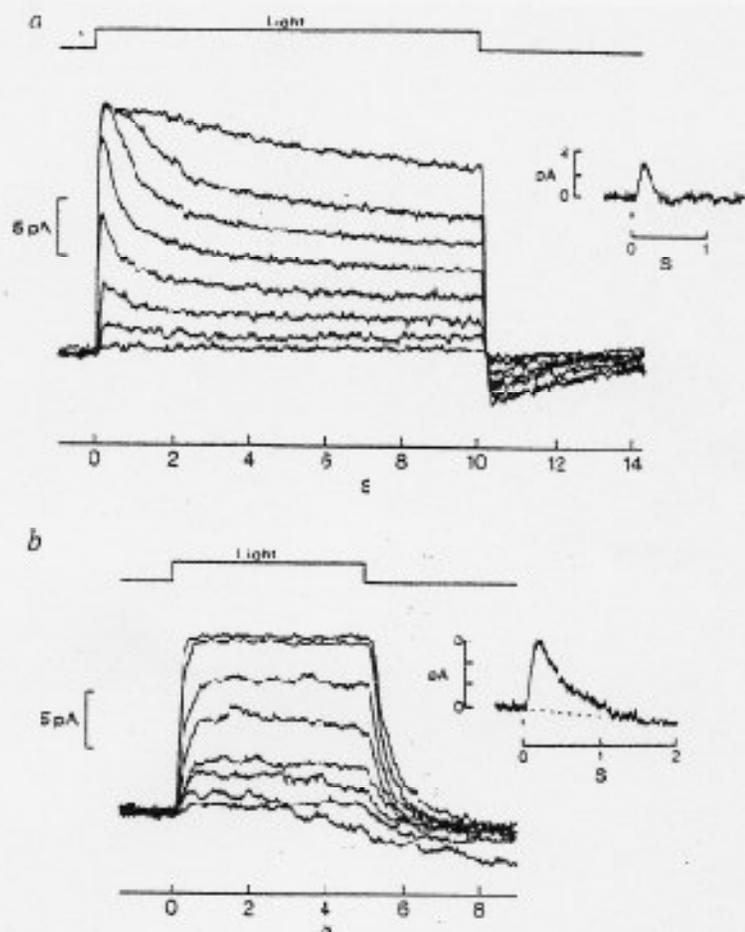
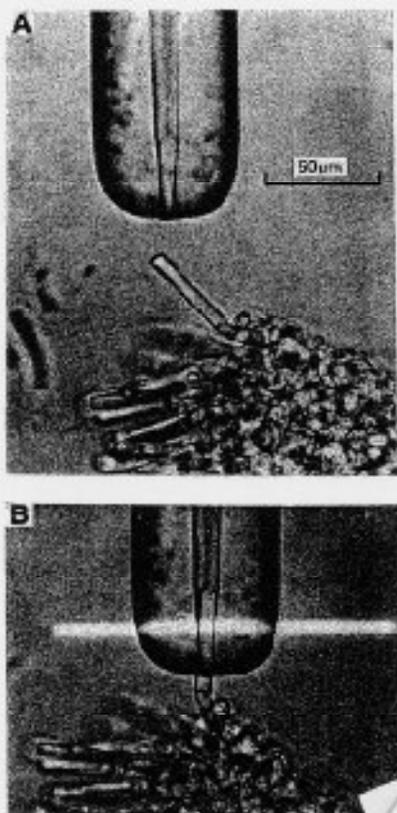
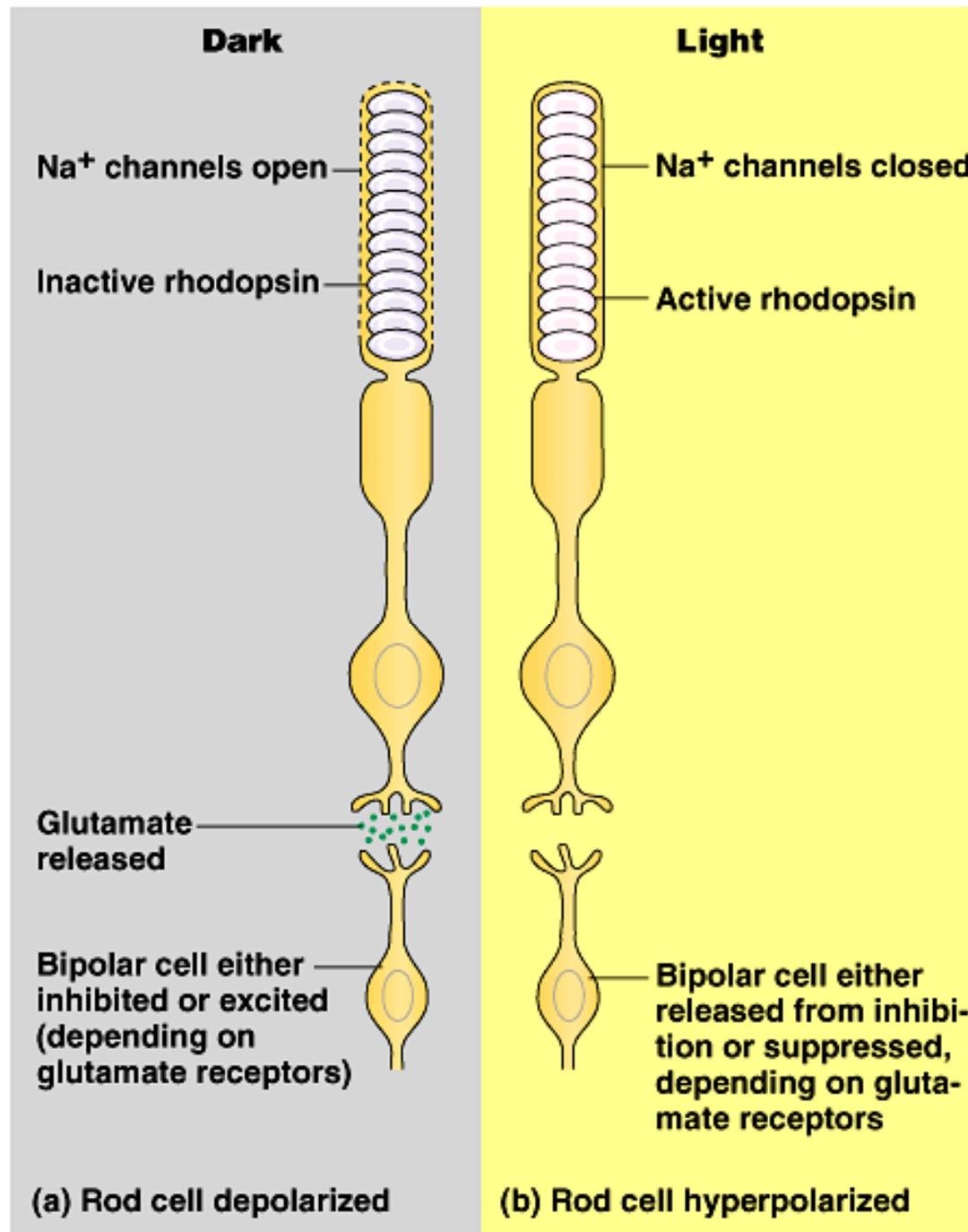


Fig. 3 Response-intensity families recorded from two cones, one in normal Ringer's solution (*a*) and the other in the test solution with the  $\text{Ca}^{2+}$  feedback removed (*b*). Single trials in all traces, 620 nm light throughout. The dark current in *a* was very stable throughout the experiment, but that in *b* showed some variations between light steps. To compensate for these variations in dark current, each response amplitude plotted in Fig. 4 has been normalized against the dark current amplitude at the time the response was elicited. Insets, averaged responses of the cones to dim flashes in the control and the test solutions. From calculations, the normalized flash sensitivity ( $k_f$ ) and the response integration time ( $t_i$ ) are  $3.0 \times 10^{-4} \text{ photon}^{-1} \mu\text{m}^2$ , 0.19 s in *a* and  $5.8 \times 10^{-4} \text{ photon}^{-1} \mu\text{m}^2$ , 0.45 s in *b*.



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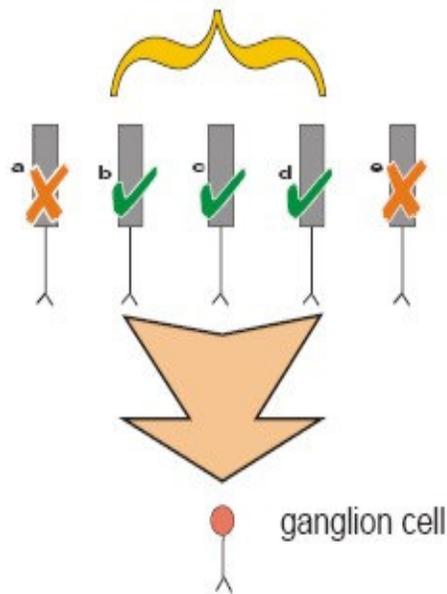
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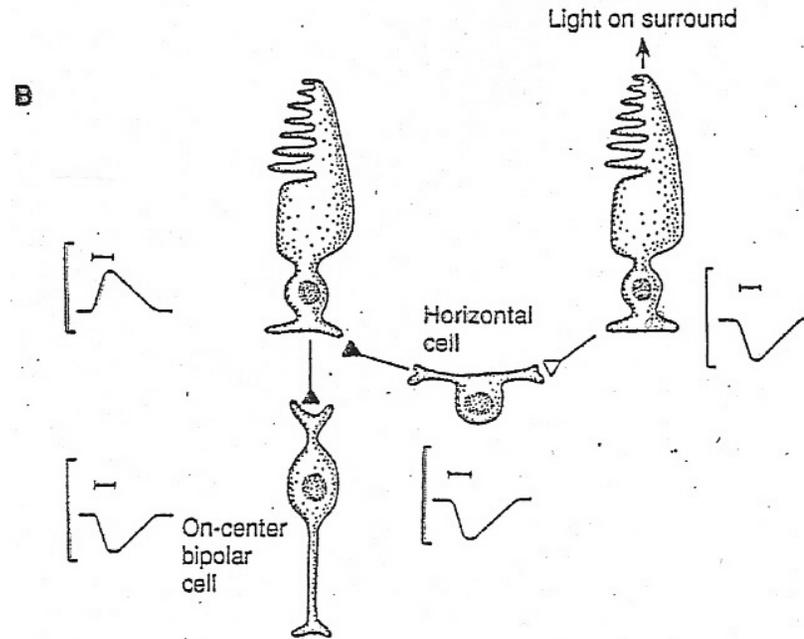
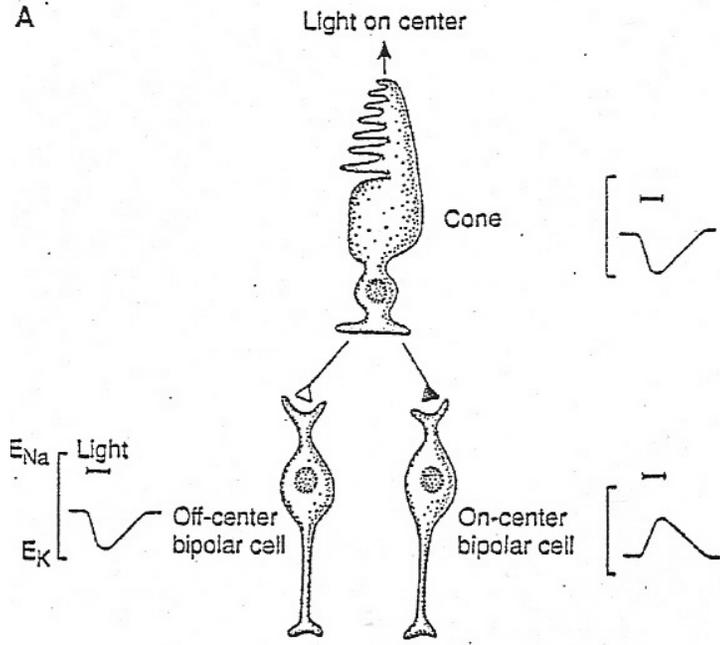
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b, c, and d are in the receptive field of this ganglion cell

a, and e are out of the receptive field of this ganglion cell



### Neural Mechanisms

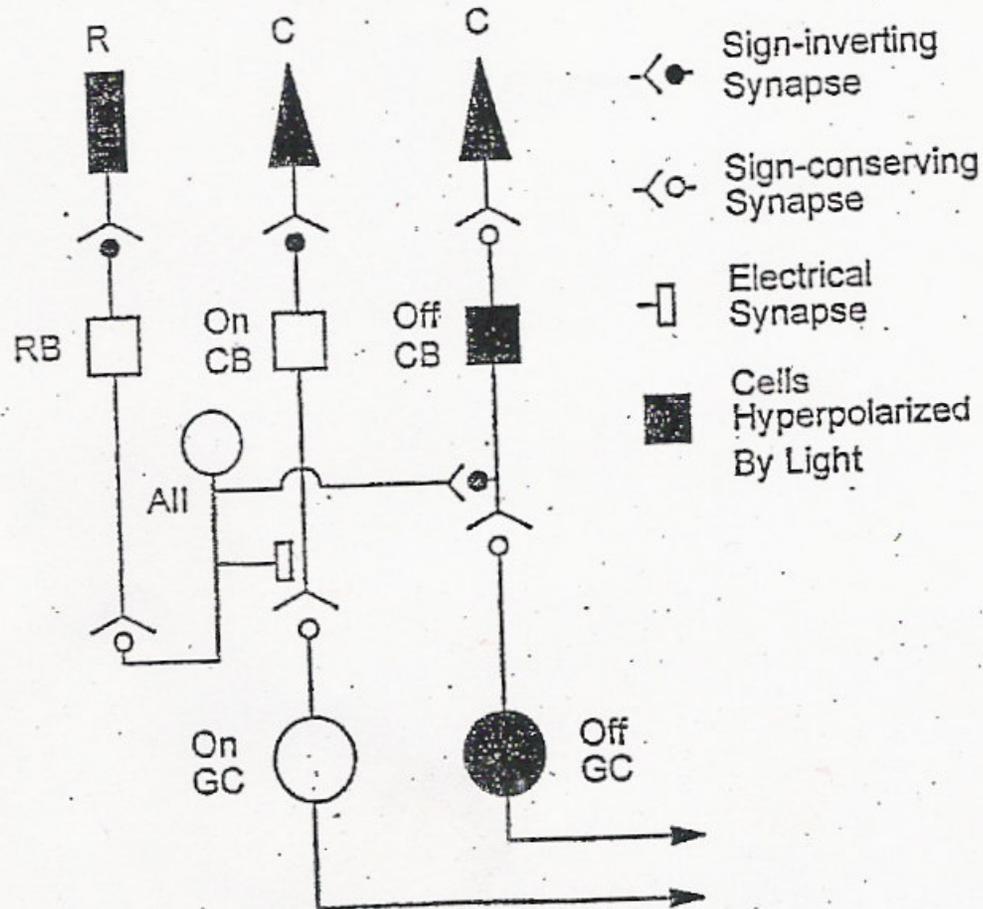
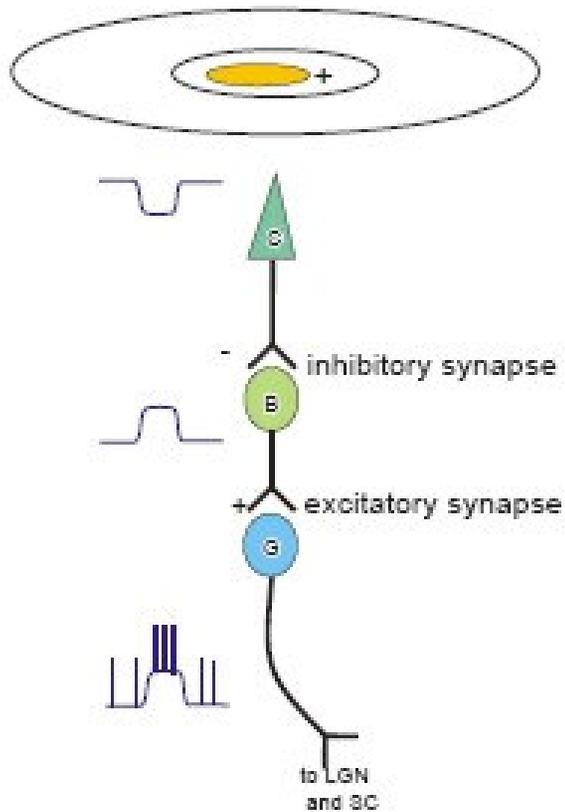
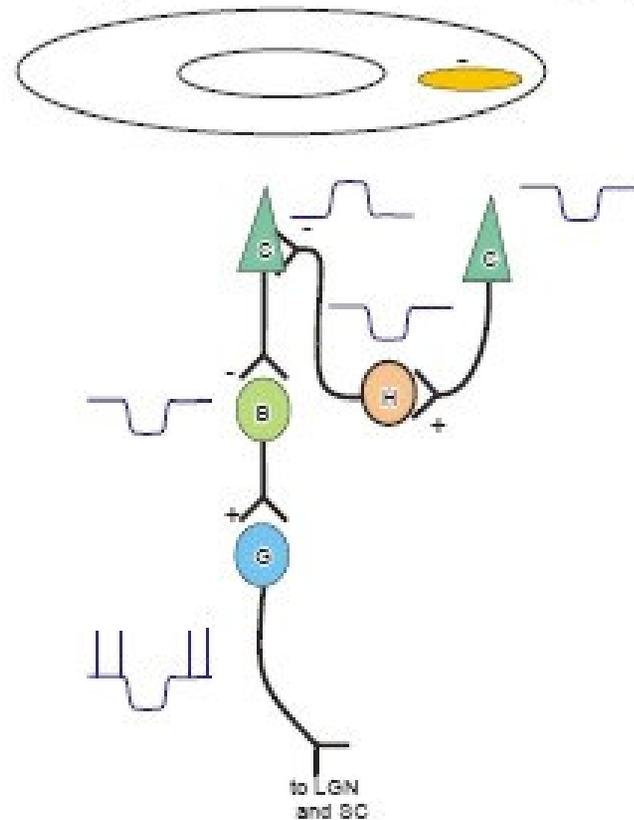


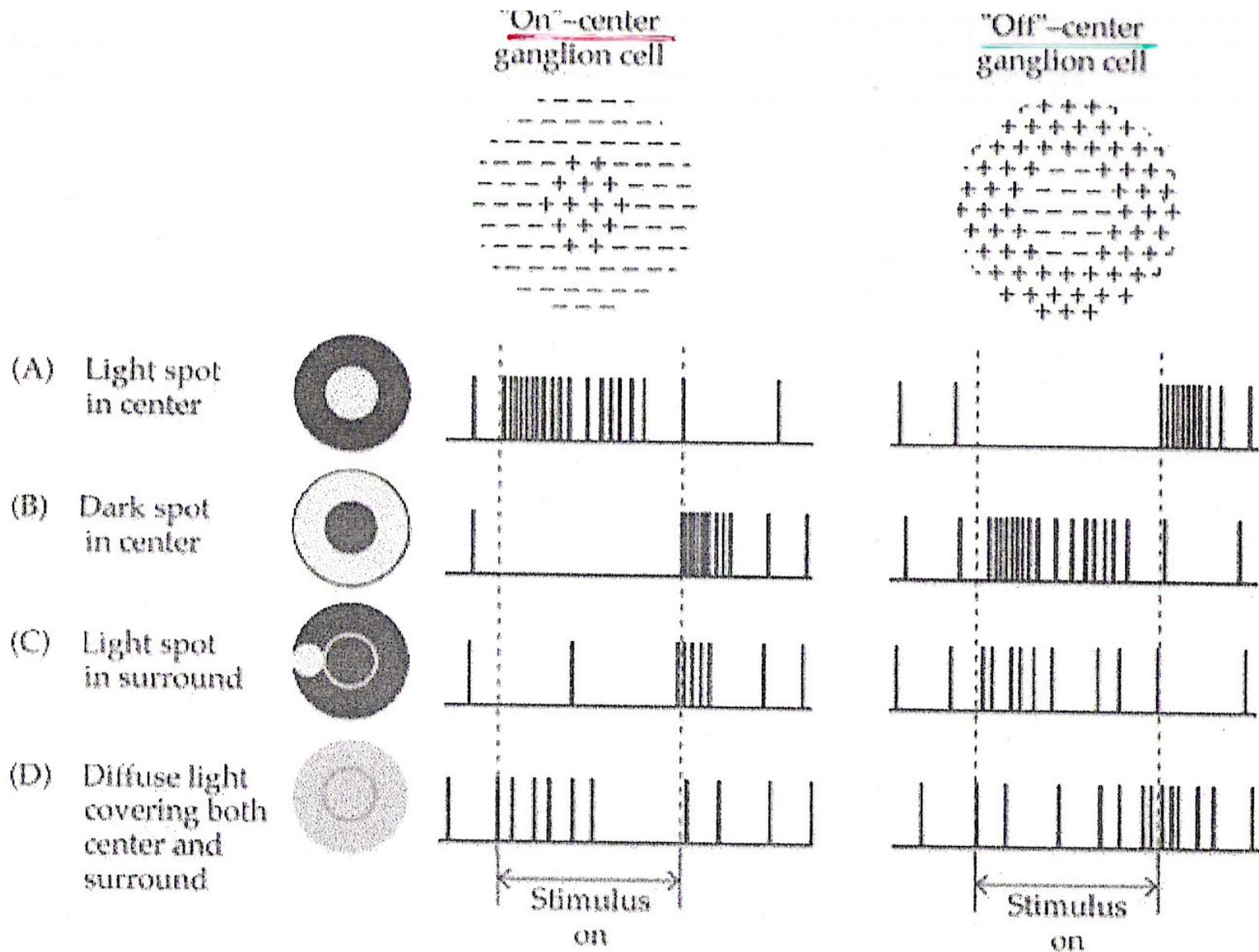
Figure 6.9. Circuitry of the mammalian rod pathway. R, rod; C, cone; RB, rod bipolar; CB, cone bipolar; All, a specific type of amacrine cell; GC, ganglion cell.

Light to a cone in the centre produces excitation of the ganglion cell.



Light to a cone in the surround produces inhibition of the ganglion cell.





The response of "on"-center and "off"-center retinal ganglion cells to stimulation of different regions of their receptive fields.

## MACH BANDS

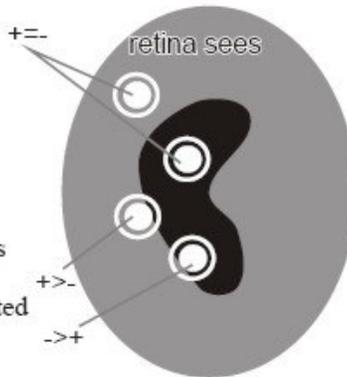
Seen



Perceived

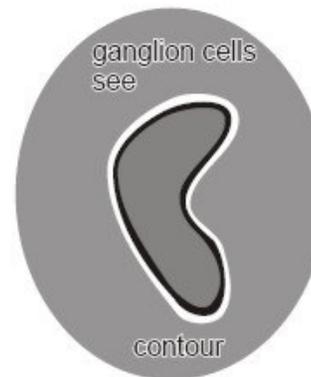


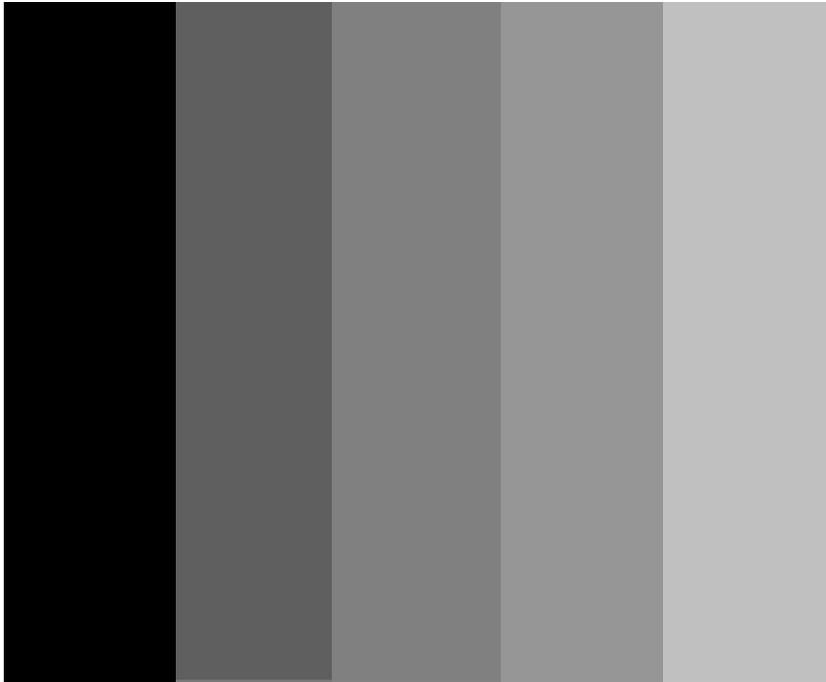
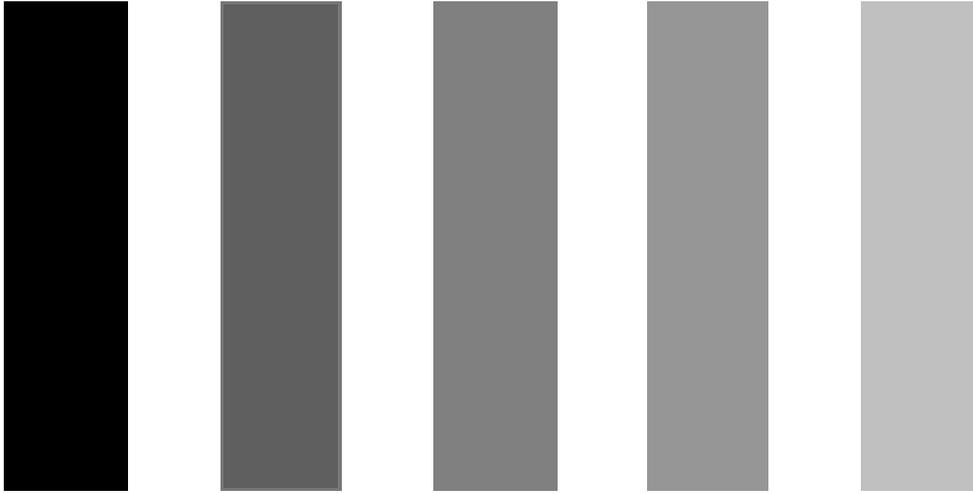
these on-center ganglion cells are unaffected because the center and surround cancel



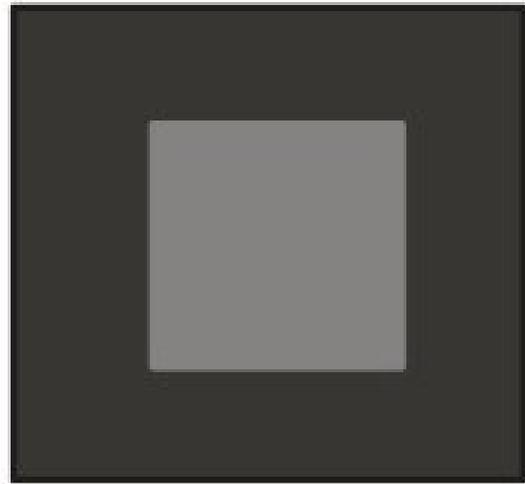
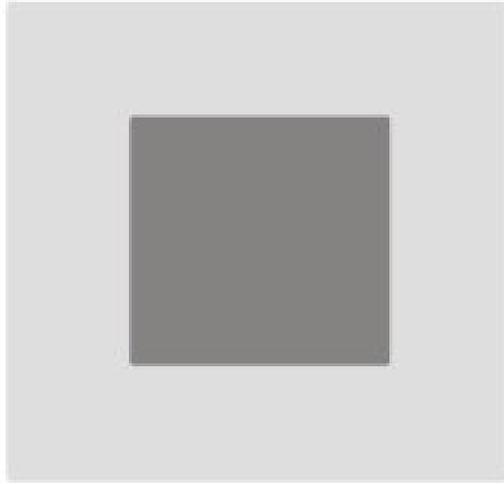
Only at the edges is the activity excited or inhibited

+>-  
->+



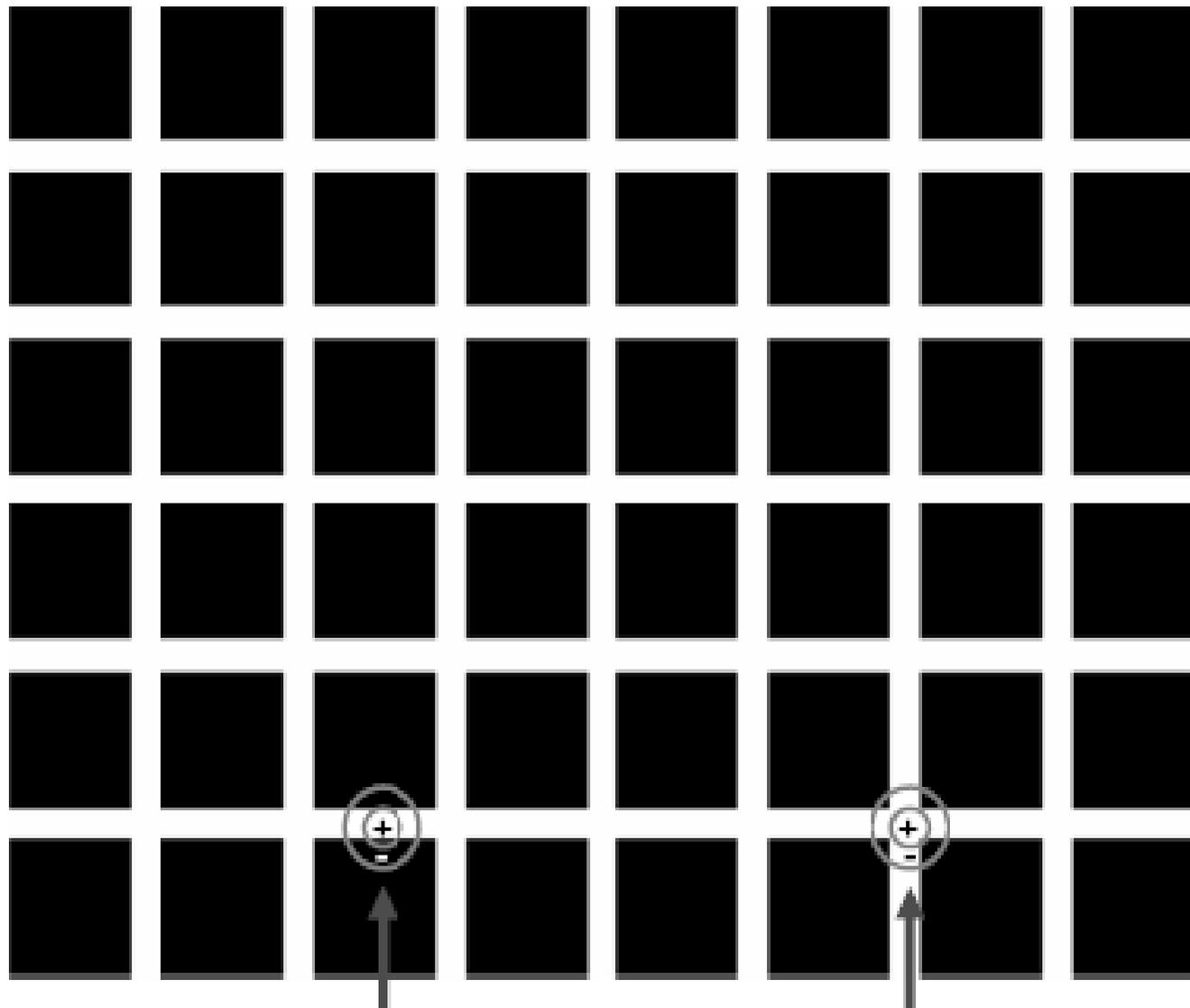


A



B



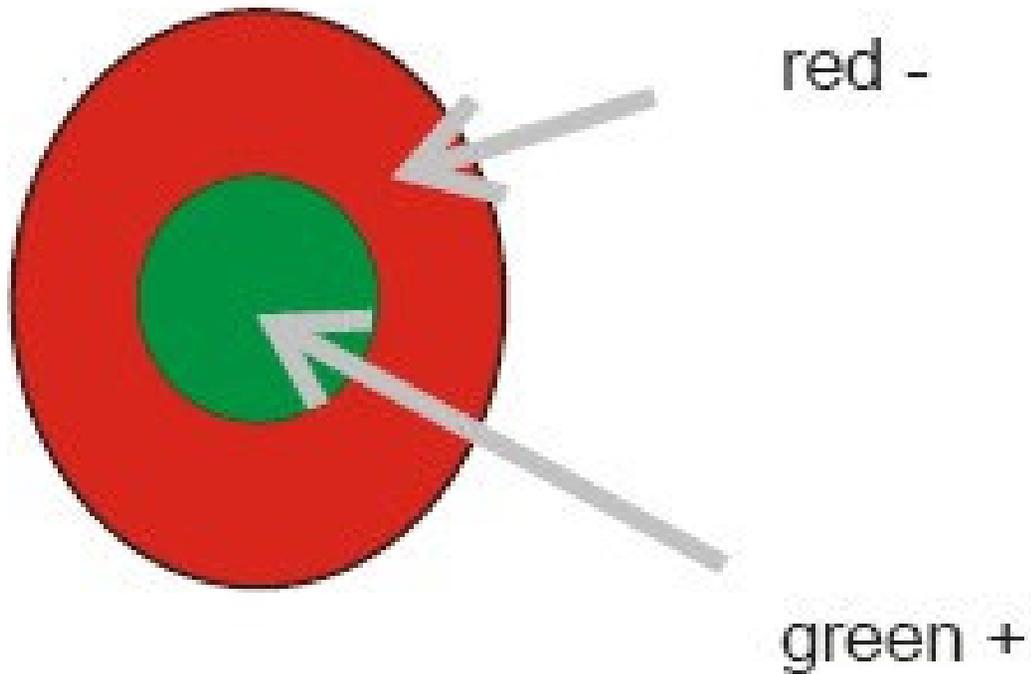


Cell A

Cell B

Cell A is stimulated more optimally than Cell B

# ganglion cell single opponent



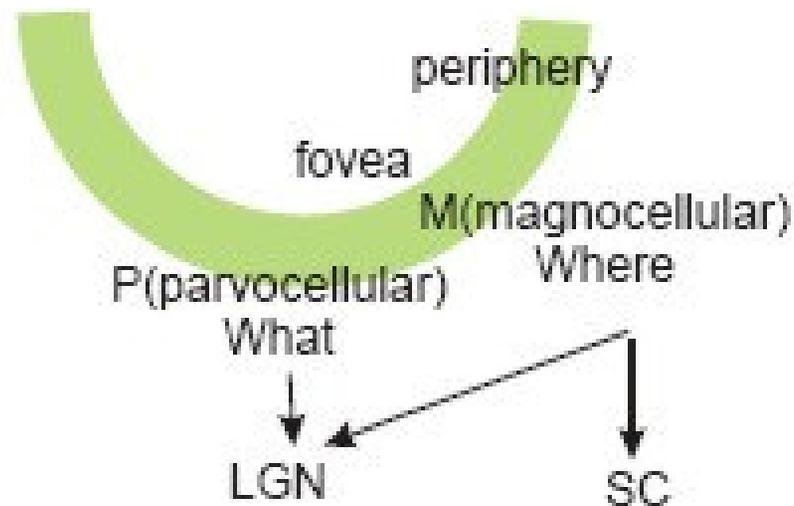
•Rouge/Vert

•Jaune (rouge+vert)/Bleu

•Blanc/Noir

## M- & P-cell properties

- M-cells
  - Large receptive fields
  - Respond well to rapid changes (mouvement)
- P-cells
  - Outnumber M-cells
  - Smaller receptive fields
  - Respond selectively to specific wavelengths (couleur)



# Retinal Ganglion Cells

- Respond to simple visual stimuli (spots of light) in their receptive field
- Come in “On-center” and “Off-center” flavors
- Another functional categorization: M-cells (‘magno’ = large) & P-cells (‘parvo’ = small).