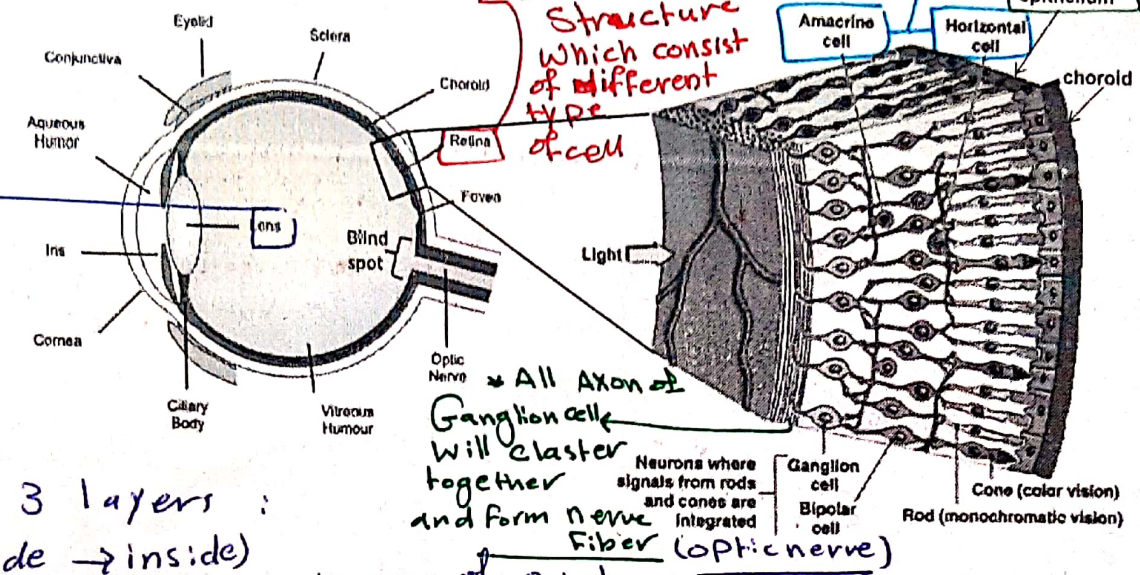
The Structure of Human Eye



for synapse. to transfer visual input (indirectly)

→ is a multilayered structure which consist of different type of cell

Pigment epithelium → single layer of cuboidal cell → responsible for regeneration of visual pigment

* responsible For focus the light of the retina

* All Axon of Ganglion cell will claster together and form nerve Fiber (optic nerve)

* The main 3 layers :
(outside → inside)

1. Sclera (The white layer of eye)
2. Choroid (Vascular layer) → responsible for perfusion
3. Retina (innermost layer) → lining of the posterior chamber

2

* In Retina :

1

1. Blind spot (or optic disk) → it lack photoreceptor cell → the only regoin of Retina that doesn't responsible for vision.
2. Fovea → The center of Retina → responsible for Sharp central vision → at which the optic nerve leaving the eye carrying the visual impulse to Brain for integration

* أي خلل فيها يؤدي لـ legal blindness

Photoreceptor cells

Retina contains two types of photoreceptors: Cones | Rods

* Both of them share / have The same Basic structures which consist of 3 primary structural and functional Regions:

* Folding or invagination of plasma membrane resulting in the formation of discs arranged on the top of each other

3 the disc separated from plasma

here there are Na^+-K^+ ATP pump

2

1

* light sensitive

* embedded in the membrane of discs

cell body

Axon terminal

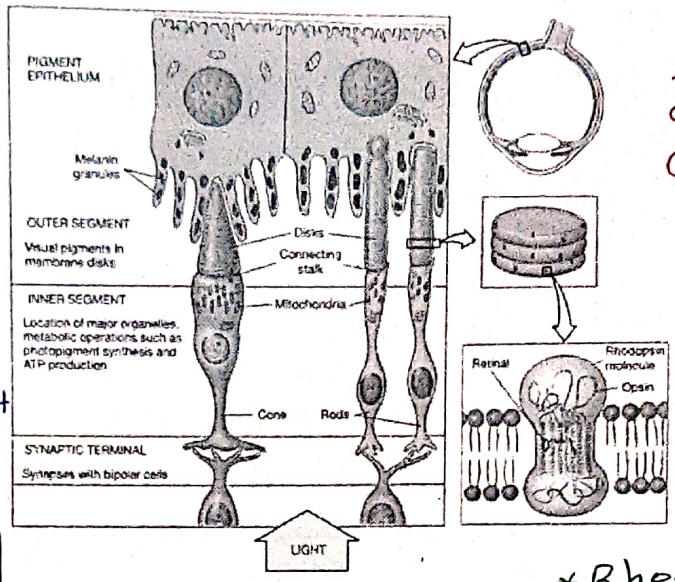
have neurotransmitter

Continous discs remain attach or connected to the plasmamembrane

4

Retina → photoreceptor cell → outer segment → **Visual Pigment**

* The biological active Form of vit. A in Retina → Aldehyde.



* Each visual pigment consist of 2 parts:
① protein part → opsin protein (transmembrane or integral protein)
→ make covalent bond with non-protein part
② non-protein part (Retinal)
↳ vit. A (Aldehyde Form)

* The visual pigment is a receptor for the light
* The light is stimulus for the retinal
* Rhodopsin → GPCR with its ligand reband and this receptor is stimulated by the light

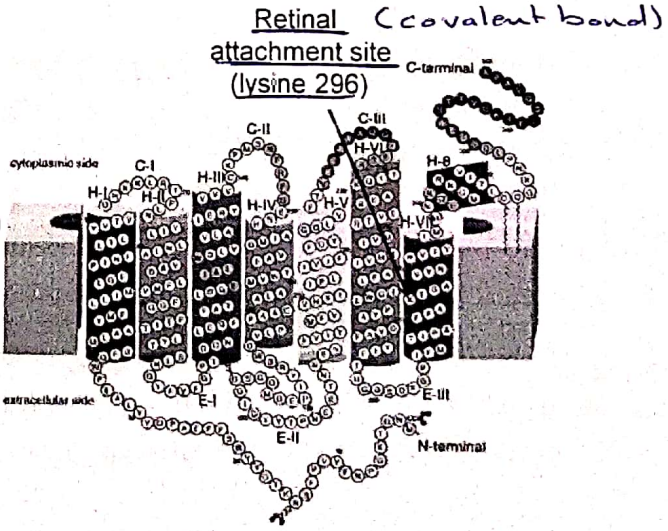
* Rhodopsin → opsin + Retinal in Rods

* Retinal → sensitive to light (activated or stimulated by the light)

* opsin → (responsible to detect the light at certain wave length + give the light to Retinal)

Structure of Rhodopsin

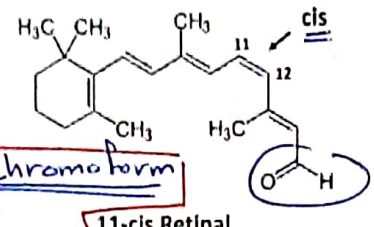
- Rhodopsin is the only visual pigment in rods
- It consists of the transmembrane protein (GPCR) called **opsin** and light sensitive moiety called **retinal** (the aldehyde form of Vitamin A)



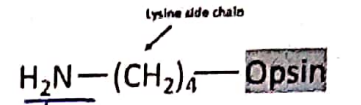
2/28/2022

* How does the covalent bond form between the opsin and the Retinal ?

Retinal Binding to Opsin

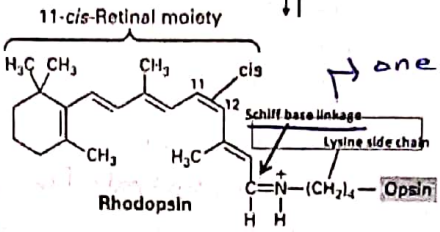


+



* In the present of light → lose its color (Photobleaching) ← Have colour

*



→ one of the covalent bond (reversible)

+ H_2O

7

Iodopsin

- Iodopsin is the visual pigment in cones consisting of cone opsin protein *(photopsin) and the same light sensitive moiety: retinal
- 3 different types of iodopsins and consequently 3 different types of cone cells (which give us color vision):
  1. L cones (photopsin I + retinal) → red light, 560nm has maximal absorbent
  2. M cones (photopsin II + retinal) → green light, 530nm medium
  3. S cones (photopsin III + retinal) → blue light, 420nm

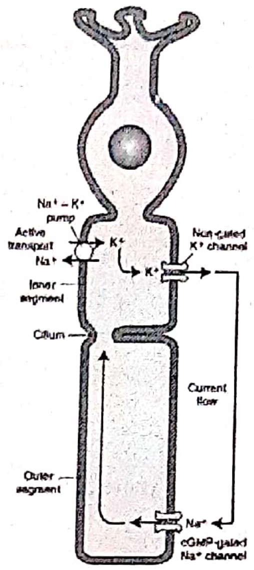
* In the state of Rodopsin → see (White/ Black)
* White in iodopsin → all color.

8

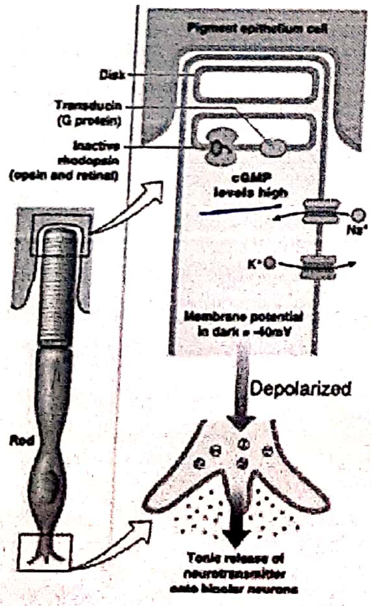
Phototransduction Cascade

- In the absence of light, the photoreceptor cell (Rod cell) is in the depolarized state with membrane potential of -40 mV. This depends on:

1. **Non-gated K⁺ channel:** outflux of **K⁺** (ongoing outward K⁺ current) open always
3. **cGMP-gated Na⁺ channel:** influx of **Na⁺** (inward Na⁺ current known as **dark current**) ↑↑ level of cAMP ← مابتفتح إلا بال dark ← ما تكون إلا بال dark
3. **Na⁺- K⁺ pump:** it is an active transport requires ATP (to transfer 3 **Na⁺** out and 2 **K⁺** in)



Phototransduction Cascade



- In darkness, **rhodopsin is inactive** and cGMP level is high thus Na⁺ channels are open.
- The neurotransmitter molecules are released from synaptic terminal of photoreceptor cell.

* There is no stimulus, How is the nerve impulse can reach to brain by optic nerve?
* How can the bipolar work (it is switch off)?
→ the neurotransmitter is "inhibitory"
That's why the photoreceptors are unusual (unlike other sensory receptor cell)

→ In the absent of light → release of inhibitory neurotransmitter → switch off to Bipolar

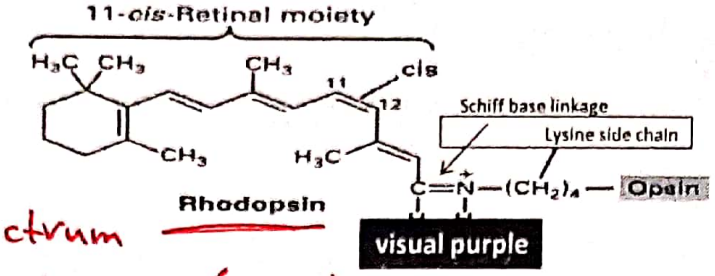
→ In the present of light → hyperpolarization → Bipolar (switch on)

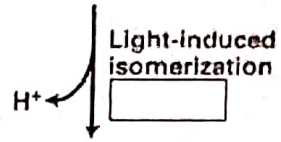
decreases in proportion to amount of light.

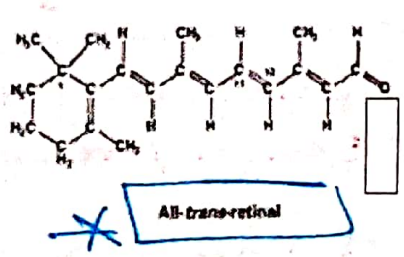
Photoisomerization of retinal

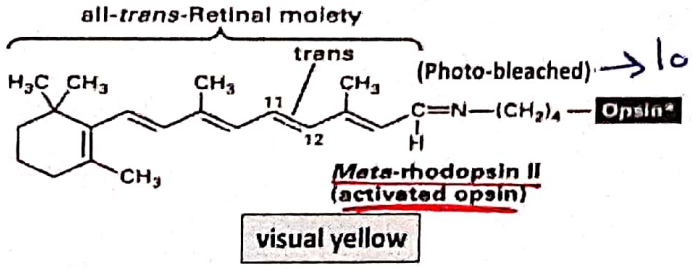
* the changes

① From cis To → Trans
② Activation of opsin.
③ Shift in Absorption spectrum of opsin from (visible) To (UV)



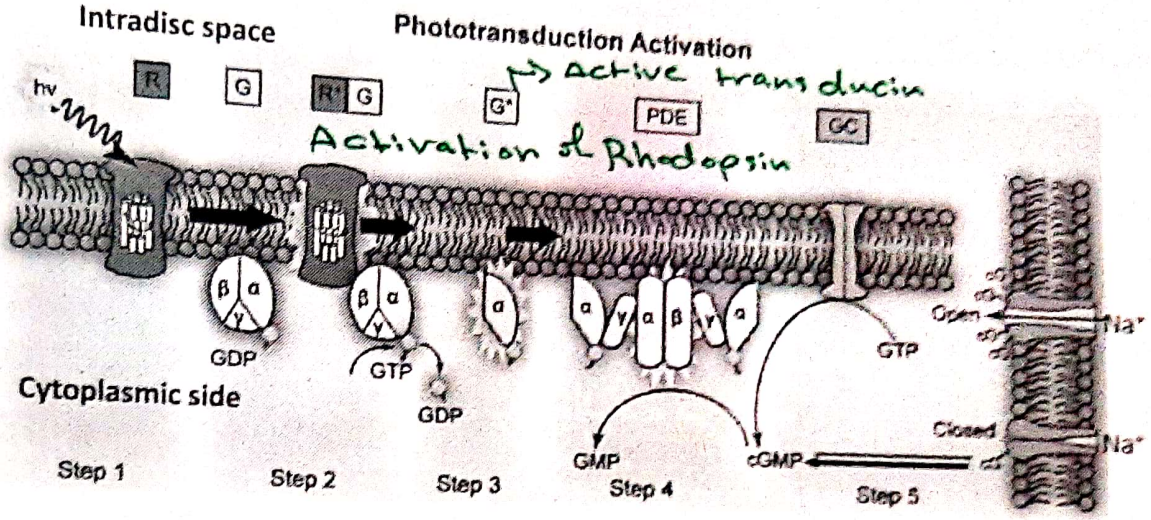






→ lost of color

G-protein signaling pathway



* G-protein in photoreceptor cell is called → transducin
* G* → responsible for activation of PDE (which degradation of cAMP
* So ↓ cAMP → Na+ Channel closed → switch on

17

G-protein signaling pathway

- The activated rhodopsin (**R***) binds to and activates the heterotrimeric G-protein "transducin" by exchanging its GDP with GTP
- The α-subunit of transducin bound to GTP (the activated transducin, **G***) dissociates from its β and γ subunits