REFLEXES OF THE EYE
PHOTOCHEMISTRY
PHOTOTRANSDUCTION

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ALL FIGURES HAVE BEEN TAKEN FROM 'COMPREHENSIVE TEXTBOOK OF PHYSIOLOGY' BY DR. G K PAL WITH PERMISSION)

REFLEXES OF EYE

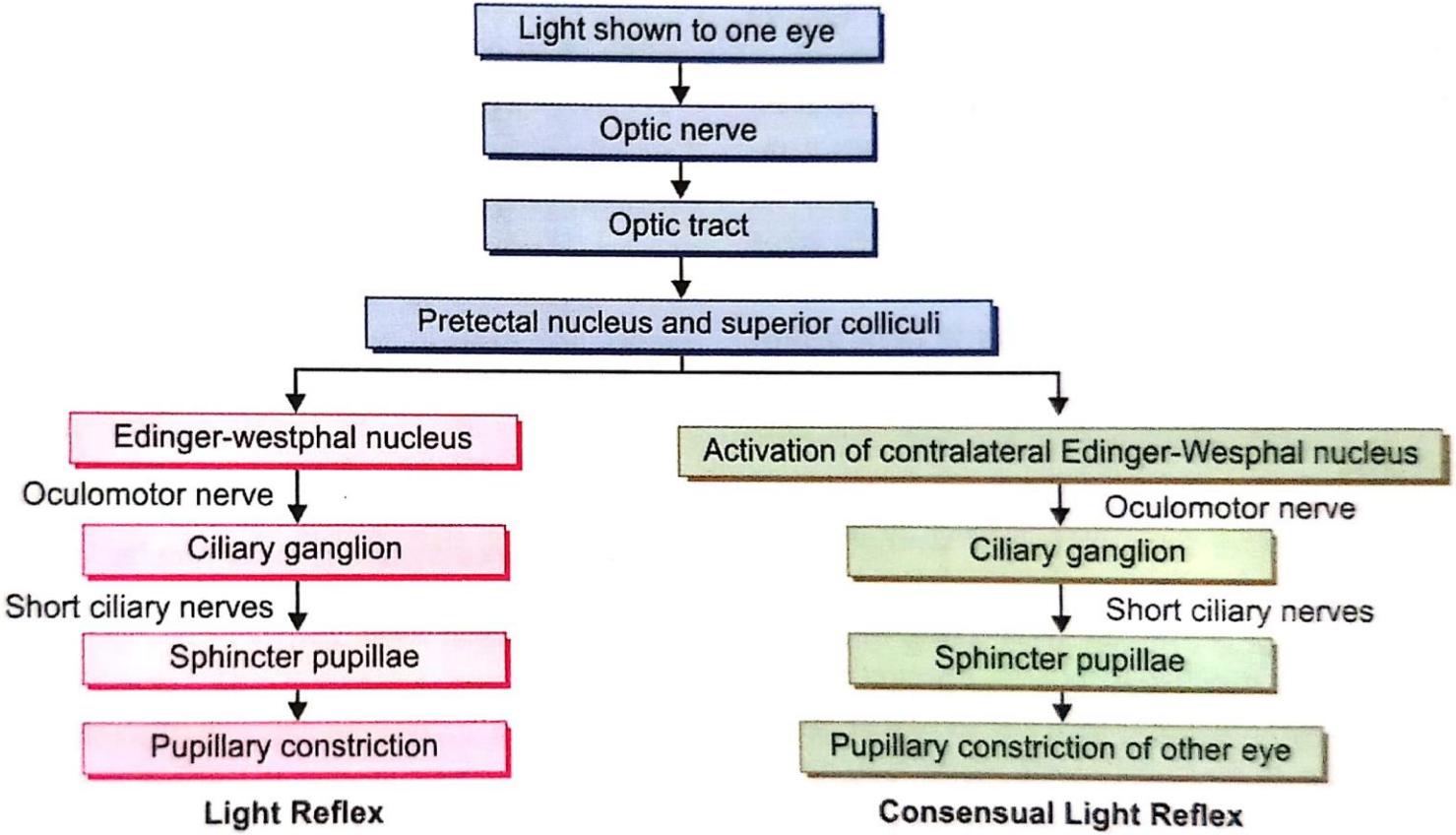
1) **PUPILLARY LIGHT REFLEX**:

- Reflex process.
- Two types:
- (i) direct light reflex
- (ii) indirect (consensual) light reflex
- Due to crossing of fibers –in the optic chiasma and in the pretectal area of the midbrain.

LIGHT REFLEX

- Stimulus: light.
- Receptors: rods and cones.
- Afferent fibers: optic nerve ⟶ optic chiasma ⟶ optic tract ⟶ pretectal area of midbrain and superior colliculus of both *sides.*
- Centre: edinger-westphal (C N 3rd).
- Efferent fibers: 3rd cranial nerve: constrictor pupillae muscle.
- Response: constriction of pupil.
- Clinical importance: absence of light reflex may indicate an advanced degree of brain damage or brain edema.

Flowchart 146.1: Pathway of direct light reflex and consensual light reflex.



ACCOMODATION REFLEX

- After looking at infinity (far distance), the gaze is transferred to a near object, some readjustment of the power of crystalline lens will occur.

- It is possible to increase or decrease the anterior curvature of the lens which causes variation in the diopteric power.

1) CONSTRICTION OF BOTH PUPILS (MIOSIS)

2) CONVERGENCE OF TWO EYES

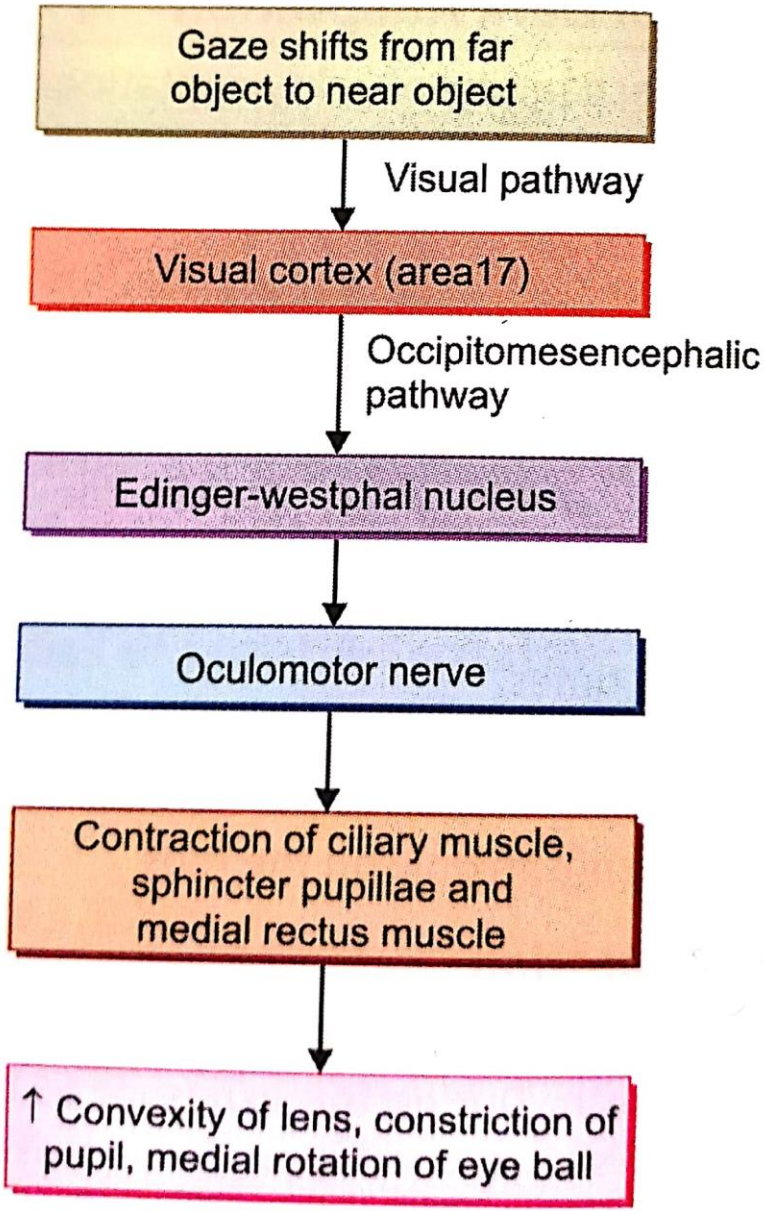
3) CONTRACTION OF CILIARY MUSCLES

NERVE ???

PATHWAY OF ACCOMODATION :

- retina
- optic nerve
- optic tract
- lateral geniculate body
- area 17 of occipital lobe
- area 8 (frontal eye field)
- midbrain edinger-westphal nucleus and motor nuclei of 3rd cranial nerve.

Flowchart 146.2: Pathway of accommodation reflex.



APPLIED

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(I) **ARGYLL ROBERTSON PUPIL**:

- Light reflex is absent but accommodation reflex is present. many cases of neurosyphilis.
- Cause: destruction (by syphilis) of the pretectal area and superior colliculus.

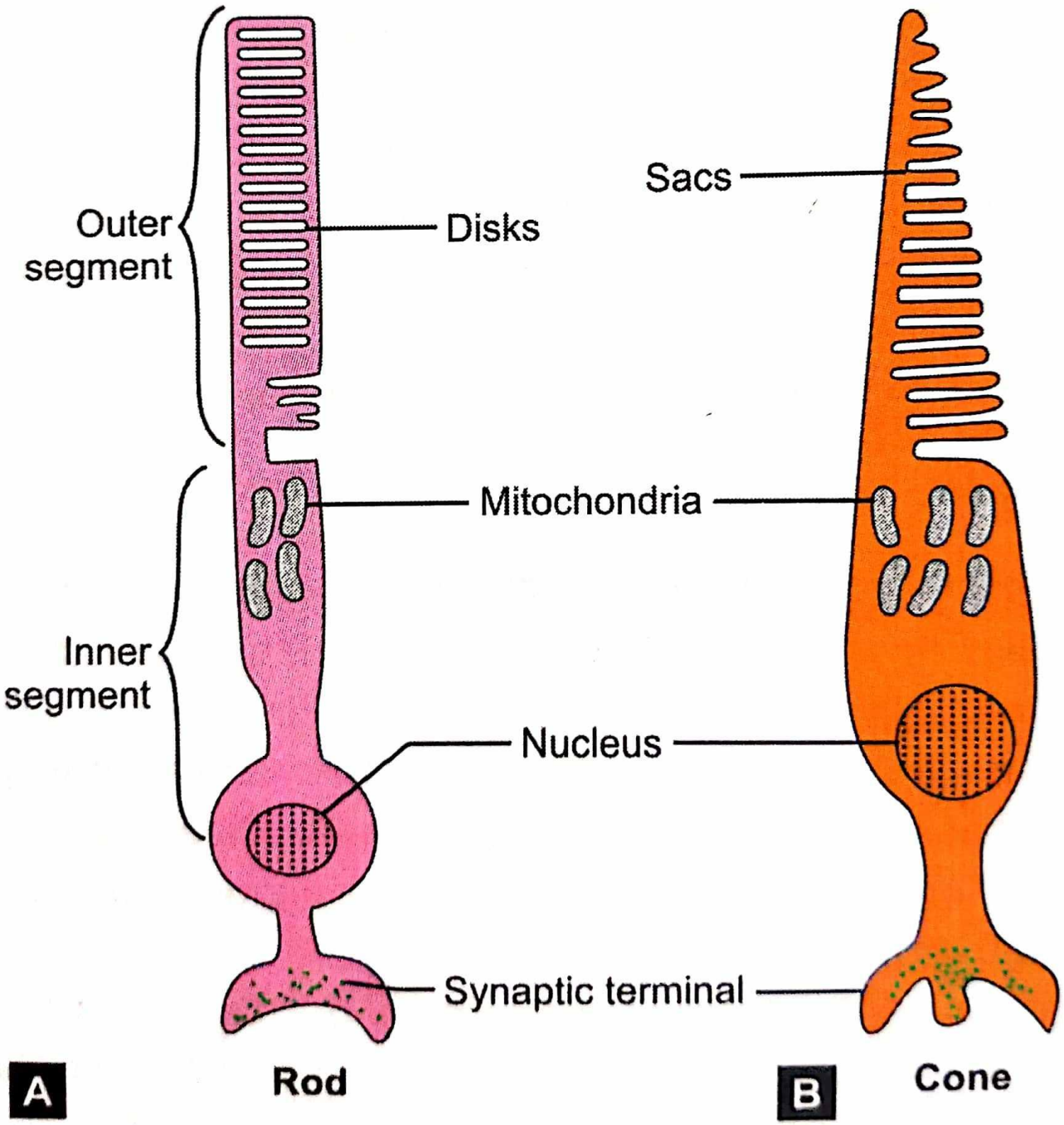
- (II) **REVERSE ARGYLL ROBERTSON PUPIL:**
- Accommodation reflex : absent light reflex : present.
- Due to damage to the prefrontal area of the cerebral cortex wherein injury to frontal eye field (area 8) occurs.

- (III) **HORNER'S SYNDROME**:
- INVOLVEMENT OF SYMPATHETIC NERVES IN THE CERVICAL SYMPATHETIC CHAIN.
- * MIOSIS (CONSTRICTED PUPIL)–DUE TO INTERRUPTION OF FIBERS TO PUPILLARY DILATOR MUSCLE OF IRIS,
- * PTOSIS (DROOPING OF UPPER EYELID),
- * ANHYDROSIS (LOSS OF SWEATING),
- * LOSS OF CILIOSPINAL REFLEX AND
- * UNILATERAL FLUSHING OF FACE.

PHOTOCHEMISTRY OF VISION

- RODS : OUTER SEGMENT A PIGMENT CALLED AS RHODOPSIN ALSO CALLED *VISUAL PURPLE*.

- OPSIN (PROTEIN): SCOTOPSIN +CIS RETINAL (VIT.A ALDEHYDE-RETINENE) RHODOPSIN


Outer segment
Disks
Sacs
Mitochondria
Inner segment
Nucleus
Synaptic terminal
A
Rod
B
Cone

- **PHOTOPIC VISION**: vision capable of discriminating different colours.

  occurs in bright light in which cones are optimally functioning.

- **SCOTOPIC VISION**: vision capable of discriminating only between shades of black and white.

  dim light in which rods are optimally functioning.

- Rhodopsin=Opsin (scotopsin)+cis retina

LIGHT STRIKES THE RODS:

- cis retinal is converted to trans retinal: isomerization.
- sequence of events occur in the rods : metarhodopsin ii is formed.

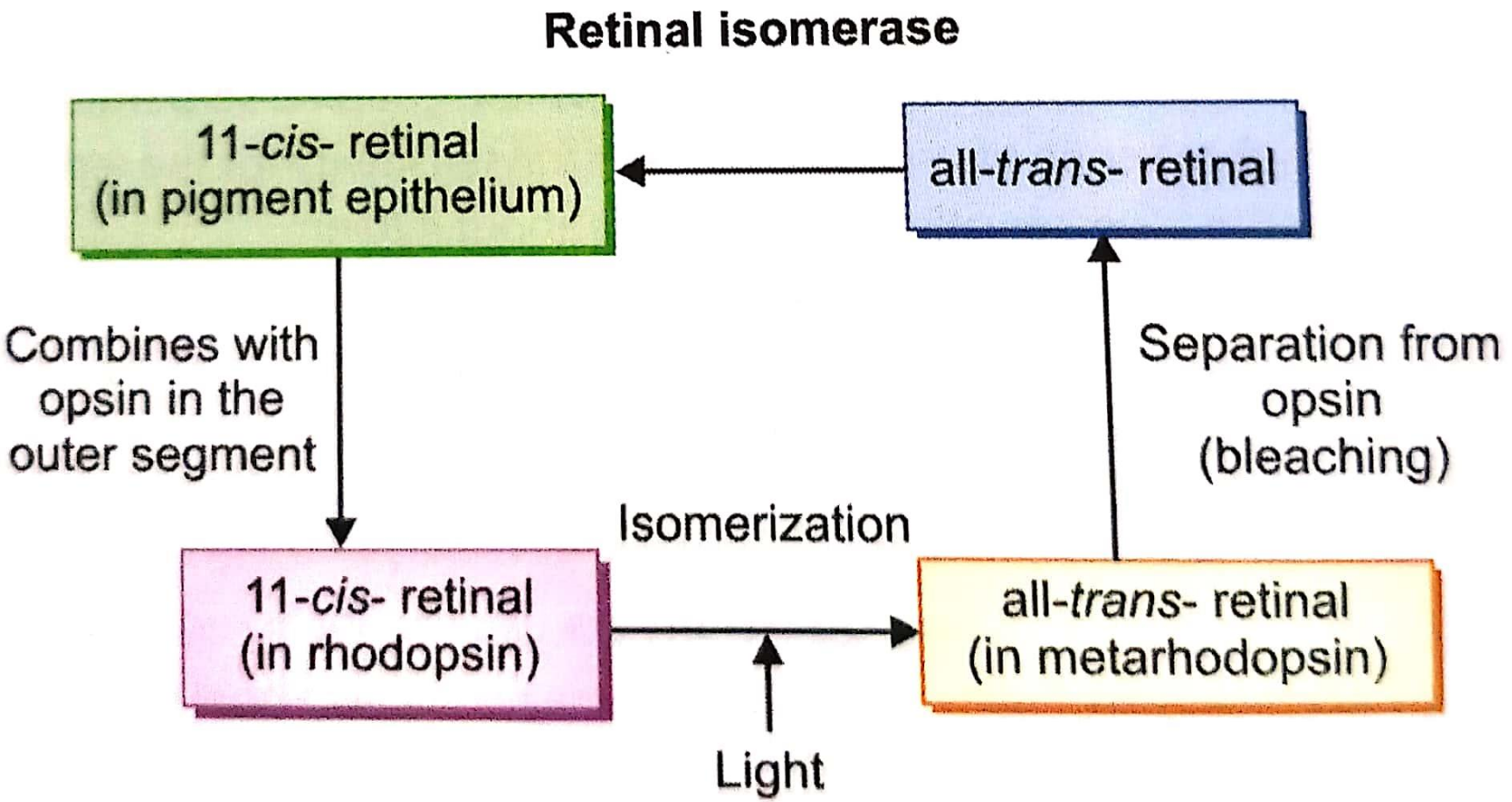


Fig. 144.3: Changes occurring in retinene$_1$ during light and dark.

- Trans retinal gets separated from the opsin (photo decomposition) : enters the pigment layer of retina leaving the opsin within the rods: photo decomposition
- rhodopsin : bleaching

- pigment layer- trans form gets converted into cis form of retinal which comes back to the rods and reunites with opsin to form rhodopsin again. the whole process is called regeneration of rhodopsin.

- Rhodopsin=Opsin (scotopsin)+cis retina
  LIGHT STRIKES THE RODS:

- cis retinal is converted to trans retinal: isomerization.
- sequence of events occur in the rods : metarhodopsin ii is formed.

- local electrical change-receptor potential rods or cones produce only generator potential.
- action potential develops only at ganglionic cells.

IONIC CHANGES: IN DARKNESS

* RMP photoreceptors is -40mv: **dark current.**
- **Dark current**: in the dark, the Na+ channels in the outer segment of photoreceptors are open as they bind with cGMP.
- Na+ enters: decreasing the RMP.
- Release of inhibitory neurotransmitter- glutamate at the synaptic terminal of photoreceptors.
- Inhibition of bipolar cells.
- Photoreceptor cell is depolarized at rest.

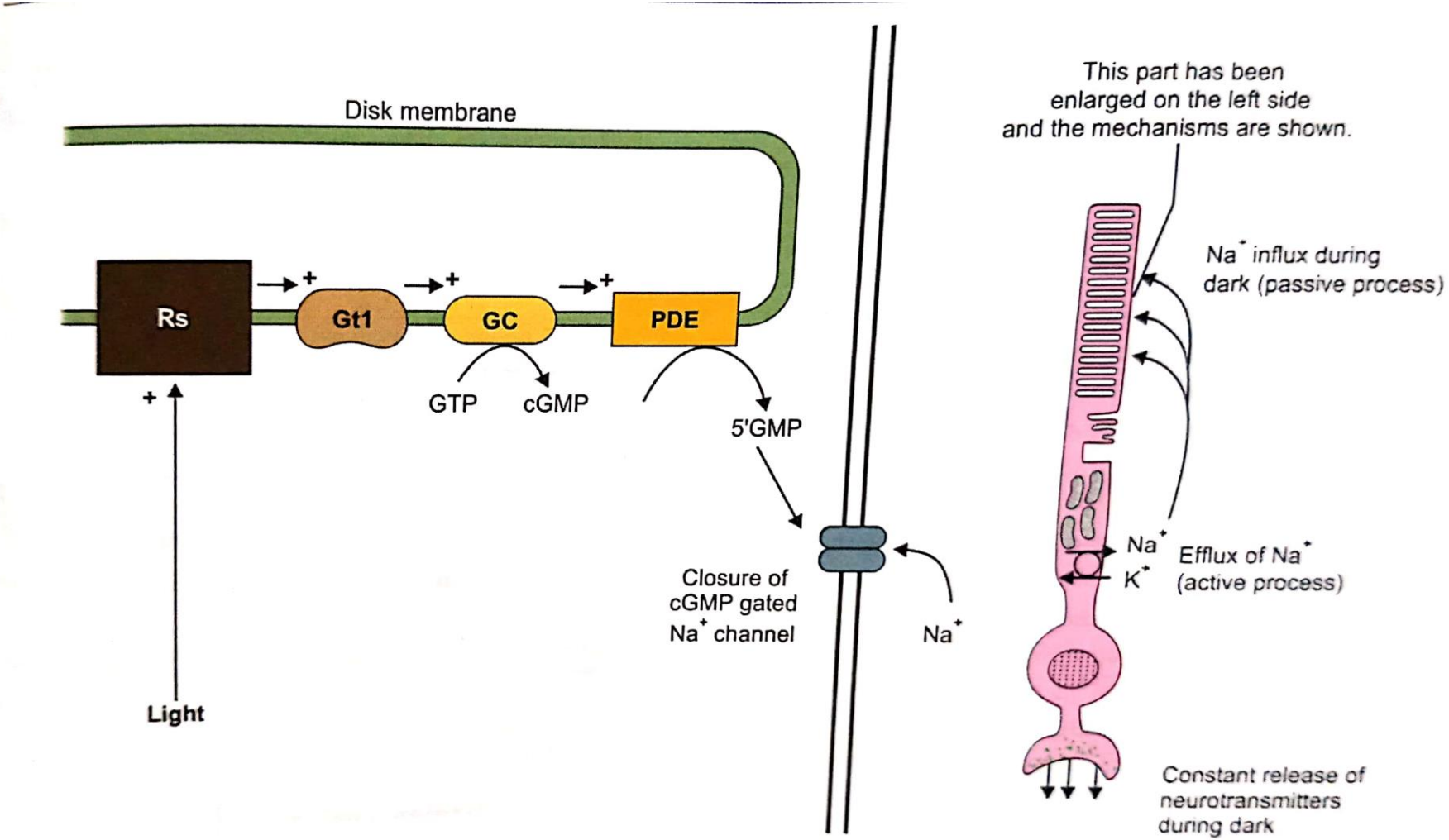


Fig. 144.2: Mechanism of phototransduction. (Rs: Rhodopsin; GC: Guanylyl cyclase; PDE: Phosphodiesterase). Light activates rhodopsin that stimulates the G protein. G_{t1} activates PDE, which converts cGMP into 5' GMP and brings in closure of cGMP-gated Na^+ channels. Guanylyl cyclase hydrolyzes GTP to cGMP. Na^+ K^+ ATPase decreases cytoplasmic Na^+ level by pumping out Na^+ from the outer segment of the photoreceptors. Na^+ enters the inner segments along concentration gradient through the cGMP-gated Na^+ channels.

WHEN LIGHT FALLS:

- Light: 11-cis retinene is converted into all-trans retinene.
- Formation of metarhodopsin II: breaks down cGMP.
- Closure of Na+ channels.
- Entry of Na+ in the photoreceptor stops but the exit of Na+ from the inner segment continues.
- Hyperpolarization of photoreceptors.
- Release of inhibitory neurotransmitter (glutamate) decreases.
- Graded potential in the bipolar cells
- Action potential in ganglionic cells.
- Conversion of light energy to neural signal by the visual pigments in the photoreceptors is known as phototransduction.

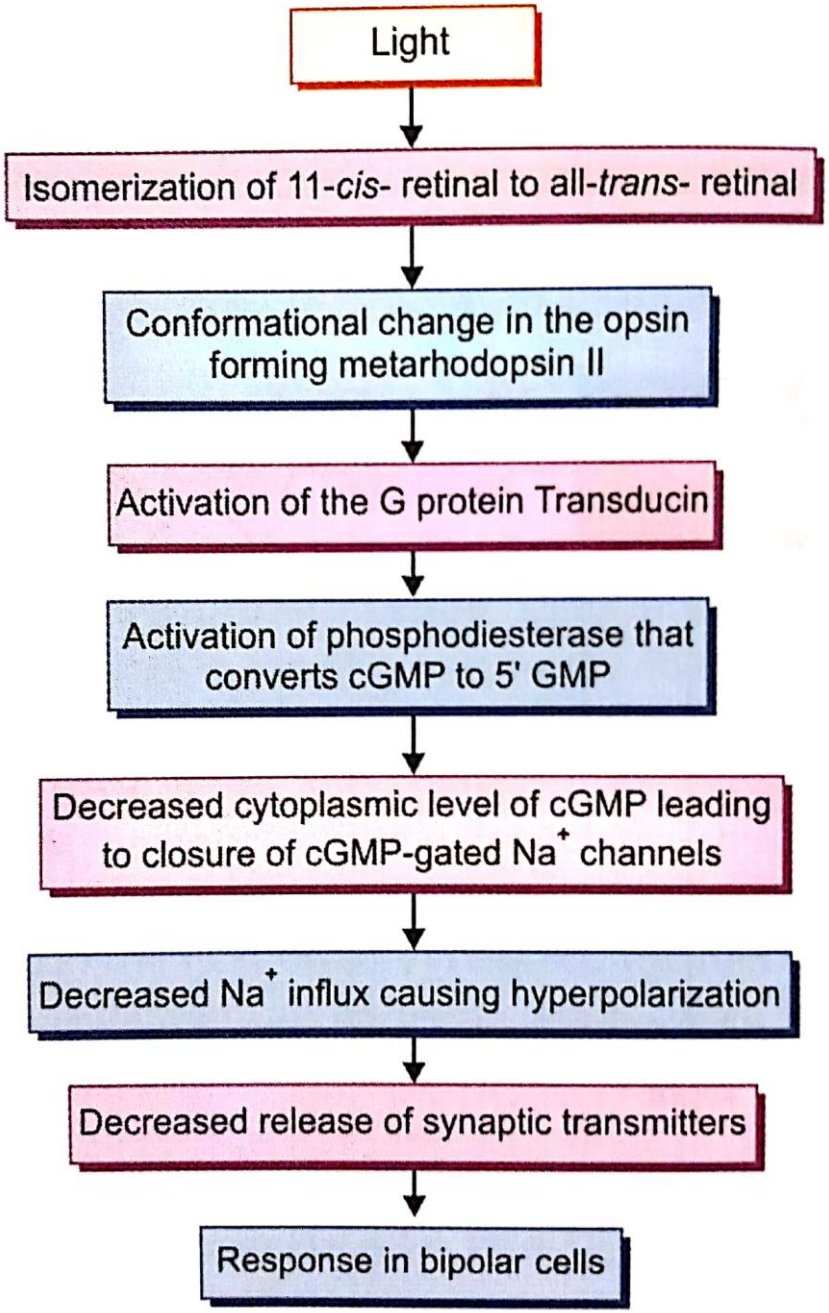


Fig. 144.4: Steps of phototransduction.

THANK YOU