

PHYSIOLOGY

Lecture : 3

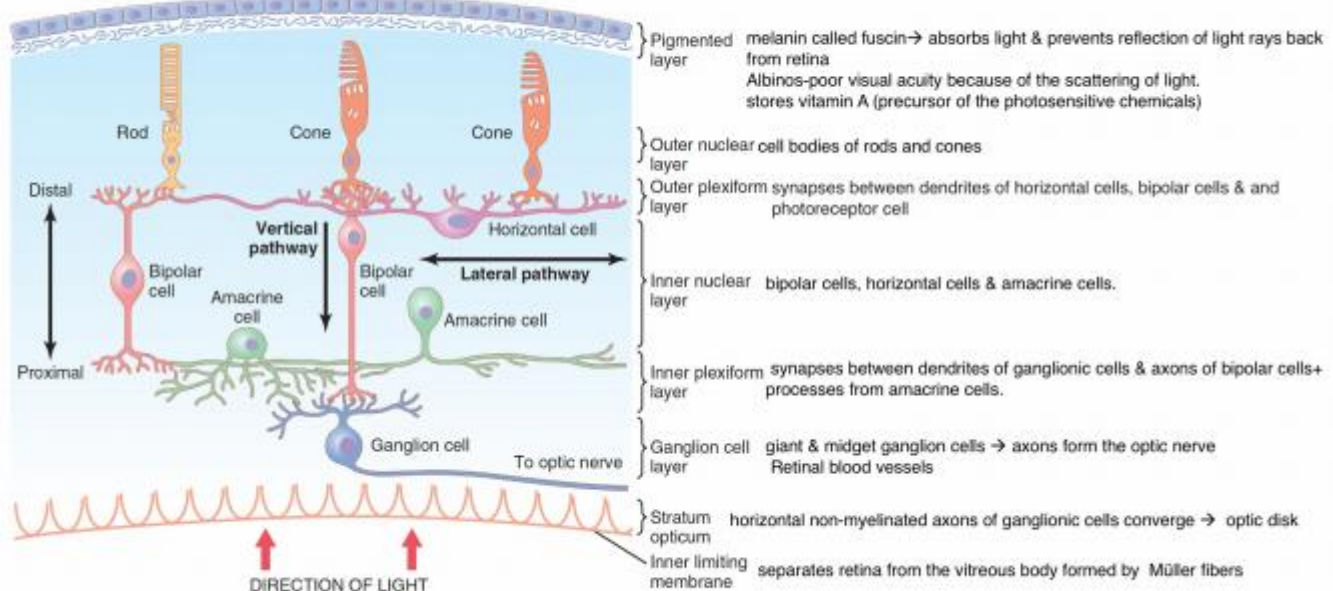
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Receptor and neural function of the retina

layer of retina

Layers of retina

outer layers of the retina → nutrition from choroid → retinal detachment → damage



Inner layers of the retina → nutrition from central retinal artery

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This figure show retina from inside to outside :

1-pigment layer : it is the Blake pigment melanin called fuscin which absorb prevent light reflection thought the globe of eye ball and this is important for clear vision without it the light would reflected to all direction within the eye ball and cause diffuse lighten to the retina rather than the normal contrast between dark and light spot required for formation prices image

In albinos people which hereditary lacking melanin in all part od body so when enter the bright room ,the light will reflected in all direction inside eyeball so normally light exited only few rod and cons but know exited many receptor so the visual acuity is poor

And also this layer store Vitamin A which is precursor to photosensitive chemical

2- outer nuclear layer contain cell body of rode and cons

3-outer layer plexiform synapse contain synapse between horizontal cell, bipolar and photoreceptor cell

4-inner nuclear cell contain bipolar cell, horizontal cell and amacrine cell

5-inner plexiform layer contains synapse between dendrite of ganglionic cell, axon of bipolar cell and processes from amacrine

6- ganglionic cell layer contain giant and mid get ganglionic cell which their axon continuo to form the optic nerve

7-stratum layer which is contain horizontal non-myelinated axon from ganglion converge to form the optic disk

8-inner limiting membrane spate retina from the vitreous body formed by Neuroglia cell called Müller fiber

Blood supply of the retina

The blood supply for the internal layer of the retina from central retinal artery

But the outer layer of the retina receive from the choroid

Retina detachment : the retina is detachment from pigment epithelium which occur in diabetes or trauma and thes lead to compromise nutrition from choroid so if not replacement soon the retina will destroyed and will not able to function even after surgery

Foveal region of retina

After light passes through lens system of the eye and then thought vitreous humor, it is enters the retina from inside surface that it pass first through the ganglion cell and then through the plexiform and nuclear layer and it is finally reaches the layer of rods and cons

And this distance is thickness it is several hundred micrometer so the visual acuity is decrease by this passage through non homogenous tissue but there are foveal region which inside these layer decrease in loss of visual acuity

The foveal is minute area in the center of the retina and it is contain almost only cons and is responsible fore acute and detailed to light

And the cons has special structure to aid these function which is long and slender bodies (1.5 micrometer) but the cons and rode in the peripheral is different in structure from the foveal region

In peripheral rode are 2-5 micrometer and cons from 5-8 micrometer

When go to the center more cons less rode ,but when go to peripheral less cone more rode

And also the cons in foveal region not converge which is connected to one ganglion (1:1 connection) these help to visual acuity

But in the peripheral more one rods and cons (manly on rod) connected with one ganglionic cell (converge) may hundred of rod and cons connected to one ganglionic cell

In foveal, the blood vessel , ganglion , inner nuclear layer, and plexiform layer are all displace to one side so just cone present so light pass unimpeded (so no non homogenous tissue) so high visual acuity (visual acuity decrease when pass through non homogenous tissue)



When light reach rods and cons (photoreceptor)these lead to excited and the signal transmitted from cons and rods to bipolar, horizontal cell or amacrine cell then to ganglia cell then to optic nerve then to the cerebral cortex

Structure of rode and cons

The functial segment of cods and rods is:

1-the outer segment 2- the inner segment 3-the nucleus 4-synaps

The outer segment have large number of disc that contain the light sensitive photochemical which is represent 40% of mass of outer segment

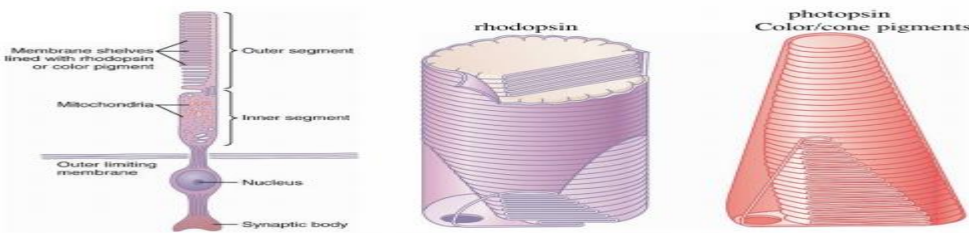
In the rod contain rhodopsin

In the cons contain three color photochemical called color pigment

Both rhodopsin and color pigment is conjugated protein that incorporate as transmembrane protein on the disk

Inner segment of rod and cons contain cytoplasmic organelle especially mitochondria which important to provide energy for the photoreceptor to metabolism or active transport

And the synaptic portion connected with neuron cell(horizontal and bipolar)



rods	cons
100 million	3million
Mainly at peripheral	Mainly at center
Low threshold	High threshold
High sensitive, specialize for night vision(black, white)	Lower sensitive, specialize for day vision\color vision
High amplification, single photon detection	Less amplification
Slow response	fast response
Sensitive to scattered light in night the light is scattered	More sensitive to direct axial ray
Low acuity, highly convergent retinal pathway, not present in center fovea	High acuity, less converge retinal pathway, concentrated in central fovea
Achromatic, one type of rod pigment Rhodopsin\visual purple	Chromatic , have three type of con(red(long spectrum) , green(intermediate) and blue(short) or porphyropsin, iodopsin and syanopsin each with a different pigment that is sensitive to a different part of the visible spectrum

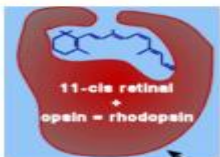
Photochemical of vision

Both rod and cones contain chemical that decompose when exposed to light

The light sensitive to the rod called rhodopsin and these is slightly different from cone pigment so we will take about rhodopsin and is similar to cone pigment

The rhodopsin is a combination between a protein called scotopsin and pigment called retinal

The retinal is derivative from vitamin A and the retinal present in cis configuration(11-cis retinal) which is the only form can bind to scotopsin



When light is absorbed by rhodopsin, the rhodopsin becomes decomposed within a very small fraction of a second

This causes photoactivation of an electron to the retinal, these lead to change from cis to trans form but still have the same chemical structure as the cis but different physical structure (straight molecule than angular molecule)

Which immediately product is bathorhodopsin which partially split combination of trans retinal and scotopsin but bathorhodopsin is unstable within nanosecond convert to lumirhodopsin then to metarhodopsin I the metarhodopsin II then completely split scotopsin and trans-retinal

Re-formation of rhodopsin (these process is ATP dependant): it is by convert trans retinal into cis retinal by retinal isomerase and these process required metabolic energy

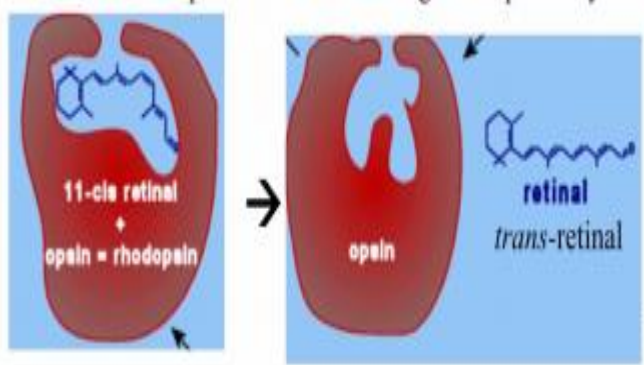
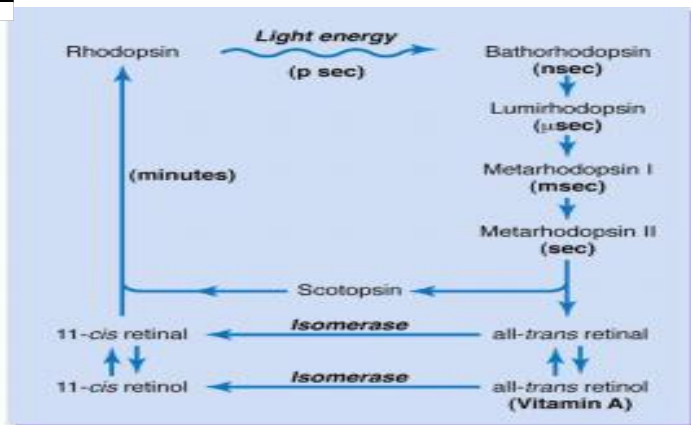
then cis retinal combine with scotopsin which remain stable until it is decomposed again triggered by absorption light energy

also vitamin A (all-trans retinol) is precursor to all-trans retinal which can be converted then by isomerase converted to cis retinal then combine with scotopsin

or by convert all-trans retinol to 11-cis retinol then convert 11-cis retinol to 11-cis retinal

vitamin A is present in cytoplasm of cones and rods and pigment layer of retina

in vitamin A deficiency these lead to night blindness which vitamin A more important on rods than cones



The rod receptor potential

Phototransduction :is conversion of light energy into receptor potential in visual receptor

When the rod expose to the light ,the result is different from all other sensory receptor

Excitation of rod lead to hyperpolarization (more negativity)than depolarization, how?

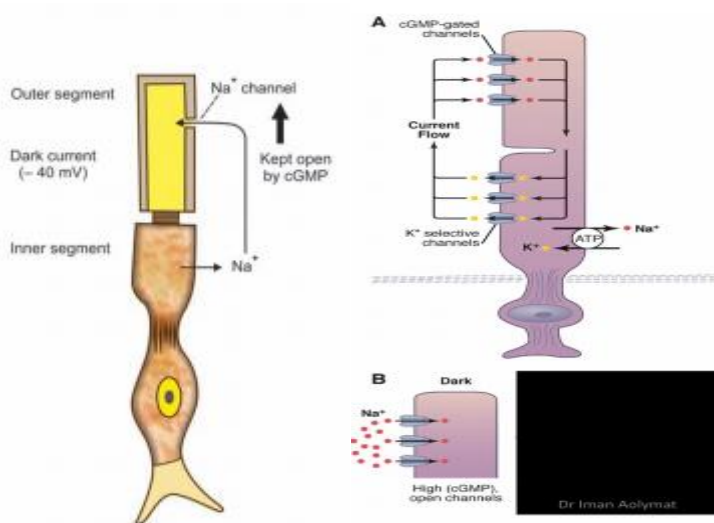
Normally the outer segment of the rod is very permeability to Na but when rod decompose, it decrease conduction of Na in the outer segment of the rod, this cause hyper polarization

** the inner segment of rod continually pump the Na from inside the rod to the out side and the K pump inside the cell

And has K leaky channel which leak K outside and has Na\K pump to create negativity inside the cell

In the dark light , The rod membrane is leaky to Na that flow thought cGMP channel

So in the **dark light** , the cGMP is high these lead to inward Na current into the outer segment of rod so depolarize and the resting membrane poteinal is -40and these increase glutamate neurotransmitter



When rod of the outer segment **expose to light** , 1-the light is absorb by the rhodopsin that cause photoactivation of electron on retinal

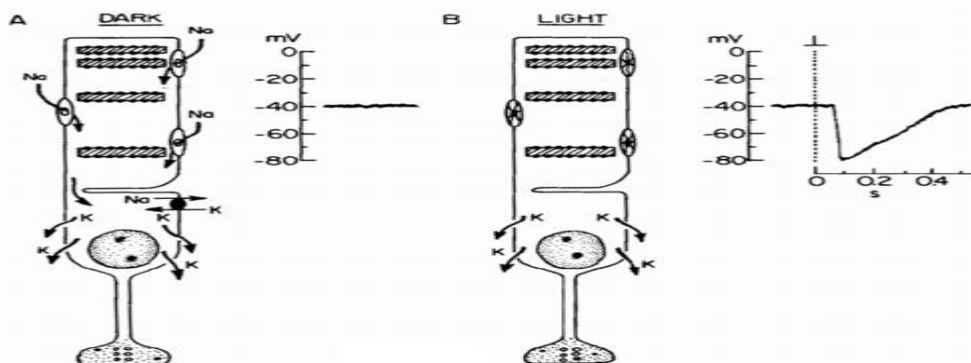
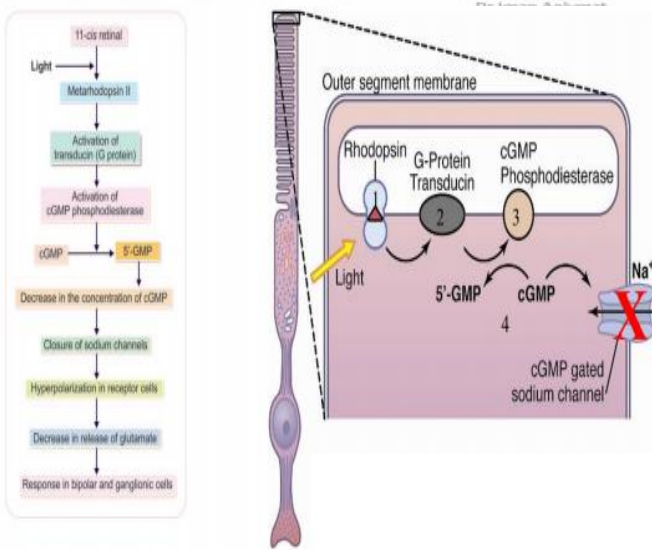
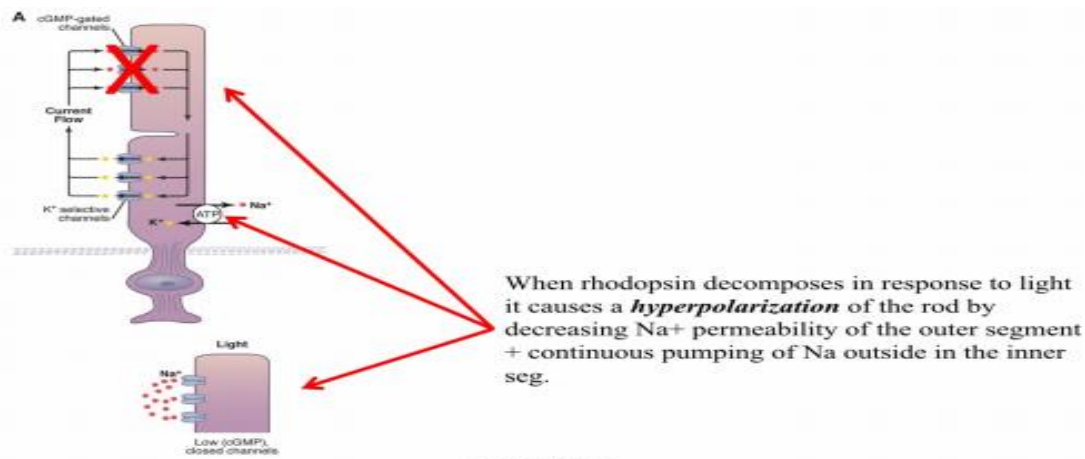
2-And the activated rhodopsin(metarhodopsin II) stimulate G-protein called transducing which then activate cGMP phosphodiesterase and these catalyze cGMP to 5-GMP

3-And the reduction of cGMP lead to cGMP-gated Na channel and reduce Na to inward

And Na continuo to pump outward through the inner segment membrane so know more Na leave the rod than leak bact in so it is state of hyperpolarization and at maximual light intensity the membrane potential reach from -70 to -80 millivolt

***the greater amount of light the greater amount the electronegativity

If the dark light become again ,the rhodopsin kinase deactivation the active rhodopsin (metarhodopsin II) and then increase cGMP and reopen Na channel



Receptor potential is a graded response to a stimulus that may depolarize or hyperpolarize
Graded mean amplitude of the receptor potential is proportional to the size of the stimulus
/logarithm of light intensity that allow eye to discriminate light intensity

هسا هون هو مش action potential هاض receptor potential ما يتبع قانون all or non بالتالي هاض ممكن
graded وهاض مهم لحتى تميز العين الضوء الي جايلها اذا كان dark or bright light

Receptor potential is 4 time faster on cod than rod

But rod is extremely sensitive under dark condition that's because rod can amplify the effect
of single photon of light and cause movement of million of Na channel

Dark adaptation

Dark adaptation is the process by which the person is able to see the object in dim light

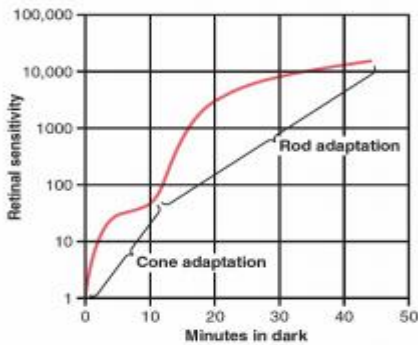
If person enters dark room from a bright area, he cannot see any object but after sometime
his eye get adapted and he start see abject slowly for 20 min

Cause of dark adaptation :

1-resynthesis of rhodopsin so increase sensitive to light

2-dilatation of eye

هاي بمعنى انت اول ما تدخل على غرفة مظلمة هسا اول ما تقوت ما بتشوف اشى بعدين بصير adaptation خلال
20min وبتيلش تشوف الاشياء



rod sensitivity begins to exceed cone sensitivity
neuronal signal convergence of
100 or more rods onto a
single ganglion cell in the
retina=summation

هسا عملية ال adaptation بتون بطيئة بتبلش اول اشى بال con

ال con adaptation اسرع ولكن ال sensitivity قليل فاو ما يدخل لمكان مظلم بشوف بسرعة بسبب ال con
adaptation

ولكن rod تبلش بعد 10 min وبوصل لل maximum خلال 20min ولكن ال rod sensitivity الو عالي بسبب
ال convergence لانو بعمل more rod convergence to one ganglion cell و هون بتبلش تشوف الاشياء
بوضوح

Light adaptation

Light adaptation is the process in which eyes get adapted to increase illumination

هاض لما يتعرض لضوء شديد مرة مثلا لما يكون بالدار ويطلع لبرة

Cause of light adaptation

- 1-Reduced sensitivity of rod due to breakdown of rhodopsin so decrease sensitivity to light
- 2-Constriction of pupil so reduce quantity of light entering eye

نهاية التلخيص سامحونا على اي اخطاء