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Photochemistry of vision

Neha Babbar

D.A.V. College, Abohar, Punjab, India.

Abstract
Vision is no doubt, the most important of all our senses. 40% of all the sensory information about our world comes to us through our eyes. But how do we see is one of the oldest scientific questions. The eye is an extraordinary sensitive instrument. The wavelength response to 400-800 nm but its degree of sensitivity is such that a fully dark adopted eye can clearly detect object in light so dim so as to correspond to a light input over the retina of only about 10000 quanta per second.

Keywords: Photochemistry, photoreceptors

Introduction

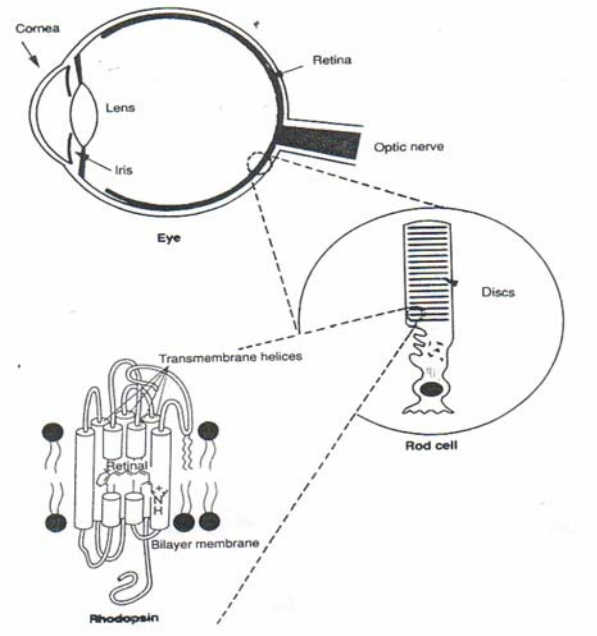
Theory of vision

If you think eye as a camera, the retina would be the film. The retina is actually the back part of the eye that contains the cells that respond to light. These specialized cells are called photoreceptors. There are two types of photoreceptors in the retina, Rods and Cones. The rods are most sensitive to light and dark changes, shape and movement and contain only one type of light sensitive pigment. Rods are not good for colour vision. These work at very low levels of light. We use this for night vision because only few photons can active rod that is why in a dim room we are colour blind since we use mainly our rods. Rods are more numerous than cones in the periphery of retina. There are about 120 million rods in the human retina.

Cones are concentrated in the fovea; rods are not present there. The fovea, is the central region of retina. The cones are not as sensitive to light as the rods. Signals from the cones are not sent to the brain which then translates these messages into the perception of colour. Cones, work only in the bright light that is why we cannot see colour very well in the dark places. So cones are used for colour vision and better suited for detecting fine details. There are about 6 million cones in human retina. Some people can't tell some colours from others these people are colour blind. Someone who is colour blind does not have a particular type of a cone in the retina or one type of cone may be weak.

Some animals do not possess both rods and cones. The retina of pigeons contains only cones. Thus while pigeons have colour vision, they see only in the bright light of the day. The retina of owls, on the other hand, have only rods, owls see very well in the dim light, but are colour blind.

The process that happens in the rods and cones are relatively similar. But these are much understood in rods than those in cones that is why we will discuss the rod vision first.



The three major players in the rods are Rhodopsin, Transducin and Phosphodiestrase, (PDE)

Rhodopsin is made up of protein opsin and cis-Retinal. cis-Retinal is a polyunsaturated aldehyde which acts as a chromophore of Rhodopsin. During this process cis- Retinal gets converted to Retinol. Retinol is basically a processed version of Vitamin-A. This explains part of the reason why Vitamin-A helps with vision.

Transducin has three sub units and PDE has two alpha sub units has to be removed.

The process starts with light. When photon of light falls over eye it strikes Rhodopsin. As soon as it strikes rhodopsin cis – retinal changes to trans – retinal. When it happens, it causes it to lose its attraction for the opsin molecule and once that connection breaks, that retinal leaves and it exposes a binding site on the opsin.

The next step in the process involves opsin going over to transducin. Since the binding site is exposed, that can catalyze reaction. On the sub unit of transducin molecule we have GDP. Once this active site is exposed it catalyzes a reaction that converts that GDP into GTP. Once that happens that sub unit is activated and this actually the other two sub units behind and goes over to the alpha subunit of the phosphodiestrase and then it removes that alpha sub unit. But we still have one more alpha sub unit. In order to remove this second alpha sub unit this entire process has to happen again.

Now we have phosphodiesterase (PDE) which converts cyclic GMP to GMP in the presence of light. In the dark, we have cyclic GMP around, the cyclic GMP-gated channels are open. We have sodium ions coming into the cell. As sodium rushes in membrane potential becomes more positive. The membrane is depolarized and neuro transmitters are being released. When cyclic GMP gets converted gets converted to GMP these channels are going to close, sodium ions will no longer rush in and neurotransmitters will no longer be released, the receptor potential is going towards equilibrium potential for potassium ions, so it’s going to become more negative so it is going down until that stimulation stops and then it is going to come back up.

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