New understanding of how we see colors

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(Medical Xpress)—Scientists have until now not fully understood how animals see in color, since visual pigments in eyes contain exactly the same chromophore (light absorbing segment of the molecule) and yet can absorb different wavelengths of light.

The chromophore retinal (Vitamin A aldehyde or retinaldehyde) is used by all animals but, depending on the photoreceptor proteins (opsins) associated with it, the same molecule can absorb a spectrum of colors from blues or even ultraviolet to reds. How a single molecule can do this has until now been uncertain.

Now researchers, led by Prof. Babak Borhan of Michigan State University at East Lansing, set out to try to understand the mechanism by which the opsins change the light absorption spectrum of the chromophore retinal. They concentrated their efforts on a pigment found in human retinal photoreceptor cells, rhodopsin, which consists of opsin and chromophore components.

One of the major theories about how retinal works is that because it is strongly positively charged at one end it could distribute this electrostatic charge across the chromophore molecule, and this would enable it to absorb the longer wavelengths at the red end of the spectrum. Another theory held that a change in shape of the chromophore-opsin complex could alter the absorption capabilities.

The problem with testing the theories, Borhan said, is that the visual pigments have proved difficult to work with. So instead, Borhan and

colleagues used human cellular retinol binding protein II, (hCRBPII), a gut protein that binds retinol, which is closely related to retinal but which tolerates mutations more readily.

The team first created a mutation of hCRPBII that could bind retinal. They then changed the distribution of the electrostatic charge on the retinal molecule by replacing amino acids at the binding site retinal uses on hCRPBII in various ways, and in so doing created a range of pigment proteins.

The team then used spectrophotometry to compare the light entering and leaving the proteins to determine which wavelengths were being absorbed. Using this approach they were able to prove the charge distribution theory was correct and that no change in shape was necessary.

A by-product of the new research is the production of the 11 new artificial pigments, which could be used in tracking proteins or cell types being studied, as well as other possible applications such as in food dyes. One of the new pigments could absorb a red wavelength of 644 nanometers (nm), which is above the theoretical maximum wavelength retinal can absorb (560 nm) and is close to infrared (750 nm +).

The paper was published in the journal *Science*.

More information:
www.sciencemag.org/content/338/6112/1340.abstract

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