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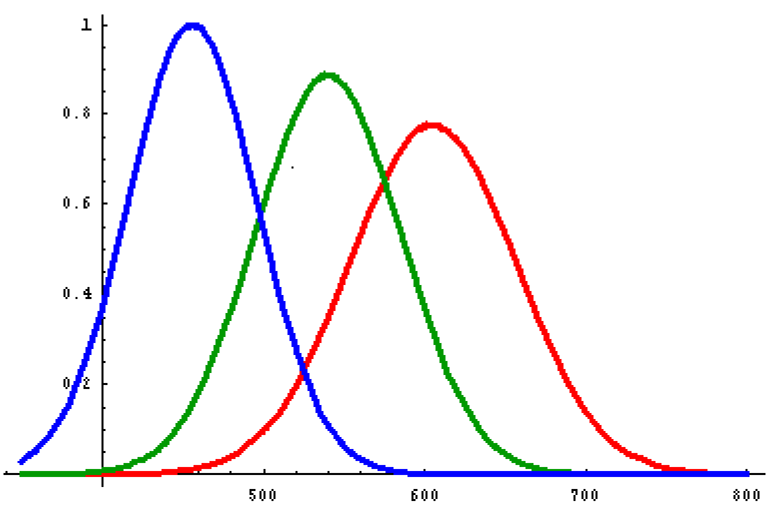
About Color Vision Deficiency (CVD)

Dr. Kreda explains how we see color and why some people have problems

How do we see colors?

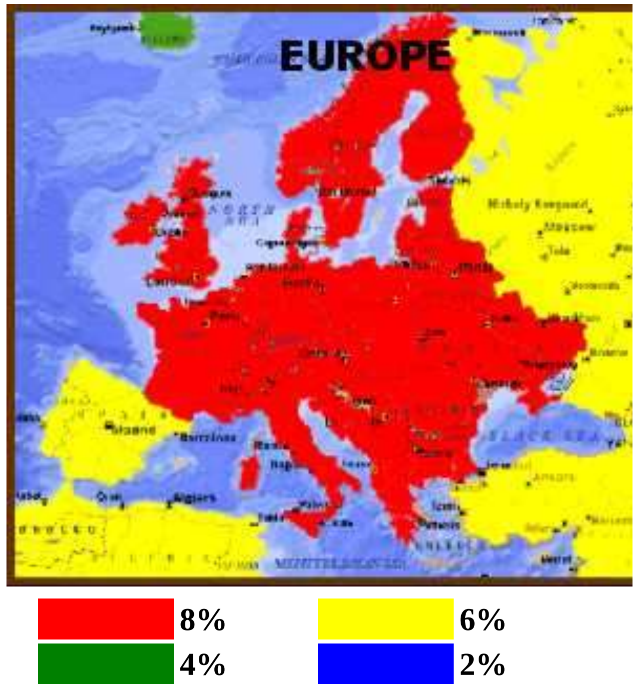
There are two types of light sensitive elements in the eye, called rods and cones. Rods are simpler because they are responsible for vision in low light level conditions and they are not color but only brightness sensitive. This is why we do not see colors in the dark. Cones have a more sophisticated structure and a more difficult task. They are responsible for precise, focused vision of details and for color perception. There are three types of cones in the human eye. Each of them is named in Greek after its order on the color scale or alternatively after the wavelength of which the most sensitive it is. We call them protos or L cone (the first from the long end, most sensitive to the Long wavelengths, the reddish colors); deuteros or M cone (the second one, most sensitive to the Medium wavelengths, the greenish colors) and tritos or S cone (the third on the row, most sensitive to the Short wavelengths, the bluish colors) When we see a certain color - in other words when light of a certain wavelength reaches our eye - one, two or all the tree of these cones get stimulated and sends different strength signals through the nervous system to the brain. The brain receives and interprets these signals, thus we see colors. The three colored curves below represent the sensitivity curves of the three corresponding color receptors. Any point selected discretion on the wavelength axis shows to what extent the three receptors are sensitive to that wavelength of the light, i.e. to a hue.



The sensitivity curves of a subject with normal color vision.

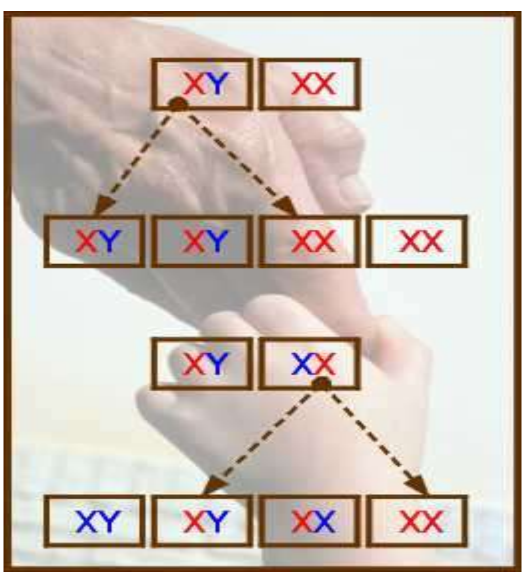
How does someone become Color Vision Deficient?

Color Vision Deficiency can be either an inherited or an acquired condition. Eight percent of the male and 0.5 % of the female population suffers from inherited CVD. This means 12 million people in the US alone.



Cruz-Coke (1970)

The genetic heritage is linked to a defect in the X chromosome and usually affects every second generation of a family. Diabetes, alcoholism or certain medicines may cause acquired CVD. Note that 27 million Americans suffer from diabetes and they are all subject to weakening or losing their color vision ability.



XY:	male
XX:	female
XY:	CVD male
XX:	carrier female
XX:	CVD female

Primary aspects and categorization of Color Vision Deficiency

Understanding the role of cones in color vision and looking at their sensitivity curves on Figure 1 indicates that (1) if the height of a cone sensitivity curve decreases or (2) if a cone sensitivity curve is shifted along the wavelength axis for any reason, color vision changes for the worse. Depending on which of the three sensitivity curves is affected and how much the affected curve deviates from the normal one we determines the following types of color vision deficiencies:

Protanomaly (PL)	mild deficiency in the L cone sensitivity (problem with red colors)
Extreme Protanomaly (XP)	serious deficiency in the L cone sensitivity (problem with red colors)
Protanopy (PP)	total lack of the L cone sensitivity (red colorblindness)
Deuteranomaly (DL)	mild deficiency in the M cone sensi-tivity (problem with green colors)
Extreme Deuteranomaly (XD)	serious deficiency in the M cone sen-sitivity (problem with green colors)
Deuteranopy (DP)	total lack of the M cone sensitivity (green colorblindness)
Tritanomaly (TL)	mild deficiency in the S cone sensitivity (problem with blue colors)
Tritanopy (TP)	total lack of the S cone sensitivity (blue colorblindness)