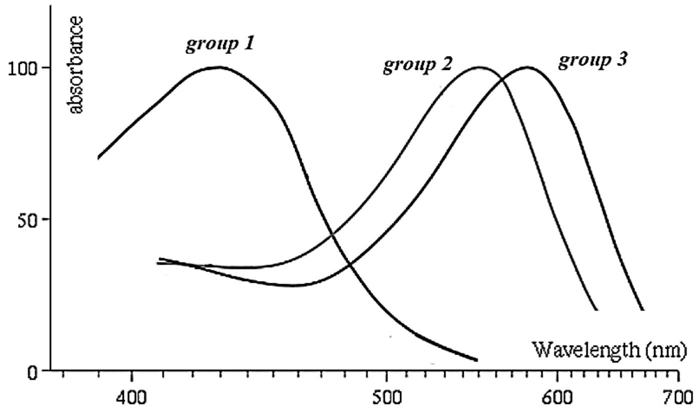
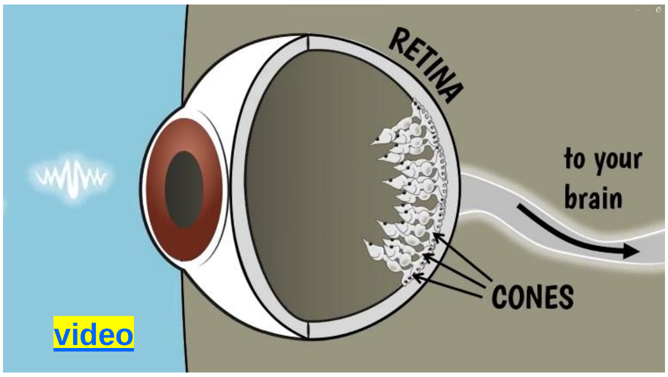
How can we see light and colours ?

Let's look at how our eyes recognize colour. While it might seems that they measure the wavelengths of light, that is not the case. Instead, our retinas contain three groups of light-sensing cone cells that respond to three different ranges of wavelengths. One group of cone cells responds to radiations near 600 nm and lets us see red, another responds to light near 550 nm and lets us see green, and a third responds to light near 450 nm and lets us see blue. These cone cells are most abundant at the center of our vision.





While our retina also contains rod cells, which are more light-sensitive than cone cells, rod cells can't distinguish colour. They are most abundant in our peripheral vision and provide us with night vision.

Having only three types of colour-sensing cells doesn't limit us to seeing just three colours. We perceive other colours whenever two or more types of cone cells are stimulated at once. Each type of cell reports the amount of light it detects, and our brain interpret the overall response as a particular colour.

While light of a certain wavelength will stimulate all three types of cone cells simultaneously, the cells don't respond equally. If the wavelength is 620 nm, the red-sensitive cone cells respond much more strongly than the green-sensitive or blue-sensitive cone cells. Because of this strong red response, we see the light as red. Other wavelengths of light stimulate the three types of cells more evenly. Light with a wavelength of 565 nm is in between red and green light. Both the red-sensitive and the green-sensitive cone cells respond about equally to this light and we see it as being yellow.

But we also see yellow when looking at an equal mixture of 640 nm light (red) and 500 nm light (green). The 640 nm light stimulates the red-sensitive cone cells and the 500 nm light stimulates the green-sensitive ones. Even though there is no 565 nm light entering our eyes, we see the same yellow colour as before. In fact, mixtures of red, green, and blue light can make us see virtually any colour. For that reason, these three are called the primary colours of light or the primary additive colours. Colour televisions and computer screens use tiny sources of red, green and blue light to produce their full-colour images (VISIOLAB).

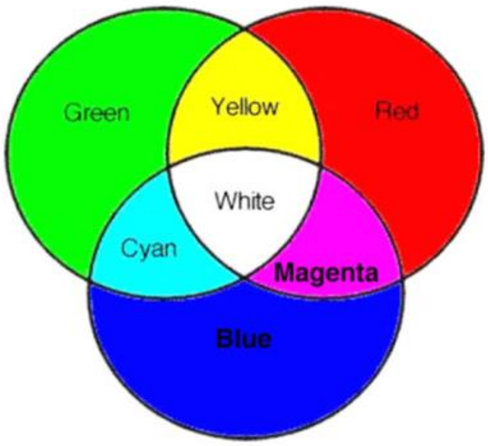
1. What is the difference between cone cells and rod cells?

2. Explain in your own words how the vision of colours is made possible by the eye.

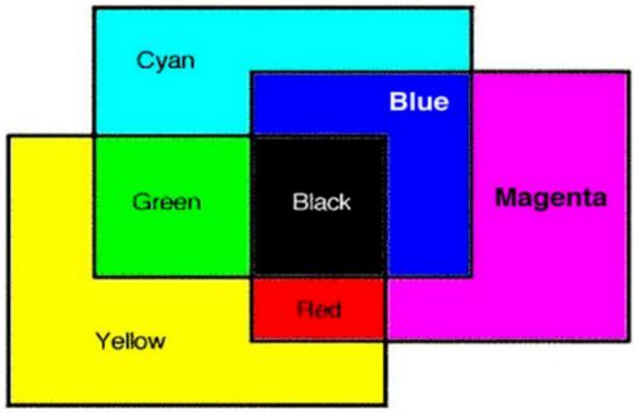
3. To which wavelength cones of group 1 and 2 respond equally? Which colour is perceived by the brain?

While the idea of mixing primary colours also applies to paints, inks, and pigments, the palette is different. The primary colours of pigment or the primary subtractive colours are cyan, magenta, and yellow. When you apply one of these primary pigments to a white surface, it absorbs or subtracts one of the primary colours of light from the surface's reflection. Cyan subtracts the reflection of red, magenta subtracts the reflection of green, and yellow subtracts the reflection of blue. Colour printers, photographs, magazines, and books use tiny patches of cyan, magenta, and yellow pigments to produce their full-colour images.

Primary additive colours



Primary subtractive colours



4. How different is the colour synthesis of a TV screen compared with the colour synthesis of a printer?

5. Virtual experiment with VISIOLAB :

1st experiment : "you have three spots to light a stage : red, blue and green"

- How can you produce a yellow light ? a white light?
- What is the colour of a green object under a yellow light? under a red light? (explain)

2d experiment : "you have three paints to do a painting: magenta, cyan and yellow"

- Which paints should you mix to have a black painting ? (explain)
- Which paints should you mix to have a blue painting ? (explain)

3rd experiment :

Create your own question and test it with your groupmates.