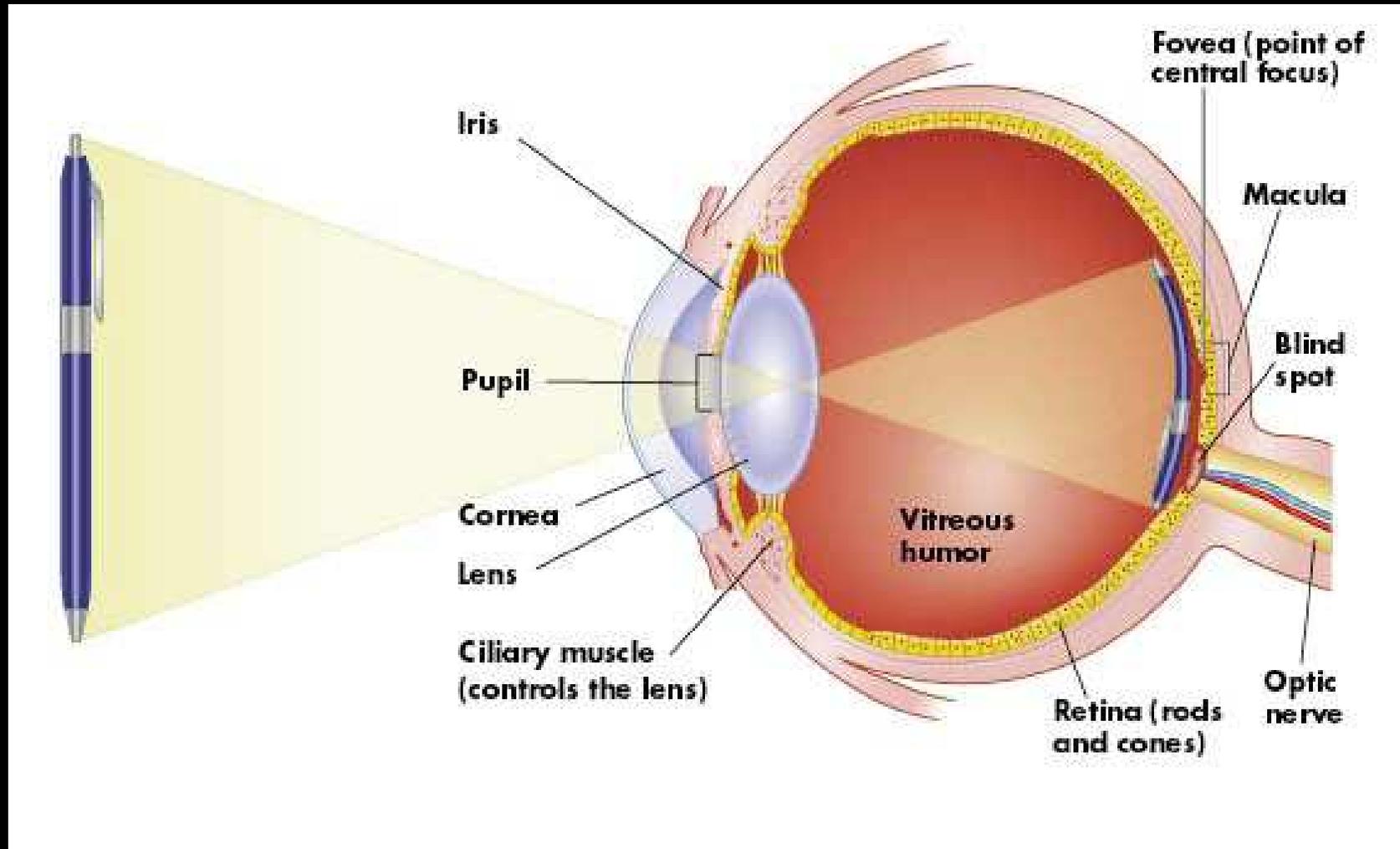


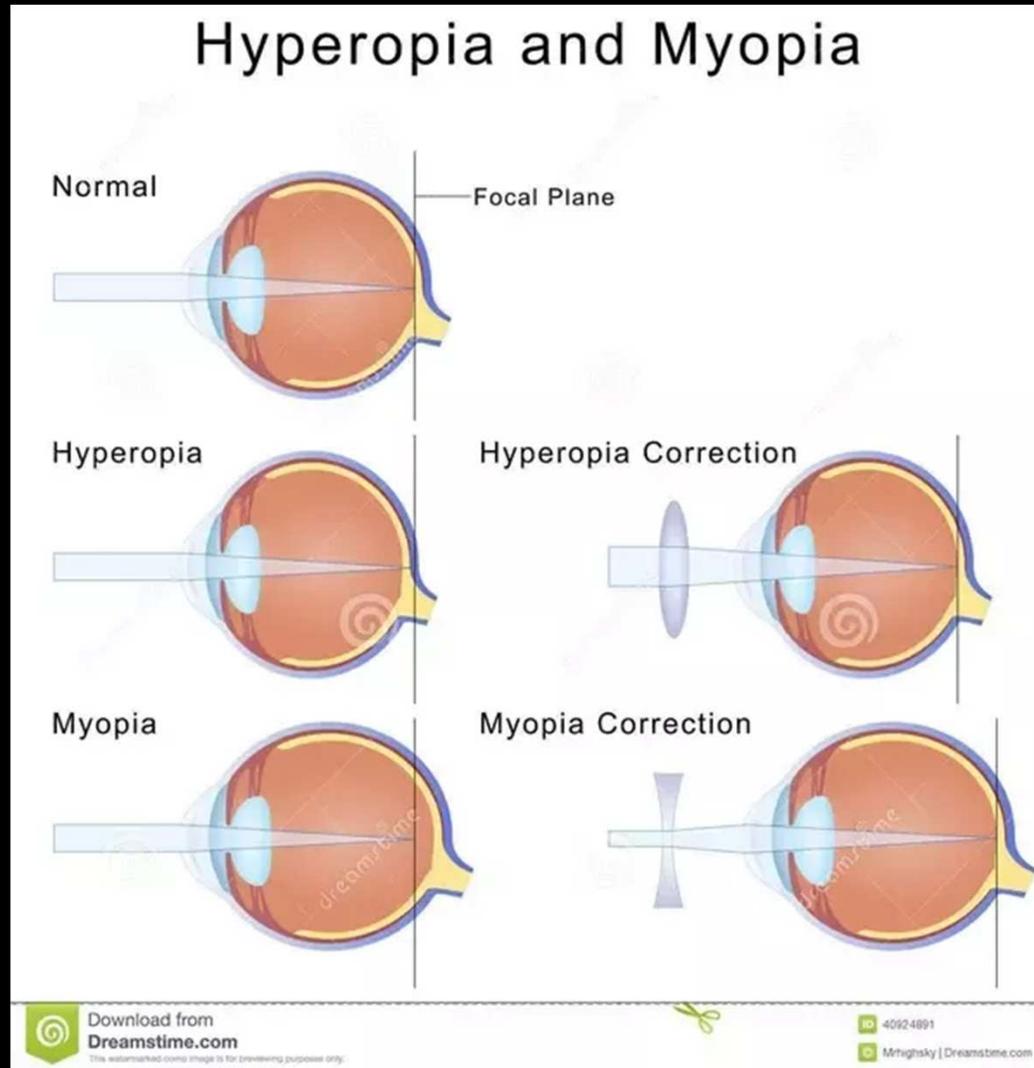
HOW DO WE SEE THINGS?

Vision, colors, light detection and how it is all quantum

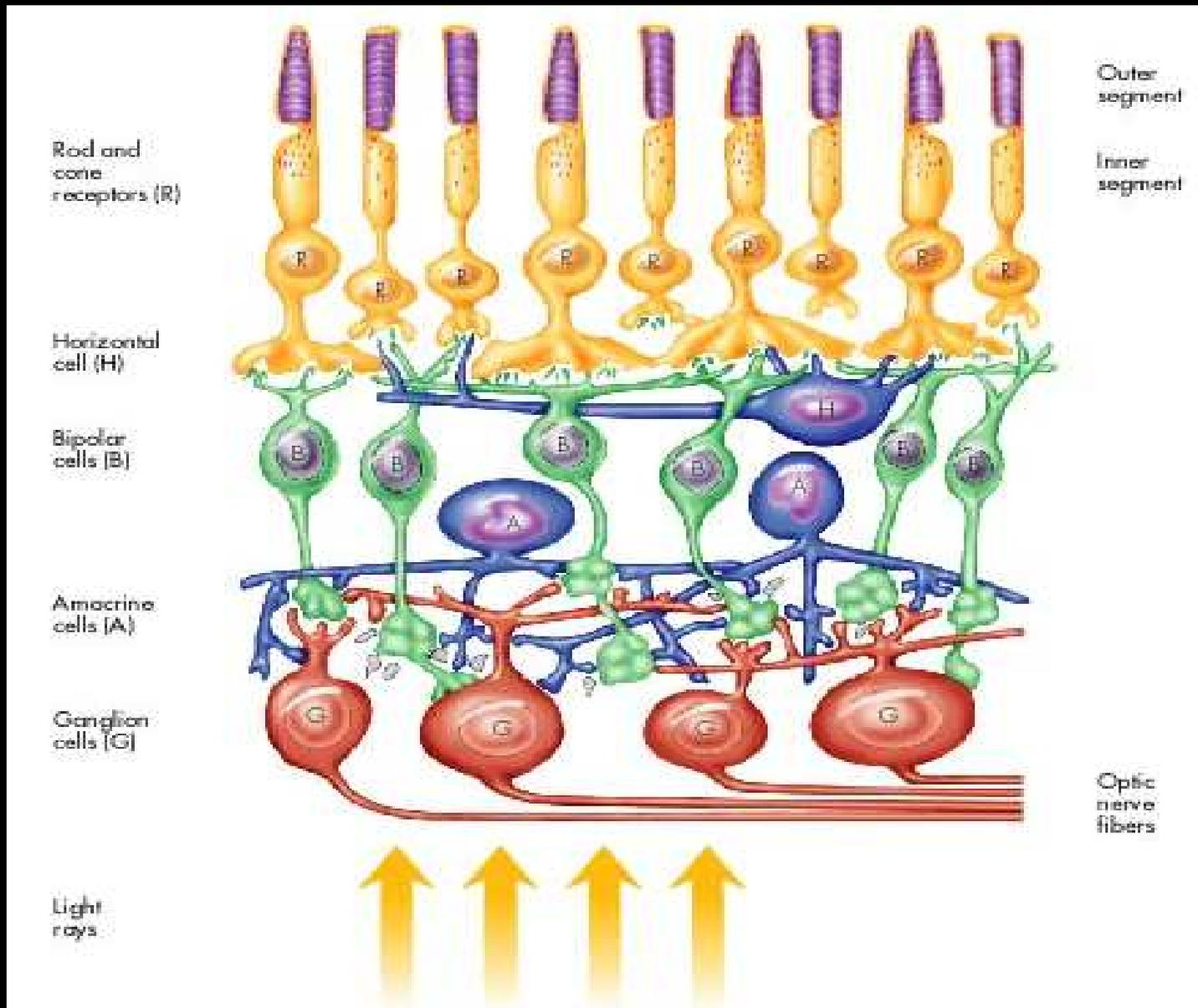
OUR INTERNAL OPTICAL SYSTEM



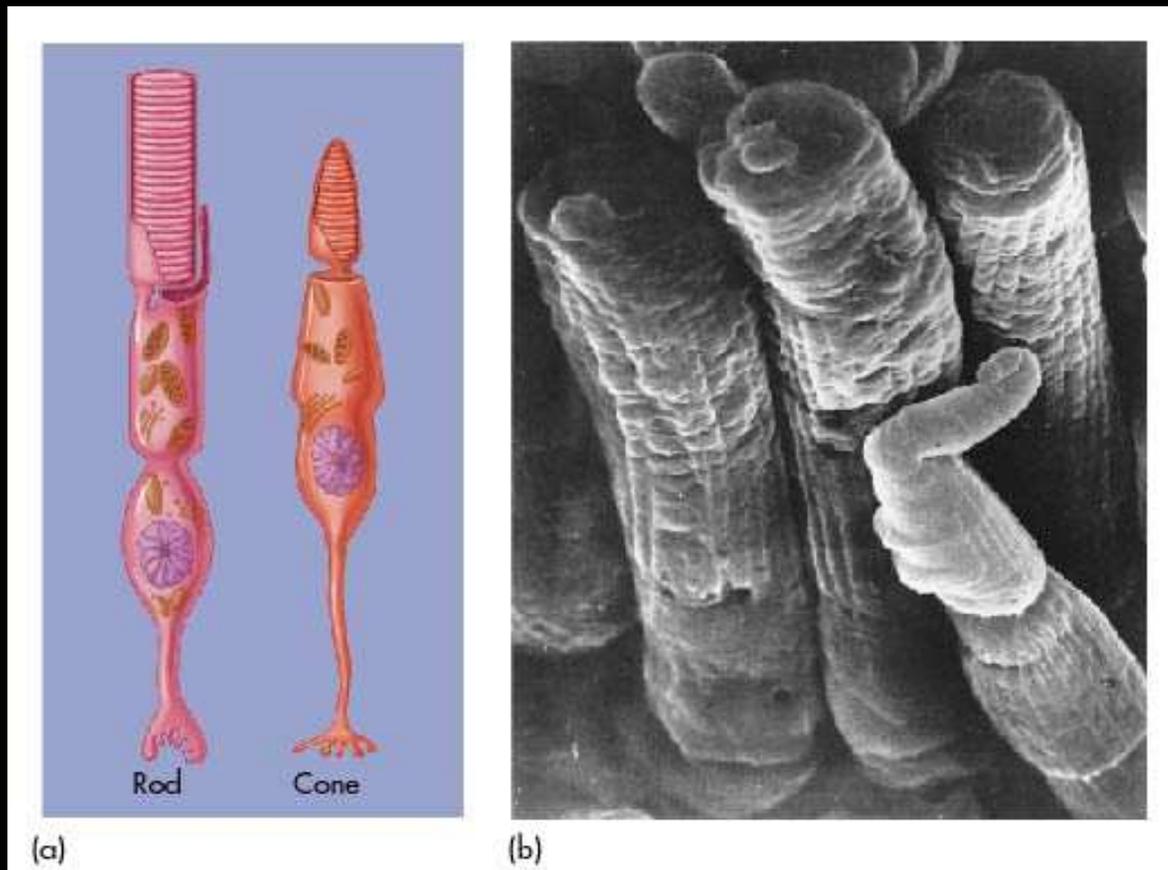
OUR INTERNAL OPTICAL SYSTEM



LIGHT TO ELECTRIC SIGNAL CONVERSION

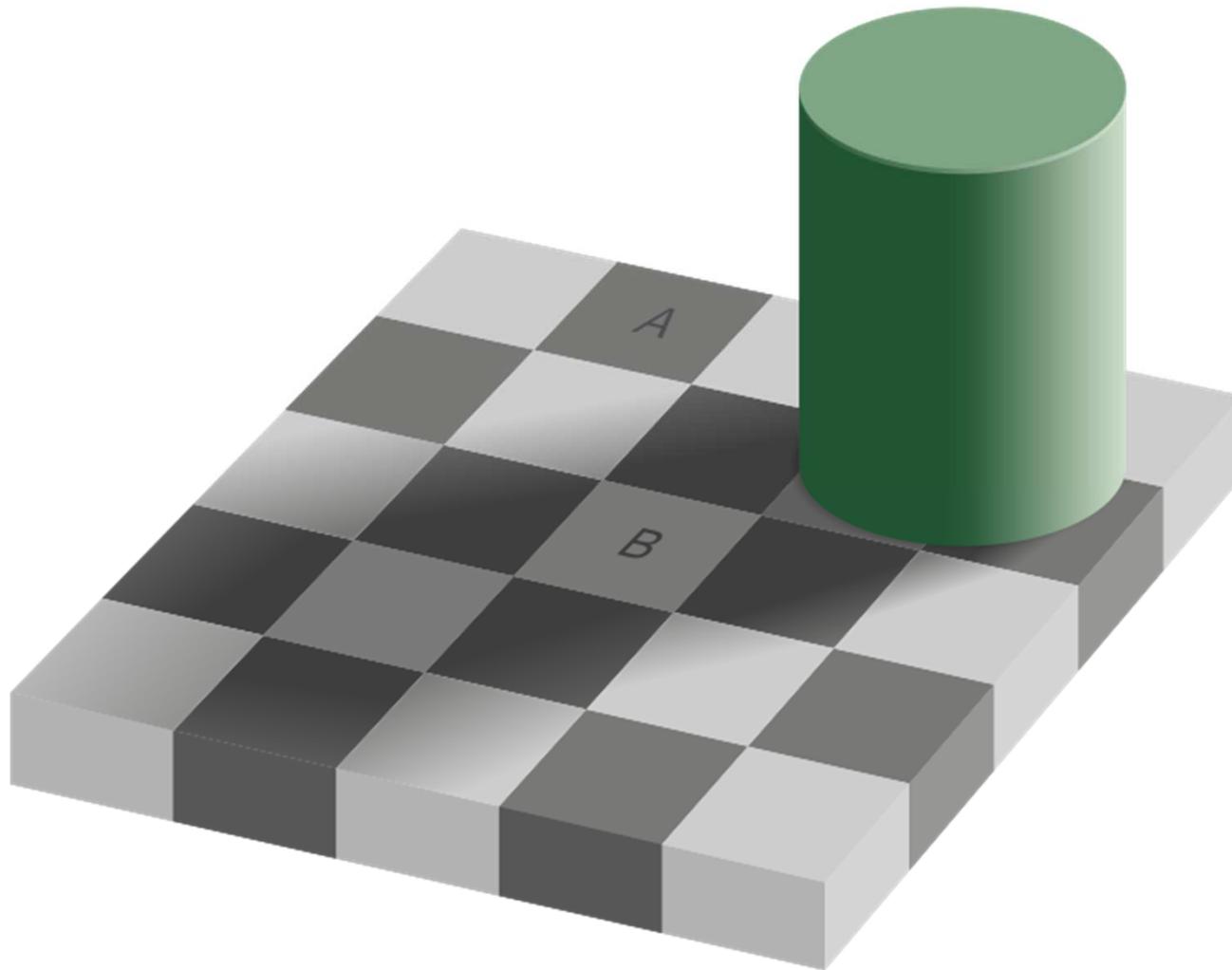


HOW WE SEE COLORS

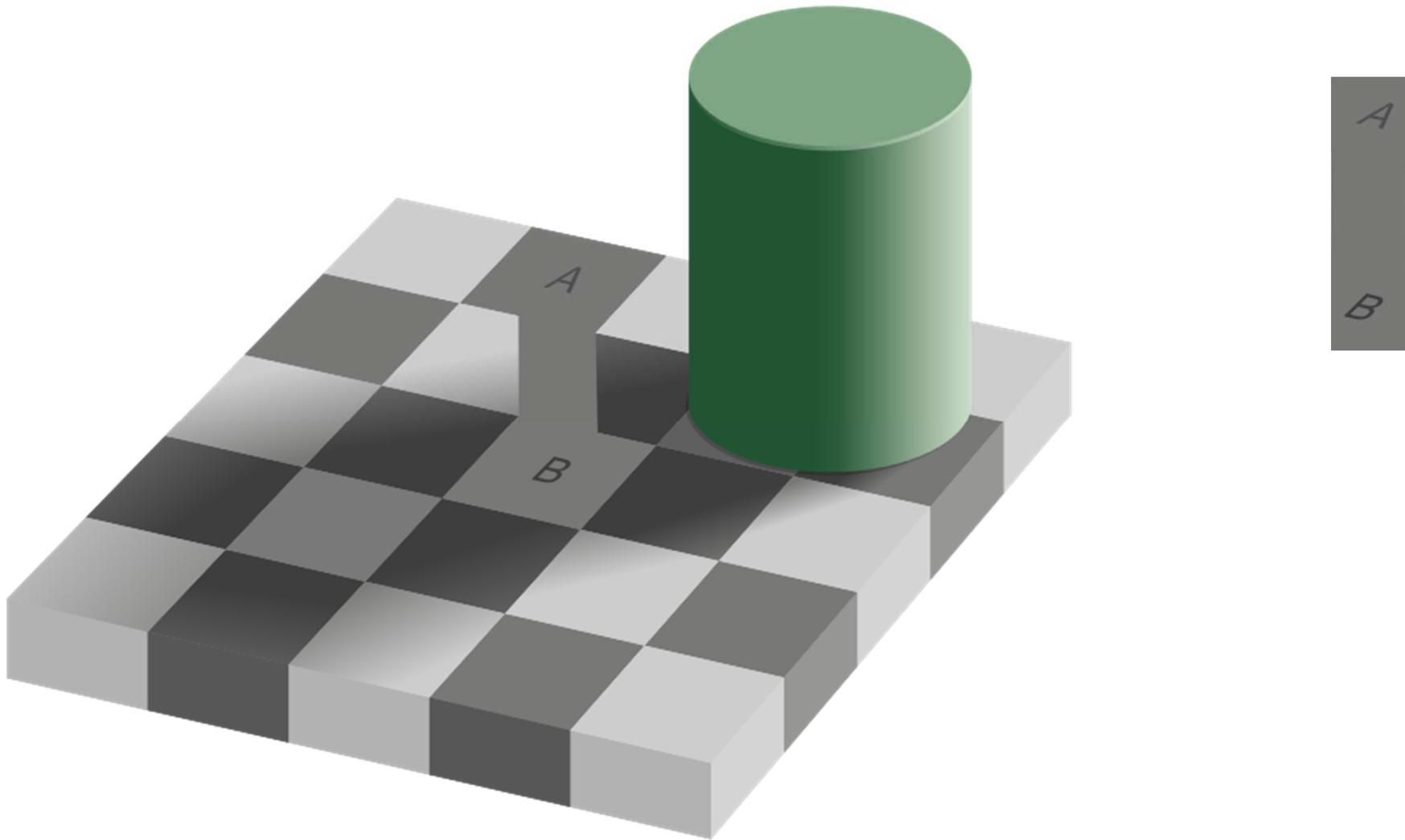


- Cones:
 - Less sensitive
 - Need high light level
 - Responsible for color vision
- Rods:
 - More sensitive
 - Highly sensitive
 - Operate on grey scale

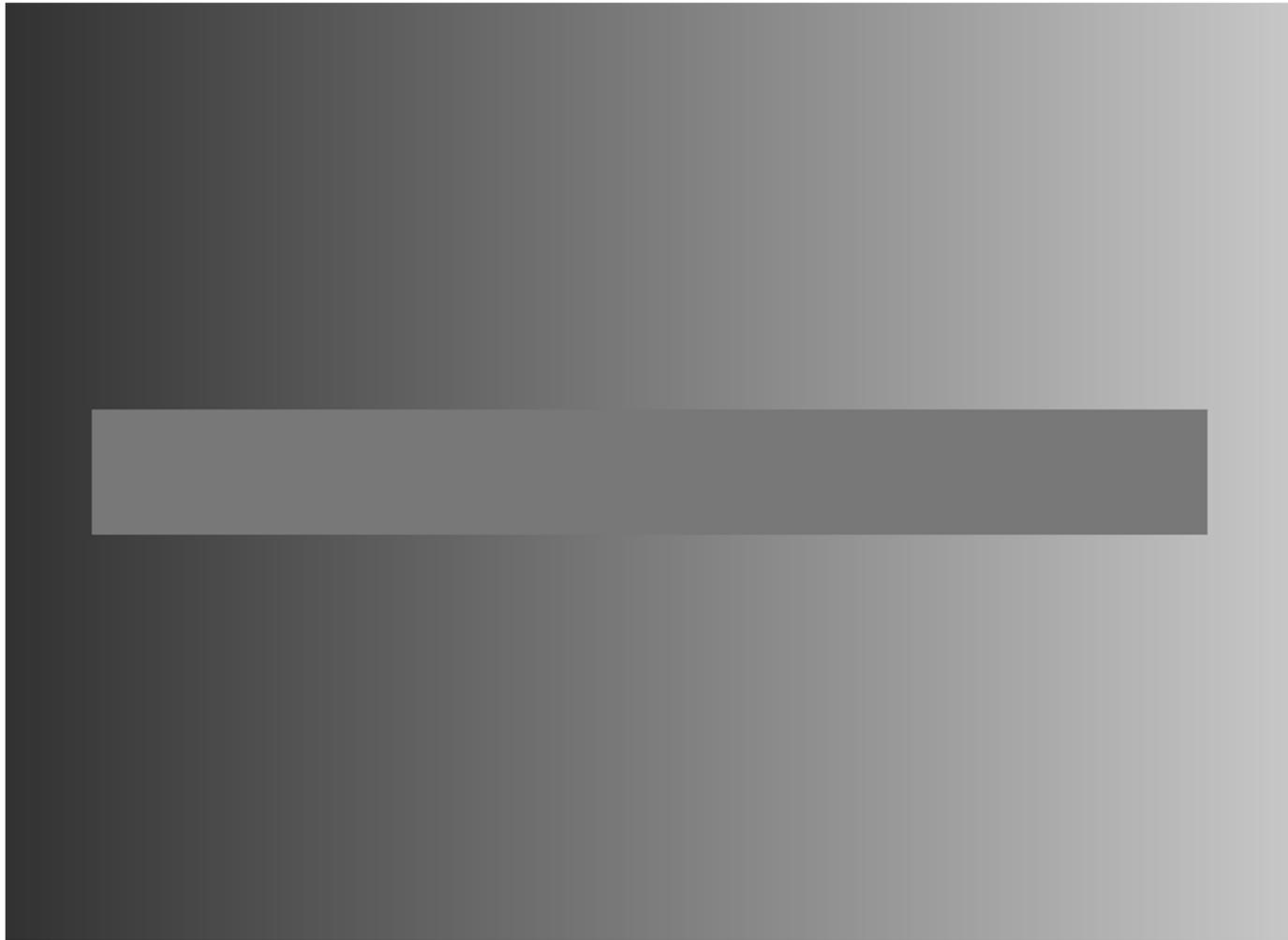
Brightness optical illusion



Brightness optical illusion



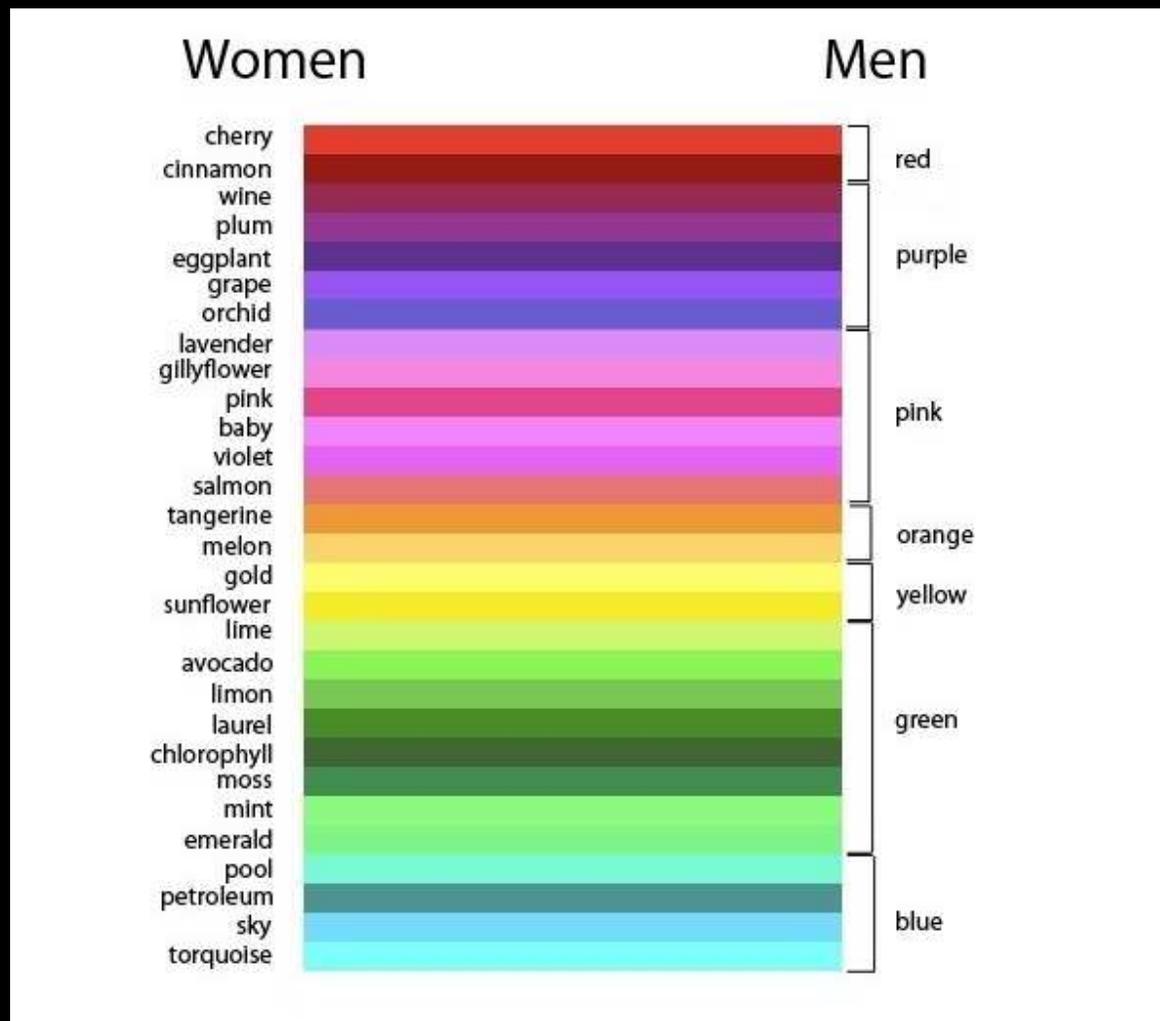
Brightness optical illusion



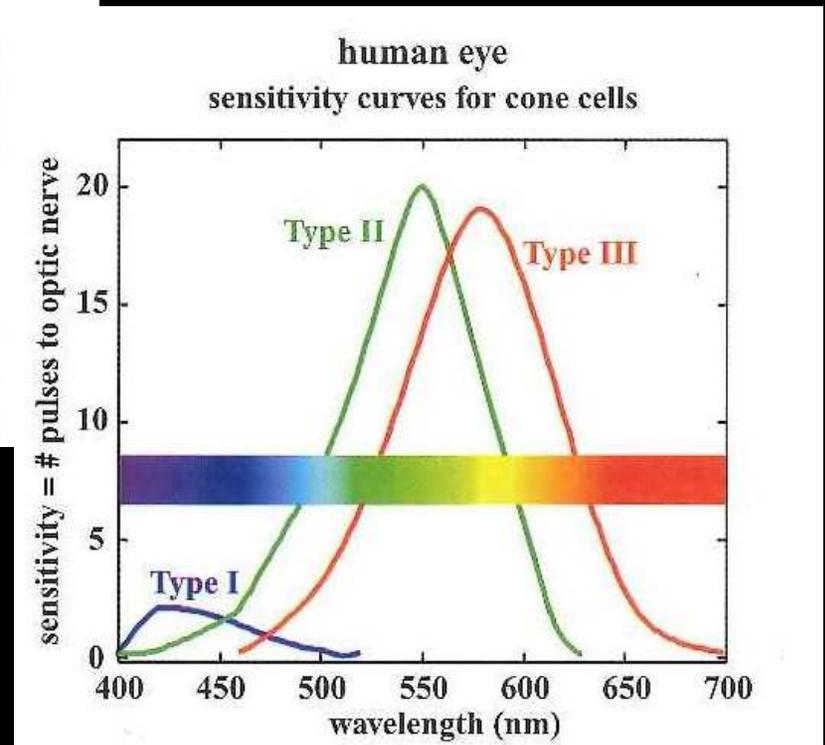
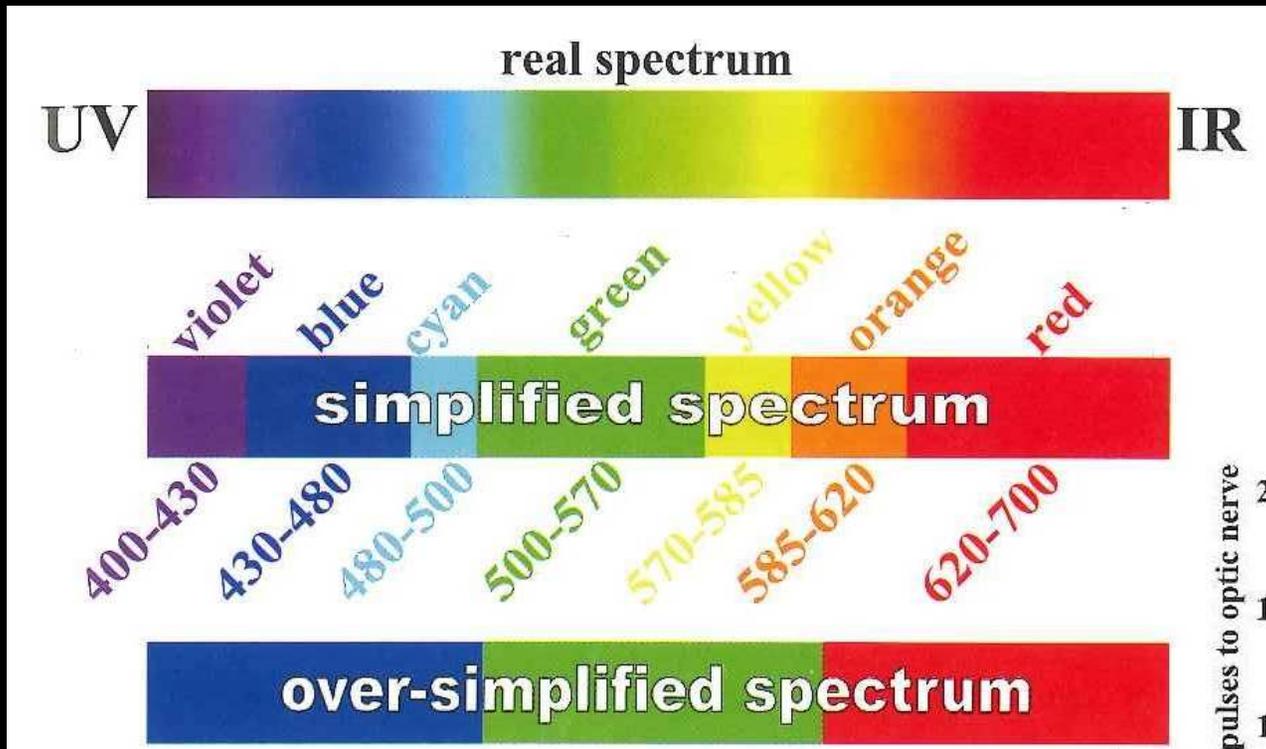
Brightness optical illusion



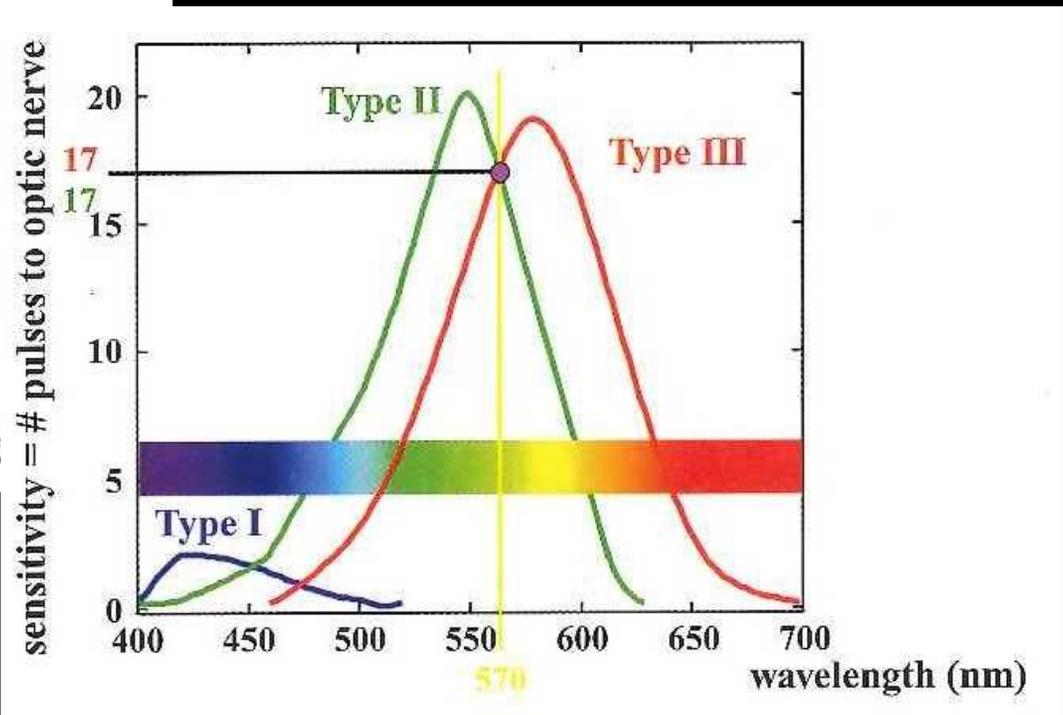
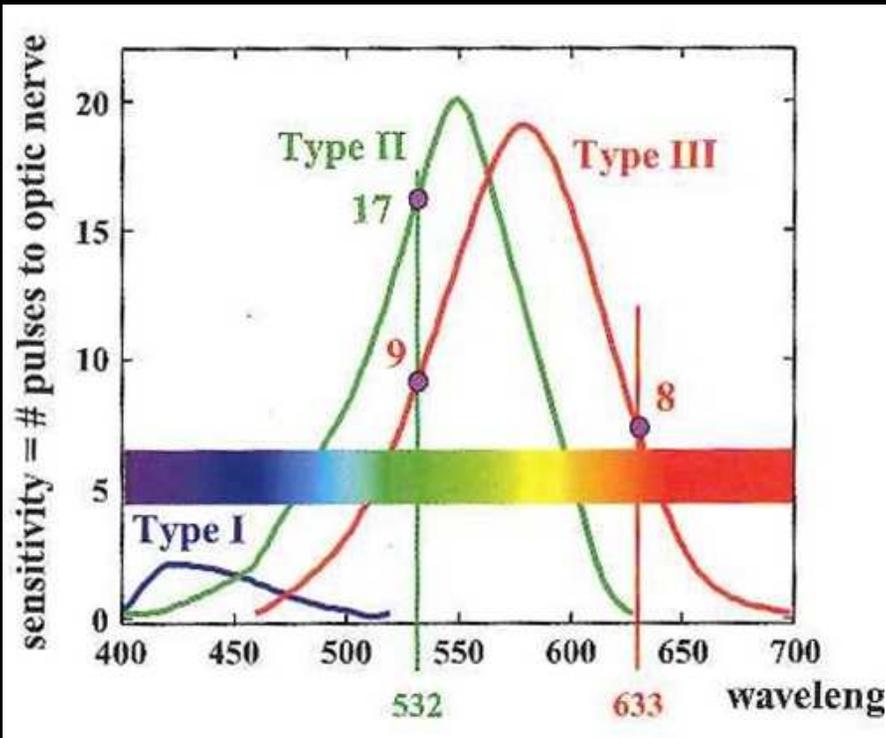
HOW MANY COLORS OUR EYES CAN SEE?

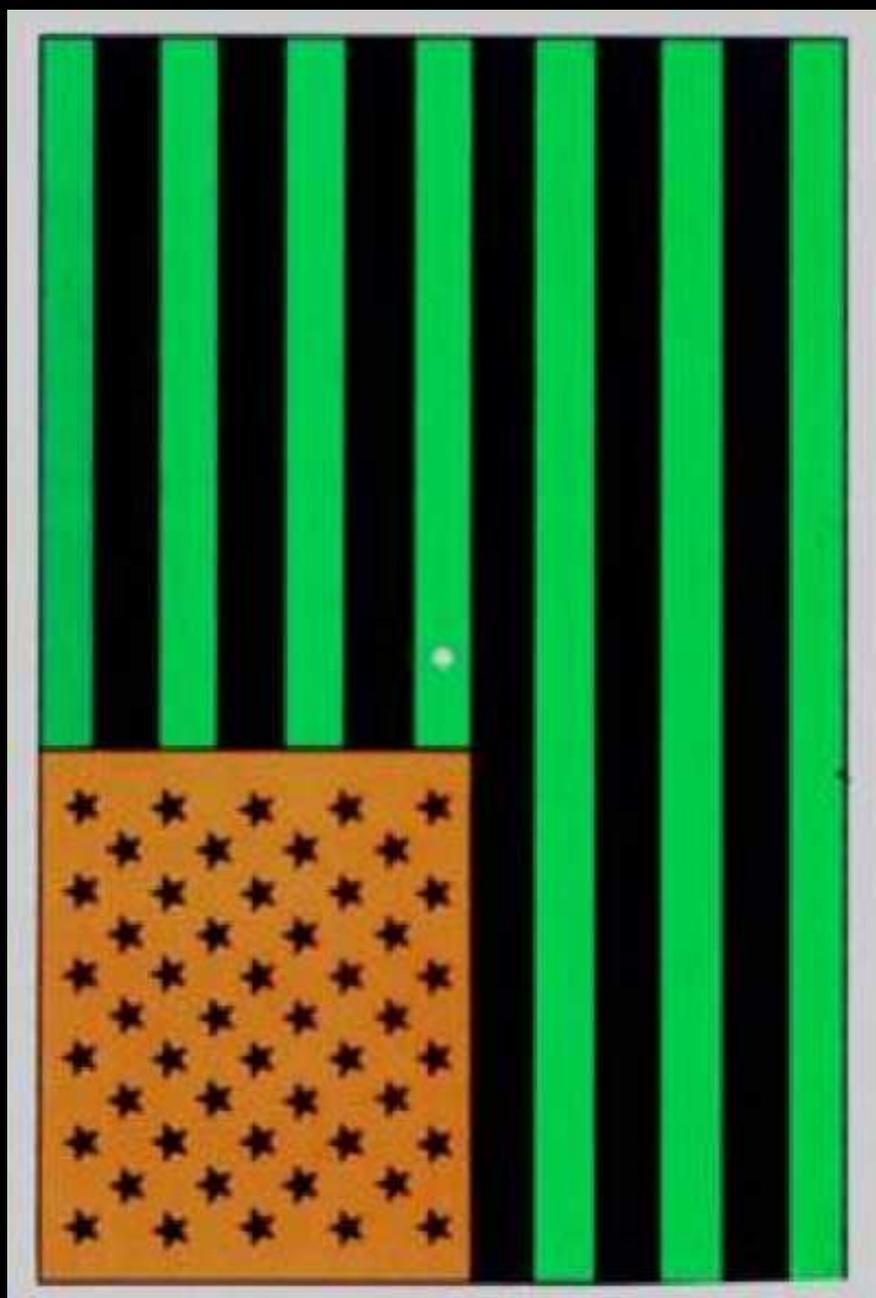


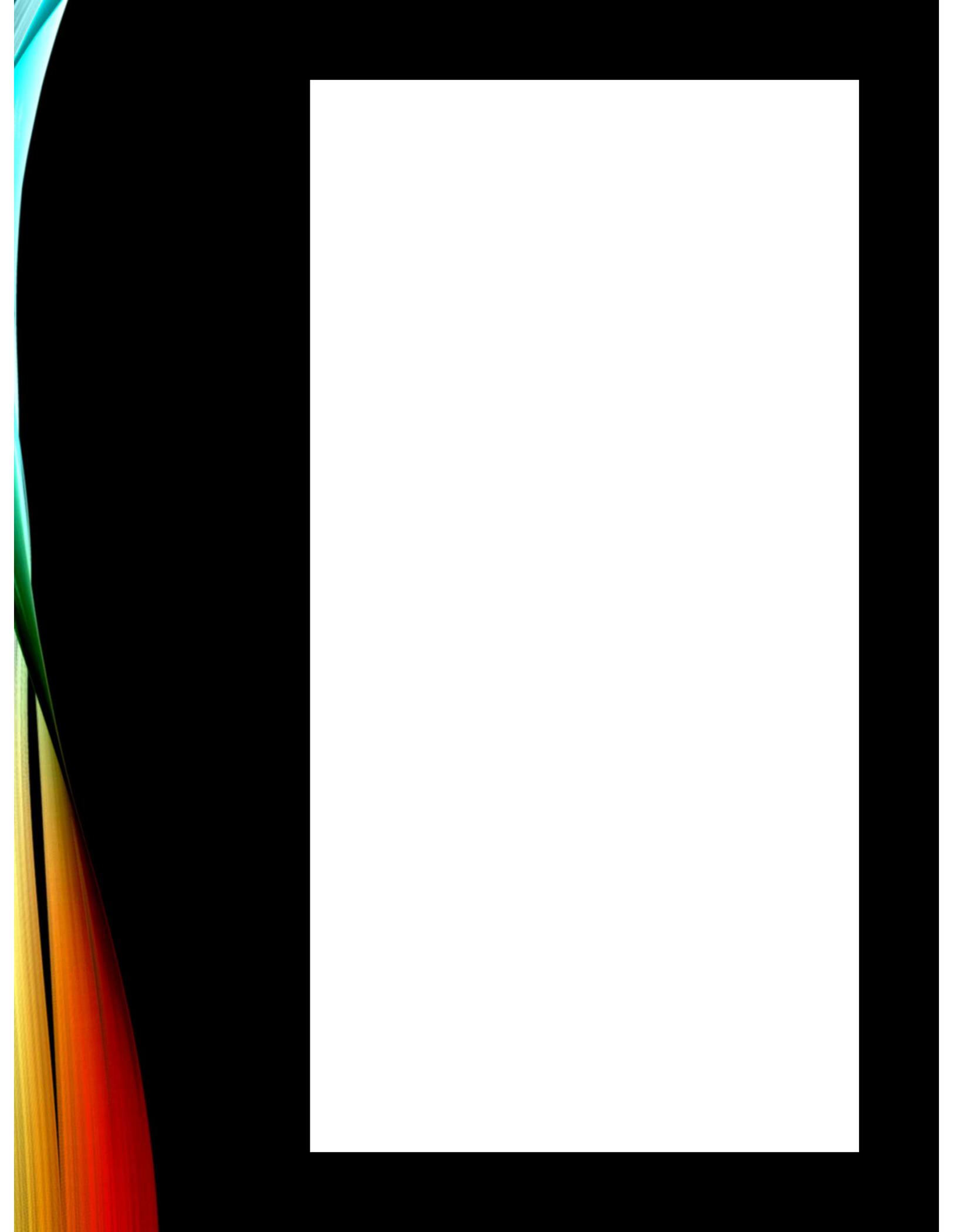
HOW MANY COLORS OUR EYES CAN SEE?



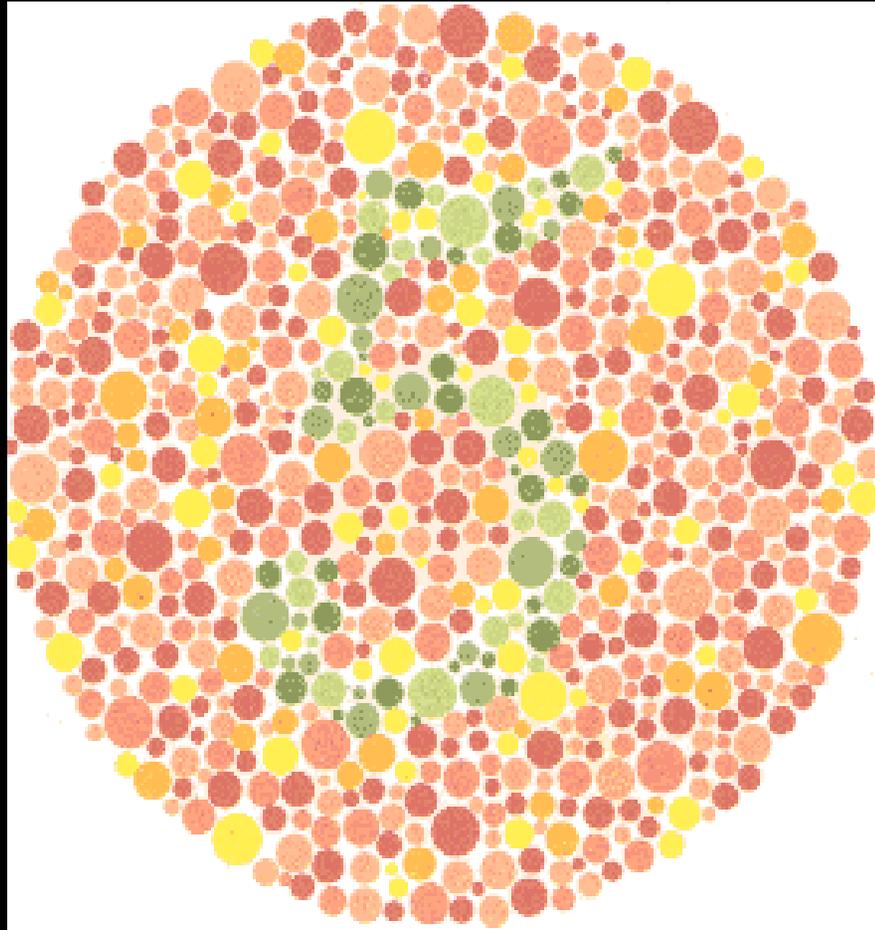
HOW MANY COLORS OUR EYES CAN SEE?



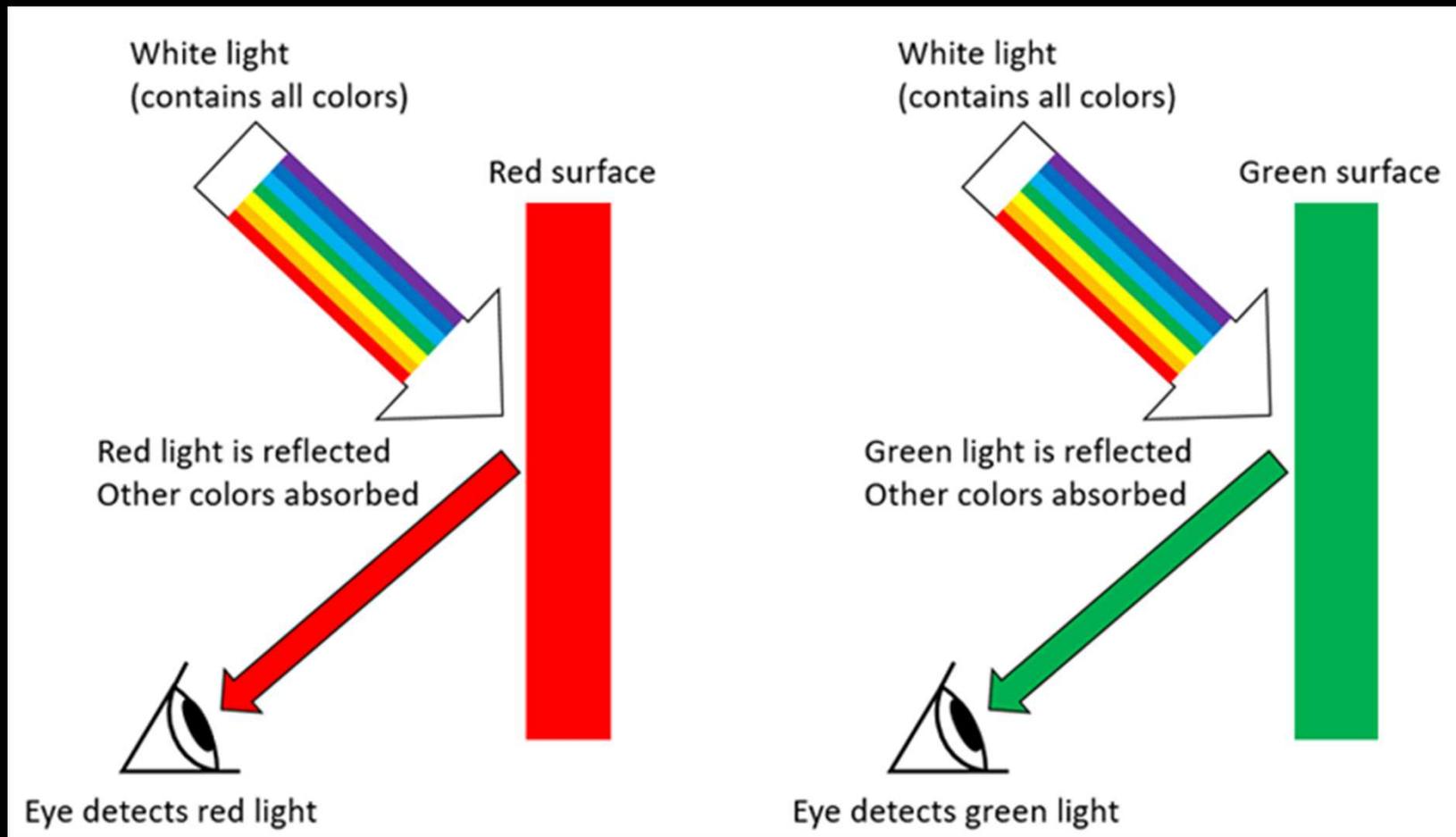




COLORBLINDNESS: ISHIHARA TEST

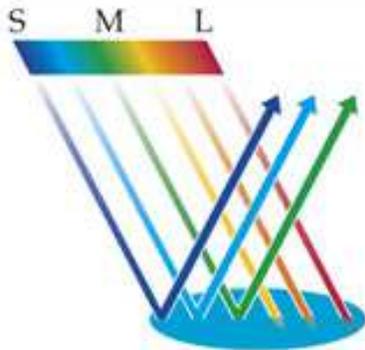


WE SEE OBJECTS IN COLOR?

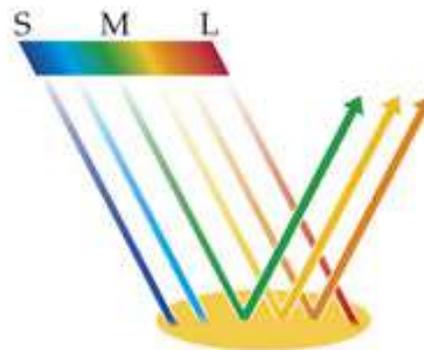


WHY COLOR MIXING WORKS

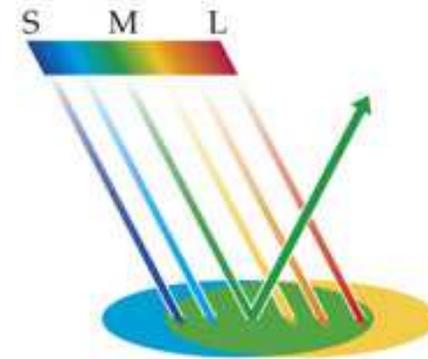
Sunlight consists of photons of all wavelengths.



This patch looks "blue" because it absorbs/ subtracts most of the long wavelengths and some of the medium wavelengths. The short- and medium-wavelength light that is reflected to the eye appears blue.



This patch looks "yellow" because it reflects best in the middle range of wavelengths and absorbs the other wavelengths.

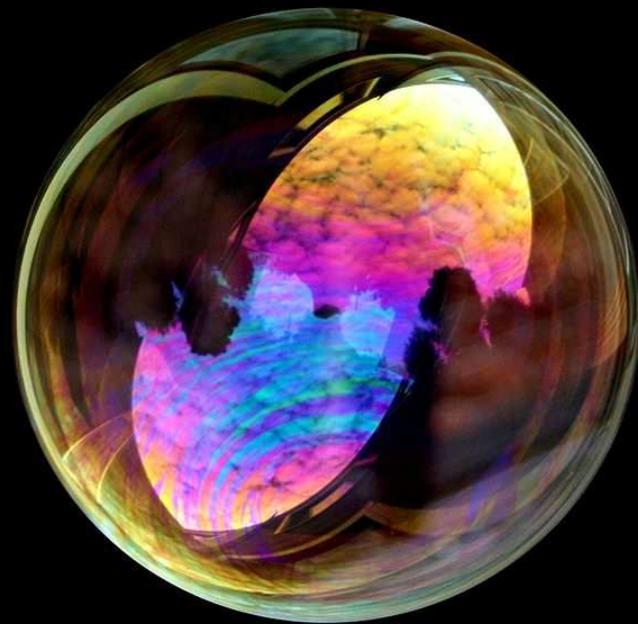


Mix the two pigments together, and what you have left when each has absorbed its wavelengths are some remaining medium wavelengths that look "green."

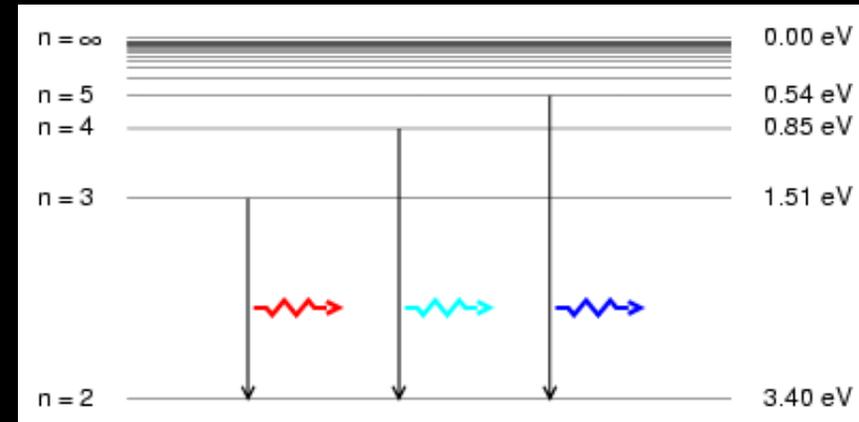
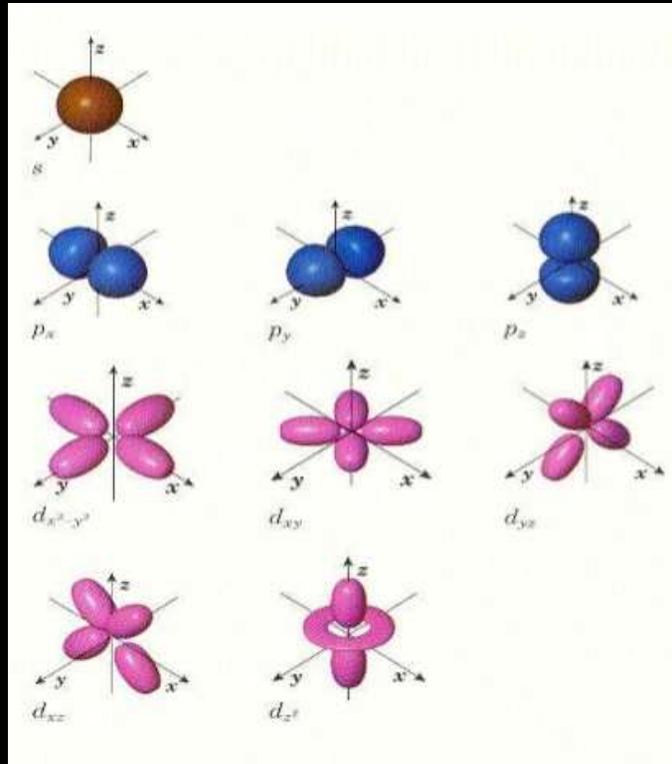
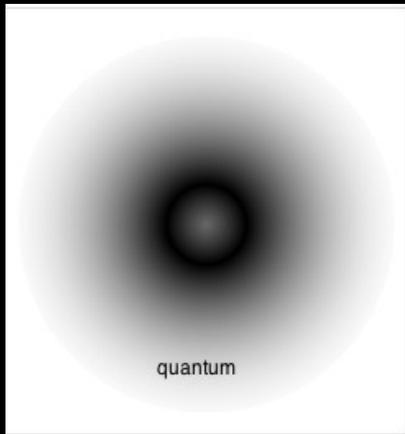
THE MIND'S MACHINE 2e, Figure 7.24

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COLORFUL FILMS



ELECTRONS AND COLORS



ATOMIC/MOLECULAR SPECTRA

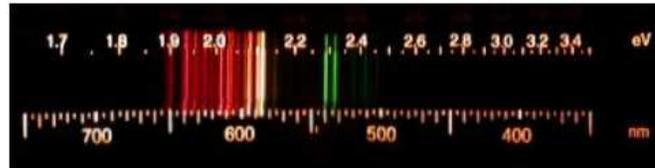
Hydrogen: a simple atom with a simple spectrum. Besides the three lines shown here, you may be able to see another in the blue near 410 nm.



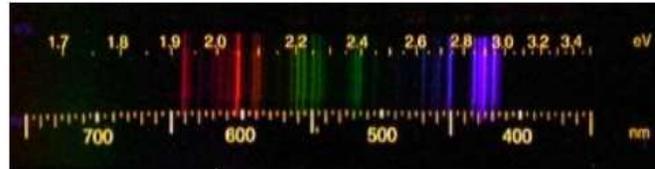
Helium: slightly more complex than hydrogen, with one yellow line and a number in the blue.



Neon: a very large number of lines in the red give neon signs their distinctive pink colors, but notice the two green lines.



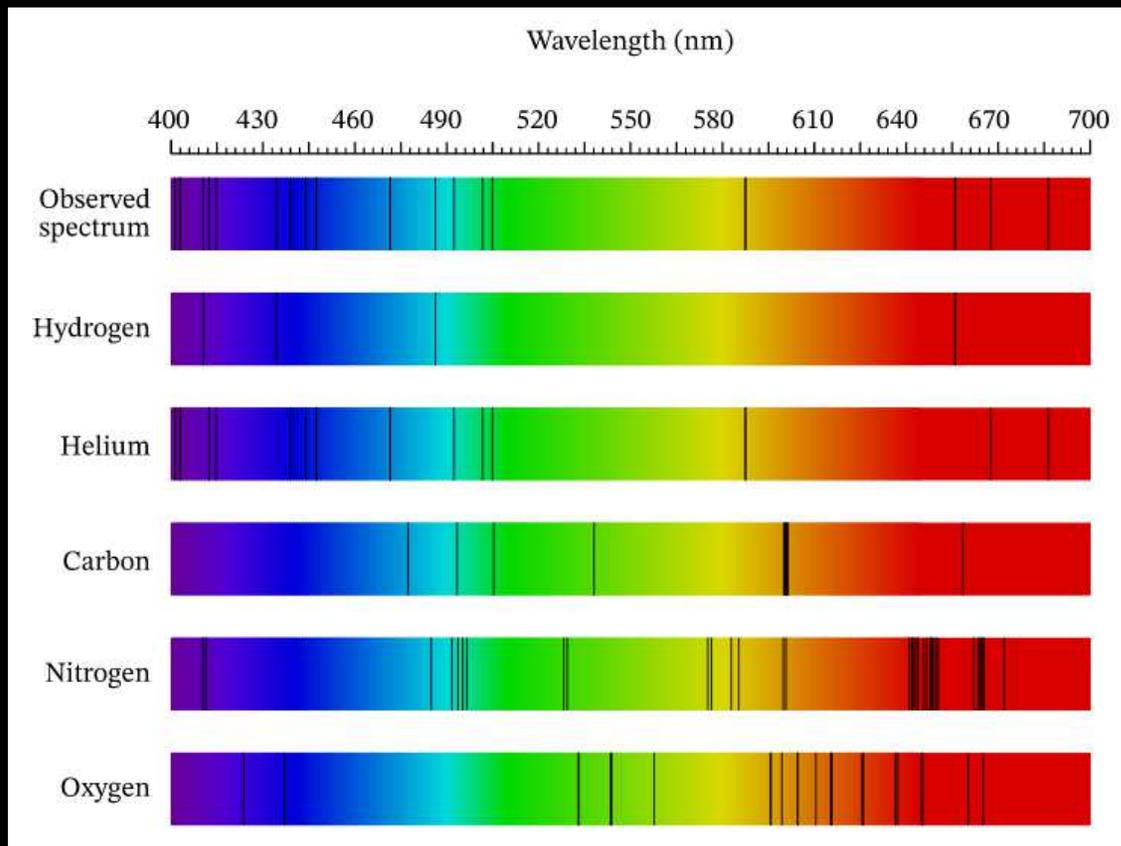
Argon: the pastel color of argon is due to a wide range of lines throughout the spectrum.



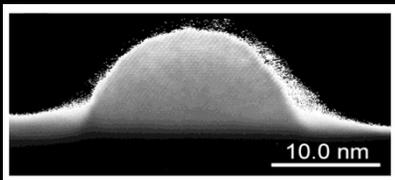
Mercury: the strongest line, at 546 nm, gives mercury a greenish color.



ATOMIC/MOLECULAR SPECTRA

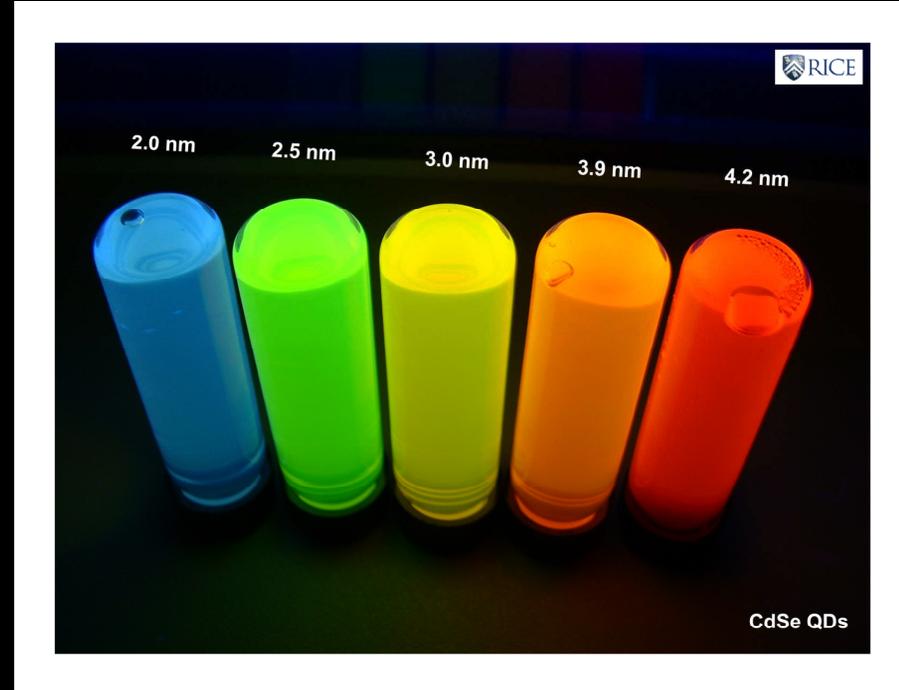
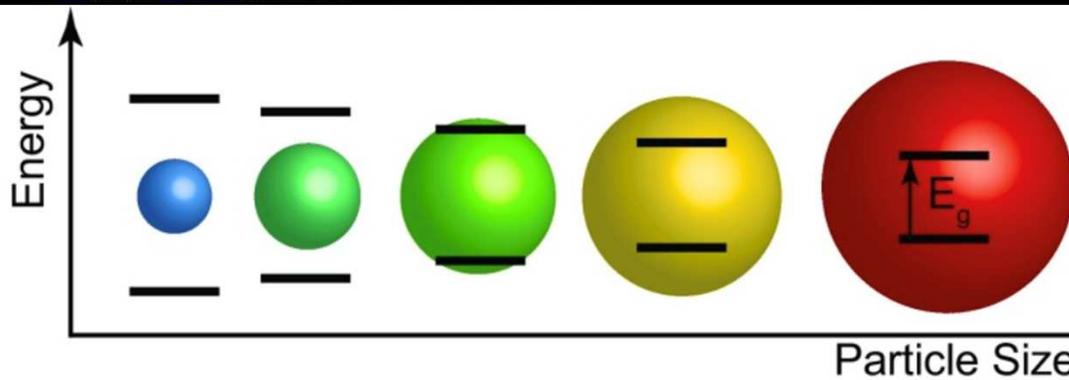
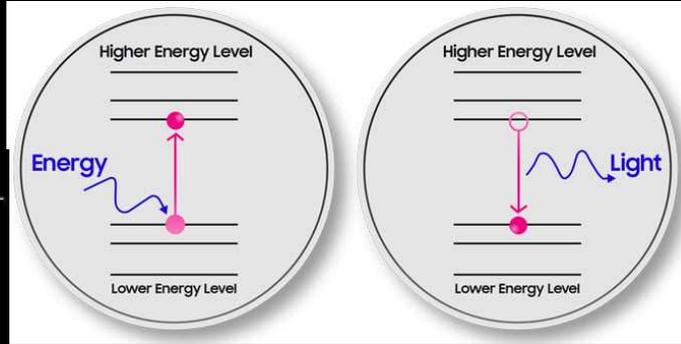


QUANTUM DOTS: "ARTIFICIAL ATOMS"

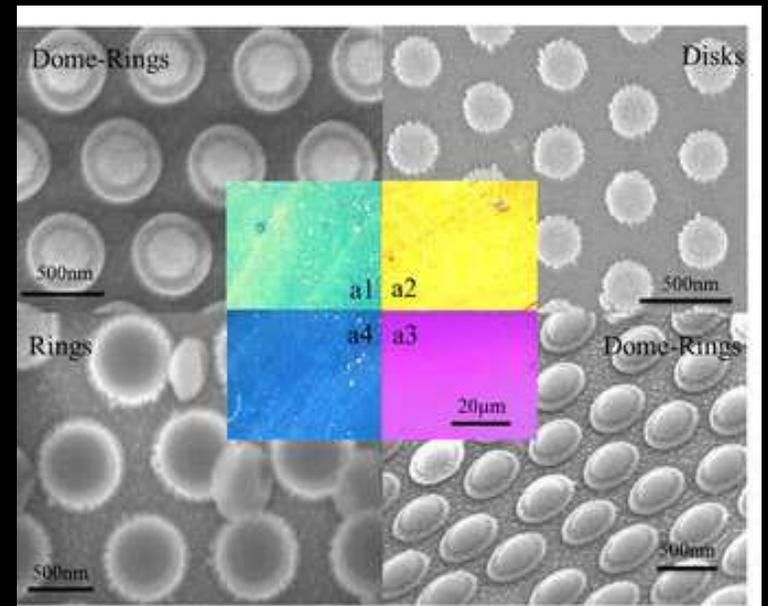
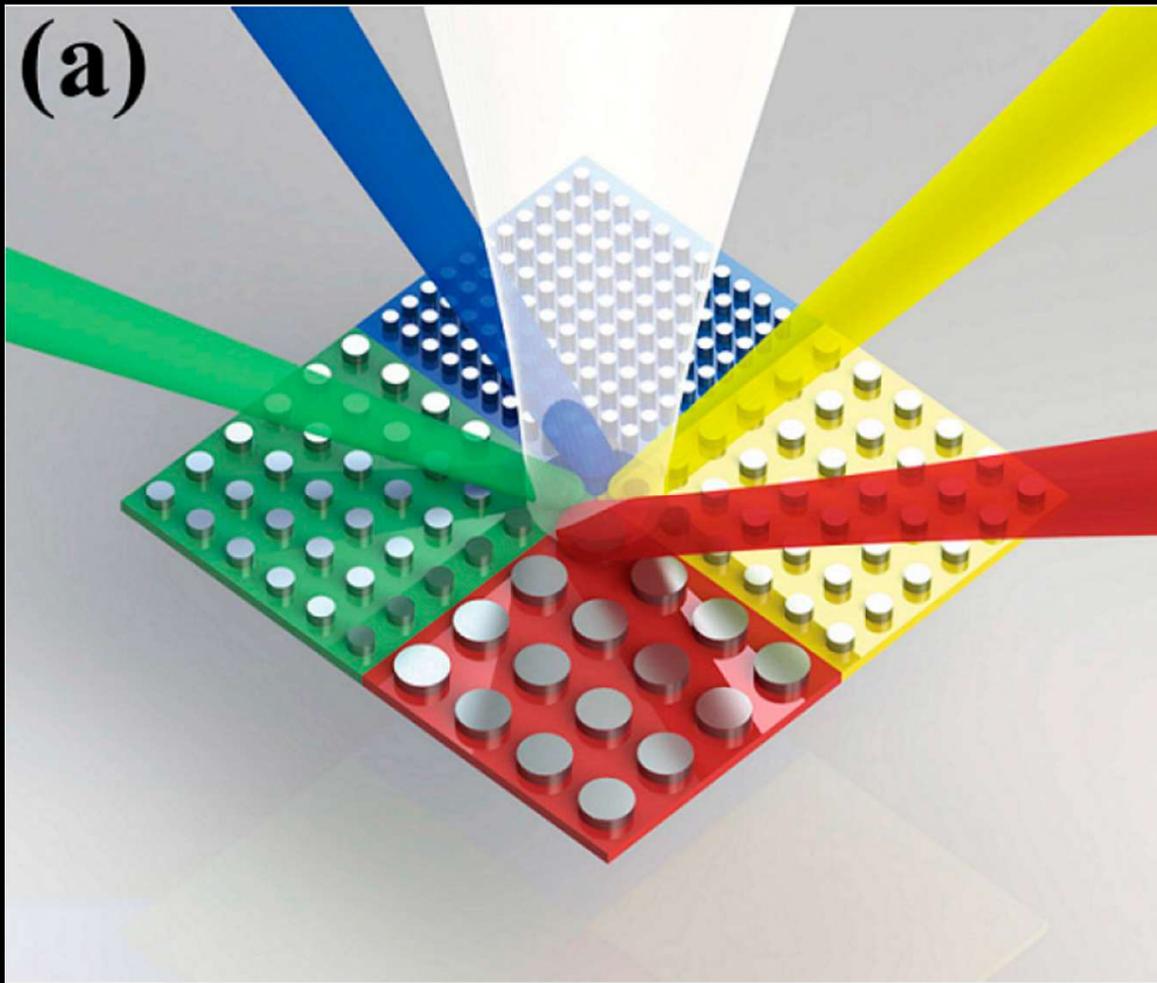


Heisenberg's Principle

$$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$$



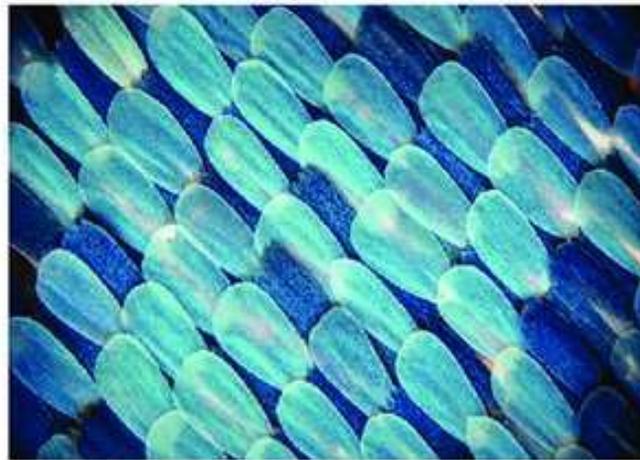
ENGINEERED COLORS



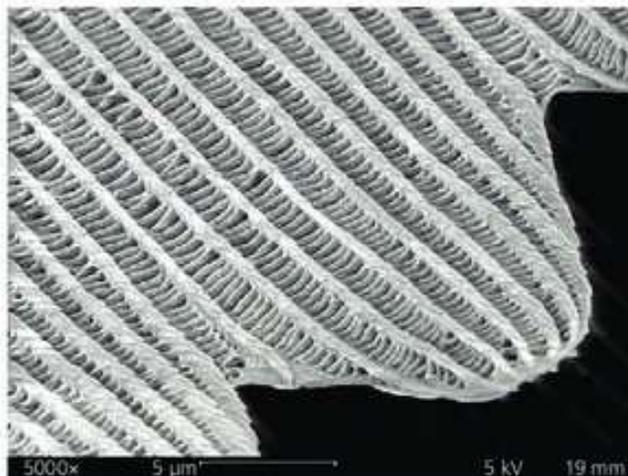
NATURAL NANOSTRUCTURES



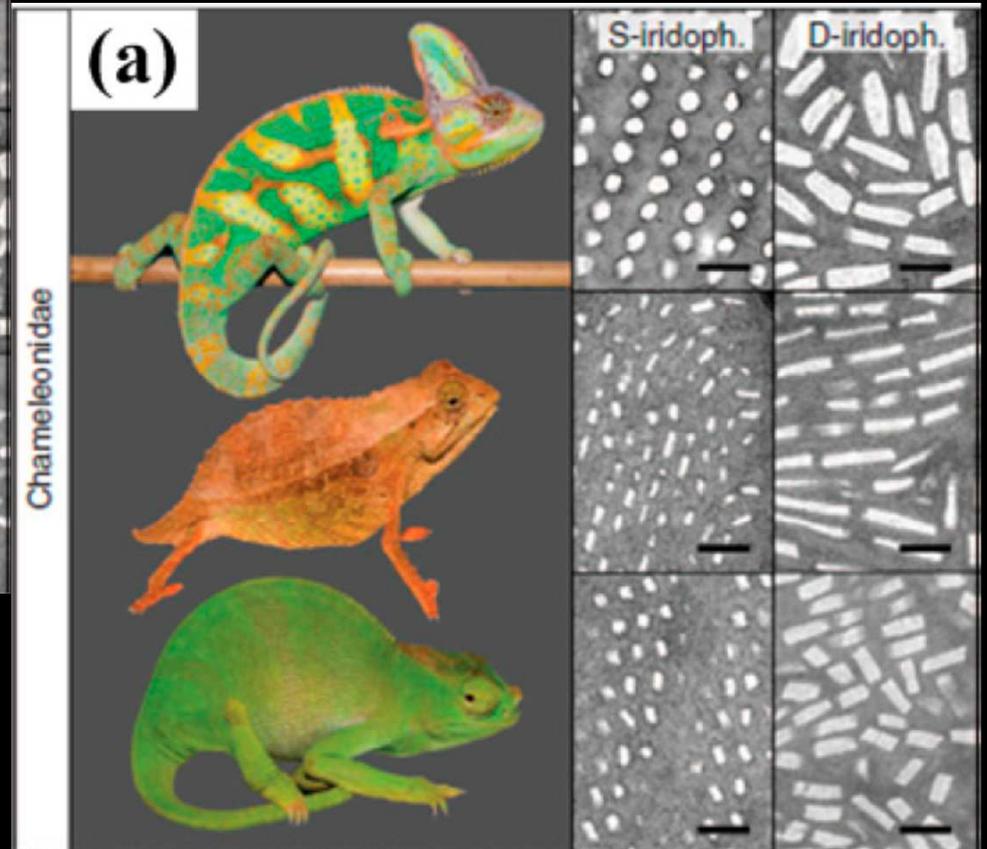
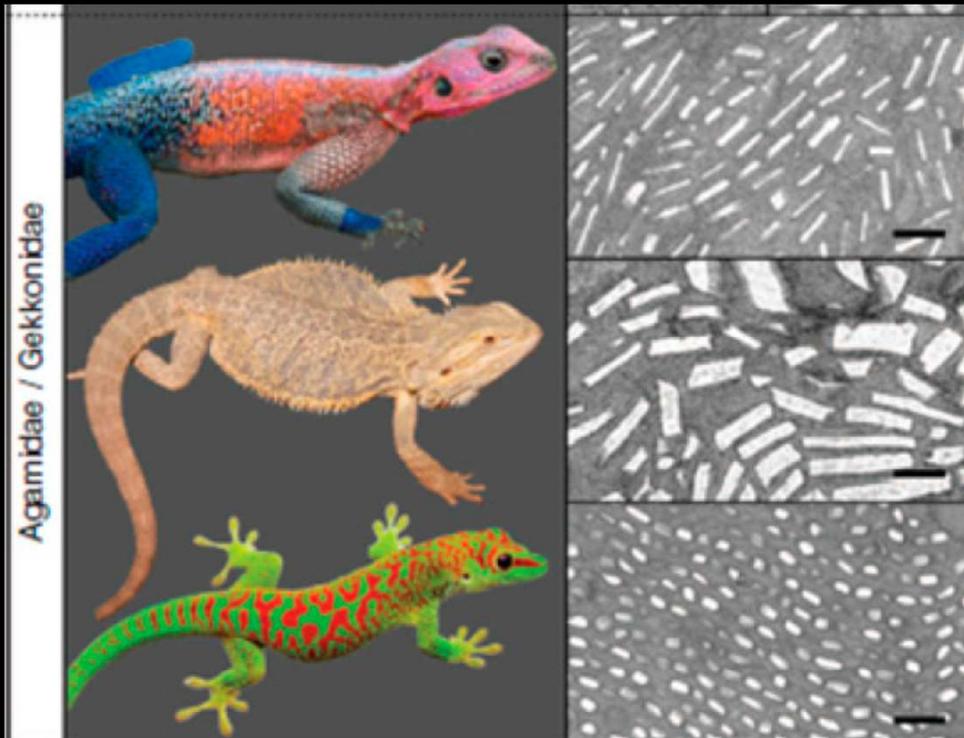
(a)



(b)



NATURAL NANOSTRUCTURES

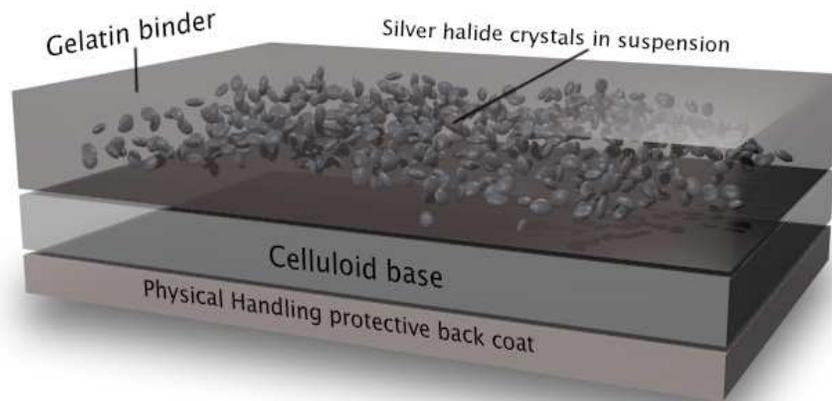


COPYING NATURE

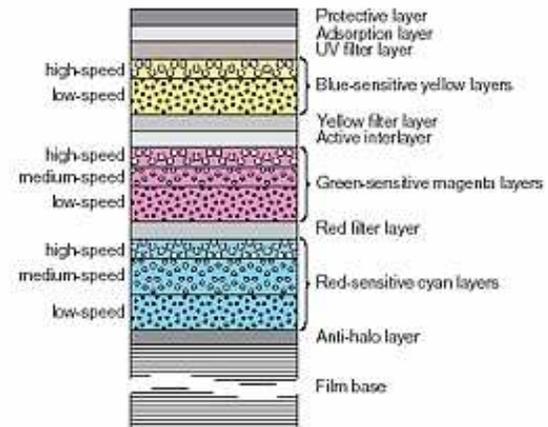


HOW DO WE DETECT LIGHT: OLDEN DAYS

The Basic Structure Of Film

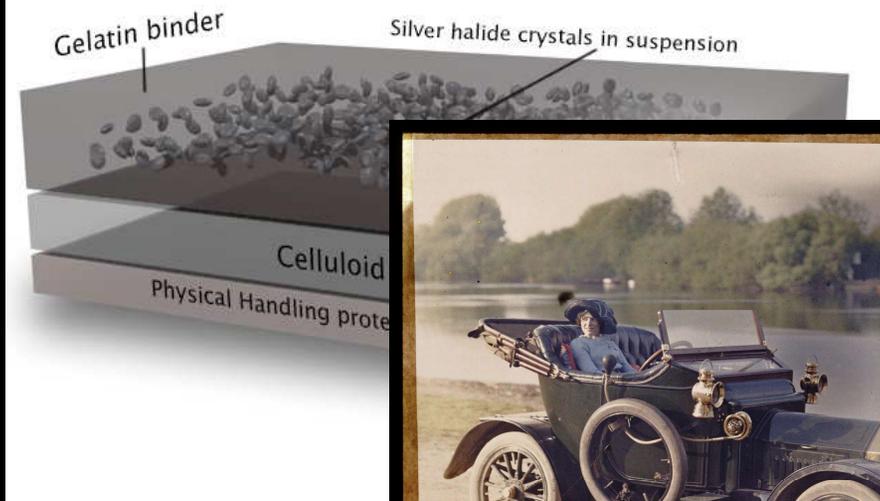


Layer structure (schematic)
AGFACOLOR PORTRAIT XPS 160 PROFESSIONAL

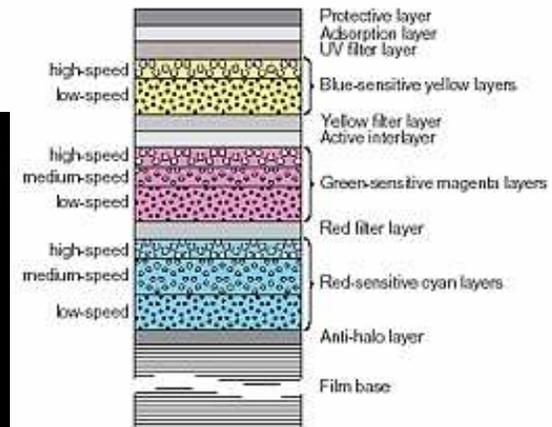


HOW DO WE DETECT LIGHT: OLDEN DAYS

The Basic Structure Of Film

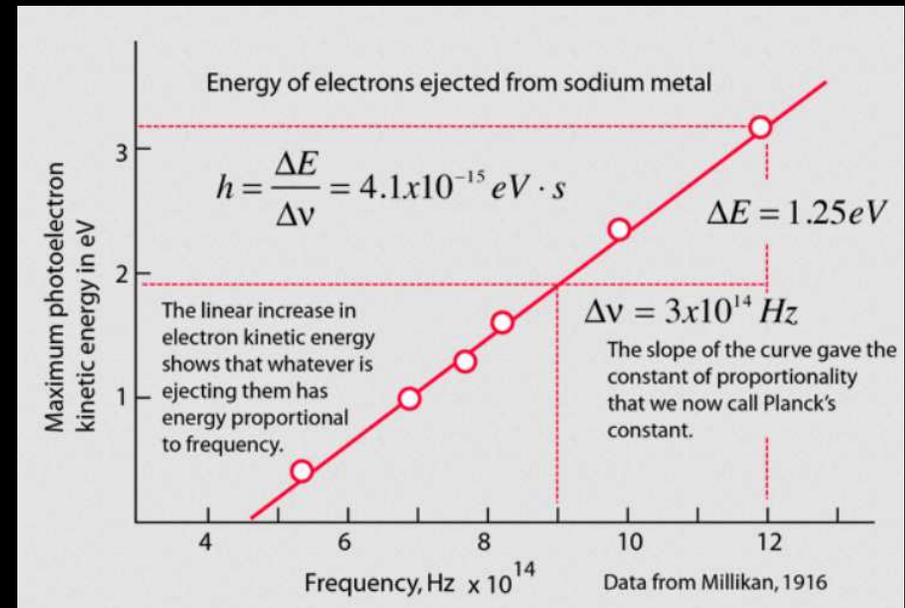
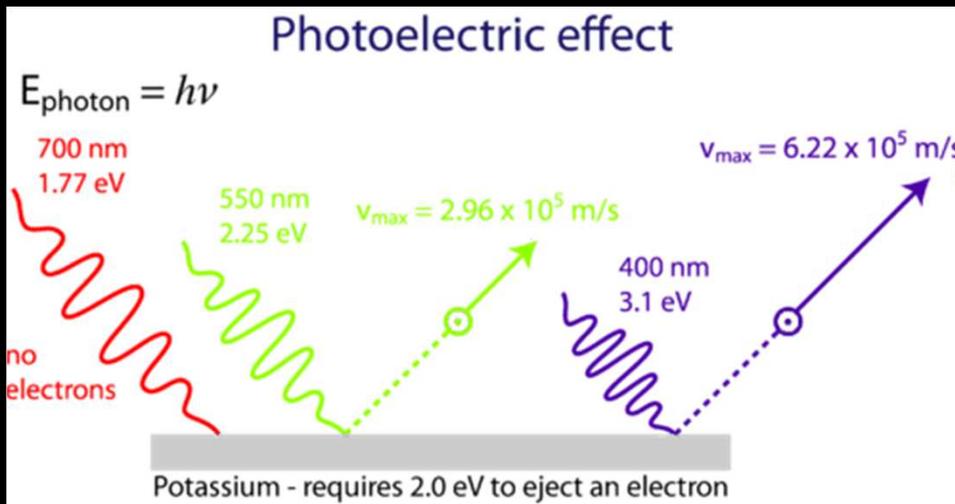


Layer structure (schematic)
AGFACOLOR PORTRAIT XPS 160 PROFESSIONAL

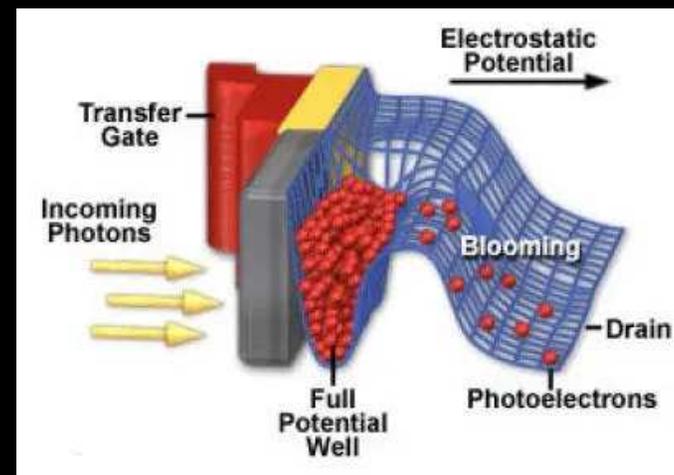
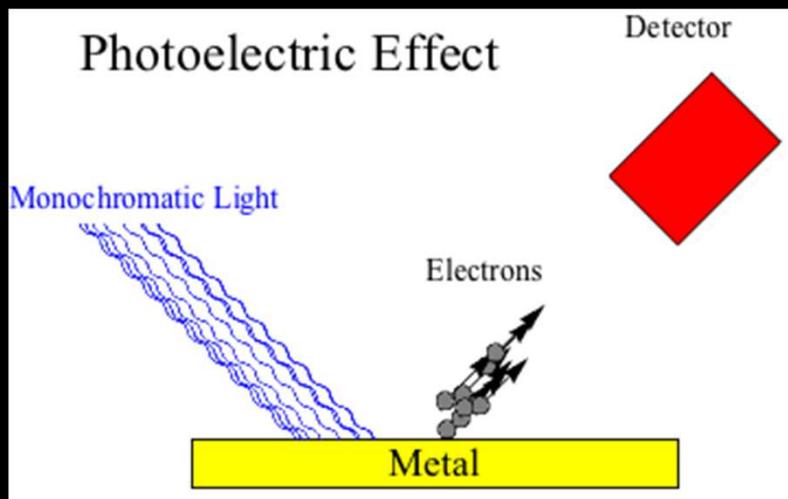


1910

PHOTOELECTRIC EFFECT



PHOTOELECTRIC EFFECT



PHOTODETECTORS AND CCD CAMERAS

