Vision - 4

Color Vision

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Objectives

- Define color vision
- Identify and describe the mechanism of color vision and the three types of cones, including the range of spectral sensitivity and color blindness
- Identify color vision theory
- Describe the items needed for any color perception
- Compare different types of color blindness


Red Rose
WEBSHOTS

Color Vision

- It the ability to discriminate between different colors.
- 1- there are 3 primary colors(blue- red- green) sensed by cones in fovea & appreciated within photopic vision.
- 2- sensation of other colors as white, yellow, orange, purple, can be produced by mixing properties of the blue &red & green in different combinations.
- 3- black means absence of light, however it is still different from the blind eye does not "see black;" rather, it "sees nothing."

Color (Photopic) Vision

'Young - Helmholtz theory'

'The Trichromatic theory'

Color vision theory :_(Young-Helmholtz theory)

- 1- we have 3 kinds of cones each has a specific photopigment (iodopsin)& is sensitive to one of the 3 primary colors
- a- Blue cone system:- has S pigment (blue sensation pigment) which respond to short wave length (440 nm senses the blue color)
- b- Green cone system:- has M pigment (green sensation pigment) which respond to middle wave length (535 nm senses the green color & less to yellow) & absorb light at the green portion.

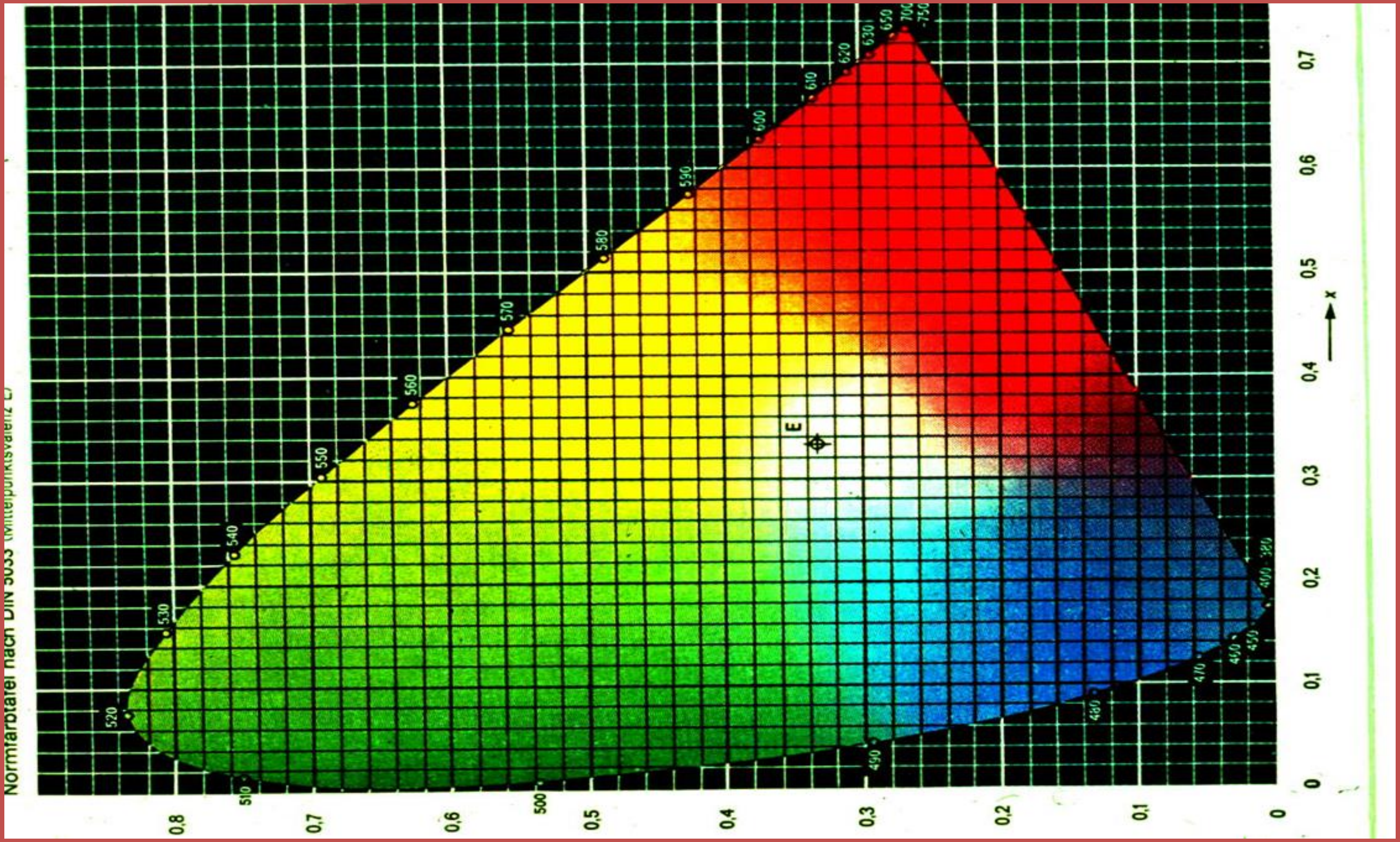
- **Red cone system:- has L pigment (red sensation pigment) which respond to large wave length at or > 565 nm so senses the red & yellow color & absorb light at the red portion.**


LB
FARMER BELLS

History of color vision

Newton (1704) used a prism to show that sunlight was composed of light with all colors in the rainbow. He defined it as the **spectrum**.

Mixing colors

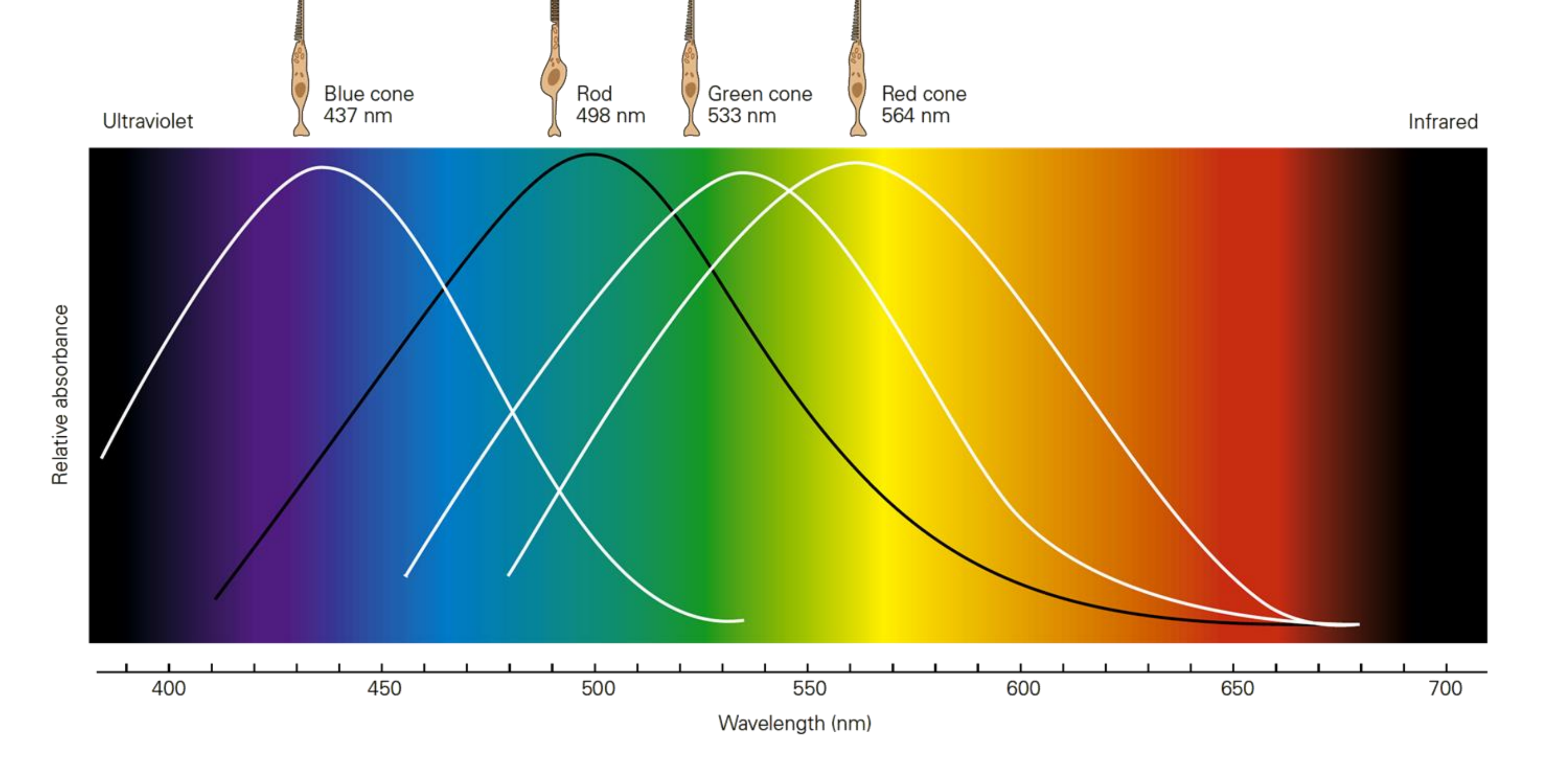


Photopic vision (CONES)

Helmholtz ..1860:

The three primary colors are perceived by three photoreceptor pigments (with broad absorption curves)

White light is produced by mixing three colours



the visible spectrum of light spans wavelengths of 390 to 670 nm

individual rod or cone photoreceptors are sensitive to a broad range of wavelengths (black and white curves

but each is most responsive to light in a particular spectral band

as a result, cone photoreceptors are classified as red, green, and blue types.

the specific colors perceived, result from the relative activation of the three cone types.

Photopic vision (CONES)

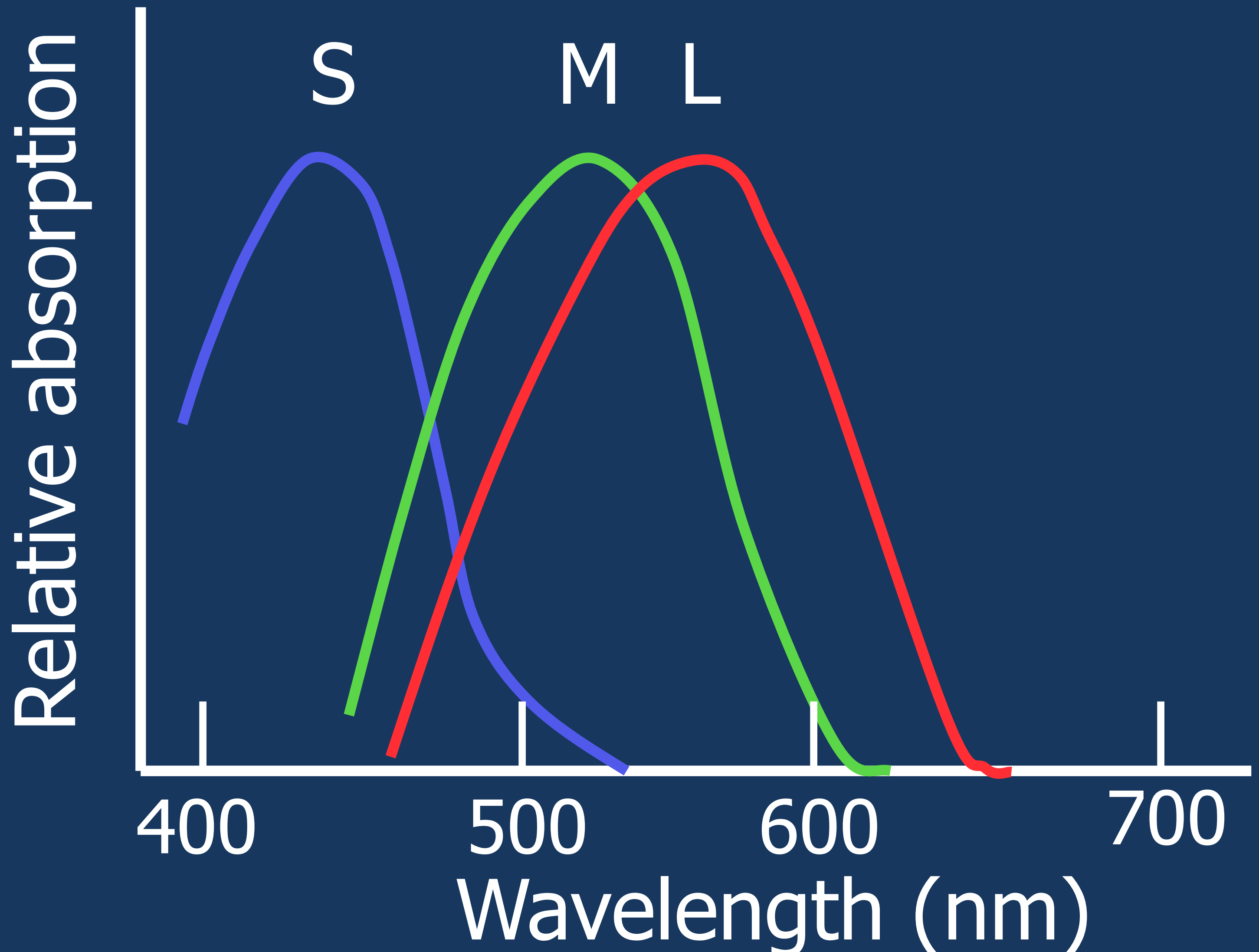
Cone pigments: three kinds

565

535

440

Cone wavelength ranges



- Only one of three types of color pigments is present in each of the different cones
- Thus making the cones selectively sensitive to different colors: blue green, or red
- Blue-sensitive pigment (s or short) showing peak absorbency at light wavelengths of 440
- Green-sensitive pigment (m or medium) showing peak absorbency at light wavelengths of 535
- Red-sensitive pigment (L or long) showing peak absorbency at light wavelengths of 565
- the absorption curve for the rhodopsin of the rods, with a peak at 505 nanometres.

Photopic vision

Sensation of any color determined by:

a-Wavelength of light

b-Amount of light absorbed by each type of cones

c-Frequency of impulses from each cone system to ganglion cells which is determined by wave length of light.

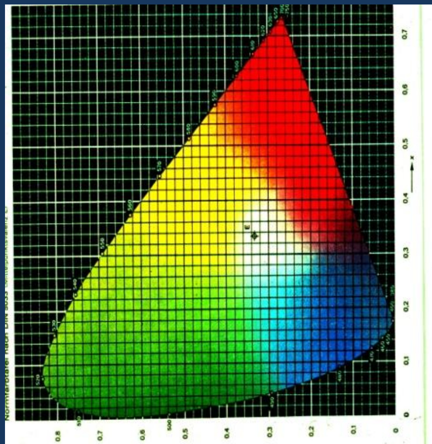
Photopic vision

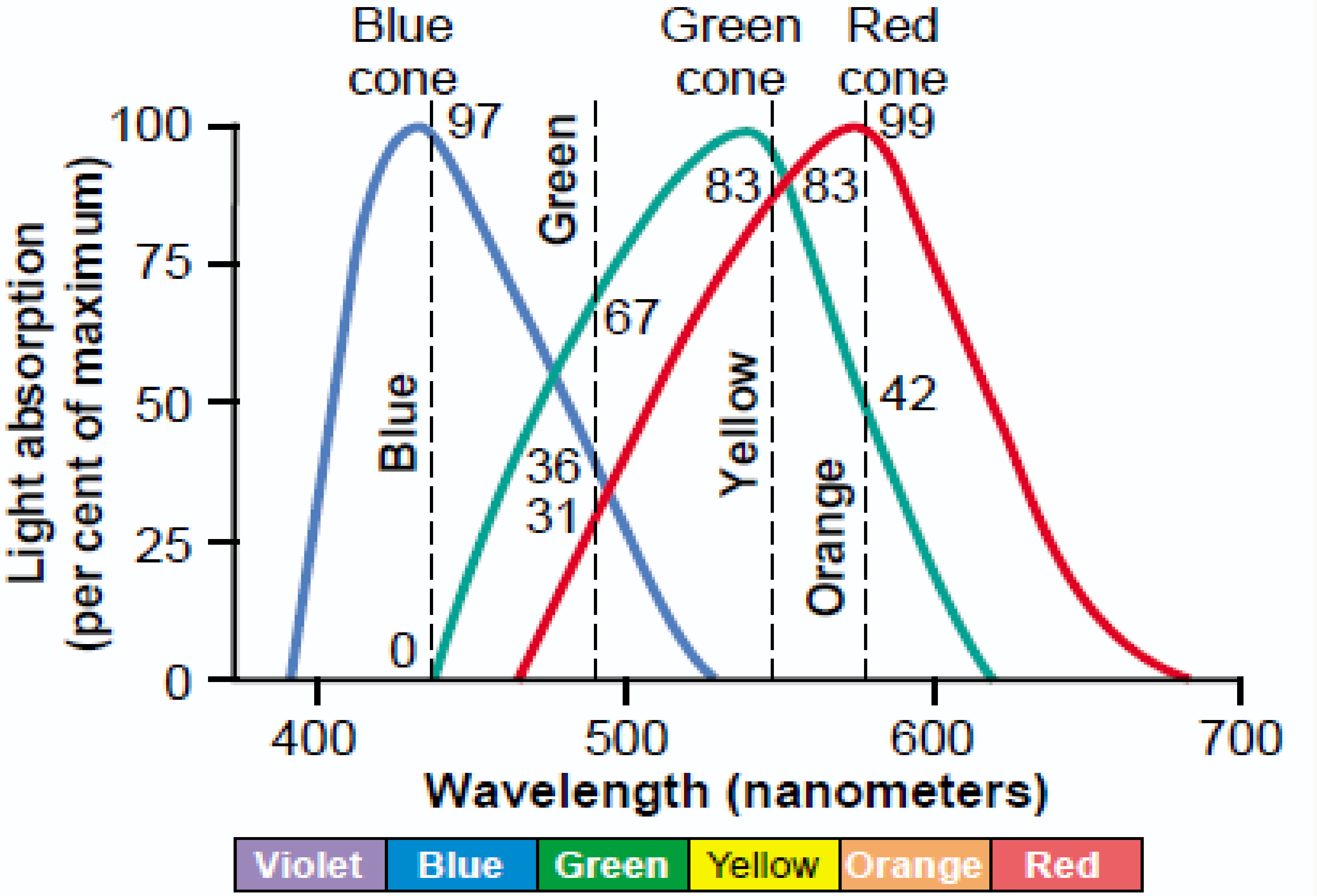
perception of white is due to:

equal stimulation of

blue & red & green cones.

(white is a combination of all wave lengths)




Blue cone
Green cone
Red cone
100
75
50
25
0
Light absorption (per cent of maximum)
97
Green
83
83
99
67
Blue
Yellow
Orange
42
36
31
0
400
500
600
700
Wavelength (nanometers)
Violet
Blue
Green
Yellow
Orange
Red

Color vision is coded by :-

- different responses in ganglion cells that depends upon the wave length of stimulus which determine frequency of impulses in ganglion cells
- the color perception in the brain depends on the amount of activity in each of the 3 cone systems as mentioned above.

Interpretation of Colour in the Nervous System

- An orange light with a wavelength of 580 nanometres stimulates the red cones to a value of about 99%
- It stimulates the green cones to a value of about 42%
- The blue cones are not stimulated at all.
- Thus, the ratios of stimulation of the three types of cones in this instance are 99 : 42 : 0.
- The nervous system interprets this set of ratios as the sensation of orange.

- **For perception of yellow the ratio is 83:83: 0.**
- **Perception of blue is due to stimulation of 0% of red cones & 0% of green cones & 97% of blue cones(so ratio is 0:0: 97)**
- **About equal stimulation of all the red, green, and blue cones gives one the sensation of seeing white.**
- **There is no single wavelength of light corresponding to white; instead, white is a combination of all the wavelengths of the spectrum.**
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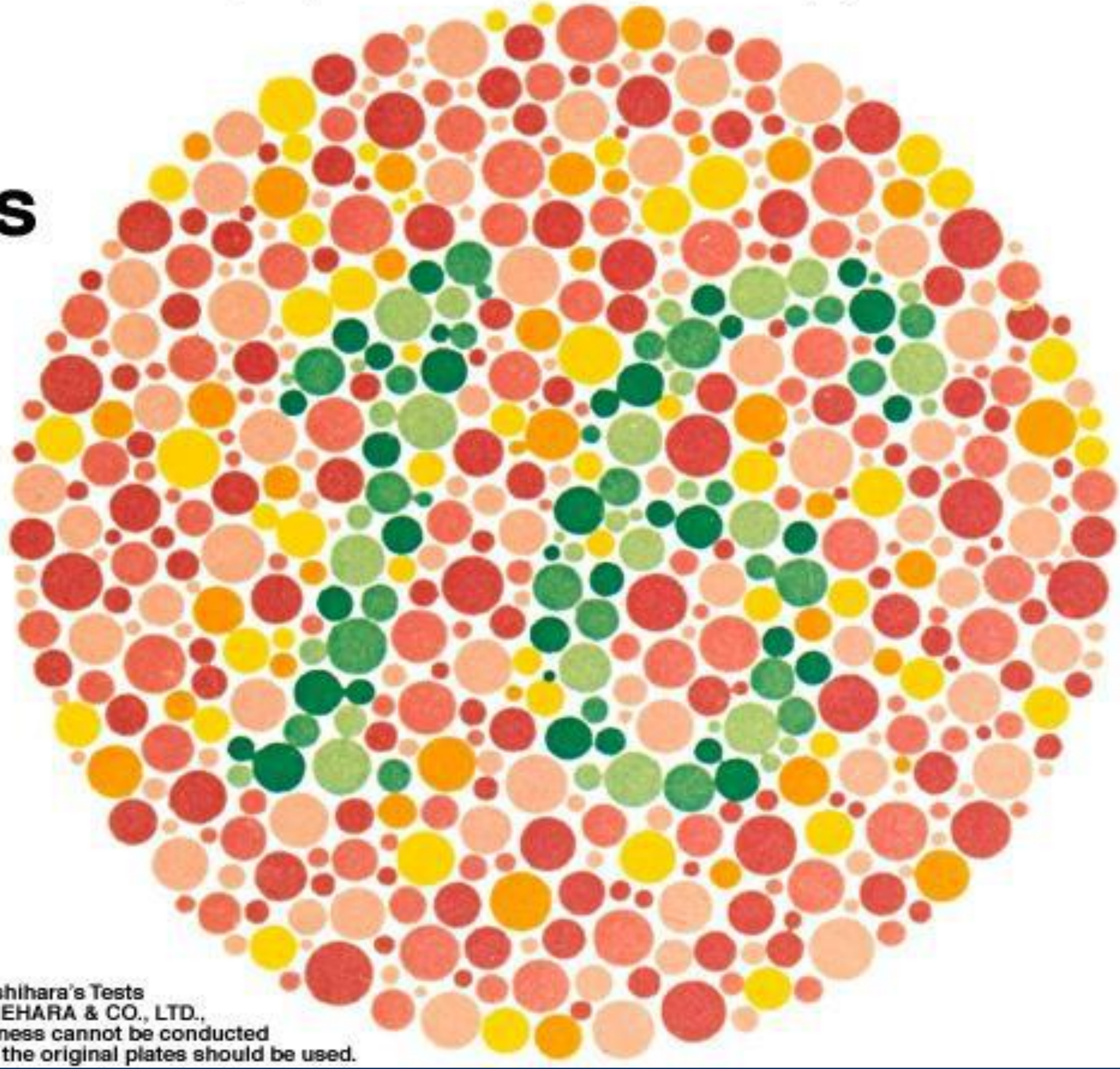
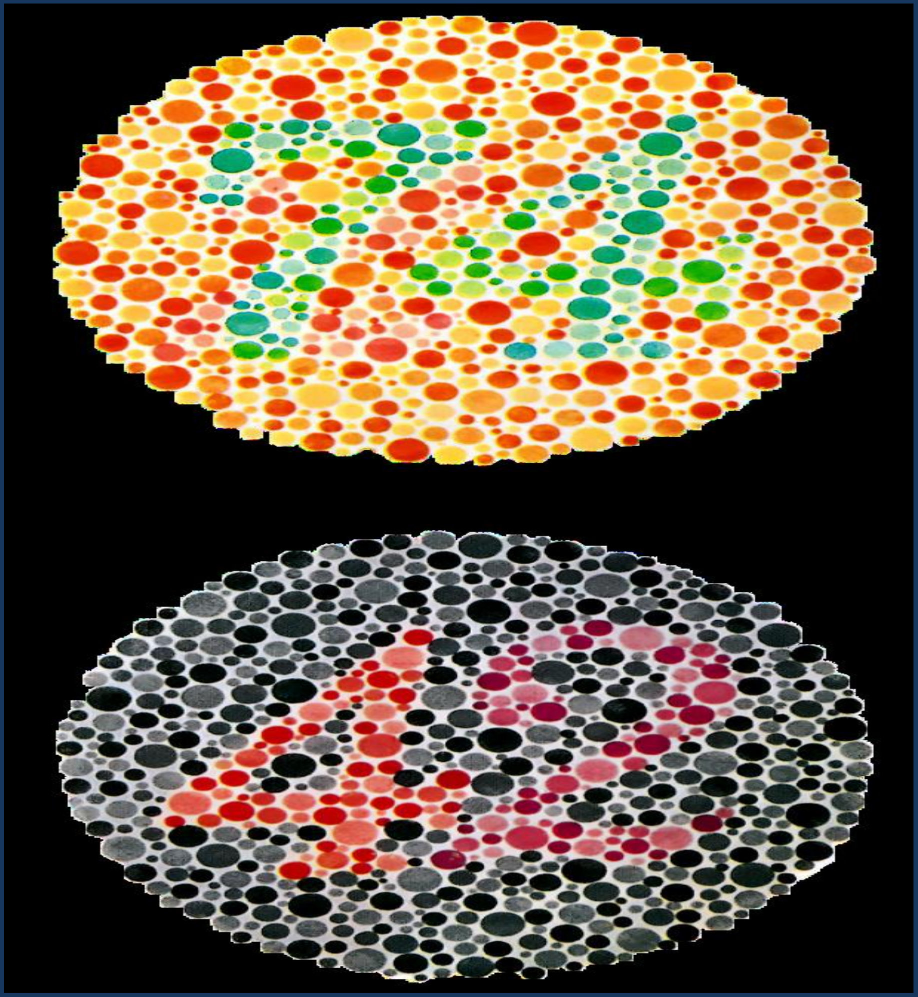
Test for Color Blindness



The above has been reproduced from Ishihara's Tests for Colour Blindness published by KANEHARA & CO., LTD., Tokyo, Japan, but tests for colour blindness cannot be conducted with this material. For accurate testing, the original plates should be used.

Ishihara Charts



Color Blindness

Weakness or total blindness in detecting a primary color:

Definitions:

1. Trichromats: see the 3 1ry colors
2. Dichromats: blind to one 1ry color
3. Monochromats: have only one color pigment

Color Blindness -cont.

- Prot …… Red
- Deuter …. Green
- Trit …… Blue

- <u>Anamoly …weakness</u>
- Protanamoly
- Deuteranamoly — Trichromats
- Tritanamoly

Color Blindness -cont.

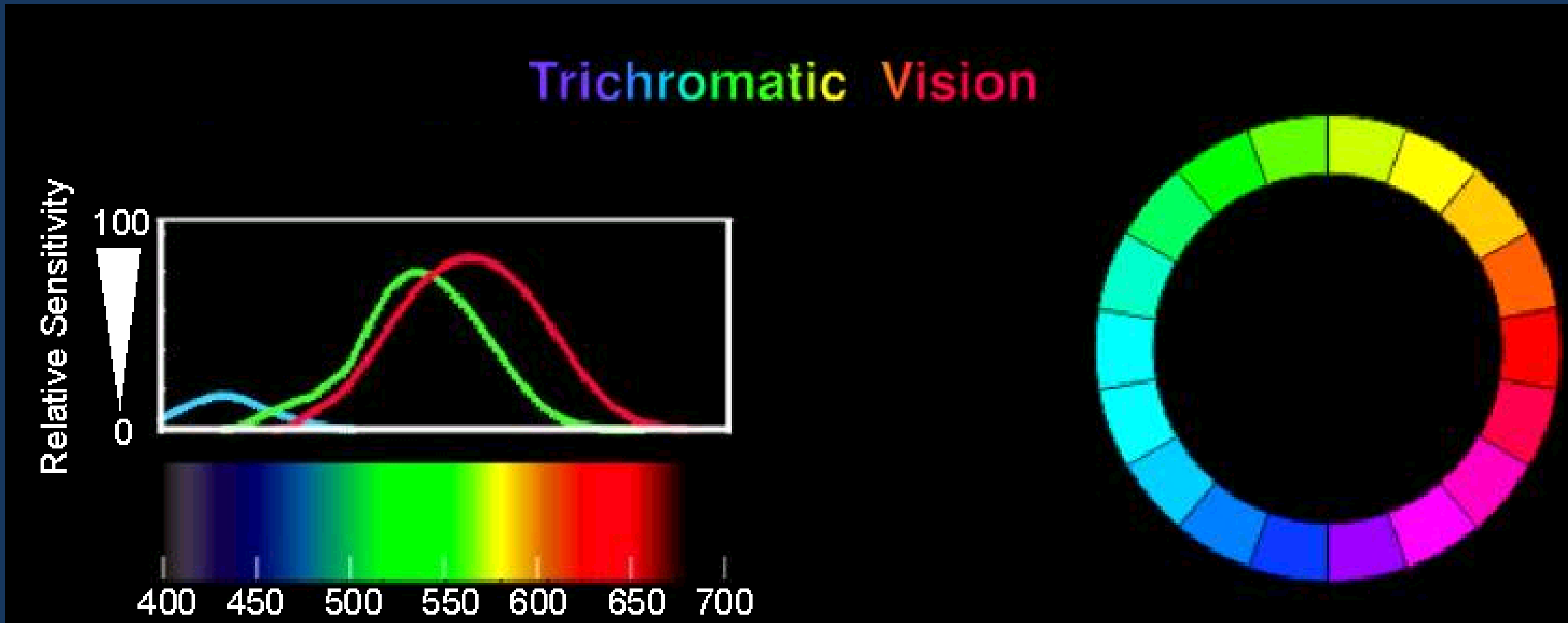
- Anamoly ...weakness
- Anopia .... Total loss

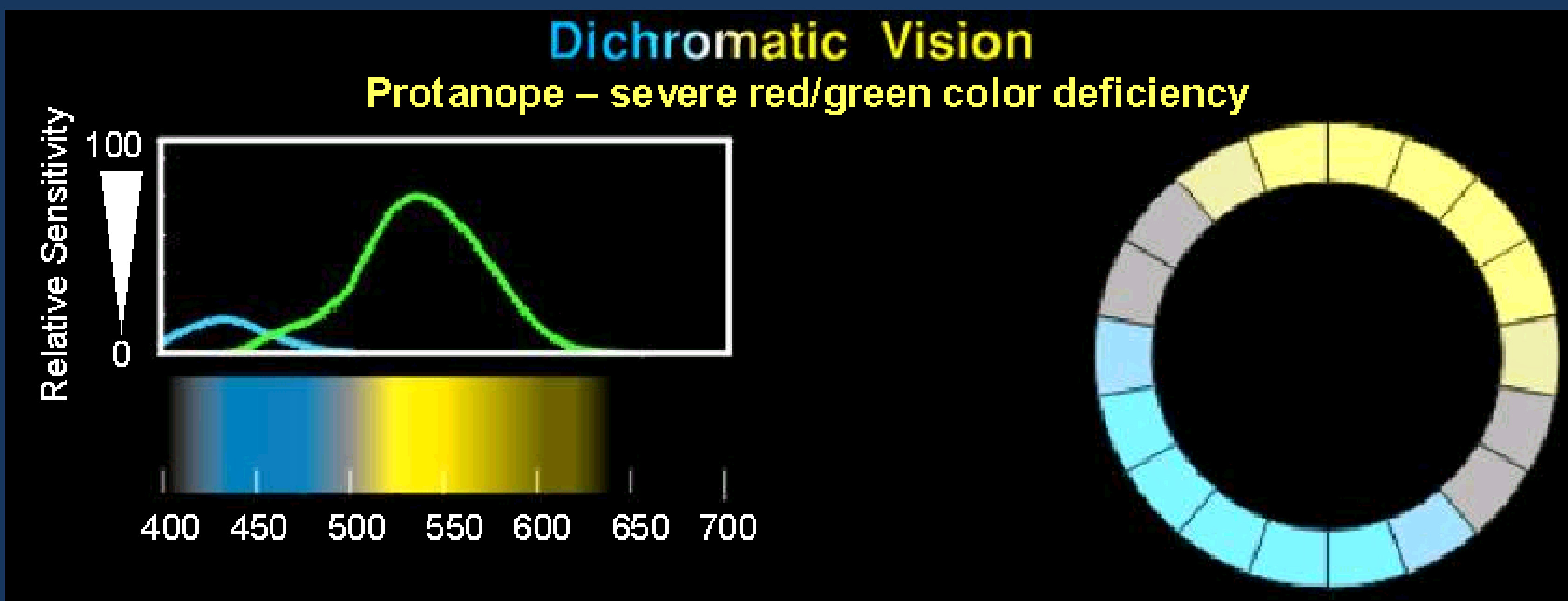
- Protanopia
- Deuteranopia — Dichromats
- Tritanopia

COLOR BLINDNESS

Red – Green Blindness:-

- Green & red cones see different colors between wave length 525-675 nm & distinguish them.
- If either of these cones are absent, the person can not distinguish 4 colors (red – green- yellow- orange)& he can not distinguish red from green (primary colors) so called (red – green blindness).


Trichromatic Vision
Relative Sensitivity
100
0
400
450
500
550
600
650
700


Dichromatic Vision
Protanope – severe red/green color deficiency
Relative Sensitivity
100
0
400
450
500
550
600
650
700

Color Blindness -cont.

- It is x- linked recessive disease transmitted from females to their male sons (8% of female are carrier)
- Males have one x & one y chromosome so if this one x chromosome miss the gene for color vision , he will get red-green color blindness(their gene is on x chromosome).
- Females show the disease only if both x chromosomes lack the gene .
- Females from color blind fathers are carriers transmit the disease to ½ of their sons.