Physiology

COLOR VISION

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Summary!

Color Vision

color vision is the ability to discriminate between different colors.

-There are **3 primary** colors (blue-green-red) sensed by cones.

-Sensation of extra spectral colors (white-orange…) can be produced by mixing the properties of the primary colors in different combinations.

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-**Black** means **absence of the light** "no wavelength is reflected from black" but at the same time it doesn't mean darkness, because in the darkness we don't see **black** only, we see shades of grey.

-**Black** is a **positive** sensation because the **blind eye** doesn't see **black**, rather it **sees nothing**.

Color vision theory (young-helmholtz theory)

we have 3 kinds of cones → each has a specific rhodopsin which is sensitive to one of the 3 primary colors.

	Blue cone system	Green cone system	Red cone system
Pigment	S (short) pigment	M (middle) pigment	L (large) pigment
wavelength	short wavelength 440 nm	Middle wavelength less than 535 nm	Long wavelength at or > 535 nm
Colours	Blue	Green and yellow	Red and yellow

-Each cone system respond to its color at a lower threshold than needed to sense the other colors.

So each cone system senses all the colors, but it needs a lower threshold to sense its own color.

- perception of the white is due to **equal** stimulation of the **3** cone systems. white is a combination of all the wavelengths.

Sensation of any colour is determined by:

1- **wavelength** of the light

2- **amount of the light** absorbed by each cone system

3- **frequency** of impulses from each cone system which determined by the wavelength of the light.

So the bottom line is that the color perception in the brain depends on the **activity of each cone system**

" which go to the brain as an action potentials and the brain interprets these action potentials as the colour we see",

Perception of	Orange	Yellow	Blue
Red cones	99%	50%	0%
Green cones	42%	50%	0%
Blue cones	0%	0%	97%

-**Ishihara charts:** used to test color vision.

-Color blindness:

there is a gene for rhodopsin in **chromosome 3** → no color if mutated
there is a gene for the S (blue) pigment in the **chromosome 7**
there is a gene for the M(Green) and L(Red) pigments in **X chromosome**

- **red green blindness**

-red and green cones see different colors between wavelength of **525-675** nm
-if either of these cones are absent, the person cannot distinguish **4 colors** (**red**-**green**-yellow-orange)
-he cannot distinguish between **red** and **green** → **red**-**green** blindness
-more common in **males.**
-the males take this condition from their mothers (X-linked).
- Females show the disease if **both** X chromosomes lack the gene.

Trichromats → have **3** cone pigments normal or have slight weakness.
Dichromats → have only **2** cone systems, they get colors by mixing only 2 primary colors.
Monochromats → have only **1** cone system or **loss of all**. see only **black** or grey or have no color perception.

Dichromats

Protanopia	**no red cone system**. (the person has shortened spectrum wavelength " red has a long wavelength but the person doesn't have the system that receives red → shortened wavelength"
Protanomaly	**weakness** in the red color vision

Deutranopia	**no green cone system** (person sees short and long wavelengths)
Deutranomaly	**weakness** in the green color vision

Tritanopia	**no blue cone system**
Tritanomaly	**weakness** in the blue color vision

Check your understanding!

1- Which rhodopsin is responsible for blue cone system?		2- Green cone system responds to green color at a ……. threshold, than to a red color.	
A	M pigment	A	Higher
B	B pigment	B	Lower
C	S pigment	C	Same
D	L pigment	D	Non of the above
3- All of the following are true about white color EXCEPT for:		**4- The L pigment responds to which of the following waves?**	
A	It's an equal stimulation of all cone systems.	A	Large wavelength >535 nm
B	It's perception is due to green & blue colors only.	B	Short wavelength (440 nm)
C	It has no waves.	C	Middle wavelength (535)
D	It's perception is due to green & red colors only.	D	Non of the above
5- Which of the following ratios is related to the perception of blue color?		**6- What of the following is the chart we use in color blindness test?**	
A	0% red, 0% green & 97% of blue cones.	A	Snellen charts.
B	0% red, 23% green & 77% of blue cones.	B	Ishihara charts.
C	23% red, 23% green & 54% of blue cones.	C	David's charts.
D	23% red, 0% green & 77% of blue cones.	D	Non of the above.
7- If the gene responsible for rhodopsin is absent, the person will see:		**8- The gene for red & green sensitive cone pigment is on:**	
A	Green & red only.	A	X chromosome.
B	Blue & green only.	B	X & Y chromosomes.
C	Red & blue only.	C	Y chromosome.
D	He/she will not see any color.	D	Chromosome number 3.
9- Weakness in red color vision is called:		**10- Ahmed can only see black and grey colors, so he's:**	

A	Tritanomaly.	A	Trichromatic.
B	Dectrabomaly.	B	Monochromatic.
C	Dectranopia.	C	Dichromatic.
D	Protanomaly.	D	Protanopic.
11- Munerah went to the clinic complaining from not seeing green color, so she has?		**12- Which one of the following is related to normal persons?**	
A	Detranopia.	A	Dichromats.
B	Detranomaly.	B	Monochromats.
C	Trinopia.	C	Trichromats.
D	Trinomaly.	D	Tetrachromats.

Answers :

1- C	**2-B**	**3- C**	**4- A**	**5- A**	**6- B**	**7-D**	**8-A**	**9- D**	**10- B**	**11-A**	**12-C**