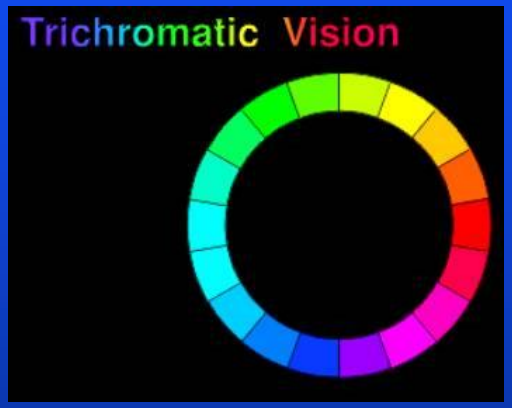
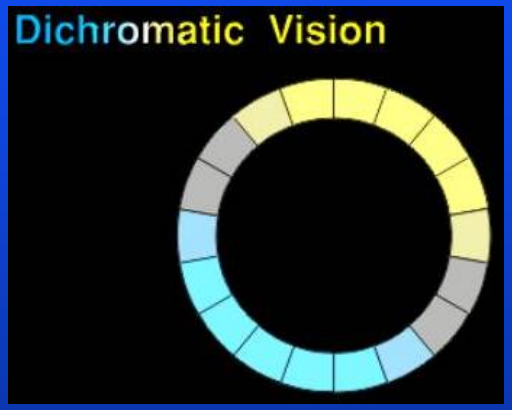
Color Vision Fundamentals





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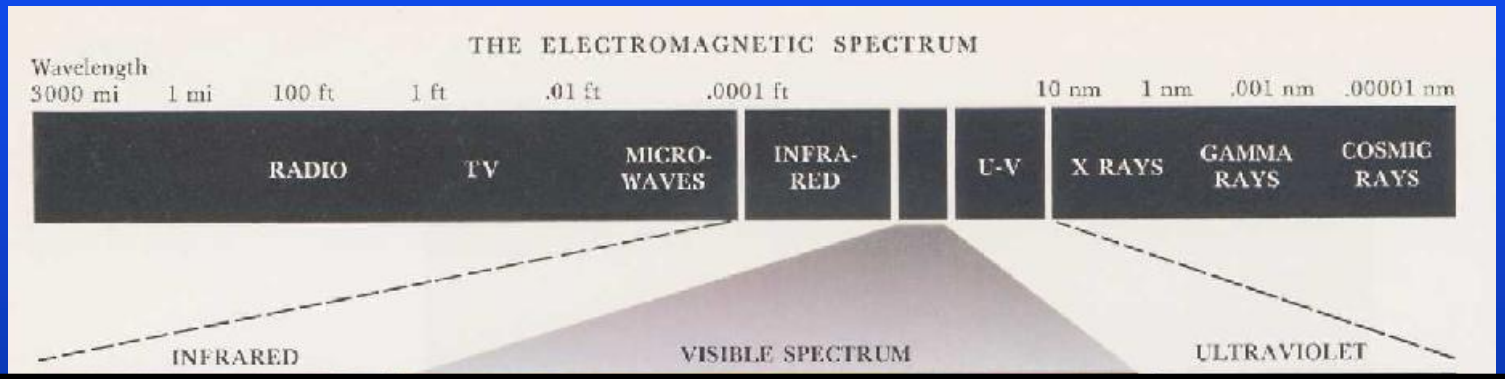
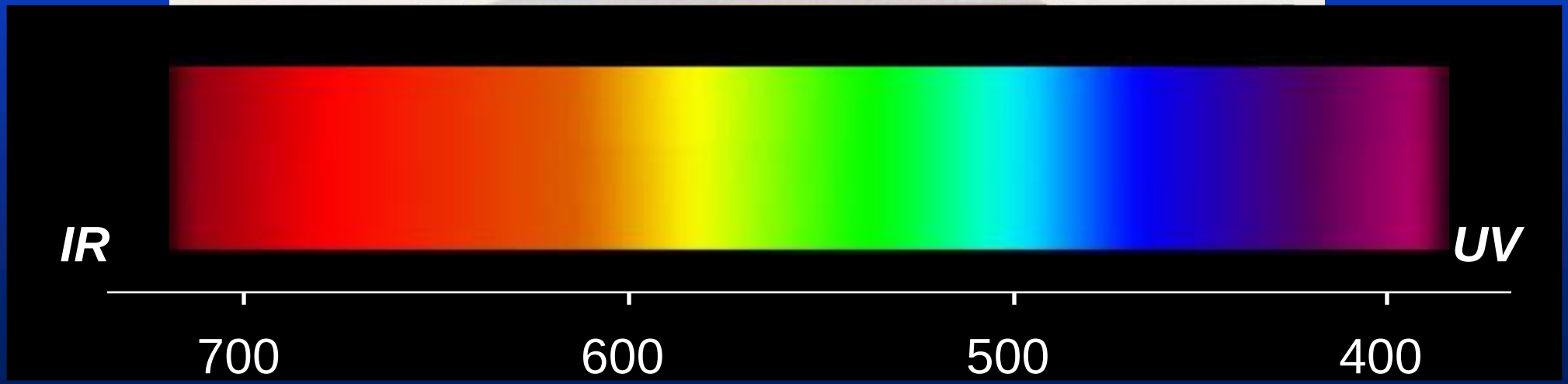
Visible light is small part of electromagnetic spectrum.

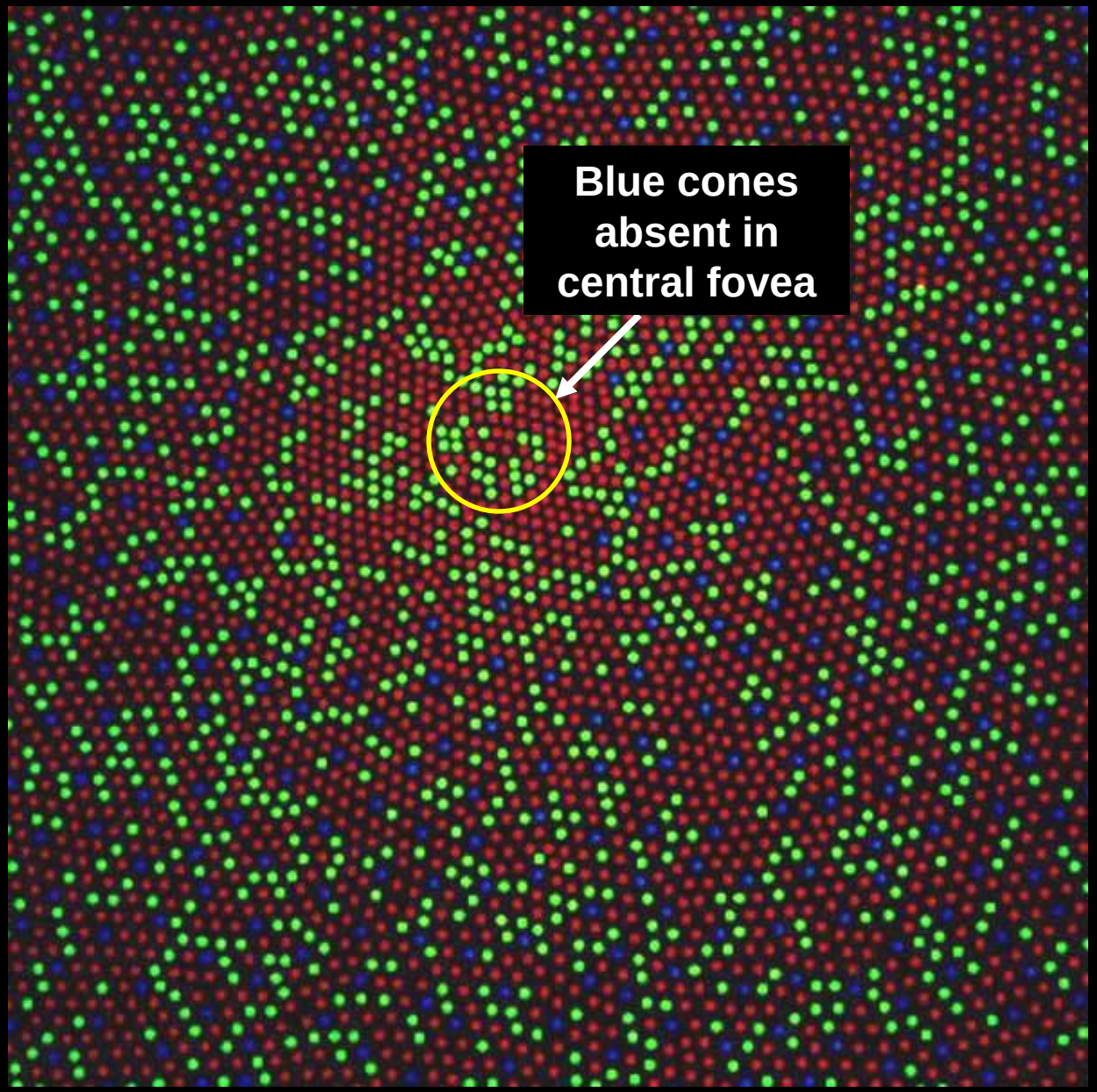




The visible spectrum includes 300 wavelengths (400-700 nm), and in some portions we can discern color differences of 1 wavelength. The ability to see so many colors depends on:

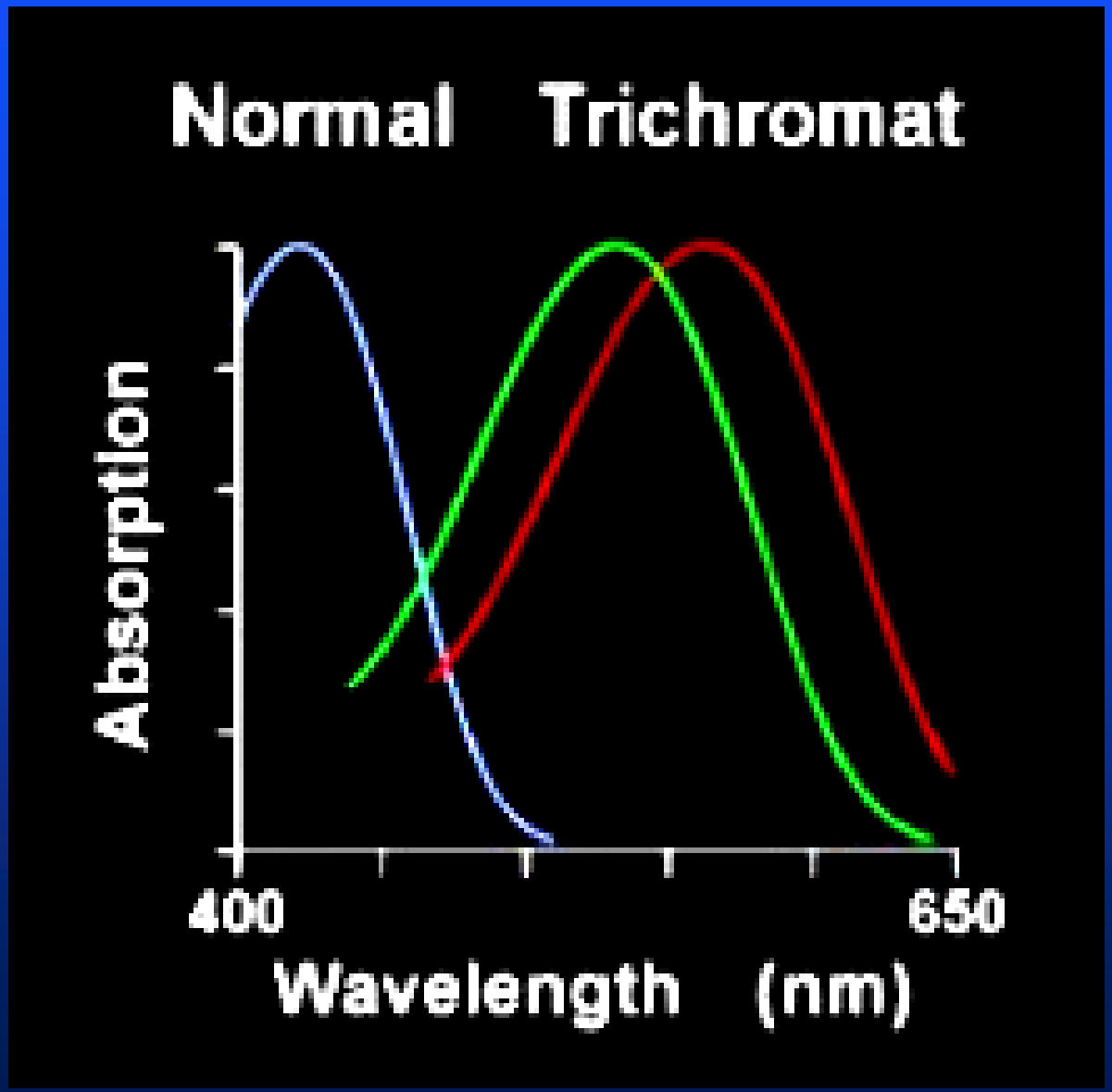
a. a separate cone for each wavelength.
b. optic nerve fibers for each color.
c. visual cortex neurons sensitive to each color.
d. difference in stimulation of red, green and blue sensitive cones.

Retinal Cones–Normal Color Vision



- Red cones
- Green cones
- Blue cones
- *Brightness* = *R* + *G*
- Color = R – G
- Color = B – (R+G)
- Red cones outnumber green cones 2/1
- Red + Green cones outnumber blue cones 10/1

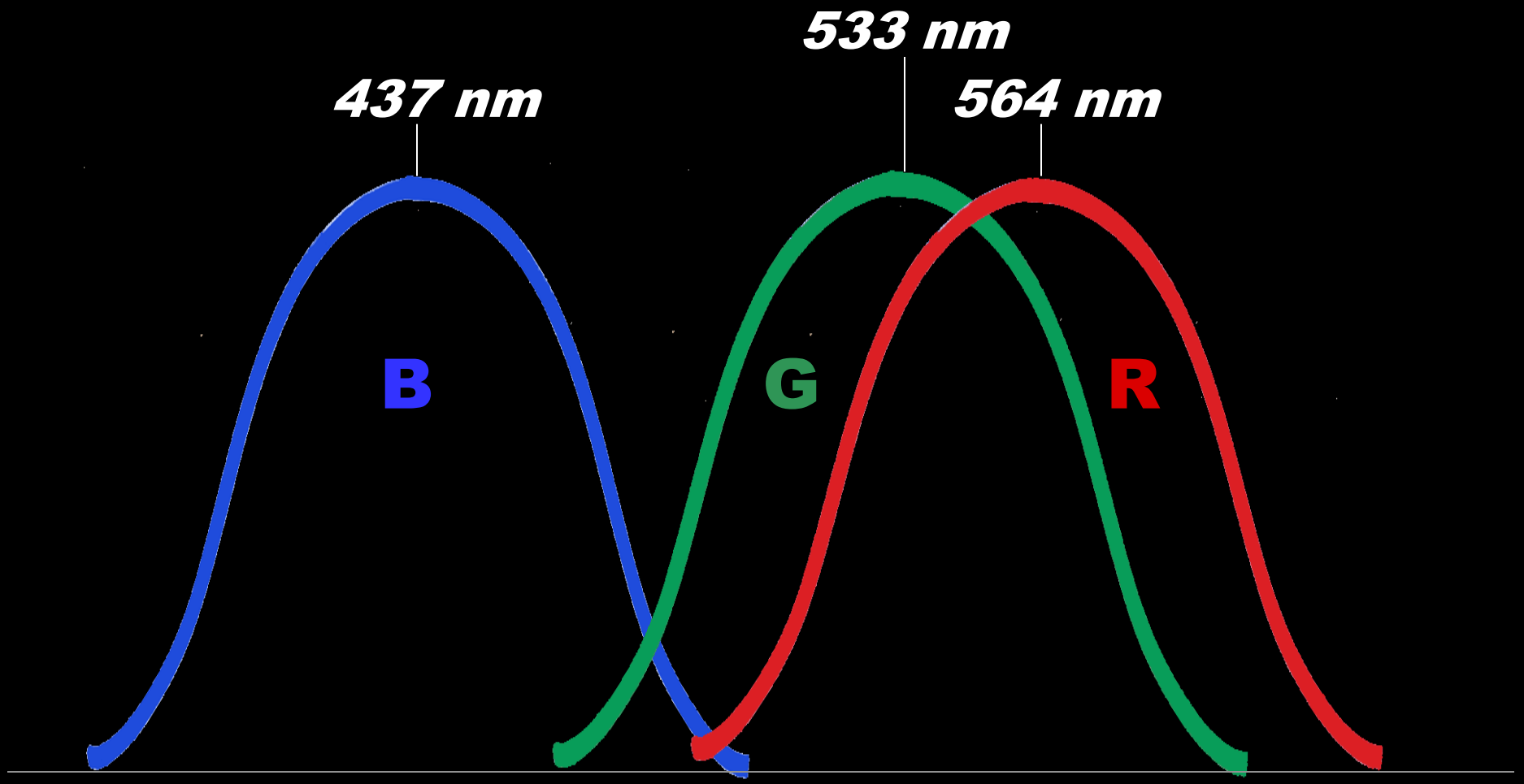
Retinal Cones–Normal Color Vision



Red, green and blue cone sensitivity vs. wavelength curves

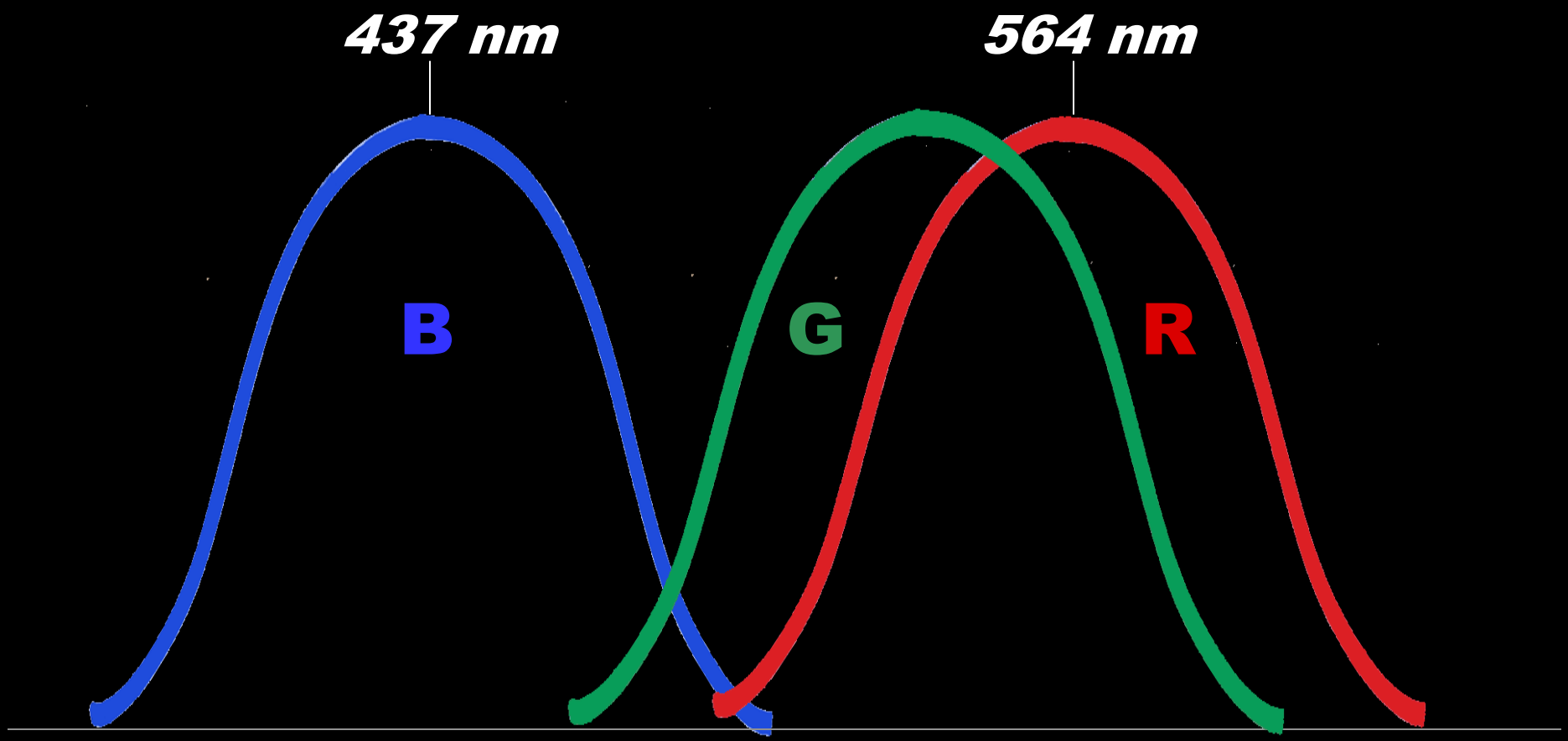
What happens in hereditary color deficiency?

- **Red** or **green** cone peak sensitivity is shifted.
- **Red** or **green** cones absent.



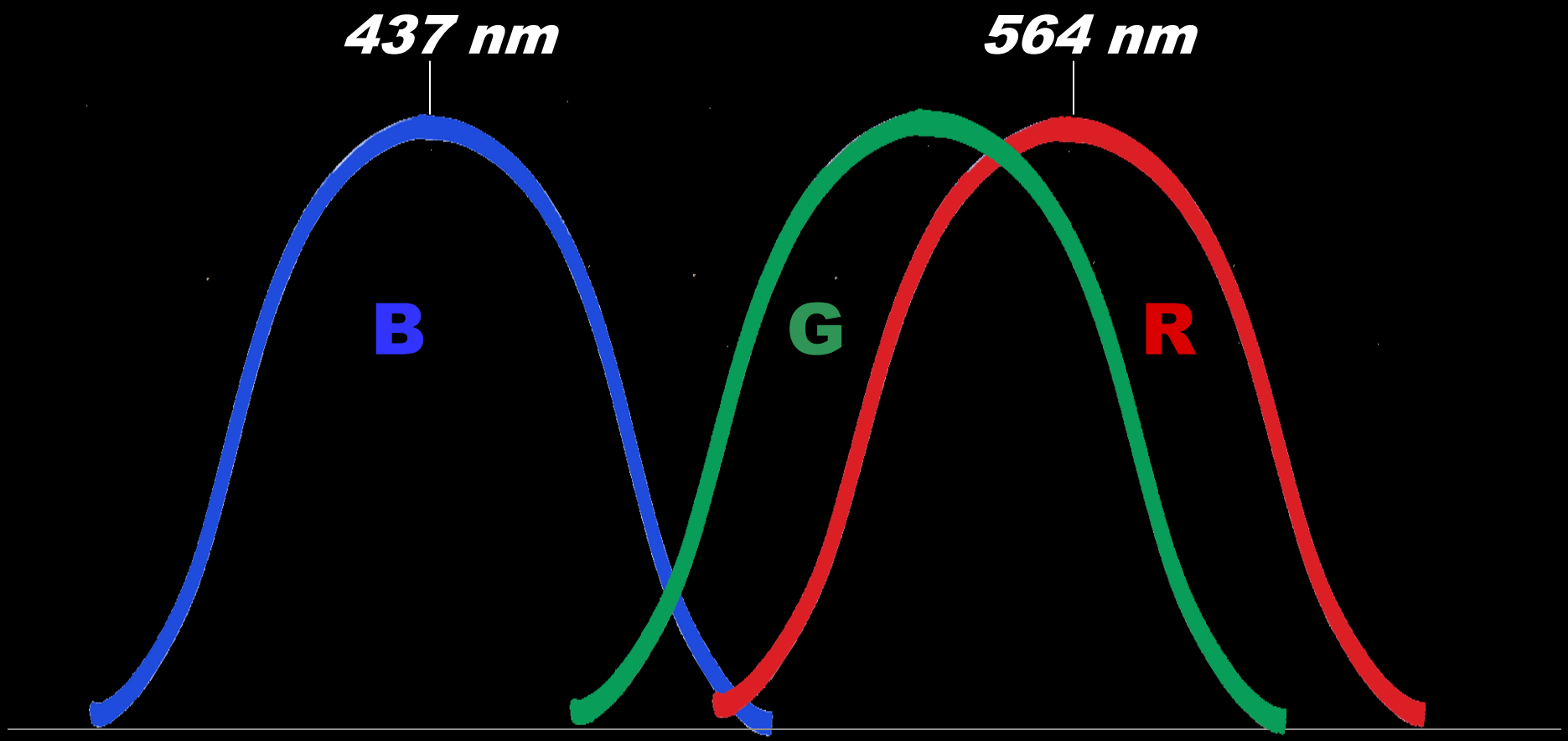
NORMAL CONE SENSITIVITY CURVES (TRICHROMAT)

5% of Males



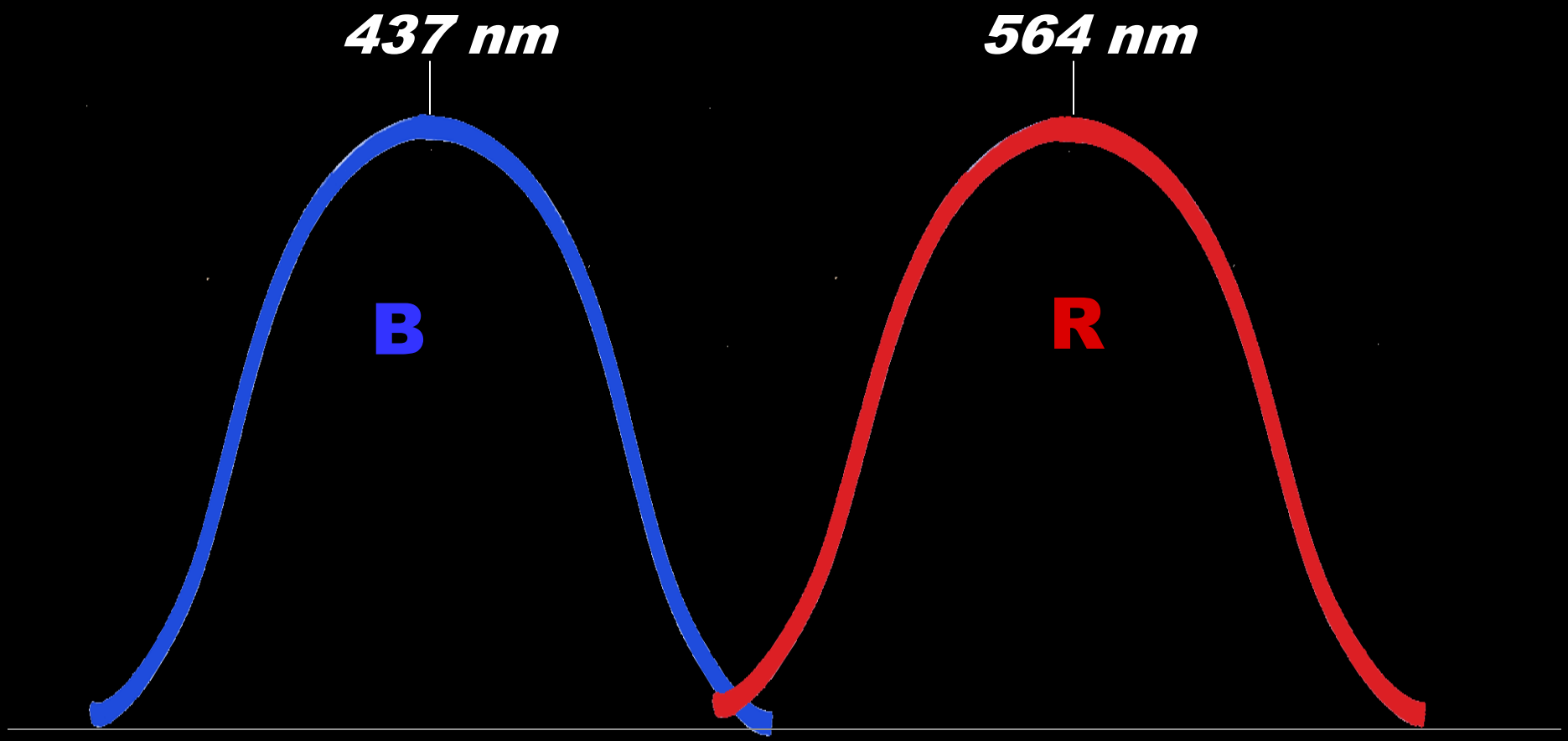
Deuteranomaly
(green shifted toward red)

1% of Males



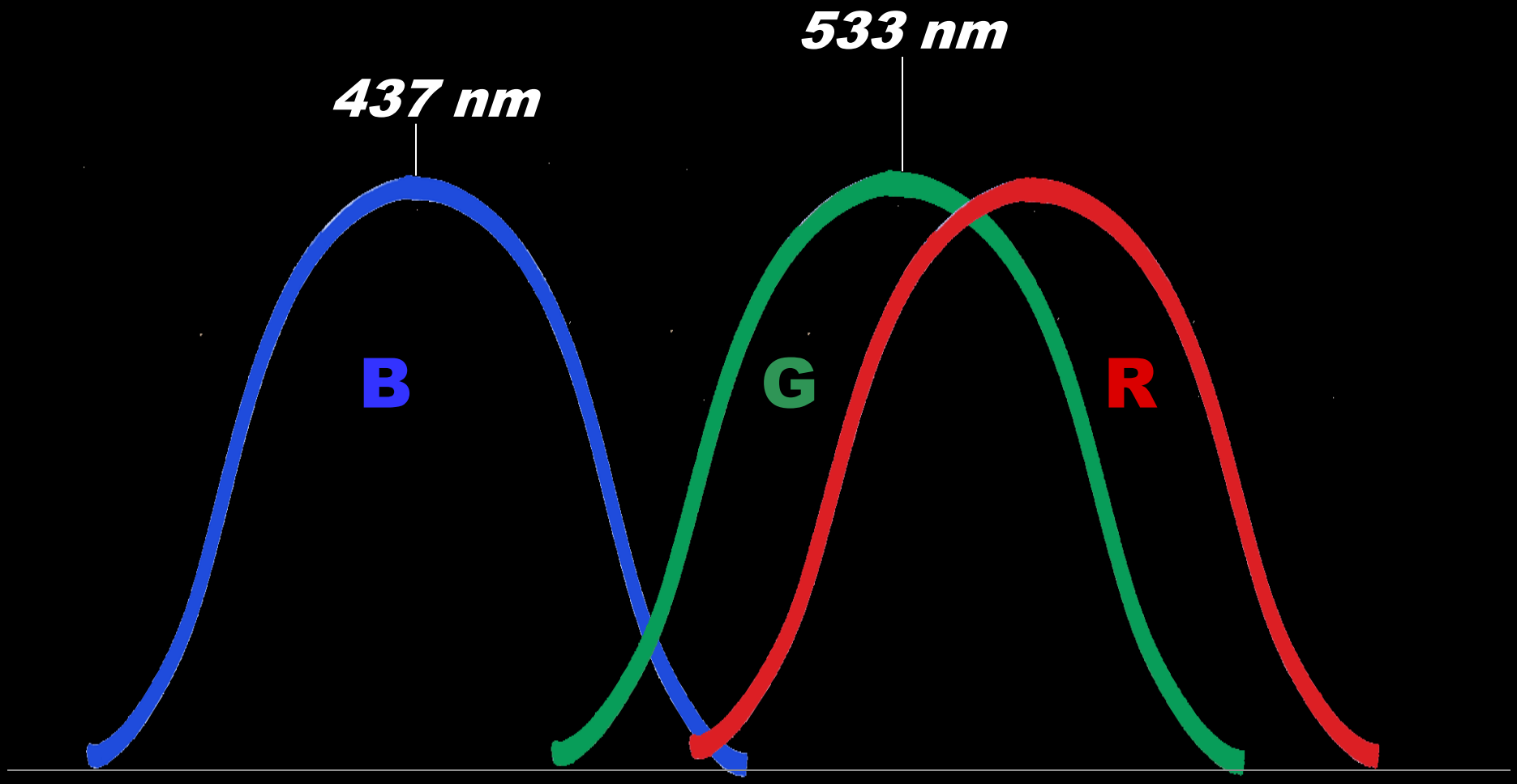
Deutan Dichromat
(no green cones; only red and blue)

1% of Males *(there is no green curve)*



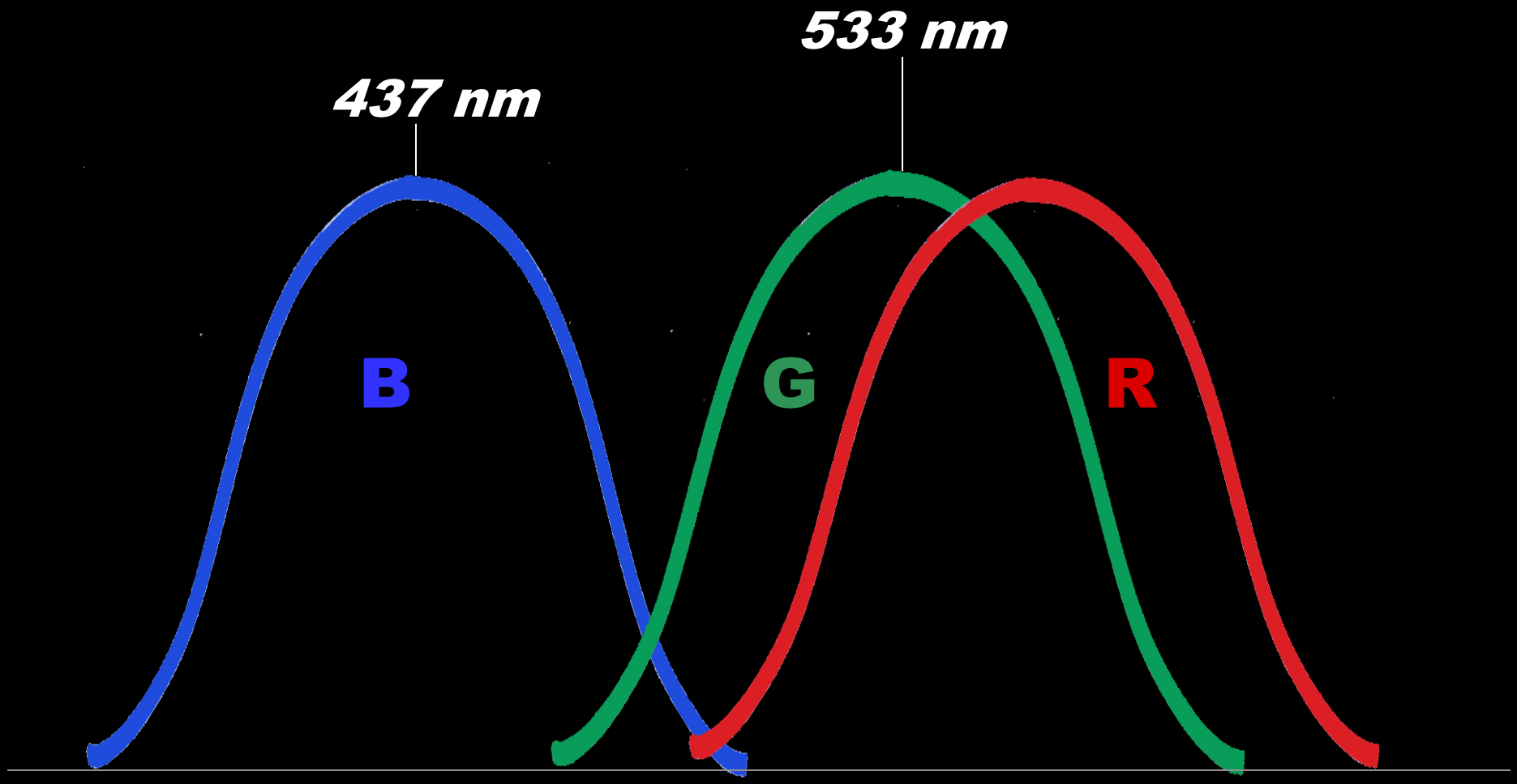
Deutan Dichromat
(no green cones; only red and blue)

1% of Males



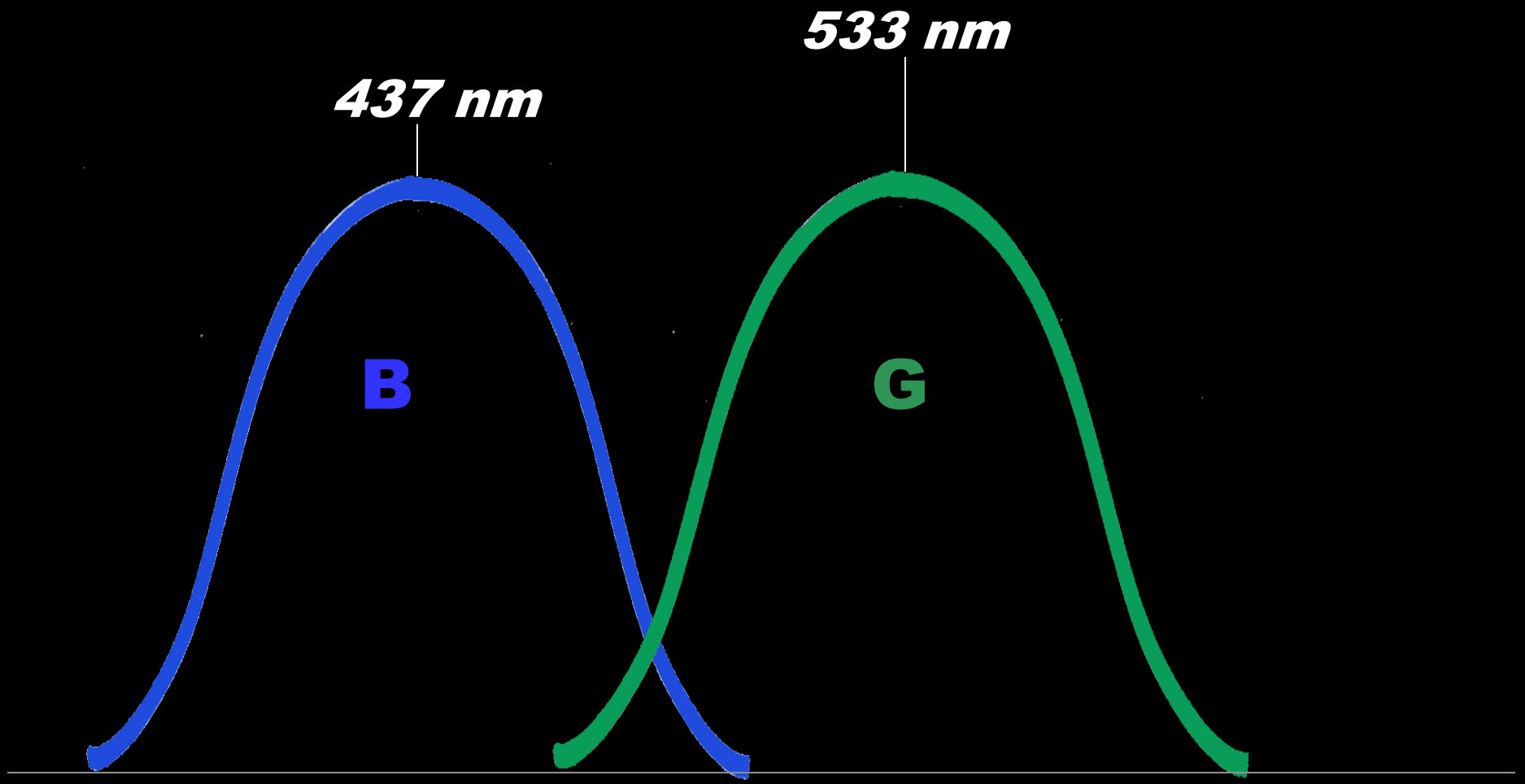
Protanomalous
(red shifted toward green)

1% of Males



Protan Dichromat
(no red cones; only green and blue)

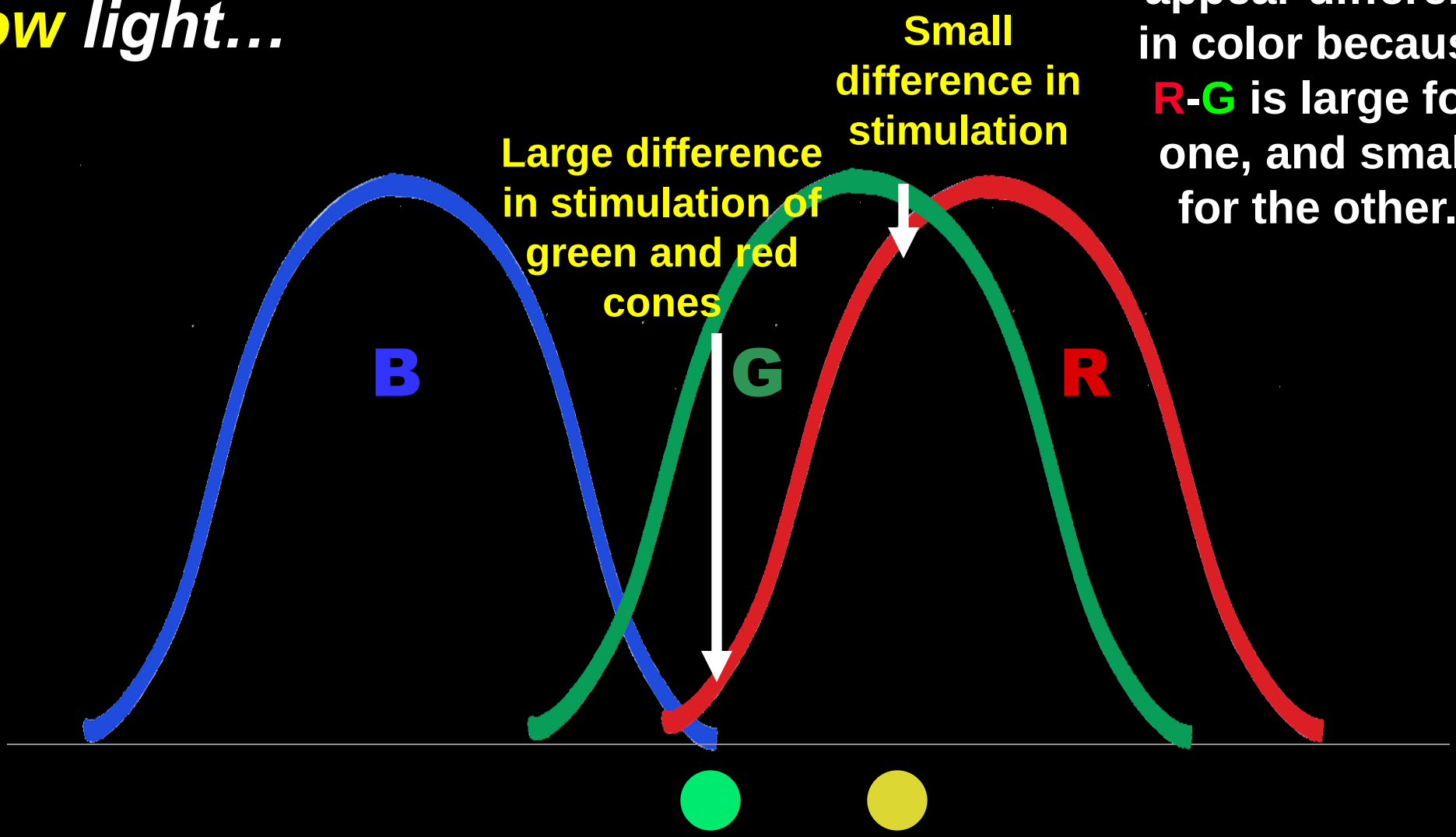
1% of Males *(there is no red curve)*



Protan Dichromat
(no red cones; only green and blue)

Why do colors that look different to us appear the same to color deficient individuals?

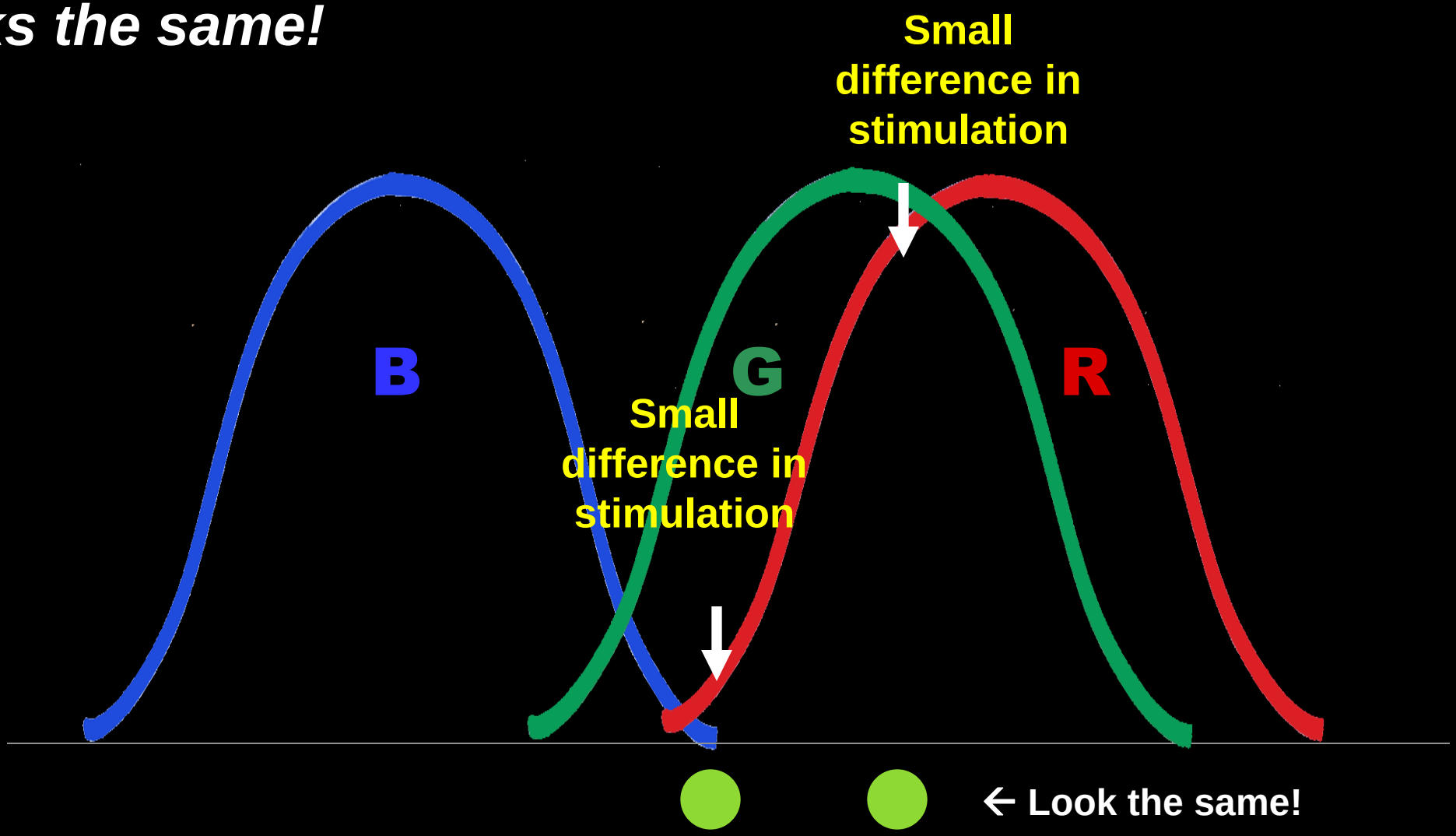
Consider a green vs. yellow light…



Color Normal Individual

The two spots appear different in color because R-G is large for one, and small for the other.

Each spot produces the same R-G stimulation and thus looks the same!



Deuteranomaly

(the green sensitivity curve is shifted toward the red)

Some Views With and Without Color Vision

Link→ Jay and Maureen Neitz Color Vision Page

Trichromatic Vision

Dichromatic Vision

Blueish-Reds
and Blueish-Greens

This Would Not Be Very Visible	This Would Not Be Very Visible
to a Person with Red-Green	to a Person with Red-Green
Color Vision Deficiency	Color Vision Deficiency

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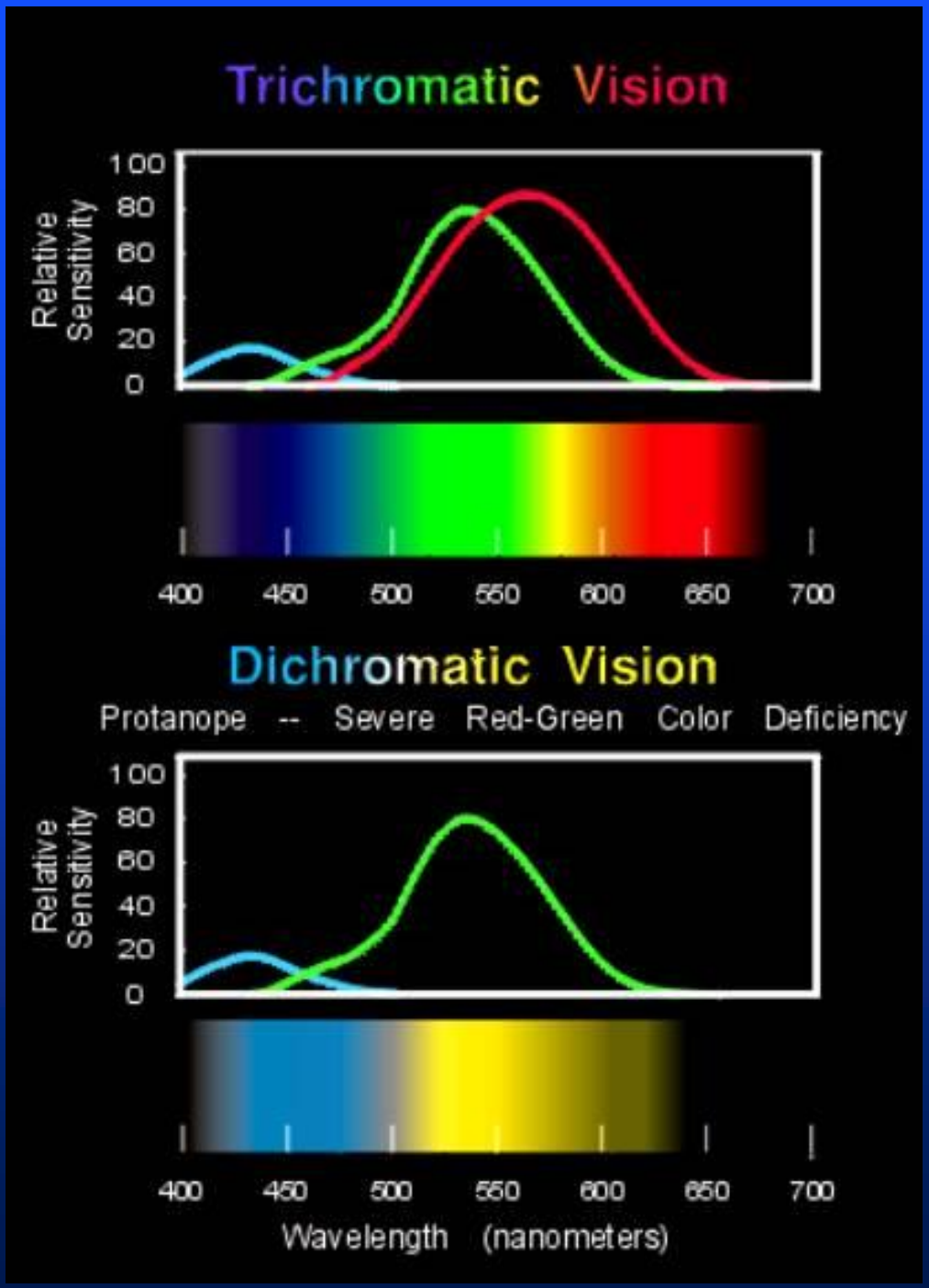

Color Labeling

- Color deficients rely heavily on context and learning—apple is "red" because patient learns to call it red —same hue may appear gray when presented without other cues.
- For wavelengths beyond 545, relative brightness, context, and learning play a significant role verbal label and response.

Hereditary Color Deficiency

- 8-10% of males and 1/200 females (0.5%) are born with red or green color deficiency.
- Sex-linked recessive condition (X chromosome).
- Protanomaly—red cone peak shifted toward green (1%)
- Protan Dichromat—red cones absent (1%)
- Deuteranomaly—green cone peak shifted toward red (5%)
- Deutan Dichromat—green cones absent (1%)
- Hereditary tritan defects are rare (0.008%)

Color Deficiency	Males	Females
Protanopia	1%	0.01%
Deuteranopia	1%	0.01%
Protanomaly	1%	0.01%
Deuteranomaly	5%	0.4%
Overall (red-green)	8%	0.5%
Tritanopia	0.008%	0.008%
Tritanomaly	Rare	Rare
Rod monochromatism	Rare	Rare
Cone monochromatism	Rare	Rare

END SLIDE SHOW

OF COLOR VISION

FUNDIMENTALS