

# Chapter 6: Vision

General Principles of Sensory Processing

The Visual Stimulus

The Anatomy of the Visual System

Coding of Light and Dark

**Coding of Color**

The Primary Visual Cortex

Perception of Visual Information

# Coding of Color

## Cones and Color Vision.

- B/W vision adequate for most purposes
- color vision is important in identifying ripeness, counteracting camouflage...
- humans, old world monkeys and apes have  
3 types of cones (3 iodopsins) providing elaborate color vision





# Coding of Color

## Cones and Color Vision.

- B/W vision adequate for most purposes
- color vision is important in identifying ripeness, counteracting camouflage...
- humans, old world monkeys and apes have  
3 types of cones (3 iodopsins) providing elaborate color vision





# Coding of Color

## Cones and Color Vision.

- B/W vision adequate for most purposes
- color vision is important in identifying ripeness, counteracting camouflage...
- humans, old world monkeys and apes have  
3 types of cones (3 iodopsins) providing elaborate color vision

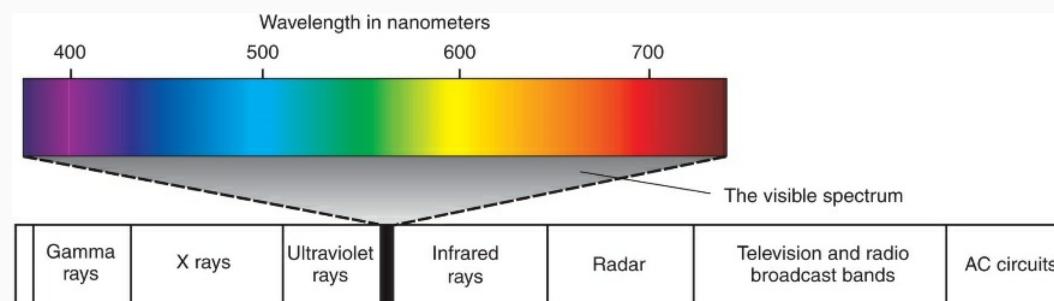




# Coding of Color

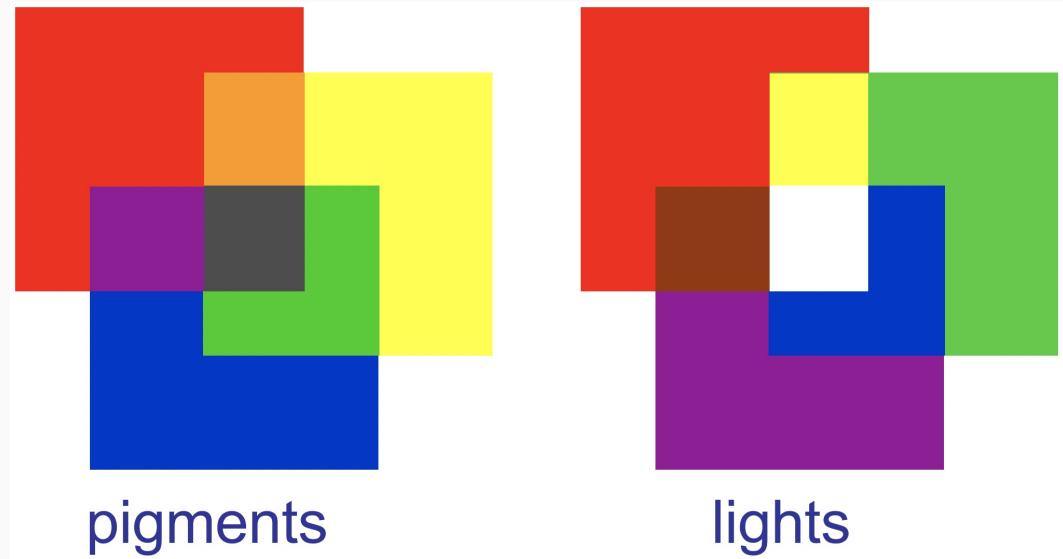
## Cones and Color Vision.

- mixing of colored light differs from pigment mixing
- red+yellow+blue = muddy gray pigment
- red+yellow+blue = white light



## Trichromatic (Young-Helmholtz) Theory of Color Vision.

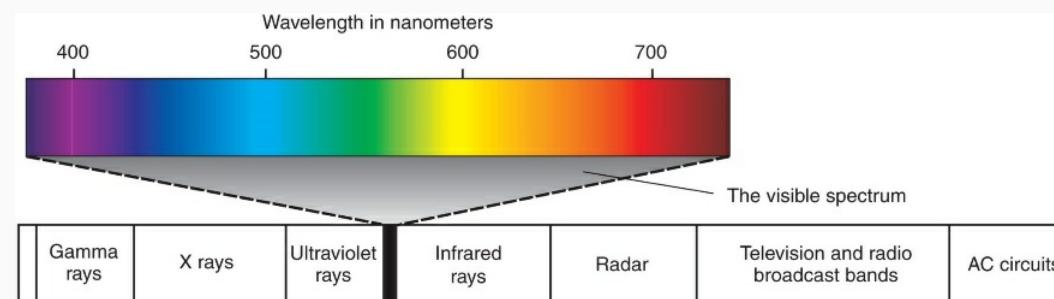
- based upon observation that any color of light can be obtained by mixing various amounts of red, yellow, blue
- proposed that humans have 3 kinds of photoreceptors that work together to give perception of color



# Coding of Color

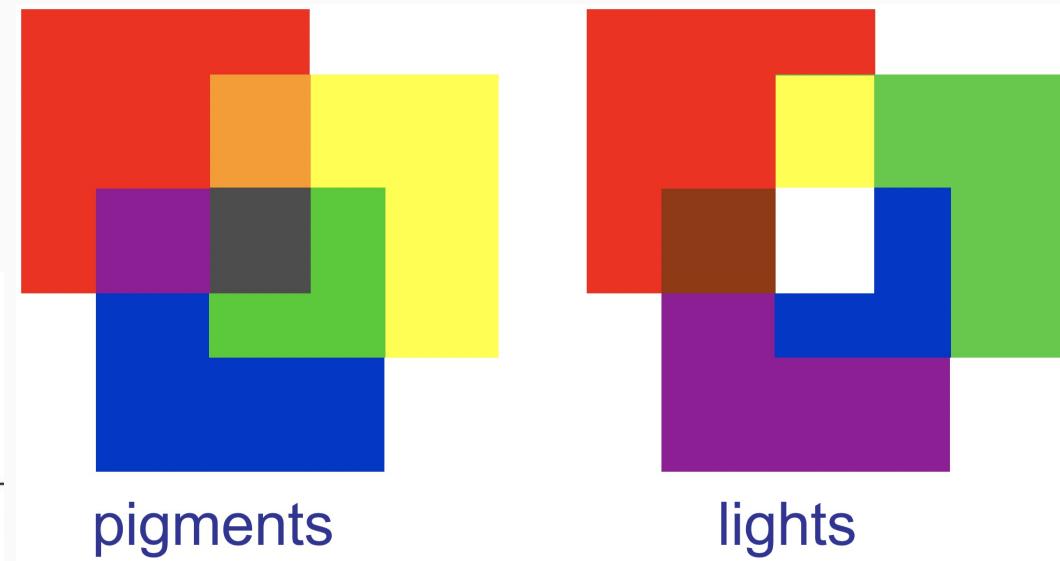
## Cones and Color Vision.

- mixing of colored light differs from pigment mixing
- red+yellow+blue = muddy gray pigment
- red+yellow+blue = white light



## Trichromatic (Young-Helmholtz) Theory of Color Vision.

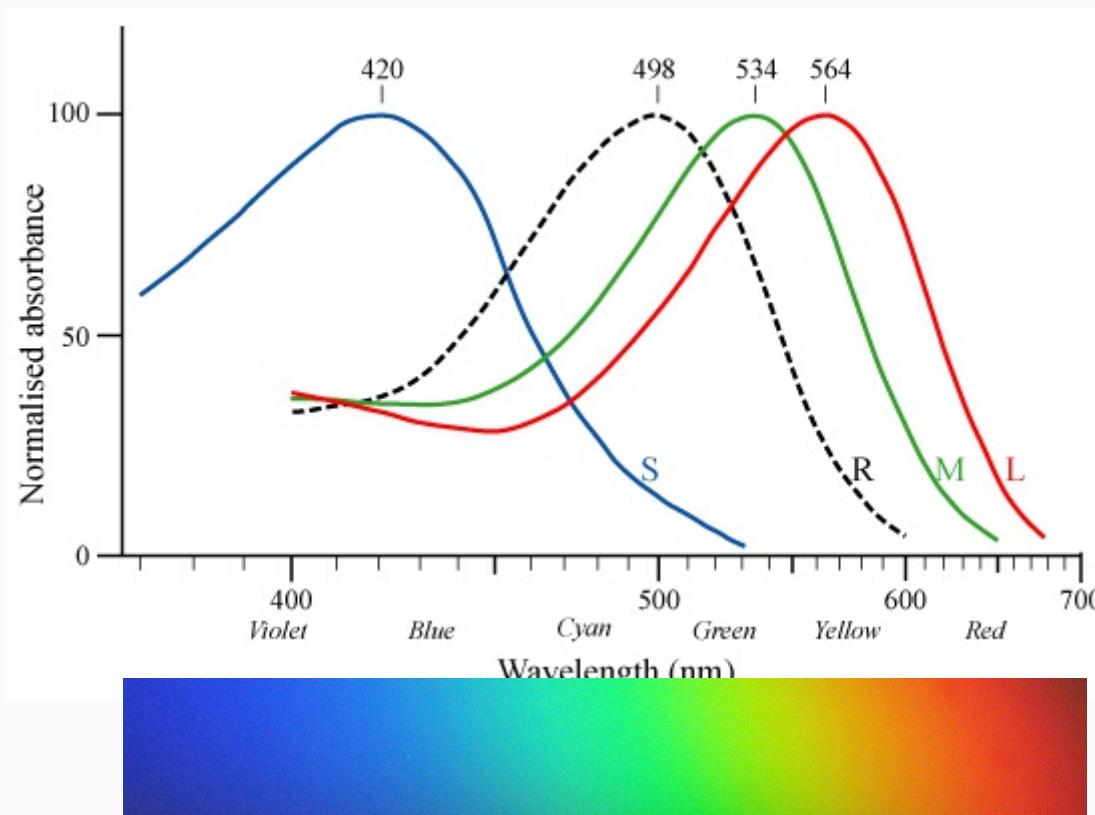
- based upon observation that any color of light can be obtained by mixing various amounts of red, yellow, blue
- proposed that humans have 3 kinds of photoreceptors that work together to give perception of color



# Coding of Color

## Cones and Color Vision.

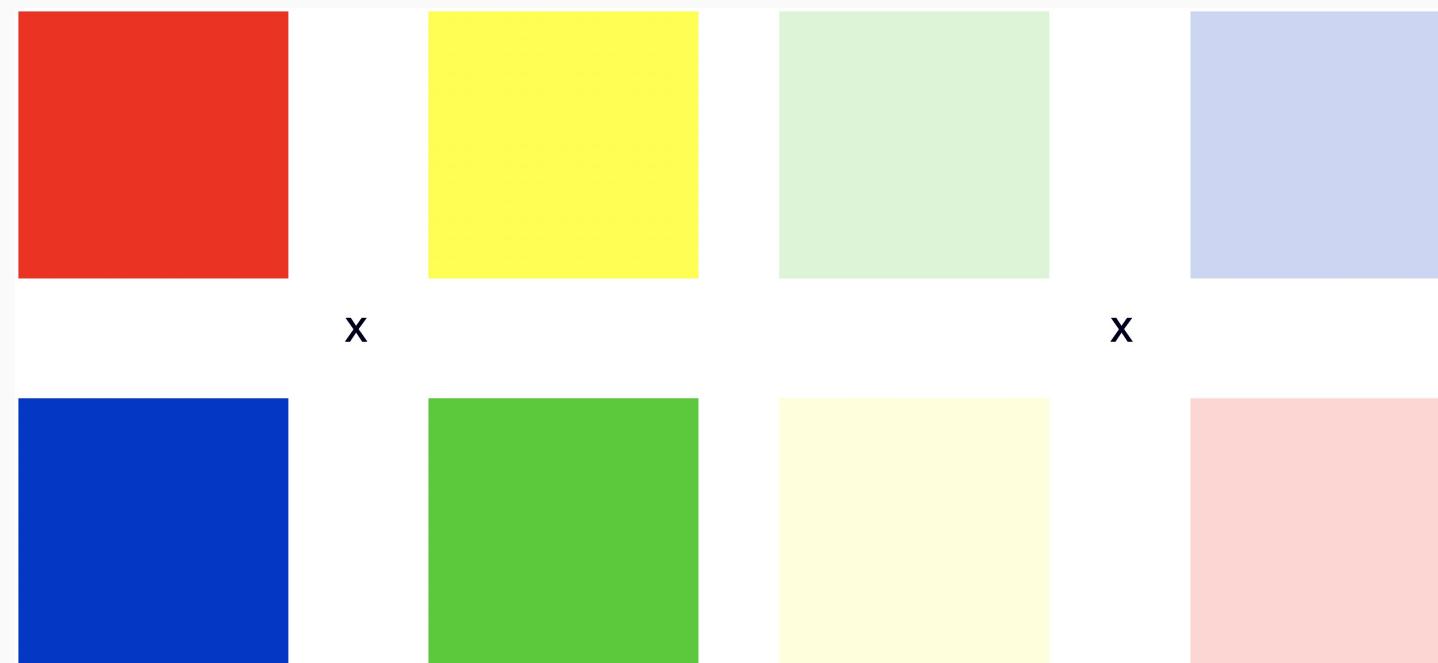
- cones exhibit maximal responses at 420 (short), 534 (medium), or 564 (long) nm
- determined by type of iodopsin in cone
- each cone responds over a range of wavelengths



# Coding of Color

## Opponent Process Theory of Color Vision.

- based upon observation that some colors don't blend
- based upon negative afterimages
- trichromatic theory cannot explain

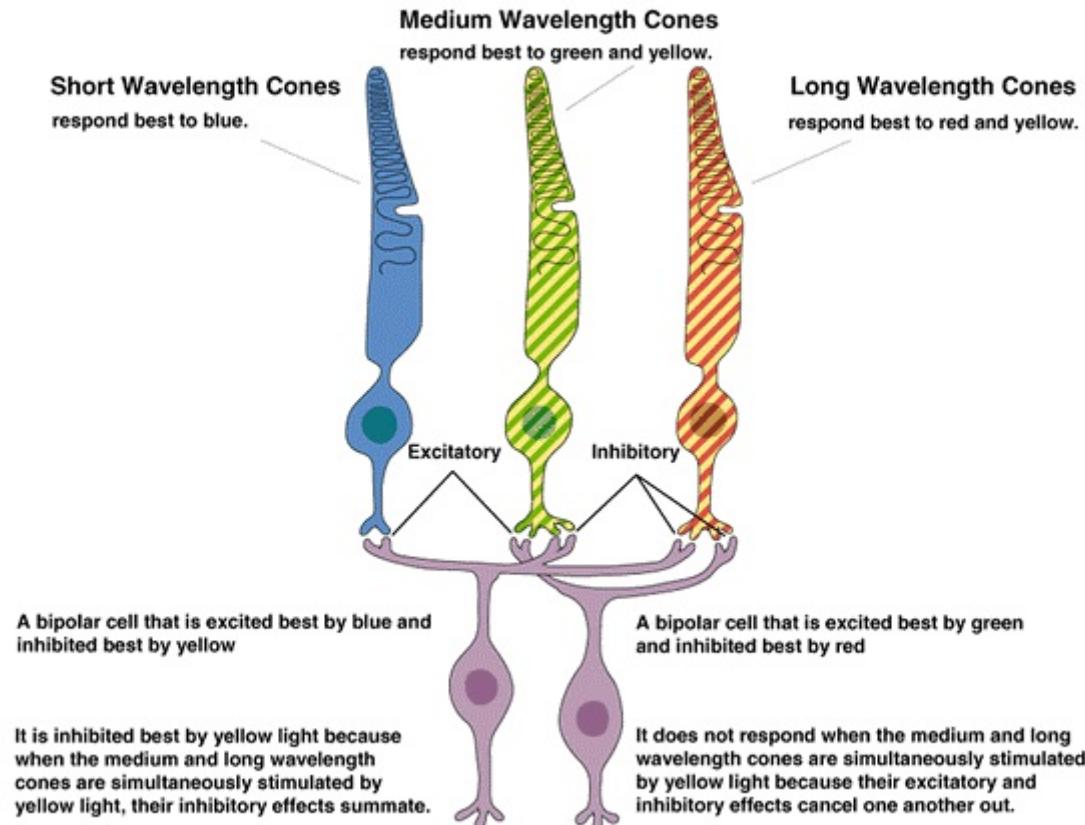


# Coding of Color

## Opponent Process Theory of Color Vision.

- 2 kinds of colour sensitivity in ganglion cells
  - "medium opposes long"
  - "short opposes medium/long"

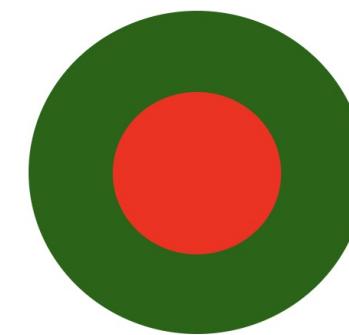
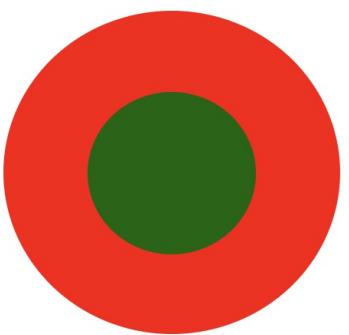
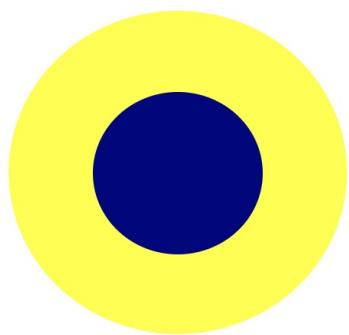
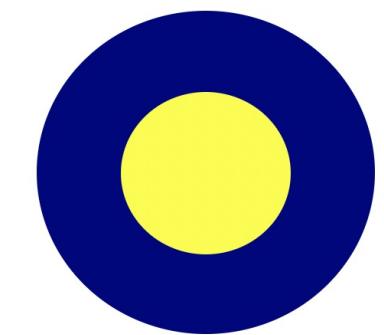
### ► Opponent Processing by a Retinal Circuit



# Coding of Color

## Opponent Process Theory of Color Vision.

- 2 kinds of colour sensitivity in ganglion cells
  - "medium opposes long"
  - "short opposes medium/long"
- roughly concentric cone-fed inputs



yellow on  
blue off

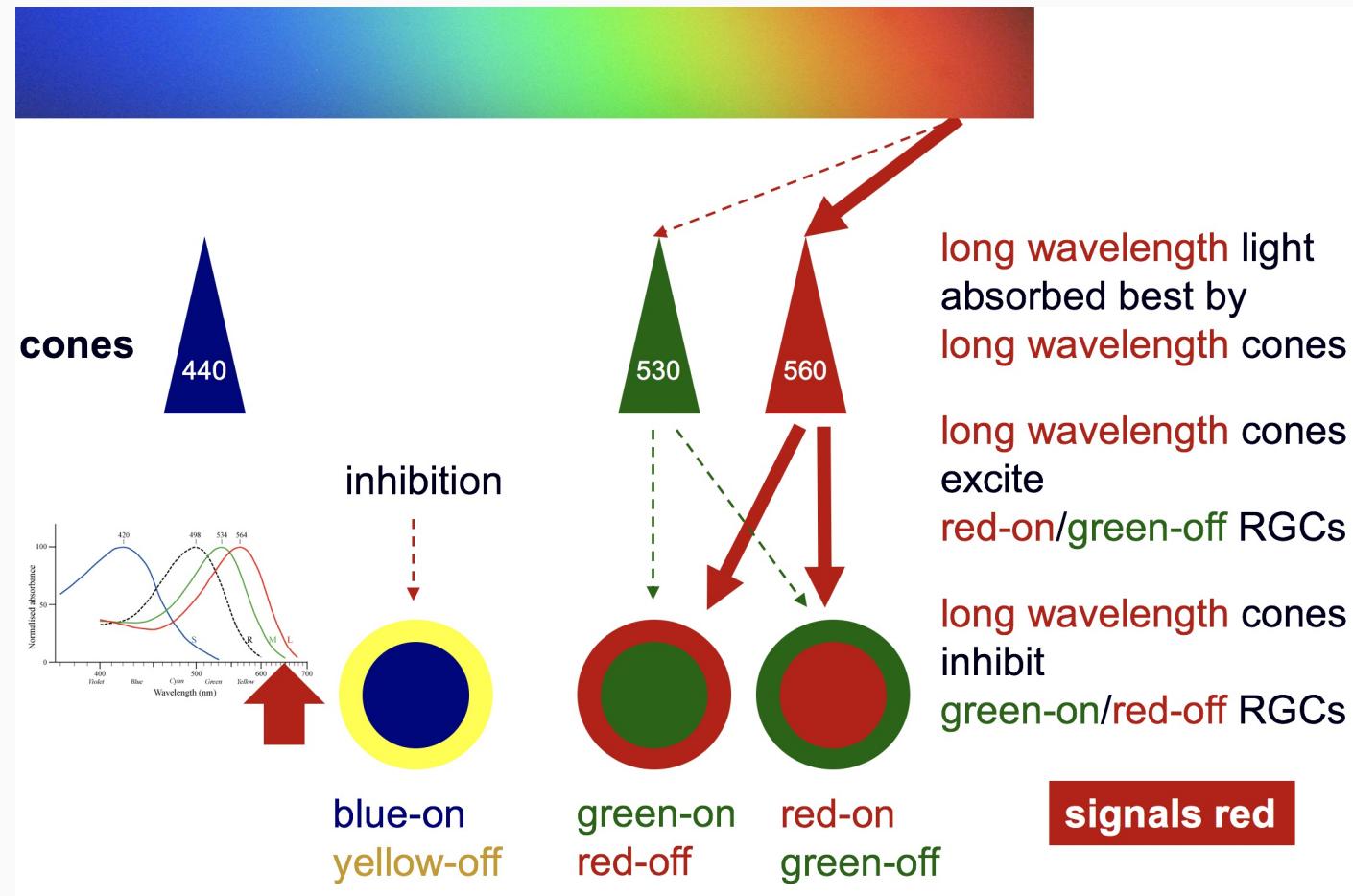
blue on  
yellow off

green on  
red off

red on,  
green off

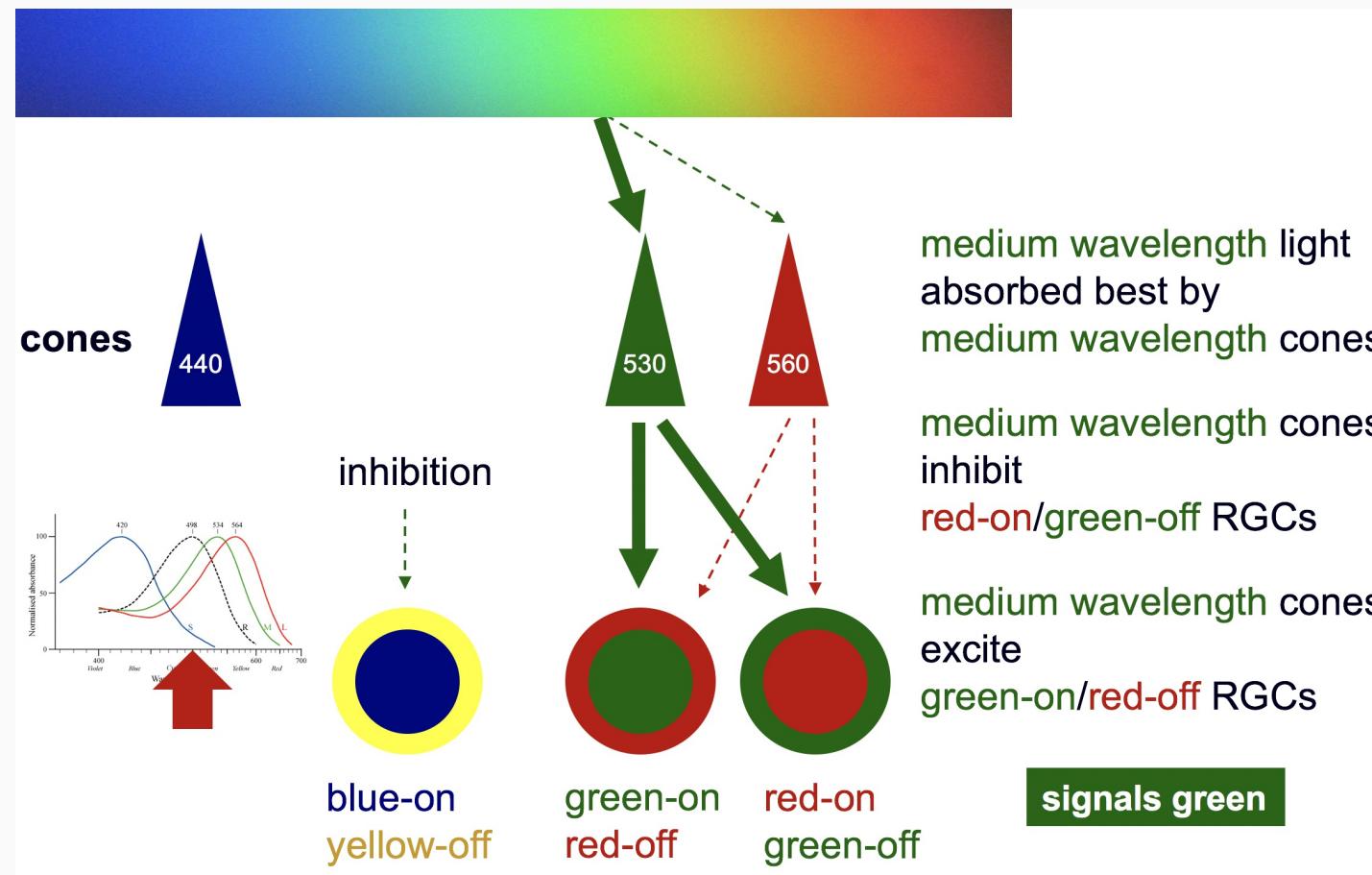
# Coding of Color

## Retinal Color-Coding, Long Wavelength Light.



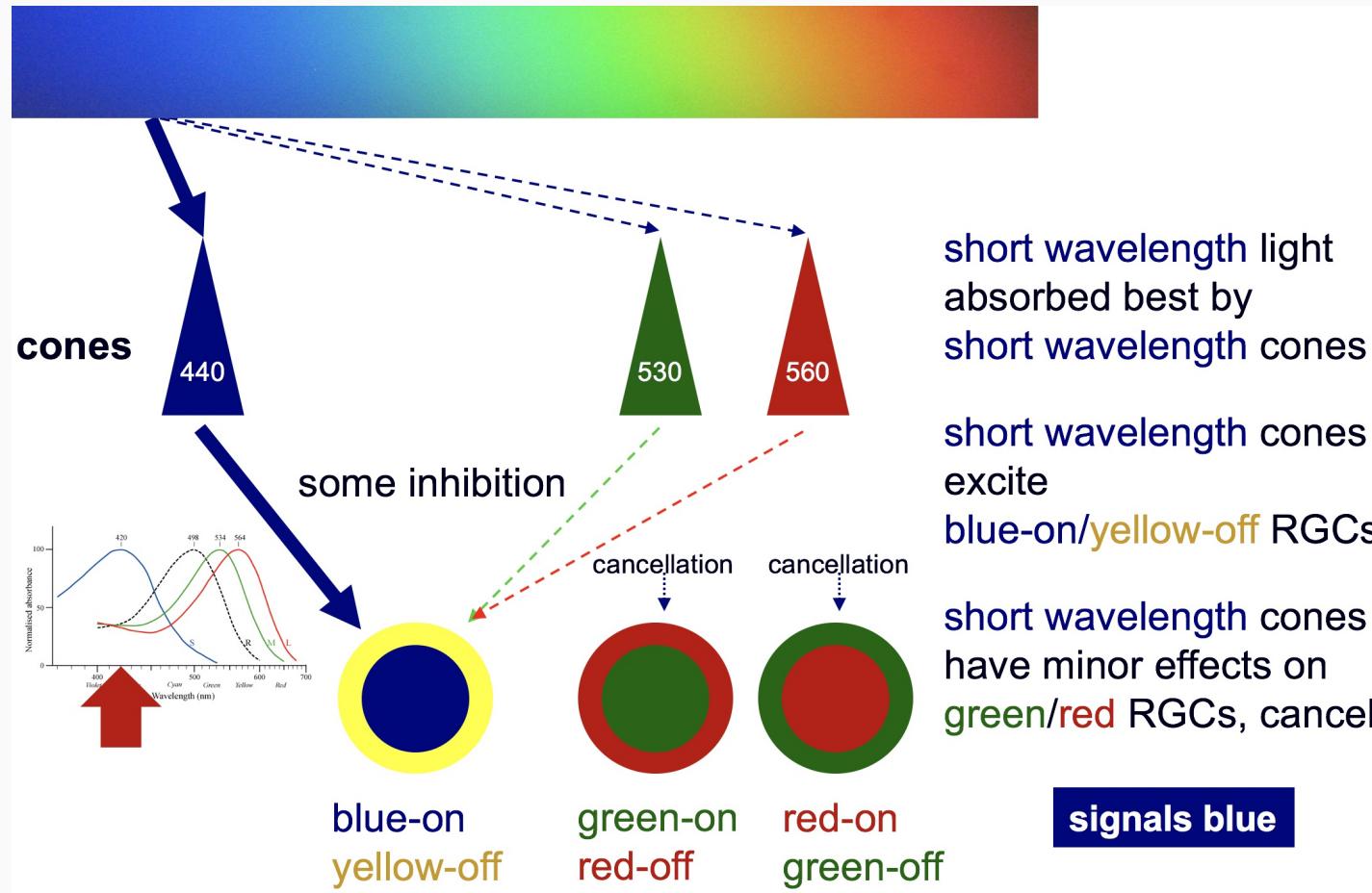
# Coding of Color

## Retinal Color-Coding, Medium Wavelength Light.



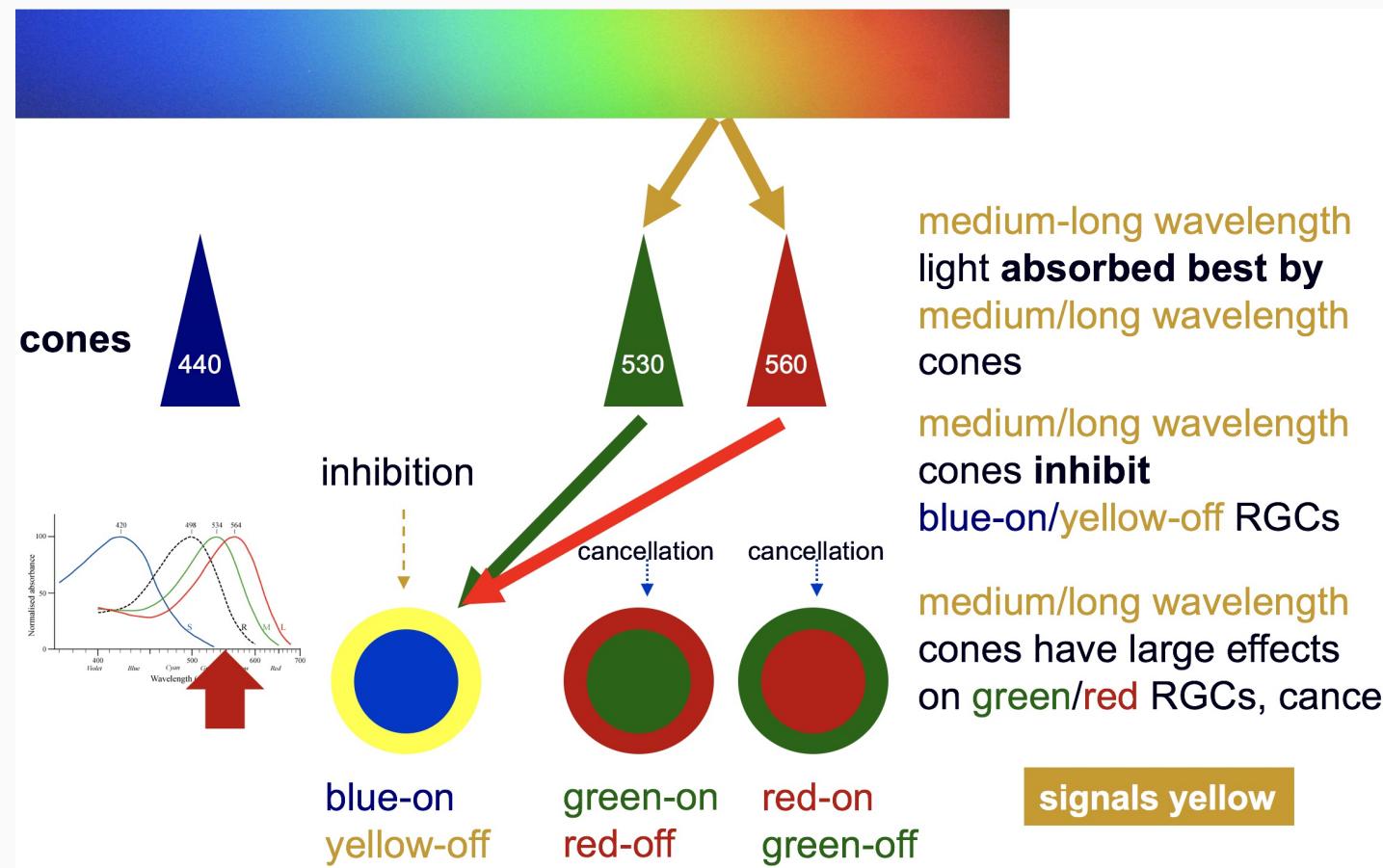
# Coding of Color

## Retinal Color-Coding, Short Wavelength Light.



# Coding of Color

## Retinal Color-Coding, Med-Long Wavelength Light.

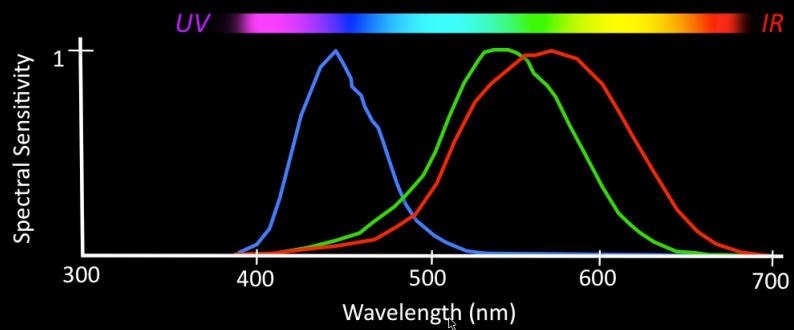
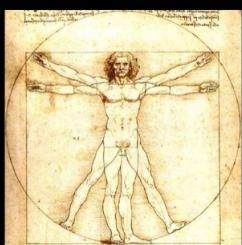


# Coding of Color

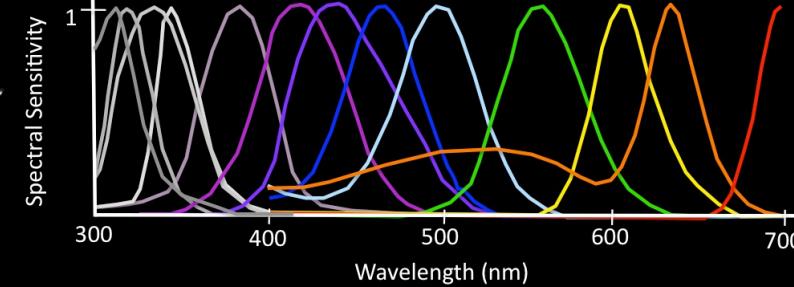
That Mantis Shrimp Again.

## Mantis Shrimp: Extraordinary Eyes

*Homo sapiens*



*Neogonodactylus oestedii*



Marshall *et al.*, 2007; Marshall and Oberwinkler, 1999



# Coding of Color

## Higher-Level Processing



# Image Credits

- slide 2: <http://m.rgbimg.com/cache1qybvK/users/t/ta/tacluda/600/n2fnFiE.jpg> <http://awakeningtoanimals.com/wp-content/uploads/2013/05/zebra-camouflage.jpg>  
[http://upload.wikimedia.org/wikipedia/commons/3/3f/Mantis\\_shrimp\\_\(Odontodactylus\\_scyllarus\).jpg](http://upload.wikimedia.org/wikipedia/commons/3/3f/Mantis_shrimp_(Odontodactylus_scyllarus).jpg)
- slide 3: [http://nunojpereira.com/portfolio/wp-content/uploads/940\\_2013quarellatray01.jpg](http://nunojpereira.com/portfolio/wp-content/uploads/940_2013quarellatray01.jpg)  
<http://thumbs.dreamstime.com/t/watercolor-tray-22470358.jpg> Carlson, N.R. (2012). Physiology of Behavior, 11th ed. Pearson Publishing drawn by D.P. Devine
- slide 4: <http://upload.wikimedia.org/wikipedia/commons/c/c2/Cone-response.png>  
<https://letubeu.files.wordpress.com/2012/03/visible-spectrum-st-patricks-day1.jpg> Pinel, J.P.J. (1997). Biopsychology, 4th ed. Allyn and Bacon
- slide 5: drawn by D.P. Devine
- slide 6: Pinel, J.P.J. (1997). Biopsychology, 4th ed. Allyn and Bacon
- slide 7: drawn by D.P. Devine
- slide 8-11: Carlson, N.R. (2012). Physiology of Behavior, 11th ed. Pearson Publishing drawn by D.P. Devine
- slide 12: [http://images.gizmag.com/hero/mantis\\_shrimp\\_body\\_armor-7.jpg](http://images.gizmag.com/hero/mantis_shrimp_body_armor-7.jpg)
- slide 13: <http://blogs-images.forbes.com/matthewherper/files/2015/02/Cube.png>