COLOR VISION

1) Color vision in nature
   a) Utility
   b) Prevalence
   c) Camouflage

2) Color
   a) Hue
      i) Perception of wavelength
   b) Brightness
      i) Note: Change in hue with changes in intensity – Bezold-Brucke shift
   c) Saturation

If a tree falls in the forest, but no one is there, does it have a color?

\[
\begin{array}{|c|c|}
\hline
\text{Approximate Wavelength Region (in nm)} & \text{Associated Hue} \\
\hline
380-470 & Reddish blue \\
470-475 & Blue \\
475-480 & Greenish blue \\
480-485 & Blue-green \\
485-535 & Bluish green \\
535-550 & Green \\
550-555 & Yellowish green \\
555-560 & Green-yellow \\
565-575 & Greenish yellow \\
575-590 & Yellow \\
590-595 & Reddish yellow \\
595-770 & Yellowish red* \\
\hline
\end{array}
\]
3) Color mixture
   a) Primary Colors
   b) Secondary Colors
   c) Tertiary Colors
   d) Additive color mixture
      i) Color circle
      ii) Complementary colors
         (1) Adding even amounts of two colors
         (2) Adding different amounts of colors
         (3) Reducing intensity of each component
      iii) Metamer
      iv) Primary colors
         (1) Why 3 colors? Why not 4 or 5 primary colors?
      v) Pointillism (Seurat, Signac)
     vi) Television/Computer Monitors
4) Effects in color vision
   a) After images
      i) Negative after image
   b) Memory color
   c) Color constancy

5) Theories of color perception
   a) Need for a theory
   b) Theories:
      i) Trichromatic Receptor Theory
      ii) Opponent Process Theory
c) Trichromatic Receptor Theory (Young-Helmholtz)

i) Cone types

(1) S, M, L cones (=B, G, R cones)
   (a) Photopigments

(2) Retina acts as a spectral analyzer

ii) Explanatory power

(1) Sidebar: Cone functioning

(2) Complementary afterimages

iii) Questions

(1) Are there things that Trichromatic Theory cannot explain?
   (a) Adding blue light to yellow light yields white or gray
      (i) The Trichromatic Theory explains this as…

      (ii) But…

   (b) Visualization: You cannot visualize reddish-green or bluish-yellow
d) Opponent Process Theory (Hering; Hurvich & Jameson)

i) Two stage process

(1) 3 cones system at retina

(2) 3 opponent processes at higher levels

(a) white-black

(b) blue-yellow

(c) red-green

ii) Ganglion + LGN cells have opponent processes / center-surround with colors

e) Blobs in cortex

i) Color-opponent neurons with double-opponent receptive fields

ii) Center surround

iii) A series of these cells can detect color bars, as well as patterns of green-red-green-red, etc.
6) Defective color vision

   a) Monochromatism

   b) Dichromatism
      i) Protanopia
      ii) Deuteranopia
      iii) Tritanopia

   c) Trichromatism anomaly
      i) Protoanomaly
      ii) Deuteranomaly

   d) Achromatopsia

7) Subjective colors

   a) Benham’s top

   b) Kinetic art (e.g., Jesus Soto)