Two types of receptors on retina: rods and cones

- **Rods:**
  - spread all over the retinal surface (75 - 150 million)
  - low resolution, no color vision, but very sensitive to low light

- **Cones:**
  - a dense array around the central portion of the retina, the fovea centralis (6 - 7 million)
  - high-resolution, color vision, but require brighter light

### Color Perception

#### Tristimulus Theory:
- the eye has three types of color receptors: Red, Green, Blue.

#### Color reproduction:
- one can generate (almost) any color on a monitor by mixing three primaries, RGB
- CRT monitor have 3 color guns: RGB

#### Color Spaces

- **HSV**
  - Hue: color
  - Saturation: peak from white light
  - Value: overall integral across all $\lambda$

- **CIE**
  - CIE L\(\alpha\)\(\beta\): equal distances mean equal perceptive differences
**CIE LAB Space**

L
(Perceived brightness)

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**Digital Image**

Image:
- 2D matrix of pixels

Image resolution:
- number of pixels along each matrix dimension

Each pixel has a value:
- a single value if greylevel image
- a triple RGB if color image

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**Dynamic Range**

Each pixel is represented by a number of bits

Quantization:
- process of discretizing a continuous value into bits

Minimal number of bits = 6 (64 greylevels or 4 levels for R,G,B)
- most medical digital images have 12 bits (4096 grey levels)

8 bits 4 bits

- not enough bits leads to quantization artifacts and loss of resolution

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**Histogram**

A histogram counts the number of pixels at each greylevel
- \( h(\nu) = \text{number of pixels having grey value } \nu \ / \ \text{total number of pixels} \)

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Partial bandwidth

Full bandwidth

Good contrast requires a histogram with full bandwidth
Contrast

Difference of brightness in adjacent regions of the image
- grey-level (luminance) contrast
- color contrast

Point Spread Function

Each pixel is not a sharp spike, but represented by a point spread function (PSF)
The PSFs overlap and form a continuous function (for the eye)
Smaller PSFs give sharper images