LIGHT:

- electromagnetic radiation.
- expressed as spectral energy distribution.

$L(\lambda)$ with $\lambda \in [350\text{nm}, 780\text{nm}]$ on electromagnetic spectrum

\[
I(\lambda) = \rho(\lambda) L(\lambda)
\]

\[
R(\lambda) = \left[ t(\lambda) L(\lambda) \right]
\]

Brillantez subjetiva. Nivel de adaptación

[Graph of subjective brightness vs. adaptation range]
**Retina:**

- 5 kinds of cells

**Bipolar cells**
- serial connections.
- between photoreceptors and ganglion cells.

**Ganglion cells**
- serial connections.
- its axons make up the optic nerve.

**Horizontal cells**
- parallel connections.
- receive synapses from photoreceptors and may act on bipolar cells and photoreceptors.

**Amacrine cells**
- parallel connections.
- receive synapses from bipolar cells and may act on ganglion cells.

- Crossing the retina, the number of cells decreases progressively. The information is concentrated more and more.

- Lateral correction made by horizontal and amacrine cells are responsible for amplitude companding and spatial frequency preemphasis by mediating the sensitivity of the ganglion cells to light. 
  
  => effect called *lateral inhibition.*
Photocells

- **RODS:** 100 millions.
  Scotopic vision, lower order of magnitude illumination.

- **CONES:** 6.5 millions
  Photopic vision
  - higher orders [5 to 6] of magnitude illumination,
  - dense in fovea,
  - responsible for color vision.
LATERAL GENICULATE NUCLEUS

- After division of information at optic chiasma. Layered organization of cells (1 layer for one eye).
- Functionment similar to ganglion cells.
- Independency from the orientation.
- Information about a region of retina is on line across 6 superposed layers alternatively relative to eye Right, Left, ...

VISUAL CORTEX

- 4 types of neurons.
  - Simple cells - orientation and position in visual field.
  - Complex cells - orientation.
  - Hypercomplex cells - orientation and discontinuity (corner, end of line).
  - Higher and hypercomplex cells ...
- Organization into columns:

\[ \Delta \Phi = 6^\circ \]

Luminance or Intensity:

- For a spatially distributed object with light distribution \( I(x, y, \lambda) \), luminance or intensity is defined as:

\[ I(x, y) = \int_0^\infty I(x, y, \lambda) V(\lambda) \, d\lambda \]

where \( V(\lambda) \) is called relative luminous efficiency function of the visual system.
- Measured in lumens (lm): amount of energy an observer perceives.
Luminance of an object is independent of the luminance of the surrounding objects.

**Brightness:** *also called apparent brightness*

- It is the perceived luminance,
- It depends on the luminance surround. Two objects with different surroundings could have identical luminances but different brightnesses,
- Cannot be measured.

## II. Spatial Visual Phenomena

**Simultaneous contrast**

*Fig. II.1.*

Simultaneous contrast:

- Small squares in the middle have equal luminances but do not appear equally bright.
- Small squares in the middle appear almost equally bright, but their luminances are different.

Our perception is sensitive to luminance contrast rather than the luminance values.
Mach bands

Mach bands, explicación
Mach Bands

Fig. II.5. Mach bands.
(c) Nature of the visual system impulse response.

The negative lobes manifest a phenomenon called lateral inhibition. Signal at a location is inhibited by some of the laterally located receptors.
MTF del sistema de visión humano
Función de sensitividad de contraste

Contornos falsos
Distorsión de línea

Distorsión de profundidad
Sitios interesantes

- http://www.purveslab.net/
- http://www.yorku.ca/eye/
- http://wisebytes.net/illusions/
- http://www.stanford.edu/class/ee368b/handouts.html