1. Rhodopsin in rod cell disc is excited by light.

2. Excited rhodopsin activates about 500 transducin molecules.

3. Activated transducin activates PDE which begins hydrolizing cGMP.

4. PDE hydrolizes up to 4,000 molecules of cGMP. Na⁺ channels close when they no longer bind cGMP.

One photon of light can block the entry of over one million Na⁺ ions!
(a) Expectro de Absorción (microespectrofotometría)

(b) Wavelength (nm)

(c) Expectro de Acción

Response amplitude (%)

Wavelength (nm)
Dazzling light; bright sun on snow
Outdoors in full sunlight
Outdoors under a tree on a sunny day
Comfortable indoor illumination; night sports events

Threshold for perception of color; bright moonlight

Threshold when dark-adapted

Photoreceptor

Reduction in current (pA)

Light intensity (Rhodopsins excited \cdot sec^{-1})
100 millones de fotorreceptores

CONVERGENCIA

1 millones de Células ganglionares

DIVERGENCIA
(a) *Limulus polyphemus*

- Lateral simple eye
- Lateral compound eye
- Median simple eye

(b) Cross-section of lateral compound eye

- Lens
- Photoreceptors
- Axon of eccentric cell

(c) Single ommatidium

- Light
- Lens
- Retinular cell
- Dendrite of eccentric cell
- Rhabdomere of retinular cell
- Eccentric cell
- Axon

(d)
(a) An on-center/off-surround cell

- On-center/off-surround receptive field
- Off-surround
- On-center
- Spot of light in center
- Spot of light in surround
- Entire center illuminated
- Entire surround illuminated
- Diffuse illumination of center and surround

Bipolar cell responses: changes in polarization
Ganglion cell responses: action potentials

(b) An off-center/on-surround cell

- Off-center/on-surround receptive field
- On-surround
- Off-center

Bipolar cell responses: changes in polarization
Ganglion cell responses: action potentials
Procesamiento en paralelo
ARCHITECTURE OF VISUAL CORTEX. A. Distinct layering of cells in a section of striate cortex of the macaque monkey, stained to show cell bodies (Nissl stain). Fibers arriving from the lateral geniculate nucleus end in layers IVa, IVb, and IVc. B. Drawing of pyramidal and stellate cells (Golgi stain) in the visual cortex of the cat. The connections for the most part run radially through the thickness of the cortex and extend for relatively short distances laterally. C. Drawing from a photograph of a portion of a pyramidal cell in the cat cortex which had been injected with a dye (procion yellow) after its activity was recorded. This cell had a complex receptive field organization. (A from Hubel and Wiesel, 1972; B after Ramón y Cajal; C from Kelly and Van Essen, 1974)
RESPONSES OF A SIMPLE CELL in cat striate cortex to spots of light (A) and bars (C). The receptive field (B) has a narrow central "on" area flanked by symmetrical antagonistic "off" areas. The best stimulus for this cell is a vertically oriented light bar (1° × 8°) in the center of its receptive field (fifth record from top in C). Other orientations are less effective or ineffective. Diffuse light (third record from top in A) does not stimulate. Illumination indicated by bar. (After Hubel and Wiesel, 1959)
RESPONSES OF A COMPLEX CELL in the striate cortex of the cat. Cell responds best to a vertical edge. A. With light on the left and dark on the right (first record), there is an “on” response. With light on the right (fifth record), there is an “off” response. Orientation other than vertical is less effective. B. Position of border within field is not important. Illumination of entire receptive field (bottom record) gives no response. (After Hubel and Wiesel, 1962)
RESPONSES OF A HYPERCOMPLEX CELL in area 18 of the cat cortex. The best stimulus for this cell is a moving (arrows), oriented edge (a corner) that does not encroach on the antagonistic right-hand portion of the receptive field (third record from top). The records also show the selective sensitivity of the cell to upward movement. (After Hubel and Wiesel, 1965)
¿Son líneas o barras siempre los mejores estímulos?
¿Existe entonces la neurona que reconoce la cara de la abuela?
BINOCULAR ACTIVATION of a simple cortical neuron that has identical receptive fields in both eyes. Simultaneous illumination of corresponding “on” areas of right and left receptive fields is more effective than stimulation of one alone (upper three records). In the same way, stimulation of “off” areas in the two eyes reinforces each other’s “off” discharges (lower records). (After Hubel and Wiesel, 1959)
(a) Method for visualization of ocular dominance columns

Computer to control camera and stimulus and record and process data

(b) Cortical regions driven by left eye reflect light differently, here coded in red

(c) Method for visualization of orientation columns

Computer to produce color display to code for different stimulus orientations and record and process data

(d) Cortical regions driven by stimuli in four different orientations are each coded in a different color
Stimuli

Peripheral, 24°

Middle, 9°

Foveal, 3°

Cerebral ventricles

Functional MRI responses to stimuli at 3 positions in the visual field; horizontal view.

Occipital

Frontal

Corpus callosum

Functional MRI responses; mid-sagittal view.
Plasticidad
4.20 Ocular-Dominance Histograms

Cells in the visual cortex of adult cats that responded only to stimulation of the opposite eye are class 1 cells. Cells that responded mainly to the opposite eye are class 2. Cells that respond equally to either eye are class 4. Cells responding only to stimulation of the eye on the same side are class 7, and so on. (a) Normal adult. (b) Following monocular deprivation through the early critical period. (c) After early deviation of one eye, that is, squint. (d) Following binocular deprivation. After Hubel and Wiesel, 1965; Wiesel and Hubel, 1965.
Expectro de Absorción (microespectrofotometría)

(a) Expectro de Acción

(c) Expectro de Acción

(b) Wavelength (nm)

400 500 600 700

[Graph showing absorption peaks at 455 (Blue), 530 (Green), and 625 (Red) nm with relative absorption on the y-axis and wavelength on the x-axis.]

[Graph showing response amplitude on the y-axis and wavelength on the x-axis with a scale of 2 mV.]
Color opponency

The cone spectral receptive fields show that there are three types of cones: short (420 nm; blue), medium (530 nm; green), and long (560 nm; yellow). Excitation and inhibition are maximally sensitive to different wavelengths.

Bipolar cells

Ganglion cells

Color detectors (spectrally opponent cells)

Brightness--darkness detectors