

Institute of Neuroinformatics
ETH/UNI Zurich

Computation in Neural Systems: Biological and Computational Vision

Lecture 1

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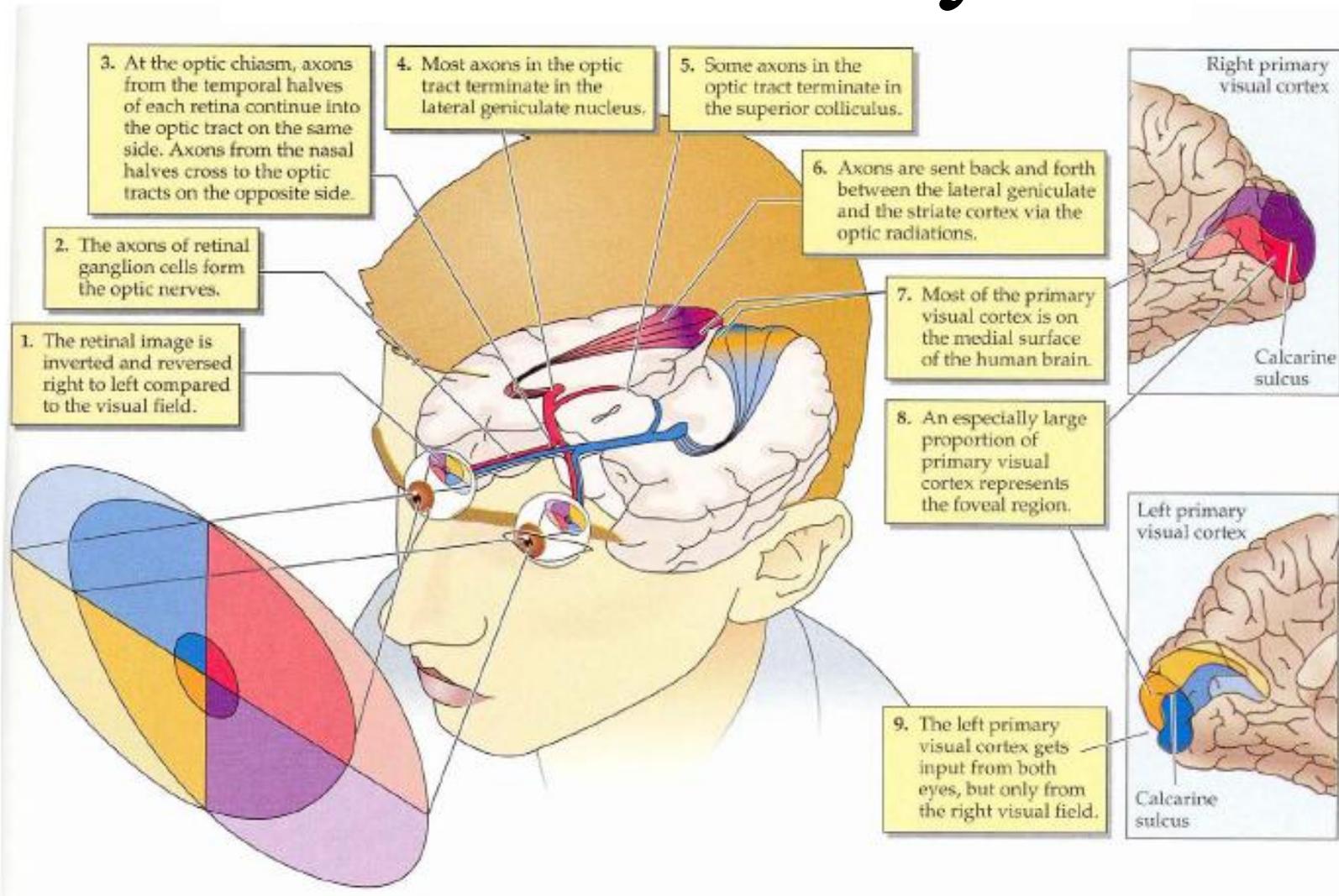
Feb. 19, 2026

www.ini.uzh.ch/~kiper/comp_vis/index.html

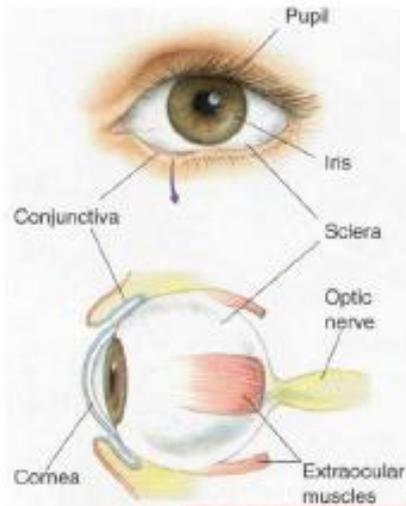
The visual pathways



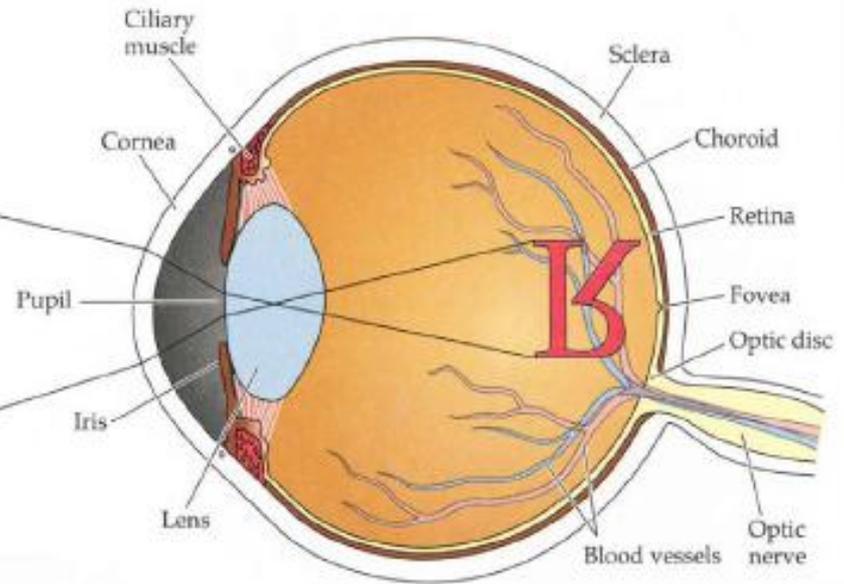
Visual Pathways



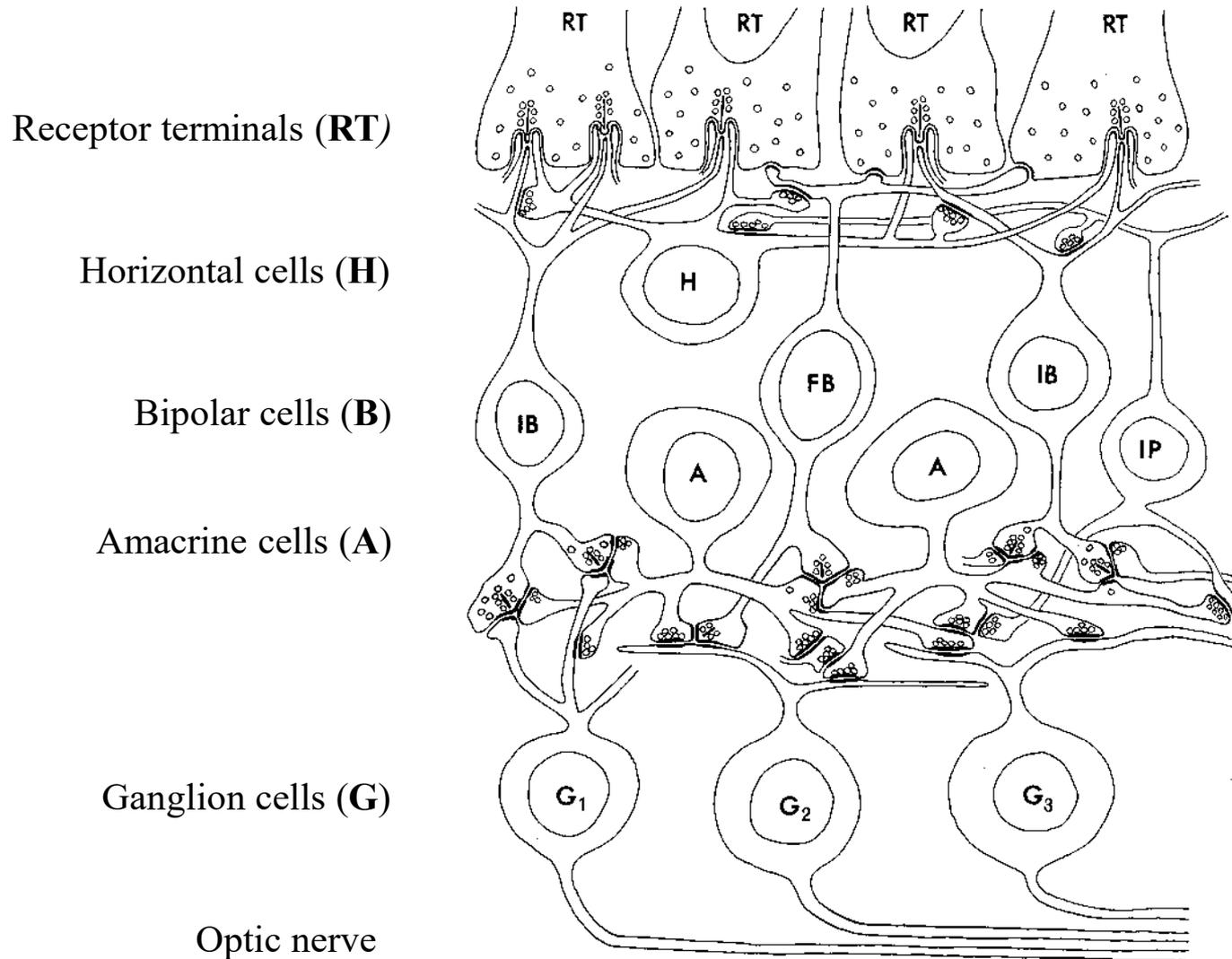
Anatomy of the eye



R

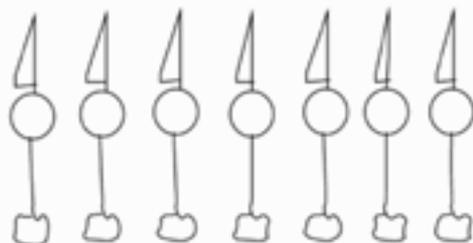


Basic retinal circuitry



spot of light

N N N N N N N

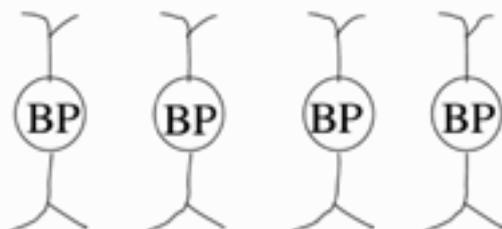


Photon Noise

Transduction Noise

Channel Noise

N N N N

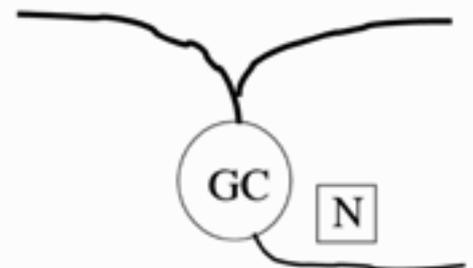


Synaptic Noise

(from Berntson & Taylor, 2003)

Channel Noise

N N N N



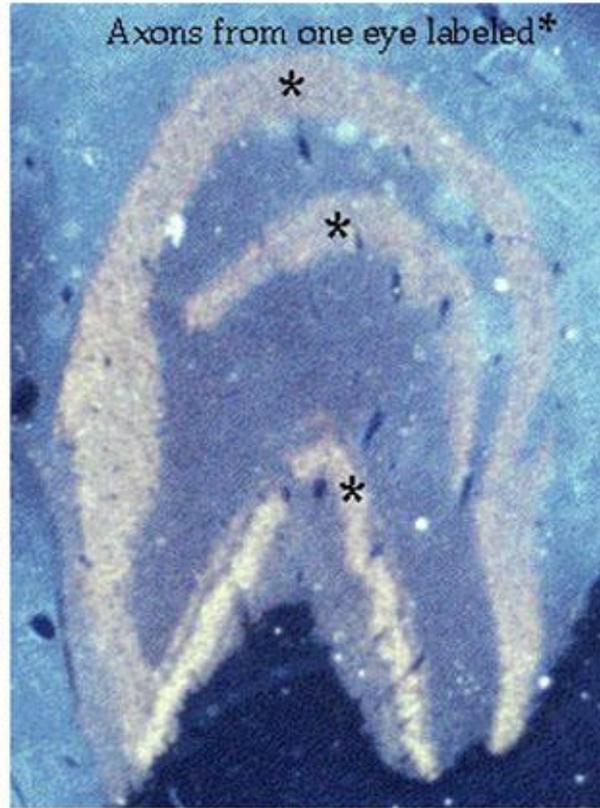
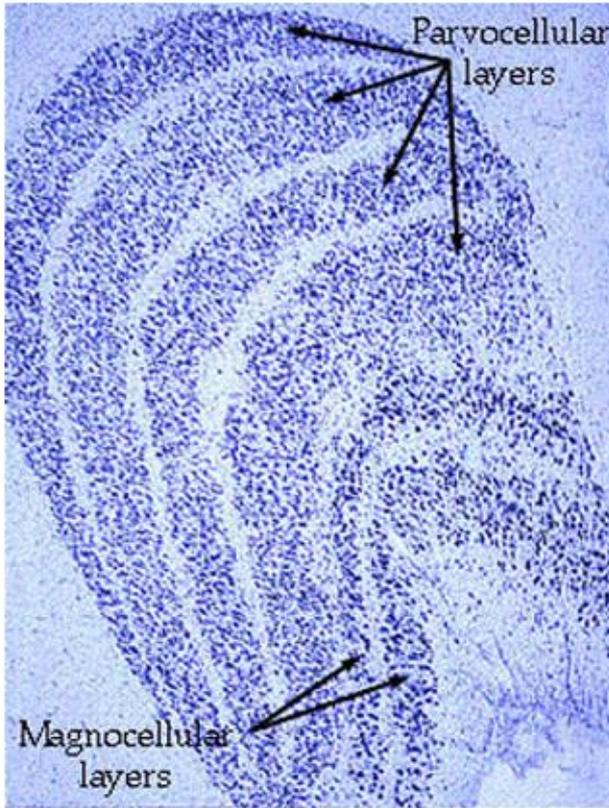
Synaptic Noise

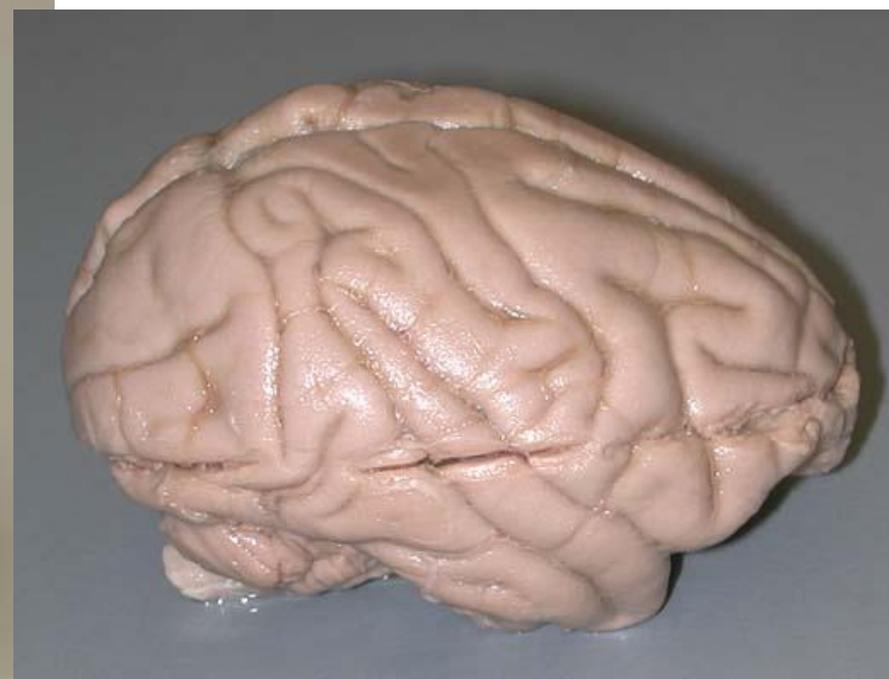
Dendritic Morphology

(from van Rossum et al, 2003)

Spike Generator

(from Dhingra & Smith, 2004)





Visual field
(retinal image)

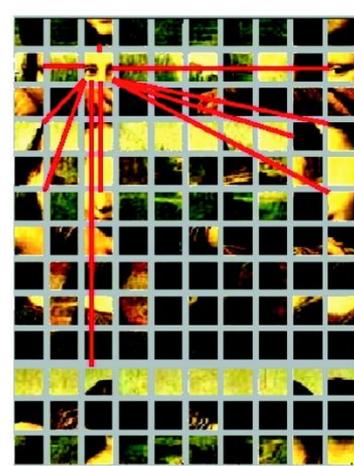


(*Da Vinci*,
1506)

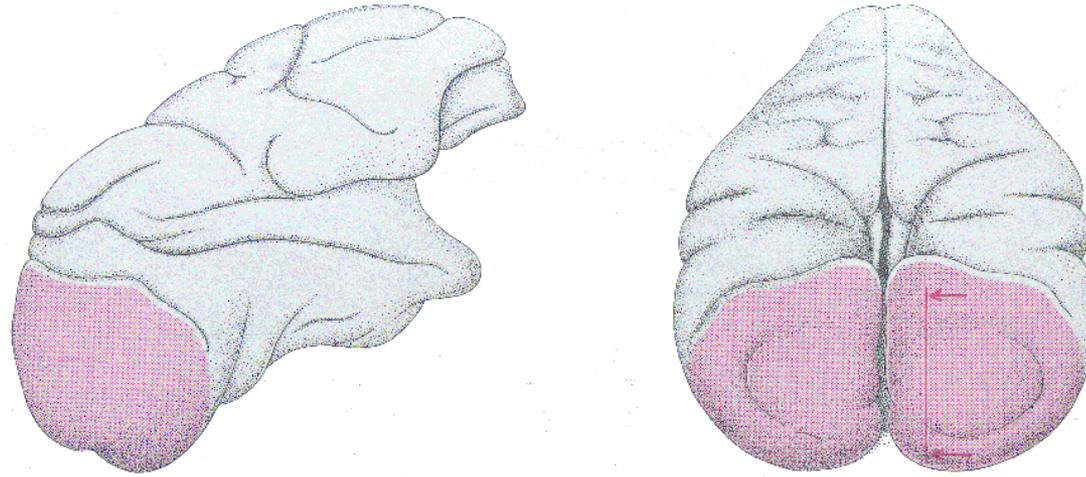
Retinotopic

Nonretinotopic

Visual cortex



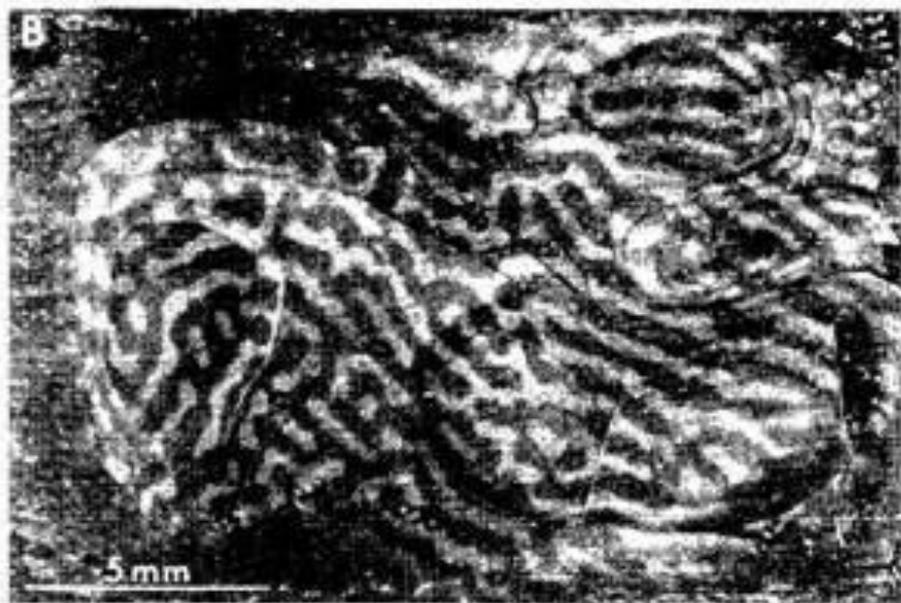




The striate cortex (V1)

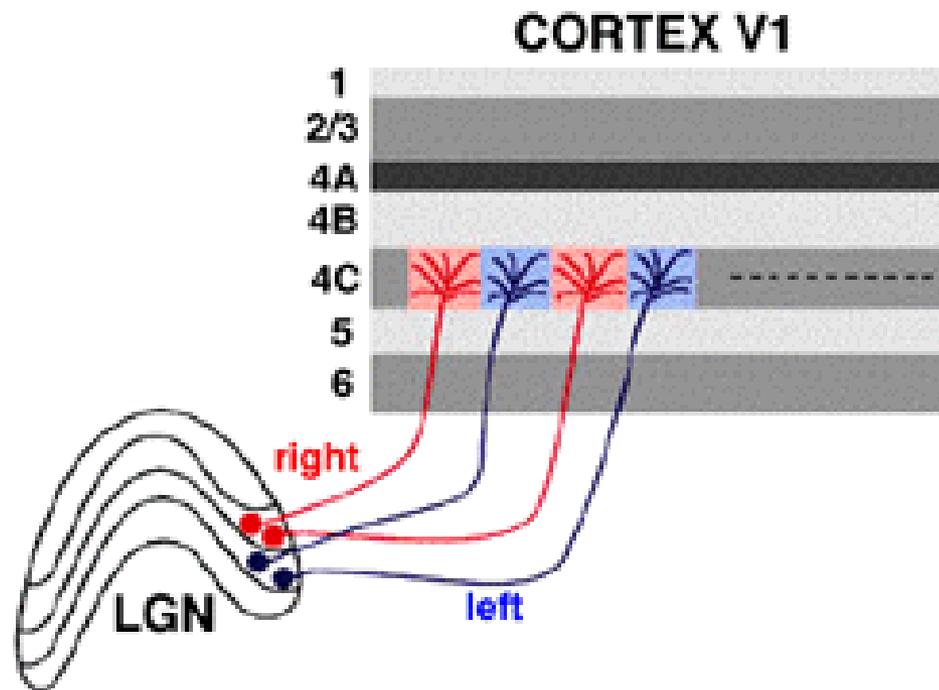


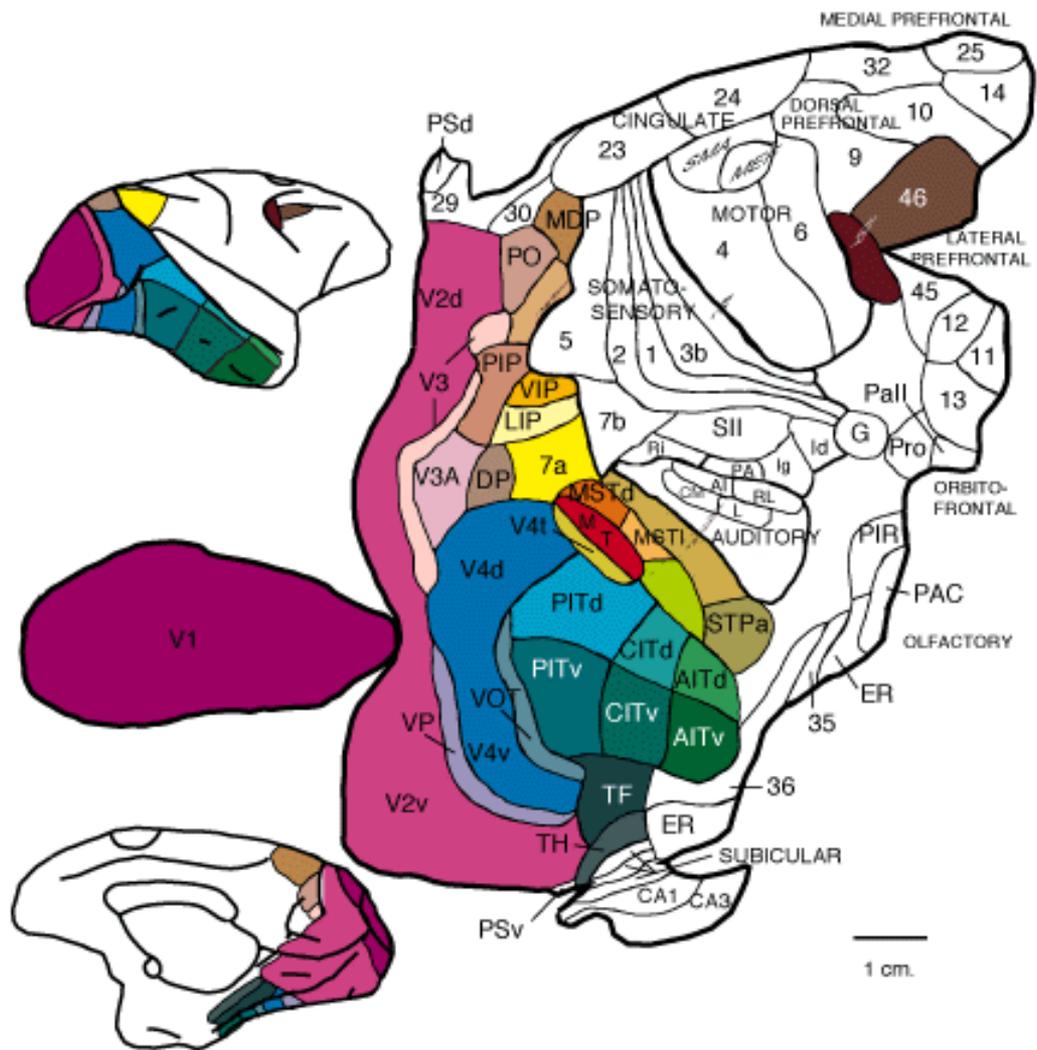


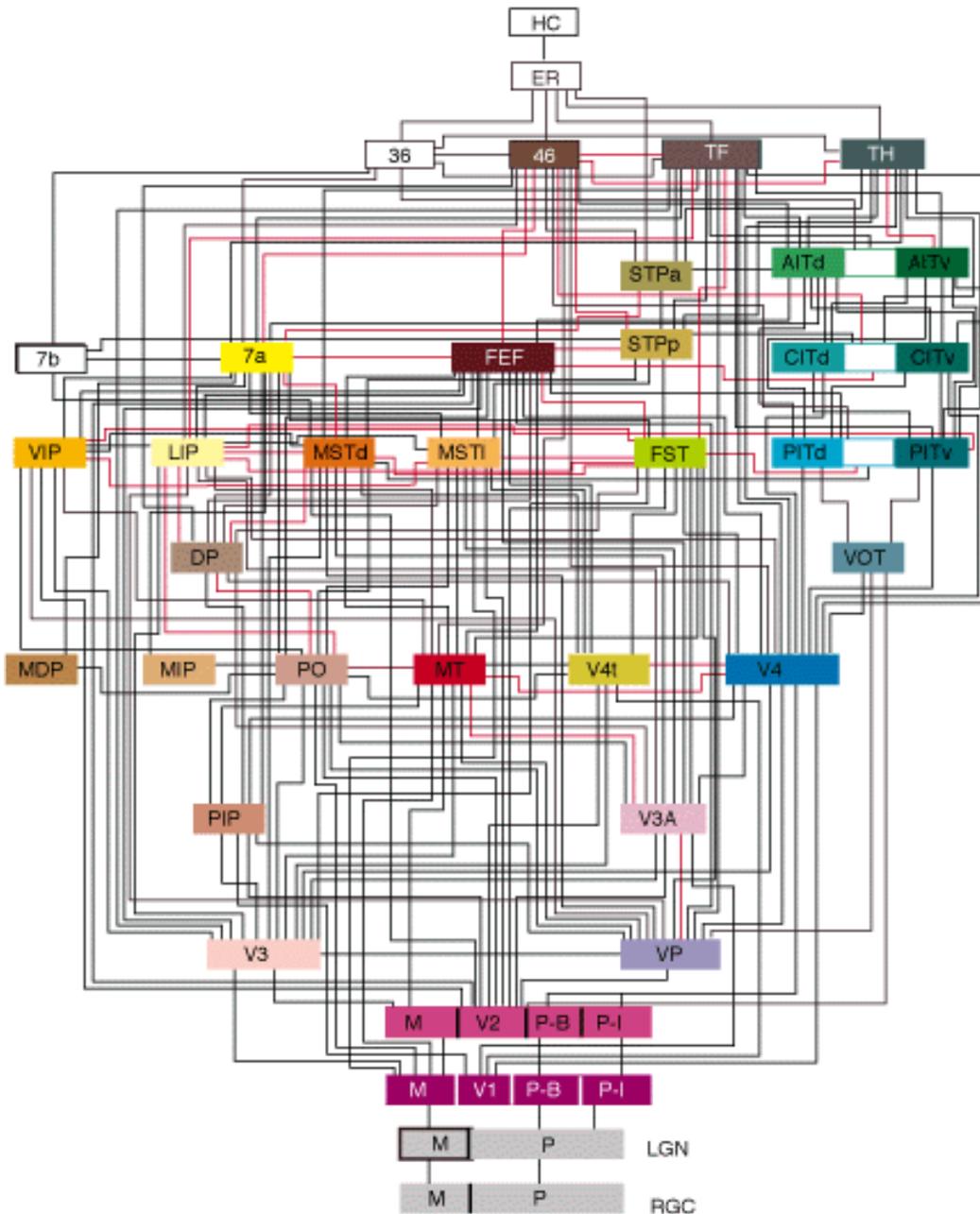


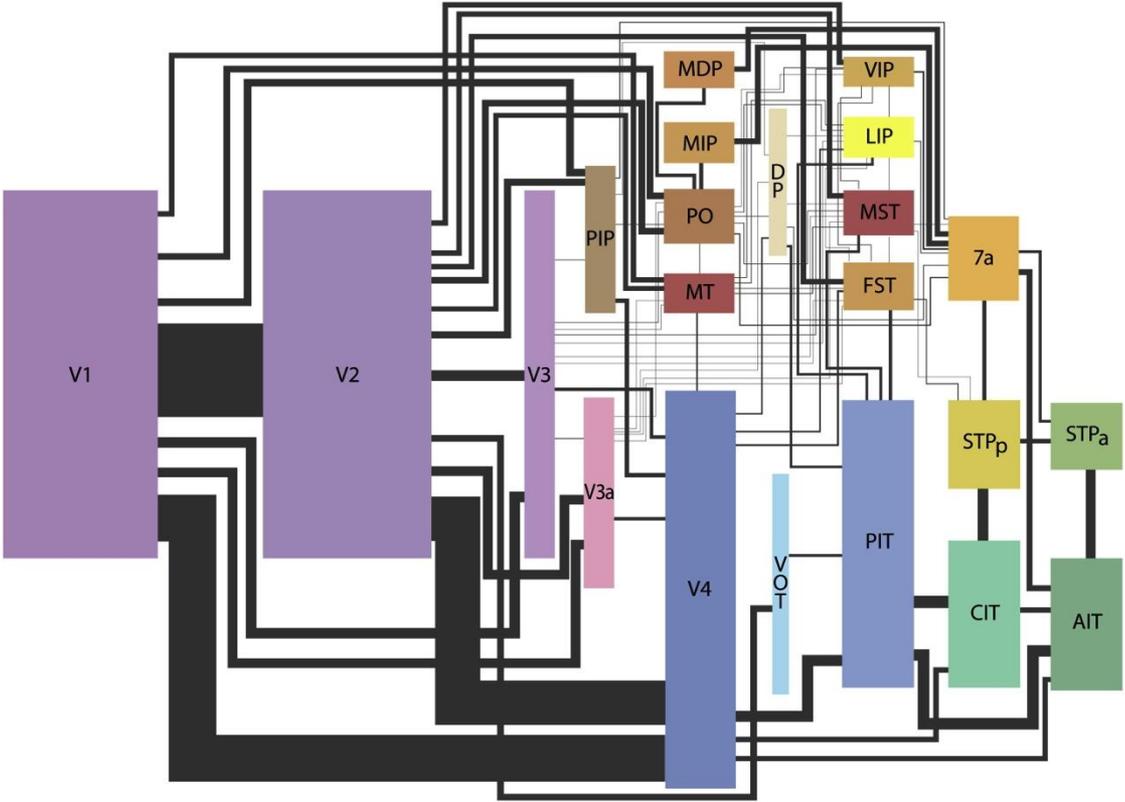
**ocular
dominance
stripes**

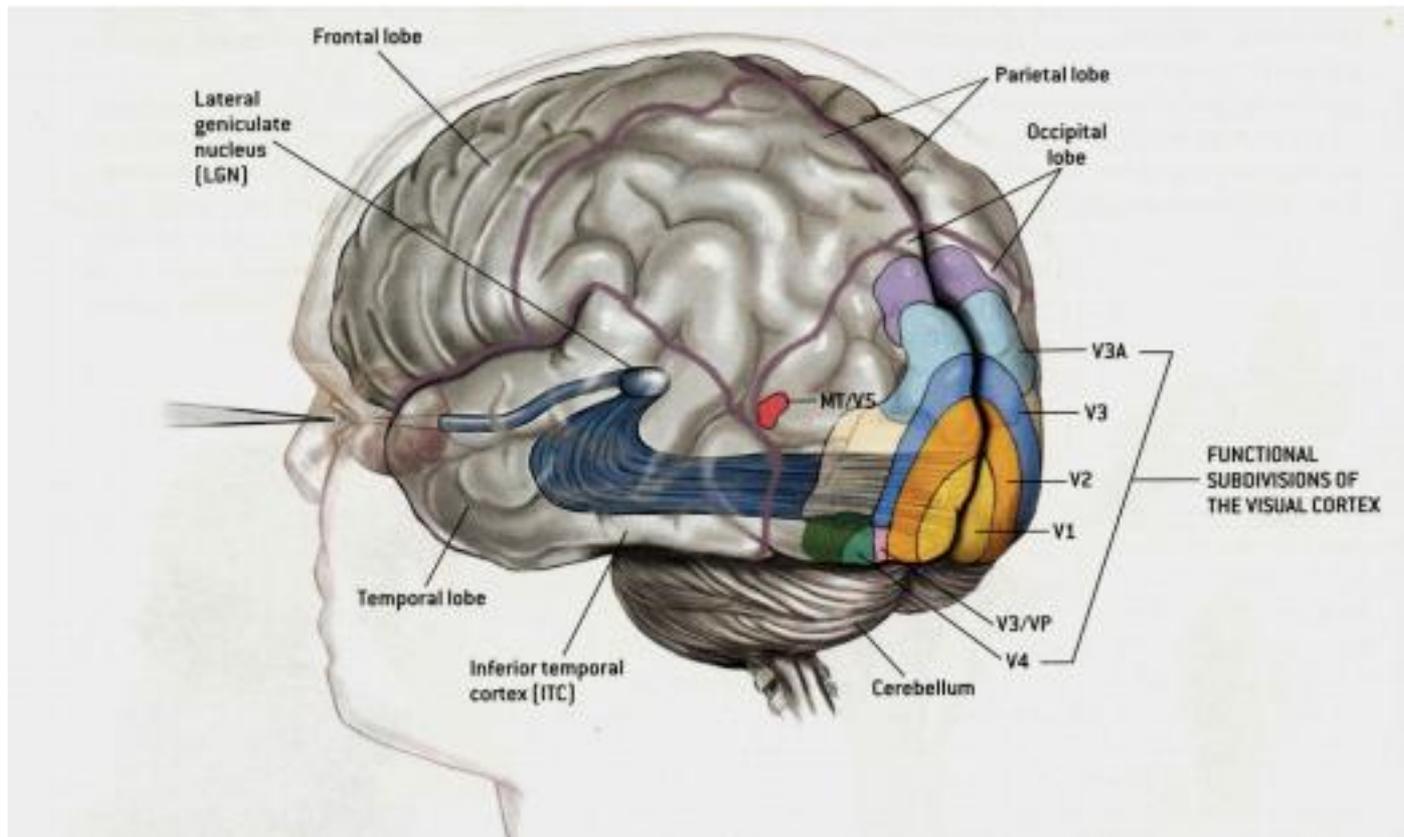




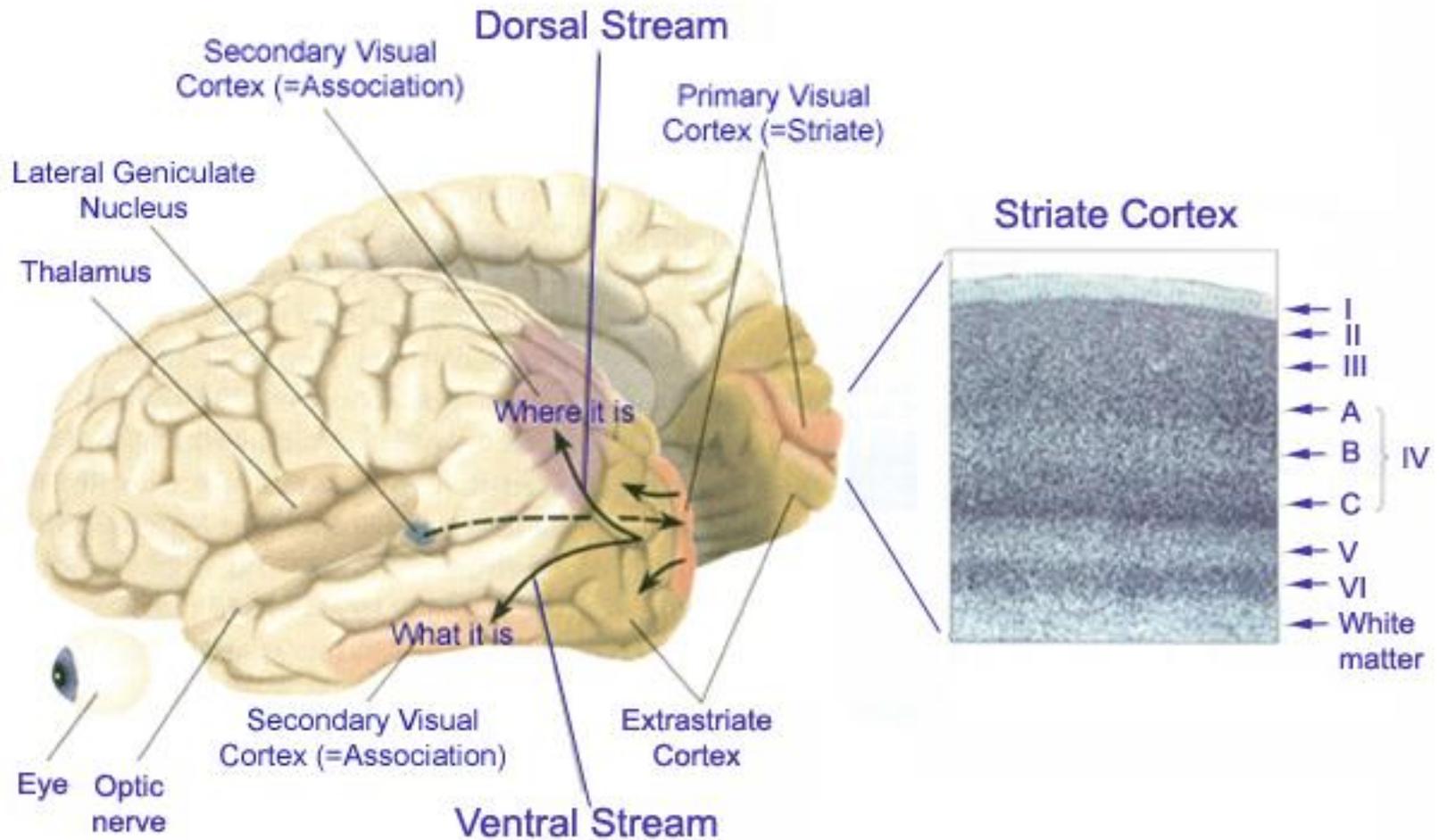




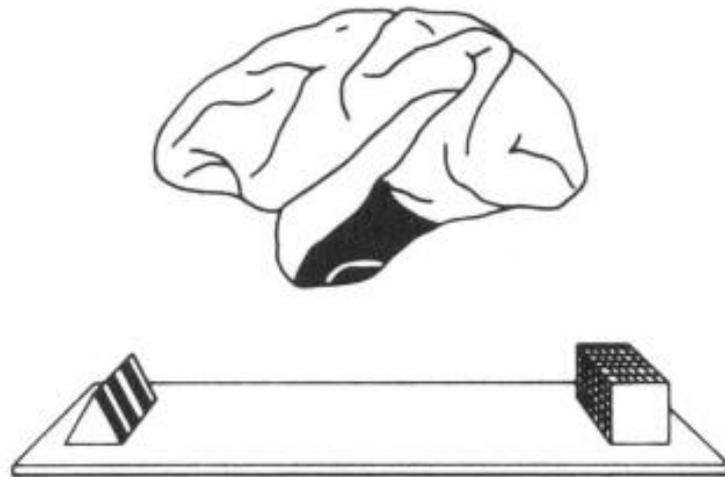
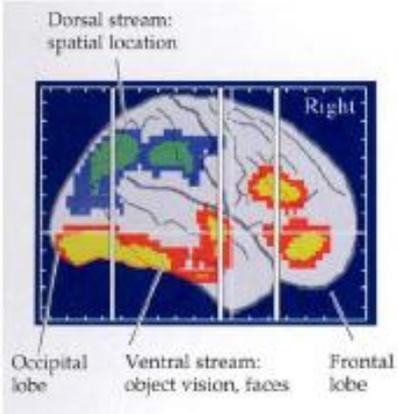




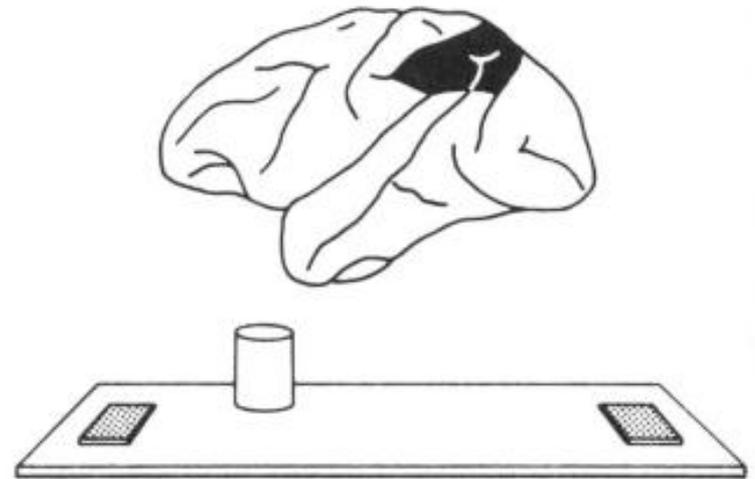
Human extrastriate cortex



What and Where



Object Discrimination

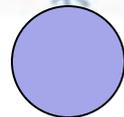
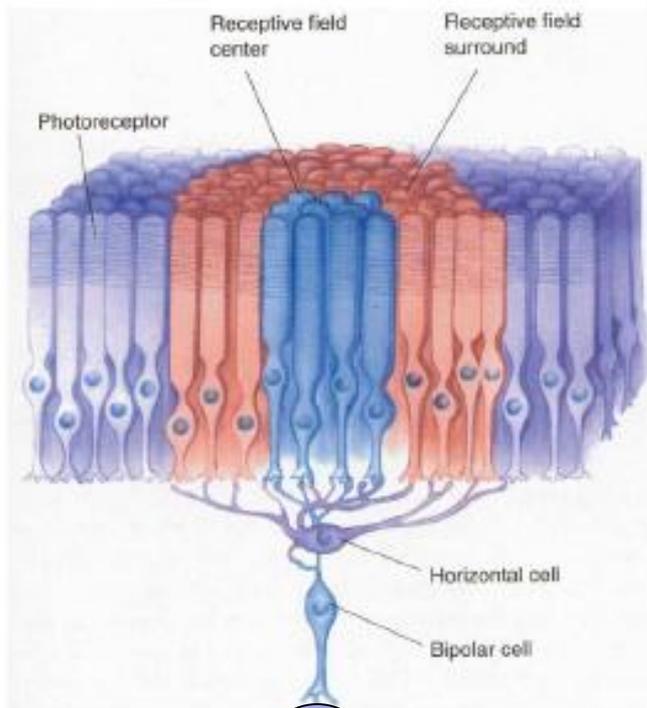


Landmark Discrimination

A very important concept: The receptive field (RF)

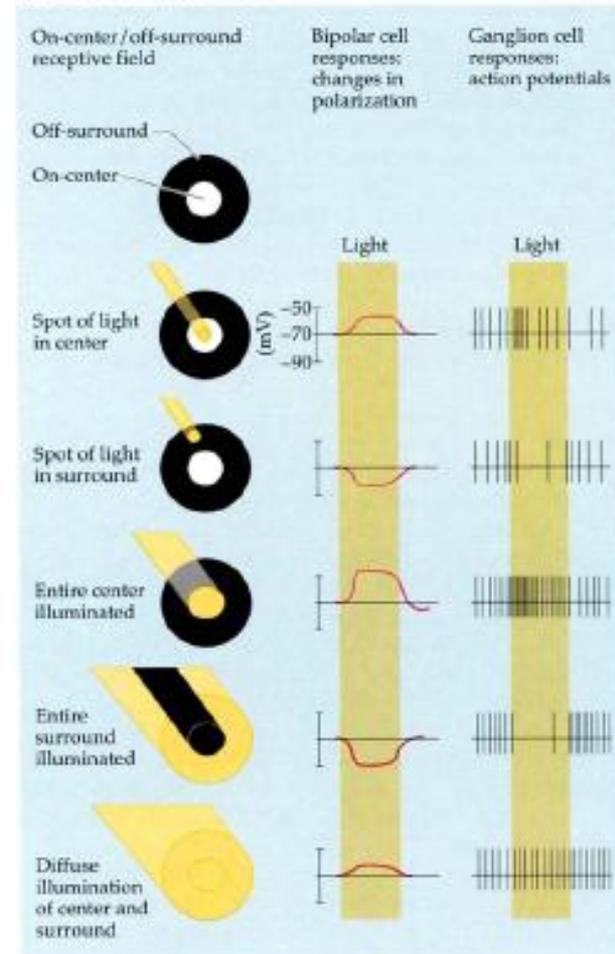
The RF of a cell is the region of visual space in which light can affect (increase or decrease) the cell's firing frequency.

The Receptive Field



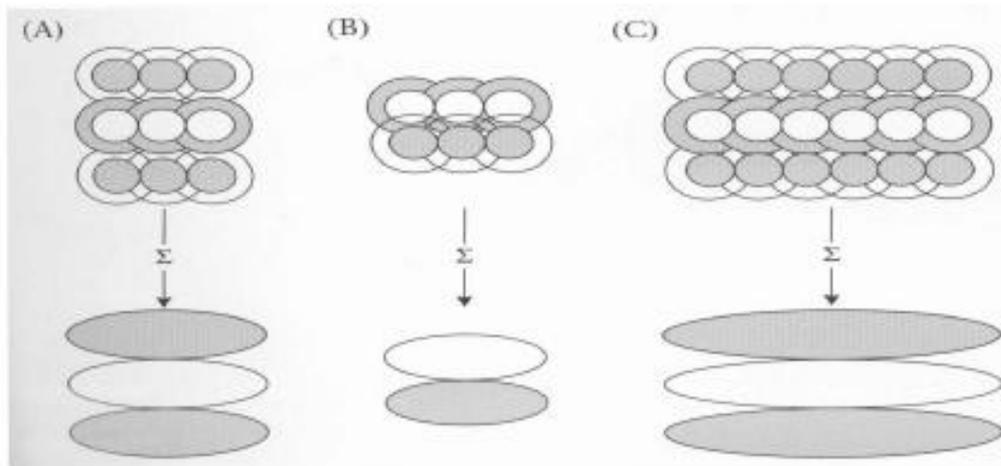
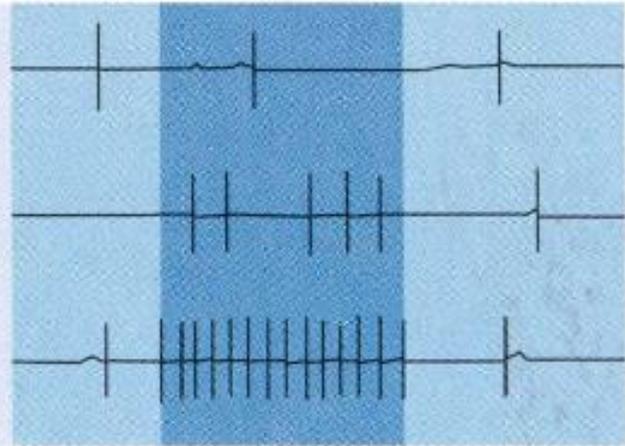
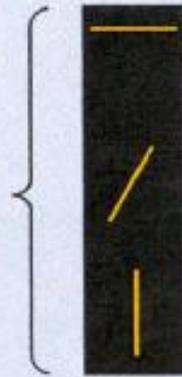
Ganglion cell

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

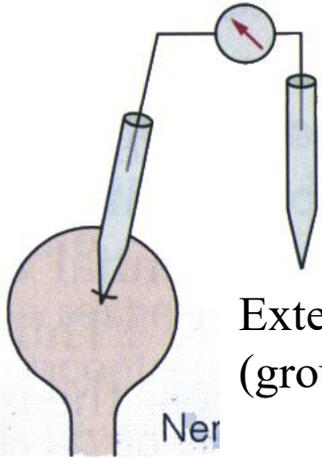


Cortical receptive fields

(b) Orientation-sensitive cortical cell. This cell responds strongly only when the stimulus is a vertical stripe.

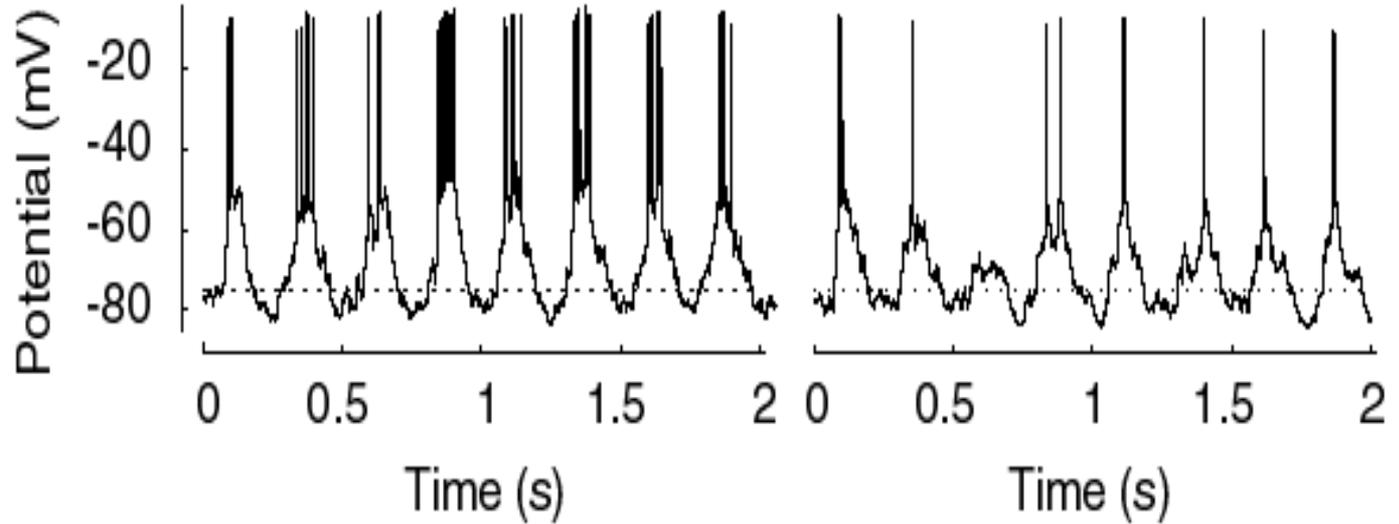


Voltage amplifier
and oscilloscope



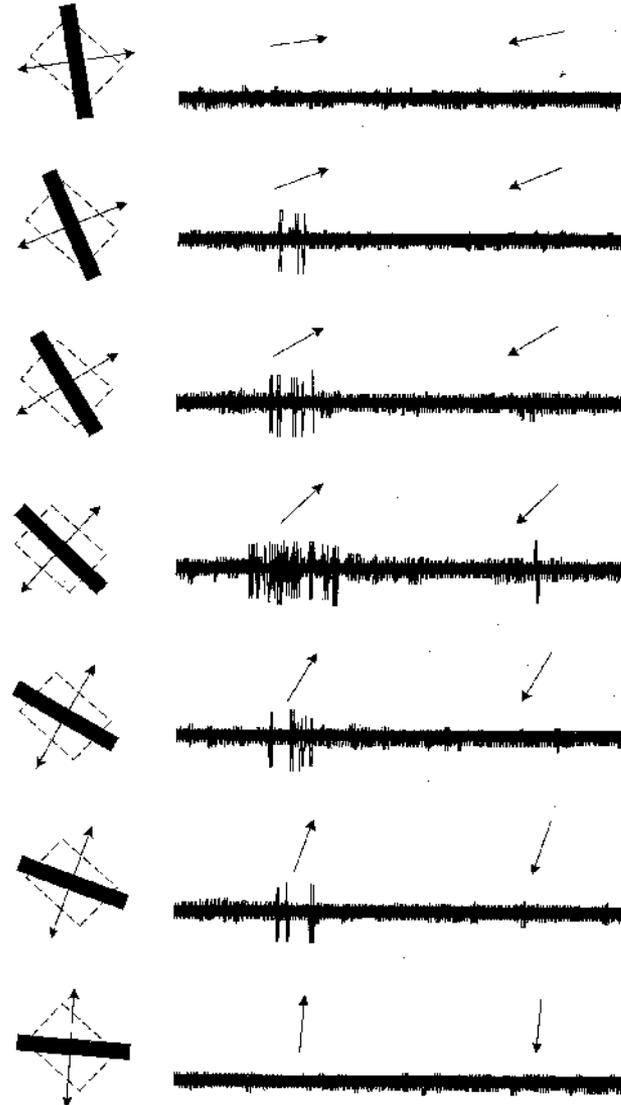
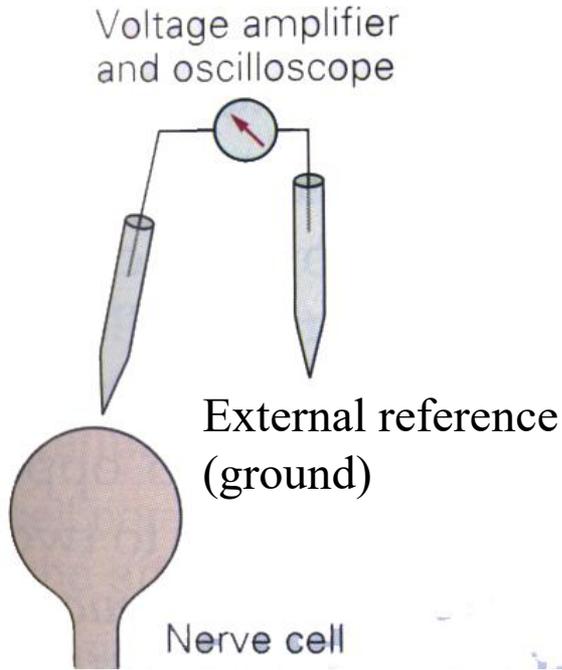
External reference
(ground)

Intracellular recordings



Extracellular recordings

Selectivity for stimulus orientation and direction in area V1:



Hubel and Wiesel (1968)
in Wandell (1995)