

Institute of Neuroinformatics  
ETH/UNI Zurich

# Computation in Neural Systems: Biological and Computational Vision

Lecture 1

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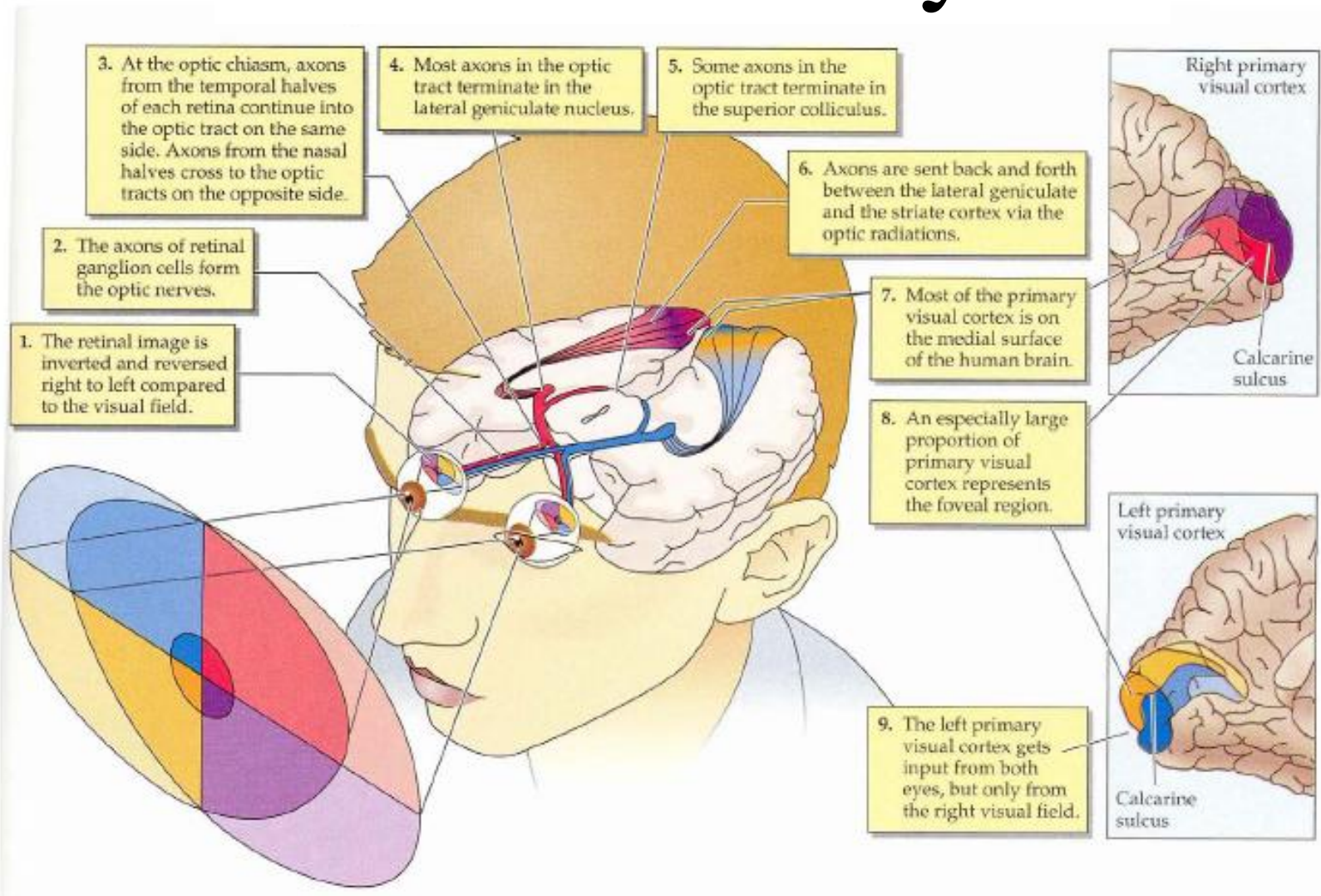
Feb. 22, 2024

[www.ini.uzh.ch/~kiper/comp\\_vis/index.html](http://www.ini.uzh.ch/~kiper/comp_vis/index.html)

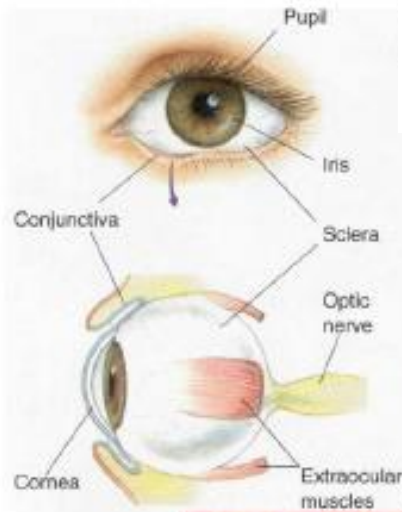
# The visual pathways



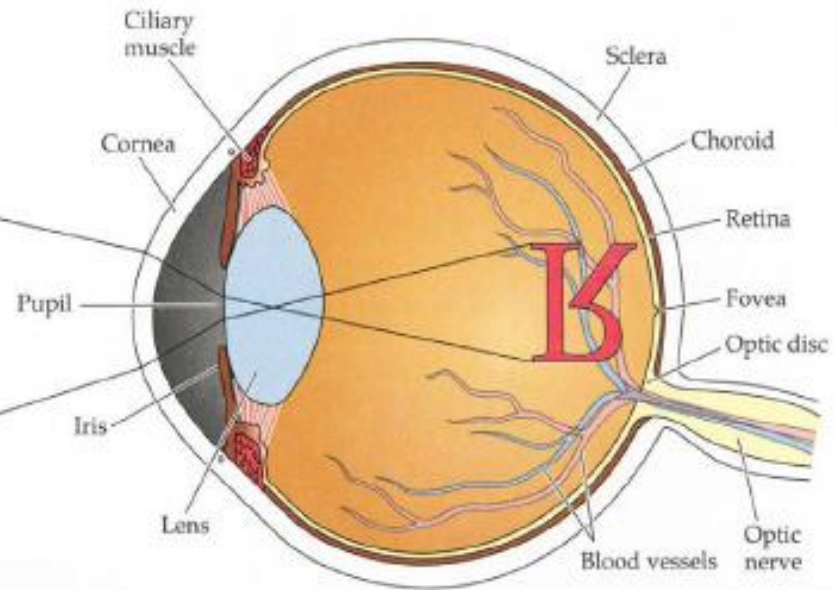
# Visual Pathways



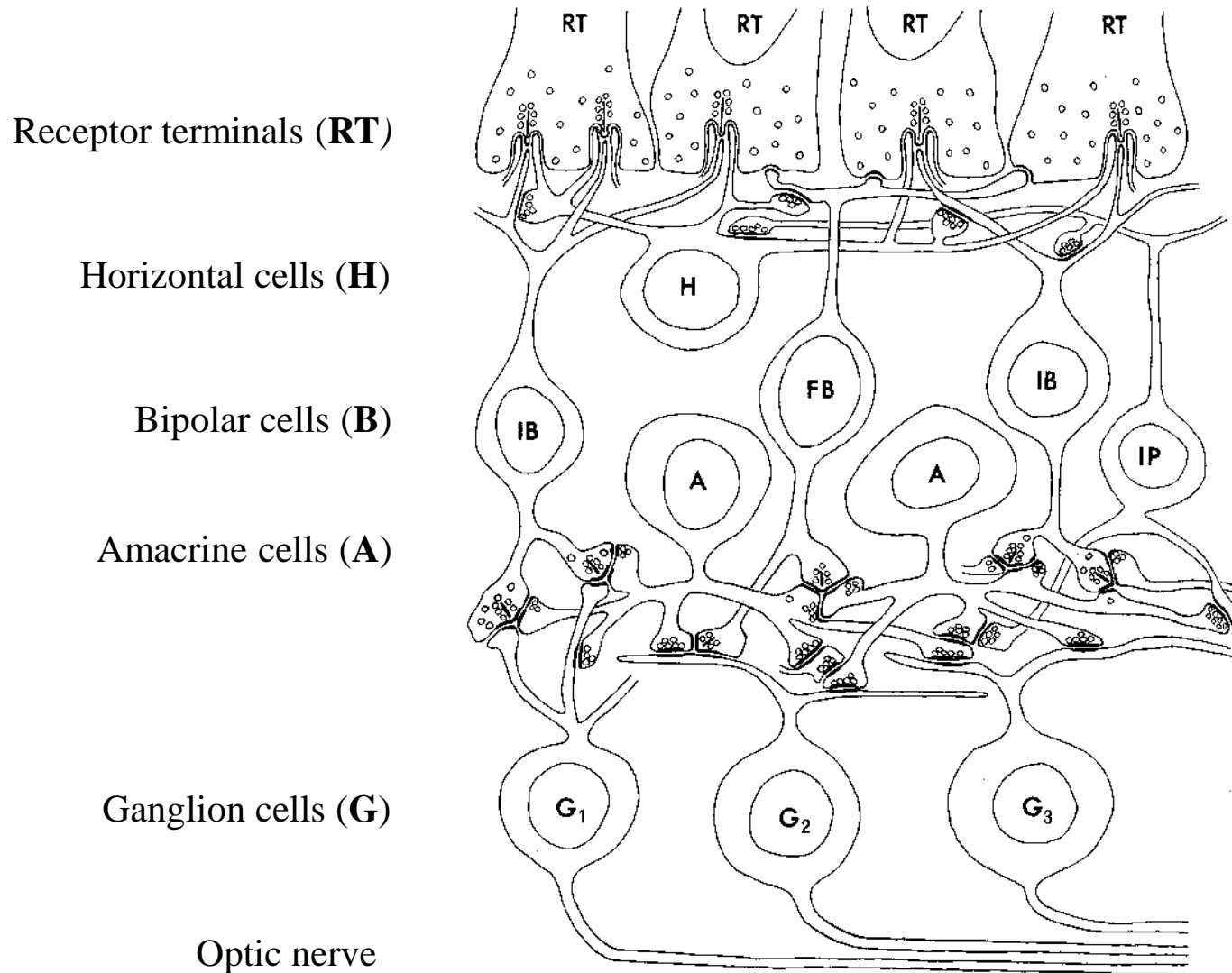
# Anatomy of the eye



**R**

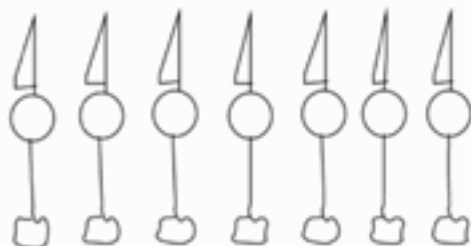


# Basic retinal circuitry

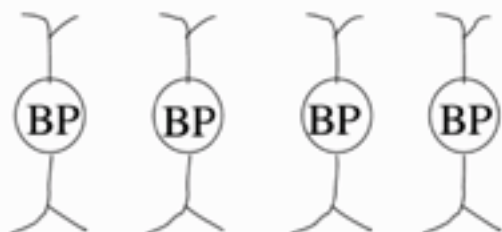


spot of light

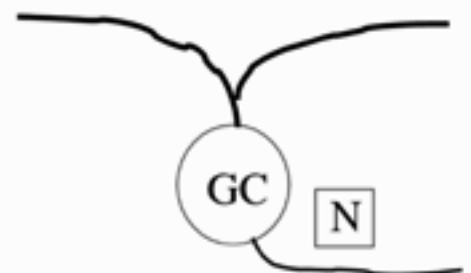
N N N N N N N



N N N N



N N N N



Photon Noise

Transduction Noise

Channel Noise

Synaptic Noise

(from Berntson & Taylor, 2003)

Channel Noise

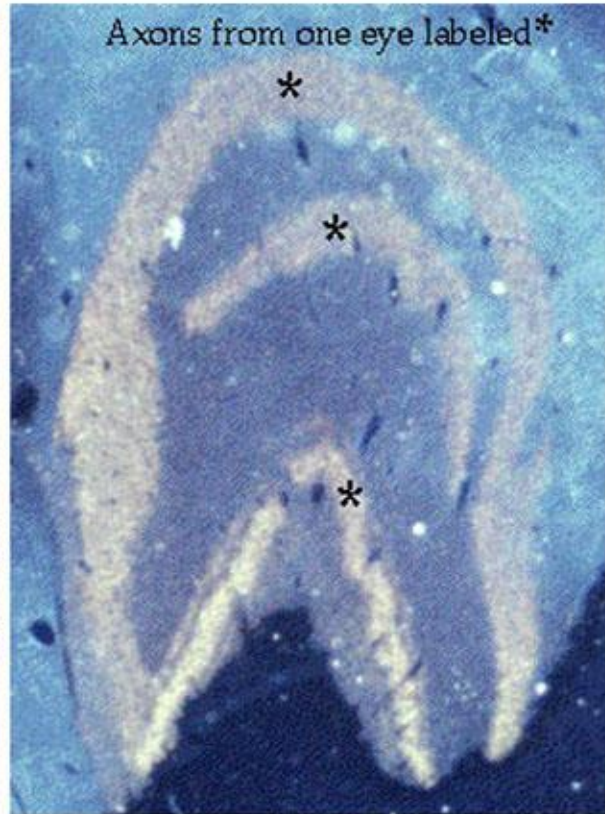
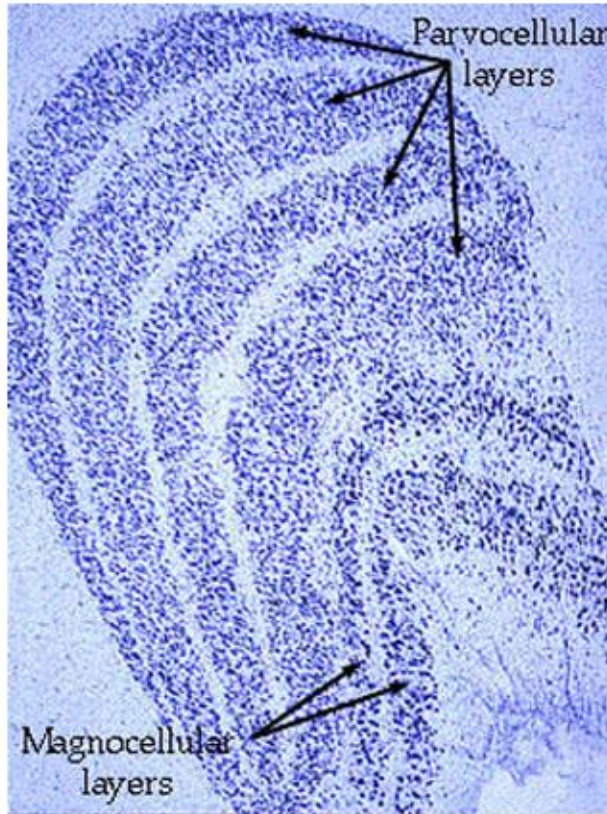
Synaptic Noise

Dendritic Morphology

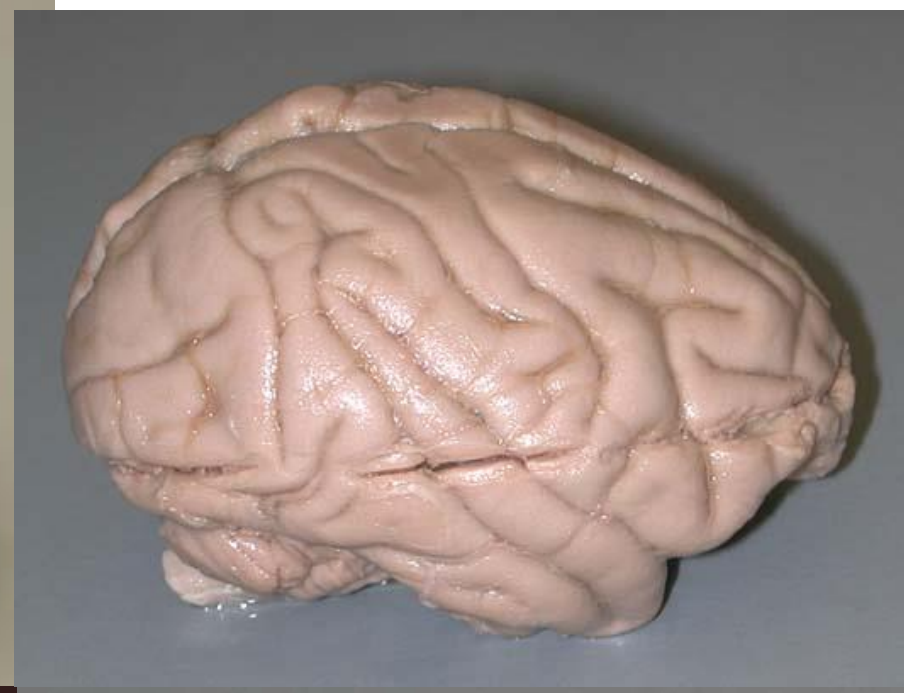
(from van Rossum et al, 2003)

Spike Generator

(from Dhingra & Smith, 2004)







Visual field  
(retinal image)

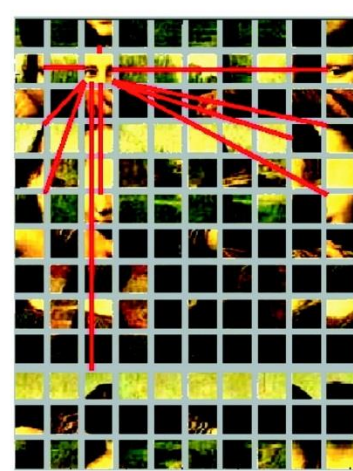


(Da Vinci,  
1506)

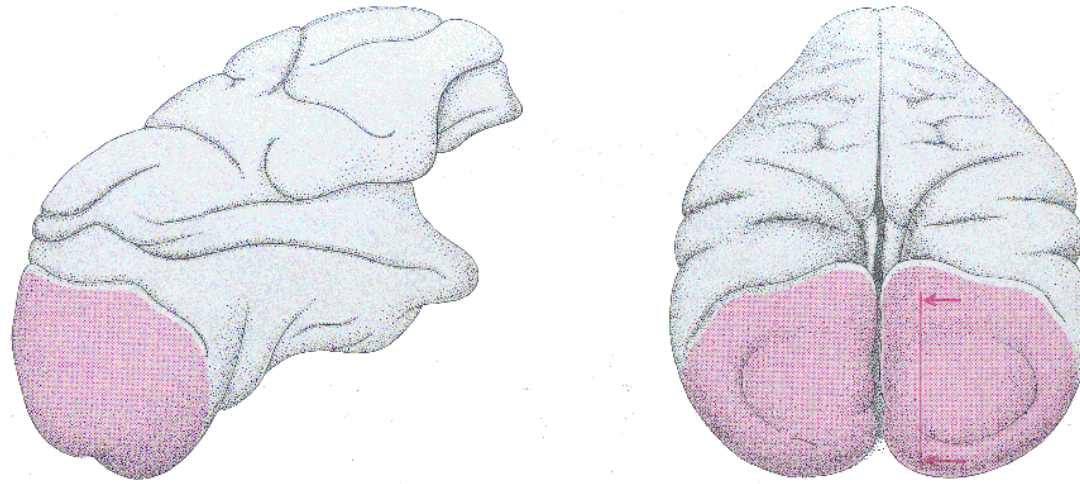
Retinotopic

Nonretinotopic

Visual cortex



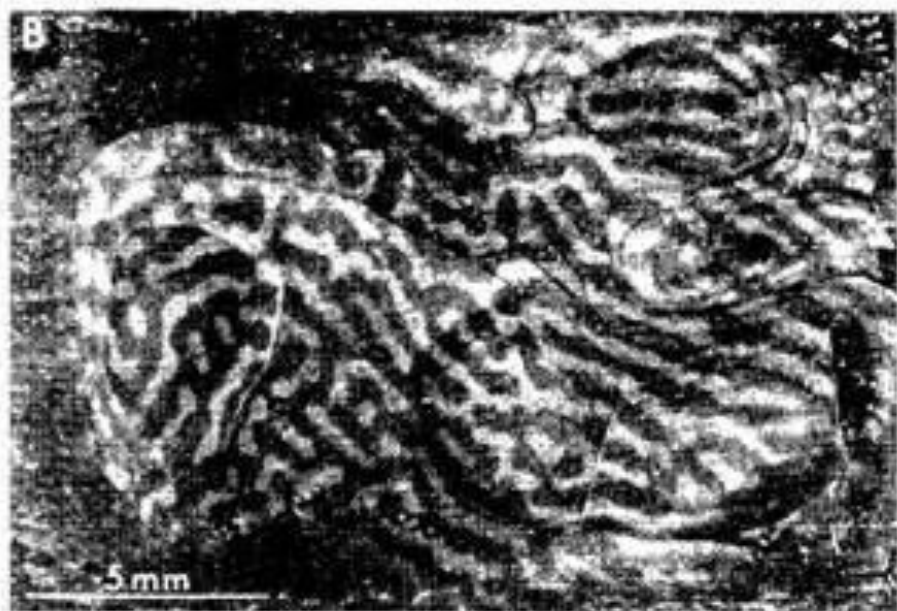




The striate cortex (V1)

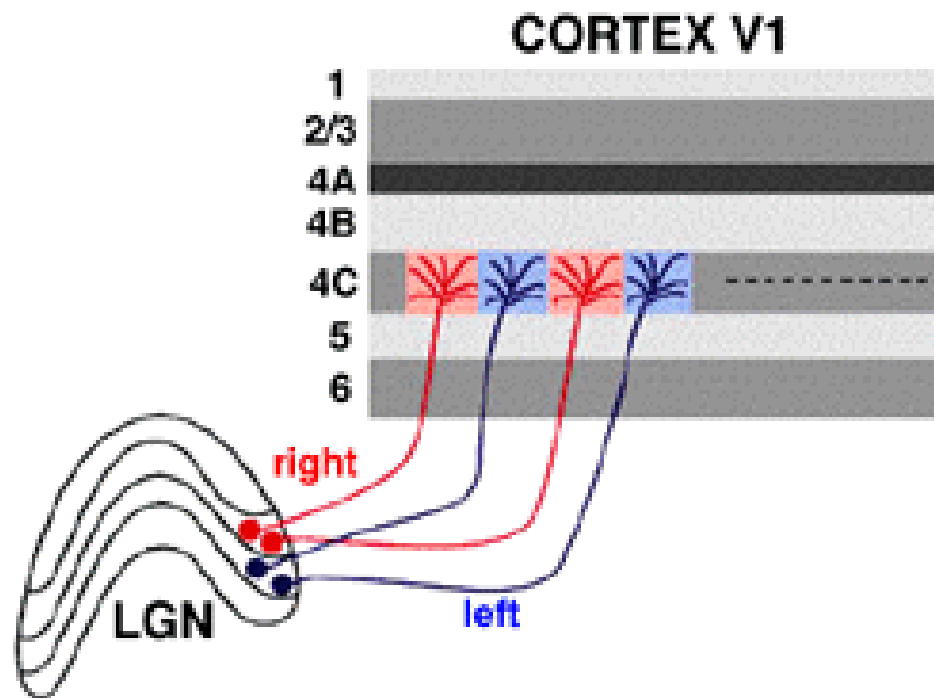




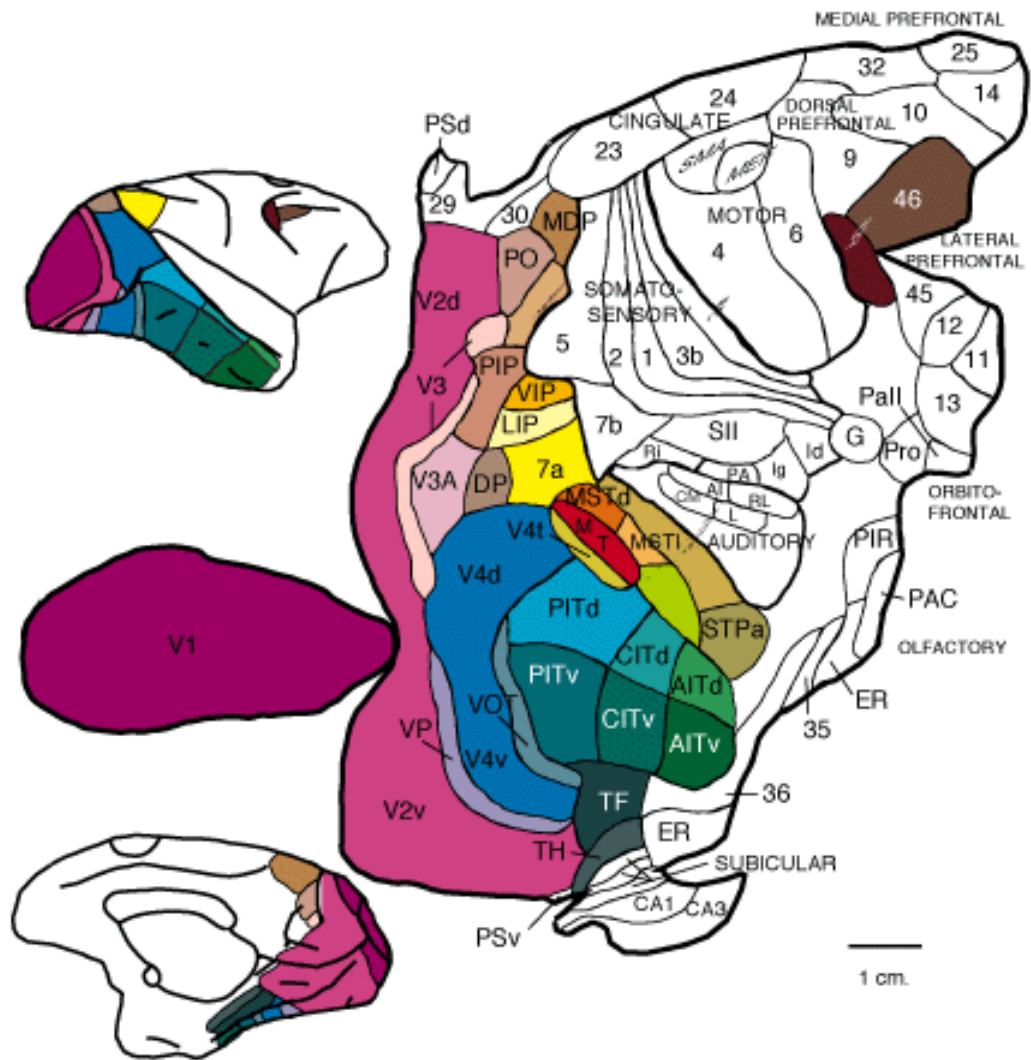


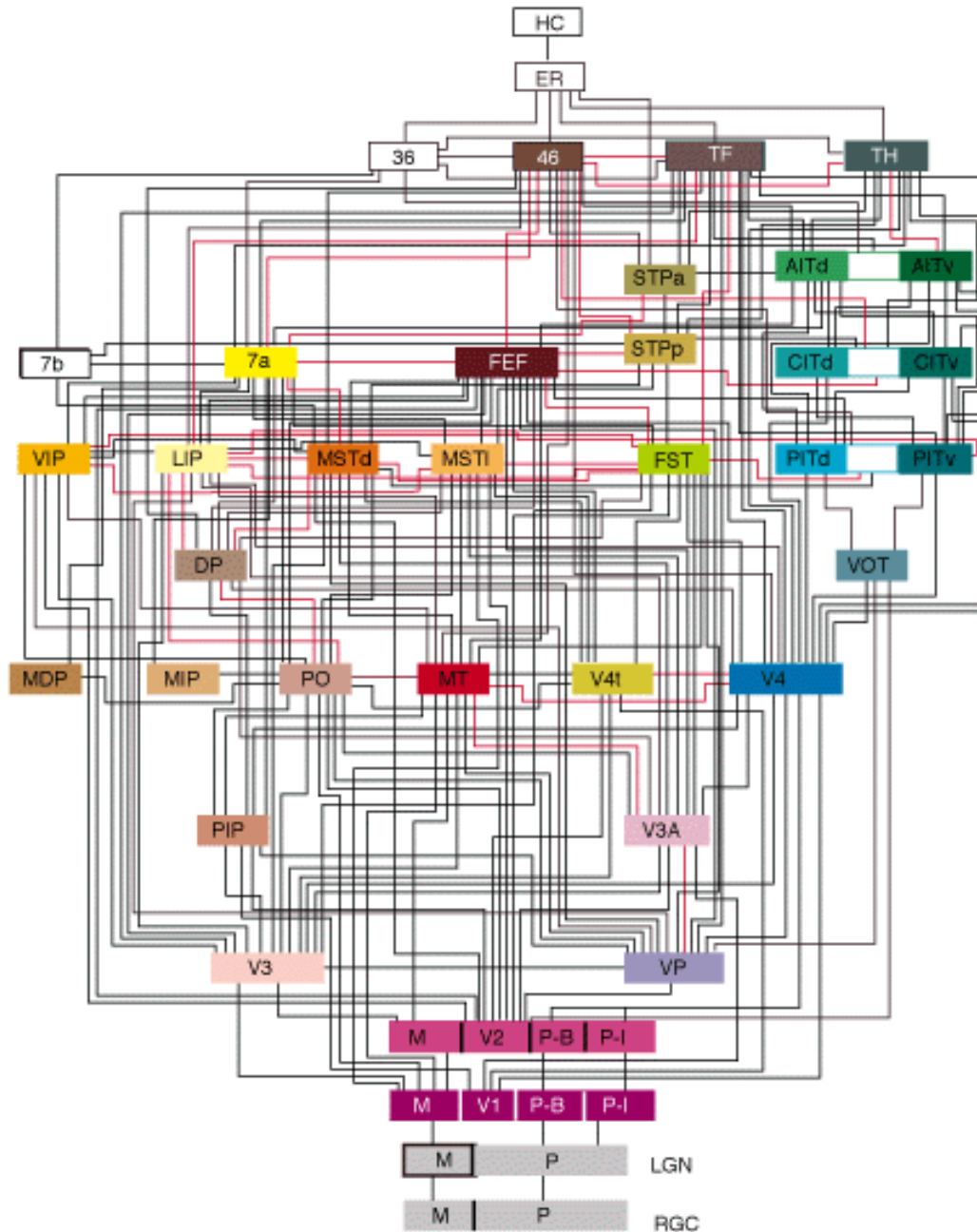
ocular  
dominance  
stripes

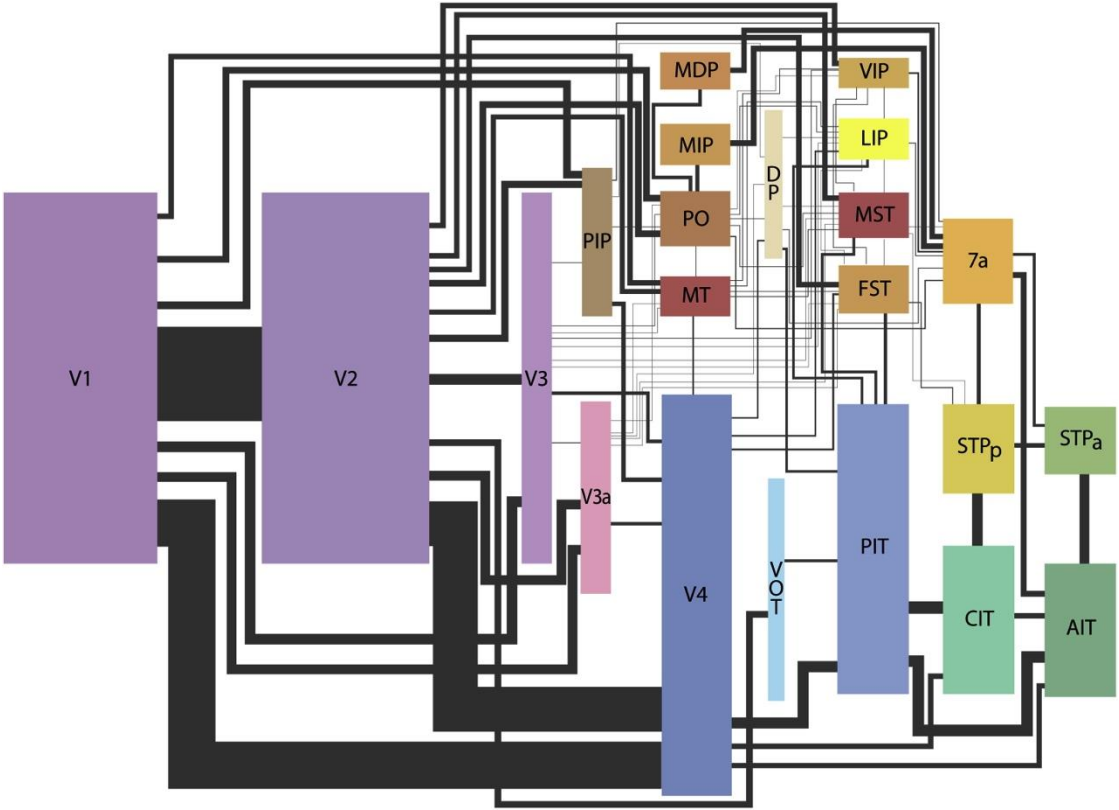


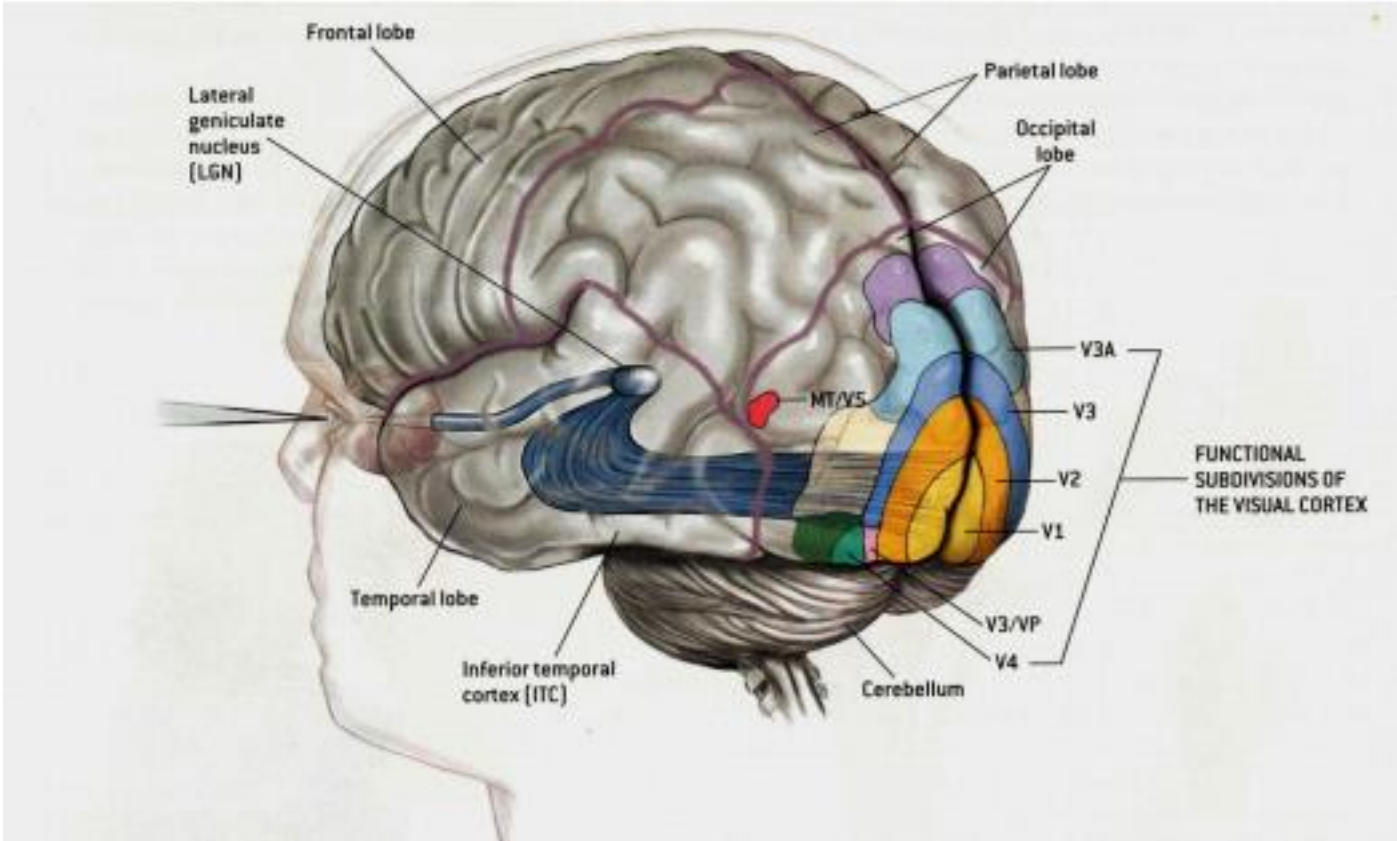




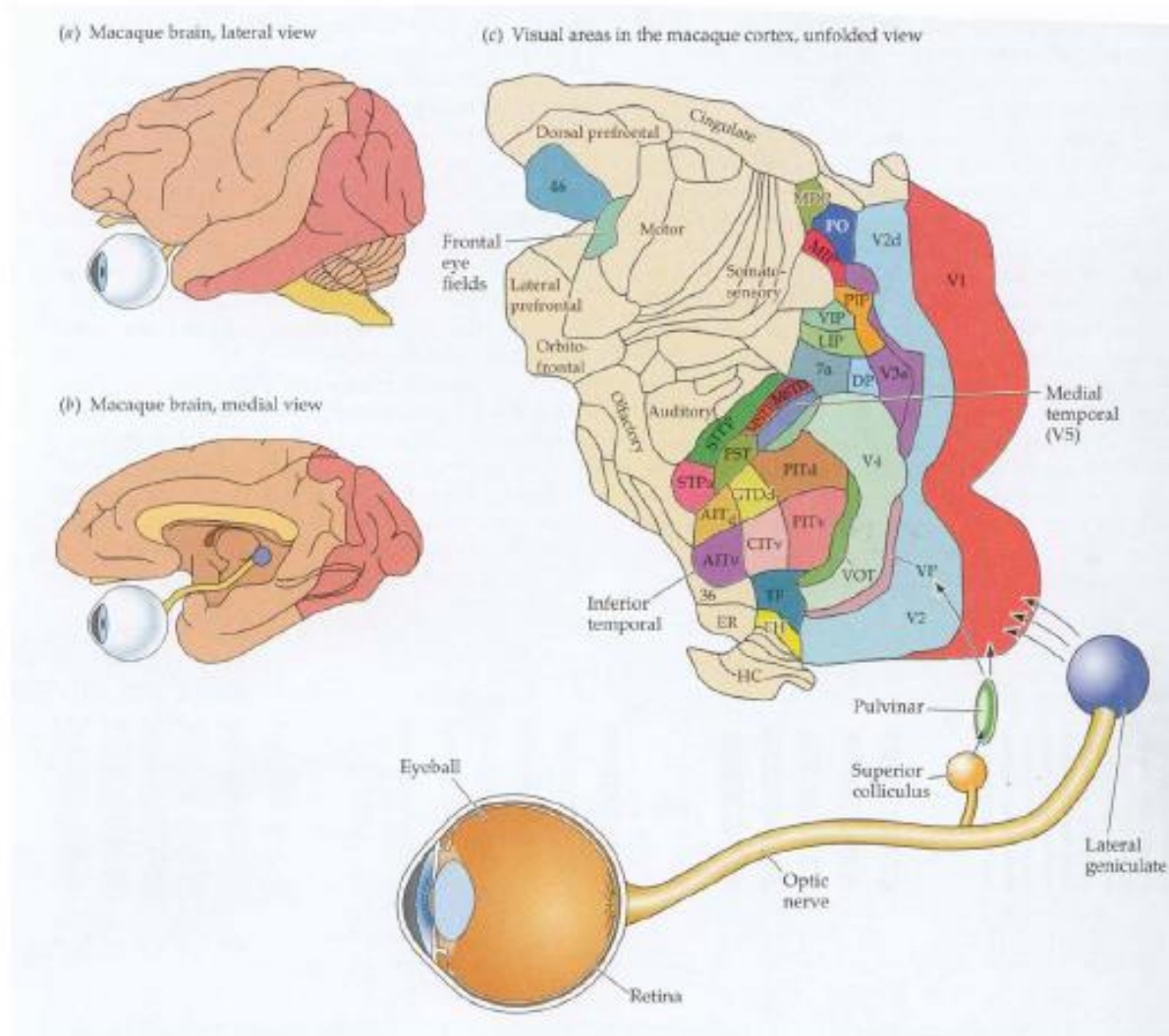




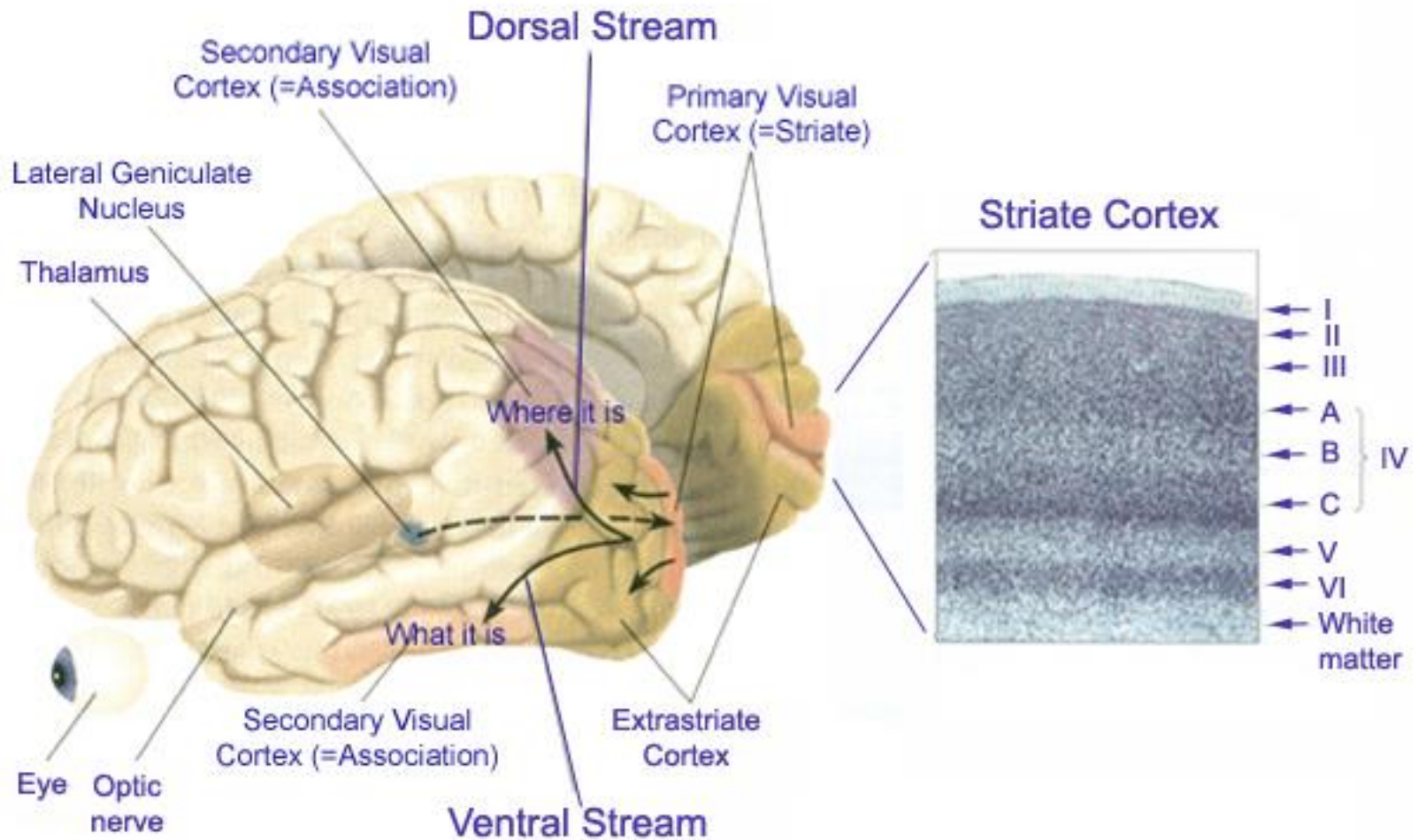




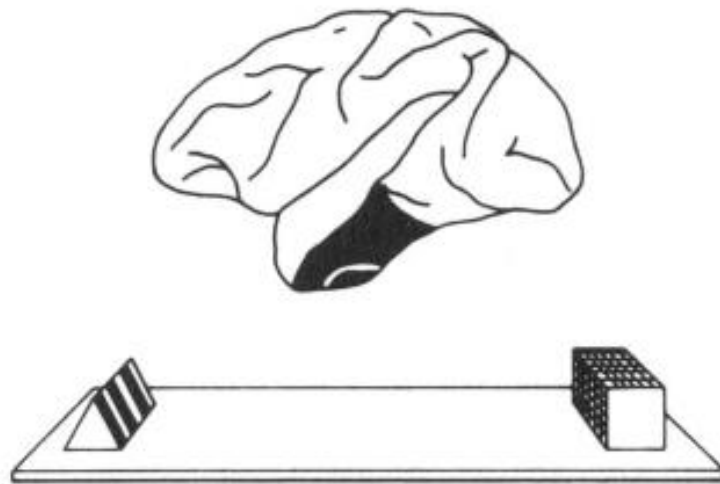
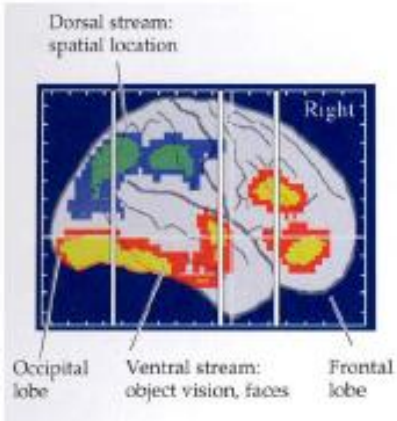
# Extrastriate cortex



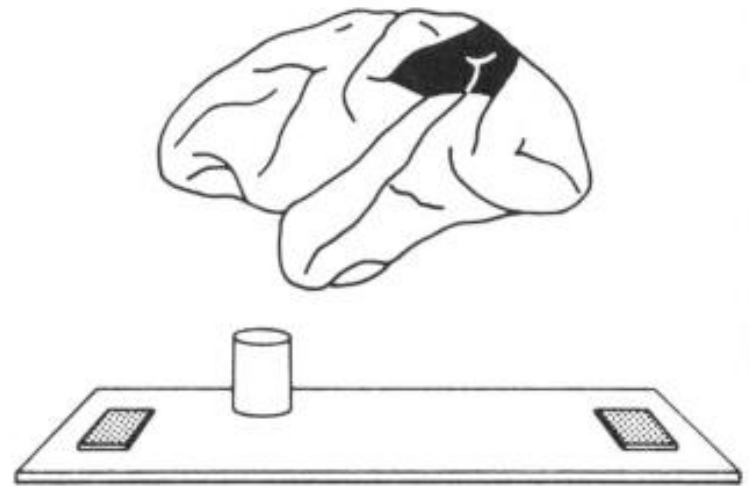
# Human extrastriate cortex



# What and Where



**Object Discrimination**



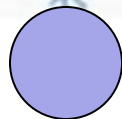
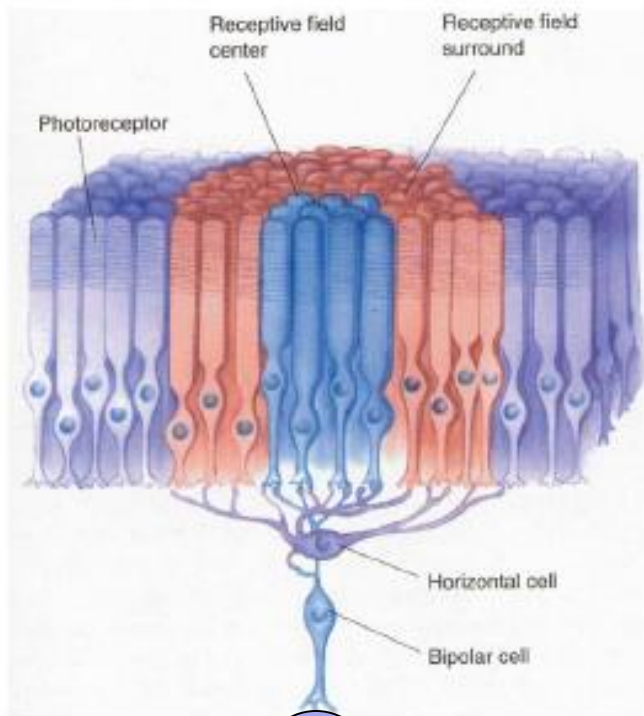
**Landmark Discrimination**

## 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.

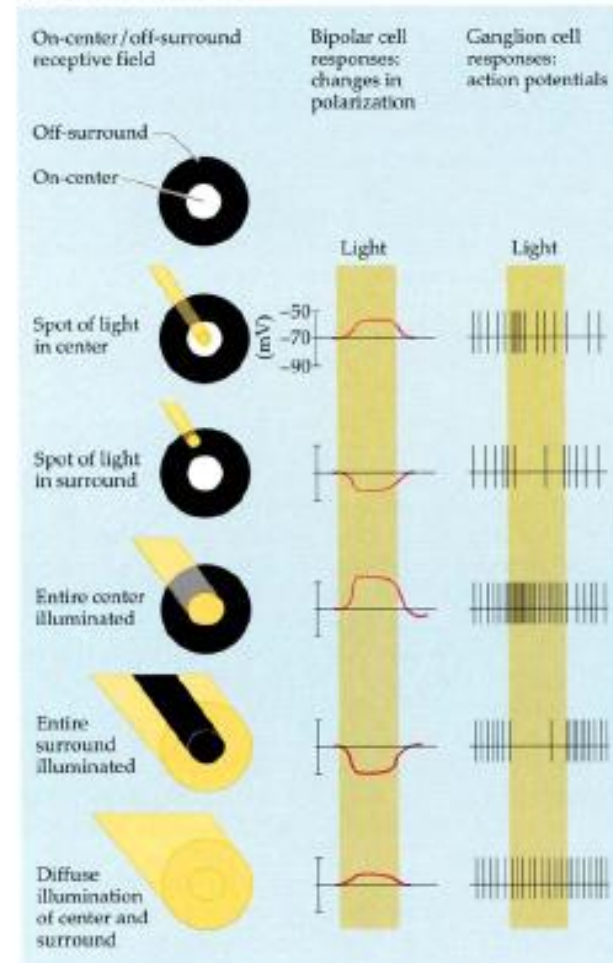


# The Receptive Field



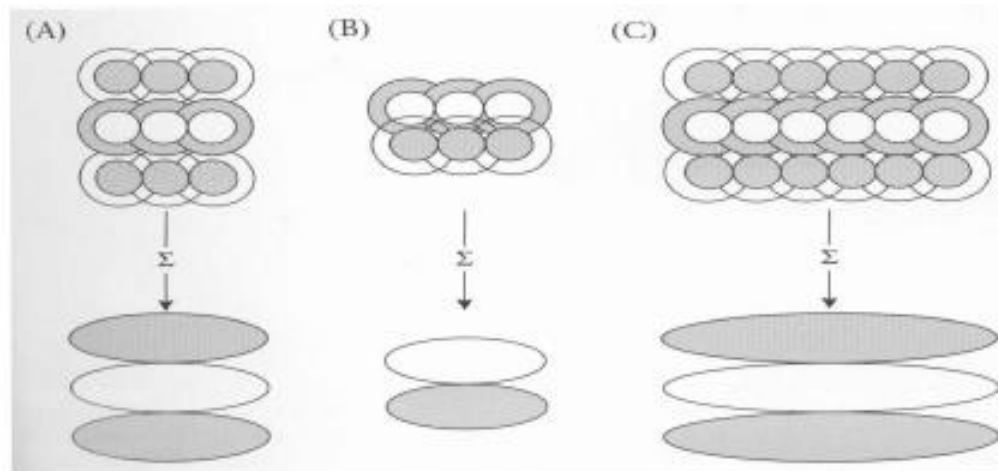
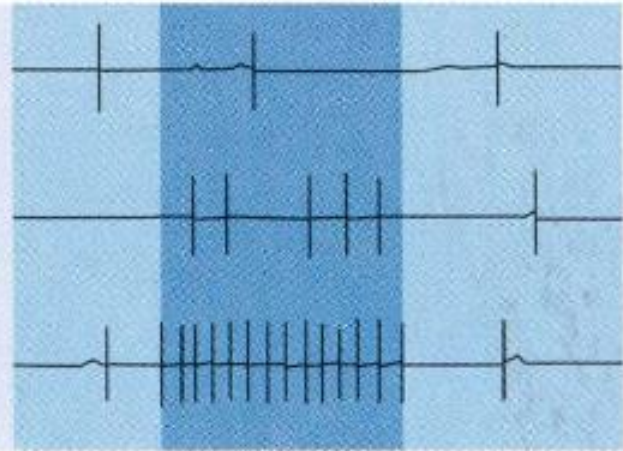
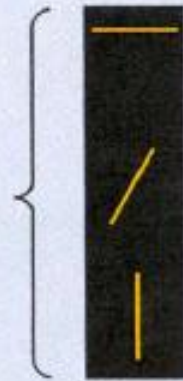
Ganglion cell

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

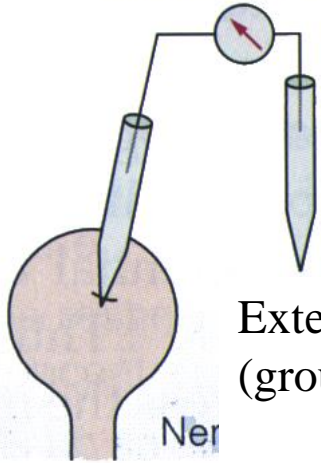


# Cortical receptive fields

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

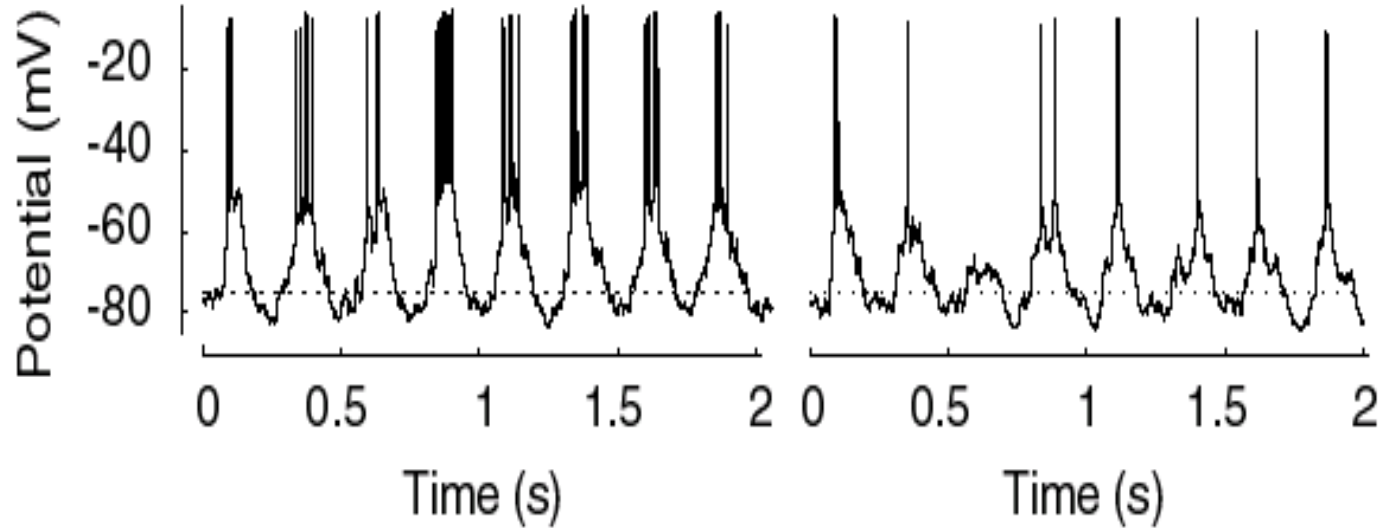


Voltage amplifier  
and oscilloscope



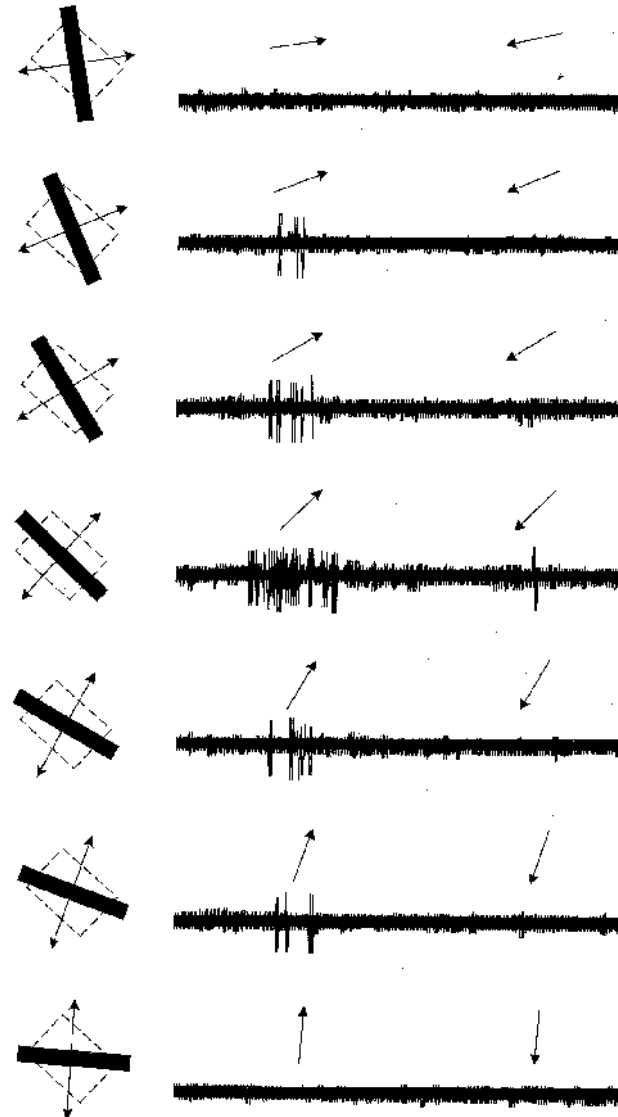
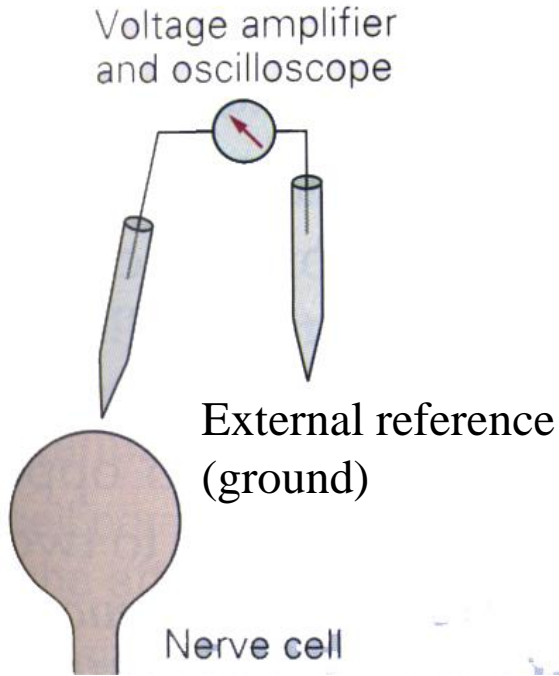
External reference  
(ground)

## Intracellular recordings



# Extracellular recordings

Selectivity for stimulus orientation and direction in area V1:



Hubel and Wiesel (1968)  
in Wandell (1995)