

Physiology of vision_2

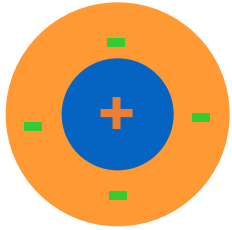
Neurophysiology

Annalisa Buffo

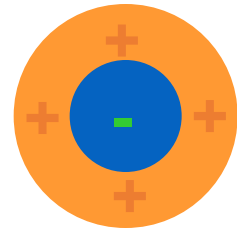
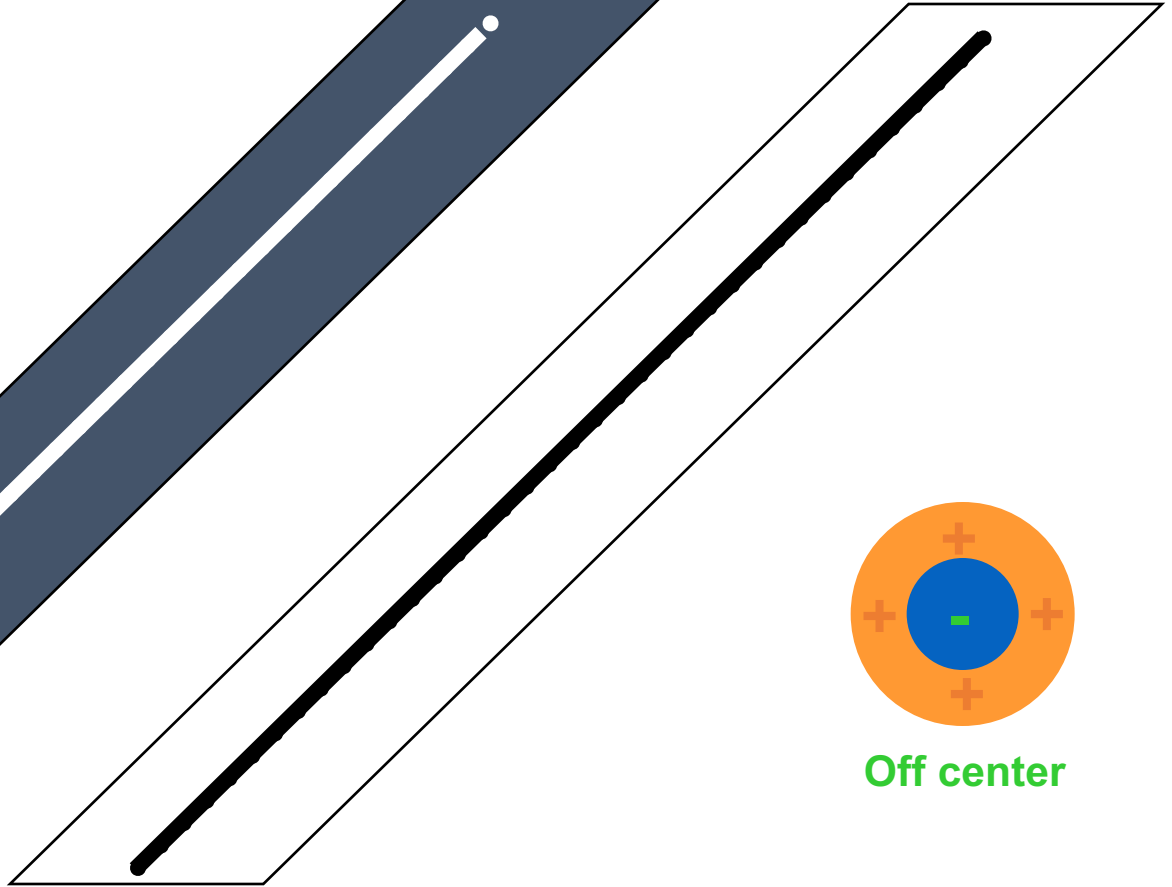
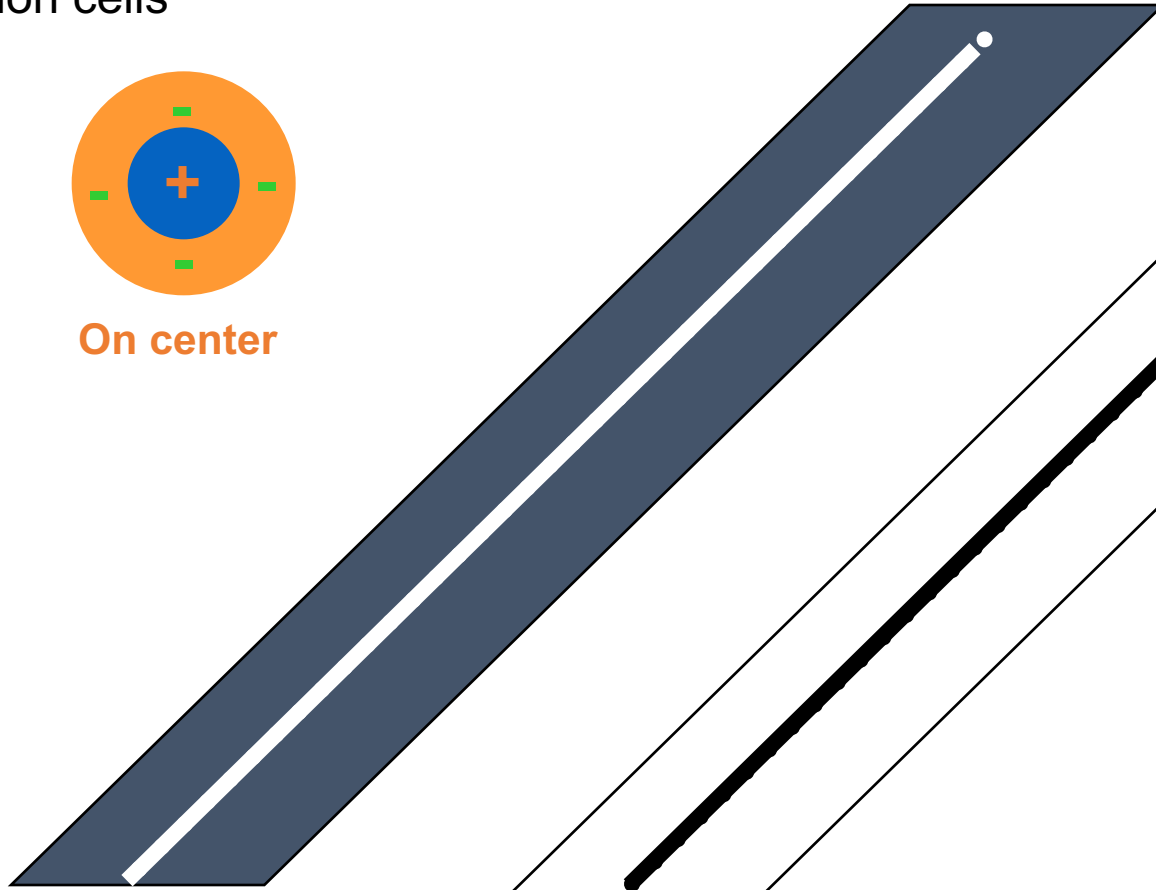
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2018/2019

Ganglion cells

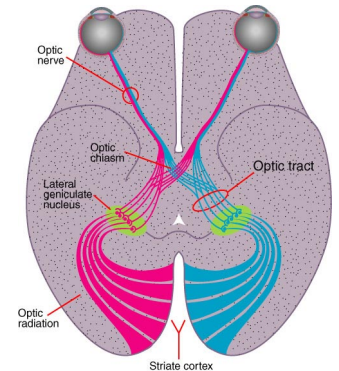
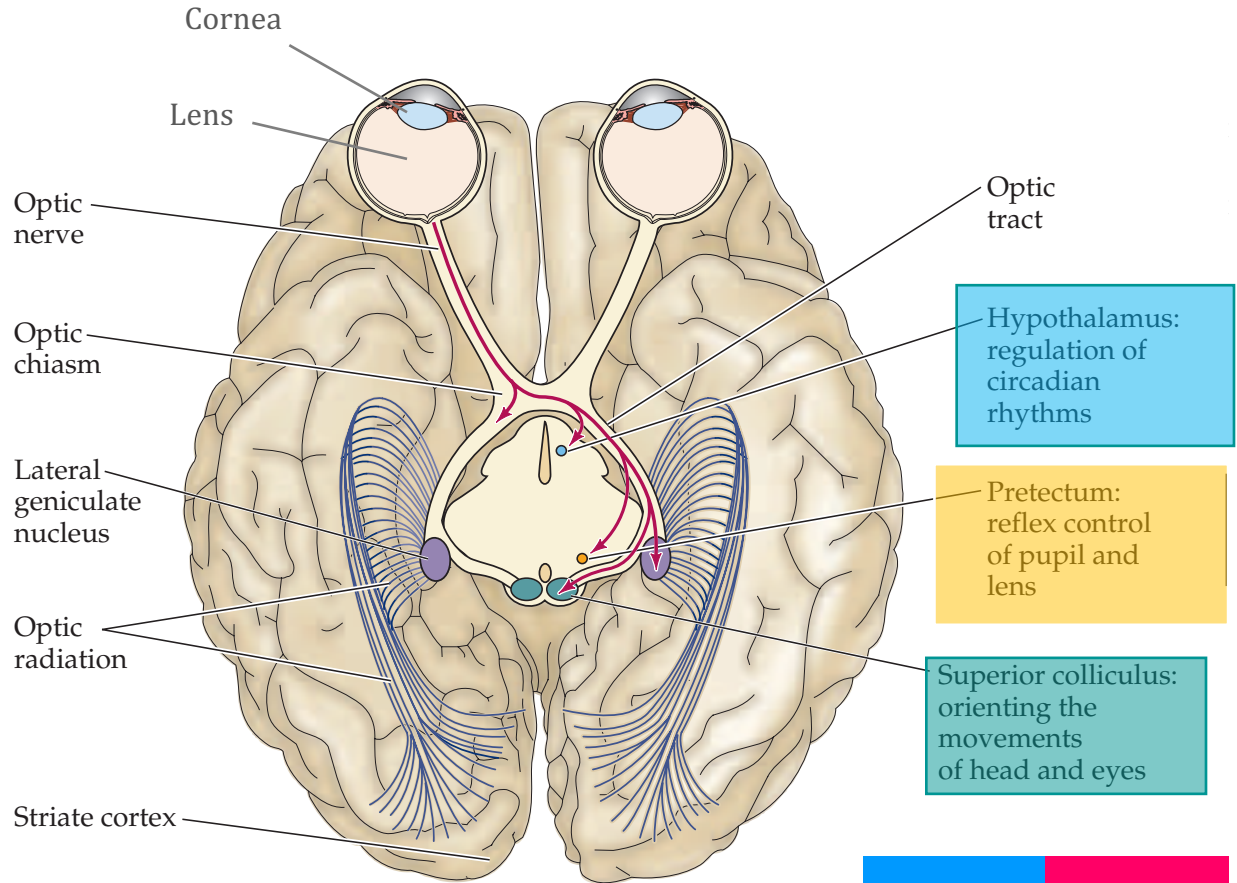


On center



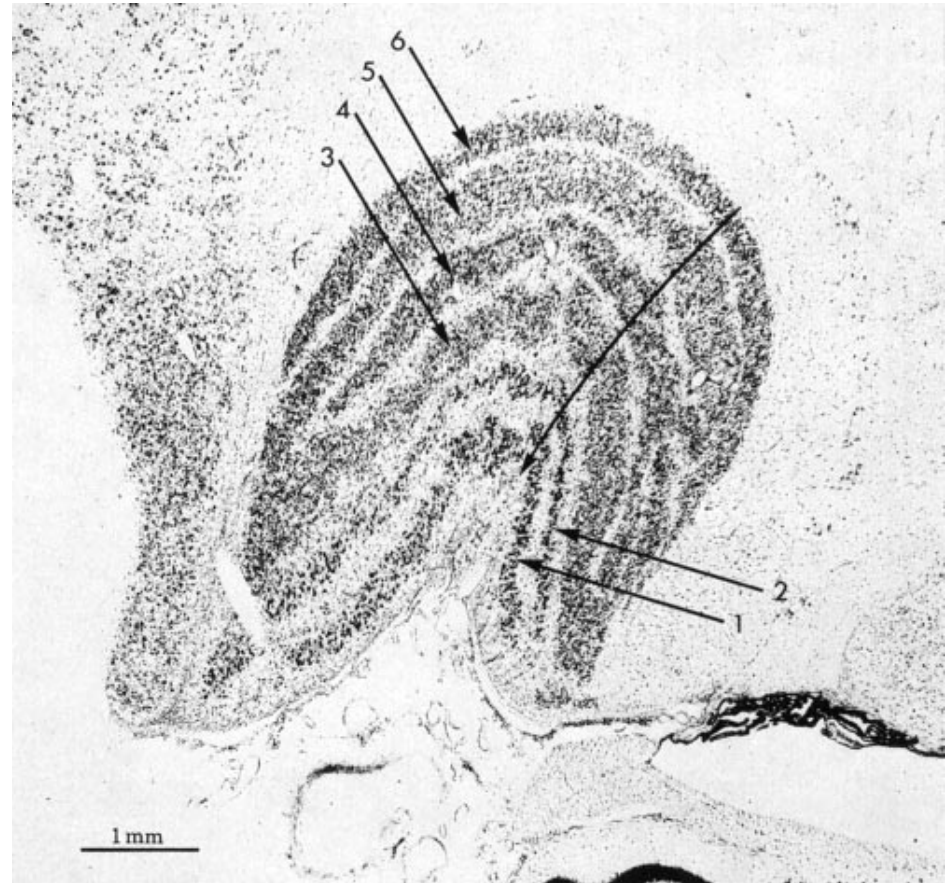
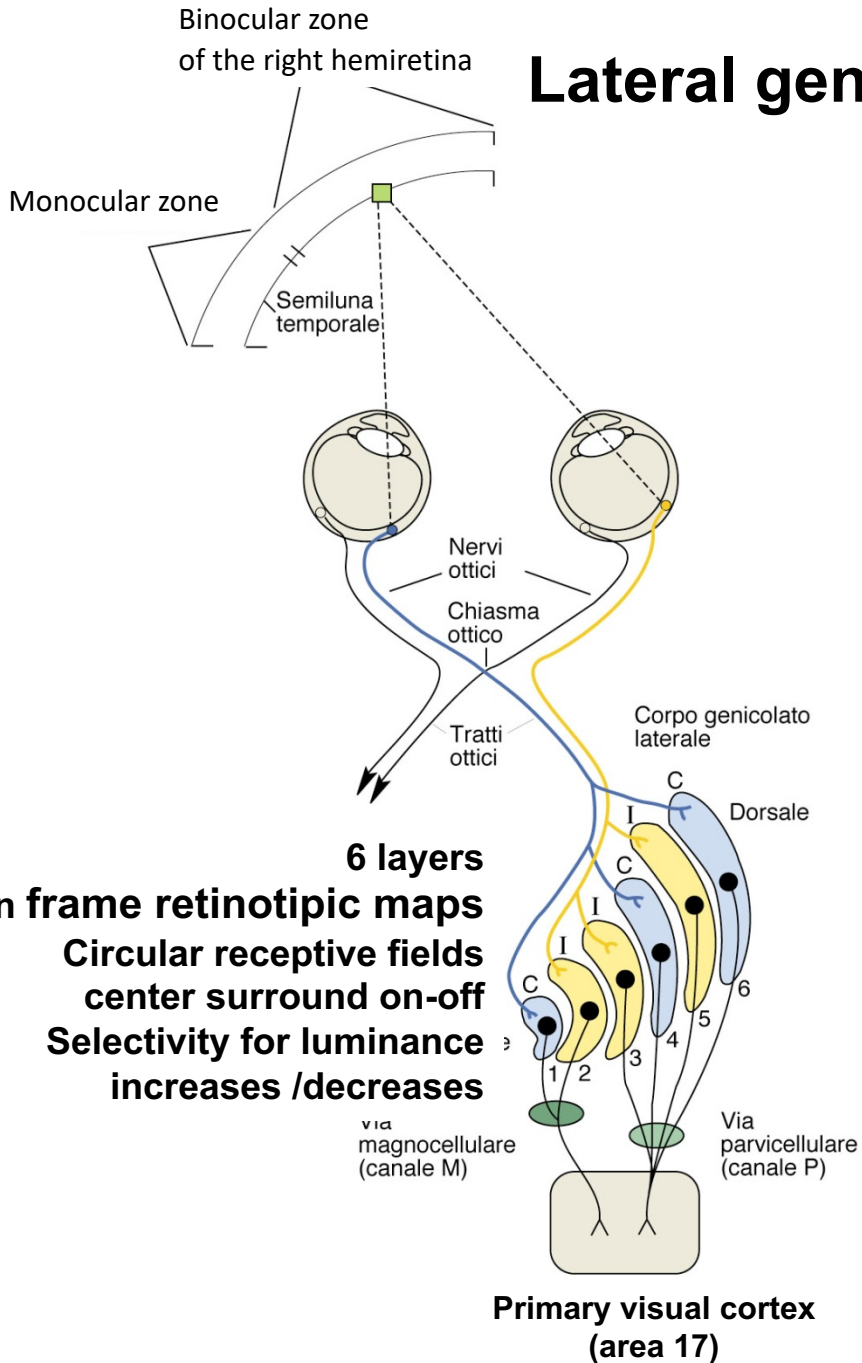
Off center

1. Images are formed on the retina thanks to the refraction of the cornea and lens
2. Light is transduced into electrical signals in the retina whose output are retinal ganglion cells
3. AP of ganglion cells relay info to the thalamus (**geniculate nucleus**) via the **optic nerve**
4. The **optical radiation** conveys info from the thalamus to the primary visual cortex (visual representation - perception)



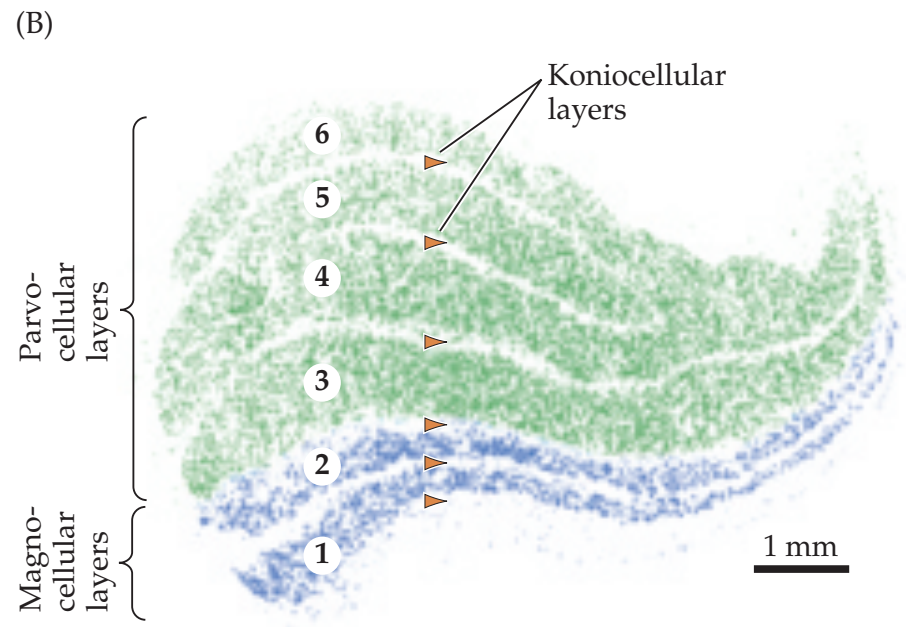
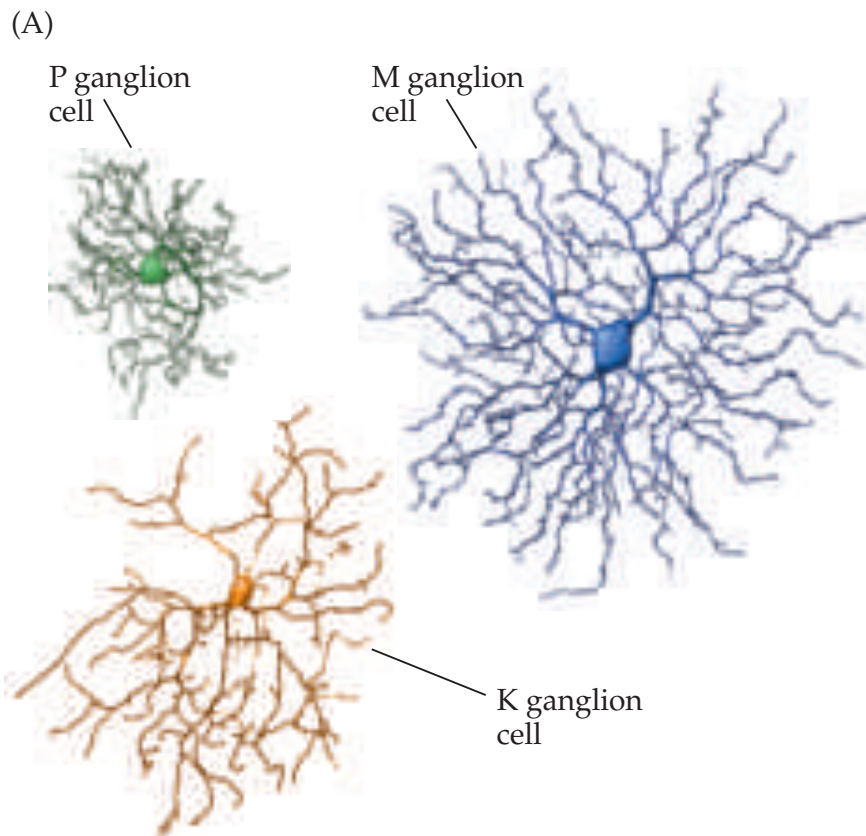
Projections of Retinal ganglion cells:
hypothalamus
pretectum
superior colliculus
geniculate nucleus

Lateral geniculate nucleus (Thalamus)



Each LGN receives afferents from the 2 hemiretinas
Receiving stimuli from the same contralateral half of the visual field

Afferents originating from the 2 eyes are segregated



M cells: large receptive fields, include cones but insensitive to colors

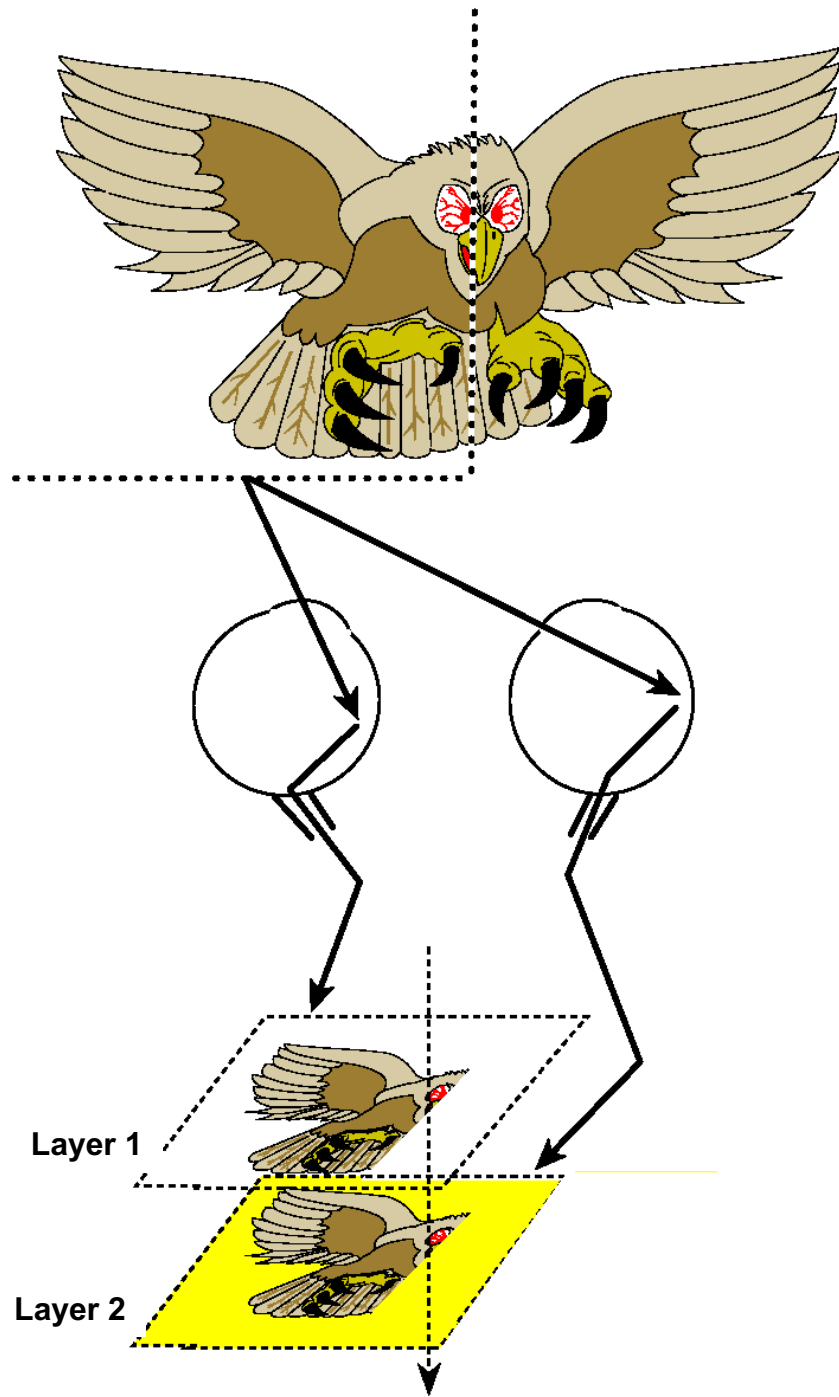
> Magnocellular layers – motion perception

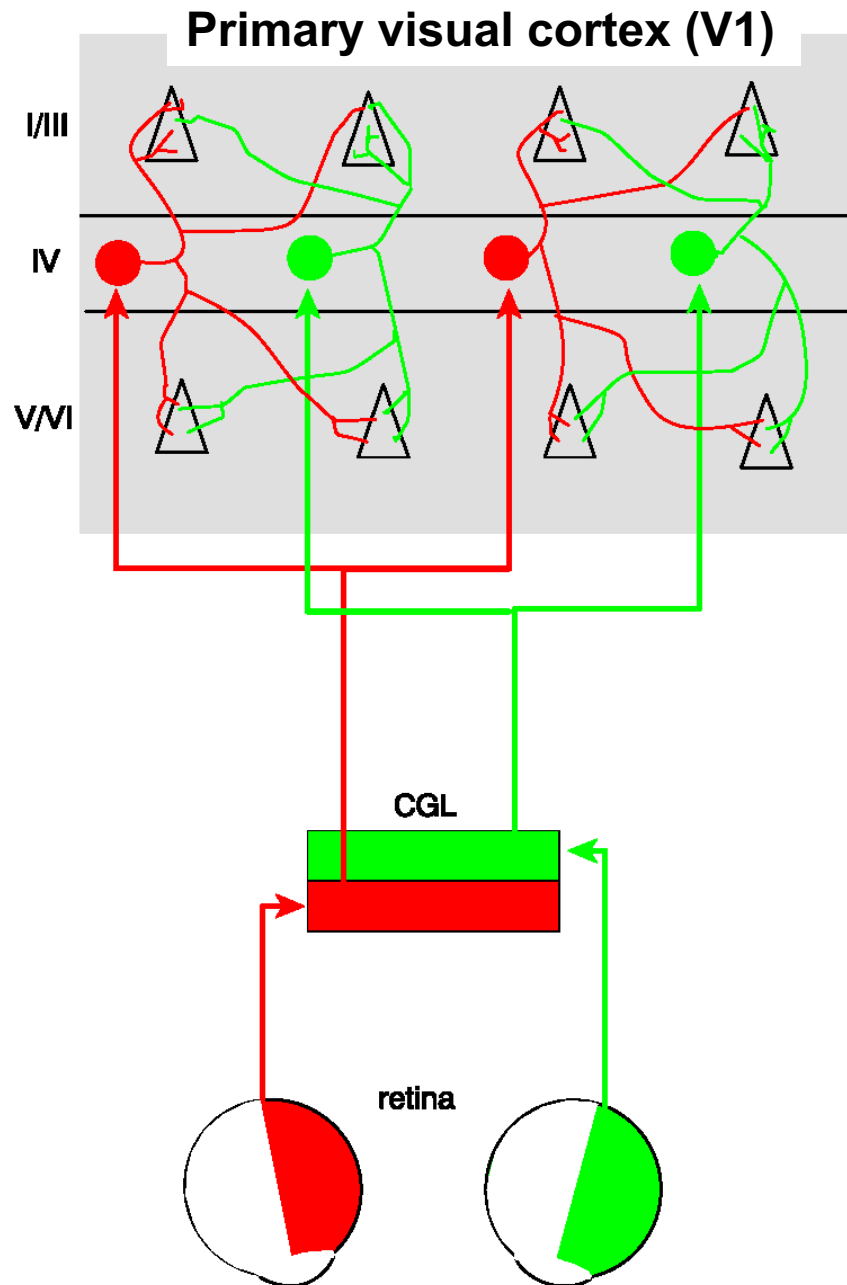
P cells: small receptive fields, only cones (sensitive to colors)

> Parvocellular layers –
high resolution vision (shape, size, color)

Kcells:

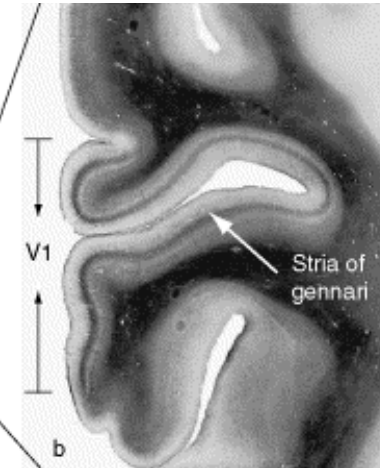
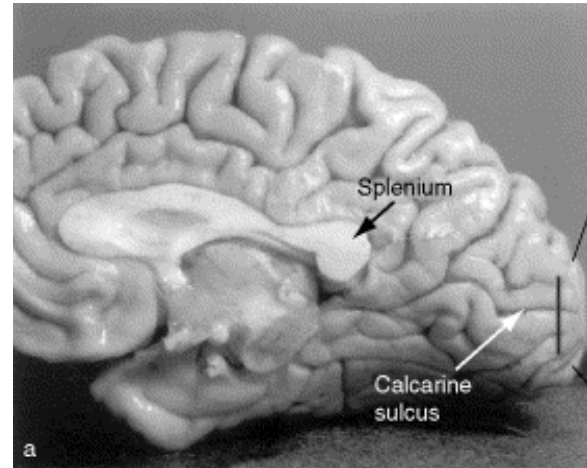
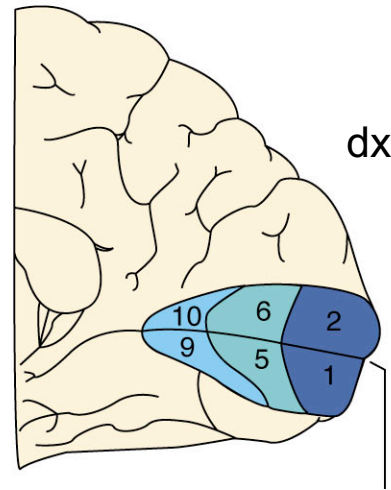
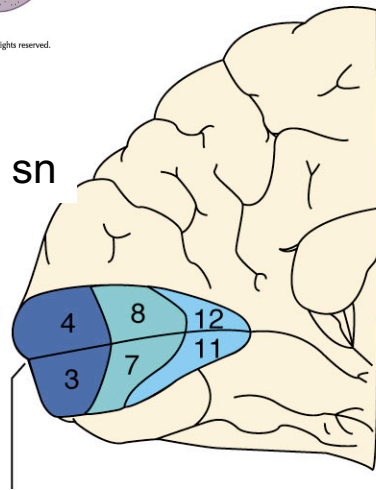
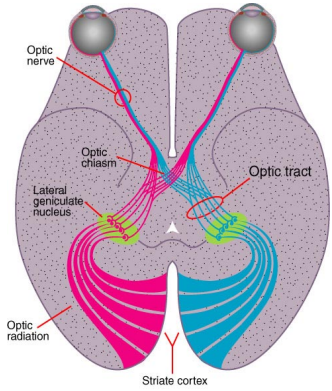
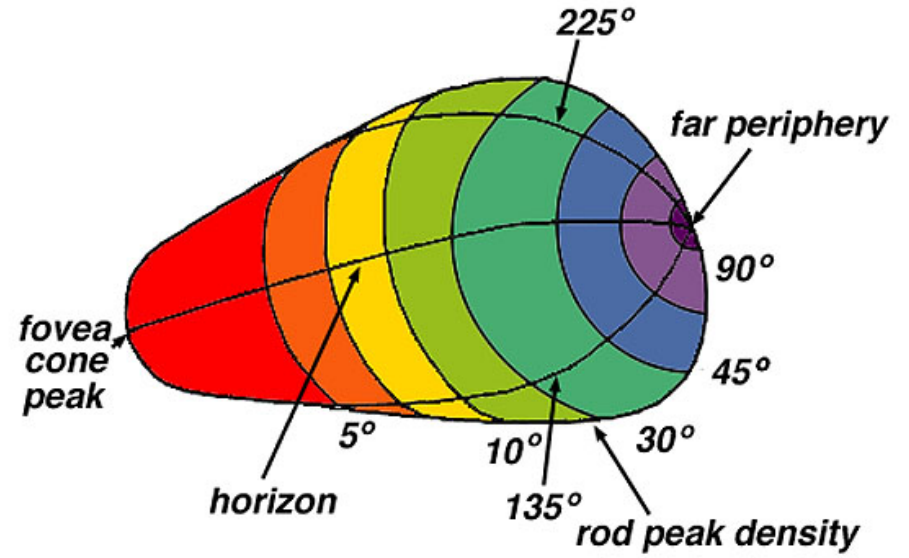
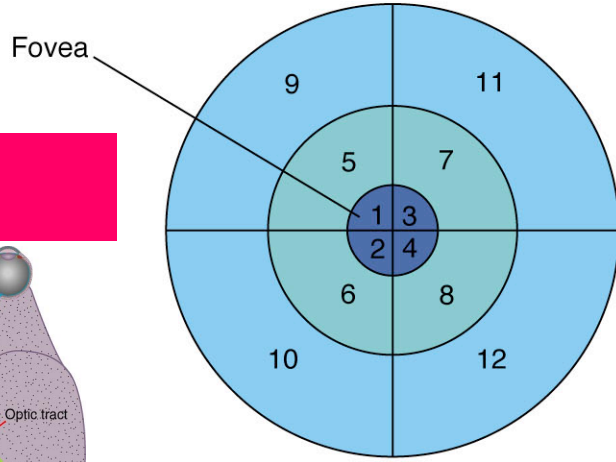
Some forms of spatial and temporal integrations? Also inputs from superior colliculus



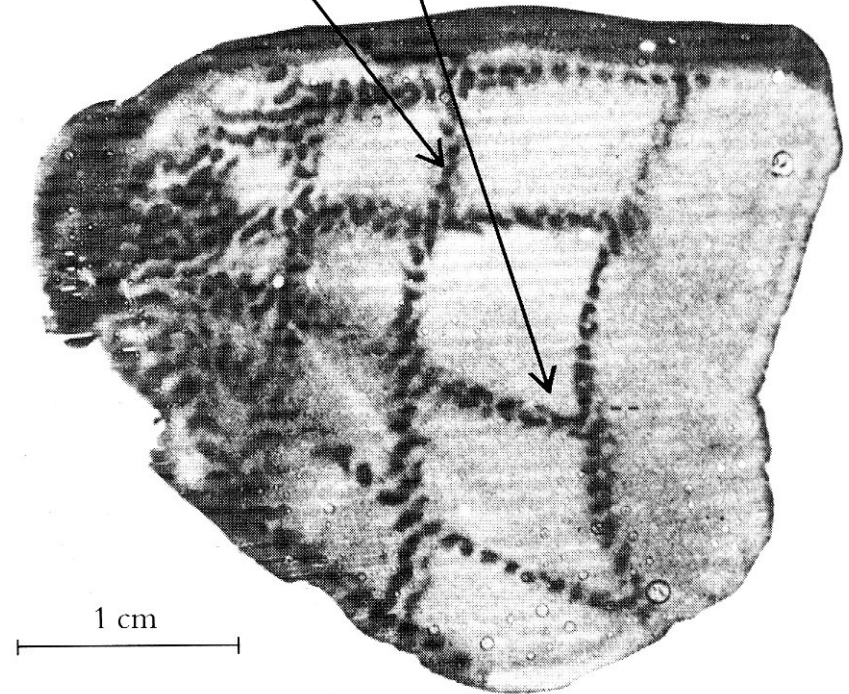
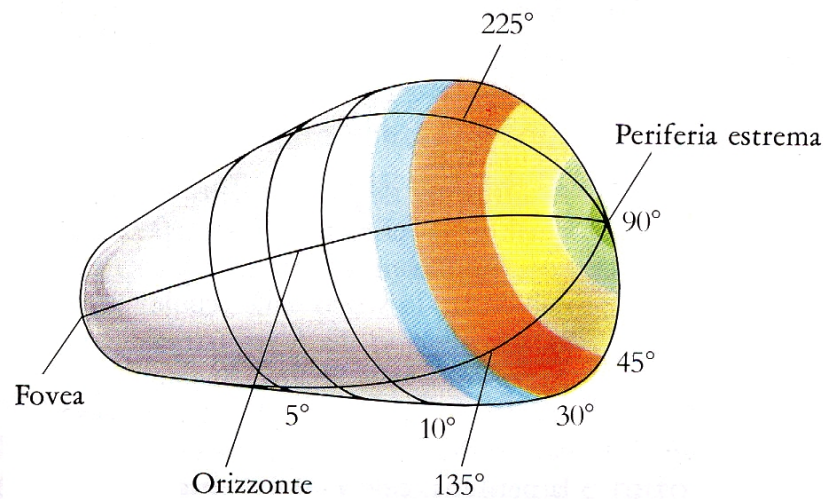
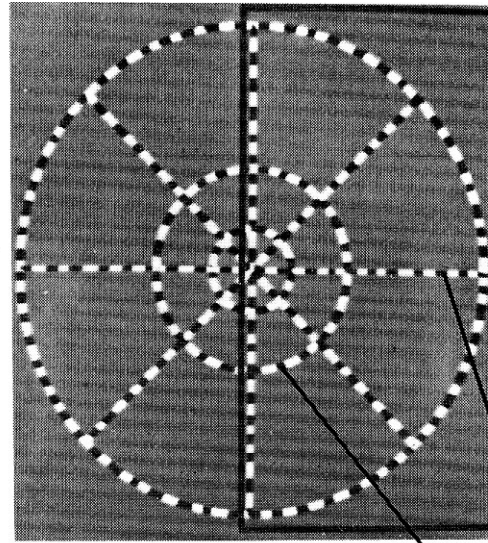
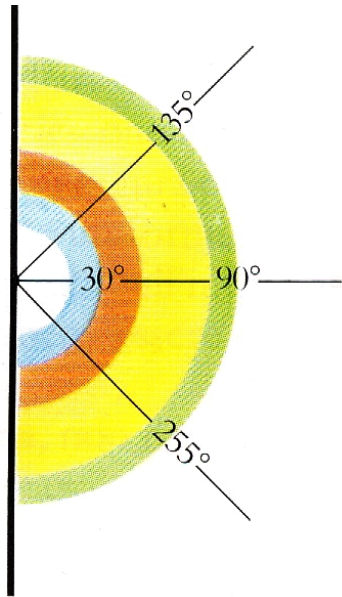


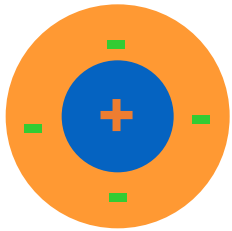
**Still some degree of segregations of signals coming from the two eyes
Binocular receptive fields**

Topographic (retinotopic) representation of the visual field in the primary visual cortex

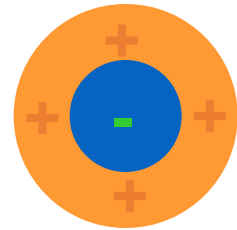
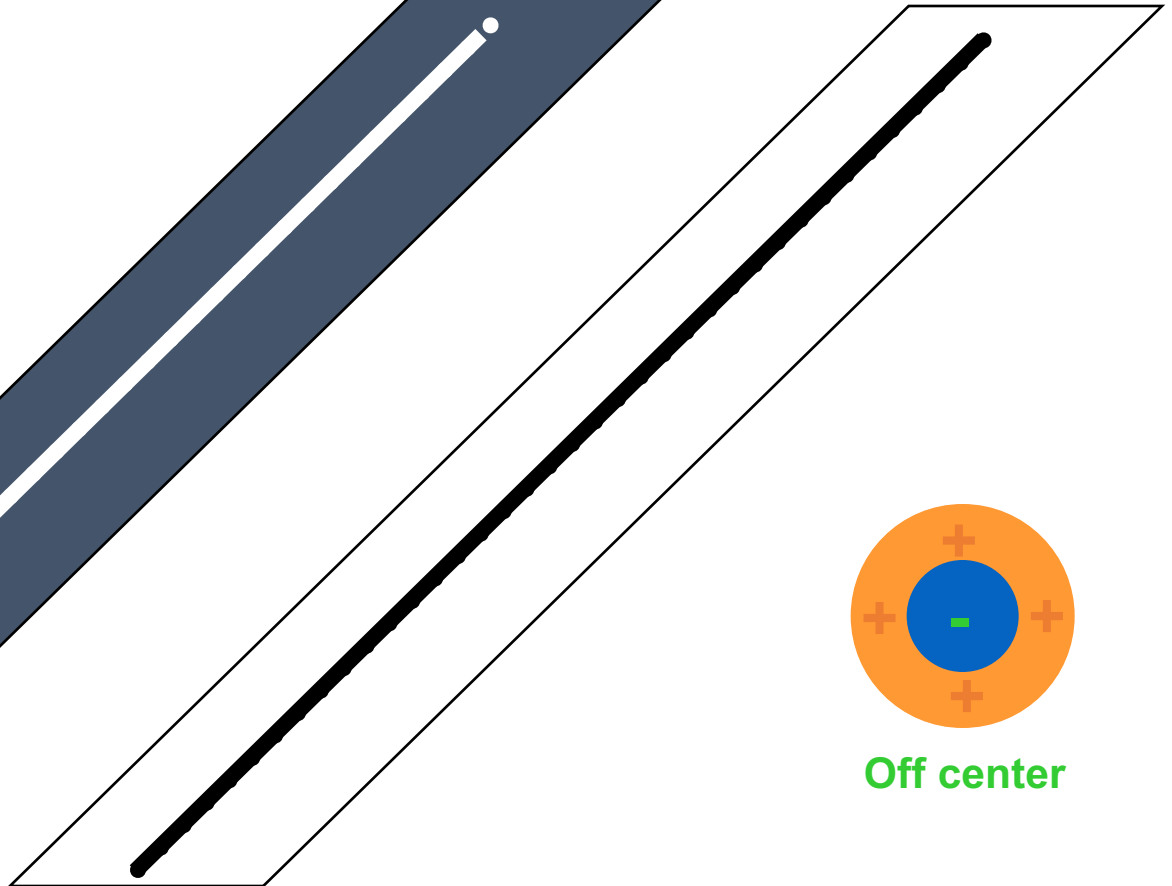
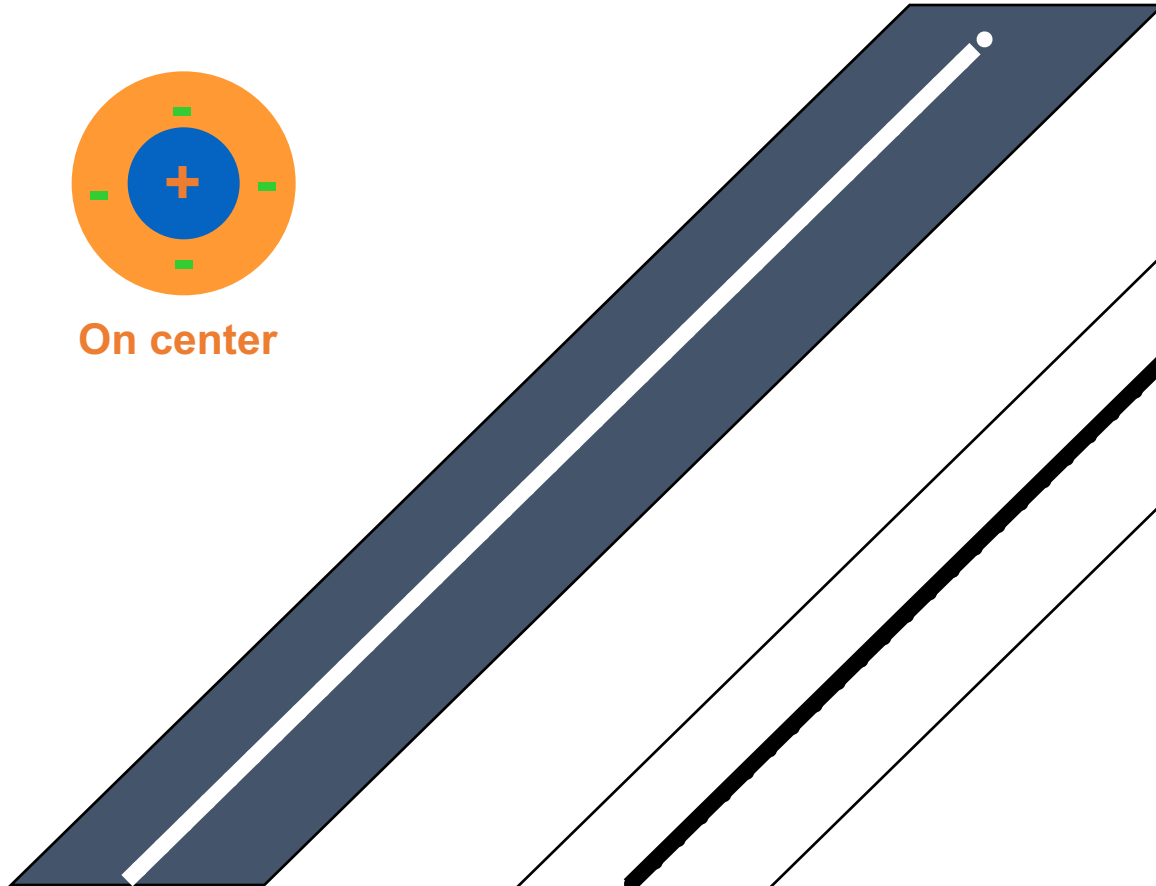


The fovea corresponds to 50% of the cortical area



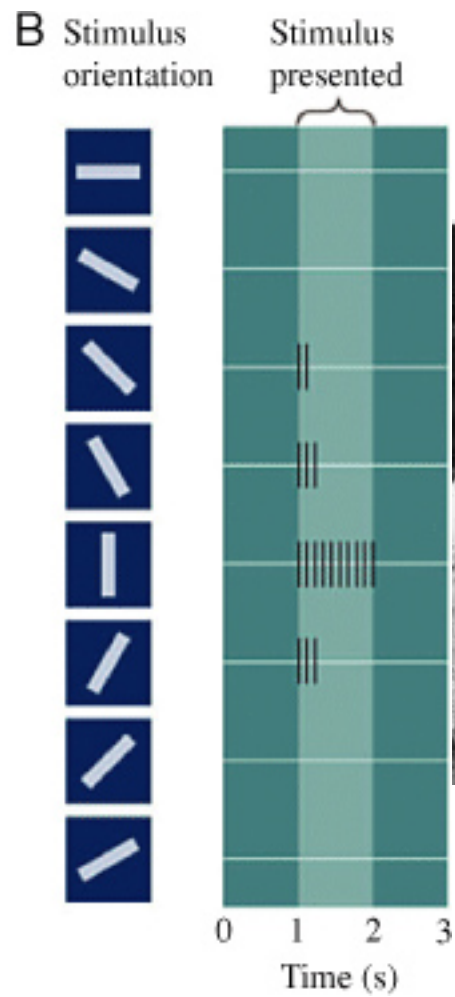
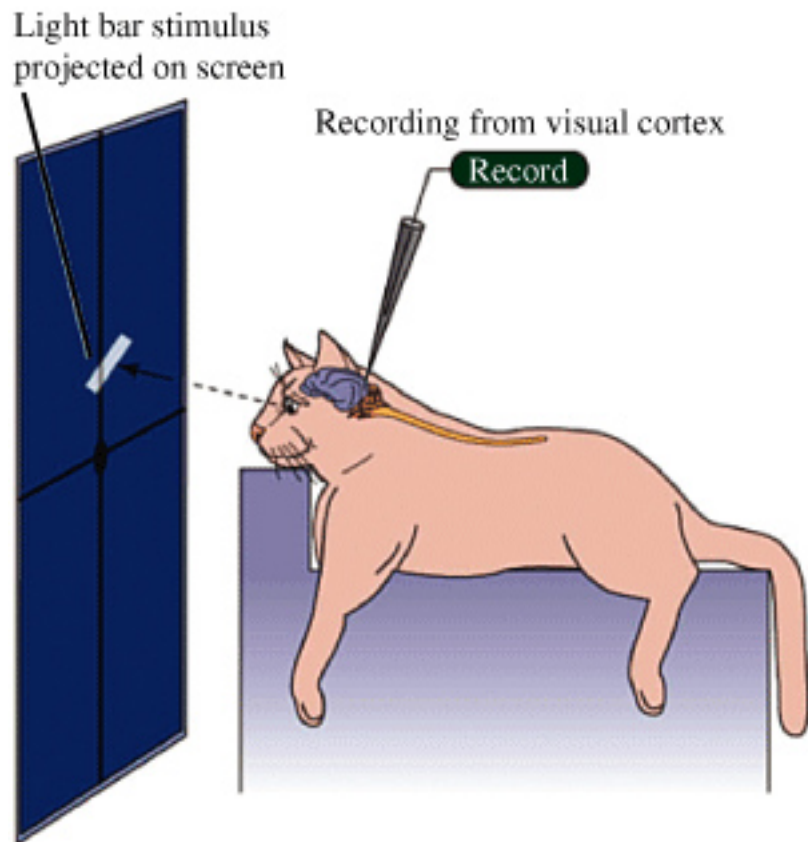


On center



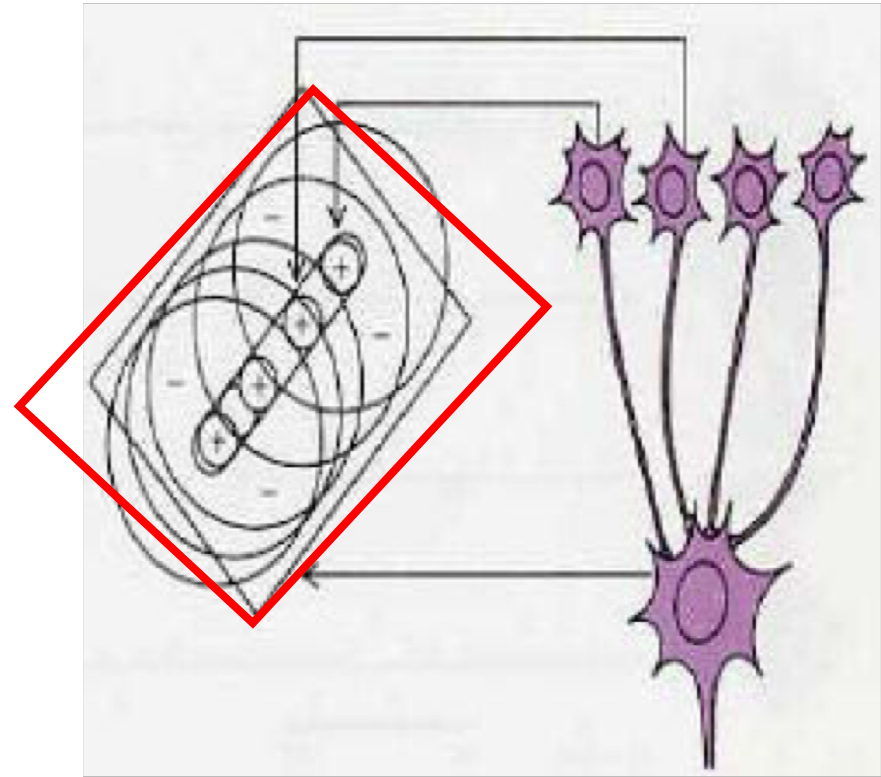
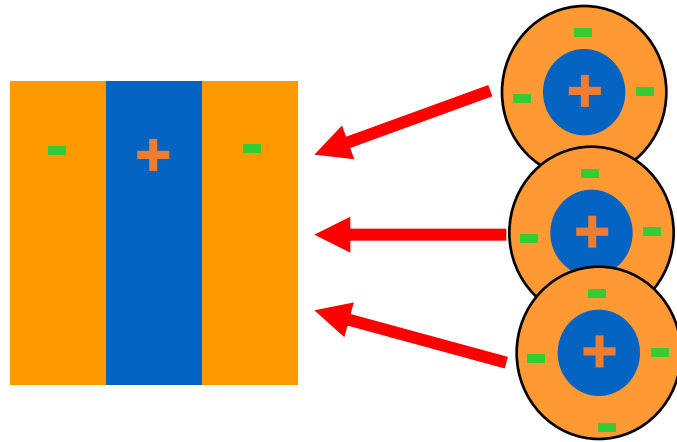
Off center

A Experimental setup



D Hubel T Wiesel
Nobel laureate, 1981

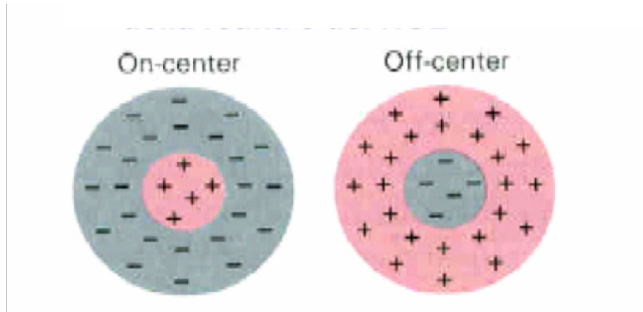
Neurons of the primary visual cortex: simple cells



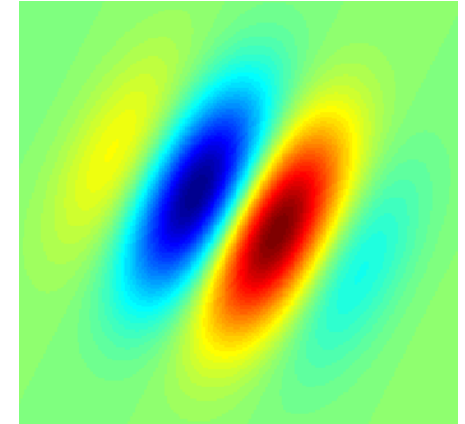
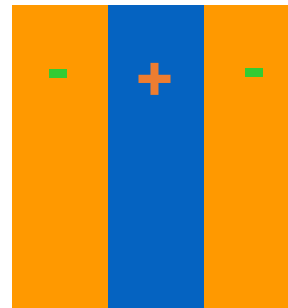
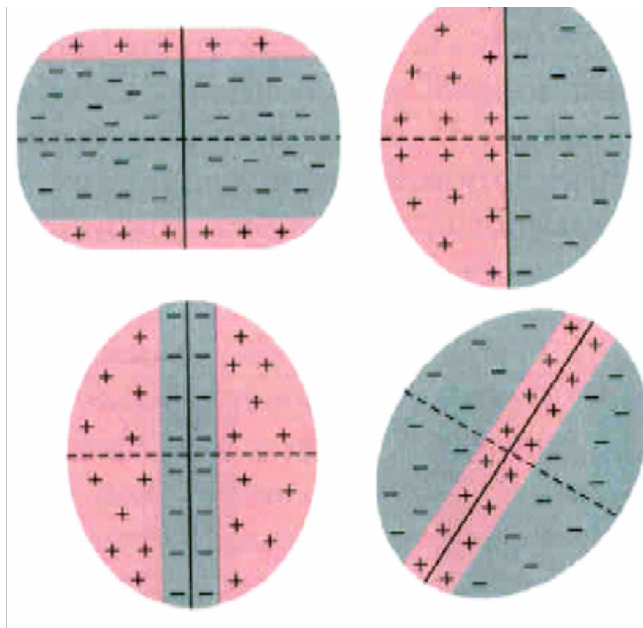
- Receptive fields bigger than those of ganglion cells and thalamic neurons
- Receptive fields are not circular patches, but elongated
- On and off regions

- **Poor response to light patches/punctiform light stimuli**
- **Response to a light bars with a defined orientation**

Concentric Receptive fields of GC and GN

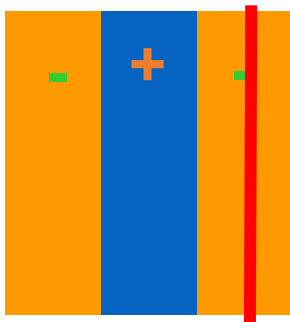
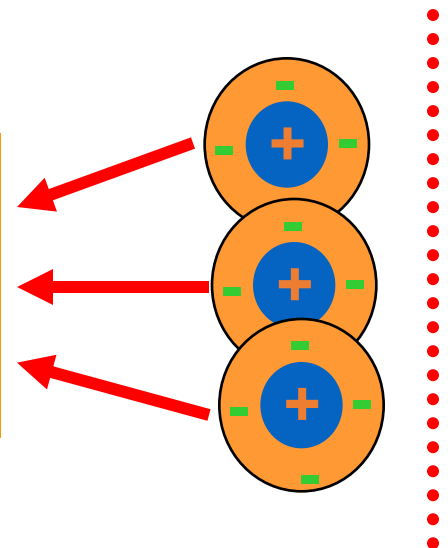
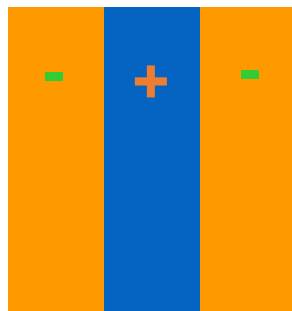
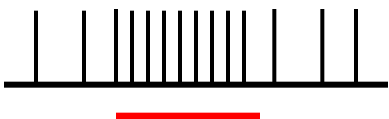
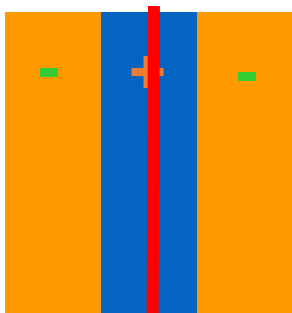
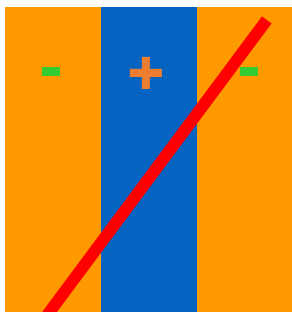
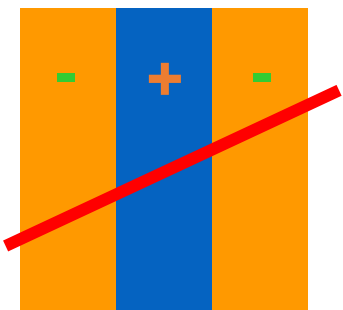
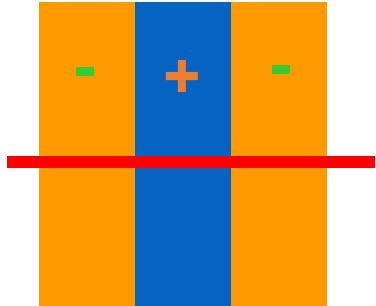


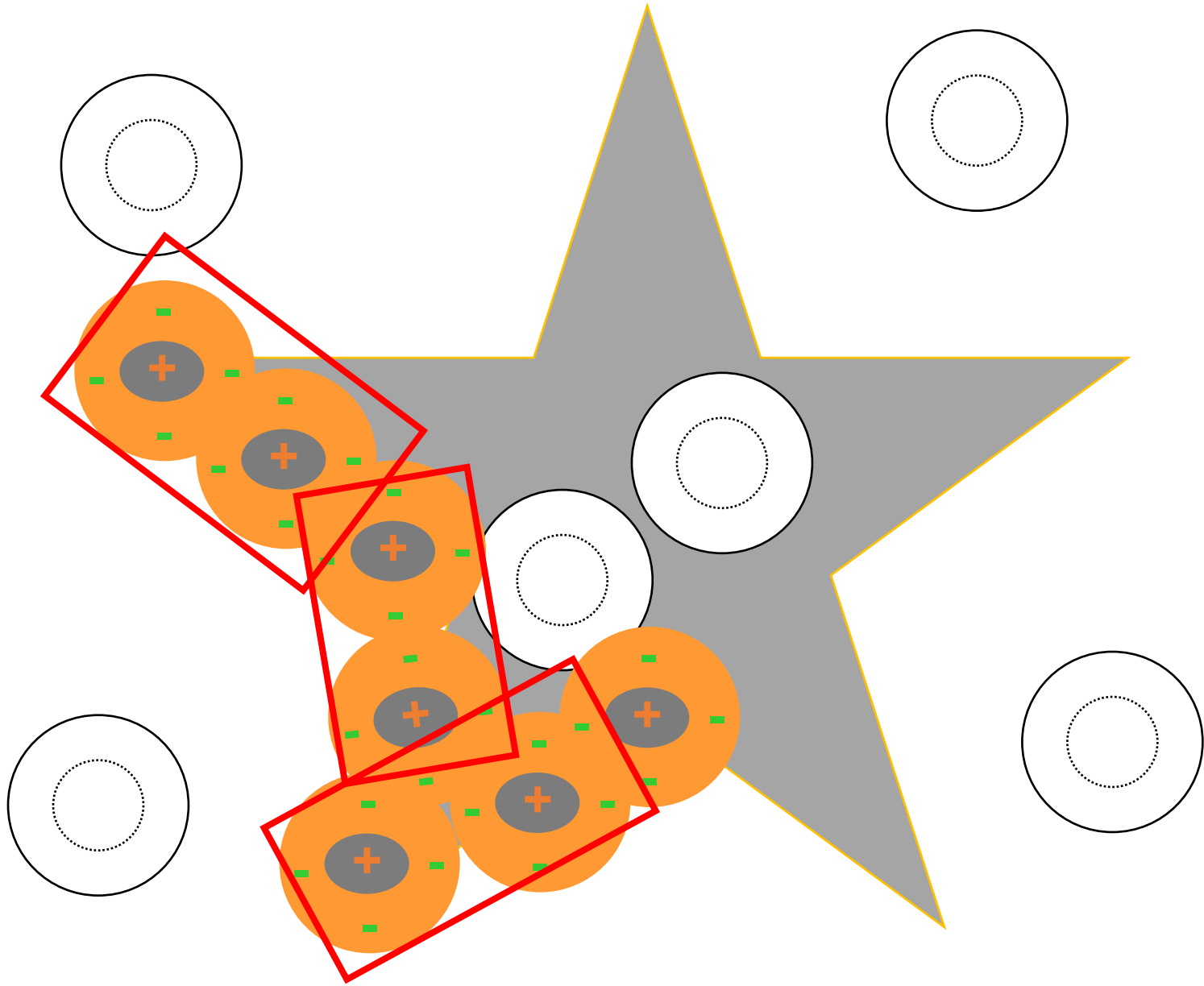
Elongated Receptive fields of simple cortical cells

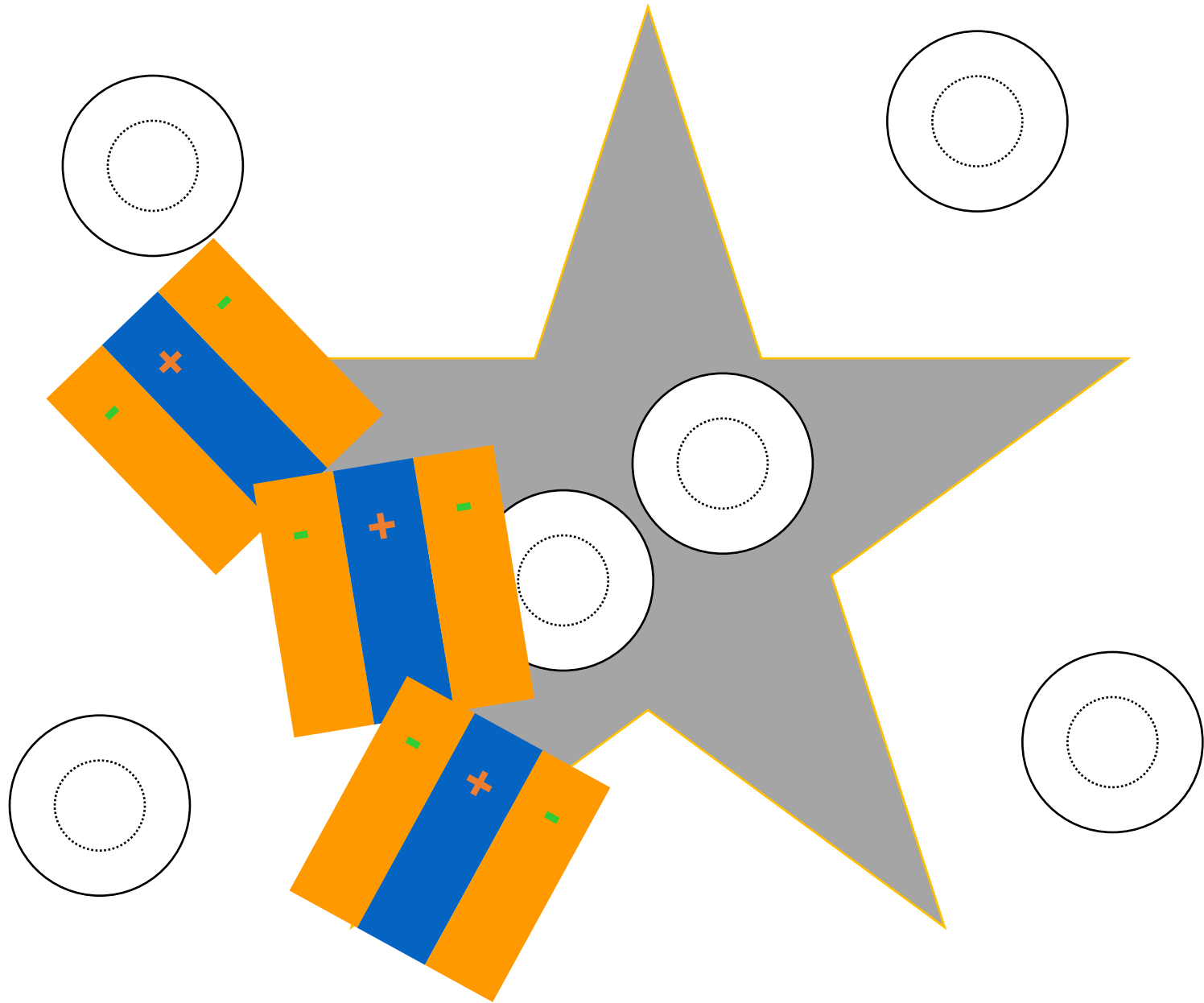


Sensitivity to:

**Position (in the visual field)
Orientation**

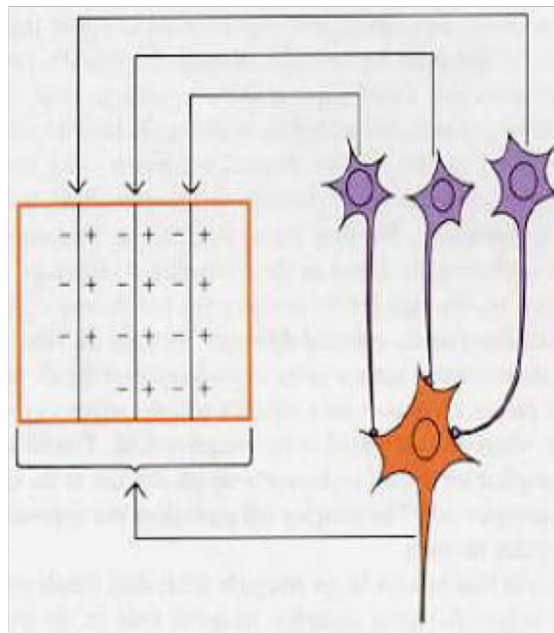


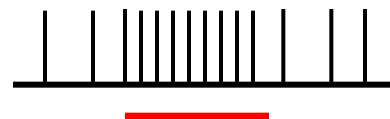
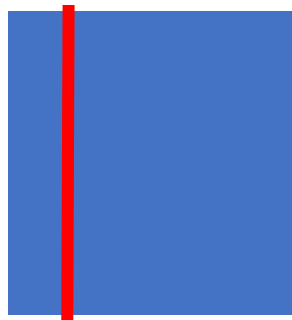
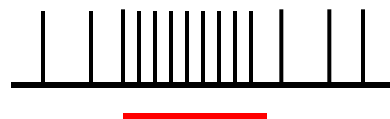
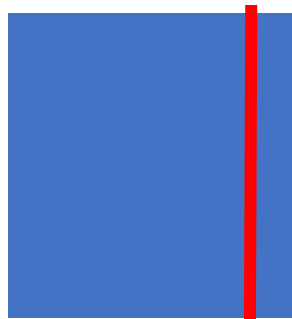
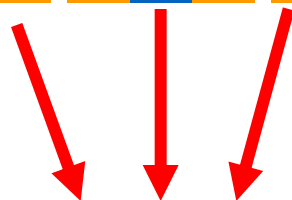
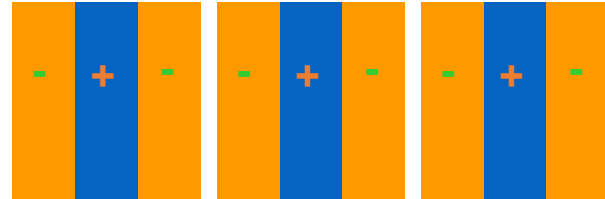
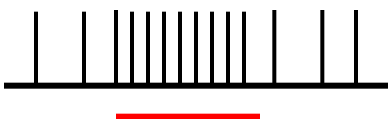
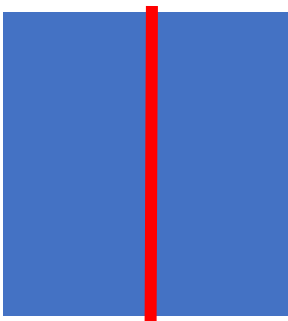
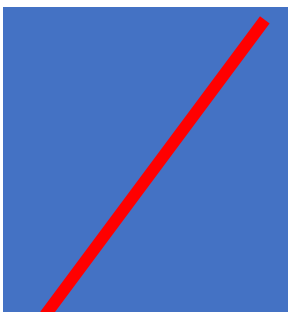
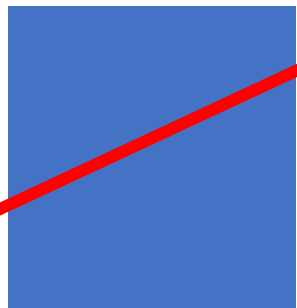
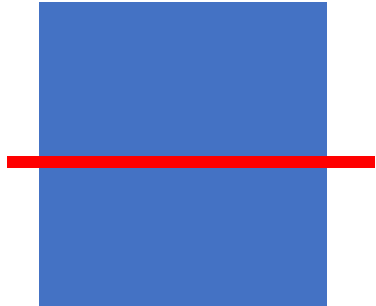


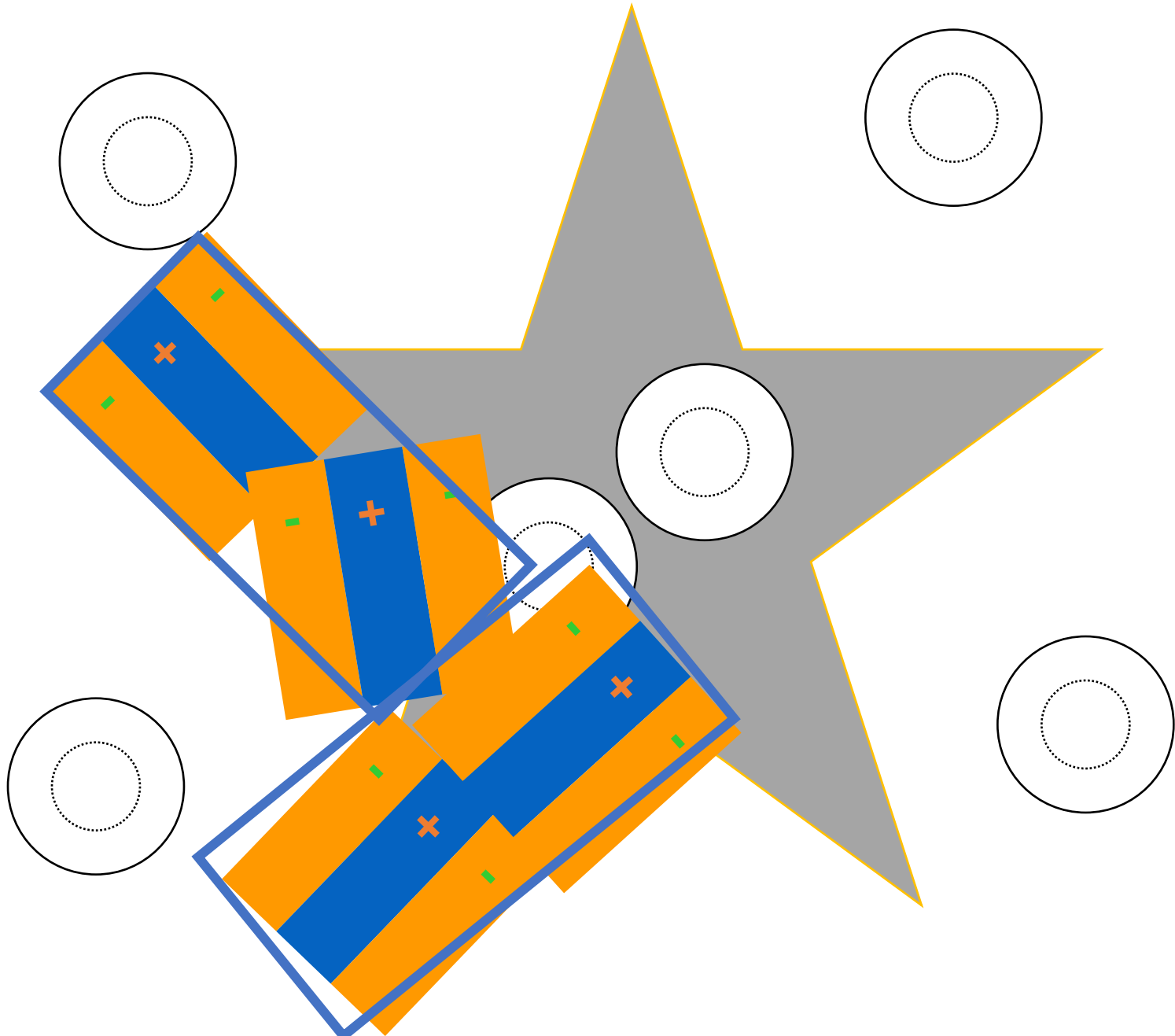


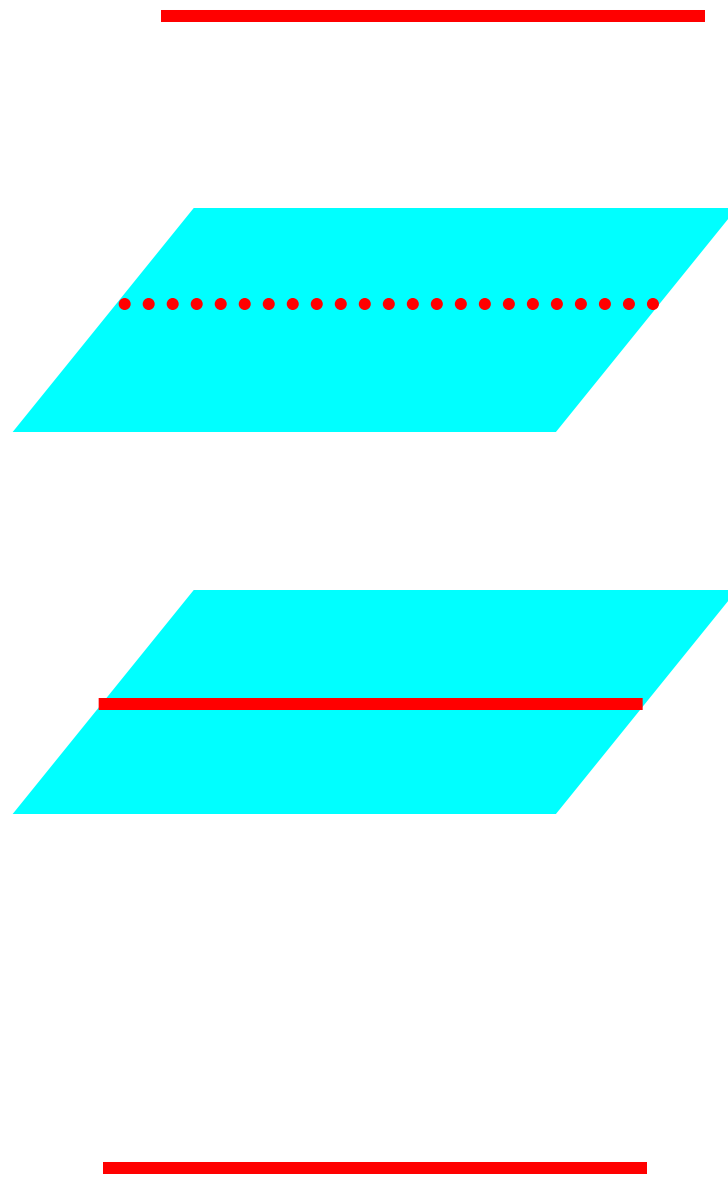
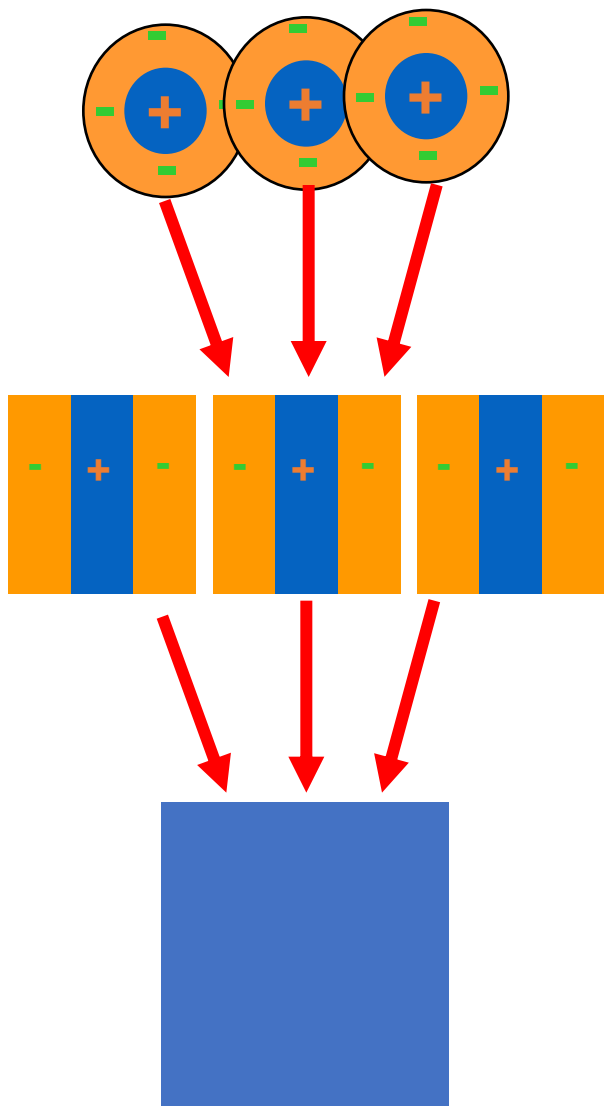
Complex cells

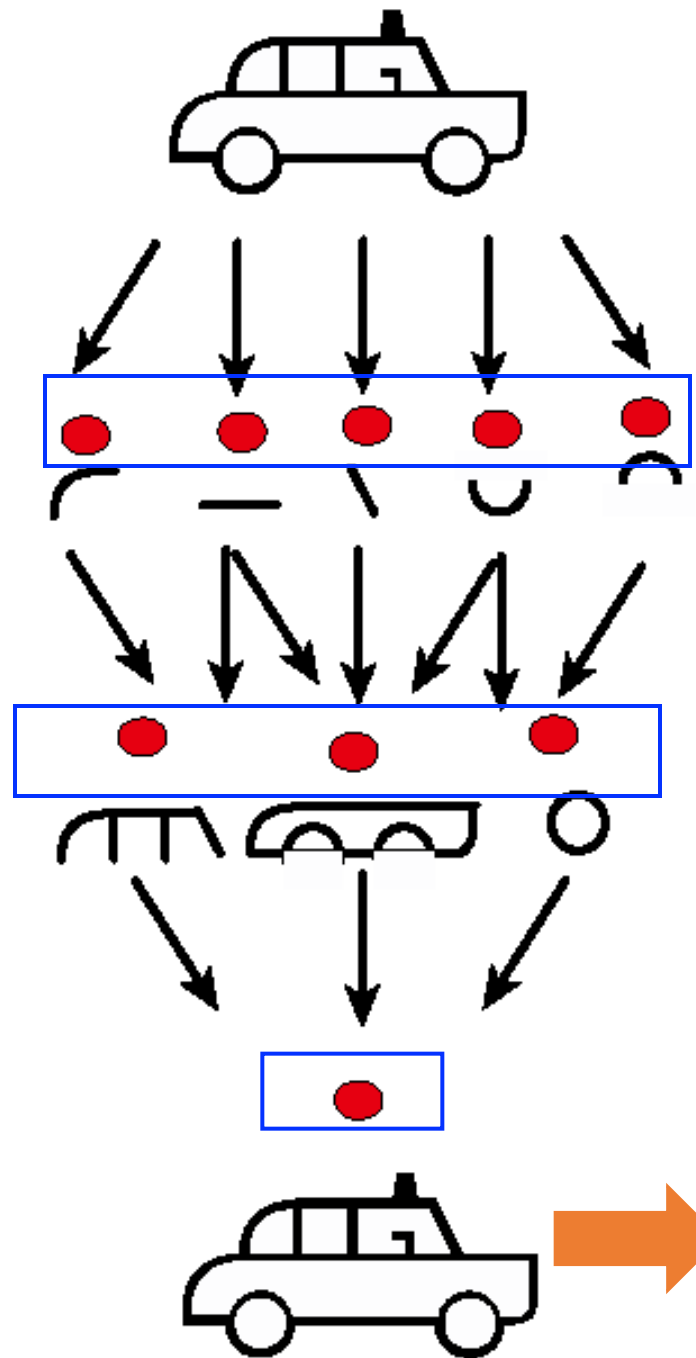
- receptive fields bigger than those of simple cells
- no “on” and “off” regions: no relevance of specific positional info
- each cell is responsive to a specific orientation of the objects
- cells integrate information from simple cells
- silhouette of objects, analysis of shapes











Bipolar cells, Ganglion cells, thalamic cells

Simple cells

Complex cells

Silhouette/shape

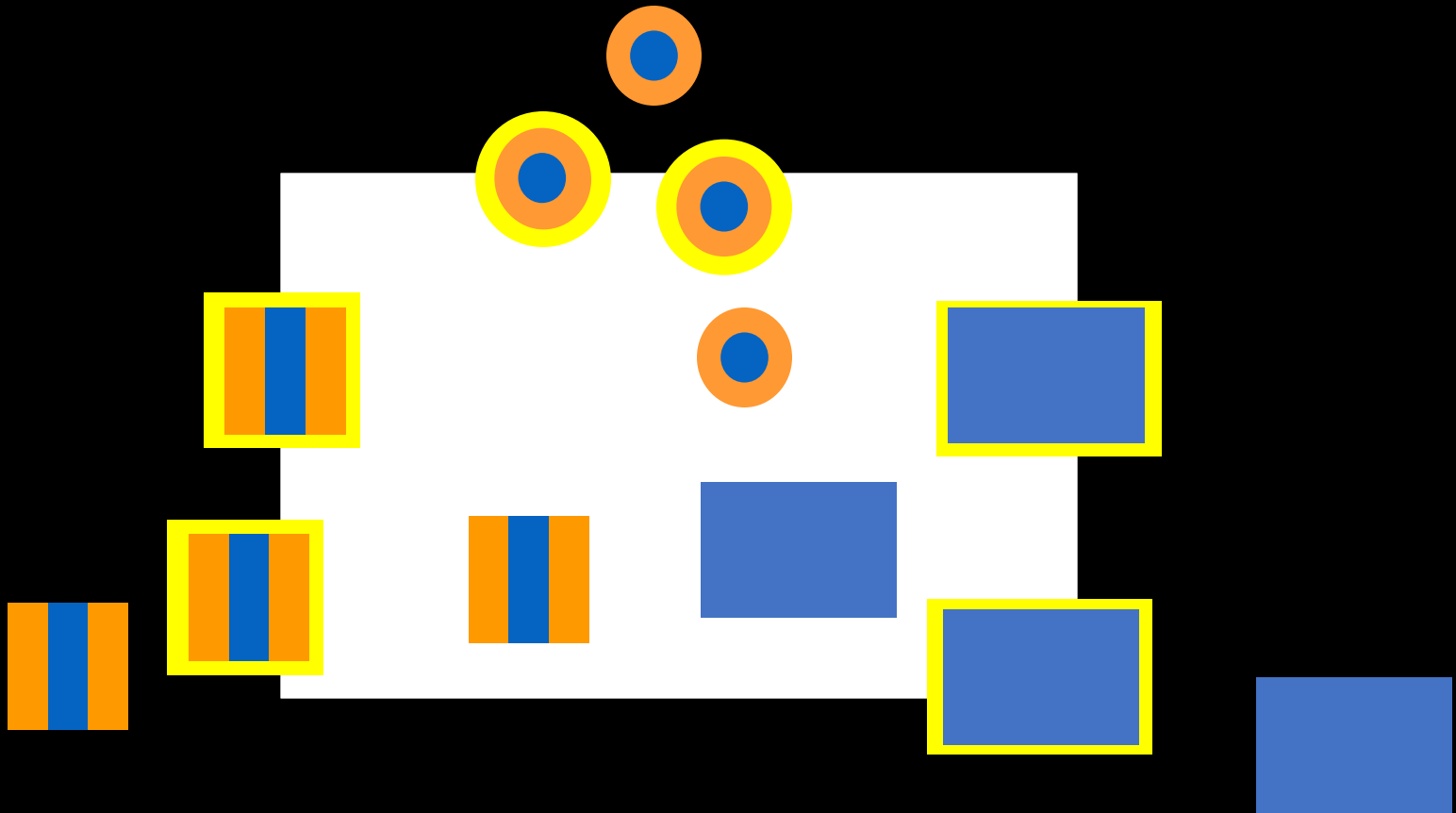
Inner part & background do not elicit responses

Hierarchical organization of the visual pathway

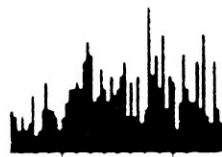
Each receptive field is the the sum of others, more simple in size and features. At distinct sites from each neuron type a more sophisticated level of information is extracted.

From contrast points of on/off center GC and GN, we move to line in simple cortical cells, and to more elaborated shapes in complex cells. In parallel, positional information becomes less relevant, while shapes are reconstructed as an abstract representation. Moreover, M and P systems are maintained in V1.

On top of such process, in higher visual areas specific types of neurons repond to very complex stimuli such as faces.

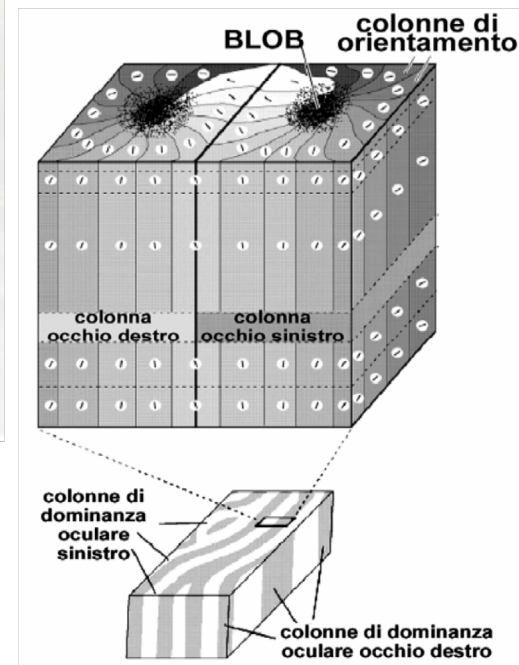
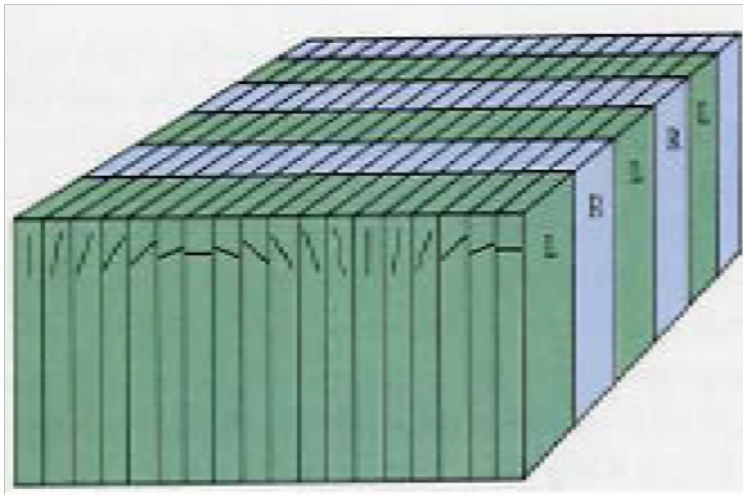




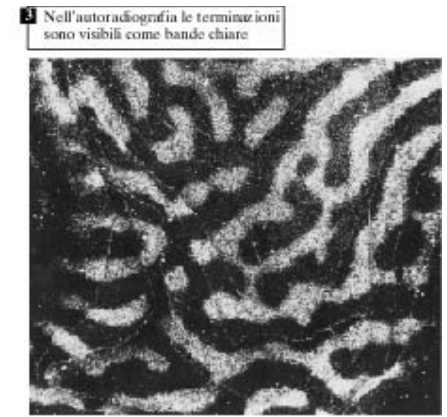
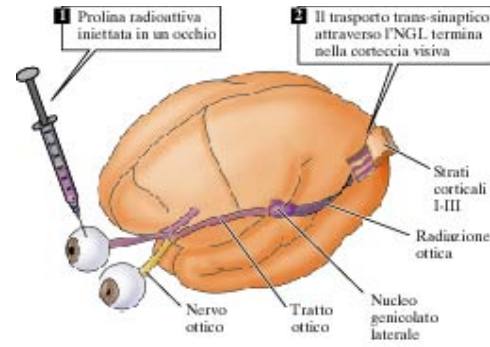
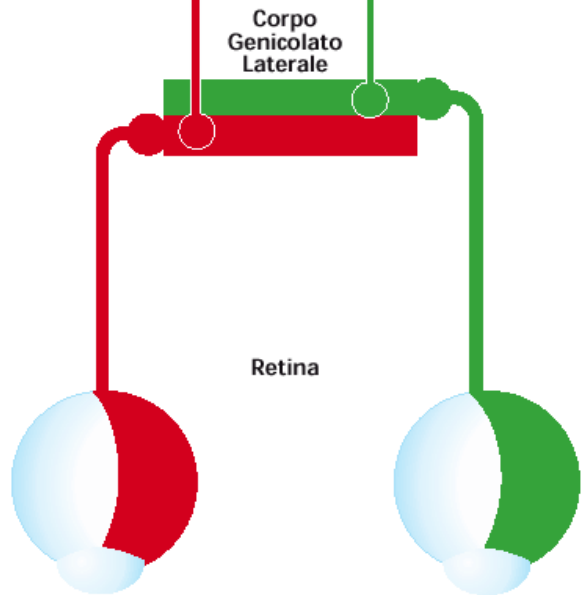
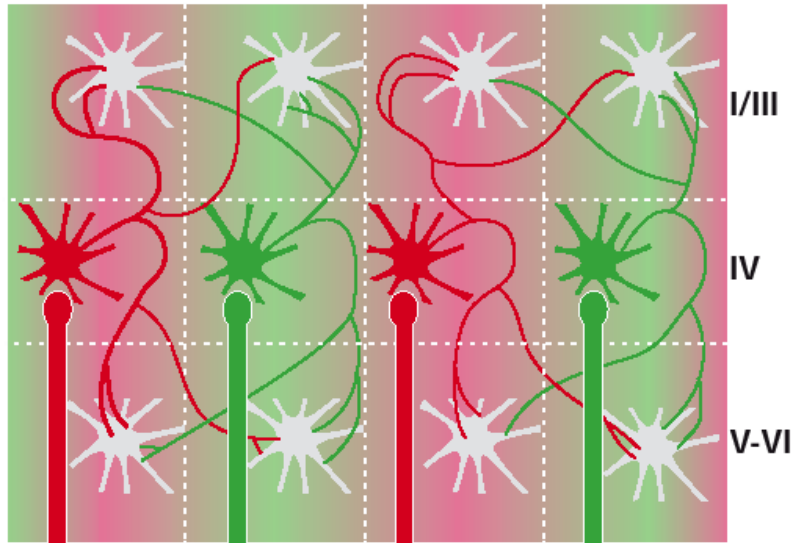


Columnar Organization in V1:

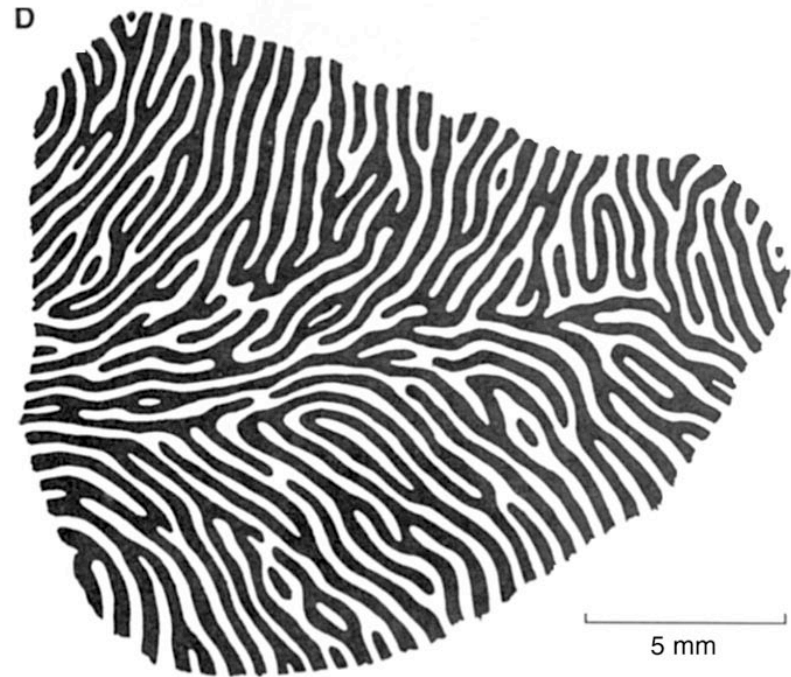
- Ocular dominance columns
- **Orientation columns**

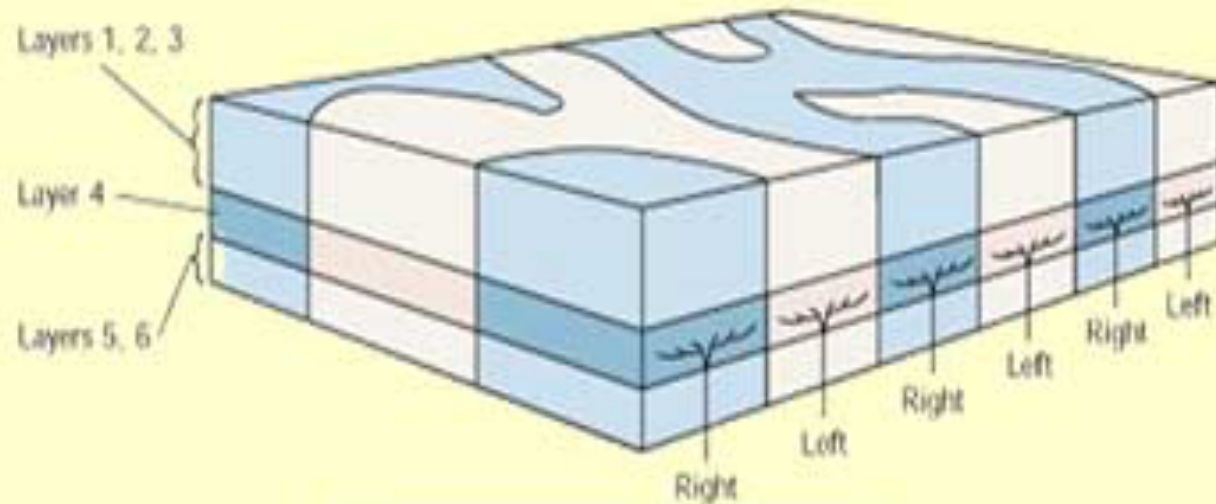


BLOB: areas where color is elaborated

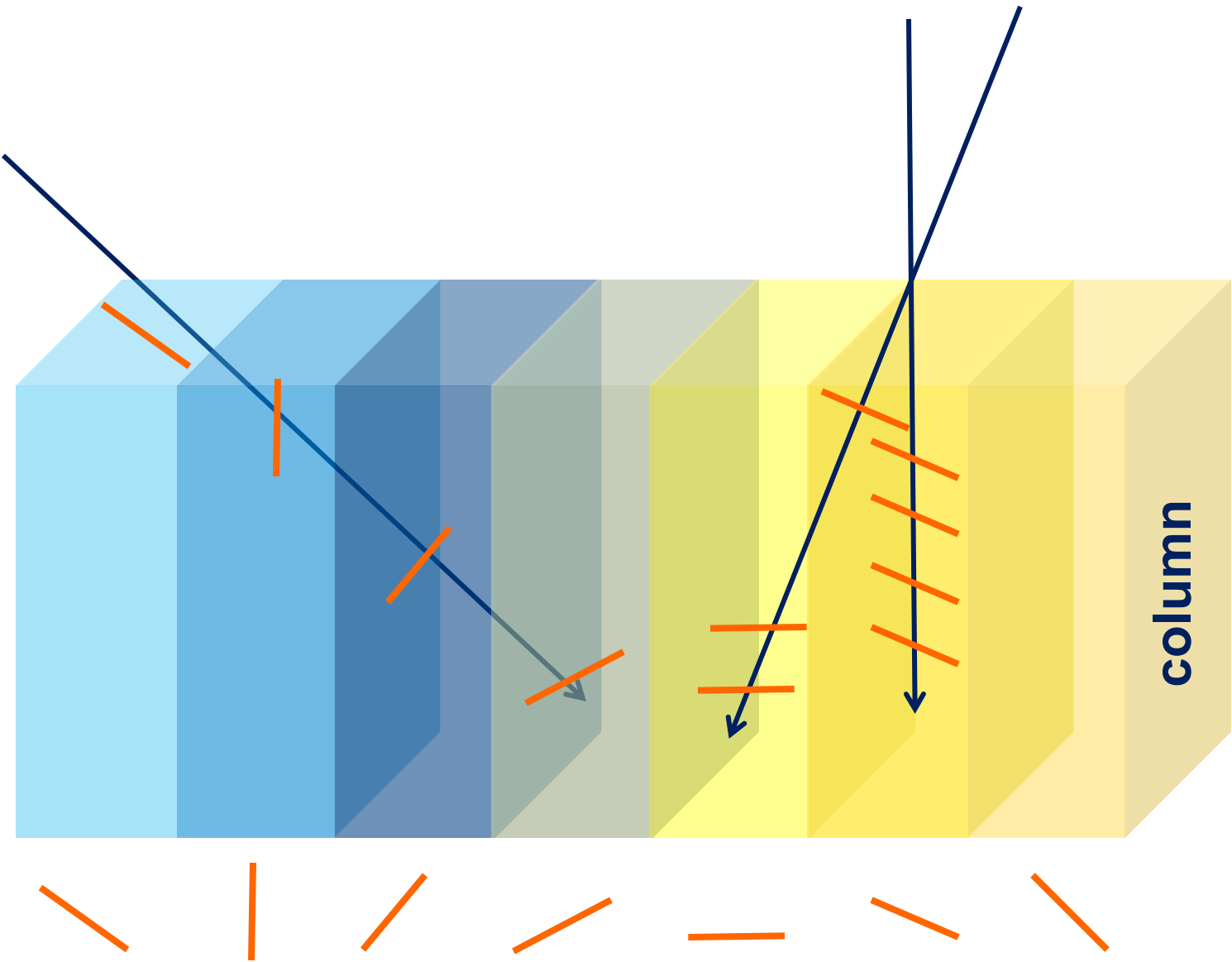


•Ocular dominance columns

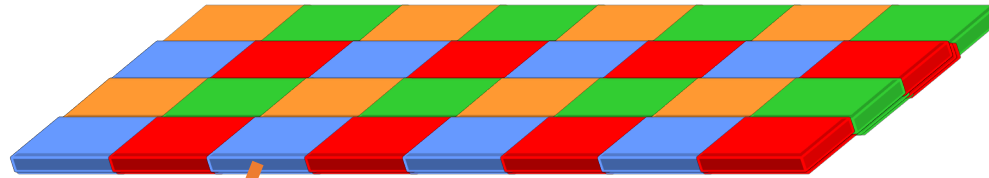




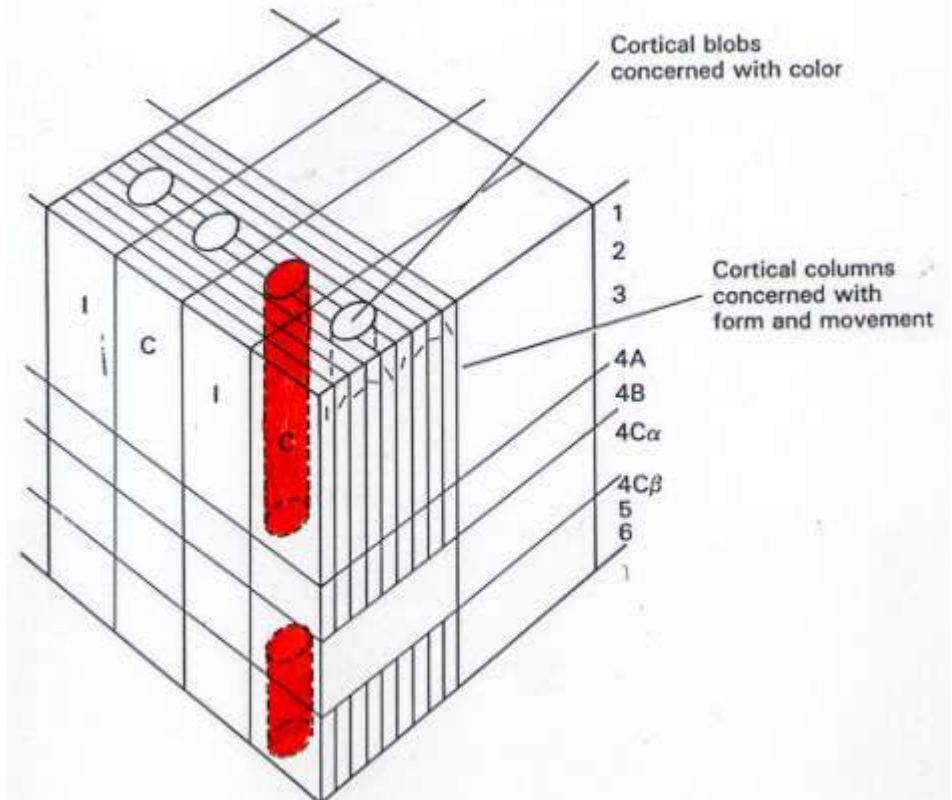
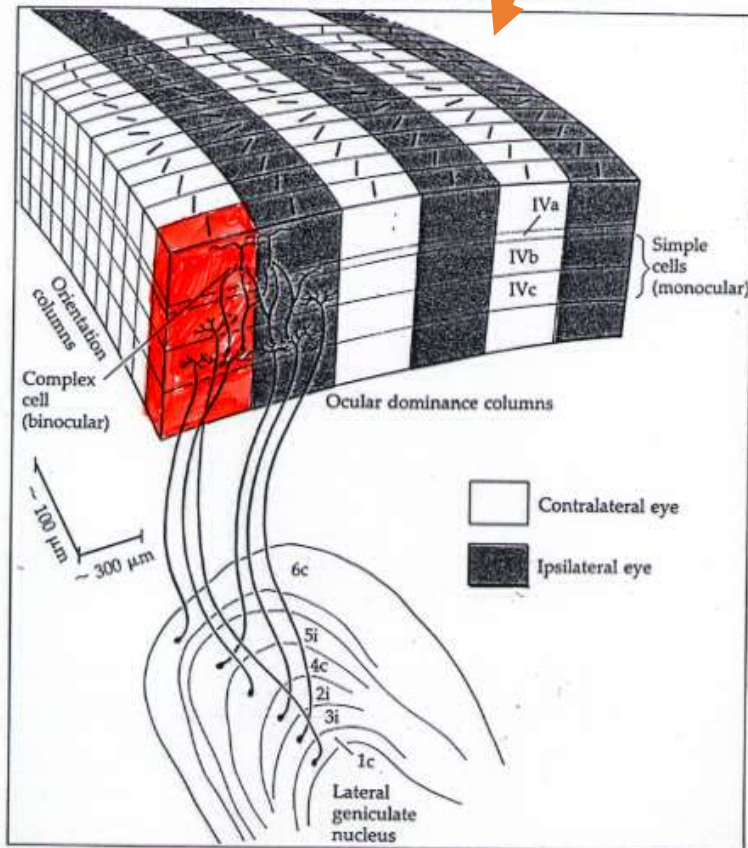
D Hubel T Wiesel
Nobel laureate, 1981



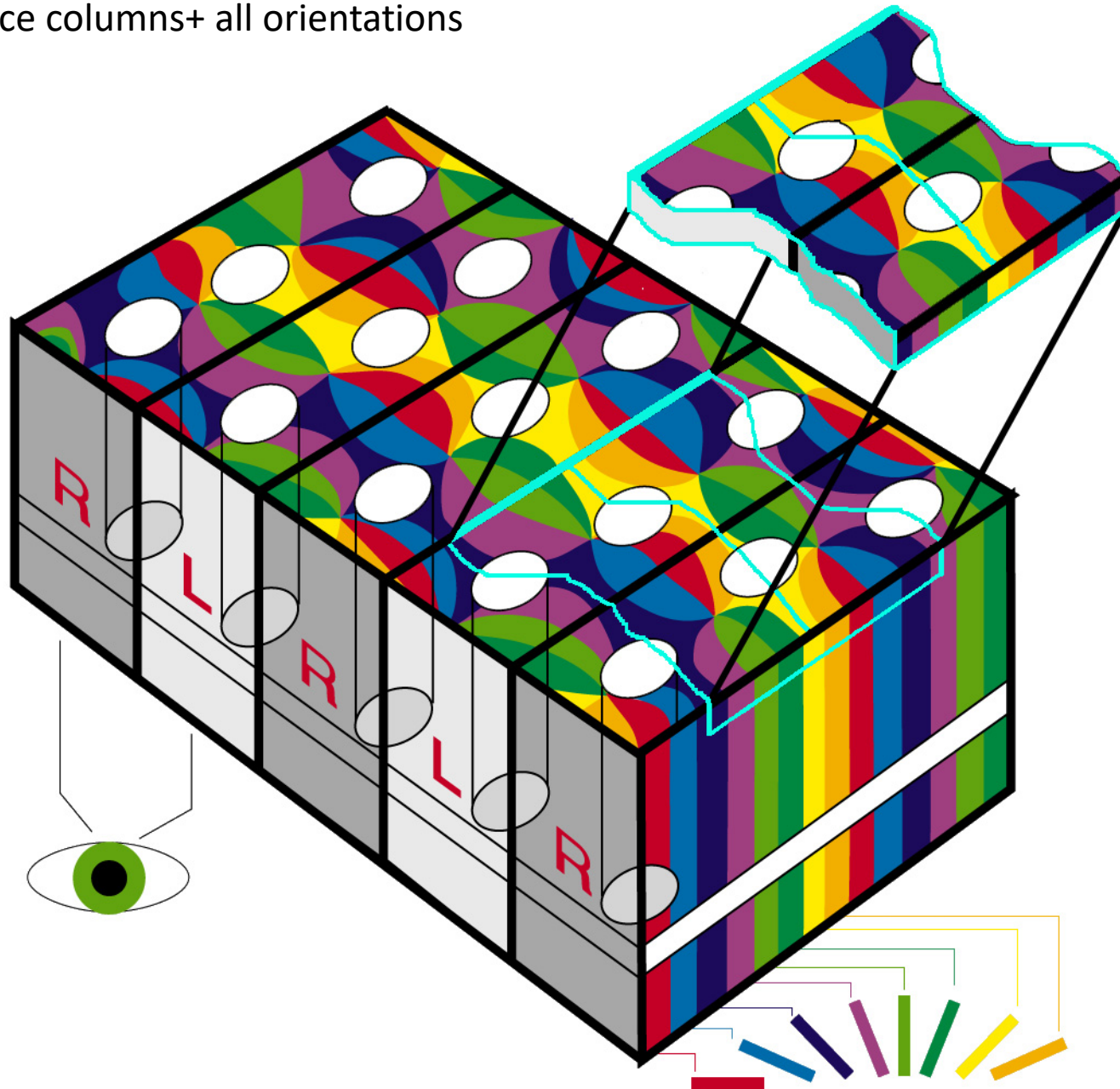
V1, visuotopic representation

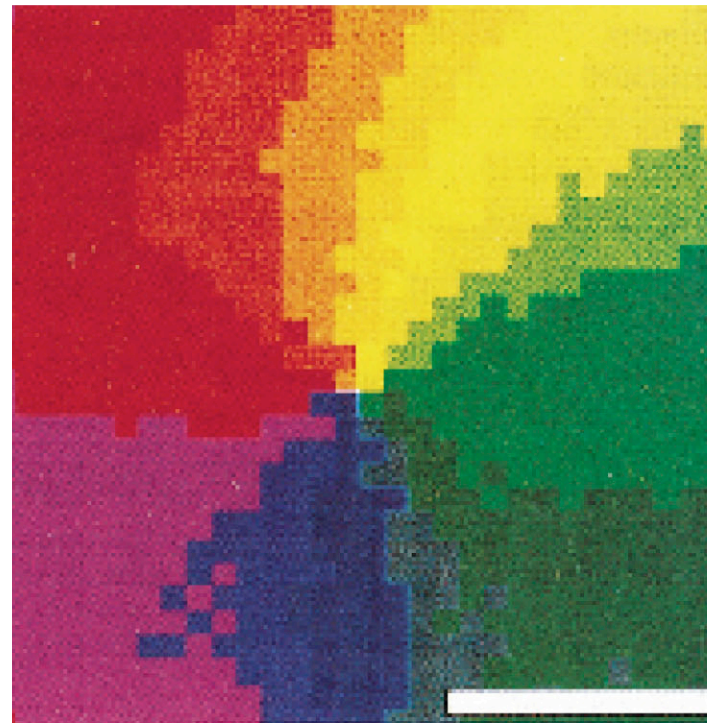


Hypercolumn:
 1 mm² cortex
 Area devoted
 to the analysis
 of the input
 from a defined
 retinal area

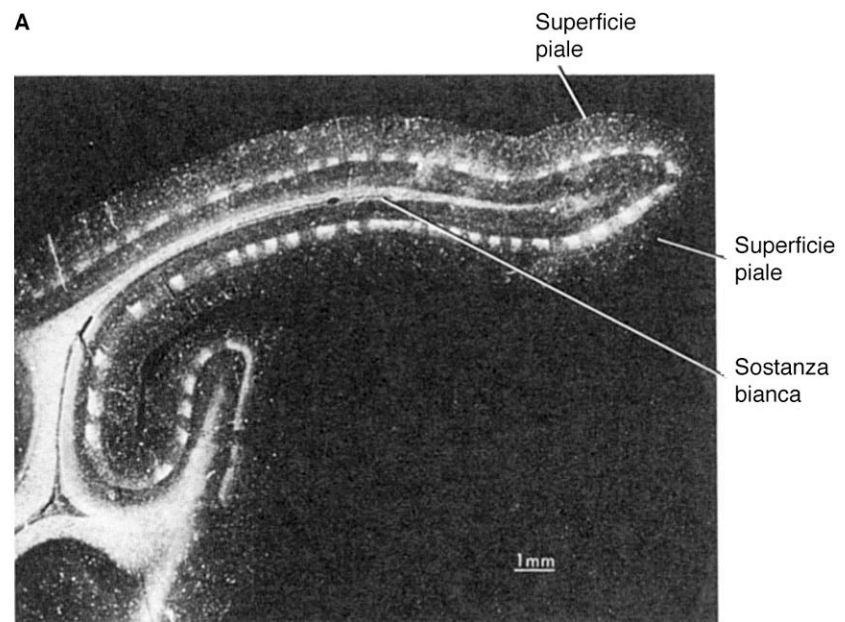


Each area of the retina: 1 hypercolumn:
Dominance columns+ all orientations



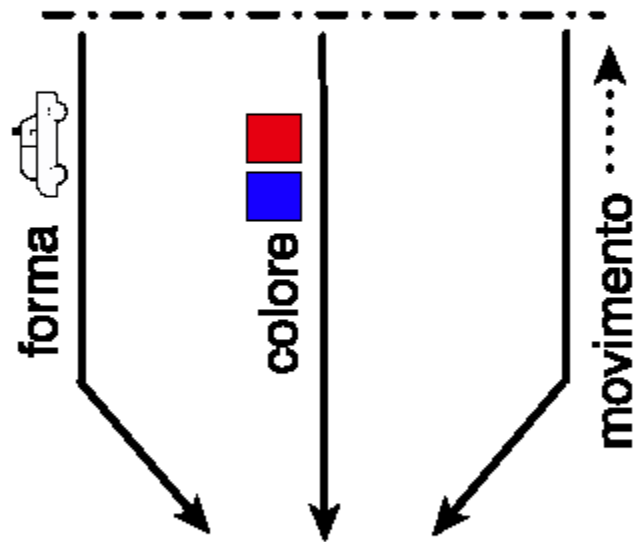


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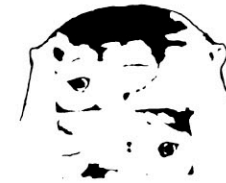
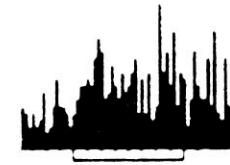
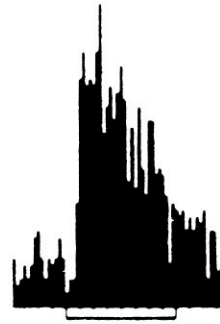
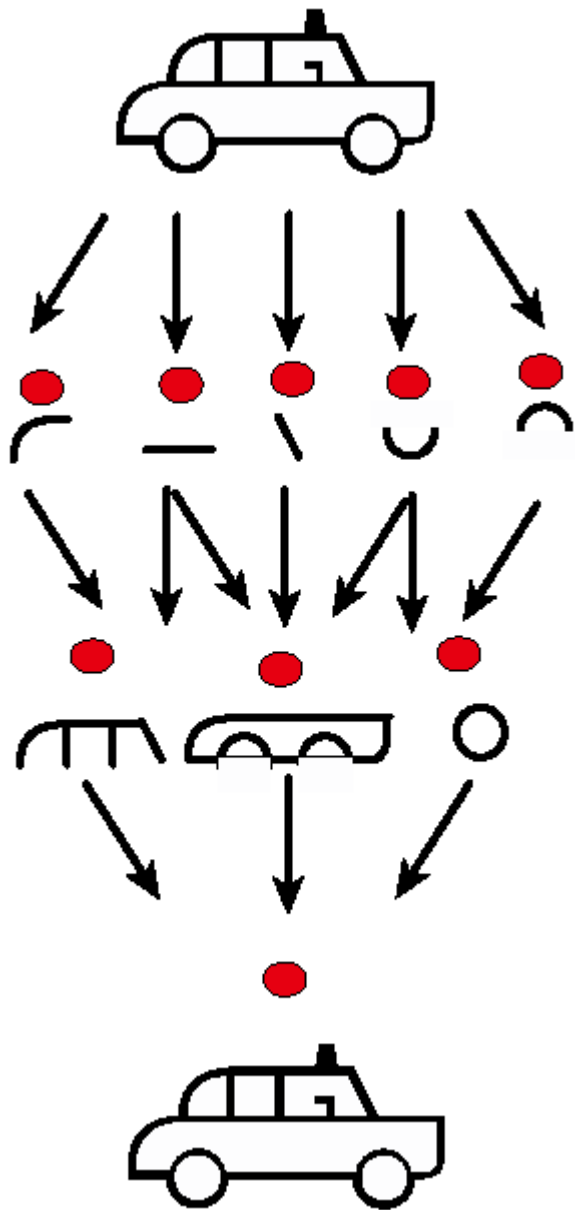


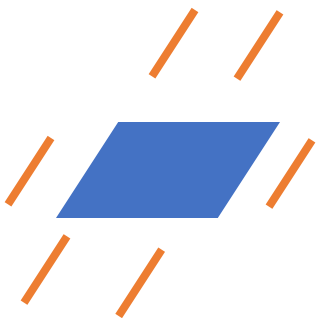
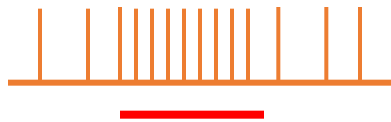
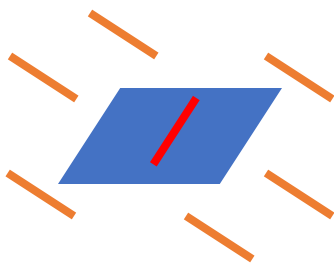
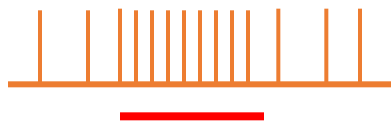
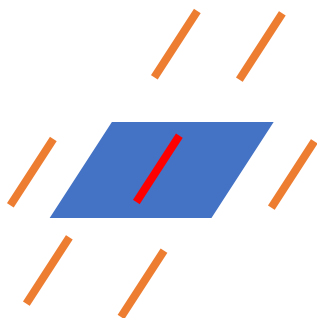


stimolo



percezione





Superior colliculus (Mesencephalon)

Sensory maps
'in frame'



Head and eye movements

