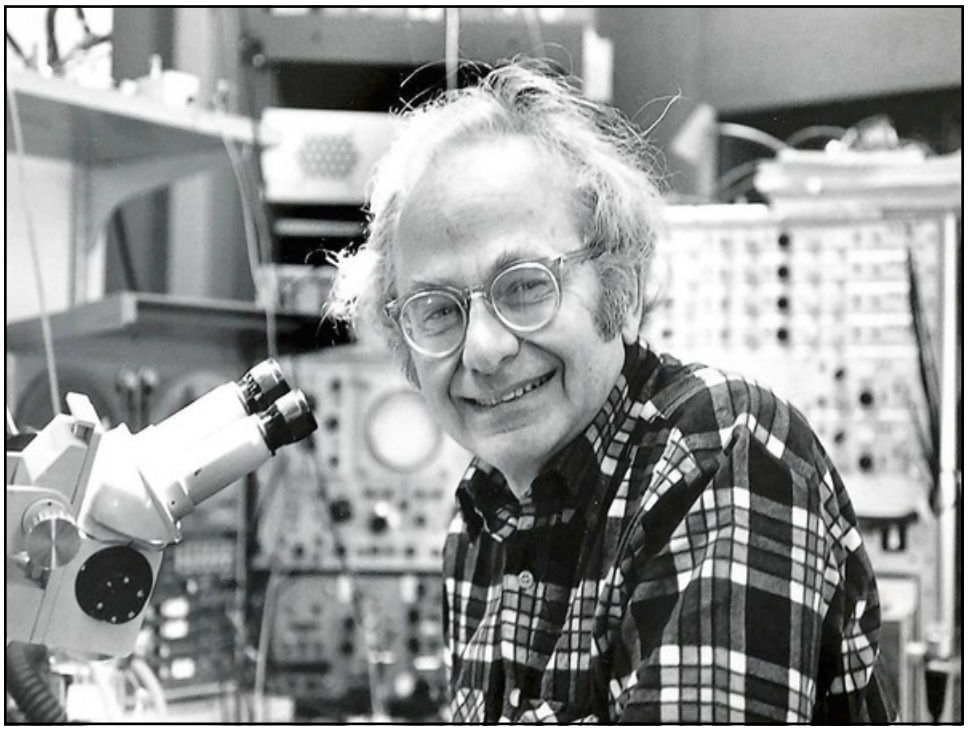

Visual System I

I. Eye, color space, adaptation
II. Receptive fields and lateral inhibition
III. Thalamus and primary visual cortex

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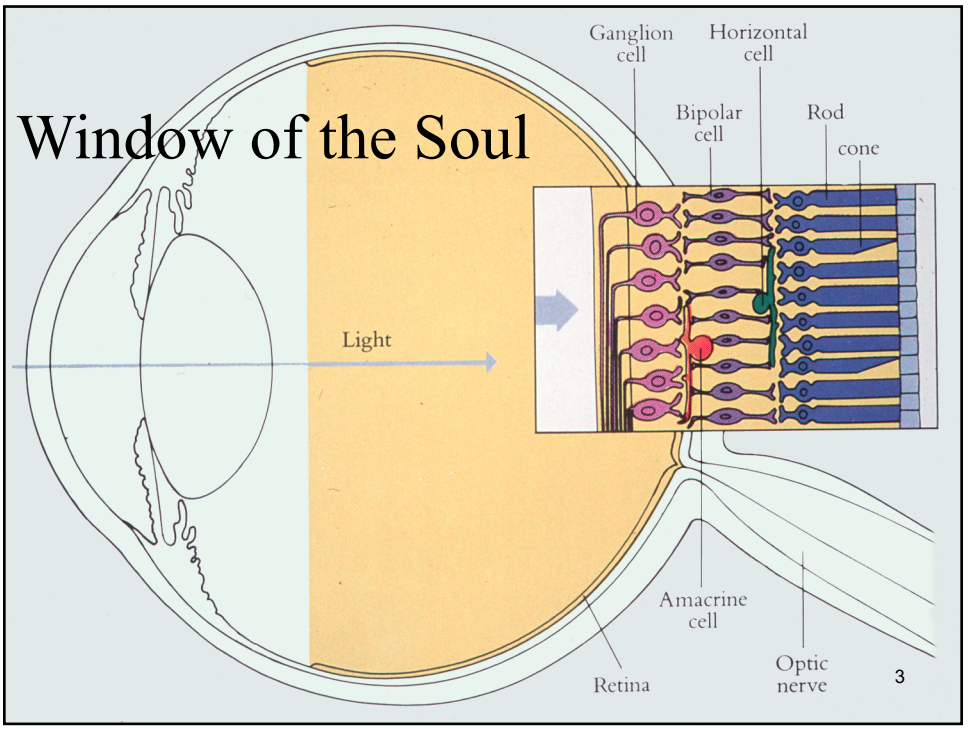
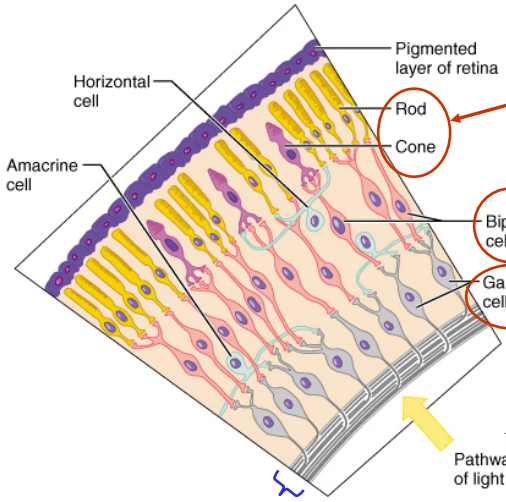
Window of the Soul



Information Flow: From Photoreceptors to the Optic Nerve



Layer 1: Photoreceptors

Layer 2: Bipolar cells

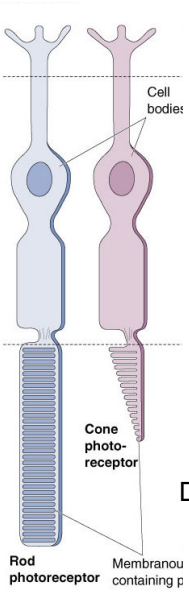
Layer 3: Ganglion cells

Stimulus: Light

Output: Optic Nerve

Types of Photoreceptors

Rods are specialized to detect in dim light, and do not detect color

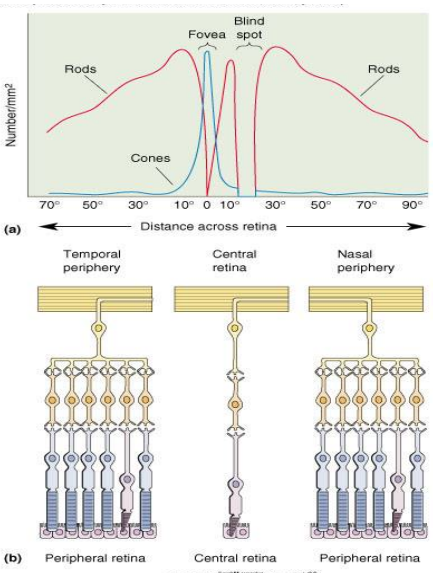


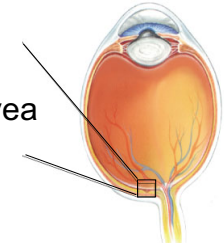
Cones are specialized for detecting **color** and bright light

Disks containing photopigment (light absorber)

5

The Distribution of Rods and Cones Differs Across the Retina





20 X more rods than cones

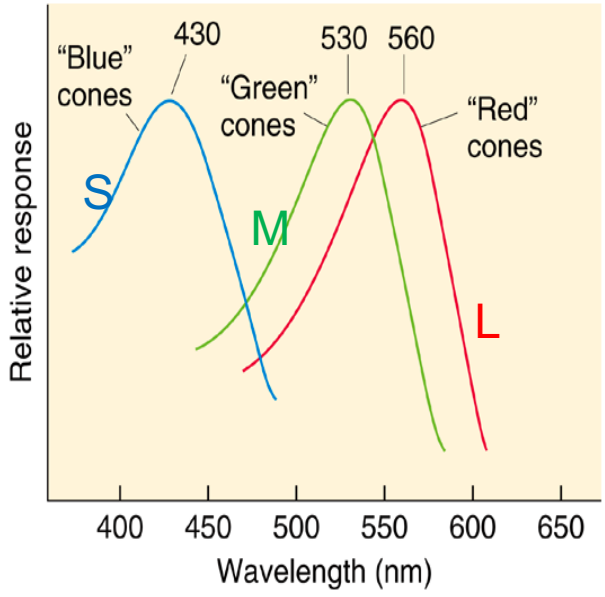
Rods	Cones
-Periphery	-Fovea
-Dim light	-Bright light
-Black & white	-Color
-Signal amplification	-Little pooling (fine discrimination)
-Much pooling (noise reduction)	

6


7


Red is important!
8

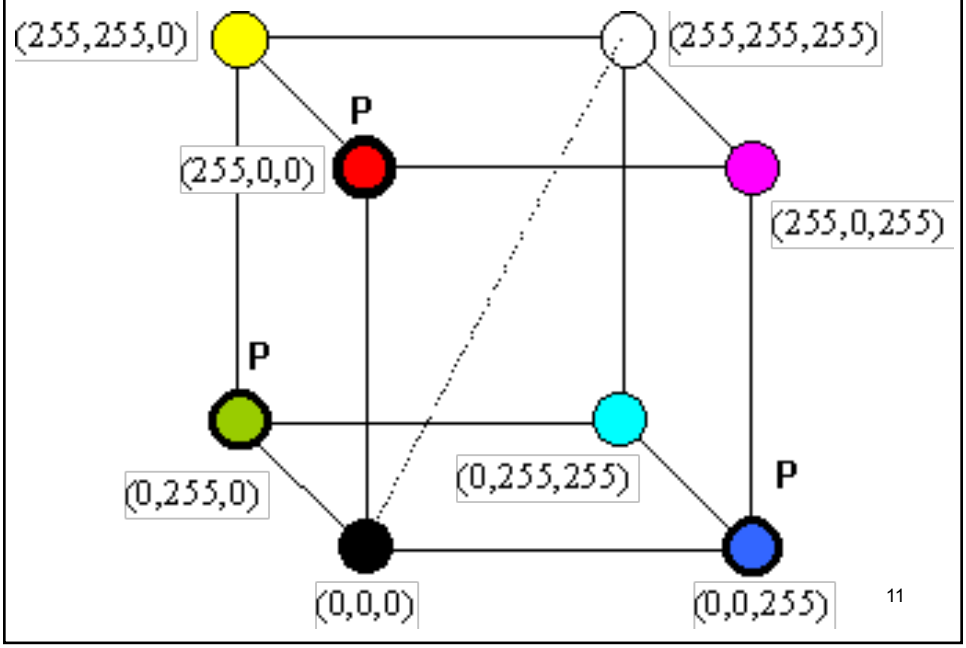
Cone tuning curves



9

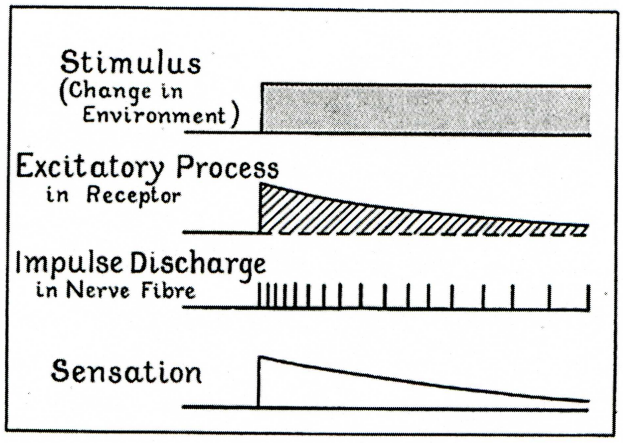
Color perception is based on the **relative activation** of the three cone types—a single cone type carries NO color information

Cone color space



11

Adaptation: decreasing response to a constant stimulus



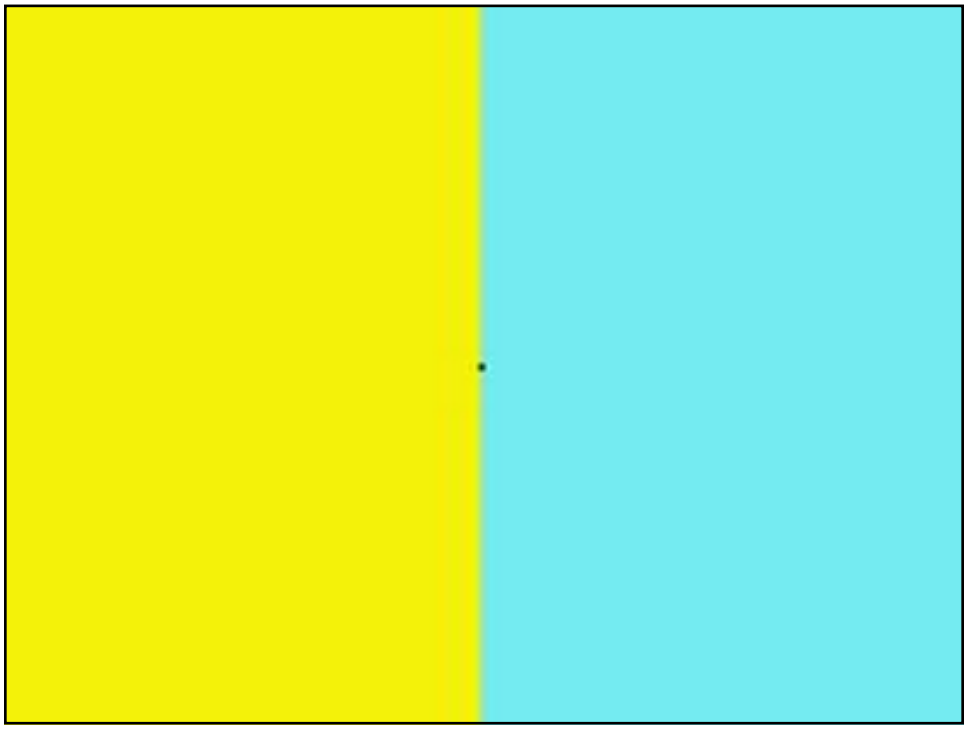
Firing rate code

FIG. 31. RELATION BETWEEN STIMULUS, SENSORY MESSAGE AND SENSATION.

Edgar Adrian "The Basis of Sensation" 1928

13

14



Visual System I

I. Eye, color space, adaptation
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III. Thalamus and primary visual cortex

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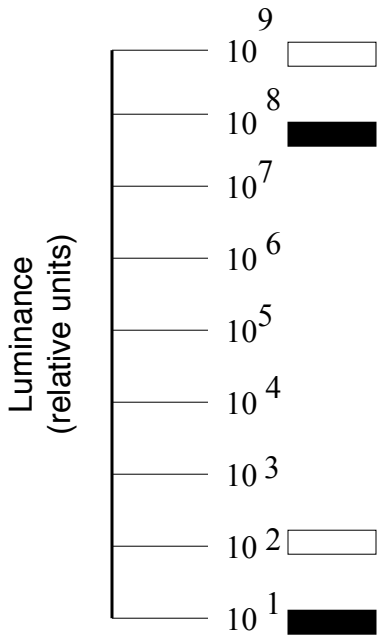


Amount of light from the white of a newspaper viewed in direct sunlight

Amount of light from the black text of a newspaper viewed in direct sunlight

Amount of light from the white of a newspaper viewed indoors

Amount of light from the black text of a newspaper viewed indoors

19

20

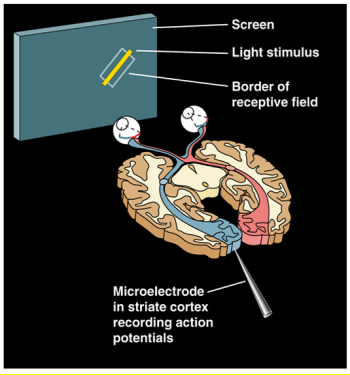
this is the same gray as the center of the O in "off"

this is the same gray as the top part of the S in "gloves"

21

Receptive Field:

An area in which stimulation leads to response of a particular sensory neuron.



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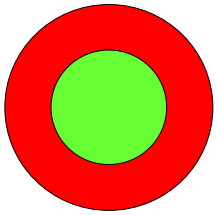
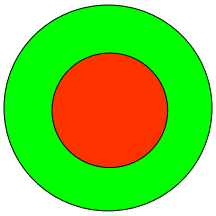
Antagonistic center-surround spatial receptive fields

2 classes of cells:



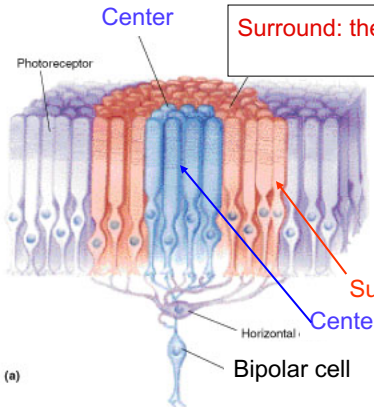
On-center:
prefer light at center
and
dark in surround



Off-center:
prefer dark at center
and
light in surround

Receptive Field of Retinal Bipolar Neurons

= the area of the retina that, when stimulated with light, influences the activity of a bipolar cell



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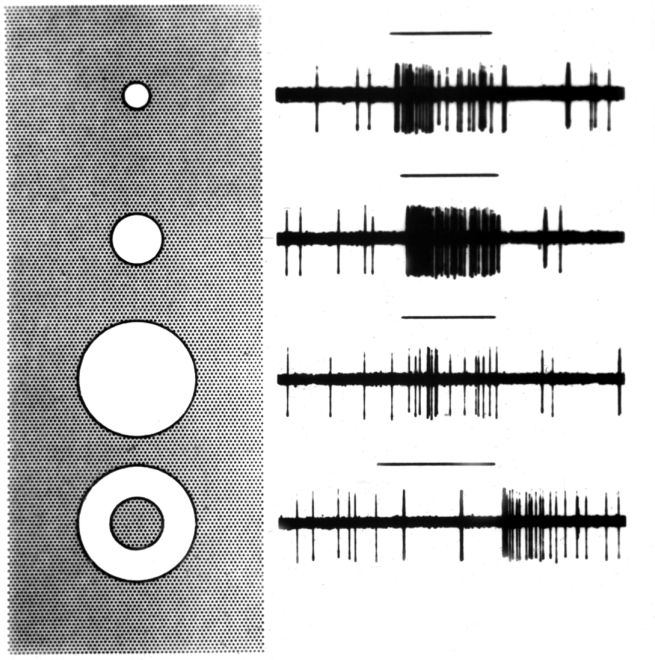
Retinal ganglion cells also fire according to a center-surround organization



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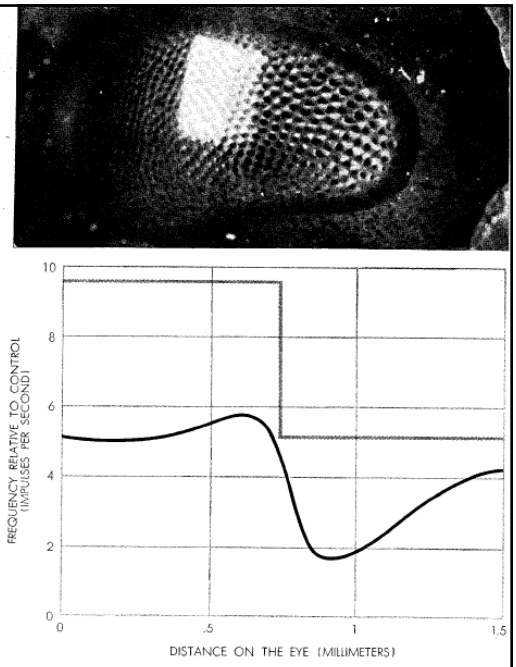
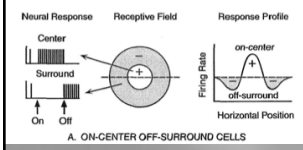
Mach Bands

Lateral inhibition produces contrast enhancement

"...at the expense of fidelity of representation."



Lateral inhibition produces center-surround RFs, which produce contrast enhancement



A. ON-CENTER OFF-SURROUND CELLS

Eye Summary

- Sensory responses depend on the recent history of stimulation, due to adaptation effects
- Bipolar cells integrate a neighborhood of photoreceptor responses to exhibit antagonistic center-surround receptive fields
- Retinal ganglion cells integrate bipolar responses and send action potentials into brain
- Center-surround RFs (lateral inhibition) enhance spatial contrasts
- Luminance and color information are processed in parallel by different cells

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Visual System I

I. Eye, color space, adaptation
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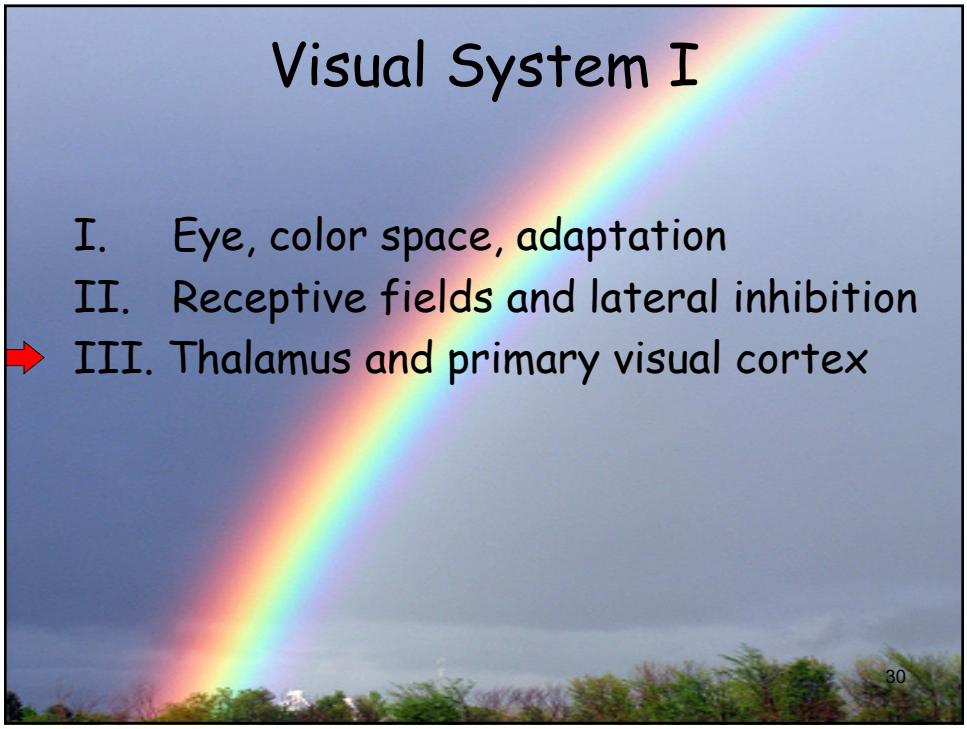
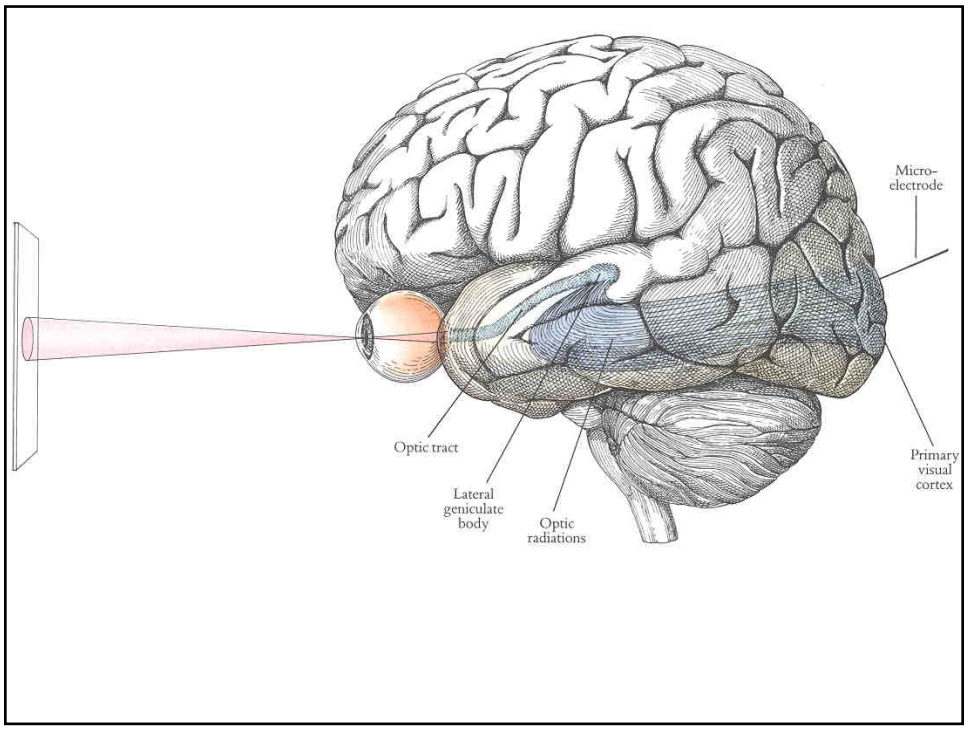
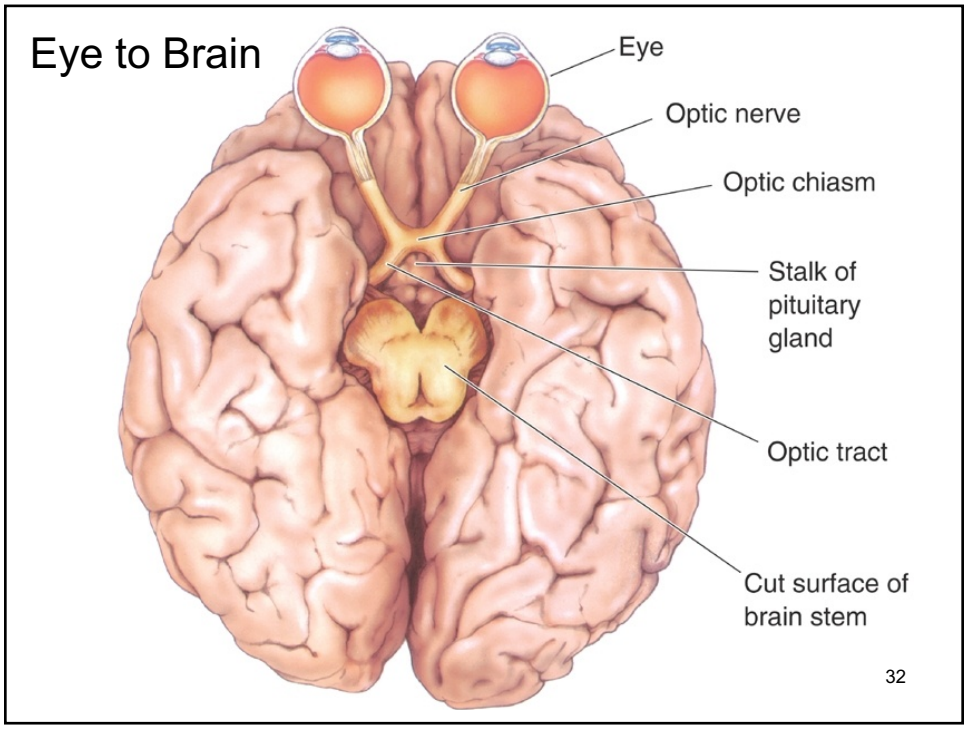
III. Thalamus and primary visual cortex



30


Micro-
electrode
Optic tract
Lateral
geniculate
body
Optic
radiations
Primary
visual
cortex


Eye to Brain
Eye
Optic nerve
Optic chiasm
Stalk of
pituitary
gland
Optic tract
Cut surface of
brain stem
32

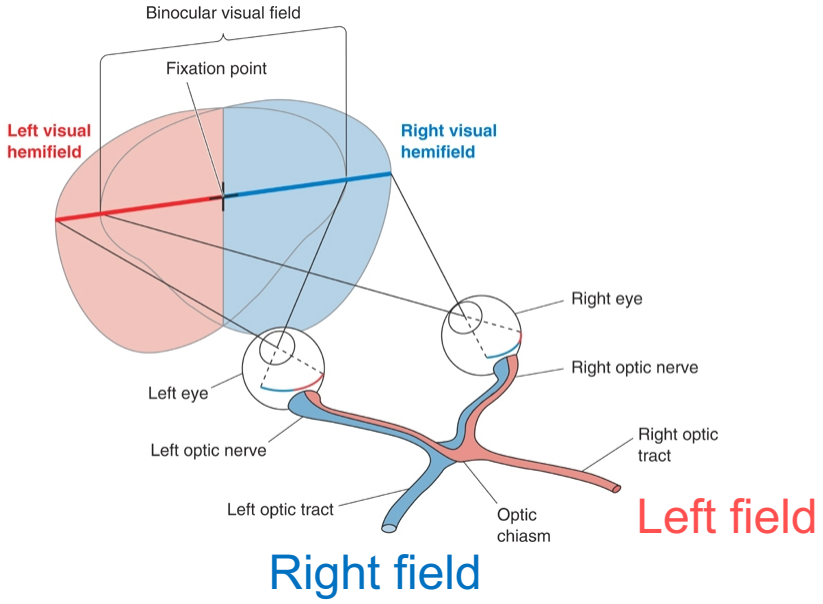


Figure 10.3

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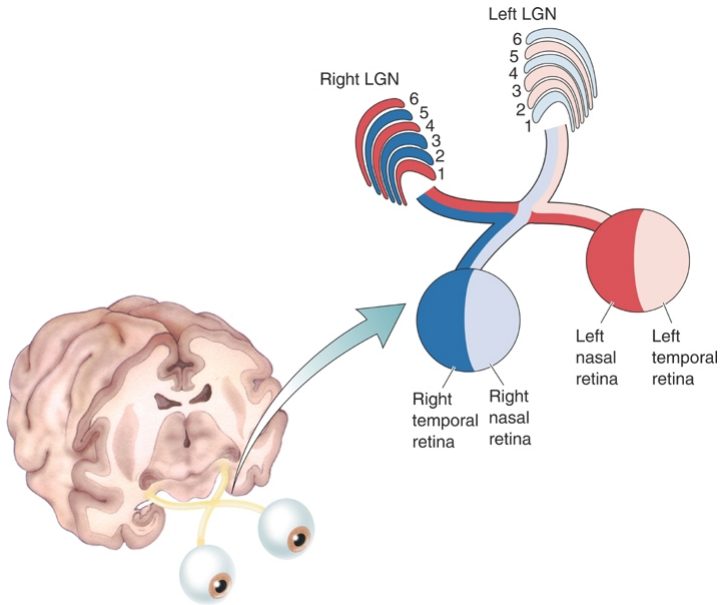
Retinal Inputs to the Right and Left LGN



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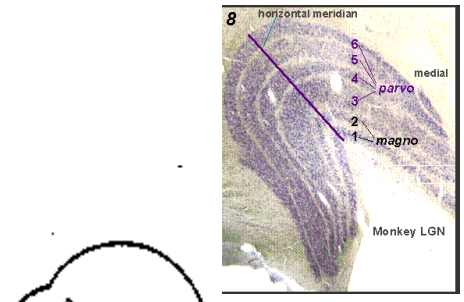
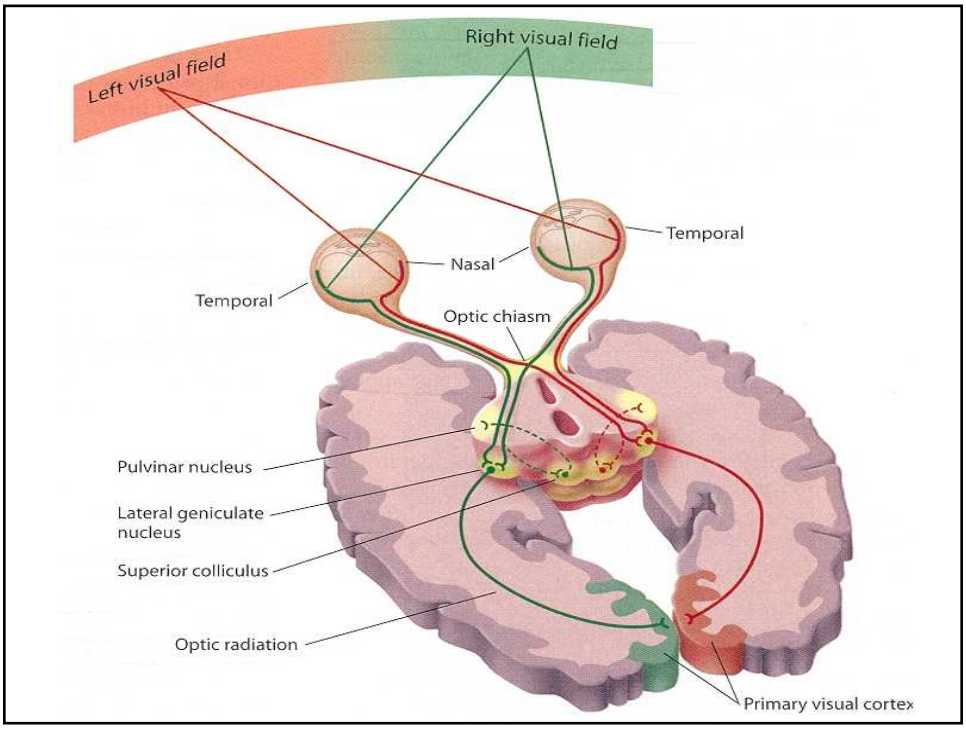
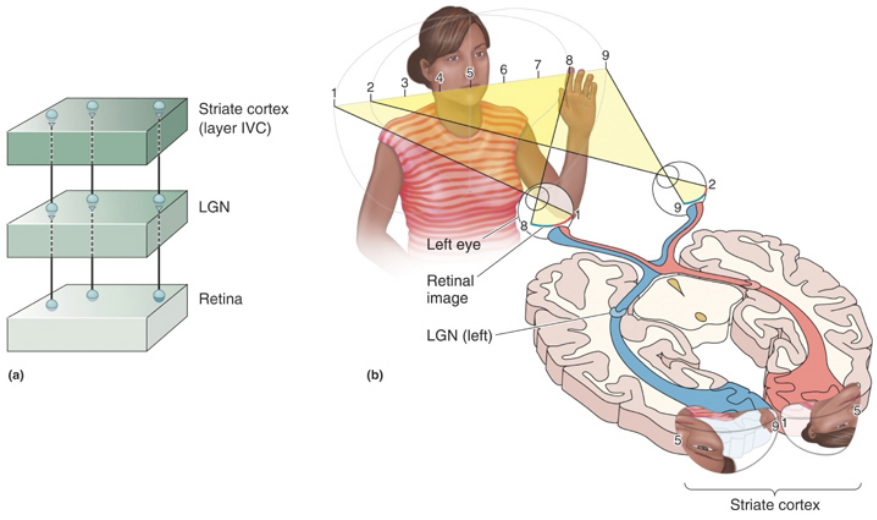
"Geniculate" means bent like a knee



35



The striate cortex (V1) contains a retinotopic map



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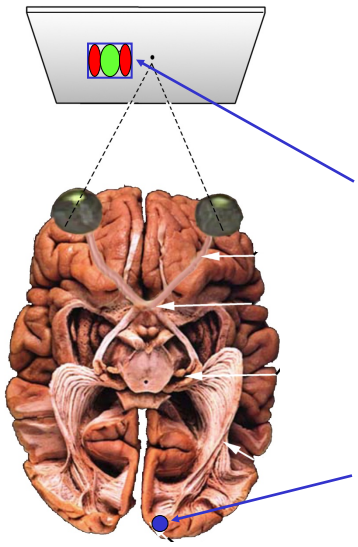
Spatial Receptive Fields

Spatial receptive field = region of visual field to which a cell responds



Receptive field of this V1 cell is to the left of where the eyes are looking
(Green = locations where light would cause cell to be excited
Red = locations where light would cause cell to be inhibited)

Cell in V1

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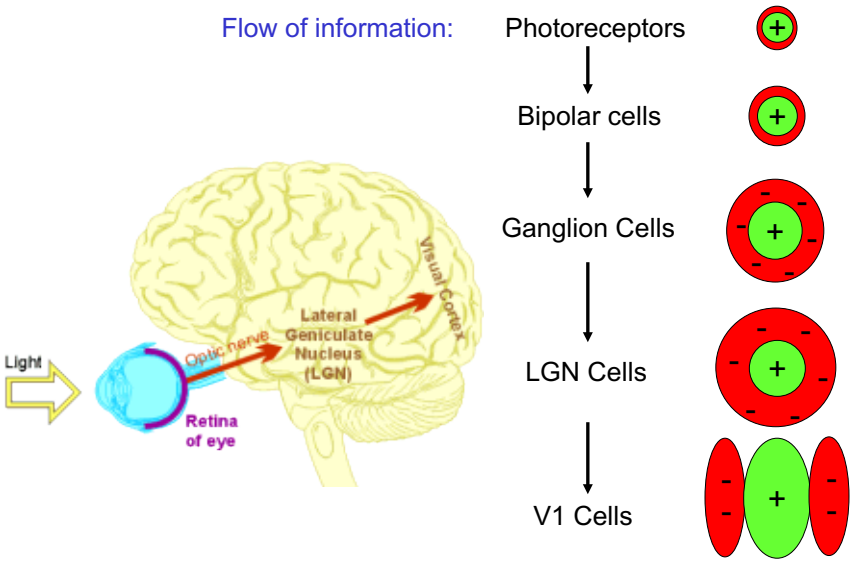
Shapes of Spatial Receptive Fields
From the Eye to Primary Visual Cortex

Flow of information:



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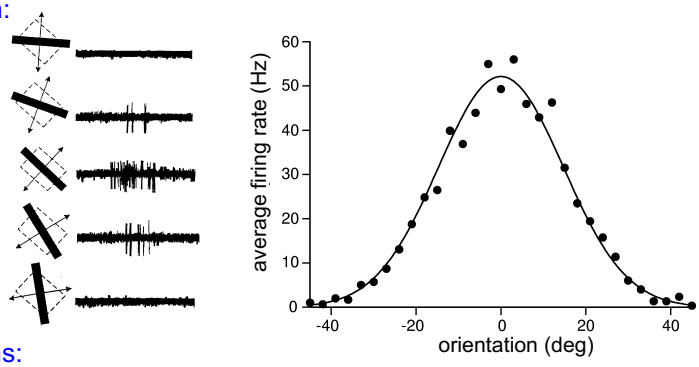
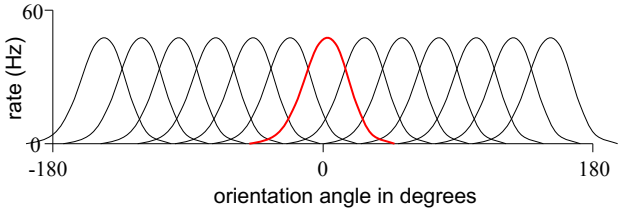
Tuning Curves in the Primary Visual Cortex

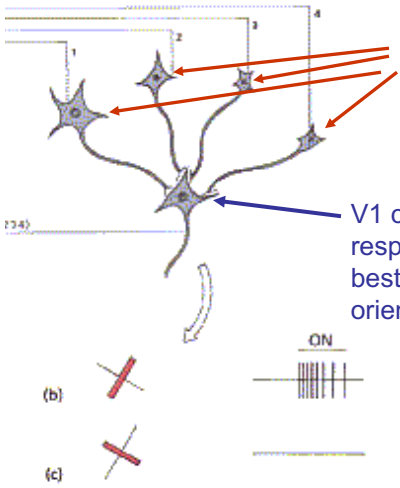
Single neuron:



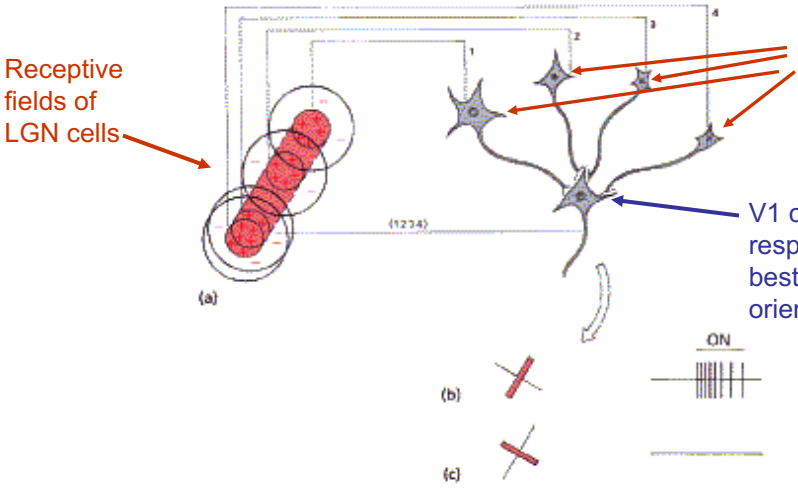
Many neurons:



Simple Feedforward Network: How V1 Receptive Fields are Formed from LGN RF's



Simple Feedforward Network: How V1 Receptive Fields are Formed from LGN RF's



Hubel & Wiesel, 1962

Conclusions

- Receptive fields and tuning curves characterize the response properties of sensory neurons
- Visual neurons are arranged in retinotopic "maps"
- Different sensory features are processed in parallel in different brain areas
- More complex and specific features-sensitivities are constructed from lower-level features (hierarchy)

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