COGS 17 Week 6

Spring 2024, A03

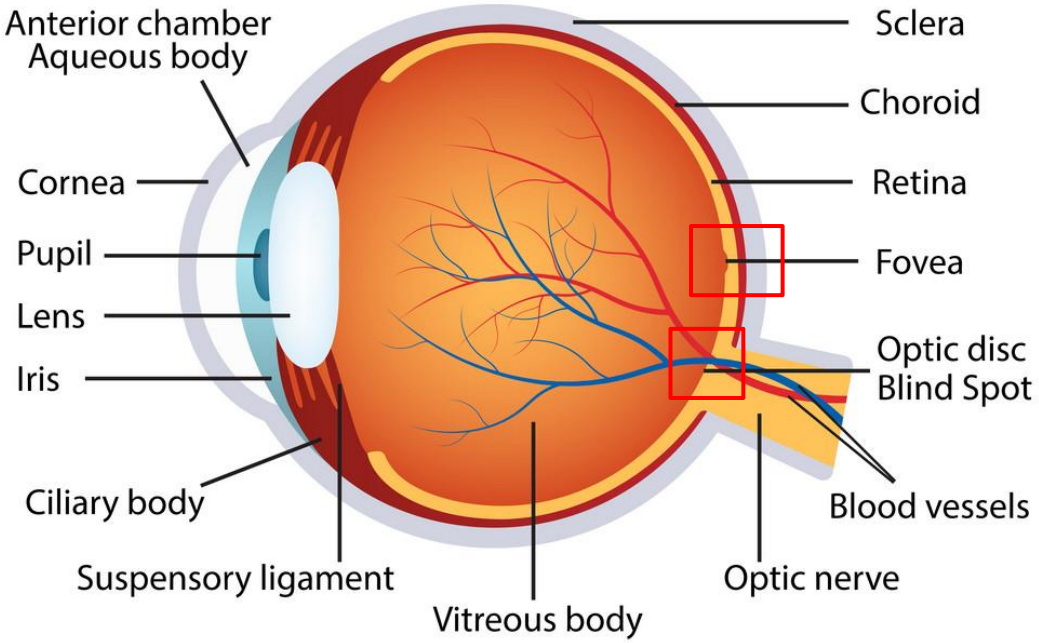
Slides Adapted From Previous Quarter

By: Jason Chen

Problem Set for Today

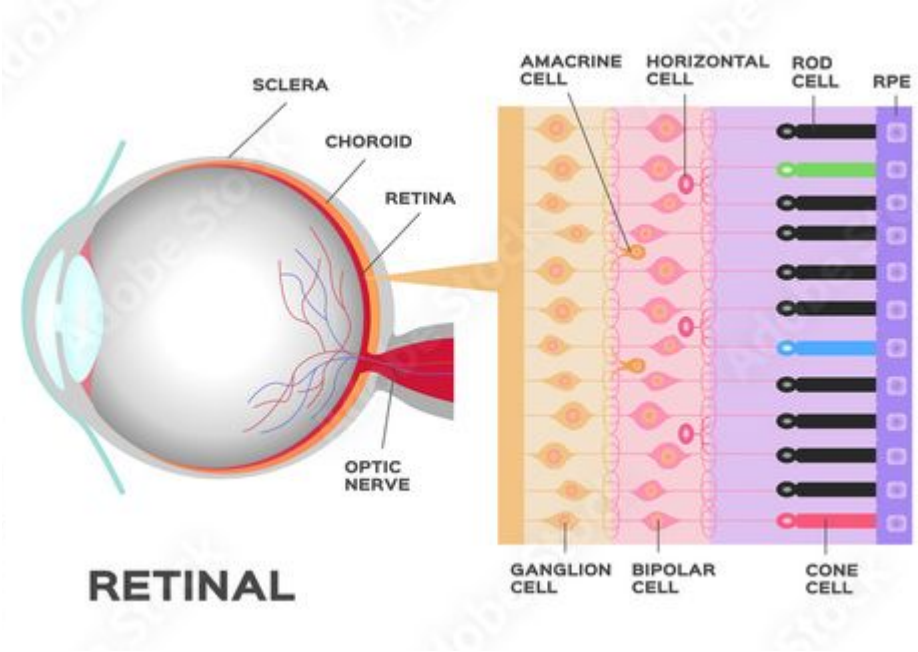
- Link: https://docs.google.com/document/d/1nTU6VCFQa2Fe893e1CsXCqFaoqiIFe9kIxi9zELD5FI/edit?usp=sharing

The Eye



- Fovea -- Small central area of high concentration of **Cones** only, for **HIGH DETAILS**
- Retina -- Senses light, send information to the brain through >>
- Optic nerve
- Blind Spot -- **No** Receptors here

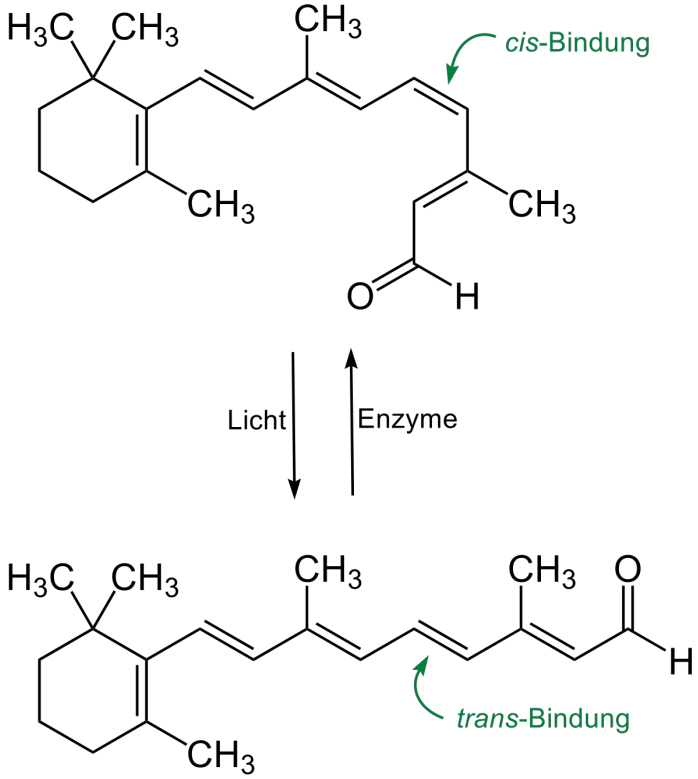
The Retina



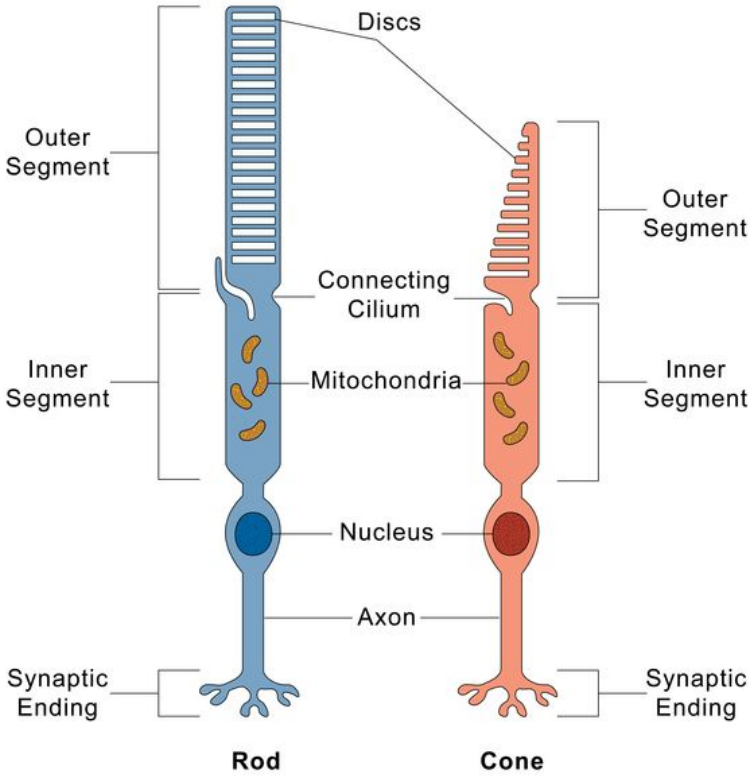
- Receptors -- Rods & Cones
- Bipolar cells -- Postsynaptic to Receptors
- Ganglions -- Axons of the Ganglion Cells form the Optic Nerve
- Interneurons -- perpendicular to pathway, influence above neurons
- Pigment Epithelium -- Non-neural cells, feed & recycle nutritions from receptors;
  helps reflect/maximize light

Isomerization

- Converting light into a neural signal
- Photopigment -- Made of Opsin & Retinal
- 11-Cis Retinal absorbs photon of light, **changes shape** >> detaches from Opsin >>
- Activates second messengers in receptor >> ion gates closing >> modifying **GRADED** release of NT
- Photopigment regeneration -- using Enzymes from Pigment Epithelium, requires time

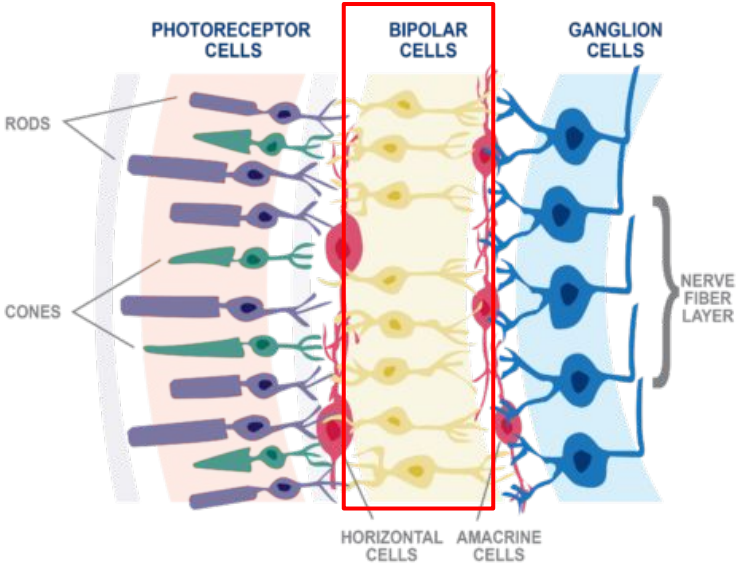


Visual Receptors



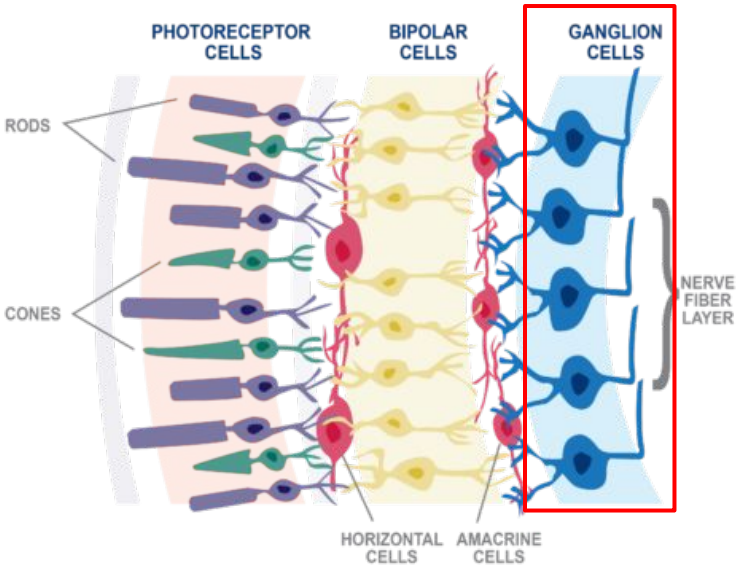
- Rods -- being larger, have MORE photopigment but only 1 kind >> **DO NOT** code color; **high** sensitivity; **poor** acuity; **excellent** for motion detection
- Cones -- smaller, have 3 kinds of photopigments >> **DO** code color; **low** sensitivity; **excellent** acuity; **poor** for motion detection
- Receptors show **Spontaneous** firing, **Graded** potentials, release **Inhibitory** NT

Bipolar Cells



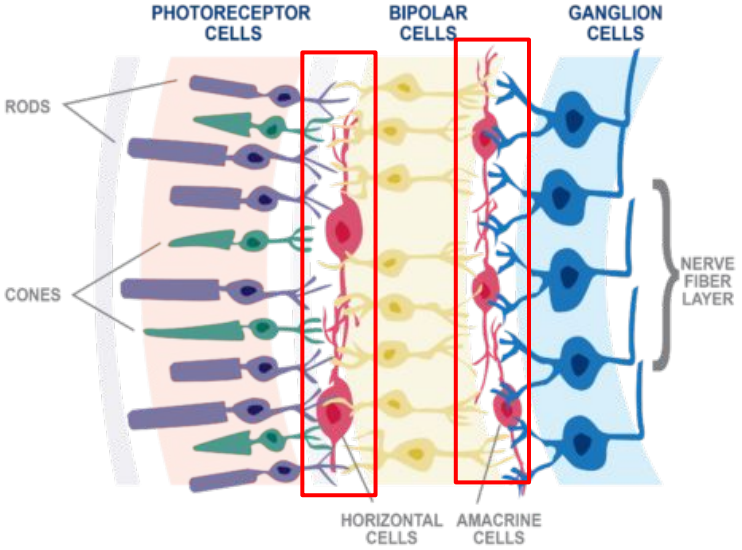
- Postsynaptic to Receptors, show **Spontaneous** firing, **Graded** Potentials, release **Excitatory** NT

Ganglion Cells



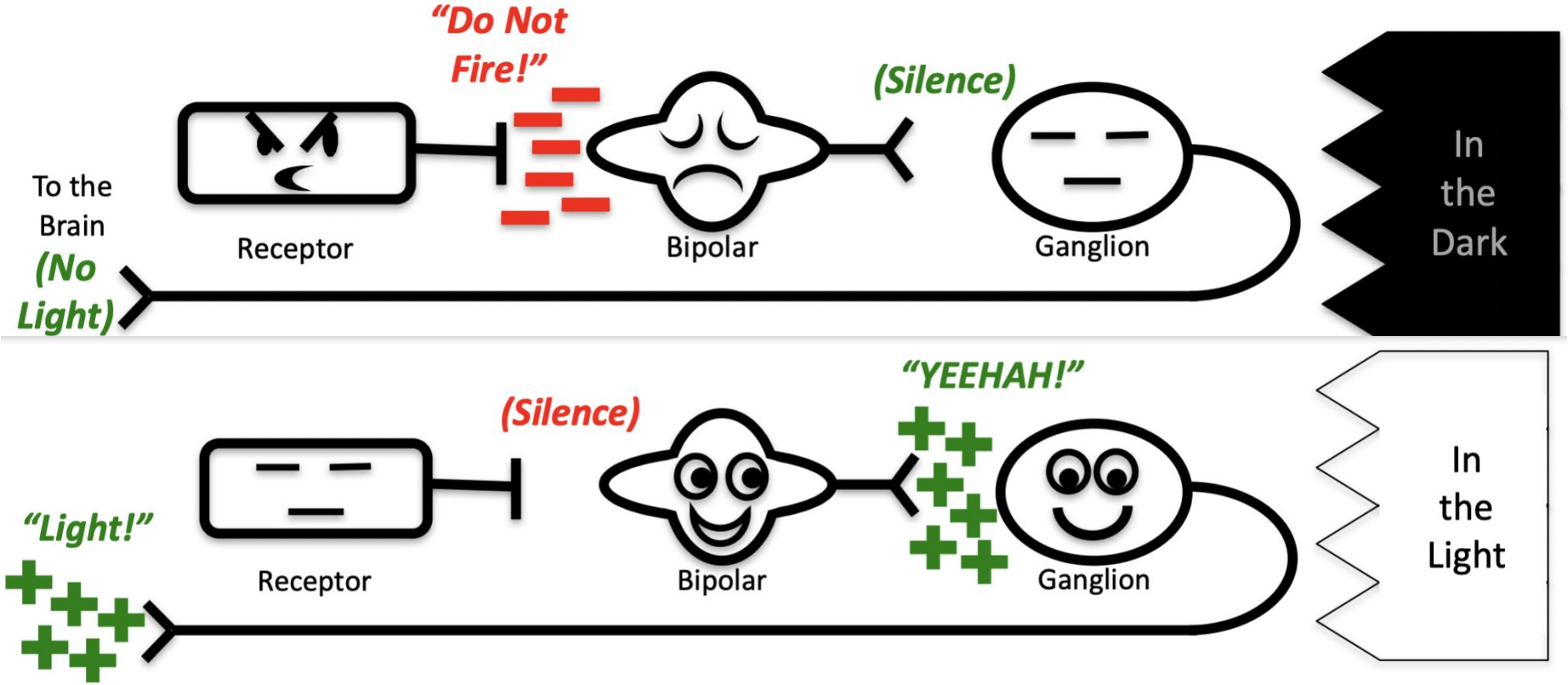
- Postsynaptic to Bipolars, show **Action** Potentials, release **Excitatory** NT

Interneurons



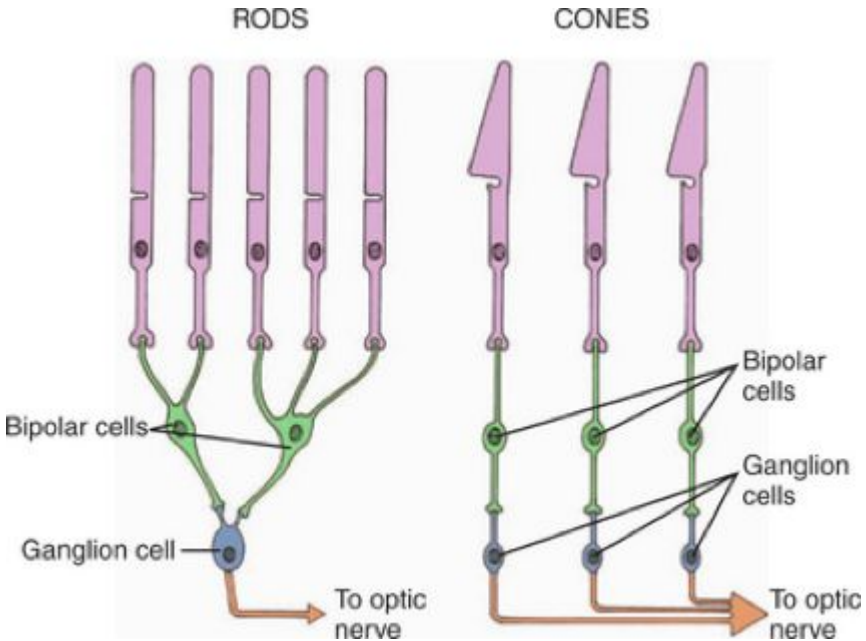
- Horizontal Cells -- **Graded** Potentials, mostly **Inhibitory** NT, modify interface of Receptors and Bipolars
- Amacrine Cells -- **Graded** Potentials, mostly **Inhibitory** NT, modify interface of Bipolars and Ganglions

Receptors Are Turned OFF By Light



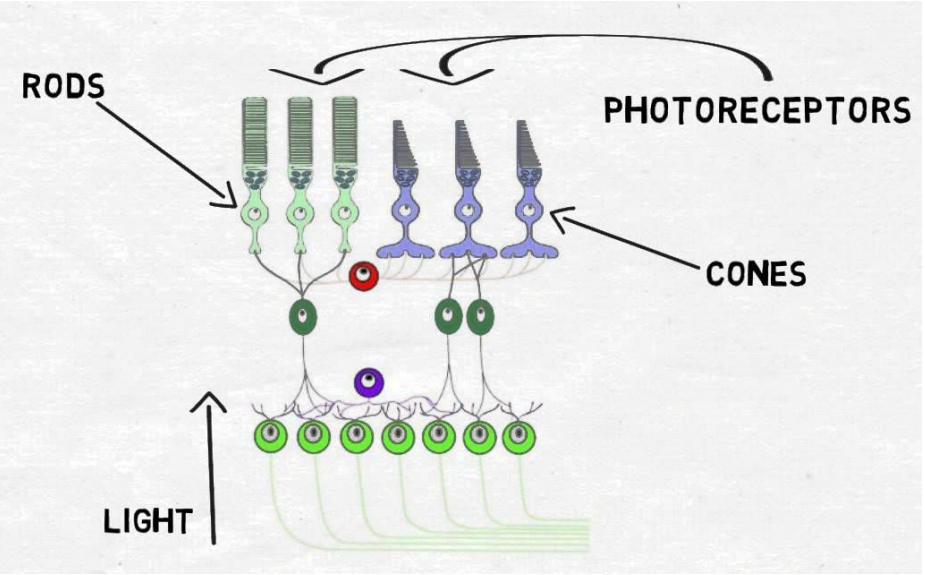
Connectivity Patterns

- Play a critical role in information transmission functions



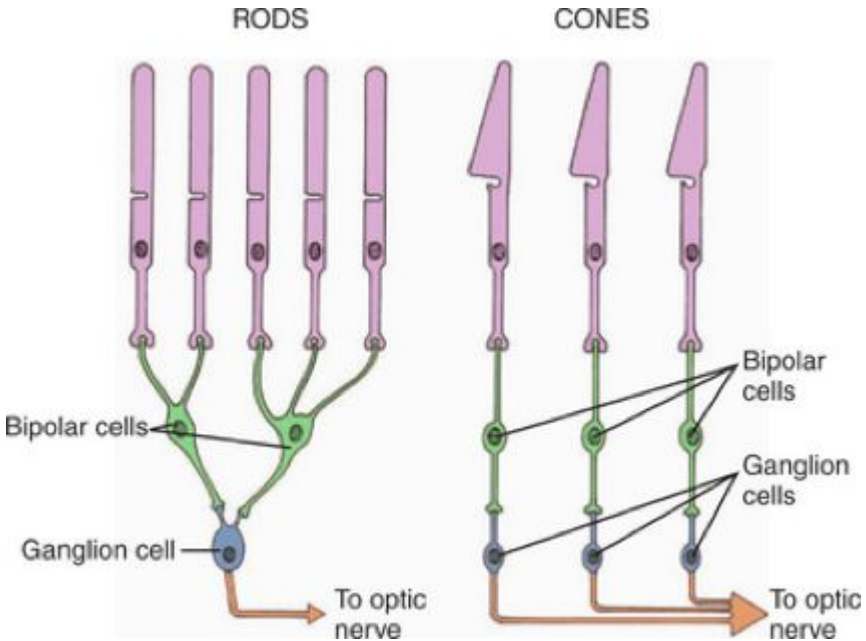
Convergence

- Receptors converge (via their Bipolars) onto Ganglion cells
- Rods -- **High** Convergence, avg. 120:1 Ganglion
- Cones -- **Low** Convergence, avg. 6:1 Ganglion
- In Fovea: **Very Low**, often only 1:1 Ganglion

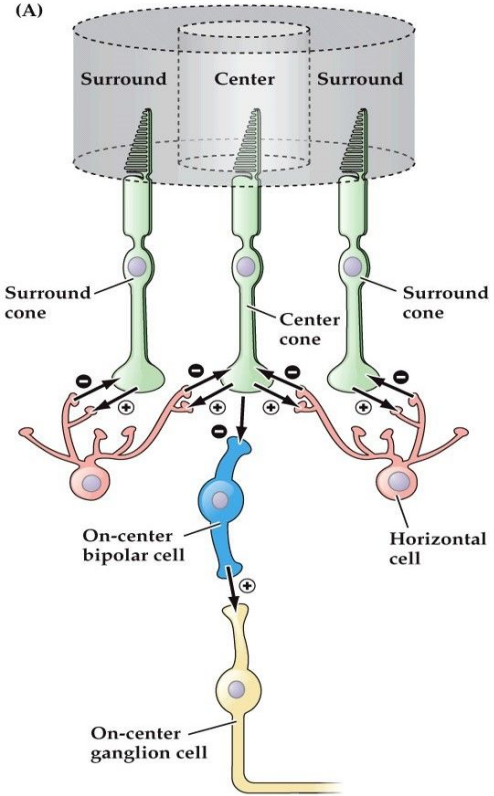


Convergence

- Helps to account for acuity and sensitivity differences between rods & cones
- Also, Rods are **LARGER** and have **more Photopigment** than Cones do, and this also contributes to sensitivity

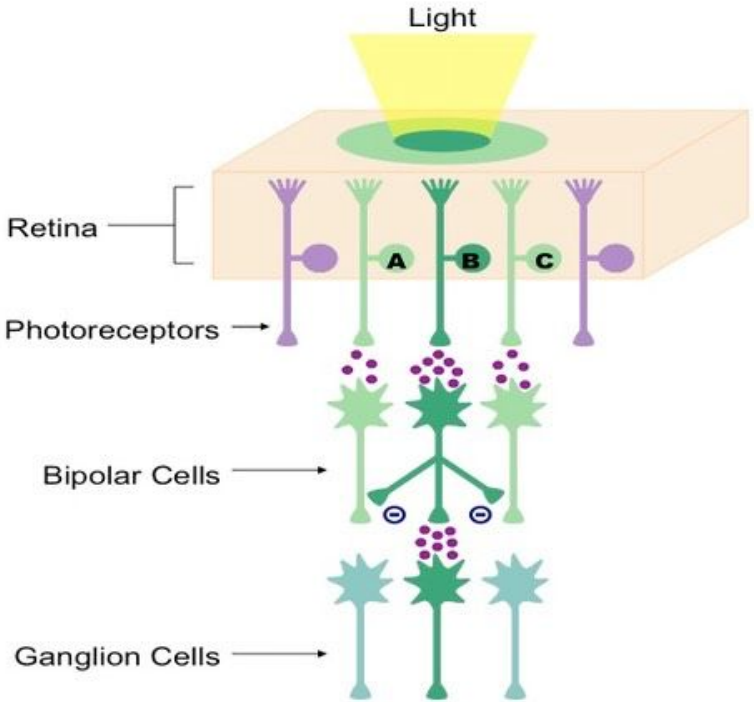


Receptive Fields



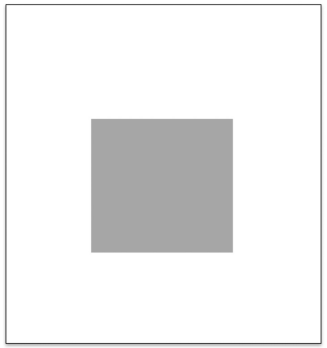
- Set of Receptors whose activity influences the activity of a “Target” cell
- Size and type of a Target’s RF is determined by **patterns** of Convergence and **Lateral influences**
- Example 1: Ganglion along path from converging Rods has large RF, while Ganglion along path from Cones has small RF
- Example 2: Some Ganglions, LGN, and V1 cells have Center-Surround RFs

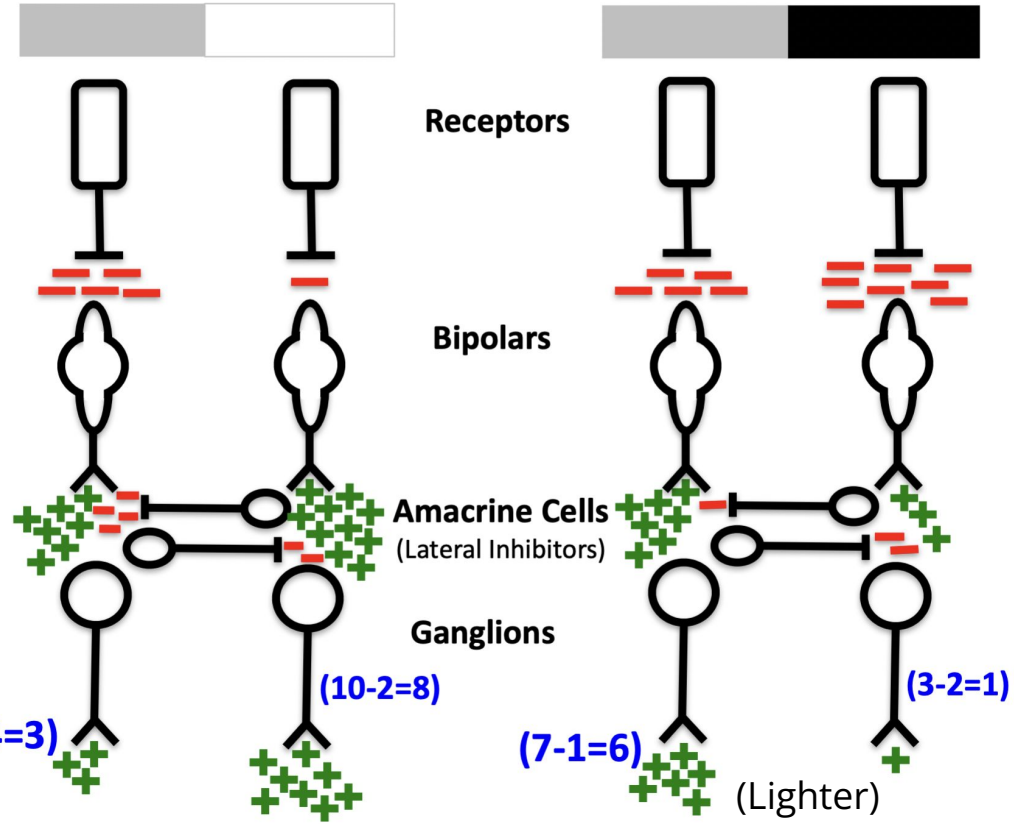
Lateral Inhibition



- A neuron's response to a stimulus is **inhibited** by the excitation of a **neighboring** neuron
- Mainly to exaggerate **differences**
- Example: simultaneous contrast

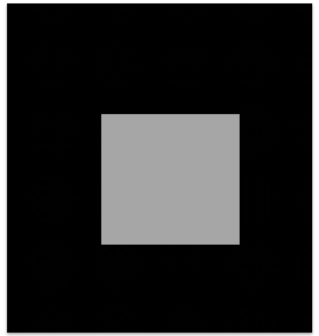
Simultaneous Contrast



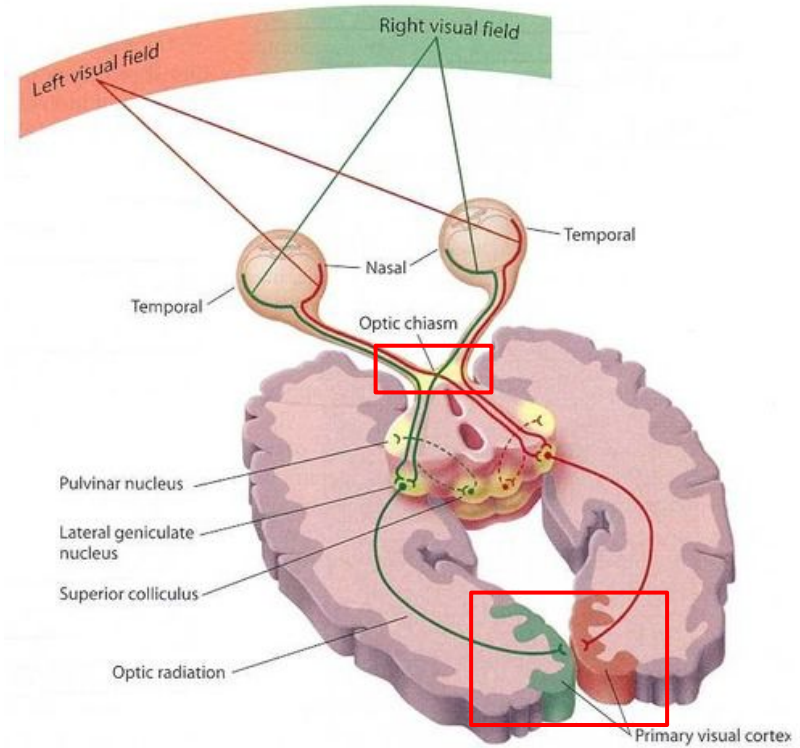


(Darker)

(Lighter)

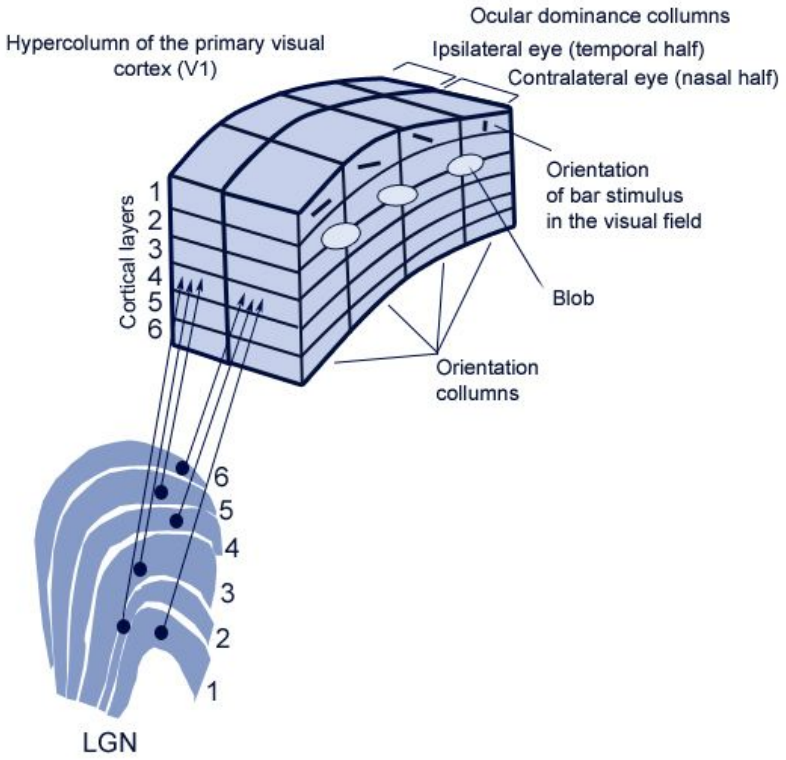


Visual Crossover



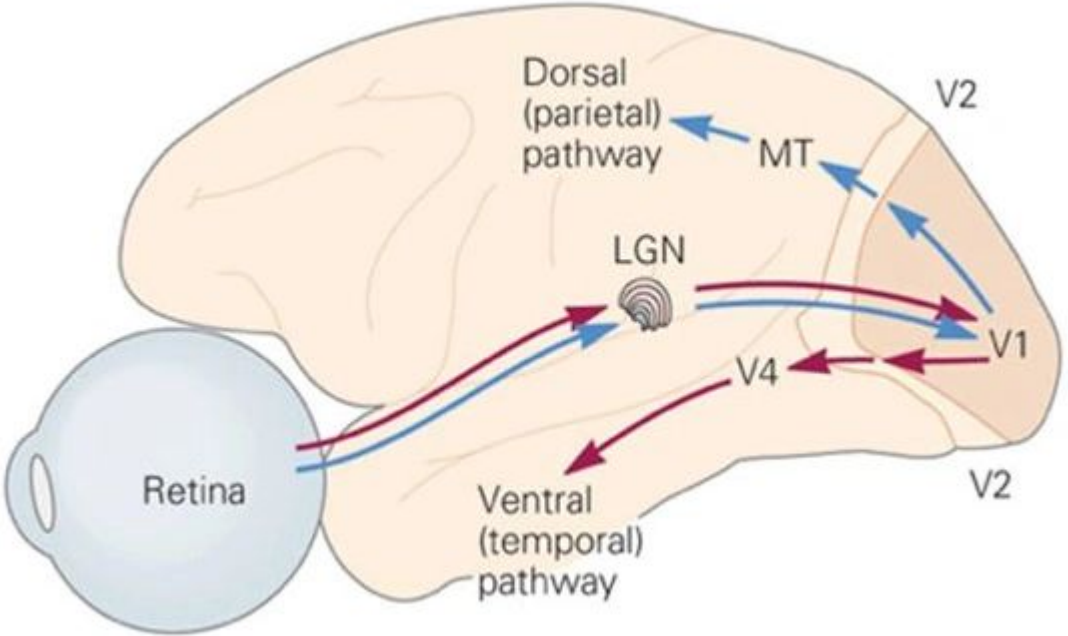
- Each Optic Nerve, from each eye, divides and goes to both sides of the brain
- Info from **Left** Visual Field => Retina on **right** side of RIGHT eye => **right** LGN => **right** Visual Cortex
- Info from **Right** Visual Field => Retina on **left** side of RIGHT eye => **crossover** at the Optic Chiasm => **right** LGN => **right** Visual Cortex
- Info from cortex exchange across corpus callosum

Visual Cortex



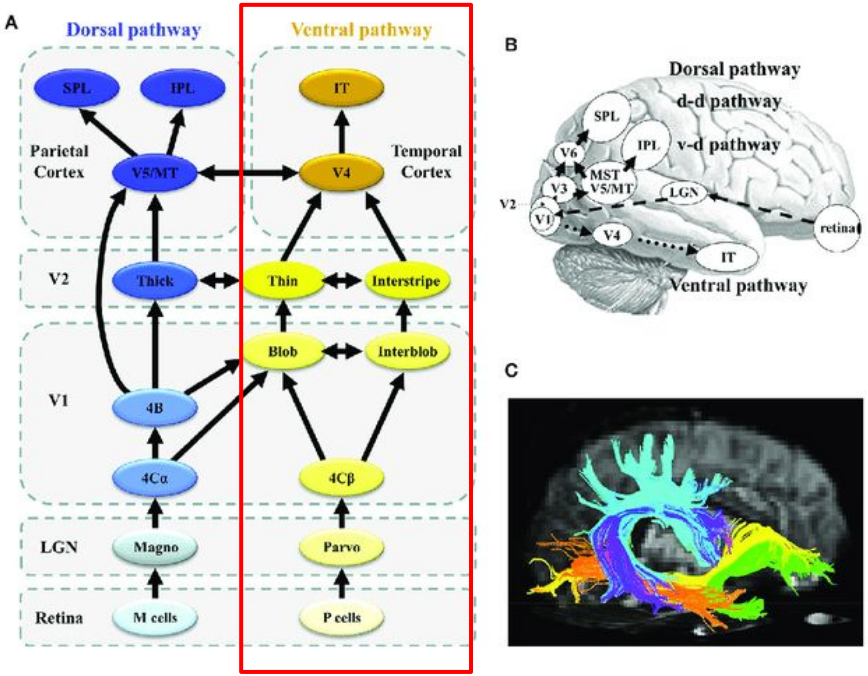
- Cells in all 6 layers that respond to same “preferred” stimulus
- E.g. lines of a particular Orientation
- Hypercolumn -- One set of orientation column w/same Receptive Field
- All cells within a given Hypercolumn have same Receptive Field
- One hypercolumn includes columns set of full orientations, plus Blobs for color processing

Visual Pathways



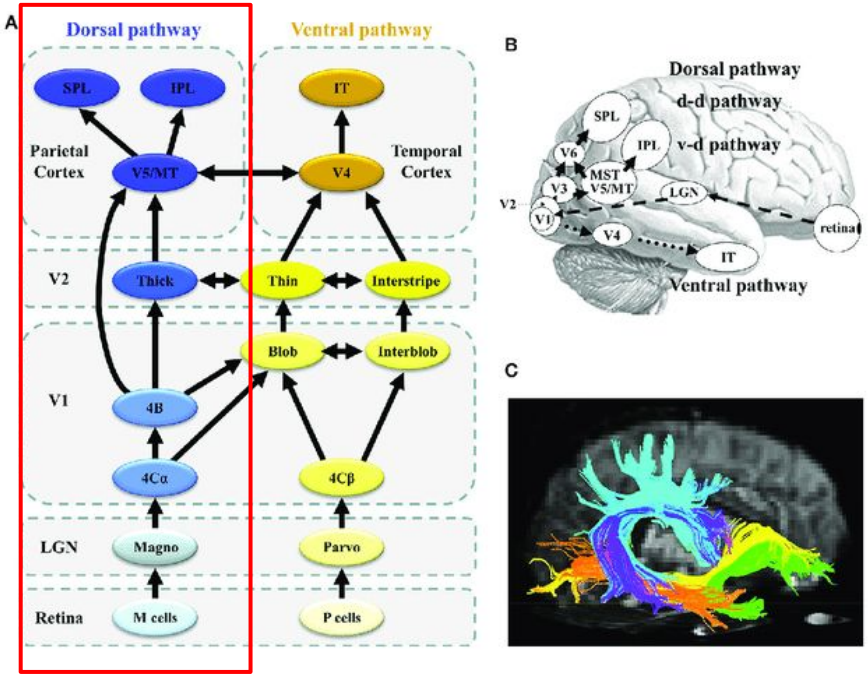
- Parvocellular Pathway (Who/What Pathway, Ventral Pathway) -- For **identifying** stimuli
- Magnocellular Pathway (Where/How Pathway, Dorsal Pathway) -- For **visual-spatial mapping**

Parvocellular Pathway



- Specialized for **color & detail**
- Begins at Cones in and near Fovea
- Mostly Parvocellular (small) Ganglions, with small RFs
- Basic pathway: Retina >> Top 4 Layers of LGN in Thalamus >> V1 >> V2 >> V3 >> V4 (all in occipital lobe) >>Inferior Temporal Cortex

Magnocellular Pathway



- Specialized for detecting motion, locating objects, navigating & manipulating environment including gross outline
- Begins at Rods & Cones in periphery of Retina
- Basic pathway: Some of info to Superior Colliculus of Midbrain (e.g. for “Blindsight”), then to LGN; Most go directly to LGN >> All info >> V1 >> V2 >> Medial Temporal Cortex >> Medial Superior Temporal Cortex >> Posterior Parietal Cortex

Questions?

Office Hours: Mon 5-6 pm

To get the section slides: https://github.com/JasonC1217/COGS17-A03-Sp24

OR: