Section 3
Vision

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COGS 17 A04

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Before We Begin 1

Summer Internships in Affective Science available at the Emotion, Health, and Psychophysiology Lab at Yale University — Summer 2025

- an eight-week internship program (June 9 - August 3, 2025) for undergraduates who are interested in conducting research at the intersection of social psychology, health, emotion, and psychophysiology
- Interns are involved in conducting lab studies, field studies, acquiring autonomic data, editing and scoring physiological responses, attending weekly tutorials, lab meetings, and professional development seminars.
- Course credit from home universities can be arranged, and stipends are available.

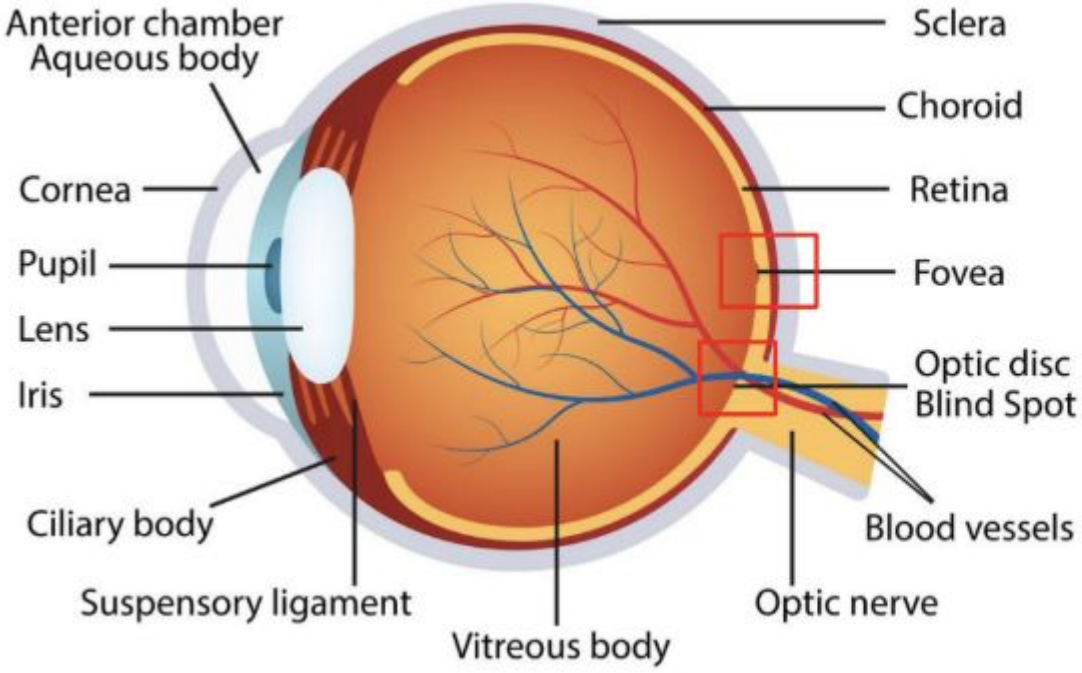
Before We Begin 2

Q. Causes of Demyelination

Multiple sclerosis (MS) is an immune-mediated disease affecting the **brain** and **spinal cord**.

- **Immune System**: The primary theory is multiple sclerosis is an autoimmune disease. The body's immune system mistakenly attacks its myelin sheath or cells that produce and maintain it.
- **Environmental factors**: Several environmental factors such as latitude gradient (changes that occur along different latitudes including climate etc), and vitamin D deficiency might contribute to the development of the disease.
- **Genetic factors**: Genetics also plays a role in the development of multiple sclerosis (MS).

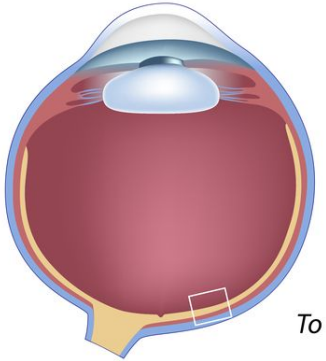
The Eye

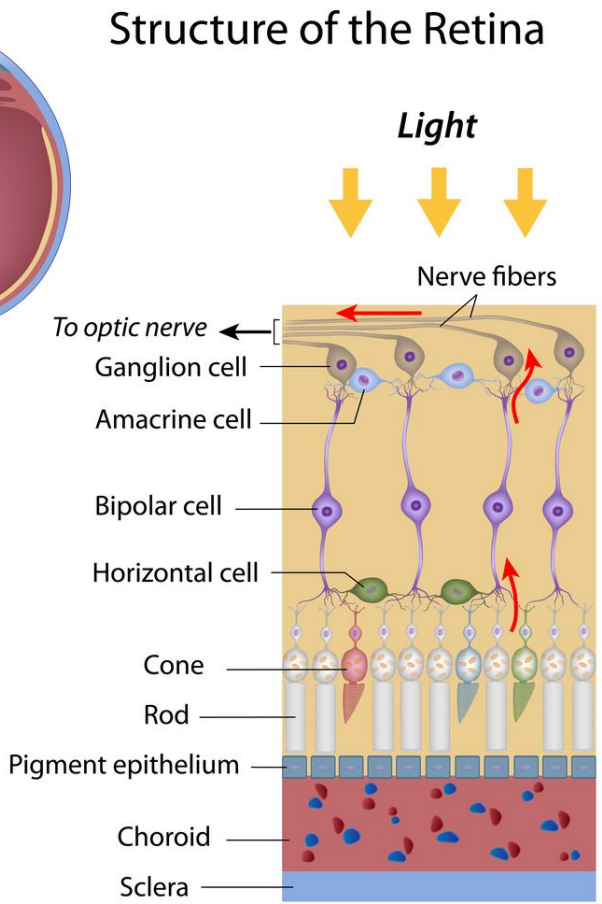


- **Fovea**: small central area of high concentration of **Cones** only, for **HIGH DETAILS**
- **Retina**: senses light, sends information to the brain through optic nerve
- Blind spot: No receptors here

- Light needs to pass through outer layers of the eye before it reaches the receptors (Cornea > Pupil > Iris > Lens > Receptors)

The Retina





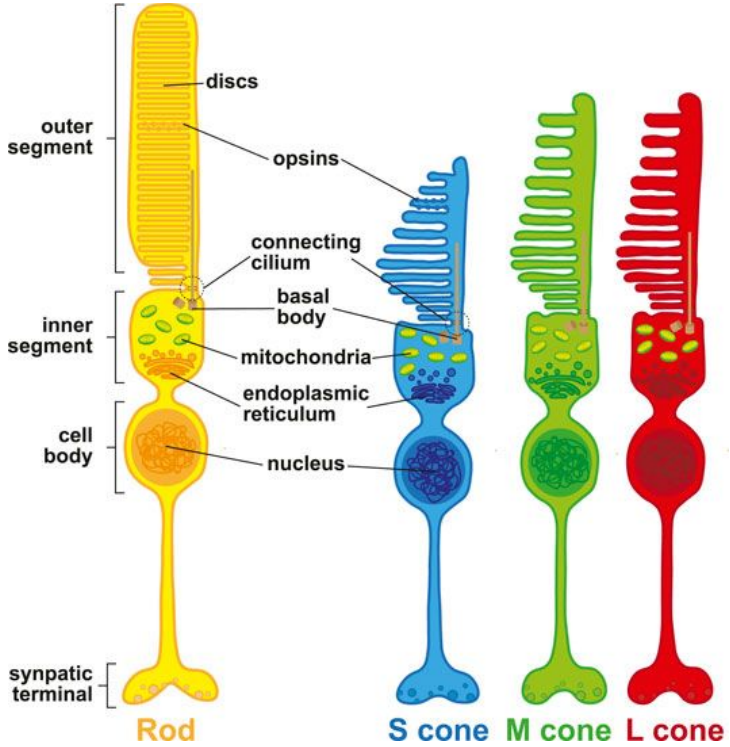
Multi-layered, covers the rear inner wall of the eyeball

- **Pigment Epithelium**: Non-neuronal cells, feed & recycle nutritions from receptors, help reflect/maximize light
- **Receptors**: Rods & Cones, rearmost layer of retina
- **Bipolar cells**: postsynaptic to receptors
- **Ganglions**: axons of the Ganglion cells form the Optic Nerve
- **Interneurons**: perpendicular to pathway, influence above neurons

Visual Receptors

- **Photoreceptors = Rods & Cones**
  - Rod's outer segment is much larger with higher amounts of photopigments (Opsin and Retinal)
  - Both are embedded in the pigment epithelium
  - Graded Potentials that release inhibitory NTs

- Outer segments of photoreceptors isomerize and convert light into neural signals



Visual Receptors

ROD CELLS

for night vision

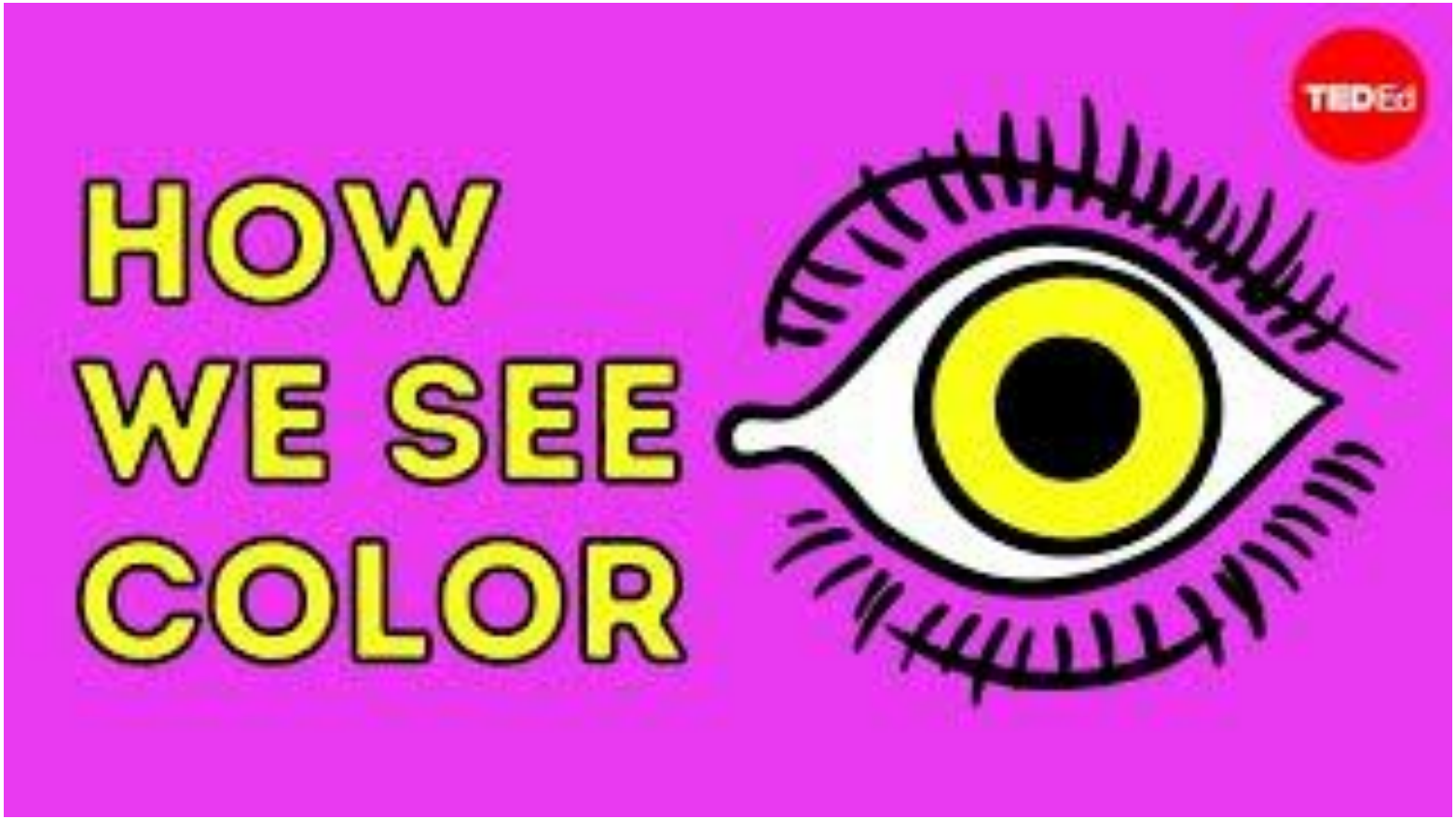
- **120 000 000**
  in the peripheral retina
- **very sensitive**
  single photon to activate
- **achromatic vision**
  single photopigment
- **low resolution**
  many rods contact
  one bipolar cell

CONE CELLS

for daytime vision

- **6 000 000**
  in the central retina
- **less sensitive**
  over 100 photons to activate
- **colour vision**
  three photopigments
- **hight resolution**
  one cone contacts
  one bipolar cell

Visual Receptors

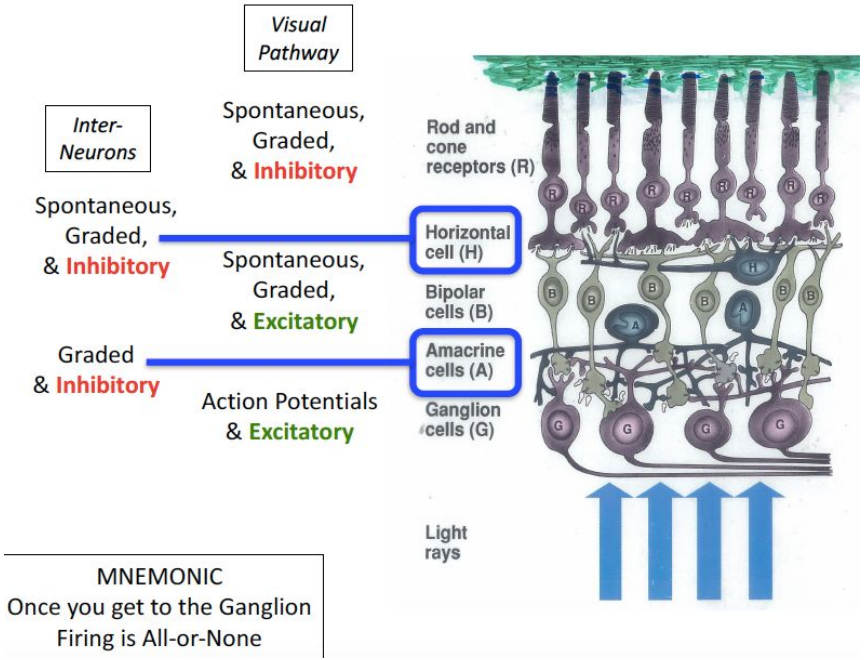


Retina

- Interneurons: **Horizontals** and **Amacrines**
  - Both send out Graded Potentials, mostly inhibitory NTs (Lateral Inhibitors)
  - Horizontals mainly modify interface of Receptors and Bipolars
  - Amacrines mainly modify interface of Bipolars and Ganglions

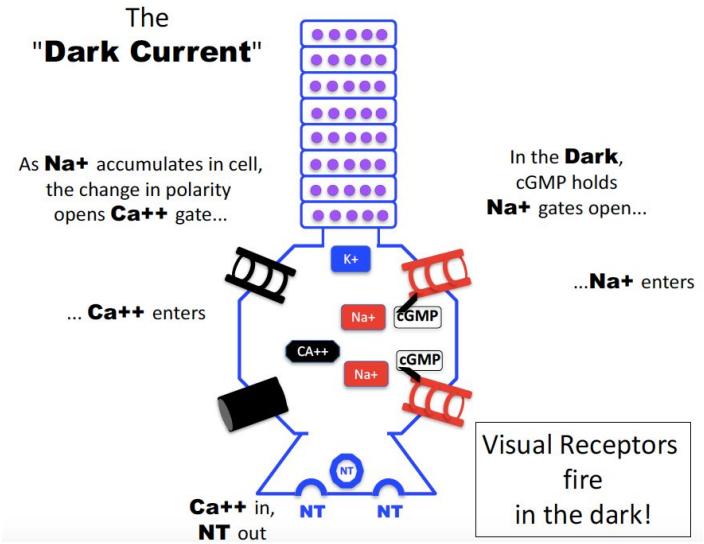
- **Bipolars**: Postsynaptic to Receptors
  - Spontaneous firing of Graded Potentials, releases Excitatory NTs

- **Ganglions**: Postsynaptic to Bipolars
  - Fires off Action Potentials, releases Excitatory NTs



In the Dark

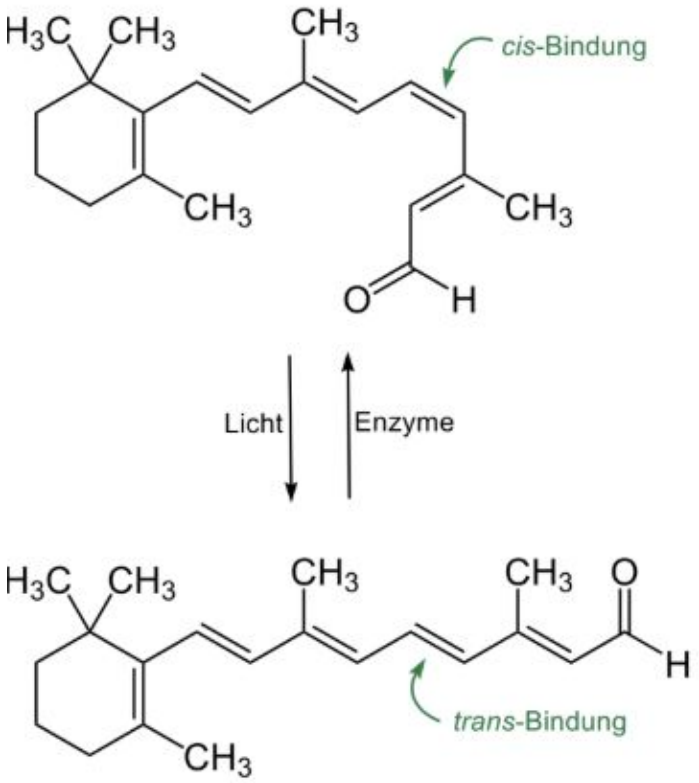
- Flow of Ions causes a constant release of NTs
- cGMP holds Na+ gates open > influx of Na+ > Change in polarity leads to Ca^2+ gates opening and influx of Ca^2+ > NT released
- When Positive charge accumulates in the cell, Na+ exits via electrostatic pressure
  - Builds up outside > Influx into cell again
  - Ca^2+ enters again
  - Continuous cycle of Ion influx/efflux
- Ca^2+ pump pushes Ca^2+ out of the cell
- Visual Receptors fire in the dark. NT is continuously released as long as there is no light



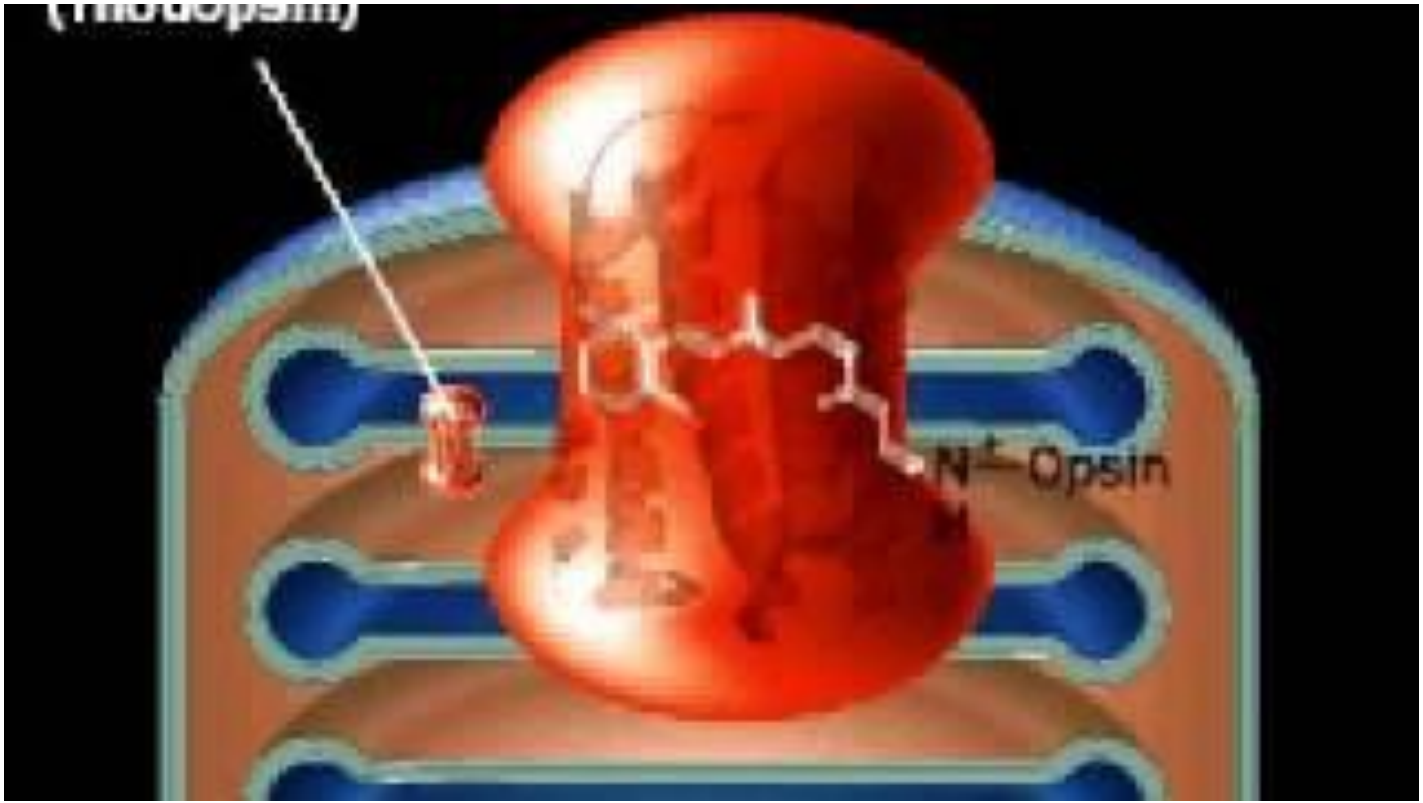
In The Light

Isomerization

- converting light into a neural signal
- photopigment: made of Opsin & Retinal, undergo a chemical change when they absorb light
- photopigment regeneration: using Enzymes from Pigment Epithelium, prepare to respond the next photon

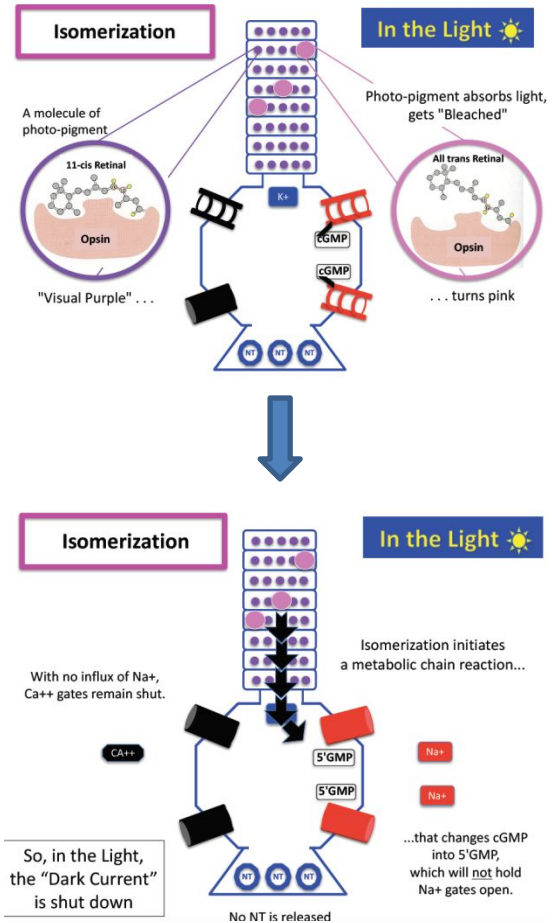


In The Light



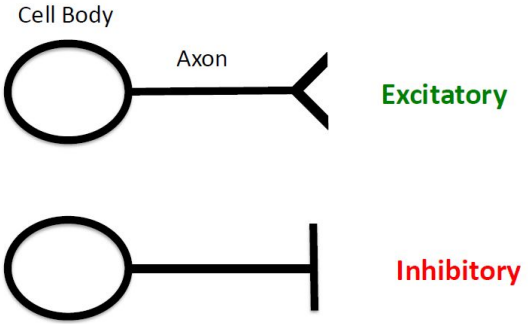
In The Light

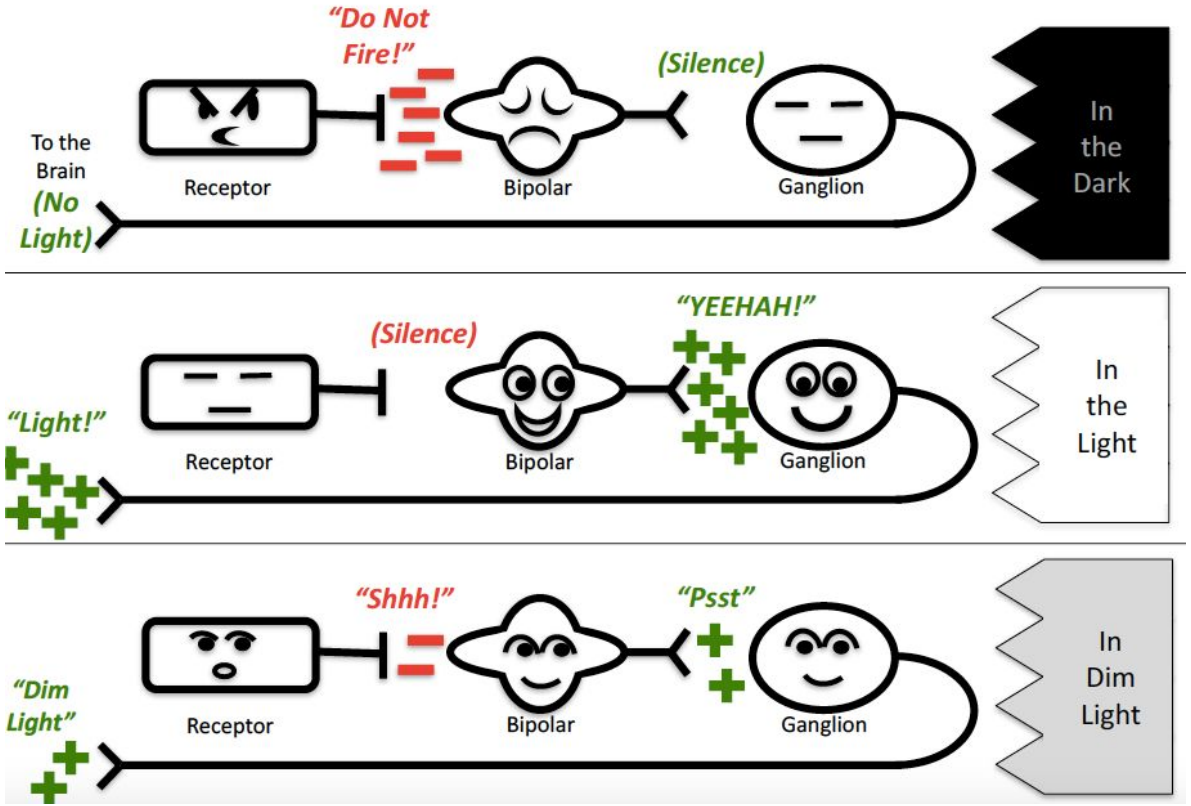
- **Isomerization** occurs as follows:
  - Before absorbing light, a molecule of photopigment, 11-cis Retinal, is attached to Opsin (aka visual purple)
  - In the light, the photopigment absorbs the light and gets 'bleached', causing Retinal to detach from the Opsin where it undergoes a form change to All trans Retinal and turns pink
  - cGMP converts 5'GMP when isomerized so that Na+ gates are closed > no Ca^2+ enters as the Ca^2+ gates are closed > no NT release
  - Ultimately when in the light, the "Dark Current" is shutdown (turned off by the light)



Connectivity Patterns

- play a critical role in information-transmission



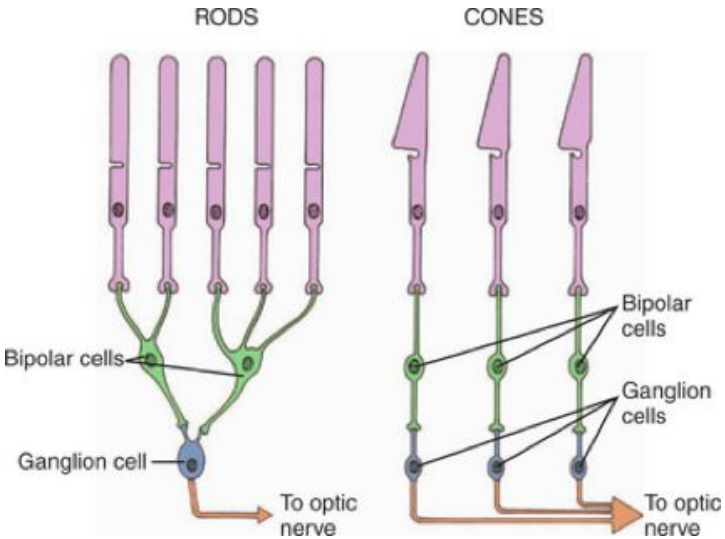


Convergence

- Receptors Converge onto Ganglion Cells (varied ways)

- **Cones**
  - **Low** Convergence (6:1 or few:1)
  - High Acuity, detailed information is preserved
  - Fovea Cones have very low conv. (1:1)

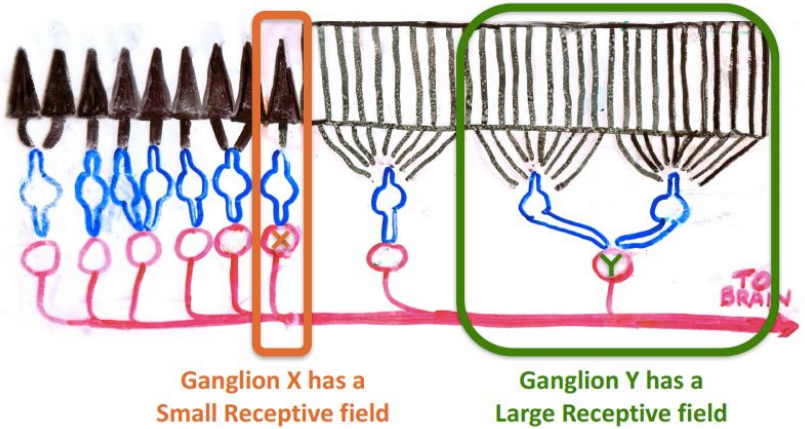
- **Rods**
  - **High** Convergence (120:1 or Many:1)
  - Low Acuity, details can be lost



Receptive Field

- A set of receptors whose activity influences the activity of a “target” downstream cell

- Better Acuity when a cell has a smaller RF
    - Ganglion along path from converging Cones has small RF



How the Brain Constructs the Visual World

Celebrate the end of Midterm 1!