

M U N I

M E D

**M U N I**  
**M E D**

**10**

**Vision II**

# Image formation

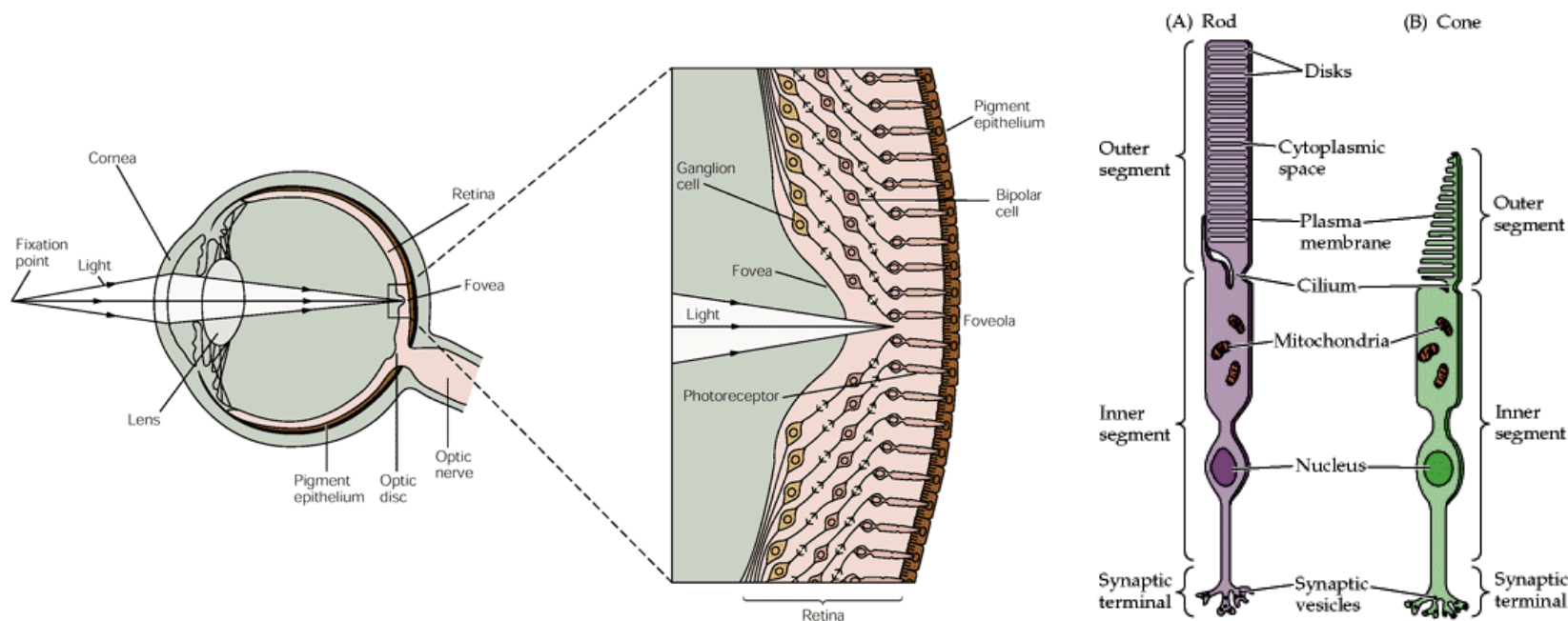
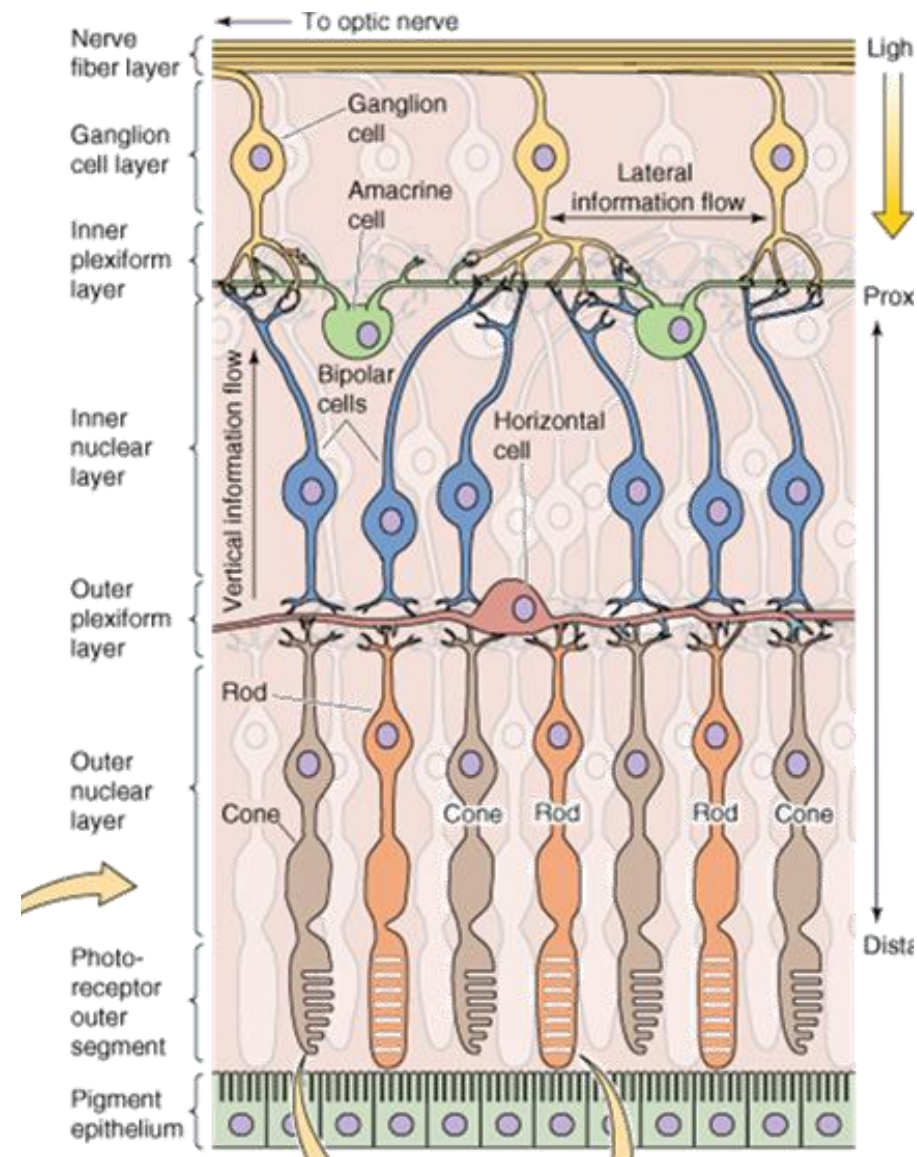


Table 26-1 Differences Between Rods and Cones and Their Neural Systems

Rods	Cones
High sensitivity to light, specialized for night vision	Lower sensitivity, specialized for day vision
More photopigment, capture more light	Less photopigment
High amplification, single photon detection	Lower amplification
Low temporal resolution: slow response, long integration time	High temporal resolution: fast response, short integration time
More sensitive to scattered light	Most sensitive to direct axial rays
<b>Rod system</b>	<b>Cone system</b>
Low acuity: not present in central fovea, highly convergent retinal pathways	High acuity: concentrated in fovea, dispersed retinal pathways
Achromatic: one type of rod pigment	Chromatic: three types of cones, each with a distinct pigment that is most sensitive to a different part of the visible light spectrum

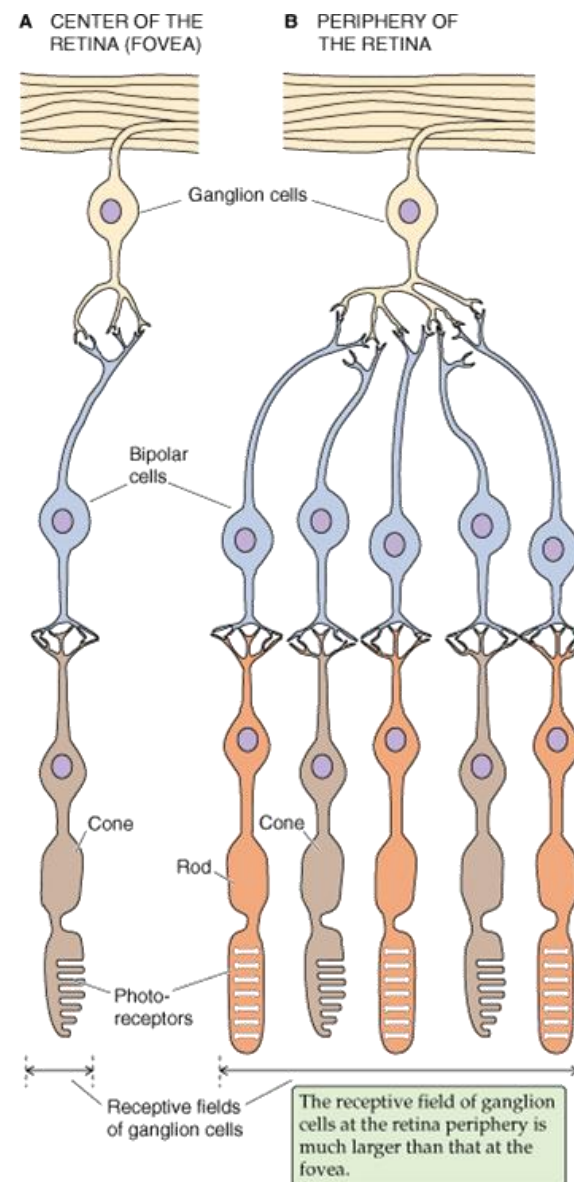
# Retina

- Photoreceptors
- Interneurons
  - Horizontal cells
    - Horizontal interconnection
  - Bipolar cells
    - Vertical interconnection
  - Amacrine cells
    - Both horizontal and vertical interconnection
- Ganglion cells
  - AP generation
  - Transmission of AP to the brain

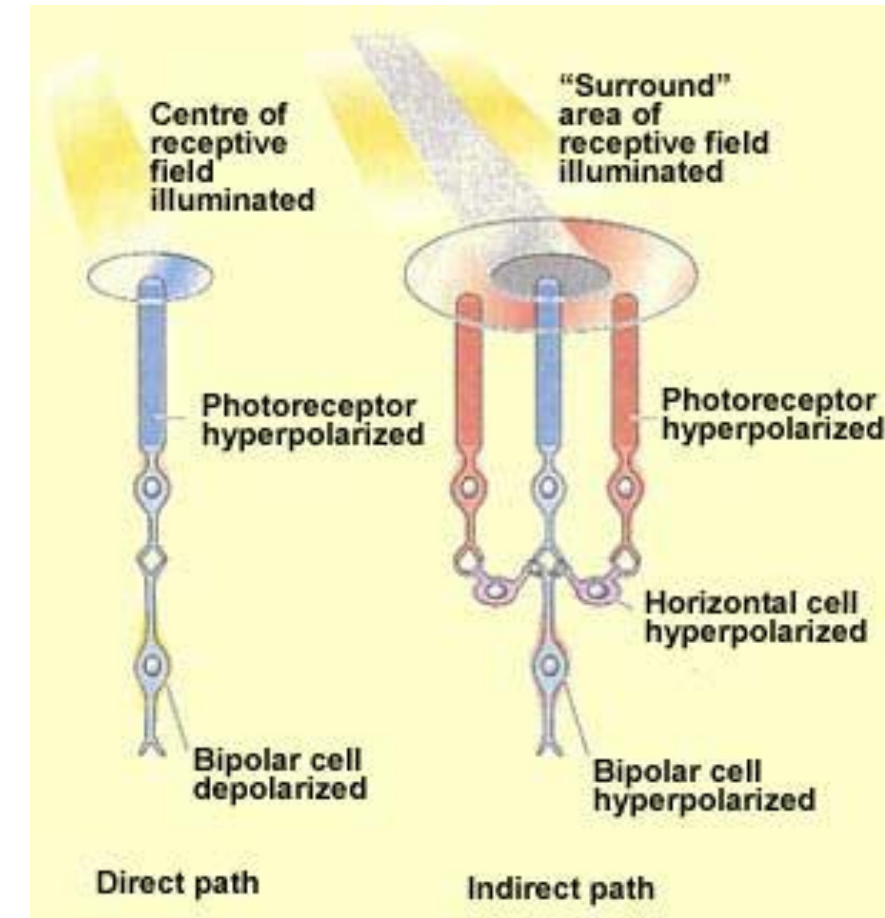
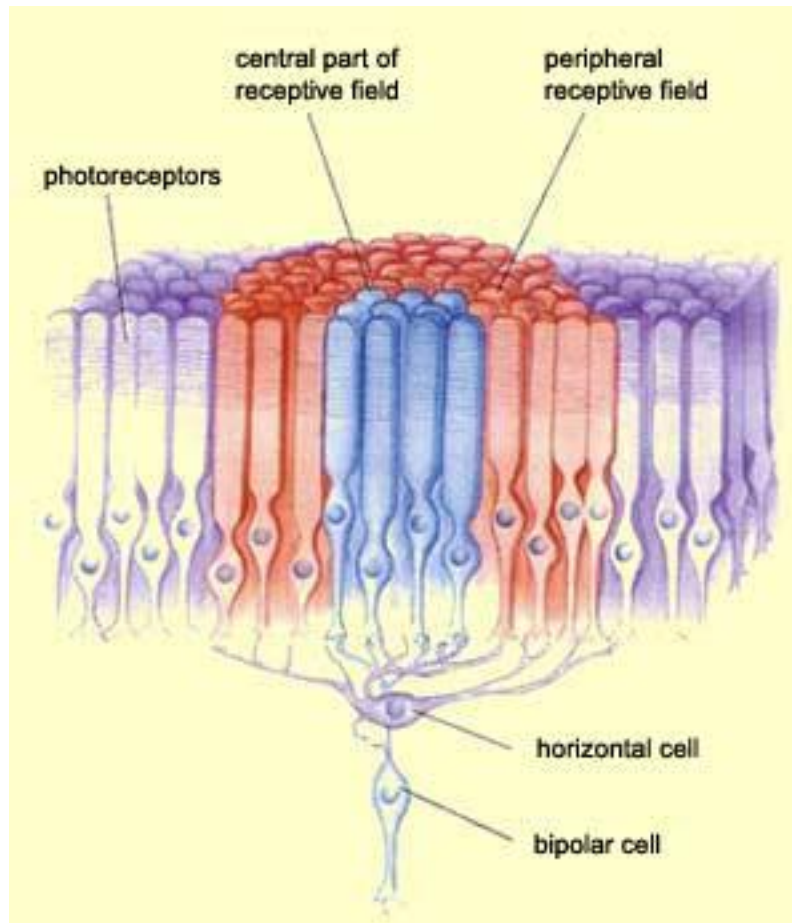


# Retina

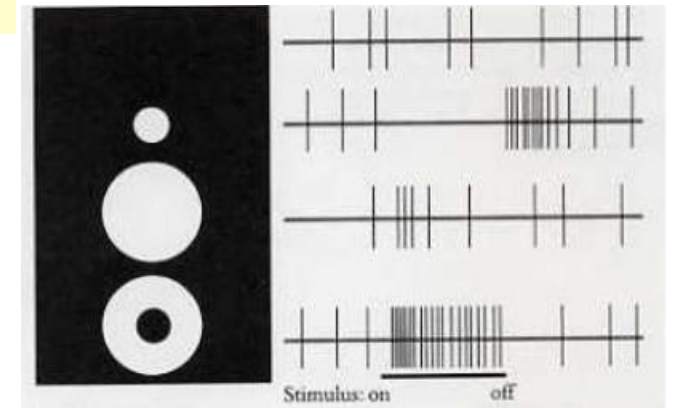
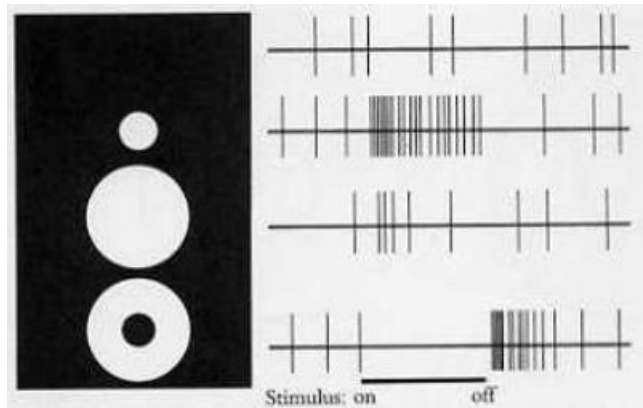
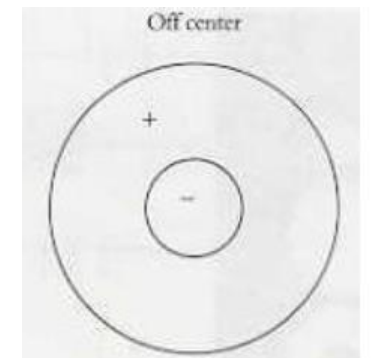
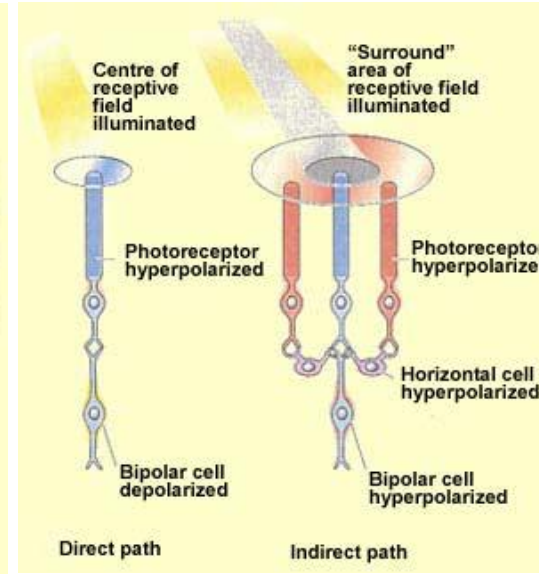
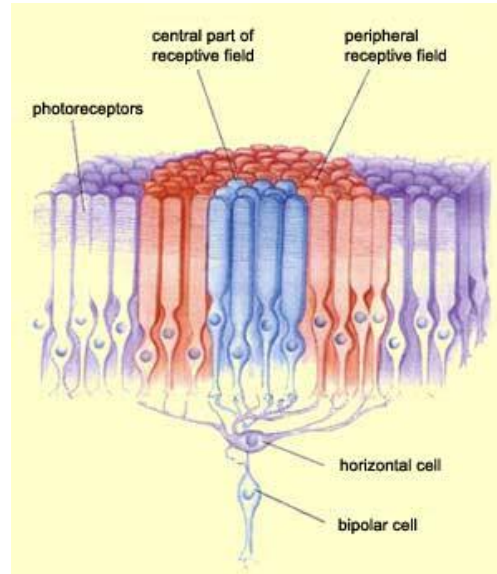
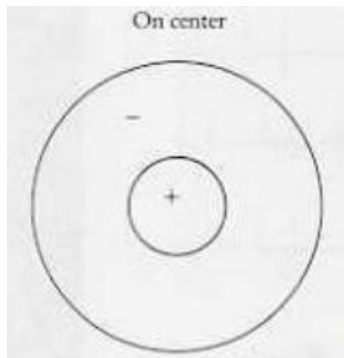
- Fovea
  - Low convergence
    - Small receptive field
    - High resolution
  - Lower sensitivity to light
- Periphery of retina
  - High degree of convergence
    - Large receptive field
    - Low resolution
  - High sensitivity to light



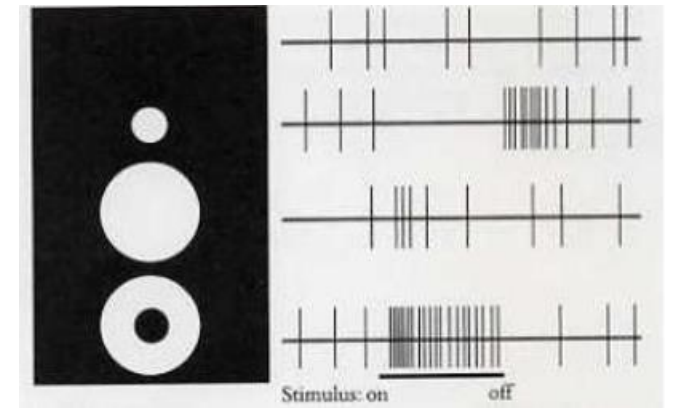
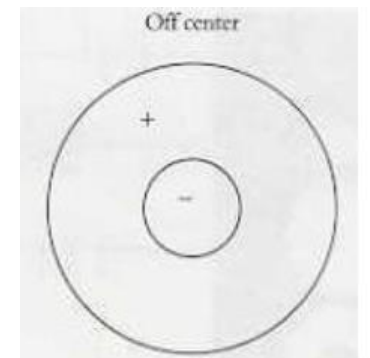
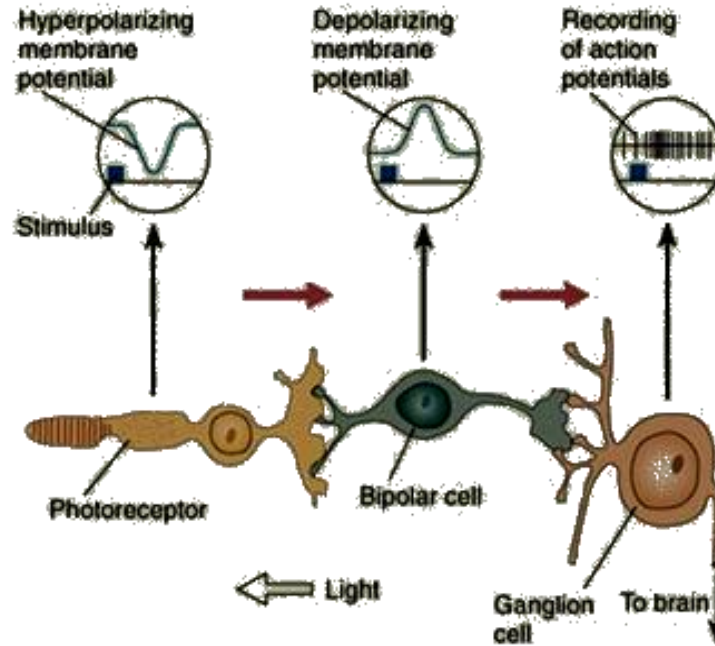
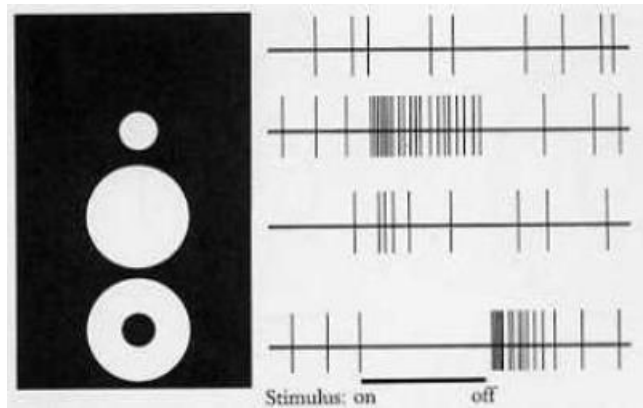
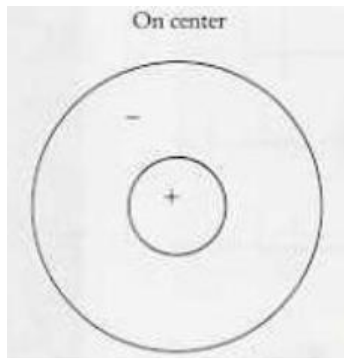
# Receptive field



# Receptive field

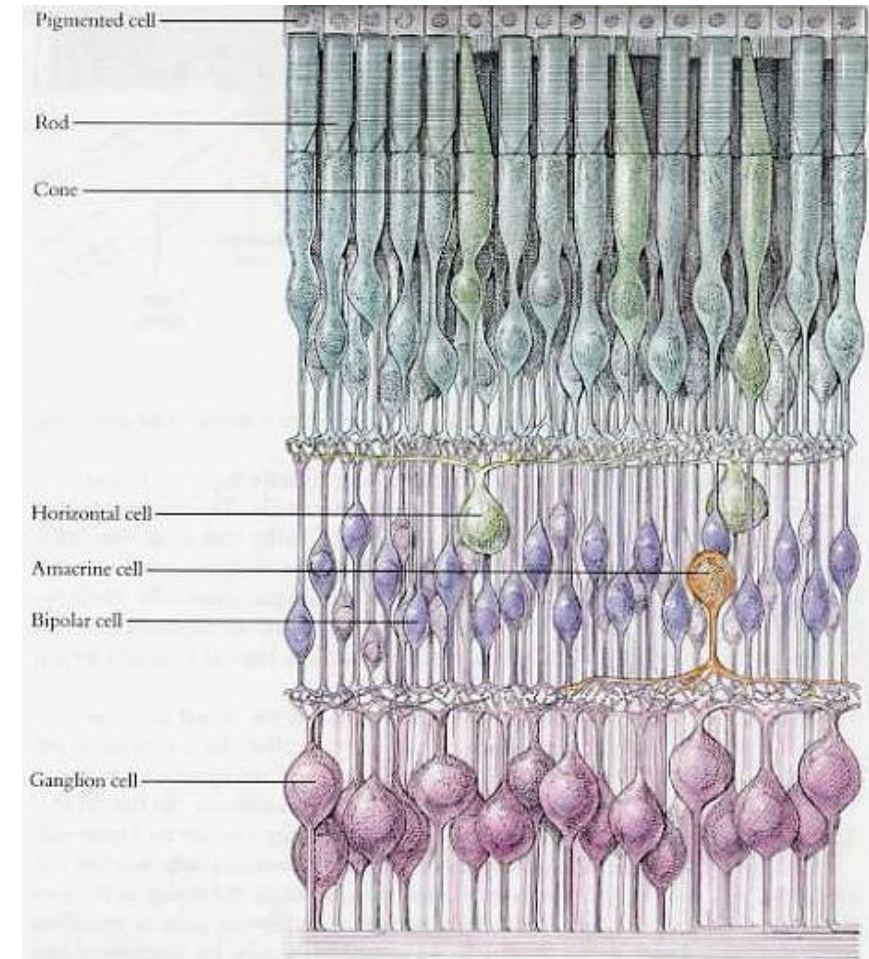
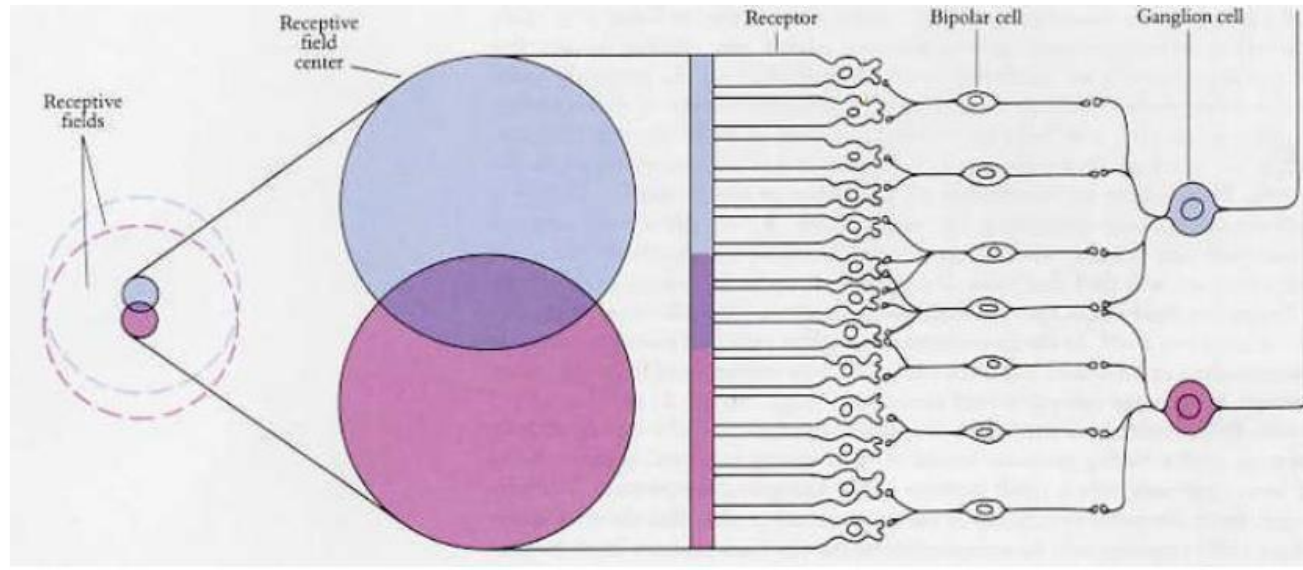


# Receptive field





# Receptive field

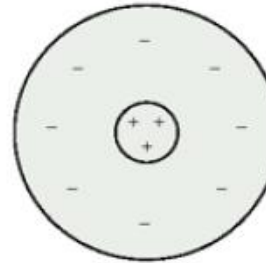


# Receptive field

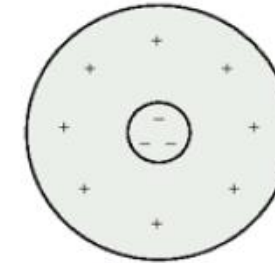
- Magnocellular system
  - Large receptive field
  - Rods and cones
  - **M ganglion cells (10%)**
  - High speed of velocity
  - Brightness/low contrast sensitivity
  - Minimal sensitivity to color

A M cells

On-center

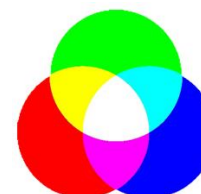
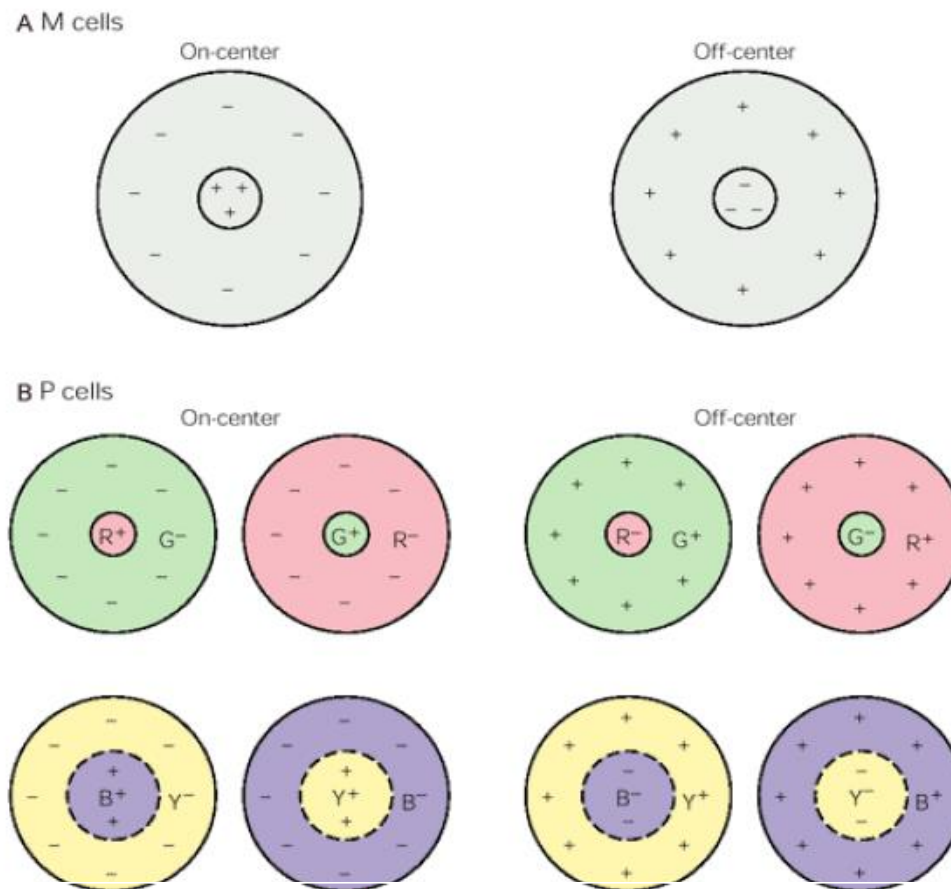


Off-center



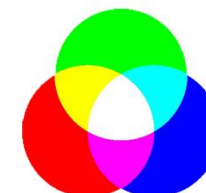
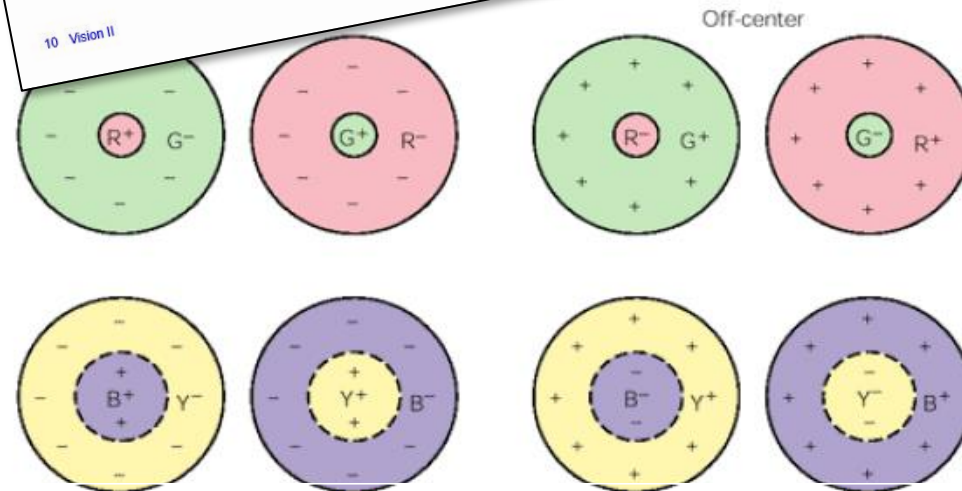
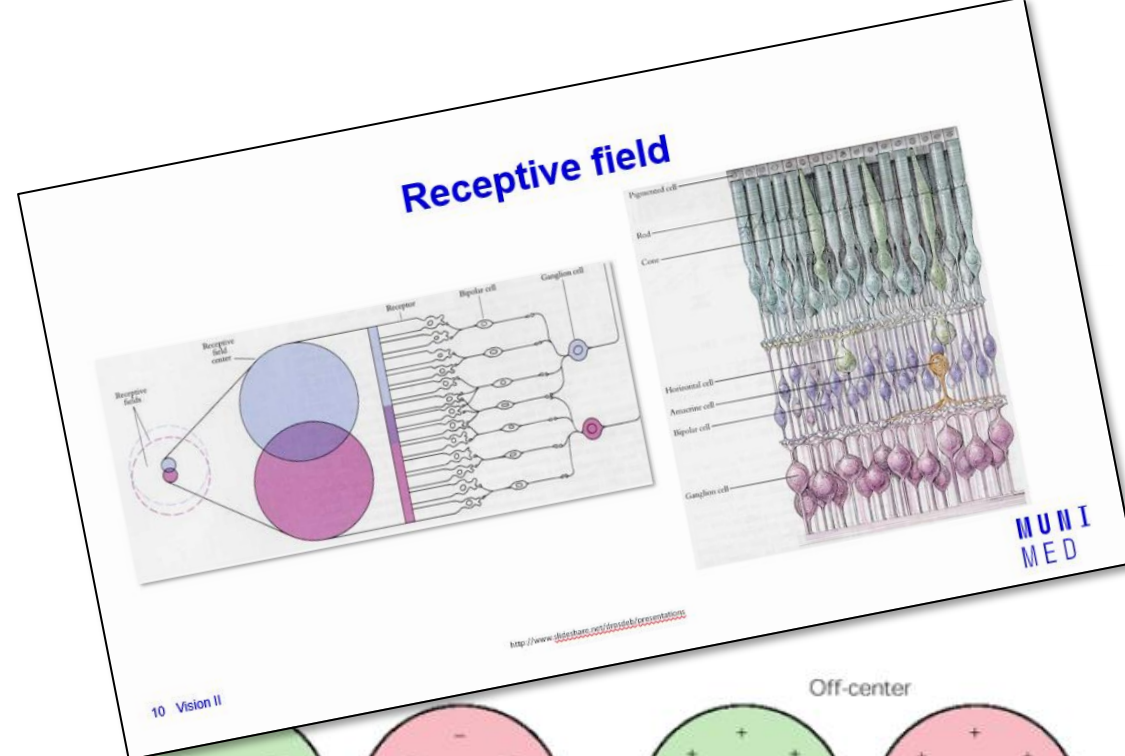
# Receptive field

- Magnocellular system
  - Large receptive field
  - Rods and cones
  - **M ganglion cells (10%)**
  - High speed of velocity
  - Brightness/low contrast sensitivity
  - Minimal sensitivity to color
- Parvocellular system
  - Small receptive field
  - Cones and rods
  - **P ganglion cells (80%)**
  - Low speed of velocity
  - Low sensitivity in low contrast
  - Good sensitivity to color



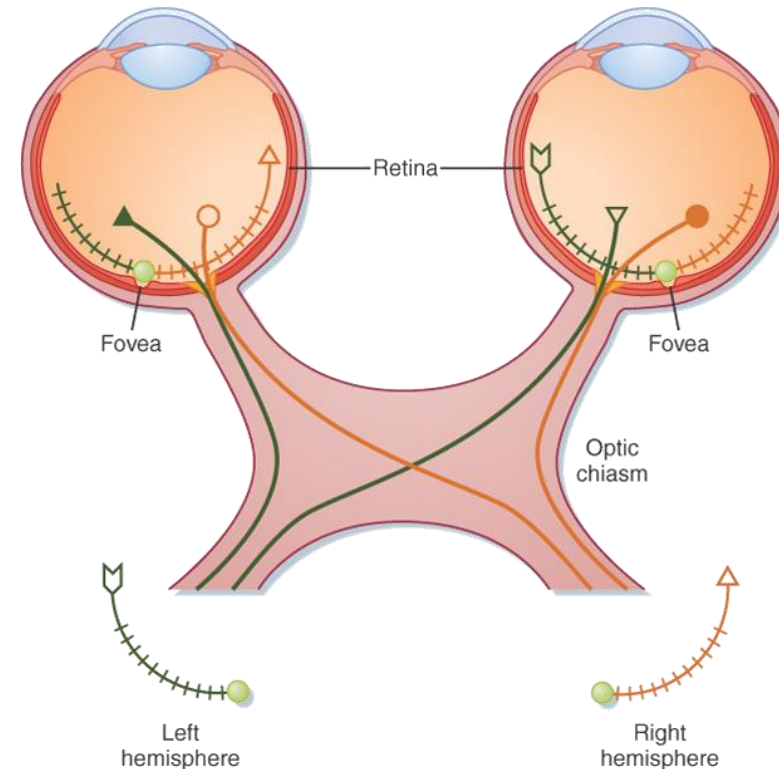
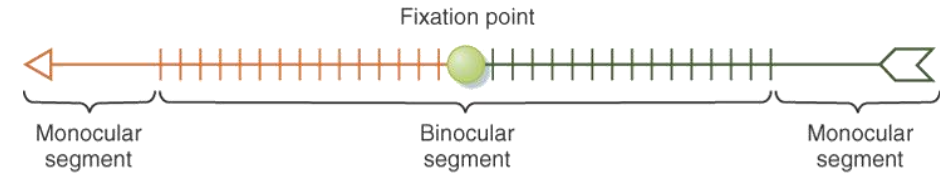
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# Optic nerve and optic tract

- Optic nerve
  - Signal from one eye
  - Signal from „whole“ visual field
- Optic tract
  - Signal from both eyes
  - Signal from half of visual field

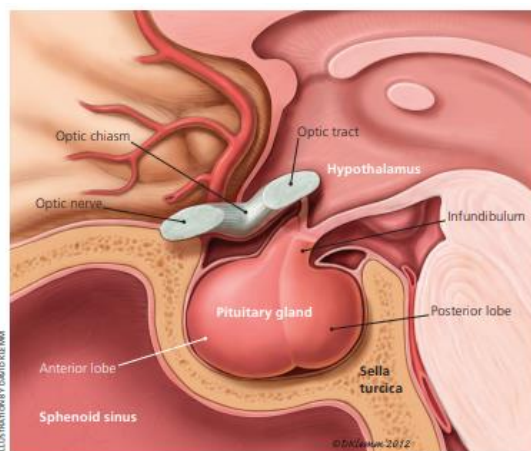
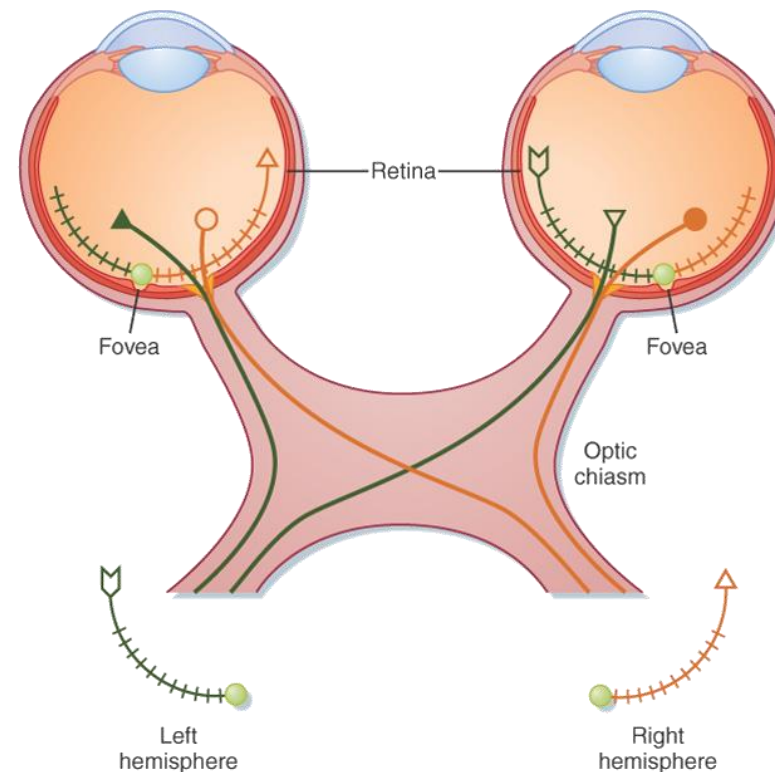
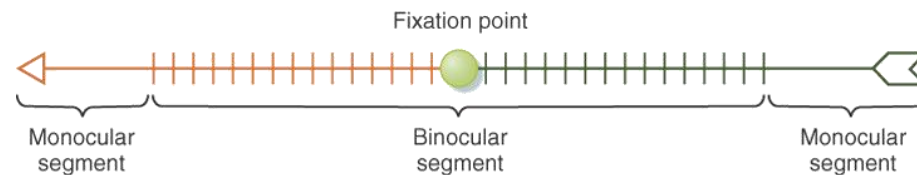


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# Optic nerve and optic tract

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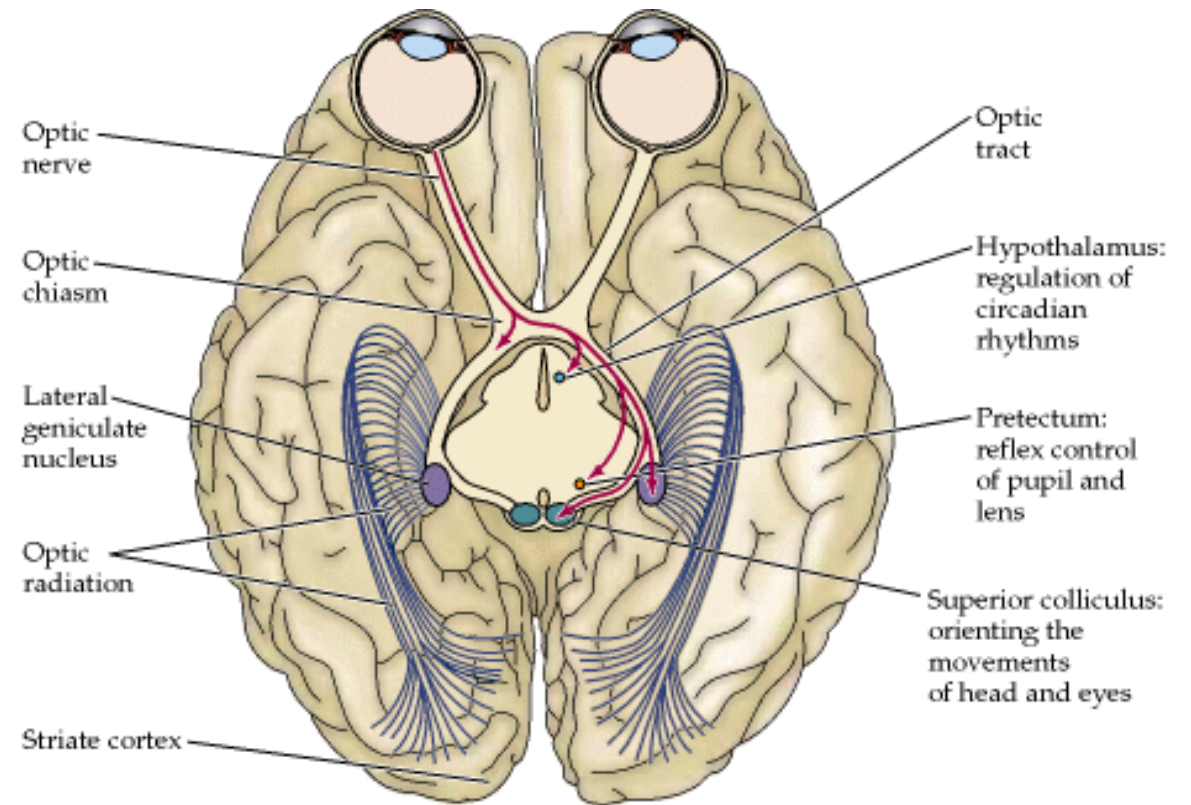
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# Visual pathways

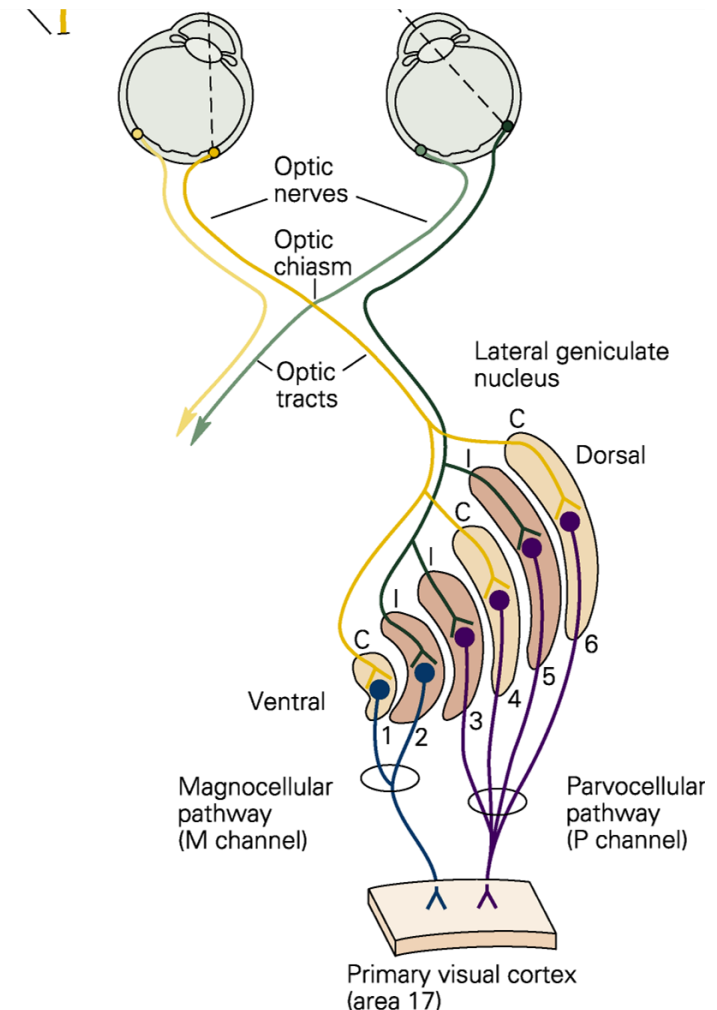
- Nucleus corporis geniculati lateralis
  - Thalamus
  - Majority of projections
  - Via optic radiation to neocortex
- Hypothalamus
  - Regulation circadian activity
- Pretectum
  - Pupillary reflex
- Colliculi superiores
  - Reflex movement of eyes and head



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# Nucleus corporis geniculati lateralis

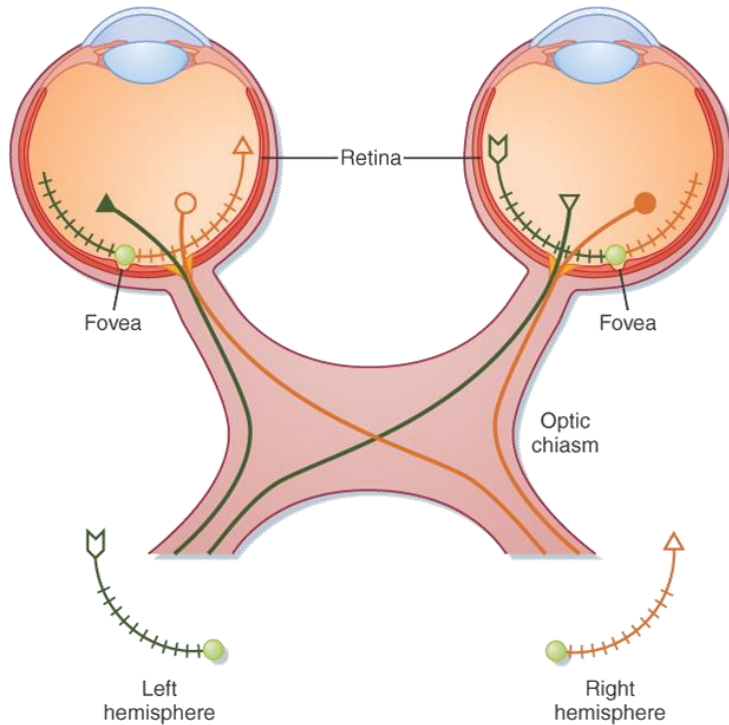
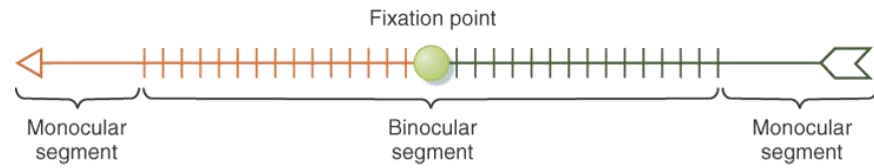
- Six nuclear layers
- Retinotopic organization
- Each layer receives input from only one eye
- Layers 1-2
  - Magnocellular system
    - M ganglion cells
    - Large receptive field/brightness sensitivity
  - Information about localization and movement
- Layers 3-6
  - Parvocellular system
    - P ganglion cells
    - Small receptive field / color sensitivity
  - Information about form and color



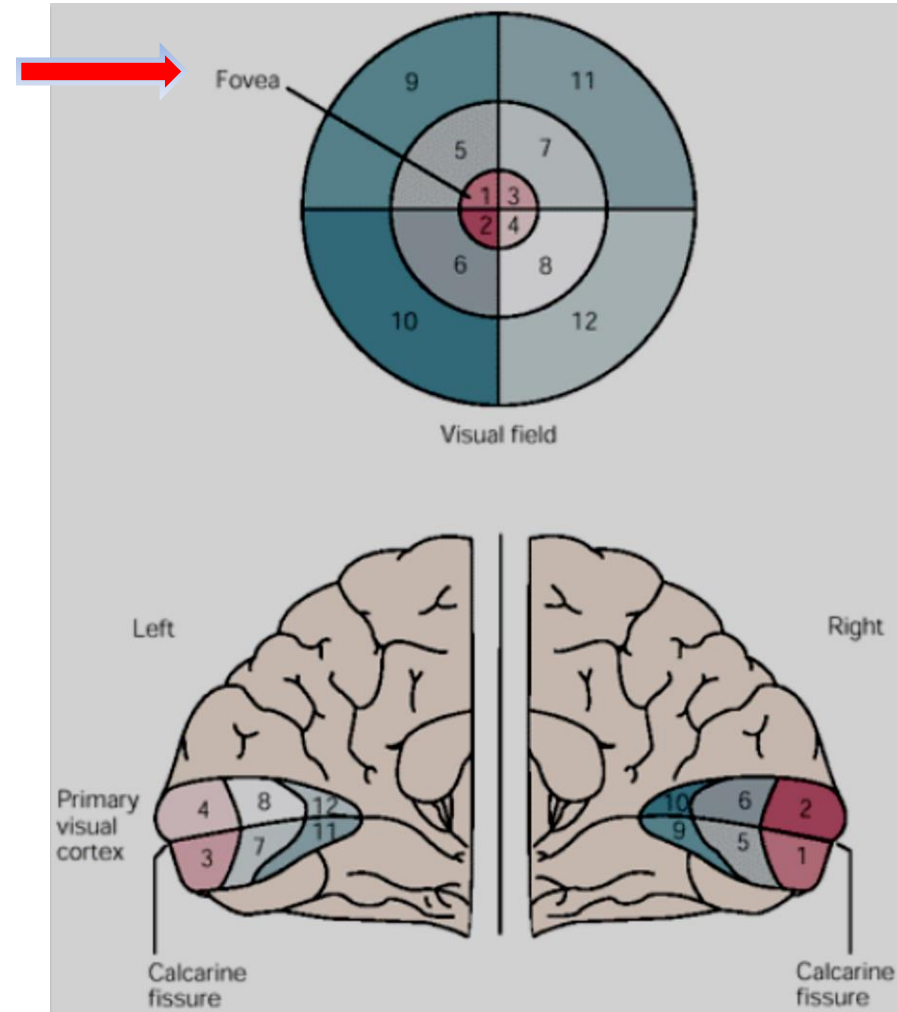


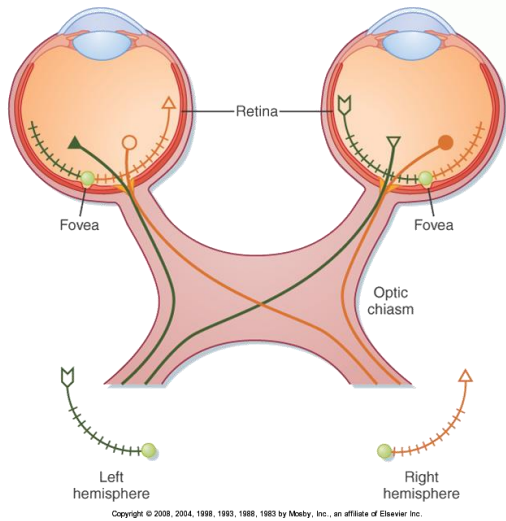
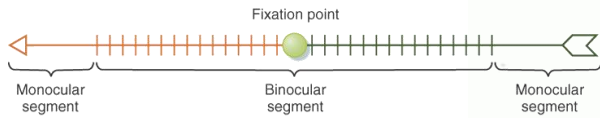
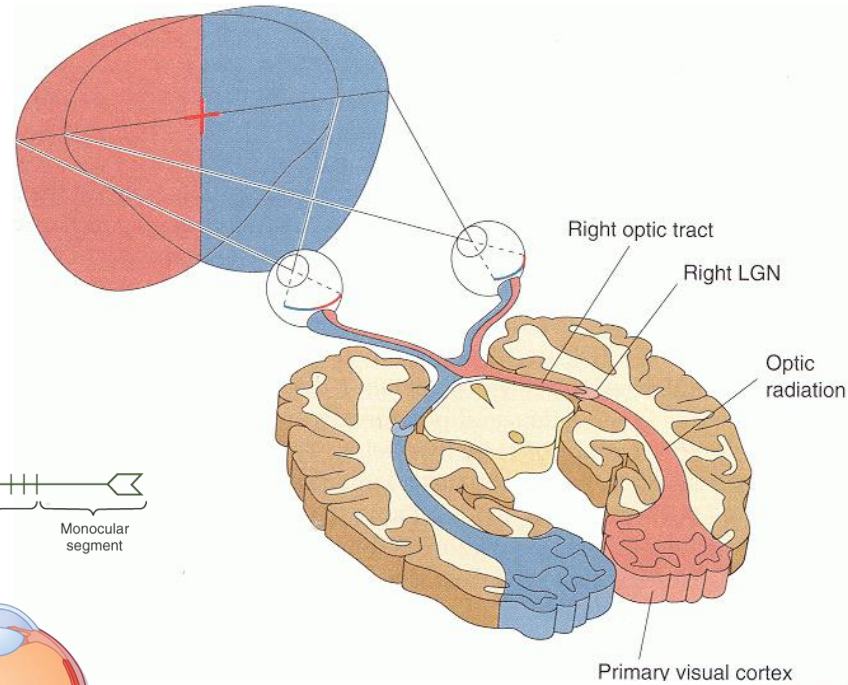
# Primary visual cortex

## Retinotopic organization



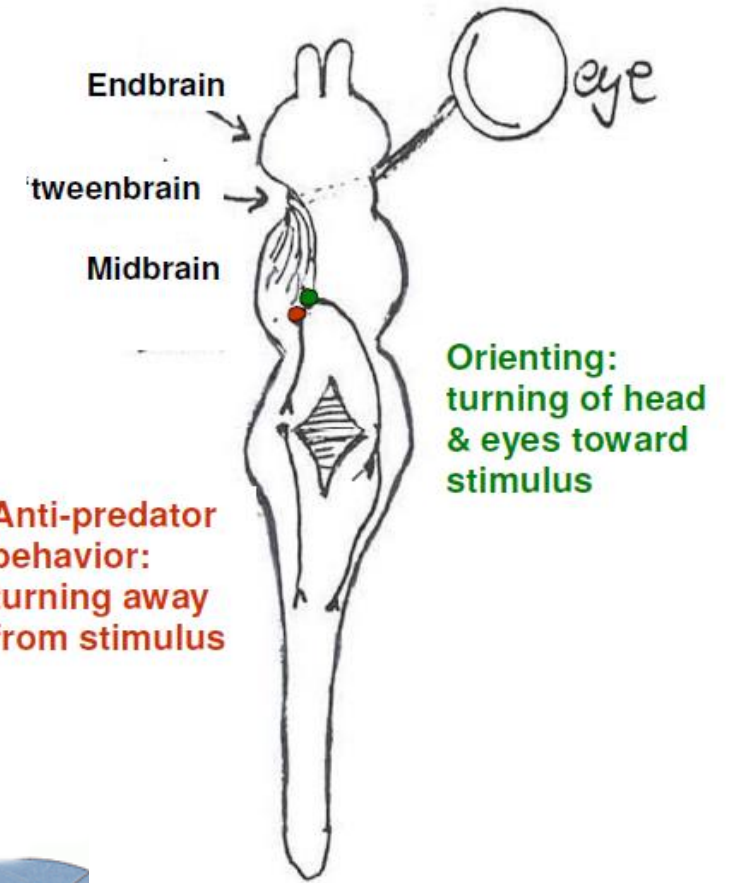
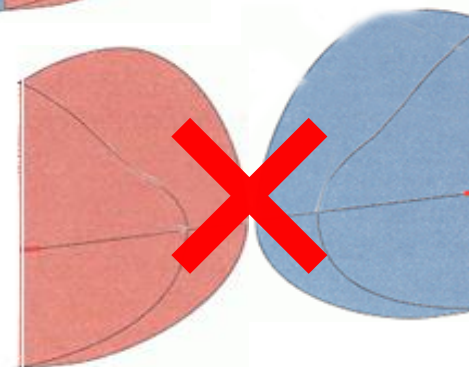
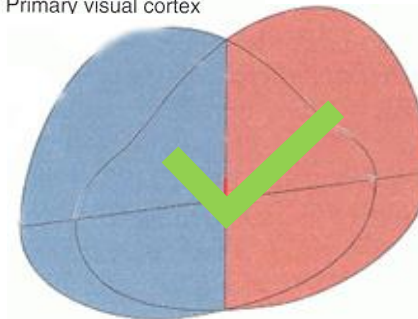
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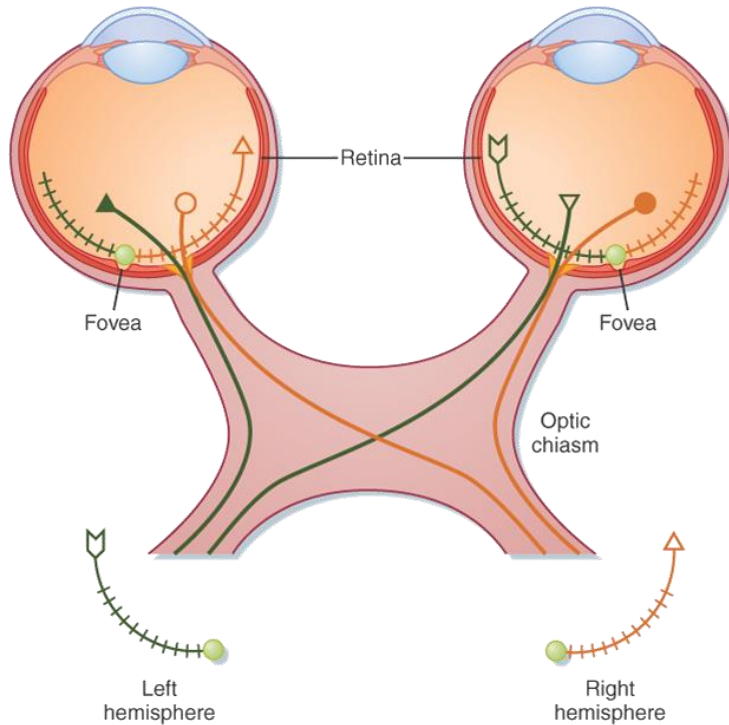
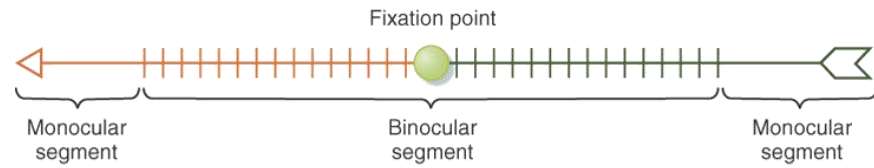
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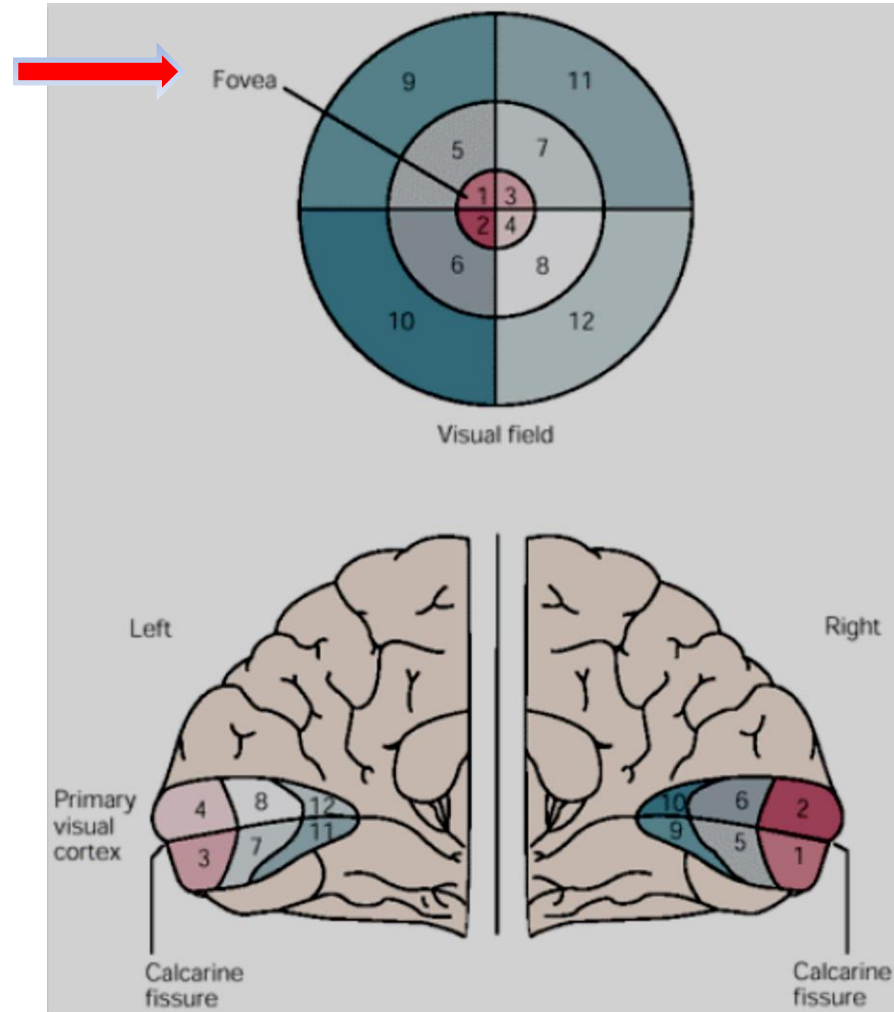


# Primary visual cortex

## Retinotopic organization



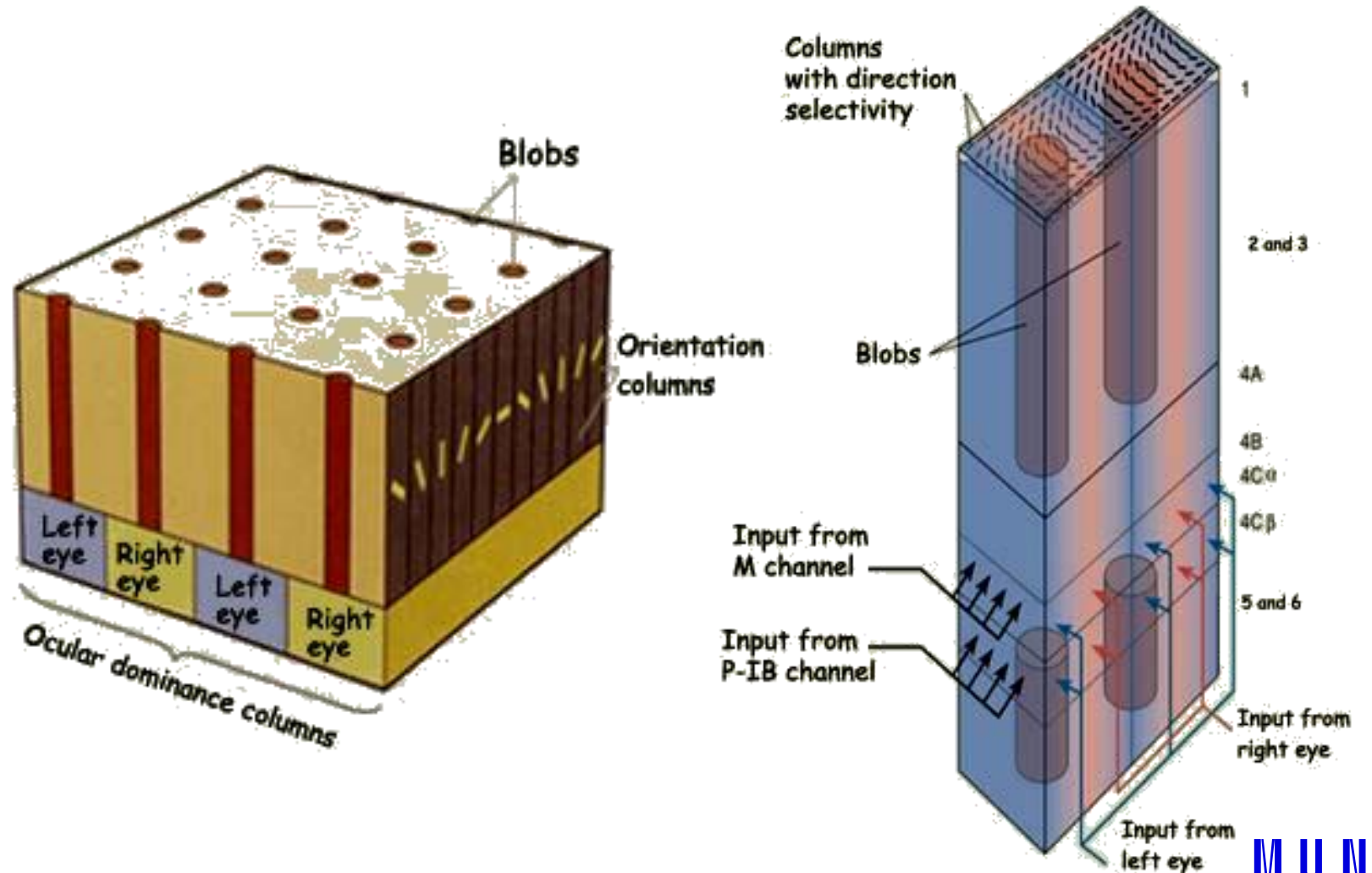
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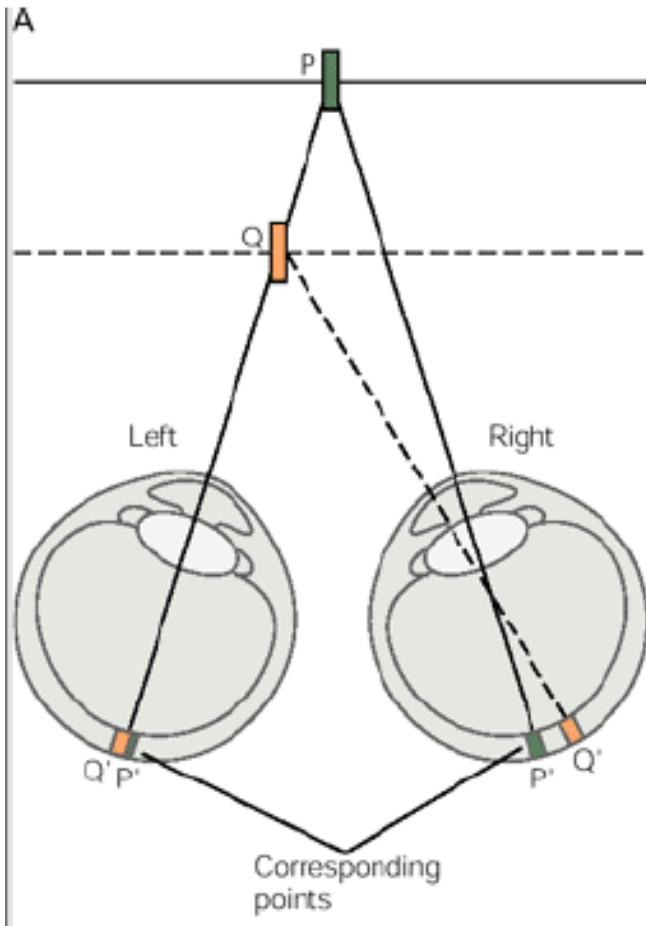
# Primary visual cortex

- ✓ Retinotopic organization
- ✓ Columnar organization
  - Orientation columns
    - Respond to specific orientation
  - Blobs
    - Respond to color
  - Ocular dominance column
    - Information from left or right eye
- ✓ Horizontal connections



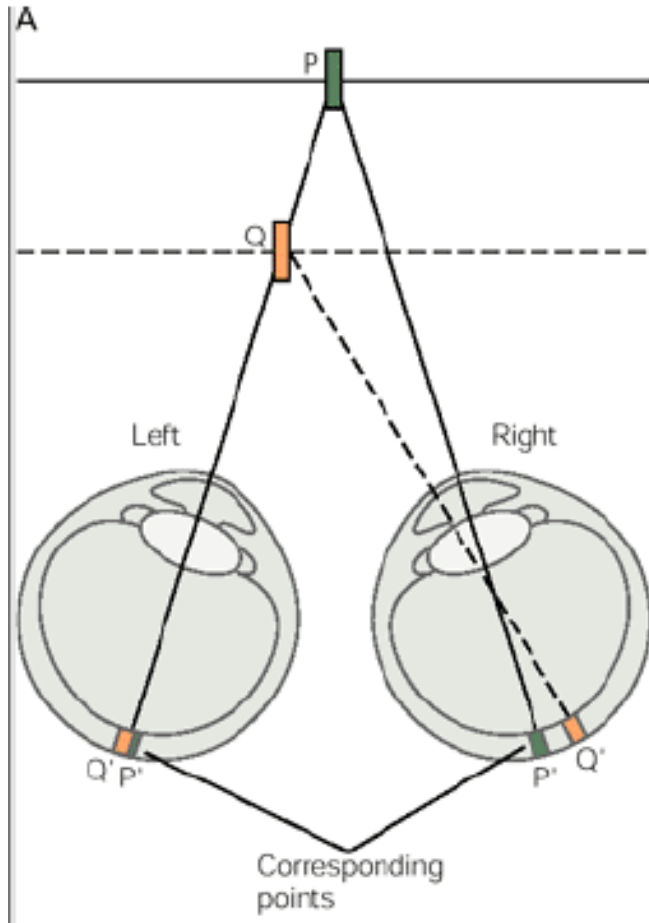
# Spatial vision

## Binocular

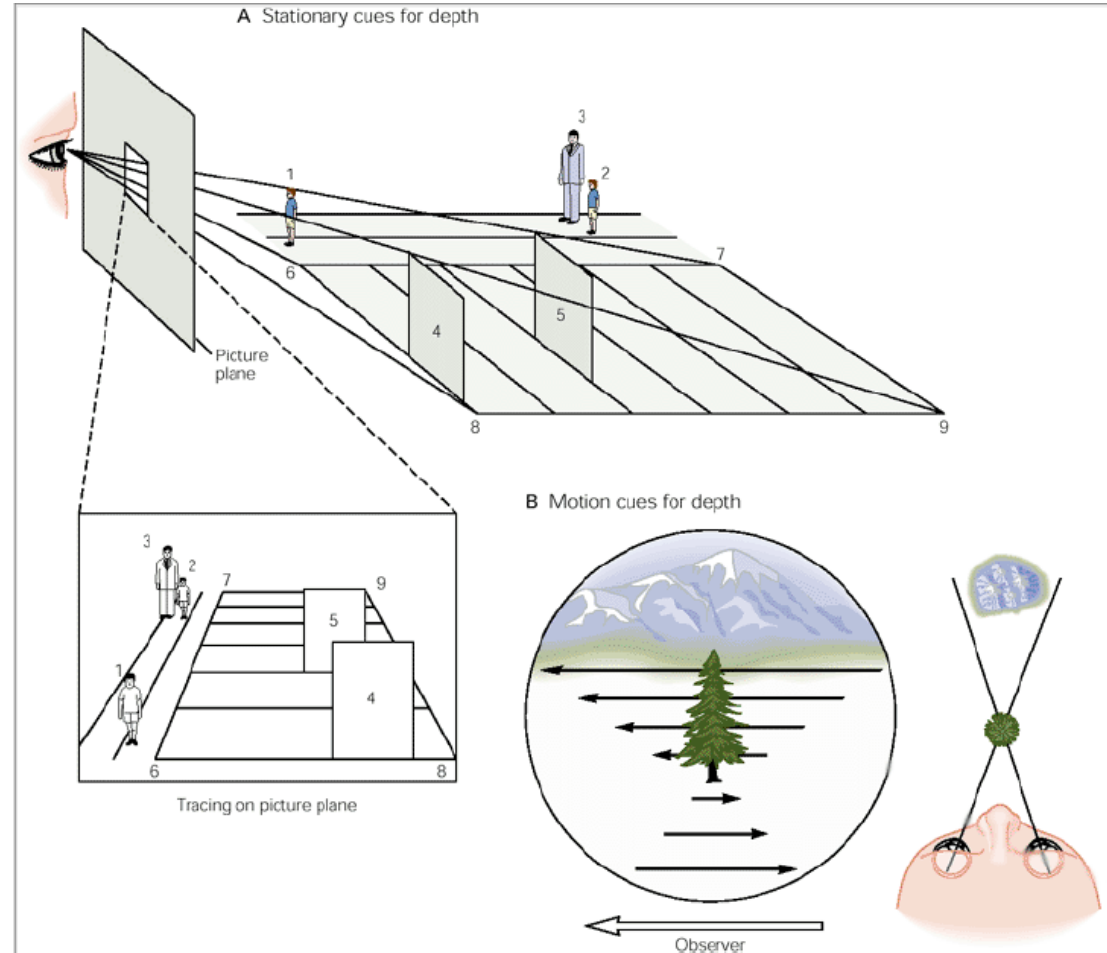


# Spatial vision

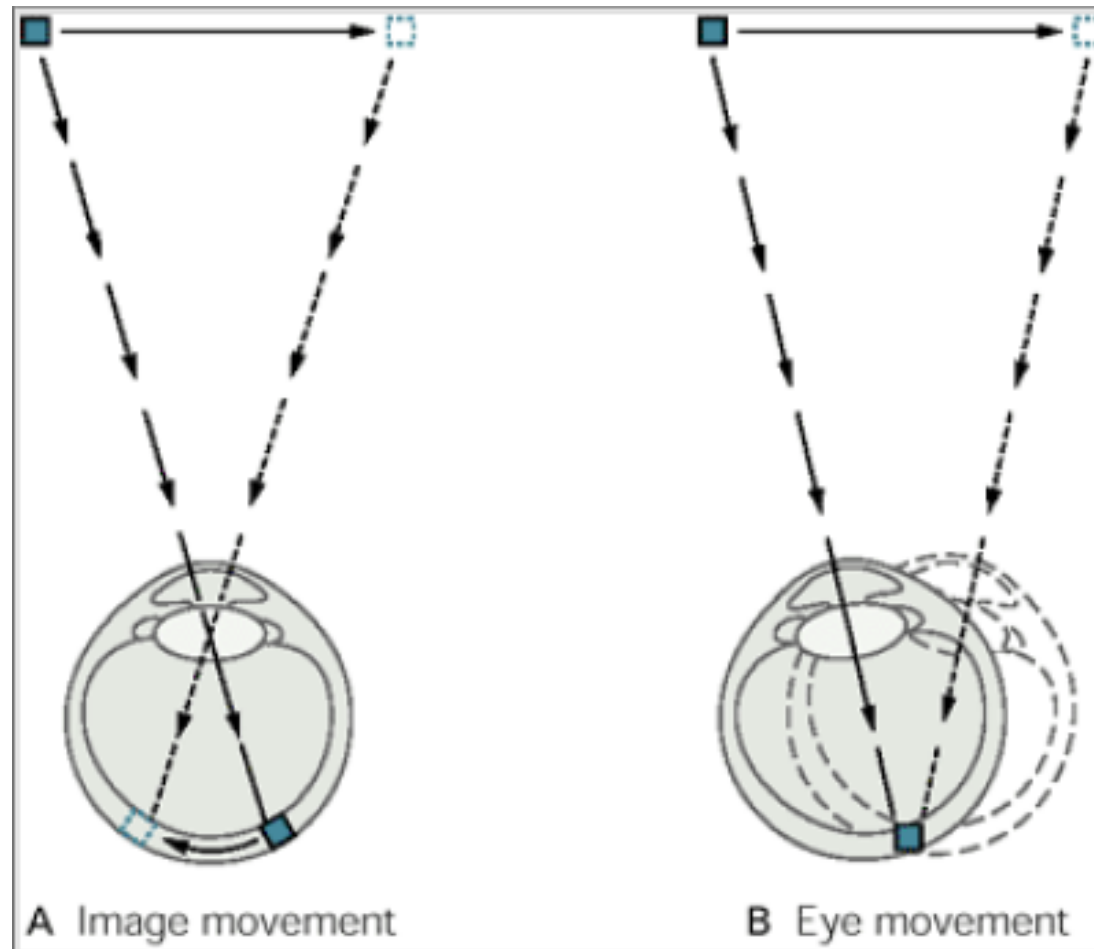
## Binocular



## Monocular – based on previous experience

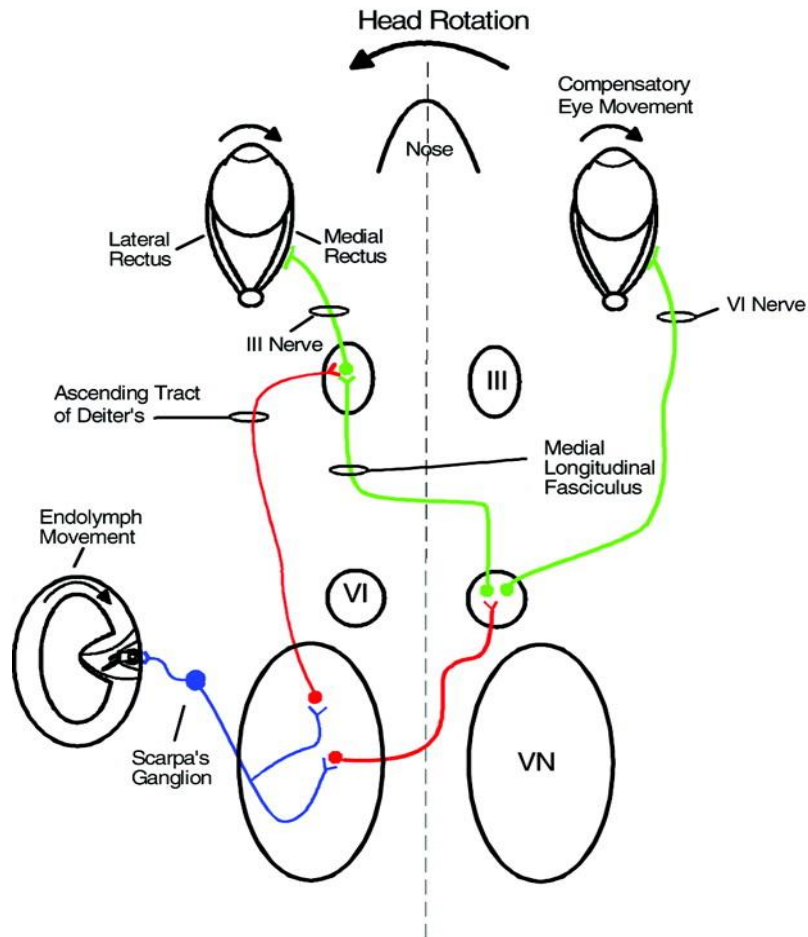


# Motion perception

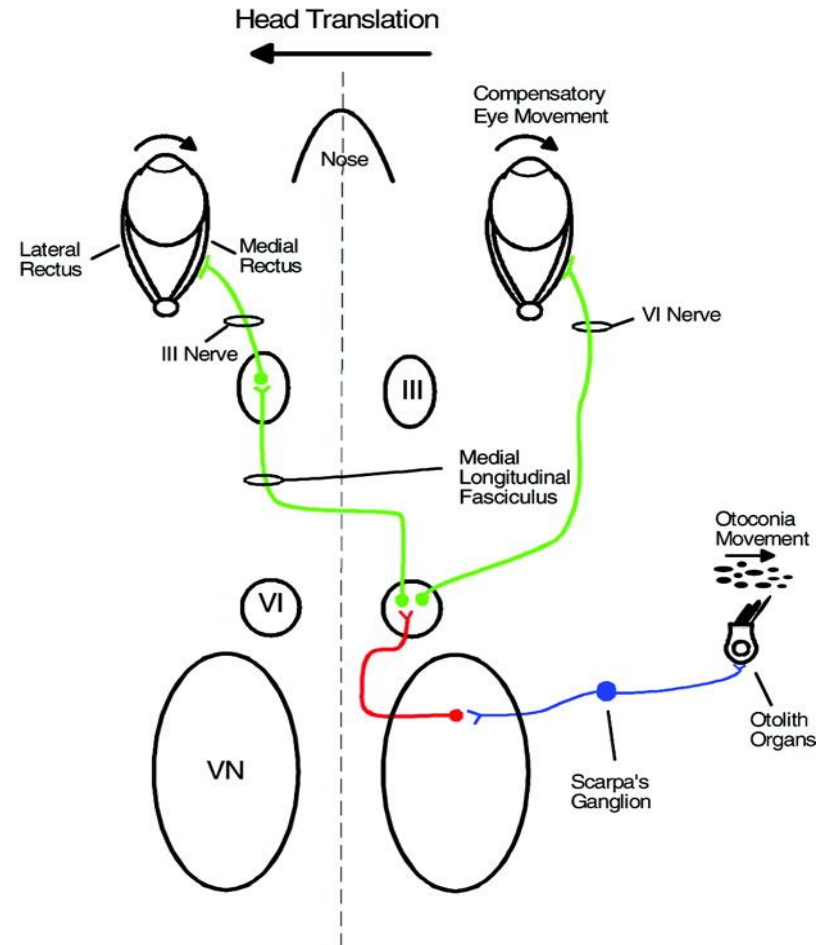


# Vestibuloocular reflex

## Rotational VOR



## Translational VOR






# Nystagmus

- Involuntary rhythmic eye movement
- Physiological
  - Postrotational
  - Optokinetic
- Pathologic
  - ✓ Peripheral
    - Vestibular system pathologies
  - ✓ Central
    - CNS damage (cerebellum, midbrain...)

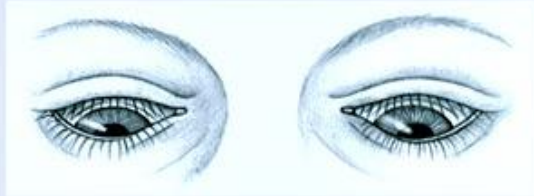
### Classifying nystagmus

The various types of jerk and pendular nystagmus are illustrated below.


**JERK NYSTAGMUS**  
*Convergence-retraction nystagmus* refers to the irregular jerking of the eyes back into the orbit during upward gaze. It can indicate midbrain tegmental damage.



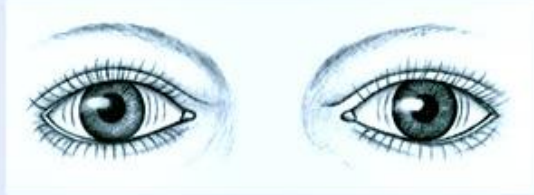
*Downbeat nystagmus* refers to the irregular downward jerking of the eyes during downward gaze. It can signal lower medullary damage.



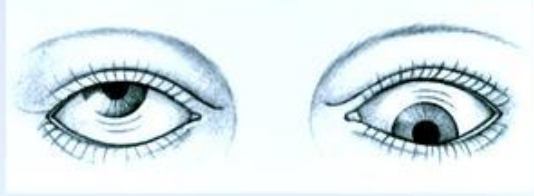
*Vestibular nystagmus*, the horizontal or rotary movement of the eyes, suggests vestibular disease or cochlear dysfunction.



**PENDULAR NYSTAGMUS**  
*Horizontal, or pendular, nystagmus* refers to oscillations of equal velocity around a center point. It can indicate congenital loss of visual acuity or multiple sclerosis.



*Vertical, or seesaw, nystagmus* is the rapid, seesaw movement of the eyes: One eye appears to rise while the other appears to fall. It suggests an optic chiasm lesion.



[http://dxline.info/img/new\\_all/nystagmus.jpg](http://dxline.info/img/new_all/nystagmus.jpg)

# Saccadic eye movements

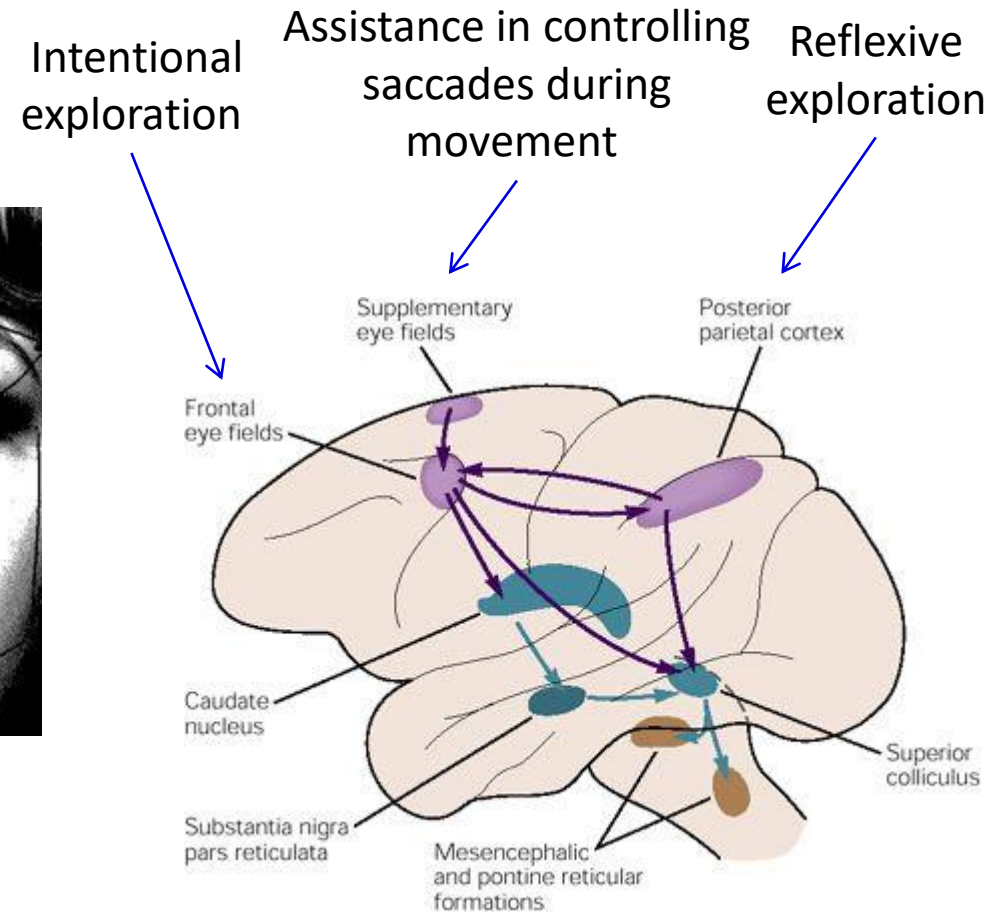


<https://en.wikipedia.org/wiki/Saccade#/media/File:Szakkad.jpg>

# Saccadic eye movements



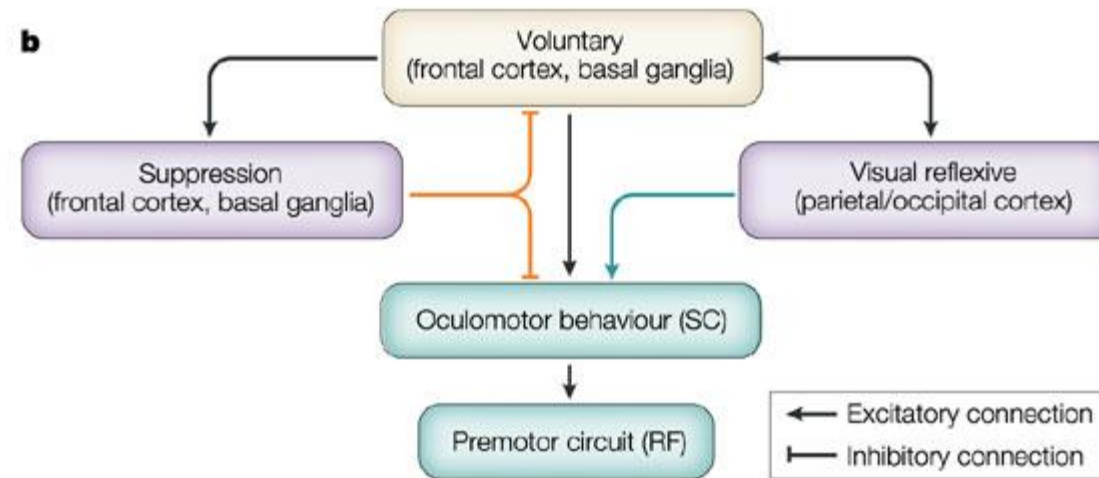
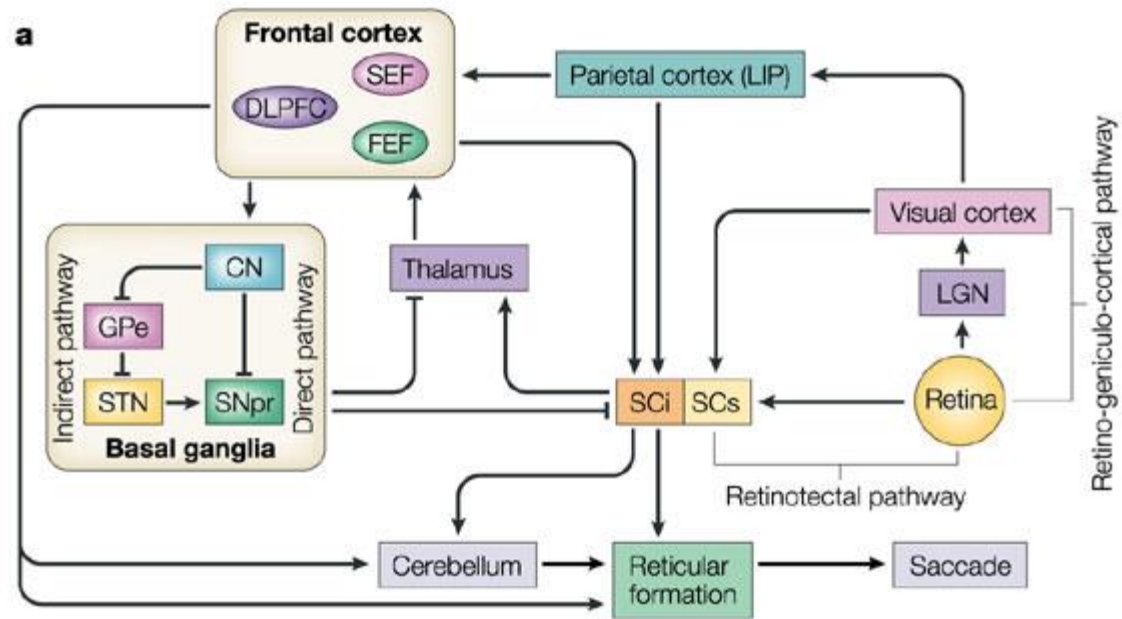
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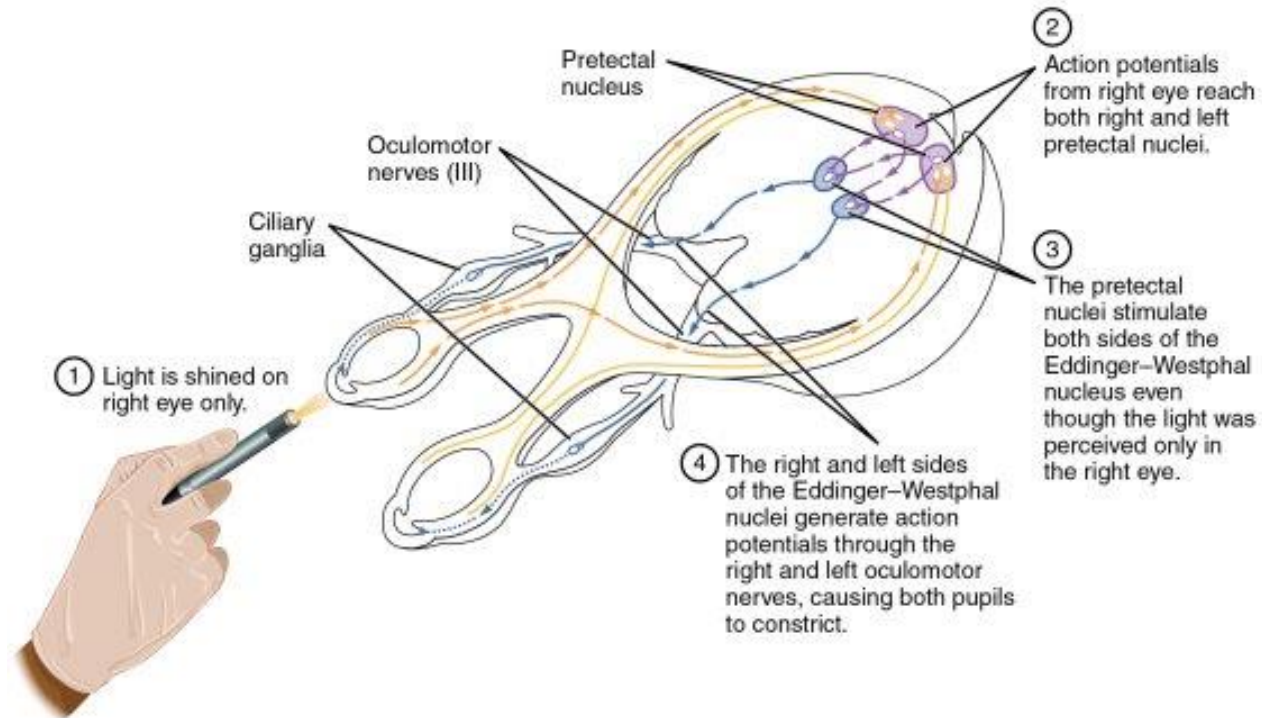
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**26TH PRAGUE  
INTERNATIONAL  
FILM FESTIVAL  
21.-29.03.2019**





# Pupillary reflex



[http://www.ubooks.pub/Books/B0/E27R7642/MAIN/images/1509\\_Pupillary\\_Reflex\\_Pathways.jpg](http://www.ubooks.pub/Books/B0/E27R7642/MAIN/images/1509_Pupillary_Reflex_Pathways.jpg)

## 78. The basic physiology of visual system – rods and cones function, on/off receptive field, nervus opticus vs. tractus opticus

- Rods and cons function
  - Characterization and comparison
  - Phototransduction mechanism and adaptation
- Brief overview of retina organization (retina process receptor potential – analog, AP is generated in ganglion cells)
- Receptive field organization
  - On/off receptive fields
  - Magnocellular system (BW)
  - Parvocellular system (Color)
- Nervus opticus vs. tractus opticus
- Projections from tractus opticus (Main centers in the brain involved in visual signals processing)

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