The Visual System

Anatomical Overview

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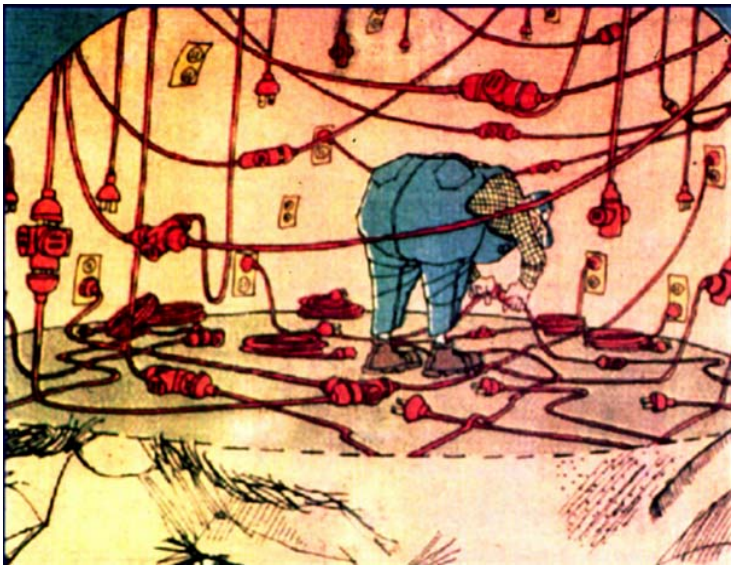


How the Brain Works

Useful Additional Reading:

Adler, F.H. Adler's Physiology of the Eye 10th Ed: Useful information can be found in this text.

Purves et al., eds "Neuroscience" Chaps 10, Vision: the eye, Chap 11 Central Visual Pathways. pp 179-222. This book provides a nice overview of the anatomy of the visual system and is in the Eskind Med library

Web Sites

http://www.neuroguide.com/ (Many links to other sites)

http://faculty.washington.edu/chudler/ (Designed for Children but gives good overview, definitions, images and links to other sites)

http://thalamus.wustl.edu/course/

http://medlib.med.utah.edu/WebPath/HISTHTML/NEURANAT/NEURANCA.html (anatomical tutorial with labeled images)

Overview

- The nervous system is made up of cells that are grouped together into functionally unique zones. These brain areas are connected to other brain areas via long and short sets of pathways (axons of nerve cells)
- The visual system is made up of many interconnected groups of cells. These groups of cells are specialized to perform different functions such as move the eyes, control pupil size, recognize objects and locations in space.

Terminology

- Names of brain areas often refer to the location of the structure in standard coordinate positions and in terms of Latin descriptions of the appearance of the structure.

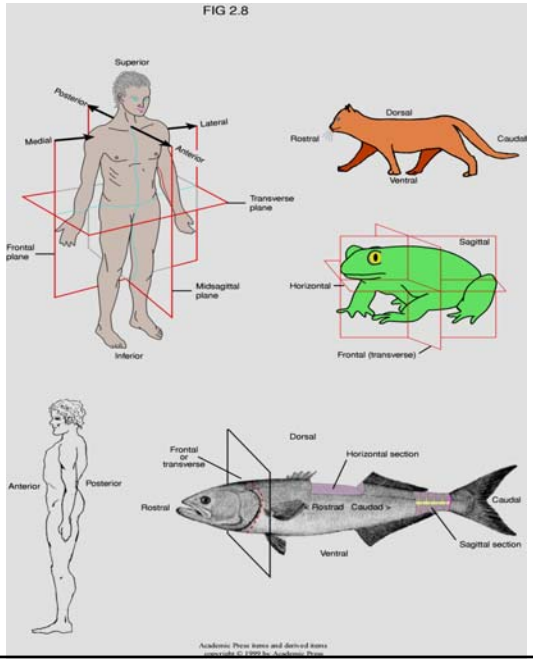
Structures are often named according to location in the nervous system

Standard Planes for brain sections.

1. **Coronal (frontal)**
2. **Sagittal (parallel to midline)**
3. **Horizontal (transverse)**

Coordinate positions

1. **Lateral/medial**
2. **Anterior/Posterior**
3. **Dorsal/ventral**



Terminology

- Names of brain areas often refer to the location of the structure in the standard coordinate positions and in terms of the Latin descriptions of the appearance of the structure.

- (e.g., lateral (position in the brain) geniculate (genu=knee, as in knee shaped) nucleus (group of cells)

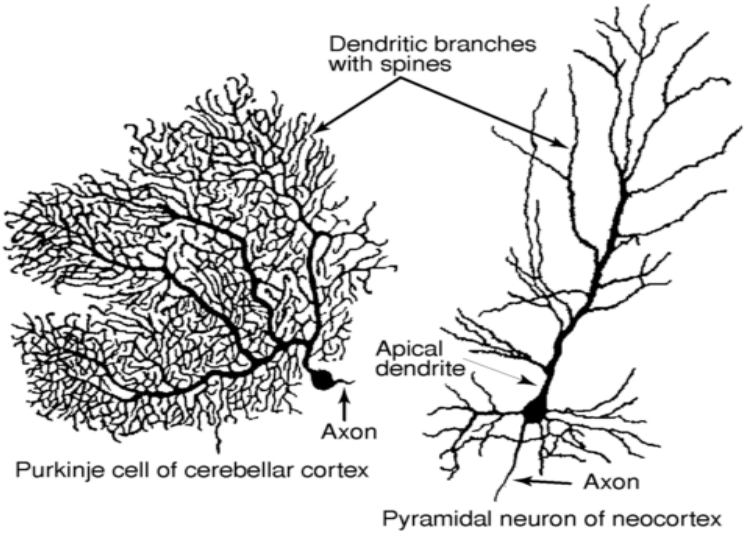
Terminology

- Individual cells can be grouped into nuclei, layers. These nuclei and layers can be grouped into larger functional areas of the brain.

- Groups of axons can be called tracts (e.g. the optic tract) or fiber bundles. The white matter refers to the appearance of groups of myelinated axons in raw brain. Grey matter refers to groups of cell bodies in raw brain.

- Afferent =toward the structure of reference
- Efferent = away from the structure of reference (e.g., retinal ganglion cells provide afferent axons to the lateral geniculate nucleus. Efferent axons from the lateral geniculate nucleus innervate cortex)

The nervous system contains a variety of cells. Nerve cells (neurons) and glia (supporting cells) come in a variety of shapes.



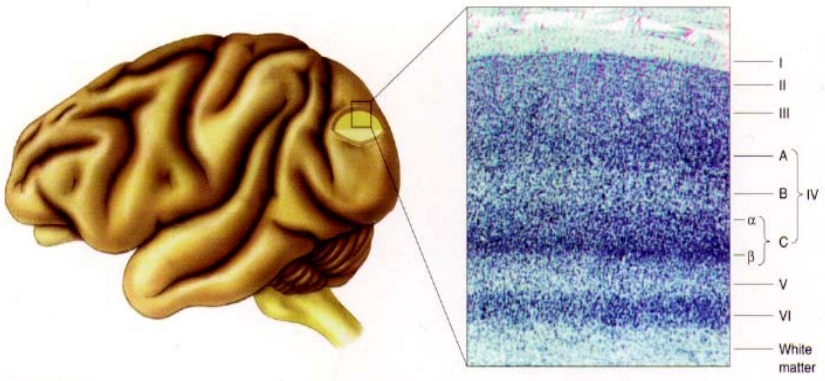
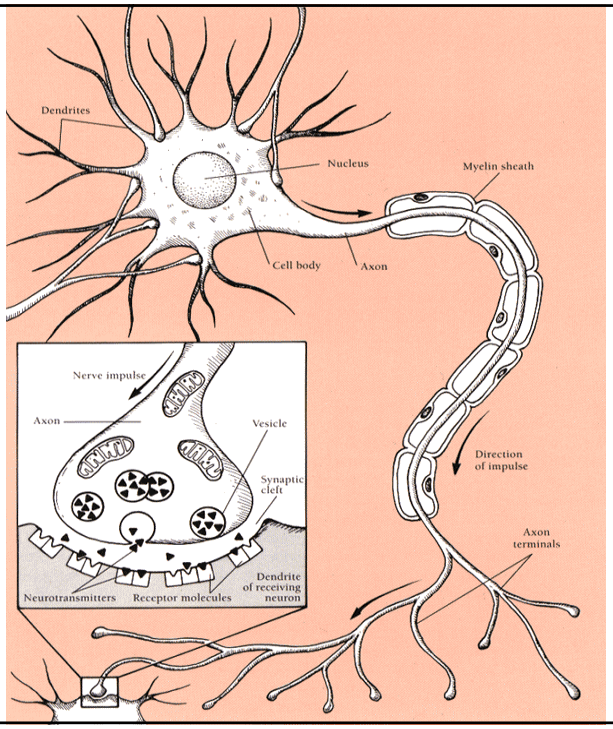
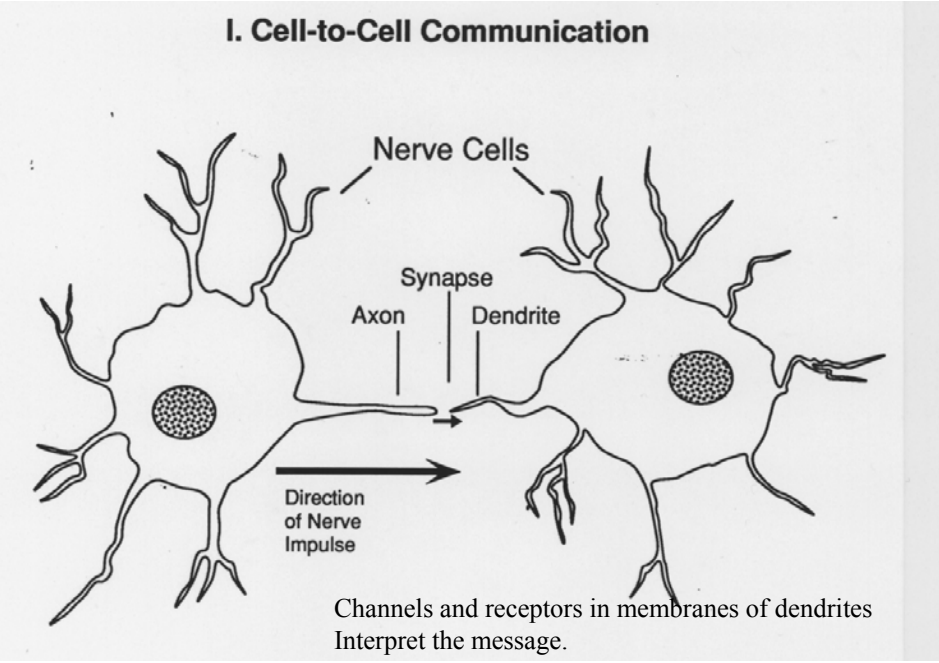
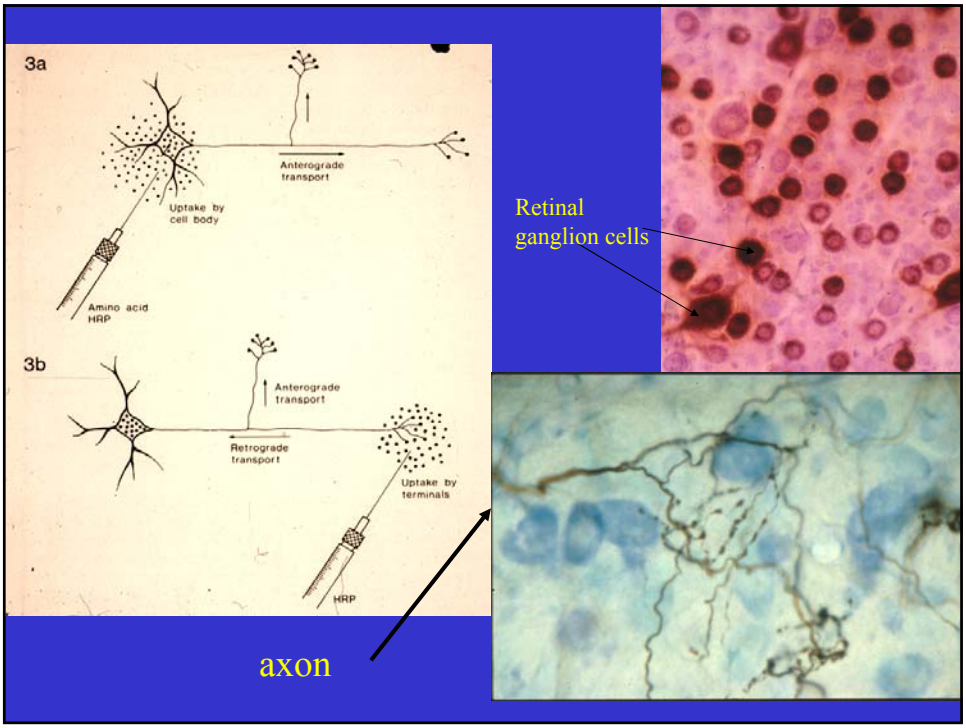


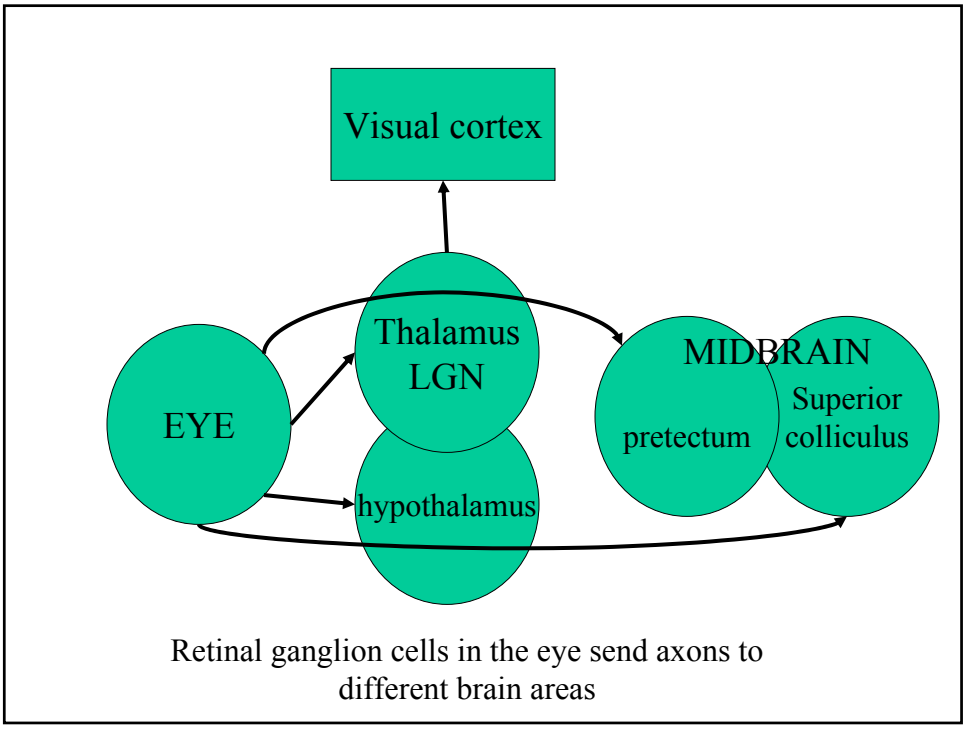
Figure 10.12
The cytoarchitecture of the striate cortex. The tissue has been Nissl stained to show cell bodies, which appear as dots. (Source: Adapted from Hubel, 1988; p. 97.)





Channels and receptors in membranes of dendrites Interpret the message.

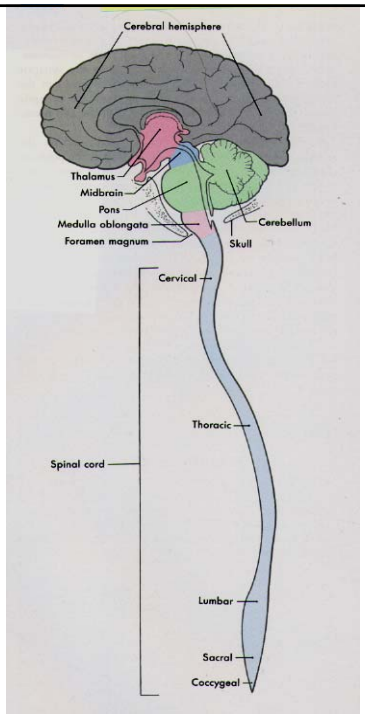


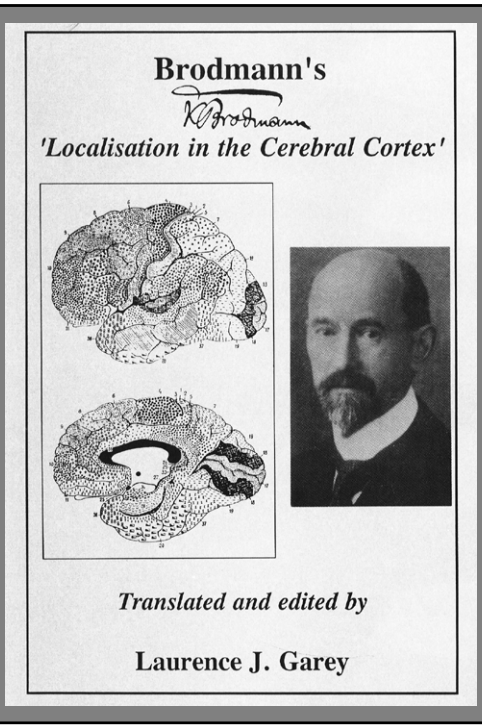


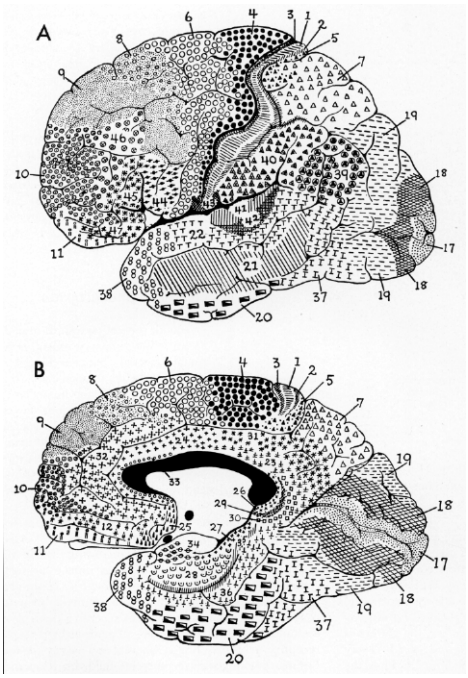
Retinal ganglion cells in the eye send axons to different brain areas

Brain Parts

- Cerebral cortex (visual cortex)
- Thalamus (lateral geniculate nucleus)
- Midbrain (pretectum and superior colliculus)
- Cerebellum/pons (cell groups that control eye movements)
- Medulla




Brodmann's
'Localisation in the Cerebral Cortex'
Translated and edited by
Laurence J. Garey


A
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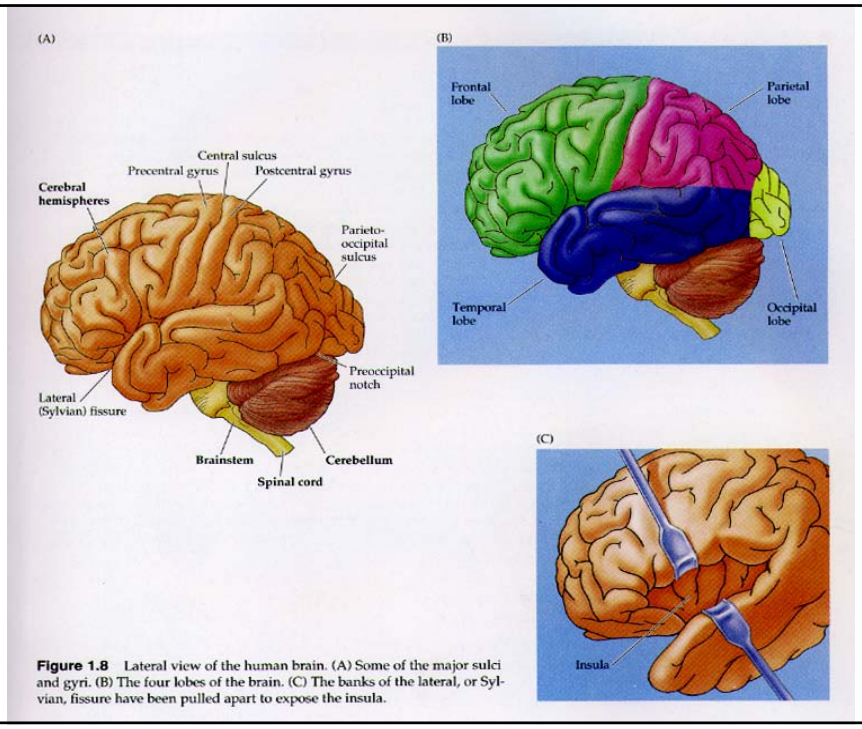
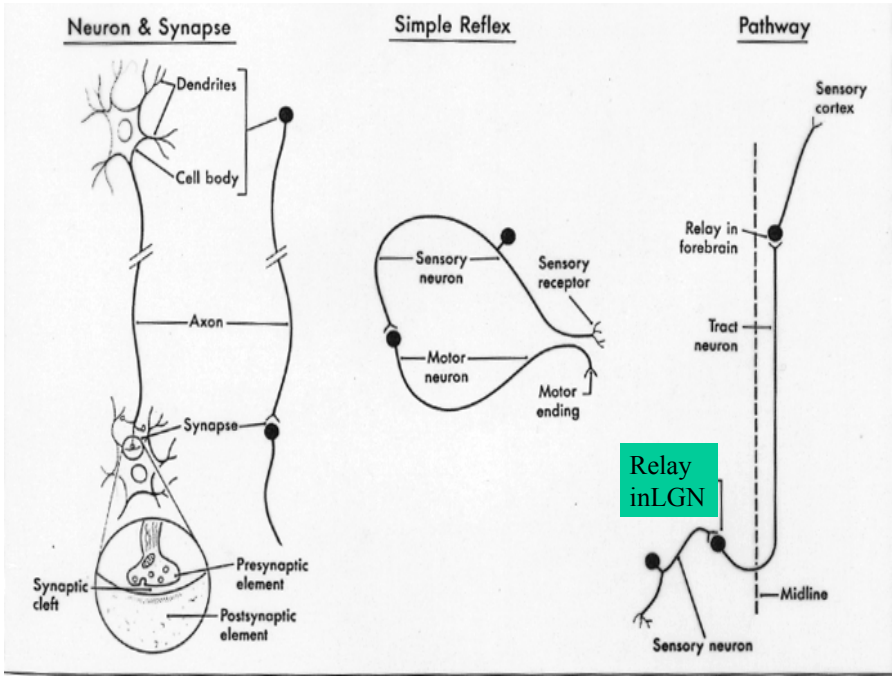
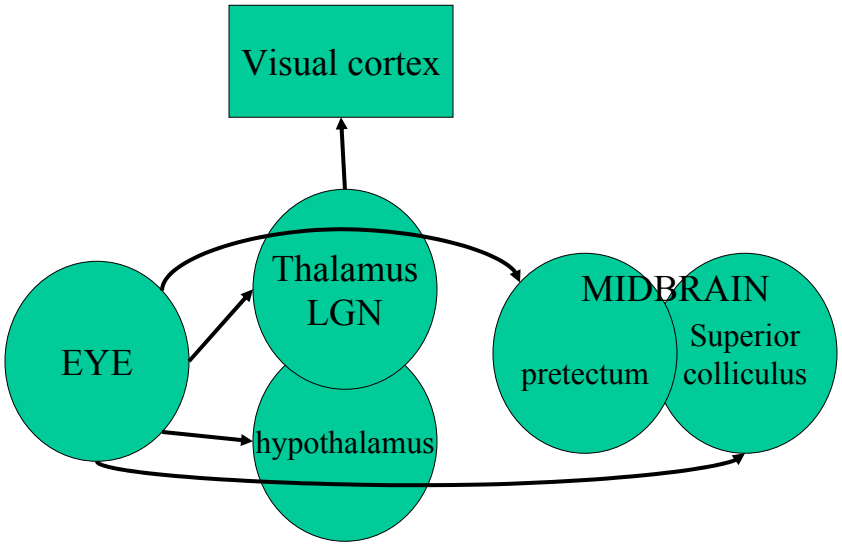
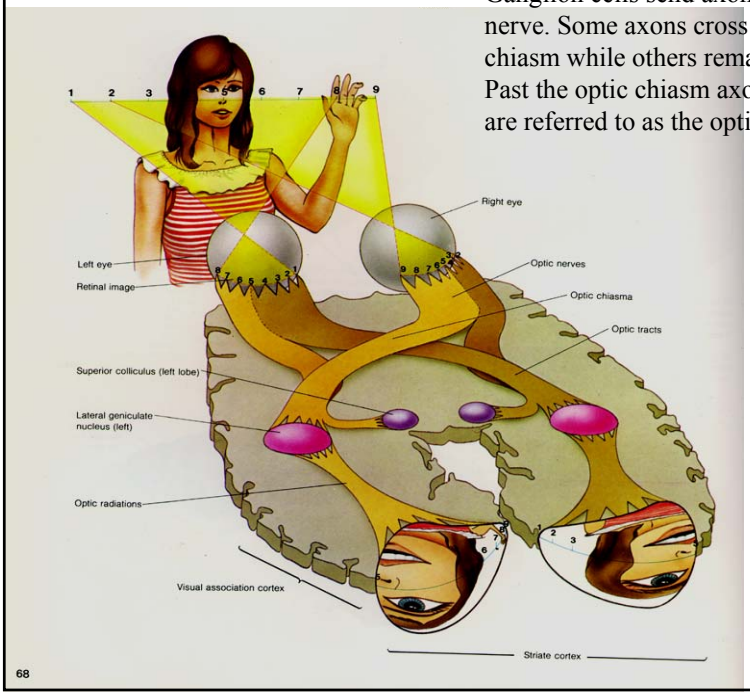


Figure 1.8 Lateral view of the human brain. (A) Some of the major sulci and gyri. (B) The four lobes of the brain. (C) The banks of the lateral, or Sylvian, fissure have been pulled apart to expose the insula.

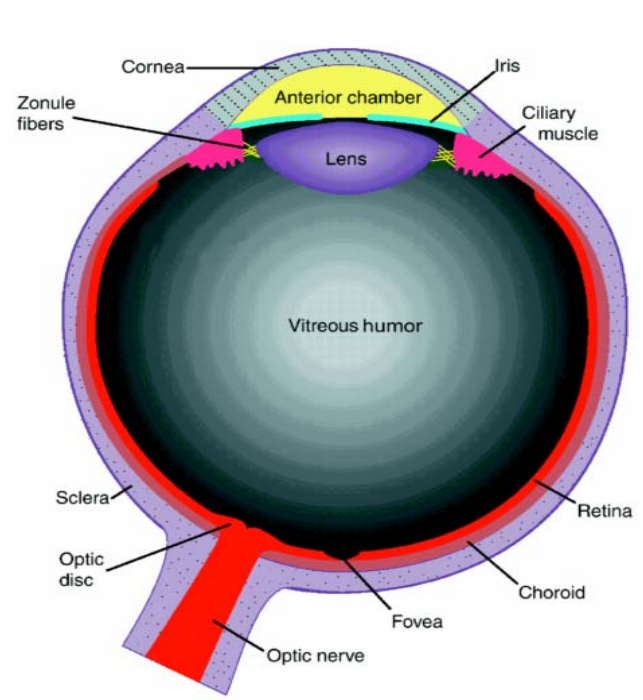




Retinal ganglion cells in the eye send axons to different brain areas



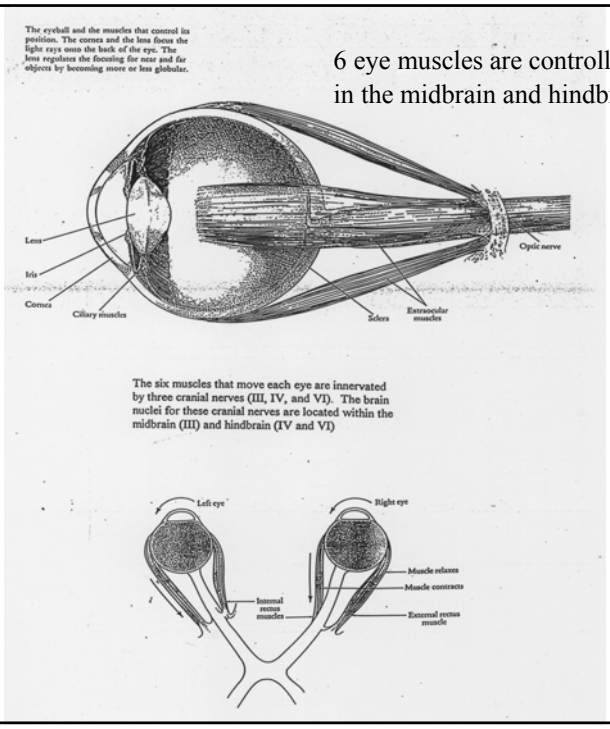
Ganglion cells send axons into the optic nerve. Some axons cross at the optic chiasm while others remain uncrossed. Past the optic chiasm axons from the eye are referred to as the optic tracts.



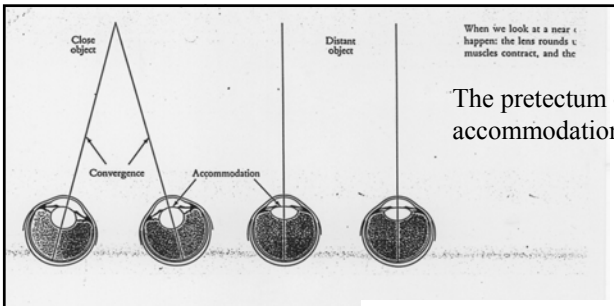
Different classes of retinal ganglion cells send axons to different brain areas

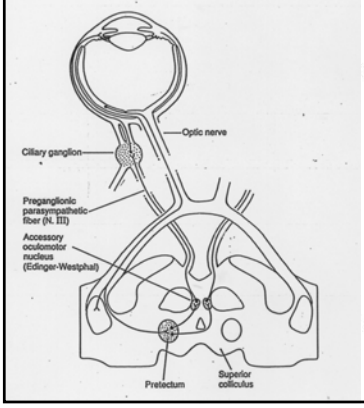
- Lateral geniculate nucleus (thalamus) = conscious vision
- Superior colliculus (midbrain) = head and eye movements
- Pretectum (midbrain) = pupillary reflexes and accommodation

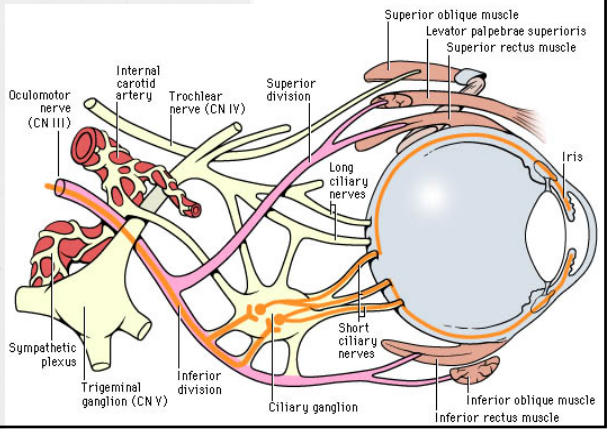
6 eye muscles are controlled by 3 cell groups (nuclei) in the midbrain and hindbrain.

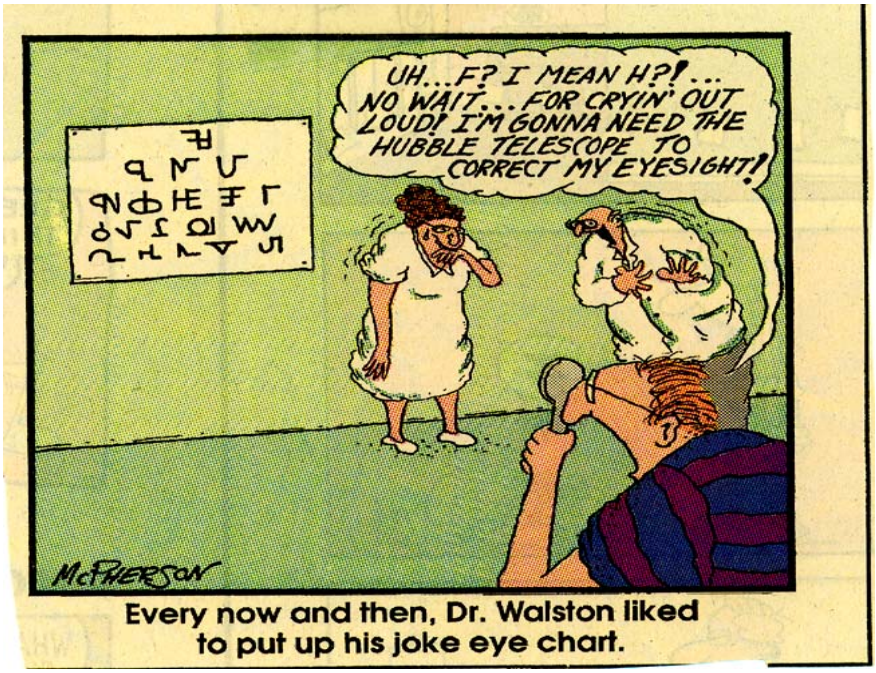


The pretectum controls pupil size and accommodation









The visual system is designed to detect objects not light

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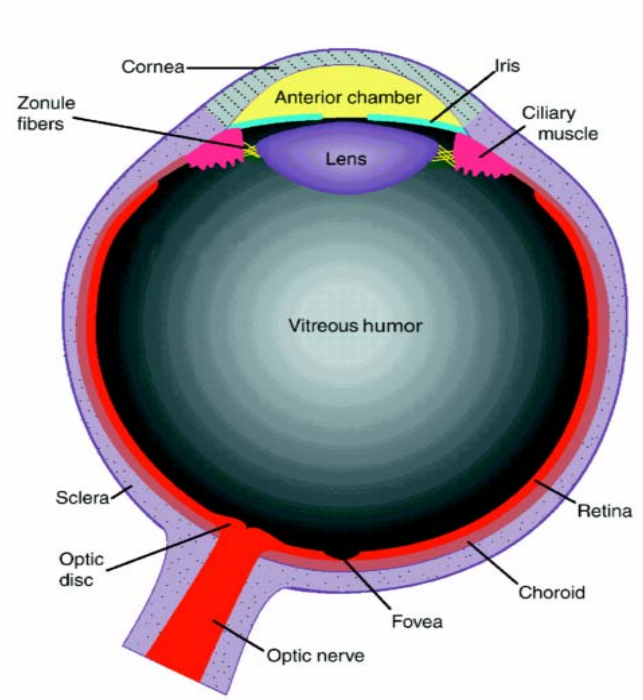

The **optic disk or blind spot** is the area where the axons from the ganglion cells of the retina exit. This area has no photoreceptors. You can demonstrate that you are blind in this area by holding the card with the dot (or circle) to the left and the X to the right. Close your left eye and focus on the dot with your right eye while moving the card slowly toward your face. At about 8 inches away you will find that the X disappears from view. Your focus must never leave the dot or this demonstration will not work.

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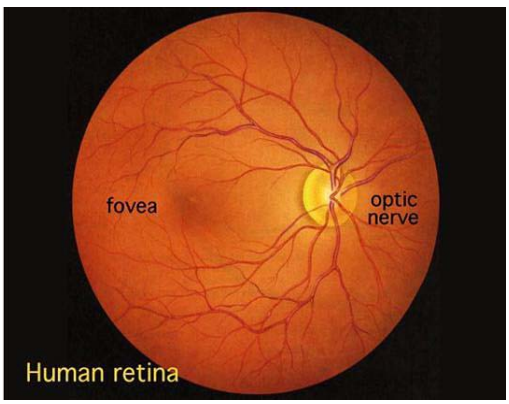
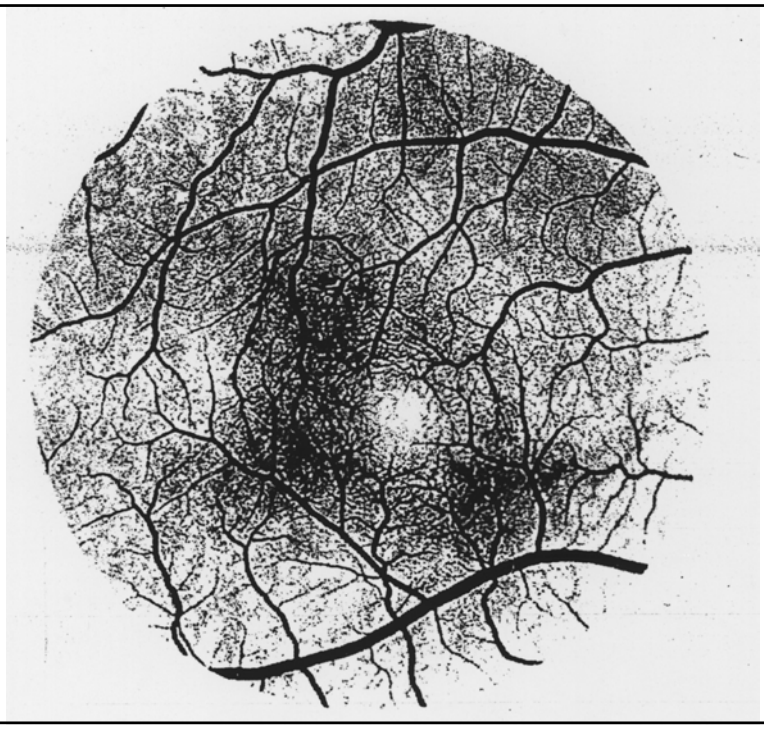
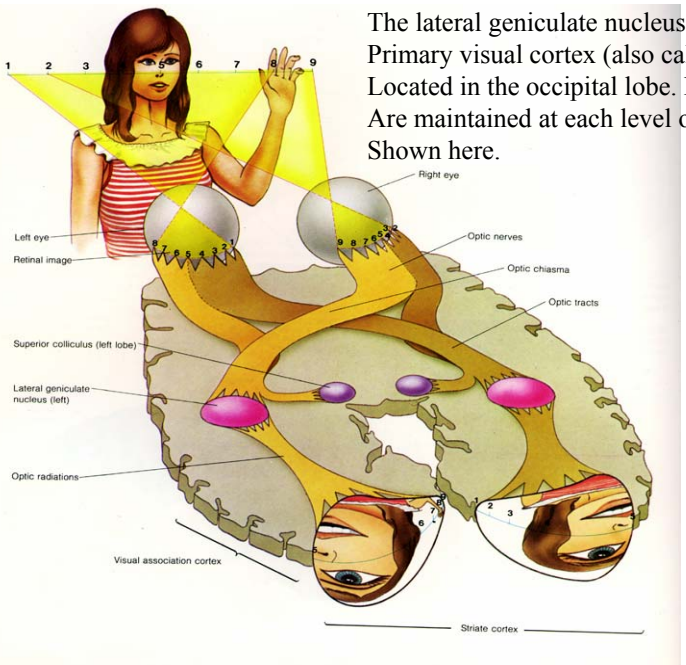


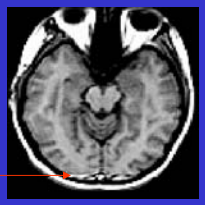




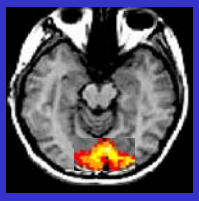
The lateral geniculate nucleus cells send axons to Primary visual cortex (also called V1 or striate cortex) Located in the occipital lobe. Maps of visual space Are maintained at each level of the visual system as Shown here.

fMRI images

Visual cortex



(lights off)

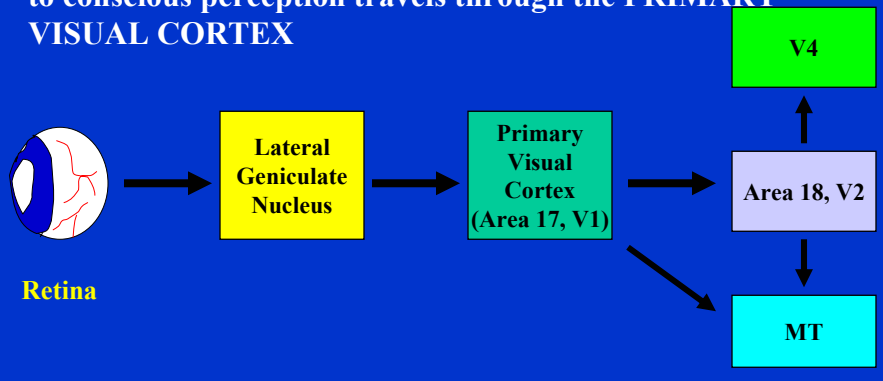


(lights on)

Looking at the physiological response with visual stimulation

Primary Visual Pathway

In primates all visual information from the retina critical to conscious perception travels through the PRIMARY VISUAL CORTEX



SUBSETS OF RETINAL GANGLION CELLS SEND AXONS TO DIFFERENT BRAIN AREAS, THESE BRAIN AREAS HAVE DIFFERENT VISUAL FUNCTIONS.

BRAIN SUBDIVISION	BRAIN AREA	ROLE
Doral thalamus	lateral geniculate nucleus	relay to primary visual cortex for conscious perception
Midbrain	pretectal nuclei	pupillary reflexes and accommodation
Midbrain	superior colliculus (Optic tectum)	orientation of the head and eyes
Hindbrain	Eye muscle nuclei	Control of eye muscles