Vision II

Steven McLoon
Department of Neuroscience
University of Minnesota

Course News

Coffee Hour

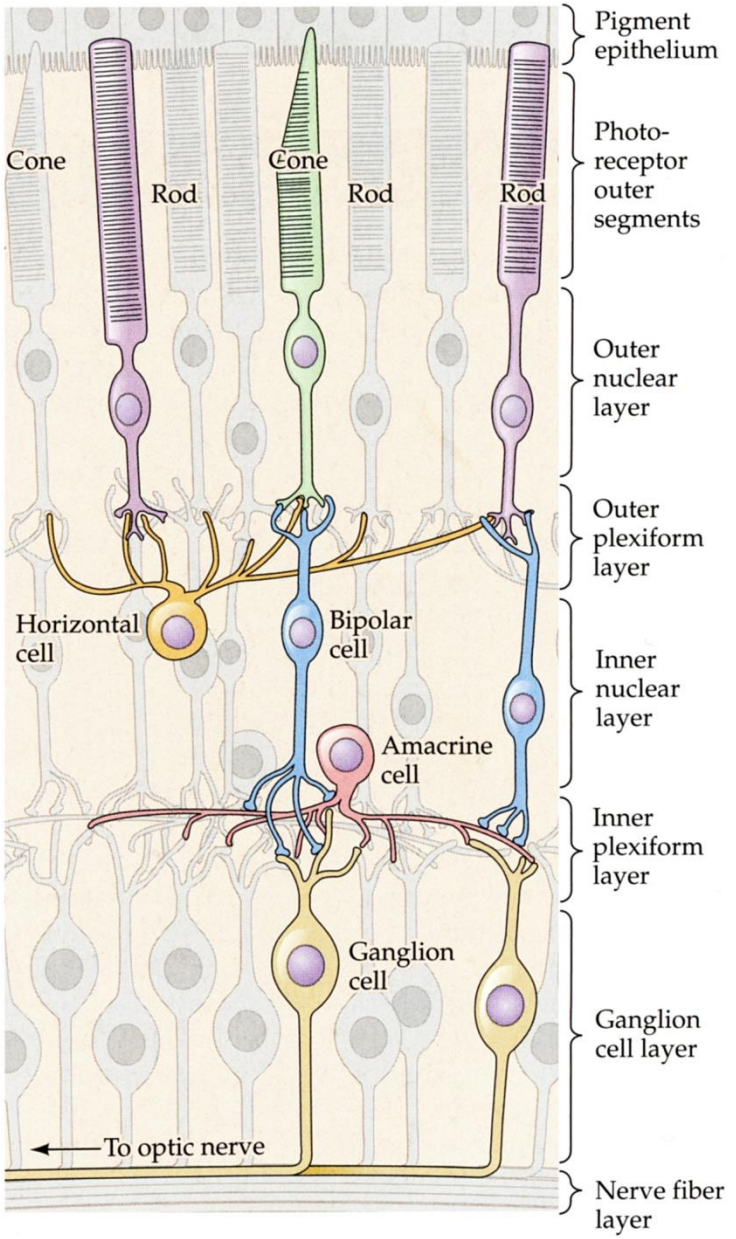
Tuesday (Oct 16)
9:30-10:30am

Surdyks Café in Northrop Auditorium

Stop by for a minute or an hour!

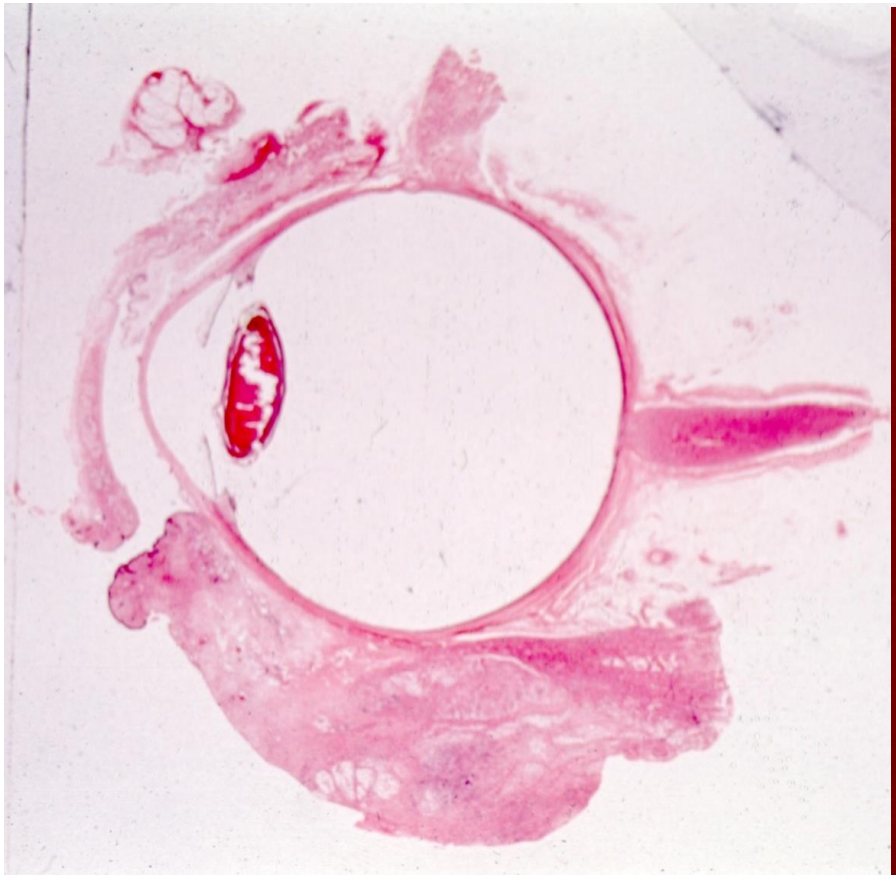
Ganglion Cells

- The axons of the retinal ganglion cells form the optic nerve and carry visual information into the brain.

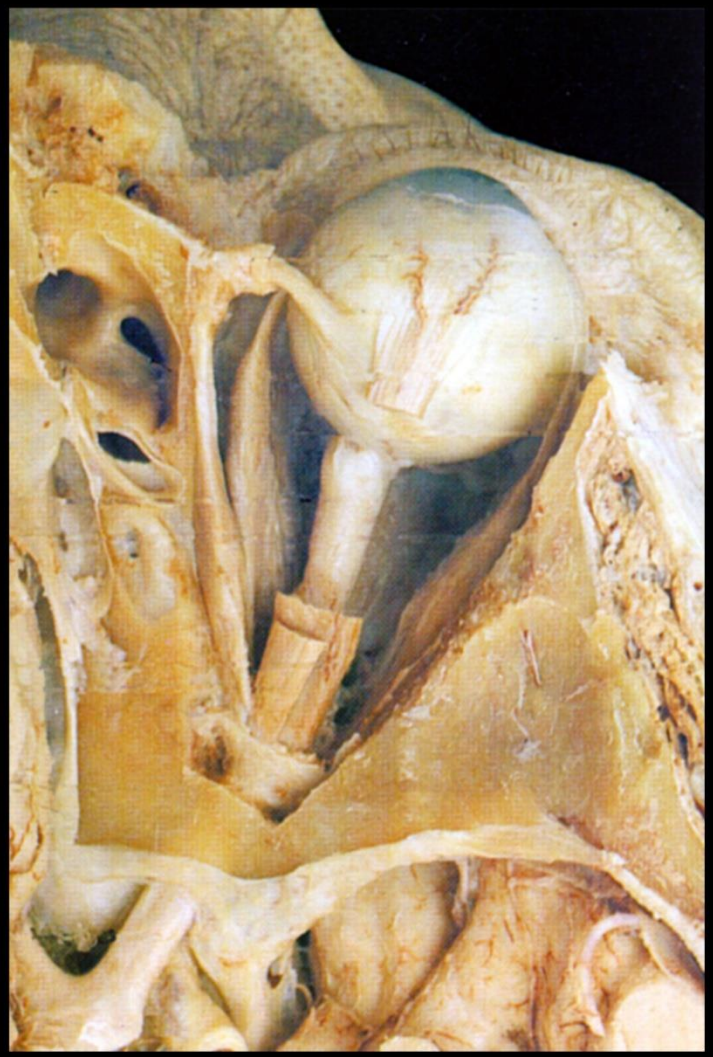


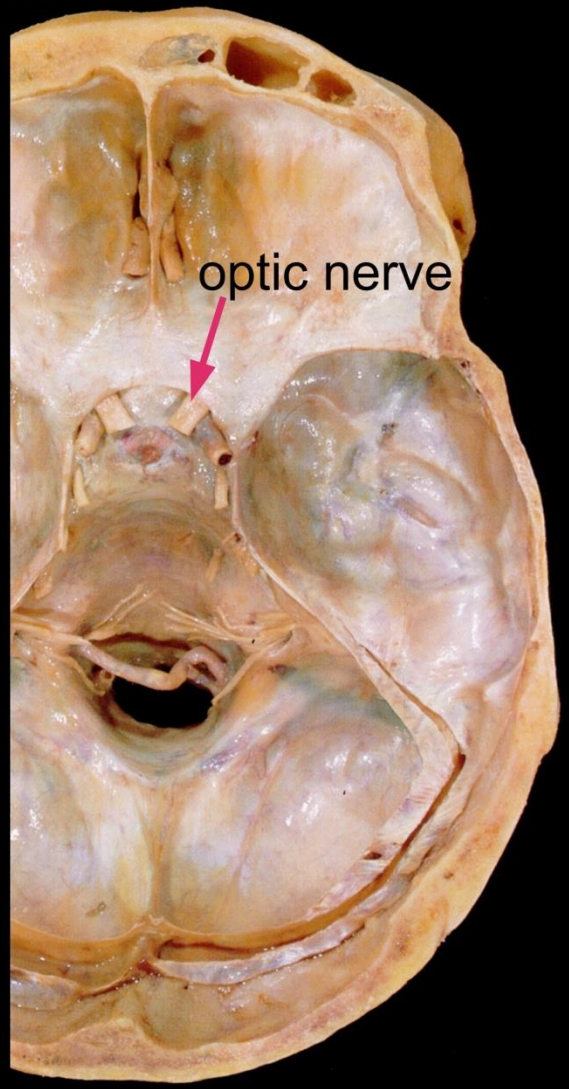
Optic Nerve (CN II)

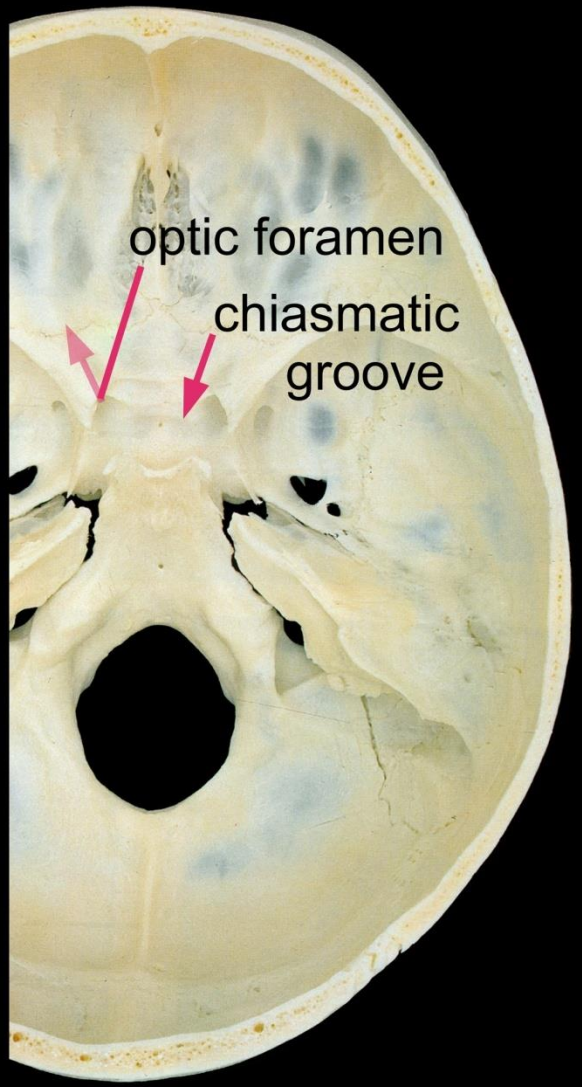
- The axons from retinal ganglion cells across the retina run to the optic nerve head.
- The optic nerve head is the start of the optic nerve.
- There is no retina at the optic nerve head (blind spot).
- The retinal axons become myelinated at the optic nerve head.



Optic Nerve (CN II)

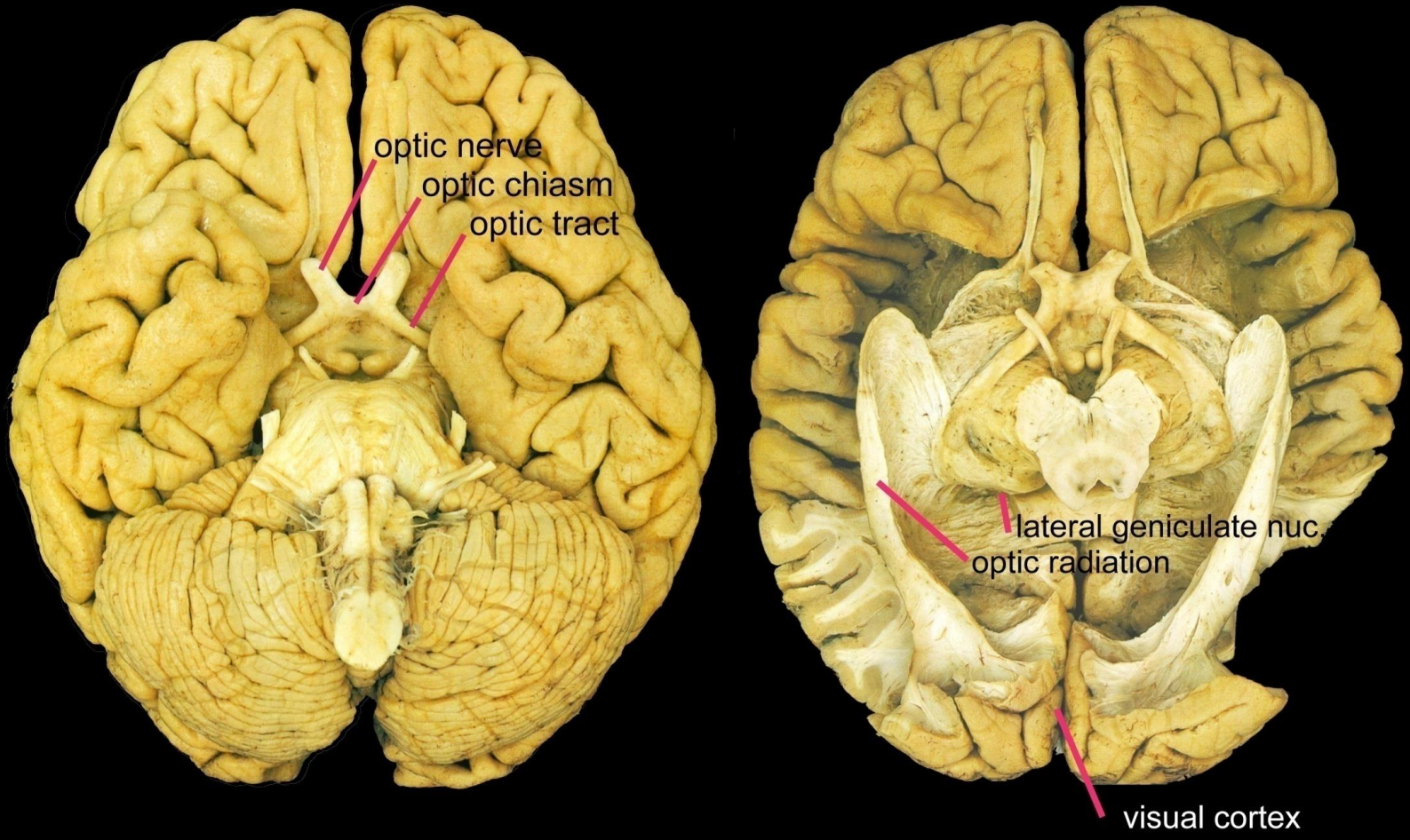






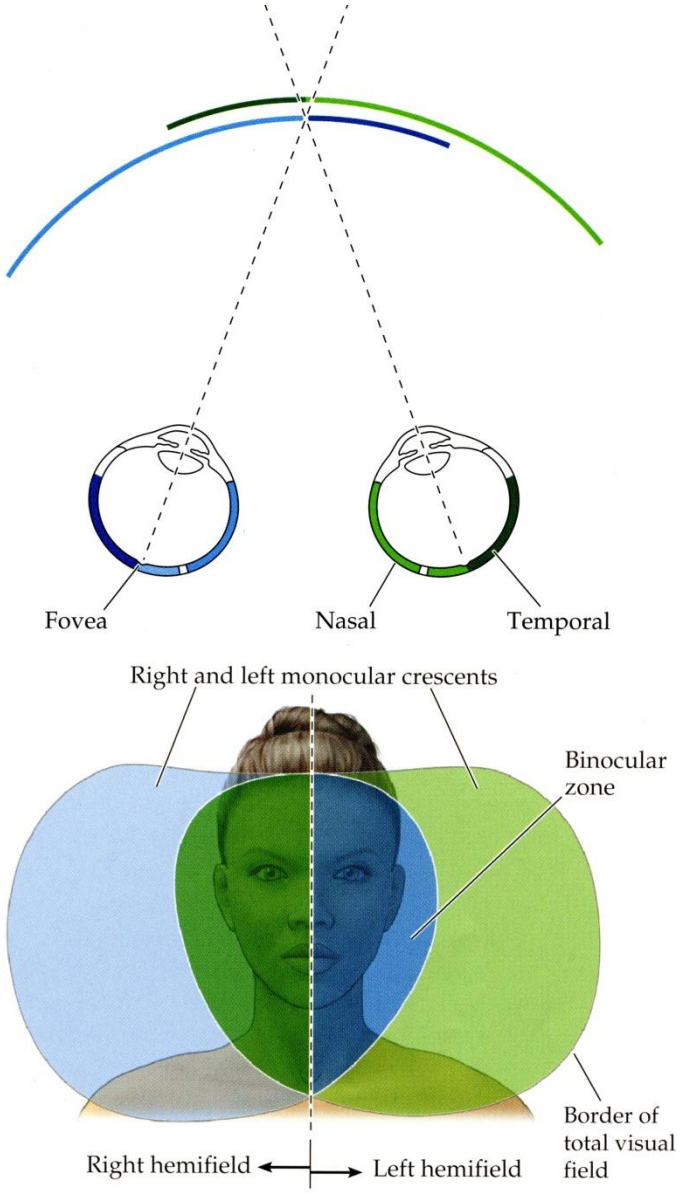
Central Visual Pathways

- The optic nerve attaches to the brain at the optic chiasm.
- Retinal axons from the nasal side of retina cross in the chiasm.
- The retinal axons continue in the optic tract.

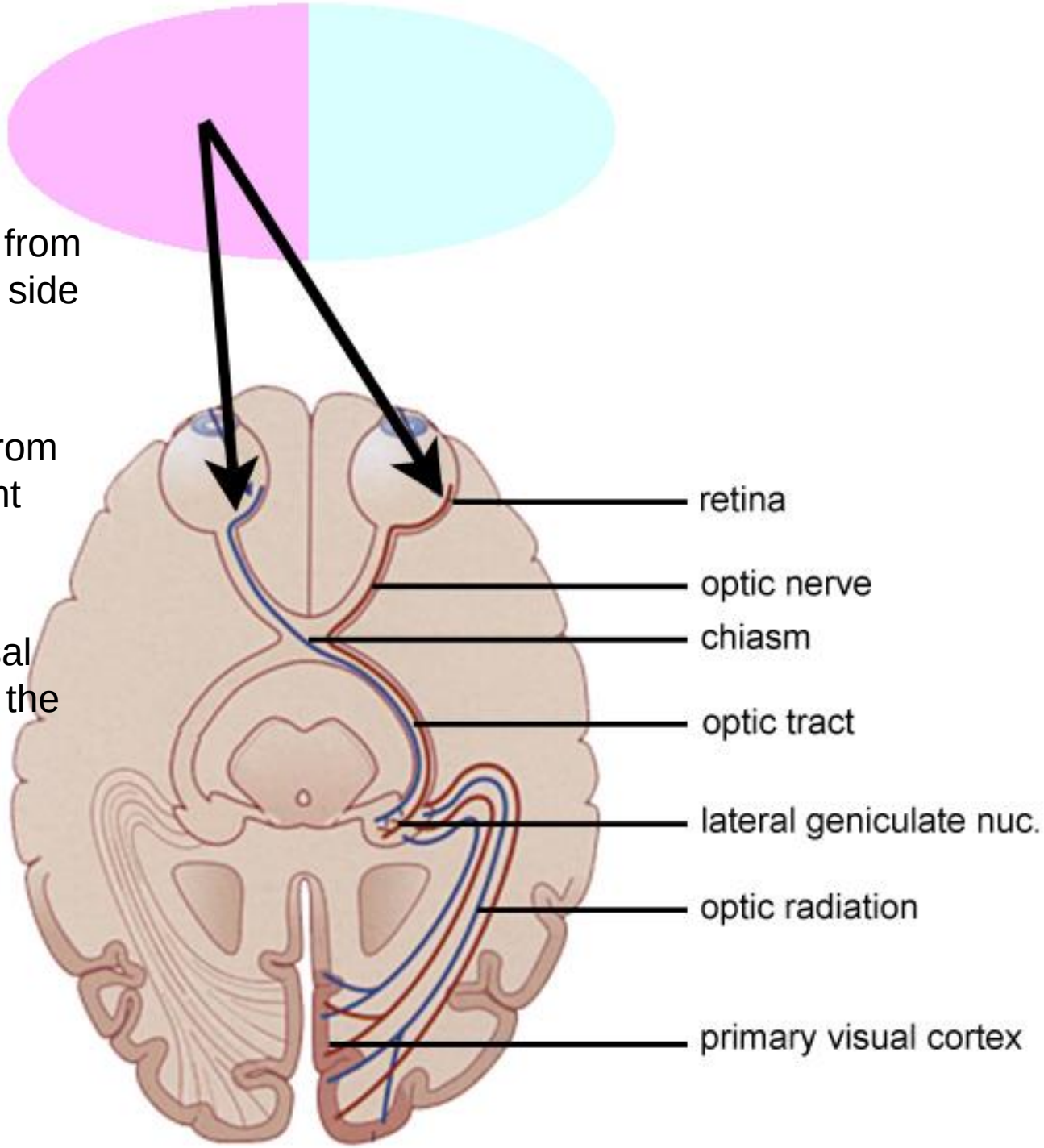


Central Visual Pathways

- Both eyes see some of both visual hemifields.
- The center of the visual field goes to both eyes, the binocular zone.
- The periphery of the visual field goes to only one eye, the monocular zone.

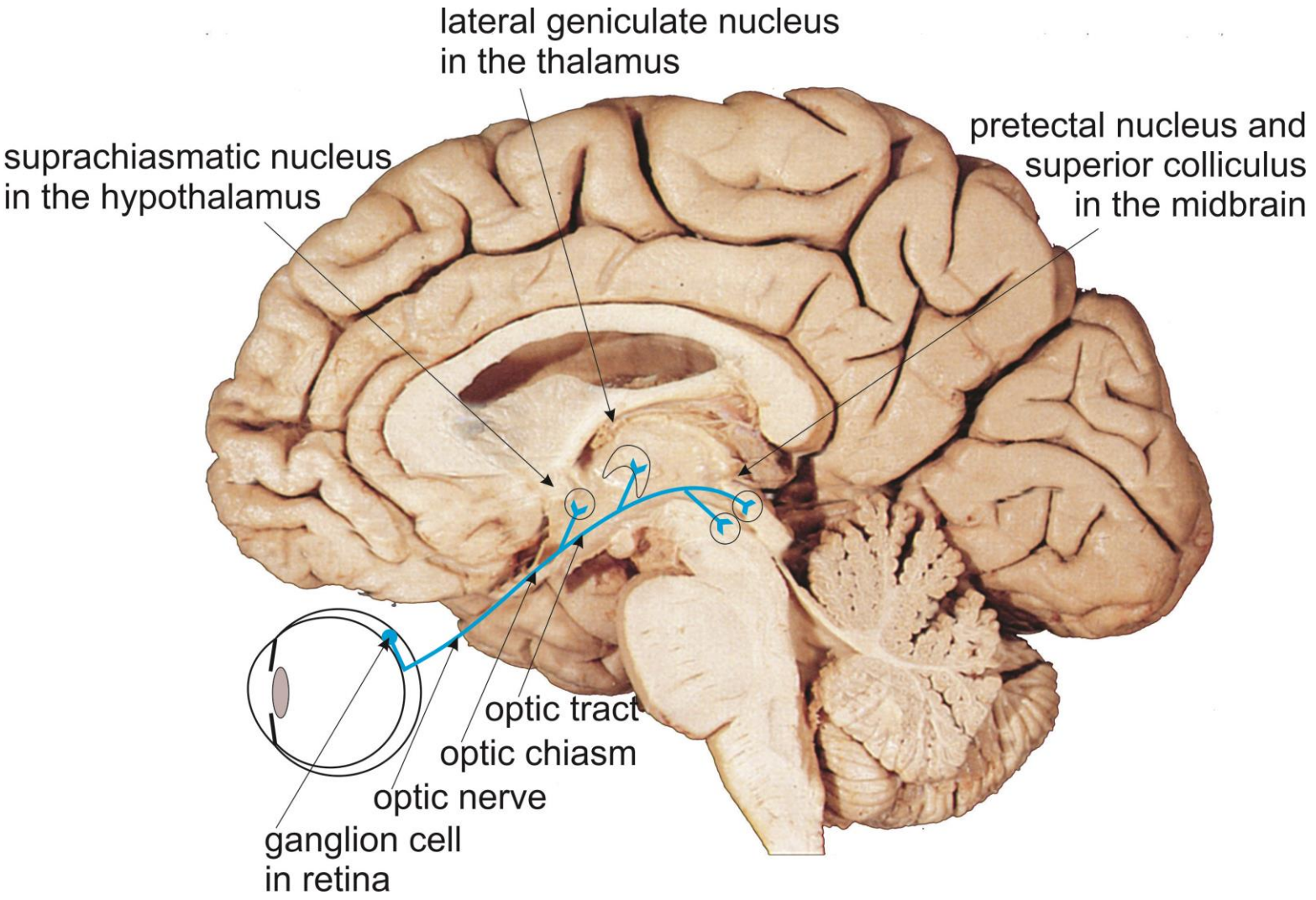


- The right visual hemifield from both eyes goes to the left side of the brain.
- The left visual hemifield from both eyes goes to the right side of the brain.
- Thus, axons from the nasal side of the retina cross in the optic chiasm.



Central Visual Pathways

- Retinal axons synapse in several visual centers in the brain.



Central Visual Pathways

Retinal axons synapse in several visual centers in the brain including:

- Suprachiasmatic nucleus in the hypothalamus for regulation of circadian rhythms.

- Lateral geniculate nucleus in the thalamus for relay to visual cortex for conscious perception of vision.

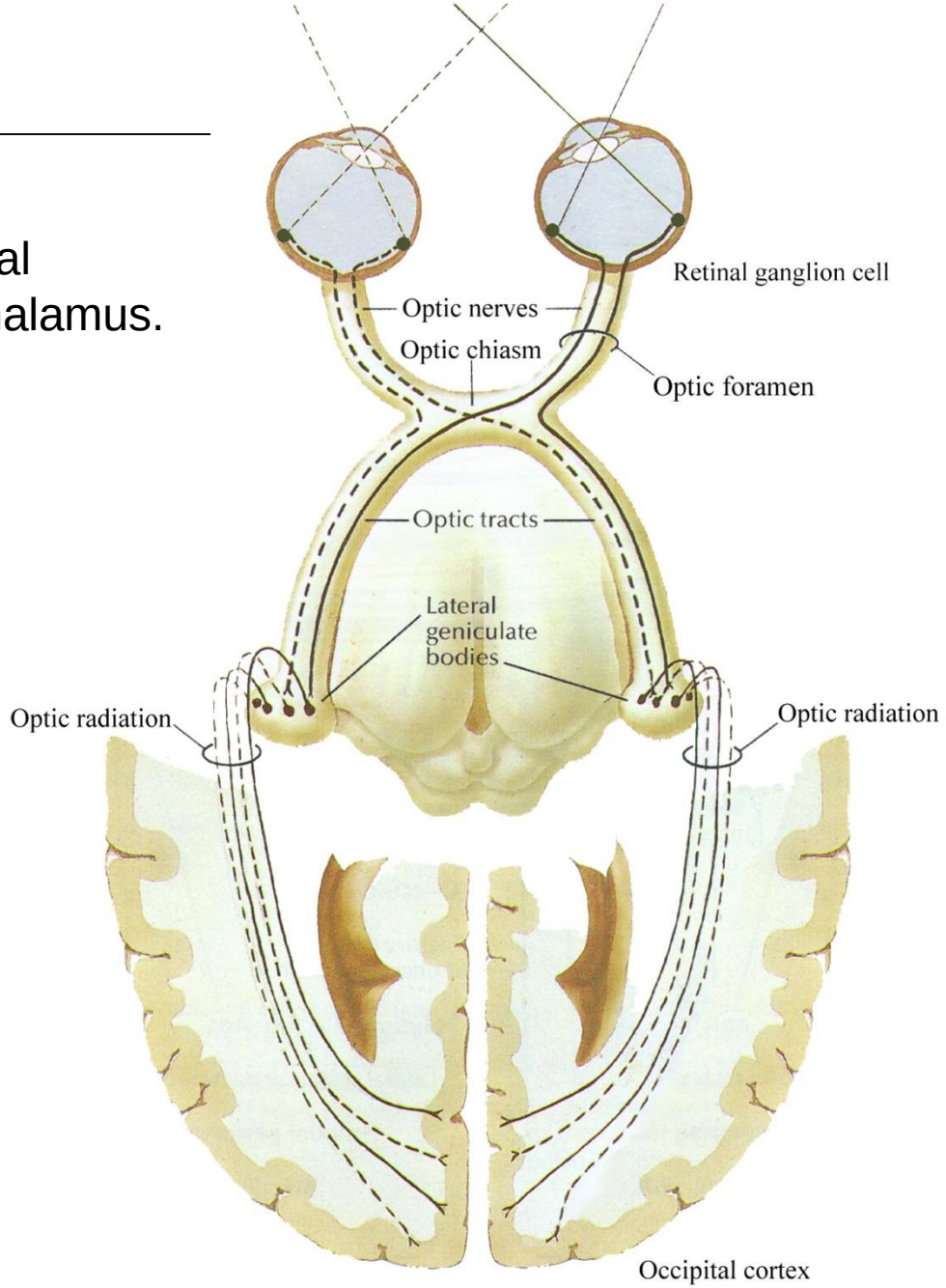
- Pretectal nucleus in the midbrain for the pupillary light reflex and other reflexes.

- Superior colliculus in the midbrain for oculomotor control.

Different ganglion cells axons go to different targets; no axon goes to all these visual centers.

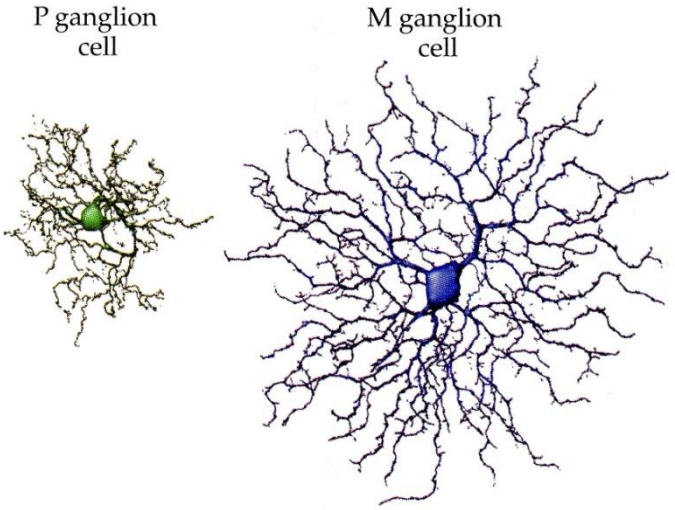
Central Visual Pathways

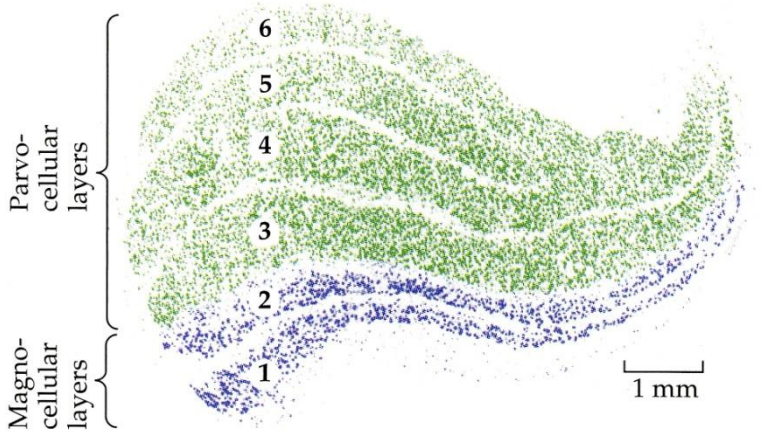
- Retinal axons synapse in the lateral geniculate nucleus (LGN) of the thalamus.



Central Visual Pathways

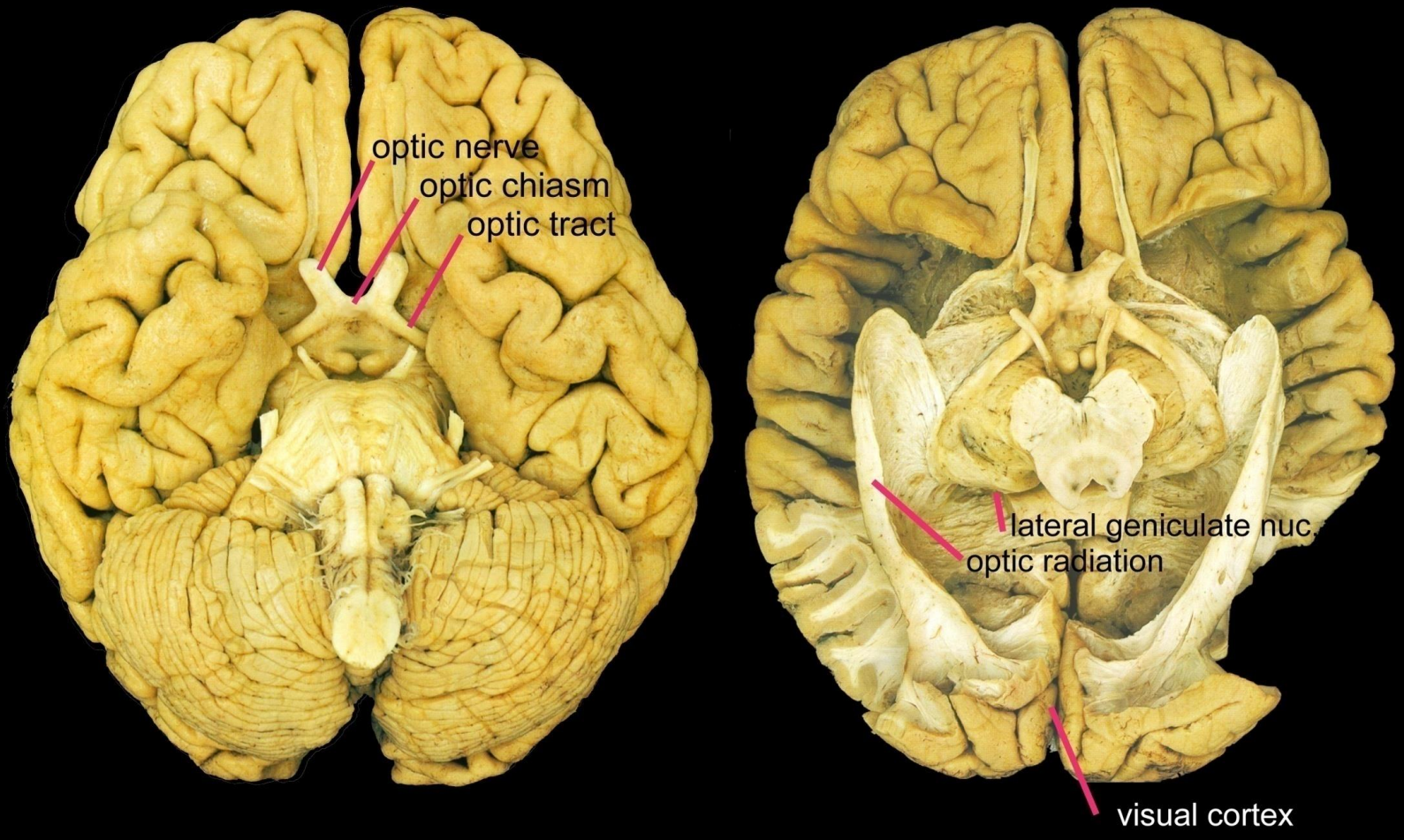
- The lateral geniculate nucleus (LGN) has six cell layers.
- Axons from the two eyes synapse in different layers. (i.e. Cells in the LGN are monocular.)
- M and P ganglion cells also synapse in different layers of the LGN.





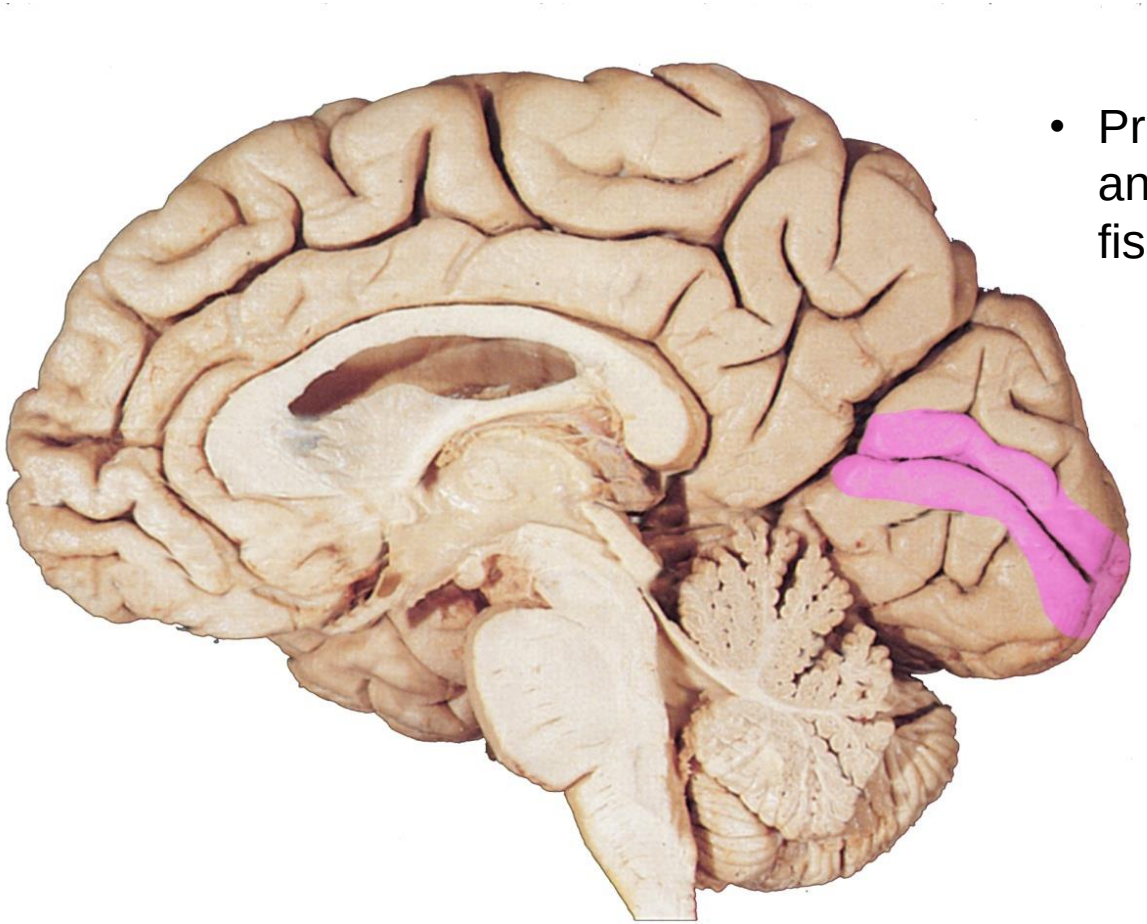
Central Visual Pathways

- Axons from neurons in the LGN project their axons via the optic radiation of the internal capsule to primary visual cortex (V1 or area 17).



Central Visual Pathways

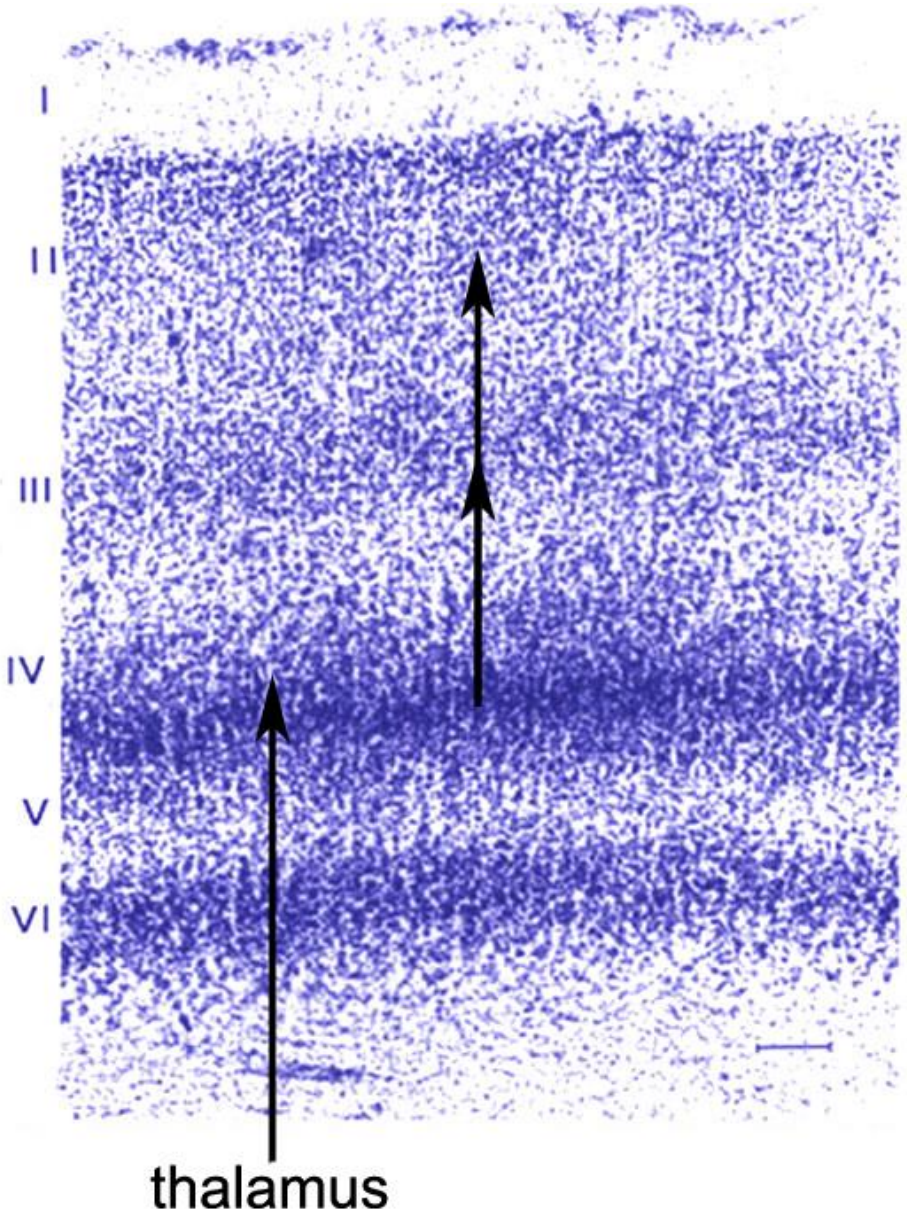
- Primary visual cortex is essential for conscious visual perception.



- Primary visual cortex is in and surrounds the calcarine fissure in the occipital lobe.

Central Visual Pathways

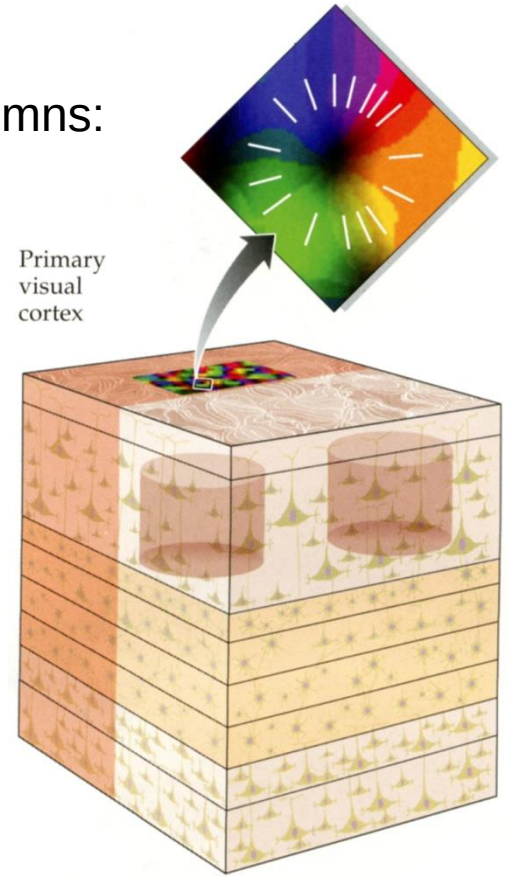
- Neocortex has six cell layers.
- Inputs from thalamus synapse in layer IV.
- Layer IV neurons send axons to layers II & III.
- Layers II & III send axons to other regions of cortex.



Functional Columns in Cortex

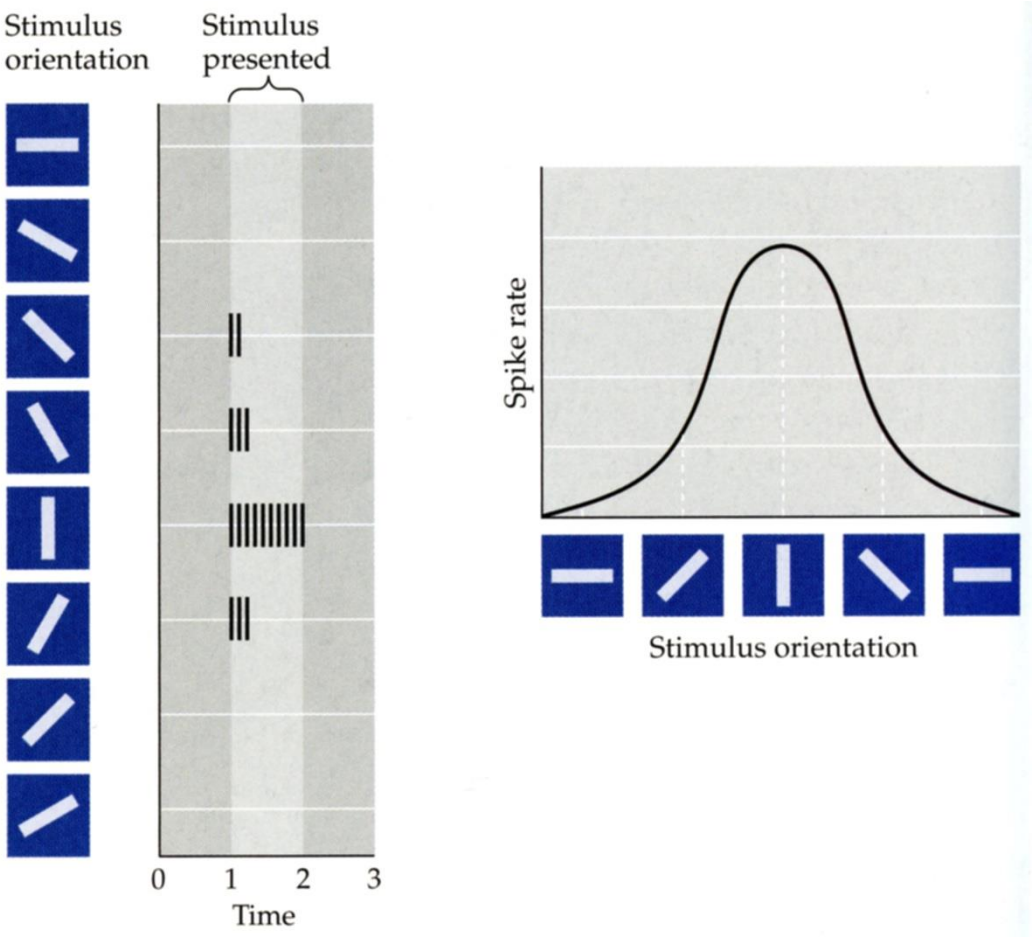
- The functional units of cortex are columns.

- Primary visual cortex has several types of columns:
  - orientation columns
  - ocular dominance columns
  - color columns (blobs)



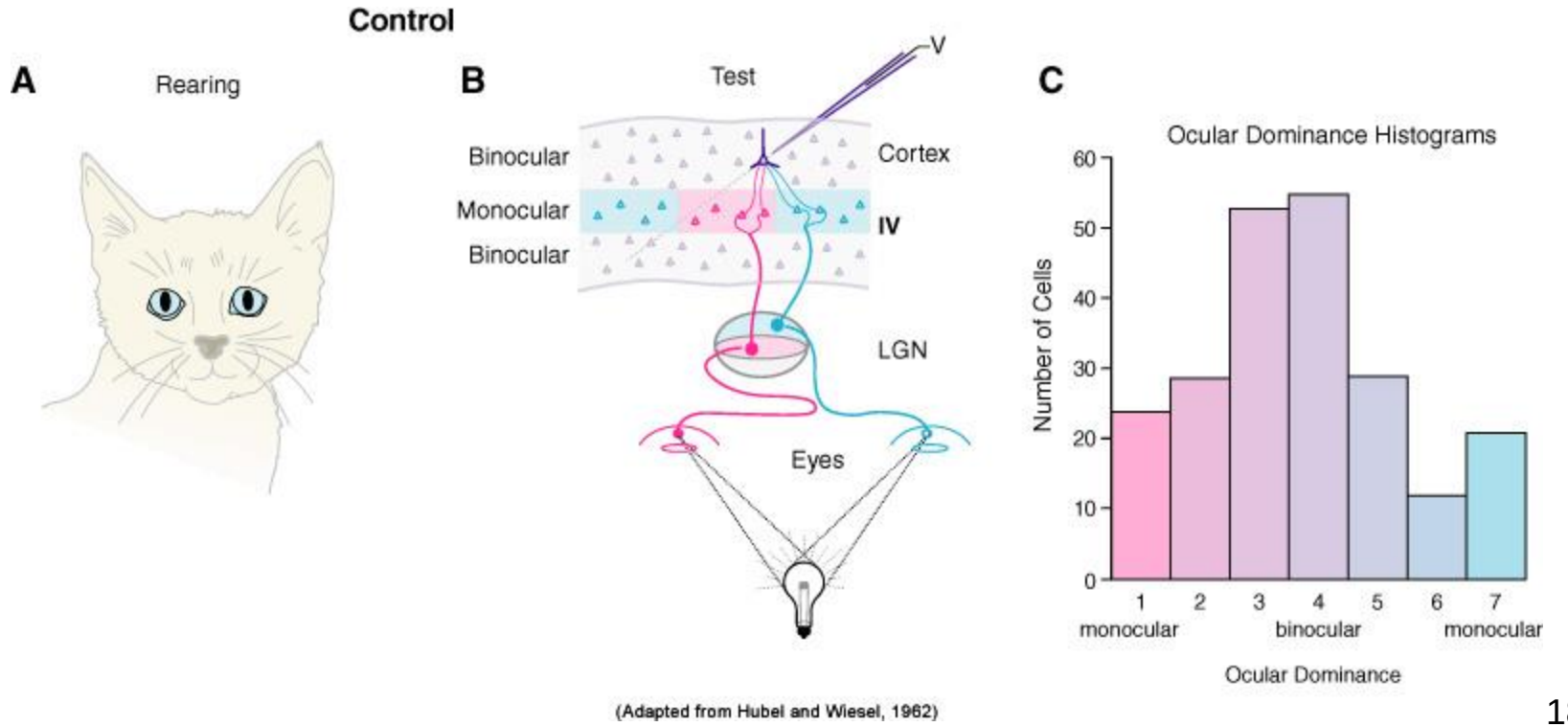
Functional Columns in Cortex

- Orientation columns



Functional Columns in Cortex

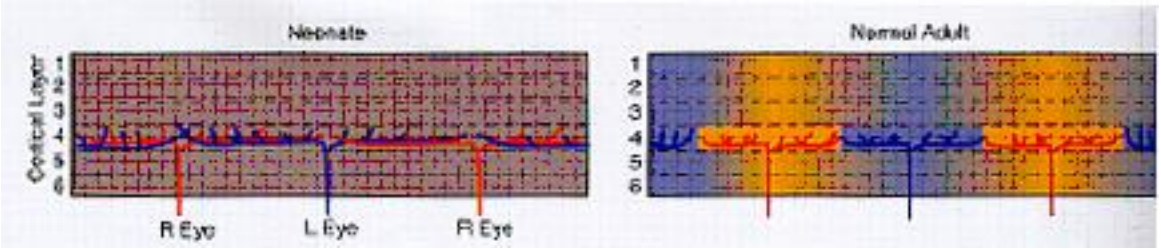
- In the adult, the axons from the lateral geniculate nucleus to layer IV of visual cortex are segregated into alternating stripes subserving the output from each eye (ocular dominance columns).
- Cells in the other cortical layers are binocular.



(Adapted from Hubel and Wiesel, 1962)

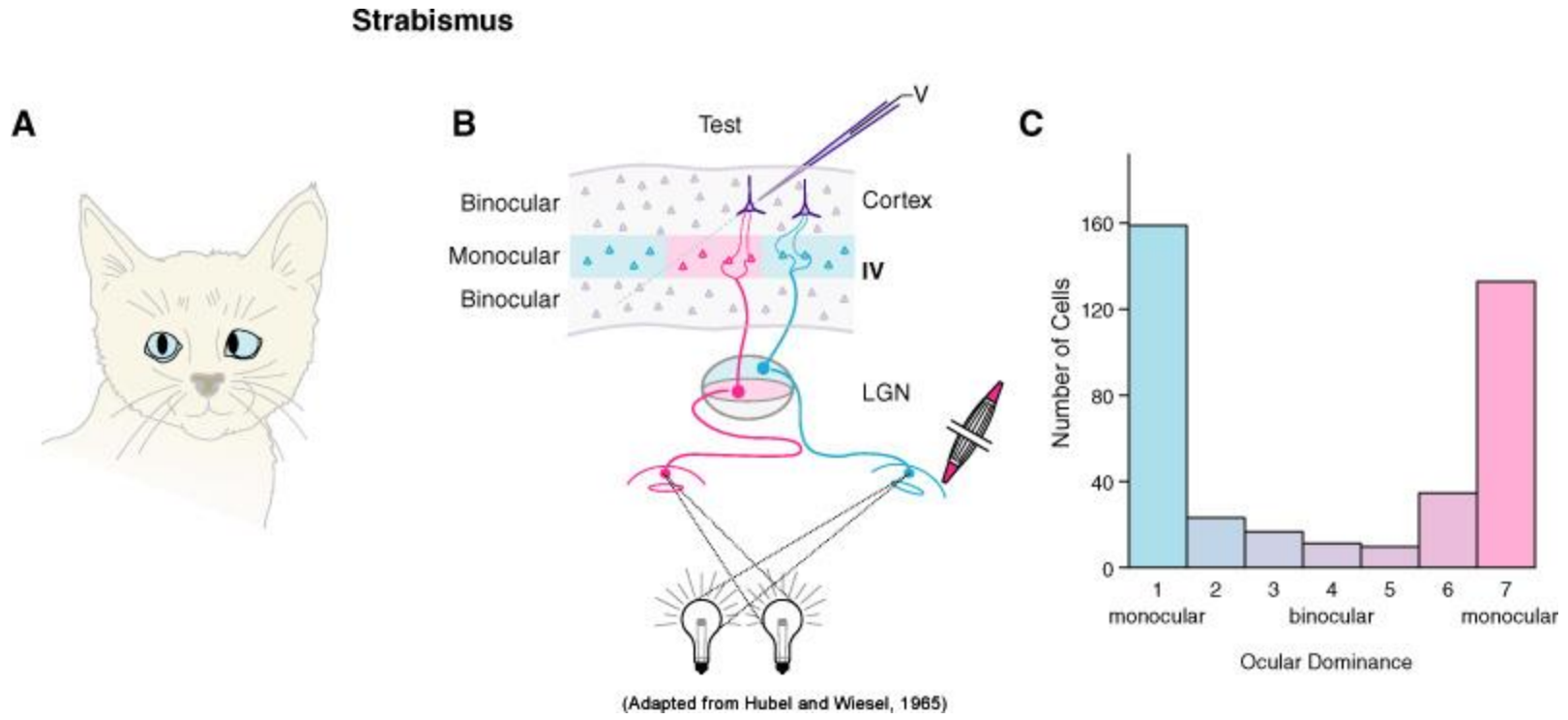
Visual experience drives development of visual cortex circuitry.

- Initially during development, the axons carrying information from the two eyes overlap in layer IV.
- Visual function is required for segregation of the inputs to layer IV.



Visual experience drives development of visual cortex circuitry.

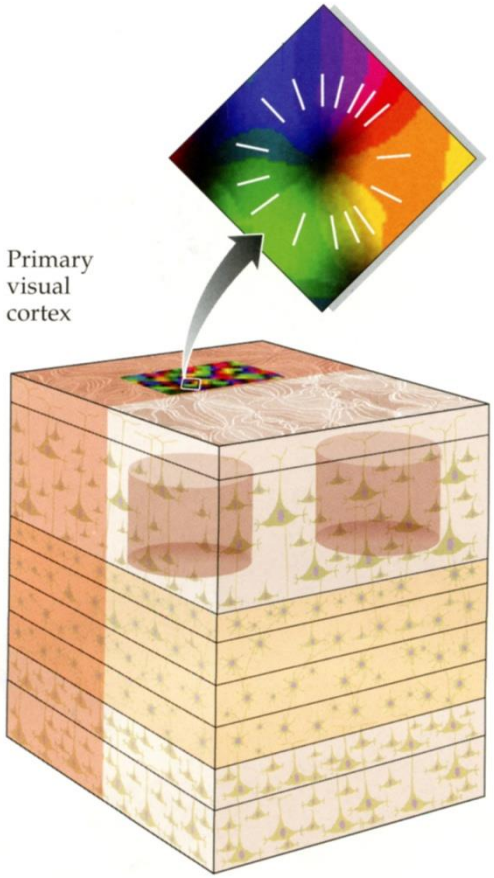
- Changing the nature of the visual activity during the "critical period" of development affects this process:
  - Strabismus (amblyopia) results in all layers being monocular.



(Adapted from Hubel and Wiesel, 1965)

Functional Columns in Cortex

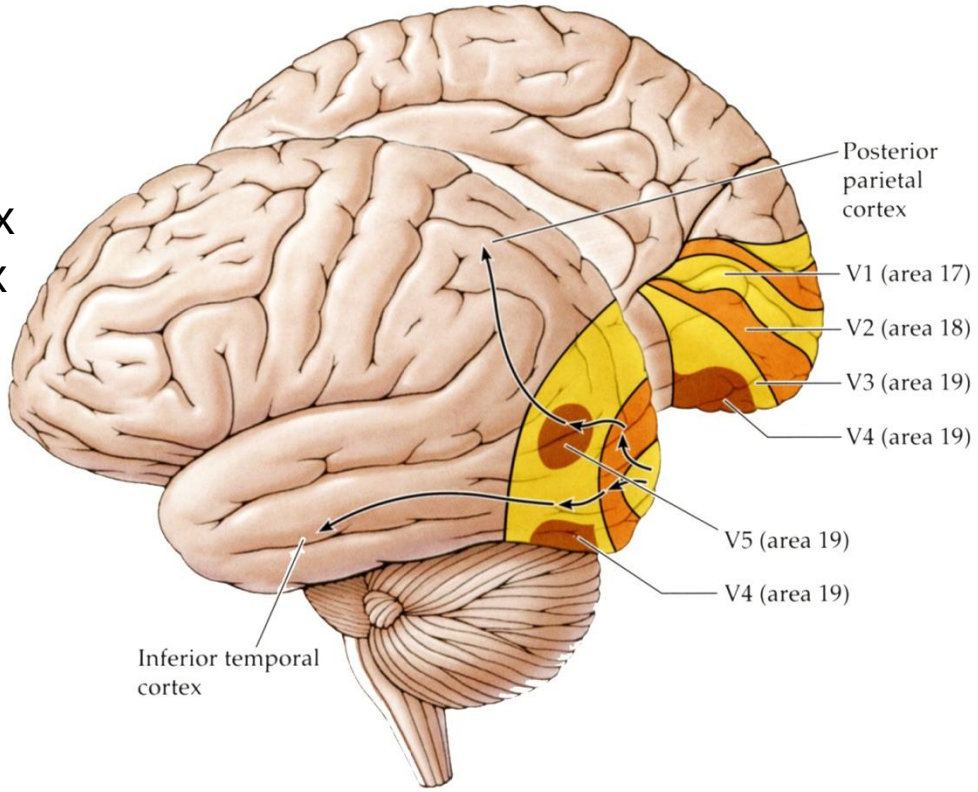
- Color columns (blobs)



Central Visual Pathways

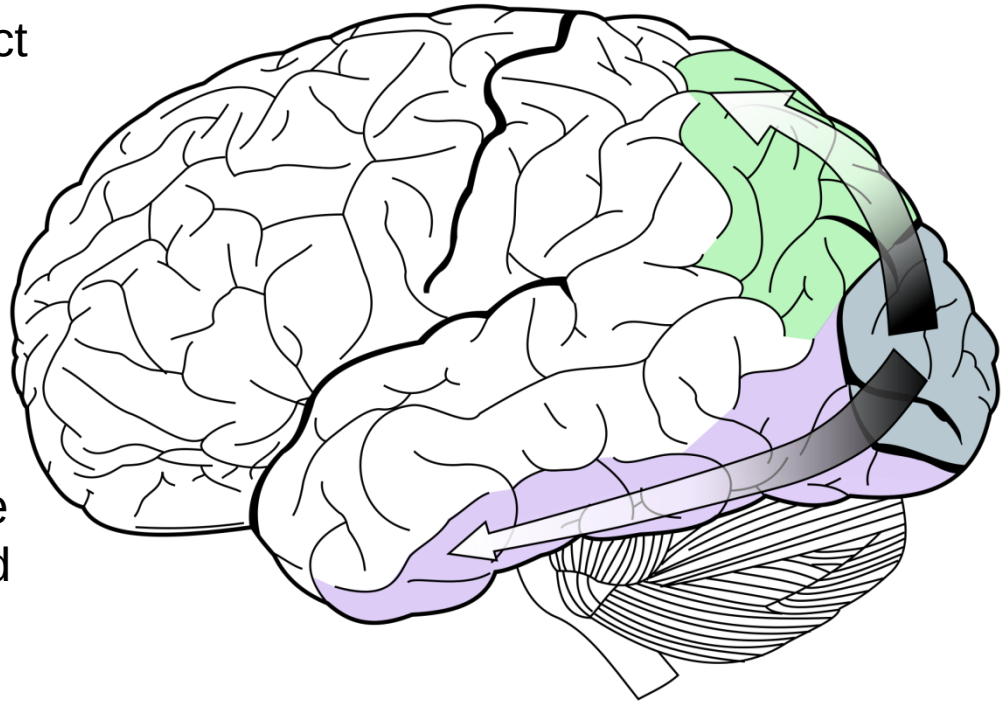
- Neurons in primary visual cortex send axons to secondary visual cortex (V2 or area 18).

- Neurons in secondary visual cortex send axons to tertiary visual cortex areas (V3 or area 19).



Central Visual Pathways

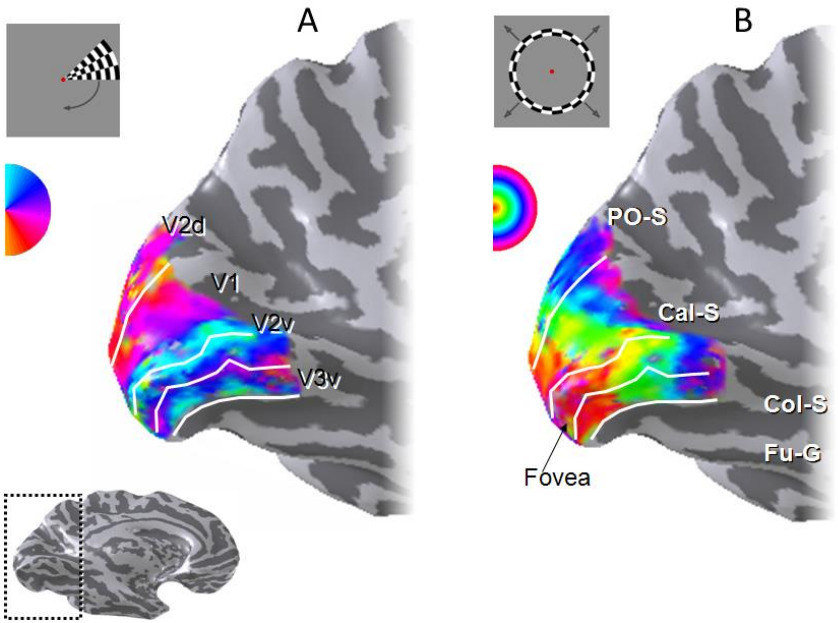
- Accessory visual cortical areas project to other cortical areas in two main streams:
  - dorsal stream into parietal lobe carrying information for motion and location analysis (M pathway)
  - ventral stream into temporal lobe carrying information for color and object recognition (P pathway)

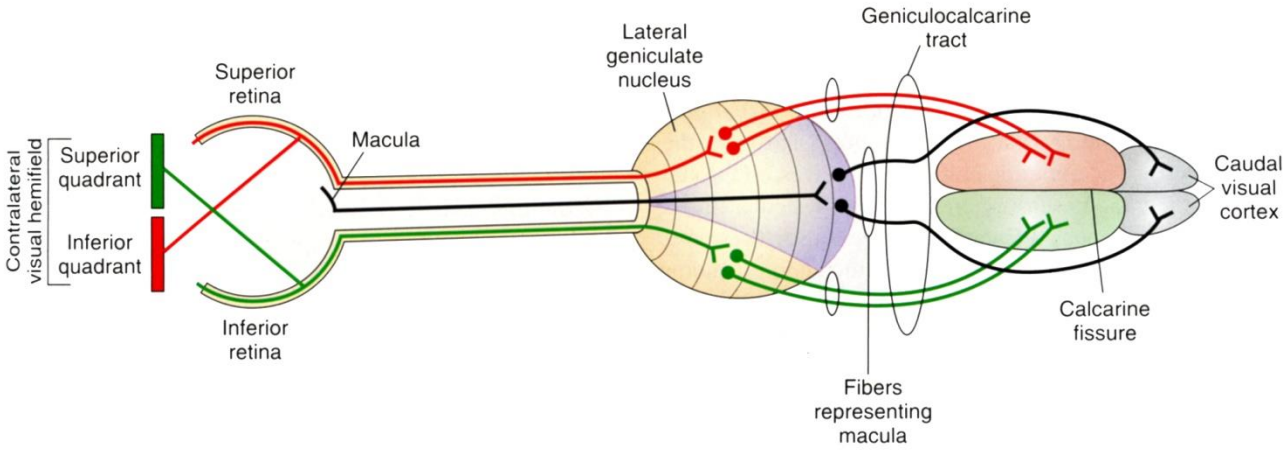


Central Visual Pathways

- The two dimensional distribution of the ganglion cells across the retina is maintained in the organization of the axons and connection through the entire pathway… retinotopic organization.

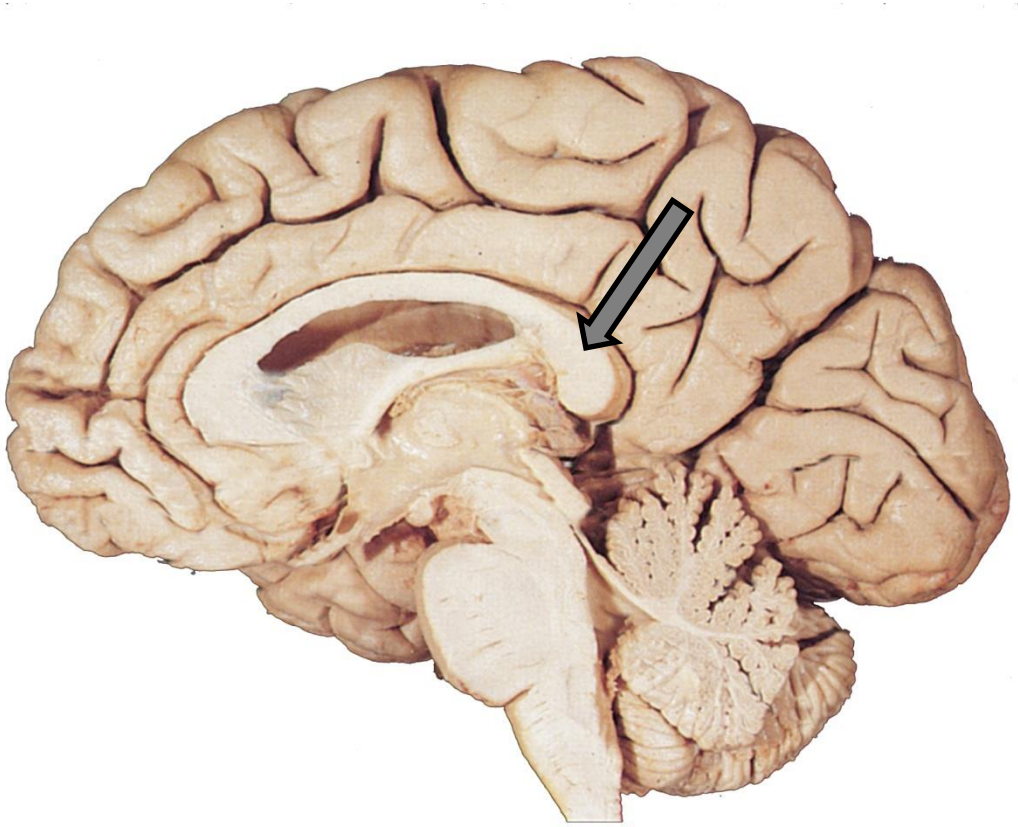
- The macula has the largest representation at all levels of the pathway.





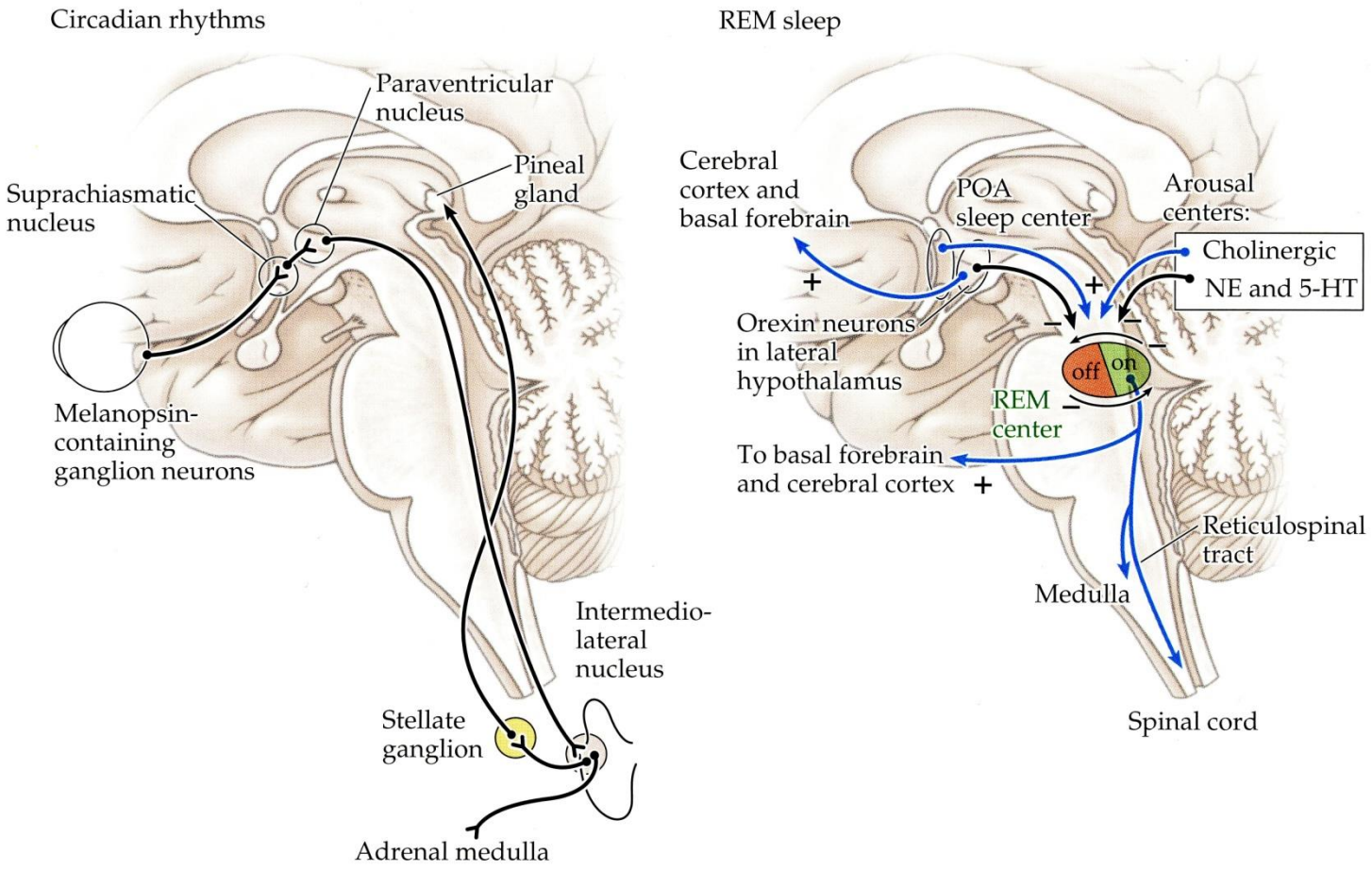
Central Visual Pathways

- Visual areas of cortex in the two hemispheres communicate with one another via the corpus callosum.
- This interaction is essential in order to perceive a continuous fused image of the two visual fields.



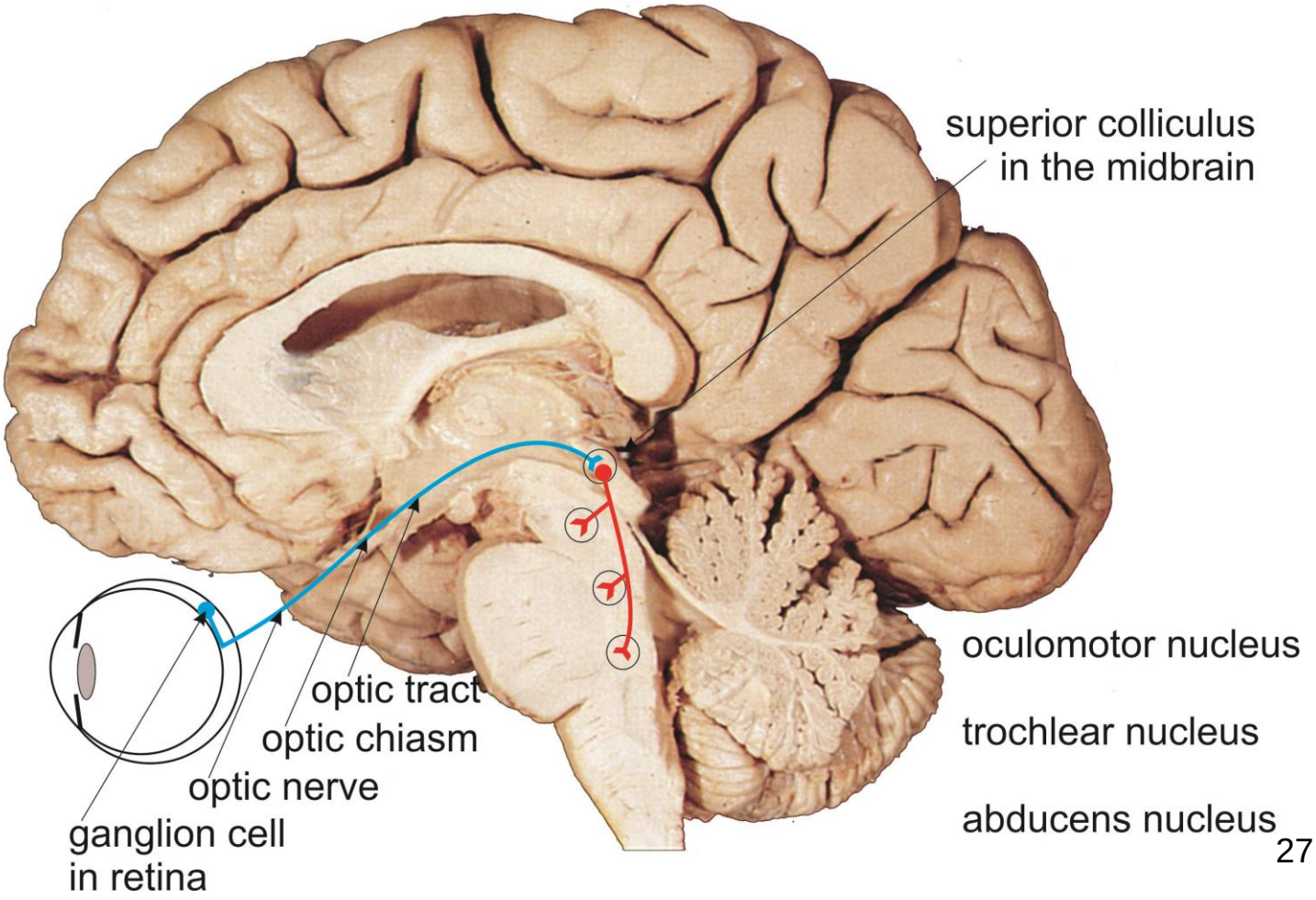
Central Visual Pathways

- The suprachiasmatic nucleus projects to other nuclei in the hypothalamus, which in turn project to numerous centers that regulate circadian rhythms and sleep.



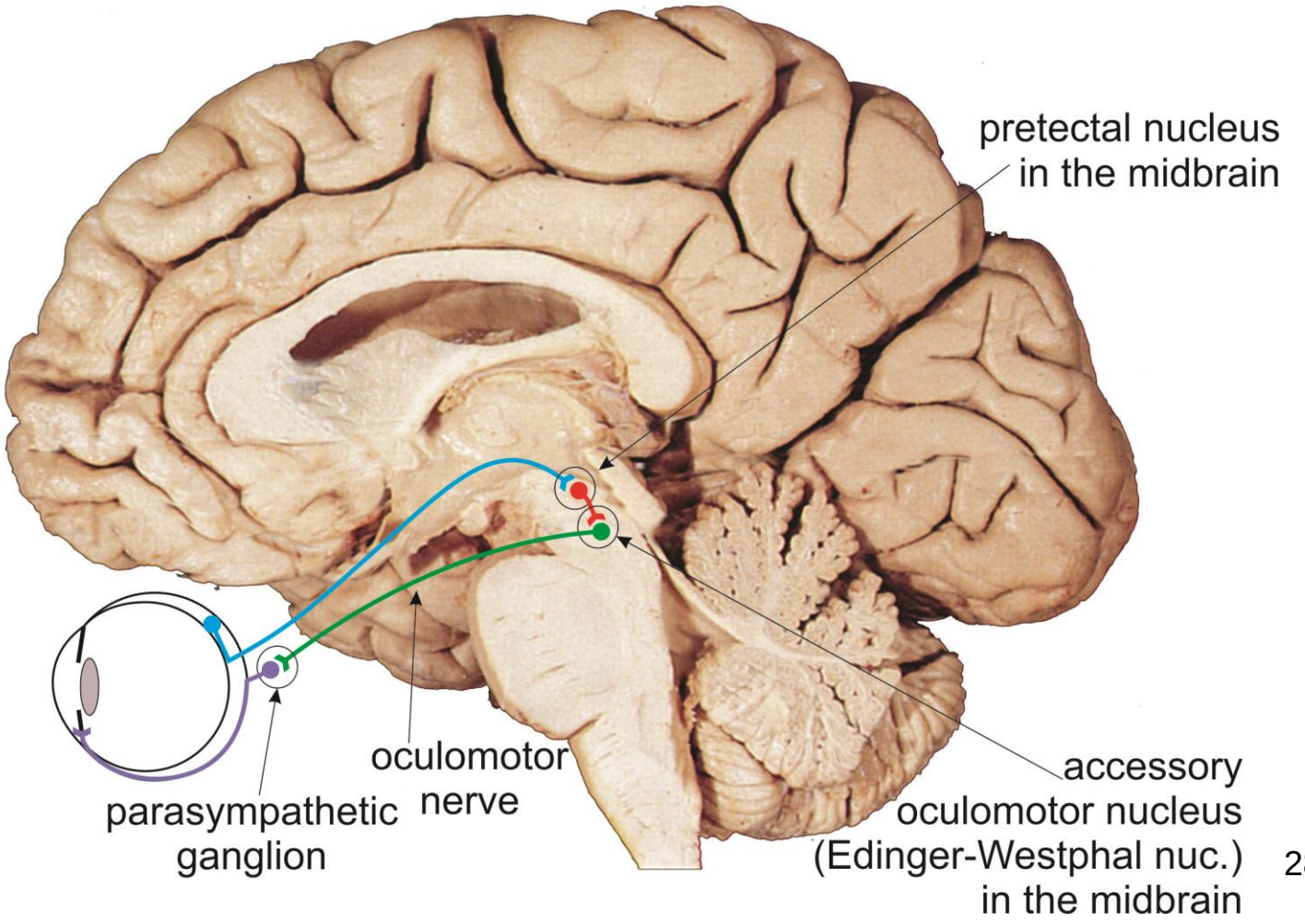
Central Visual Pathways

- The superior colliculus projects to the motor nuclei that control the extraocular muscles and neck muscles.



Central Visual Pathways

- The pupillary light reflex involves the pretectal nucleus that controls the parasympathetic system component of the oculomotor nerve.



Central Visual Pathways

http://www.youtube.com/watch?v=iTncbhfbl6A

Central Visual Pathways

- Why is the pupillary light reflex <u>consensual</u>?