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Retina and Visual System

M1 – CNS Sequence

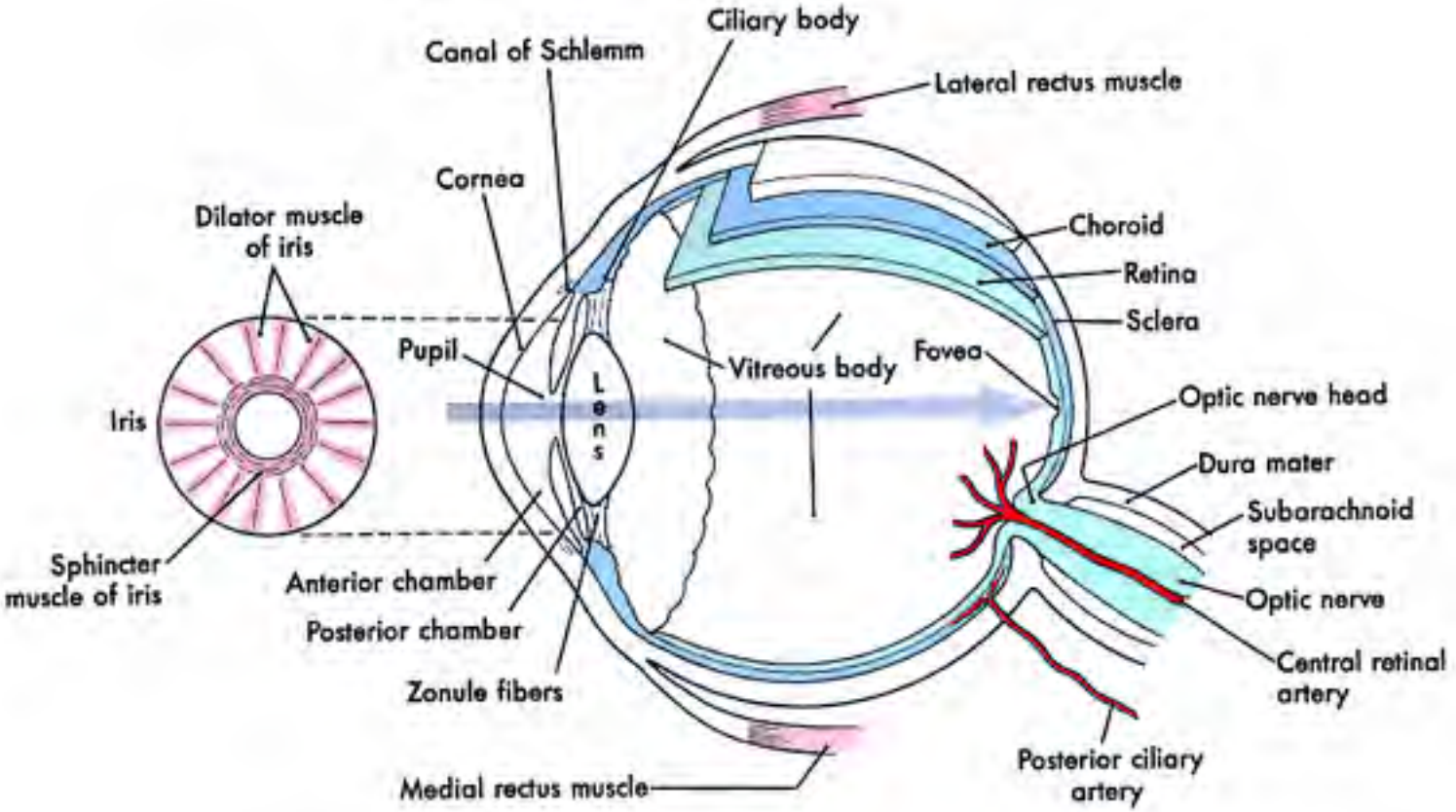
Peter Hitchcock, Ph.D.

Winter, 2009

The topic of today's lecture is the central visual pathways.

I. anatomy of the eye
II. laminar and cellular anatomy of the retina
III. regional specializations of the retina
IV. central visual pathways
V. visual association cortex
VI. subcortical projections of ganglion cell axons
circadian rhythms
pupilary light reflex
VI. visual information processing

Schematic diagram of the eye.



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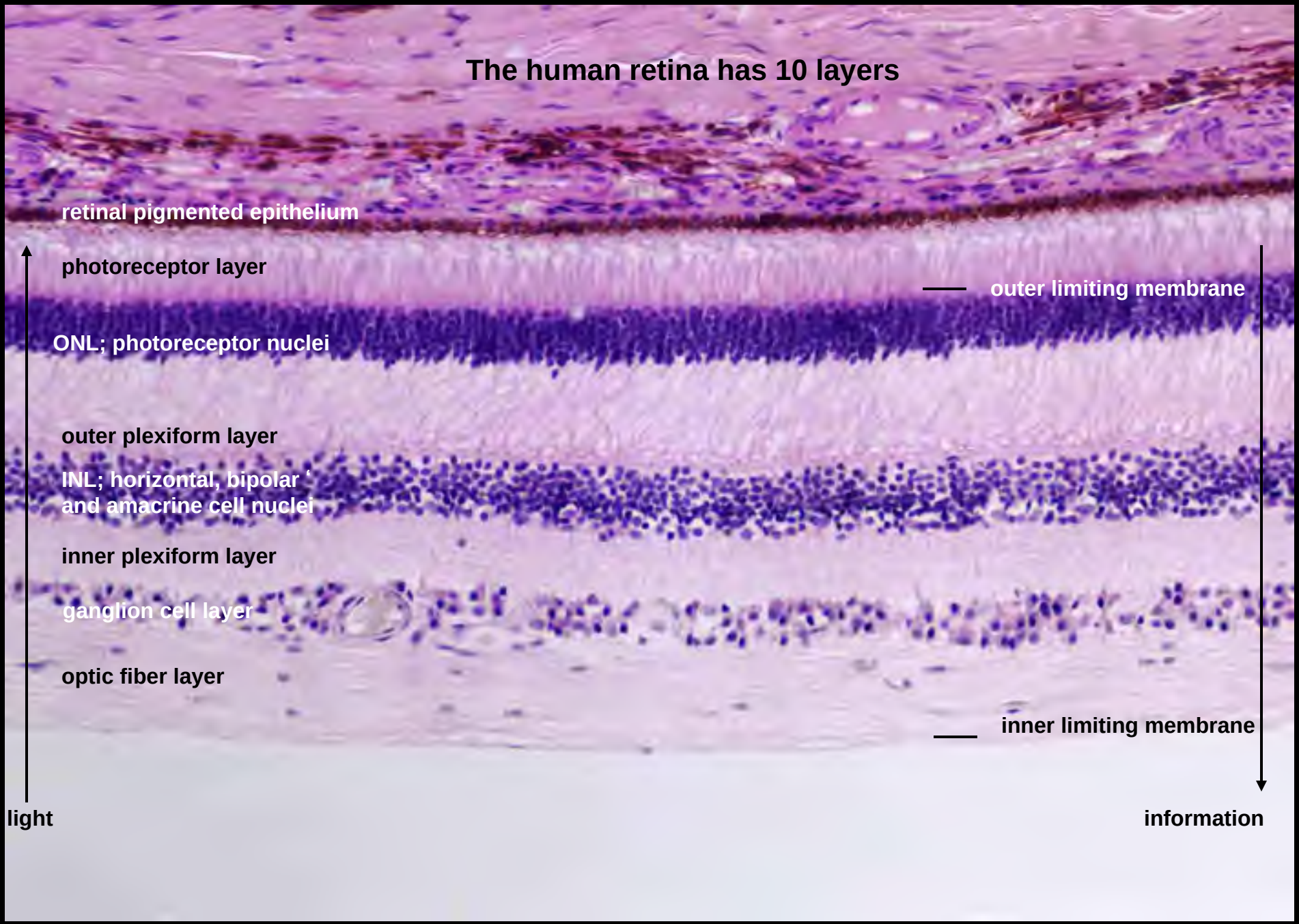
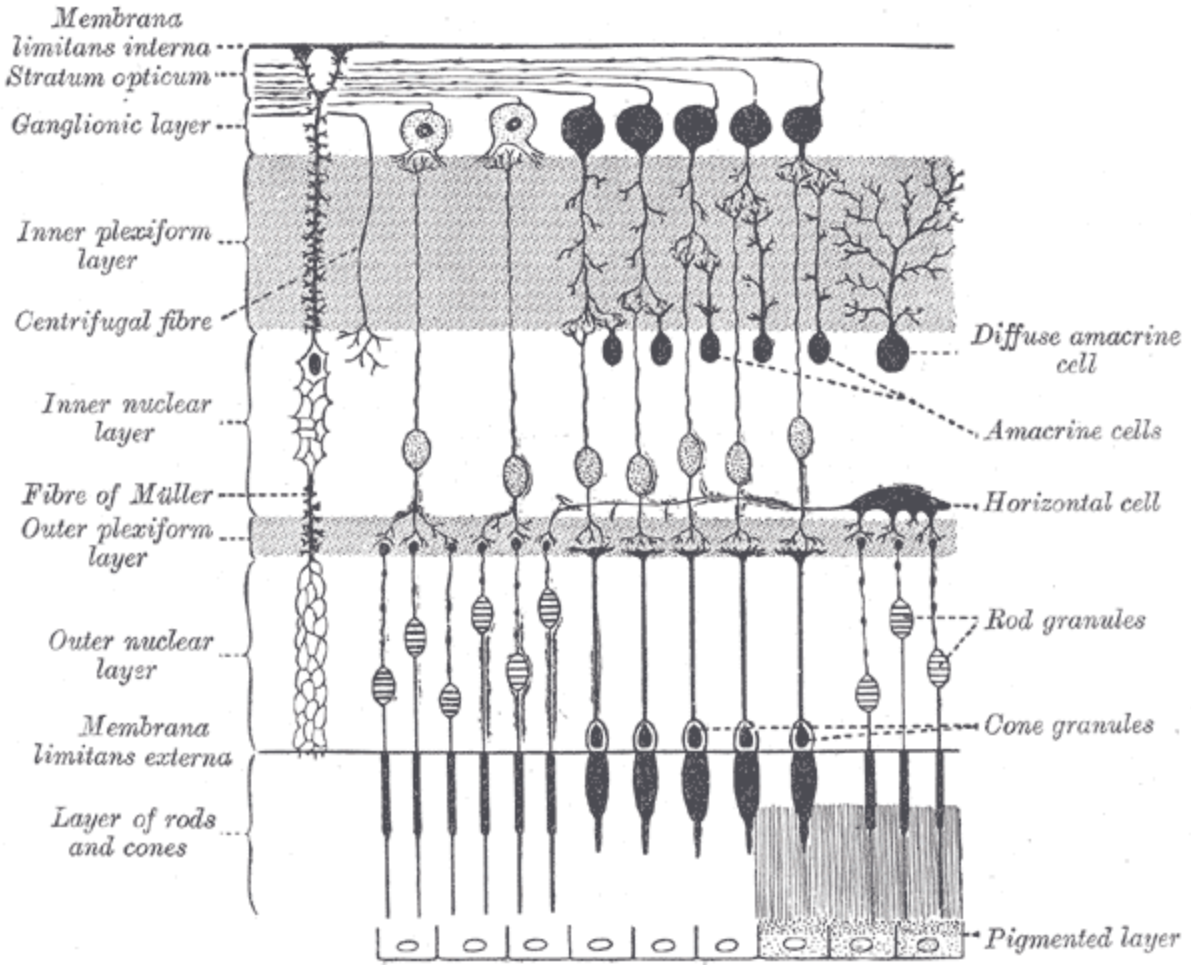


The retina consists of a direct pathway, photoreceptors - bipolar cells - ganglion cells. Information in the direct pathway is modified by horizontal and amacrine cells.



PD-1HCL Gray's Anatomy

c - cones
r-rods
b-bipolar cells
h-horizontal cells
a-amacrine cells
g-ganglion cells

Photoreceptors and processes of the RPE interdigitate, but form no specialized junctions.

Functions of RPE:

- **phagocytose photoreceptors**
- **transport and store Vit. A**
- **recycle photopigments**
- **absorb stray light**
- **regulate fluid levels in the sub-retinal space**

Retinal detachment occurs when fluid accumulates in the space between the retina and RPE and separates the retina from the RPE. This space was part of the third ventricle in the embryonic brain.

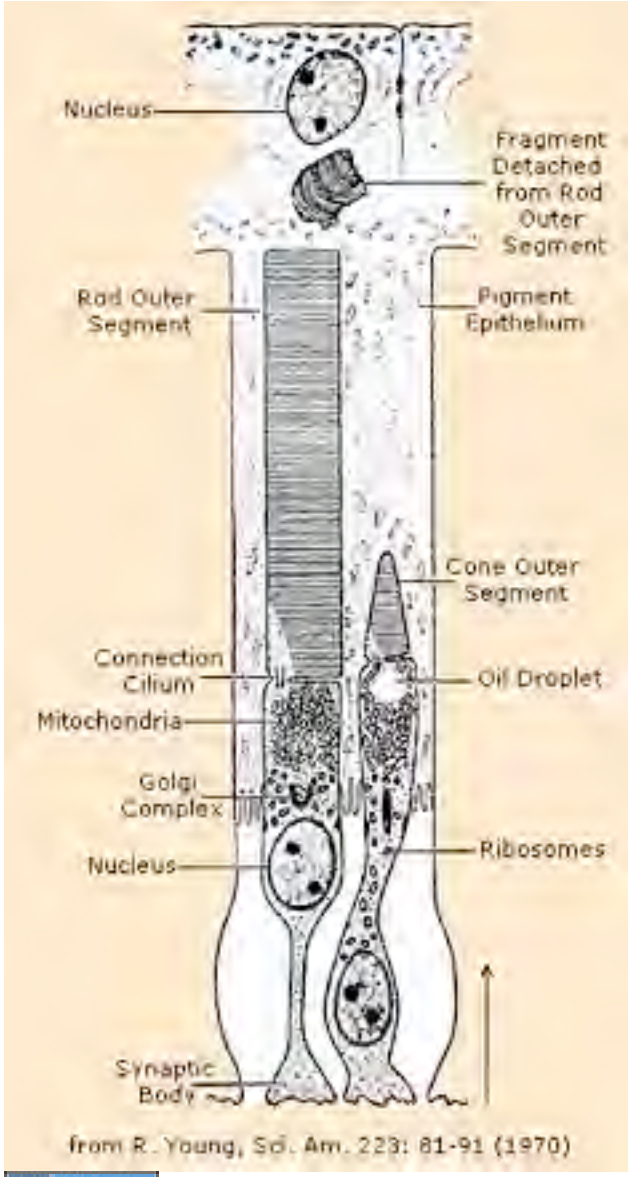
Müller cells are a specialized type of radial glia

Müller cells help maintain ionic balances within the extracellular spaces in the retina. They also form the inner and outer limiting membranes

Images of Muller cells removed

The two classes of photoreceptors divide visible light into two domains: intensity and wavelength

Rods –
dim light, monochromatic

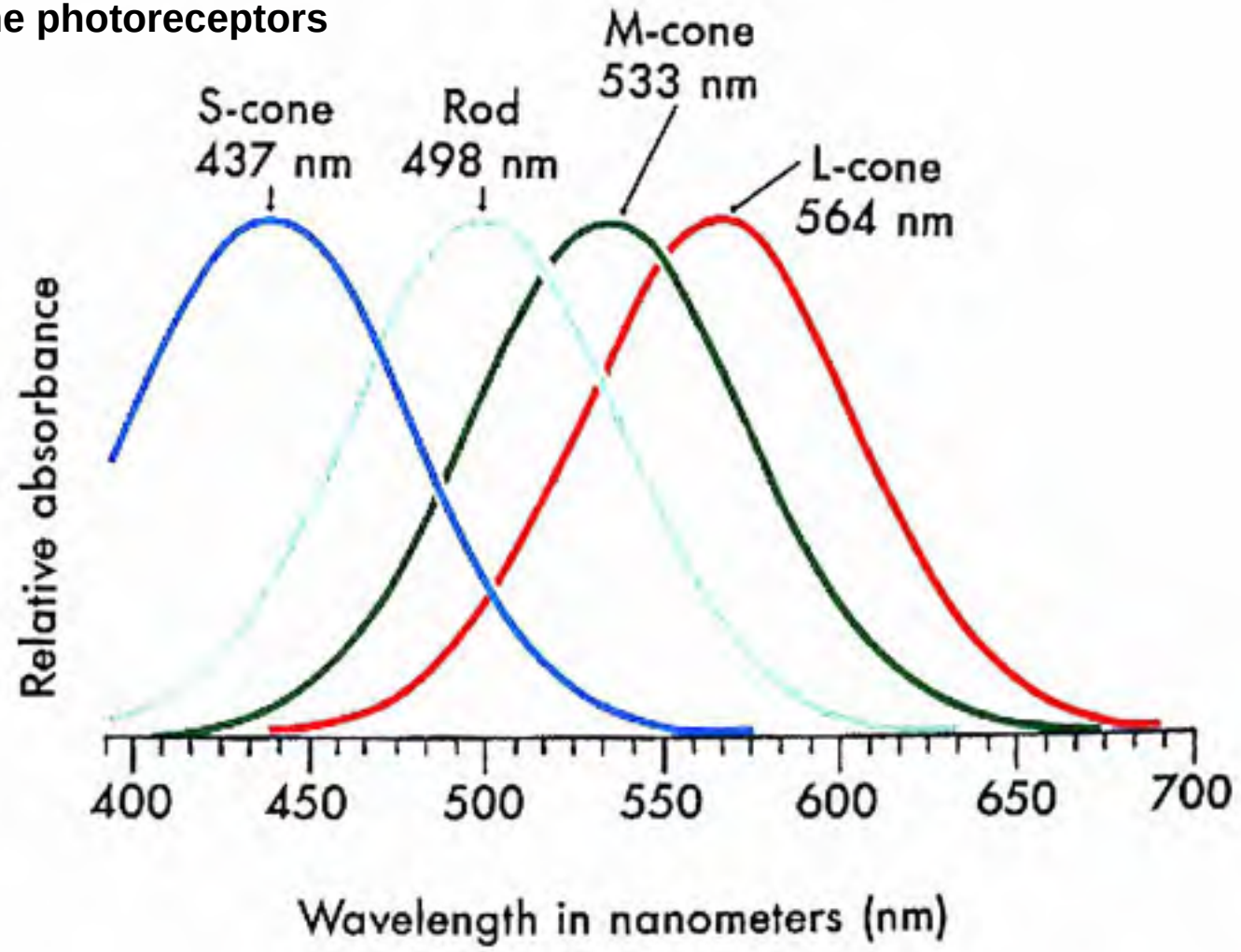


PD-SELF R. Young, wikipedia

Cones –
bright light, 3 wavelength sensitive subgroups

There are several inherited diseases that result in death of photoreceptors, e.g, retinitis pigmentosa, age-related macular degeneration.

Absorption spectra for rod and
The 3 classes of cone photoreceptors



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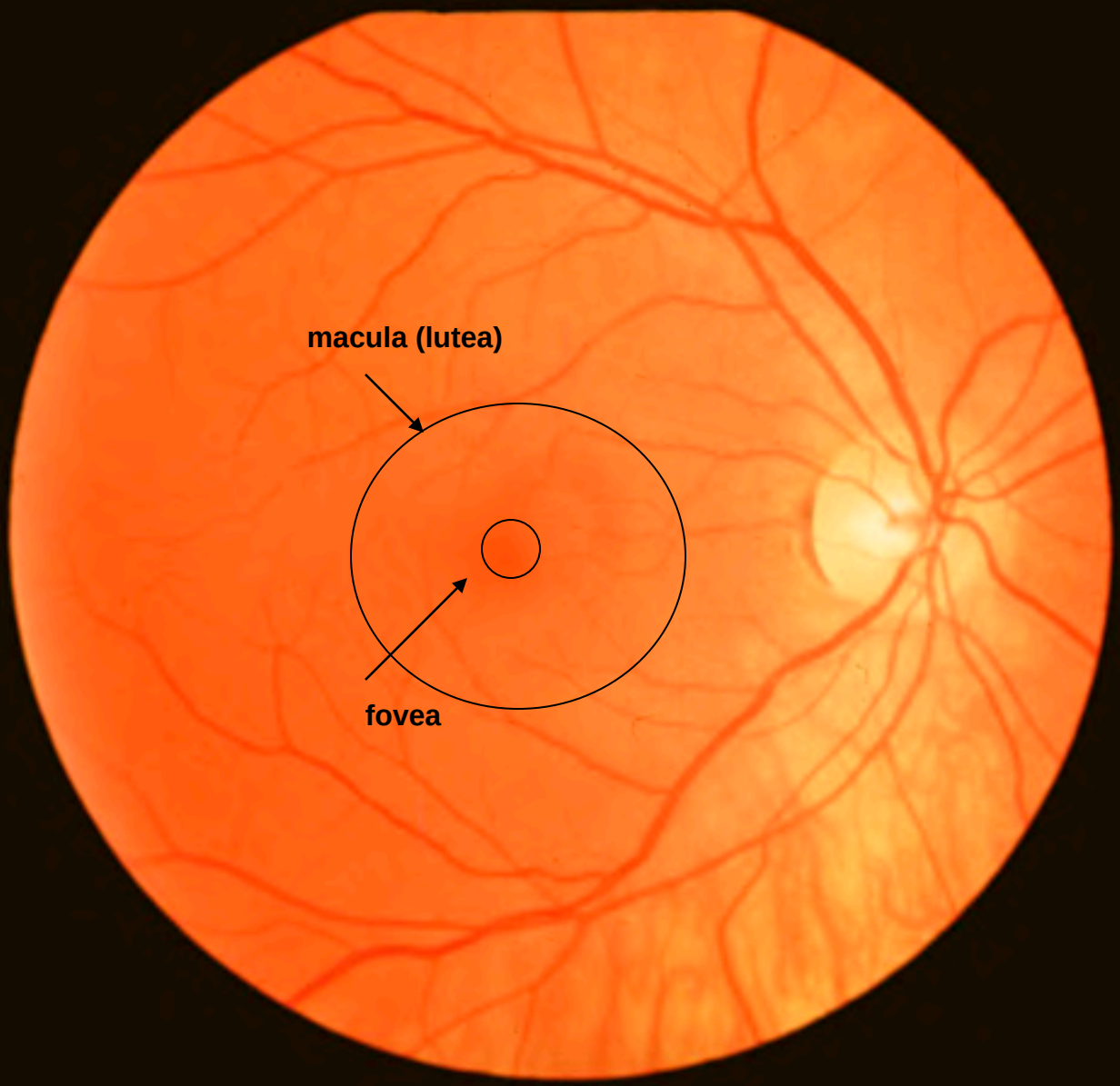
Regional specializations in the retina.

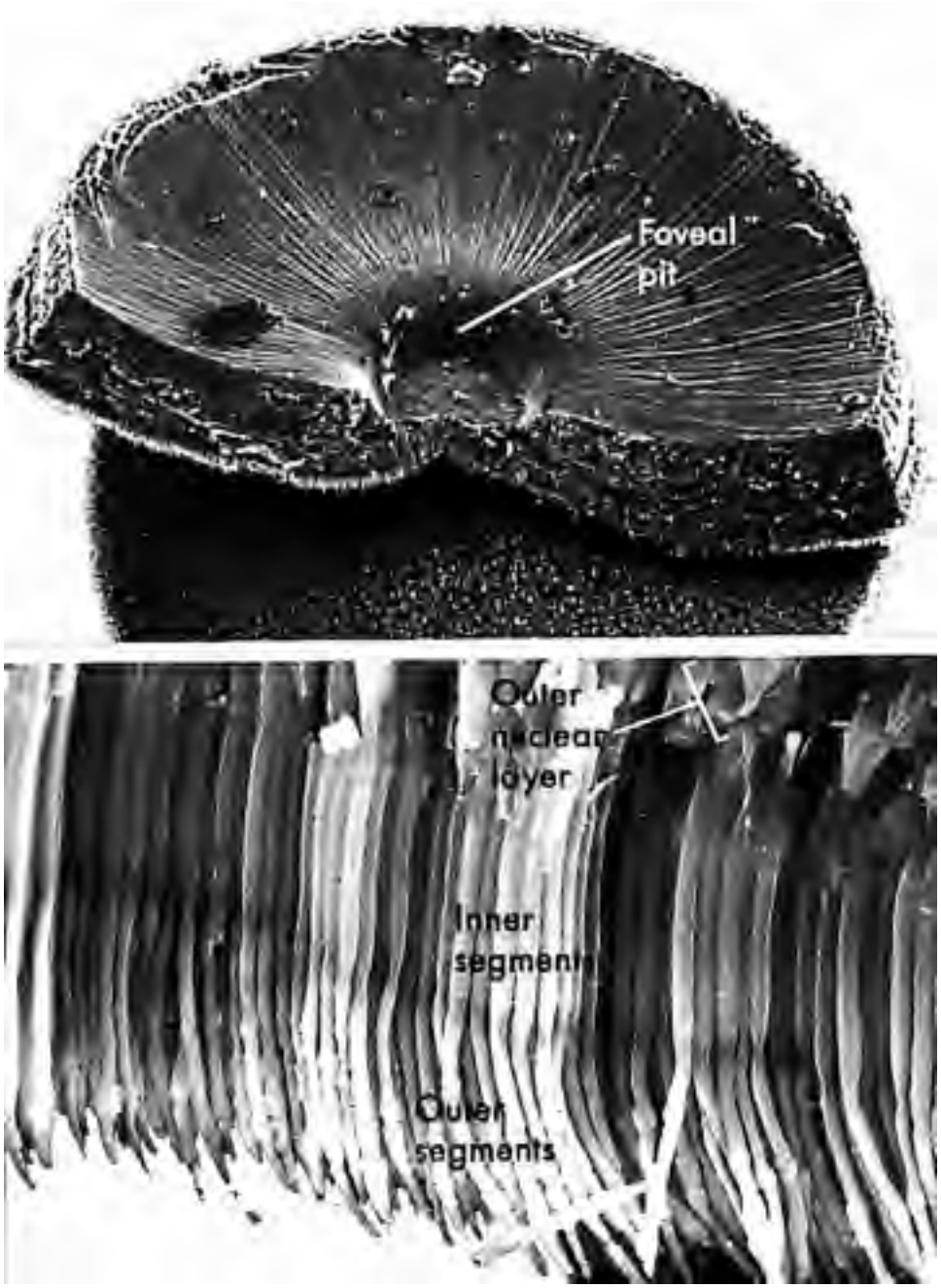


Fundus photograph of living, human retina illustrating the vasculature, fovea and optic nerve head (disc)

The fovea is an pit (excavation) in the retina, wherein the inner layers are displaced laterally.

RPE, retinal pigmented epithelium; ONL, outer nuclear layer; INL, inner nuclear layer IPL, inner plexiform layer; GCL, ganglion cell layer

The fovea contains cone photoreceptors only (no rods) at an extremely high density.



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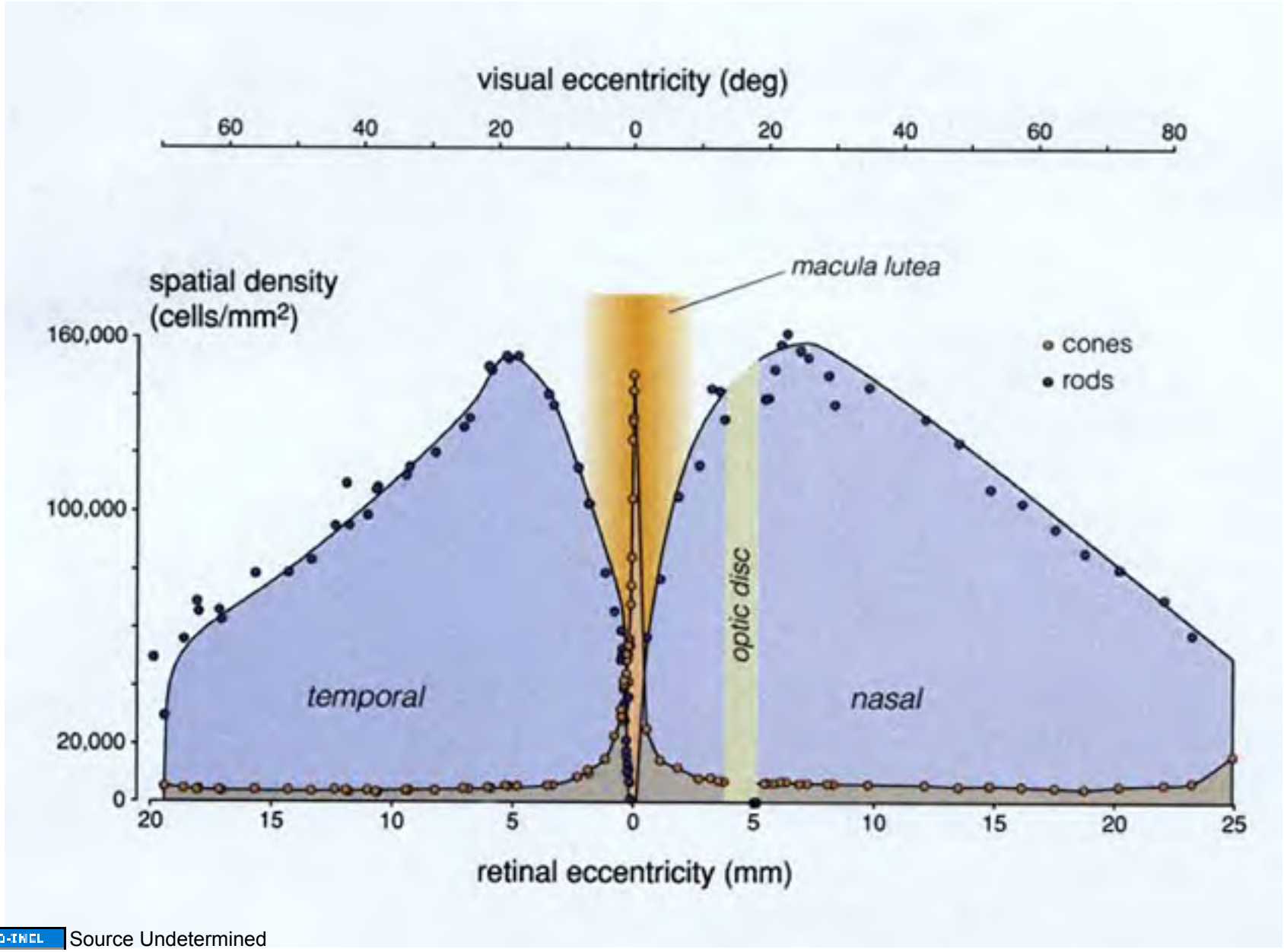
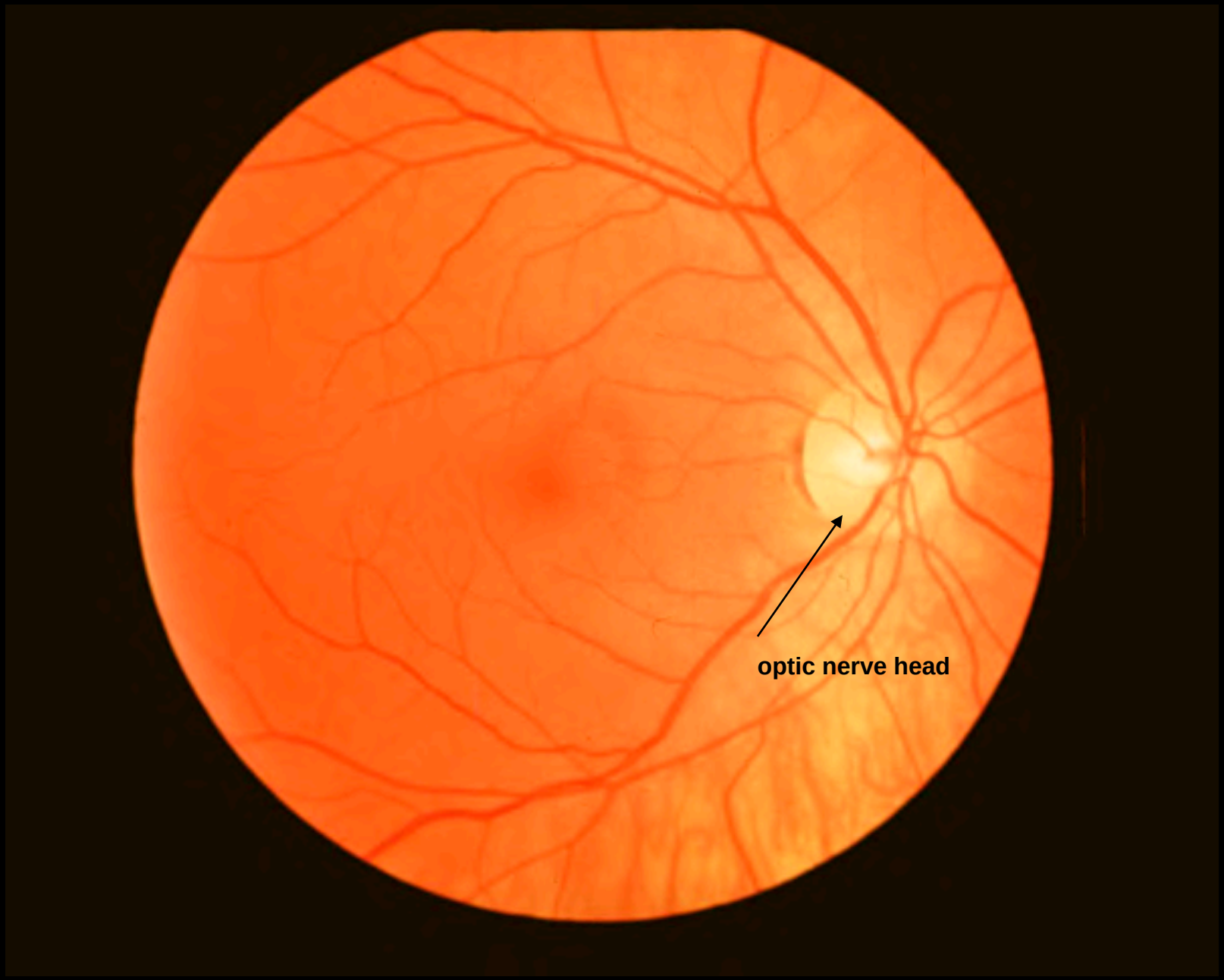
% photorecptors?

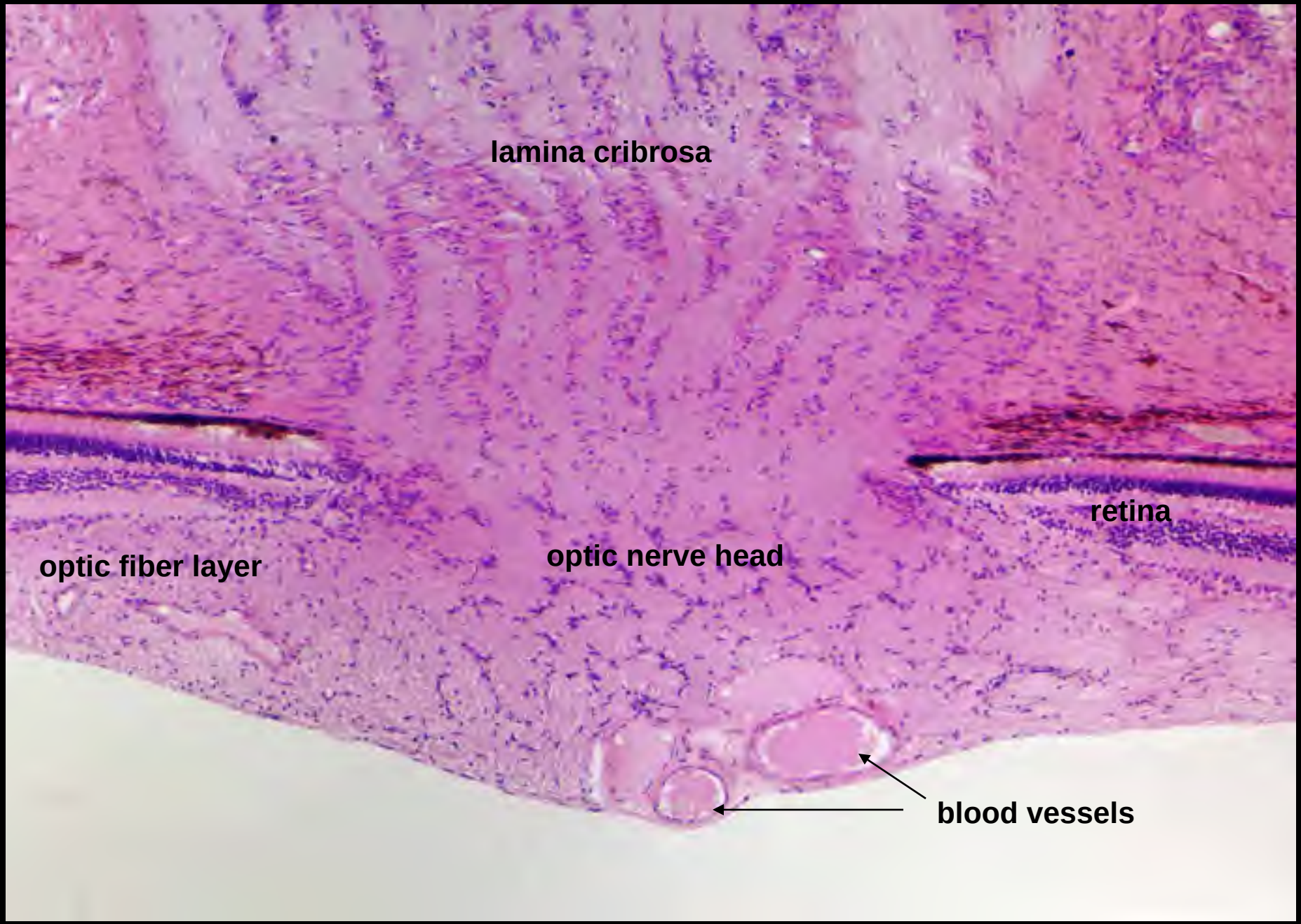
cones - 5%

rods - 95%

Density distribution of photoreceptors in the retina along a line passing through the fovea and optic disc.







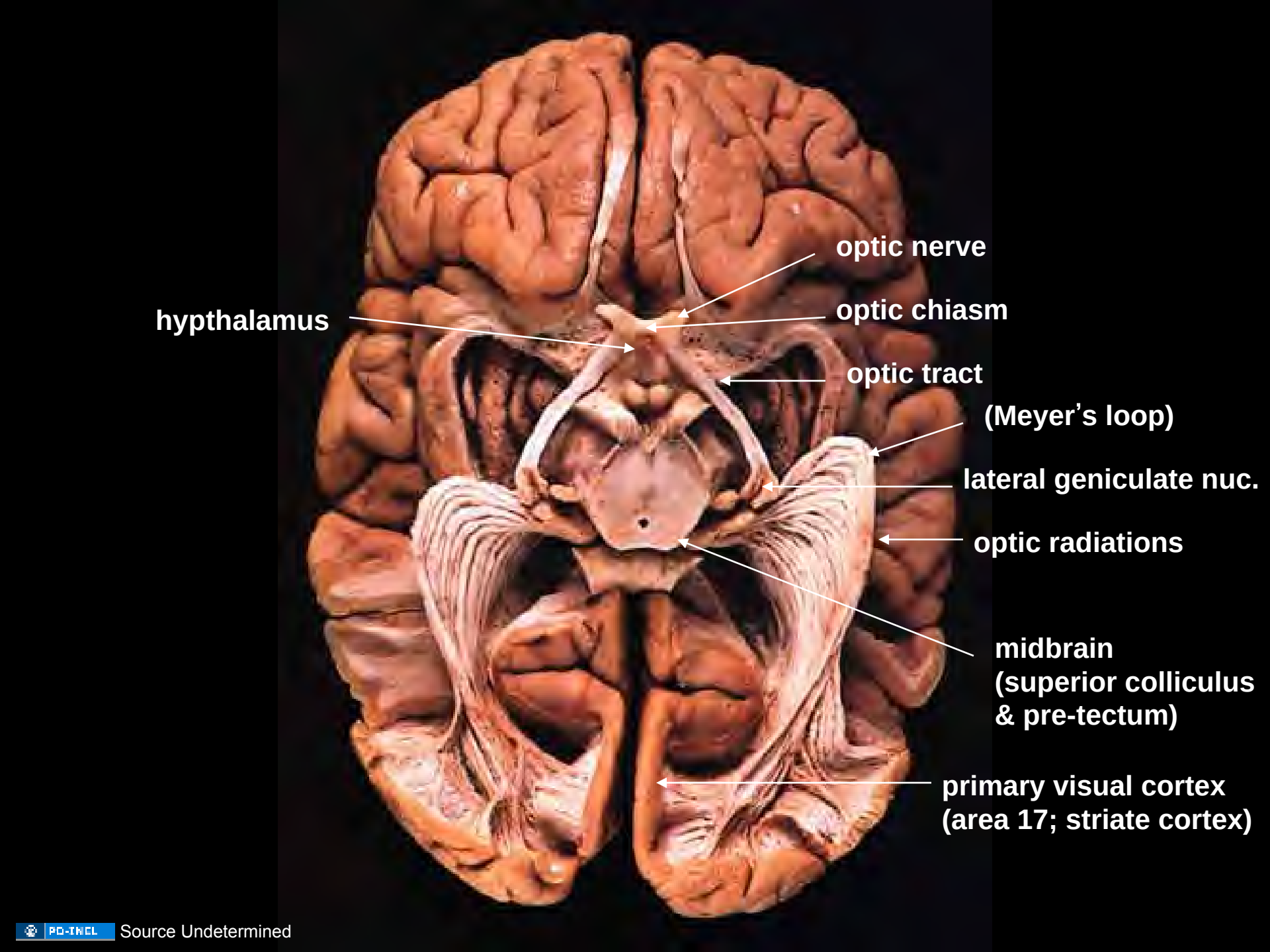
Find your blind spot! Using the diagram below, fixate on the star, close your left eye and hold the figure about 1.5 feet from your face. When the filled circle disappears, its image is on your blind spot.

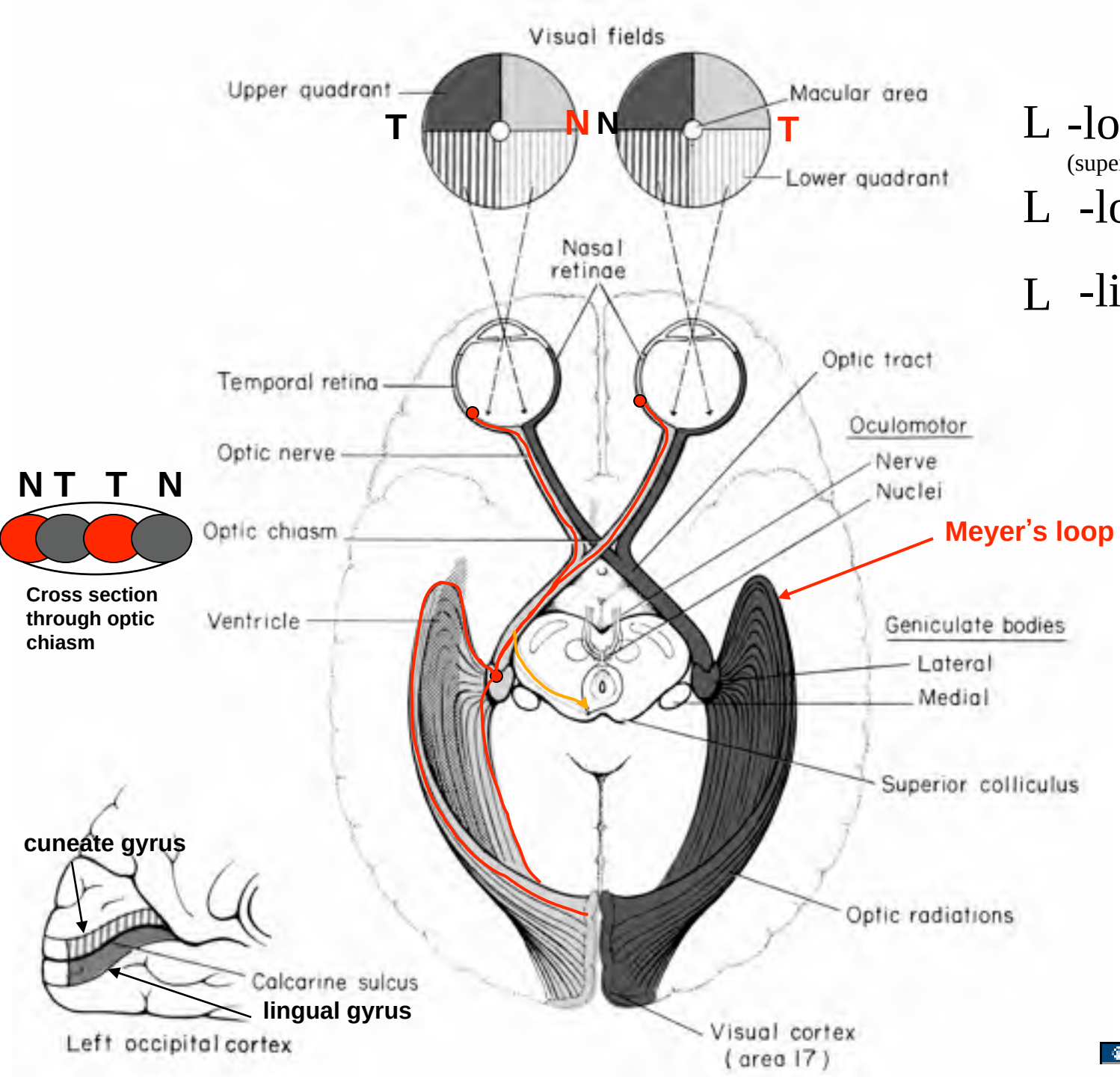
Connections from the retina into the hypothalamus diencephalon and midbrain (only 4 will be described)

primate visual system

AOS	accessory optic system
DTN	dorsal terminal nucleus
LGN	lateral geniculate nucleus
LTN	lateral terminal nucleus
MTN	medial terminal nucleus
NOT	nucleus of the optic tract
ON	olivary nucleus
NPP	posterior pretectal nucleus
SC	superior colliculus
SCN	supraschiasmatic nuclei

Image of visual system connections removed

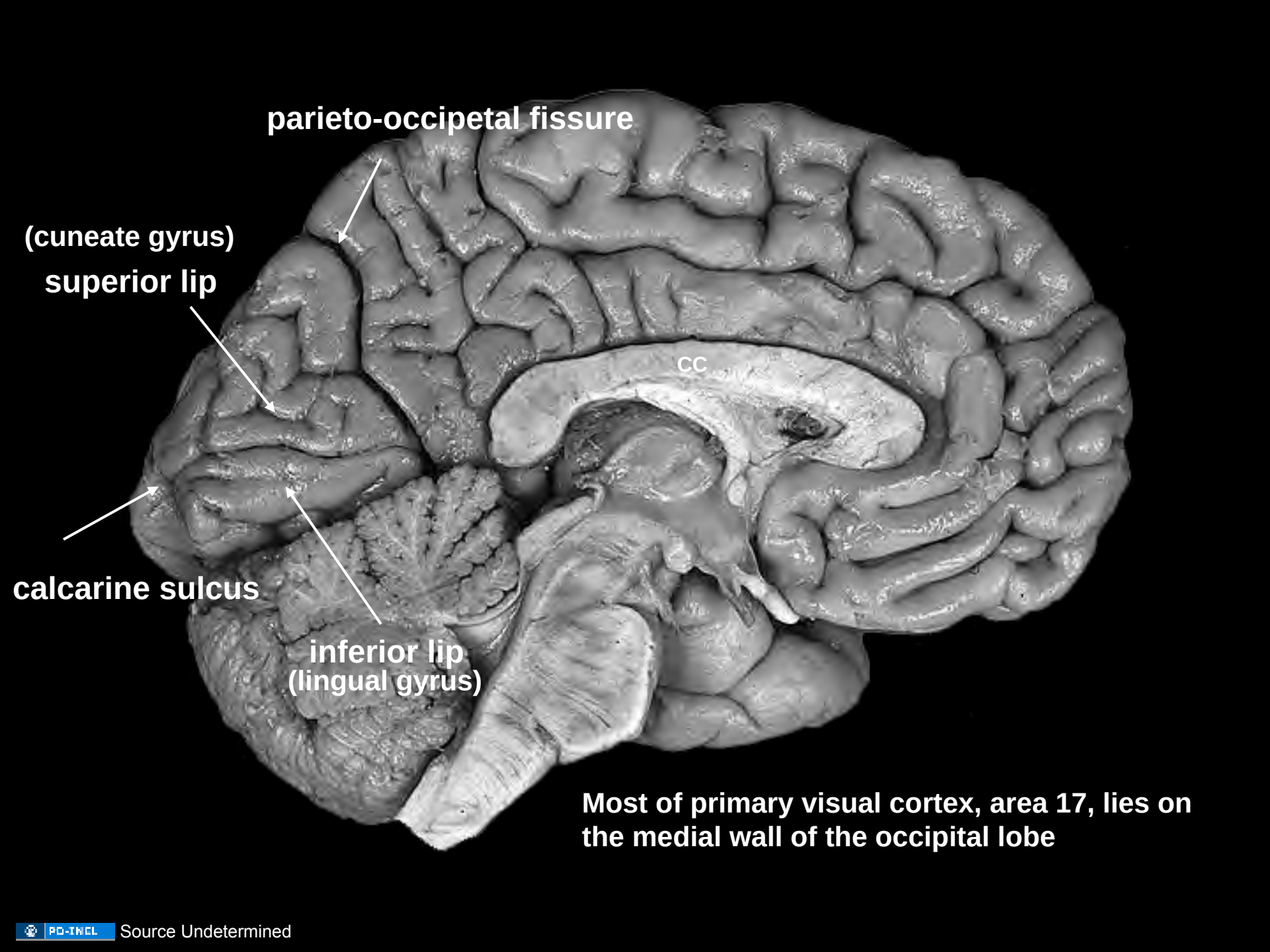




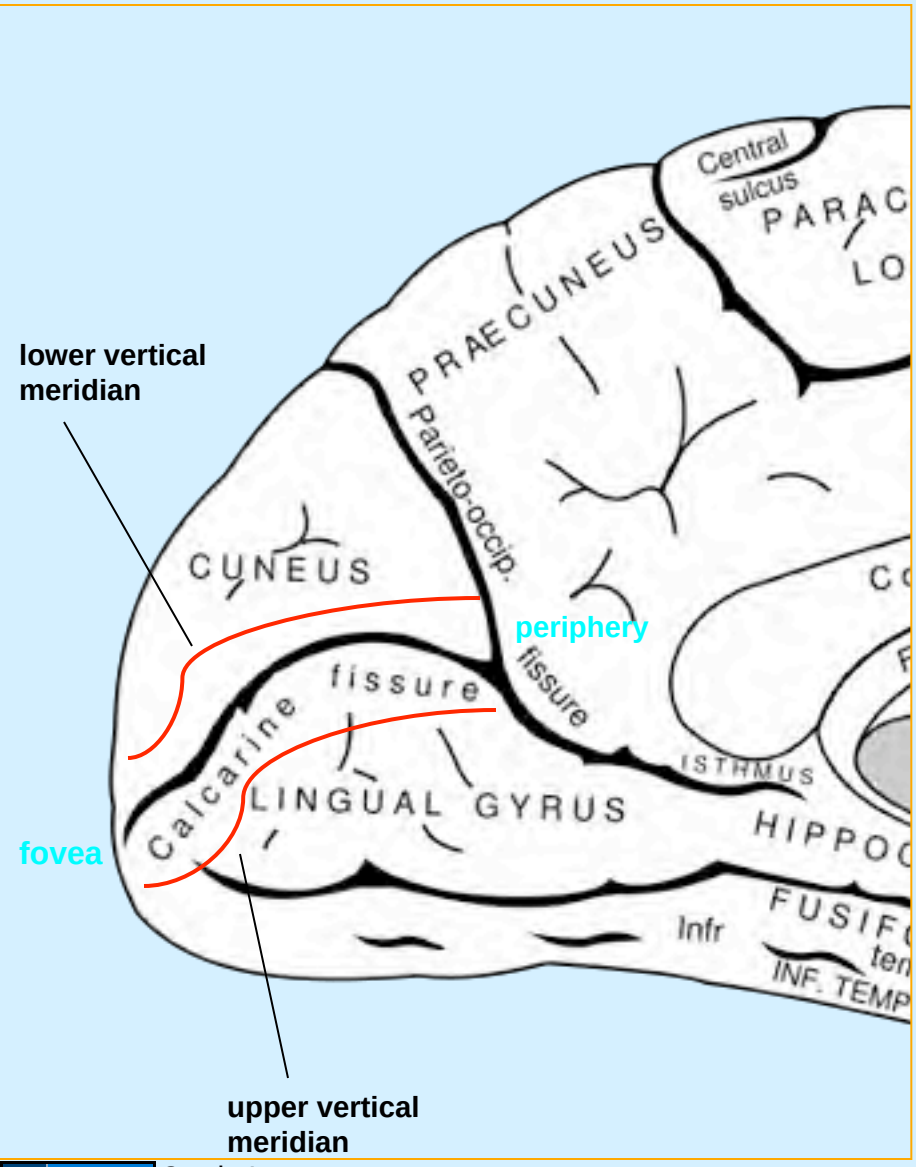
L -lower retina
(superior visual fields)

L -loop (Meyer's)

L -lingual gyrus

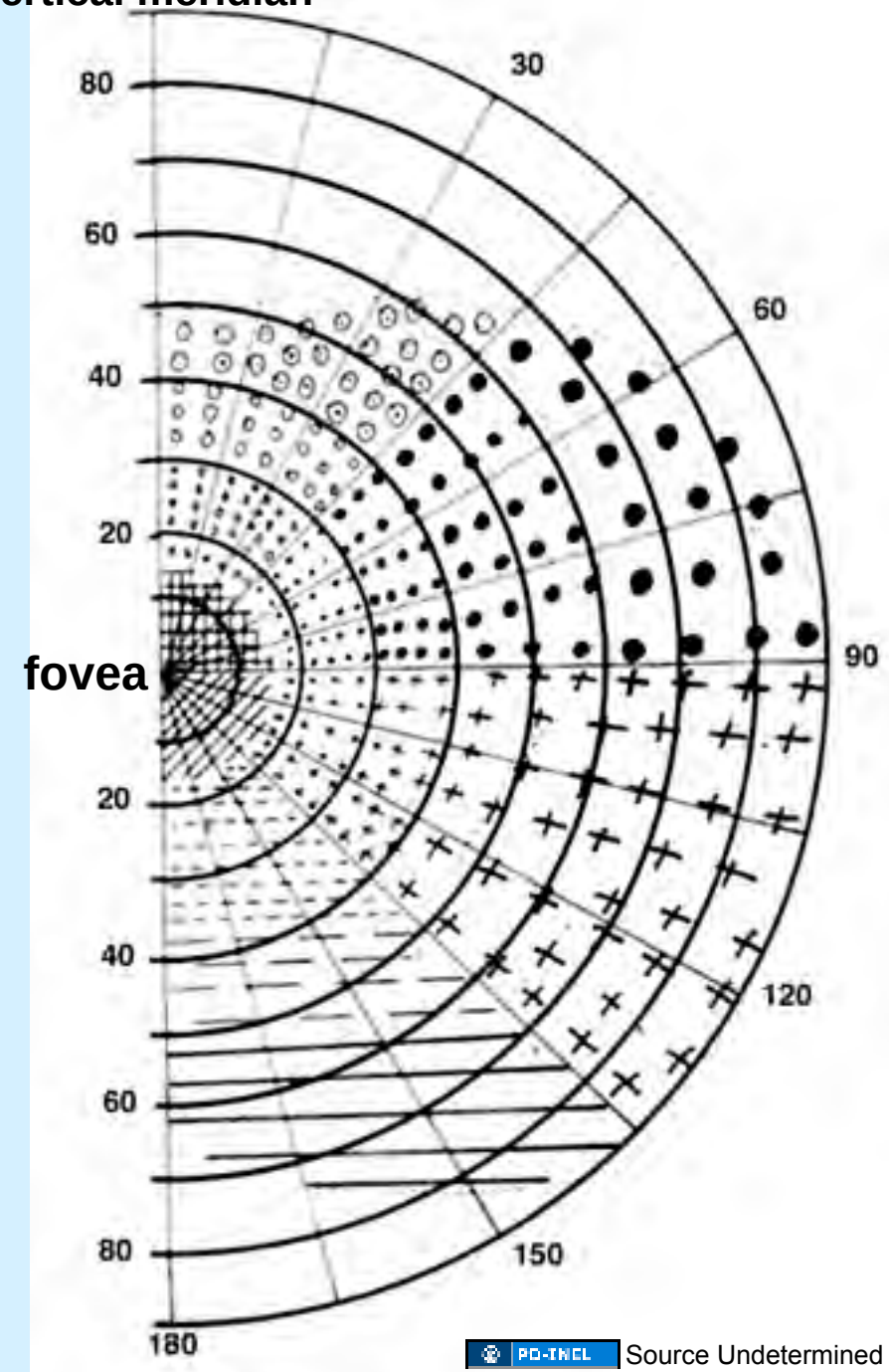


Most of primary visual cortex, area 17, lies on the medial wall of the occipital lobe



PD-INCL Gray's Anatomy

vertical meridian



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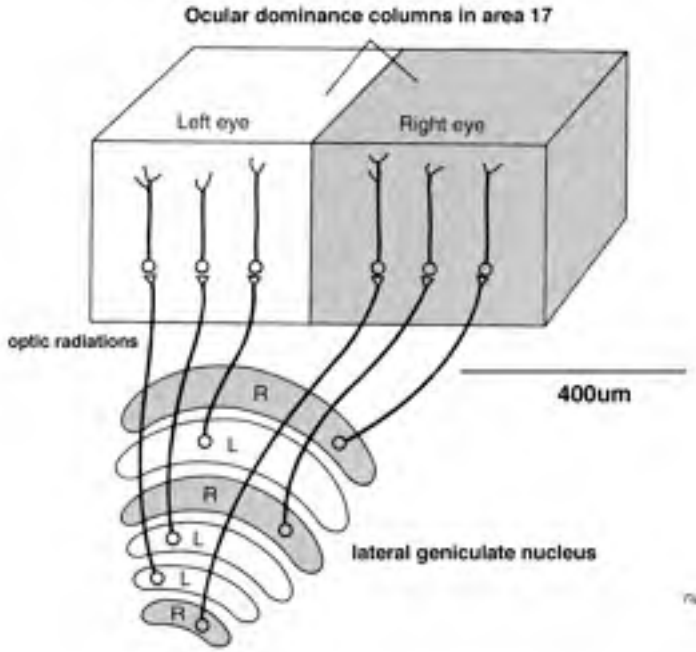
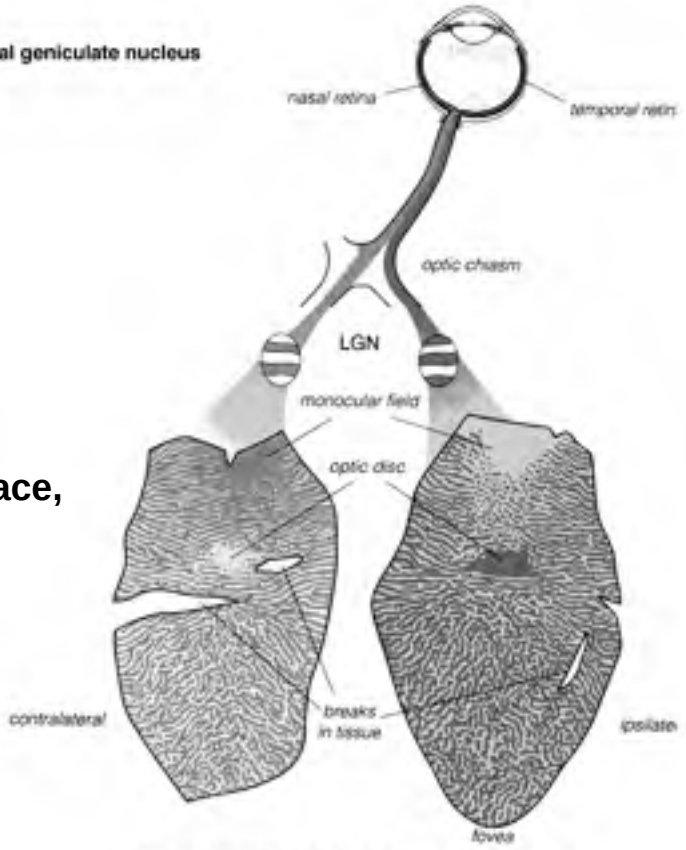
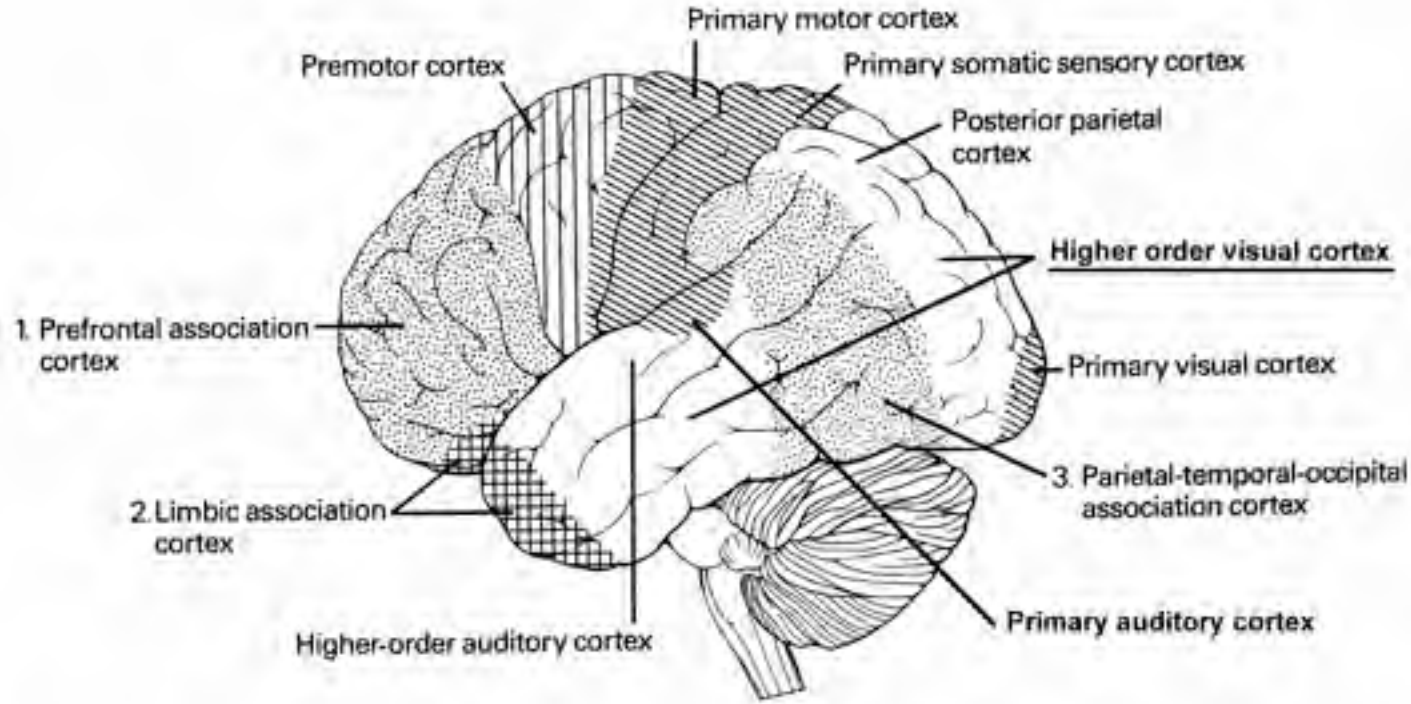


L=left eye
R=right eye



area 17 flattened and viewed from the surface, illustrating the complete pattern of ocular dominance columns



Higher-order visual cortex consists of the **inferior temporal lobe**, important for object recognition, and the **parietal lobe**, important for perceiving spatial relations between objects.

These two regions are sometimes referred as the ventral stream (what is it?) and a dorsal stream (where is it?).

Cortical lesions in ventral or dorsal stream produce unique perceptual deficits

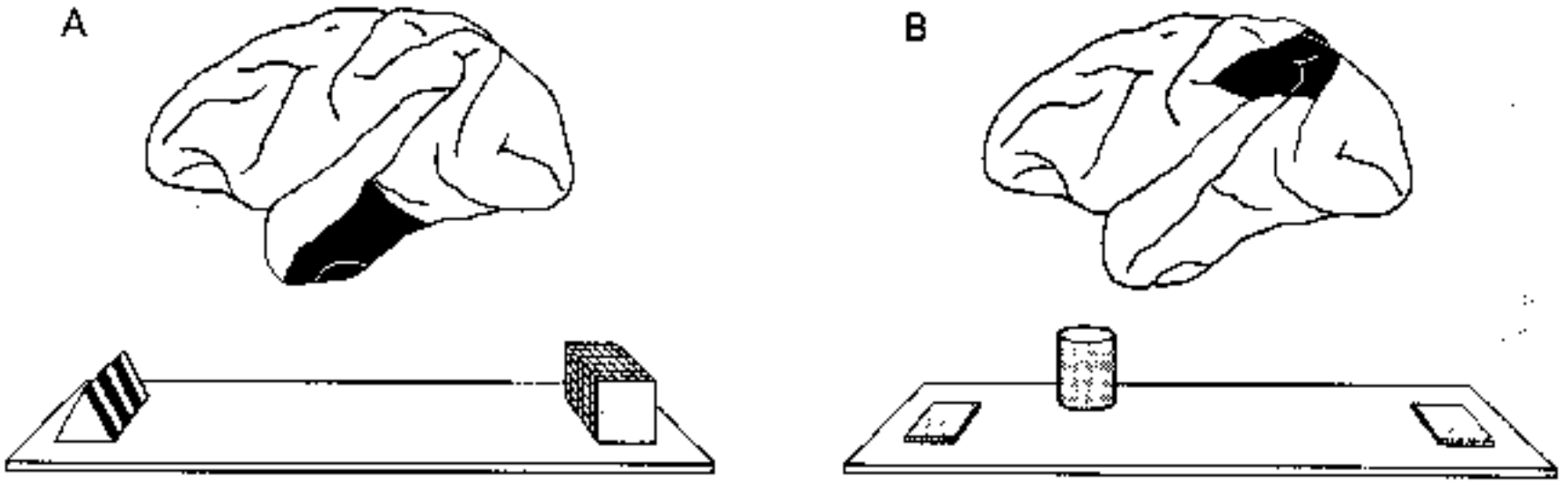
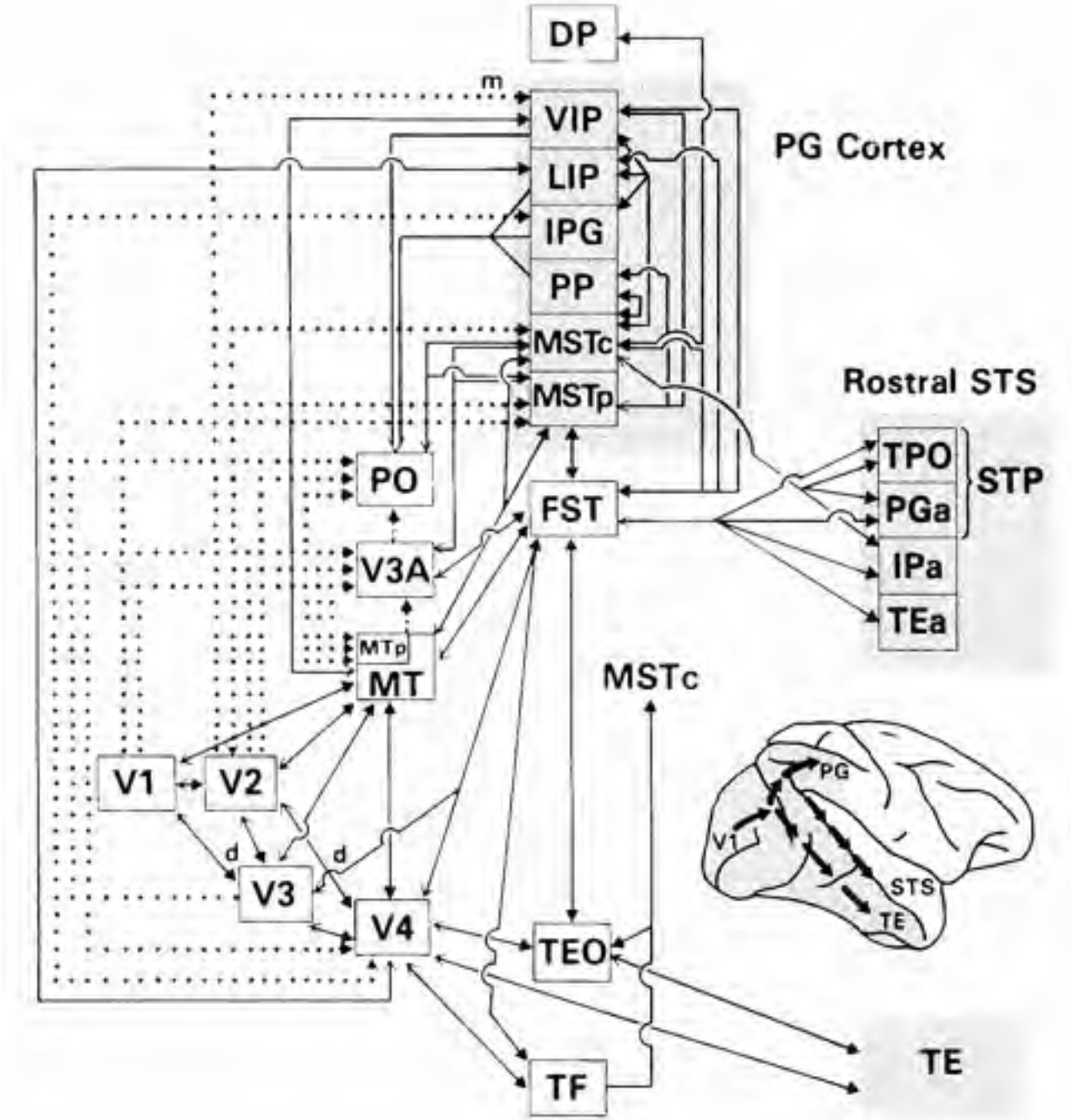
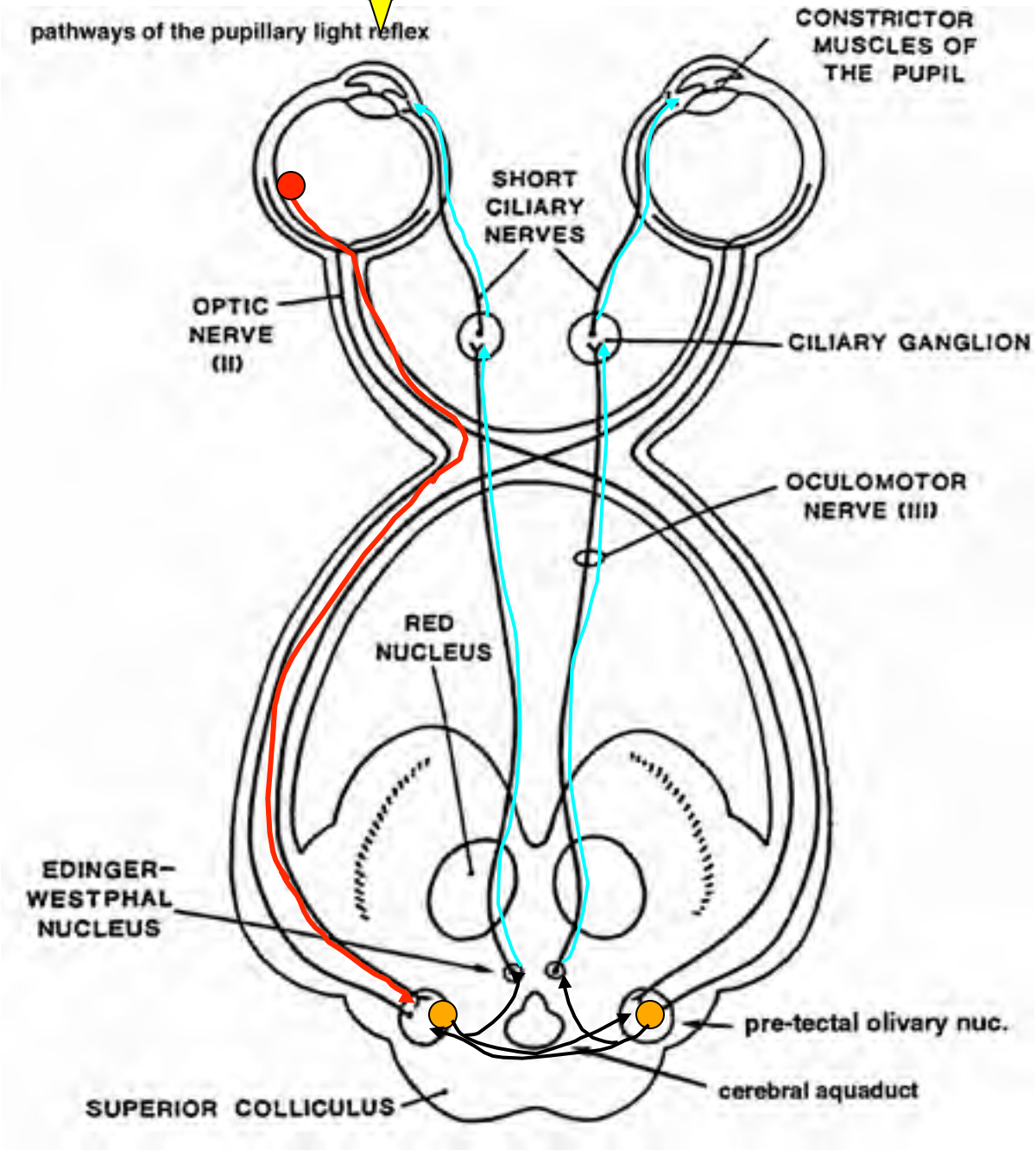


Fig. 2. *Behavioral tasks sensitive to cortical visual lesions in monkeys.* **(A)** *Object discrimination. Bilateral removal of area TE in inferior temporal cortex produces severe impairment on object discrimination. A simple version of such a discrimination is a one-trial object-recognition task based on the principle of non-matching to sample, in which monkeys are first familiarized with one object of a pair in a central location (familiarization trial not shown) and are then rewarded in the choice test for selecting the unfamiliar object.* **(B)** *Landmark discrimination. Bilateral removal of posterior parietal cortex produces severe impairment on landmark discrimination. On this task, monkeys are rewarded for choosing the covered foodwell closer to a tall cylinder, the 'landmark', which is positioned randomly from trial to trial closer to the left cover or closer to the right cover, the two covers being otherwise identical.*





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