

Visual System: Pathways & Function

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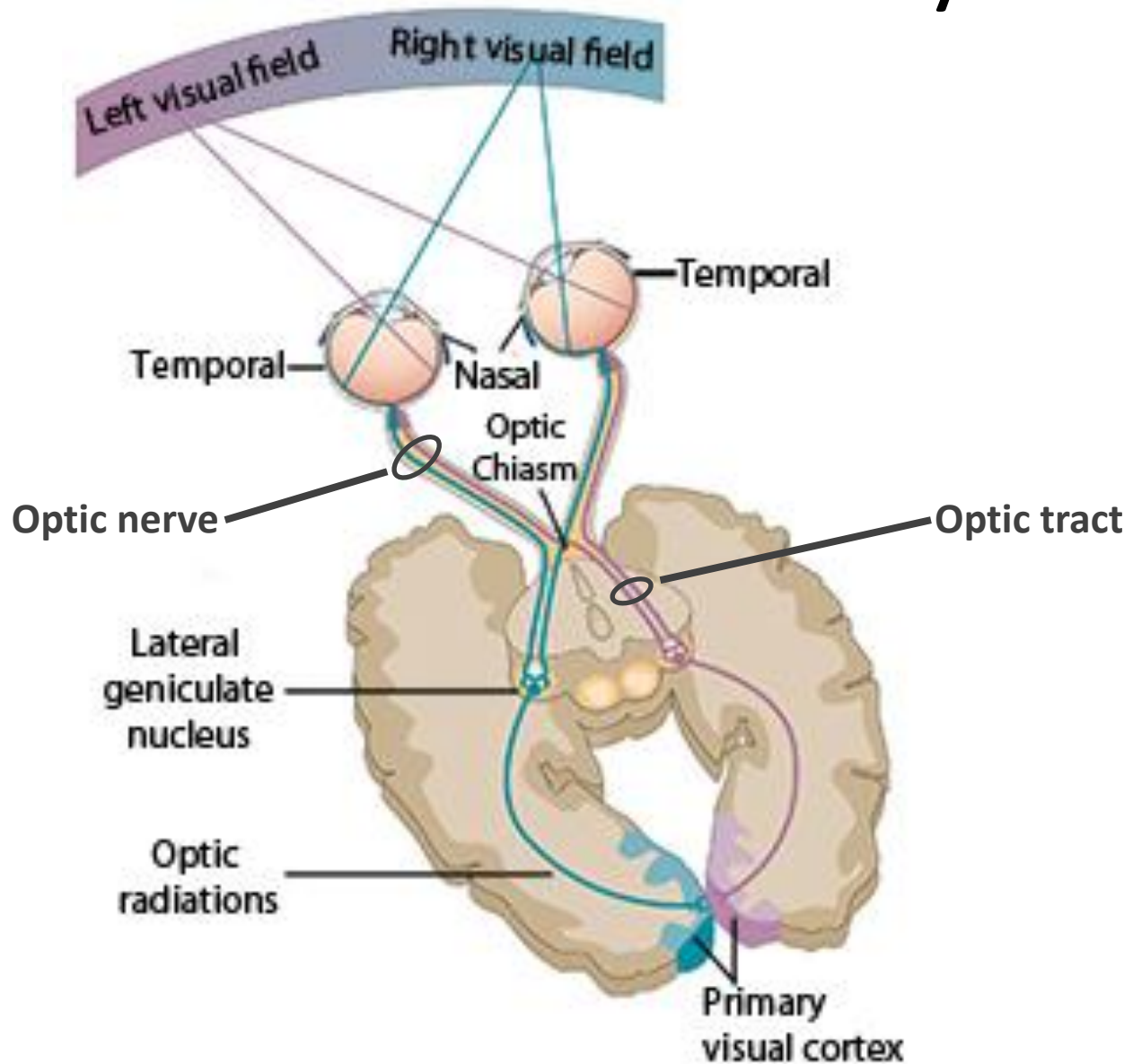
Learning Objectives

- Know the anatomy of the visual pathways
- Appreciate visual dysfunction associated with different sites of neuroanatomical damage

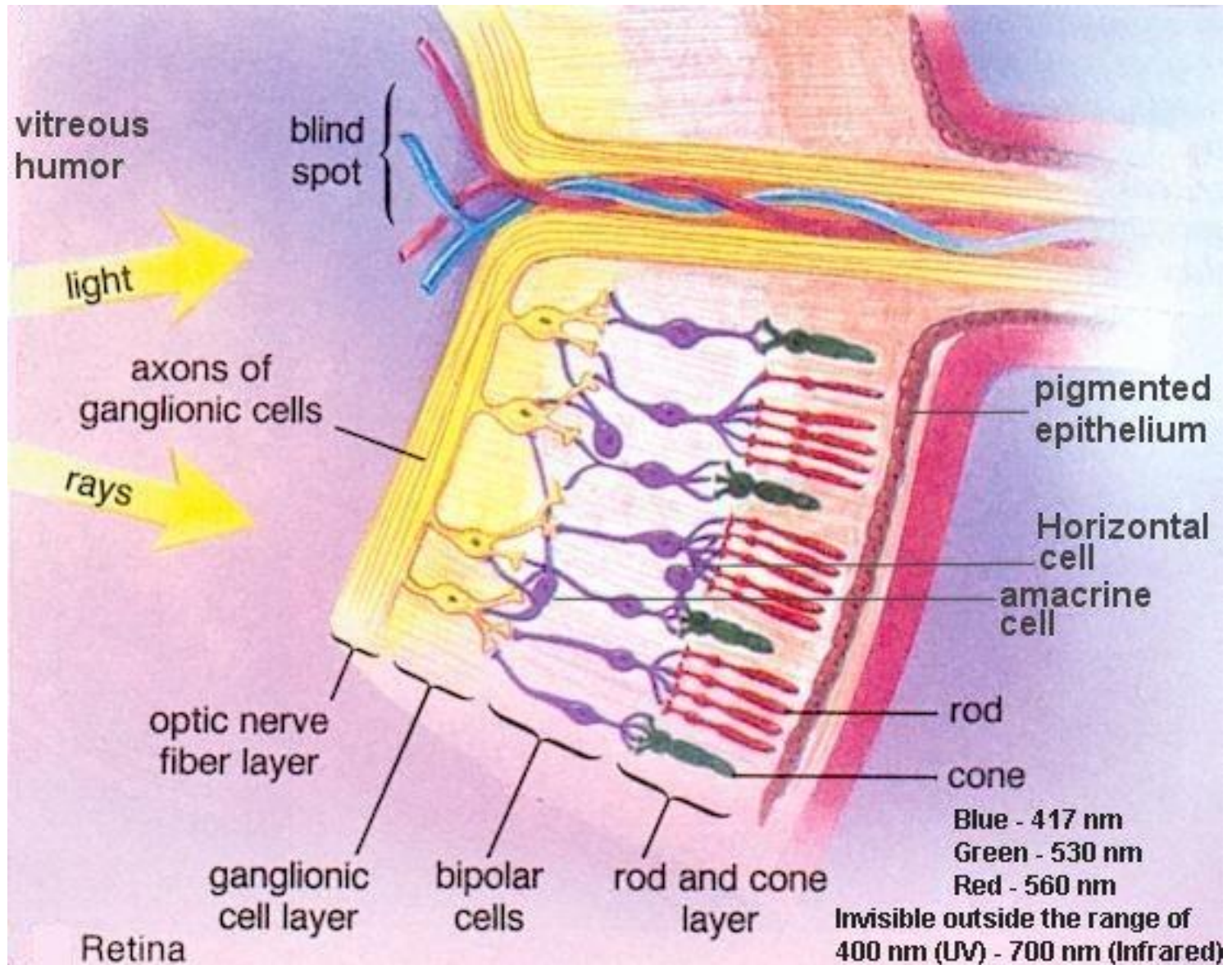
Outline

- Anatomy
 - Central visual pathway
 - Dorsal & ventral streams
 - Pupillary light reflex
- Effects of focal dysfunction & clinical relevance

Central Visual Pathway



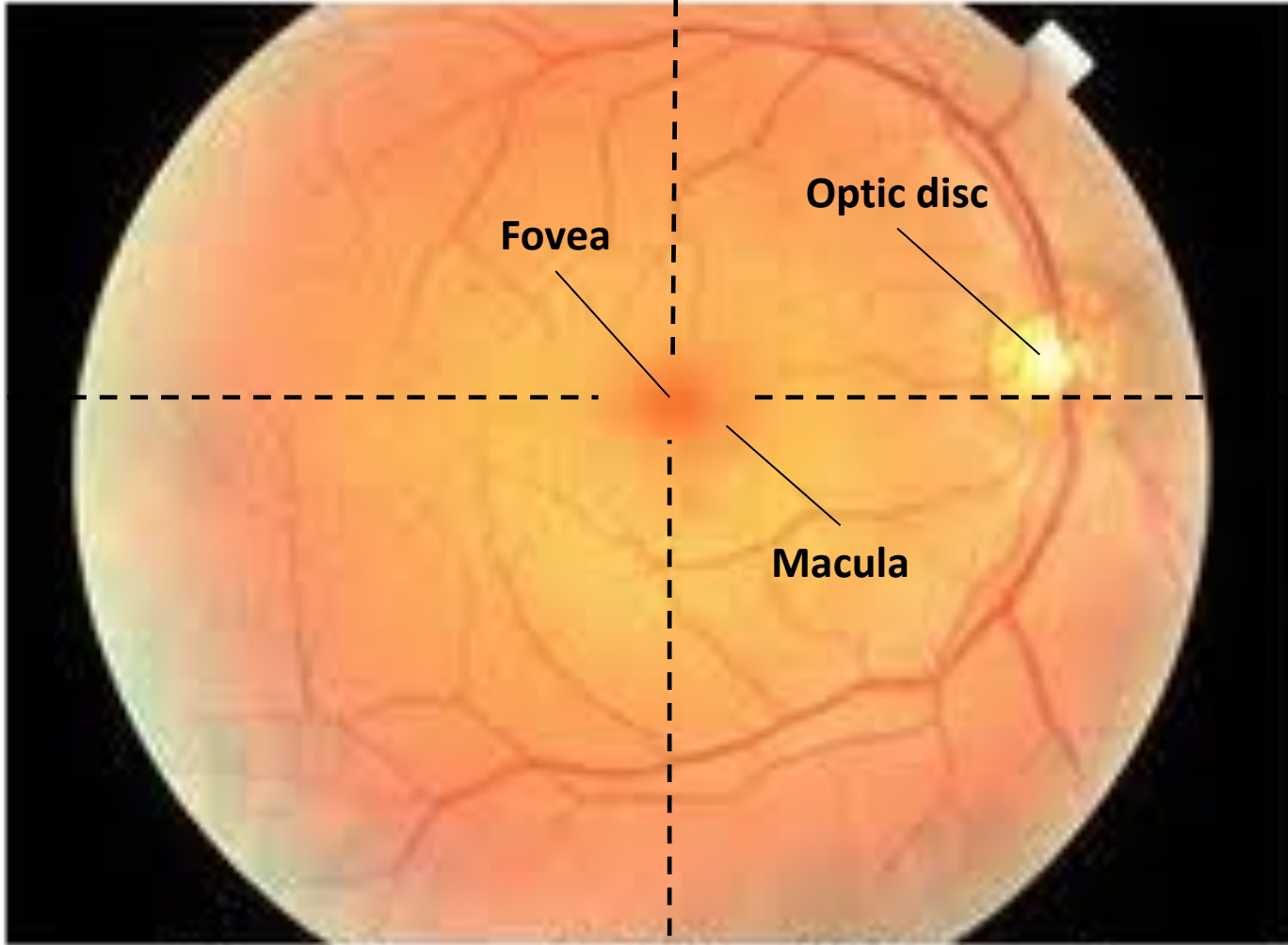
Retina



Retina

S u p e r i o r

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Optic disc

Fovea

Macula

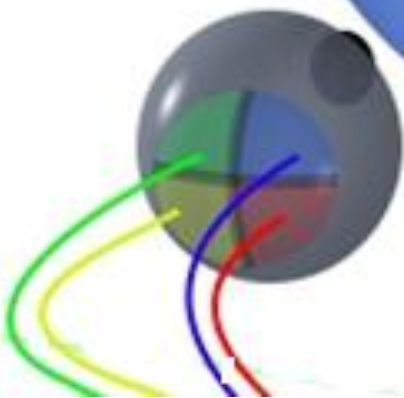
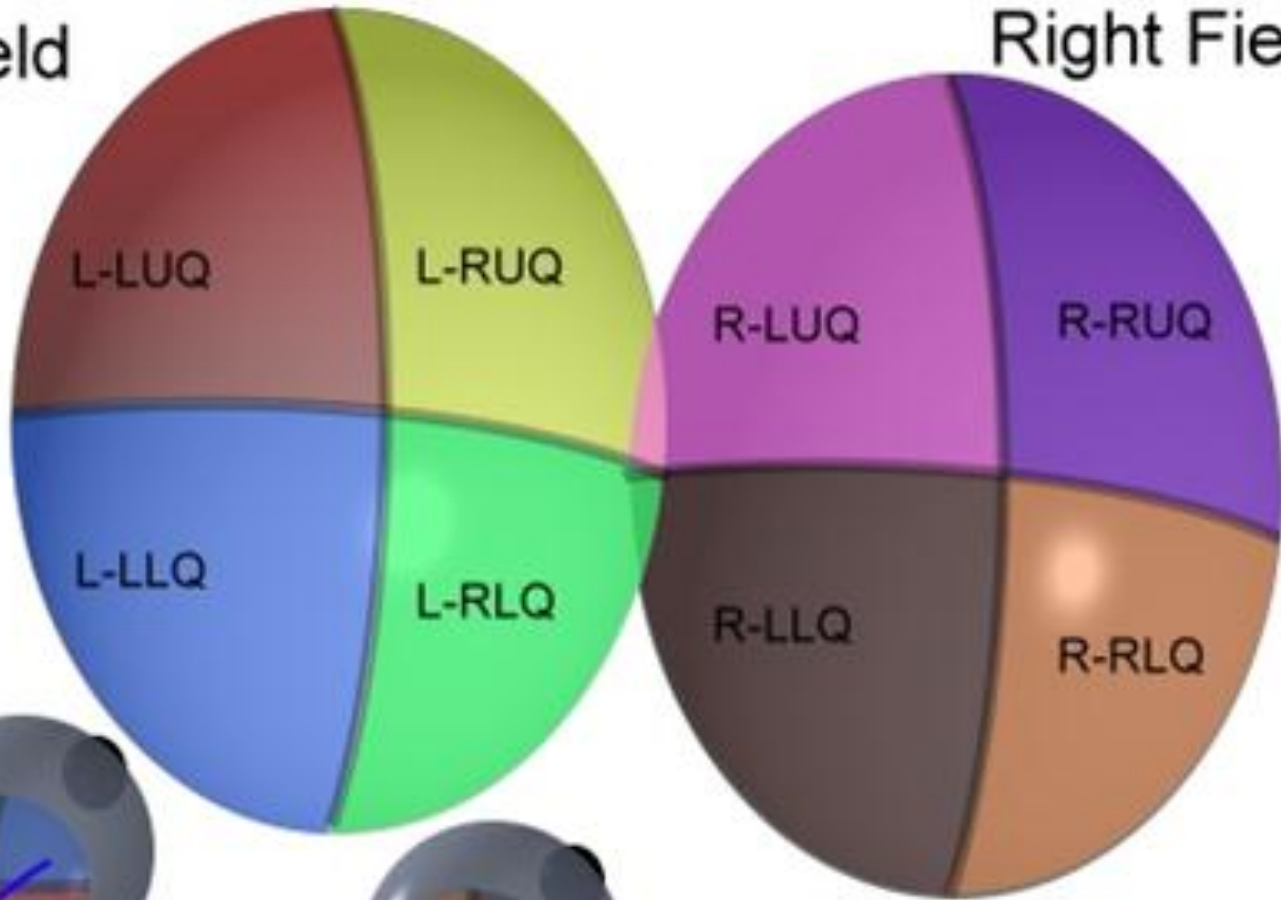
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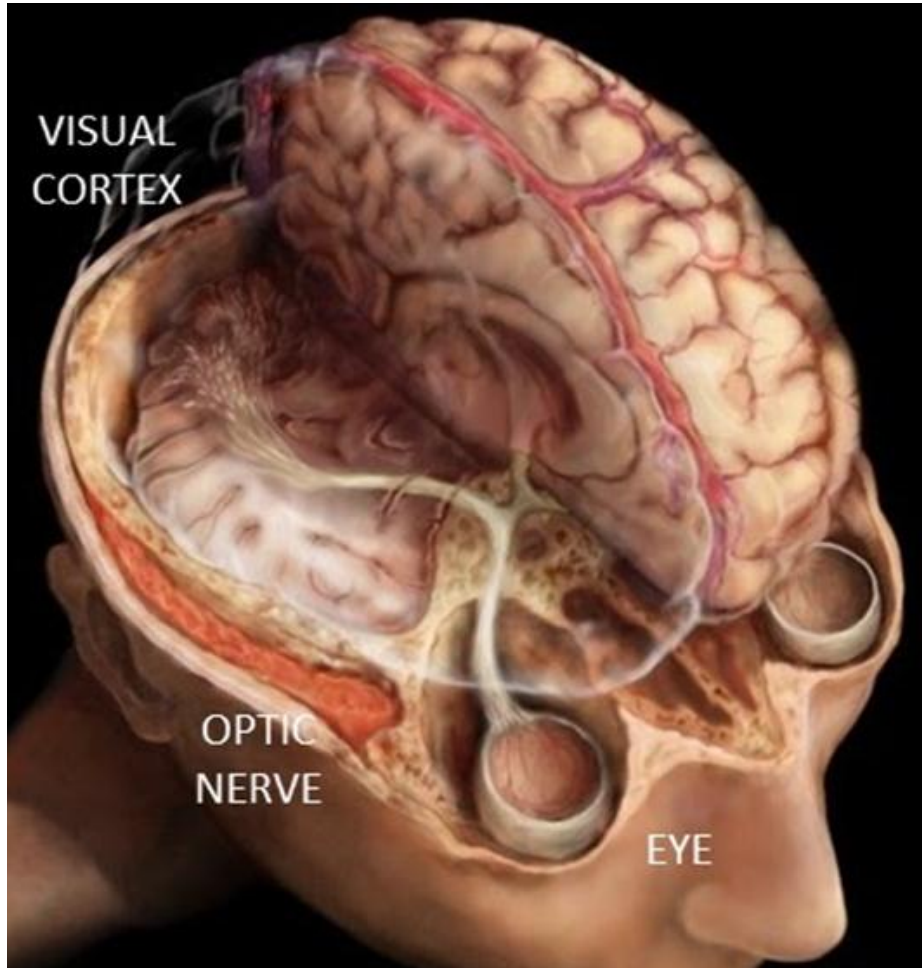
Retina

Left Field

Right Field

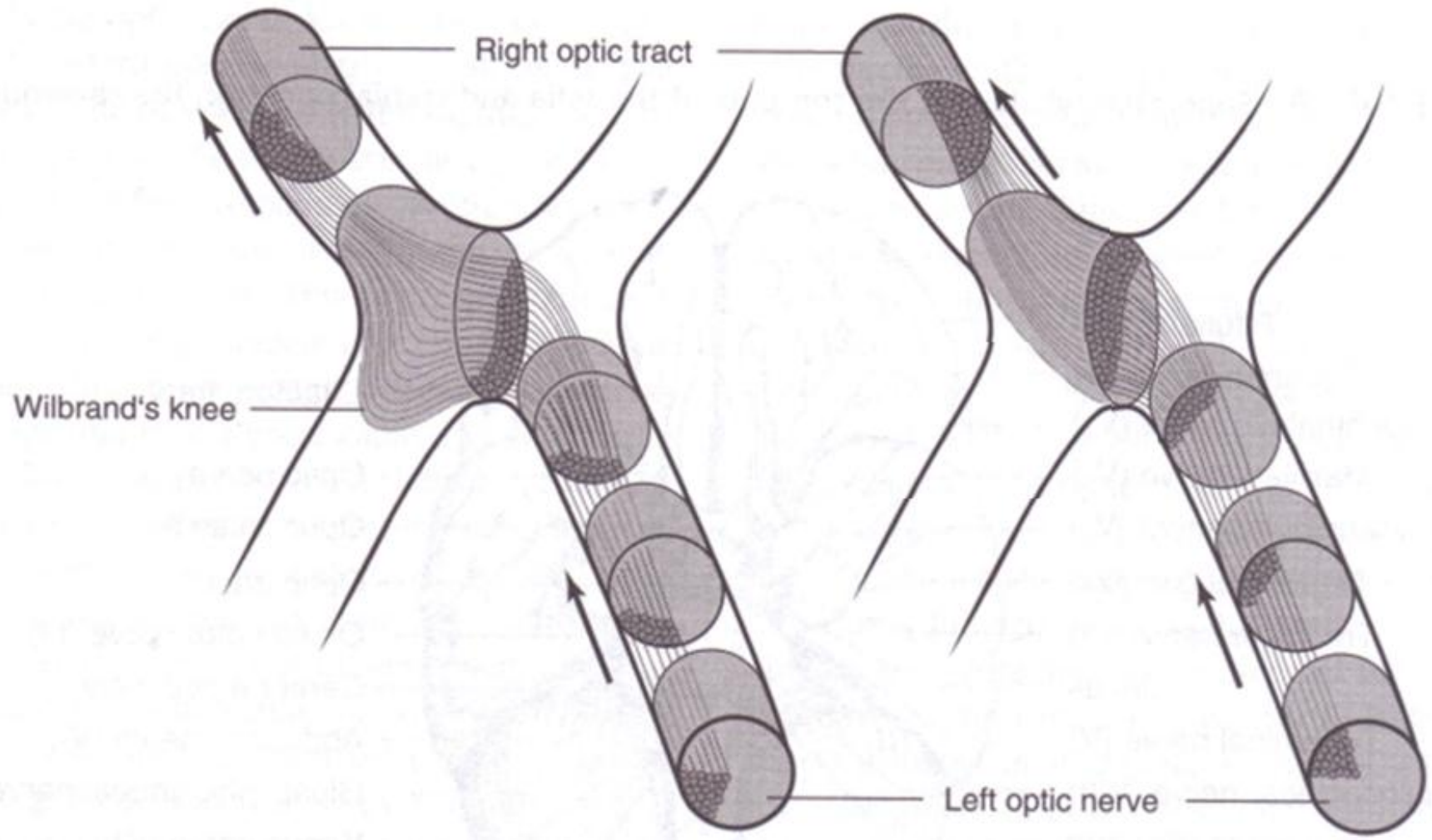


Optic Nerve

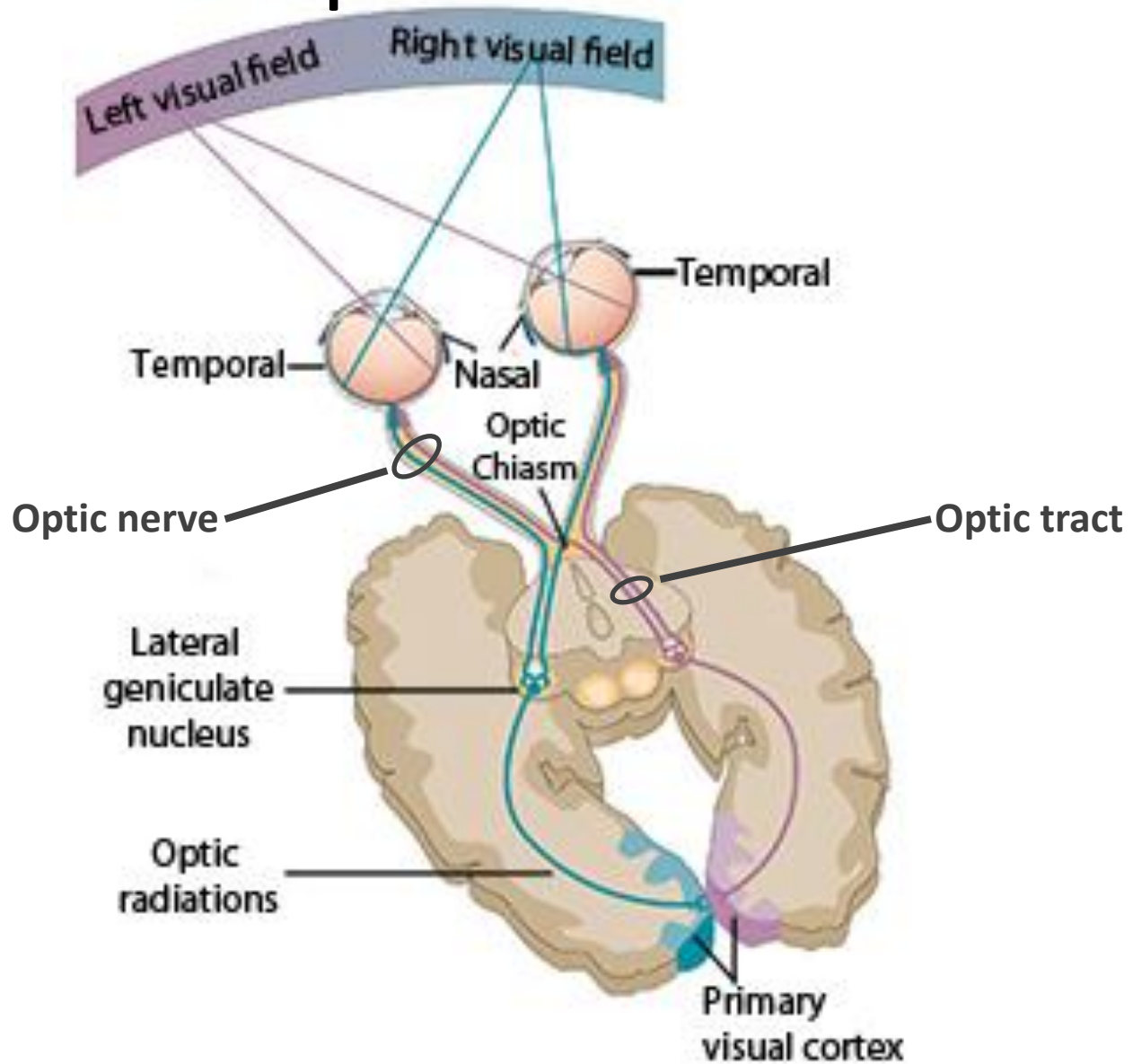


- CNS structure
- \approx 50mm long
- 800, 000 to 1.5 million ganglion cell axons
- 4 portions from globe to chiasm:
 - Intraocular
 - Intraorbital
 - Intracanalicular
 - Intracranial

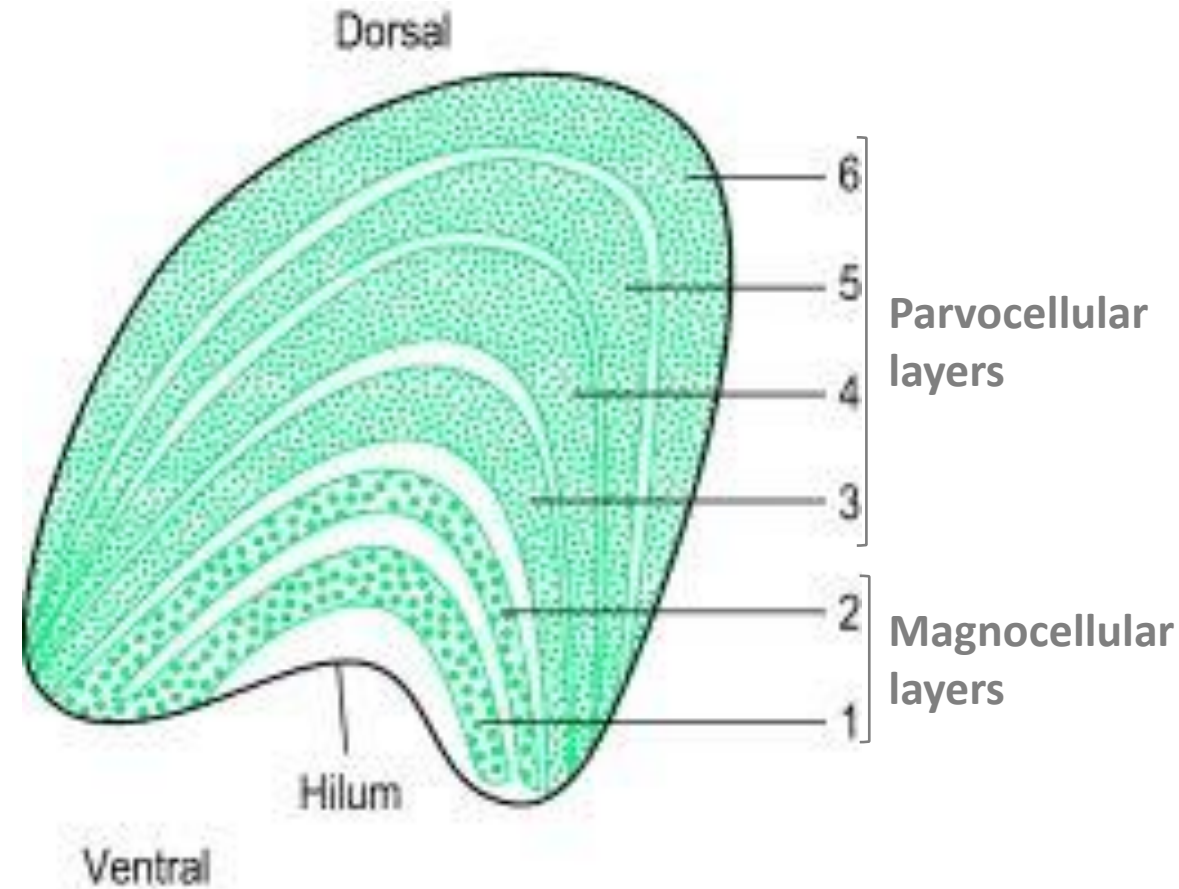
Optic Chiasm



Optic Tract

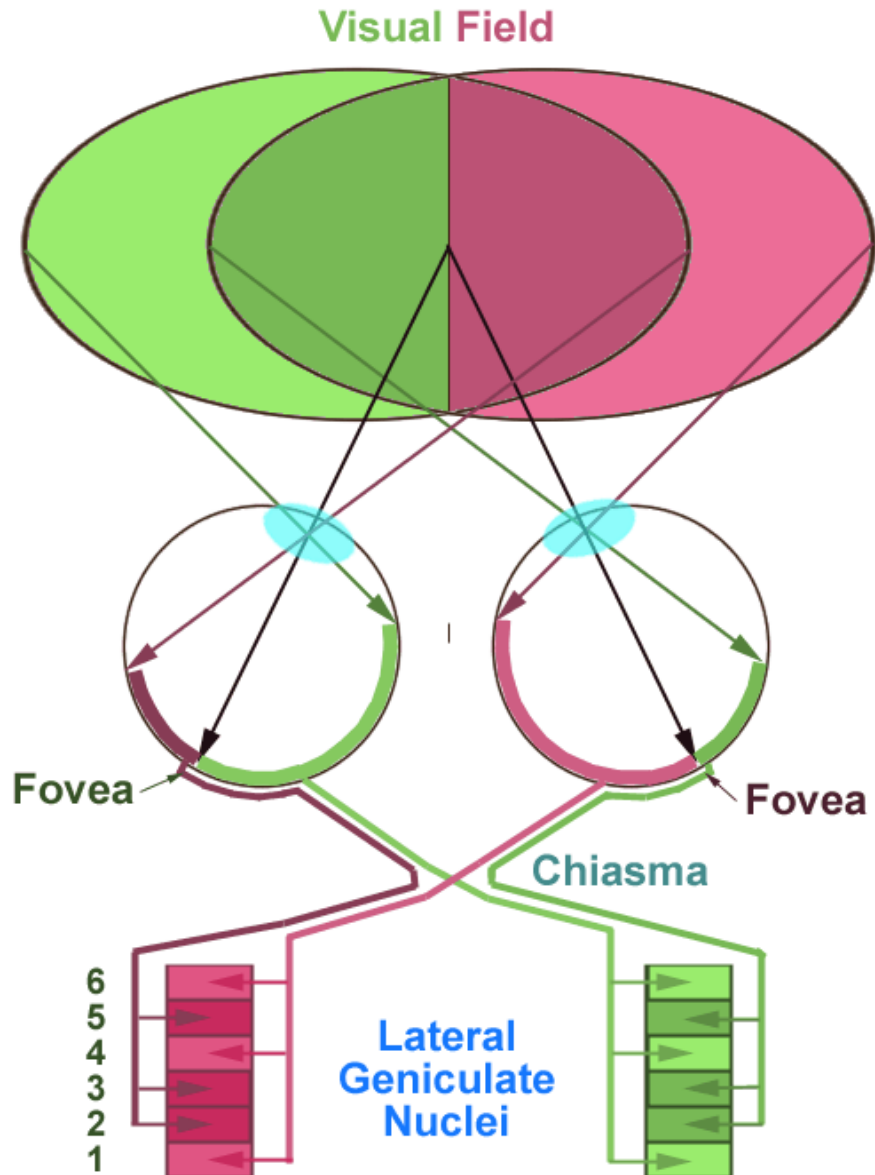


Lateral Geniculate Nucleus



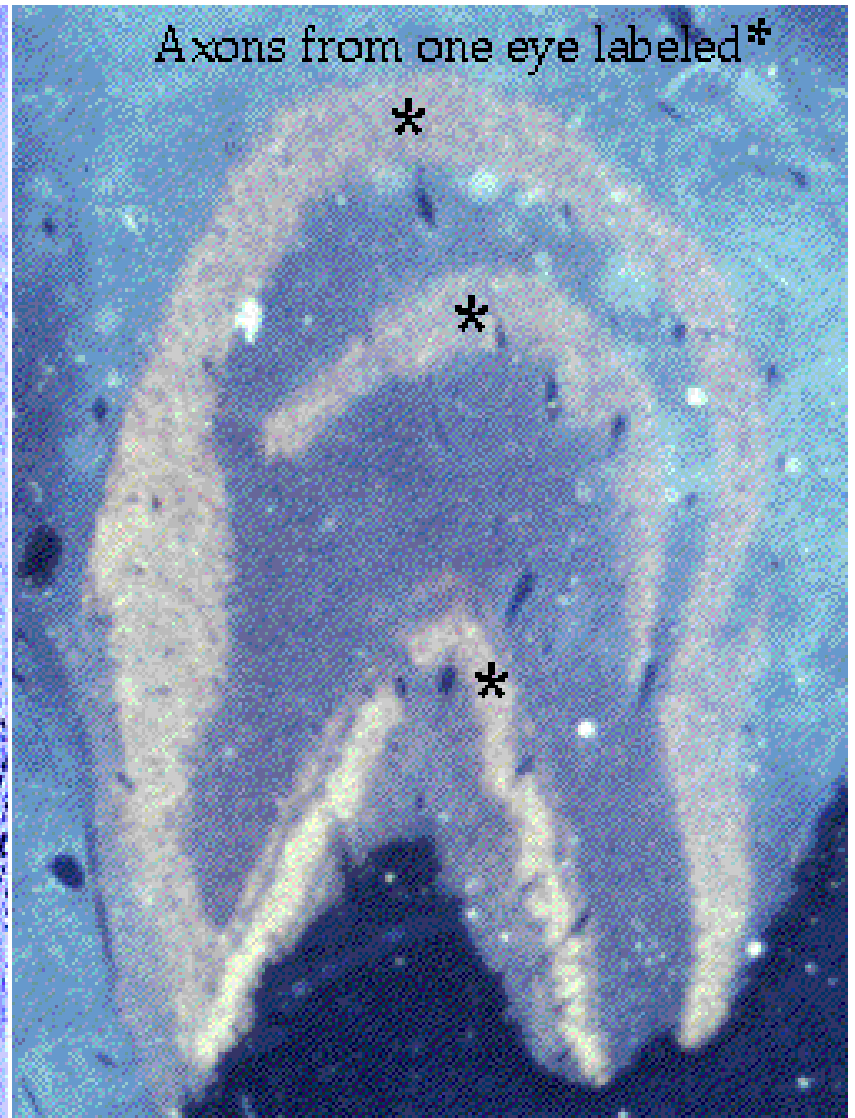
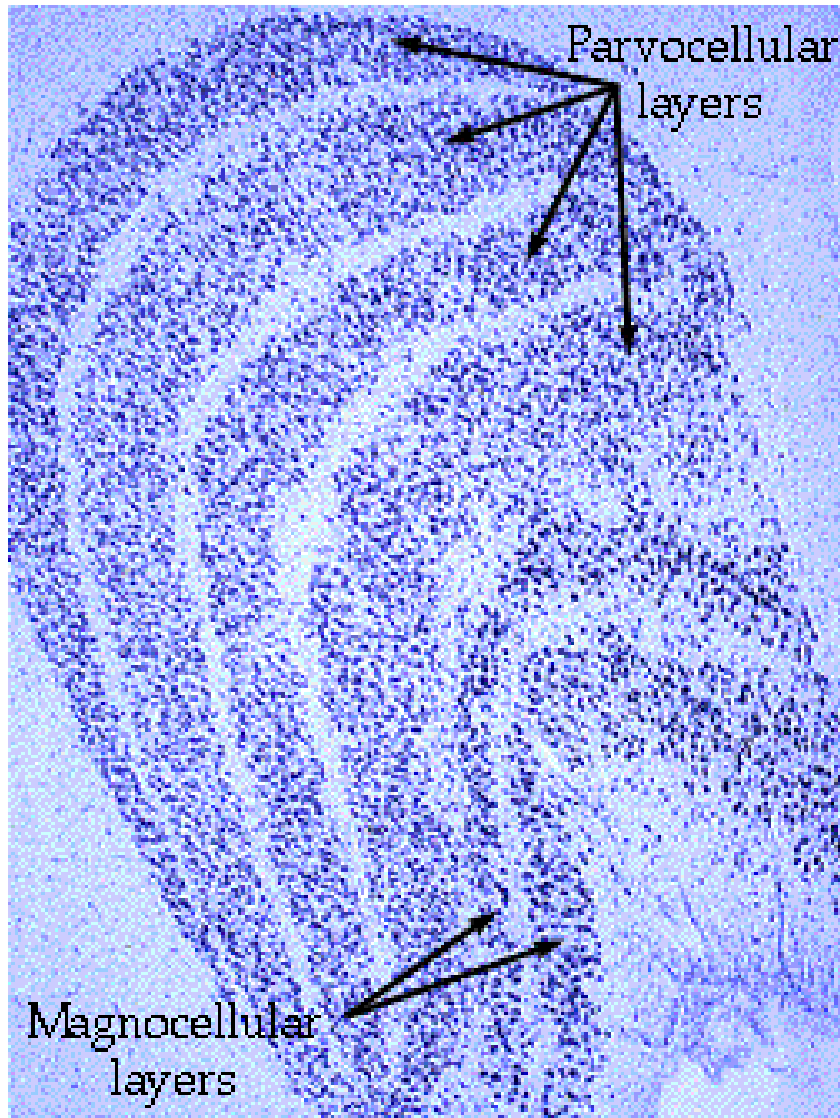
- 6 layers
- Layers 1 and 2 receive signals that travel by the magnocellular pathway
- Layers 3 to 6 receive signals that travel by the parvocellular pathway

Lateral Geniculate Nucleus

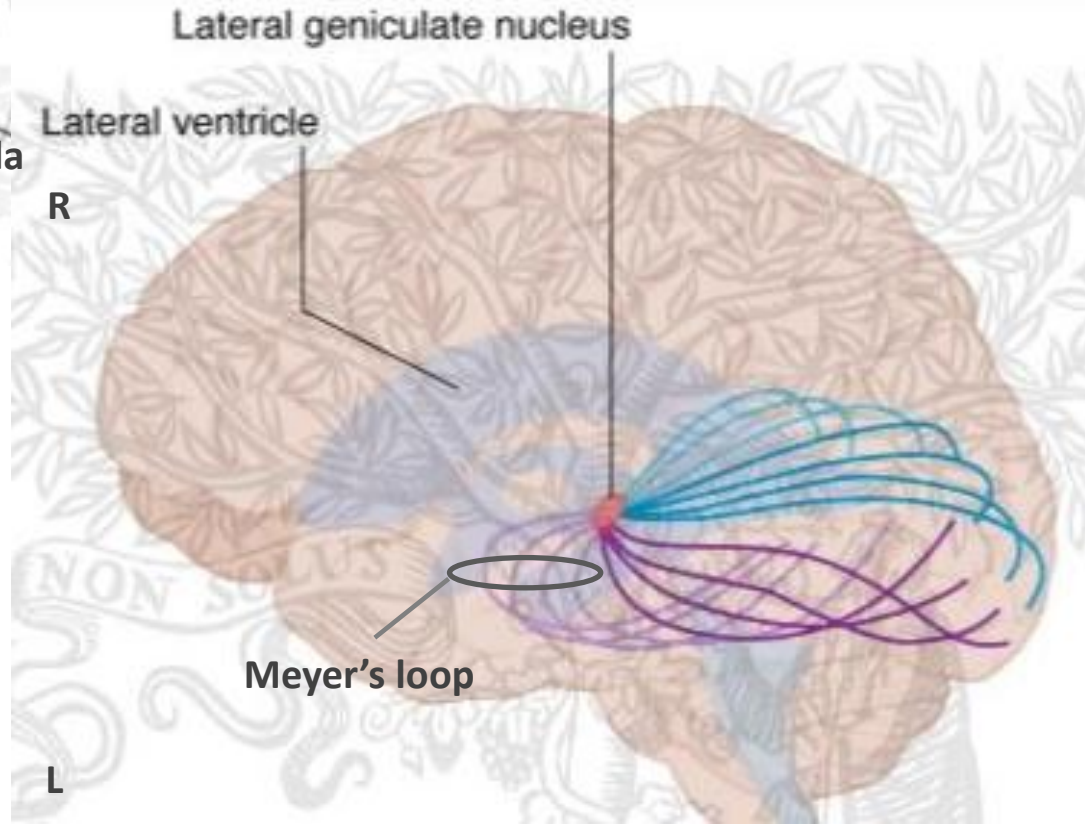
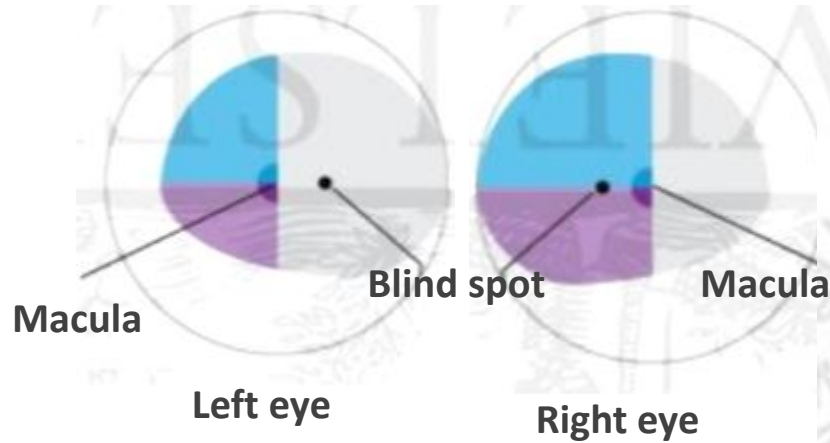


- Information from the contralateral eye goes to layers 1, 4 and 6
- Information from the ipsilateral eye goes to layers 2, 3 and 5

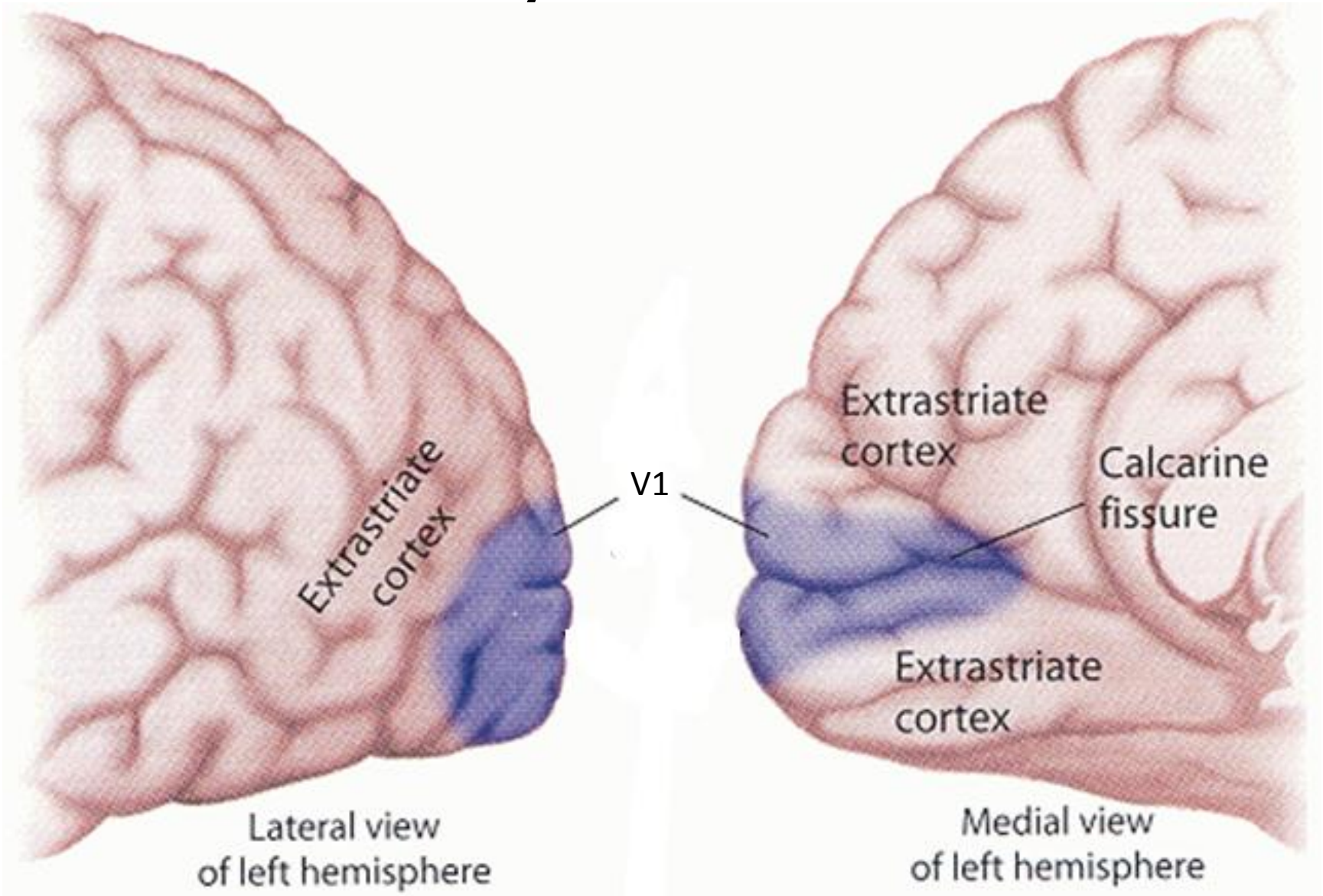
Lateral Geniculate Nucleus



Optic Radiations

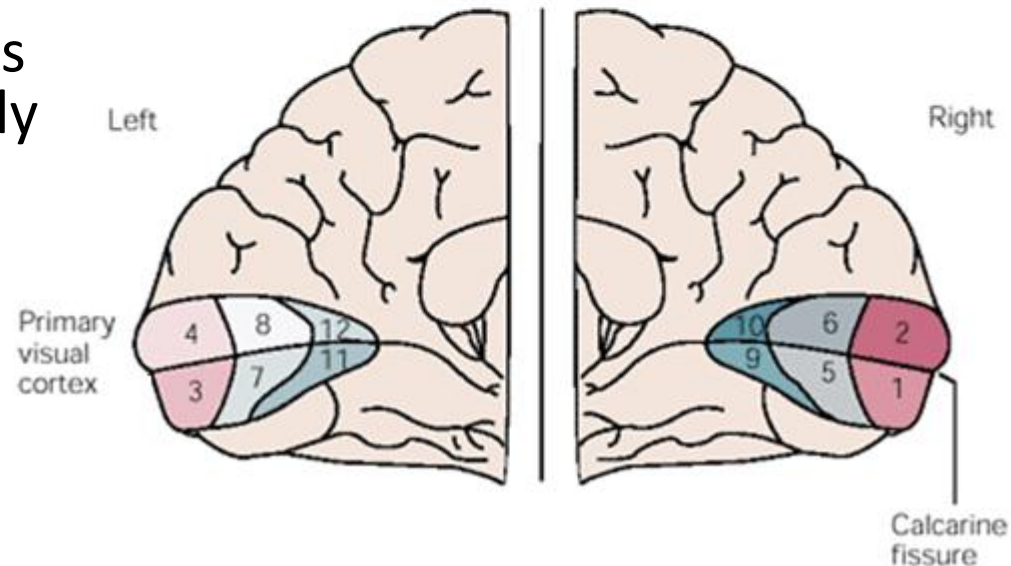
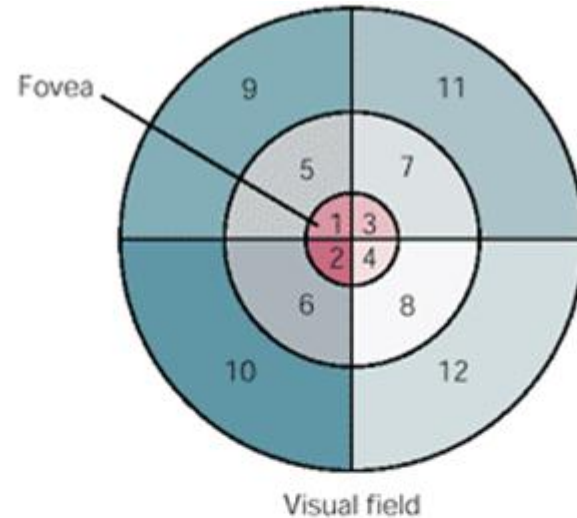


Primary Visual Cortex



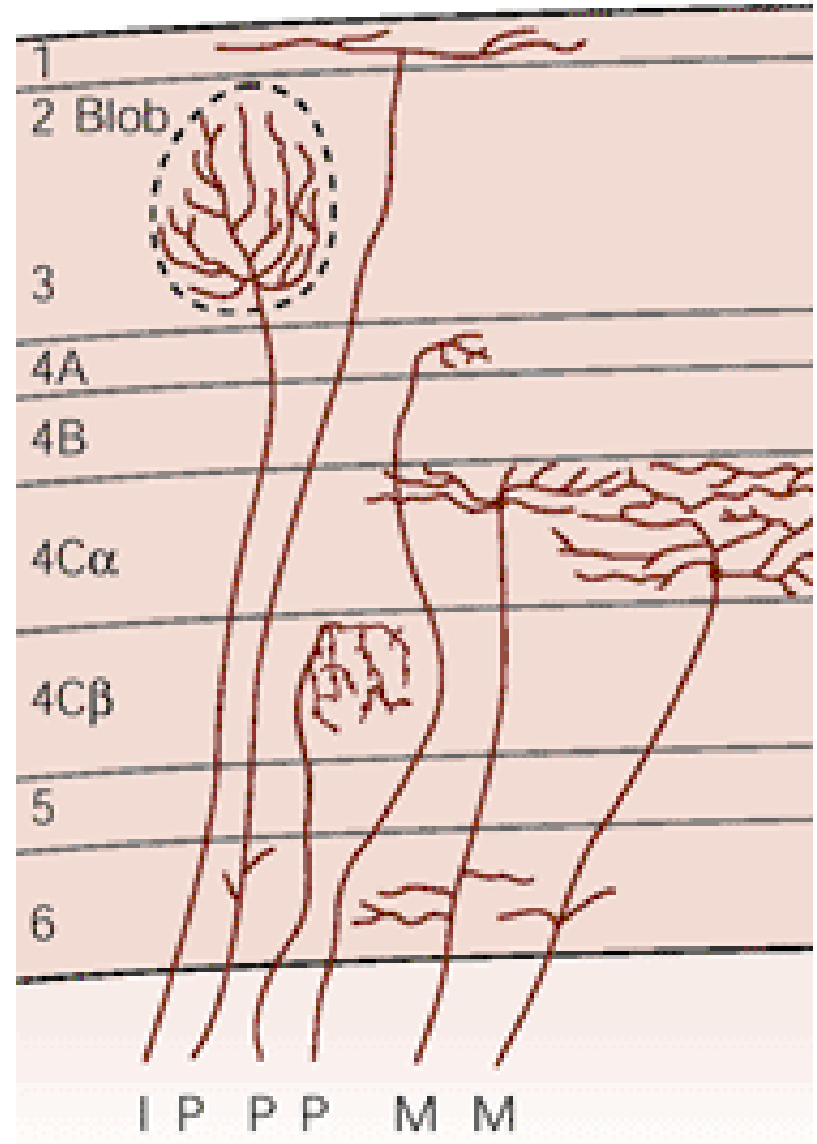
Primary Visual Cortex

- The left visual field projects onto the right occipital lobe & vice versa
- The central part of the visual field is represented posteriorly
- The peripheral visual field is represented more anteriorly
- The superior visual field is represented ventrally



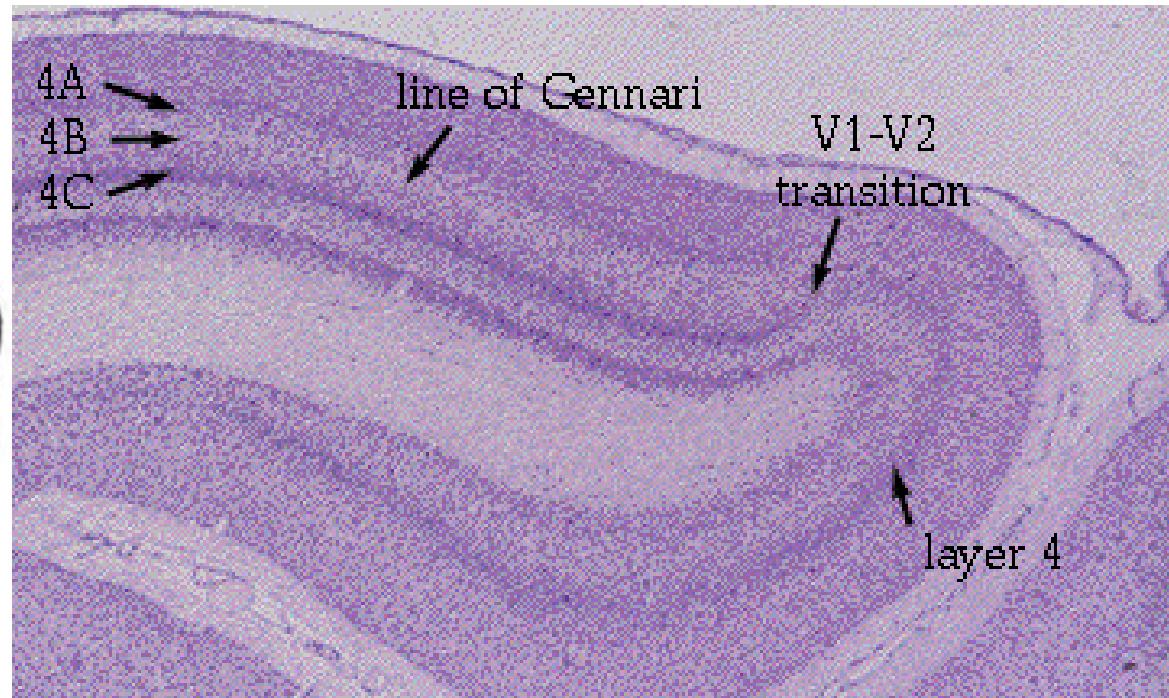
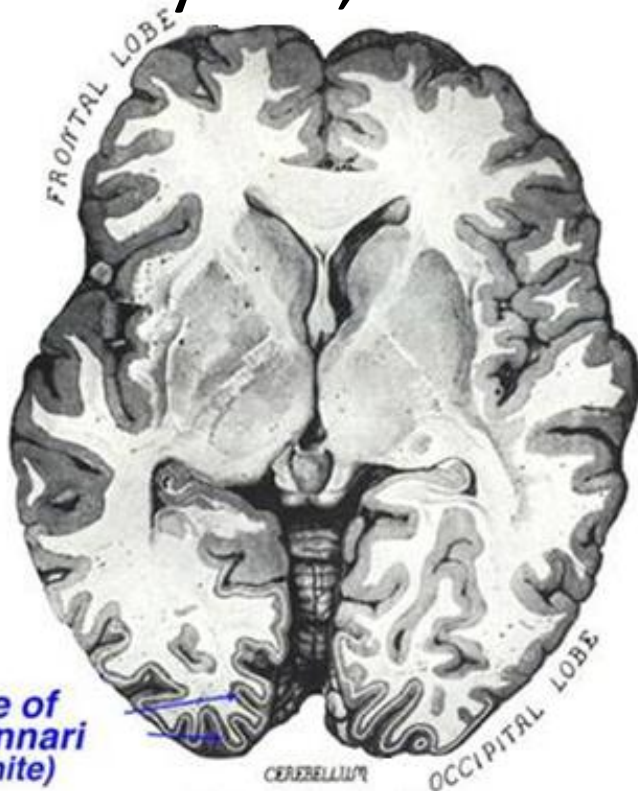
Primary Visual Cortex

- 6 layers
- Principal layer for inputs from LGN is layer 4:
 - 4A - minor inputs from parvocellular layers
 - 4C α - from magnocellular layers
 - 4C β - from parvocellular layers



Primary Visual Cortex

- Also called the *Striate* cortex because it contains a prominent stripe of white matter in layer 4, the *stria of Gennari*



Primary Visual Cortex

- Several types of neurones make up V1:

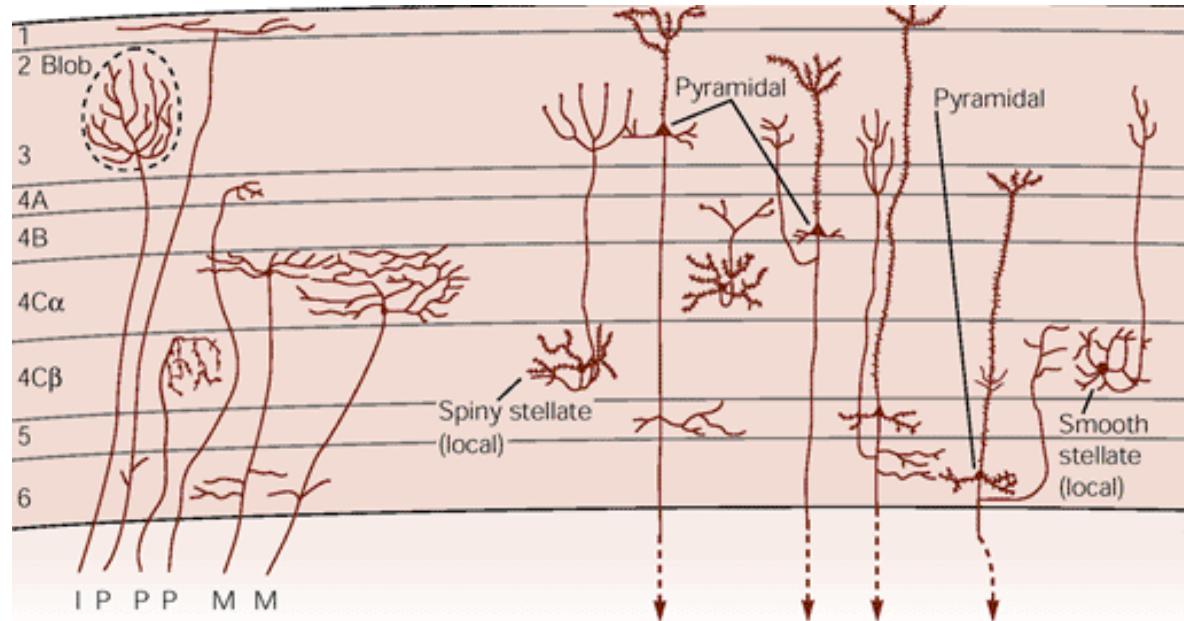
- Pyramidal cells
 - Excitatory
 - Axons project locally & out of the cortex

- Spiny stellate cells

- Excitatory
- Interneurones - axons project locally within V1

- Smooth stellate cells

- Inhibitory
- Interneurones - axons project locally within V1



Primary Visual Cortex

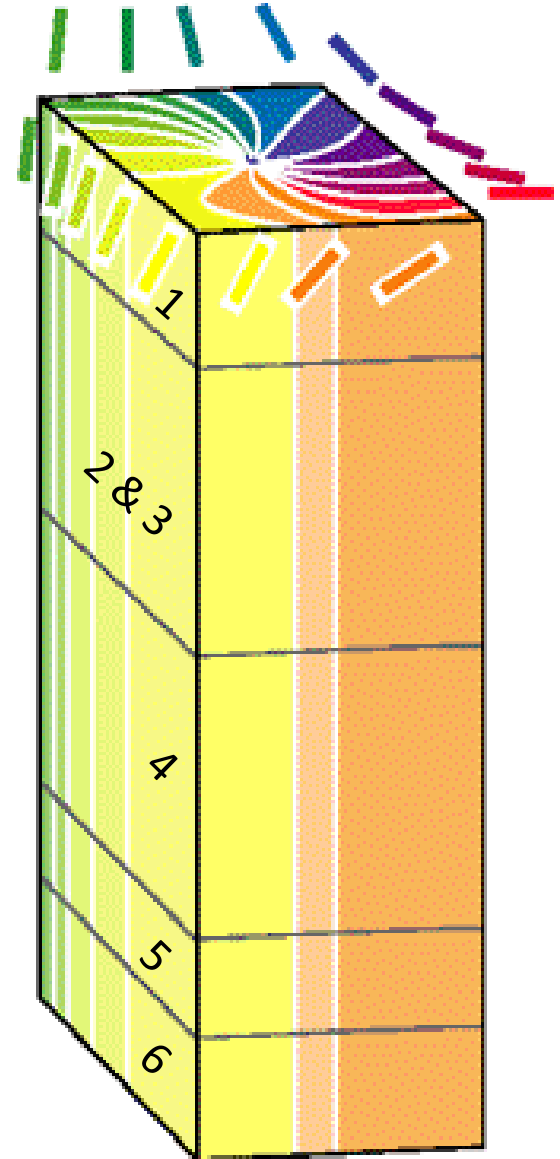
- Receptive fields of V1 cells can be:
 - Simple
 - Respond to bars of light with a specific orientation
 - Complex
 - Respond to a moving light stimulus of a particular orientation & direction of travel

Primary Visual Cortex

- Columnar organisation:
 - Orientation columns
 - Ocular dominance columns
 - Blobs
 - Hypercolumns (cortical modules)

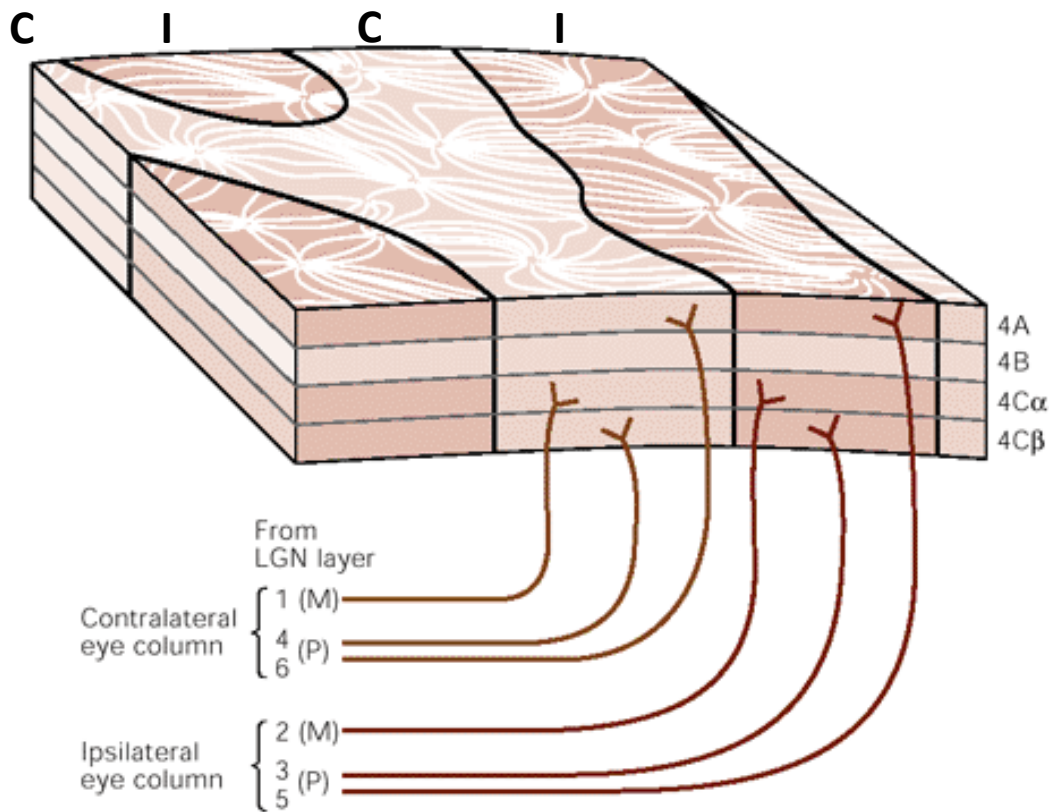
Primary Visual Cortex

- Orientation columns contain cells with the same orientation preference



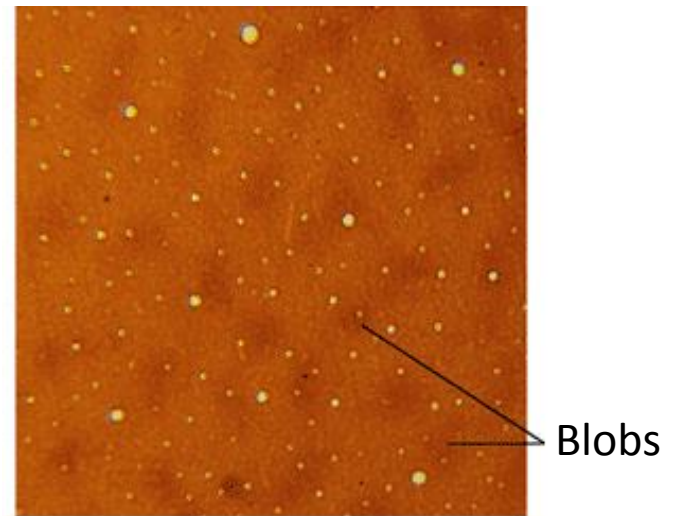
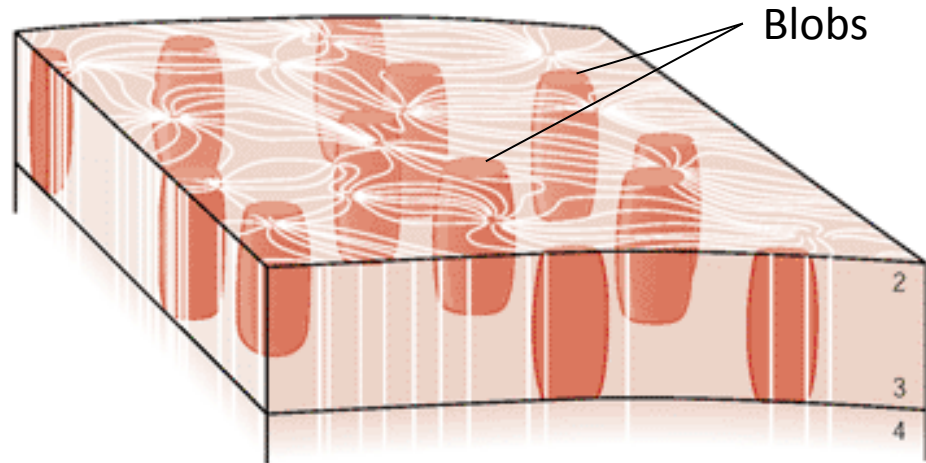
Primary Visual Cortex

- Ocular dominance columns located in layer 4C process separate inputs from each eye



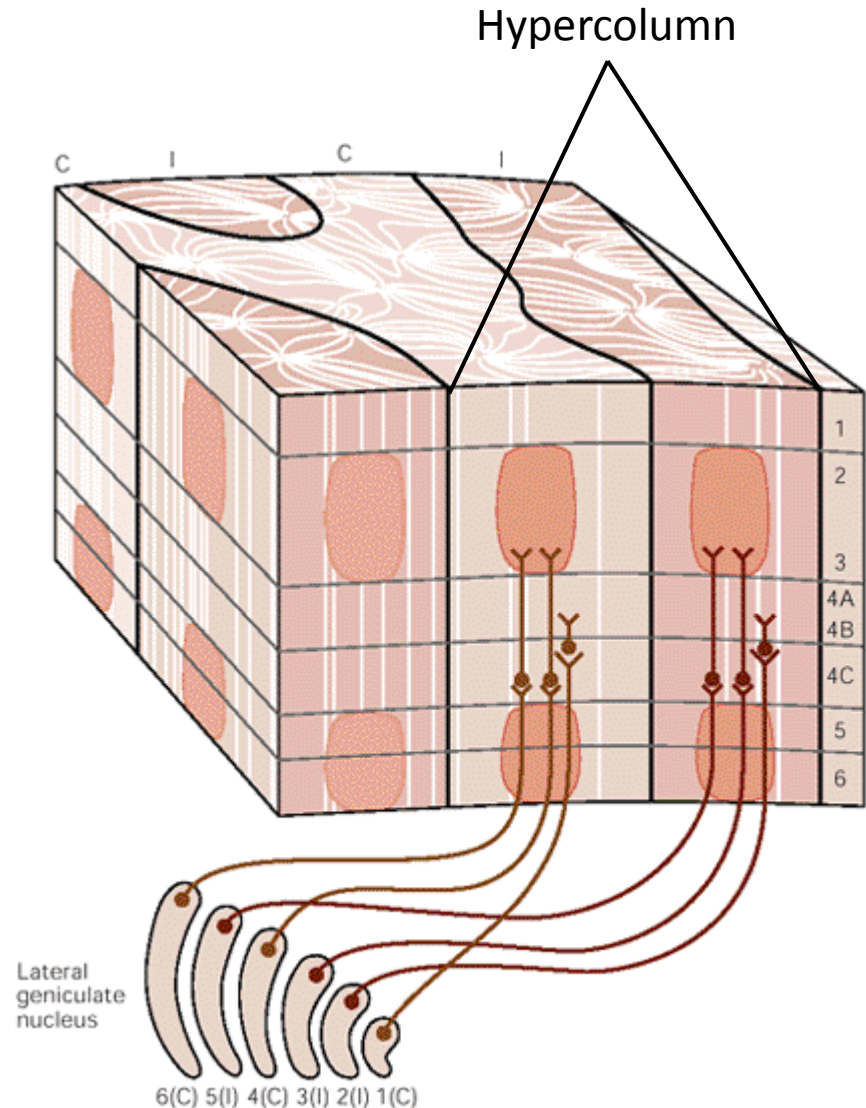
Primary Visual Cortex

- Blobs are:
 - Peg-shaped regions of cells prominent in layers 2 & 3 that interrupt the pattern of the orientation columns
 - Sensitive to the wavelength of light ie: to colour
- Interblob regions are areas between the blobs

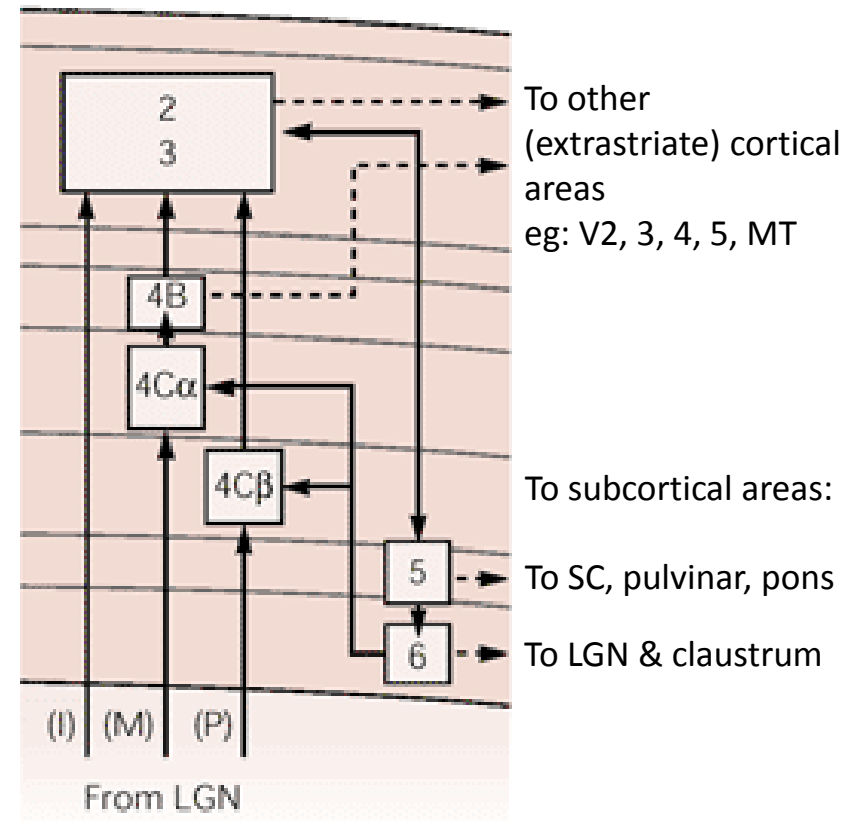
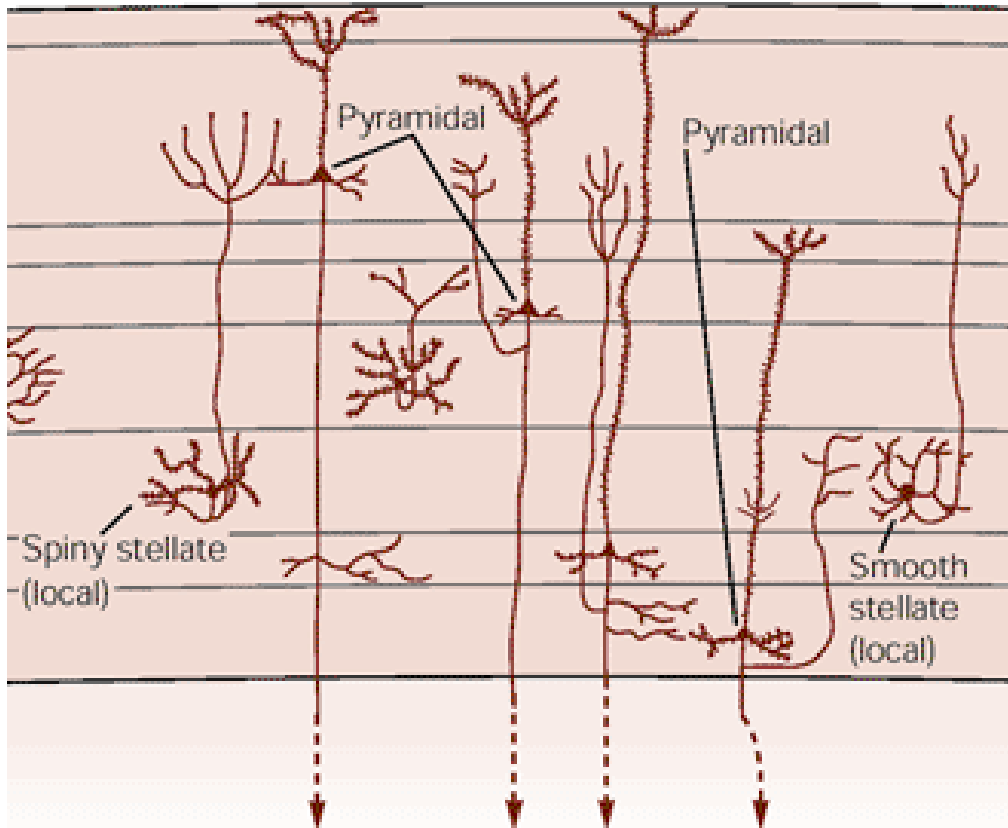


Primary Visual Cortex

- A hypercolumn is a set of columns responsive to lines of all orientations from a particular region in the visual field & viewed by both eyes



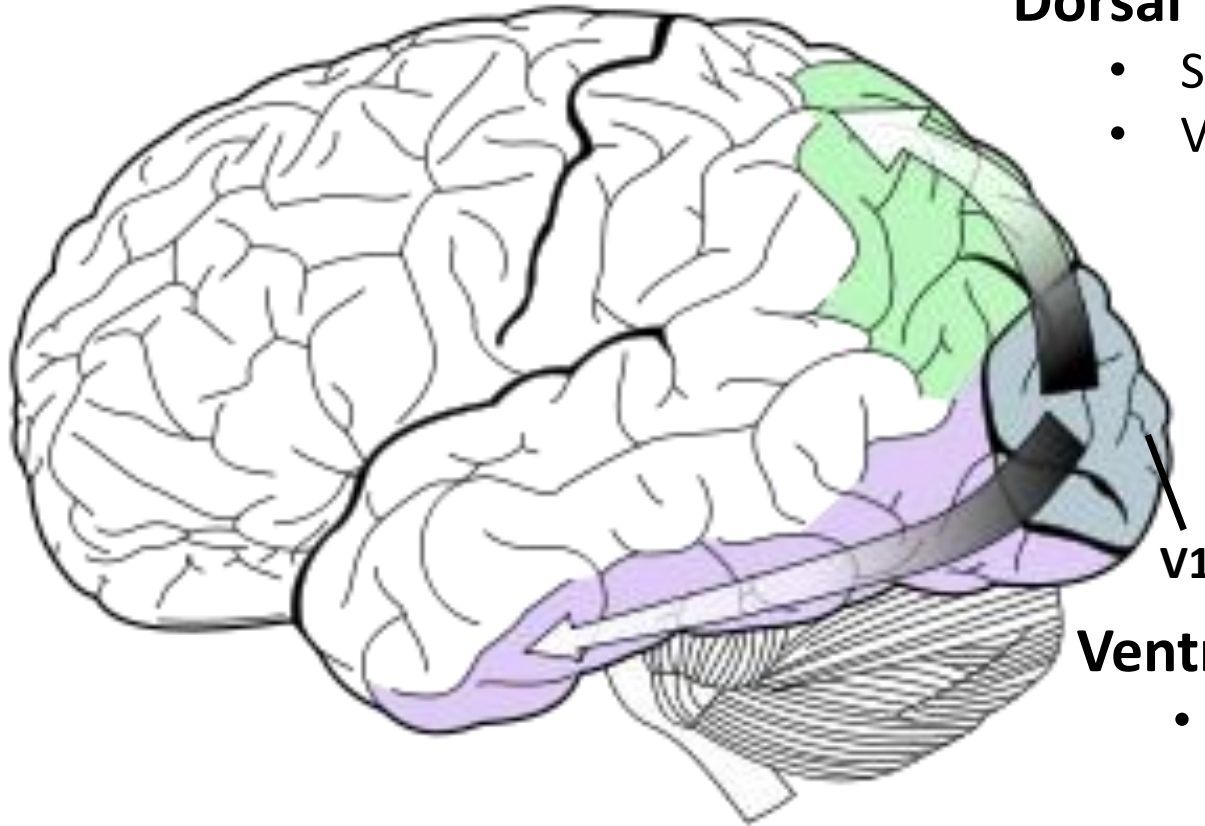
Information Flow Through V1



Extrastriate Visual Areas

Dorsal 'Where' Stream

- Spatial awareness
- Visually-guided behaviour

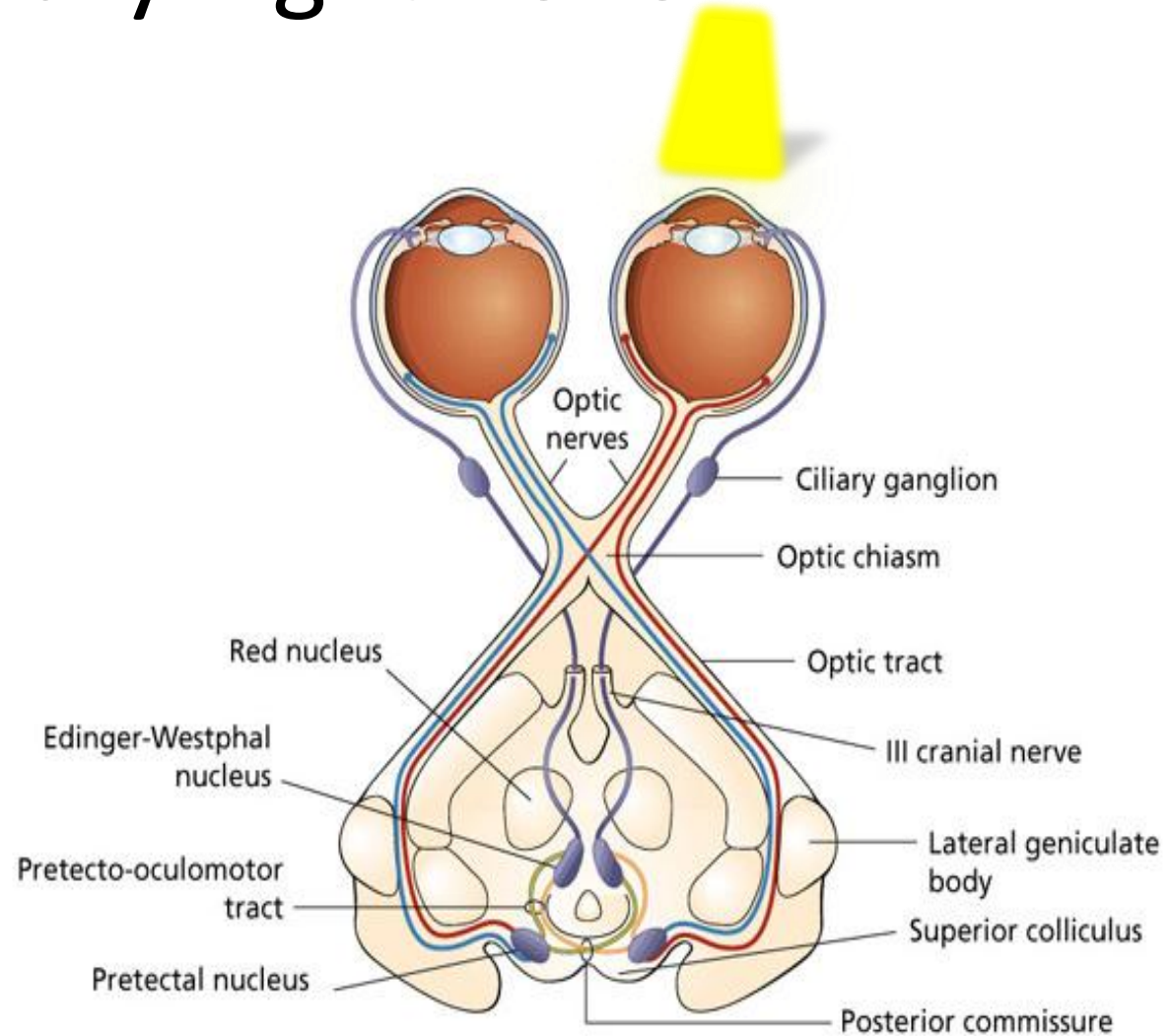


Ventral 'What' Stream

- Recognition & discrimination of visual shapes & objects
- Perception & recognition of faces

Pupillary Light Reflex

- Controls the amount of light reaching the retina
- Illumination of the retina causes reflex constriction of the pupil
- Direct & consensual components

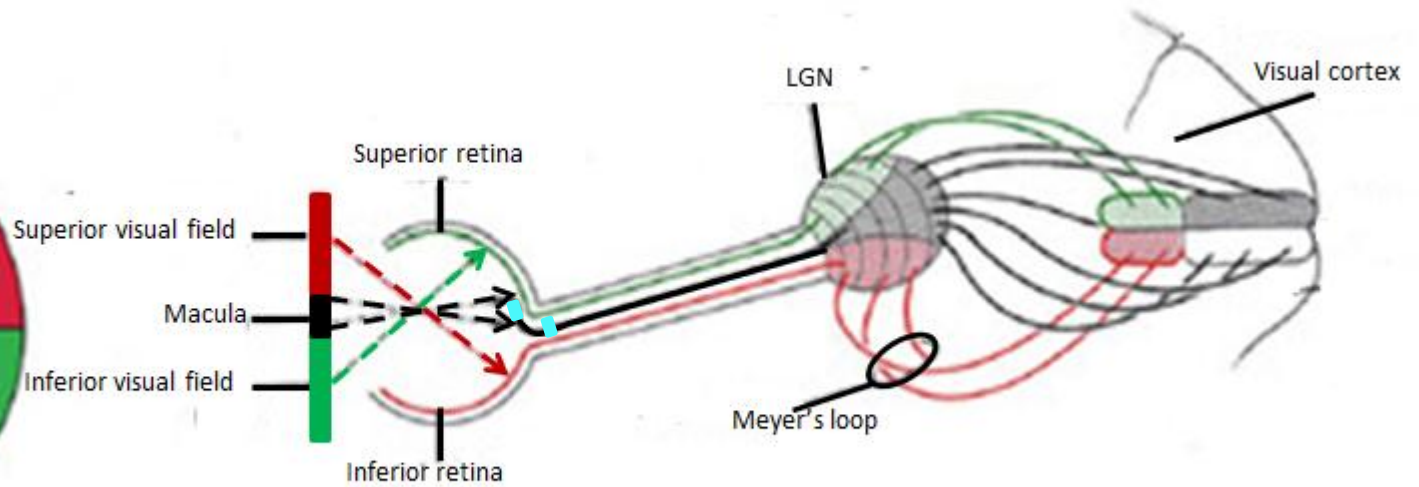
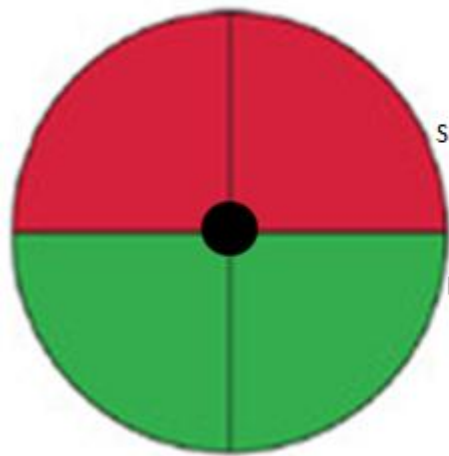


Visual Dysfunction in Neurological Disease

Right Eye Central Scotoma



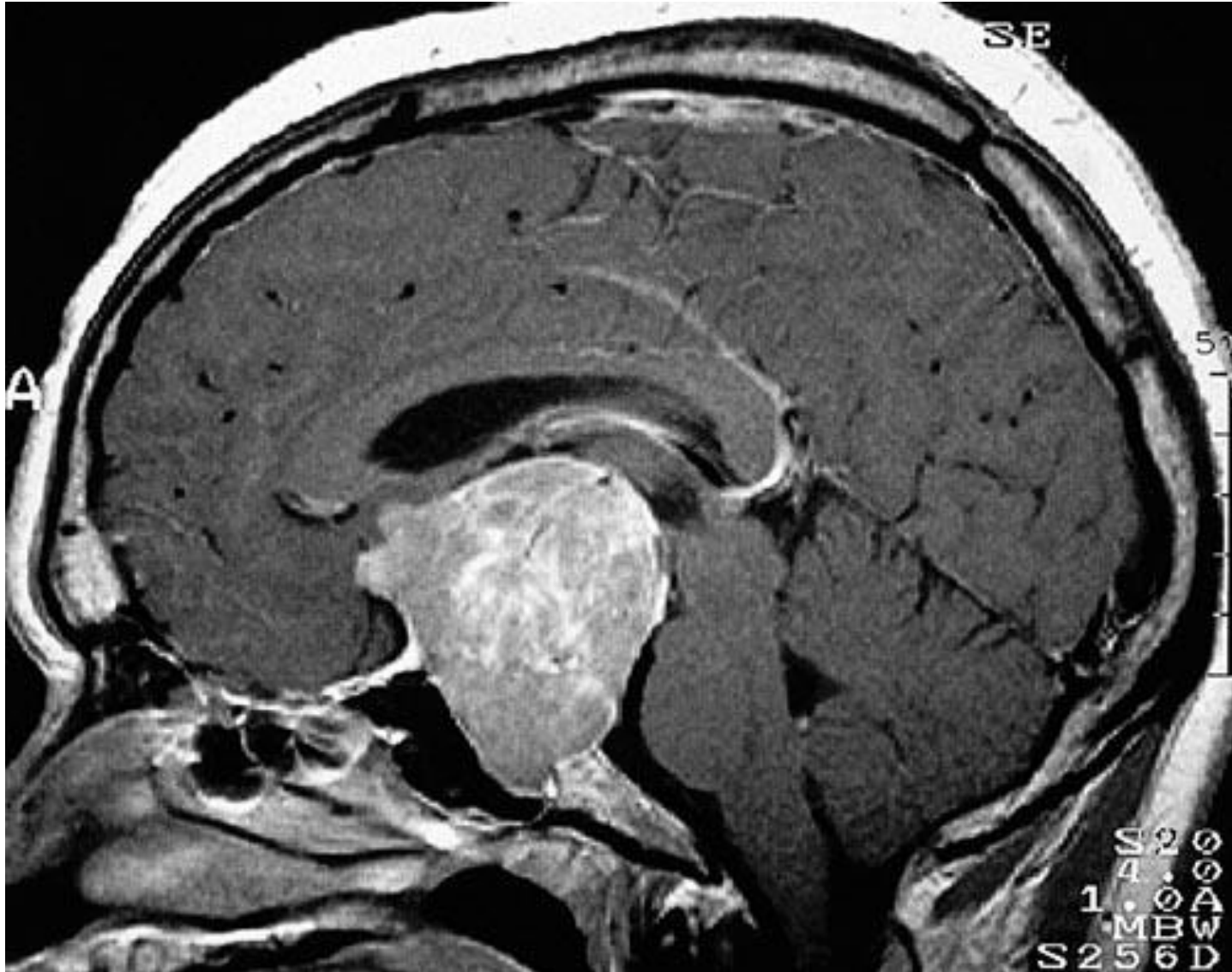
Where is the lesion?



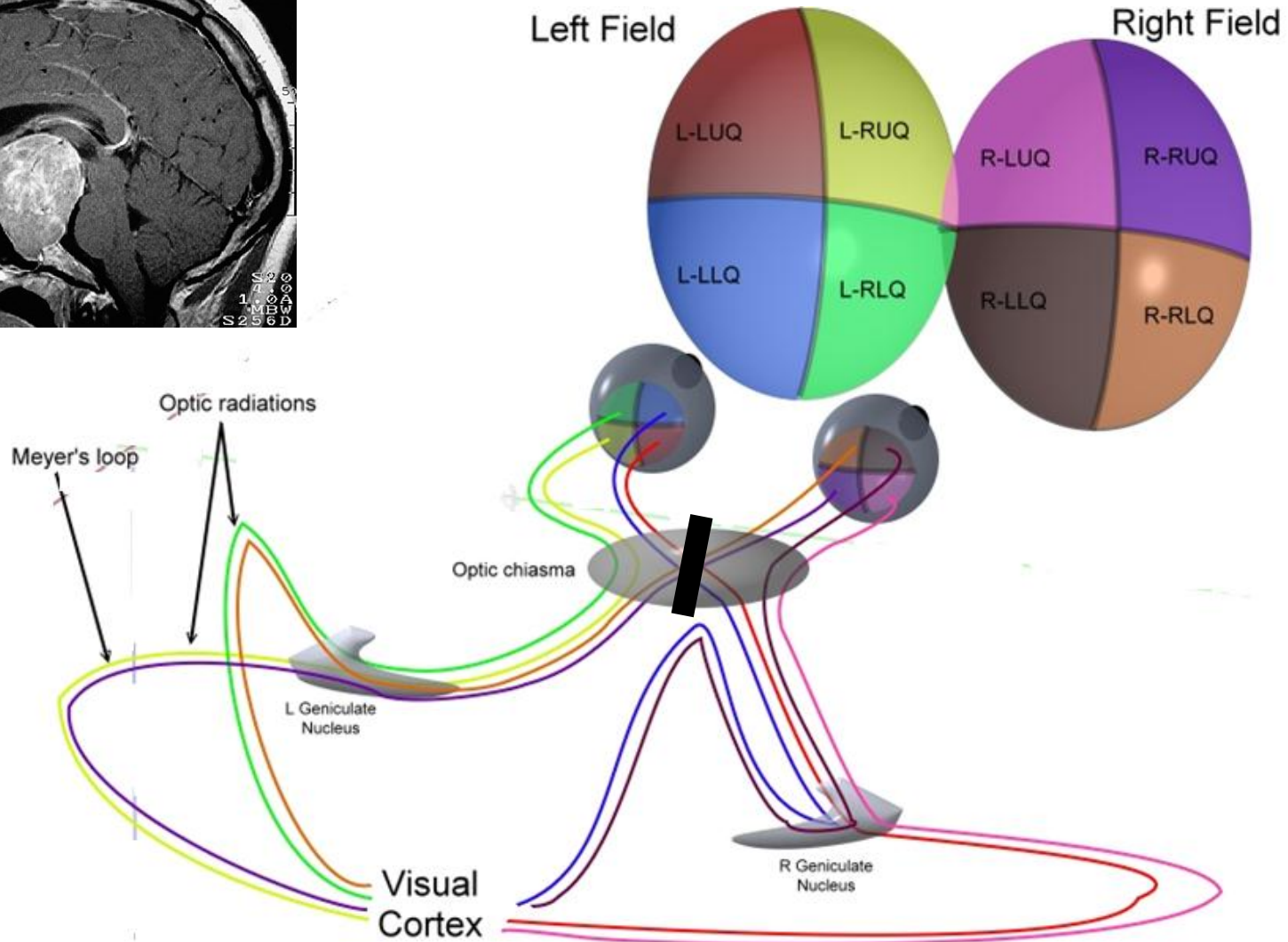
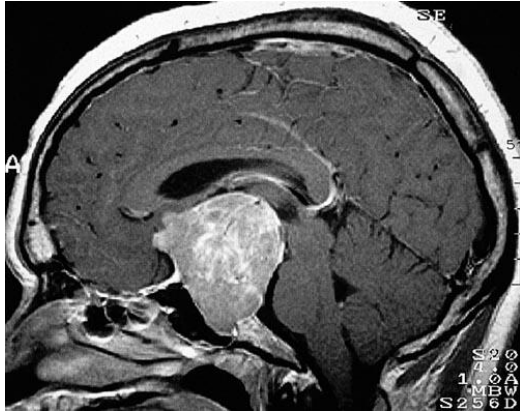
Complete Monocular Visual Loss



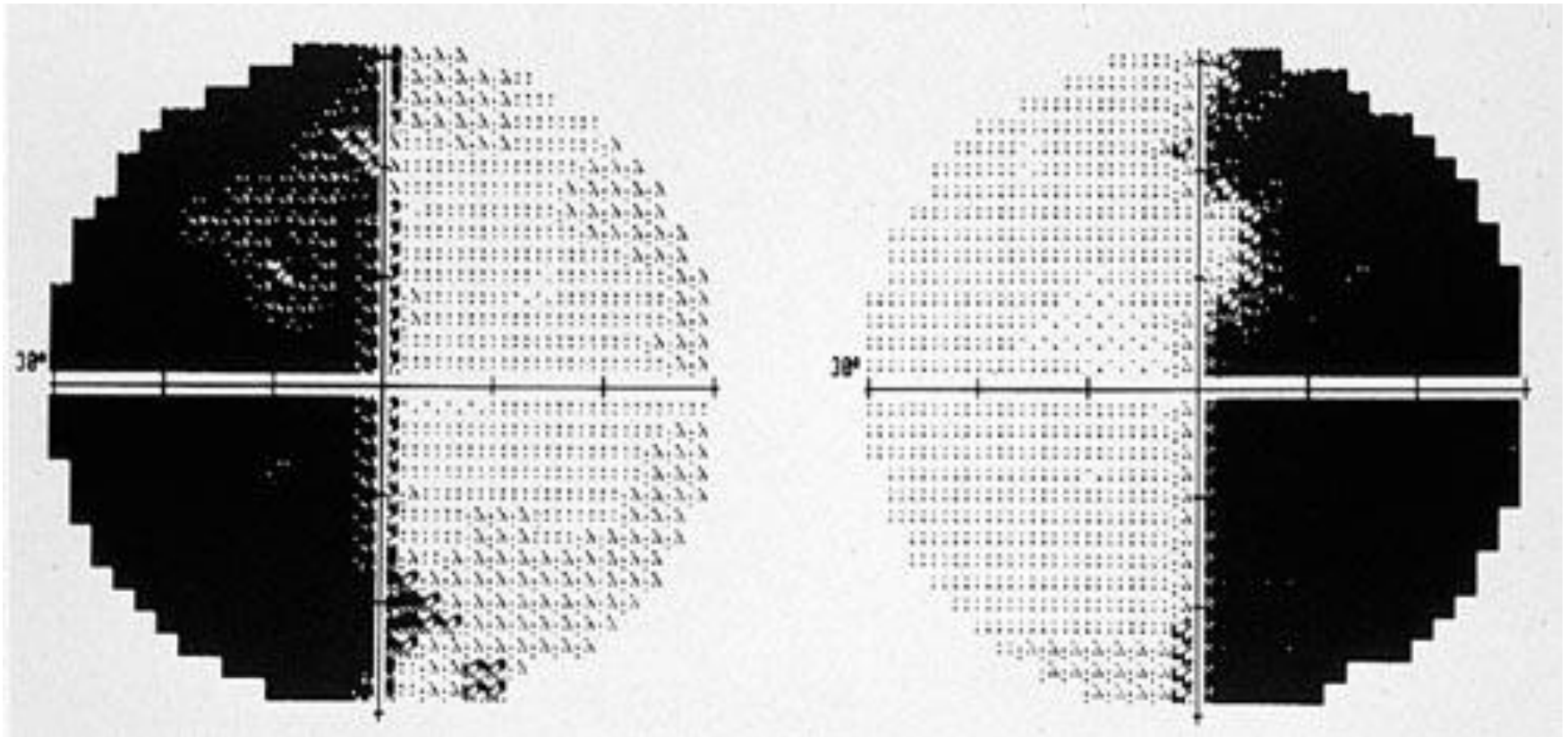
Pituitary Adenoma



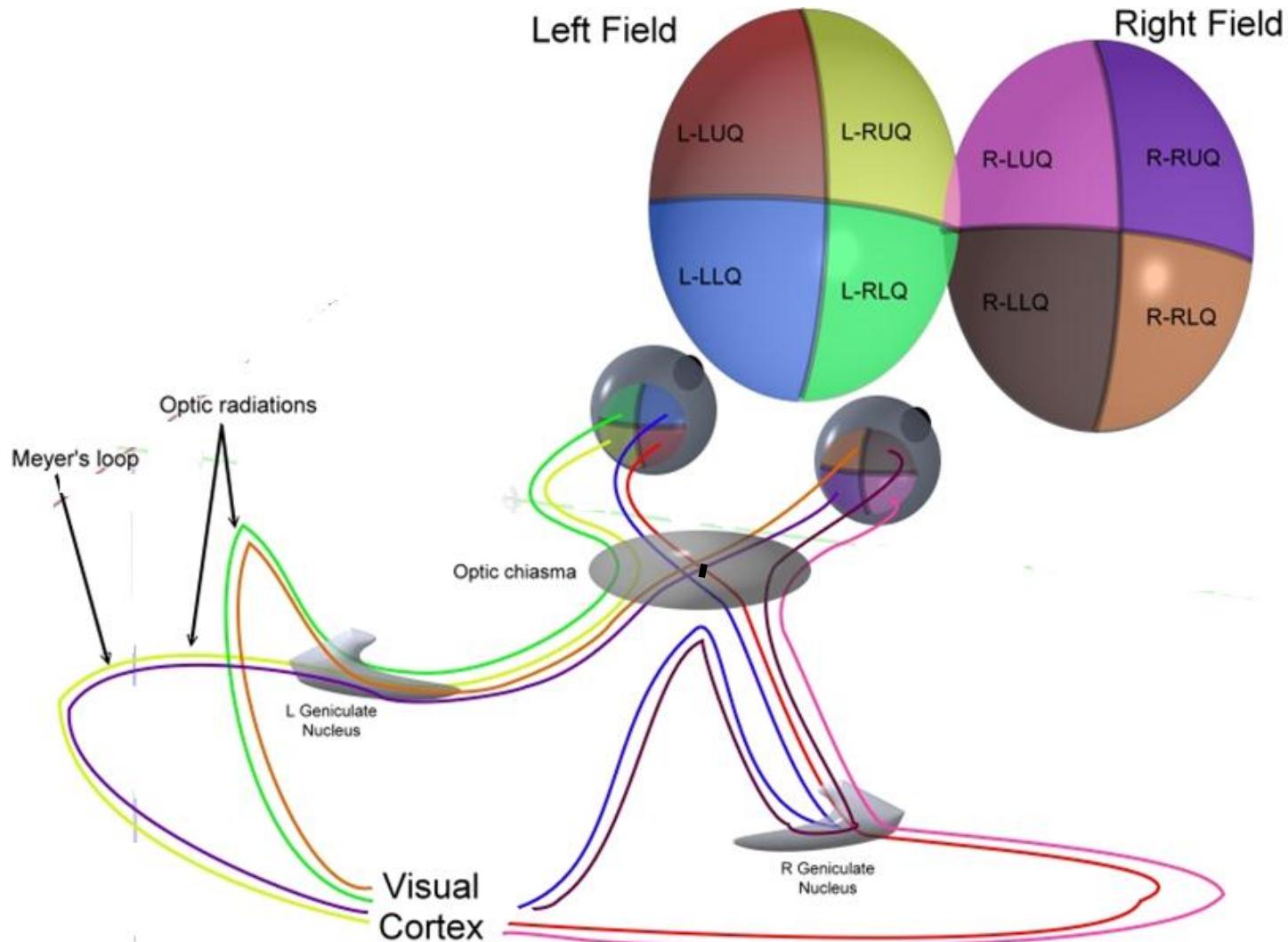
What is the visual field deficit?



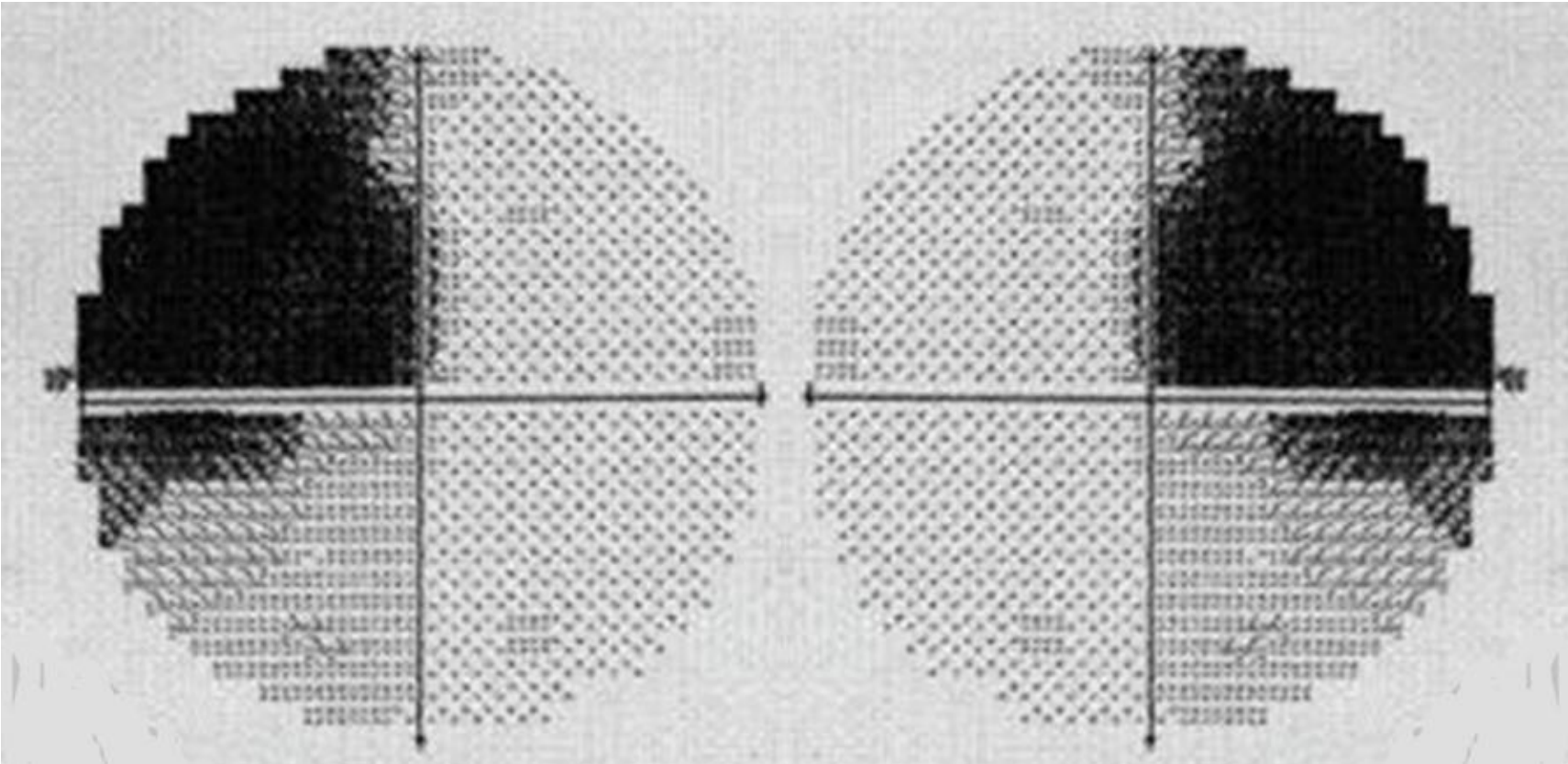
Bitemporal Hemianopia



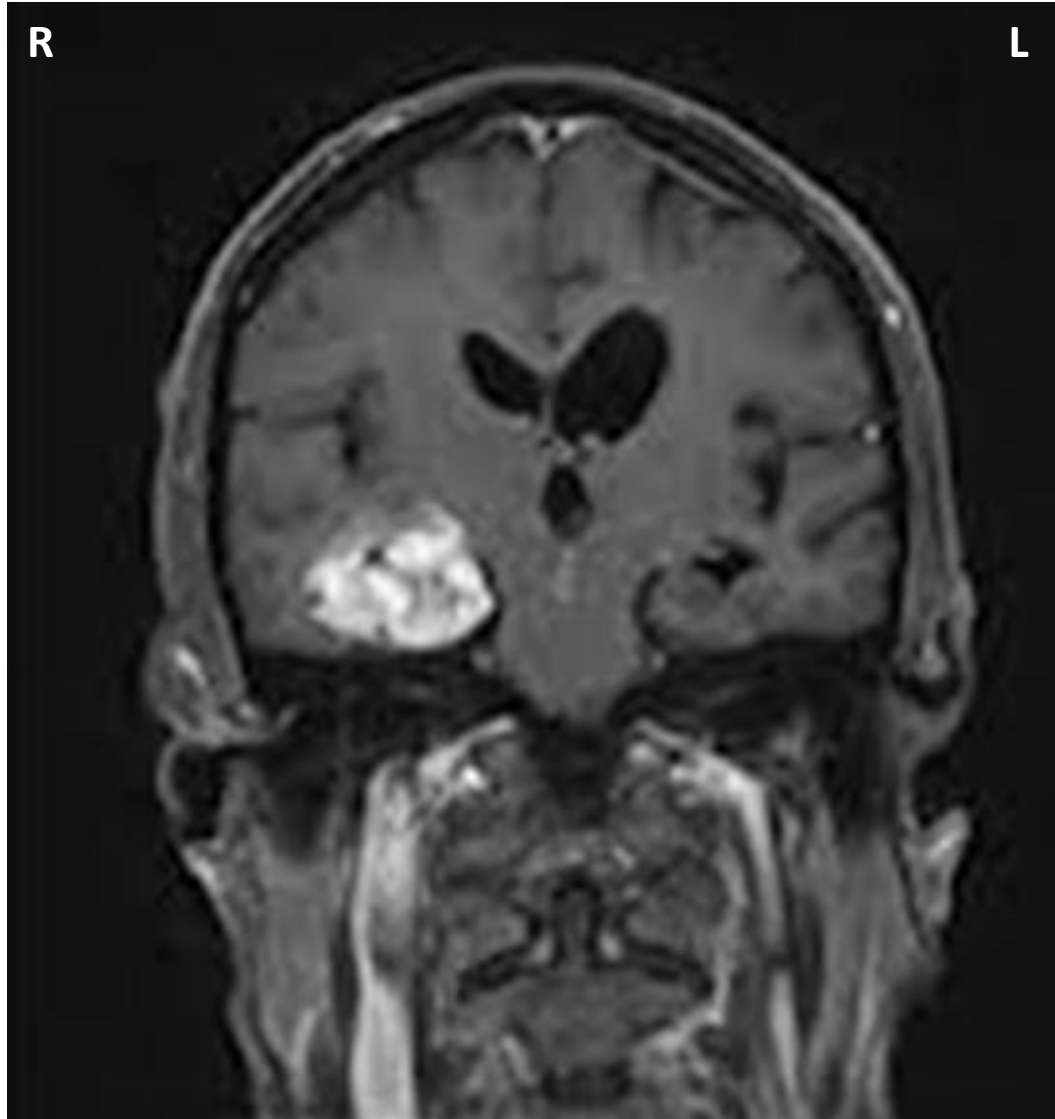
What visual field deficit may have been apparent in the early stages?



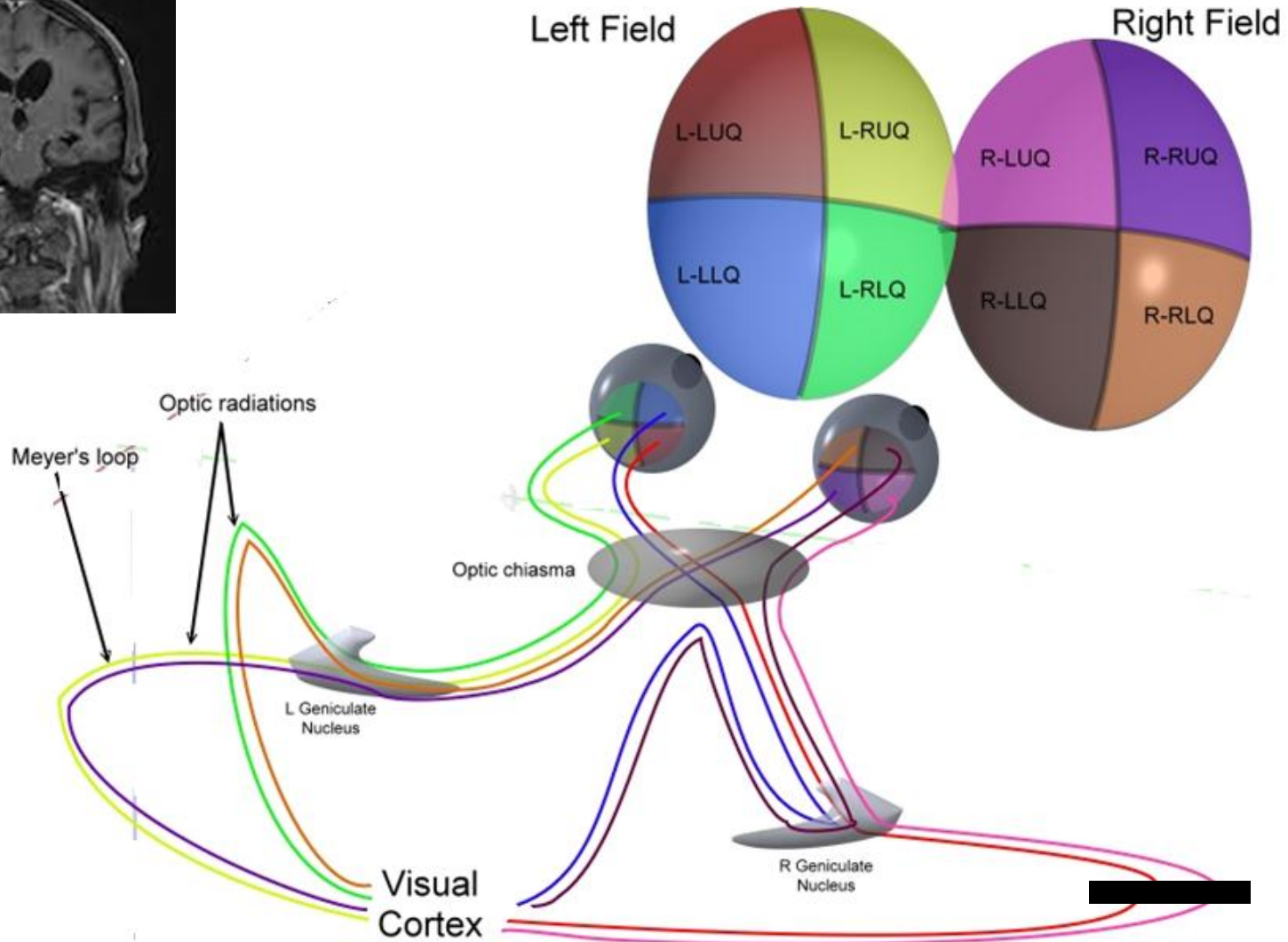
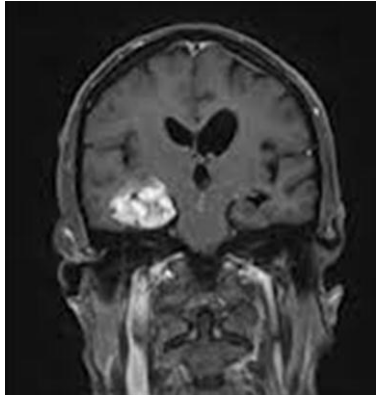
Bitemporal Superior Quadrantanopia



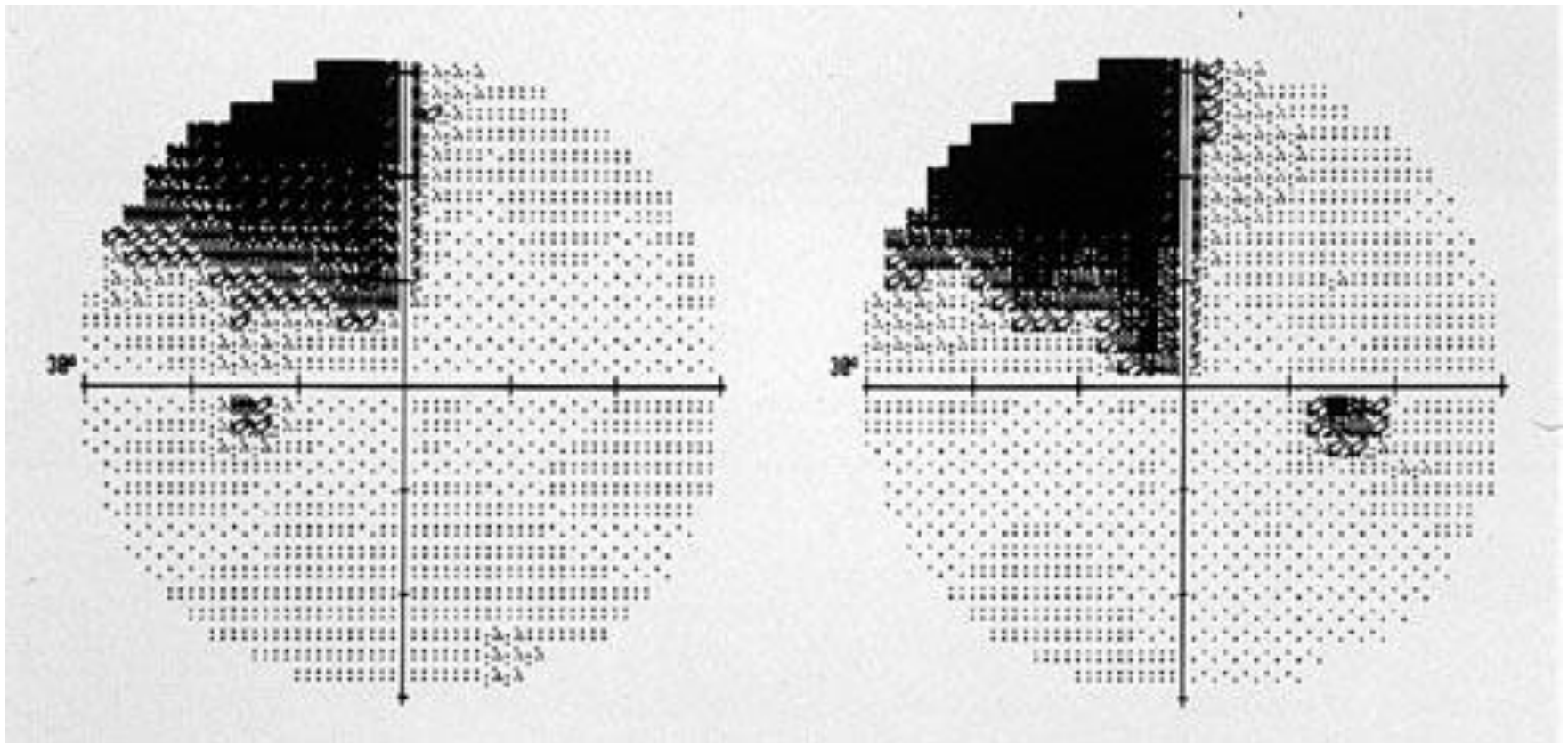
Right Temporal Glioma



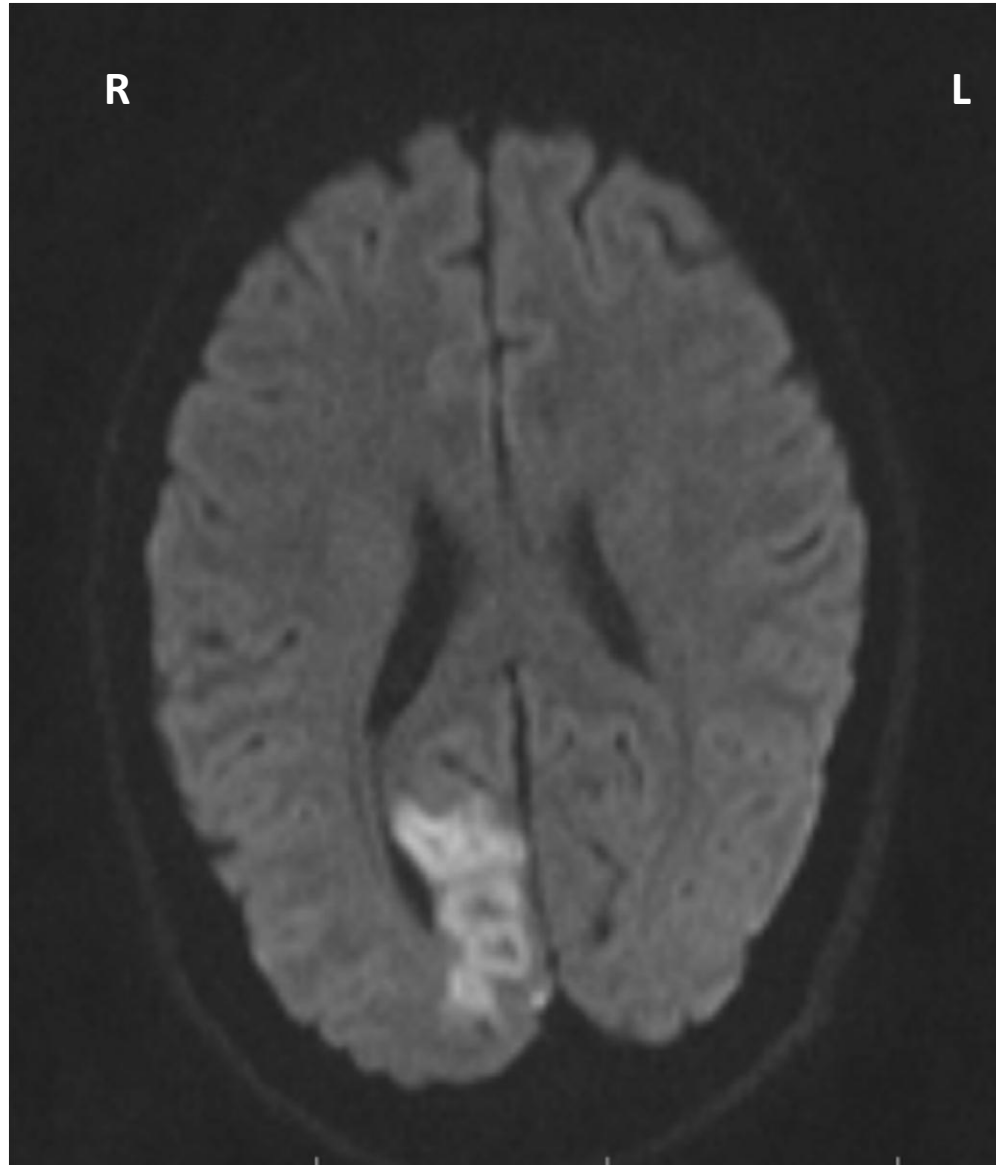
What is the visual field deficit?



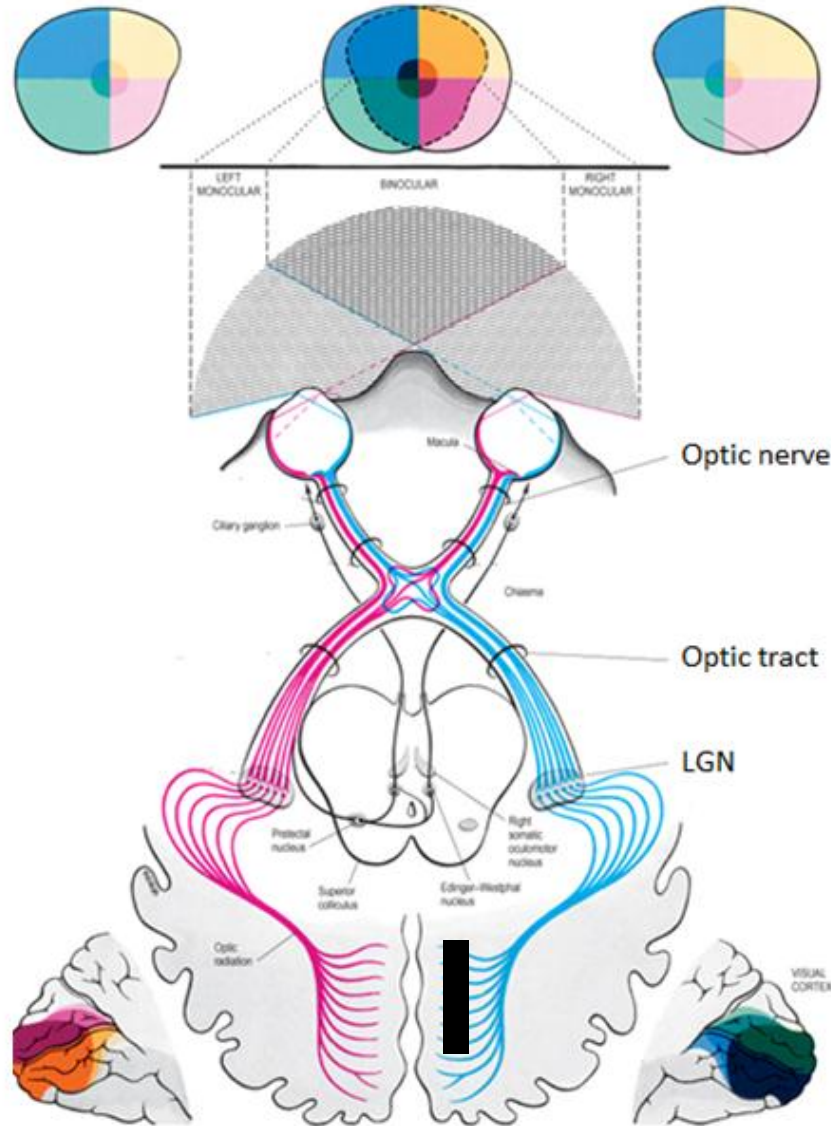
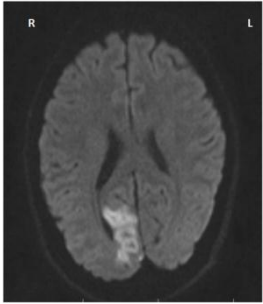
Left Homonymous Superior Quadrantanopia



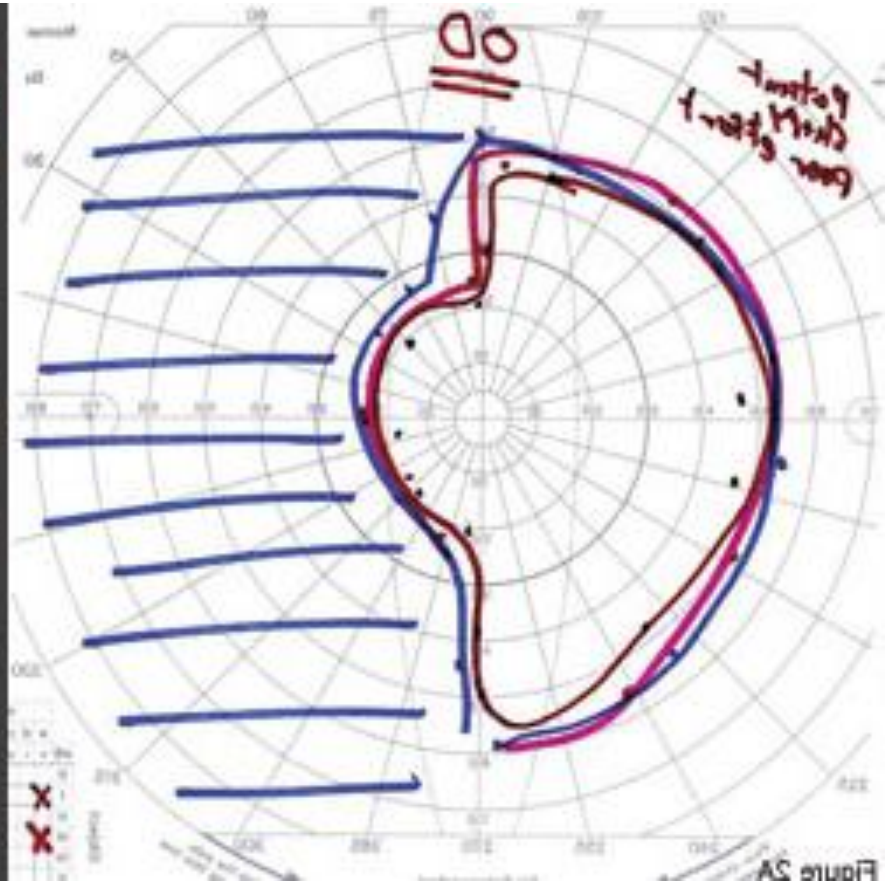
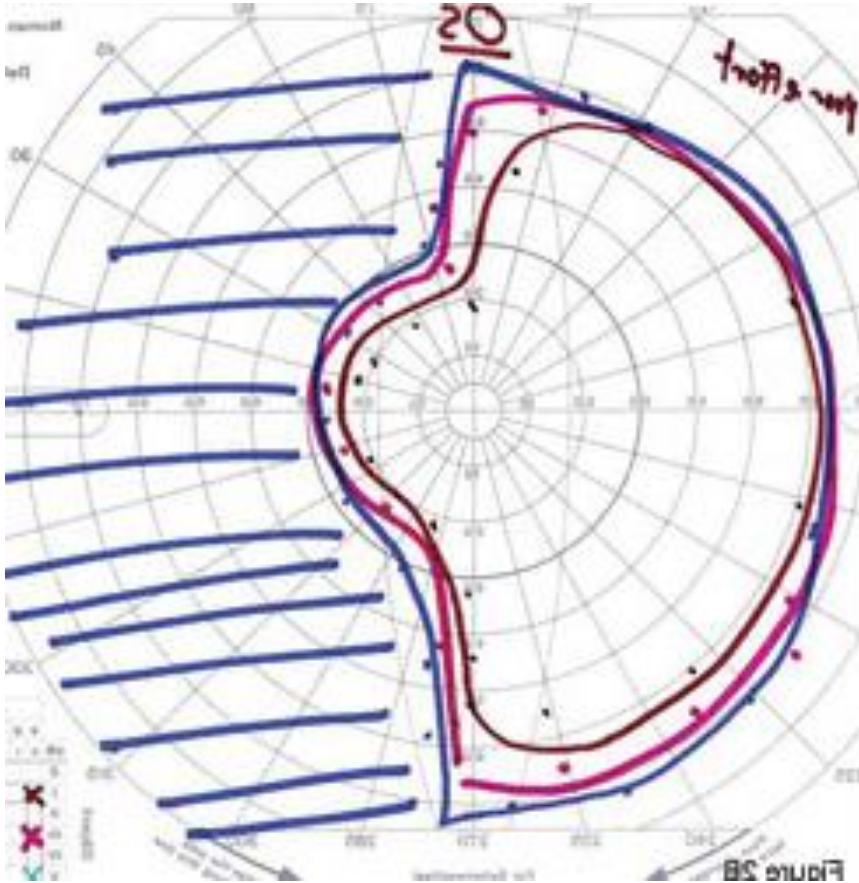
Right Occipital Infarct



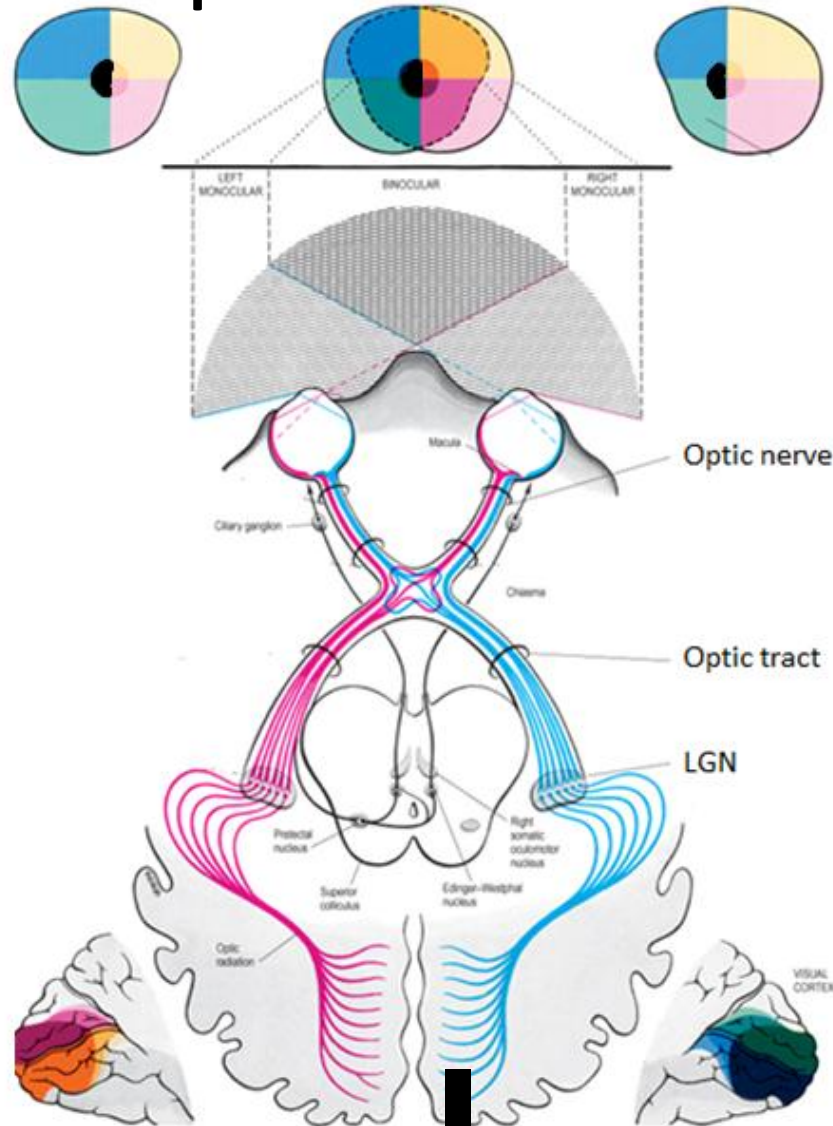
What is the visual field defect?



Left Homonymous Hemianopia with Macular Sparing



What visual field defect would you expect to find?

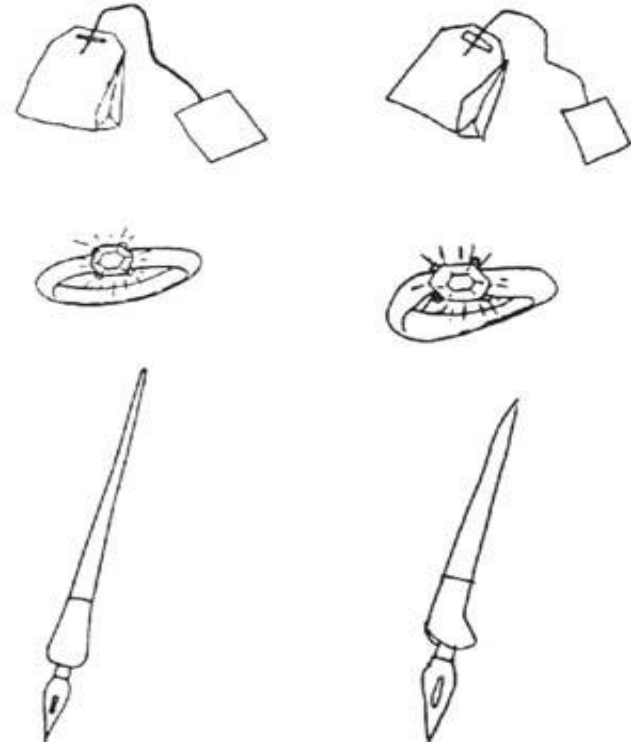


Visual Agnosia



Apperceptive

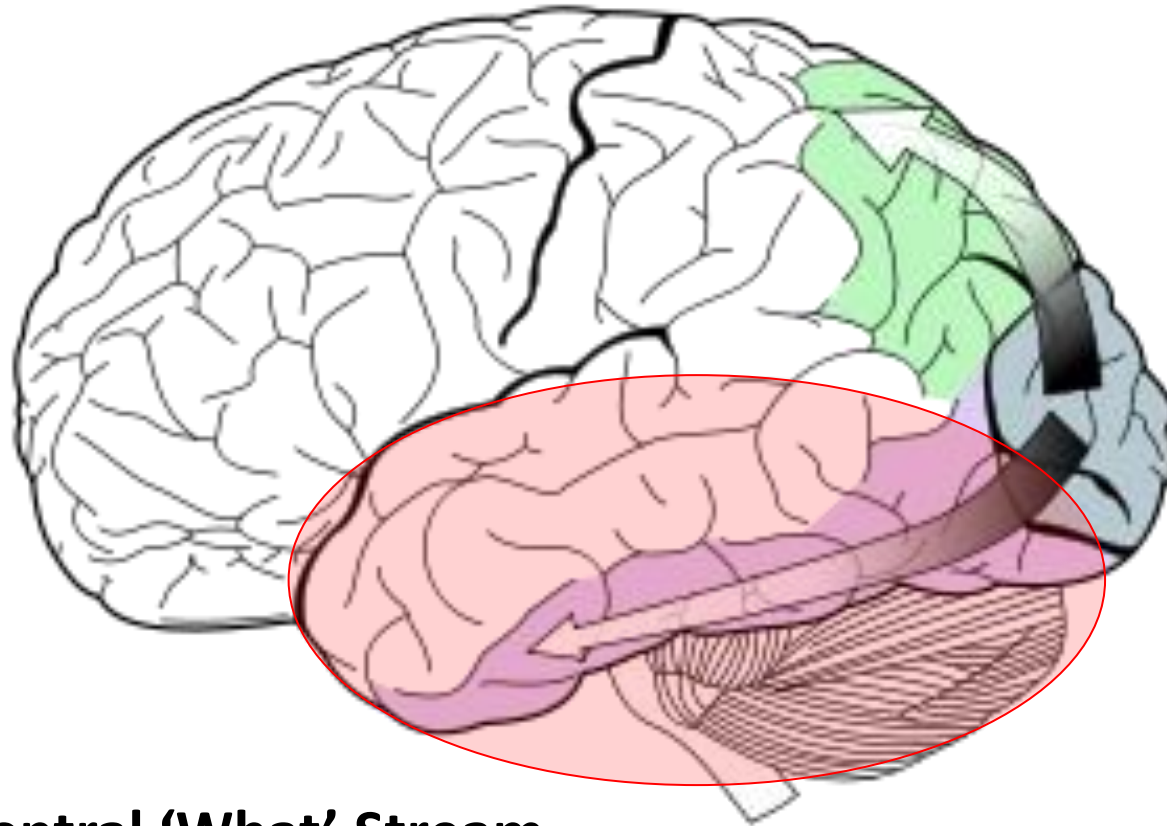
- Cannot recognise by shape
- Cannot copy drawings
- Often associated with prosopagnosia



Associative

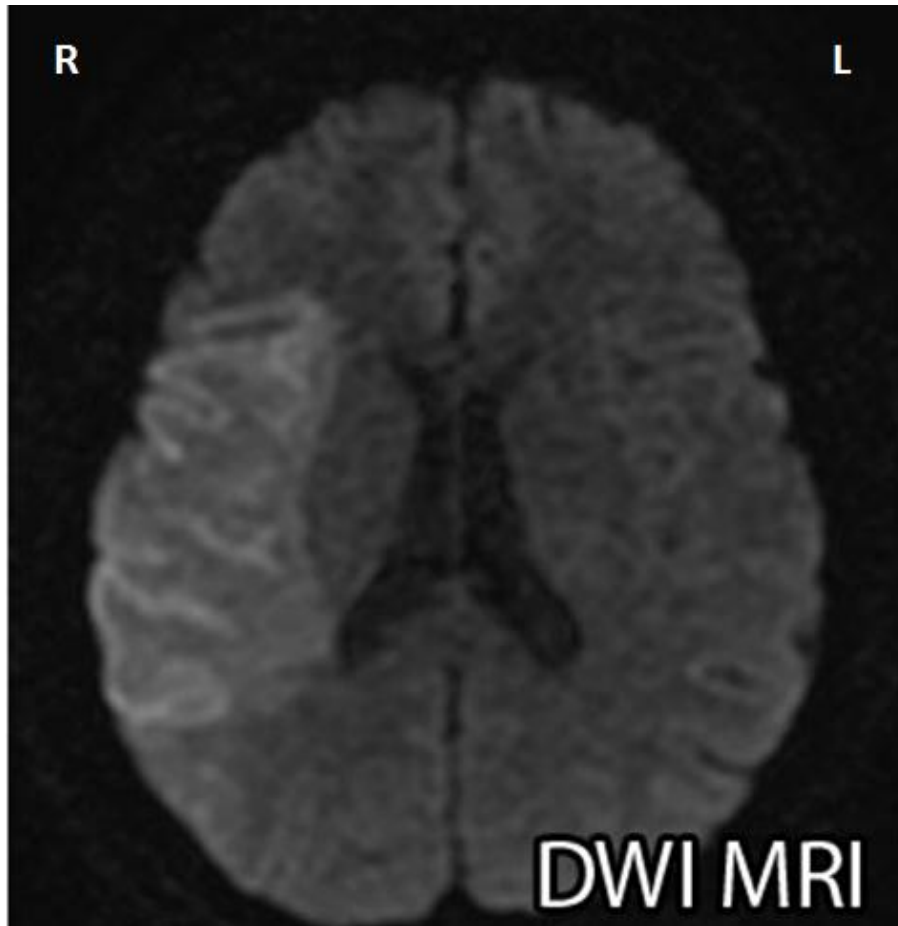
- Can copy but unable to identify objects

Which visual pathway is affected?



Ventral 'What' Stream

What deficits may this patient have?



Right Parietal Infarct

- Left homonymous inferior quadrantanopia
- Left-sided neglect

Left-sided Neglect

Copying:



Spontaneous drawing:



- Stimuli in the left visual field are not consciously perceived



METRO

Five jailed for helping 21/7 gang

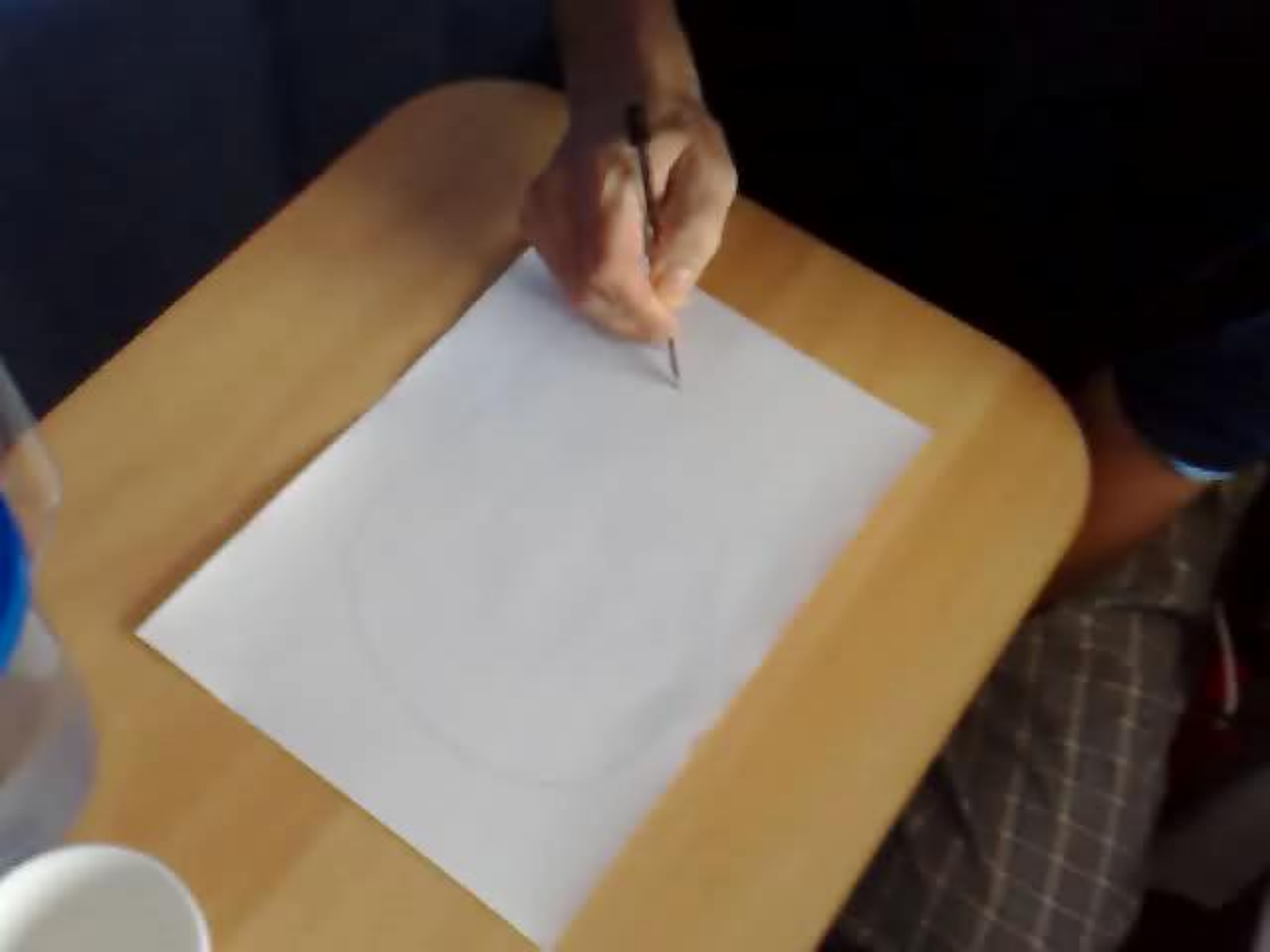


Search: The police searched part of the beach where the search hitlers took



Jeff Goldblum's eyes are everywhere
15-year special inquiry that will be the





<http://www.guardian.co.uk/science/video/2012/dec/23/stroke-half-world-disappear-video>