

Visual Pathway Disorders

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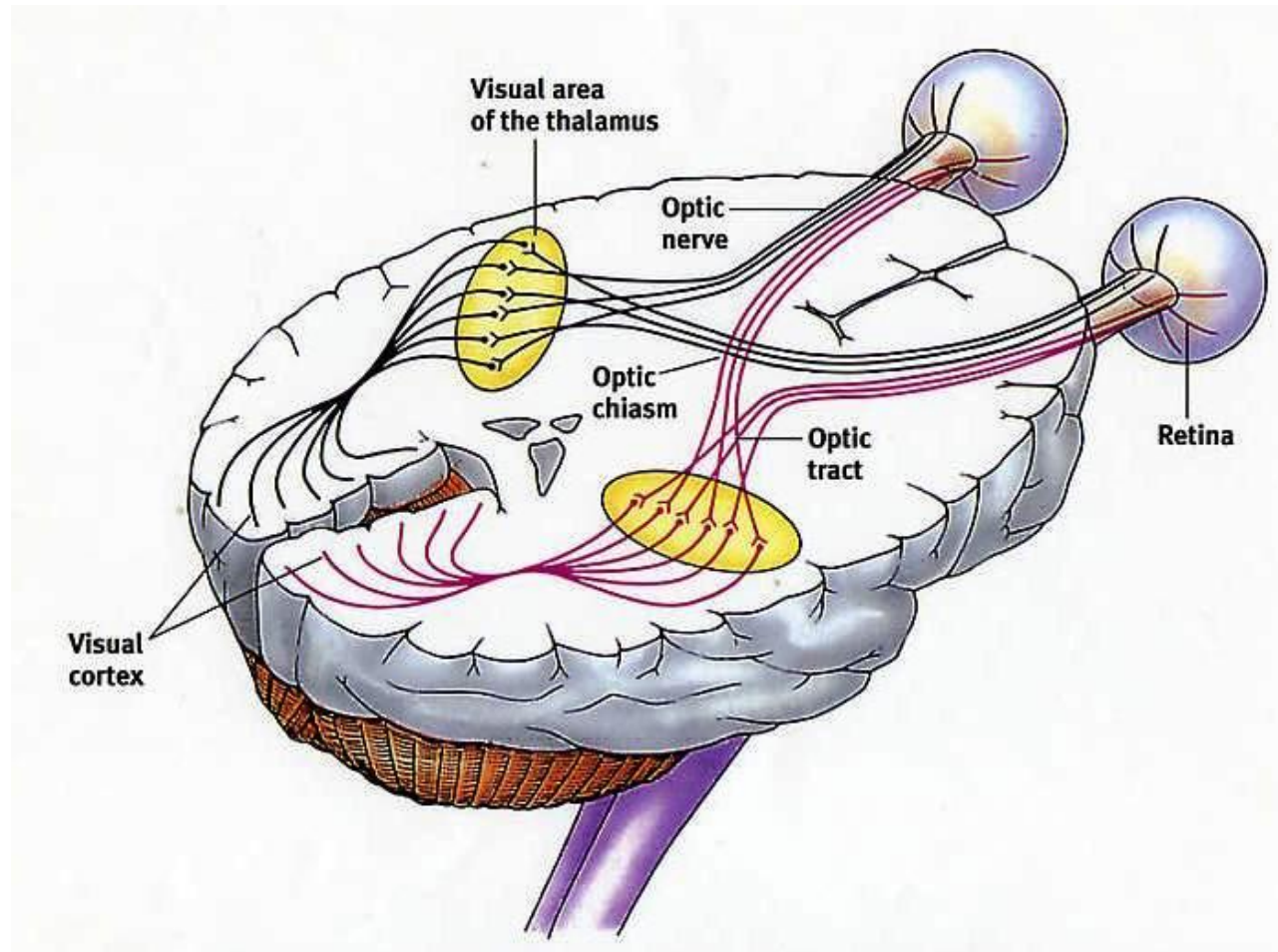
Optic nerve

- **Anatomy of visual pathway**
- **How to examine**
- **Visual pathway disorders**
- **Quiz**

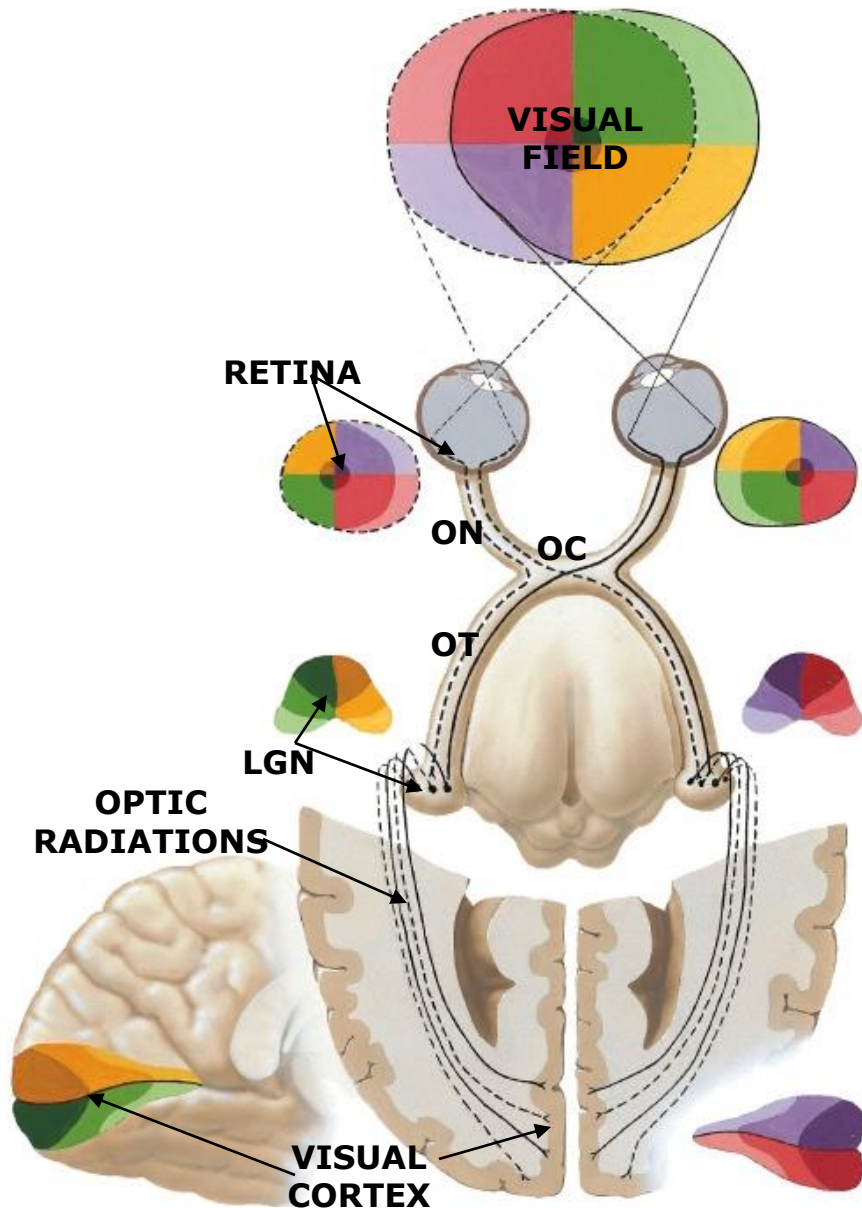
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Optic nerve



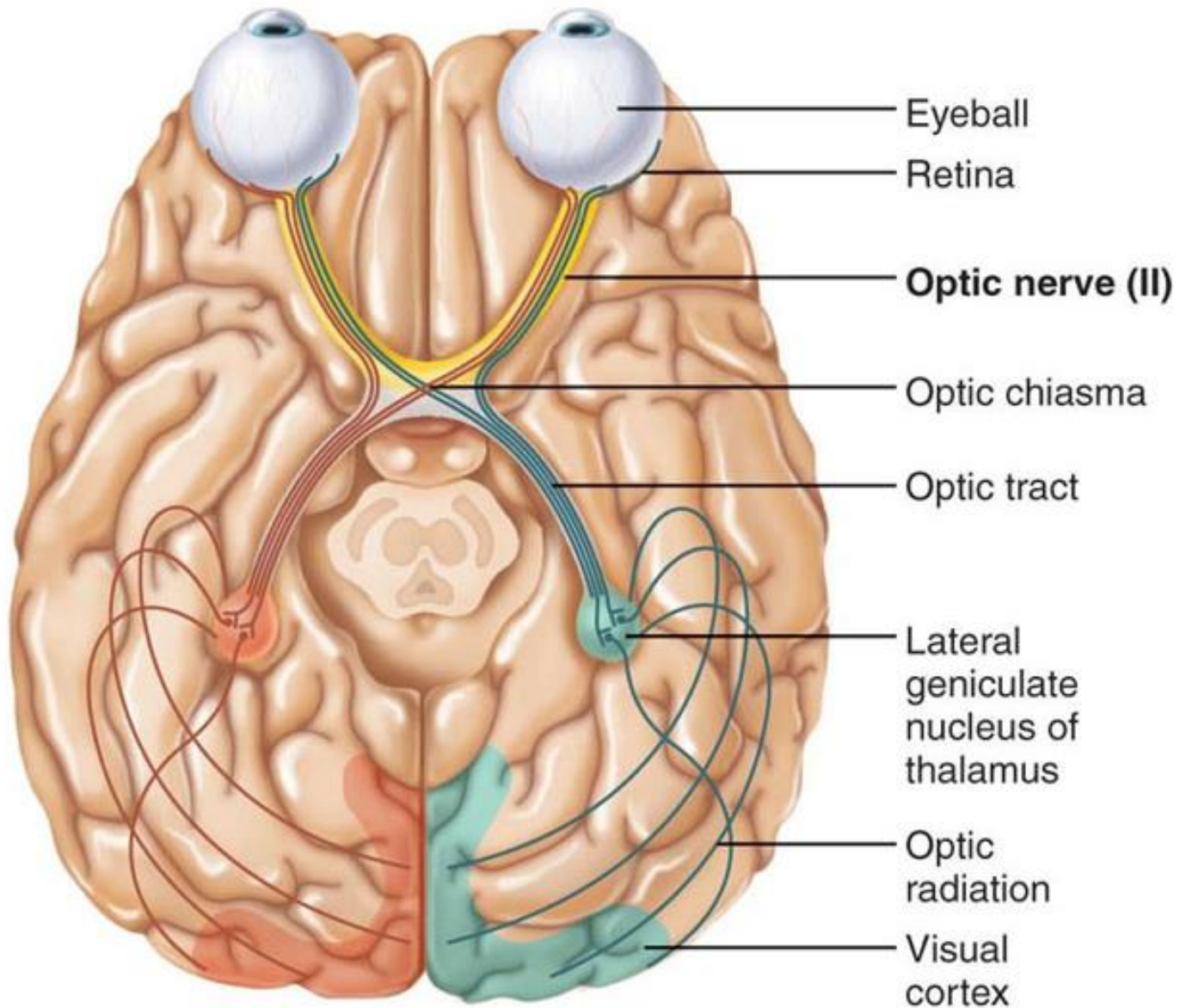
The Visual Pathway



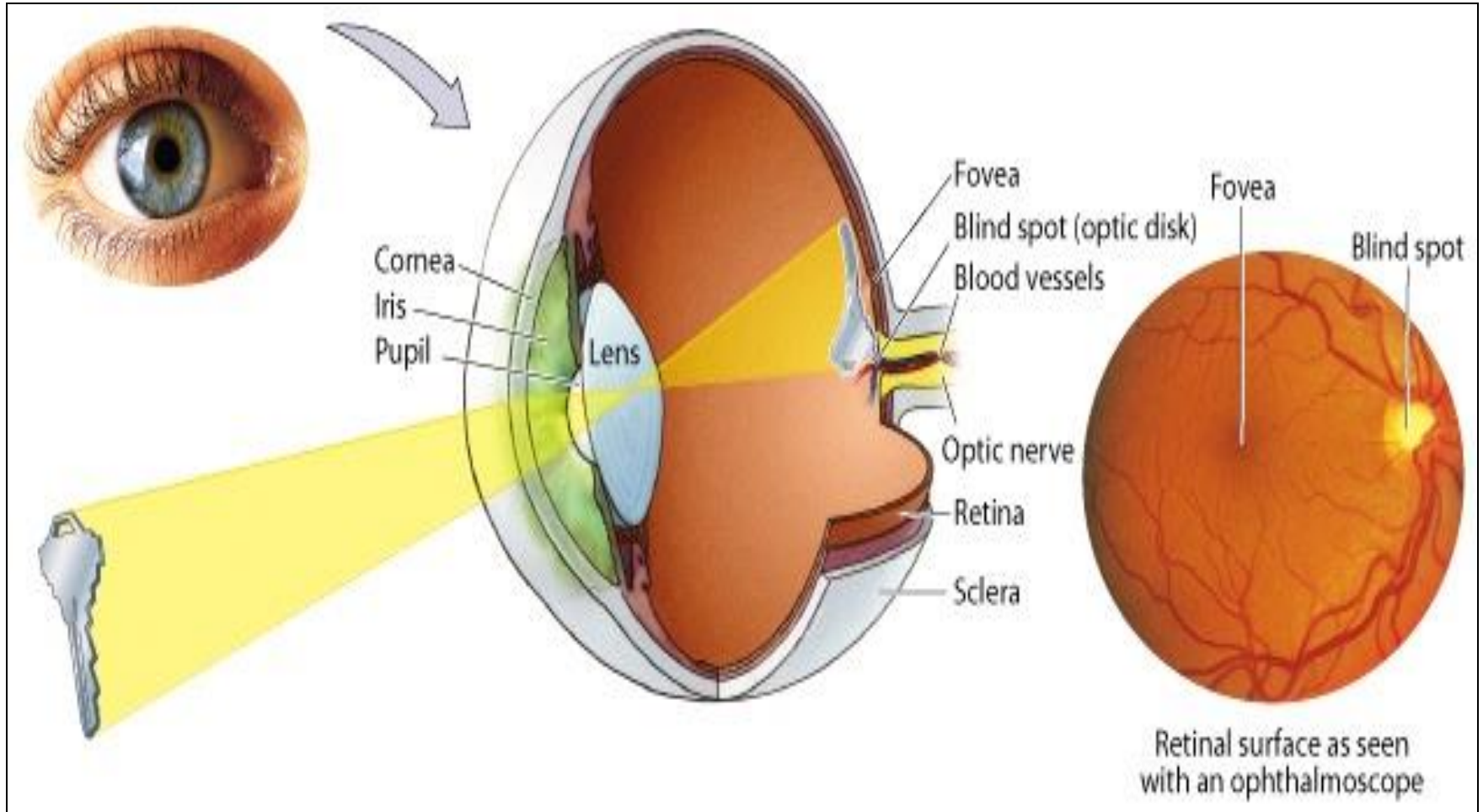
Pathway extends from the 'front' to the 'back' of the brain.

ON = Optic Nerve
OC = Optic Chiasm
OT = Optic Tract
LGN = Lateral Geniculate Nucleus of Thalamus

The Visual Pathway

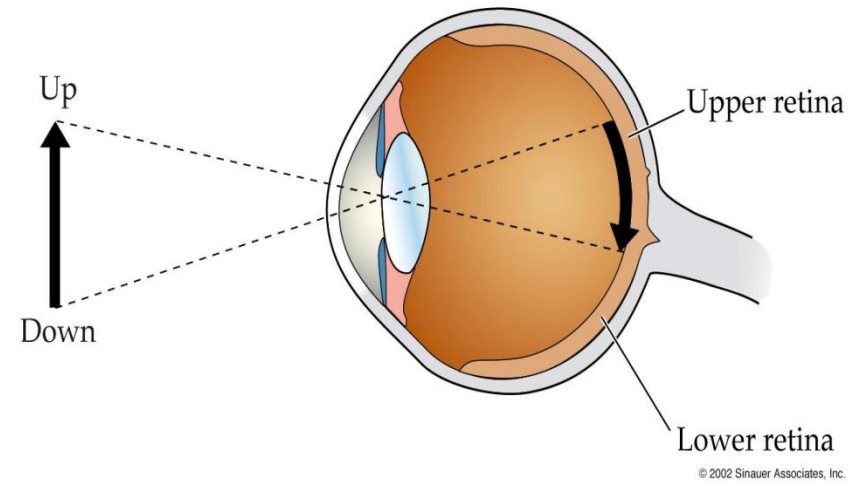
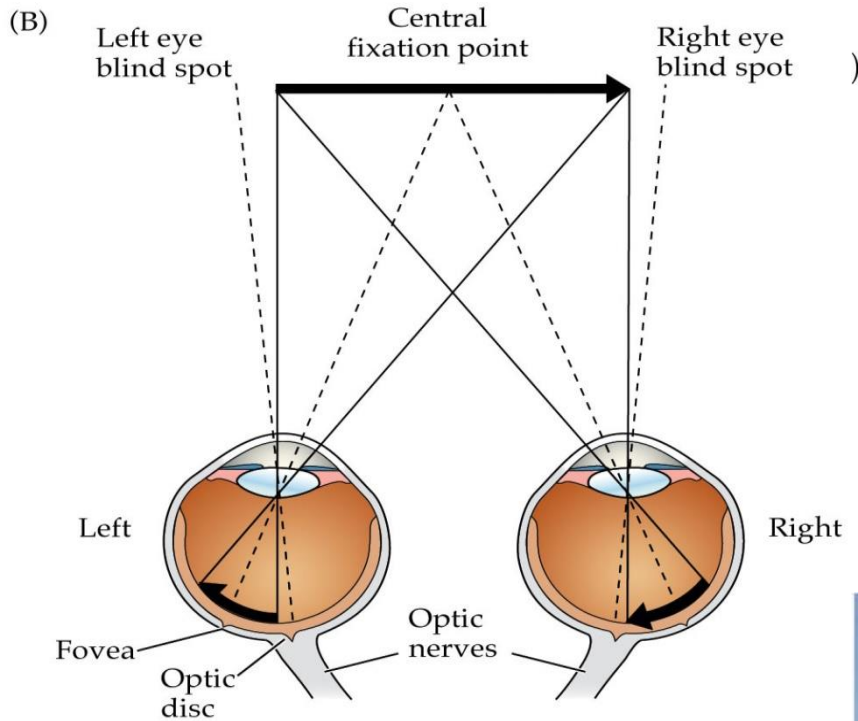


Eyes & Retina

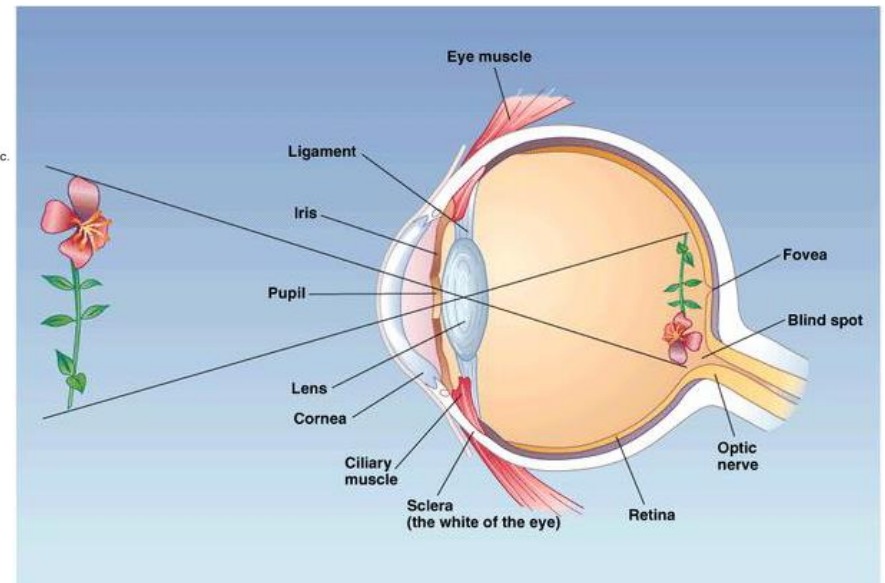
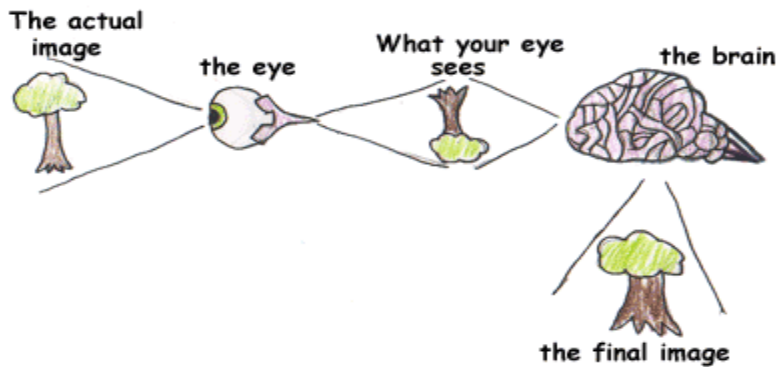


Light >> lens >> retina (inverted and reversed image).

Eyes & Retina



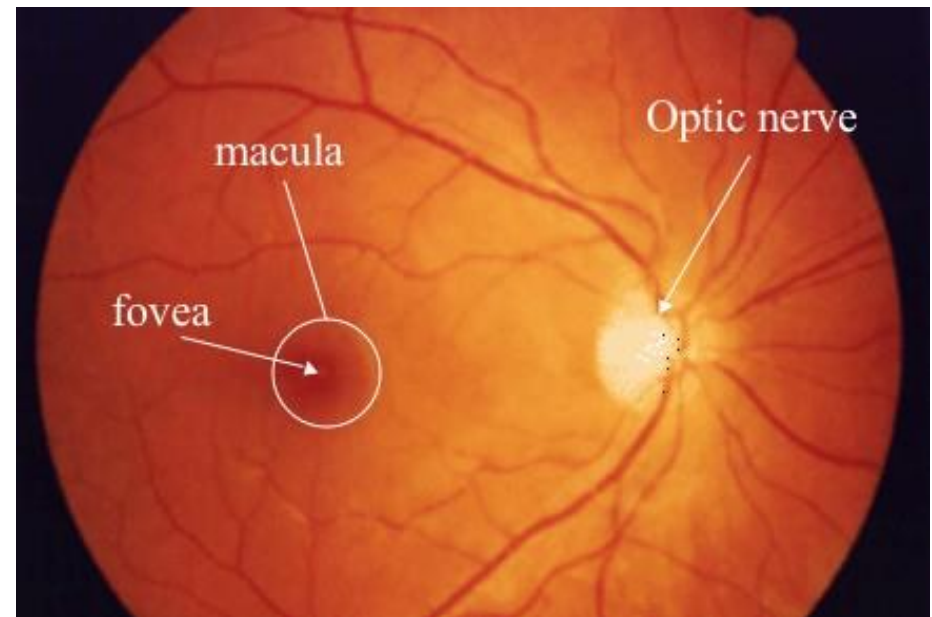
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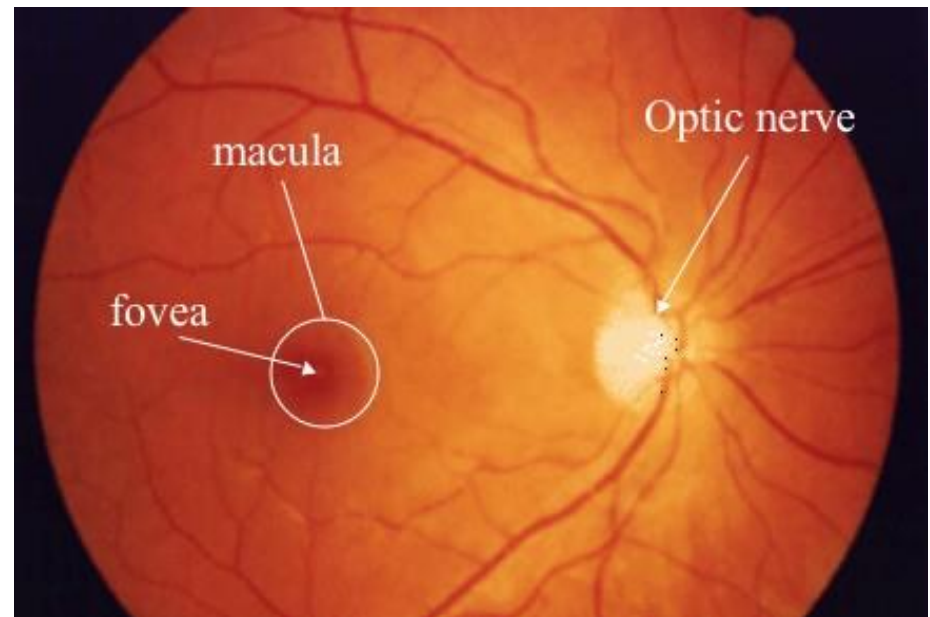
Eyes & Retina

- **Macula**: oval region approximately 3-5 mm that surrounds the fovea, also has high visual acuity.
- **Fovea**: central fixation point of each eye// region of the retina with highest visual acuity.



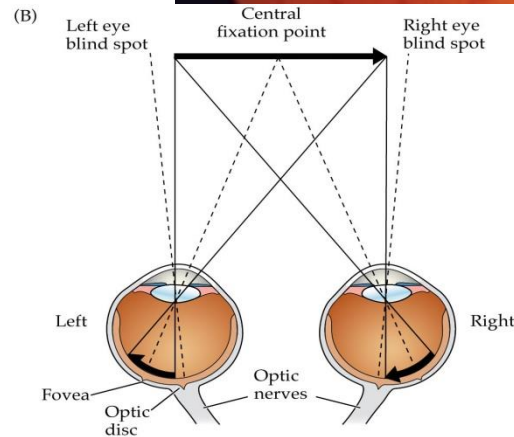
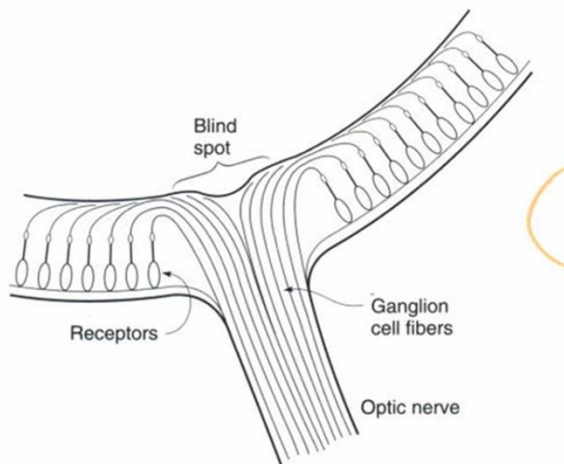
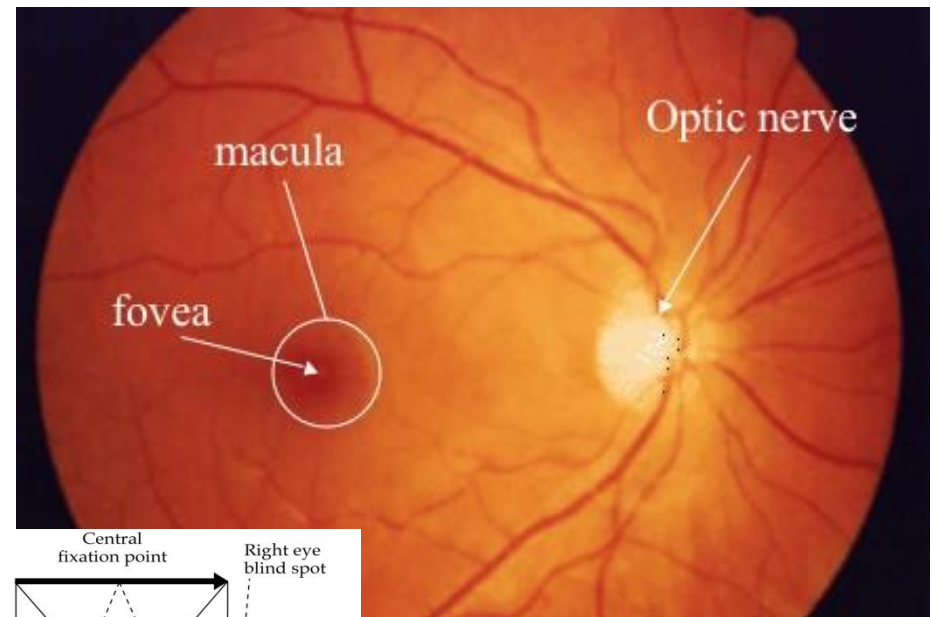
Eyes & Retina

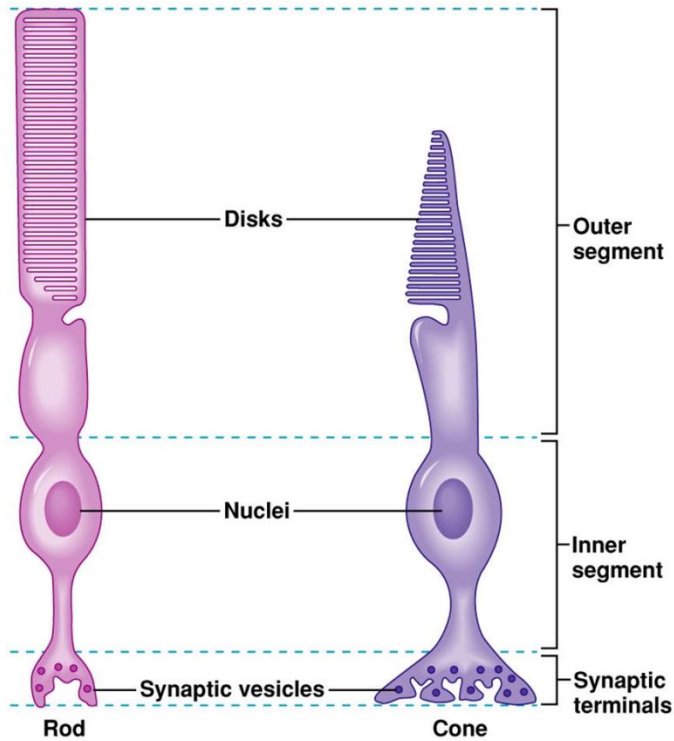
- **Optic disc:** region where axons leaving the retina gather to form the **Optic nerve.**



Eyes & Retina

- **Blind spot** located 15° lateral and inferior to central fixation point of each eye.

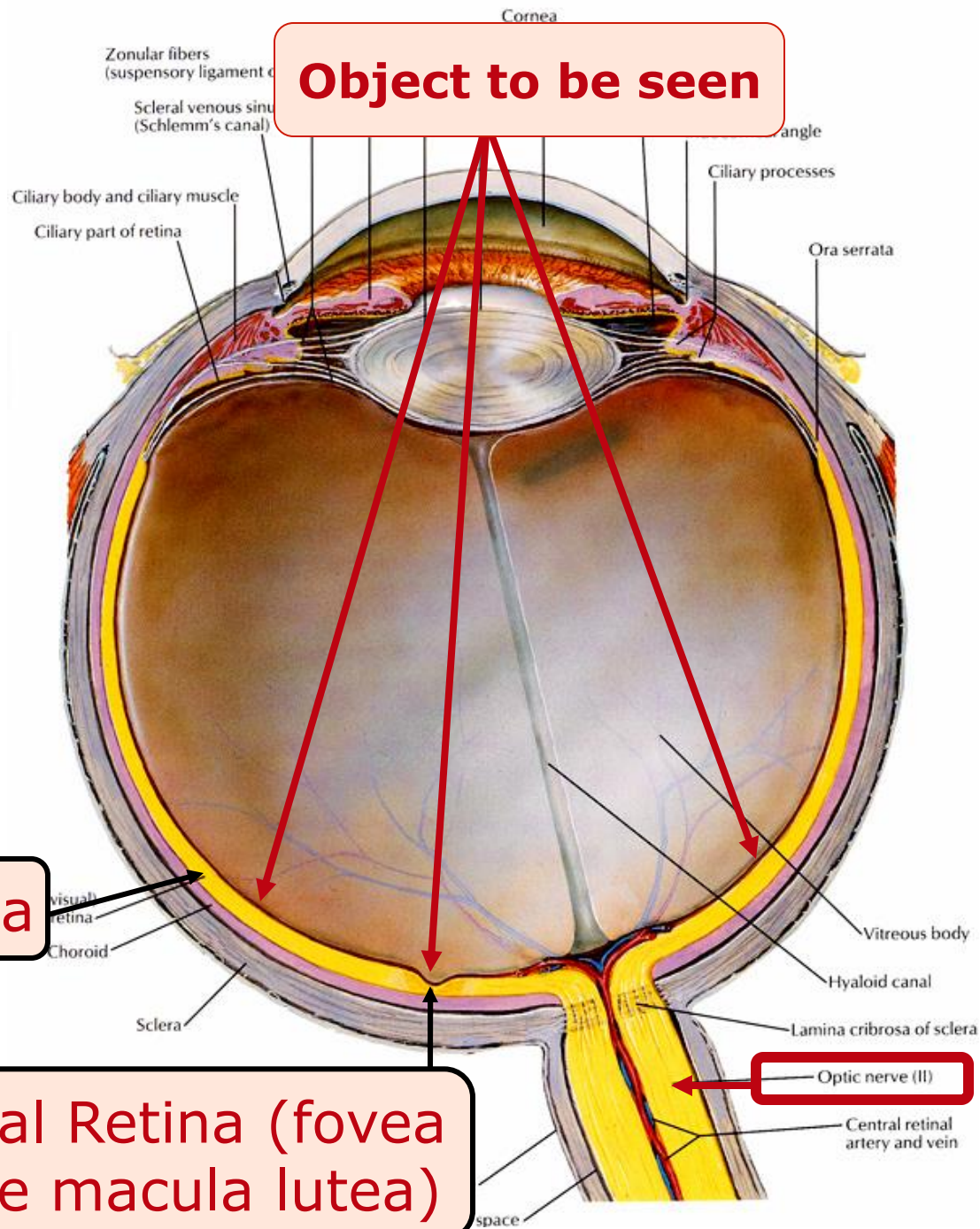




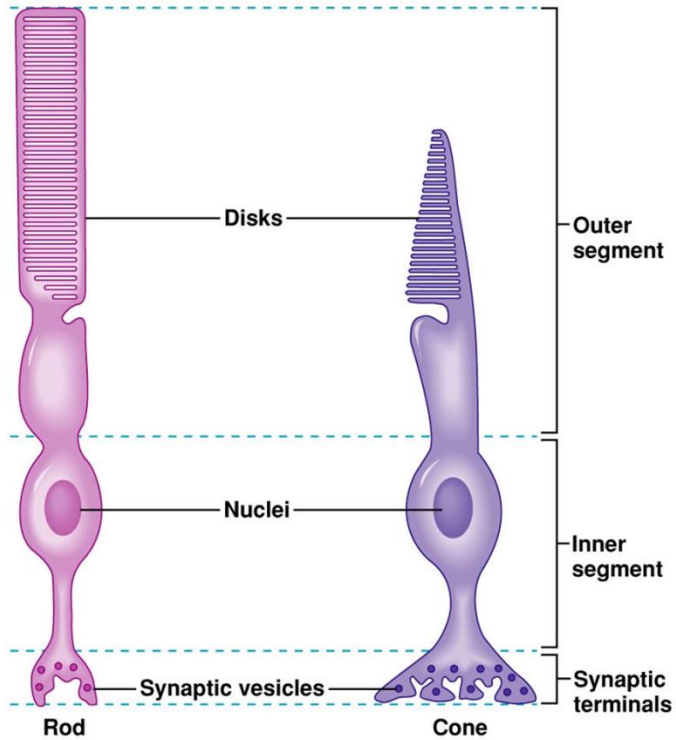
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Peripheral Retina

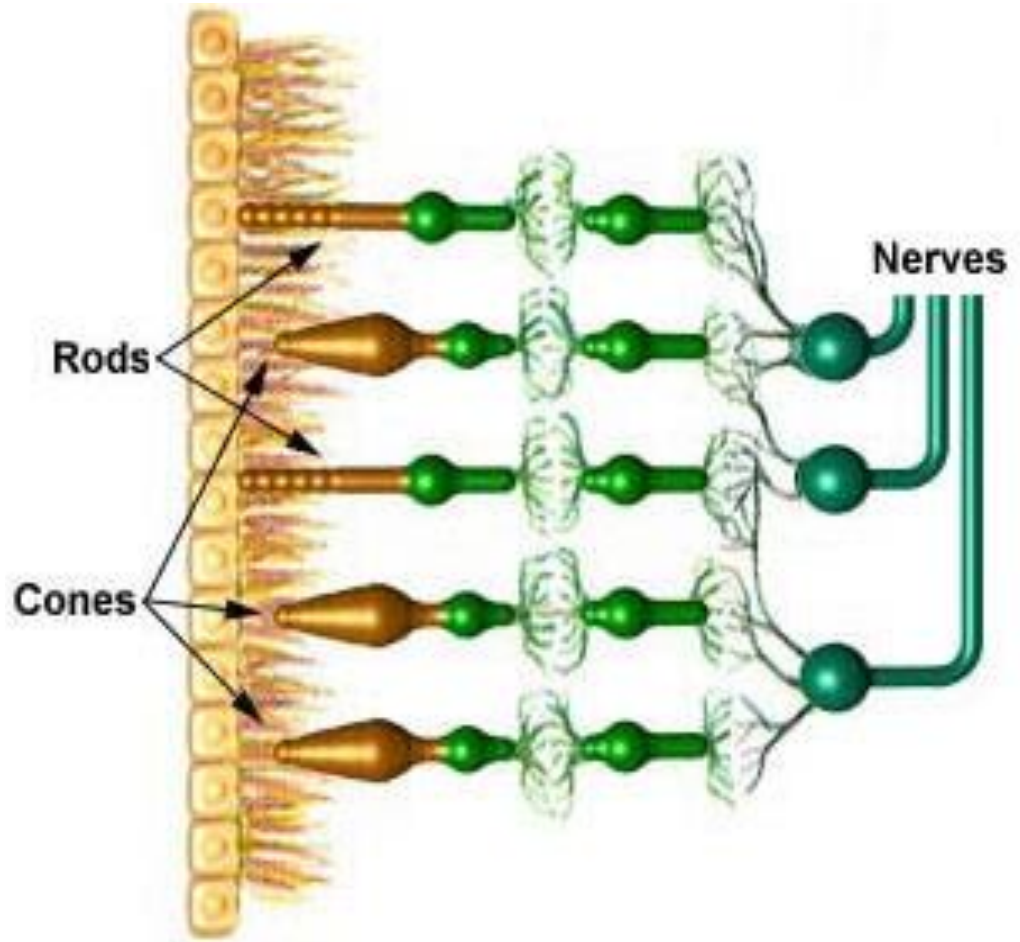
Central Retina (fovea in the macula lutea)



Photoreceptors



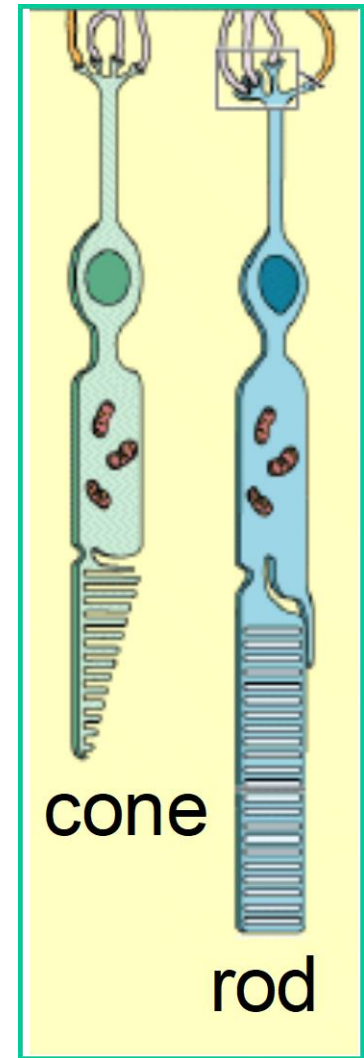
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Photoreceptors

Cones

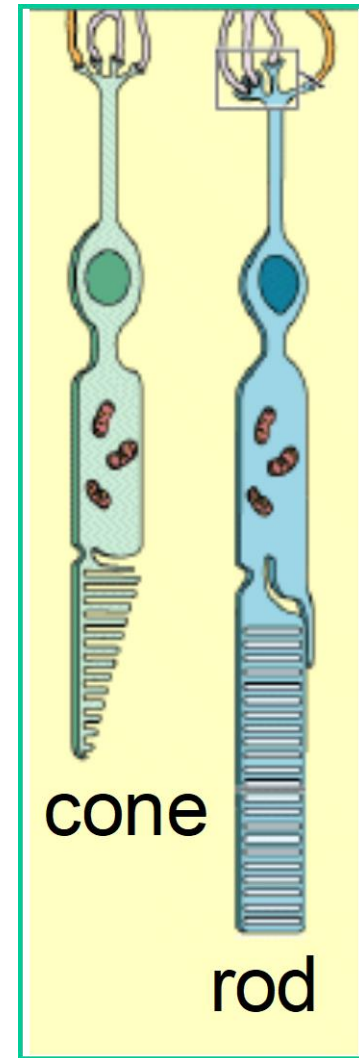
- Cone-shaped
- Less sensitive
- Operate in high light
- Color vision
- Less numerous
- Highly represented in the fovea >> have high spatial & temporal resolution >> they detect colors.



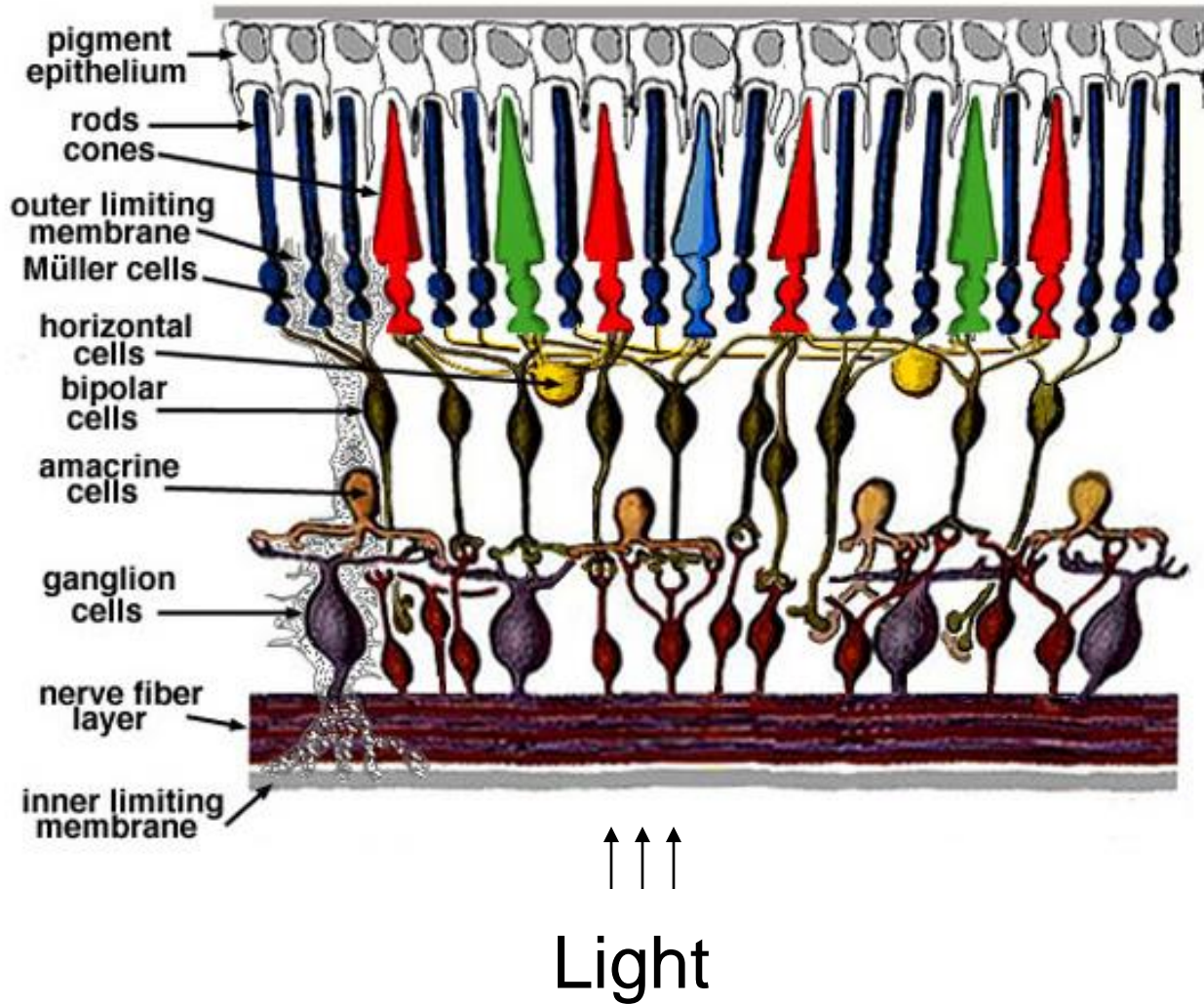
Photoreceptors

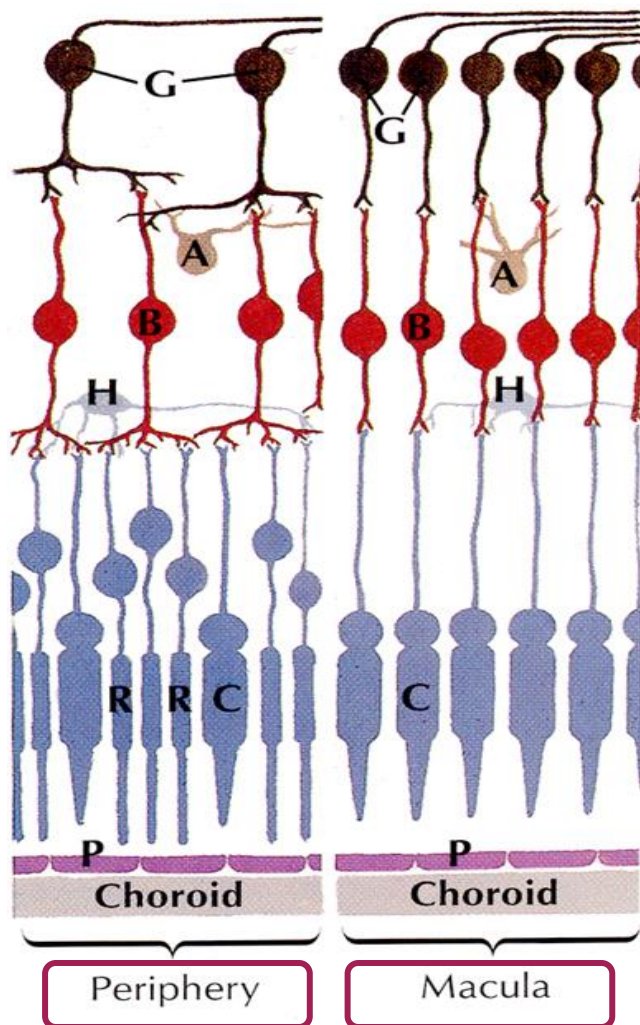
Rods

- Rod-shaped
- Highly sensitive
- Operate at night
- Gray-scale vision
- More numerous than cones - 20:1, have poor spatial & temporal resolution of visual stimuli, do not detect colors
>> vision in low level lighting conditions



Retina up-close



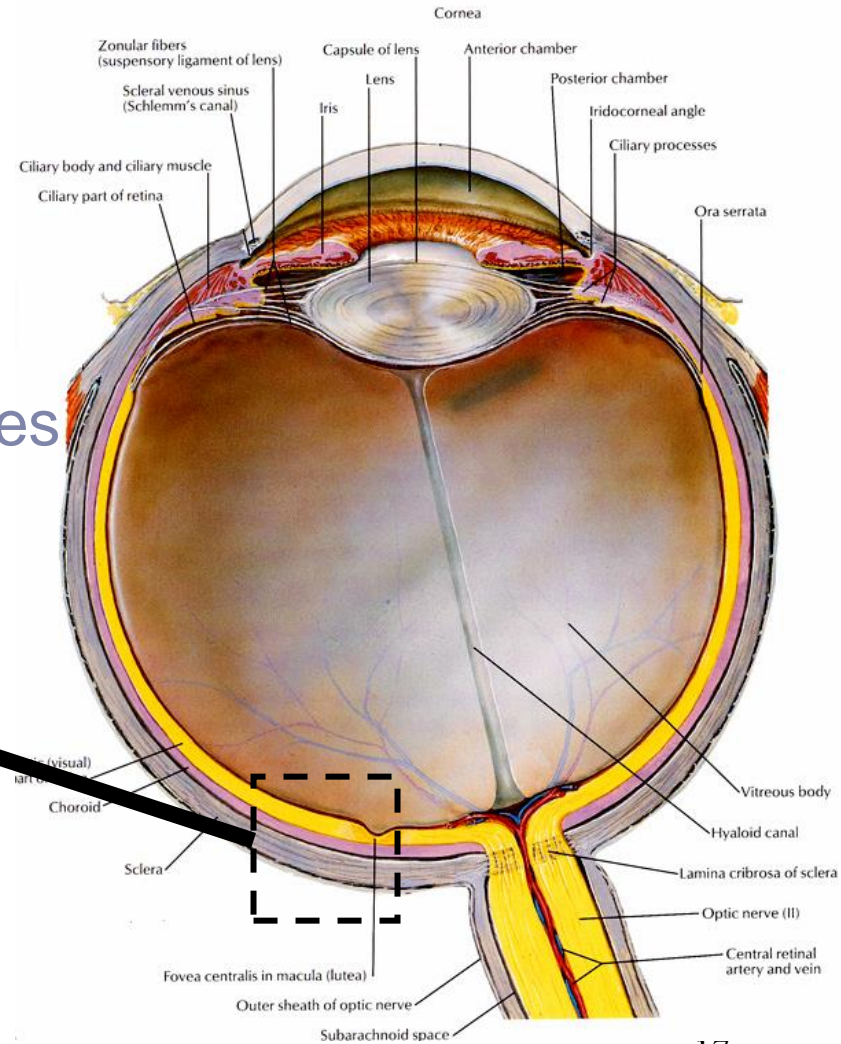


Ganglion cells

axons form the optic nerve

Bipolar cells

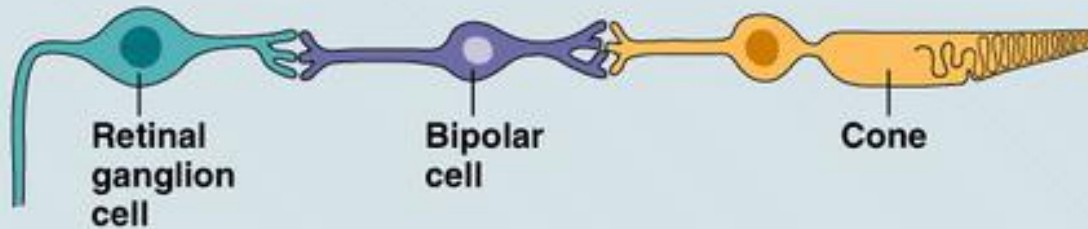
Rods and Cones
(Receptors)



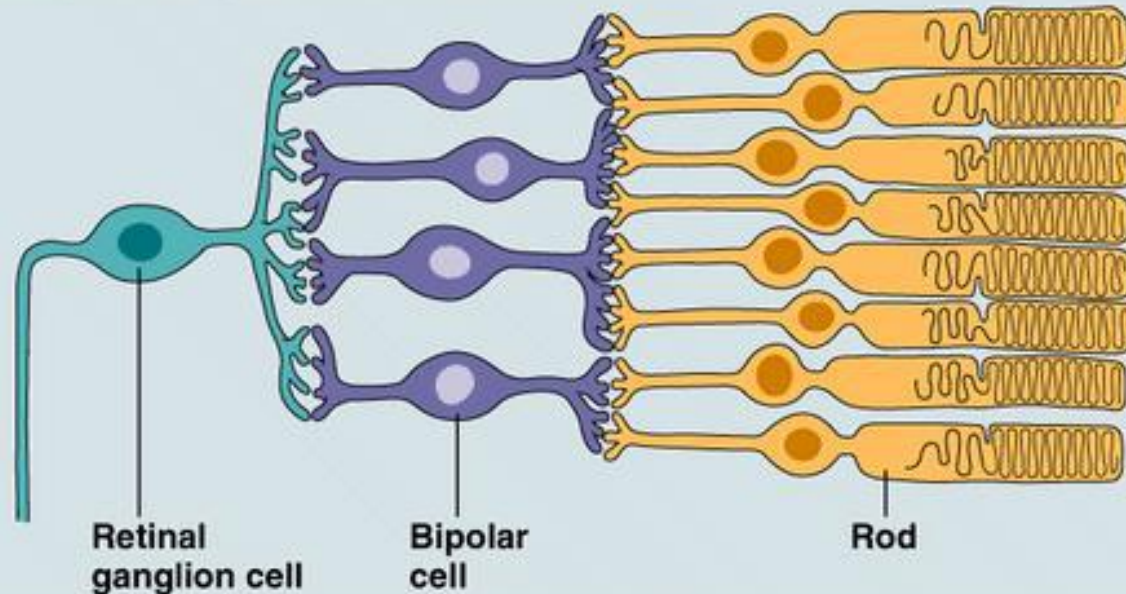
Photoreceptors

► Convergence of Cones and Rods

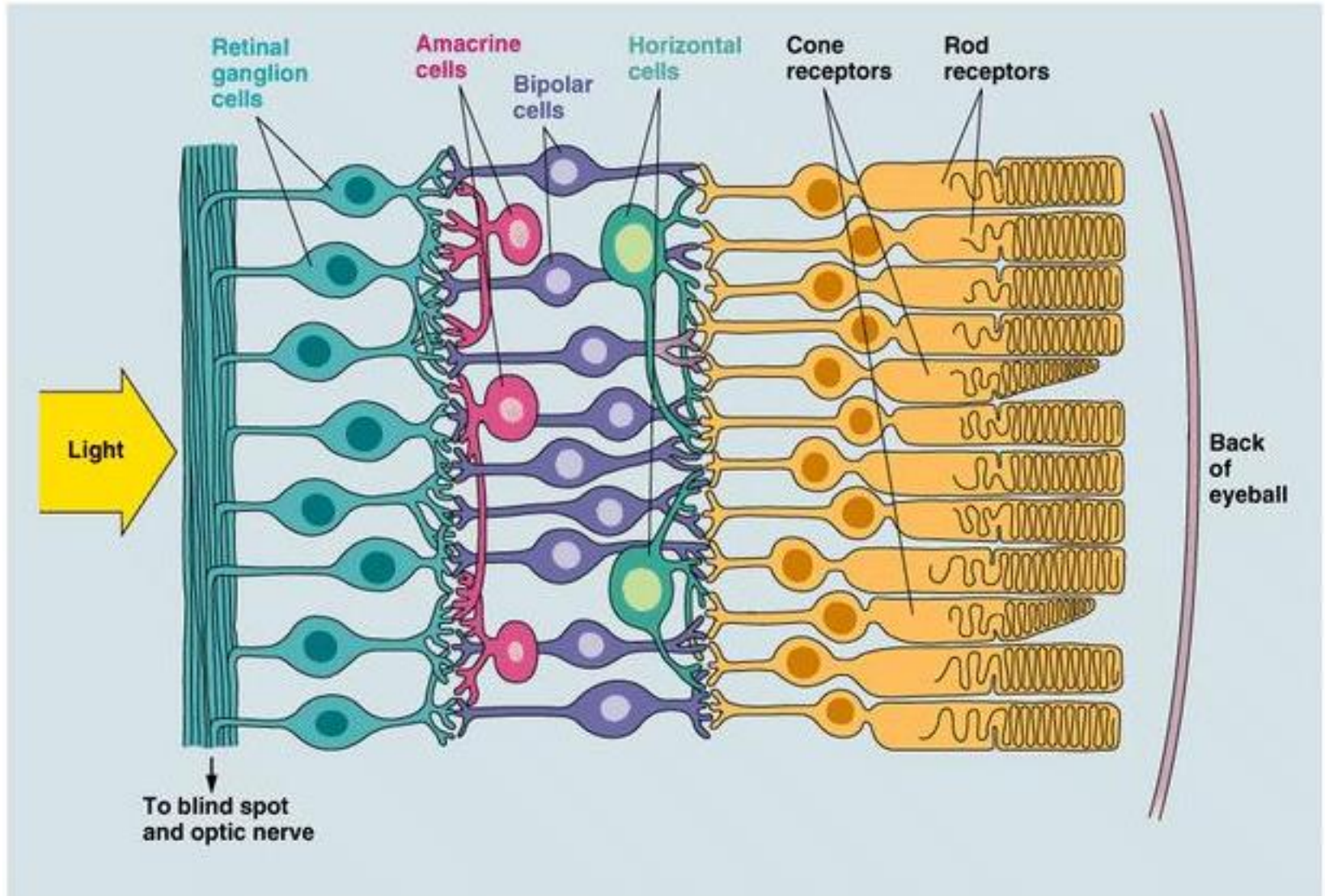
Low Convergence in Cone-Fed Circuits



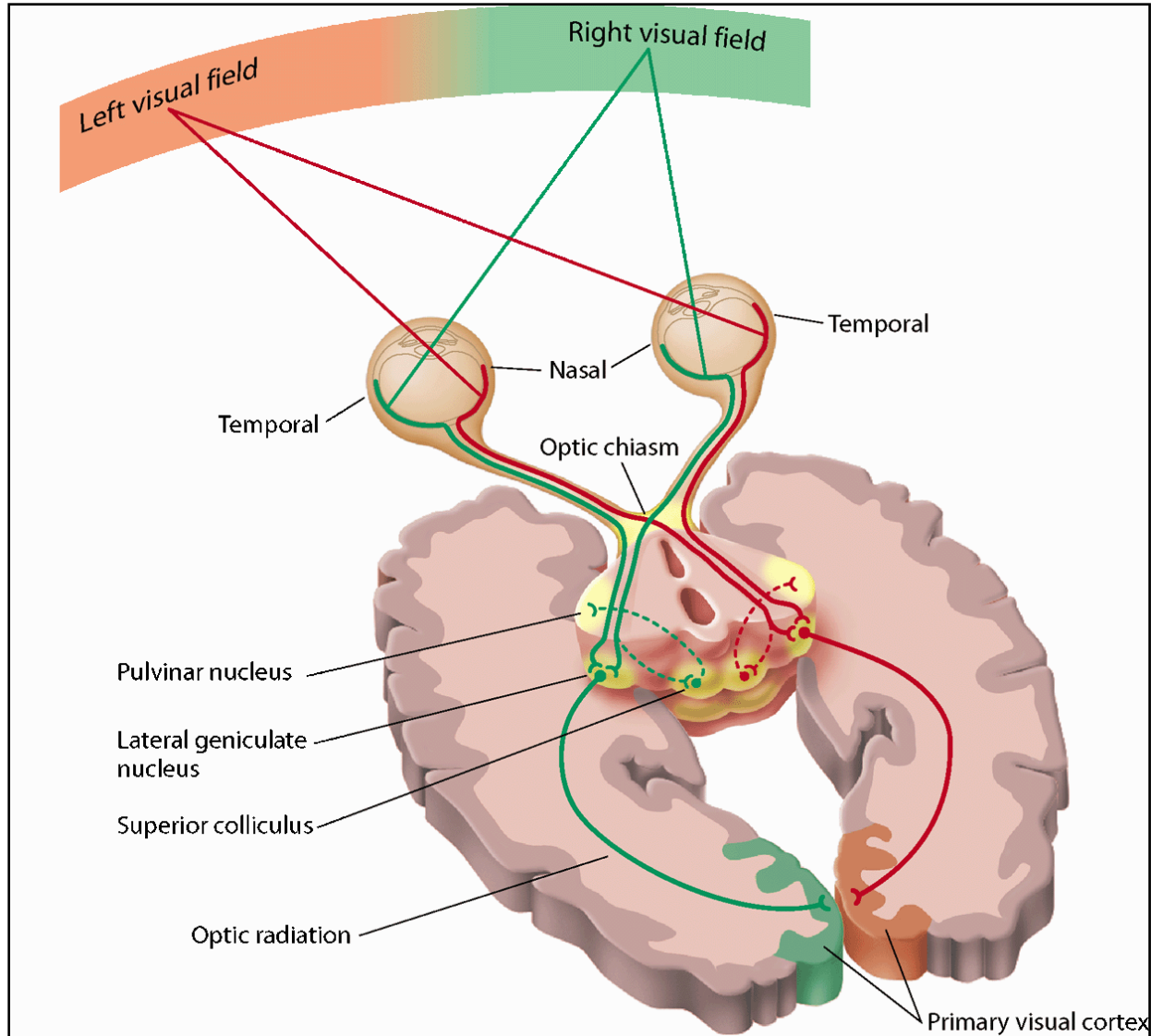
High Convergence in Rod-Fed Circuits



Photoreceptors

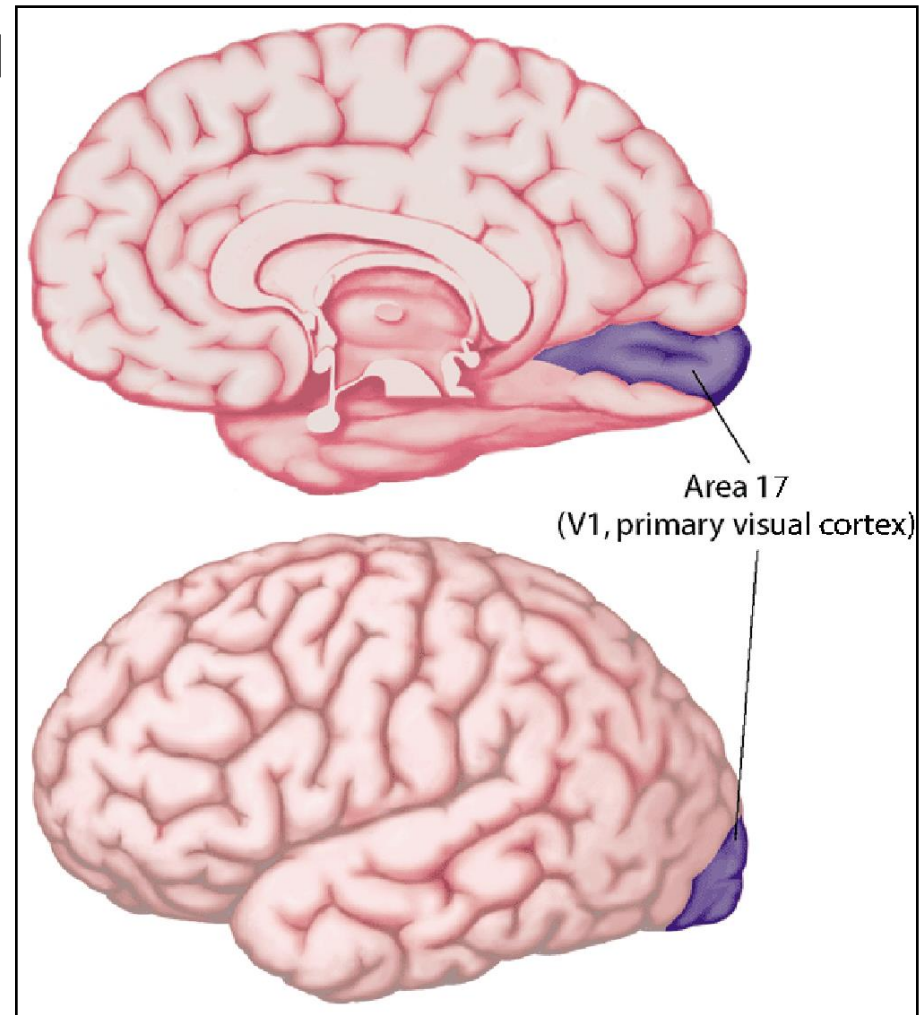
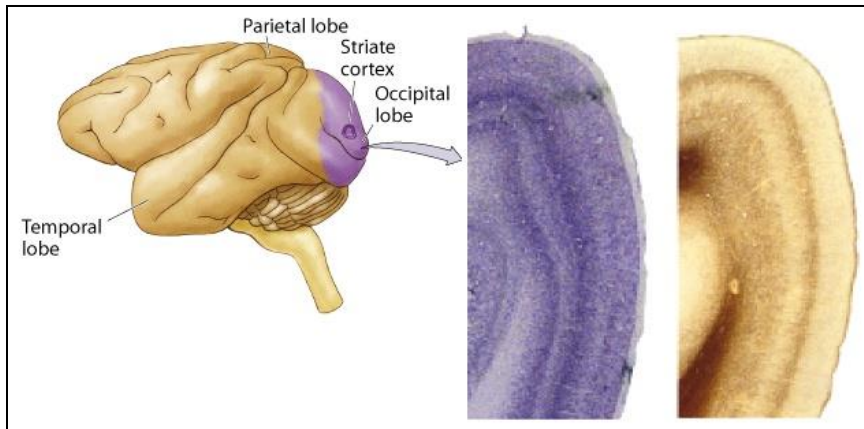


Form Eye to the CNS

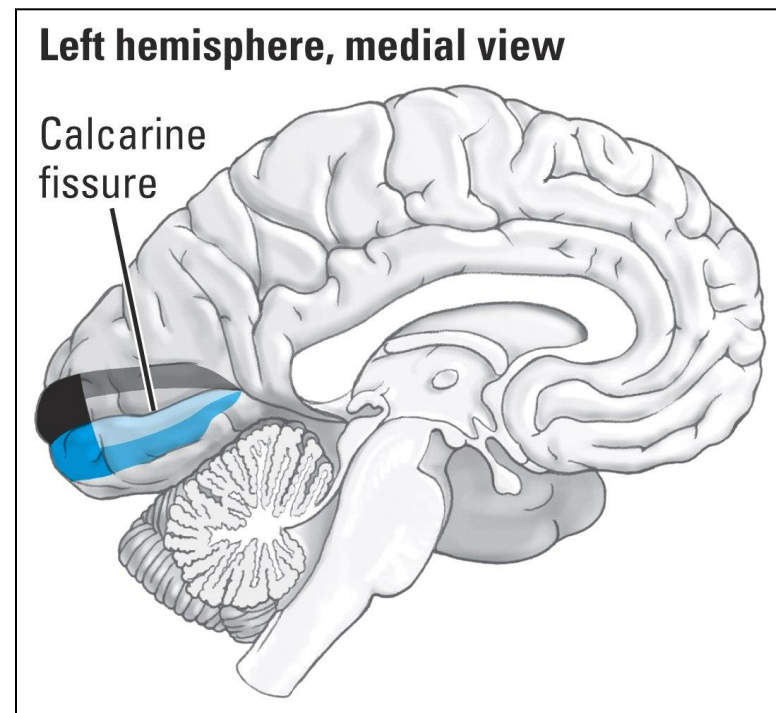
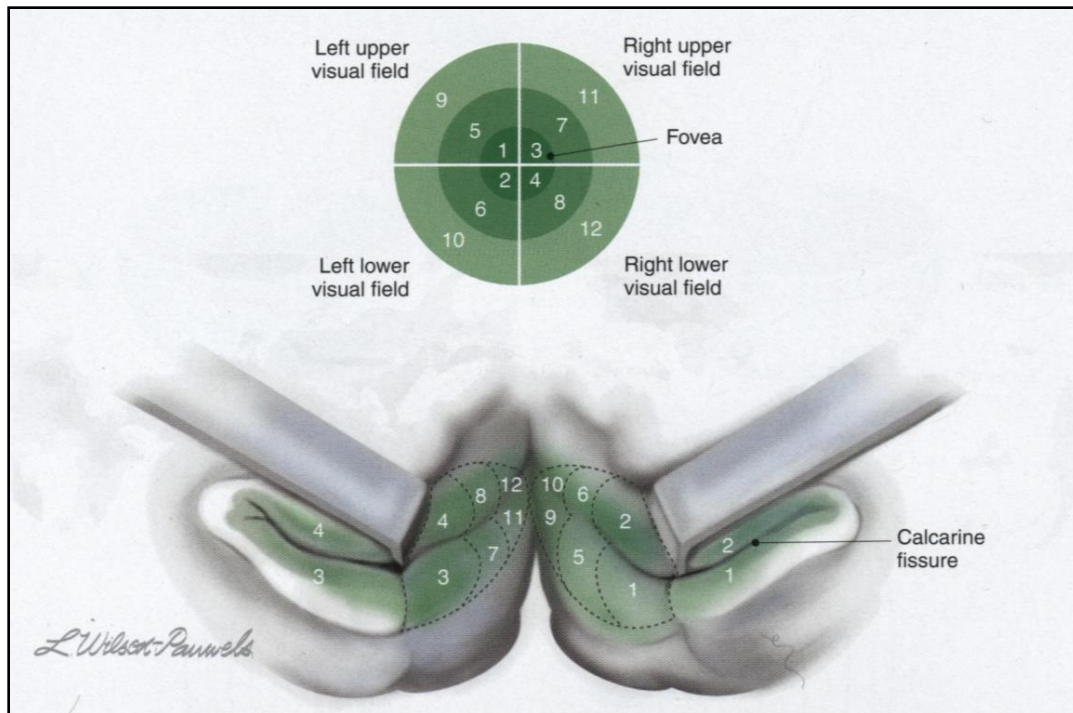


Visual Cortex – Primary Visual Cortex

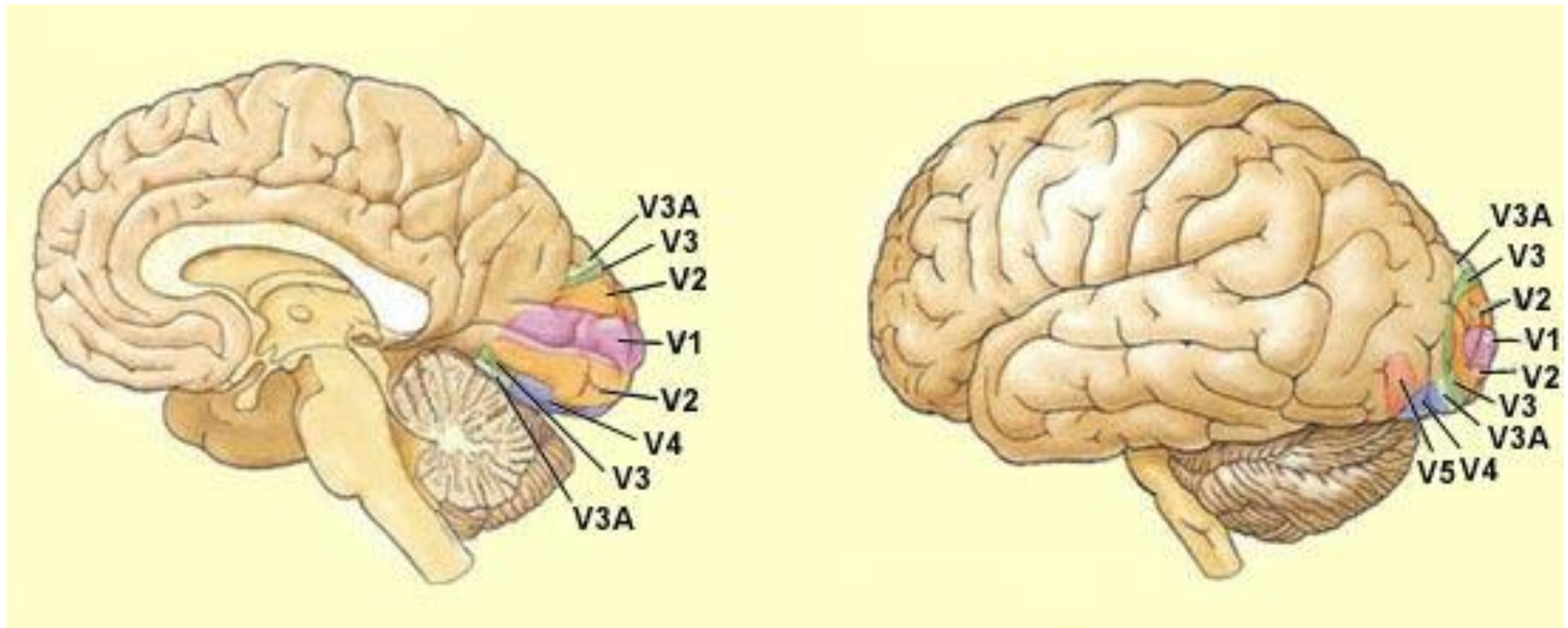
- Different names for primary visual cortex:
- Brodmann's area 17
- V1
- primary visual cortex
- striate cortex (“striped” cortex)



Retinal Topography



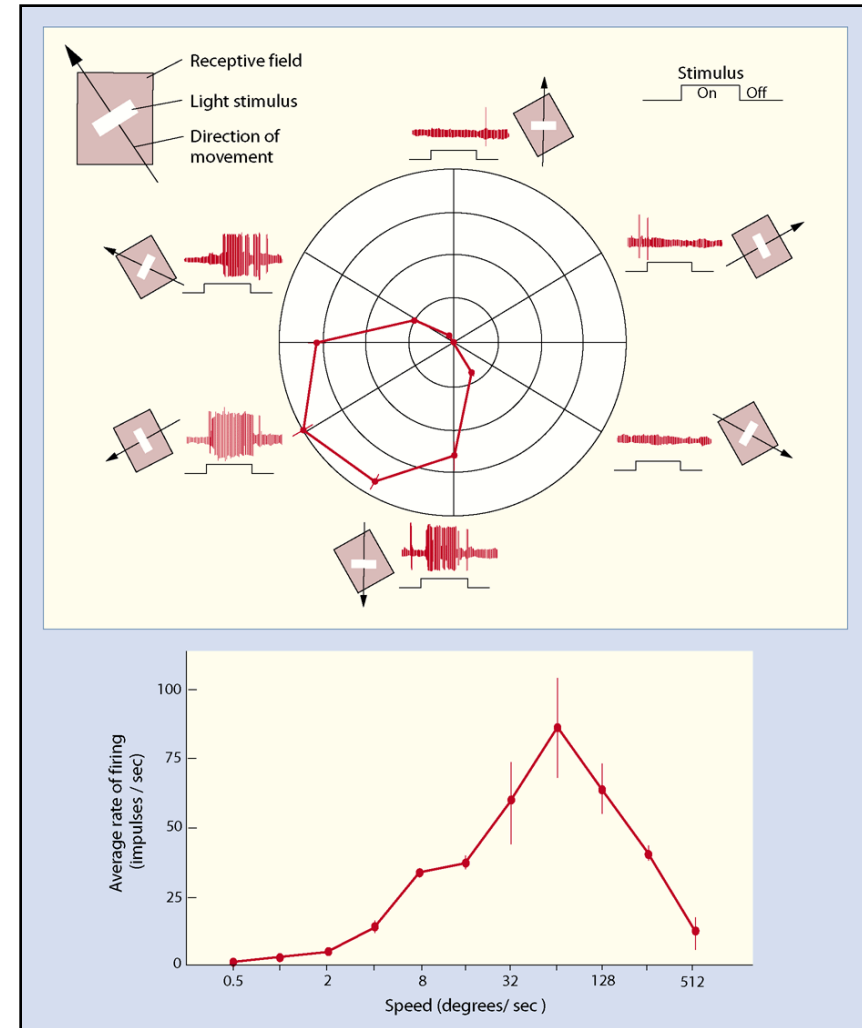
Visual Cortex



Visual Cortex: Area MT or V5

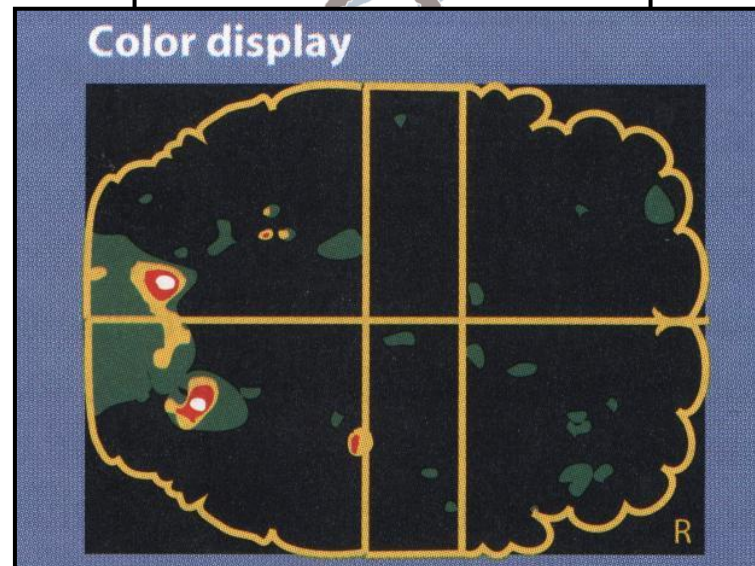
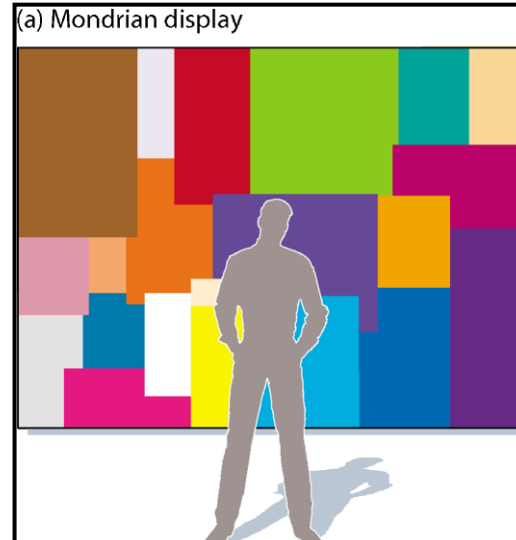
MOTION

- Cells in area MT or V5 respond to movement but not color
- For example, this particular neuron in this monkey's V5 area responds best when stimulus moved down and to the left

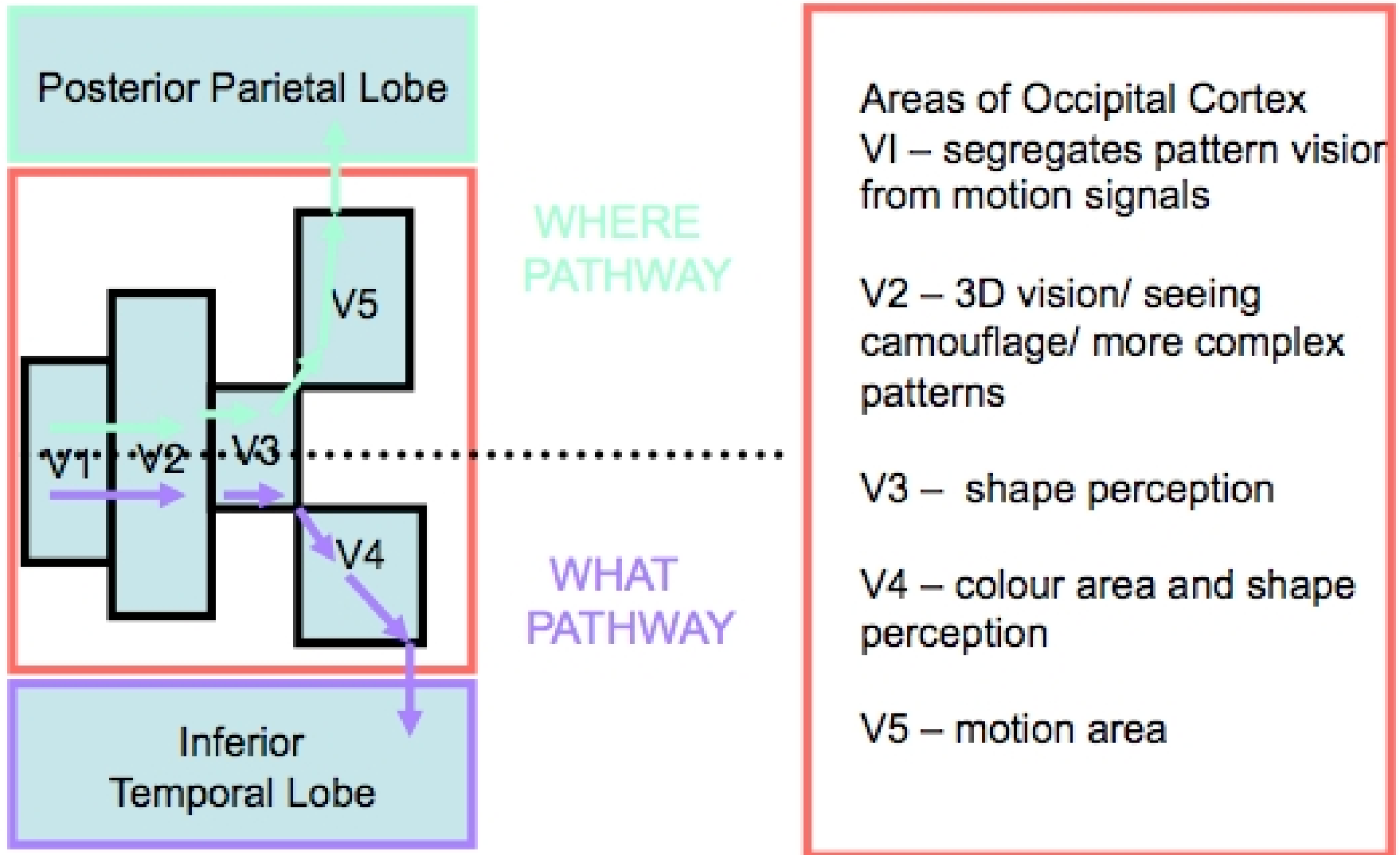


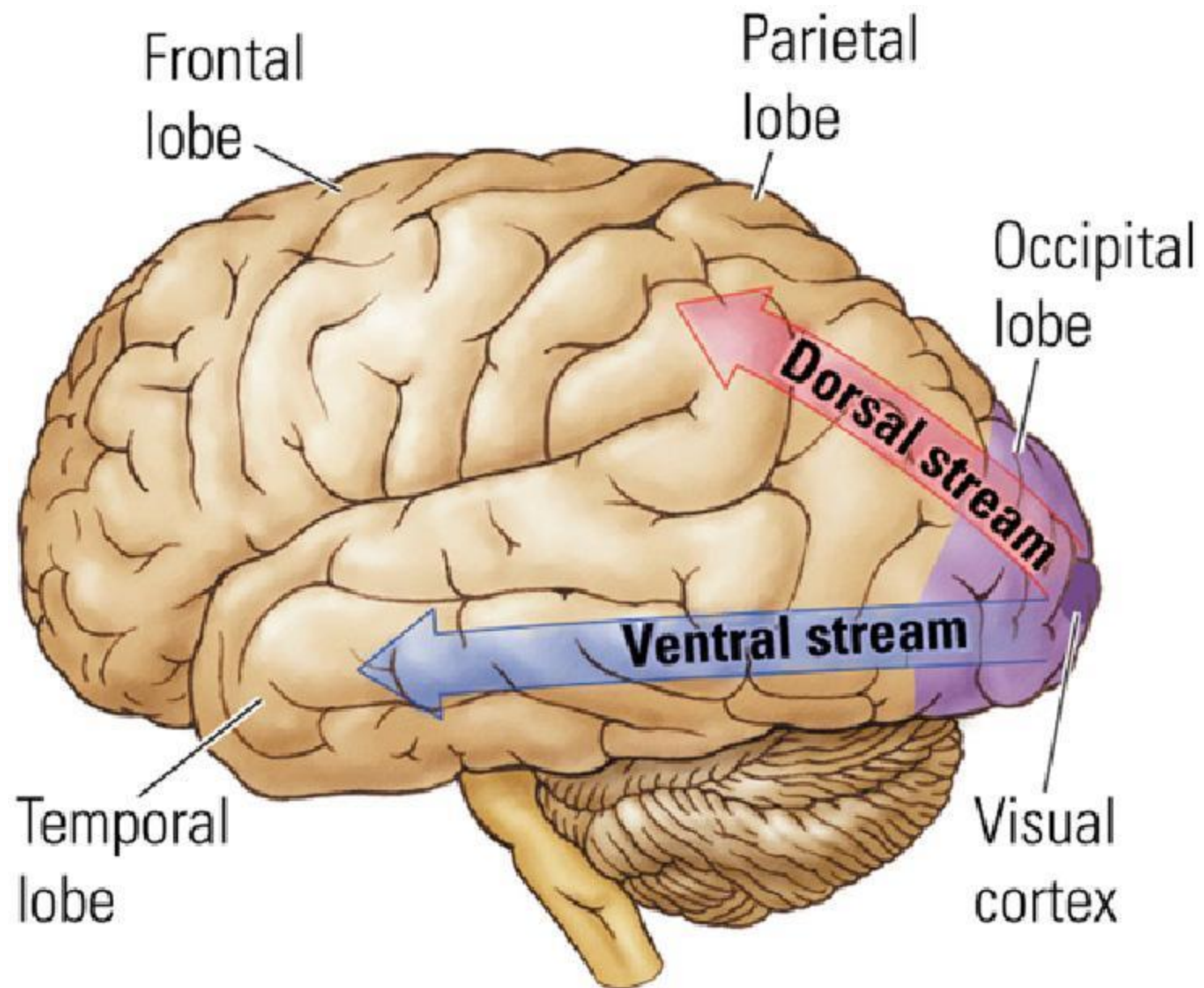
Visual Cortex:Area V4

COLOUR



Visual Cortex





Optic nerve

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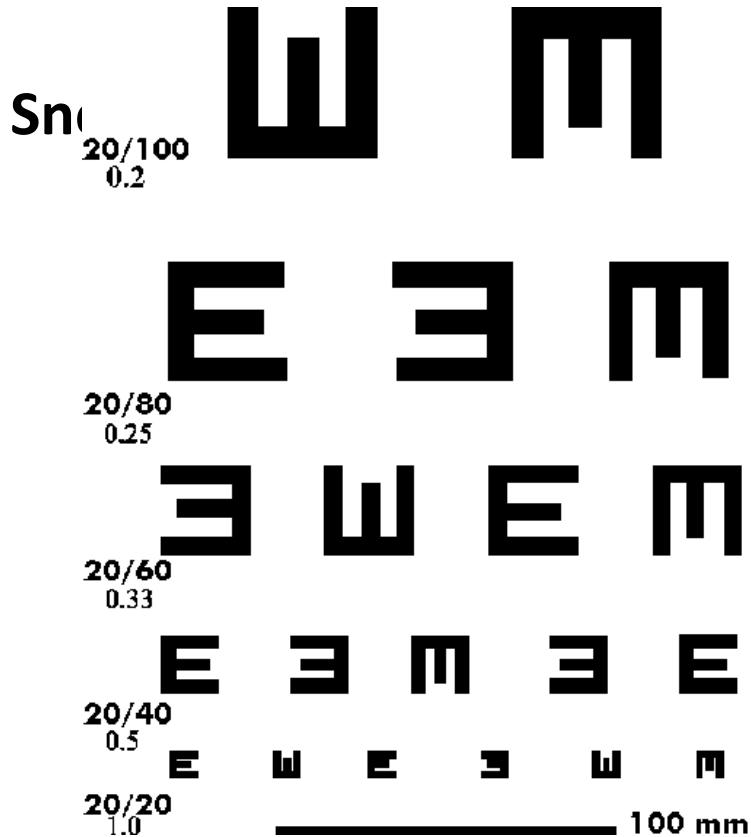
Optic nerve

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How to examine

- Visual acuity
- Colour vision
- Visual field
- Fundus examination

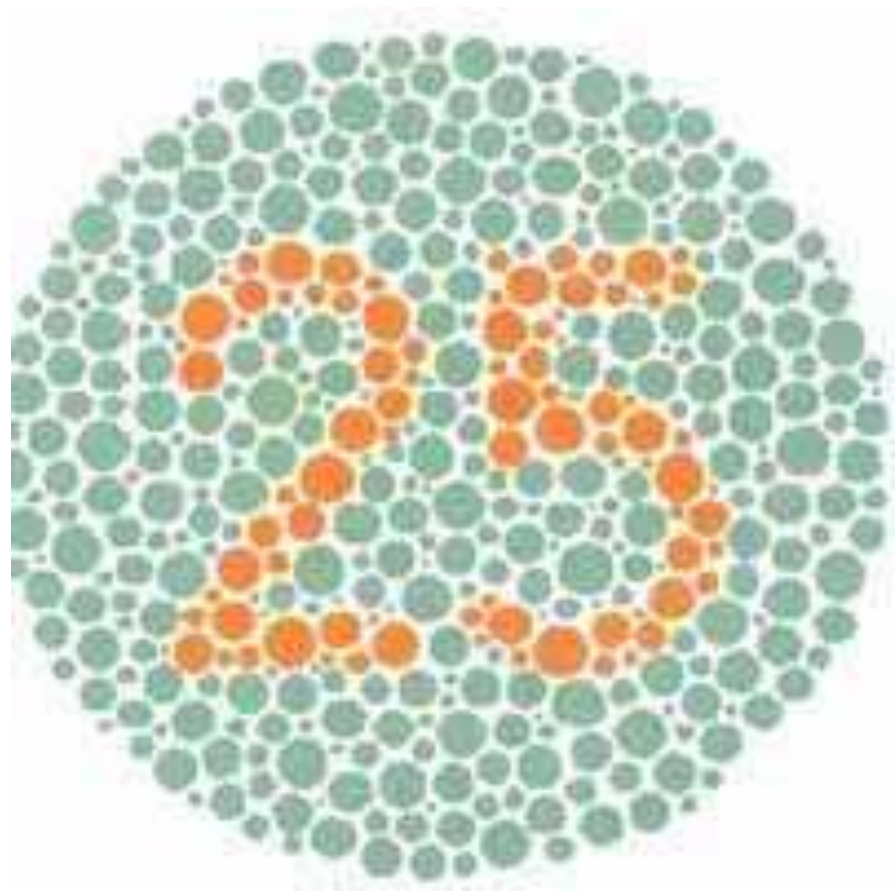
Visual acuity



- Counting fingers 6 meters to 30 cm.
- Hand movement.
- Perception of light.

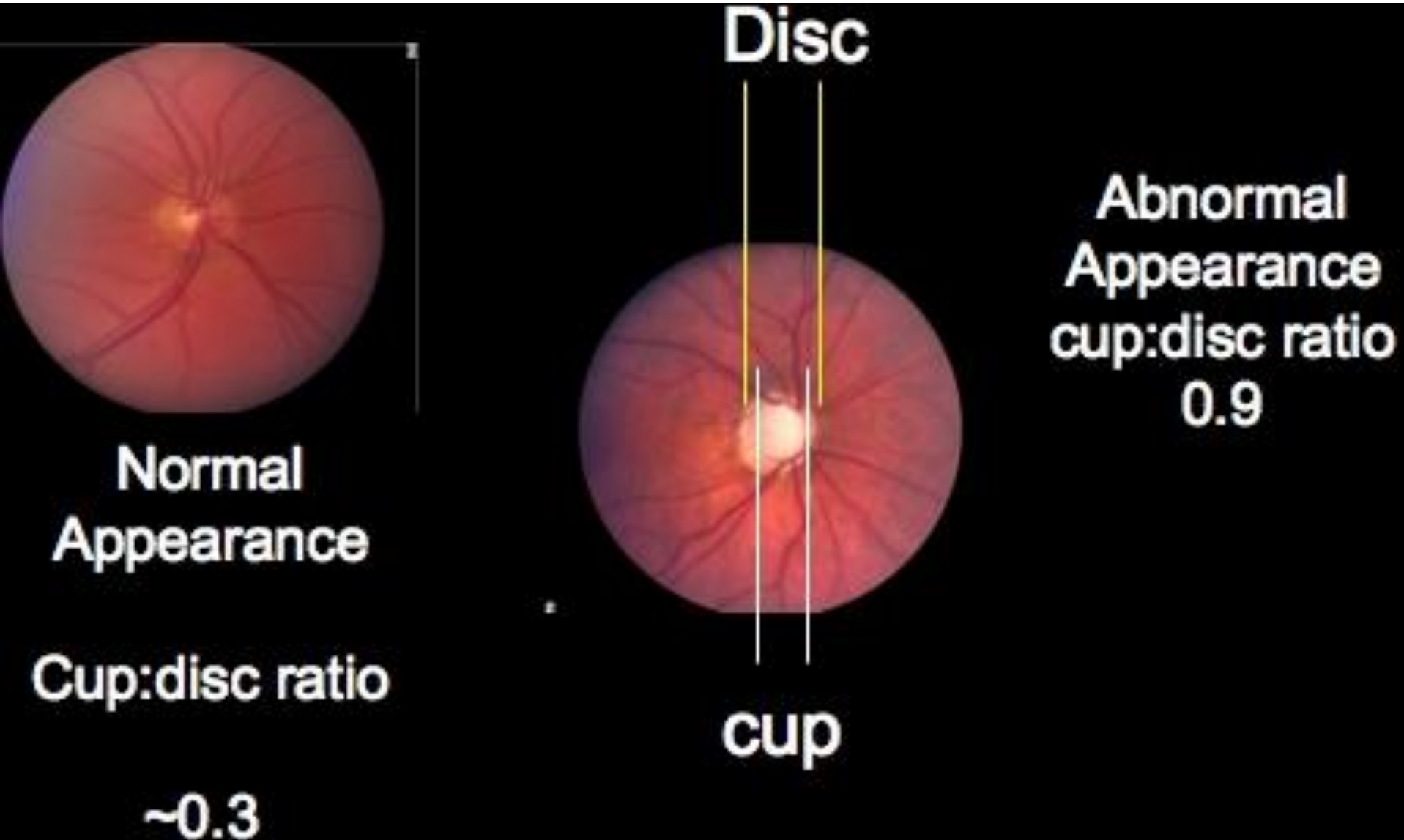
Colour vision

- Ishihara colour plates



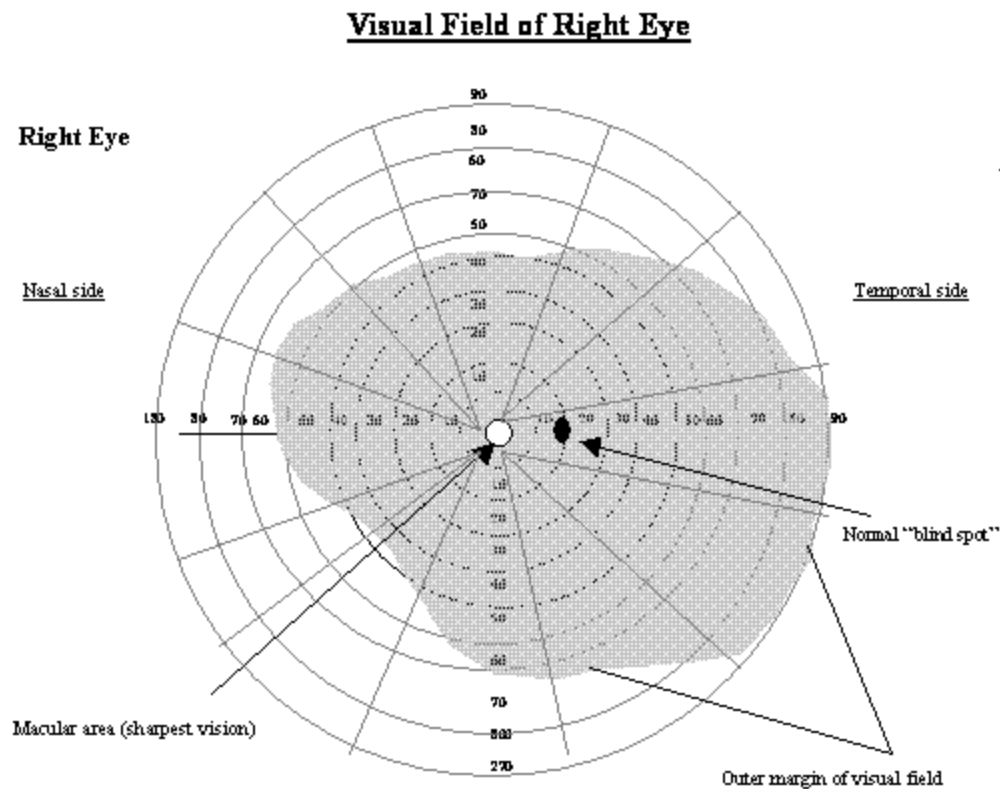
Fundus examination

- NORMAL FUNDUS



Field examination

- Confrontation method



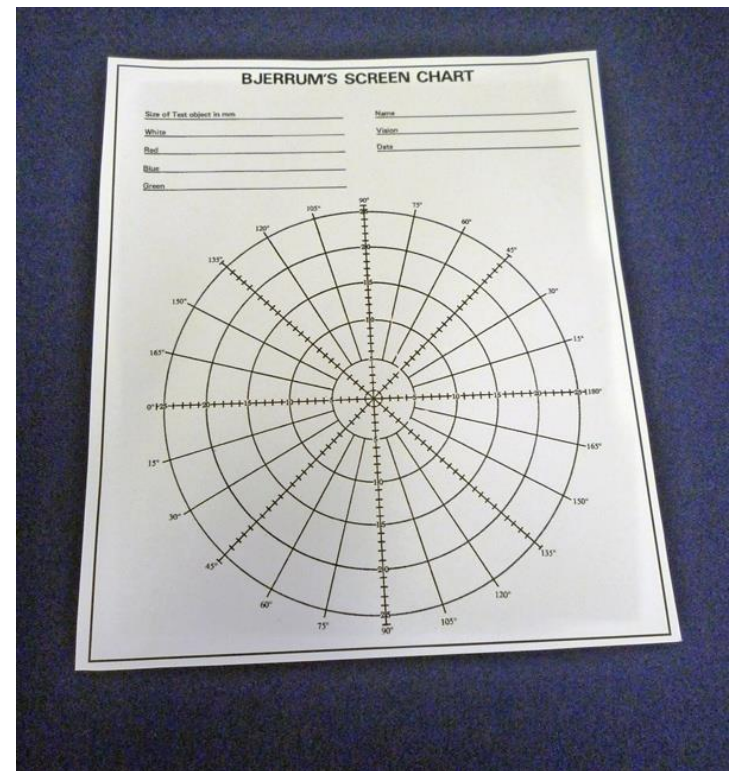
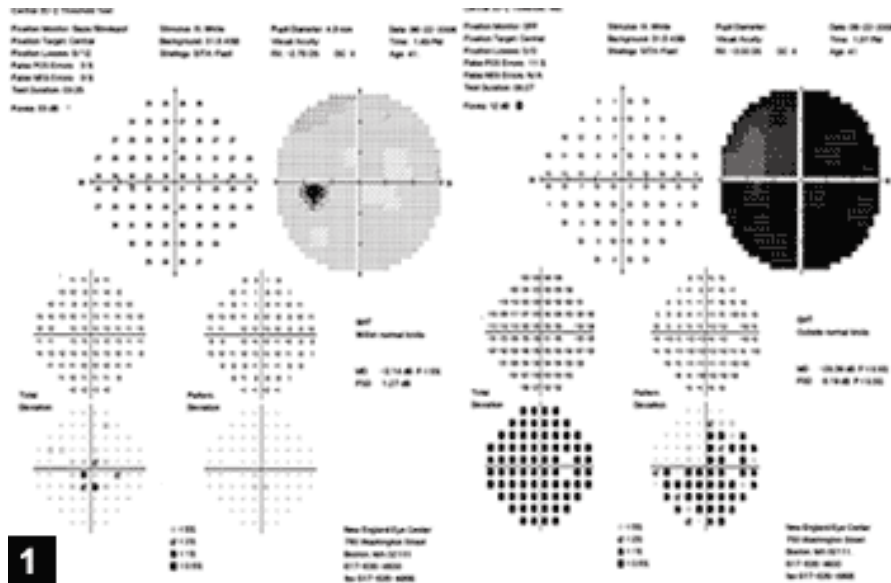
The normal binocular field of vision is 160° – 170°



Field examination

Automated perimetry

Bjerrum screen.



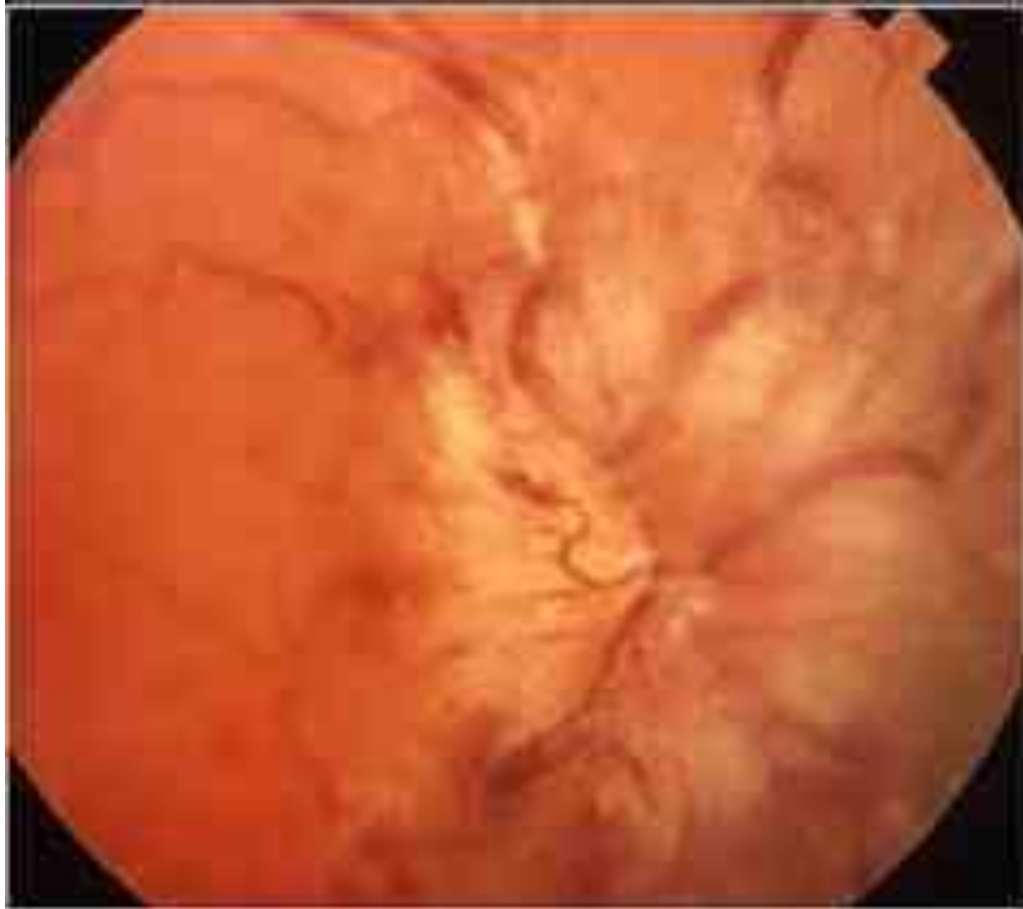
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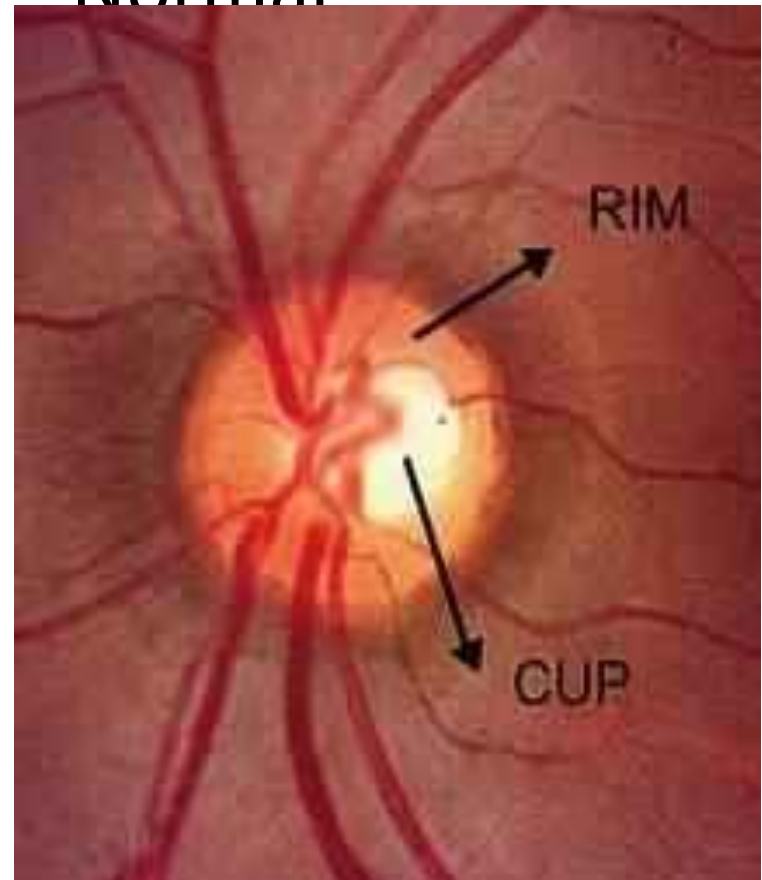
Optic nerve

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PAPILLODEMA



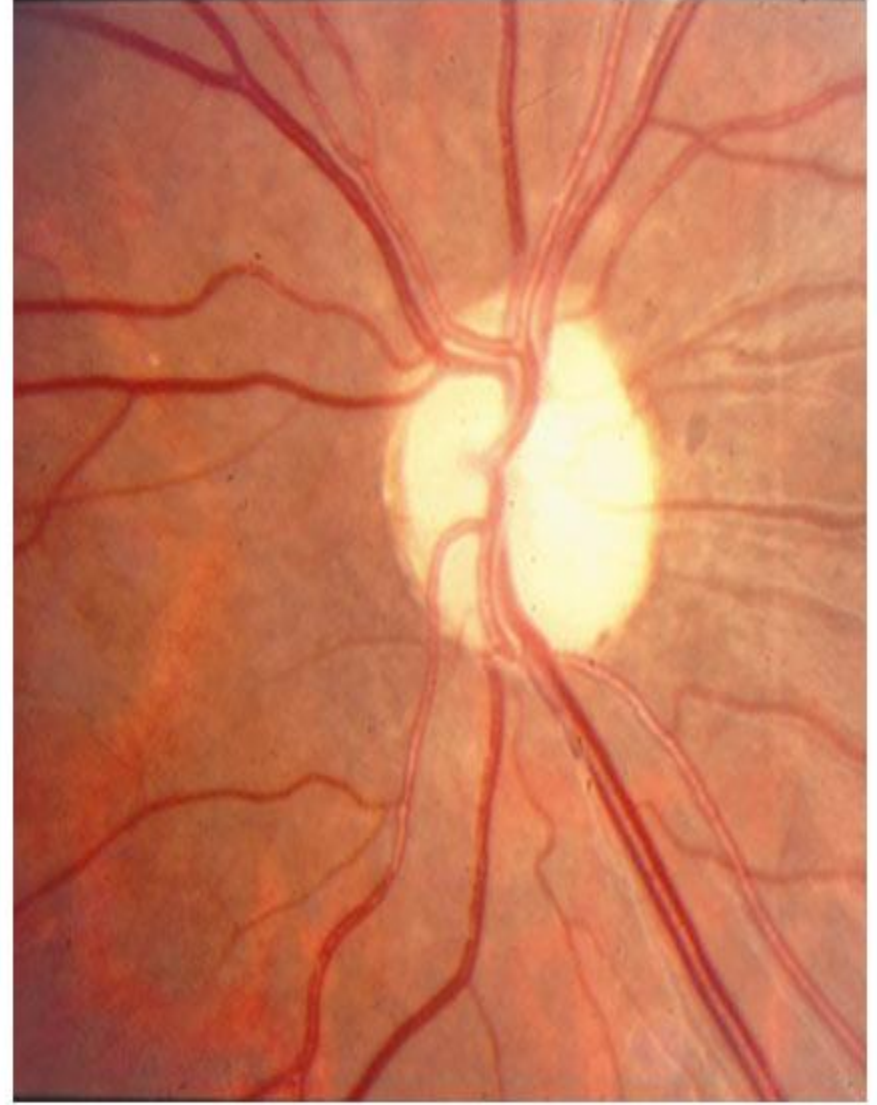
Normal



Retinitis Pigmentosa



Primary Optic Atrophy



Optic Neuritis : Common presentation

Visual field defect

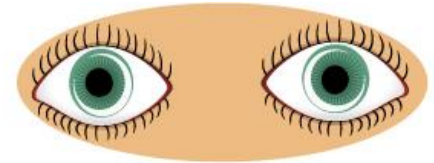


Dyschromatopsia

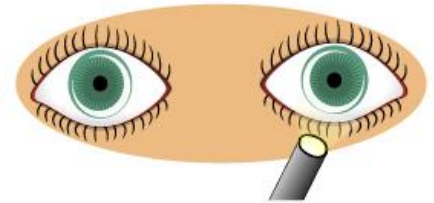
Abnormal papillary response

± Diminution/loss of vision

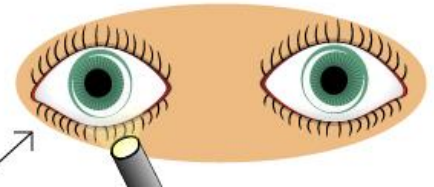
No Light



Normal
Response
to Light



Positive
RAPD of
Right Eye



A. Before ON

Left eye



Right eye



B. 2 weeks after onset of ON

Left eye



Right eye



C. 4 weeks after onset of ON

Left eye



Right eye



D. 6 months after onset of ON

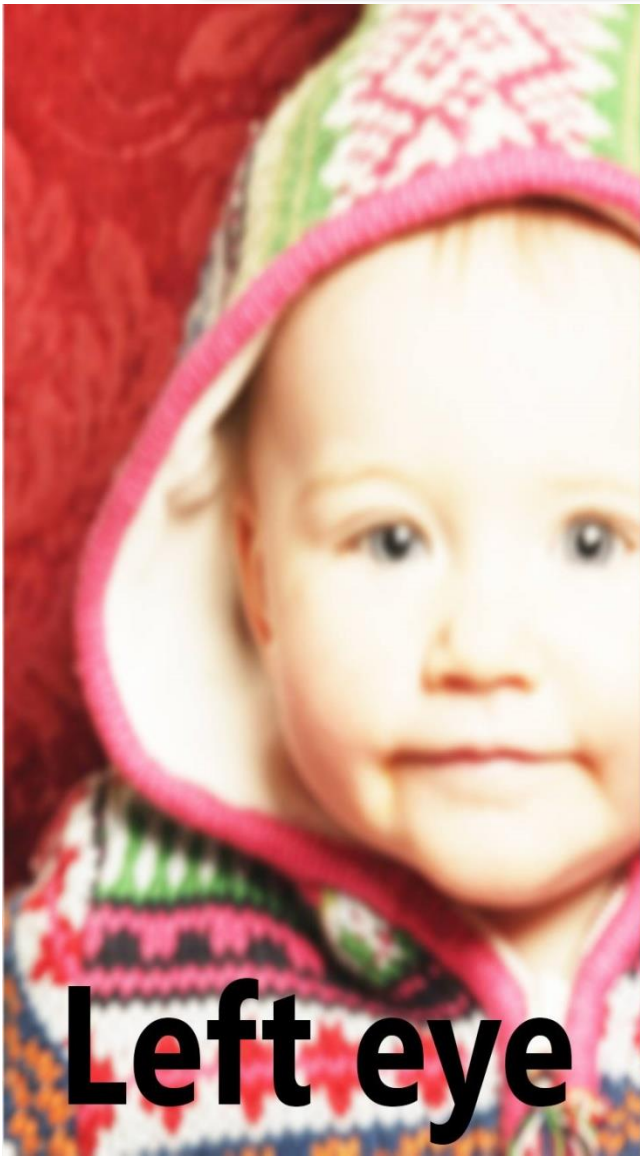
Left eye



Right eye



An Egyptian Patient

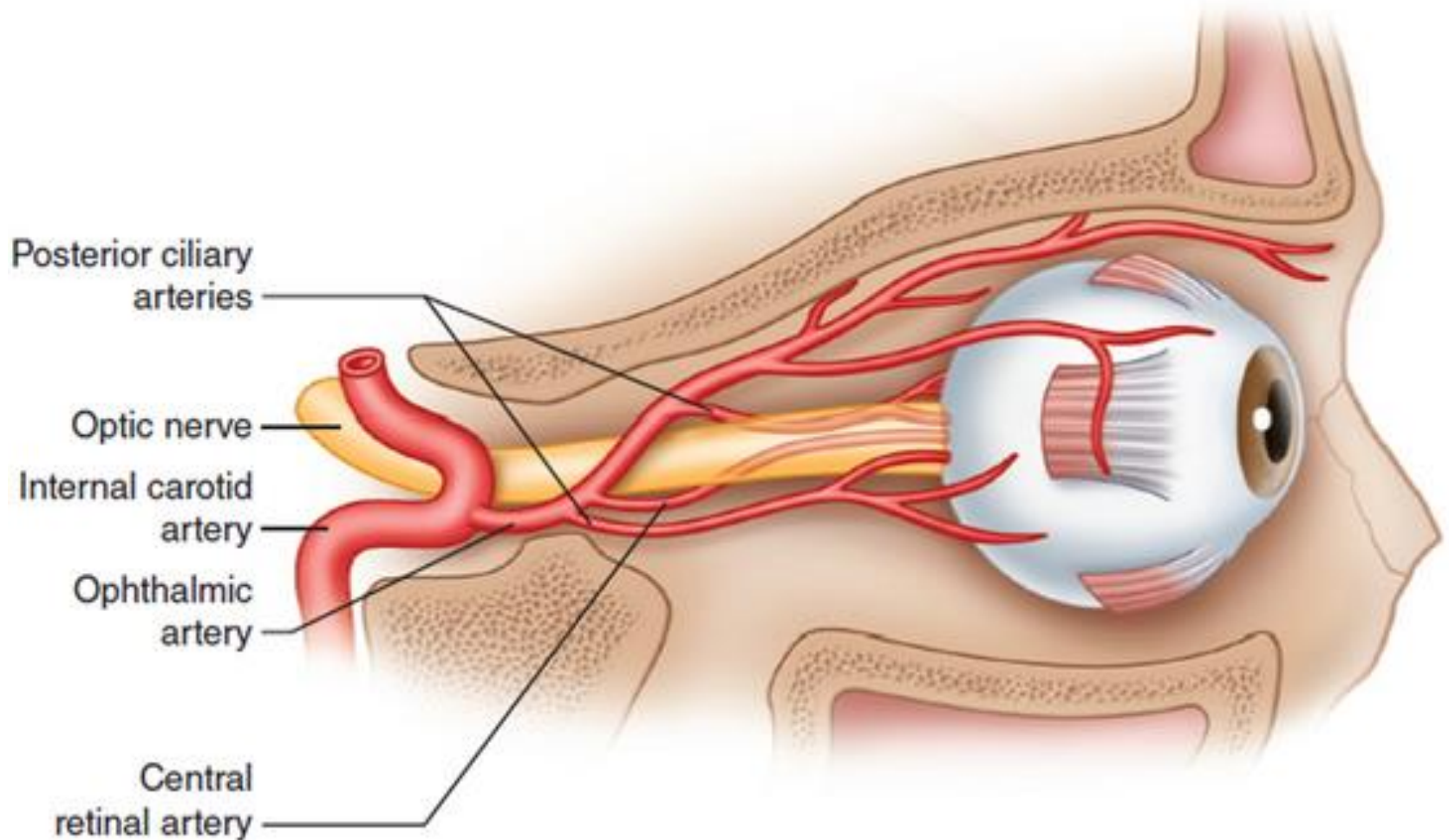


Left eye

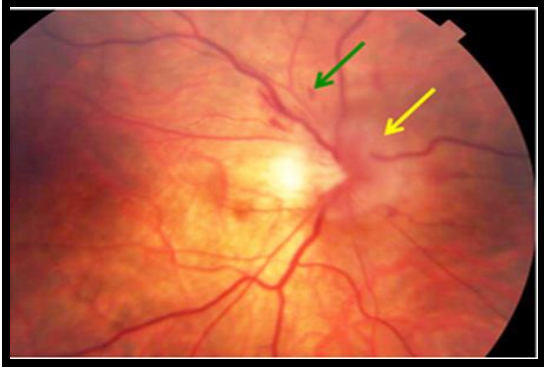
Original

Right eye

Blood supply of the optic nerve



Ischemic Optic Neuropathy: **NAION**

PARAMETER	FINDING
Visual Acuity	Often better than 20/100.
Visual Field	Typically Inferior Altitudinal defect.
Colour Vision	May be severely impaired when VA is good.
Ophthalmic Exam Findings 	Diffuse OR sectorial hyperaemic disc swelling associated with FEW peripapillary splinter-shaped haemorrhages.
	Small OR cupless disc in fellow eye.
	Swelling gradually resolves and pallor in 3-6 weeks after onset.
FA Finding	Acute Stage: localized disc hyperfluorescence, intense, eventually involves entire disc.
Laboratory Evaluation	No associated laboratory abnormalities.

Ischemic Optic Neuropathy: **NAION**

NAION

Optic neuritis

Age	>50	<40
pain	Unusual	92%+
Pupil	APD+	APD+
VF	Altitudinal	Central
Optic disk	Edema 100% pale	Edema 33% hyperemic
Retinal Hge	Common	Unusual
F.A.	Delayed disk filling	No delayed
MRI	No optic nerve enhancement	enhancement

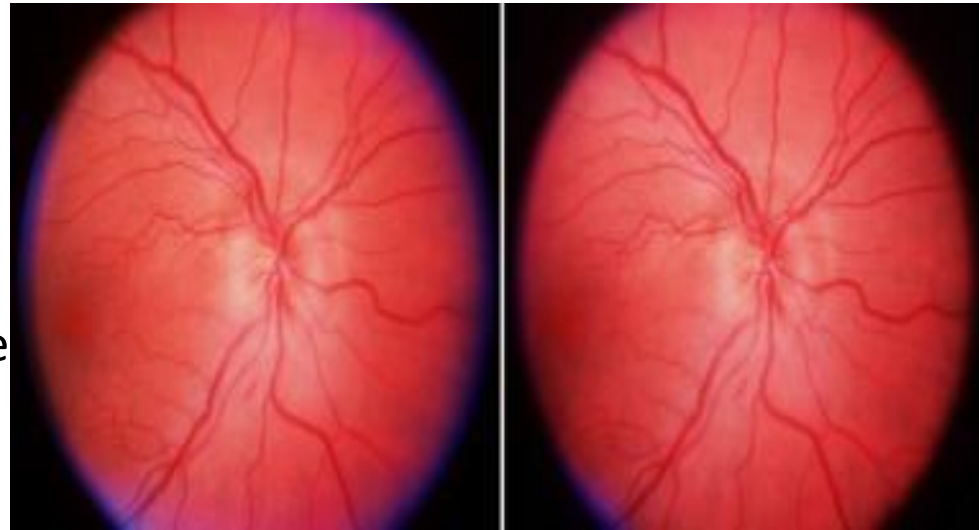
Ischemic Optic Neuropathy: **AAION**

Symptoms:

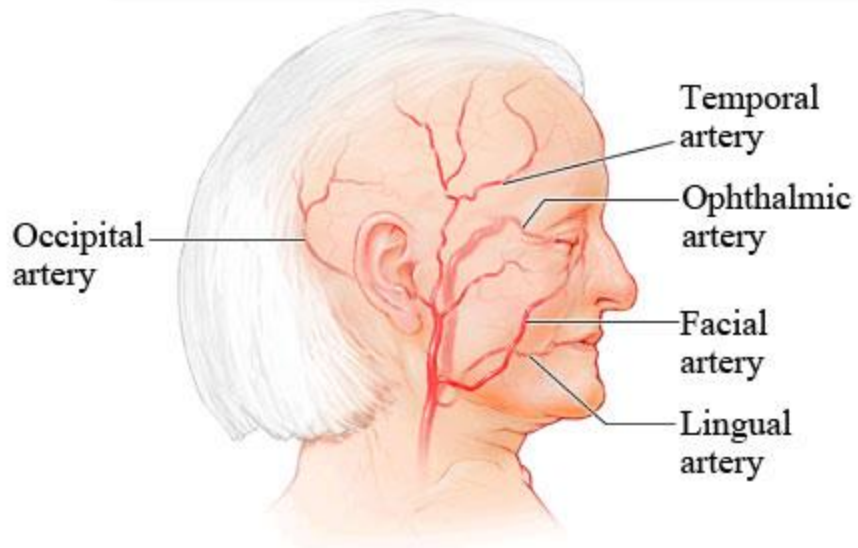
- Acute vision loss one or both eyes
- Painless

Signs:

- VF loss
- RAPD +ve
- Swollen Optic Disc (AION) + flame haemorrhage



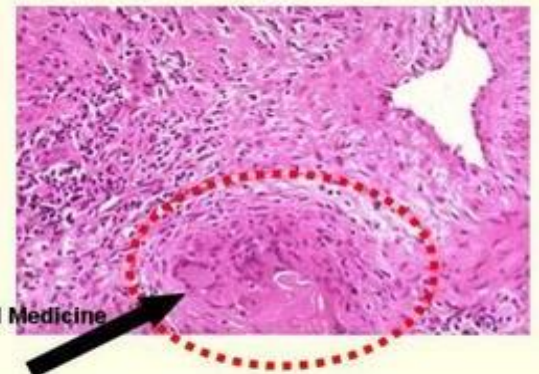
Ischemic Optic Neuropathy: **AAION**



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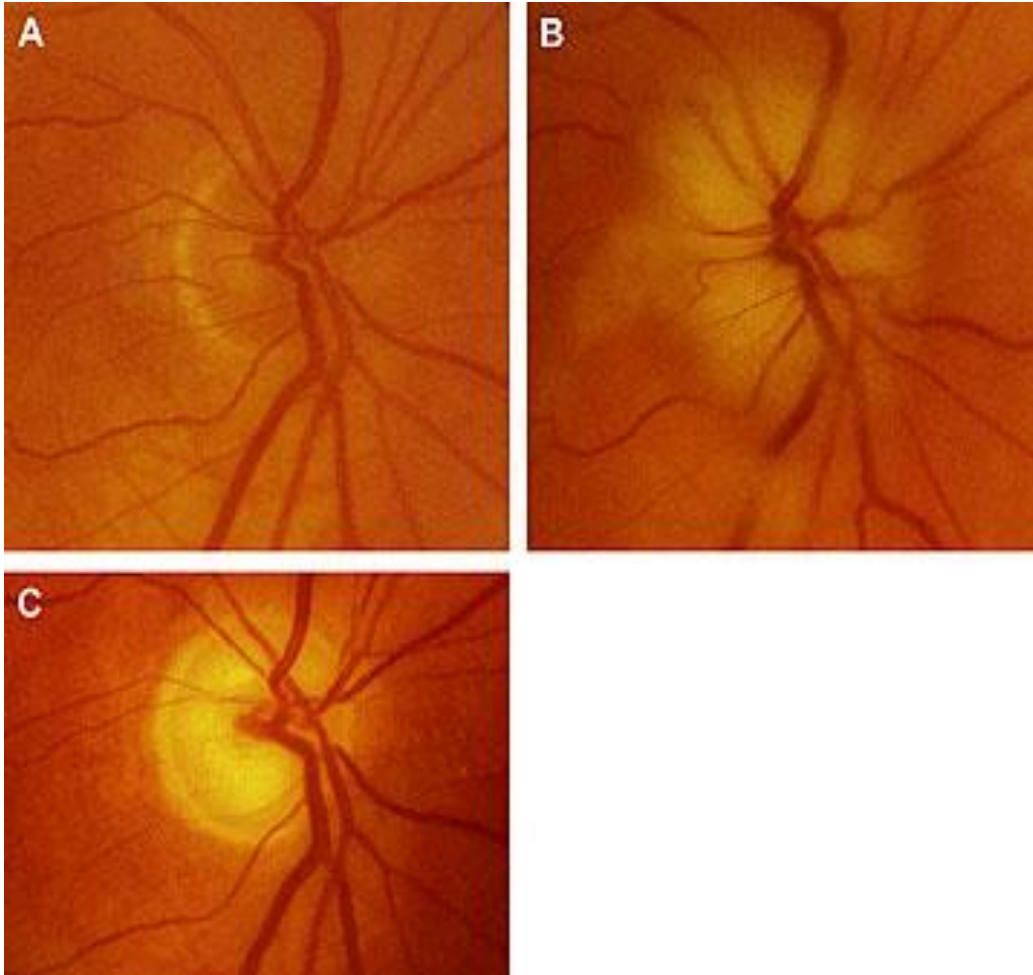


Source: Tufts School of Dental Medicine



Giant cells (arrow) within a granuloma (circle)
of granulomatous inflammation

Ischemic Optic Neuropathy: **AAION**



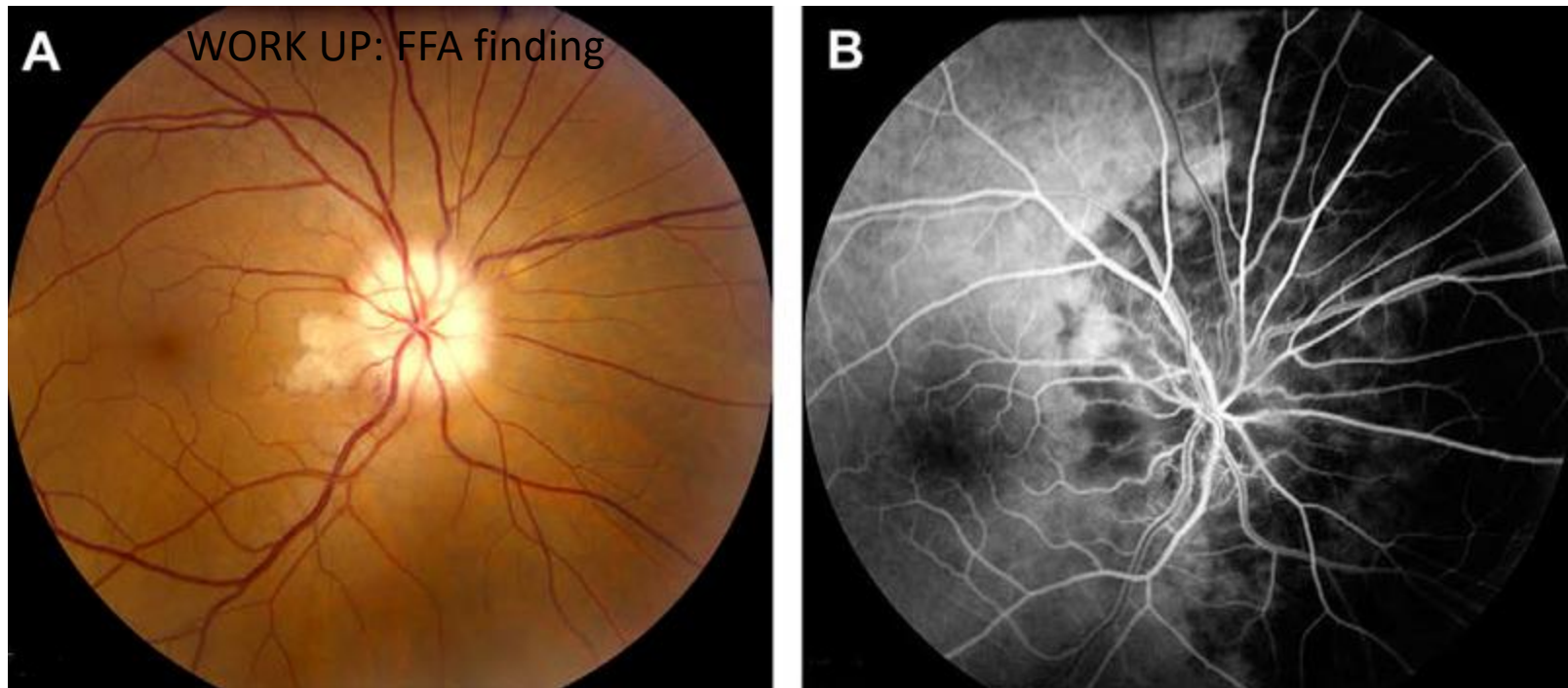
Fundus photographs of right eye with A-AION:

(A) Before developing A-AION

(B) One week after developing A-AION with chalky white optic disc edema and

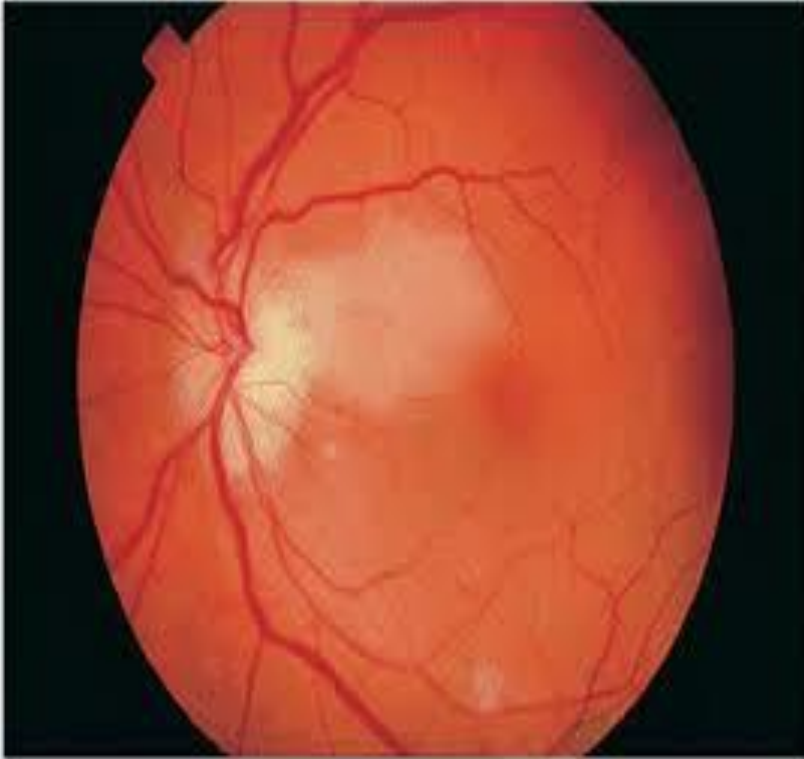
(C) 4 months later showing optic disc cupping with a cup/disc ratio of 0.8 (note no cup in A)

Ischemic Optic Neuropathy: **AAION**

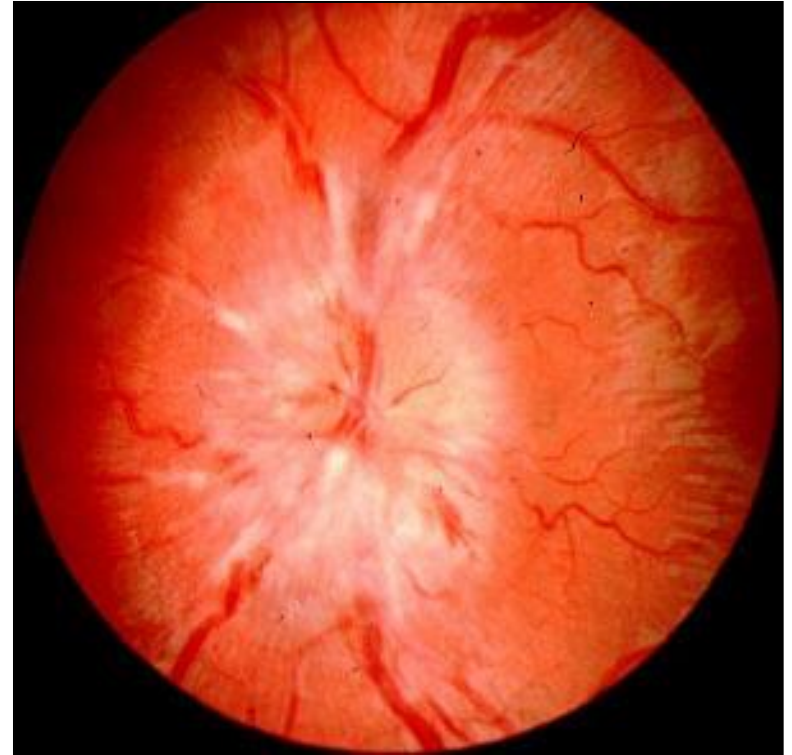


Fundus photograph (**A**) and fluorescein fundus angiogram (**B**) of right eye with A-AION and cilioretinal artery occlusion during the initial stages. (**A**) Fundus photograph shows chalky white optic disc edema with retinal infarct in the distribution of occluded cilioretinal artery. (**B**) Fluorescein fundus angiogram shows evidence of occlusion of the medial posterior ciliary artery and no filling of the cilioretinal artery.

Ischemic Optic Neuropathy: **AAION**



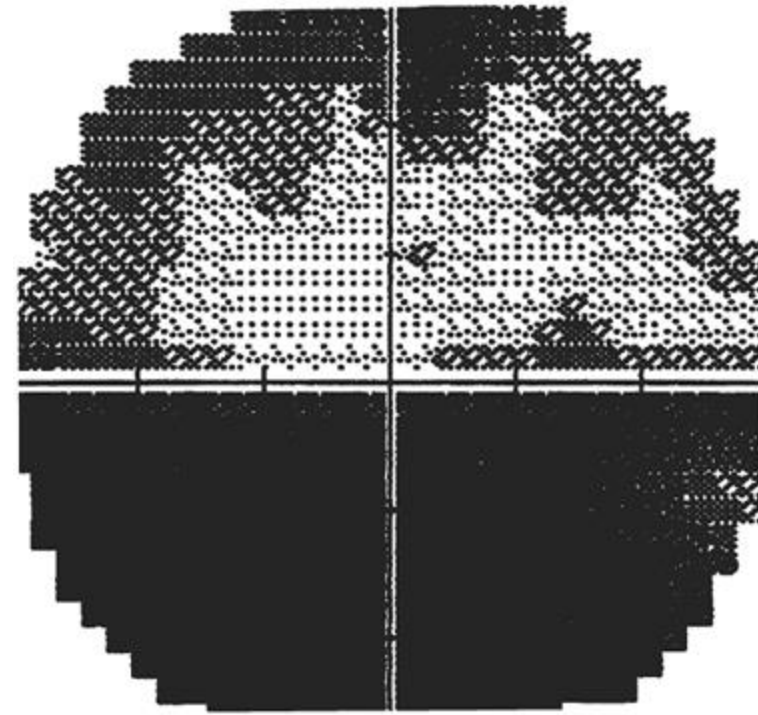
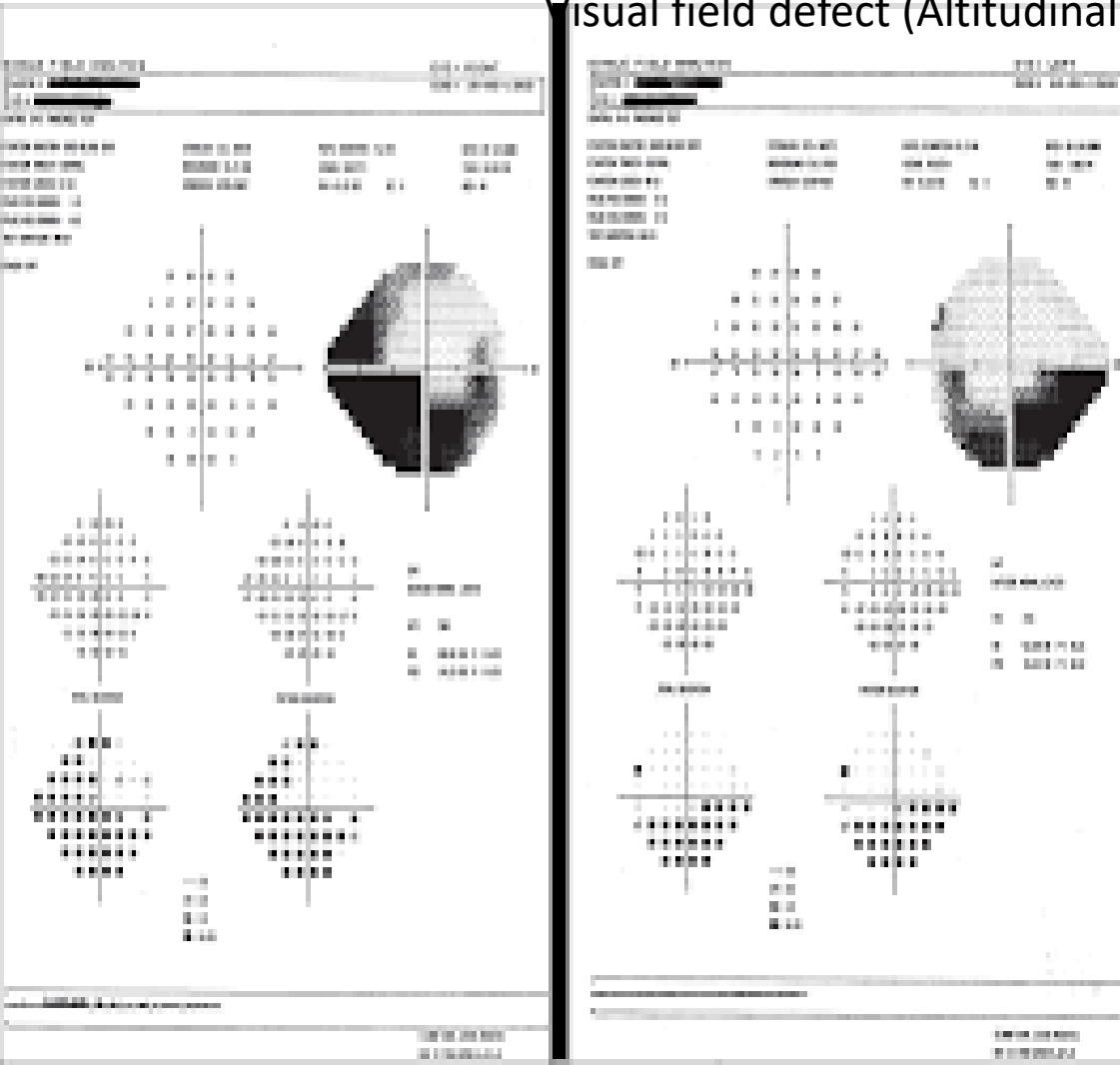
Pale optic disc edema with adjacent retina infarcted



Chalky white pale, swollen and hyperemic optic disc

Ischemic Optic Neuropathy: **AAION**

Visual field defect (Altitudinal & inferiorly)



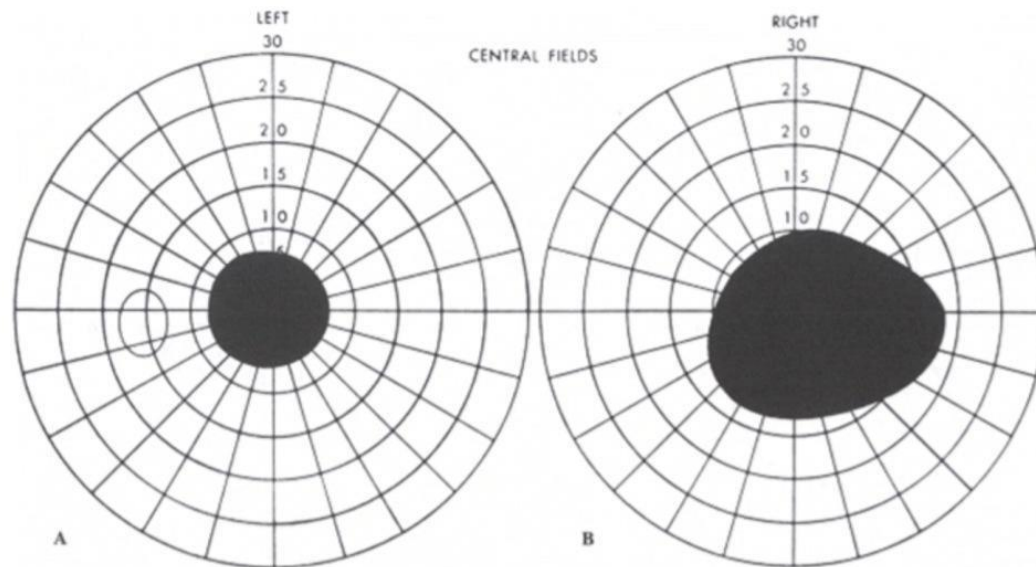
Hereditary Optic Neuropathy: **AD** (Kjers' type)

- The optic disc : temporal pallor and in some cases severe excavation and cupping.



Hereditary Optic Neuropathy: **LHON**

- Visual field defects tend to be central or cecocentral as the papillo-macular bundle is first and most severely affected



Hereditary Optic Neuropathy: LHON

- Fundoscopy may show disk swelling, thickening of the peripapillary retinal nerve fiber layer

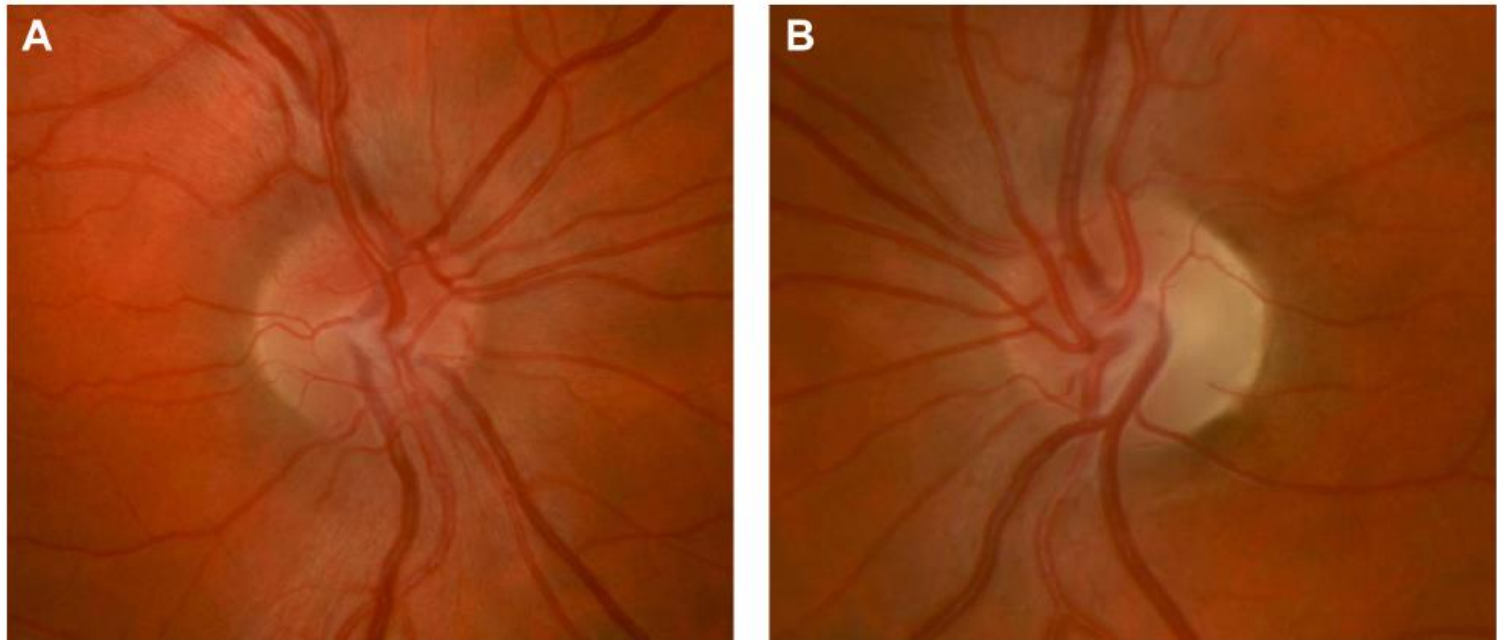
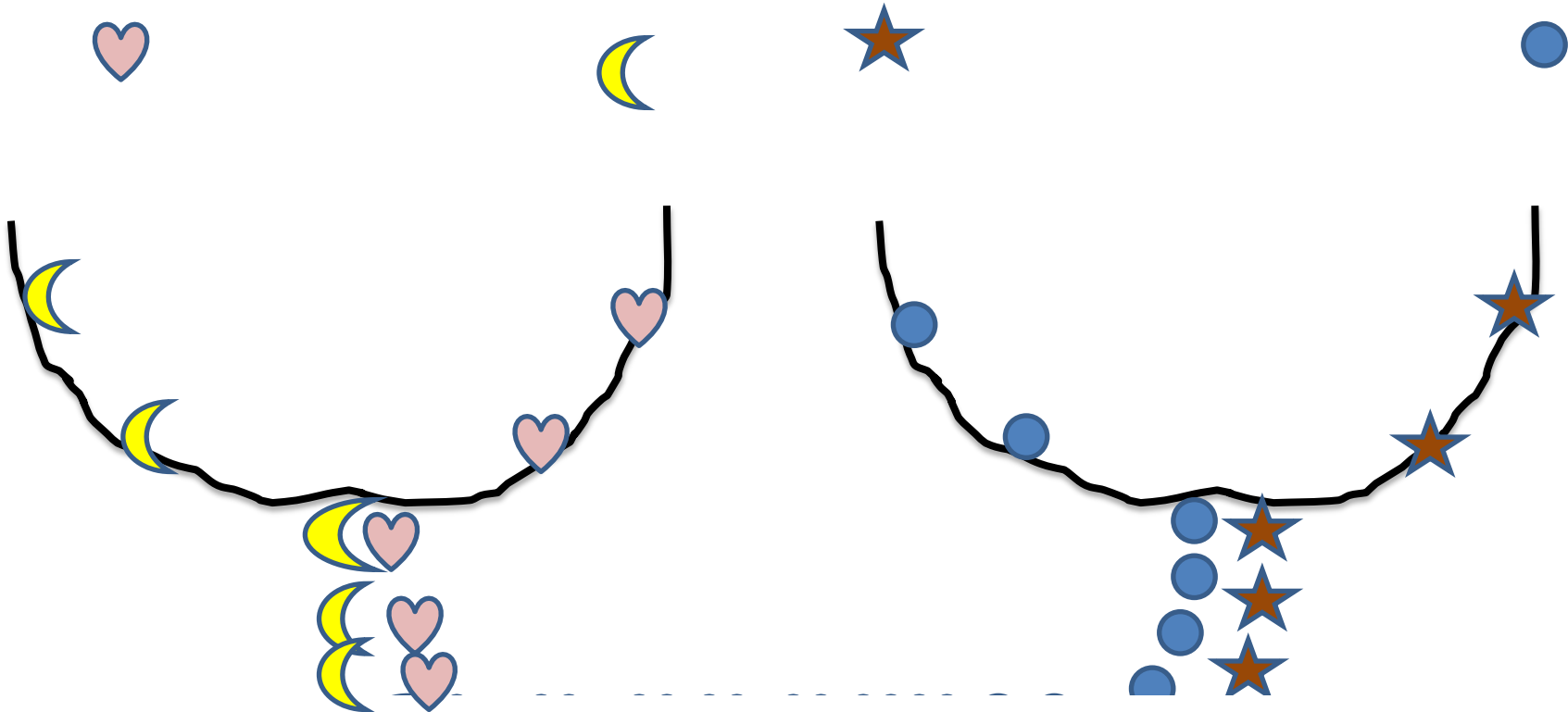
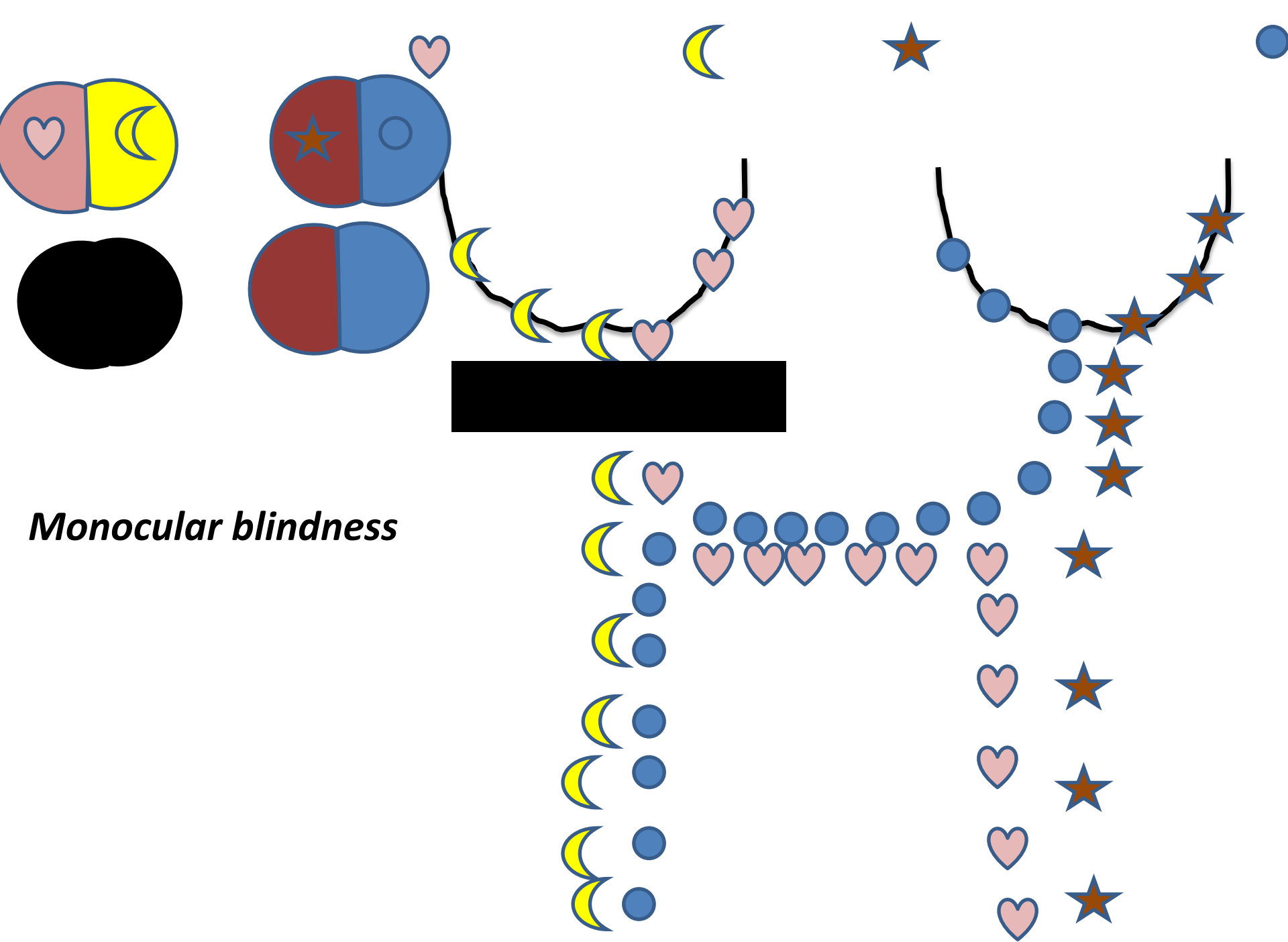
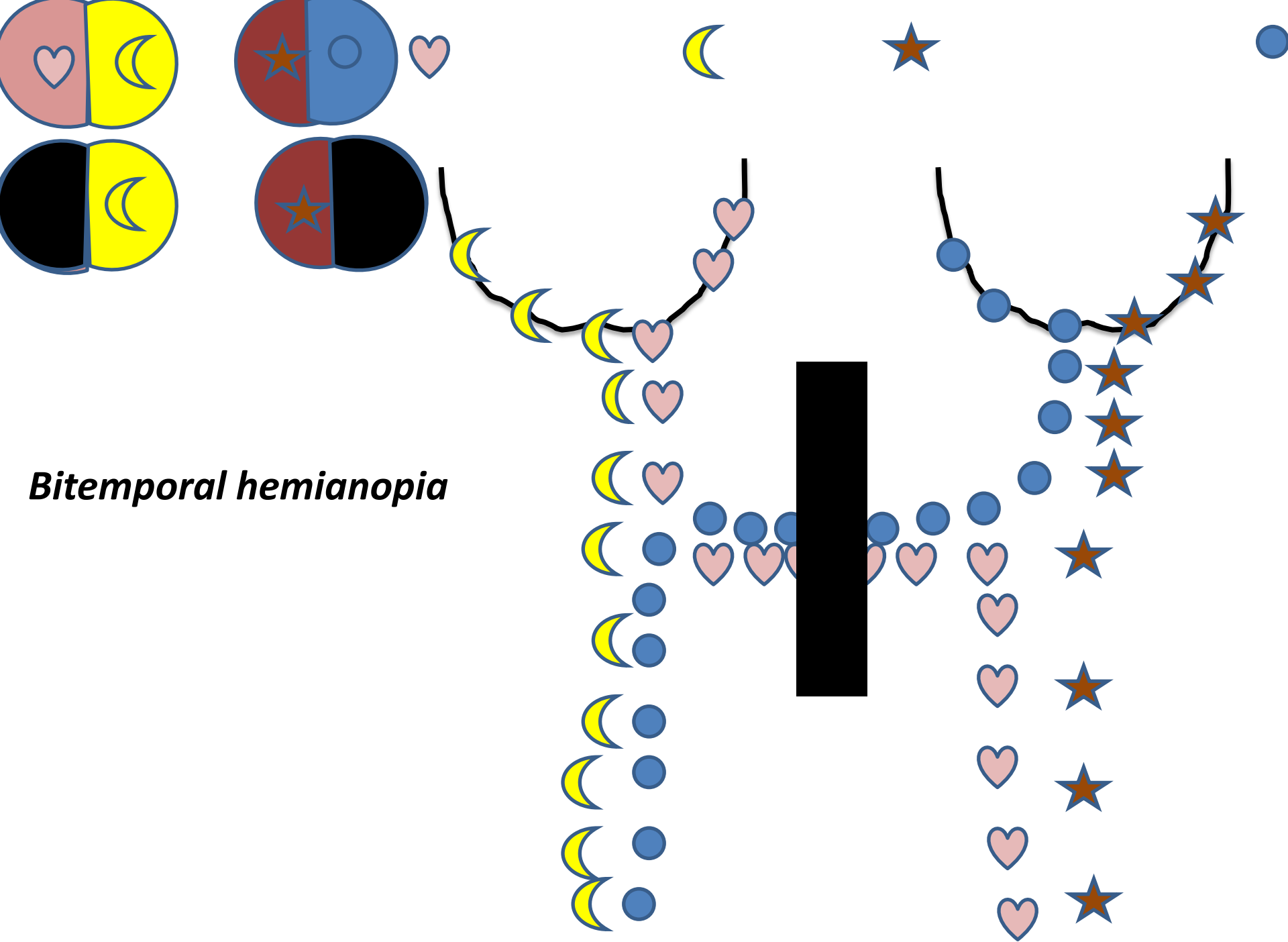


Figure 2 Right optic nerve (**A**) of a patient with acute LHON-related vision loss showing mild hyperemia, blurring of the disc margin, and elevation of the optic nerve head from swelling of the peripapillary retinal nerve fiber layer. LHON-related vision loss in the left eye had occurred 6 months prior leading to prominent temporal optic nerve pallor (**B**) from atrophy of the retinal nerve fiber layer.

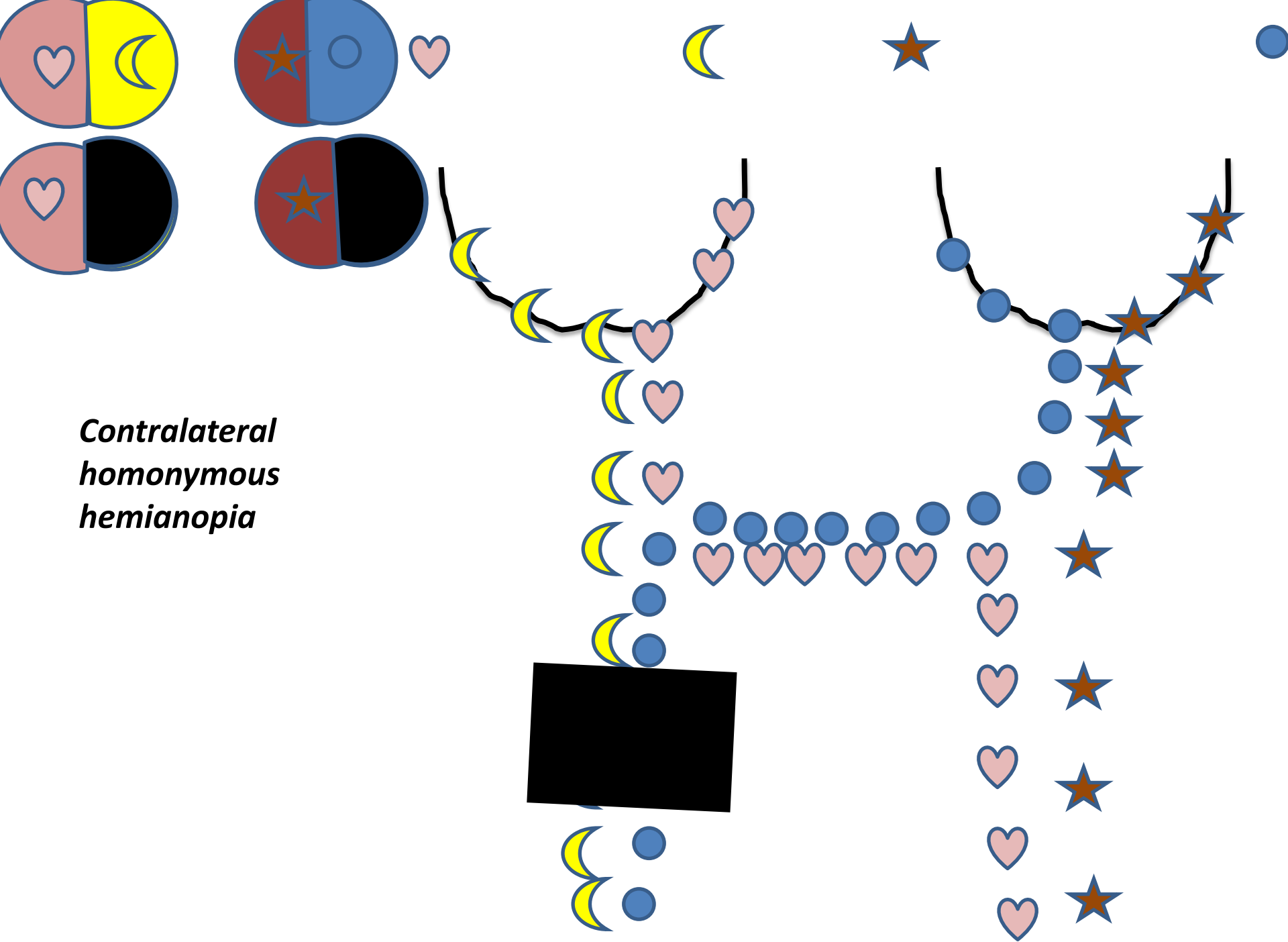
Abbreviation: LHON, Leber hereditary optic neuropathy.





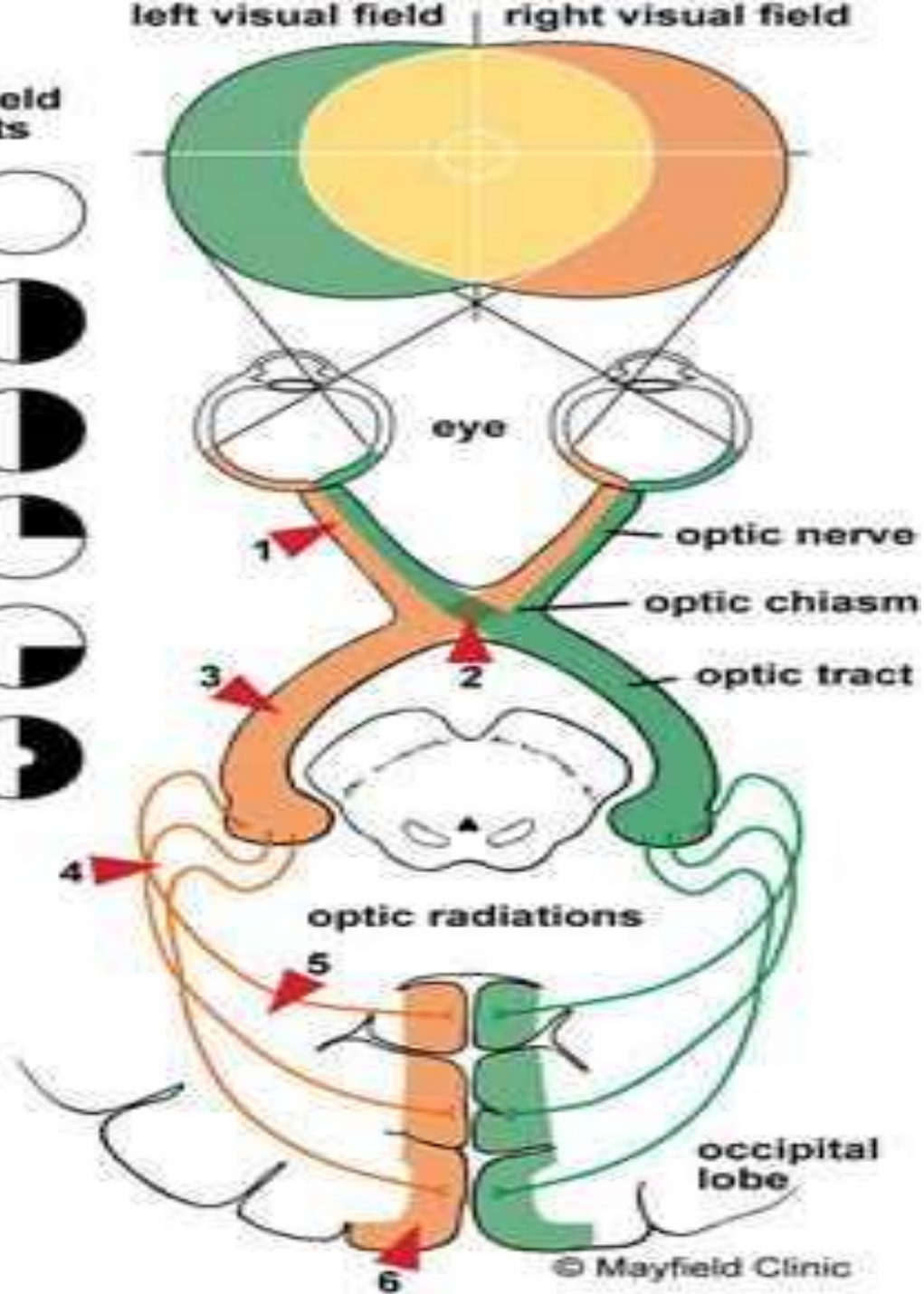
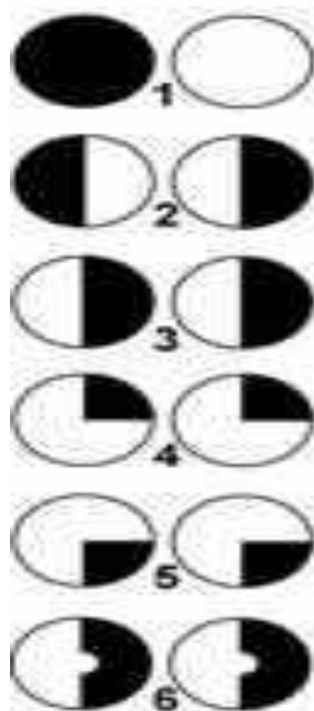


Bitemporal hemianopia



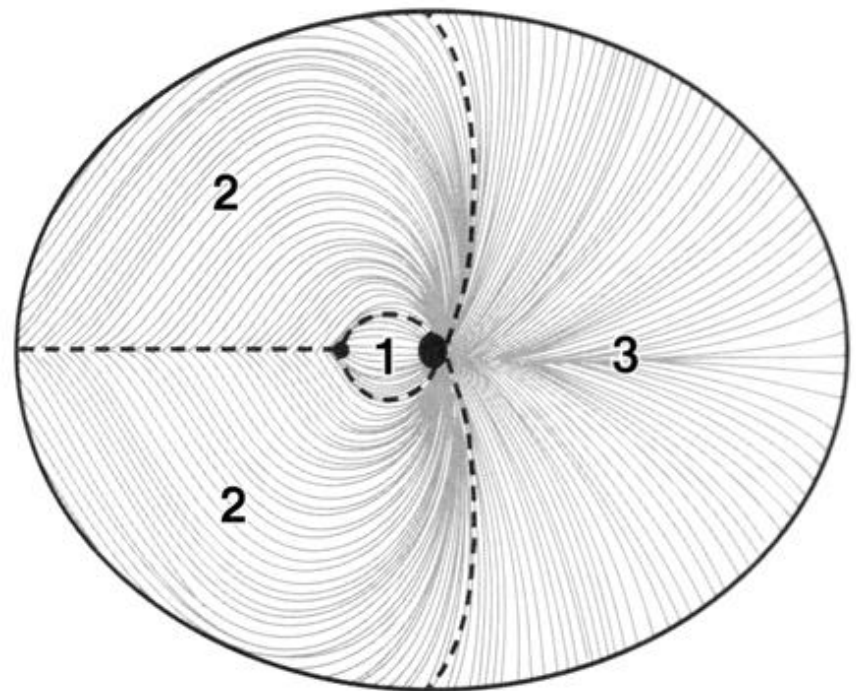
***Contralateral
homonymous
hemianopia***

visual field defects



Optic nerve-type field defects

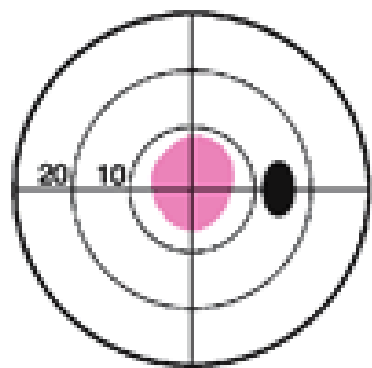
- Retinal fibers enter optic discs in a specific manner.
- **Nerve fiber bundle (NFB) defects are of the following:**
 1. Papillomacular bundle.
 2. Sup. & Inf. Arcuate bundle.
 3. Nasal bundle.



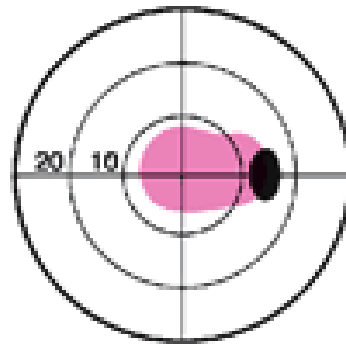
Papillomacular Bundle

- Macular fibers that enter the temporal aspect of the disc.
- *Defect, result in the following:*
 1. **Central scotoma:** defect covering central fixation.
 2. **Centrocecal scotoma:** a central scotoma conneted to the blind spot.
 3. **Paracentral scotoma:** defect of some of the fibers of the papillomacular bundle lying next to, but not involving central fixation.

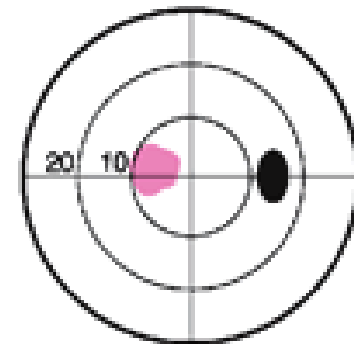
Papillomacular bundle-defects



A *central scotoma* involves the point of central fixation. It's always associated with decreased visual acuity.

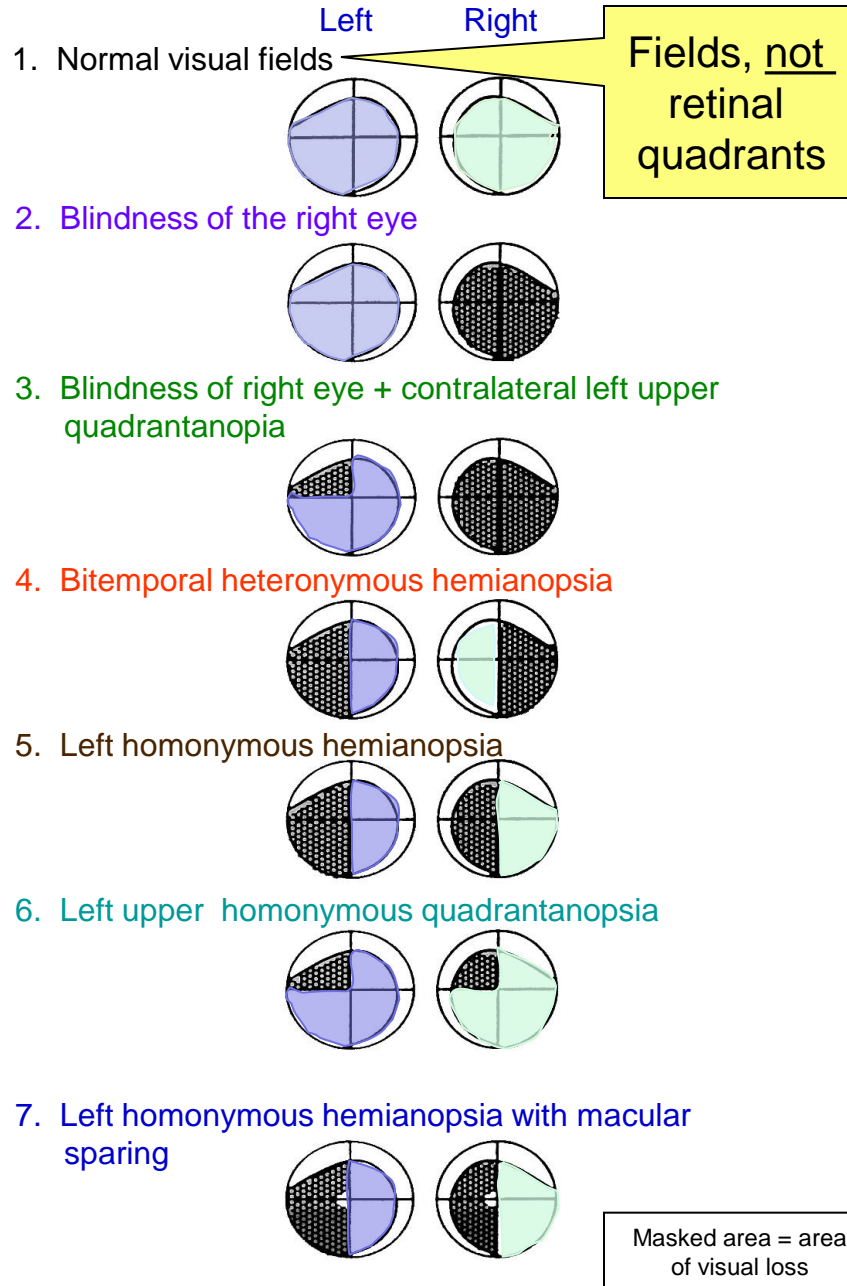


A *centrocecal scotoma* involves the point of central fixation and the area between the blind spot and the fixation point.



A *paracentral scotoma* affects an area of the visual field that is nasal or temporal to the point of central fixation.

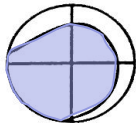
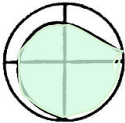
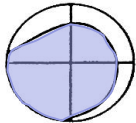
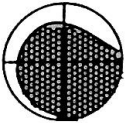
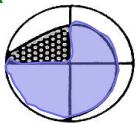
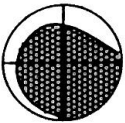
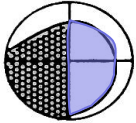
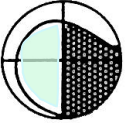
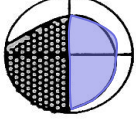
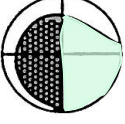
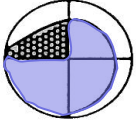
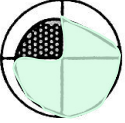
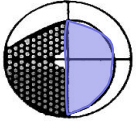
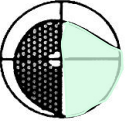
Lesions of the Visual Pathway

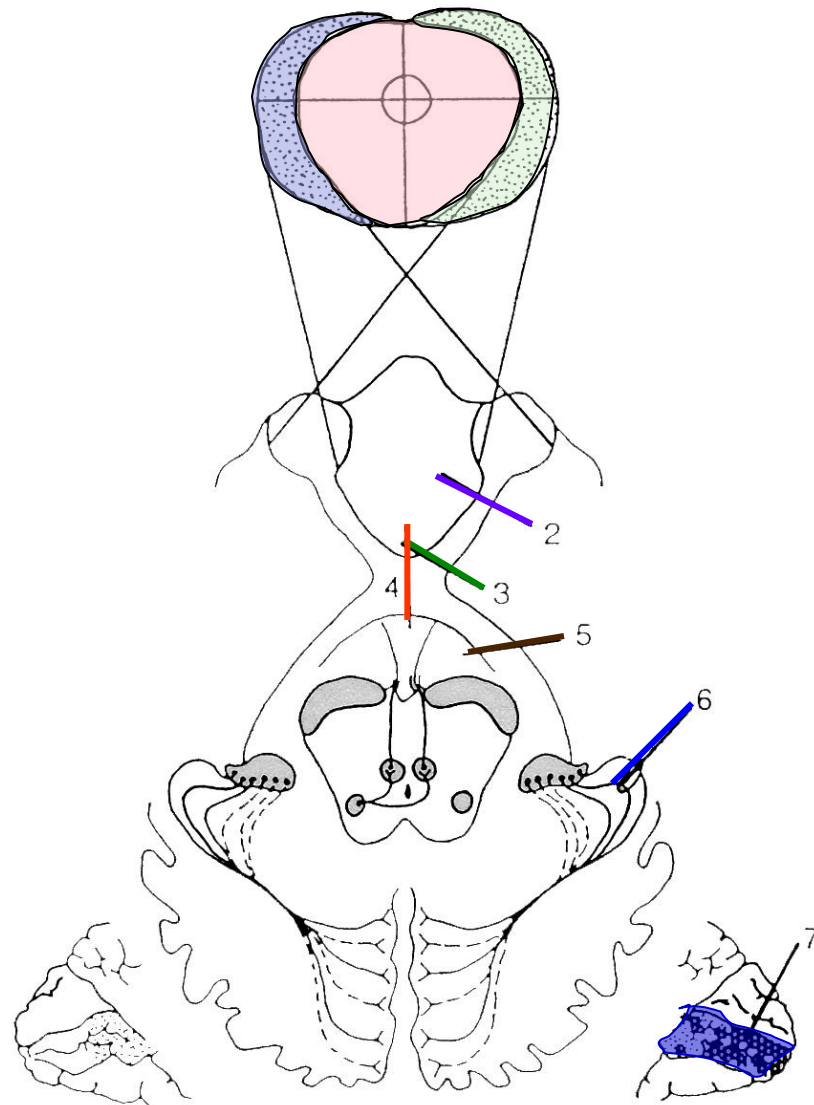


Definitions

- ✓ Strabismus
 - ✓ Diplopia
 - ✓ Amblyopia
 - ✓ Scotoma
 - ✓ Quadrantanopsia - # 3, 6
 - ✓ Hemianopsia - # 4, 5, 7
 - ✓ Heteronymous Defects - # 3, 4
 - ✓ Homonymous Defects - # 5, 6, 7
 - ✓ Congruous Defects - # 5, 6, 7
 - ✓ Incongruous Defects - # 3
 - ✓ Altitudinal Defects - # 6
- Aka "field cuts"

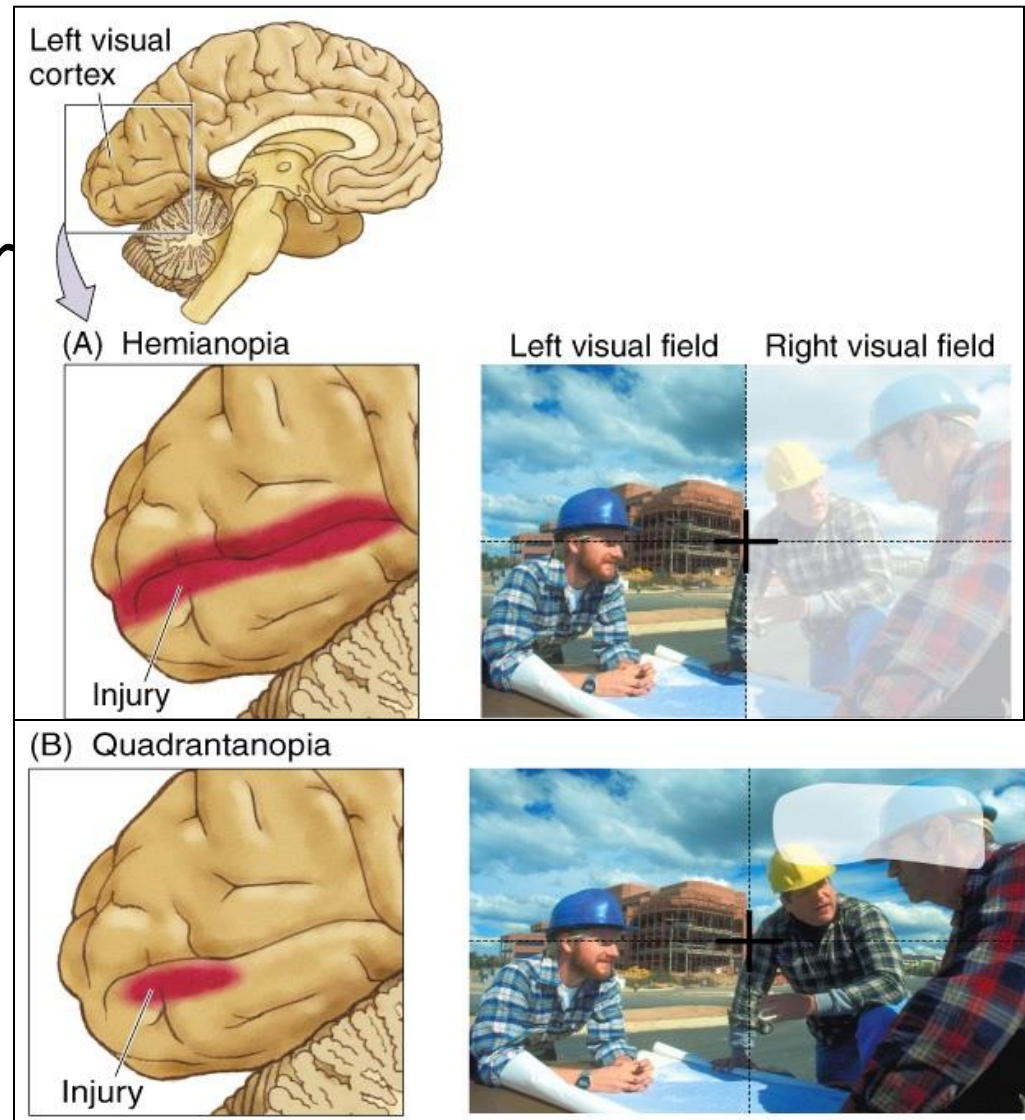
Lesions of the Visual Pathway

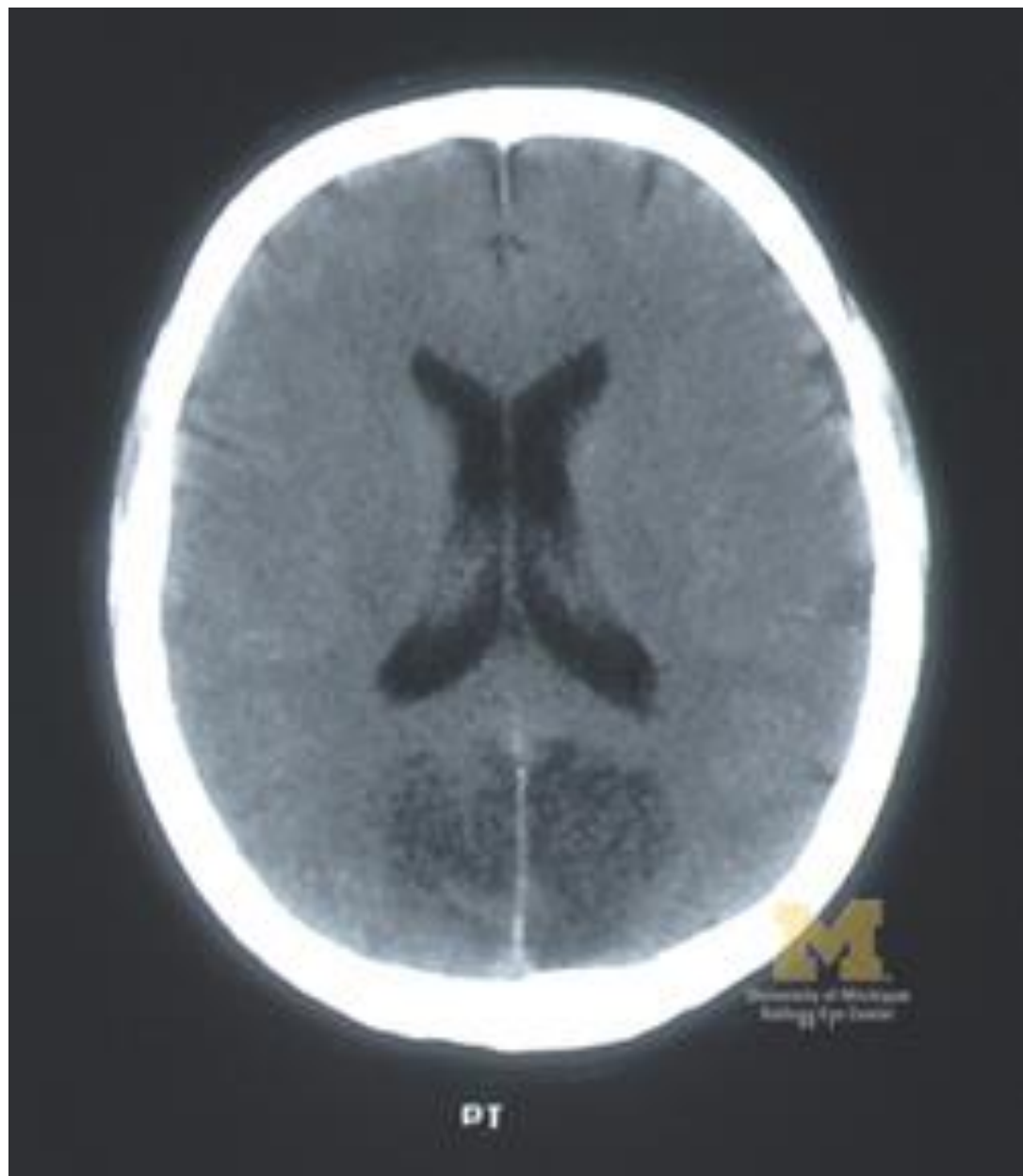
- | | Left | Right |
|---|---|---|
| 1. Normal visual fields |  |  |
| 2. Blindness of the right eye |  |  |
| 3. Blindness of right eye + contralateral left upper quadrantanopia |  |  |
| 4. Bitemporal heteronymous hemianopsia |  |  |
| 5. Left homonymous hemianopsia |  |  |
| 6. Left upper homonymous quadrantanopia |  |  |
| 7. Left homonymous hemianopsia with macular sparing |  |  |

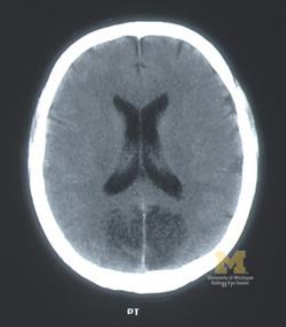


Lesions of the Visual Pathway

- **Hemianopia** – loss of pattern vision in either the left or right visual field
- **Quadrantanopia** – blindness in one quadrant of the visual field – damage to the optic tract, LGN or V1







Anton–Babinski syndrome

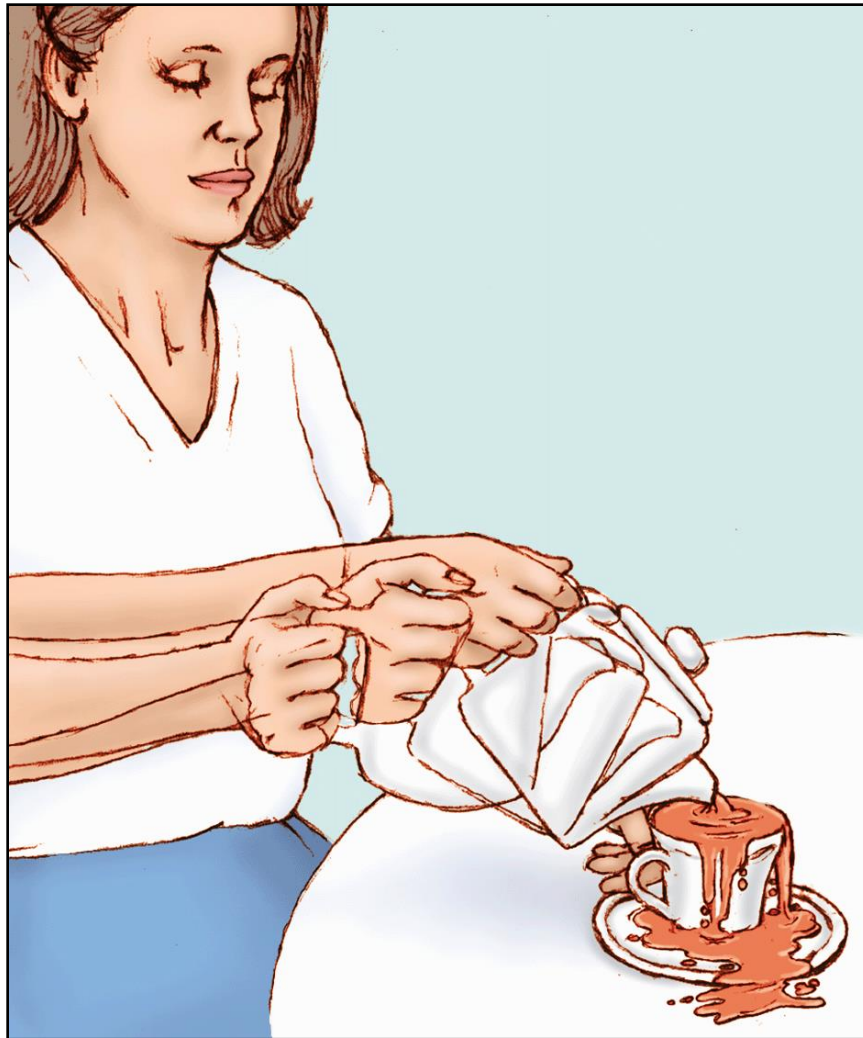
(Visual anosognosia)



Gabriel Anton

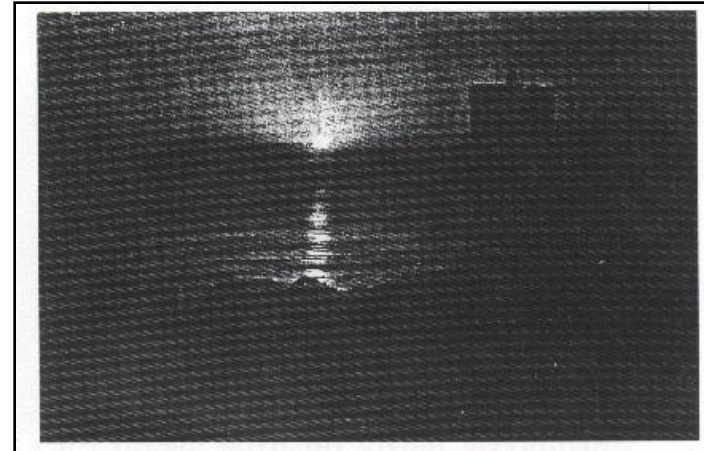
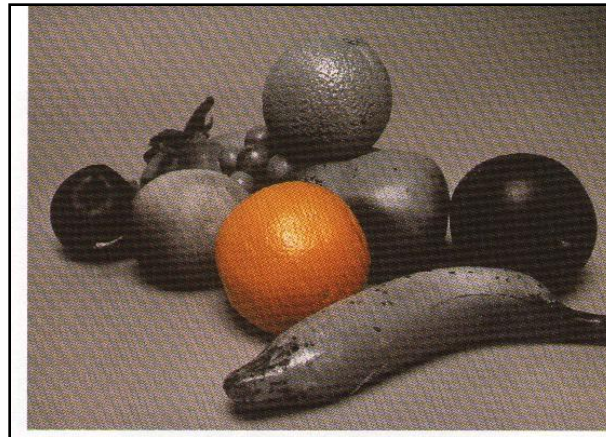
- Denial of blindness who cannot see.
- The lesion extend beyond the striate cortex to involve visual association areas.
- Failing to accept being blind, the sufferer dismisses evidence of his condition and employs confabulation to fill in the missing sensory input.
- Lesion is in visual association areas superior to calcarine cortex.

Deficits in Motion Perception: Akinetopsia



Deficits in Color Perception - Achromatopsia

- Congenital colorblindness (dichromats) vs. acquired colorblindness
- Usually associated with damage to V4
- Object recognition OK



Deficits in Color Perception - Achromatopsia



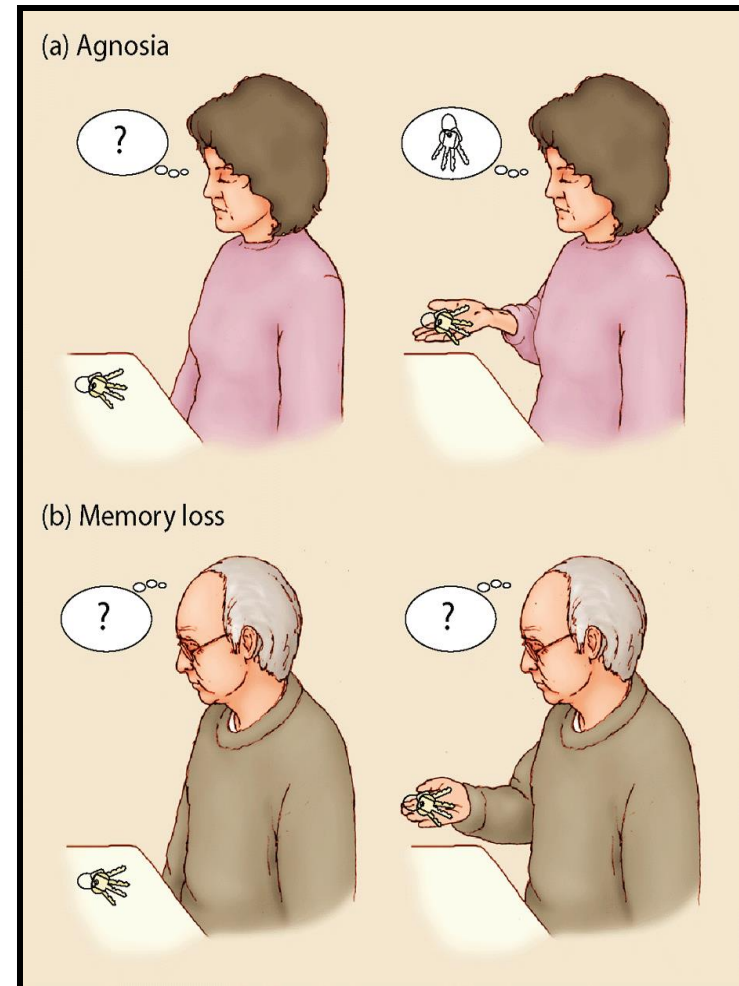
Simulation of hemiachromatopsia



Normal colour vision

Deficits Following Damage to the WHAT Pathway

- **Visual agnosia** – partial or total inability to recognize visual stimuli, unexplainable by a defect in elementary sensation or reduced level of alertness or memory



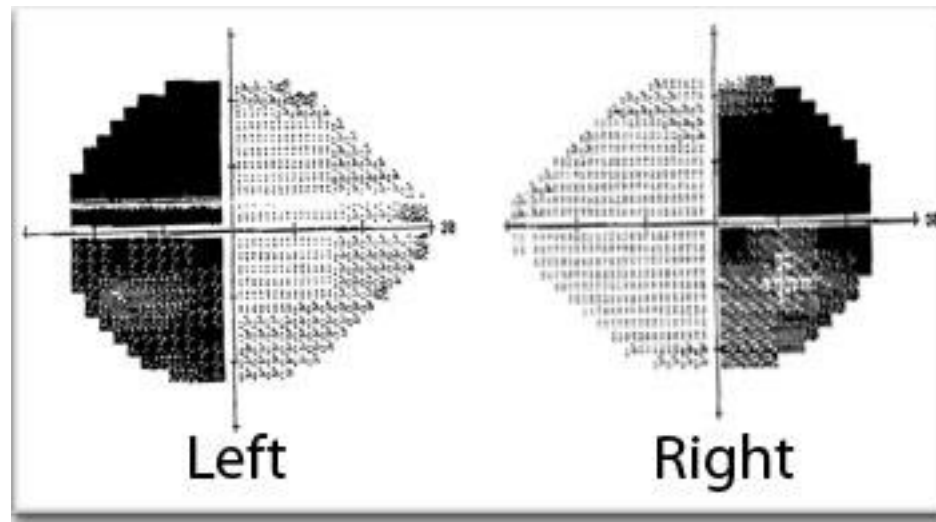
Optic nerve

- **Anatomy of visual pathway**
- **How to examine**
- **Visual pathway disorders**
- **Quiz**

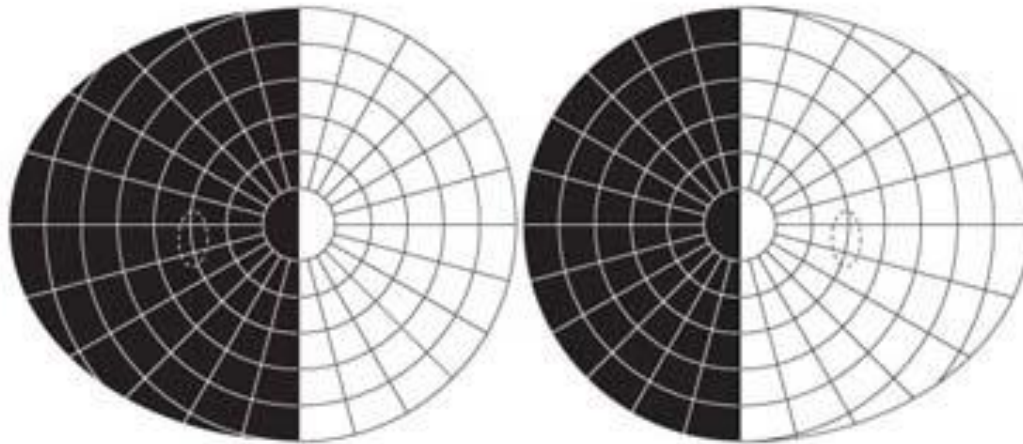
Optic nerve

- **Anatomy of visual pathway**
- **How to examine**
- **Visual pathway disorders**
- **Quiz**

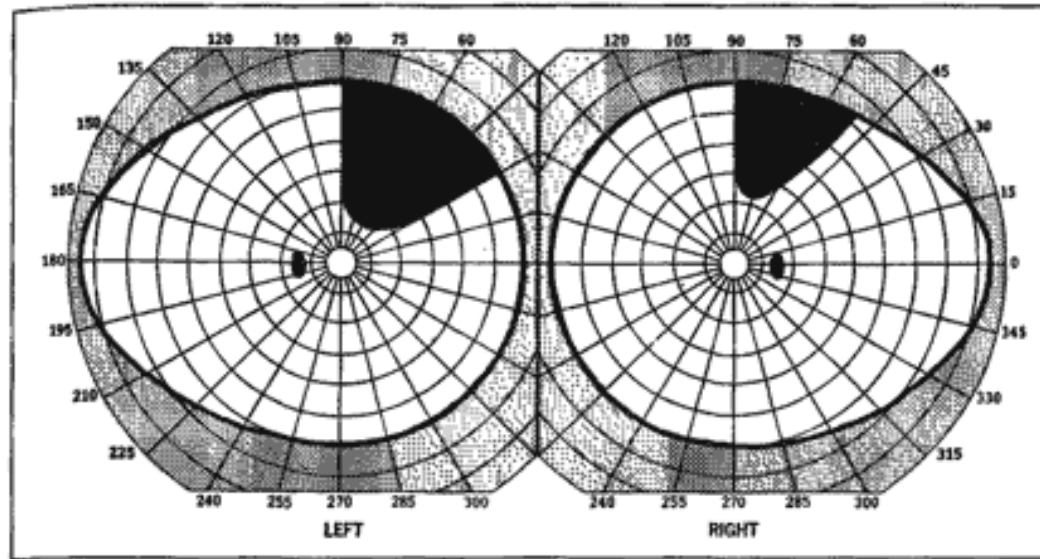
Describe the visual field defect ?



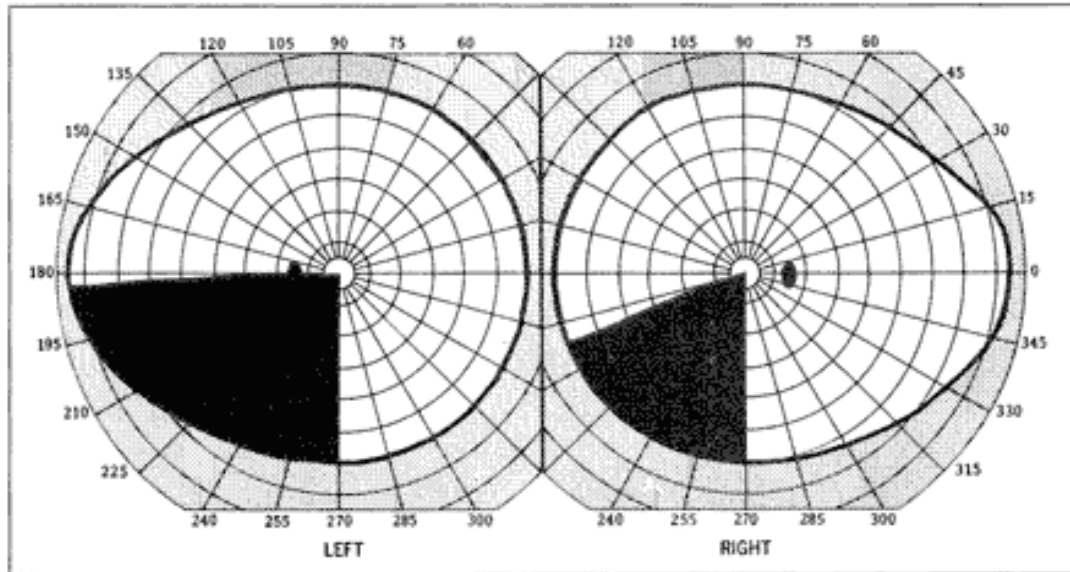
Describe the visual field defect ?



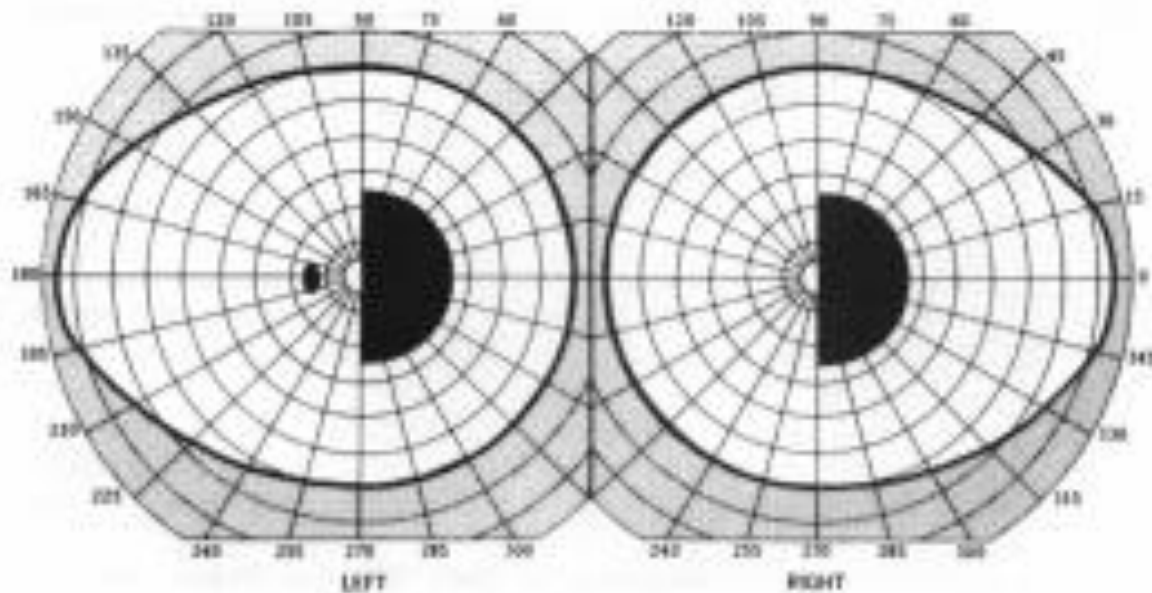
Describe the visual field defect ?



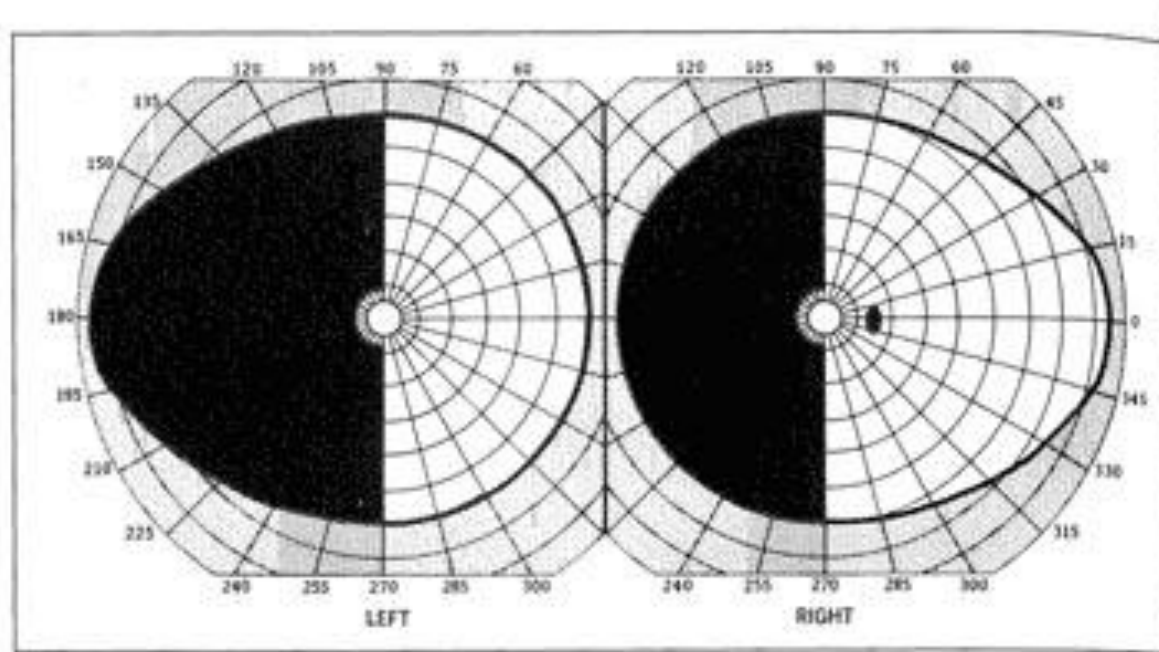
Describe the visual field defect ?



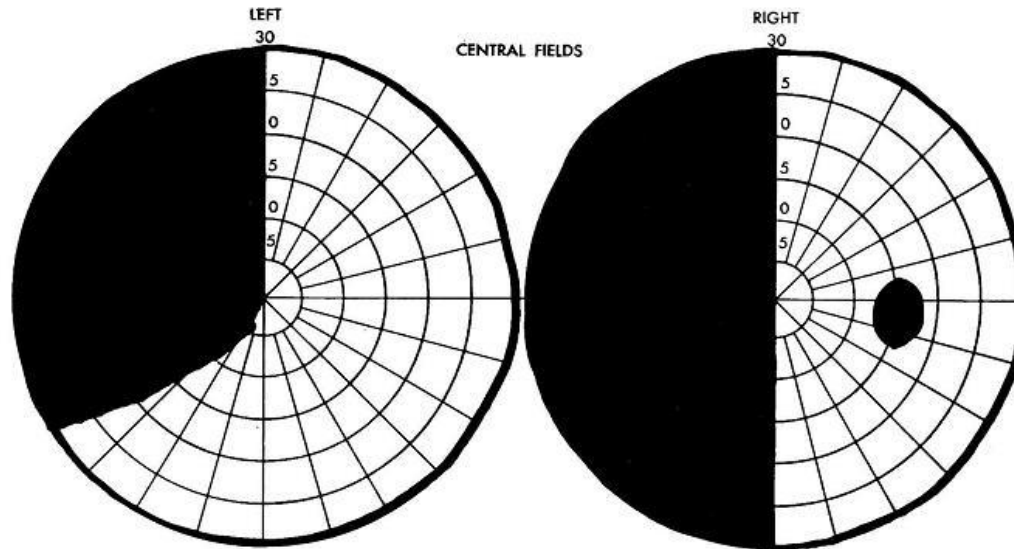
Describe the visual field defect ?



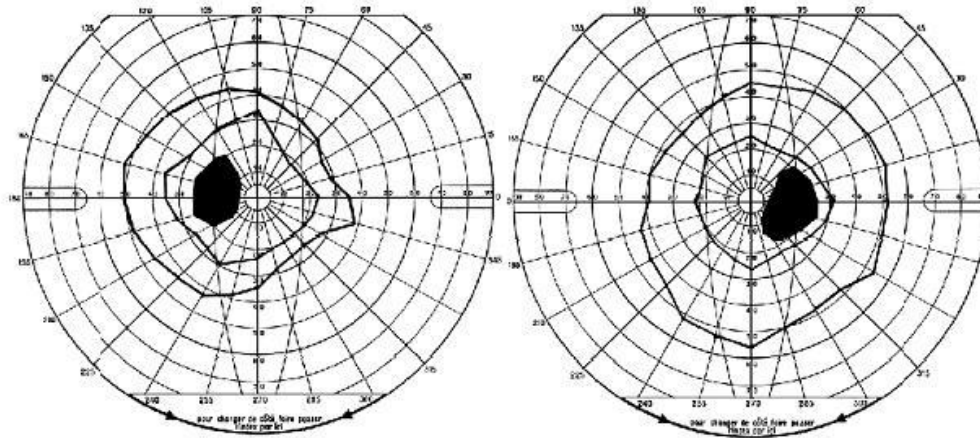
Describe the visual field defect ?



Describe the visual field defect ?



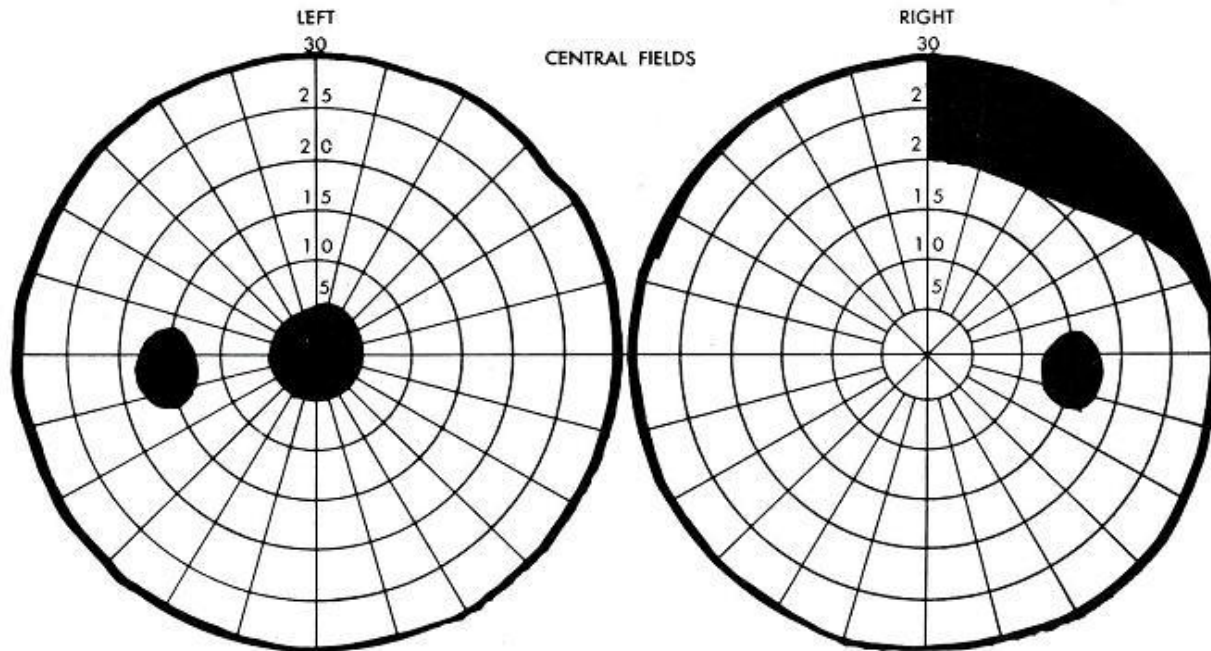
Describe the visual field defect ?



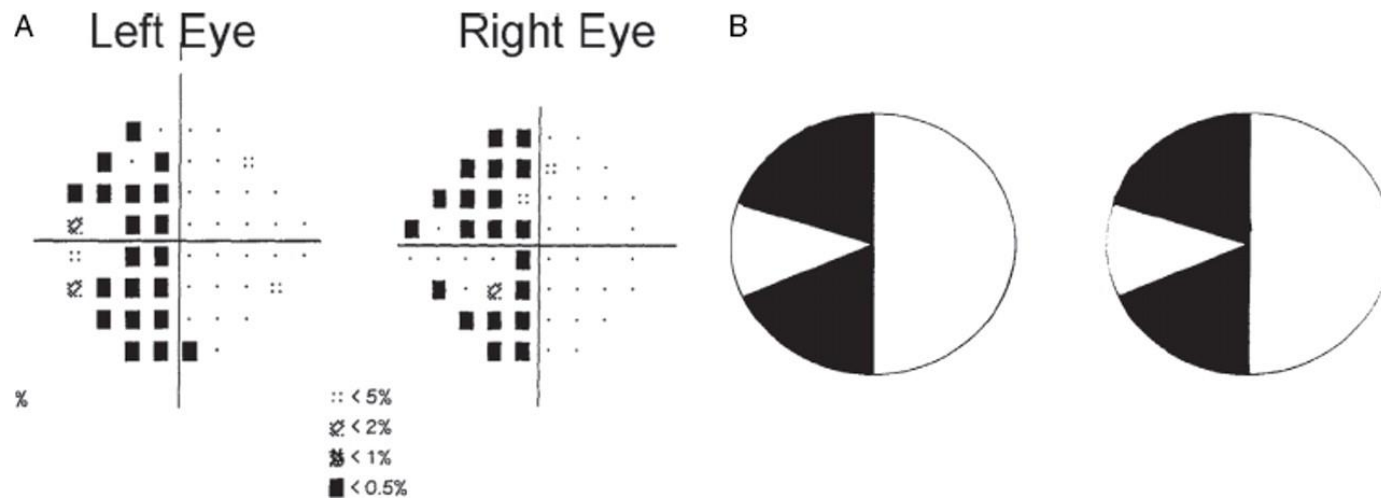
Left eye

Right eye

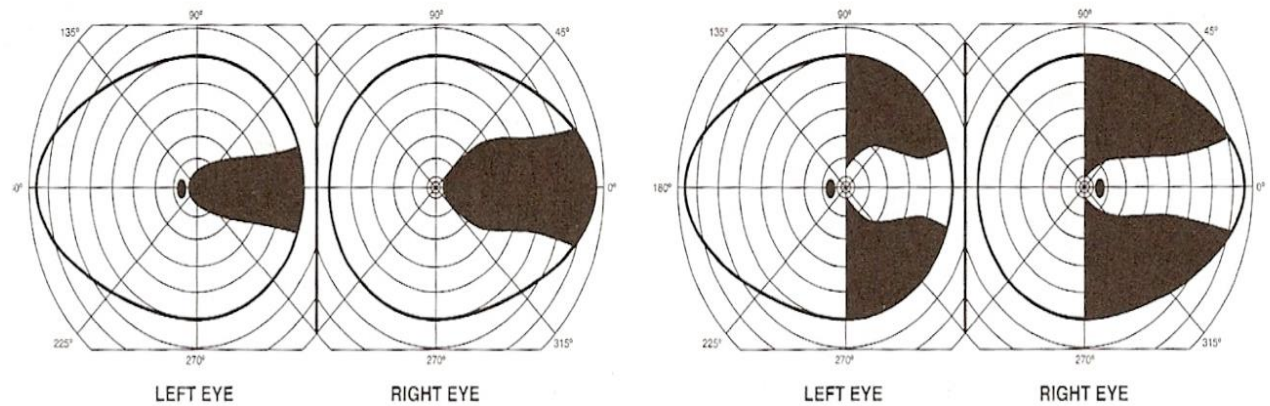
Describe the visual field defect ?



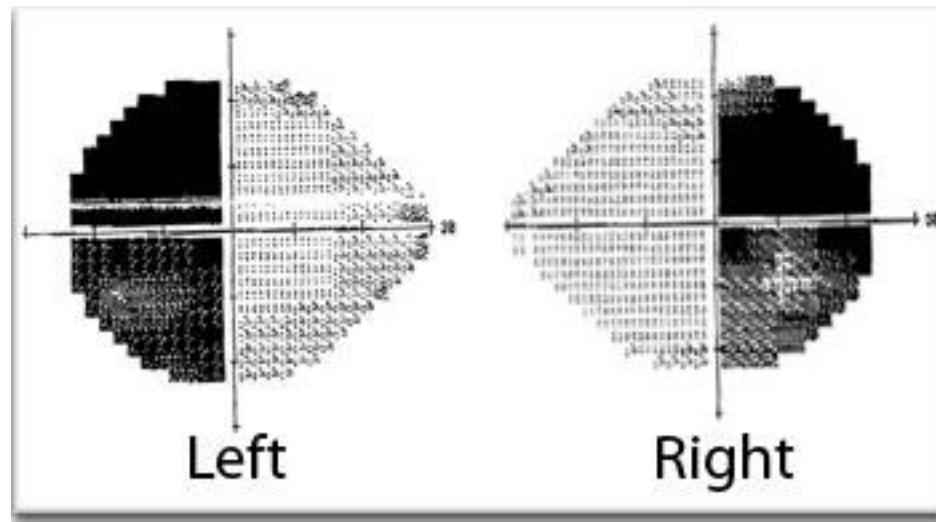
Describe the visual field defect ?



Describe the visual field defect ?

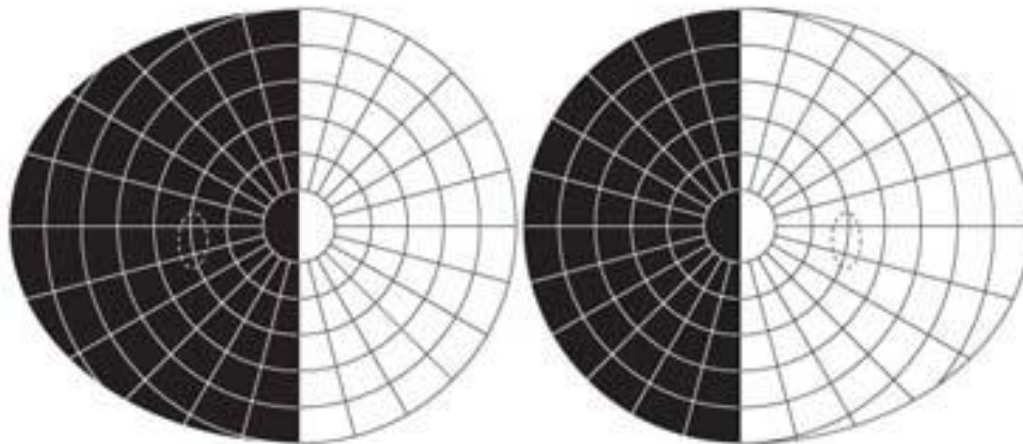


Describe the visual field defect ?



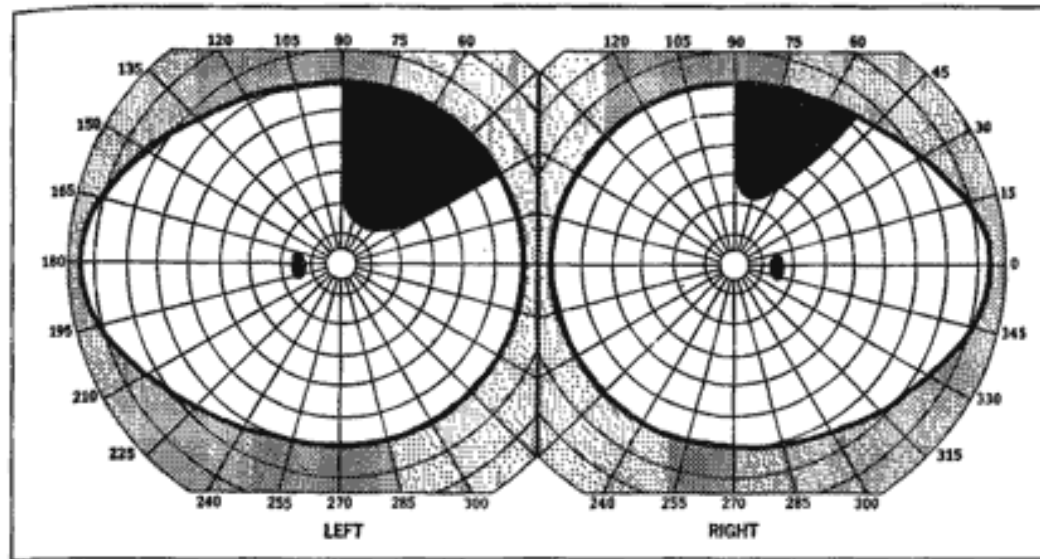
Bitemporal Homonymous Hemianopia

Describe the visual field defect ?



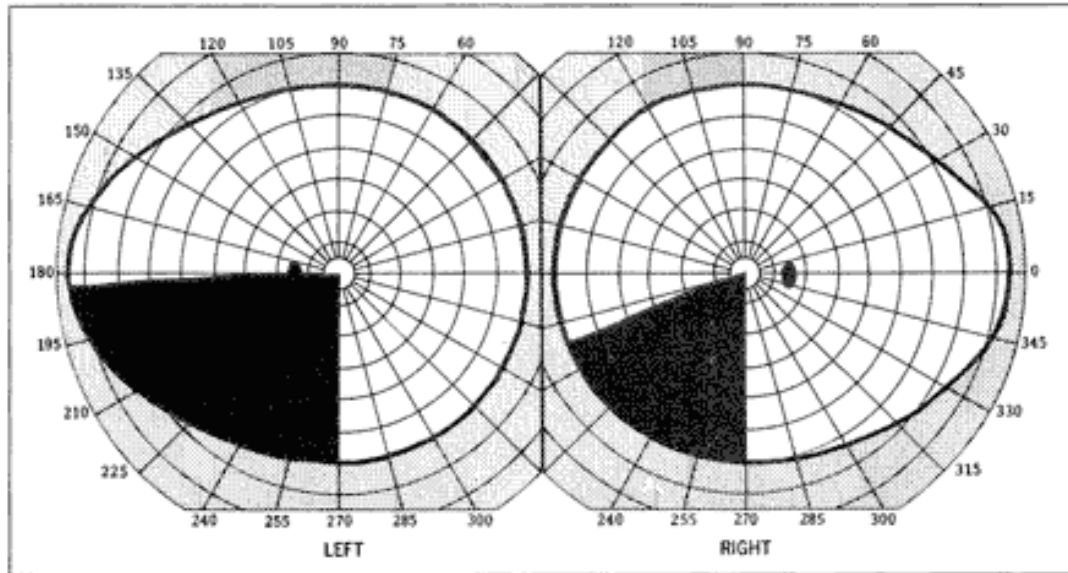
Left Homonymous Hemianopia

Describe the visual field defect ?



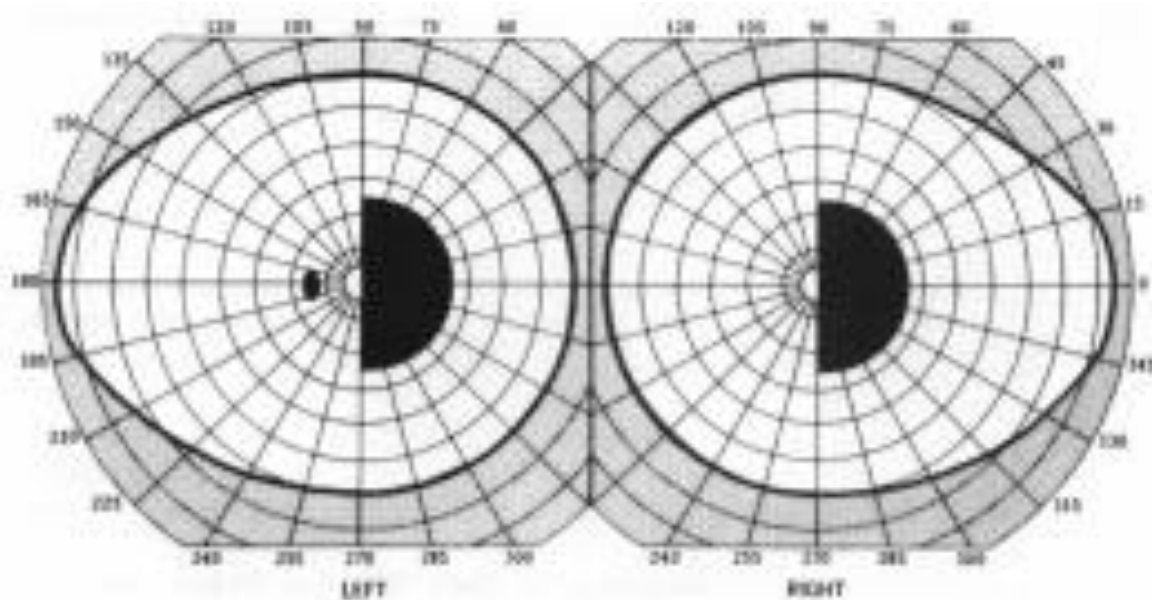
**Right superior quadrantanopia >>
temporal lobe lesion**

Describe the visual field defect ?



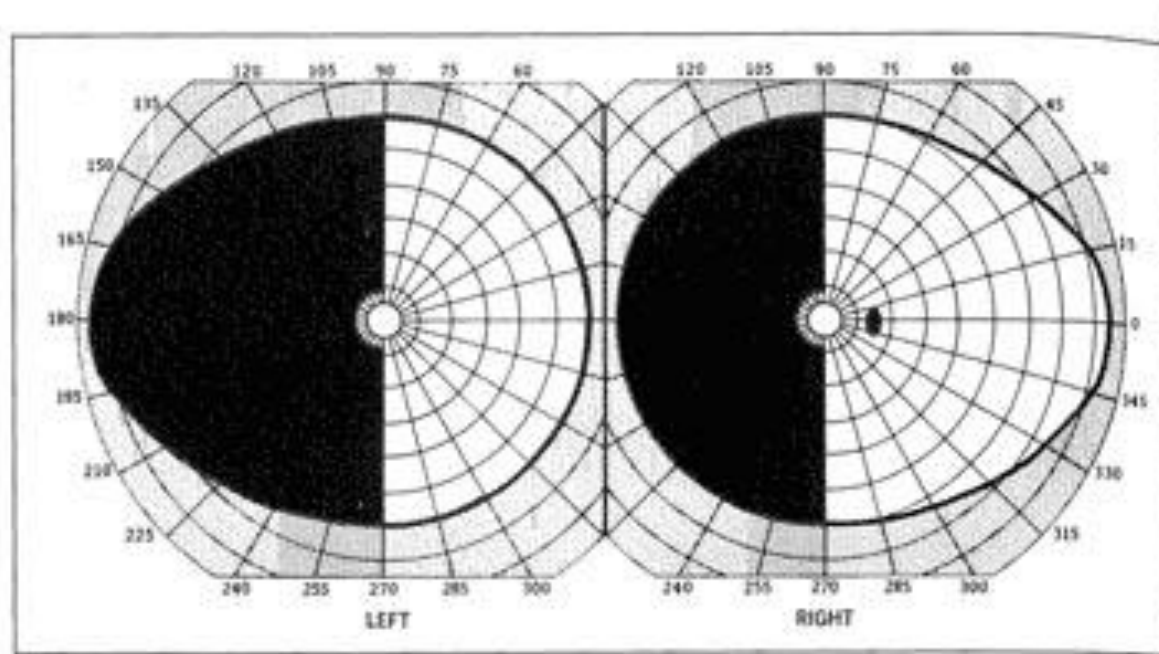
Left inferior quadrantanopia >> parietal lobe lesion

Describe the visual field defect ?



Right homonymous hemianopia

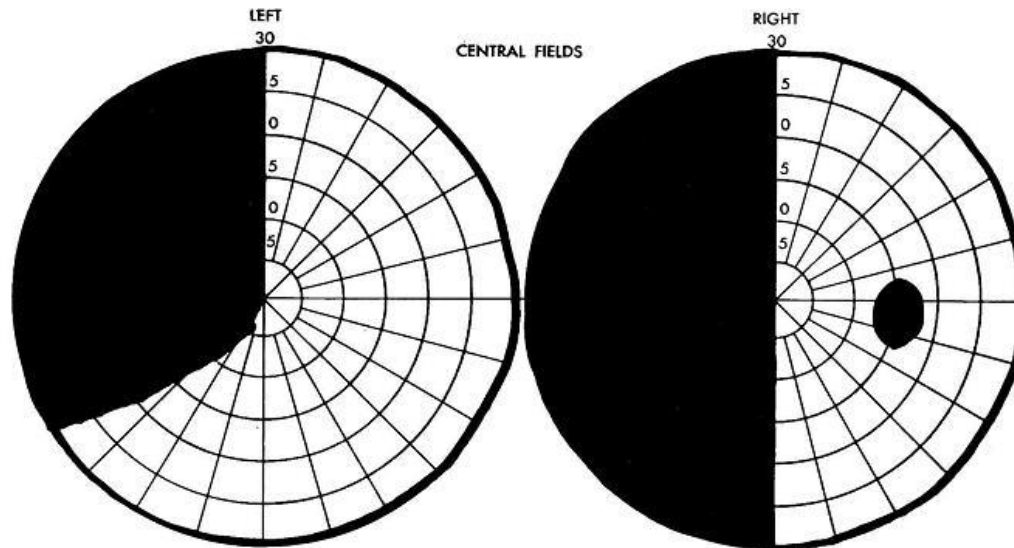
Describe the visual field defect ?



6

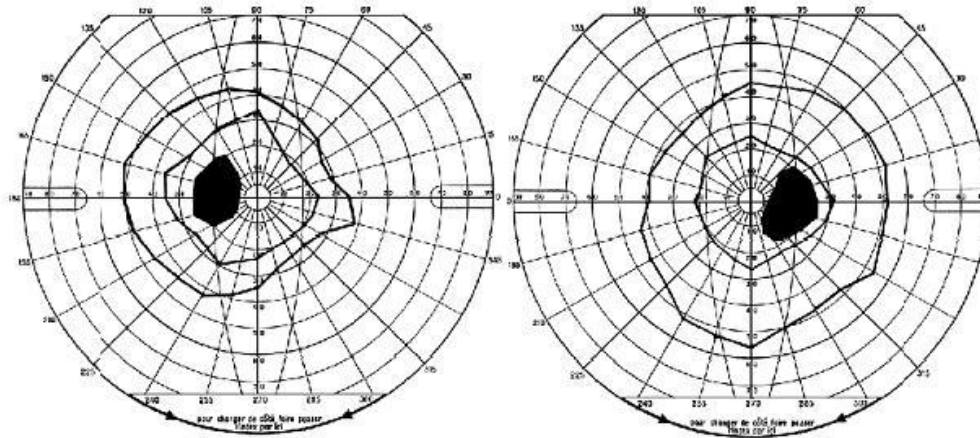
**Left homonymous hemianopia with
macular sparing**

Describe the visual field defect ?



Left incongruous homonymous hemianopia

Describe the visual field defect ?

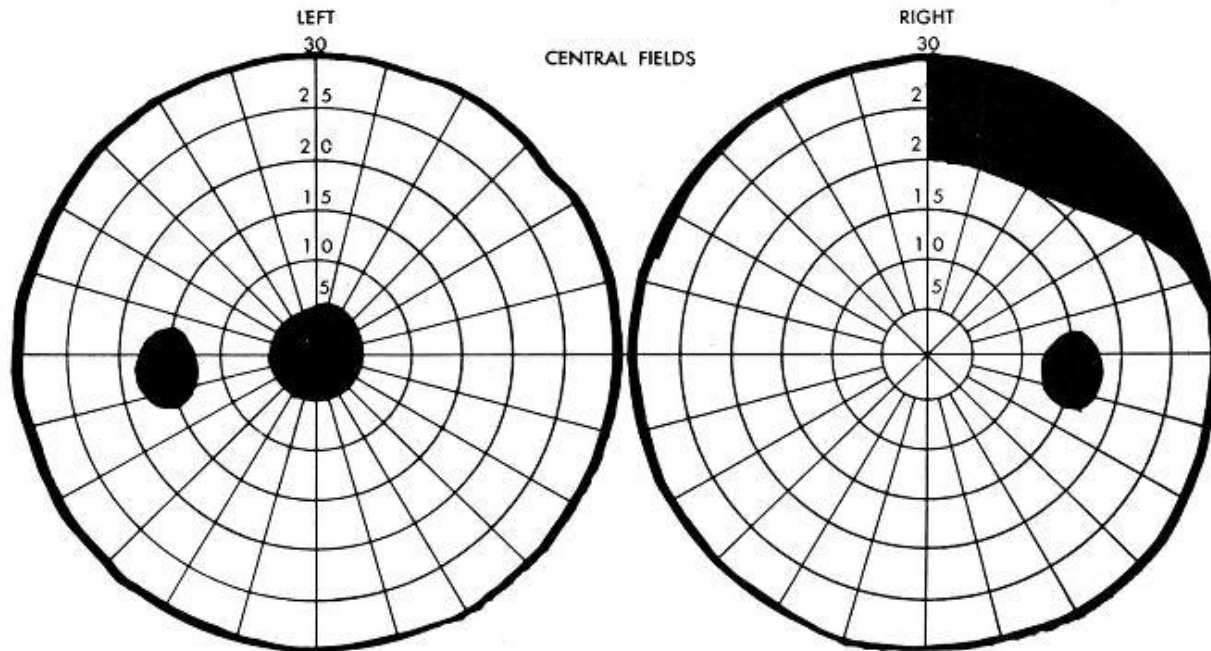


Left eye

Right eye

Enlarged Blind Spot

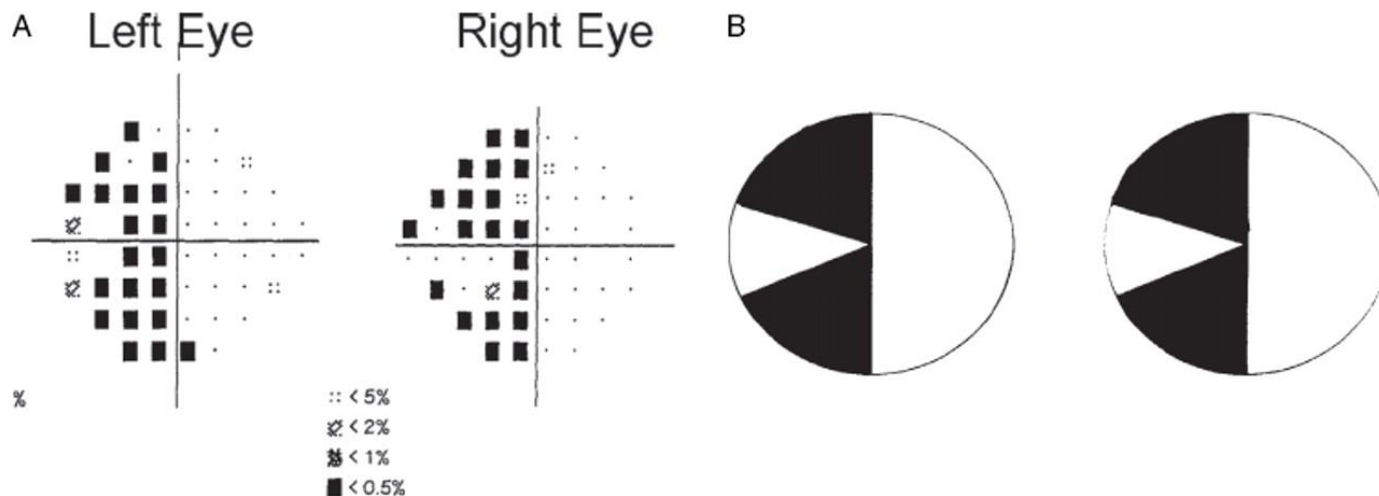
Describe the visual field defect ?



9

Junctional scotoma: lesion at junction of optic nerve and chiasm

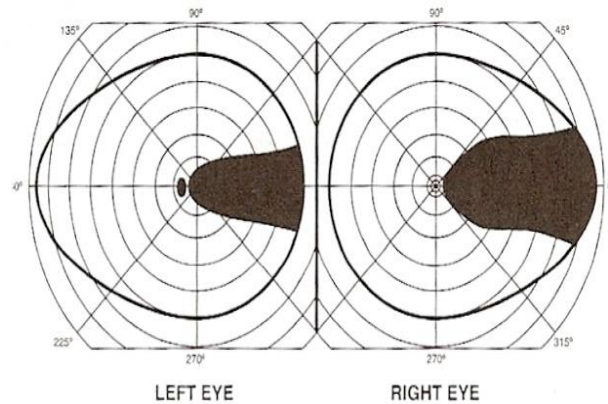
Describe the visual field defect ?



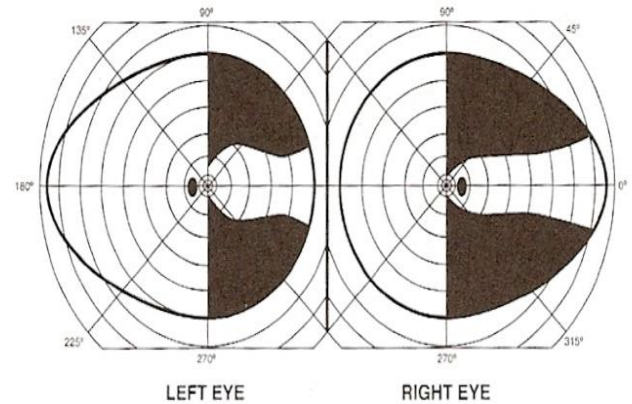
Left sector sparing homonymous hemianopia >> lesion at LGN.

Describe the visual field defect ?

A.



B.



Describe the visual field defect ?

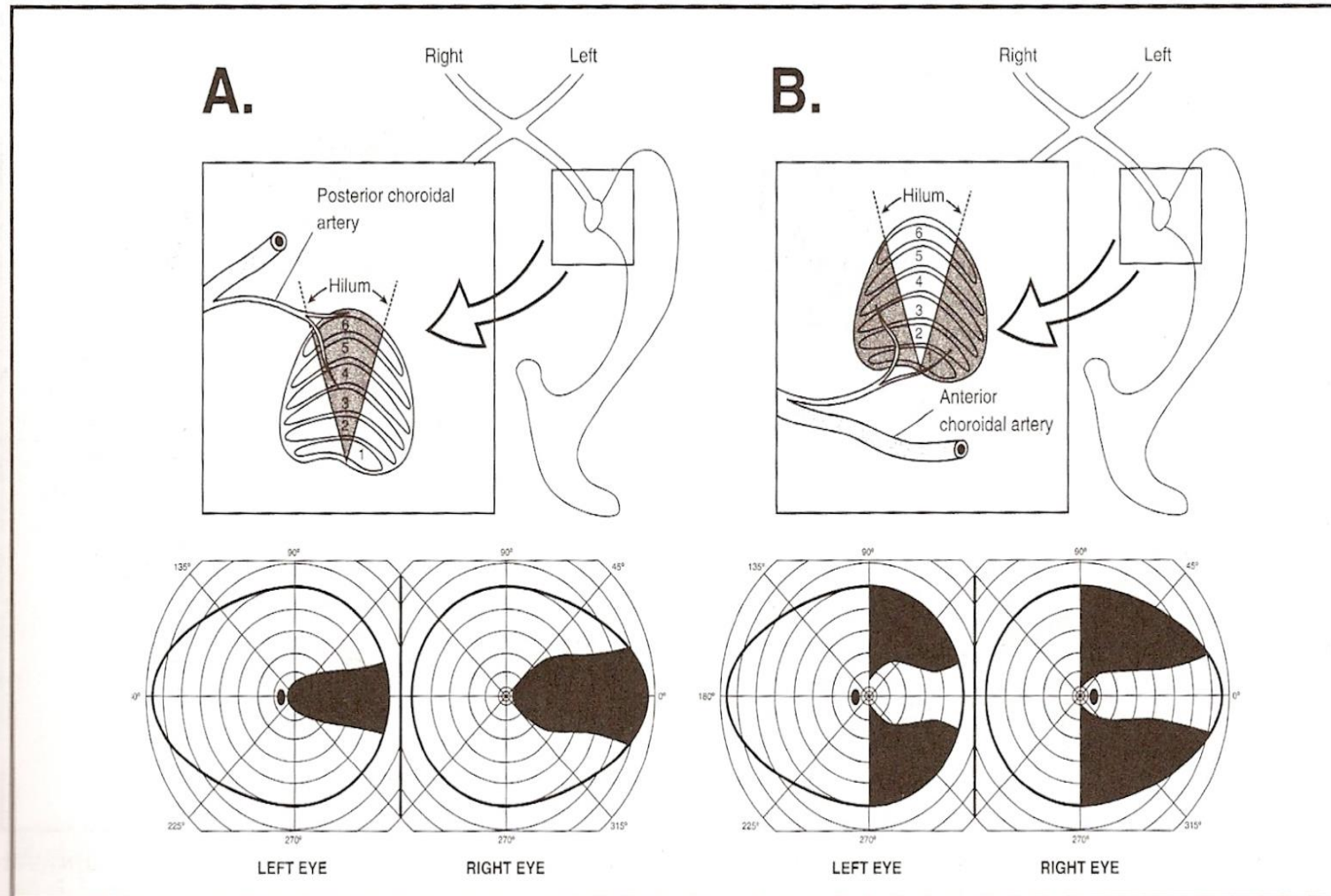


Figure 1-15. (A) Posterior choroidal artery occlusion leads to homonymous horizontal sectoranopia. (B) Anterior choroidal artery occlusion causes sector-sparing homonymous hemianopia.



THANK YOU

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