

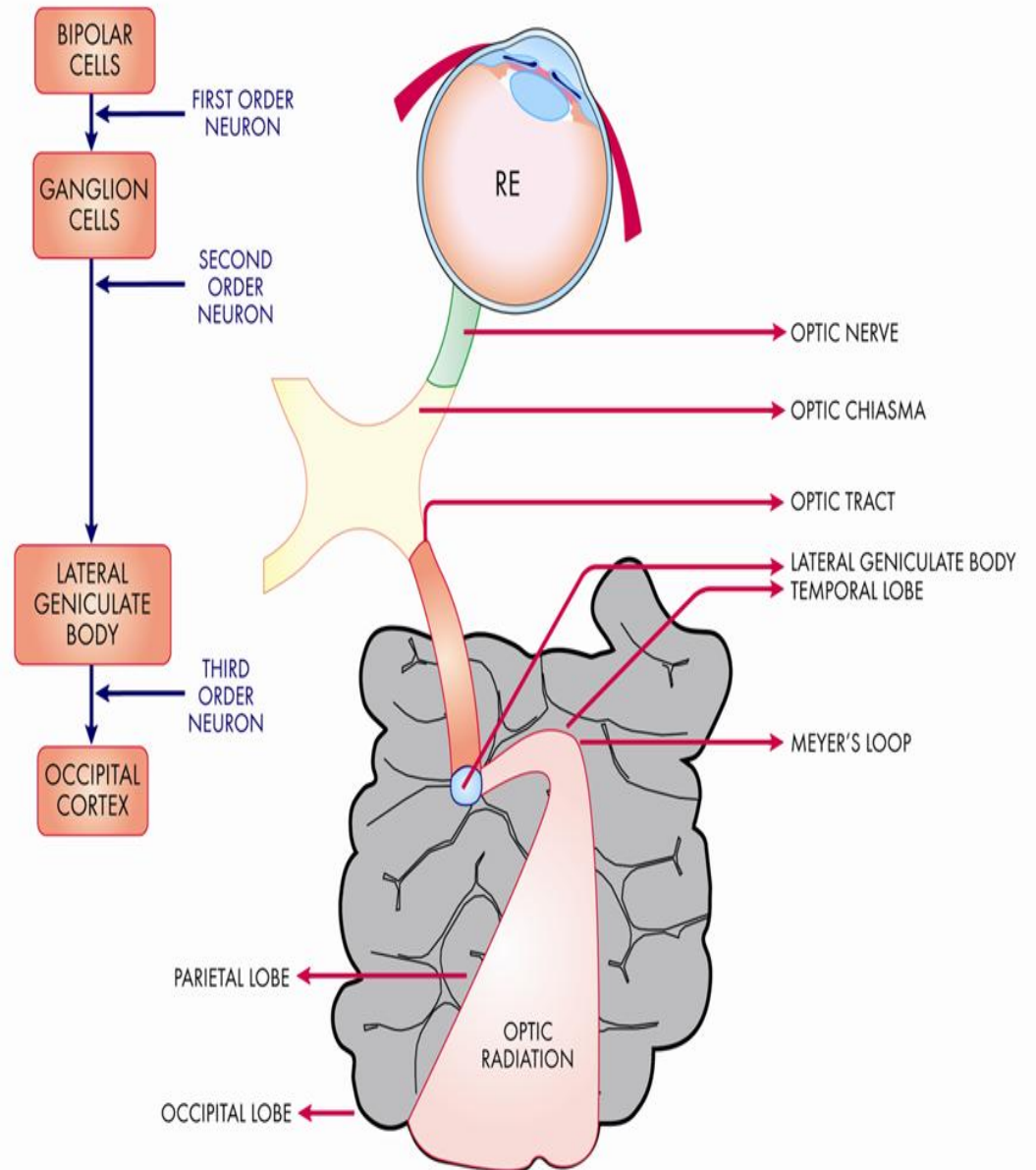
# ANATOMY OF VISUAL PATHWAY

Sourav.k

Refers to neuronal networks that extend from the retina to visual cortex

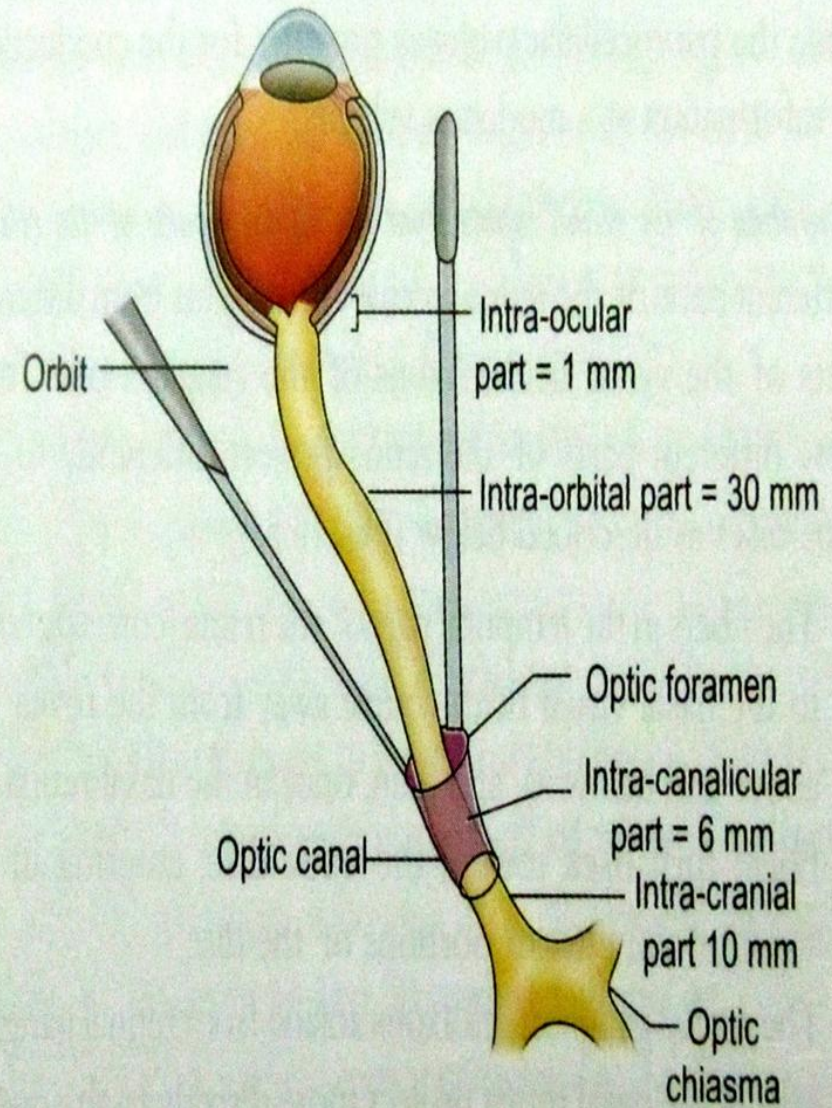
comprises of

1. optic nerve
2. optic chiasma
3. optic tract
4. lateral geniculate body
5. optic radiations
6. visual cortex



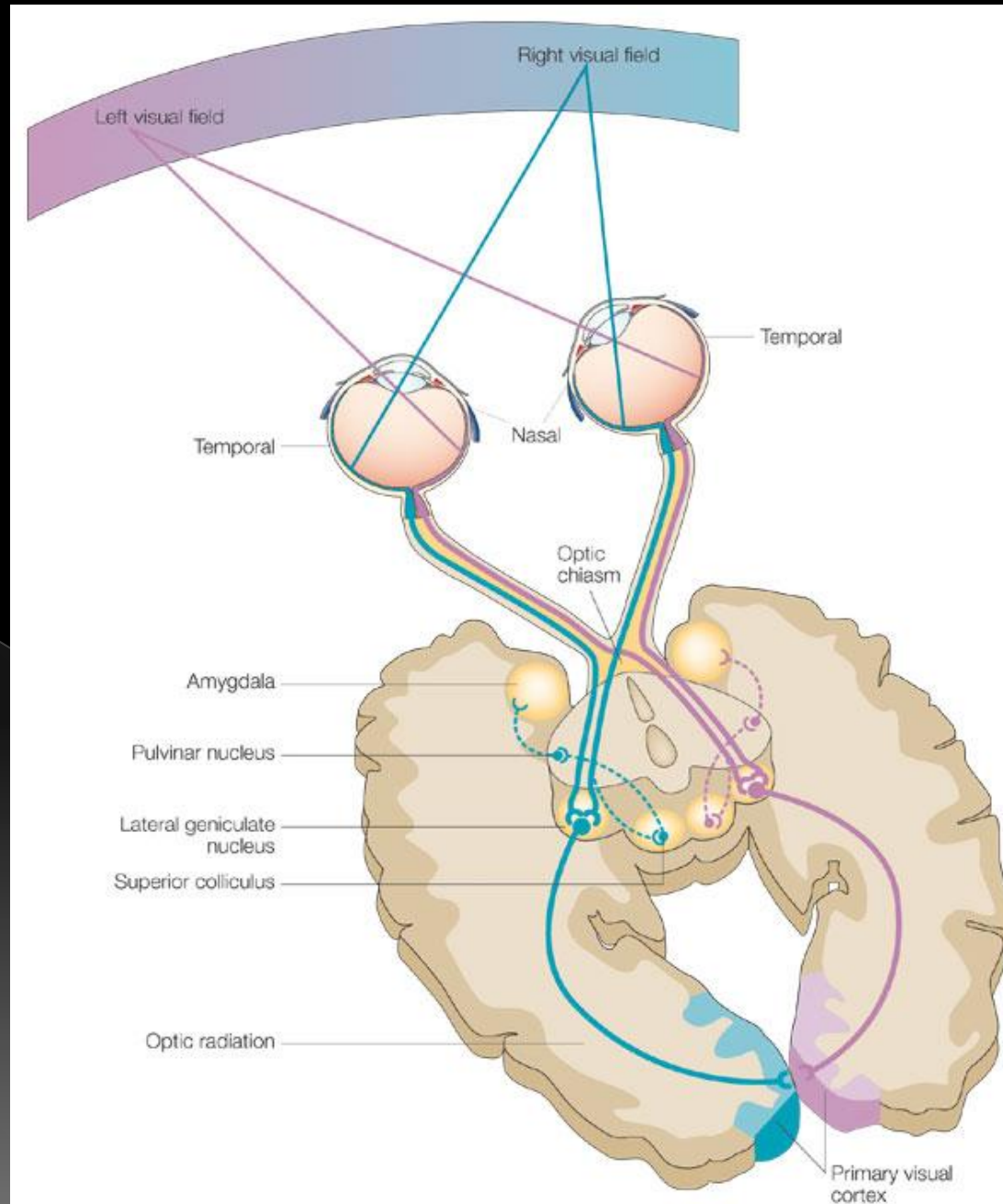
# Optic nerve

- Comprises axons of ganglion cells
- 47-50 mm length
- Extends from optic disc to chiasma
- Contains the afferent fibres of light reflex
- Has 4 parts : 1)intraocular (1mm)  
2)intraorbital (30mm)  
3)intra canalicular (6-9mm)  
4)intracranial (10mm)



**Fig. 16.5.4:** Various parts of the optic nerve

- Each optic nerve start from optic disc and extend up to optic chiasma.
- Morphologically and embryologically optic nerve is comparable to a sensory tract of the brain
- Optic nerve is an outgrowth of brain.
- Not covered by neurilemma so does not regenerate when cut.
- Fibres of optic nerve are very thin (2-10  $\mu\text{m}$  in diameter) & are million in number.
- surrounded by meninges unlike other peripheral nerves.





# Intra ocular part (1 mm)

- Part passes through sclera and choroid and appears as optic disc
- Short introcular course of optic nerve is k/a optic nerve head and portion that can be seen by ophthalmoscope is called optic disc
- Intraocular portion of the ONH has an average diameter of 1.5mm which extends to approx 3 mm just behind the sclera.
- Divided in to
  - 1.surface nerve fibre layer
  - 2.prelaminar region
  - 3.lamina cribrosa
  - 4.retro laminar region

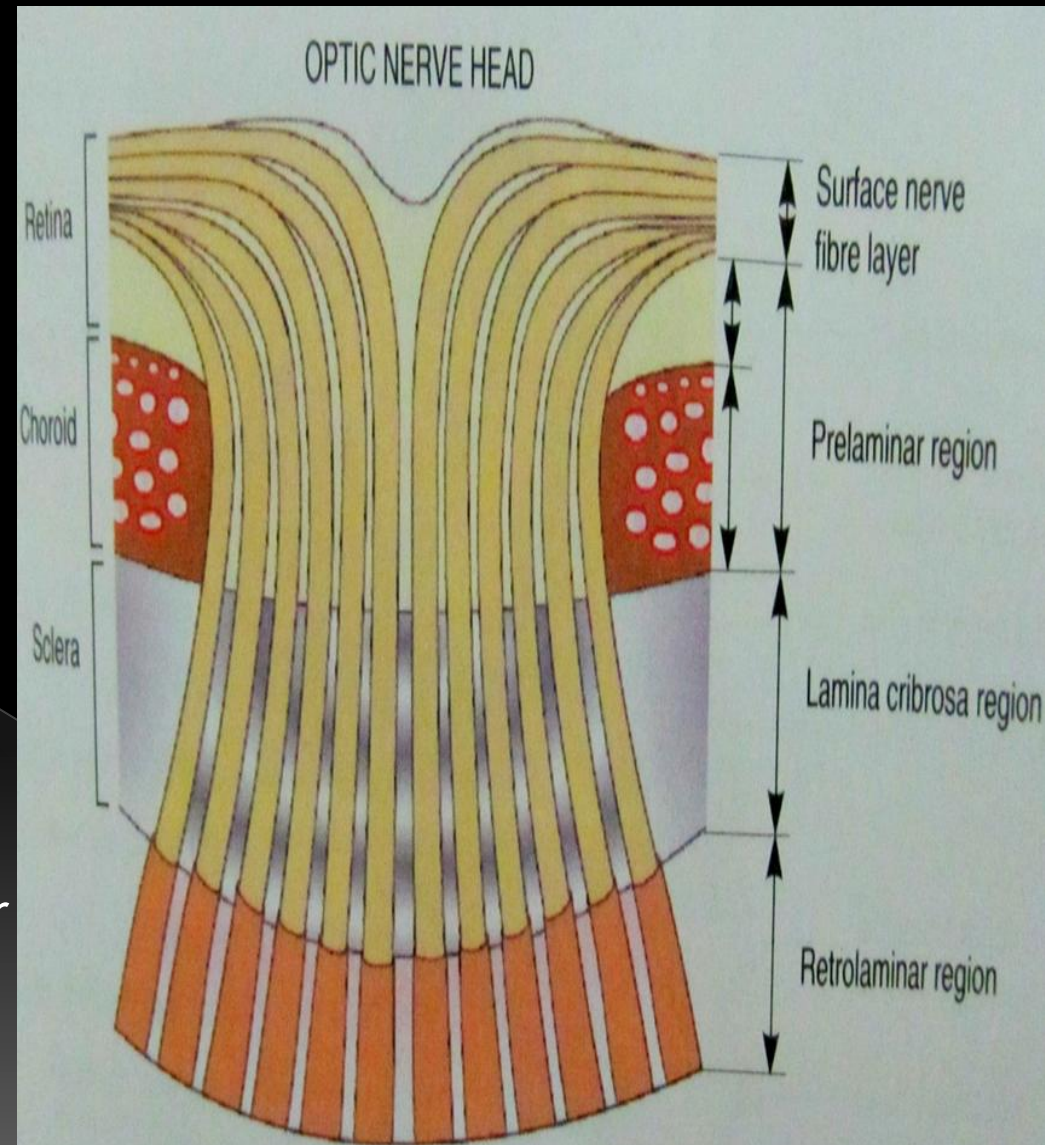


Fig. 6.13. Schematic drawing of optic nerve head.

# 1.surface nerve fibre layer

- ◎ This part is essentially composed of axon bundles, i.e. nerve fibers of the retina (94%) which converge on the optic disc and astrocytes (5%).
- ◎ The optic disc is covered by a thin layer of astrocytes, the ILM of Elschnig, which separate it from the vitreous and continuous with ILM. When central portion of this membrane is thickened, it is referred to as the central meniscus Khunt.

## 2.prelaminar region

- The predominant structures at this level are neurons and significantly increase quantity of astroglial tissue.

## 3.lamina cribrosa

- It is fibrillar sieve-like structure made up of fenestrated sheets of scleral connective tissue lined by glial tissue. It bridges the posterior scleral foramina. The bundle of ON fibers leaves the eye through these fenestration.
- The lamina cribrosa gets its rich blood supply from the circle of zinn.

## 4. retro laminar region

- ◎ This area is characterized by a decrease in astrocytes and gain of myelin that is supplied by oligodendrocytes. The addition of myelin sheath nearly doubles the diameter of the optic nerve (from 1.5 to 3.0 mm) as it passes through the sclera.



# Intra orbital part

- 25 mm in length
- Extends from globe to orbital apex
- Takes curved path, extra length allows gentle movement of globe

## RELATIONS

- Surrounded by all 3 layers of meninges & subarachnoid space.
- Some fibres of superior & medial rectus are adherent to its sheath & account for painful ocular movements in **retrobulbar neuritis**.
- The central retinal artery along with vein crosses the subarachnoid space to enter the nerve on its inferomedial aspect about 10 mm.

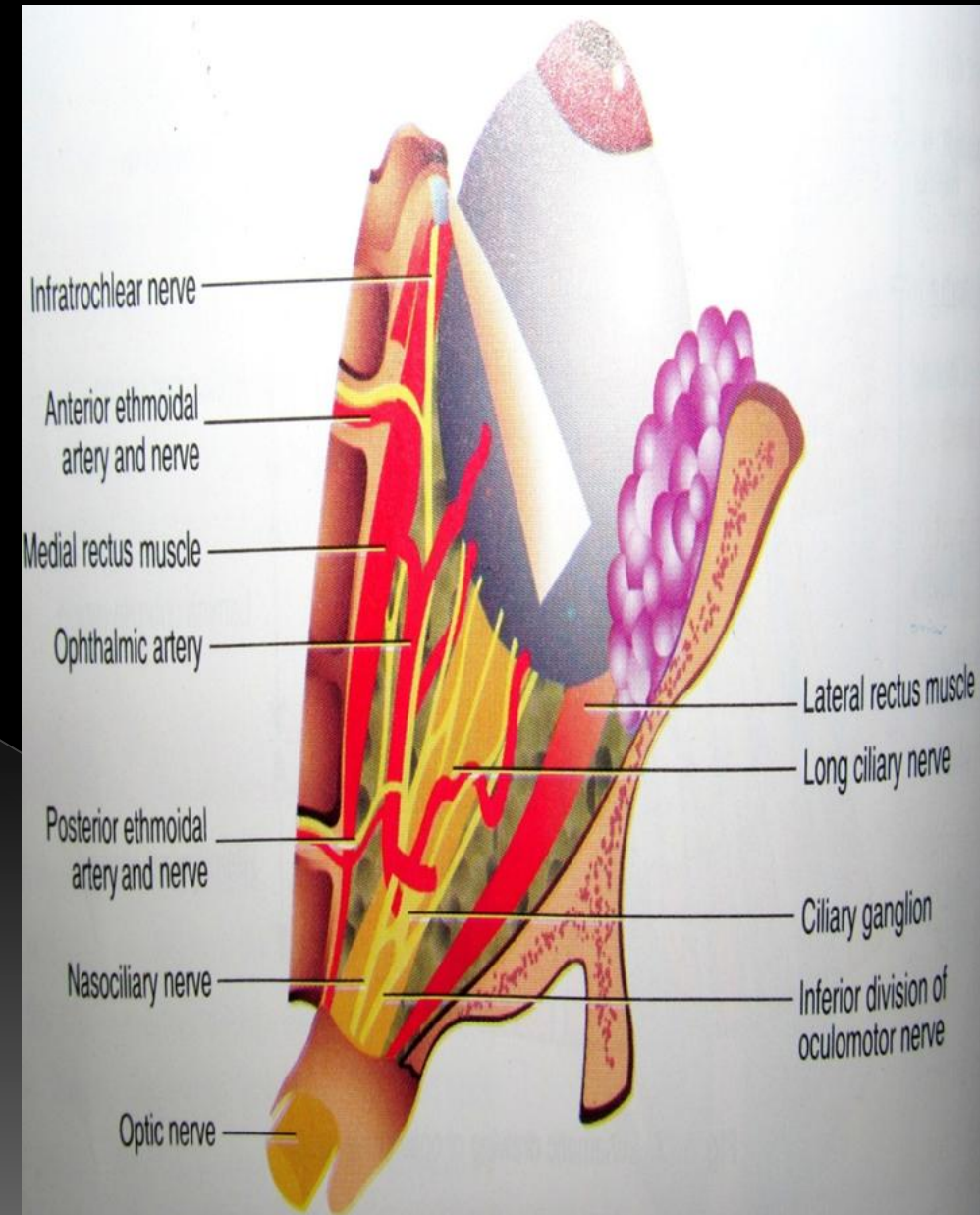


Fig. 6.14. Relations of intraorbital part of optic nerve.

# Continue...

- Posteriorly near optic nerve is closely surrounded by annulus of Zinn and the origin of the 4 rectus muscles.
- Anteriorly, the nerve is separated from the EOM by orbital fat.
- Long and short ciliary nerve and arteries surround the optic nerve before these enter the eyeball.
- Between the optic nerve and LR are situated the ciliary ganglion, division of the oculomotor nerve, nasociliary nerve sympathetic and abducent nerve.
- Ophthalmic artery, superior ophthalmic vein and nasociliary nerve superiorly from the lateral to the medial side.

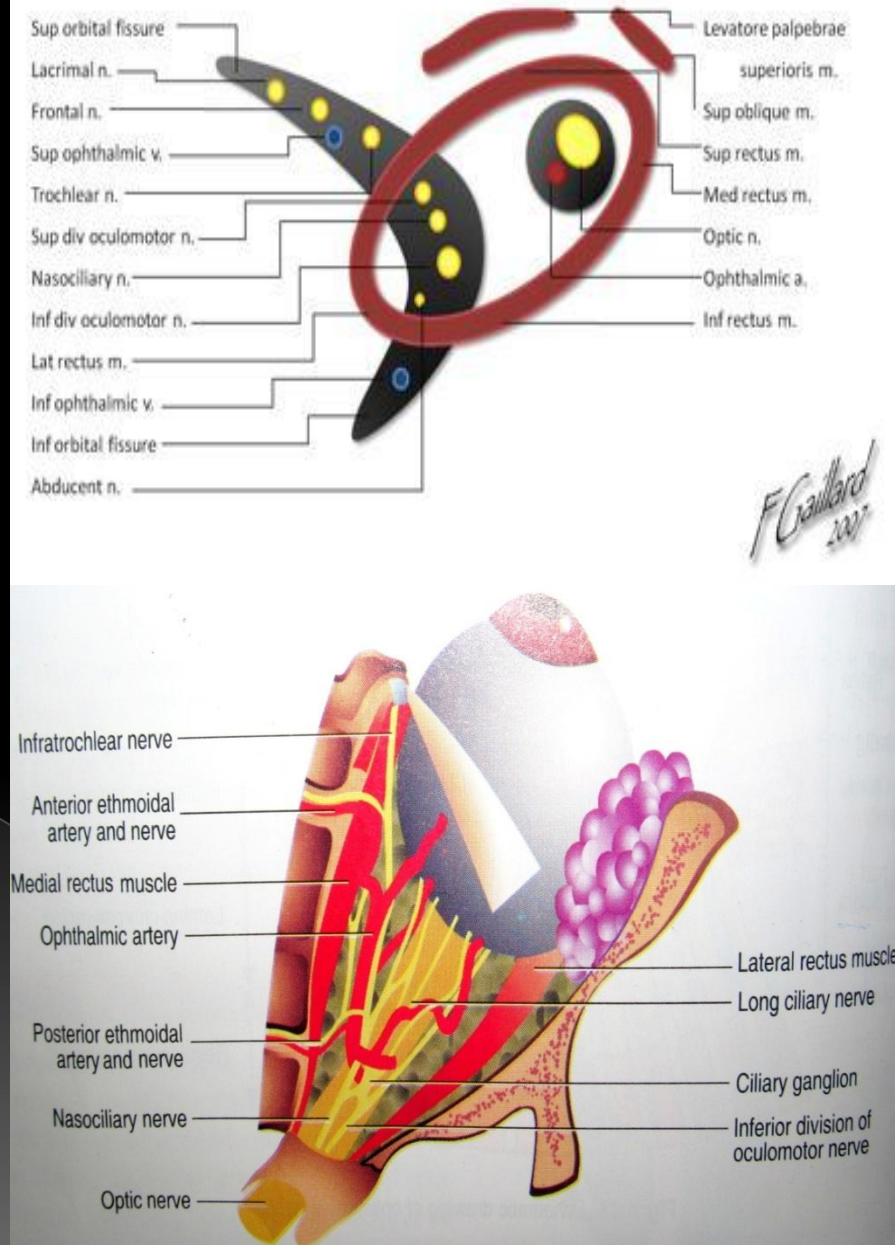


Fig. 6.14. Relations of intraorbital part of optic nerve.



# INTRA CANALICULAR P

- 10MM LONG
- Begins where optic nerve leaves optic foramen and ends at a point where optic nerve enters optic canal
- Limited space for expansion
- Most traumatic optic neuropathies frequently affected

## RELATIONS

- ophthalmic artery crosses from medial to lateral side
- **Sphenoid & posterior ethmoidal sinuses** lie medial to it & separated by thin bony lamina, coz retrobulbar neuritis following infection of sinuses.

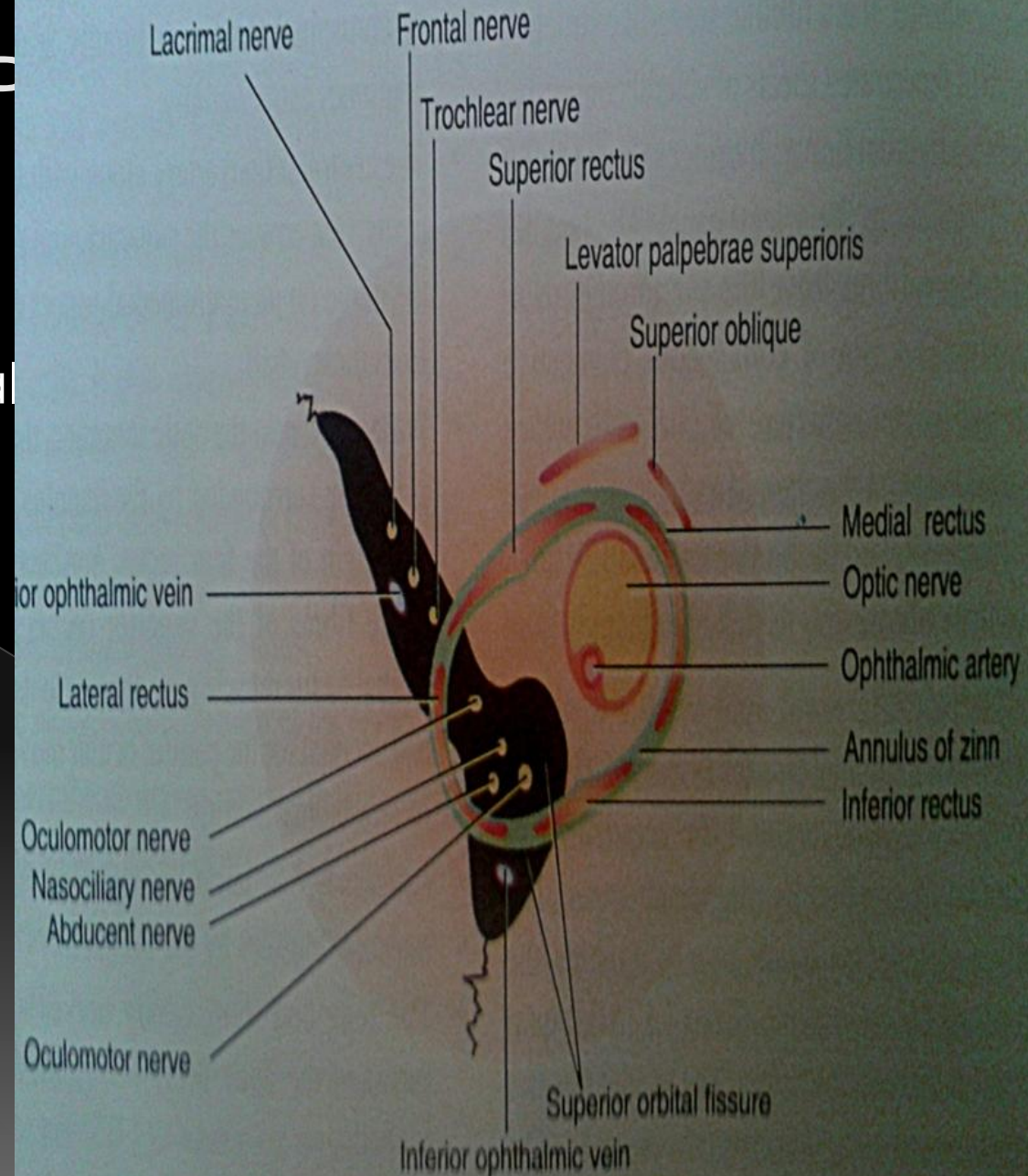


Fig. 6.15. Relations of intracanalicular part of optic nerve.

# Intra cranial part

- 10mm length
- Lies above cavernous sinus and Internal carotid artery runs below then lateral to it.
- The ophthalmic artery arise from the internal carotid artery below the optic nerve at about its middle.

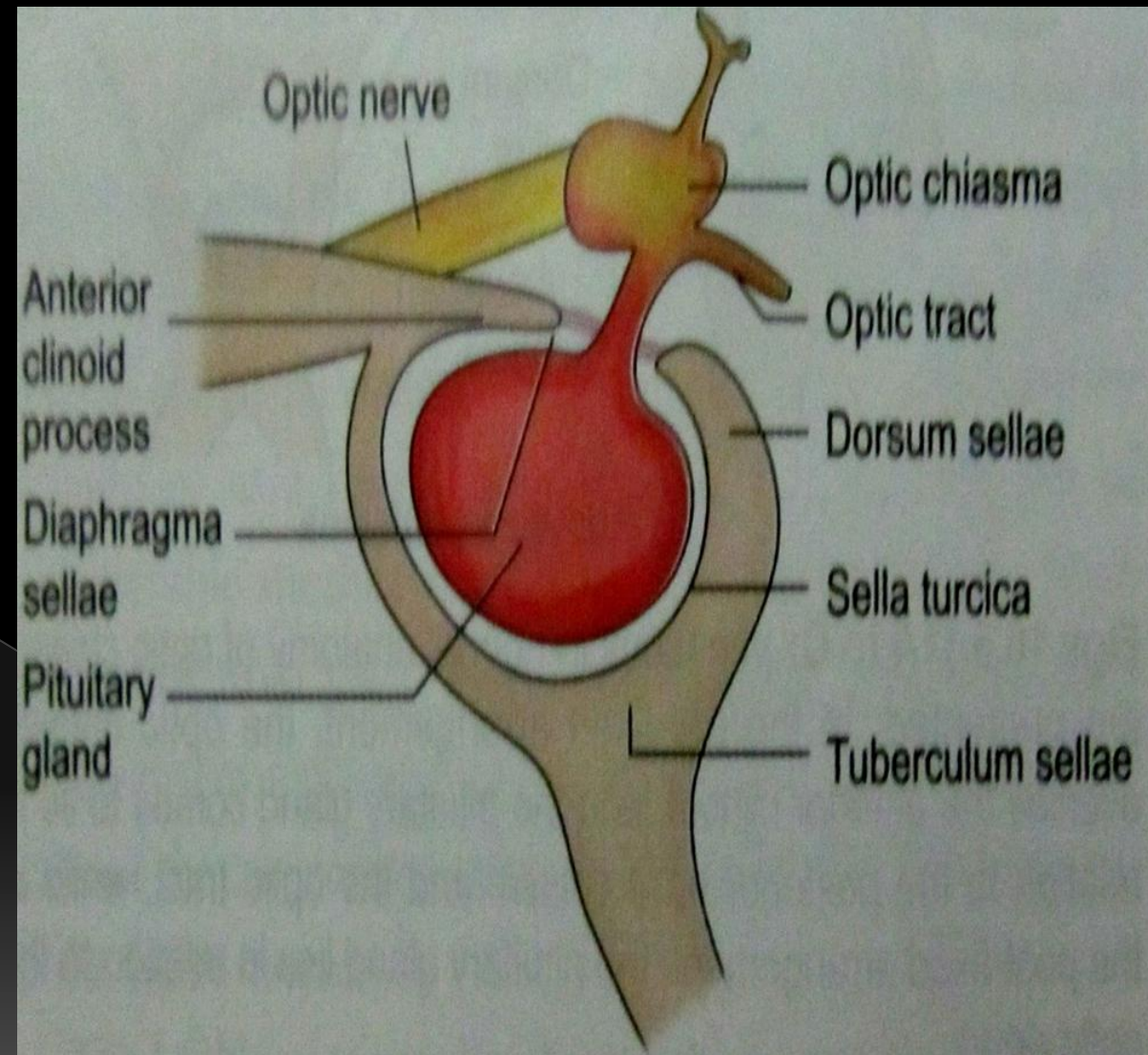
# Meningeal sheaths of optic nerve

- The intracranial part of the ON is covered by pia only, while the intracanalicular and intraorbital parts of the nerve have three covering: the pia, arachnoid and dura.
- Meningeal sheaths and subarachnoid and subdural space around the ON are continuous with those of the brain.
- Anteriorly, all the three meningeal sheaths terminate by becoming continuous with the periosteum of the orbit while the inner forms the dural sheath of the optic nerve.



# Optic chiasma

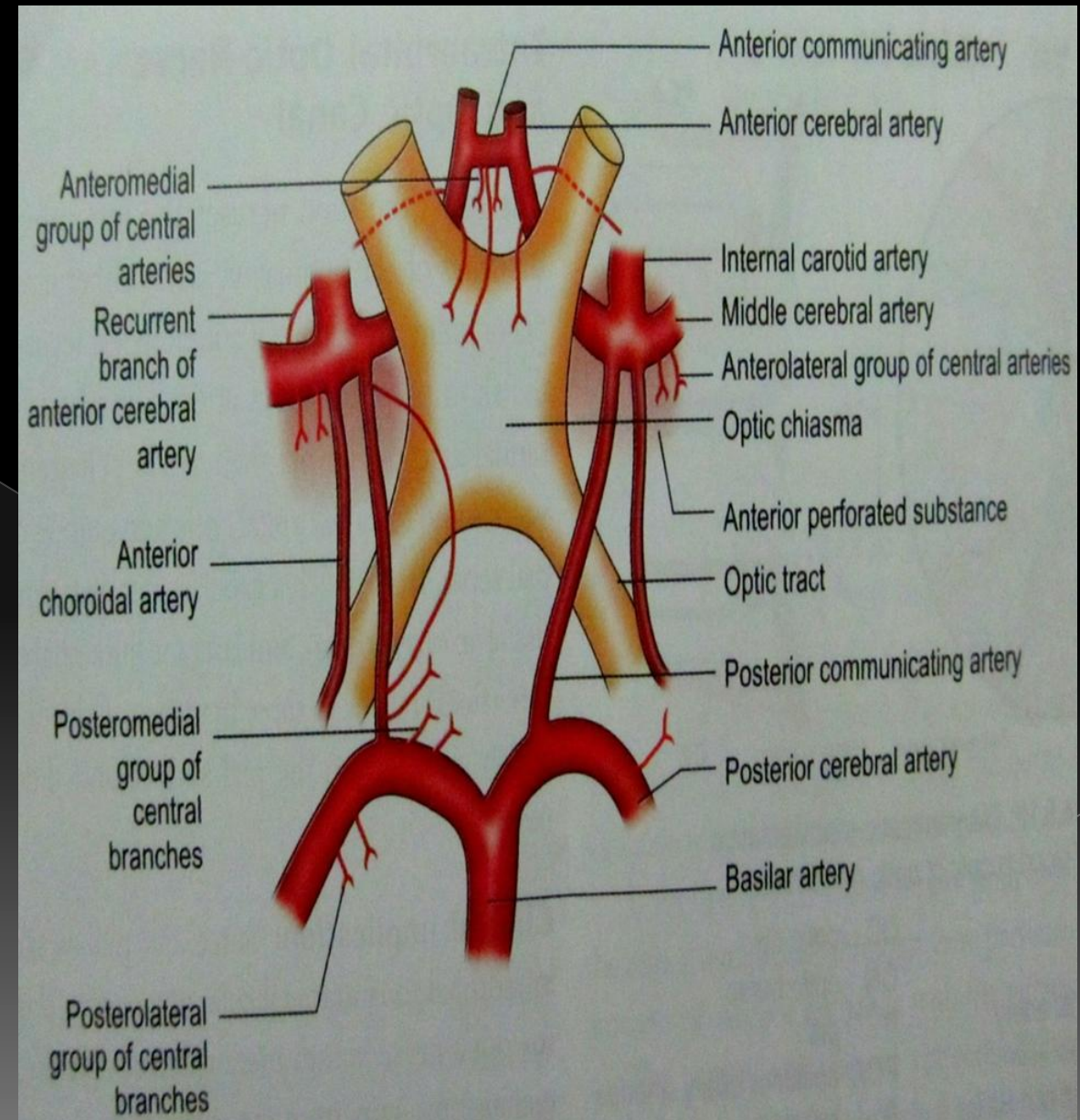
- Results from cross over of two optic nerves
- Dorso ventrally flattened
- Lies over sella, so visual field defects seen in patients with supra sellar extension
- Surrounded by meninges and CSF
- Size-8mm length, 15 mm width and 4 mm thickness



**Fig. 16.5.9:** Antero-posterior relationship of the optic chiasma (sagittal section)

- RELATIONS-

- **Anterior** - anterior cerebral arteries & its communicating arteries.
- **Posterior**- tuber cinereum, infundibulum, pituitary body, posterior perforated substance.
- **Superior**- third ventricle.
- **Inferior**- hypophysis
- **Lateral**- extra cavernous part of internal carotid artery & anterior perforated substance.

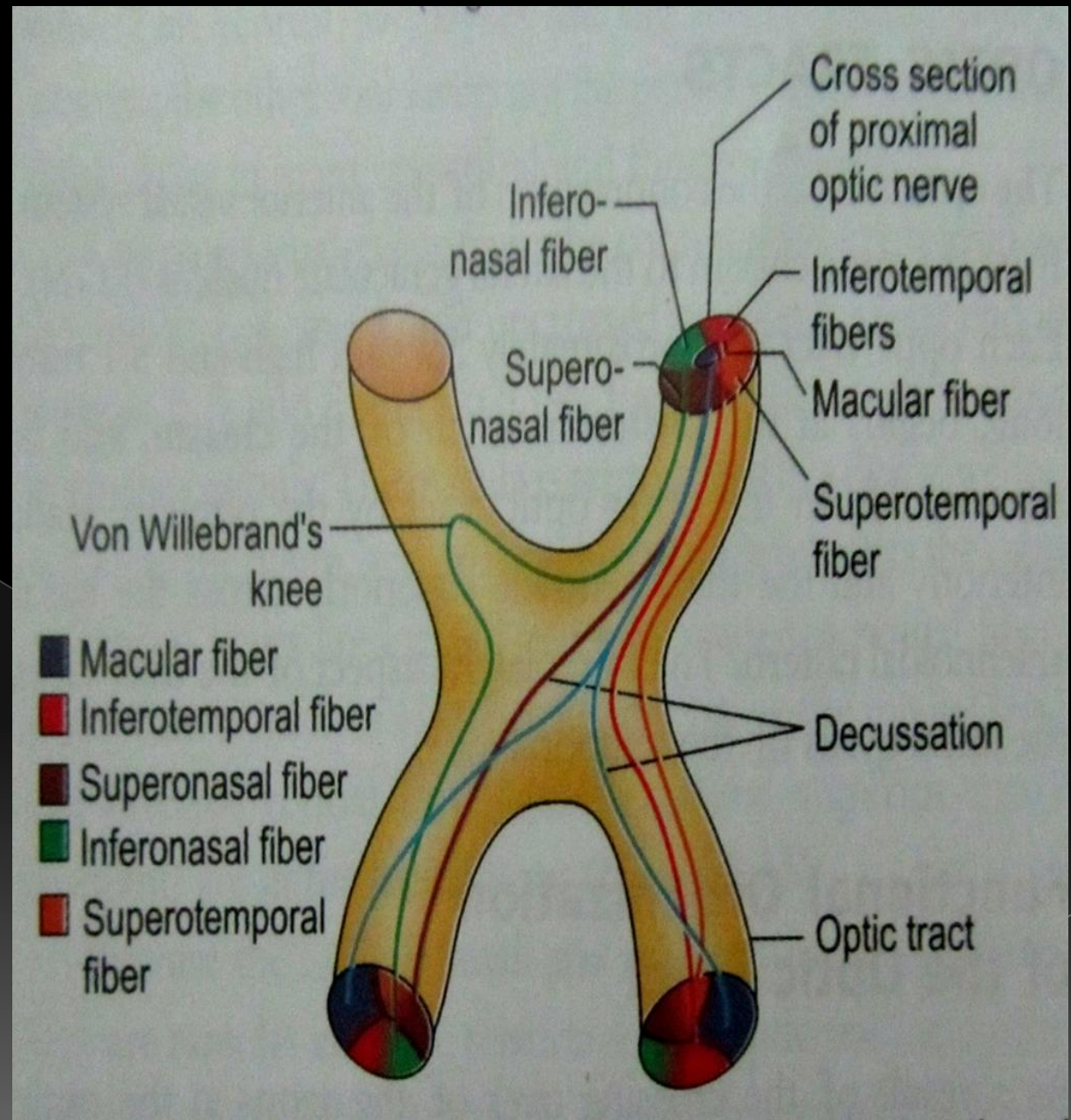




## ● ORGANISATION OF OPTIC CHIASMA-

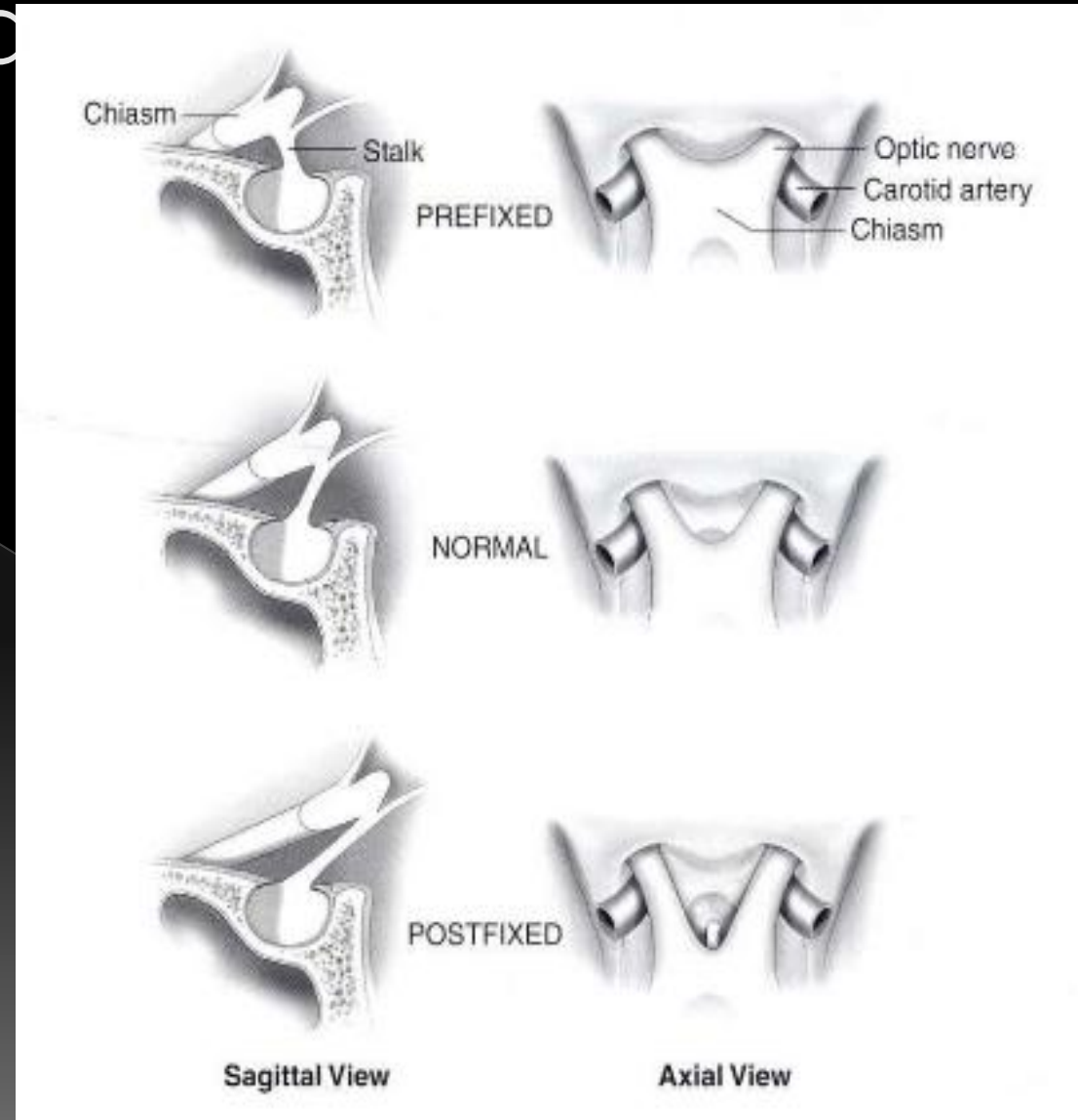
● In general nasal fibres from optic nerve cross in chiasma and temporal fibres remains uncrossed

● Fibres from ext macular inf nasal retina cross and loop anteriorly in C/L optic nerve before they head in to optic tract forming **VON WILLEBRANDS KNEE**



# Anatomical variation in position of normal optic chiasma

- a) central : lies directly over sella, expanding pituitary tumor involves chiasma first.
- b) pre-fixed : lies more anteriorly over tuberculum sellae, pituitary tumor involves optic tract first.
- c) post-fixed : lies more posterior over dorsum sellae, pituitary tumor damage optic nerve first.



# OPTIC TRACTS

- Extends from optic chiasma to LGB
- 3.5 mm height and 5mm long
- Consists fibres from temporal half of same eye and nasal half of other eye
- Run outwards & backwards from posterolateral aspect of optic chiasma, between tuber cinereum & anterior perforated substance to unite with LGB

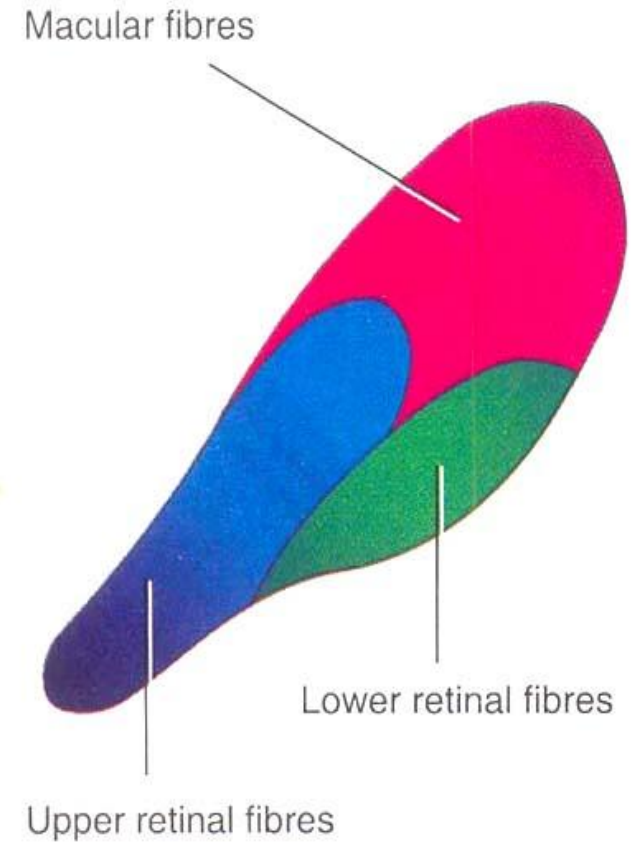
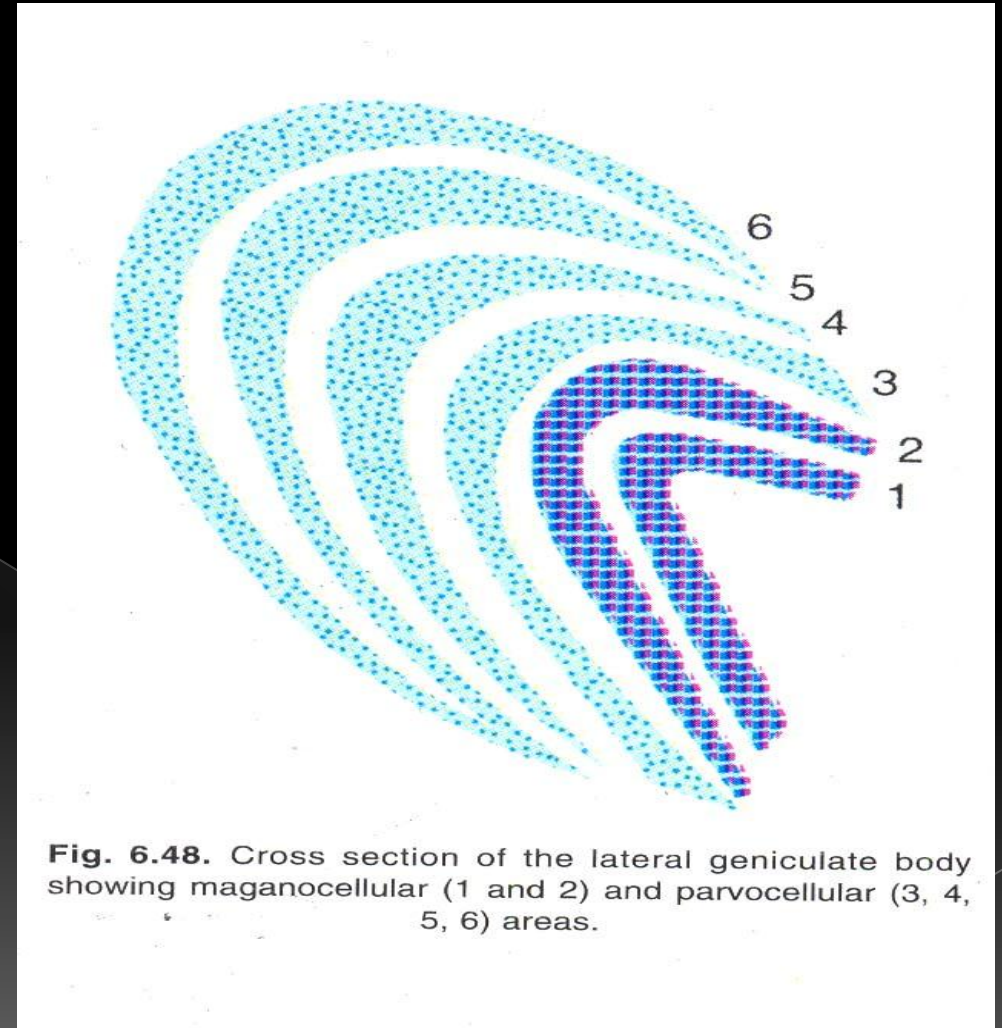


Fig. 6.24. Arrangement of fibres in the optic tract.

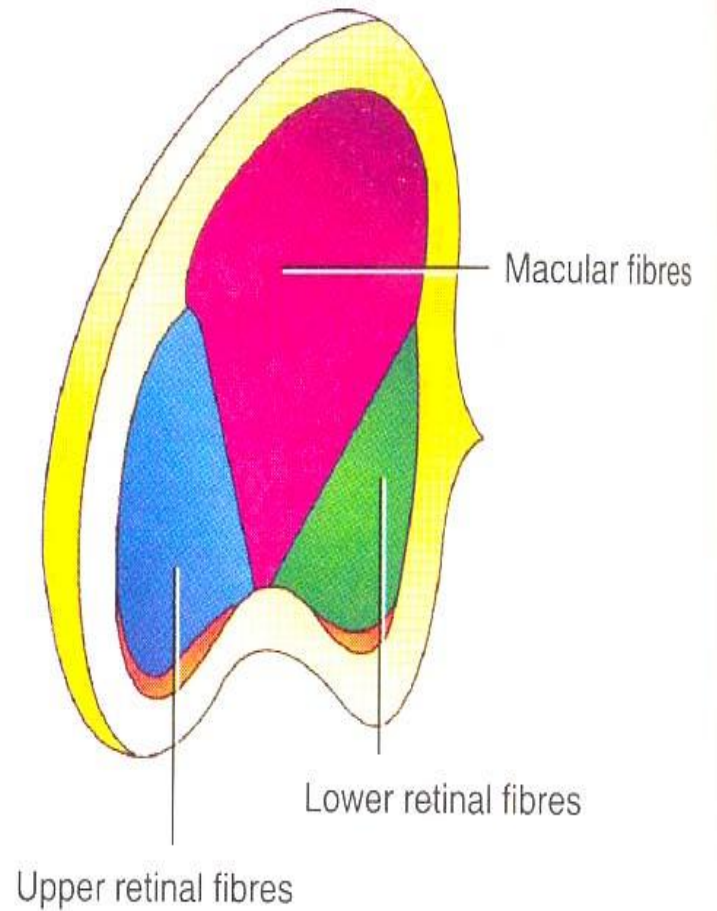
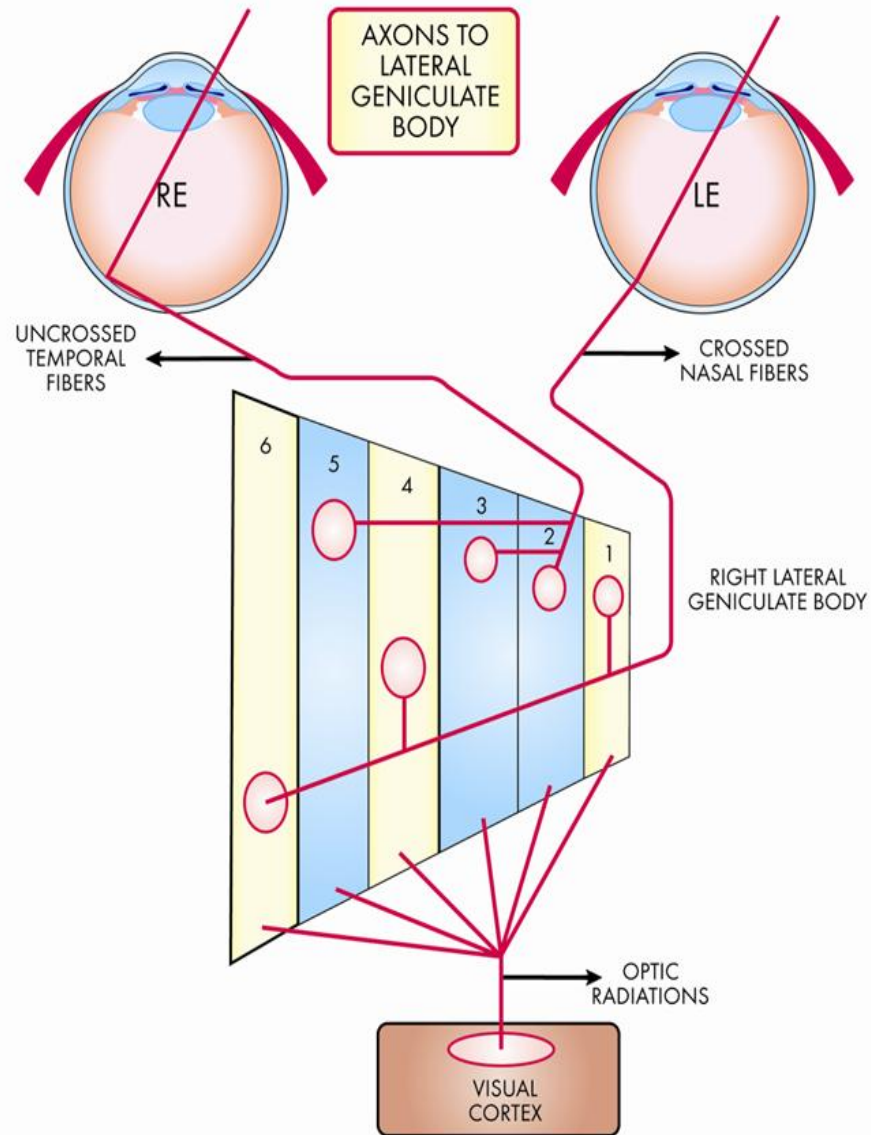


# Lateral geniculate body

- Thalamic relay nucleus, is positioned b/l along lateral aspects of mid brain
- Serves as a relay station which is very accurate that there is exact point to point transmission of impulse from the retina to visual cortex.
- 2<sup>nd</sup> order neurons arising from ganglion cells relay here
- Each consist of 6 layers of neurons (grey matter) alternating with white matter (optic fibres)



**Fig. 6.48.** Cross section of the lateral geniculate body showing maganocellular (1 and 2) and parvocellular (3, 4, 5, 6) areas.



**Fig. 6.25.** Arrangement of fibres in the lateral geniculate body.

- The crossed fibres end in lamina 1, 4 and 6 while uncrossed fibres end in the lamina 2, 3 and 5.
- The layers 1 and 2 of the LGN have large cells and are called magnocellular, whereas layers 3-6 have small cells and are called parvocellular.
- **Magnocellular layers** receive their visual input from the large Y ganglion cells of retina. It provides rapidly conducting pathway to the visual cortex, i.e. carry signals for **detection of movement and flicker**.
- **Parvocellular layers** receive their input almost entirely from the X-ganglion cells and thus transmit colour vision and also convey **accurate point-to-point spatial information, for texture, shape and fine depth vision**

# Optic radiations (Geniculo-Calcarine Pathway)

- From LGB to the occipital cortex.
- Pass forwards then laterally through the area of wernicke as **optic peduncles**.
- Then fibres spread out fan wise to form **medullary optic lamina**
- There occurs temporal rotation of fibres

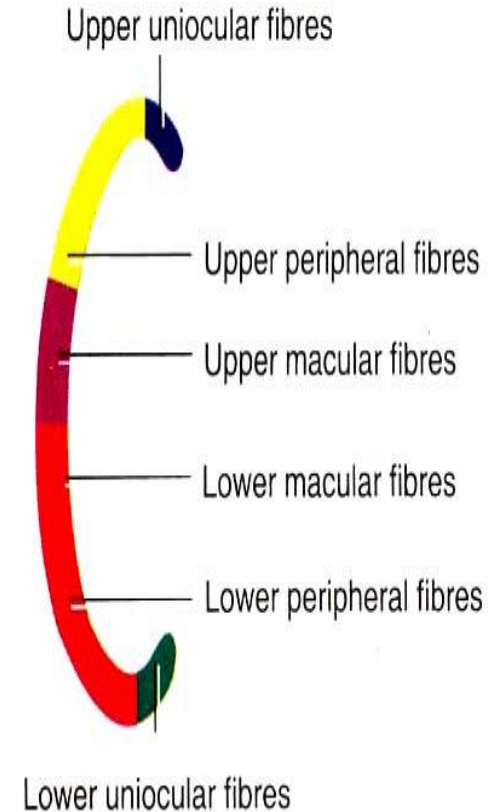
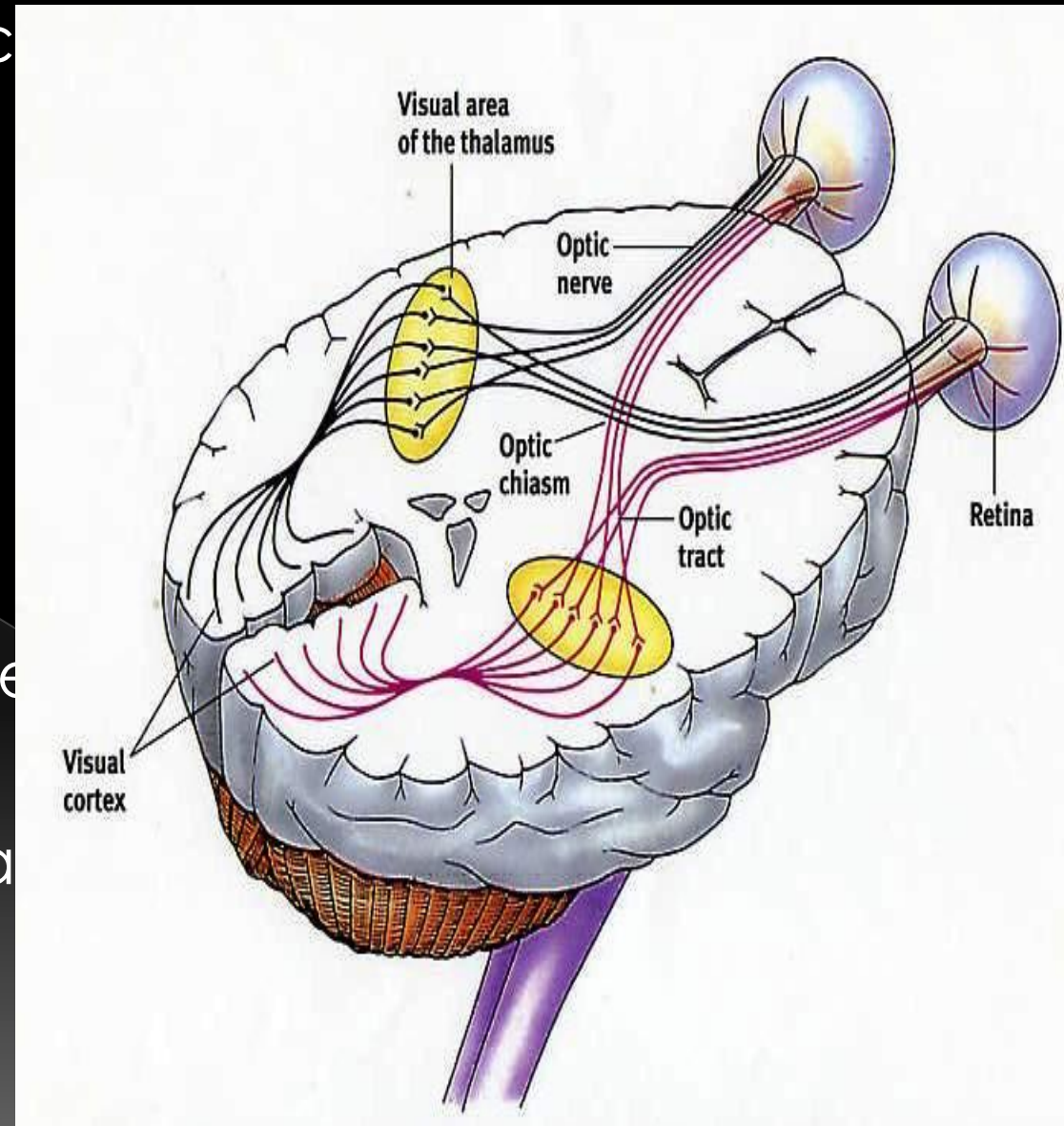


Fig. 6.27. Arrangement of fibres in the optic radiations.



- The inferior fibres of the optic radiations, which subserve the upper visual fields, first sweep antero inferiorly in Meyers loop around the anterior tip of the temporal horn of the lateral ventricle, and into the temporal lobe.
- The superior fibres of the radiations, which subserve the inferior visual fields, proceed directly posteriorly through the parietal lobe to the visual cortex



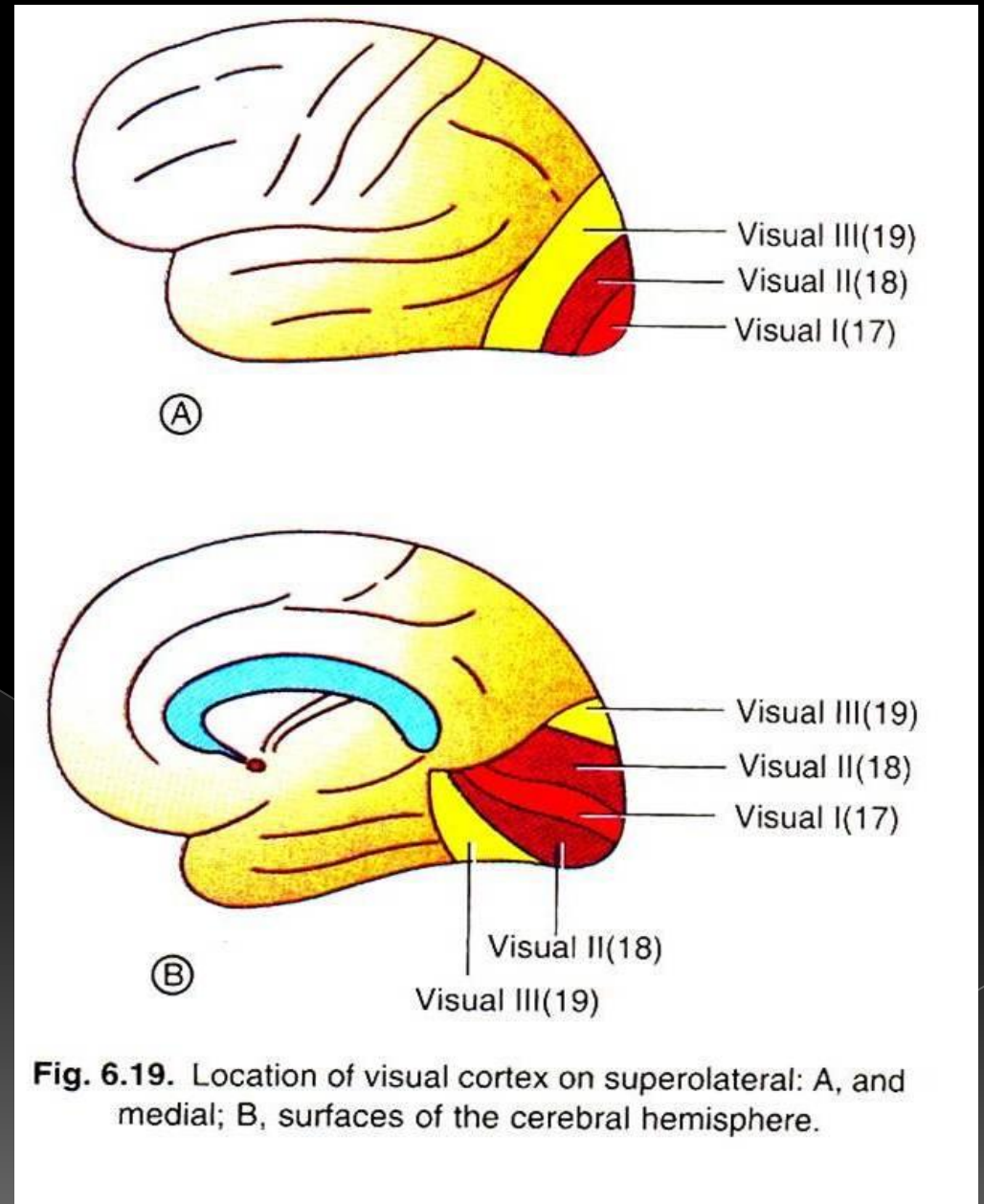


# Visual cortex

- It is located on the medial aspect of the occipital lobe in the calcarine fissure.
- It is subdivided into the visuosensory area (striate area 17) and visuopsychic area (peristriate area 18 and parastriate area 19)
- Since visual cortex receives much larger input from macular area the macula is less affected in lesions of occipital cortex

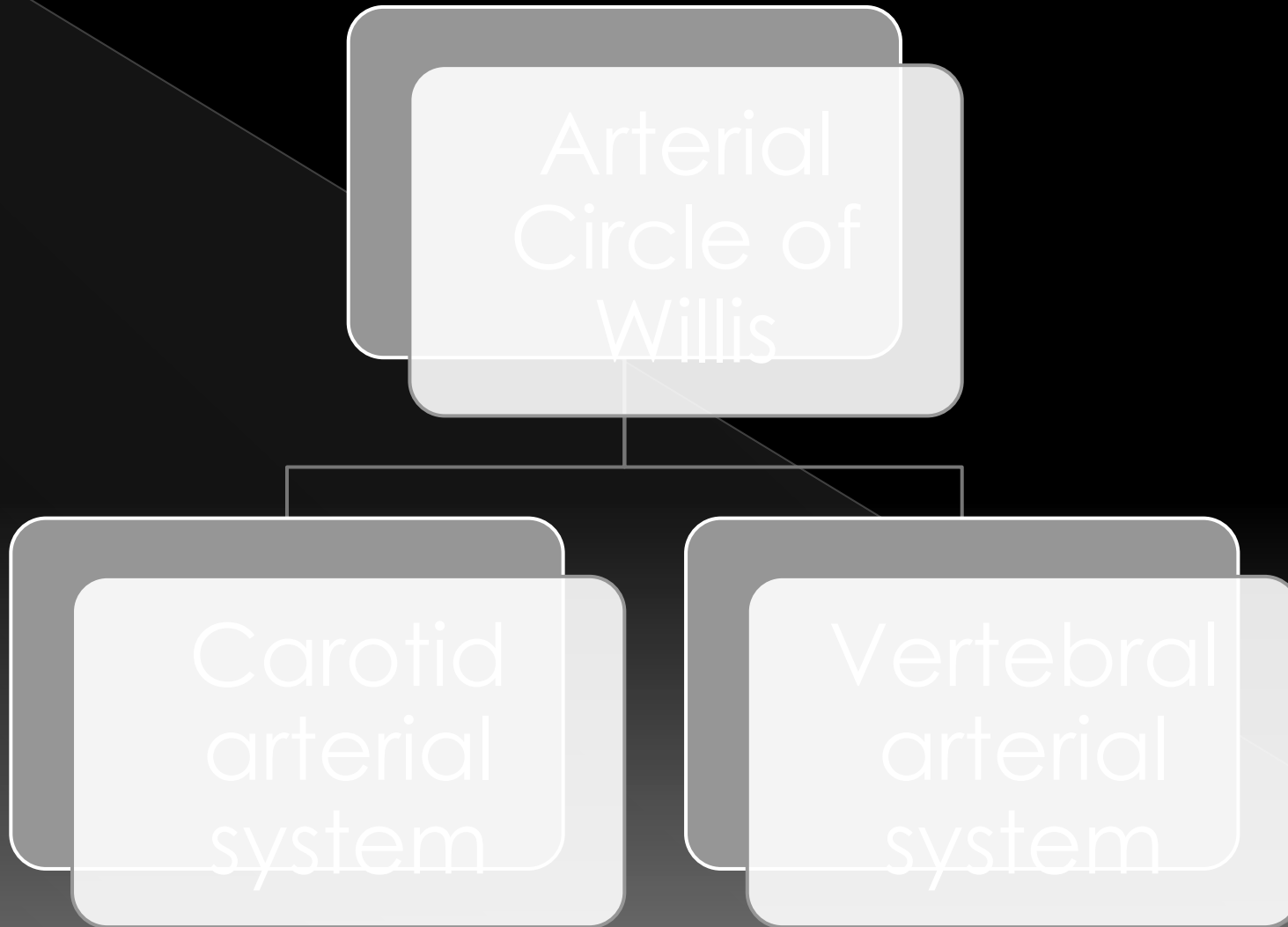
## Modified nomenclature:

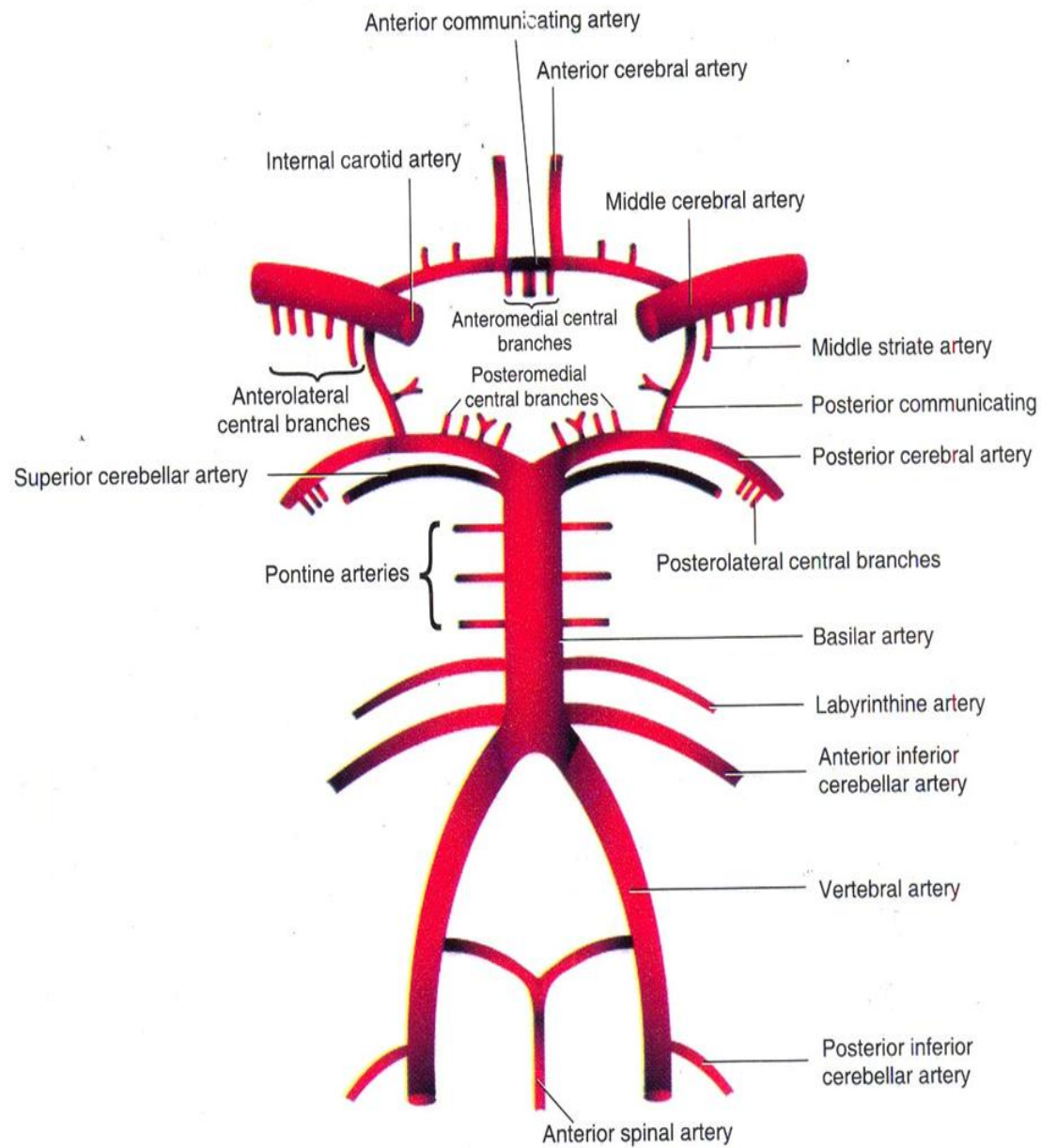
- V1 in area 17
- V2 occupying the greater part of area 18, but not the whole of it
- V3 occupying a narrow strip over the anterior part of area 18
- V4 within area 19
- V5 at the posterior end of superior temporal gyrus.



**Fig. 6.19.** Location of visual cortex on superolateral: A, and medial; B, surfaces of the cerebral hemisphere.

# Blood supply of Visual Pathway

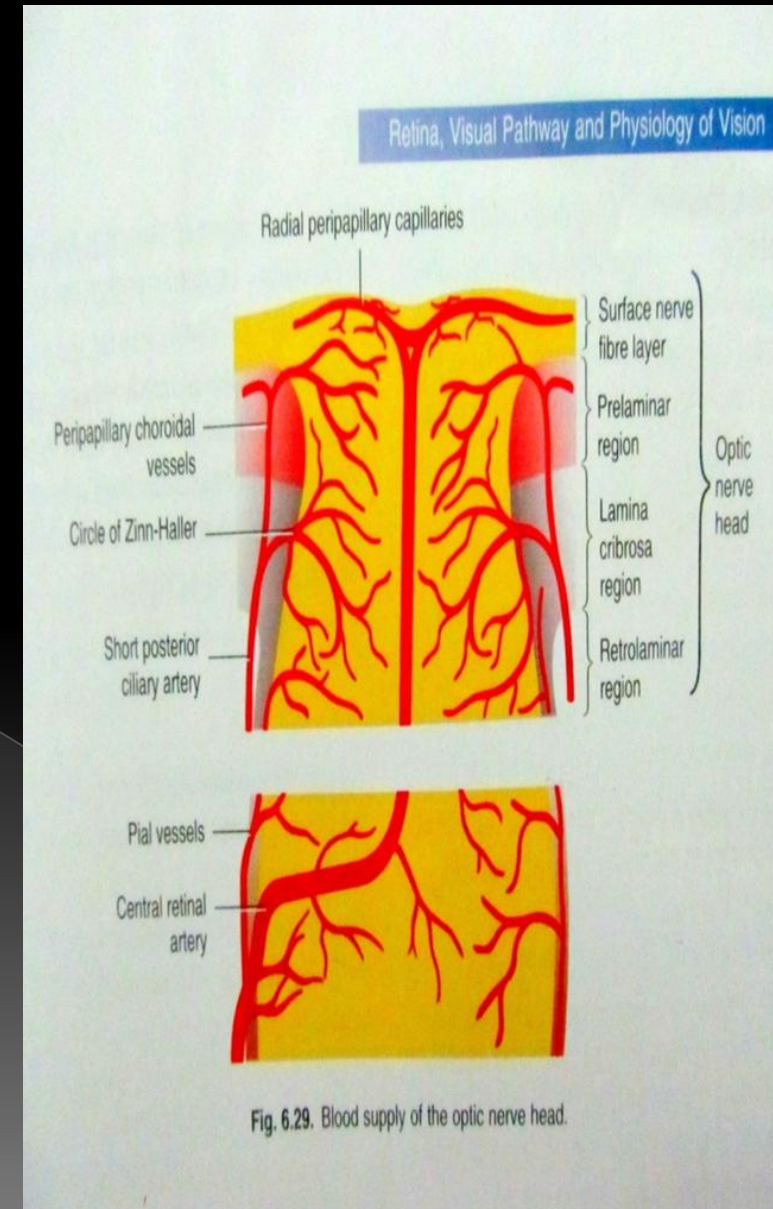




**Fig. 12.3.** The circle of Willis.

# Blood supply of Optic Nerve:

- A. Intraocular part
- Surface NFL-capillaries derived from retinal arterioles





## B . Intraorbital part :

### Periaxial system of vessels

- Derived from 6 branches of internal carotid artery:
- ophthalmic
- long & short posterior ciliary artery.
- Lacrimal artery.
- Central artery of retina.

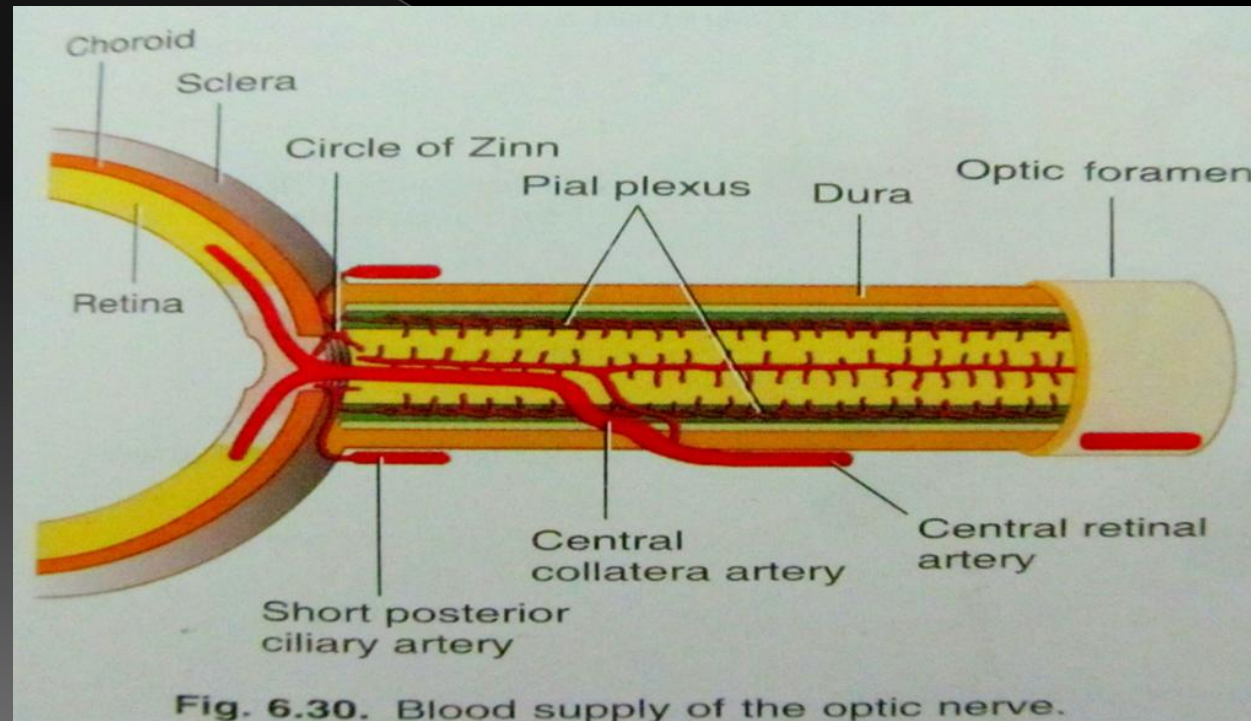
### Axial system of vessels

- Intraneural b/o central retinal artery.
- Central collateral b/o central retinal artery.
- Central artery of optic nerve.

## C .Intracanalicular part :

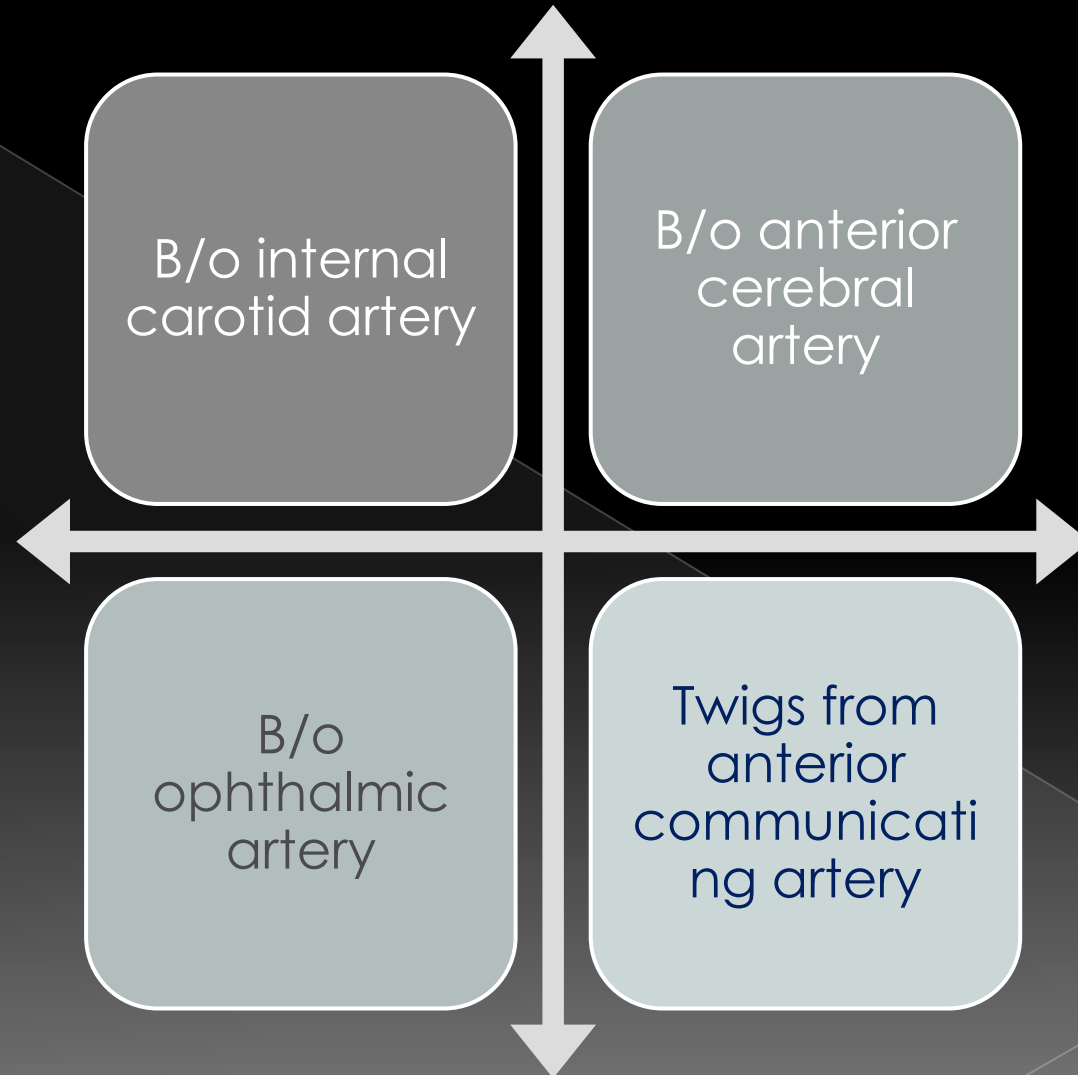
Periaxial system of vessels.

Since pial vessels supply intra orbital and intracanalicular parts of ON during sx if pia gets removed, blood supply is lost to nerve



## D . Intracranial part :

Pial system of vessels



## Venous drainage :

### Optic nerve head

- Central retinal vein

### Orbital part

- Peripheral pial plexus
- Central retinal vein

### Intracranial part

- Pial plexus which ends in anterior cerebral & basal vein



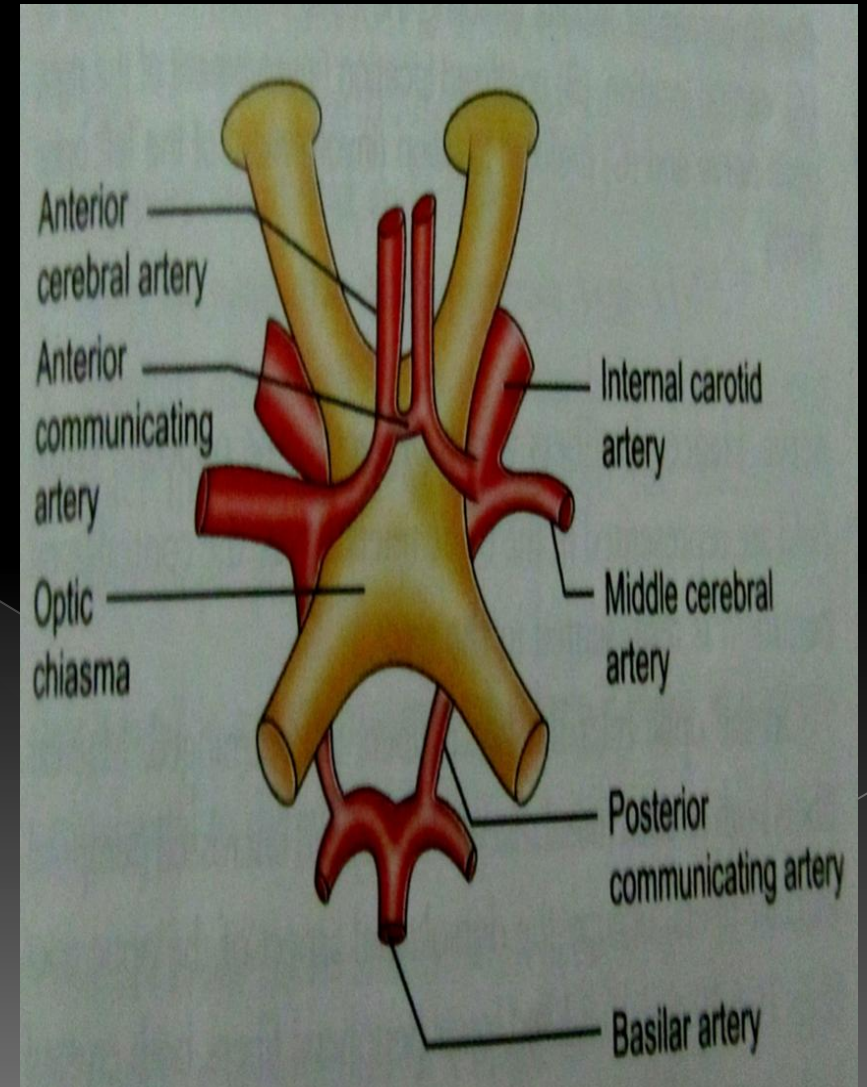
# OPTIC CHIASMA

## ● Arterial supply

1. ant cerebral
2. Ant communicating
3. Sup hypophyseal
4. Post communicating

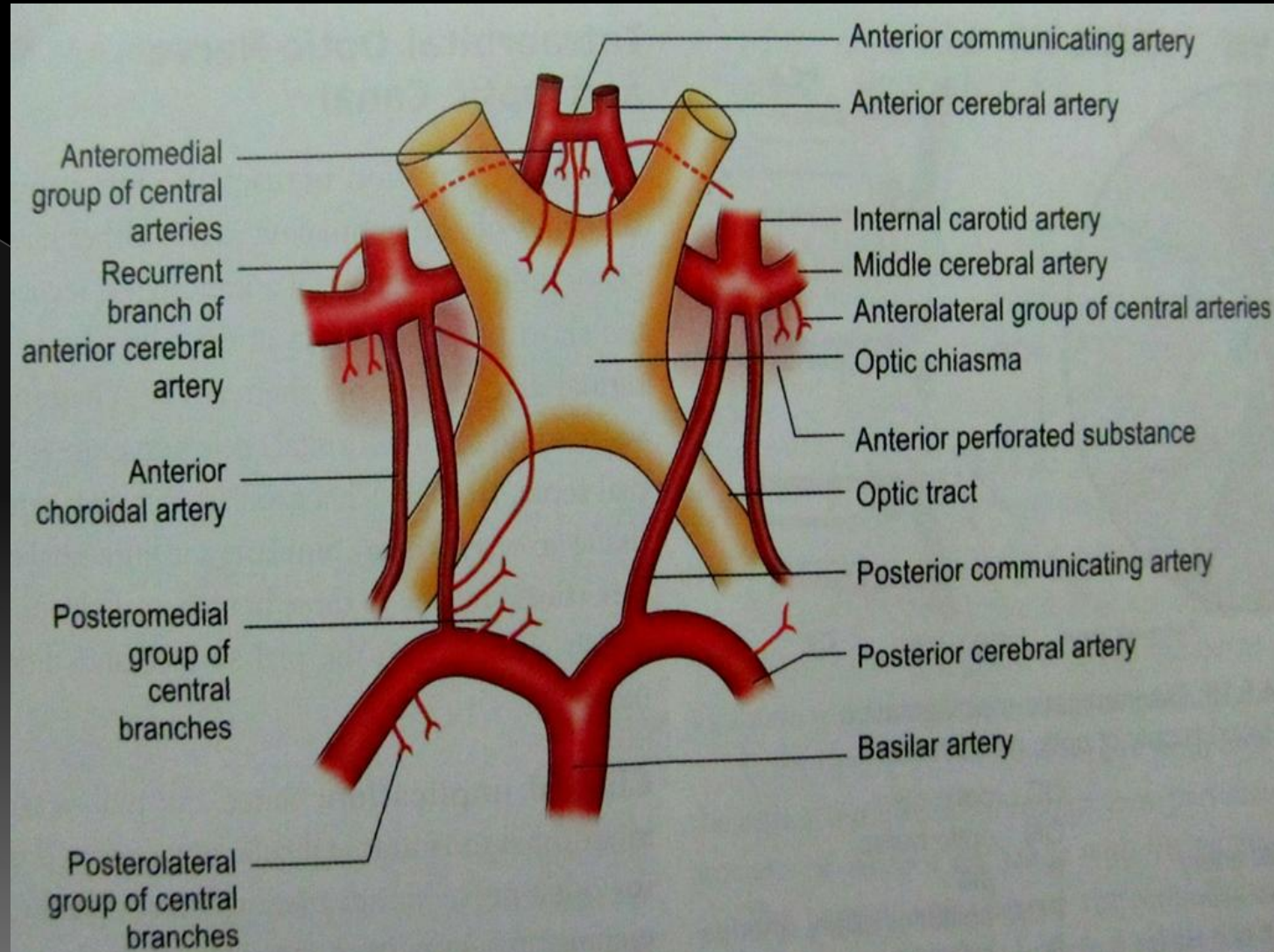
## • Venous drainage

1. Sup chiasmal in to ant cerebral vein
2. Inferior pre infundibular in to basal veins



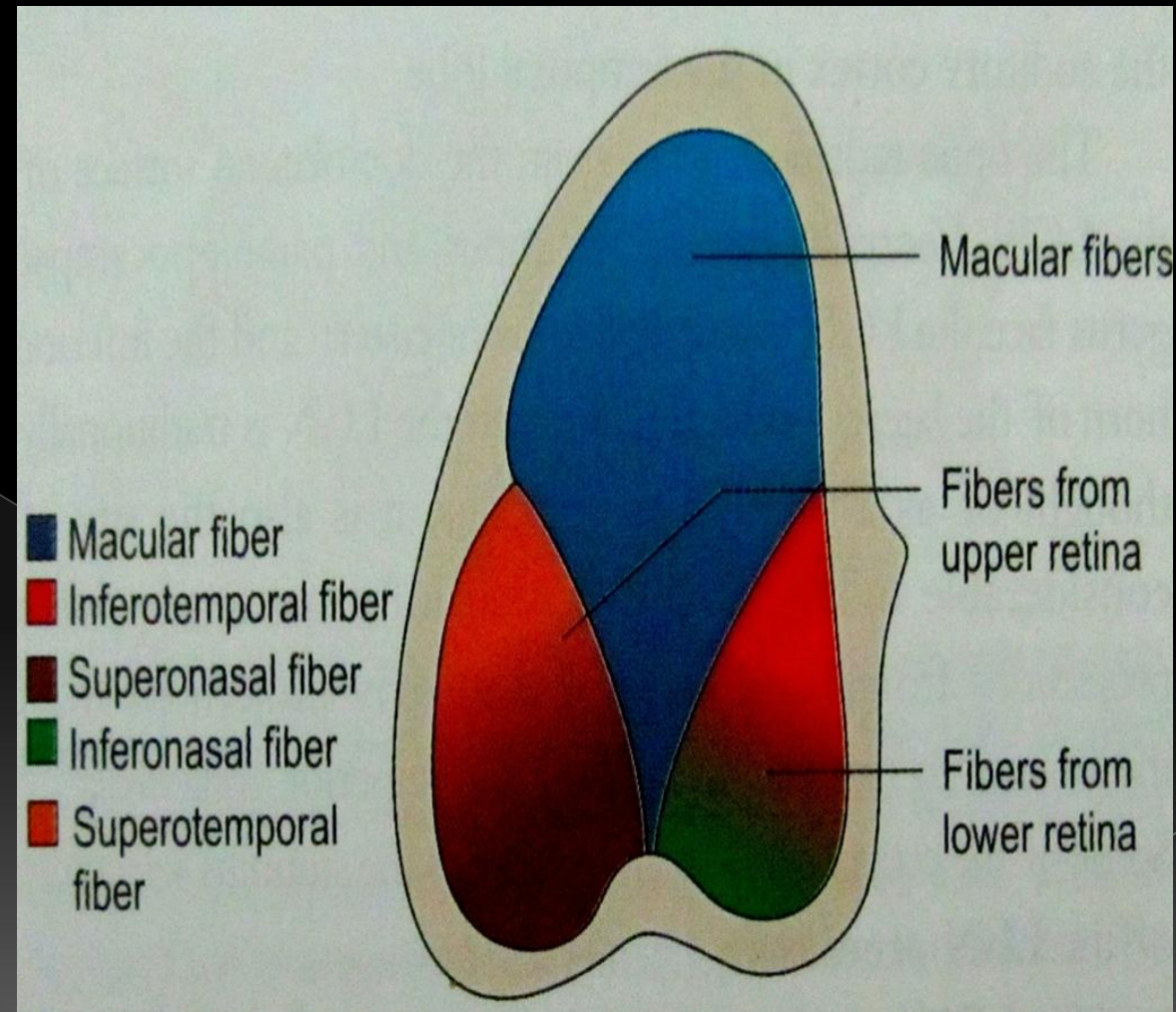
# Blood supply of optic tract:

- **Arterial:** Pial plexus receiving contribution from posterior communicating artery, anterior choroidal artery & middle cerebral artery.
- **Venous drainage:** anterior cerebral vein & basal vein.

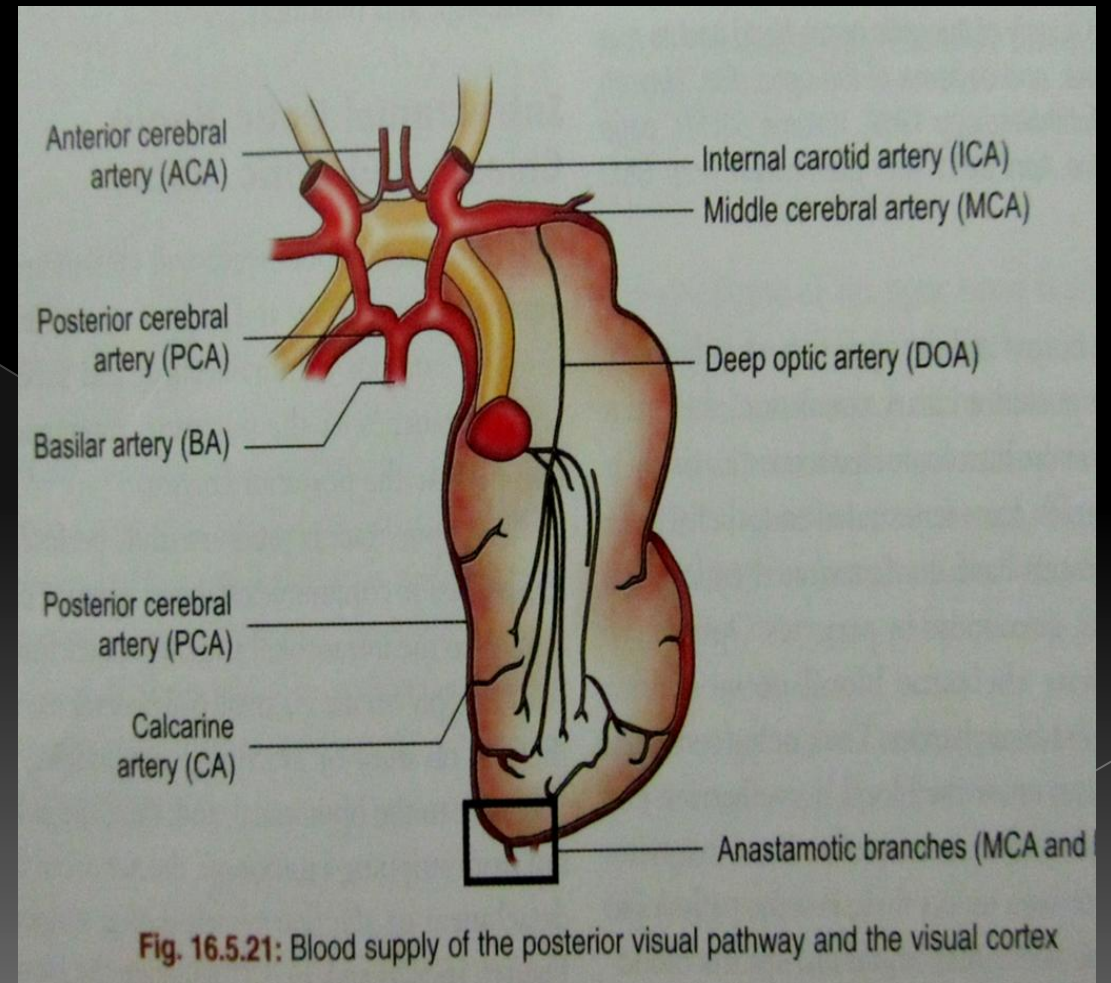




# Blood supply of lateral geniculate body:

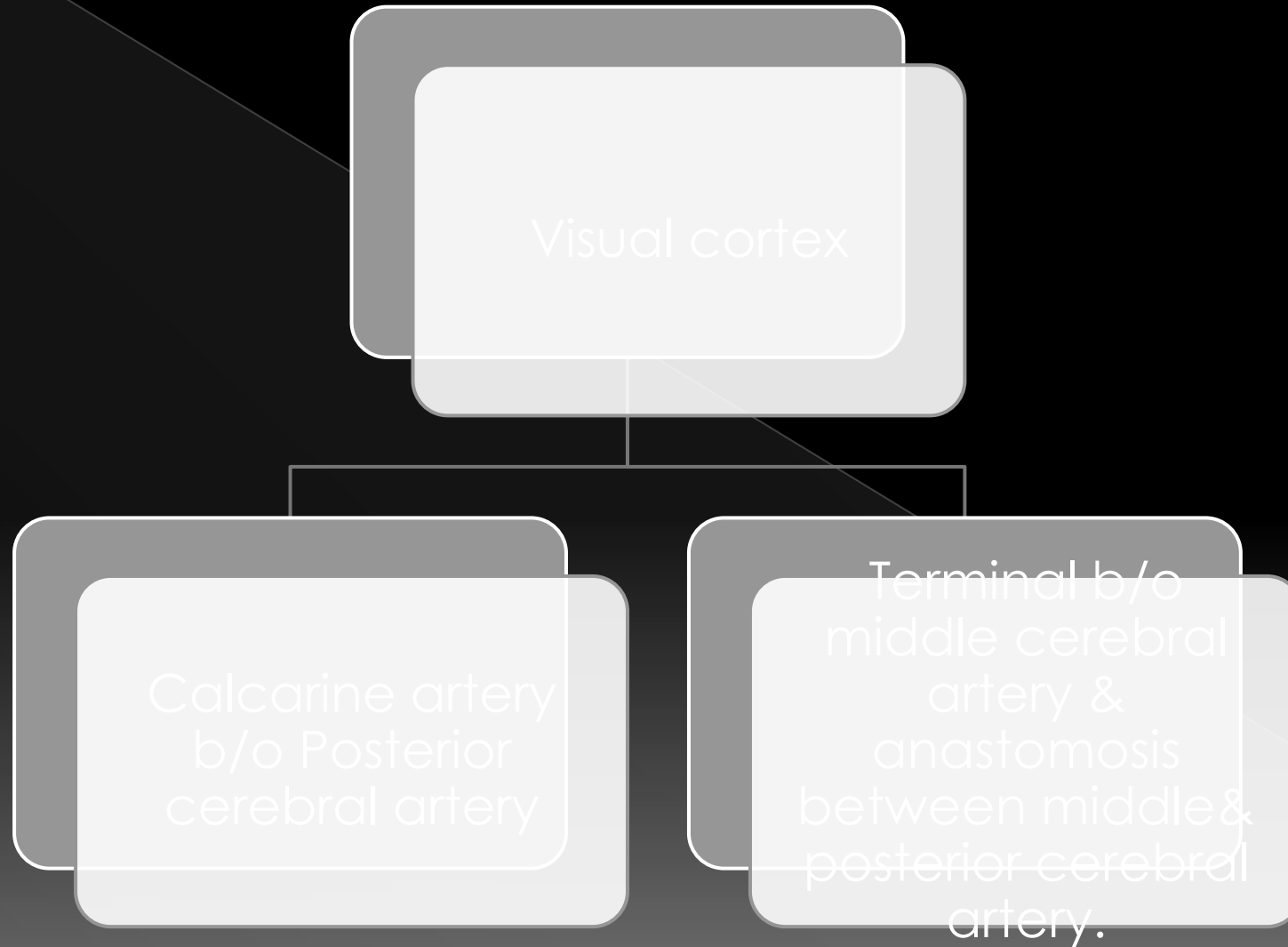


# Blood supply of Optic radiations

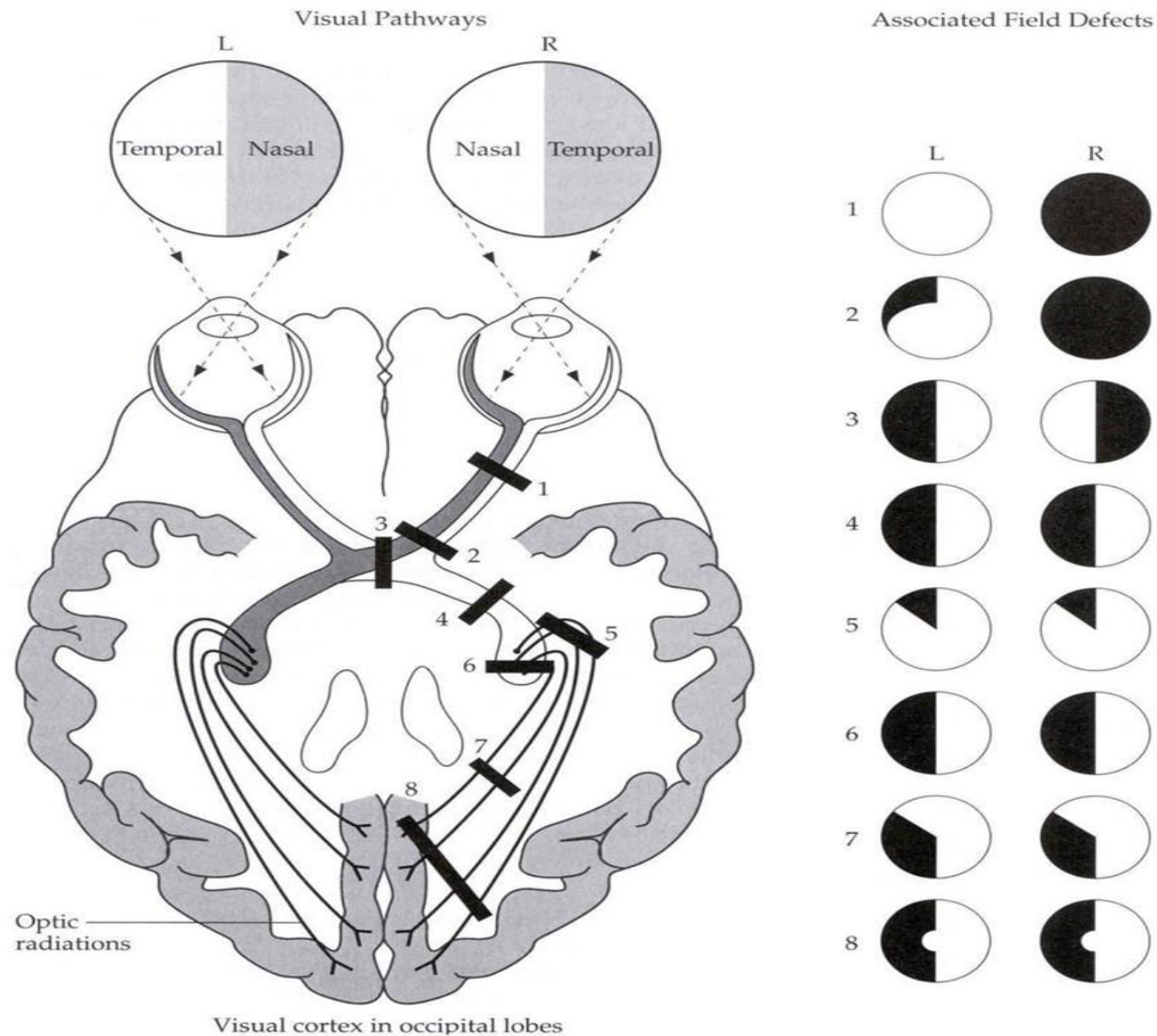




# Blood supply of visual cortex



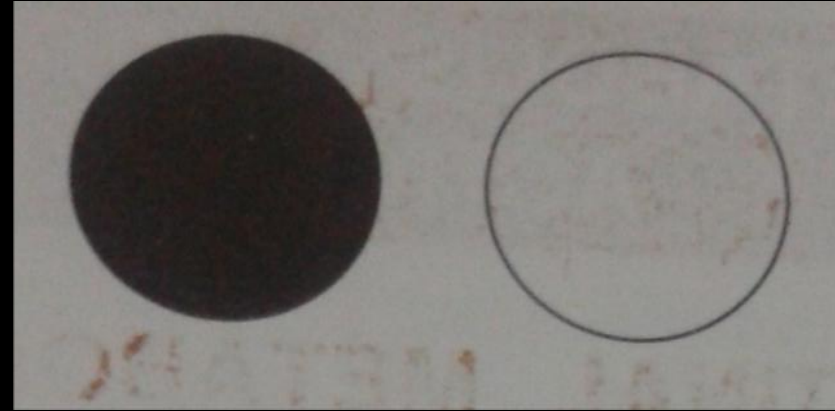
# LESIONS OF VISUAL PATHWAY



# 1) LESIONS OF OPTIC NERVE :

Causes:

- optic atrophy
- indirect optic neuropathy
- acute optic neuritis
- traumatic avulsion of optic nerve.

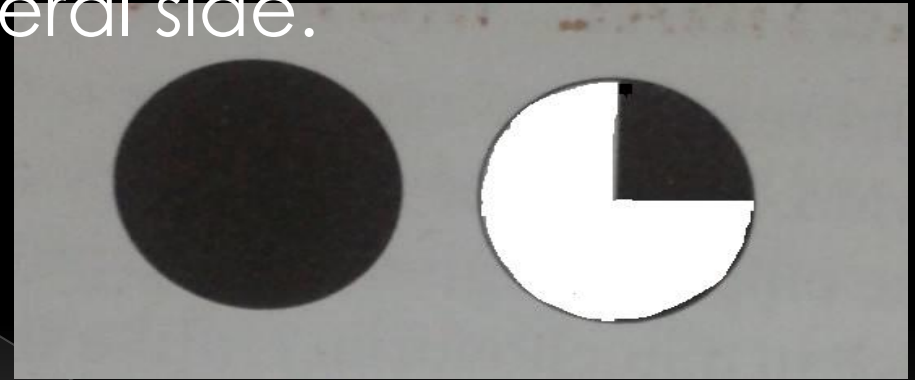


Characterised by: complete blindness in affected eye with loss of both direct on ipsilateral & consensual light reflex on contralateral side. Near reflex is preserved.

- Eg. Right optic nerve involvement

## 2) Lesions through proximal part of optic chiasma :

- ✓ ipsilateral blindness.
- ✓ contralateral quadrantic hemianopia
- ✓ abolition of direct light reflex on affected side & consensual light reflex on contralateral side.
- ✓ near reflex intact.



Eg. Rt optic nerve Involvement in Proximal part  
d/t von willebrands knee-traquairs junctional  
scotoma



### 3) Central lesions of chiasma (sagittal)

#### causes:

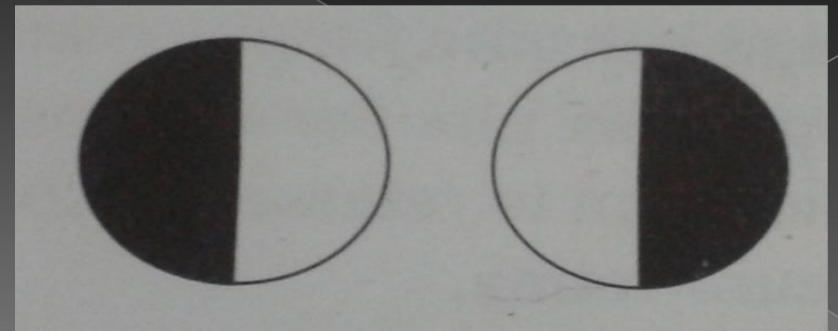
- ❑ suprasellar aneurysm
- ❑ tumors of pituitary gland
- ❑ craniopharyngioma
- ❑ suprasellar meningioma & glioma of 3<sup>rd</sup> ventricle.
- ❑ third ventricular dilatation due to obstructive hydrocephalus.
- ❑ chronic chiasmal arachnoiditis.

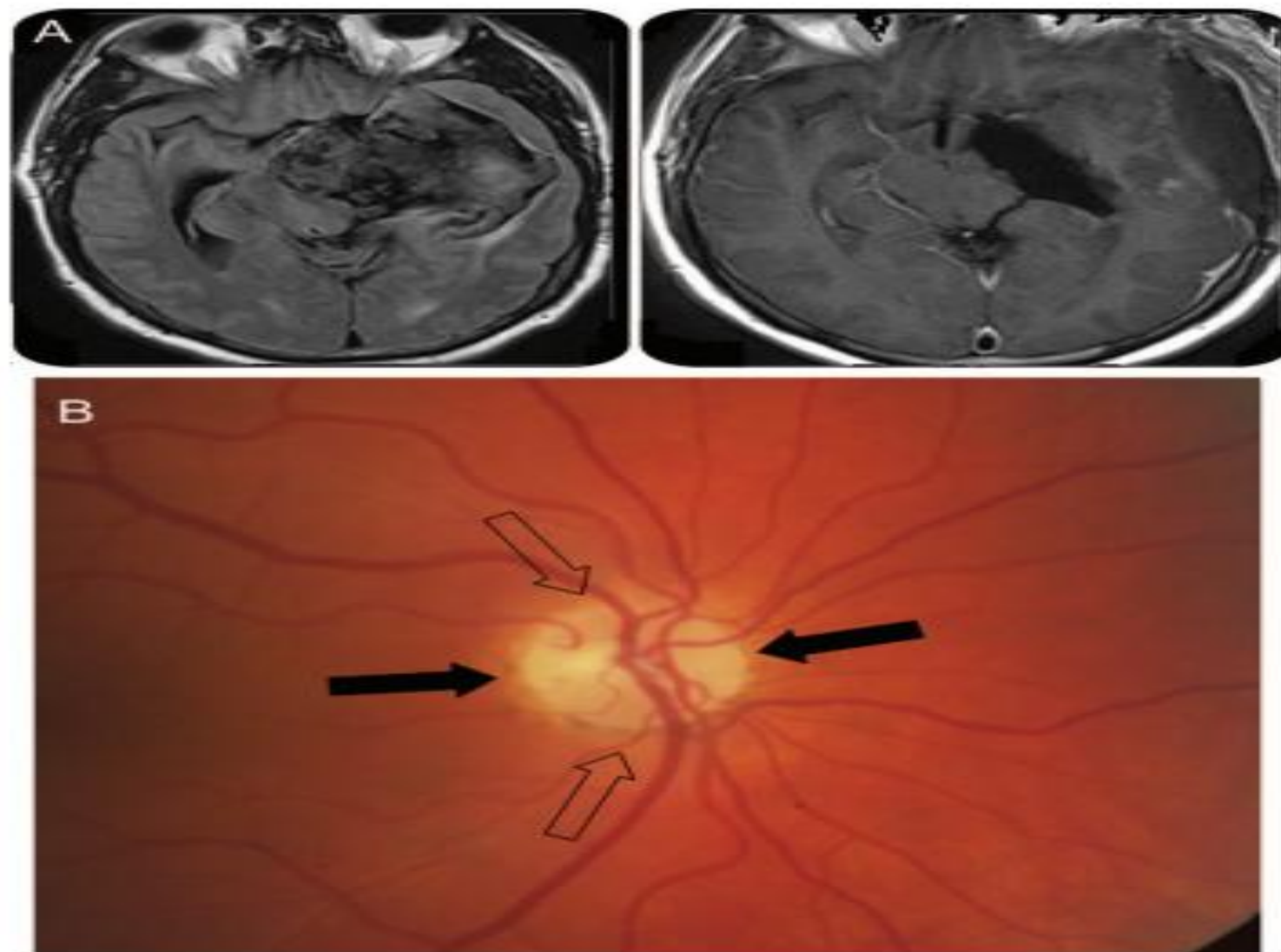
#### ▪ Characterised by:

- ✓ Bitemporal hemianopia
- ✓ Bitemporal hemianopic

paralysis of pupillary reflex. (usually lead to partial descending optic atrophy)

**Bowtie atrophy or band atrophy**





(A) Preoperative and postoperative MRI. (B) Bowtie atrophy. Fibers from the retina nasal to the optic disc and fibers nasal to the fovea but temporal to the disc project to the central portion of the optic nerve (black arrows). Fibers from the temporal retina form the poles of the optic disc (hollow arrows).

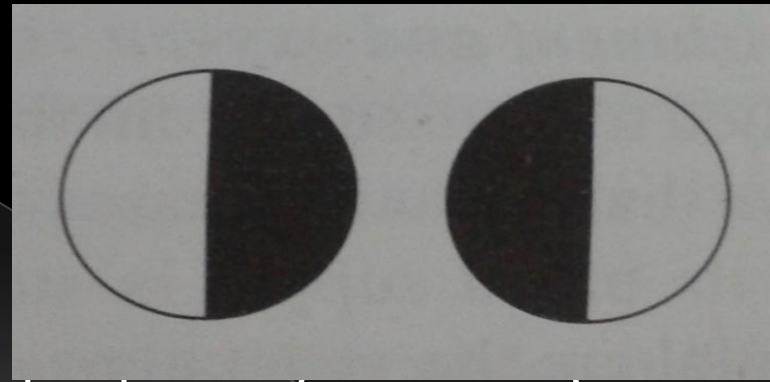
## 4) Lateral chiasmal lesions :

## causes:

- Distension of 3<sup>rd</sup> ventricle causing pressure on each side of optic chiasma
- Atheroma of carotids & posterior communicating artery.

## Characterised by

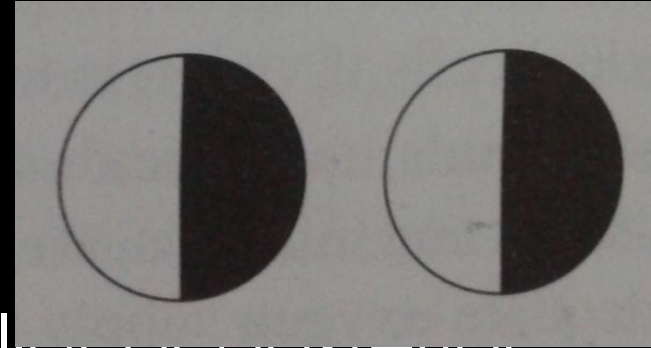
- Binasal hemianopia
- Binasal hemianopic paralysis of accommodation (may lead to partial descending optic atrophy)



## 5) Lesions of optic tract :

### Causes:

- ❑ Syphilitic meningitis/ gumma.
- ❑ Tuberculosis
- ❑ Tumors of optic thalamus
- ❑ Aneurysm of superior cerebellar or posterior cerebral arteries.



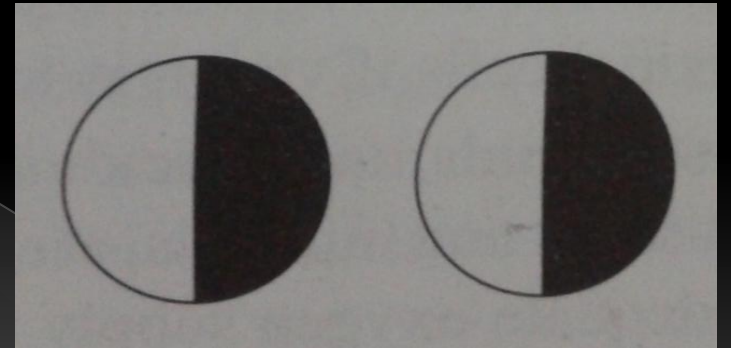
### Characterised by :

- Incongruous homonymous hemianopia with C/L hemianopic pupillary reaction( wernicke's reaction)



## 6) Lesions of lateral geniculate body :

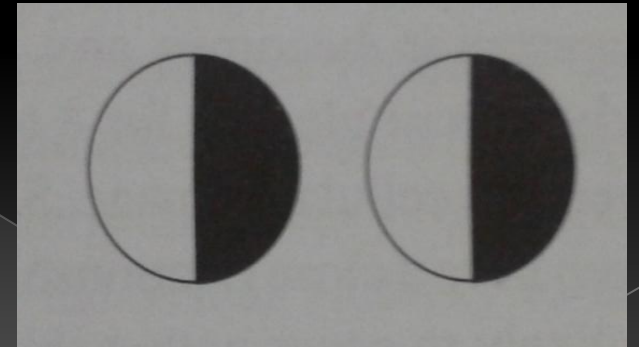
- leads to homonymous hemianopia with sparing of pupillary reflexes & may end in partial optic atrophy.

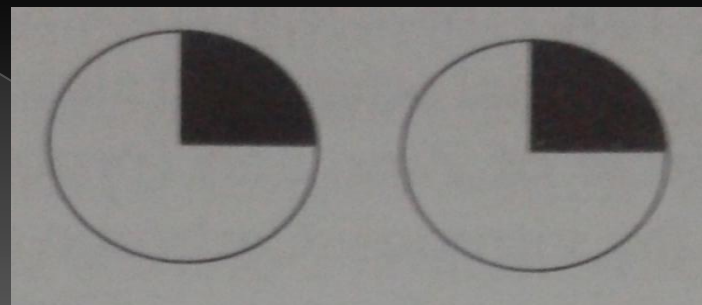
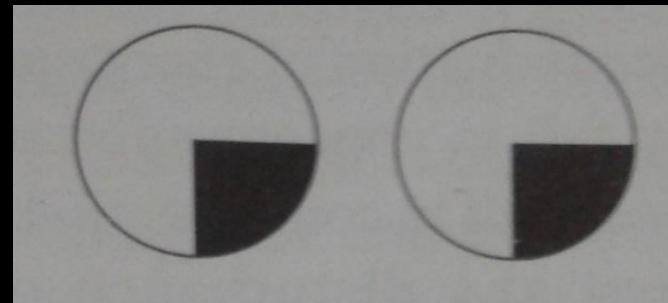


## 7) Lesions of optic radiations :

### Causes:

- Vascular\_occlusion
- Primary & secondary tumors
- Trauma
- Characterised by :





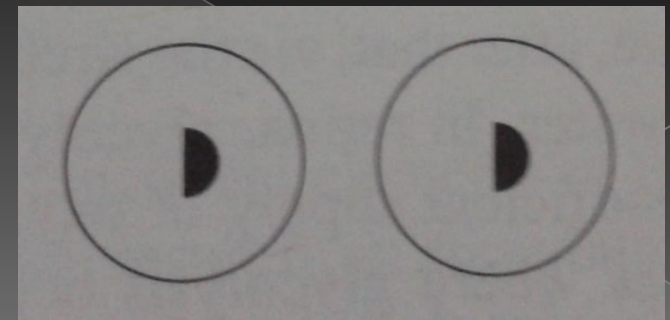
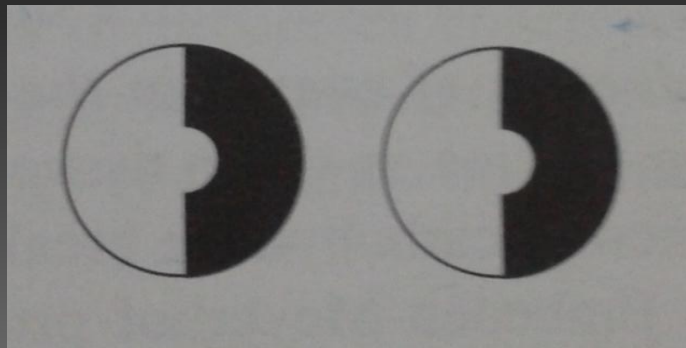
## In lesions of optic radiations

- Pupillary reactions are normal as fibres of light reflex leave the optic tracts to synapse in the superior colliculi.
- Lesions of optic radiations do not produce optic atrophy as the 2<sup>nd</sup> order neurons (optic nerve fibres) synapse in LGB.



## 8) Lesions of visual cortex :

- blood supply by MCA(ant 1/3<sup>rd</sup>) and PCA(post 2/3<sup>rd</sup>)



THANK  
YOU

