Vision, Accommodation & pupillary light reflex
L4

DR.ABDUL MAJEED AL-DREES

Objectives

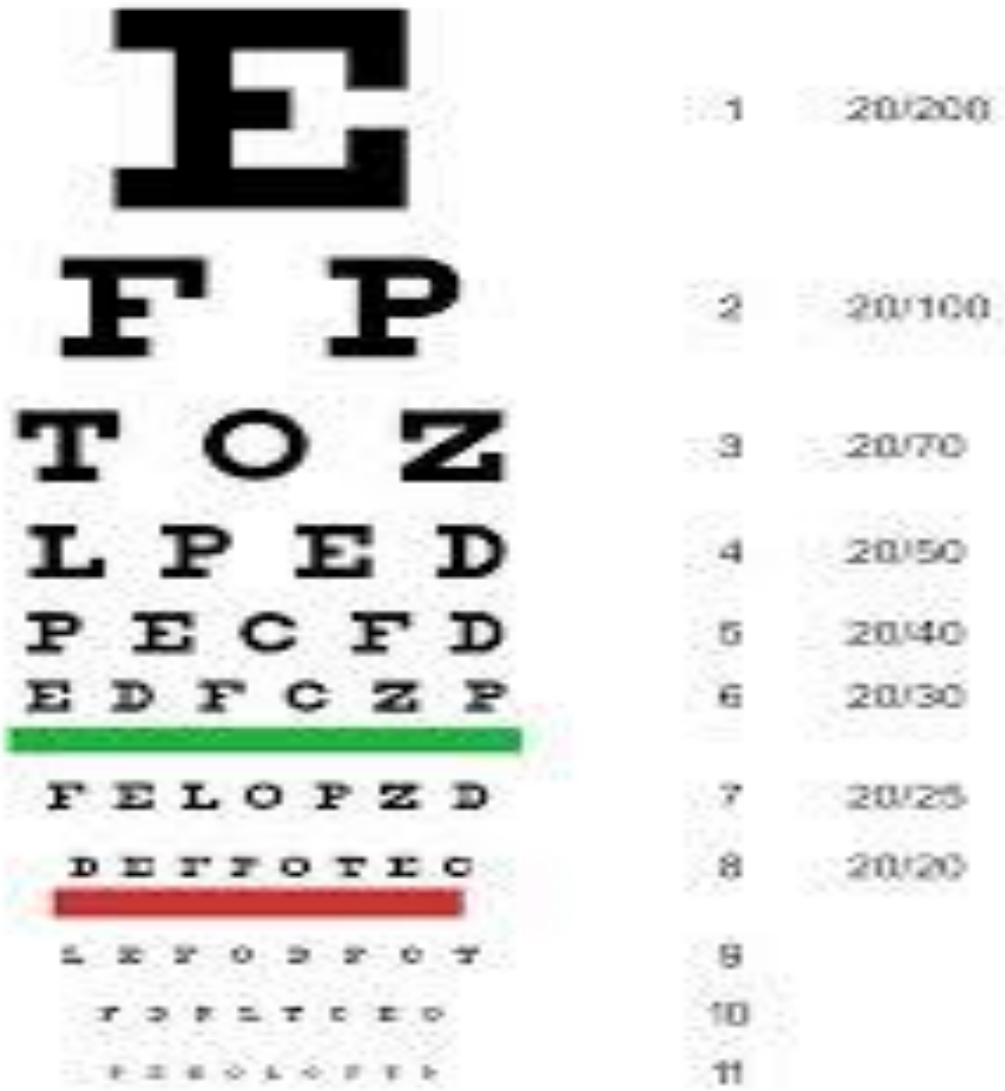
- **Describe visual acuity**
- **To know visual pathway and field of vision**
- **Describe the process of accommodation reflex and its pathway, contrasting the refraction of light by the lens in near vision and in far vision**
- **Identify and describe pupillary light reflex and its pathway and relate these to clinical situations as argyl Robertson pupil**
- **Identify the lateral geniculate body and visual cortex**

VISUAL ACUITY

- **-degree to which the details of objects are percieved**

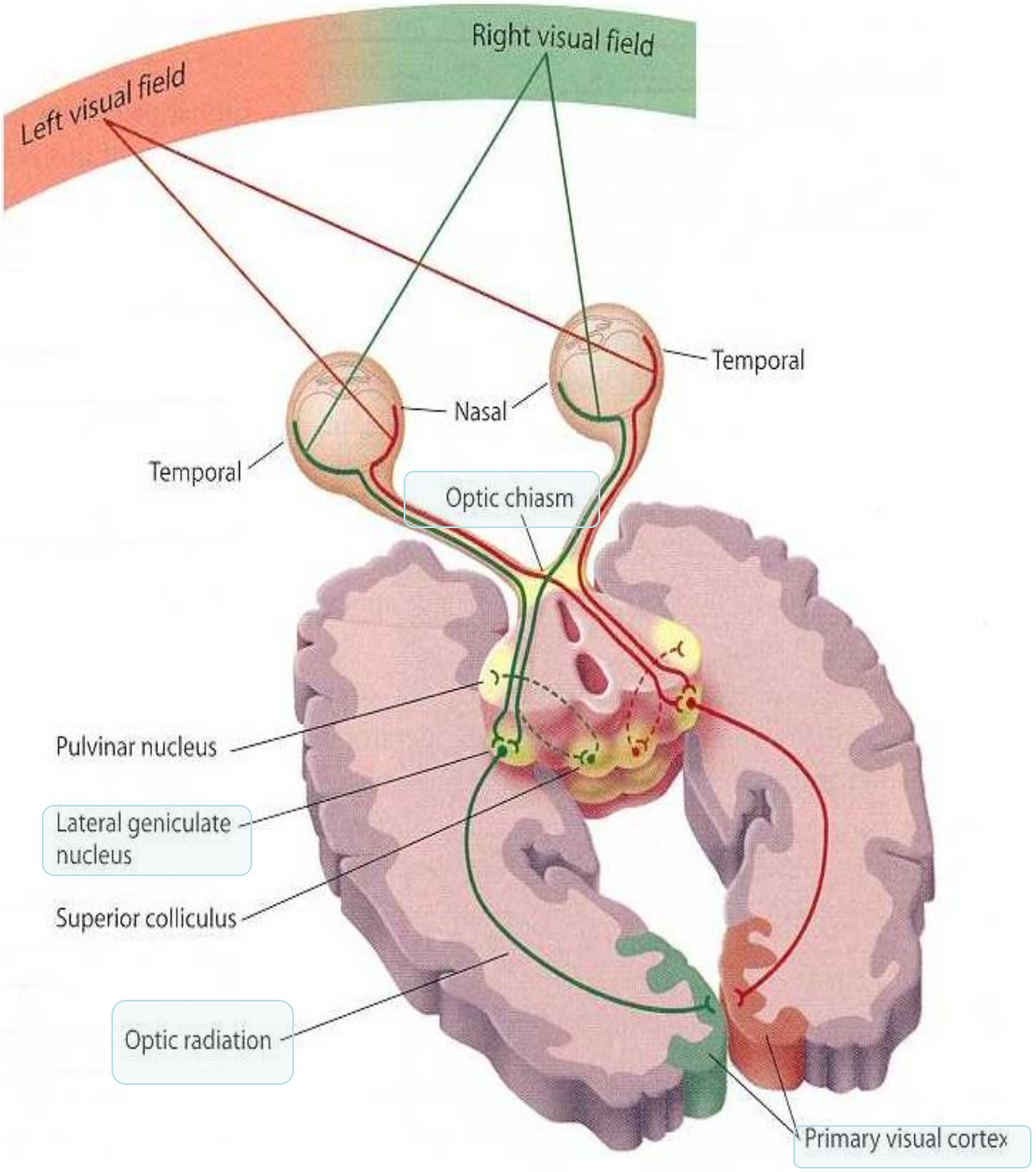
- **-Snellens chart to measure visual acuity**
- **Normal acuity = (d/D = distance of Patient / distance of normal person = 6/6)**

- **Visual threshold :is minimal amount of light that elicit sensation of light**


E
F P
T O Z
L P E D
P E C F D
E D F C Z P
F E L O P Z D
P E C F O T E C
1 20/200
2 20/100
3 20/70
4 20/50
5 20/40
6 20/30
7 20/25
8 20/20
9
10
11

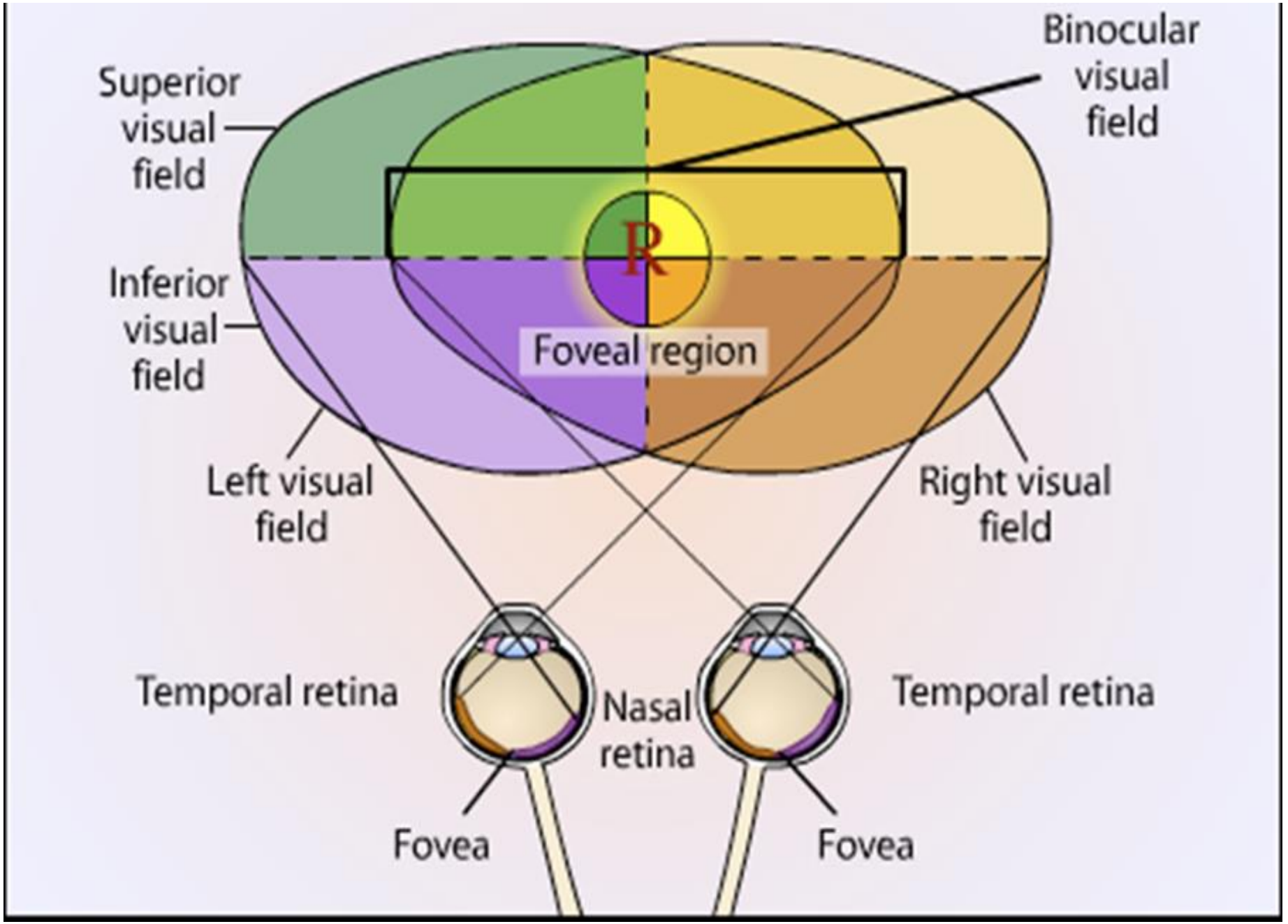
Visual Pathway

1. Optic nerve
2. Optic chiasm
3. Optic tract
4. Lateral geniculate body (nucleus)
5. Optic radiation
6. Visual cortex



Visual Pathway

- The optic nerves from the left and right eyes partially decussate in the optic chiasma
  - Fibers from nasal retina cross over
  - Leads to binocular vision
    - Left visual field viewed through right hemisphere
- Travel through optic tracts to the Lateral Geniculate Nucleus (LGN) of the Thalamus


Binocular visual field
Superior visual field
Inferior visual field
Foveal region
Left visual field
Right visual field
Temporal retina
Nasal retina
Temporal retina
Fovea
Fovea

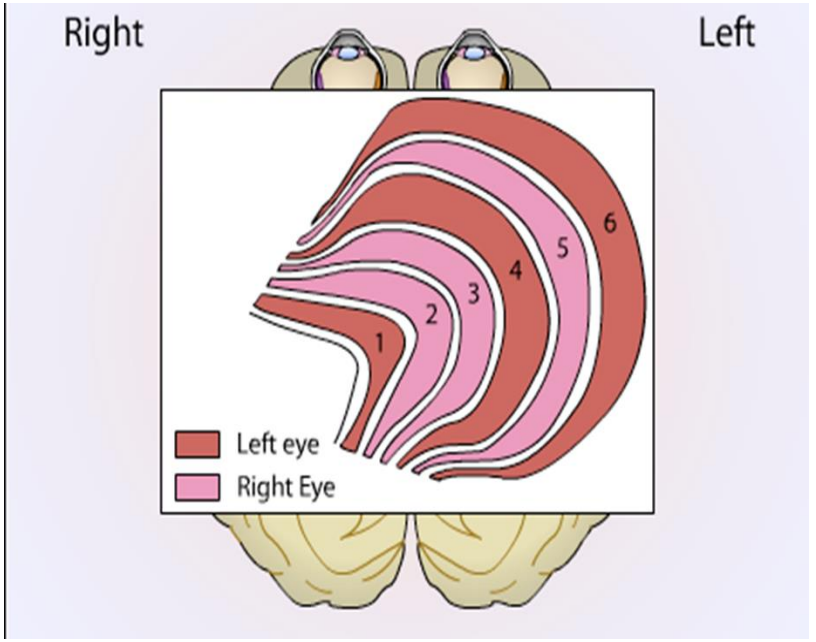
LGB

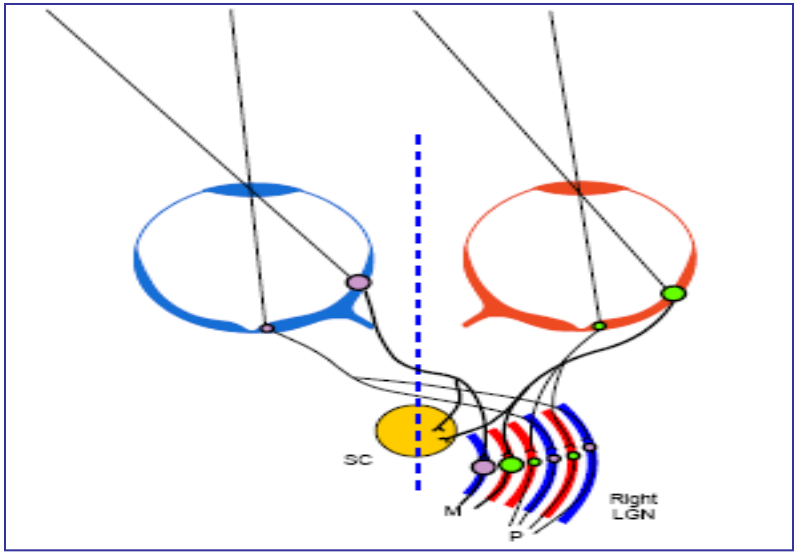
- **Each layer receives input from one eye only:**

  - Layers 1,4,6 from contralateral eye

  - Layers 2, 3,5 from ipsilateral eye

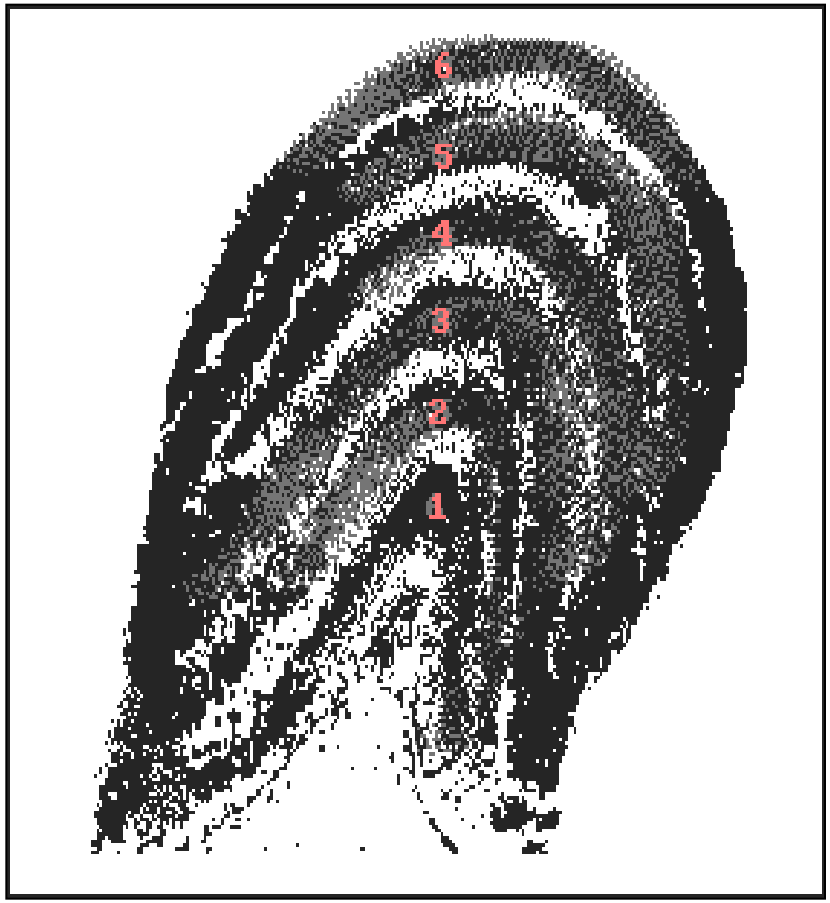
- **LGB also receives input from brain stem, reticular formation & feedback from cerebral cortex**





Lateral Geniculate Body; LGB

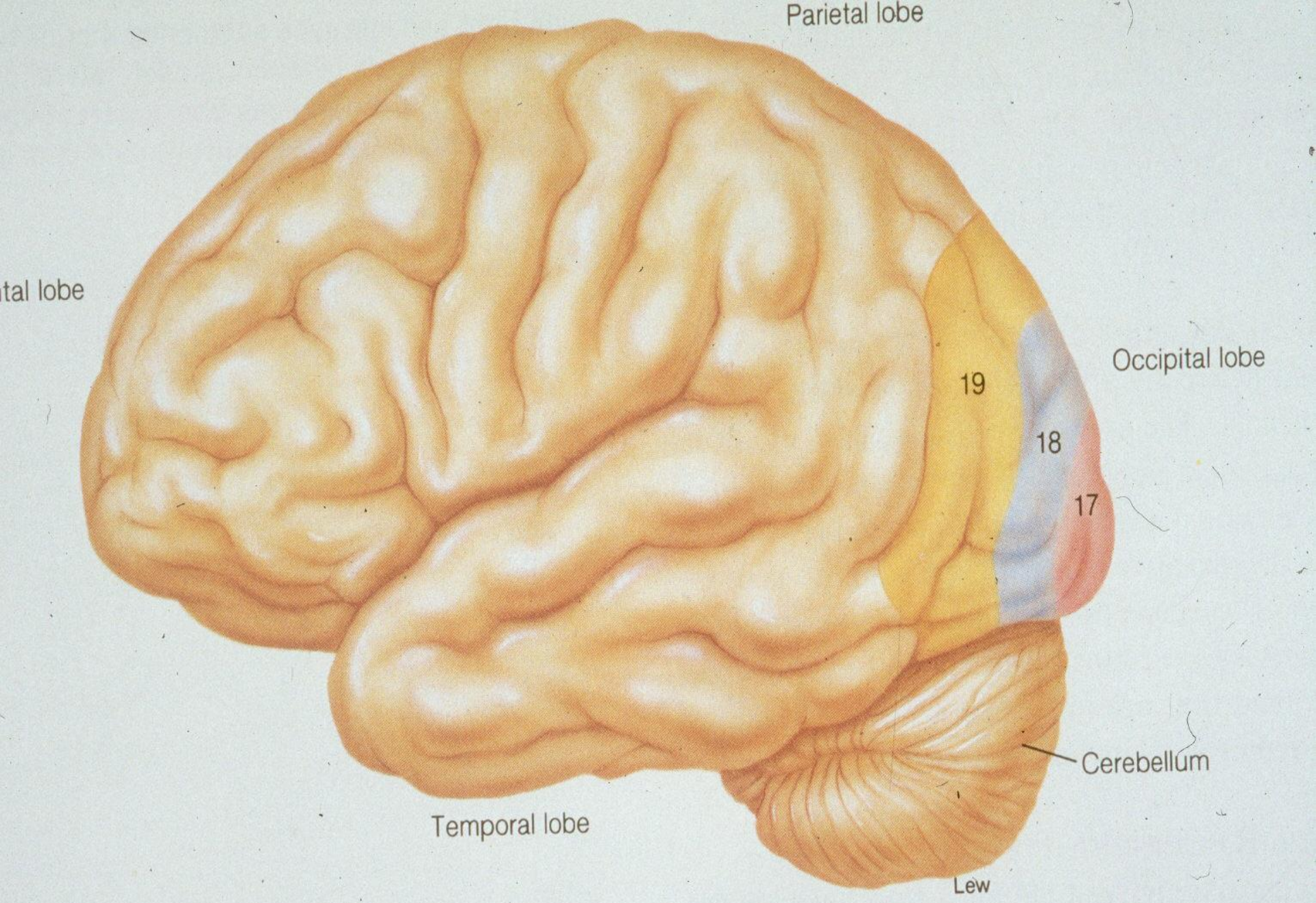
- The Subcortical thalamic relay nucleus of vision, starting the process of co-ordinating vision from the two eyes
- C-shaped 6 defined layers
- Layers 1, 2 receive from large M ganglion cells → Magnocellular division
- Layers 3,4,5 & 6 from small P ganglion cells → Parvocellular division



Cortical Visual areas

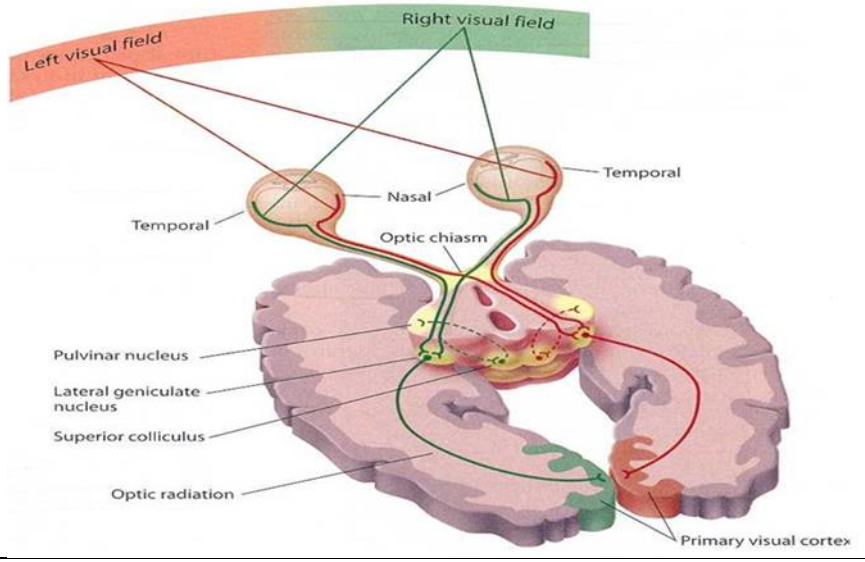
- **- Primary (area 17)**

  - Secondary association area, (areas 18, 19)

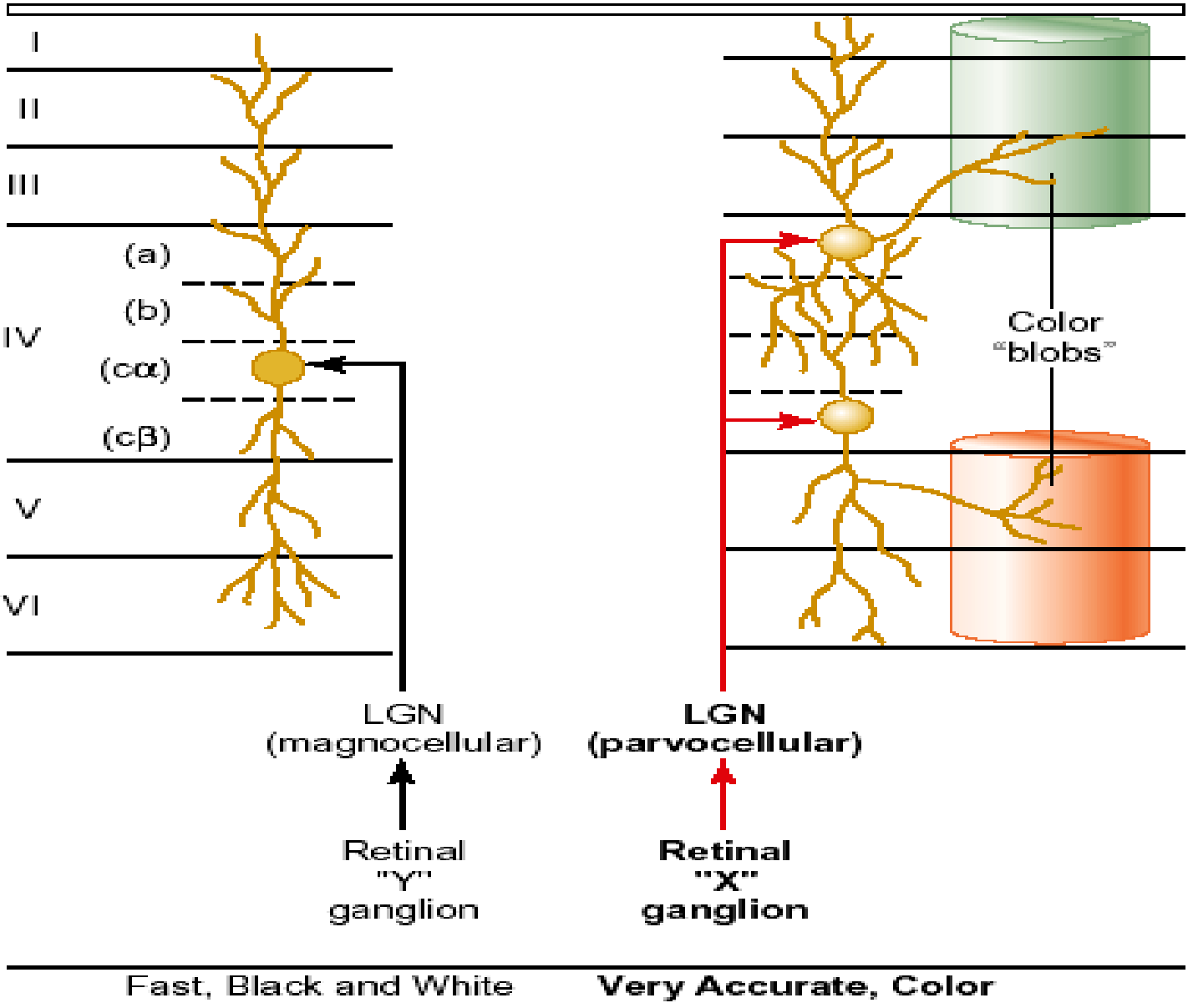

Parietal lobe
tal lobe
19
18
17
Occipital lobe
Cerebellum
Temporal lobe
Lew

Primary Visual area (Area 17)

- **Brodmann's**
- **On medial aspect of each occipital lobe**
- **Its neurons arranged in the form of columns forming 6 distinct layers**
- **Fovea has broad presentation**



Visual Projection to Area 17



Role of Area 17

- **Perception of visible objects without knowing the meaning of these objects**

- **Details of image; shape, borders & colours**

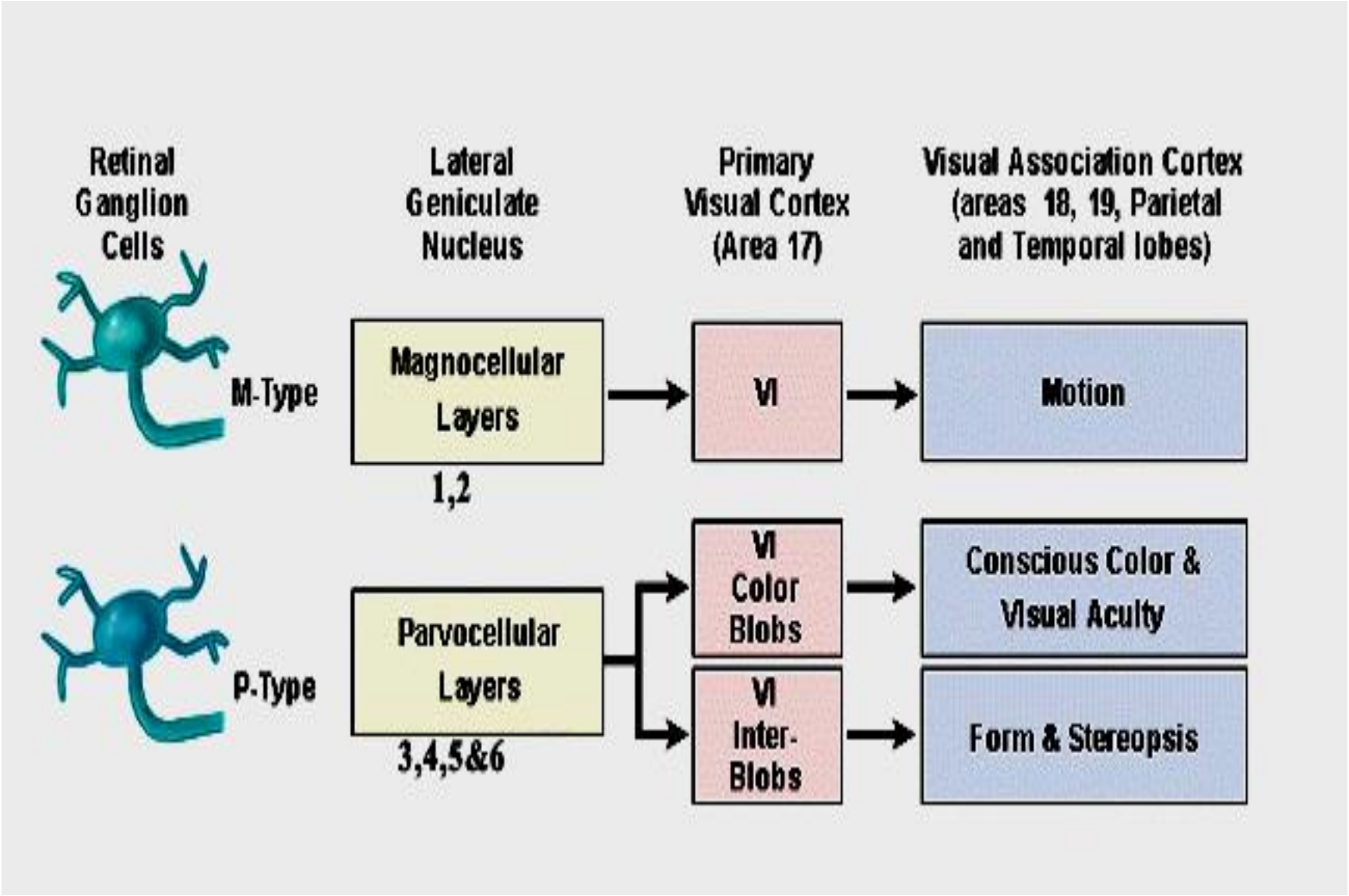
- **Orientation of object in space**

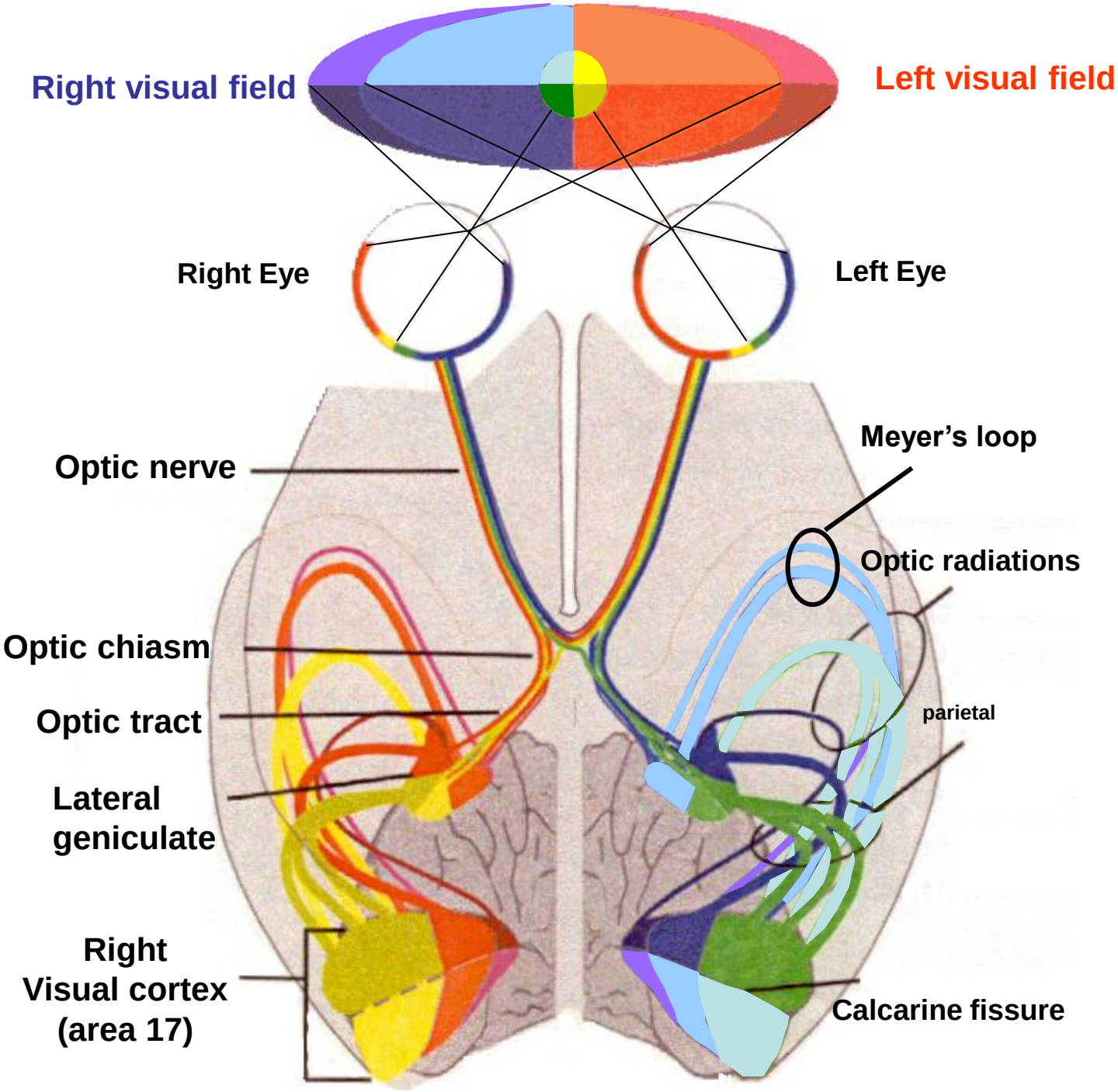
- **3D vision (stereoscopic)**

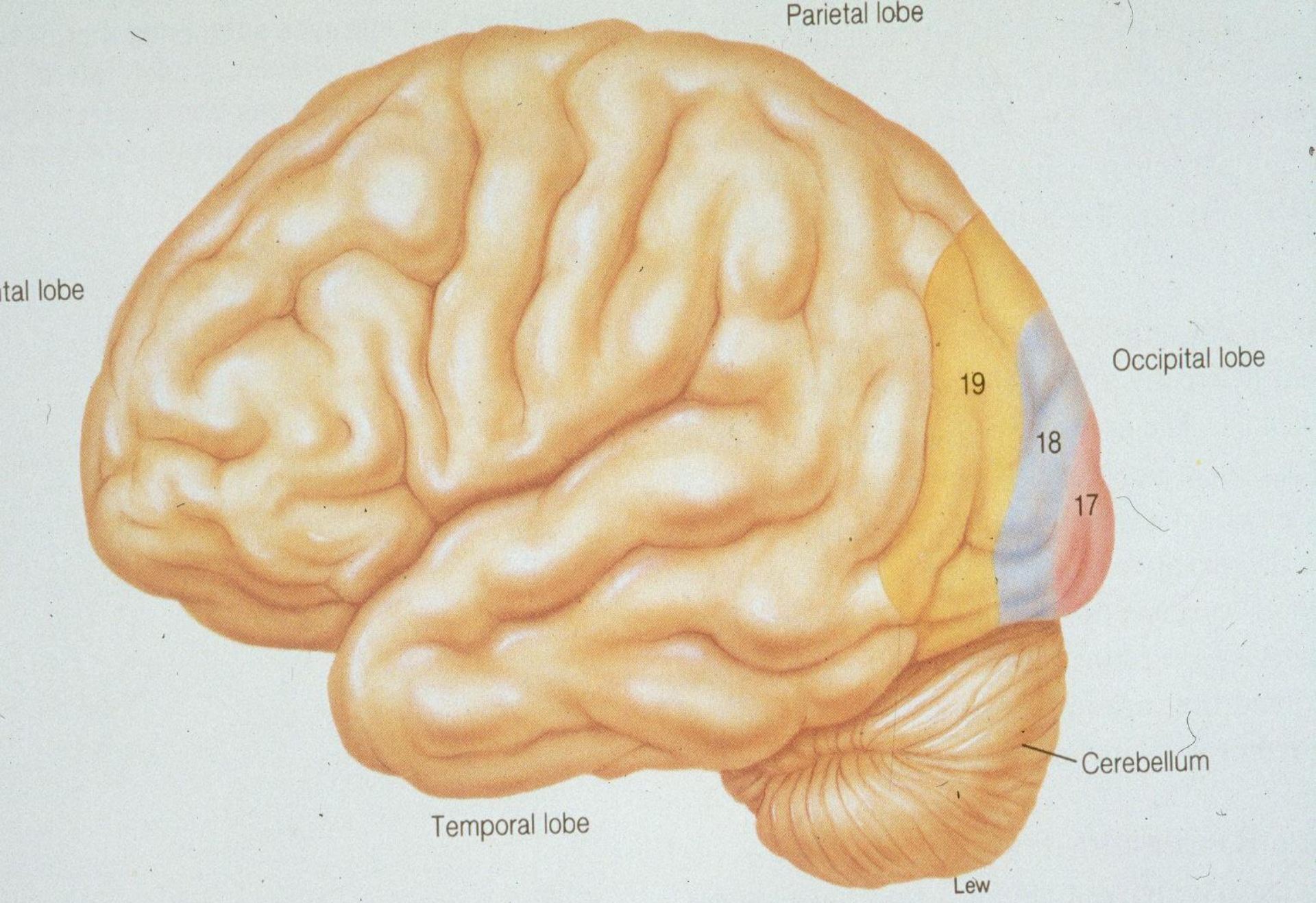
Secondary Visual Processing: Association Areas (18 &19)

- **In parietal & temporal lobes**
- **Interpretation of visual stimuli**
- **Dealing with complex perception of patterns & forms responsible for object recognition**
- **cells in large complex receptive fields & selective for specific stimuli (familiar faces)**

Retinotopic Organization & Processing of visual information




Right visual field
Left visual field
Right Eye
Left Eye
Optic nerve
Meyer's loop
Optic radiations
Optic chiasm
Optic tract
parietal
Lateral geniculate
Right Visual cortex (area 17)
Calcarine fissure


Parietal lobe
tal lobe
19
18
17
Occipital lobe
Cerebellum
Temporal lobe
Lew

Accomodation


DS2_0680

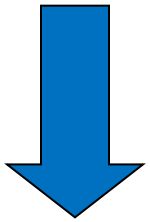
Accomodation

Modification of the
refractive power of the eye
(curvature of the lens)
to view a nearby object

Clear vision of a nearby object

Accomodation- cont.

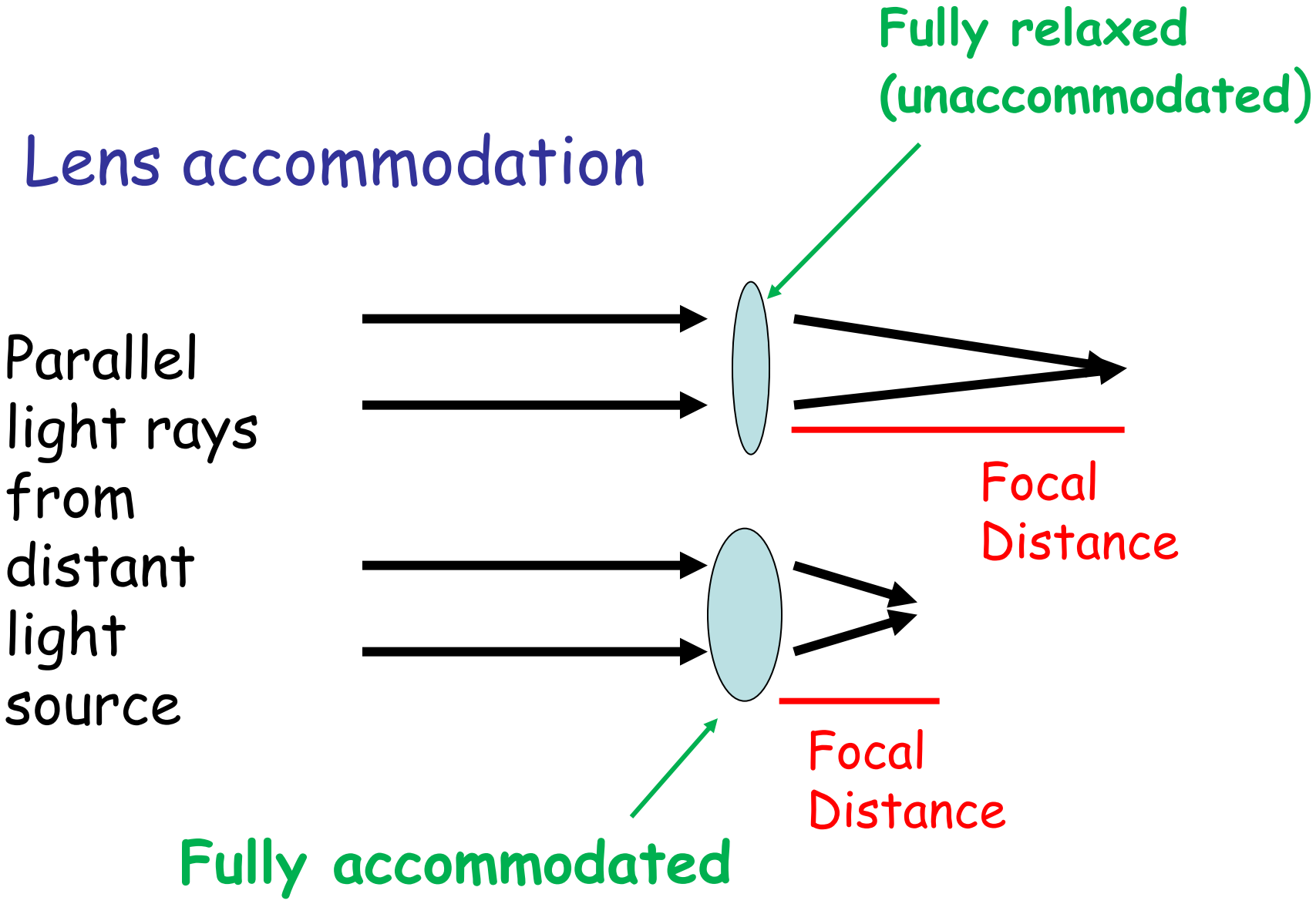
- Lens changes (accomodation)
- Changes in the pupil
- Convergence of the eyes

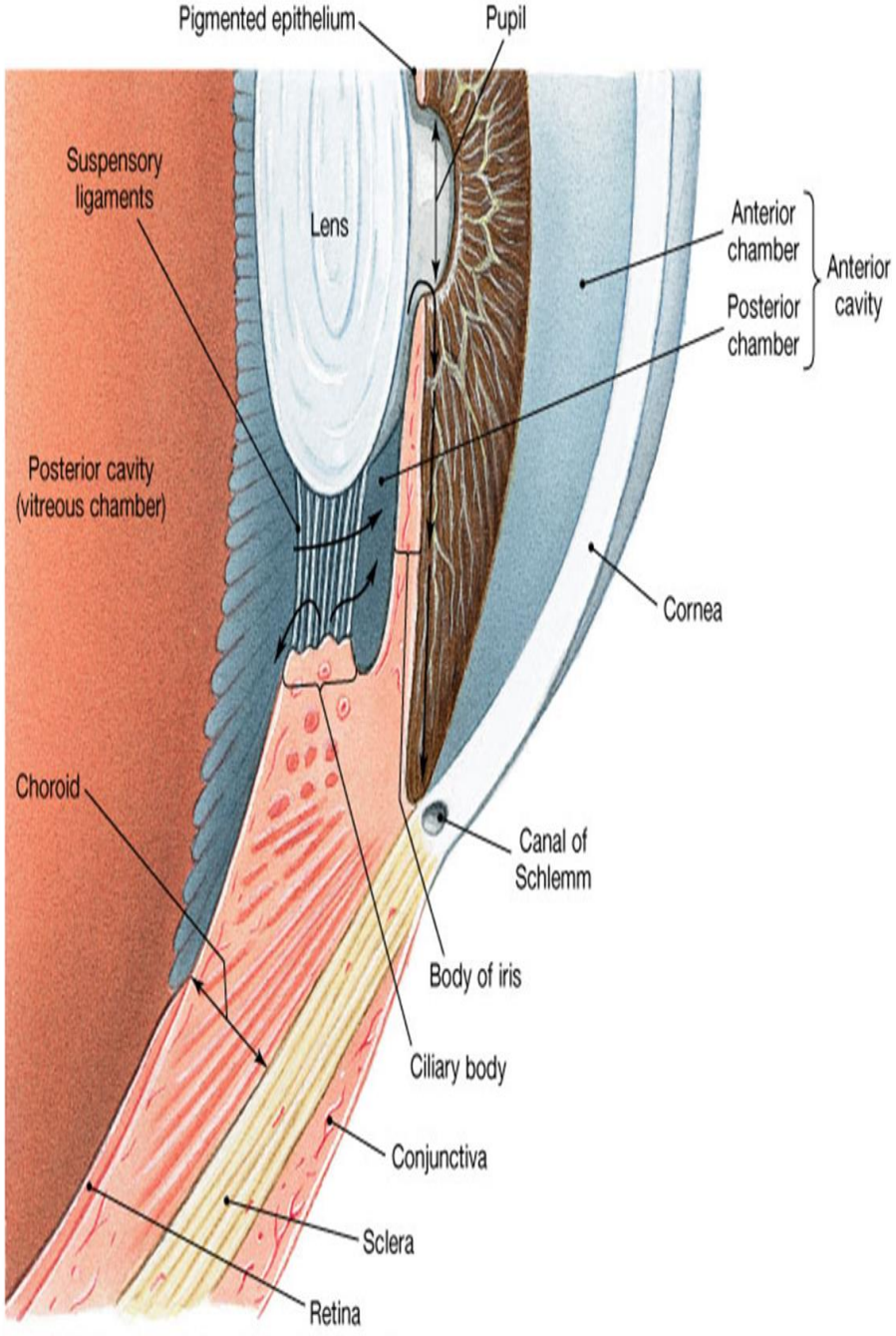


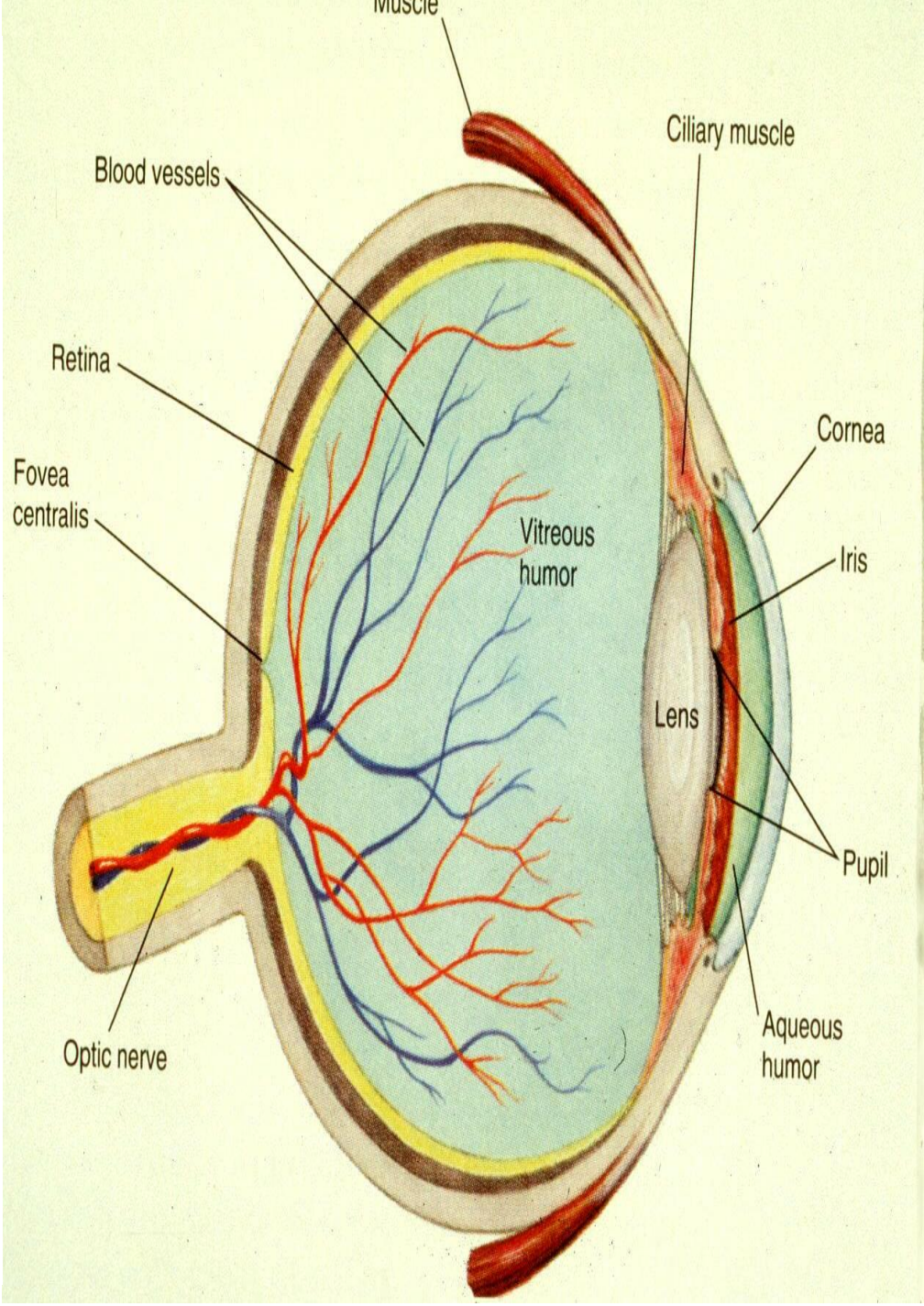
The near response

Image Focusing

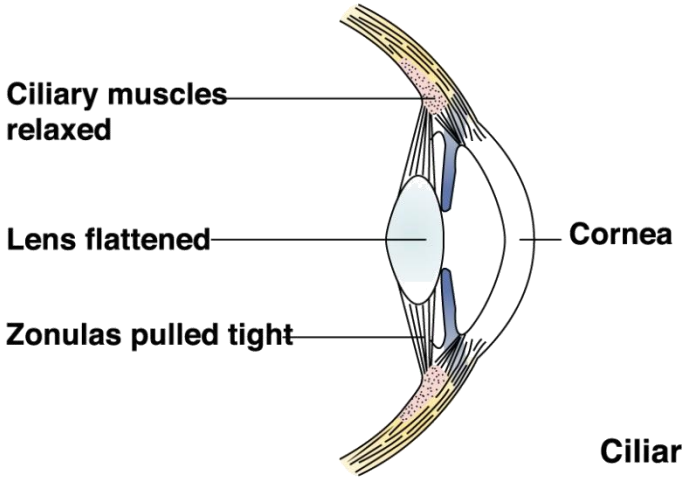
- Lens accommodation



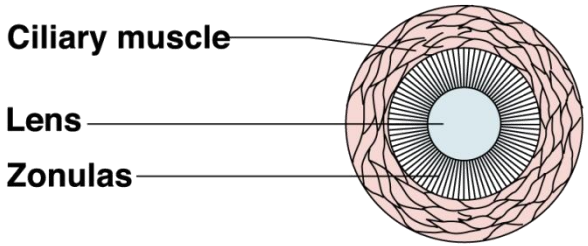

Pigmented epithelium
Pupil
Suspensory ligaments
Lens
Anterior chamber
Posterior chamber
Anterior cavity
Posterior cavity (vitreous chamber)
Cornea
Choroid
Canal of Schlemm
Body of iris
Ciliary body
Conjunctiva
Sclera
Retina


Ciliary muscle
Blood vessels
Retina
Cornea
Fovea centralis
Vitreous humor
Iris
Lens
Pupil
Optic nerve
Aqueous humor

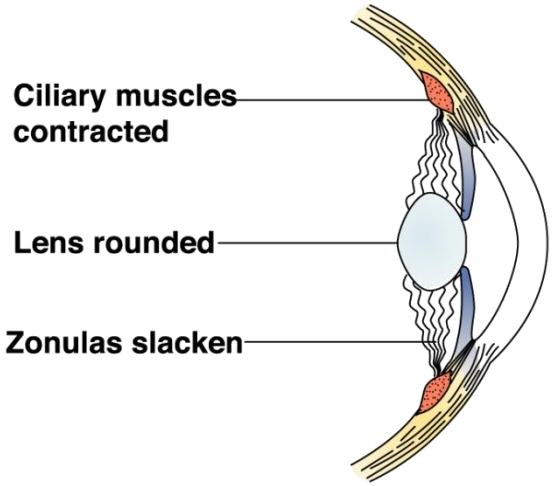
Accommodation



When the cilary muscles are relaxed, the zonalus pulls tight and keeps the lens flattened for distant vision



The elastic lens is attached to the circular cilary muscles by the zonalus which is made of inelastic fibres



When the cilary muscles contract, it releases the tension on the zonalus and the elastic lens returns to a more rounded shape suitable for near vision

Mechanism of accomodation

Ciliary muscle ….Contraction:

↓

Relaxation of the suspensory ligament

↓

Lens more convex

↓

Increase diopteric power of the eye

↓

Near object focussed on the retina

Mechanism of accomodation- cont

Ciliary muscle ….Relaxation:

↓

Contraction of the suspensory ligament

↓

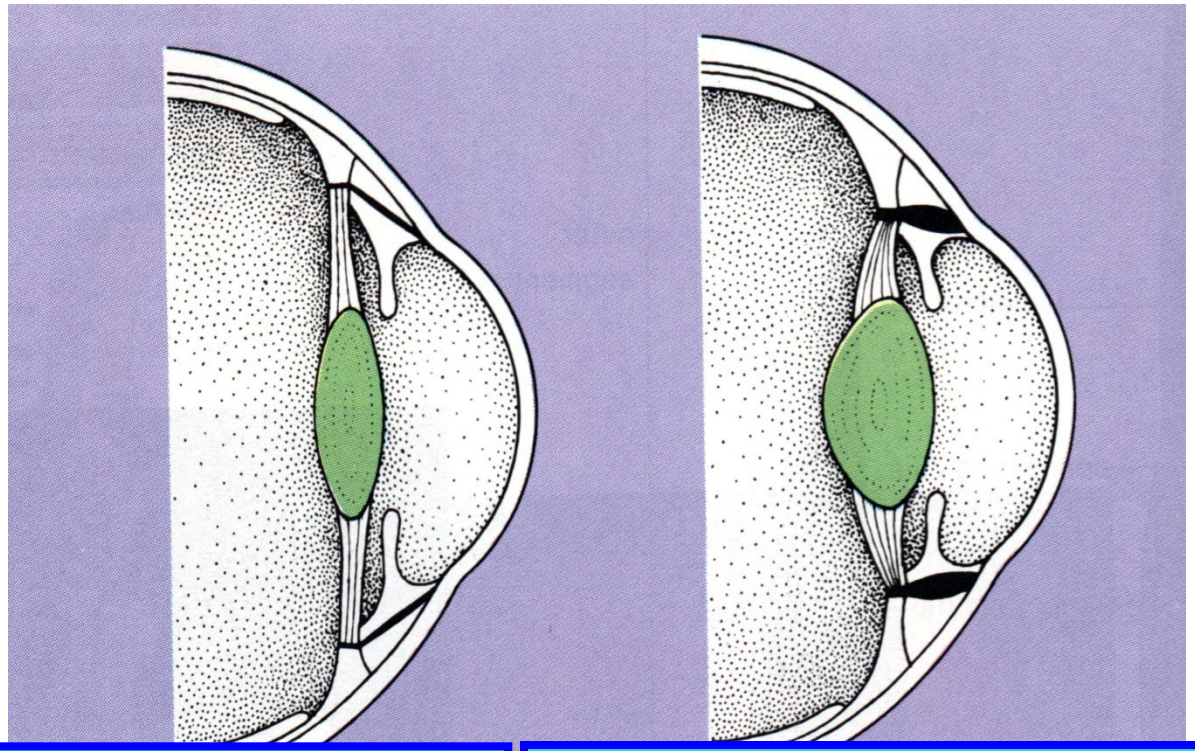
Lens less convex (Flat)

↓

Decrease diopteric power of the eye

↓

Far object focussed on the retina



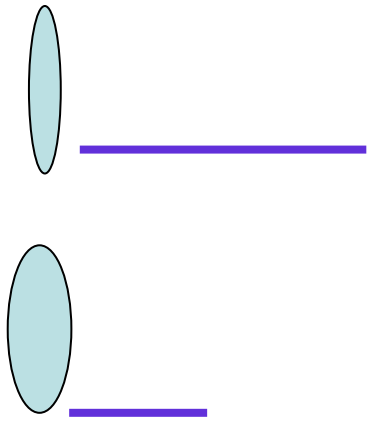
Distant Vision:
Ciliary Muscle Relaxed
Suspensory Ligaments Under Tension
Lens is Flattened
Focus on Distant Objects

Accommodation:
Ciliary Muscle Contracts
Reduced Tension on Suspensory Ligaments
Lens becomes Round
Focus on Near Objects

Accomodation-cont

Lens changes during accomodation:

- Affect the anterior surface of the lens mainly
- Lens thickness increases



Accomodation-cont

Lens changes during accomodation:

- Affect the anterior surface of the lens mainly
- Lens thickness increases

Diopter (D)

$$\text{Dioptre (s)} = \frac{1}{\text{Focal length (m)}}$$

Diopteric power if the eye:

Cornea ……40-45 D

Lens …… 15-20 D

Accomodation …. +12 D

Amplitude of Accomodation

Definition

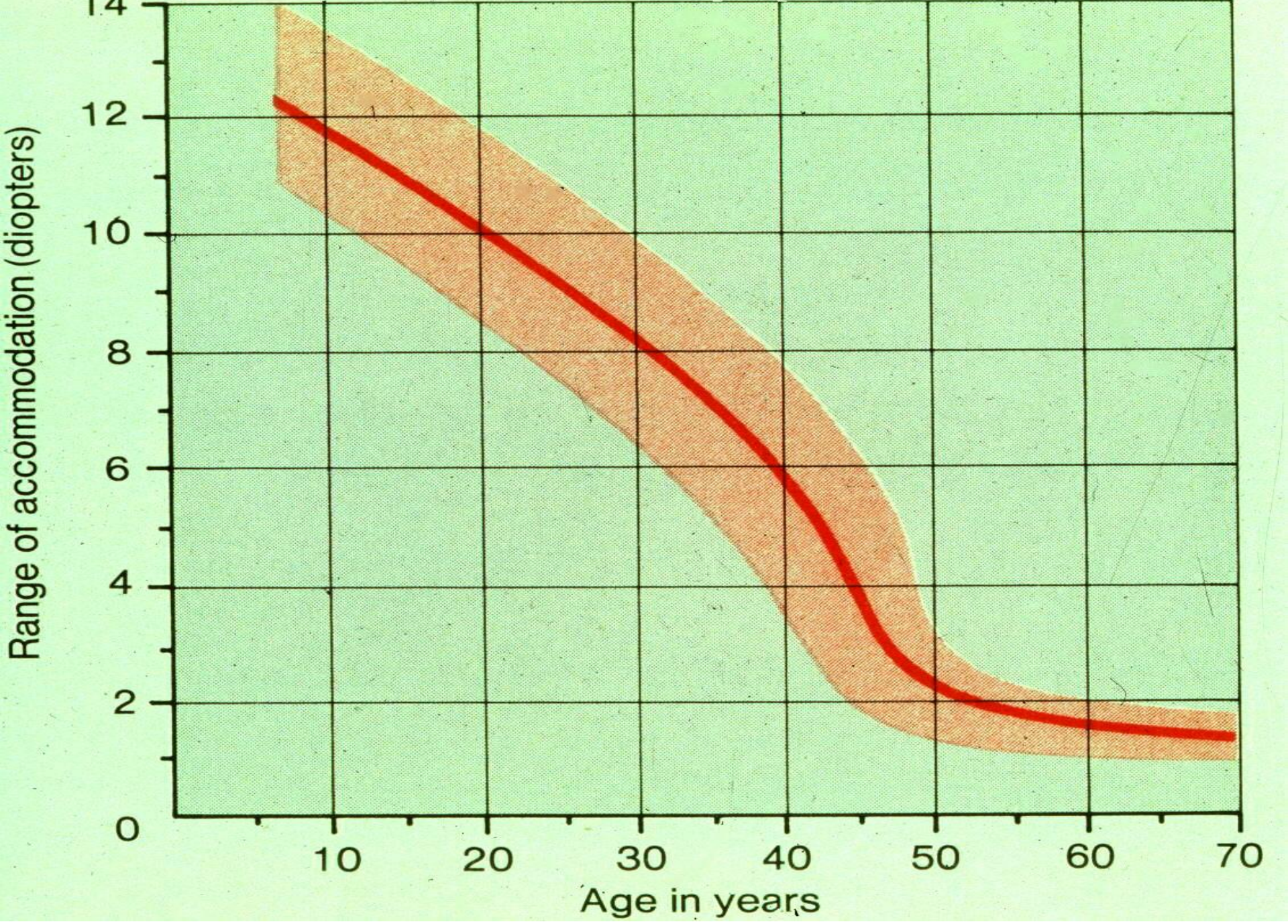
The additional diopters added by increasing the convexity of the lens

Near point:

The nearest point to the eye where an object can be seen clearly

Presbyobia:

Loss of lens elasticity in old age >>loss of accomodation


Range of accommodation (diopters)
14
12
10
8
6
4
2
0
10
20
30
40
50
60
70
Age in years

Near point and amplitude of accomodation

Age (yrs)	Near point (cm)	Amplitude of Accomodation
10	9.0	11.0
20	10.0	10.0
30	12.5	8.0
40	18	5.5
60	83	1.2
70	100	1.0

The accomodation Reflex

Afferent:

Retina ⇨ optic nerve ⇨ optic chiasma ⇨ optic tract ⇨ lateral geniculate body ⇨ visual cortex

Efferent: Occuluomotor nucleus ⇨ (parasympathetic) ⇨ ciliary ganglion ⇨

⇨ ciliary muscle

⇨ circular pupillary muscle

Convergence of the eyes

- **perception of two images as one**

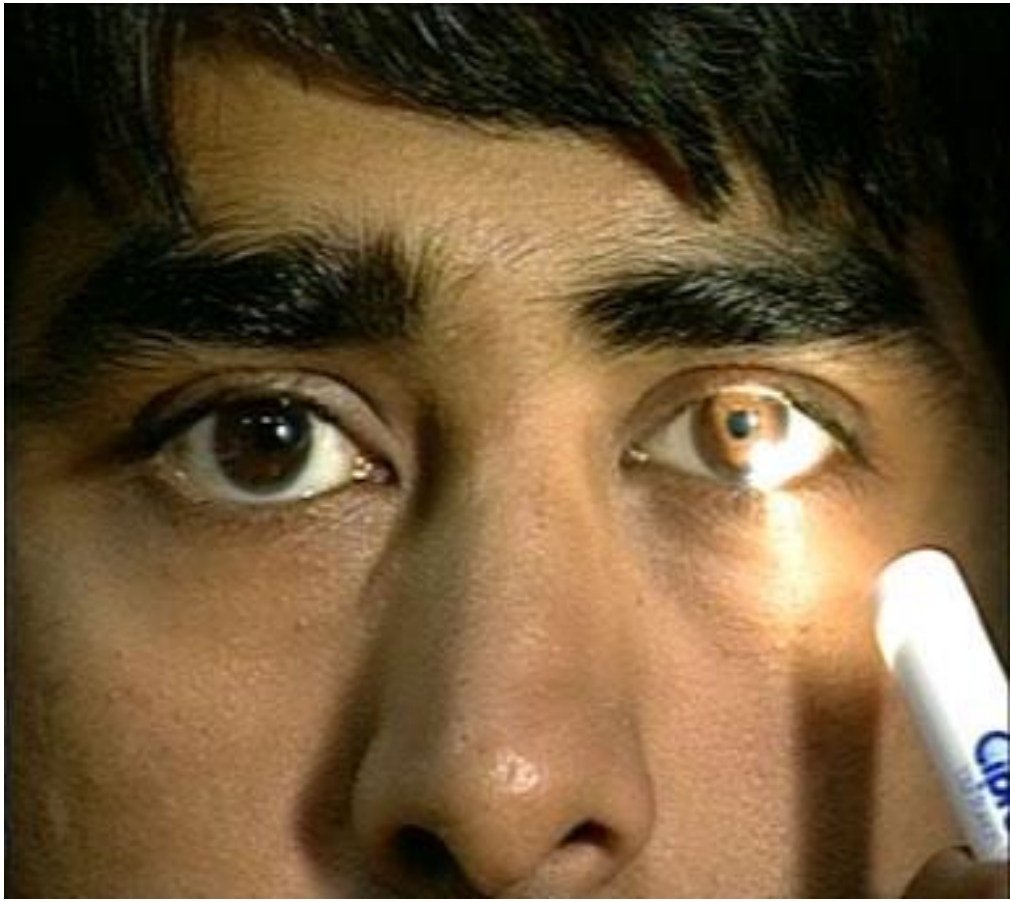
- **When the 2 images are not in register as one cortical neurons → excitation of interference cortical neurons → signals to Oculomotor apparatus → convergence or divergence or rotation to re-establish fusion**


Oriental Garden, Shore Acres State Park, Oregon

The light reflex

Light Reflex

subject to bright light,
a direct light reflex
occurs(constriction of
the pupil) as well as a
consensual (indirect) reflex
of the other (Right) pupil



The light reflex

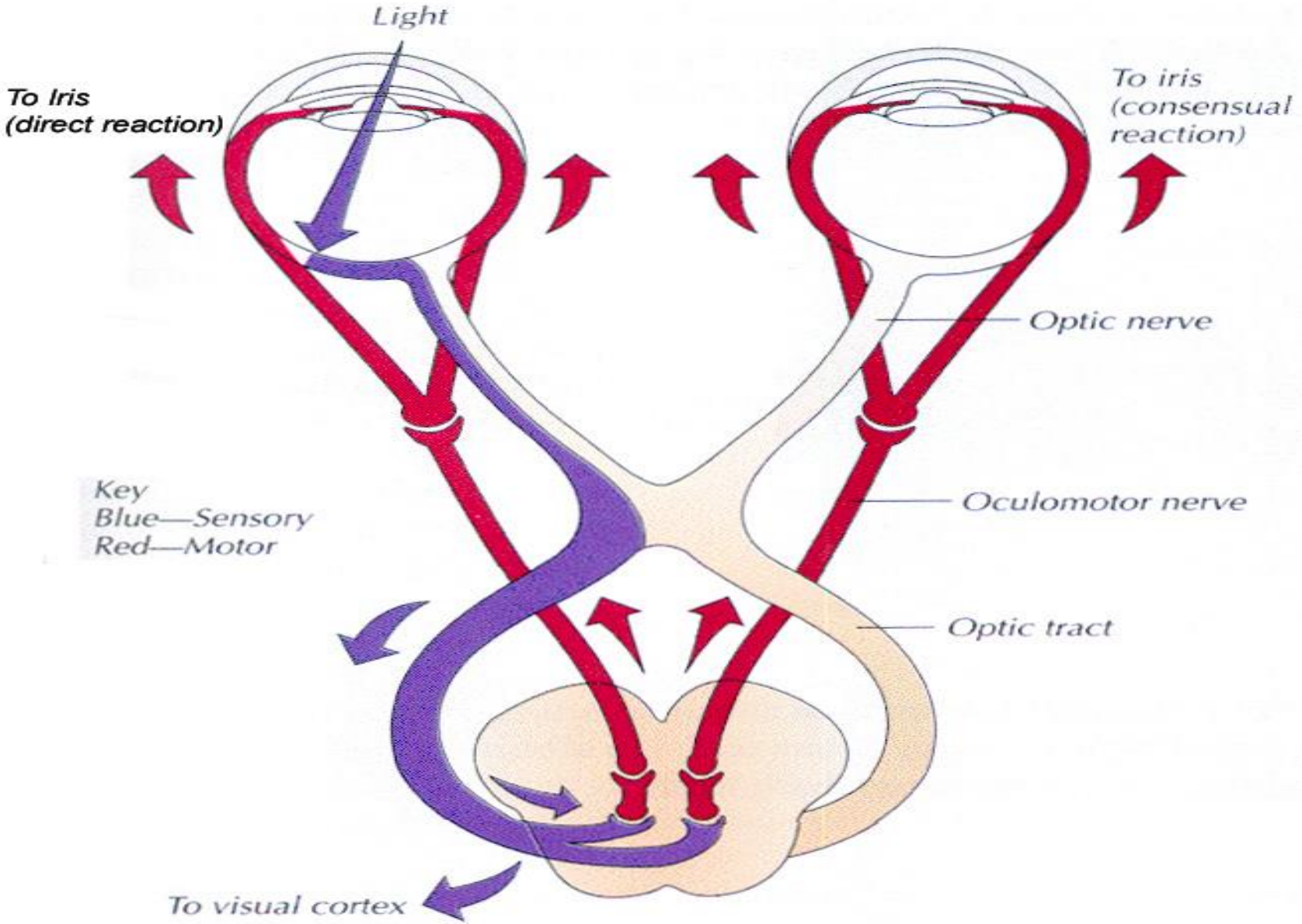
==The constriction of the pupil in response to light

Pathway:

Retina ⇨ optic tract ⇨ superior colliculus ⇨ occulomotor nucleus ⇨ pupillary muscles

Reflex arc:

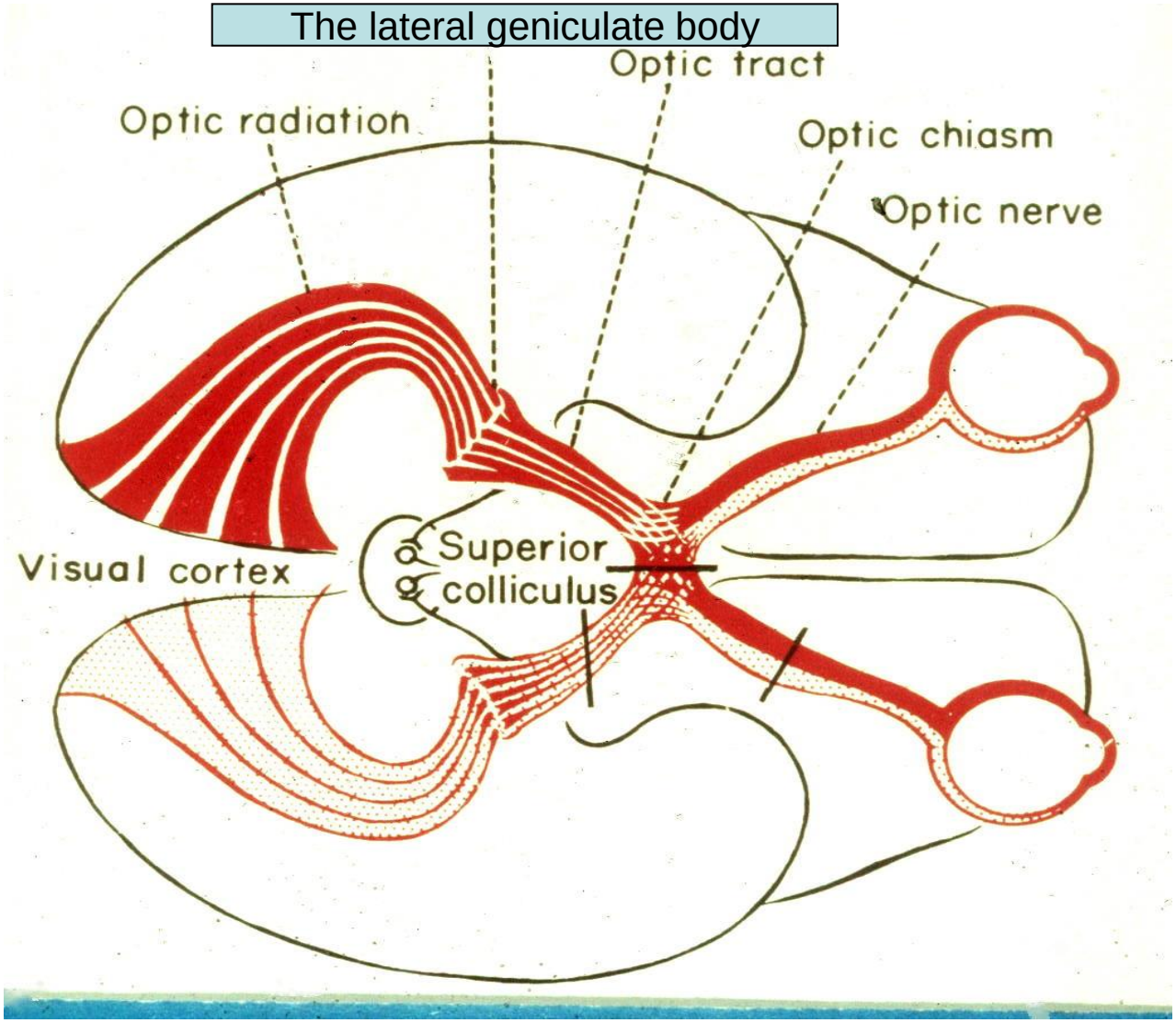
- light receptors ⇨ optic nerve ⇨ optic tract - ⇨ pretectal area ⇨ **Edinger-Westphal nucleus** ⇨ parasympathetic fibers of n. oculomotor ⇨ n. ciliaris ⇨ m. sphincter pupillae ⇨ decrease of pupillary diameter.
-
- **Consensual pupillary light reflex:** reaction of eye pupil to light irritation of opposite eye. It is possible due to diverging of nerve fibers from one **pretectal nucleus to both Edinger-Westphal nuclei.**



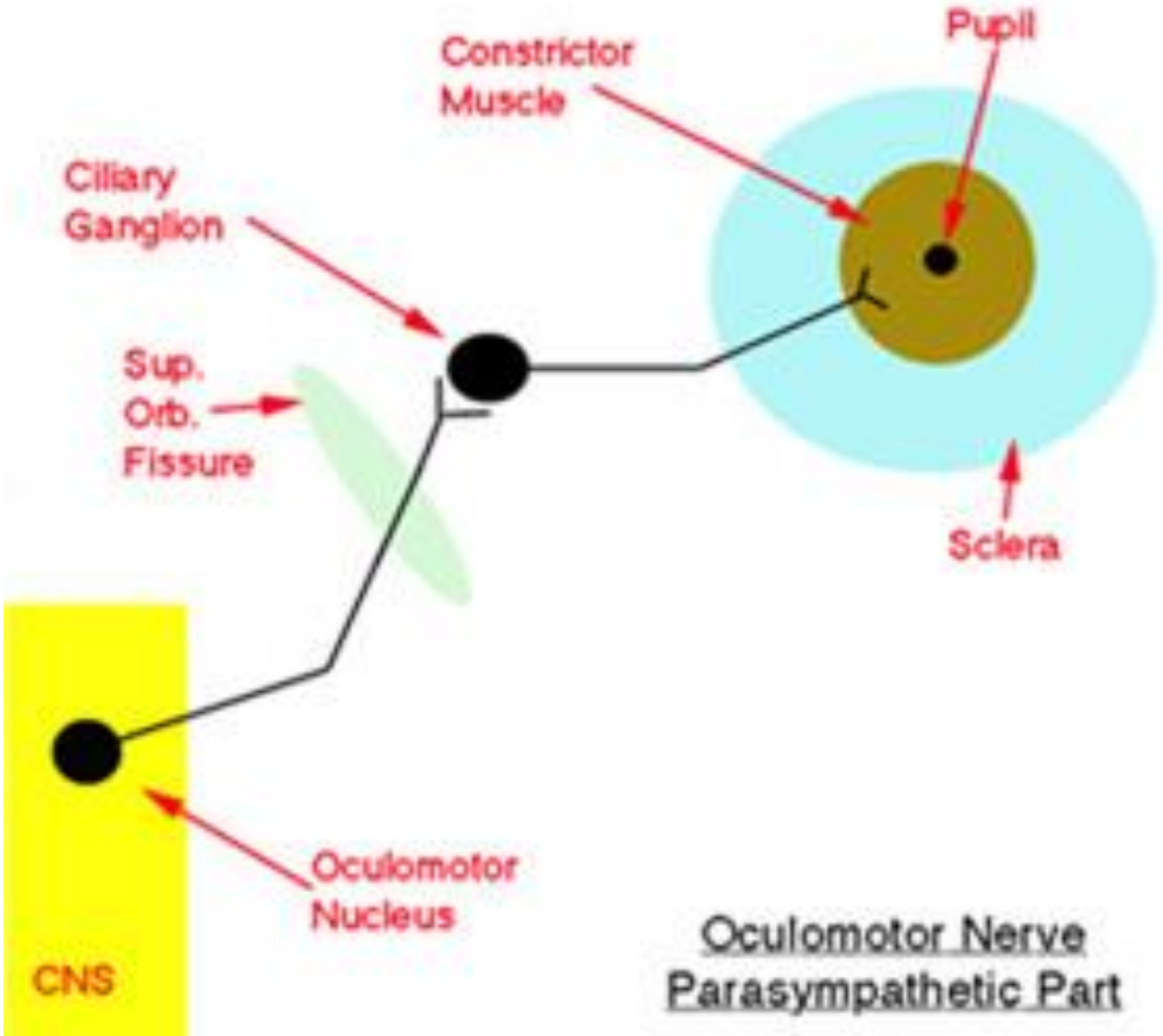
PATHWAYS OF THE LIGHT REACTION

Bates, A Guide to Physical Examination and History Taking. JB Lippincott, Co.

The lateral geniculate body



Note the pathway for pupillary contraction



Constriction of the pupil

The pupil constricts in response to:

- The accomodation Reflex
- The light reflex

Argyll Robertson pupils (Neurosyphilis)

Pupils constrict in response:

to accomodation reflex

but not

to the light reflex

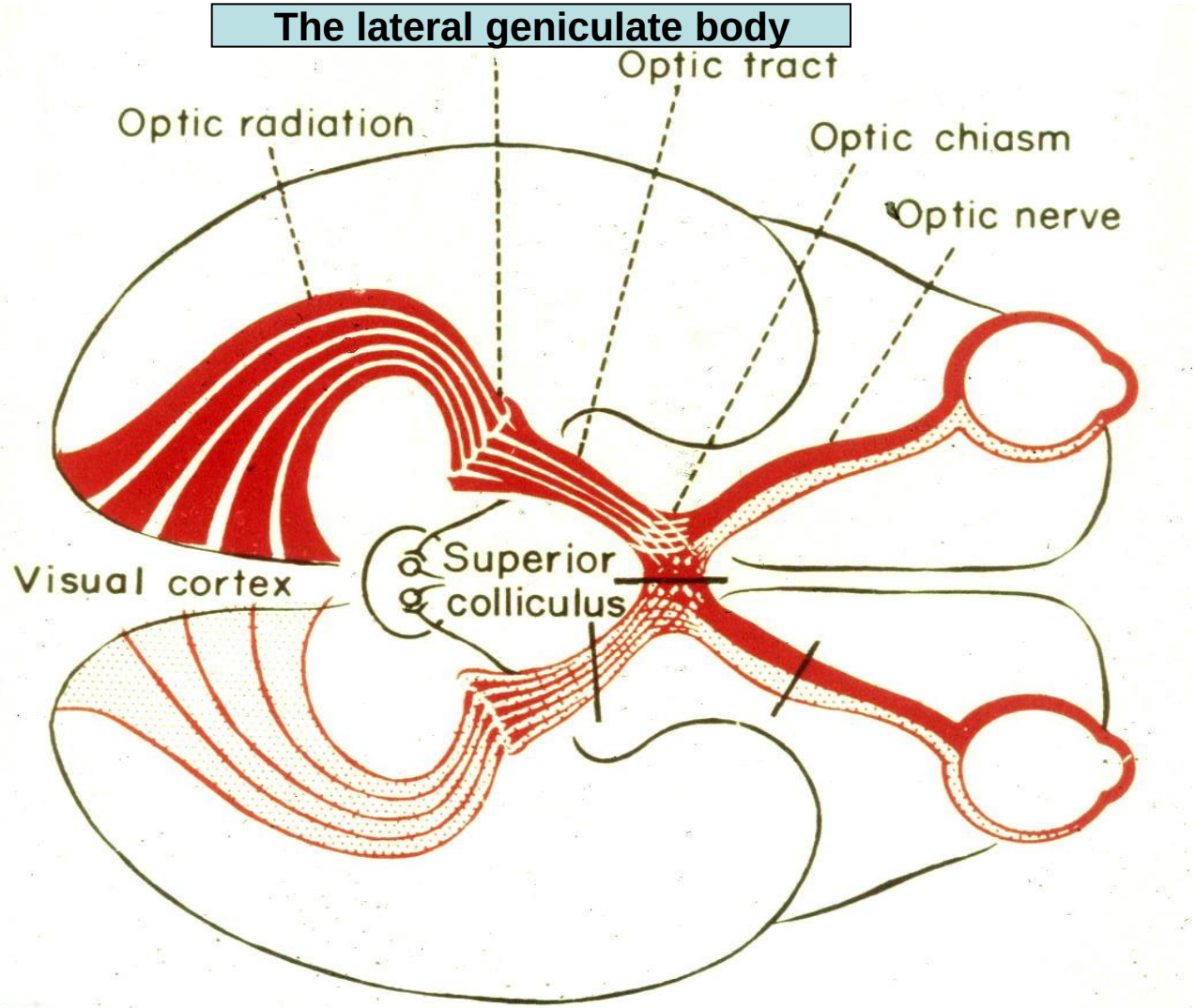
Destruction of pretectal nucleus

Argyll Robertson pupils

- **ARP**, standing for **A**ccomodation **R**eflex **P**resent.

  Read it from back to front: it is **PRA**, standing for **P**upillary **R**eflex **A**bsent.

The lateral geniculate body




Sunset Over the Mississippi River, Arkansas