Vision -LECTURE 2

Accomodation& pupillary light reflex

By
Prof/Faten zakareia

Objectives:

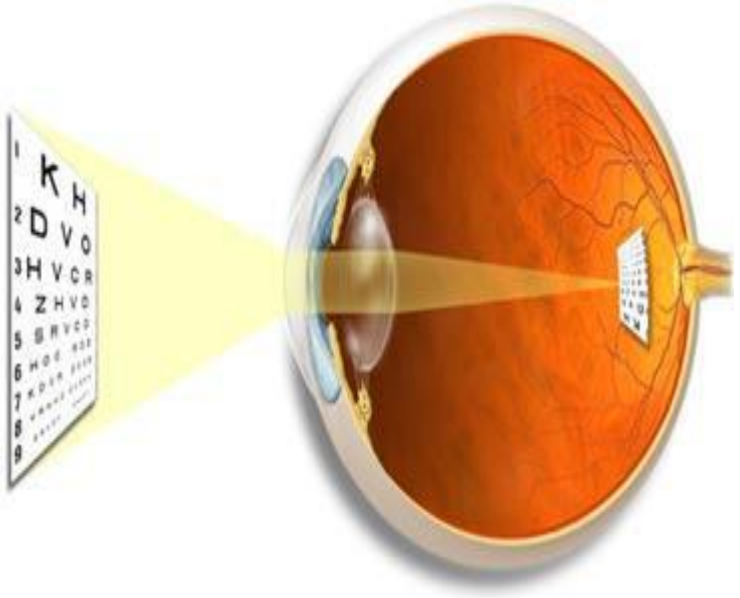
At the end of this lecture ,the student should be able to;- ---
-Describe visual acuity & depth perception
-Contrast photopic and scotopic vision
-To know visual pathway and field of vision
-Describe the process of accommodation reflex and its pathway, contrasting the refraction of light by the lens in near vision and in far vision
-Identify and describe pupillary light reflex , its pathway and -relate these to clinical situations as argyl Robertson pupil
-Identify the lateral geniculate body and visual cortex functions

Textbook/Guyton & Hall Reference book/Ganong review of medical physiology

VISUAL ACUITY

- -Difinition :-
- -The degree to which the details and contours of objects are perceived,
- --it is usually defined in terms of the shortest distance by which two lines can be separated and still be seen as 2 lines

- -Visual threshold
- -Is minimal amount of light that elicit sensation of light
- Snellen s chart to measure visual acuity
- Normal acuity = (d/D = d distance of Patient / D distance of normal person = 6/6)
- A person of 6/12 has less vision than normal vision



DUPLICITY THEORY OF VISION

(2 kinds of vision under diff conditions)

Q.Differentiate between cones & rodes vision.

1-PHOTOPIC VISION (bright light vision)

-served by cones

-high visual acuity = colors & details

- low sensitivity to light = needs high visual threshold to be stimulated

2-SCOTOPIC VISION (night vision, dimlight vision)

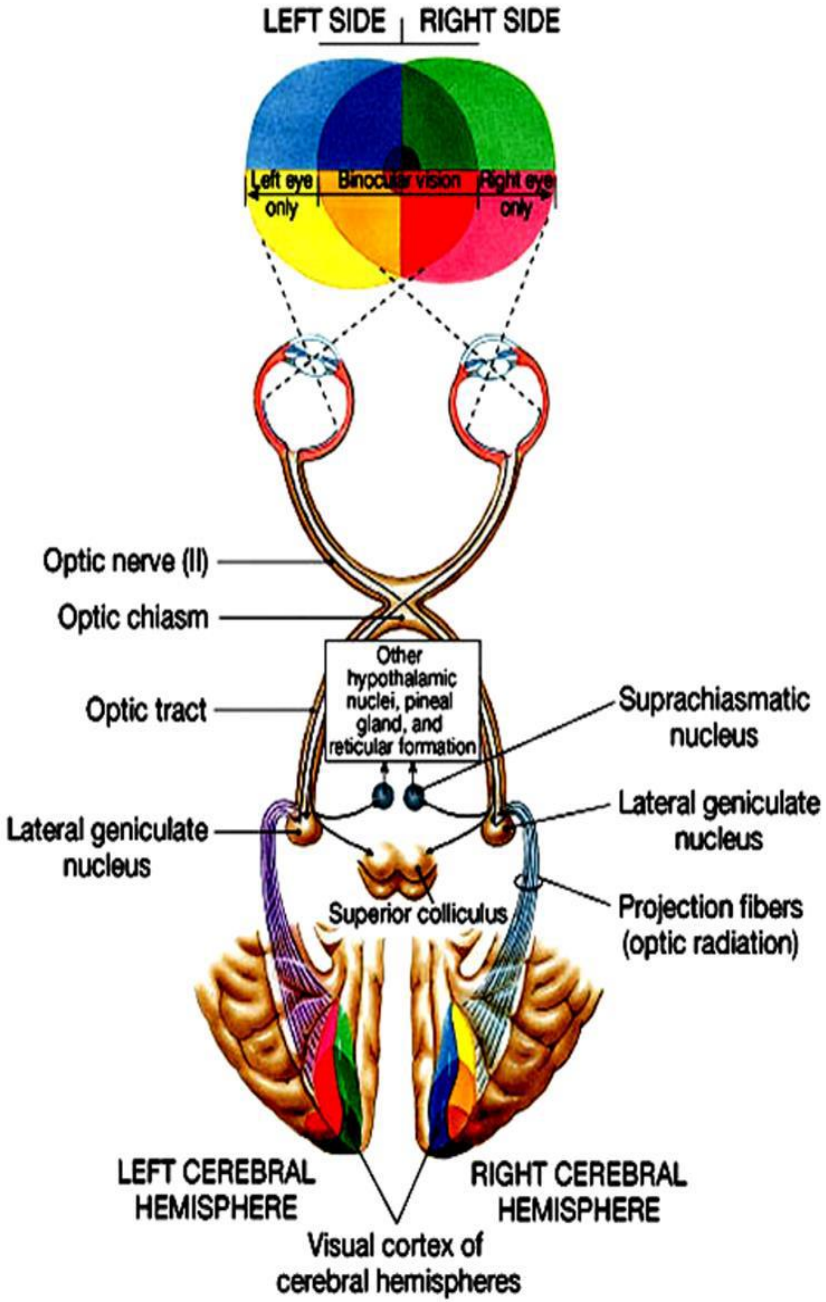
- - served by rodes
- - low visual acuity = no colors or details
- - great sensitivity to light = low visual threshold

VISUAL PATHWAY

- Photoreceptors :Rods and Cones synapse on Bipolar Cells , which in turn , synapse on Ganglion Cells .
- •Axons of Ganglion Cells constitute the Optic Nerve . These axons converge at the Optic disc ,which is also called Blind Spot
- (Why ?) .
- •Passing through the Blind Spot they leave the eye , constituting the Optic Nerve .
- -

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

-Optic tract send impulses to →lateral geniculate body in thalamus → its axons form geniculocalcarine tract that send to optic radiation → visual cortex in occipital cortex (Broadmann area 17)



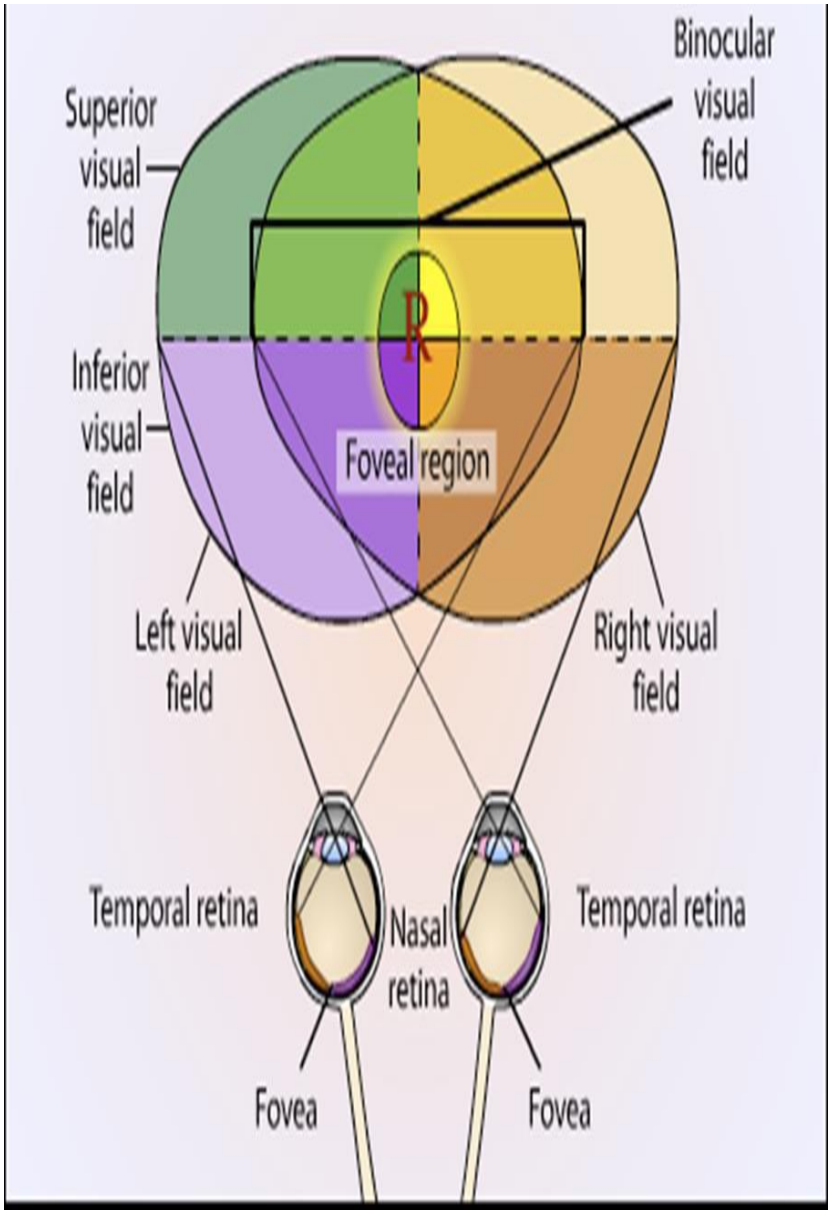
- •Optic nerve fibers from the medial (nasal) side of retinae decussate in the Optic Chiasma .
- •Therefore an Optic Chiasma lesion (e,g, Pituitary Tumor) will cause vision loss from the both lateral halves of the Field of Vision
- •Optic nerve fibers from the lateral (temporal) parts of the retinae do not decussate .
- •Therefore , **each optic tract carries fibers from :-**
- **-the temporal fibers of the ipsilateral retina (nasal field of vision of ipsilateral retina) + nasal fibers of the contralateral retina (temporal field of of vision of the contralateral retina**
- .

- **-VISUAL PATHWAY & FIELD :-**

- **-The nasal fibers (medial) cross to opposite side at optic chiasma**
- **- The temporal fibers (lateral) do not cross**
- **-Nasal fibers conveys temporal field (outer)of vision**
- **-Temporal fibers conveys nasal field (inner)of vision**
- **OPTIC TRACT :-**

-The left optic tract corresponds to the right ½ of the visual field .

-The right optic tract corresponds to the left ½ of the visual field .



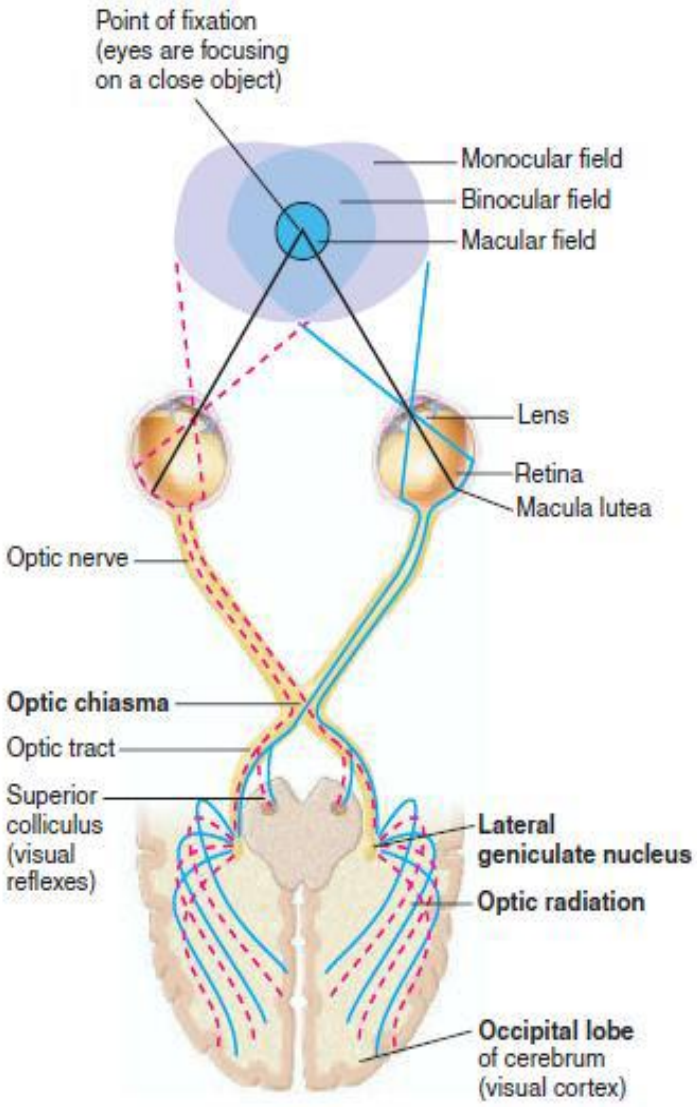
Visual pathway---cont

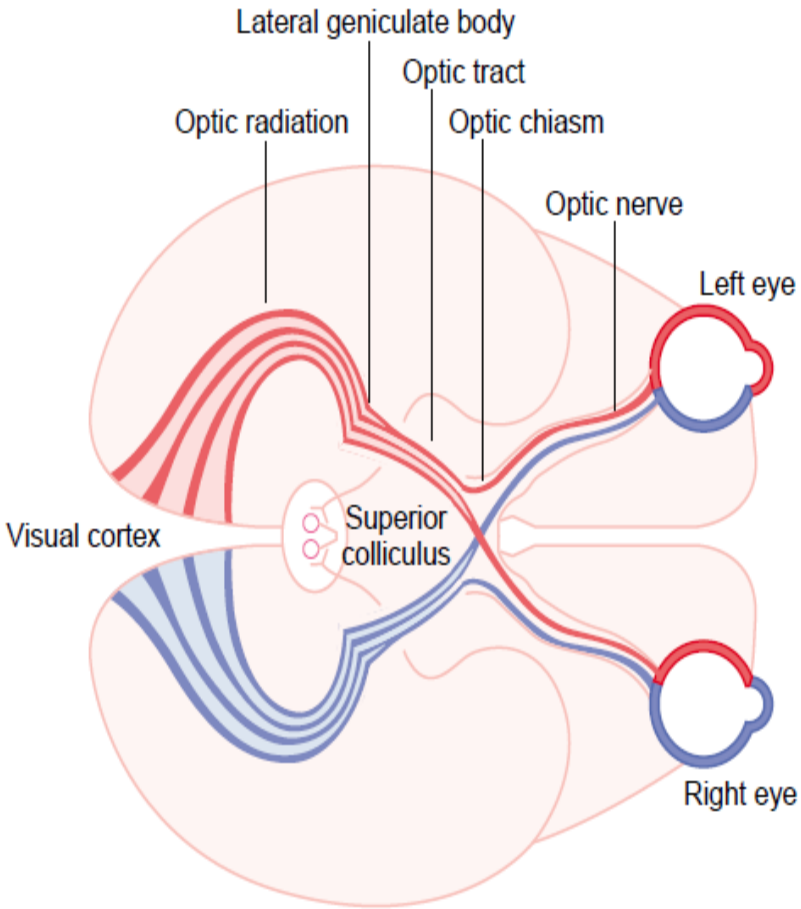
1- some ganglion cells axons pass from optic tract to pretectal region of midbrain for pupillary reflexes & eye movement

*****

2- Some axons of ganglion cells from optic chiasma pass directly to hypothalamus for circadian rhythm (light-dark cycle)

***3-Some axons from lateral geniculate body in thalamus to superior colliculus in midbrain for accomodation. R & its miosis component**


Point of fixation
(eyes are focusing
on a close object)
Monocular field
Binocular field
Macular field
Lens
Retina
Macula lutea
Optic nerve
Optic chiasma
Optic tract
Superior
colliculus
(visual
reflexes)
Lateral
geniculate nucleus
Optic radiation
Occipital lobe
of cerebrum
(visual cortex)


Lateral geniculate body
Optic tract
Optic radiation
Optic chiasm
Optic nerve
Left eye
Visual cortex
Superior
colliculus
Right eye

Accomodation(focusing)

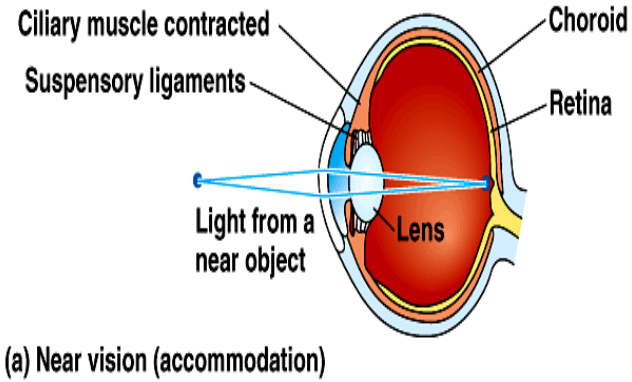
-Is an active process for modification of the refractive power of the eye to view a nearby object by increasing the curvature of lens
--*Ciliary muscle* has two separate sets of smooth muscle fibers—*longitudinal fibers* and *circular fibers.*

- Contraction of either set in the ciliary muscle relaxes the ligaments to the lens capsule, and the lens assumes a more spherical shape, because of the natural elasticity of the lens capsule& and increase its refractive power

-The ciliary muscle of accommodation is Controlled by Parasympathetic Nerves transmitted to the eye through Oculomotor nerve

Mechanism of accomodation

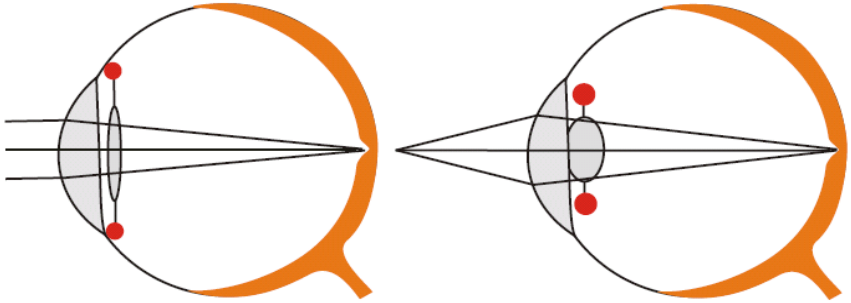
-Ciliary muscle Contraction>>>
>> Relaxation of the suspensory ligament>>> Lens more convex >>>>>Increase diopteric power of the lens >>>>Near object focused on the retina



(a) Near vision (accommodation)

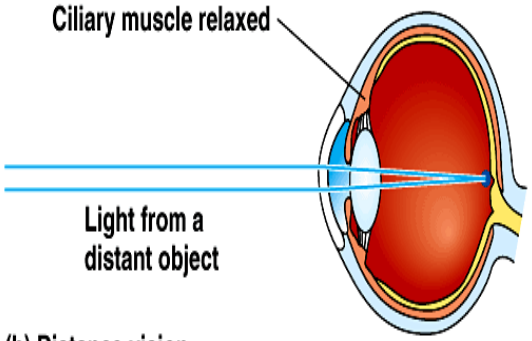
-The lens is flattened for distant objects.

-The lens is rounded for near objects.



When the ciliary muscles are **relaxed** the lens is flat and distant objects are focussed onto the retina

When the ciliary muscles are **contracted**, the lens becomes more round and a close object is focussed onto the retina



(b) Distance vision

At rest (looking at far objects):-

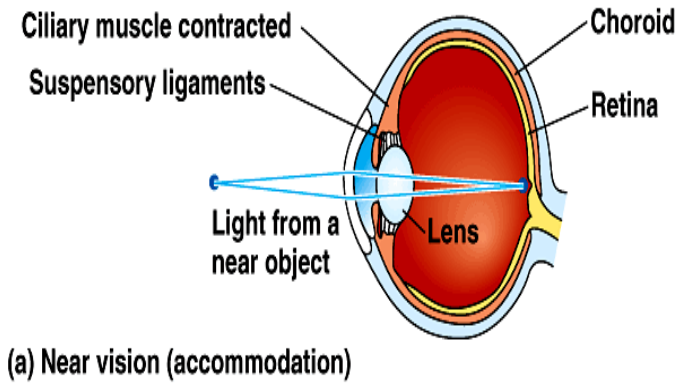
- **-Ciliary muscles are relaxed + taut (tense) ligaments + flat lens**

- **- looking at near objects:-**
- **-from near (close) objects parallel rays focus behind retina(if ciliary muscles remain relaxed)>>>>>**
- **>>>blurred vision**
- **-Solution is to increase curvature & refractive power of lens by accomodation to bring focus on retina.**

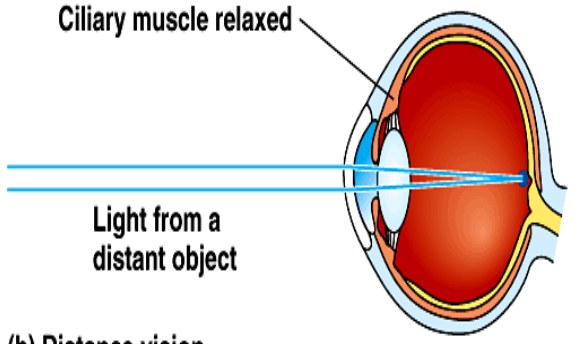
- **Diopteric power if the eye:**
- **Cornea ……40-45 D**
- **Lens …… 15-20 D**
- **Accomodation …. +12 D**

Accomodation reflex:-

- Focusing at near object(increased anterior surface curvature of lens by ciliary muscles contraction >>>>> slack = relaxed ligaments & increased anterior surface curvature of lens . why?
-to add 12D to refractive power of lens.
-both circular & longitudinal cilliary muscles contract to pull cilliary muscle forwards & inwards>>>>>cilliary muscles edges come close to each other to increase anterior surface curvature of lens.
Test//sanson purkinje image



(a) Near vision (accommodation)



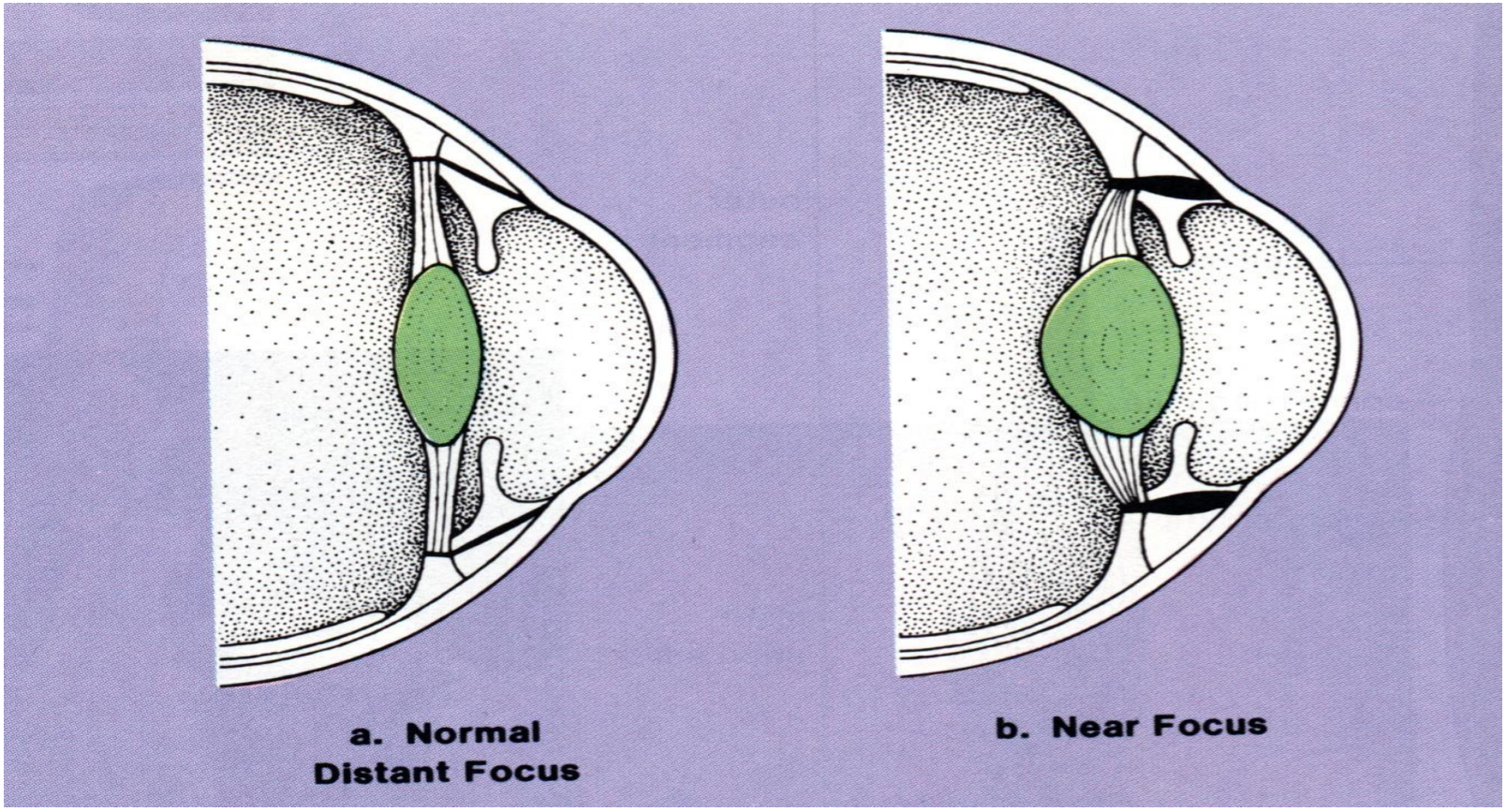
(b) Distance vision

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



looking at a close object
(near response)

a- convergence of both visual axis. Why?

b- pupil constriction. Why?

c- Accomodation. Why?

Near point:-

Nearest point to eye at which object can brought into focus on retina by ACCOMODATION

-10 years-----9 cm

-At 60 years-----80-100 cm, due to hardness of lens & loss of accomodation.

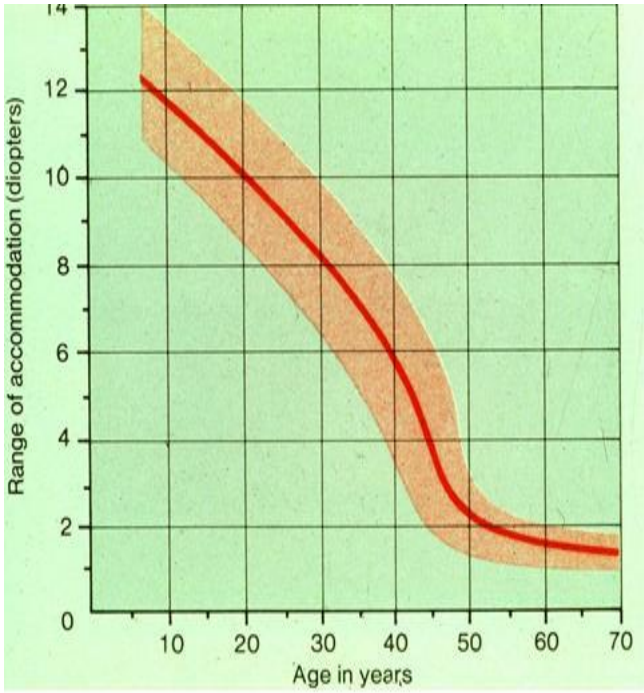
-(presbyopia:-((triade)

1-loss of accomodation & focus behind retina

2-loss of lens elasticity

3- near point receed

-correction by biconvex lens



Pathway of accomodation:-

Afferent pathway

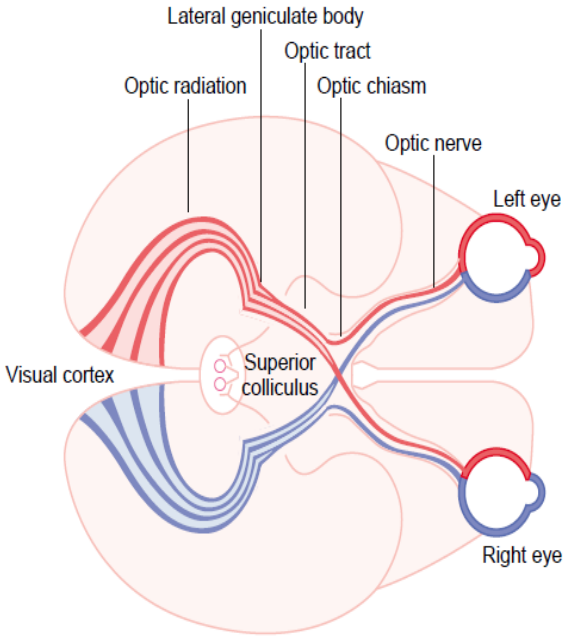
Light on eye>>>>>>retina >>>>>optic nerve >>>>>optic chiasma>>>> optic tract->>>> lateral geniculate body in thalamus & to superior colliculus in midbrain (center)

-efferent pathway

-(oculomotor nerve nucleus= parasympathetic) >>>>> cilliary ganglion to oculomotor N >>>>>> to

bilateral cilliary muscle contraction (accomodation. R)

+ contraction of iris circular muscles for miosis of near response



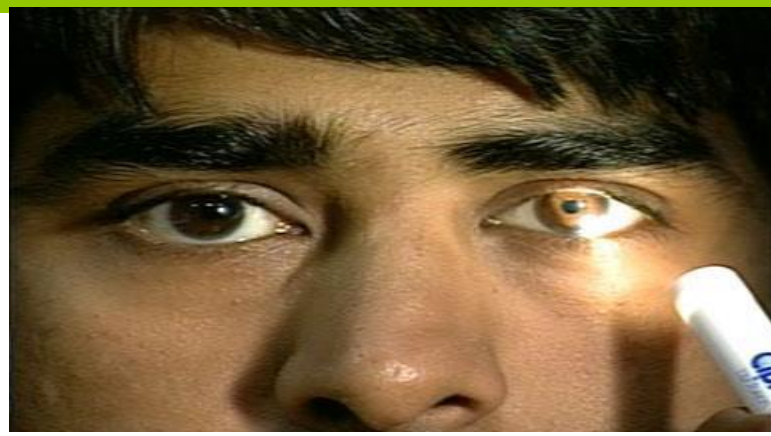
Pupilary light reflex

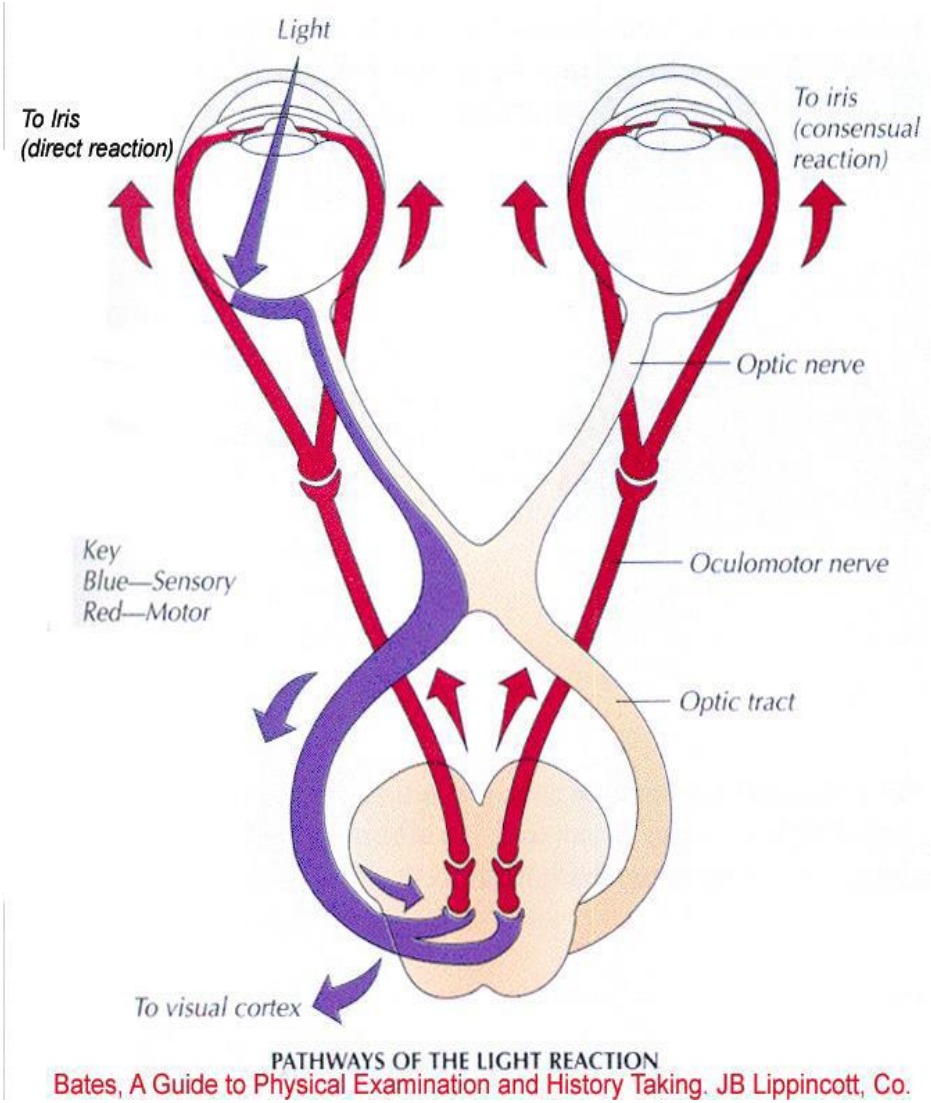
- **-Light fall on one eye pupil>>>>>>constiction of its pupil (direct pupillary reflex) & the other eye pupil (indirect reflex or consensual)**
- **Pathway of Pupilary light reflex (indirect):-**

-Light on eye >>>>retina>>>optic nerve >>>optic chiasma>>>>>optic tract>>>>pass through superior colliculus to end in pretectal nucleus >>>>>both oculomotor nerve nuclei (EWN)>>>>> both ciliary ganglia>>>>>supply both eyes by oculomotor nerves>>>>>>>(short ciliary nerve to constrictor pupillae)>>>>>>miosis in both eyes.

- Conversely, in darkness, the reflex becomes inhibited, which results in dilation of the pupil.

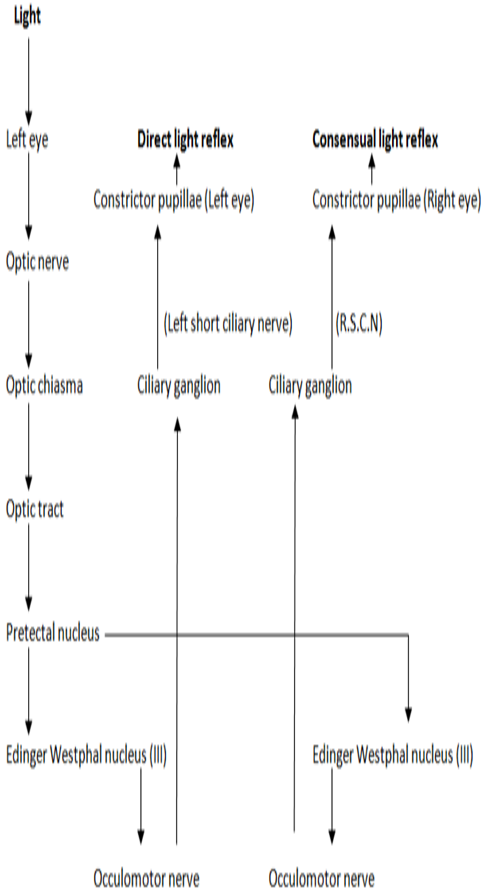
Direct reflex on right & Consensual reflex on left





PATHWAYS OF THE LIGHT REACTION

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



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

-In syphilis tabes dorsalis which destroy pretectal nucleus only, away from superior colliculus & fibers of accomodation.

-light .R is lost but accomodation R remains

Lateral geniculate body LGB

left LGB (similar to left optic tract) has all layers receive from RIGHT ½ of visual field

- **Right LGB (similar to right optic tract) has all layers receive from LEFT ½ of visual field.**
- **- LGB has 6 layers**

Function of LGB:-

1-acts as a relay station for visual information from optic tract to cortex.

2-It has point to point transmission with high degree of (تحديد المكان بدقة spatial fidelity)

3-Acts as gate controls signal transmission to visual cortex i.e control how much signals reach visual cortex

4-color vision & detect shapes & texture

LGB pathways to visual cortex

1-Th magnocellular pathway

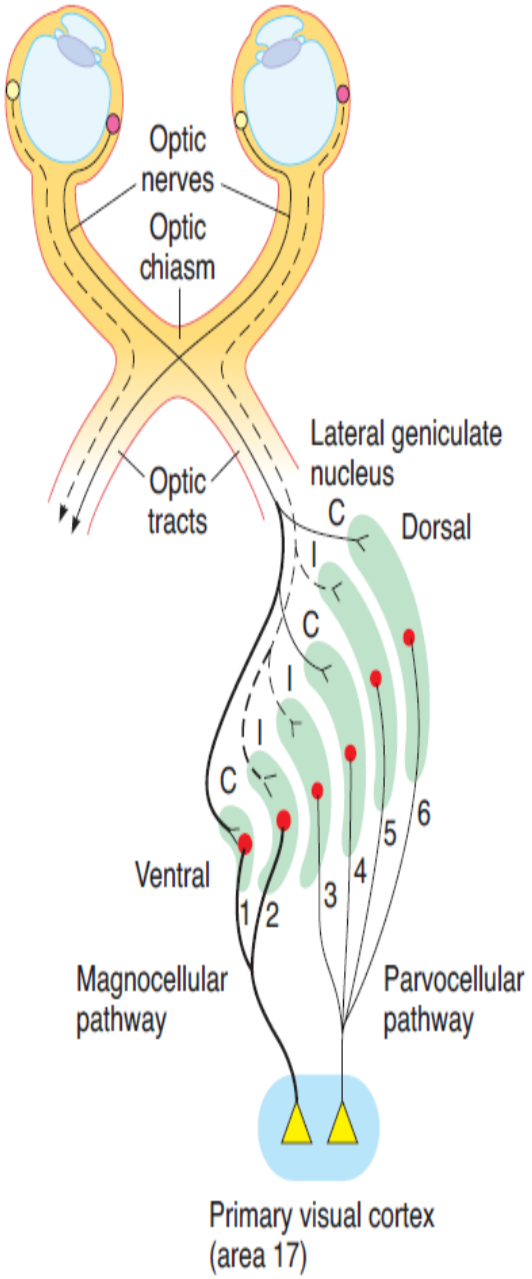
- from layers 1 and 2 which have large cells and are called magnocellular, carries signals for detection of movement,depth, and flicker.

- a *rapidly conducting* pathway to the visual cortex.

2-The parvocellular pathway

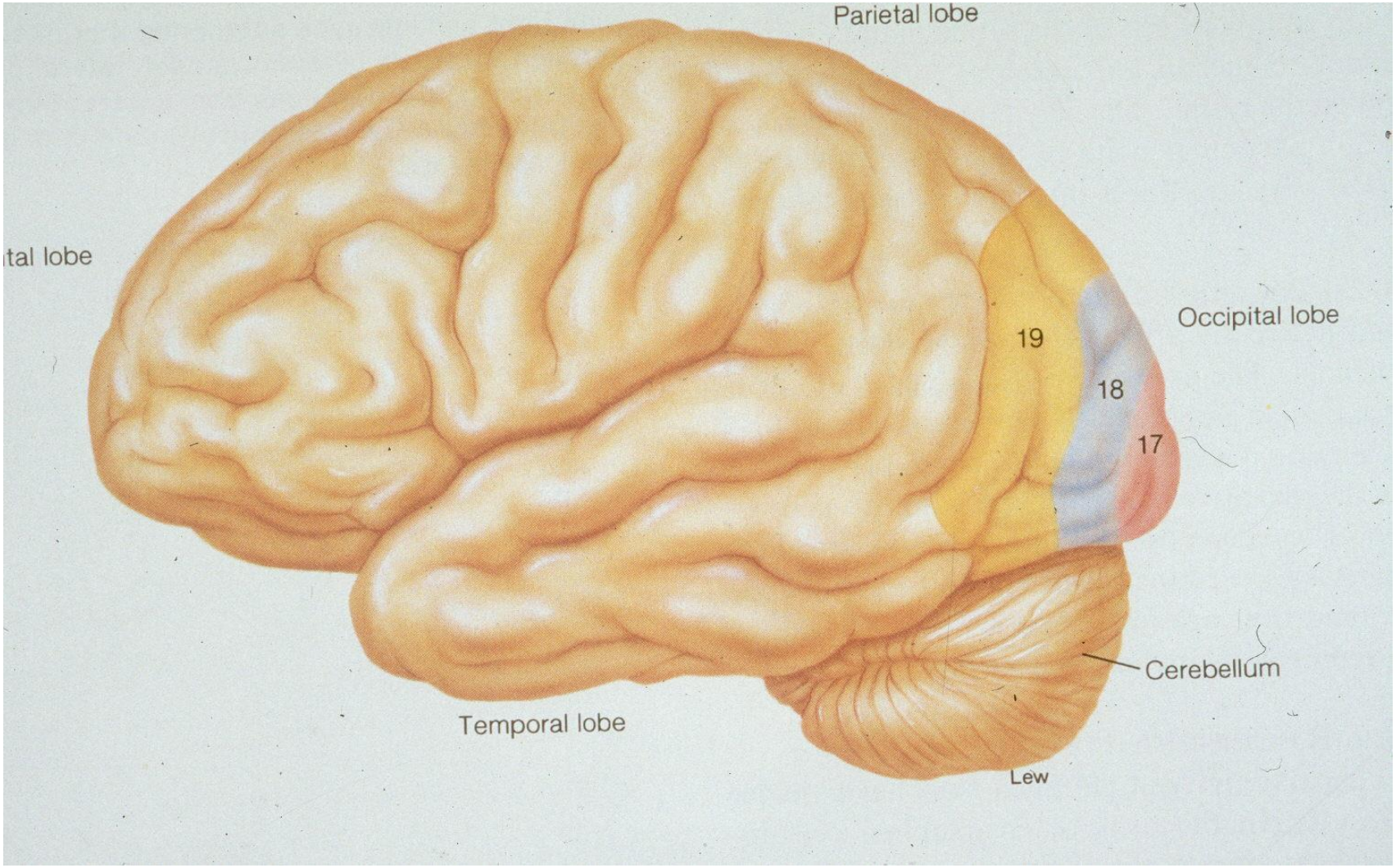
- **From layers 3,4,5,6 which have small cells and are called parvocellular, carries signals for color vision, texture, shape, and fine detail.**

- moderate velocity of conduction.



Cortical Visual areas

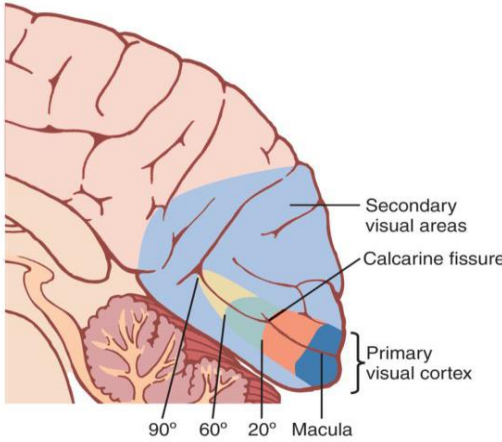
- **Primary (area 17)**
- **Secondary association area, (areas 18, 19)**

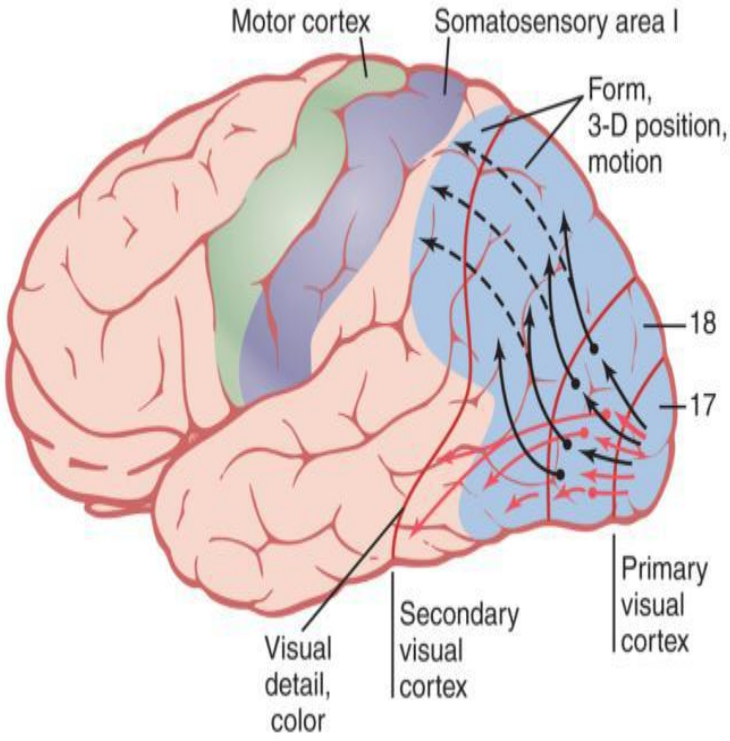


Visual cortex

-The Primary Visual Cortex Has Six Major Layers of cells arranged vertically each act as a separate unit for processing of informations

-The fovea is responsible for the highest degree of visual acuity, so it has larger representation in the primary visual cortex than the most peripheral portions of the retina.



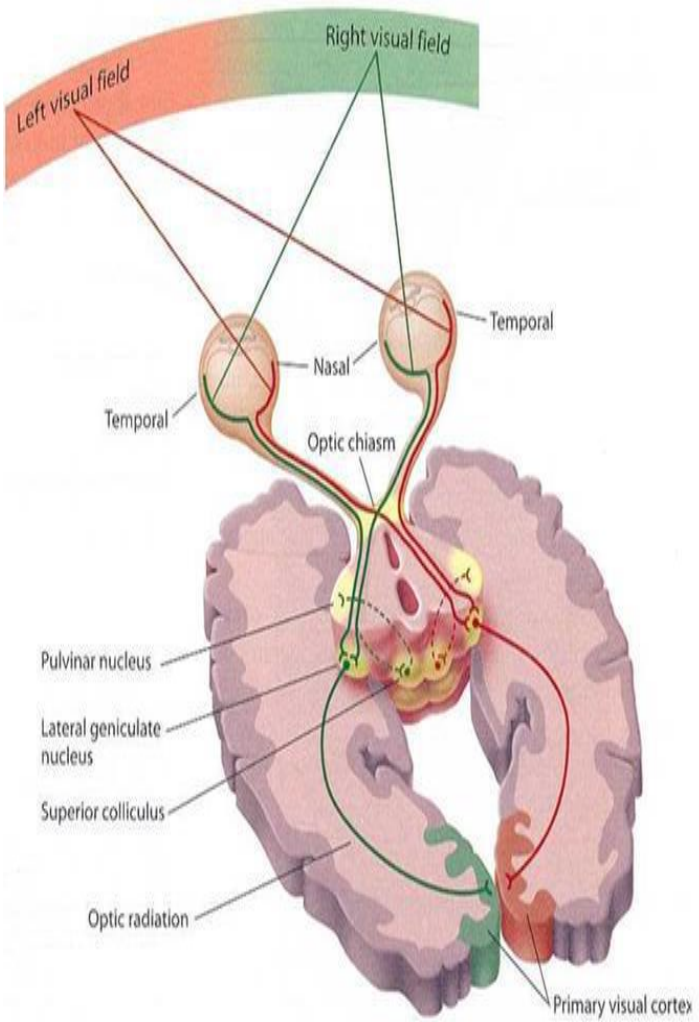


1-Primary visual cortex (braodmann area 17):-

-Percieve sensation of vision (movement + shapes+ stereoscopic vision + brightness) &has blobs for color detection

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

-**effect of removing the primary visual cortex** removal of the primary visual cortex **causes loss of conscious vision, (blindness)**



2-association visual cortex (area 18&19) (secondary visual areas):-

-located mainly anterior to the primary visual cortex

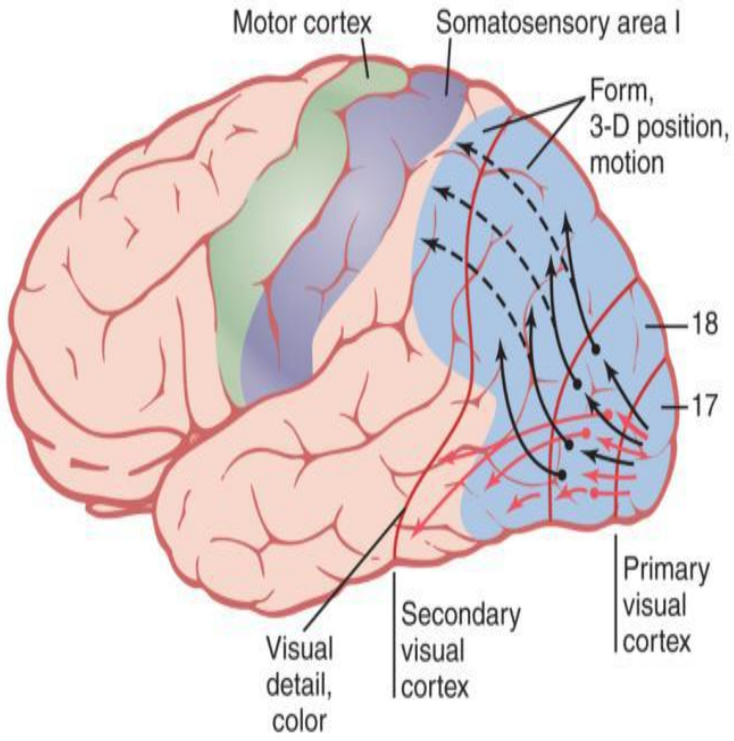
~~extend to parietal & temporal lobes~~

function:-

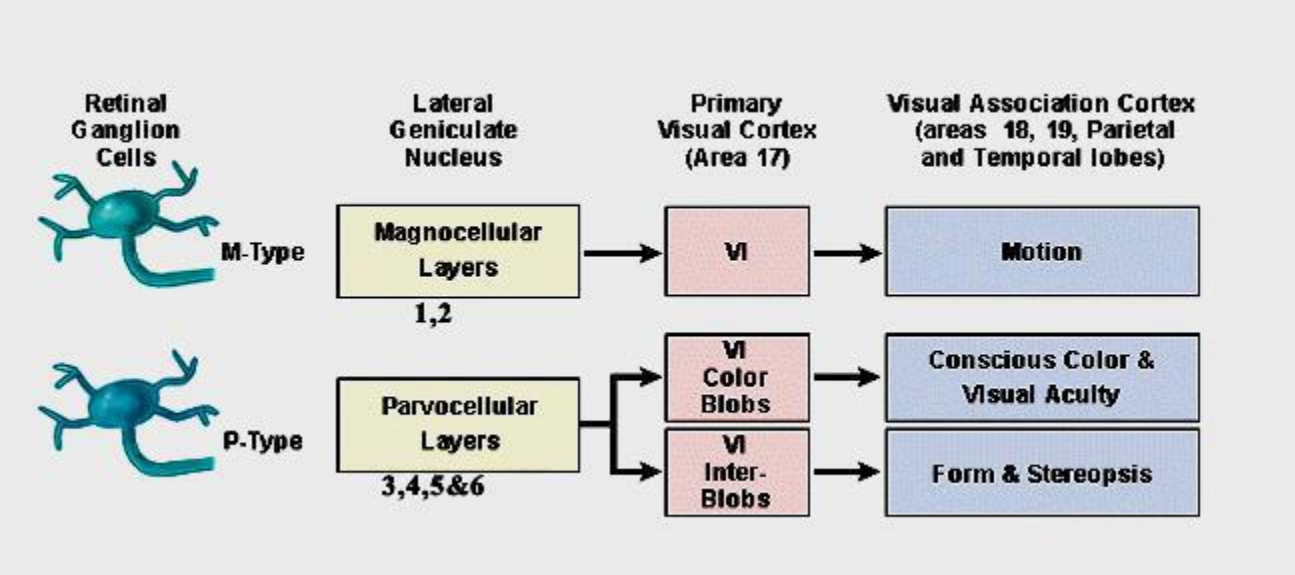
-interpretation of visual stimuli

•dealing with complex perception of patterns & forms & responsible for object recognition

-the fixation mechanism that causes the eyes to "lock" on the object of attention is controlled by *secondary visual center*.



Retinotopic Organization & Processing of visual information



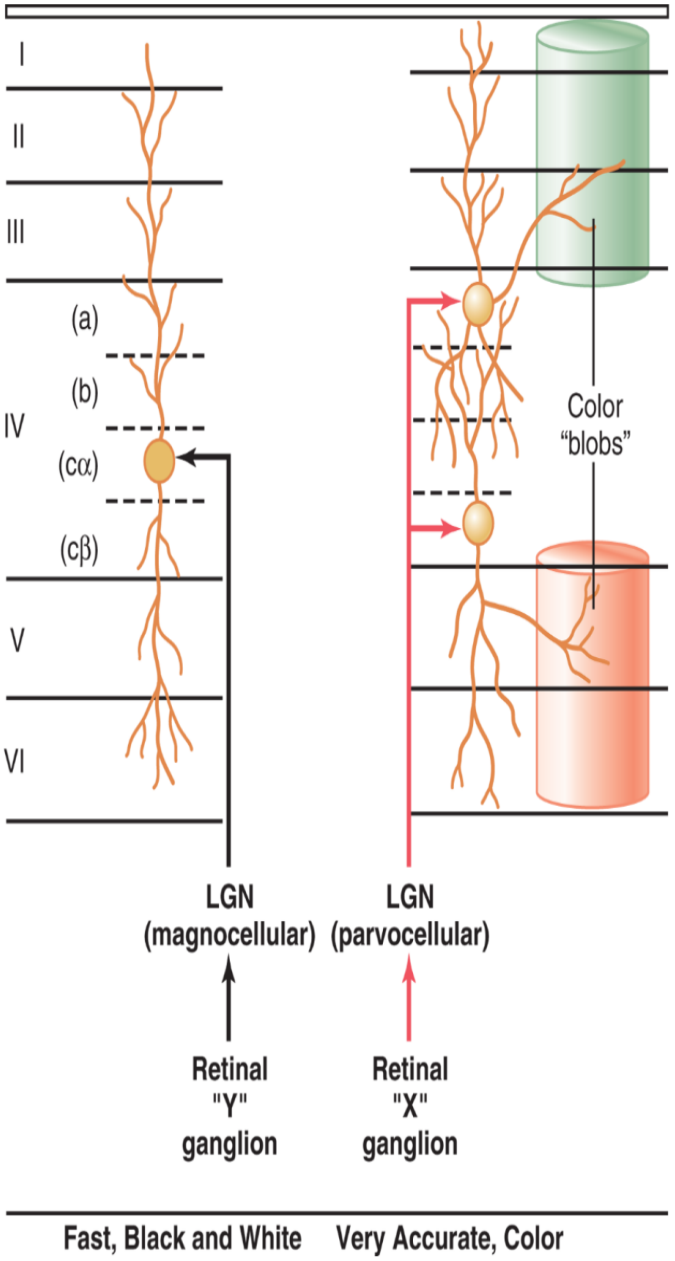
Visual Projections to Area 17

1-**Color Blobs are** in the Visual Cortex. Interspersed among the primary visual columns & among the columns of the secondary visual areas

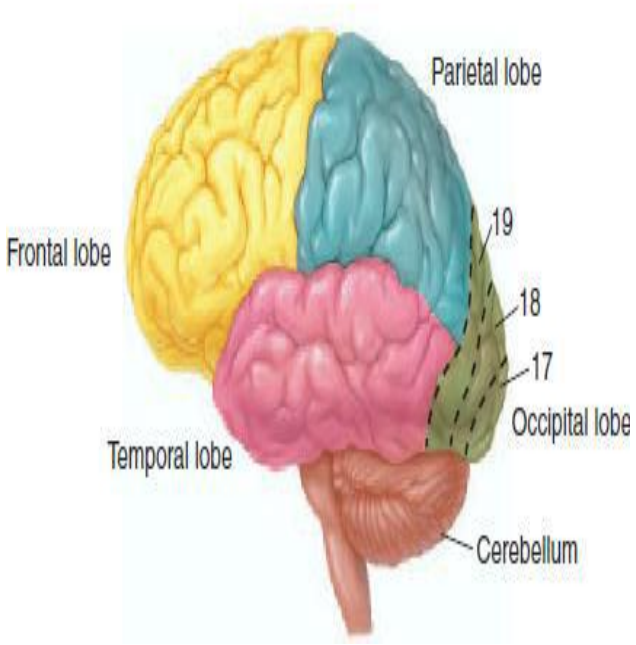
-clusters of cells responsible for color detection

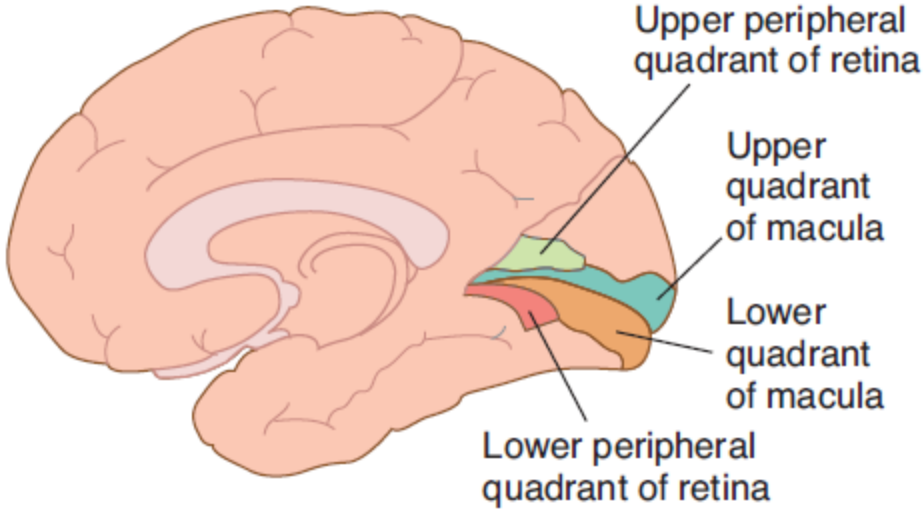
2-Simple cells detect color contrast details, bars of light, lines , borders and edges

3-Complex cells detect Line Orientation When a Line Is Displaced Laterally or Vertically in the Visual Field (linear movements of a stimulus)



Macular sparing = loss of peripheral vision with intact macular vision because the macular representation is separate from that of the peripheral fields and is very large relative to that of the peripheral fields.

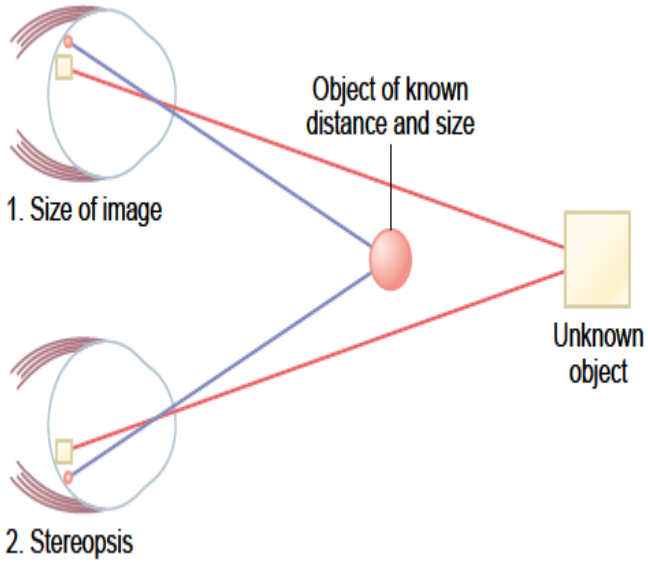




Determination of Distance of an Object from the Eye—"Depth Perception"

•A person normally perceives distance by three major means:

•(1) the sizes of the images of known objects on the retina



•(2) the phenomenon of moving parallax :*when the person moves his head to one side or the other, the images of close-by objects move rapidly across the retinas, while the images of distant objects remain almost completely stationary*

•(3) the phenomenon of stereopsis or Binocular

Three types of retinal ganglion cells and their respective fields

1-W cells/ sensitive or detecting directional movement in the field of vision, and they are probably important for much of our rod vision under dark

•2- X Cells / Transmission of the Visual Image and Color Vision

• 3-Y Cells // to Transmit Instantaneous & rapid Changes in the Visual Image , either rapid movement or rapid change in light intensity

In primates a different classification is used:

1. Parvocellular (P) cells which project to parvocellular layer of LGB, conducting signal of fine details & colors

2. Magnocellur(M) cells , which project to magnocellular layer of LGB, and they are high sensitive to low contrast stimuli and to rapid movement visual signals


Sunset Over the Mississippi River, Arkansas