

LECTURE 2

Vision Accommodation & 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

-Definition :-

- 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
- (person can normally distinguish two separate points if their centers lie up to 2 micrometers apart on the retina, which is slightly greater than the width of a foveal cone)

-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 & rods 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 rods
- low visual acuity = no colors or details
- great sensitivity to light = low visual threshold

VISUAL PATHWAY:-

- **Cones & rods → bipolar cells → ganglion cells → optic nerve (axons of ganglion cells) → optic chiasma → optic tract → lateral geniculate body in thalamus → axons of cells form geniculocalcarine tract send to optic radiation → visual cortex in occipital cortex (Broadmann area 17)**

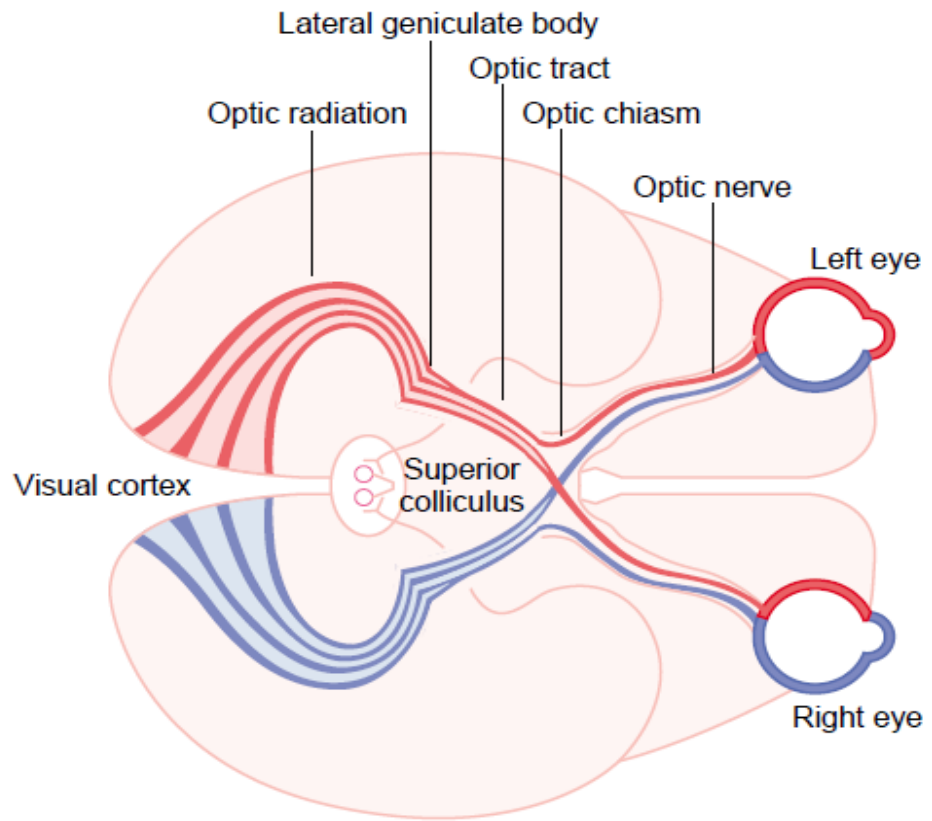
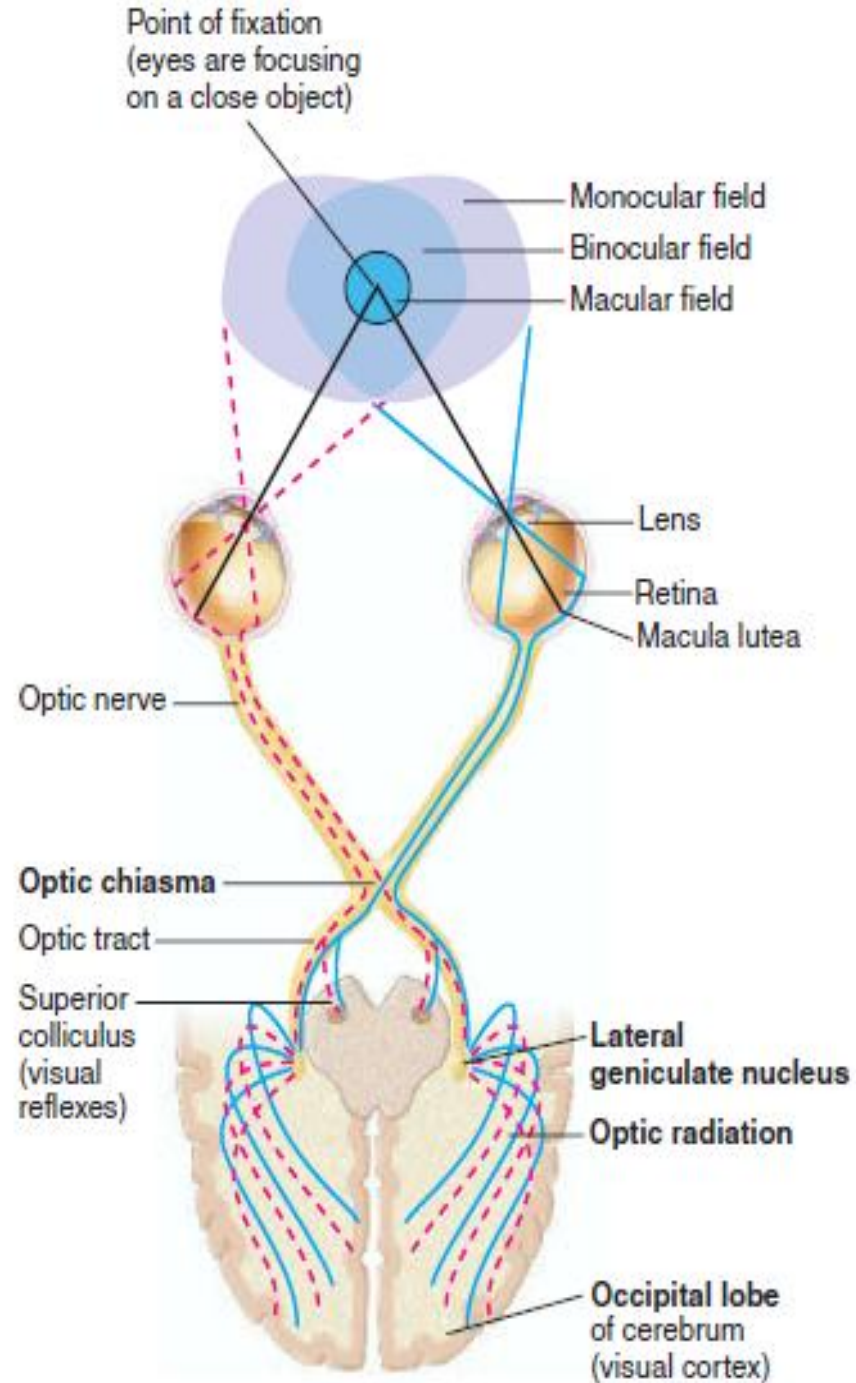
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* 1- some ganglion cells axons pass from optic tract to pretectal region of midbrain for pupillary reflexes & eye movement

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2- Some axons of ganglion cells from optic chiasma pass directly to hypothalamus for circadian rhythm (light-dark cycle) that synchronize various physiologic changes of the body with night and day

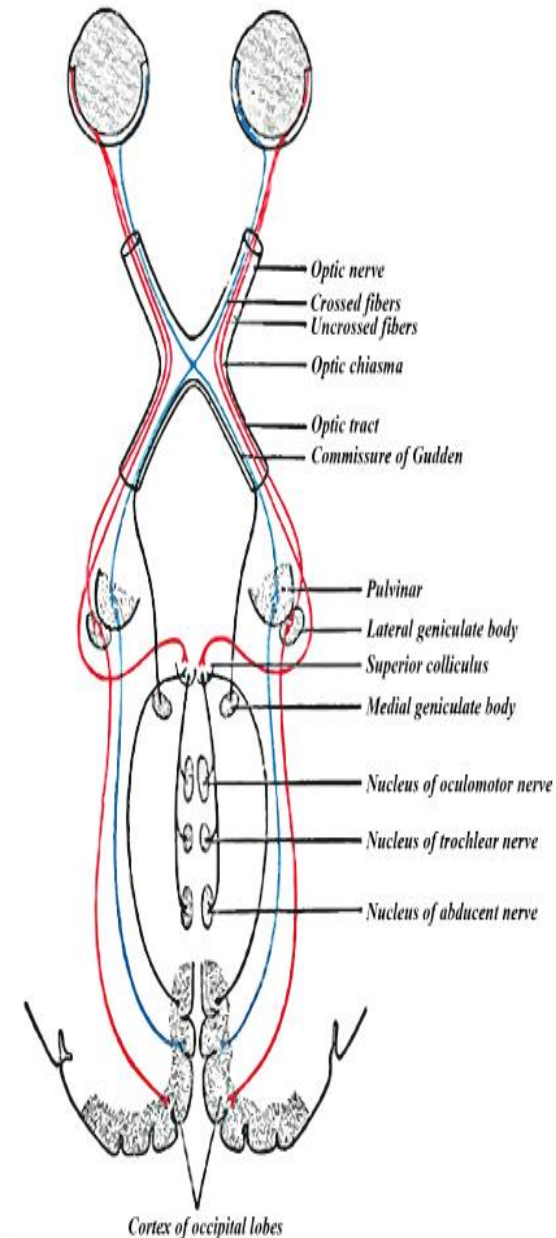
*3- Some axons from lateral geniculate body in thalamus to superior colliculus in midbrain for accommodation. R & its miosis component & to control rapid directional movements of the two eyes





-VISUAL PATHWAY & FIELD :-

- -The nasal fibers (medial) cross to opposite side
- -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 :-
- includes:-
- 1- LATERAL FIBERS of the same side(nasal field (inner)of vision)
- 2- MEDIAL fibers of the opposite side i.e temporal field of other eye(outer)



exp//LEFT OPTIC TRACT:-

Conveys LATERAL(temporal) fibers of the left eye

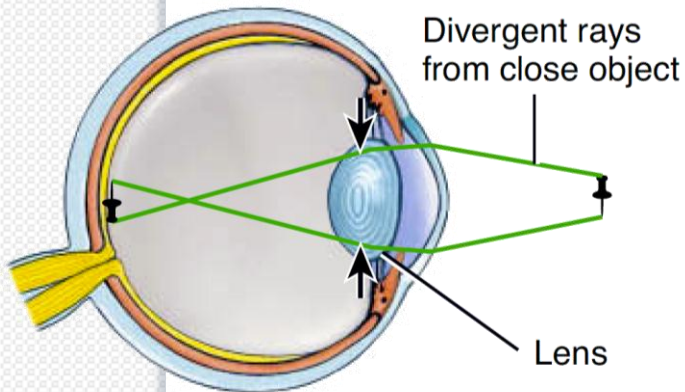
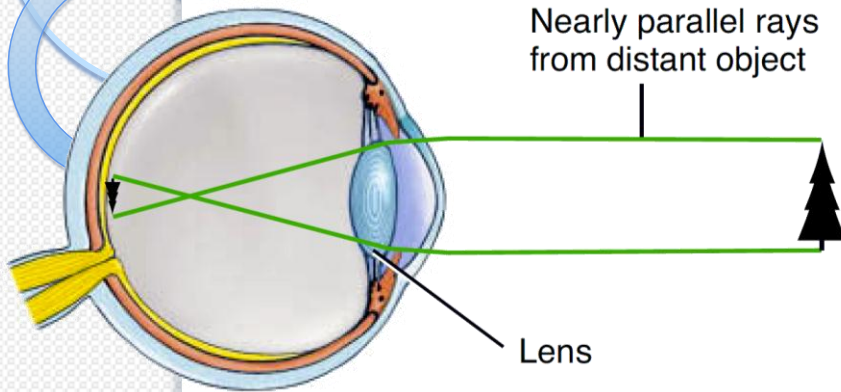
+ MEDIAL (nasal fibers) of the right eye
=RIGHT half of visual field of left eye)&
RIGHT half of visual field of right eye),
both form right half of visual field of both eyes.

N.B

-- The **left** optic tract corresponds to the **right** $\frac{1}{2}$ of the visual field

--The **right** optic tract corresponds to the **left** $\frac{1}{2}$ of the visual field

Accommodation(focusing)



WHEN AN OBJECT IS 6 M (20 FT) OR MORE AWAY FROM THE VIEWER, THE LIGHT RAYS REFLECTED FROM THE OBJECT ARE NEARLY PARALLEL TO ONE ANOTHER


THE LENS MUST BEND THESE PARALLEL RAYS JUST ENOUGH TO BE FOCUSED ON THE CENTRAL FOVEA, WHERE VISION IS SHARPEST.

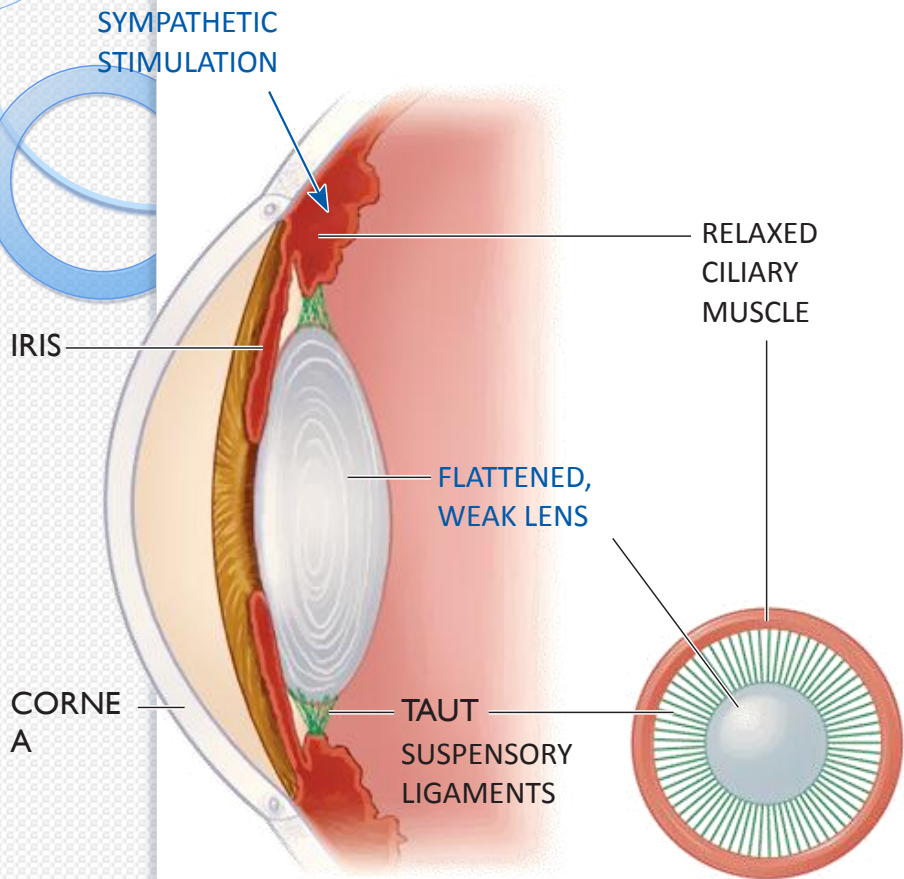
BECAUSE LIGHT RAYS THAT ARE REFLECTED FROM OBJECTS CLOSER THAN 6 M (20 FT) ARE DIVERGENT RATHER THAN PARALLEL, THE RAYS MUST BE REFRACTED MORE IF THEY ARE TO BE FOCUSED ON THE RETINA.

THIS ADDITIONAL REFRACTION IS ACCOMPLISHED THROUGH A PROCESS CALLED ACCOMMODATION

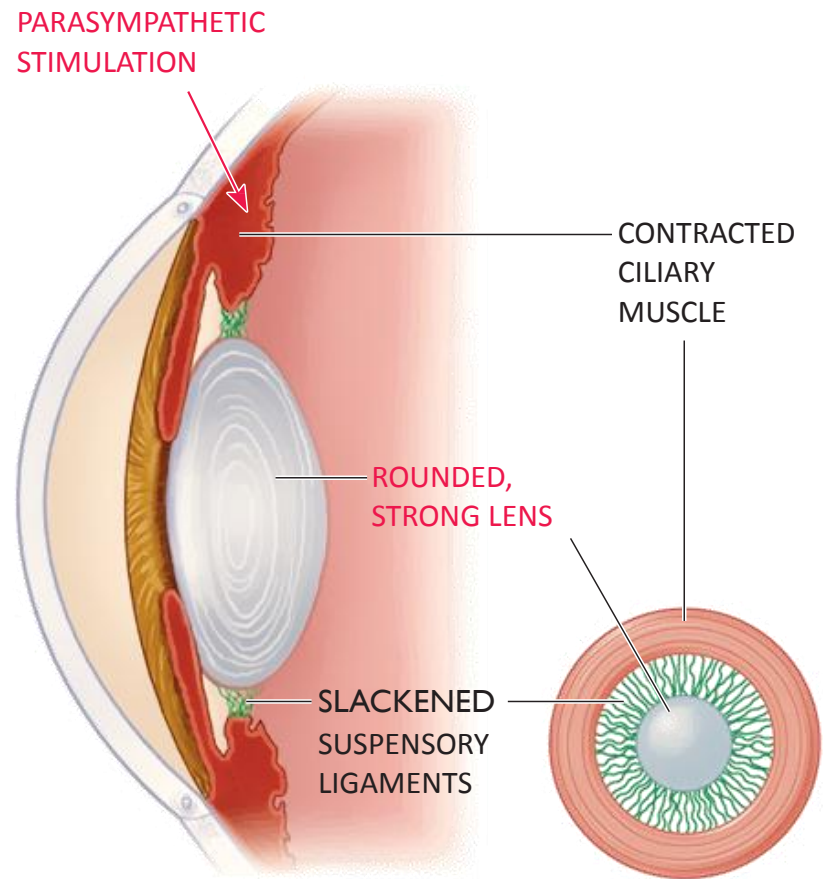
Accommodation(focusing)

- 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****

- 
- 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 accommodation to bring focus on retina.



AT REST, THE LENS IS HELD UNDER TENSION BY THE LENS LIGAMENTS. BECAUSE THE LENS SUBSTANCE IS MALLEABLE AND THE LENS CAPSULE HAS CONSIDERABLE ELASTICITY, THE LENS IS PULLED INTO A FLATTENED SHAPE.



IF THE GAZE IS DIRECTED AT A NEAR OBJECT, THE CILIARY MUSCLE CONTRACTS. THIS DECREASES THE DISTANCE BETWEEN THE EDGES OF THE CILIARY BODY AND RELAXES THE LENS LIGAMENTS, SO THAT THE LENS SPRINGS INTO A MORE CONVEX SHAPE



- **Accommodation reflex:-**

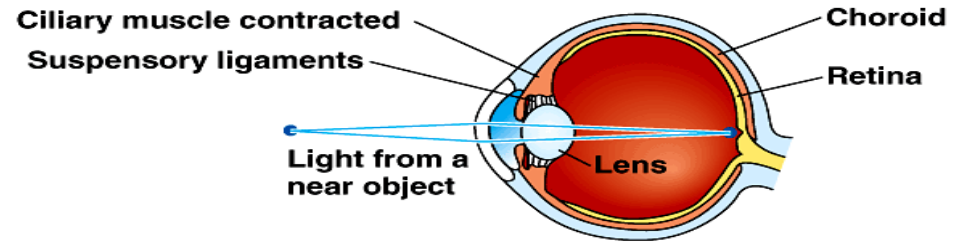
- - Focusing at near object(**increased** anterior surface curvature of lens by ciliary muscles **contraction** , **slack = relaxed** ligaments & **increased** anterior surface curvature of lens . why?
- - **to add 12D to refractive power of lens.**
- -both circular & longitudinal ciliary muscles contract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

Accommodation is the focusing of light in the retina.

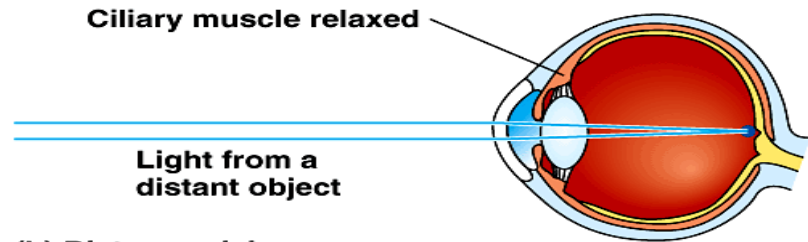
We focus by changing the shape of the lens.

-The lens is flattened for distant objects.

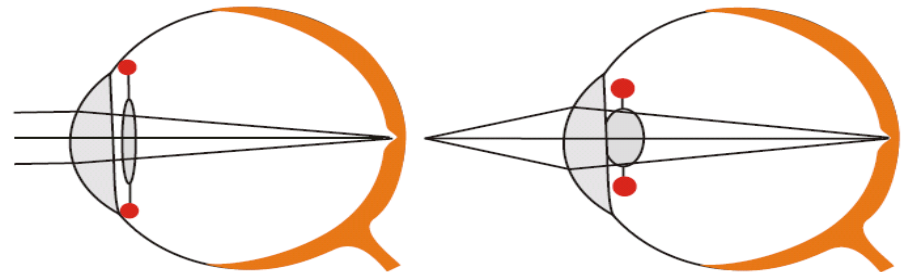
-The lens is rounded for near objects.



(a) Near vision (accommodation)



(b) Distance vision



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

- 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**

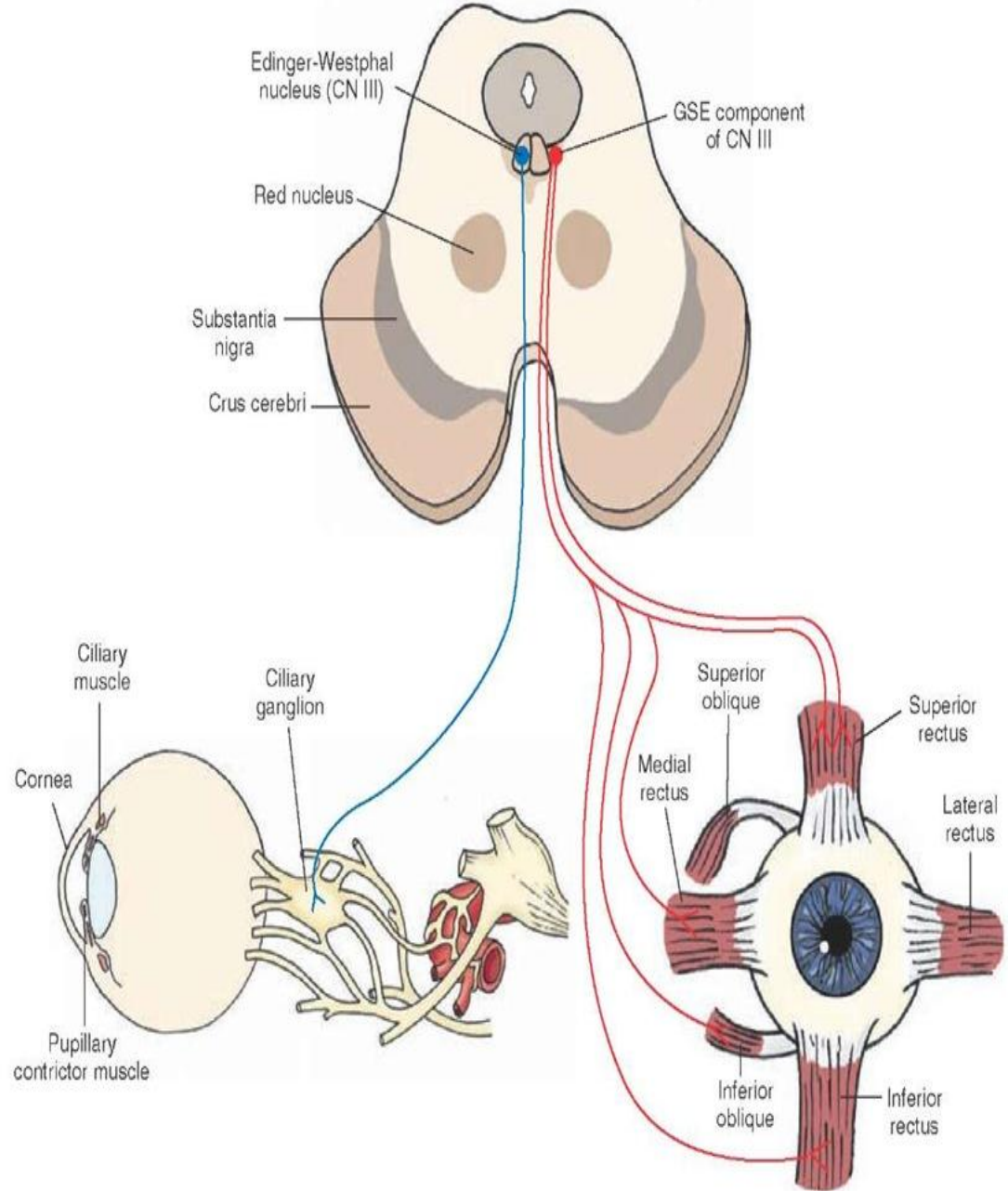
Near point and amplitude of accommodation

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



- **Pathway of accommodation:-**

- **Light on eye>>>>>retina >>>>>optic nerve >>>>>optic chiasma>>>> optic tract->>>> lateral geniculate body in thalamus & to superior colliculus in midbrain for->>>>EWN>>>>> ciliary ganglion to oculomotor N >>>>>> bilateral ciliary muscle contraction (accommodation. R) & contraction of iris muscles for miosis of near response**



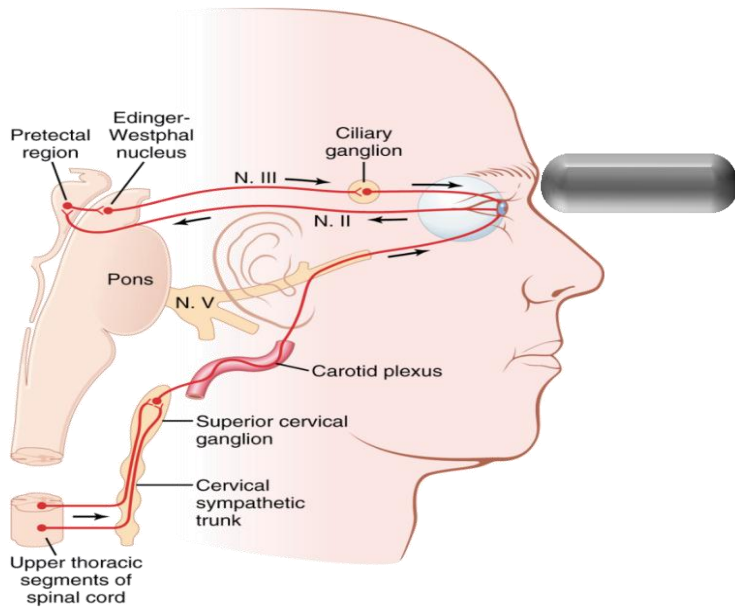
Pupillary light reflex:-

Light on one eye pupil>>>>>constiction of this pupil (direct) & the other pupil (indirect or consensual)

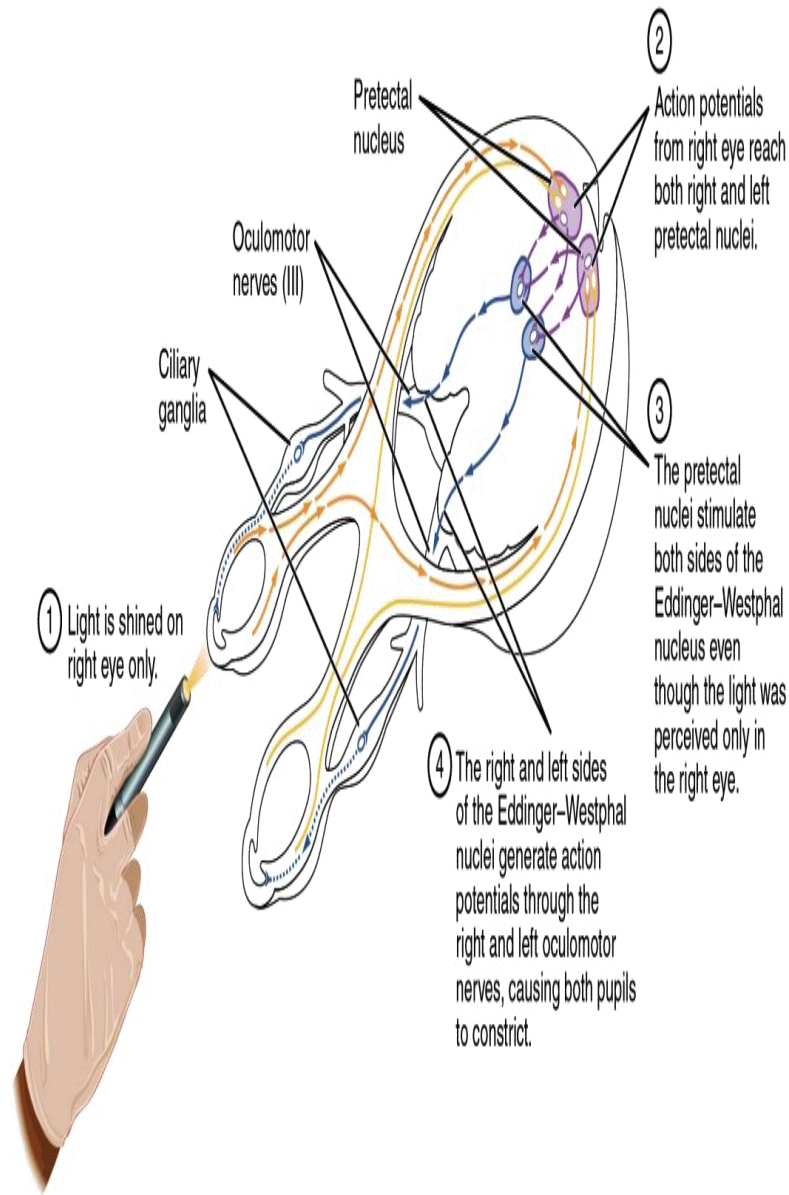
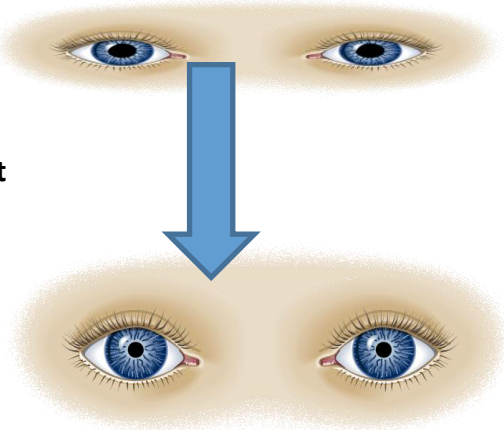
Pathway of consensual Pupillary light reflex (indirect):-

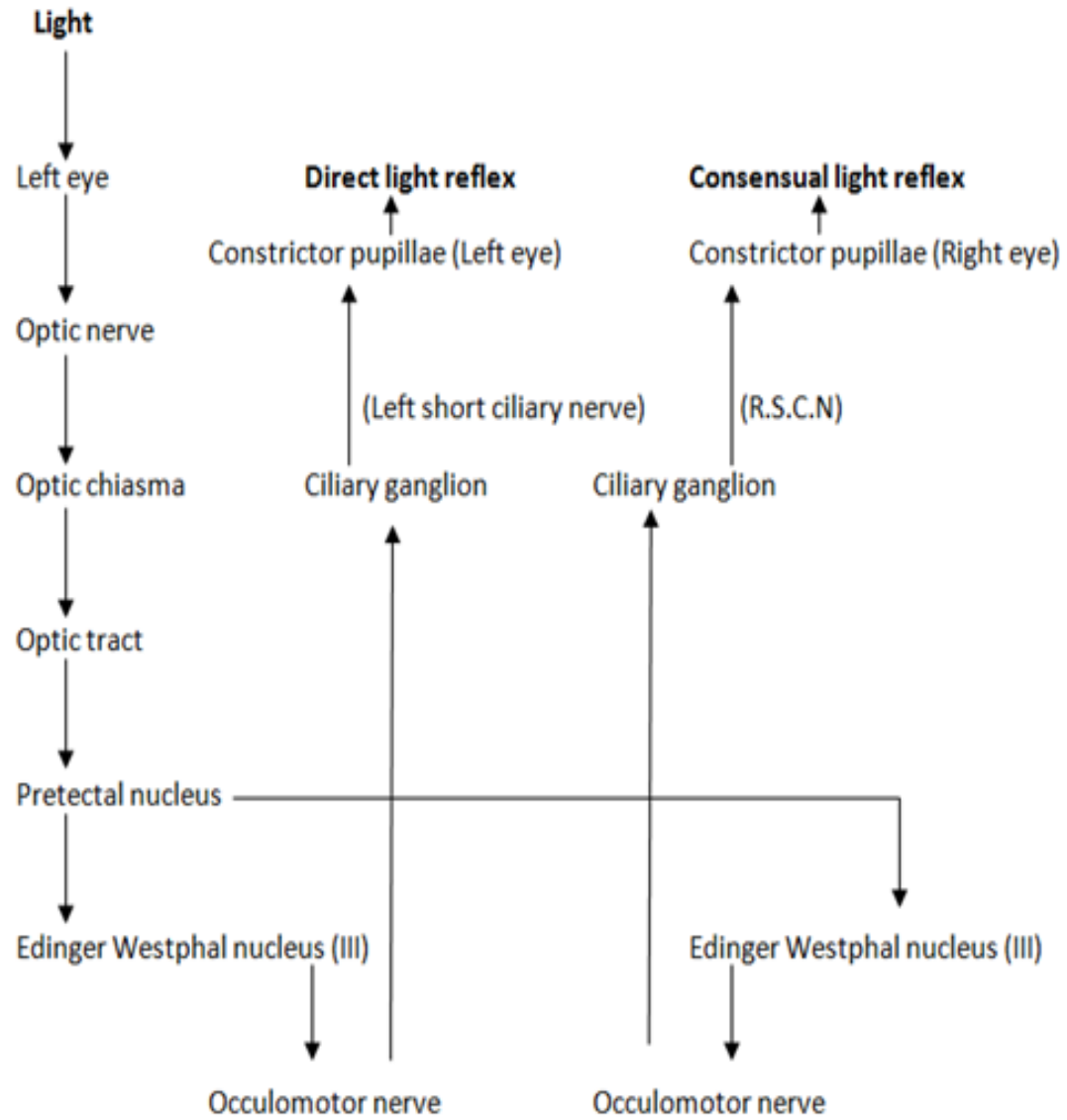
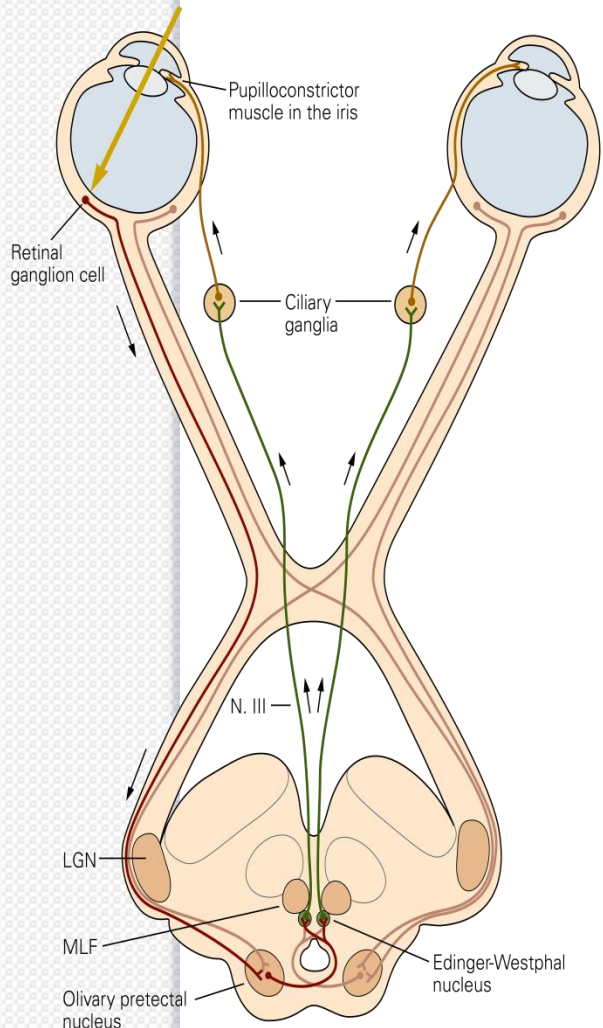
Light on eye>>>>retina>>>optic nerve >>>optic chiasma>>>>optic tract>>>>pass through superior colliculus to end **in pretectal nucleus** >>>>>both oculomotor nerve nuclei (EWN)>>>>> both ciliary ganglia>>>>>supply both eyes by oculomotor nerves>>>>>>(short ciliary nerve to constrictor pupillae)>>>>>>miosis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

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



both pupils constrict





Q. Argyll Robertson pupil?

In syphilis tabes dorsalis which destroy pretectal nucleus

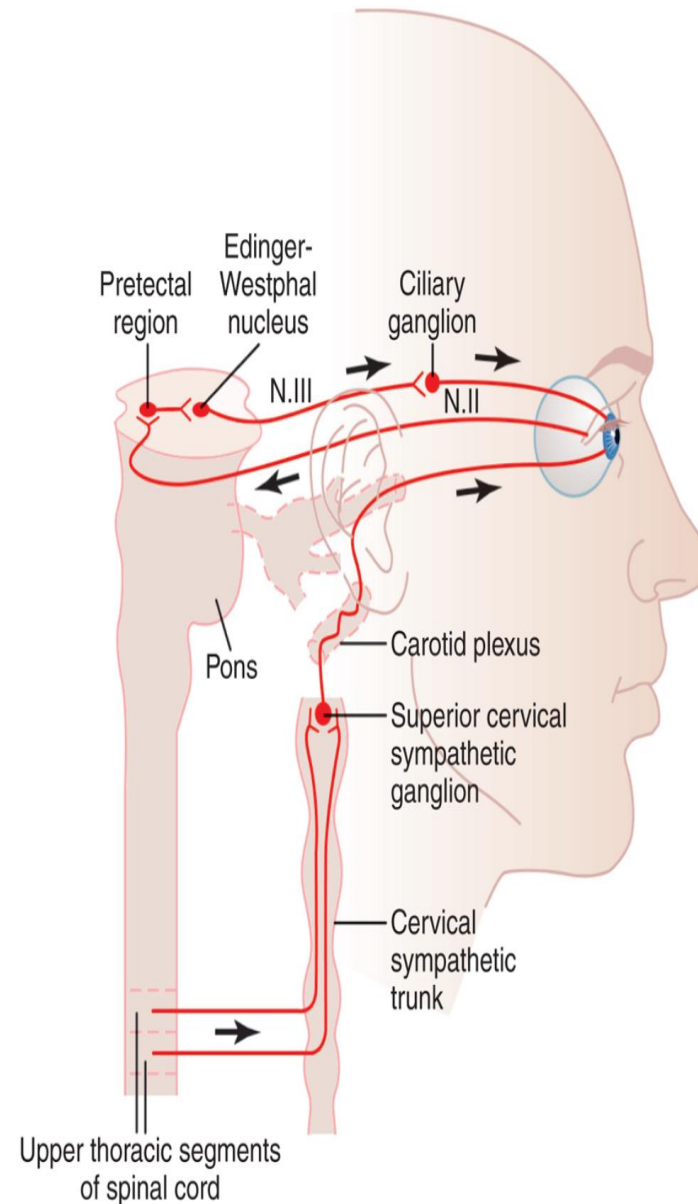
-light .R is lost & accommodation .R remains

- **because lesion is in pretectal nucleus only, away from superior colliculus & fibers of accommodation.**
- **▫ damage of transmission of visual signals from the retinas to the edinger-westphal nucleus, blocking the pupillary reflexes as in alcoholism, encephalitis**

Autonomic Control of Accommodation and Pupillary Aperture

- Parasympathetic preganglionic fibers in the *Edinger-Westphal nucleus* to *third nerve* to the *ciliary ganglion*. Then preganglionic fibers synapse with postganglionic parasympathetic neurons, which send in *ciliary nerves* into the eyeball to:-
 - (1) the ciliary muscle that controls focusing of the eye lens
 - (2) the sphincter pupillae of the iris that constricts the pupil.

--The sympathetic innervation of the eye originates in *lateral horn cells* of the first thoracic segment of the spinal cord, to sympathetic chain to the *superior cervical ganglion*, synapse with postganglionic neurons. sympathetic fibers spread along the surfaces of the carotid artery, to innervate the radial fibers of the iris (which open the pupil)



Determination of Distance of an Object from the Eye—“Depth Perception”

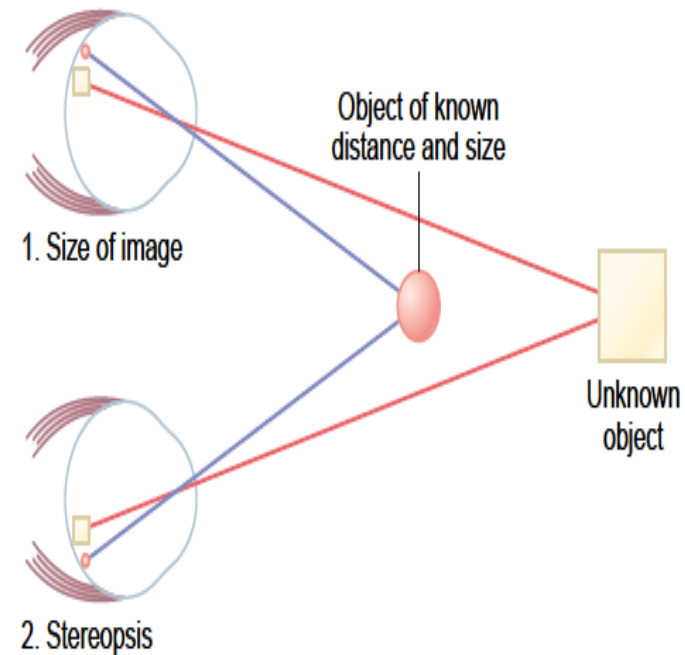
A person normally perceives distance by three major means:

(1) the sizes of the images of known objects on the retina, the brain calculate from image sizes the distances of objects

(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 Vision

- this binocular parallax (or *stereopsis*) that gives a person with two eyes far greater ability to judge distances



- **Lateral geniculate body LGB(6 layers):-**

- left LGB (similar to left optic tract) has all layers receive from RIGHT 1/2 of visual field
- - Right LGB (similar to right optic tract) has all layers receive from LEFT 1/2 of visual field.

- **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

- N.B/- It receives gating control signals from two major sources:

- (1) corticofugal fibers returning in a backward direction from the primary visual cortex to the lateral geniculate nucleus
- (2) reticular areas of the mesencephalon.
- Both of these are inhibitory and, when stimulated, can turn off transmission through selected portions of the dorsal lateral geniculate nucleus.

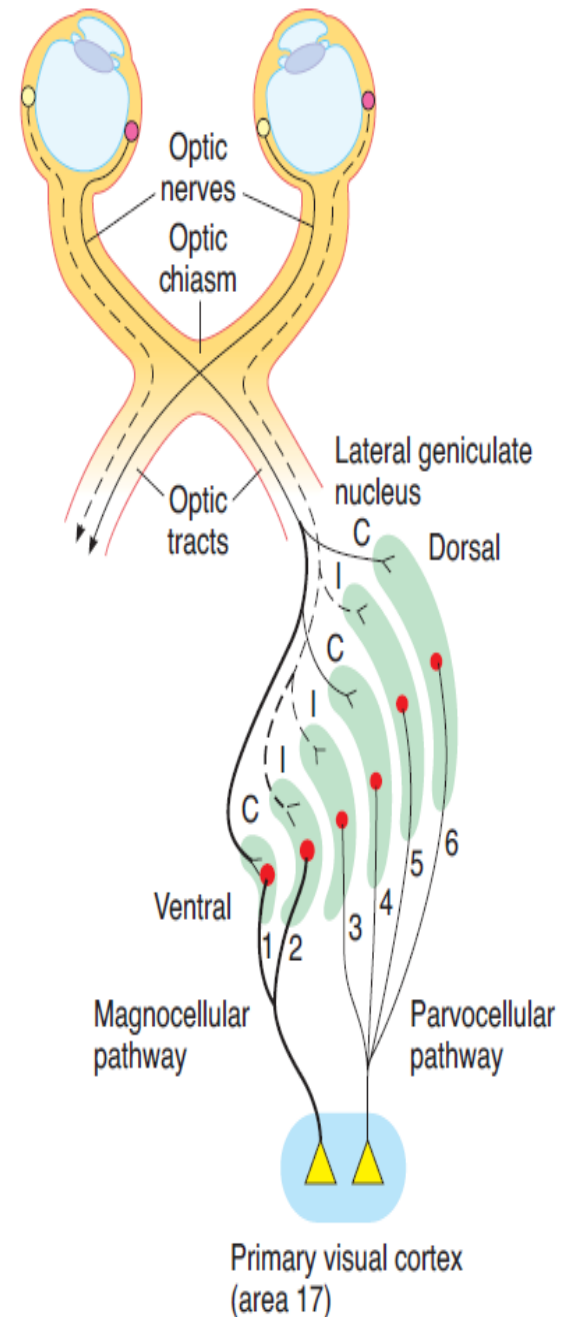
LGB pathways to visual cortex

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

This magnocellular system provides a *rapidly conducting* pathway to the visual cortex. However, this system is color blind, transmitting only black-and-white information.

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.



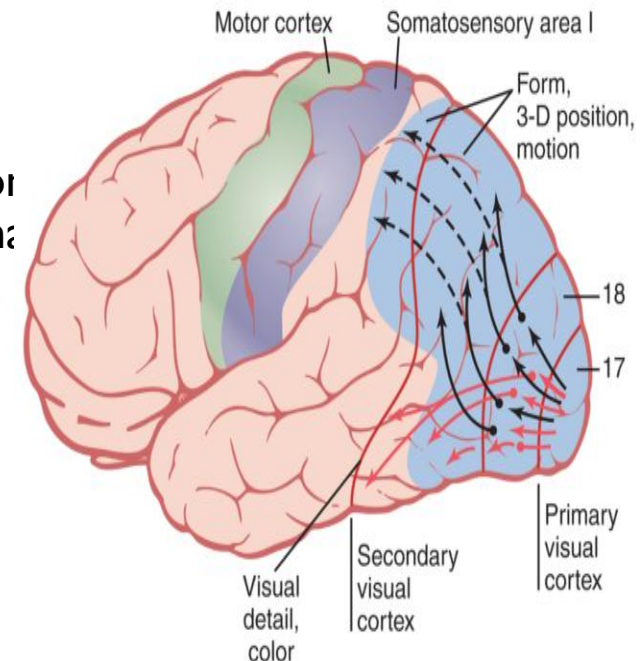
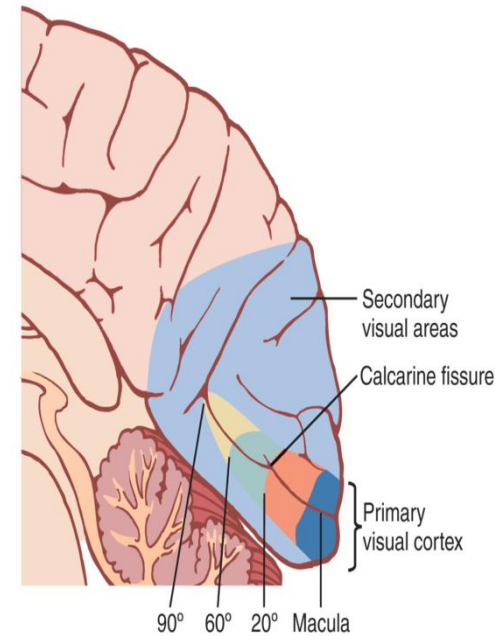
Visual cortex

- The Primary Visual Cortex Has Six Major Layers of cells arranged vertically each act as a separate functional 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.

- Signals from the retinal fovea transmits its signals terminate near the occipital pole, whereas signals from the more peripheral retina terminate in concentric half circles anterior to the pole on the medial occipital lobe. ---

- The upper portion of the retina is represented superiorly and the lower portion inferiorly.



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

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

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

Located mainly anterior to the primary visual cortex

Function:-

- **interpretation of visual stimuli,**
- the fixation mechanism that causes the eyes to “lock” on the object of attention is controlled by *secondary visual center*.
- -When this fixation area is destroyed bilaterally, causes difficulty keeping its eyes directed toward a given fixation point

-Effect of Removing the Primary Visual Cortex

Removal of the primary visual cortex causes loss of conscious vision, (blindness)

(but patient react subconsciously to changes in light intensity, to movement in the visual scene.)

-These reactions include turning the eyes, turning the head, and avoidance. This vision is believed to be subserved by neuronal pathways that pass from the optic tracts mainly into the superior colliculi

•-**Color Blobs are** in the Visual Cortex.

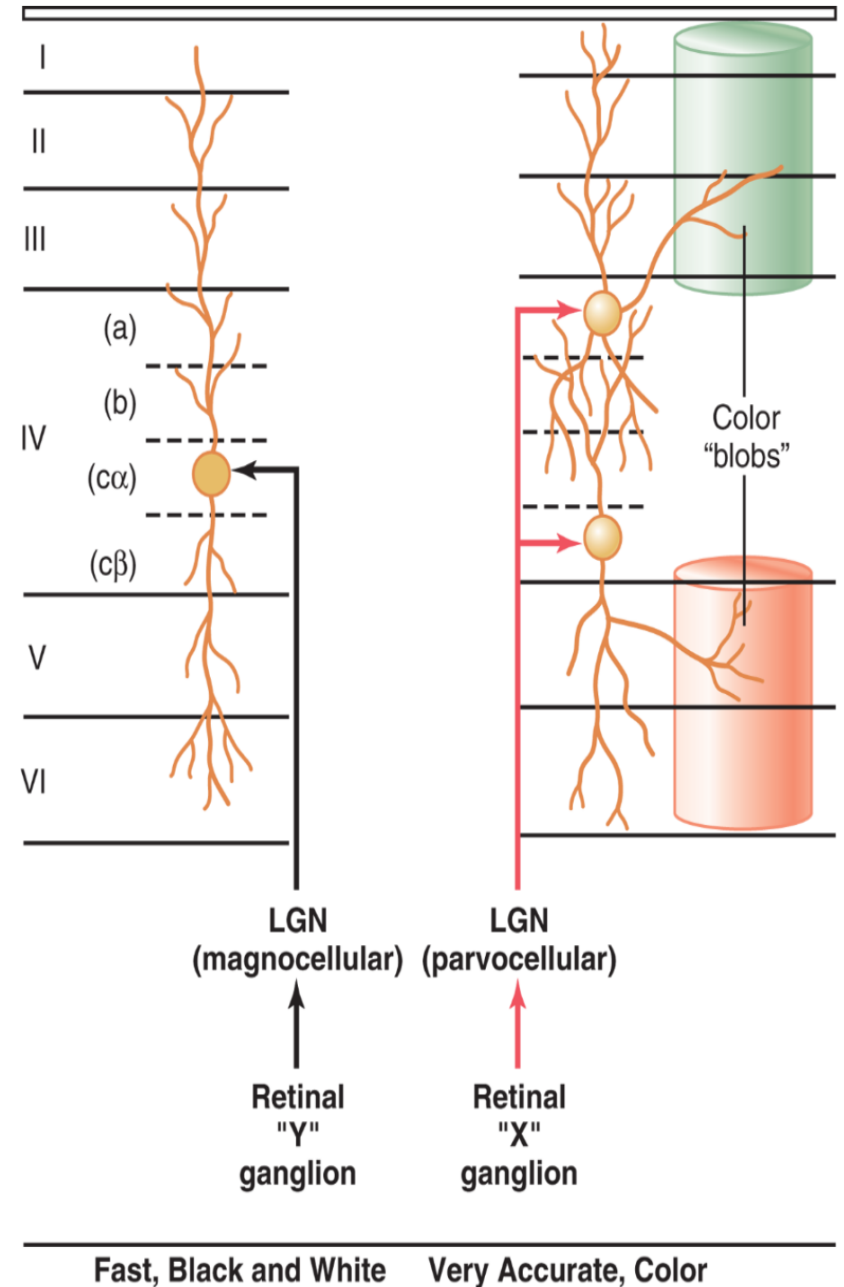
Interspersed among the primary visual columns & among the columns of the secondary visual areas

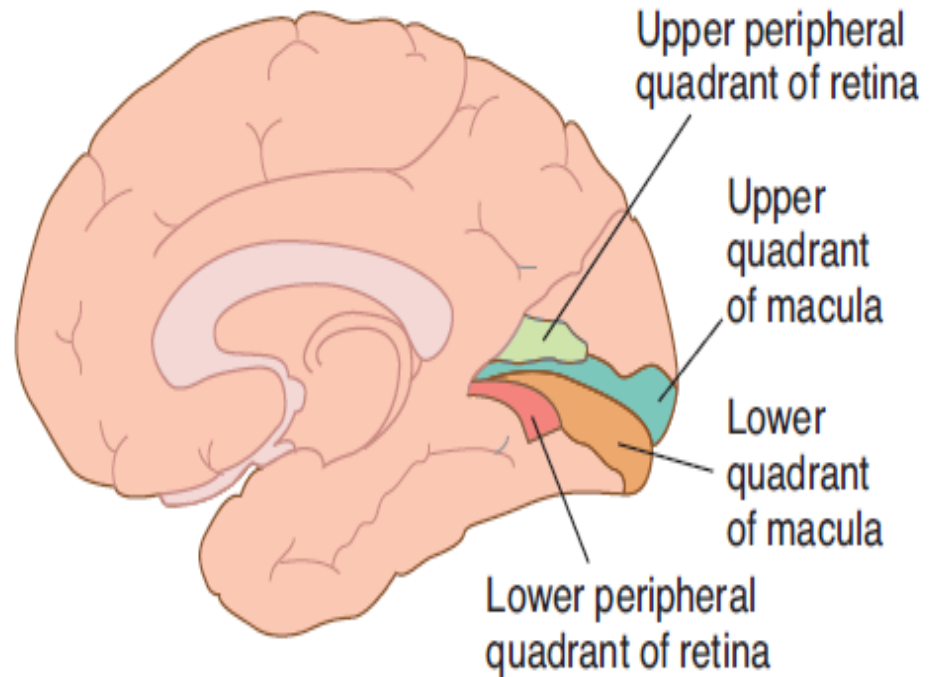
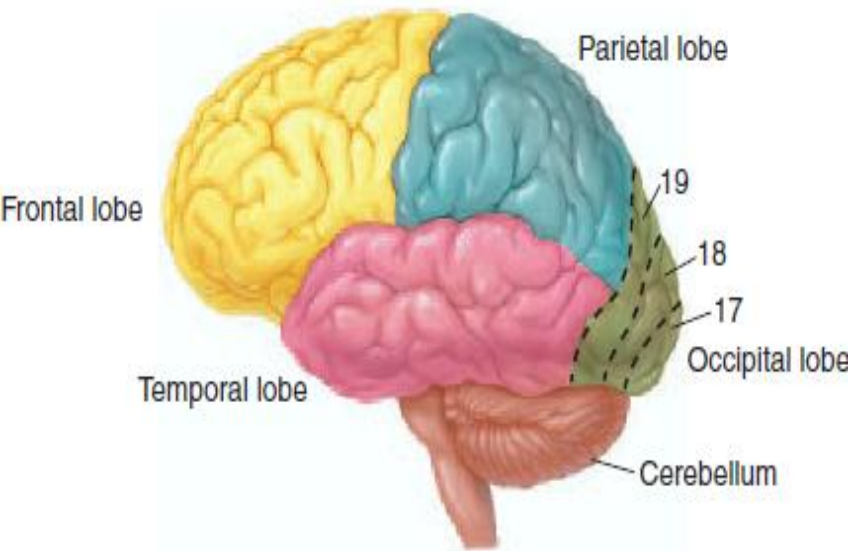
•- Column-like areas called *color blobs*.

clusters of cells responsible for color detection

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

-**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.

Thank you for

