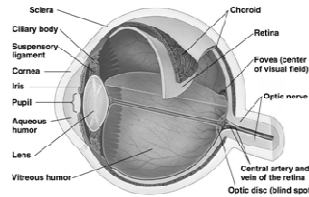


LECTURE 1

PHYSIOLOGY OF THE EYE & REFRACTION



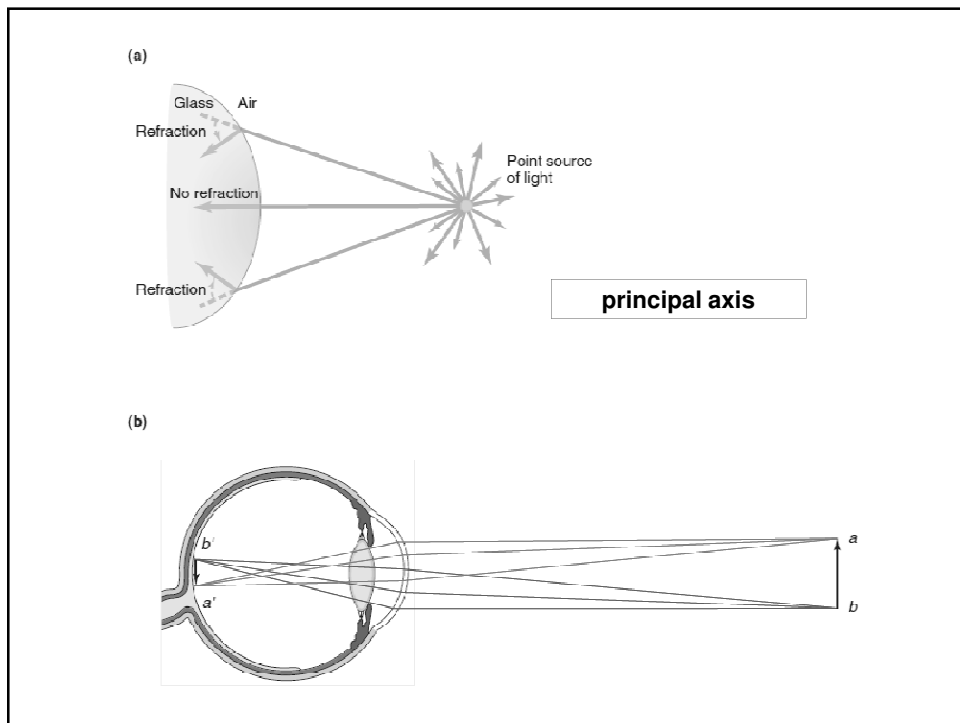
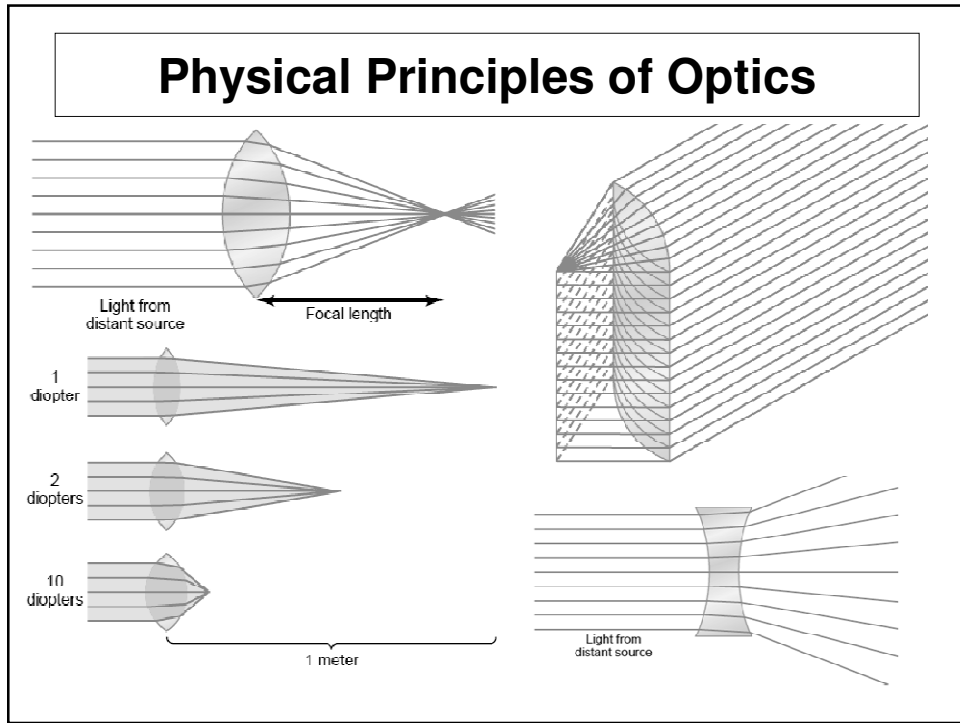
DR SYED SHAHID HABIB
MBBS DSDM PGDCR FCPS
Professor
Dept. of Physiology
College of Medicine & KCUH

OBJECTIVES

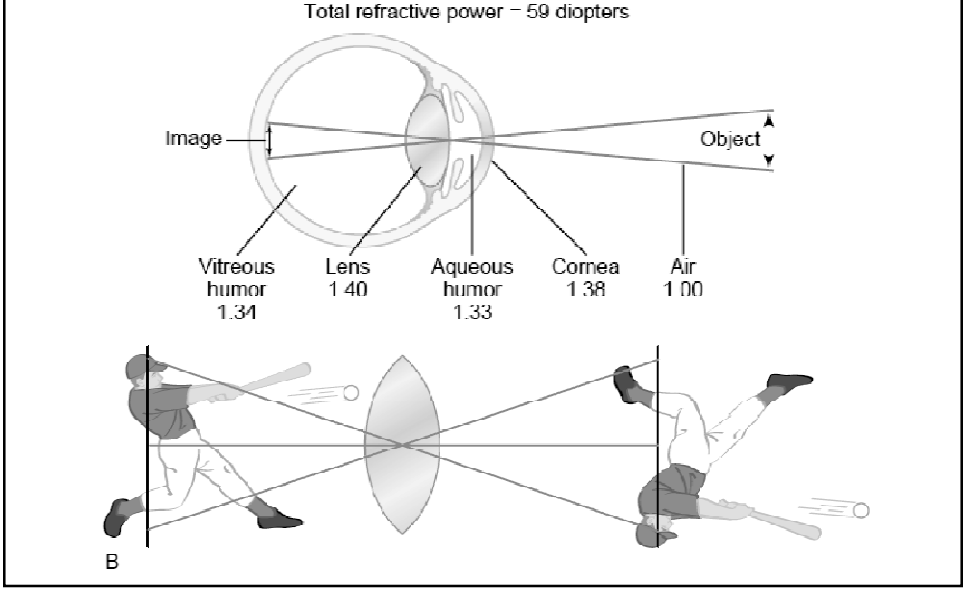
At the end of this lecture you should be able to describe:

- Different components of the eye and function of each and understand the eye protection media
- Refraction of light as it passes through the eye to the retina, identifying the refractive media of the eye
- Principles of optics and errors of refraction
- Visual acuity, glaucoma and binocular vision





Formation of an Image on the Retina



Refractive power of lens is measured in Dioptre (D)

Equals the reciprocal of the focal distance in meters.
 Example: 10 diopters = 1/10 meters = 10 cm

Dioptre (s) = 1 / Focal length (m)

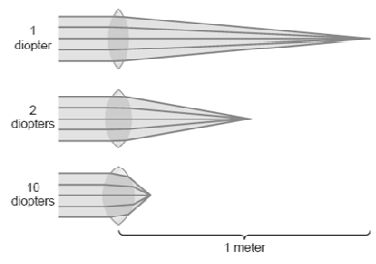
Dioptric power of the eye:

Cornea40-45 D (max refraction)

Lens 15-20 D

Accomodation +12 D

? If Principal focal distance of a lens is 50cm, how much is RF?

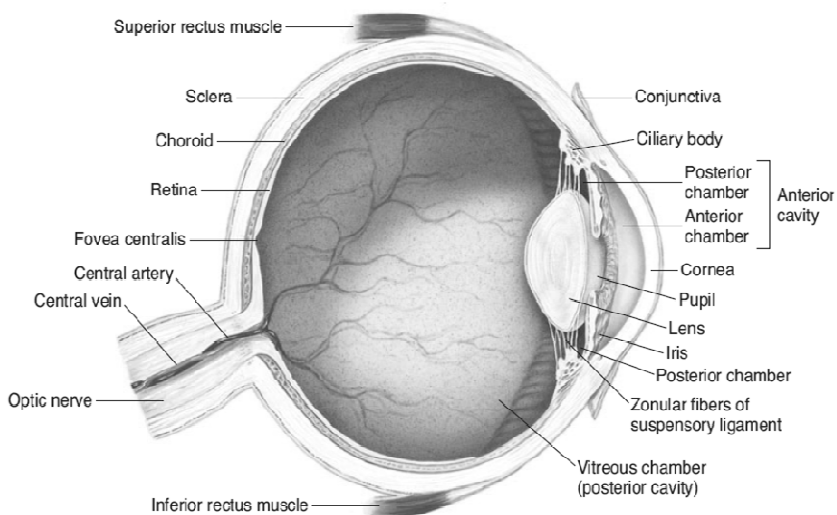
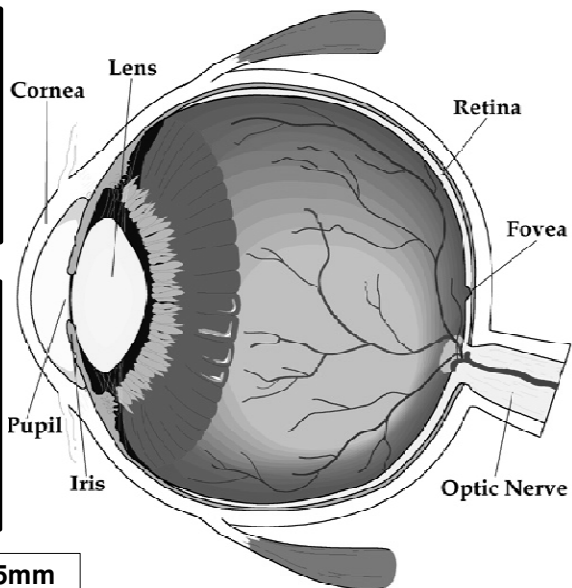


Human Eye – Cross section

1. Refracting Media
2. 3 Coats (Sclera, Choroid and Retina)
3. Post2/3Retina, Ant1/6Cornea

1. 70% of all sensory receptors in body are in the eye.
2. Requires the most learning.
3. Easily fooled sense (optical illusions)

Lens--retina distance =15mm



- What is glaucoma ? (intraocular pressure more than 20mm Hg)
- Why it causes damage of optic nerve?

(a) (b)

Retina:

- **PHOTORECEPTORS: Rods & Cones**
- **OPTIC DISC: (blind spot-WHY? -2 - 3mm medial & above post pole of eye - optic nerve leave & retinal blood vessels enter & no photoreceptors)**
- **FOVEA CENTRALIS: Depression in Macula lutea - yellow pigmented spot at post pole of eye. Have cones only**

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Retina

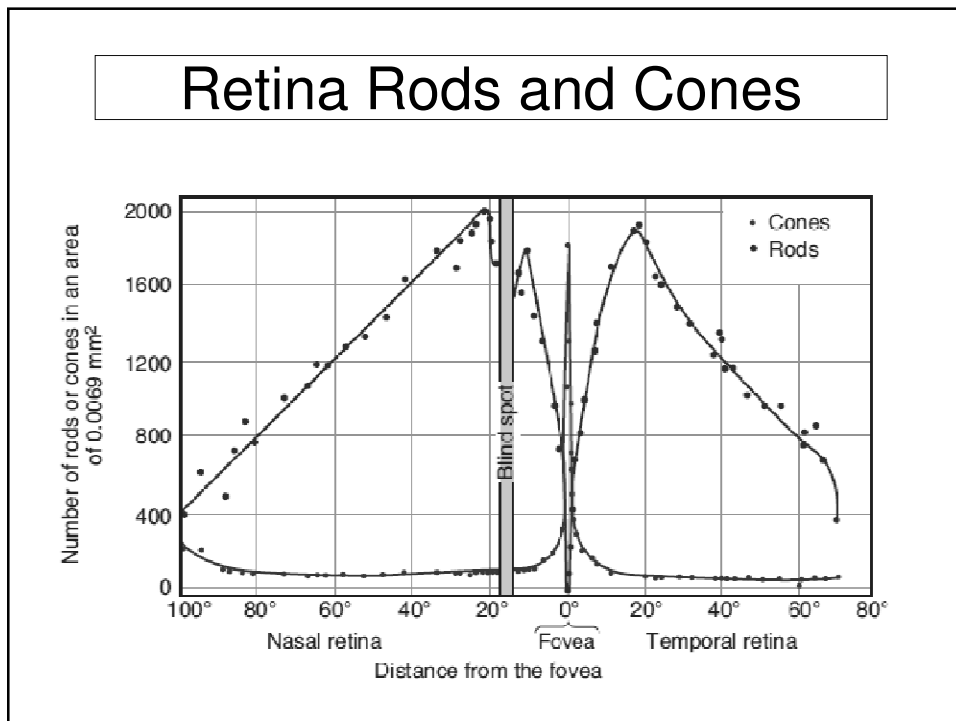
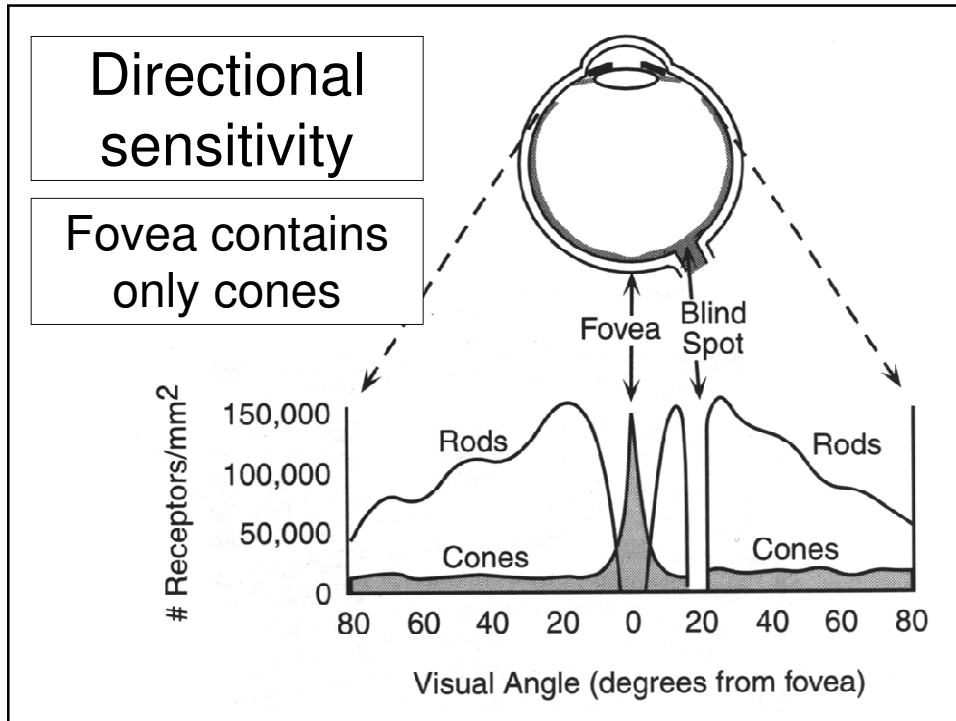
Artery

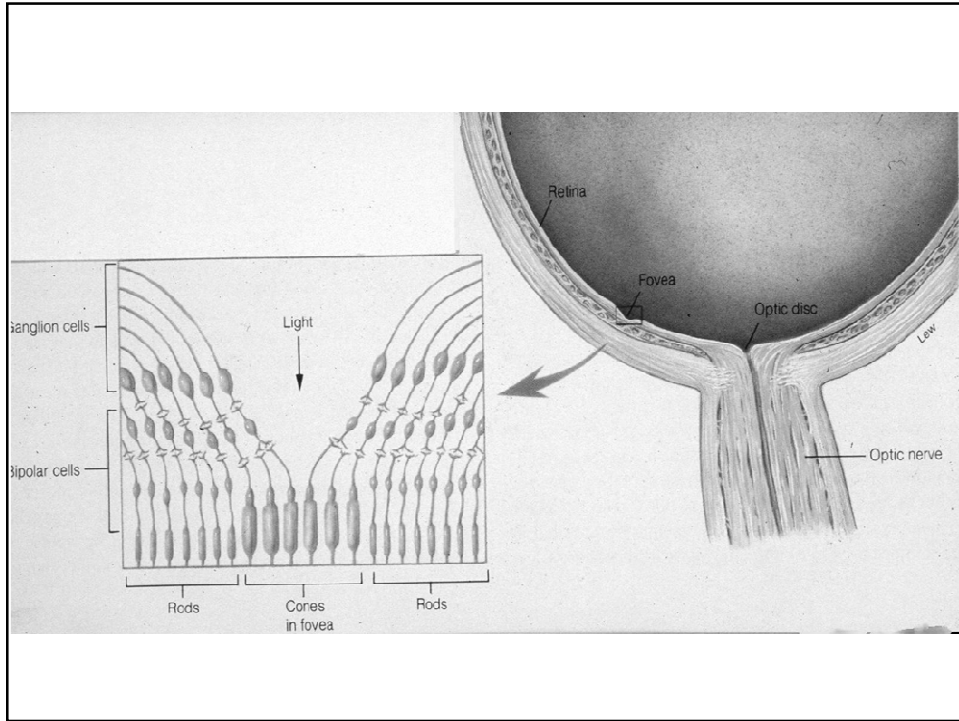
Veins

Optic disk

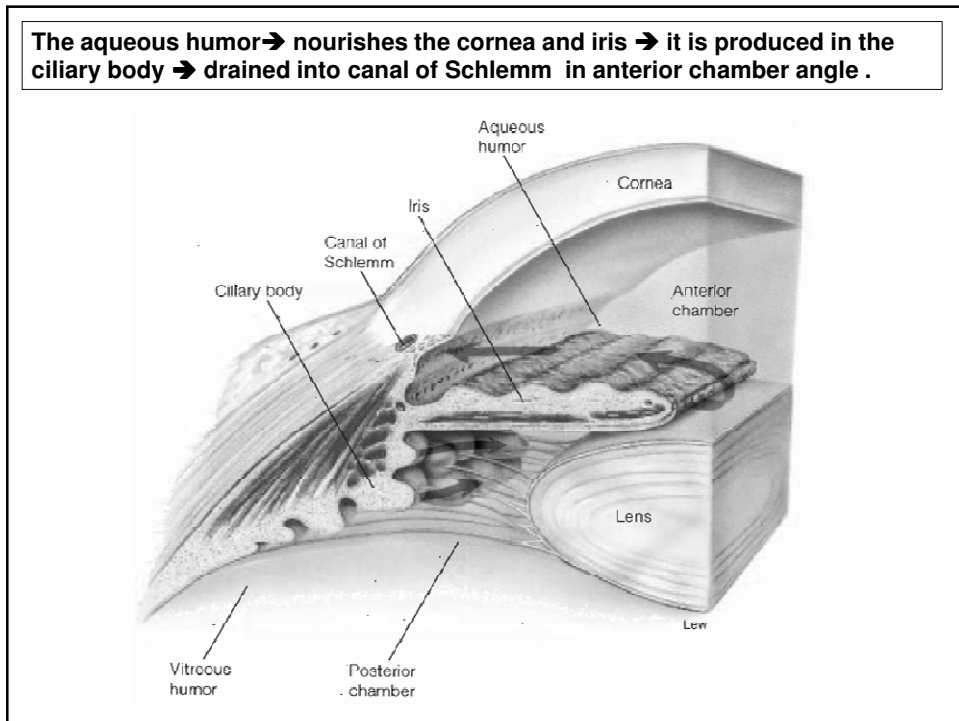
Fovea centralis

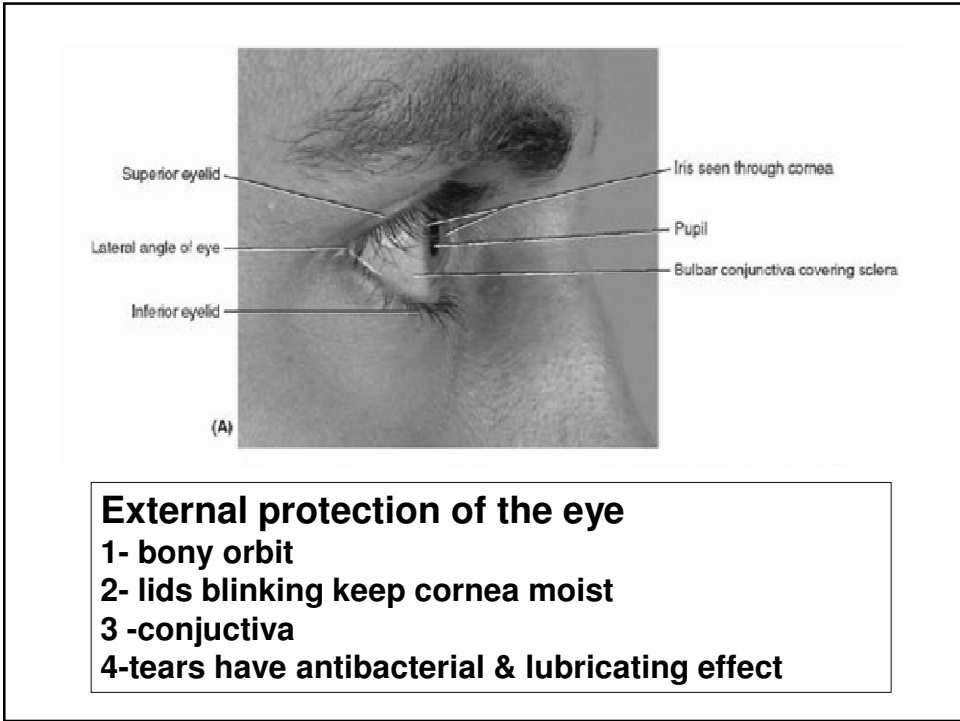
Macula lutea





The aqueous humor → nourishes the cornea and iris → it is produced in the ciliary body → drained into canal of Schlemm in anterior chamber angle .





External protection of the eye
1- bony orbit
2- lids blinking keep cornea moist
3 -conjunctiva
4-tears have antibacterial & lubricating effect

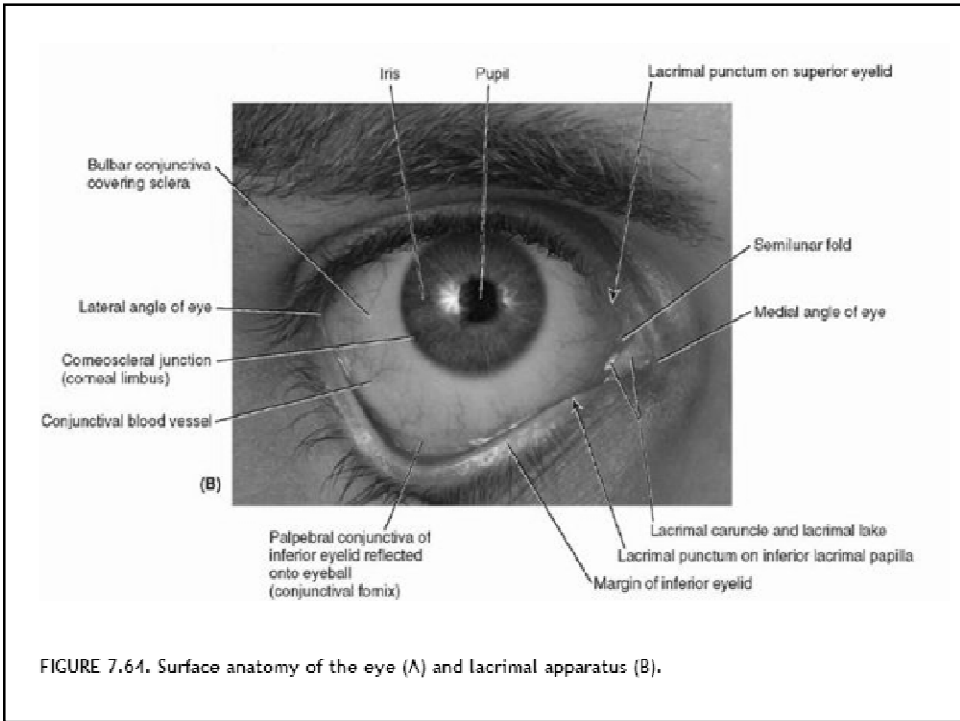
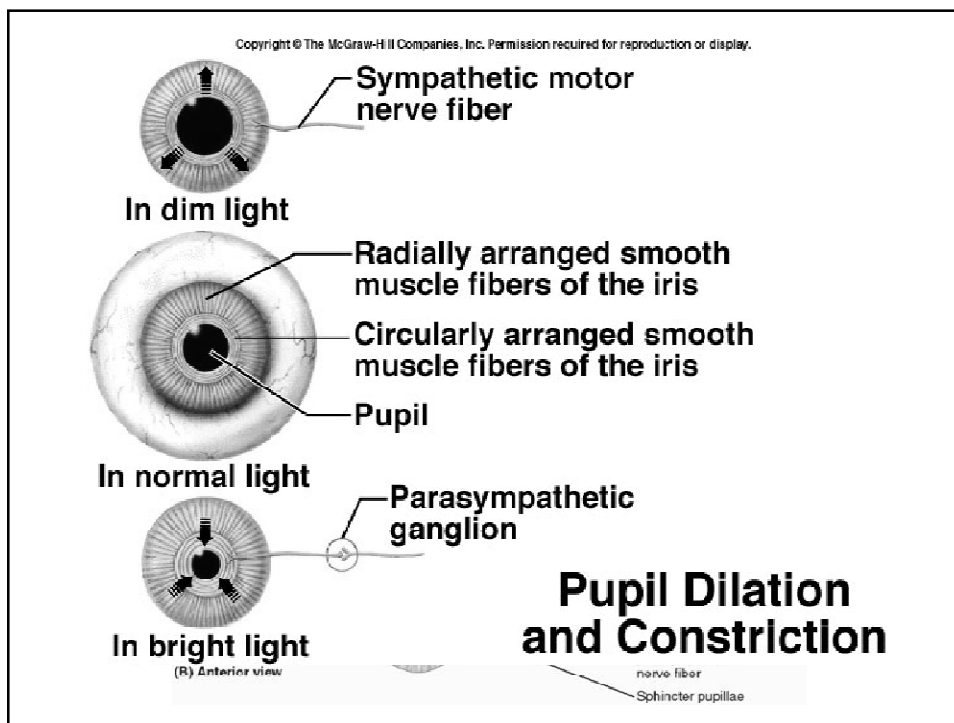
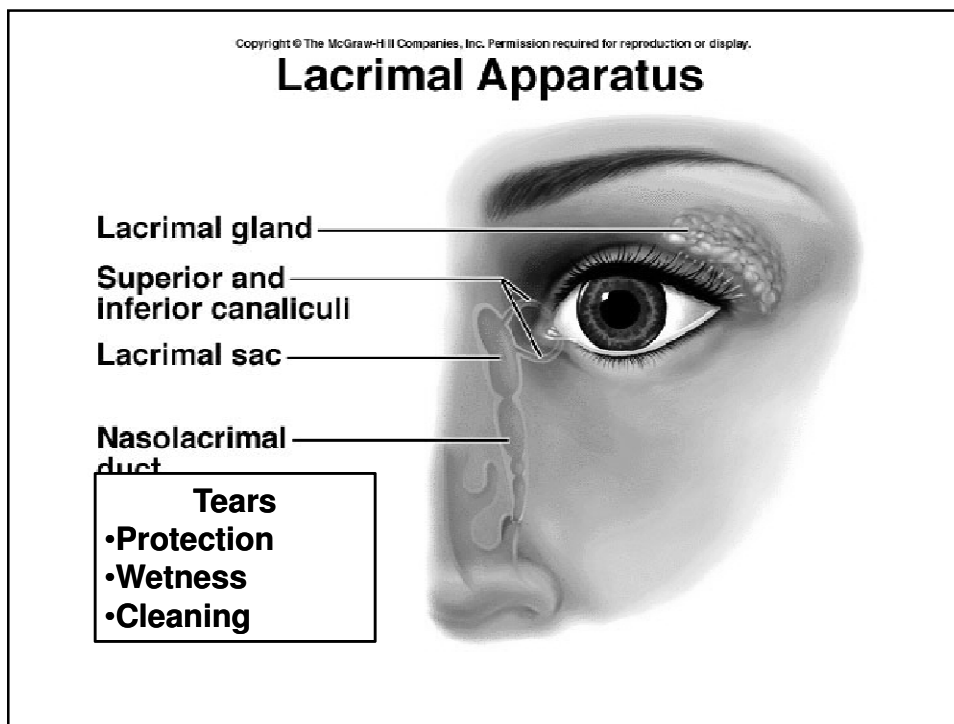
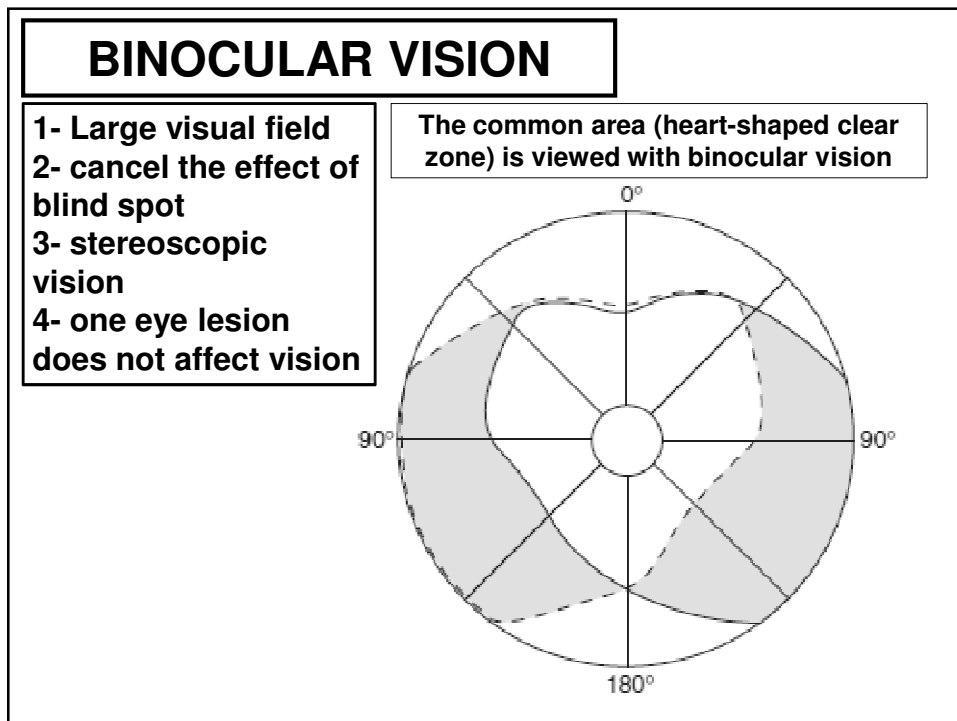
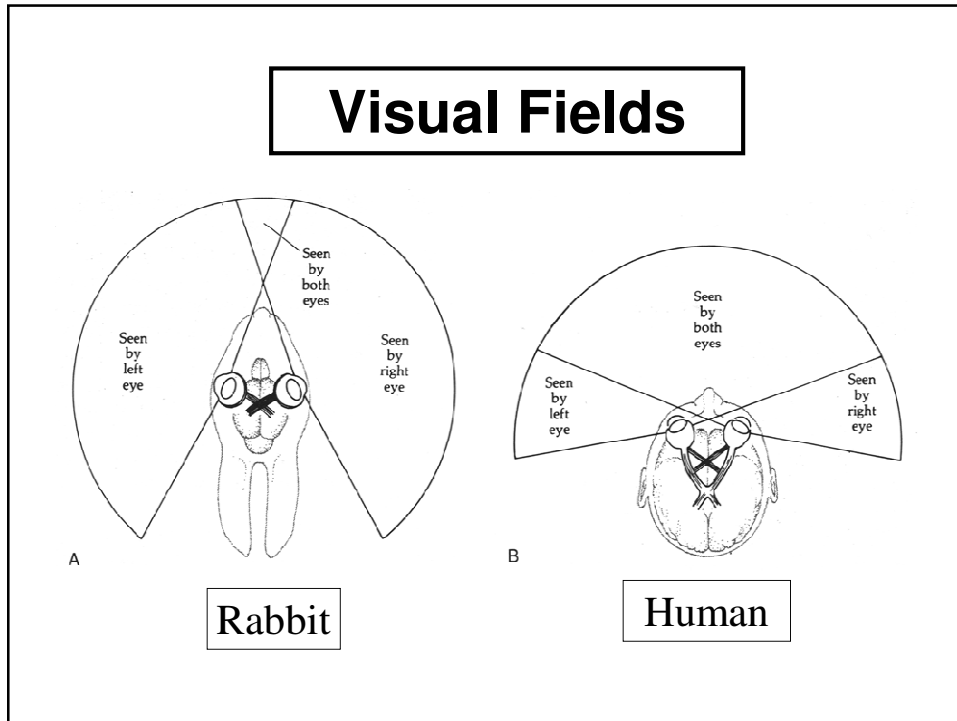


FIGURE 7.64. Surface anatomy of the eye (A) and lacrimal apparatus (B).





OBJECTIVES

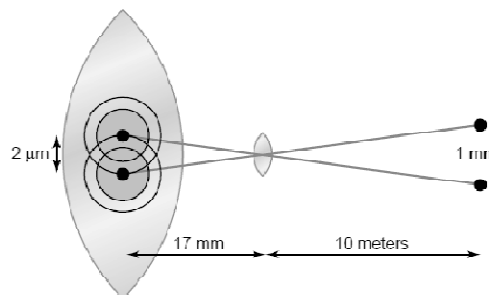
At the end of this lecture you should be able to describe:

- Describe visual acuity
- 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 and its pathway and -relate these to clinical situations as argyl Robertson pupil
- Identify the lateral geniculate body and visual cortex



Visual Acuity

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



Visual threshold / is minimal amount of light that elicit sensation of light

Visual Acuity (Cont.)

❖ Clinically, visual acuity is often determined by the use of the familiar Snellen's letter charts viewed at a distance of 20 ft (6 m)

❖ The numerator of the fraction is 20, the distance at which the subject reads the chart

❖ Normal visual acuity is 20/20;

❖ Subject with 20/15 visual acuity has better than normal vision

❖ What is meant by 15/20 visual Acuity?

Snellen Test

www.provisu.ch

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

DUPLICITY THEORY OF VISION (2 kinds of vision)

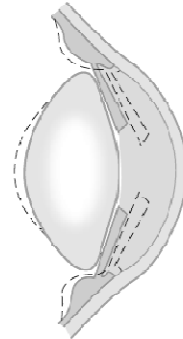
1-PHOTOPIC VISION (bright light vision) - served by cones -high visual acuity = colors & details - low sensitivity to light = needs high visual threshold to be stimulated

2-SCOTOPIC VISION (night vision, dimlight vision) - served by rods - low visual acuity = no colors or details - great sensitivity to light =low visual threshold

Accomodation

Accomodatopn is an active process for modification of the refractive power of the eye to view a nearby object by increasing the curvature of lens.

Mechanism: Ciliary muscles contract
→ relaxes the lens ligaments →
mainly increase curvature of anterior
surface of lens

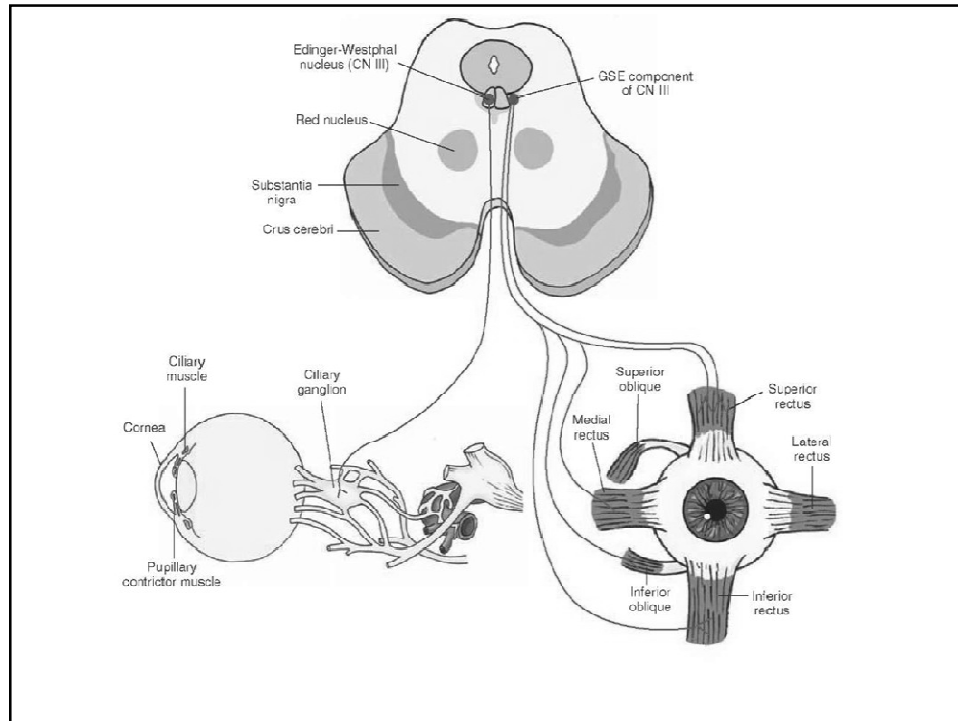


Test: Sanson Purkinje Image

THE ACCOMODATION REFLEX

Retina → optic nerve → optic chiasma optic tract → lateral geniculate body → visual cortex
→ EWN → Occulomotor nucleus
 (parasympathetic) → ciliary ganglion → ciliary muscle & constrictor pupillary muscle

The light reflex: Retina → optic tract →
PRETECTAL NUCLEUS → oculomotor nucleus (EWN) → oculomotor nerve → ciliary ganglion → constrictor pupillary muscle



The near response

Three Part Response

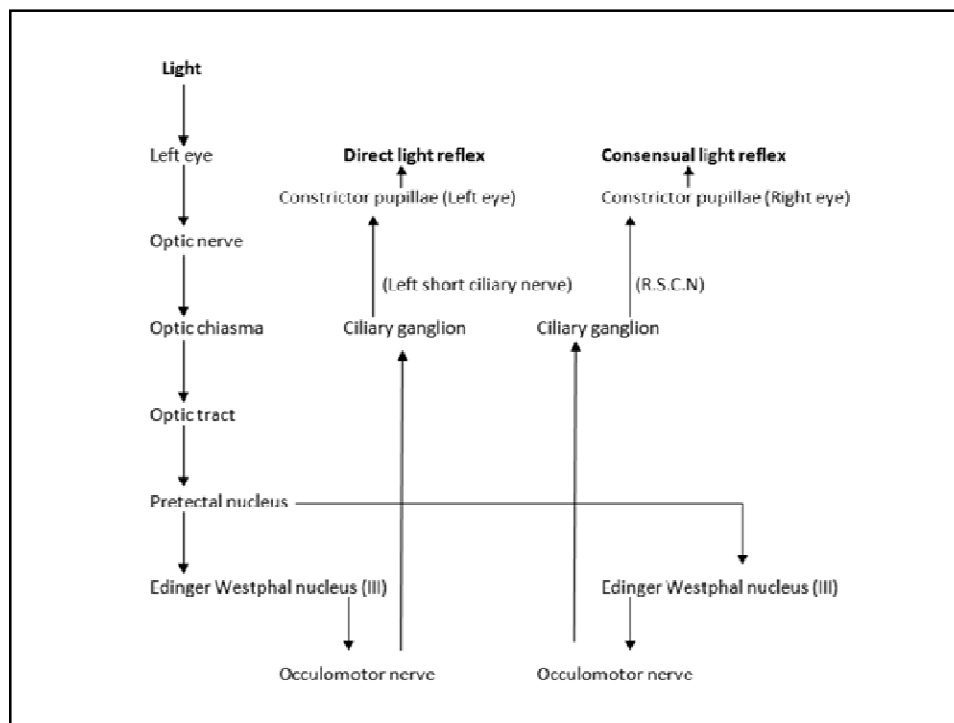
- Accomodation
- Pupillary Constriction
- Convergence of Visual Axes

PUPILLARY LIGHT REFLEXES

- When light is directed into one eye, the pupil constricts (direct light response).
- The pupil of the other eye also constricts (consensual light response).

The light reflex: Retina → optic tract → Pretectal Nucleus → oculomotor nucleus (EWN) → oculomotor nerve → ciliary ganglion → constrictor pupillary muscle



Note: Blindness with preservation of the pupillary light reflex is usually due to bilateral lesions caudal to the optic tract.



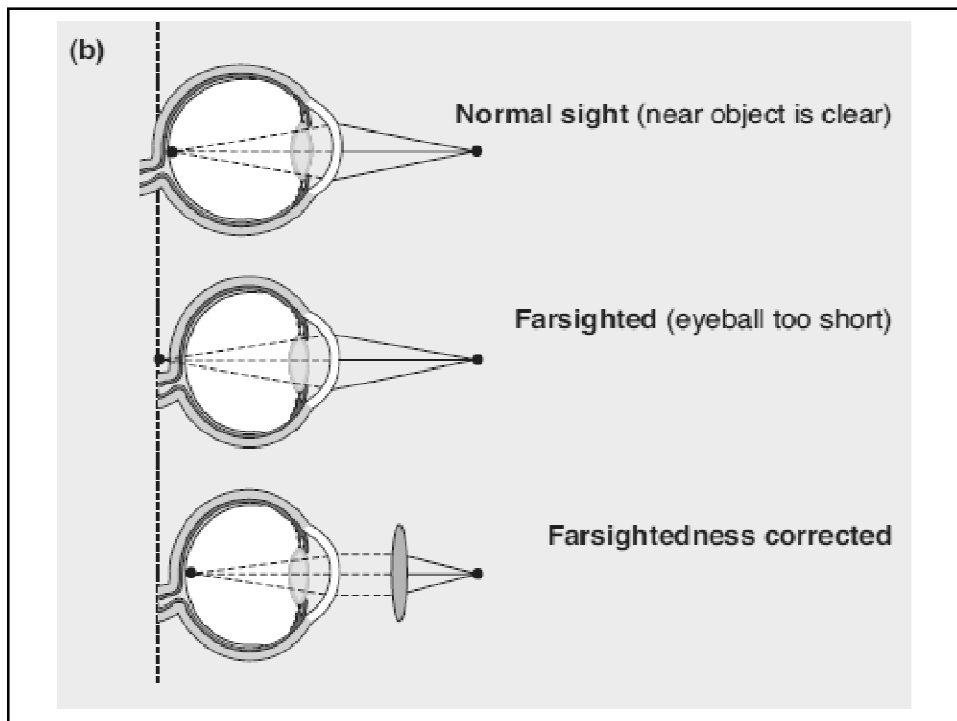
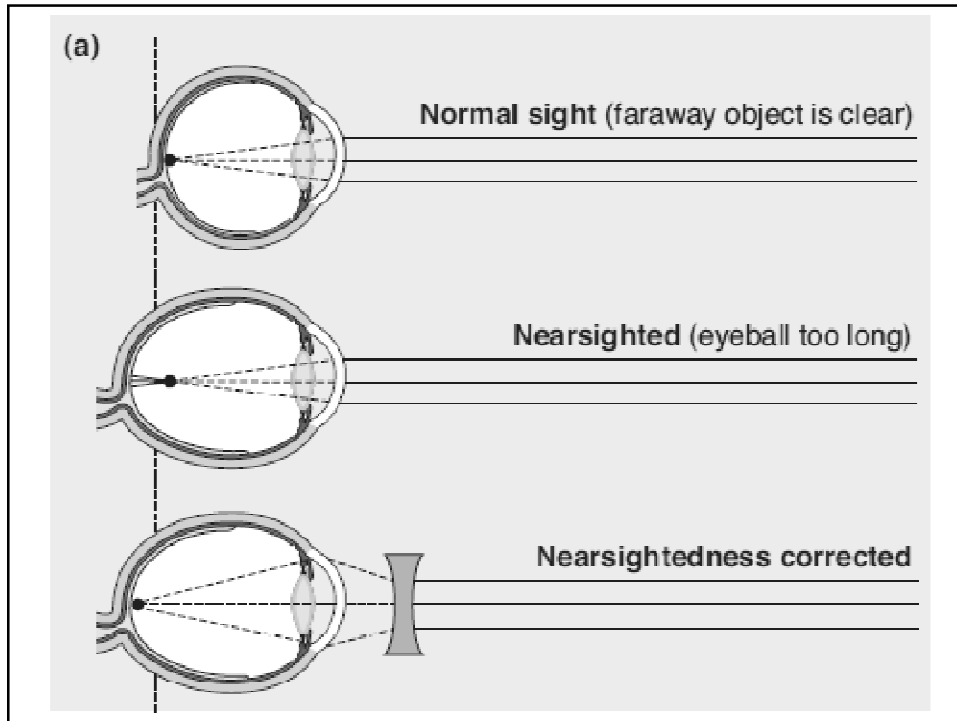
Near point and amplitude of Accomodation

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

Argyll Robertson pupils in Neurosyphilis

Pupils constrict in response:
to accomodation reflex 
but not
to the light reflex 

In syphilis tabes dorsalis destroys
pretectal nucleus



Errors of Refraction

- ❖ **Hyperopia (Farsightedness):** the eyeball is shorter than normal and the parallel rays of light are brought to a focus behind the retina. [Headache & Blurred Vision]
- ❖ **Myopia (Nearsightedness)** the anteroposterior diameter of the eyeball is too long and the parallel rays of light are brought to a focus in front the retina.
- ❖ **Astigmatism:** the curvature of the cornea is not uniform. When the curvature in one meridian is different from that in others, light rays in that meridian are refracted to a different focus (part of the retinal image is blurred)
- ❖ **Presbyopia:** loss of accommodation with age

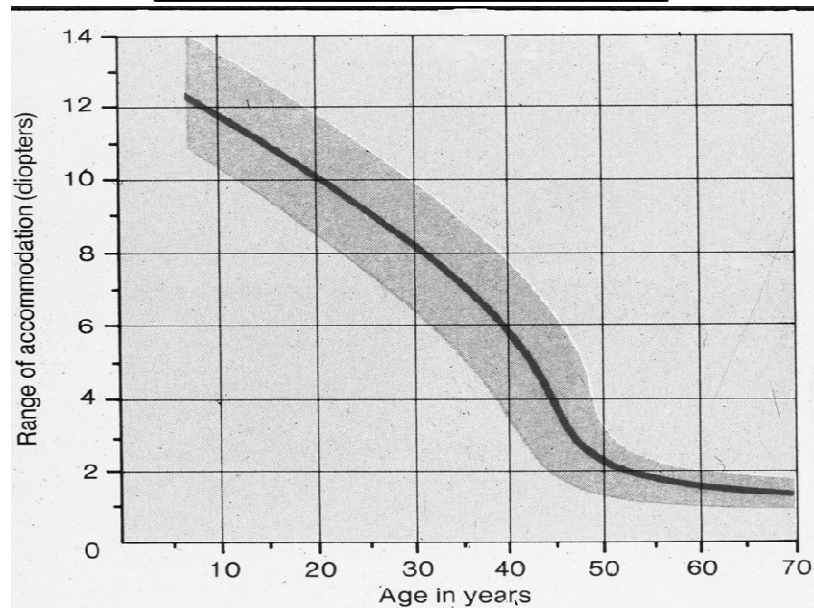
NEAR POINT

- Nearest point to eye at which an object can be brought into focus on retina by **ACCOMODATION**
- 10 years-----9 cm
- At 60 years-----80-100 cm.

Presbyopia : With increase in age (45-50) loss of accommodation is usually sufficient to make reading and close work difficult .

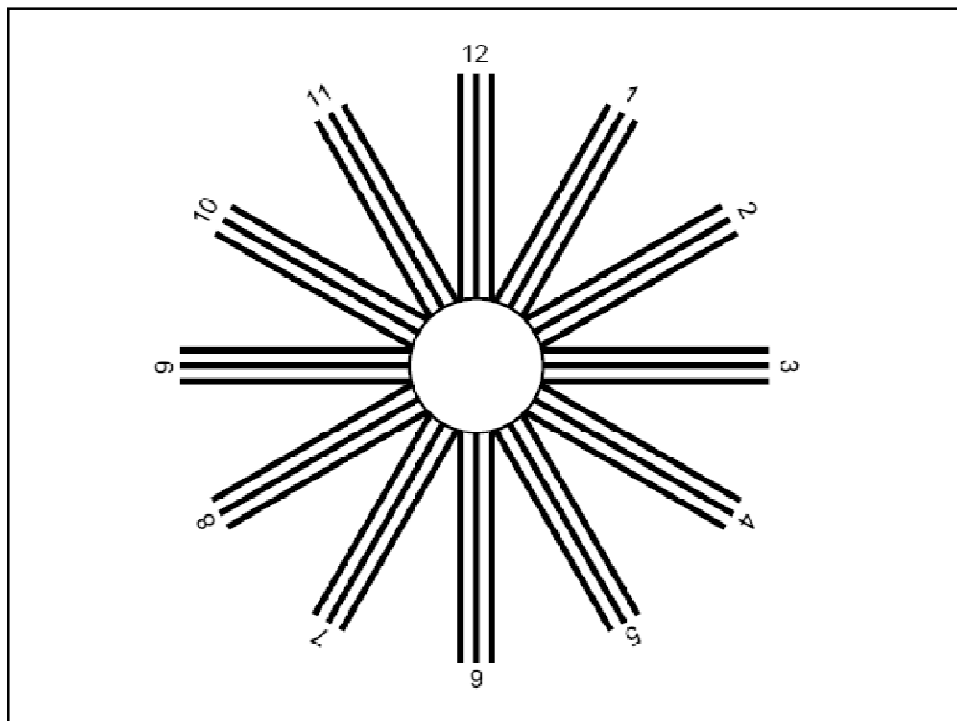
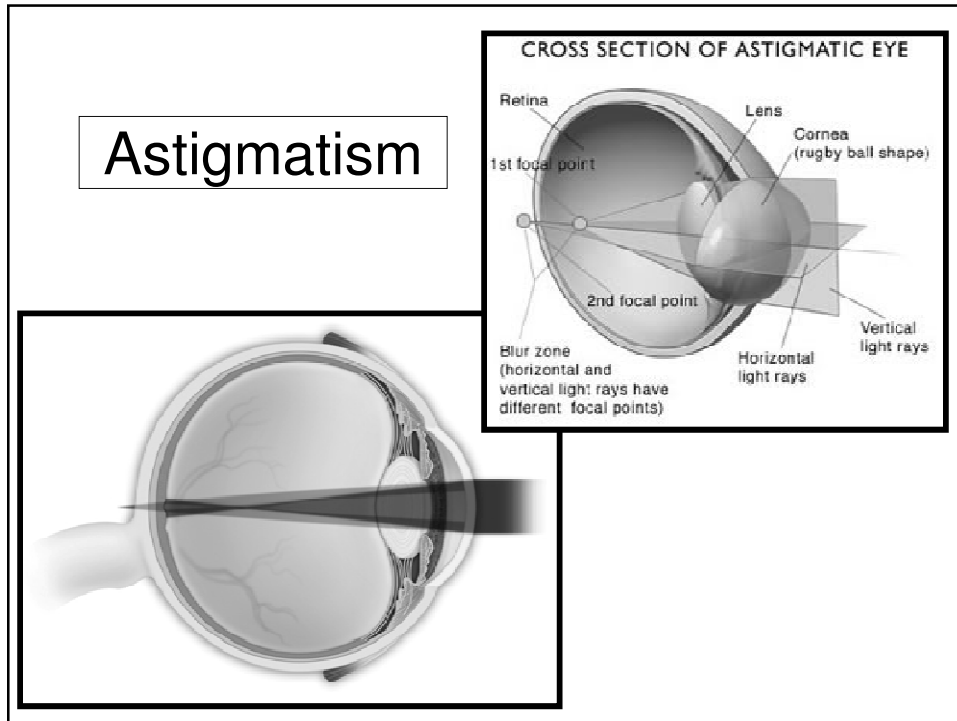
- Loss of lens elasticity
- Near point is receded
- Corrected by convex lenses

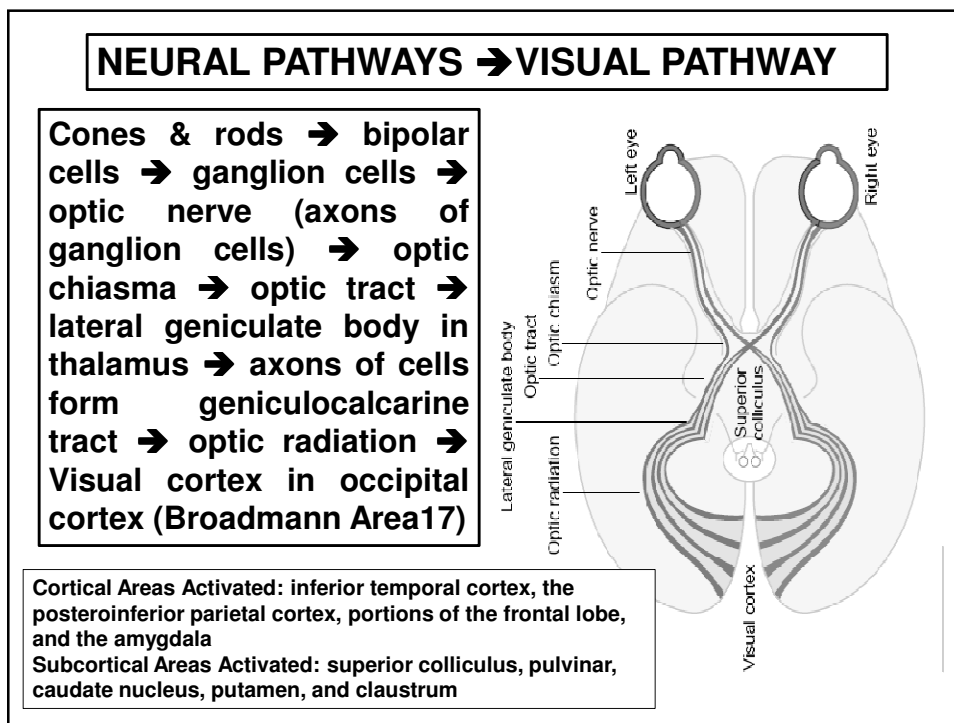
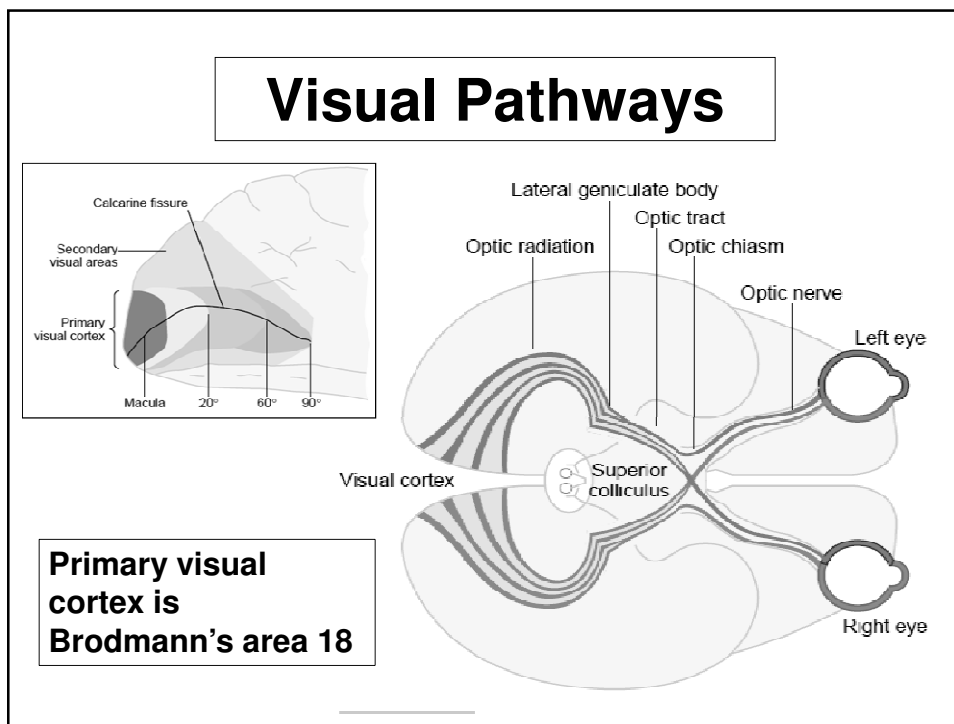
Accomodation & Aging



COMMON DEFECTS OF THE IMAGE-FORMING MECHANISM

- **Strabismus (misalignment of the eyes) → turning inward (esotropia), outward (exotropia)**
- **Suppression scotoma (Visual images chronically fall on noncorresponding points in the two retinas in young children & one is eventually suppressed It is a cortical phenomenon)**
- **Amblyopia (suppression with subsequent permanent loss of visual acuity children)**





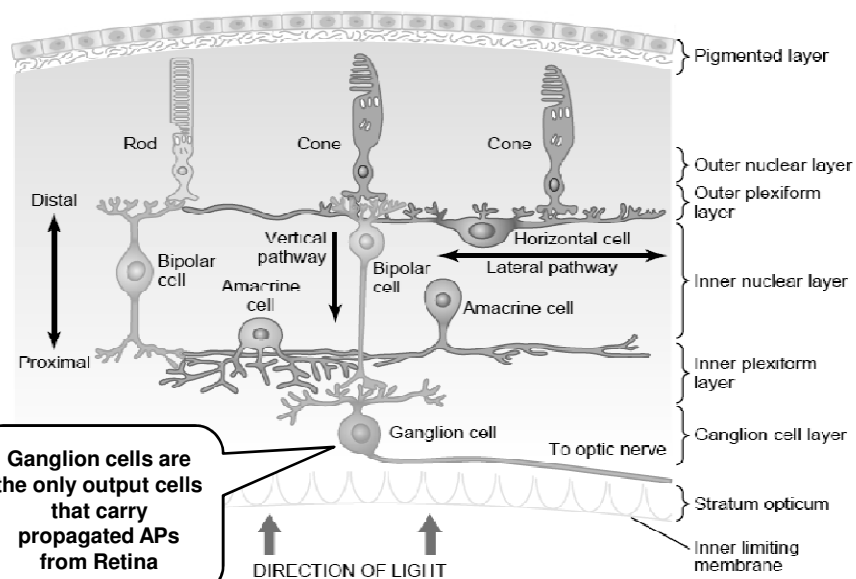
NEURAL PATHWAYS → VISUAL PATHWAY

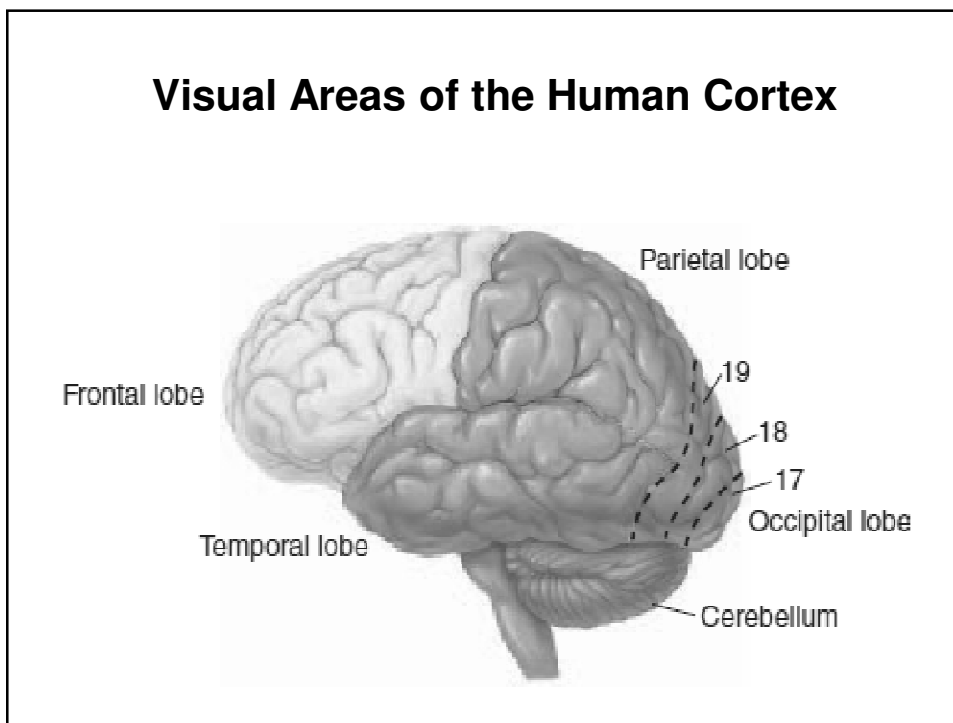
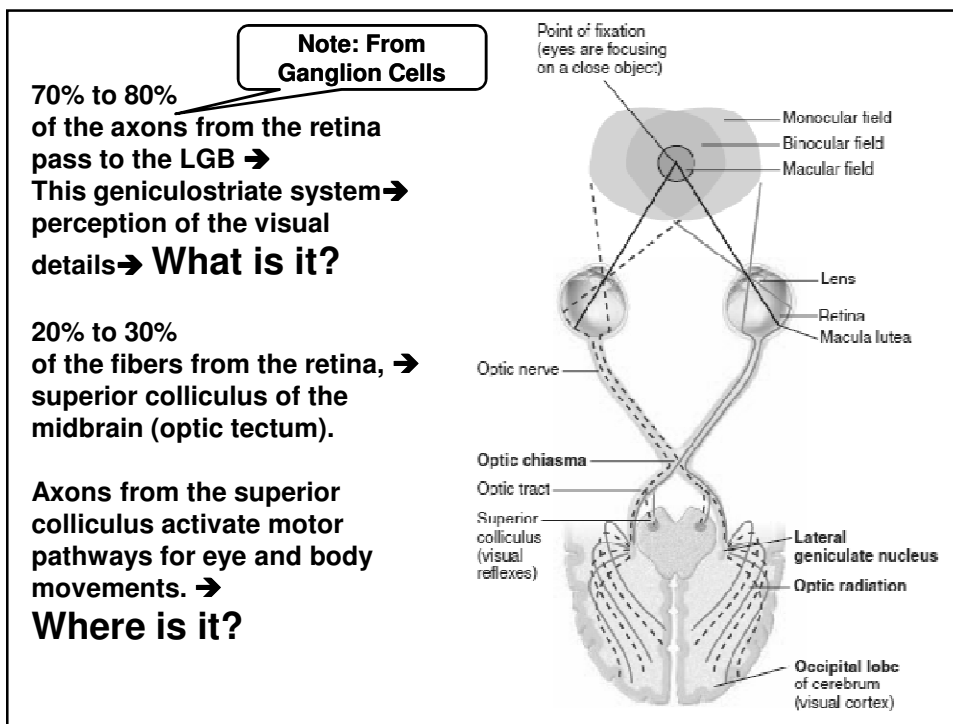
Cortical Areas Activated: Inferior temporal cortex, the posteroinferior parietal cortex, portions of the frontal lobe, and the amygdala

Subcortical Areas Activated: superior colliculus, pulvinar, caudate nucleus, putamen, and claustrum

- 1- Some ganglion cells axons pass 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 pass to superior colliculus in midbrain for accommodation and eye movements

Layers of retina



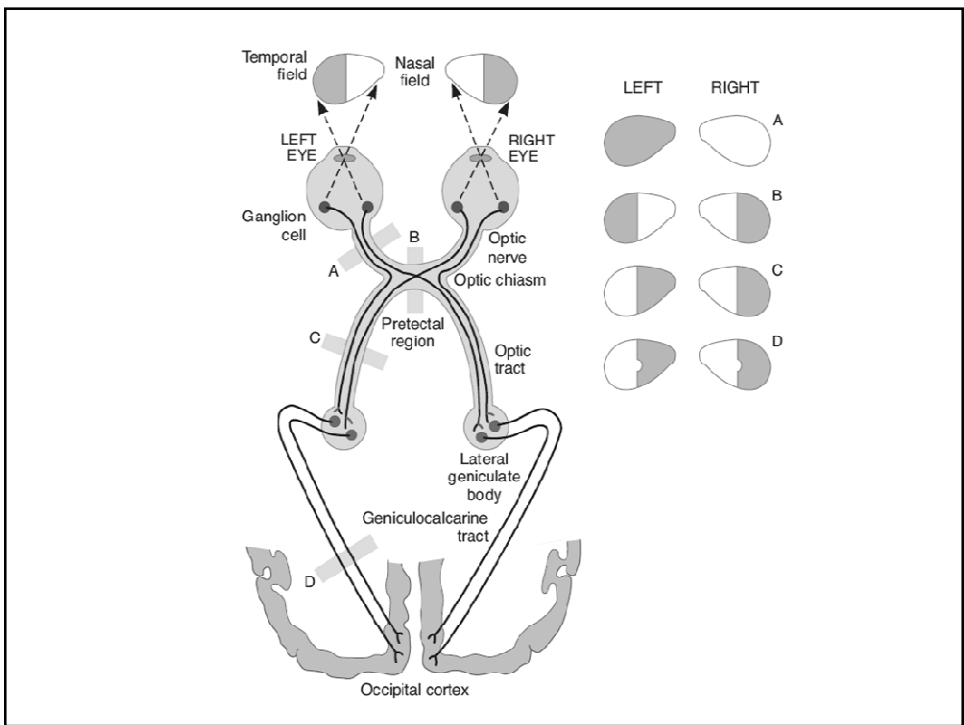
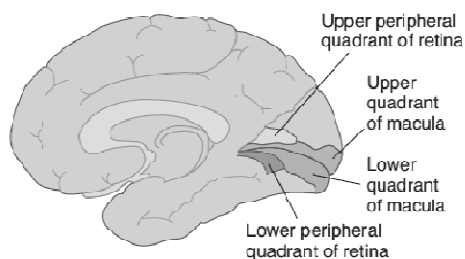


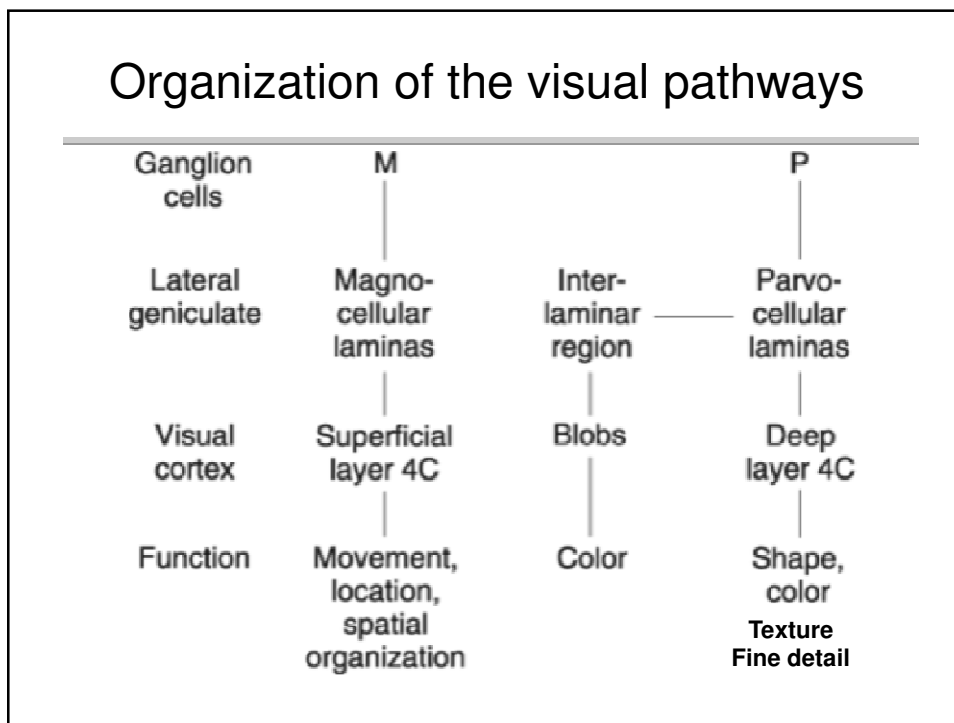
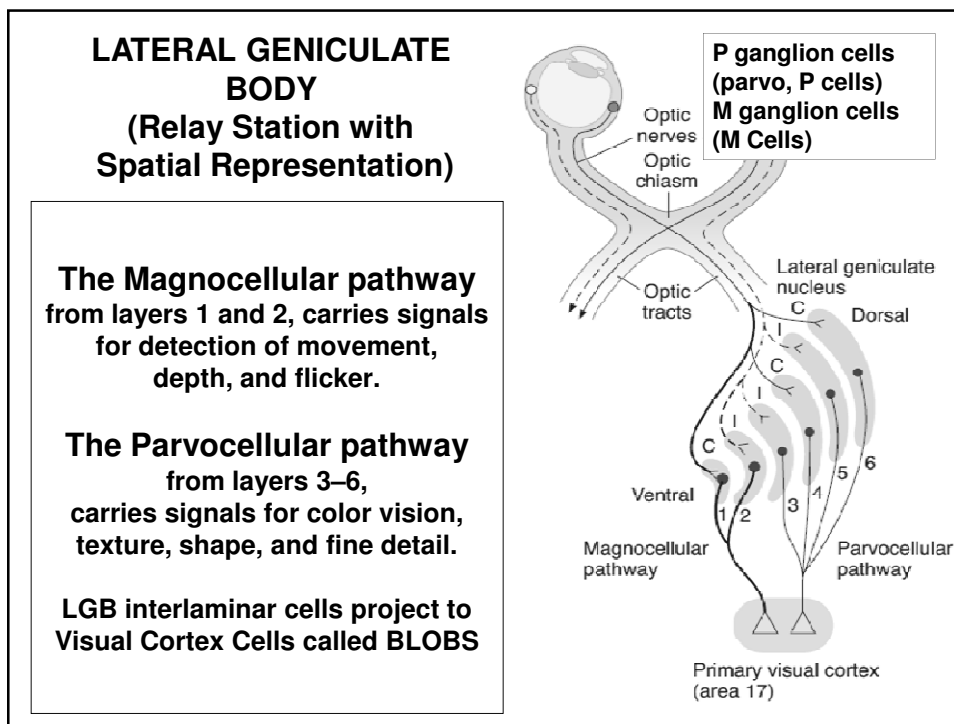
VISUAL CORTEX

Visual cortex has 6 layers
1-Primary visual cortex(broadmann area 17 (also V1):
 percieve sensation of vision (movement + shapes+
 stereoscopic vision + brightness) & has clusters of
 cells called blobs for color detection
2-Association visual cortex(area 18&19): for
 interpretation of visual information

FEATURE DETECTORS
 •Simple cells detect bars of
 light, lines and edges
 •Complex cells detect linear
 movements of a stimulus

**Note: Macular sparing in
 cortical Lesions Why?**





Superior Colliculus and Eye Movements

Neural pathways from the superior colliculus to motor neurons in the spinal cord help mediate the startle response to the sight and also stimulate the extrinsic eye muscles, which are the striated muscles that move the eyes

Smooth pursuit movements track moving objects and keep the image focused on the fovea centralis.

Saccadic eye movements are quick (lasting 20 to 50 msec), jerky movements of both eyes that occur while the eyes appear to be still. These saccadic movements continuously move the image to different photoreceptors.

Ability of the eyes to jump from word to word as you read a line, so that the image of each word in succession is focused on the fovea.

