

OPTICS OF THE EYE

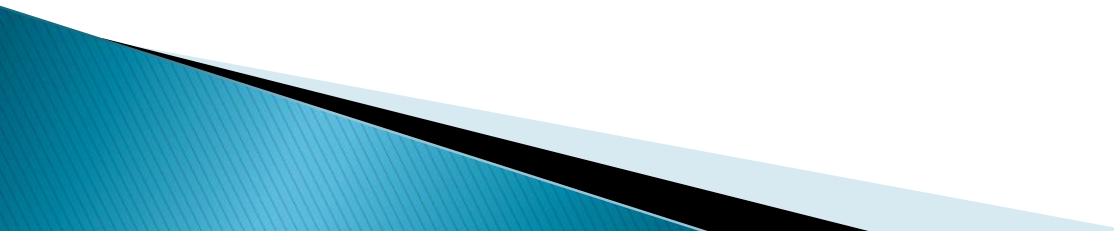
ERRORS OF REFRACTION

DR. SHAISTA SAIYAD

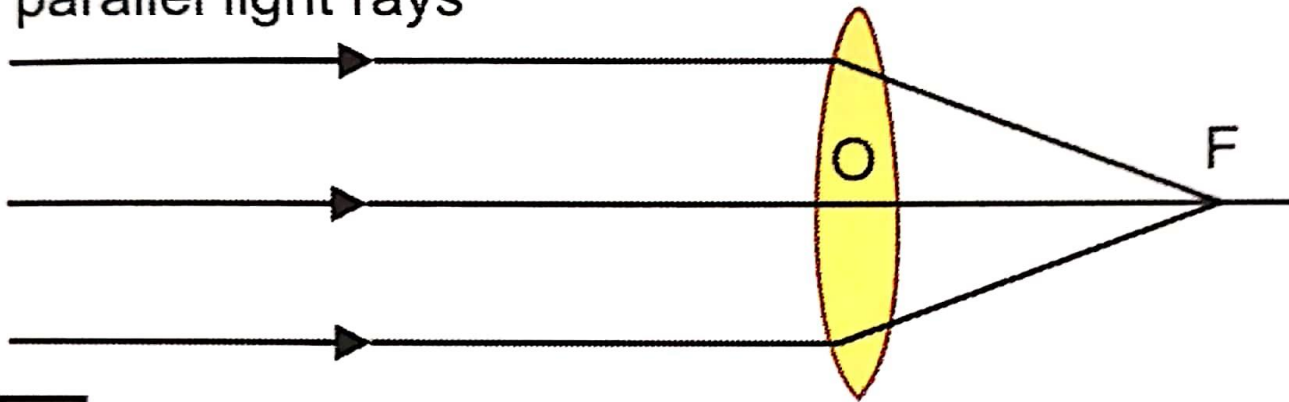
(MD, Ph.D., ACME, FAIMER)

ALL FIGURES HAVE BEEN TAKEN FROM 'COMPREHENSIVE TEXTBOOK
OF PHYSIOLOGY' BY DR. G K PAL WITH RELEVANT PERMISSION)

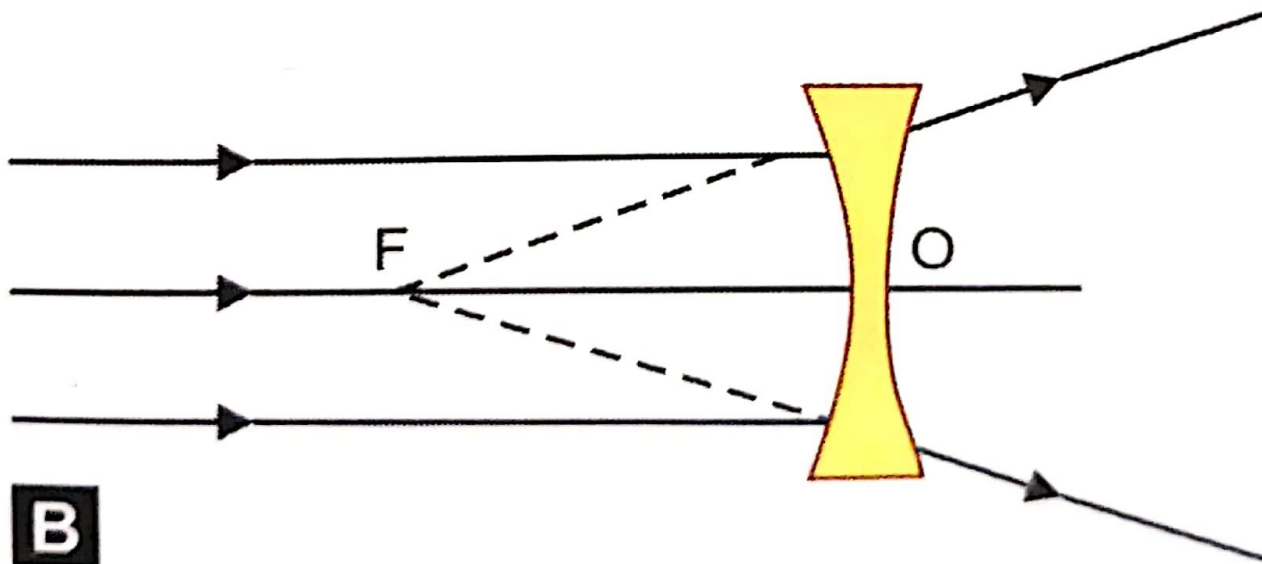
OPTICS OF EYE

- ▶ REFRACTION
 - ▶ REFRACTIVE INDEX
 - ▶ NODAL POINT
 - ▶ PRINCIPLE AXIS
 - ▶ FOCAL LENGTH
 - ▶ REFRACTIVE POWER OF LENS – DIOPTRE
- 

parallel light rays



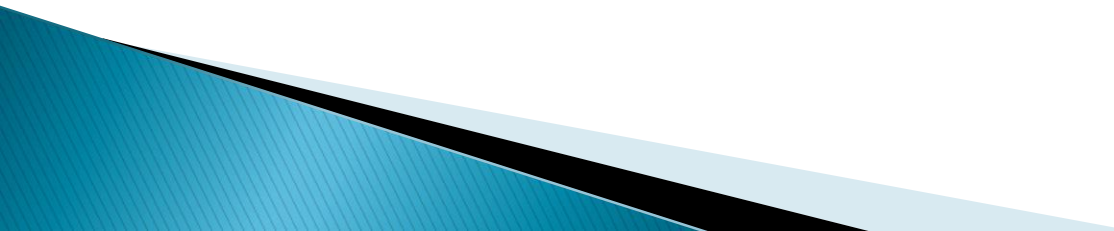
A



B

Figs. 143.1A and B: Refraction of light rays by (A) convex, and (B) concave lenses.

REFRACTIVE INDEX

- ▶ RATIO OF VELOCITY OF LIGHT IN AIR TO VELOCITY OF LIGHT IN THAT MEDIUM
 - ▶ CORNEA=1.38
 - ▶ AQUEOUS HUMOR=1.33
 - ▶ LENS= 1.38
 - ▶ VITREOUS HUMOR=1.33
 - ▶ AIR =1
- 

REFRACTIVE POWER

- ▶ $\text{DIOPTRE} = \frac{1}{\text{FOCAL LENGTH IN MTS.}}$
- ▶ CORNEA = +48D
- ▶ LENS = +15 D

- ▶ LENS OUTSIDE EYE = + 150D

REDUCED EYE OF LISTING

- ANTEROPOST. DIAMETER= 24 MM
- ▶ FOCAL LENGTH= 17 MM
- ▶ POWER= +59D

Chapter 143: Image-forming Mechanism 1173

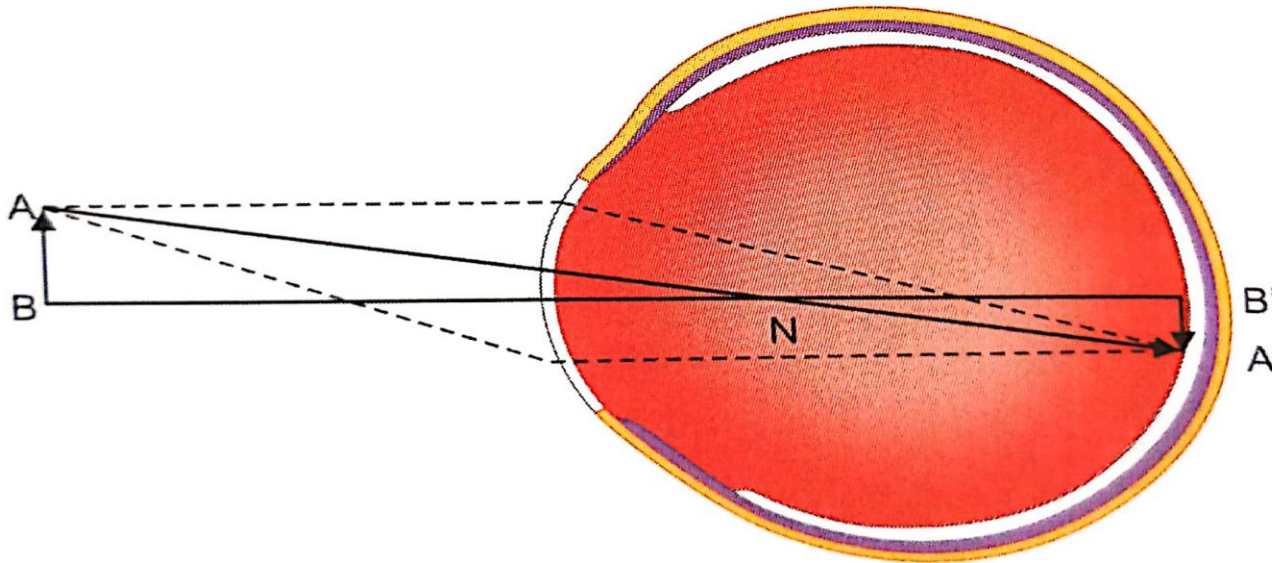


Fig. 143.2: Reduced eye. AB: the object; N: nodal point; A'B': the image formed on the retina. All refractions are assumed to occur on the surface of cornea (refraction by lens is not taken into account).

- ▶ NEAR POINT: NEAREST DISTANCE FROM THE EYE AT WHICH OBJECT CAN BE SEEN CLEARLY. IN NORMAL YOUNG PERSON IT IS 25 CMS (APPROX. 10 INCHES) FROM THE EYE.
- ▶ FAR POINT: FARTHEST DISTANCE FROM THE EYE AT WHICH AN OBJECT CAN BE SEEN CLEARLY. SUPPOSED TO BE 20 FT FROM THE EYE OR INFINITY.

Table 143.1: Effect of age on state of near point and accommodation ability.

| Age (in years) | Near point (in cm) | Accommodation ability (in diopters) |
|---------------------------|-------------------------------|--|
| 10 | 9 | 11 |
| 20 | 10 | 10 |
| 30 | 13 | 8 |
| 40 | 18 | 6 |
| 50 | 50 | 2 |
| 60 | 85 | 1.5 |
| 70 | 100 | 1 |

▶ EMMETROPIA: REFRACTIVE CONDITION OF NORMAL EYE.

▶ AMMETROPIA: ERRORS OF REFRACTION.

PATHOLOGICAL : MYOPIA

HYPERMETROPIA

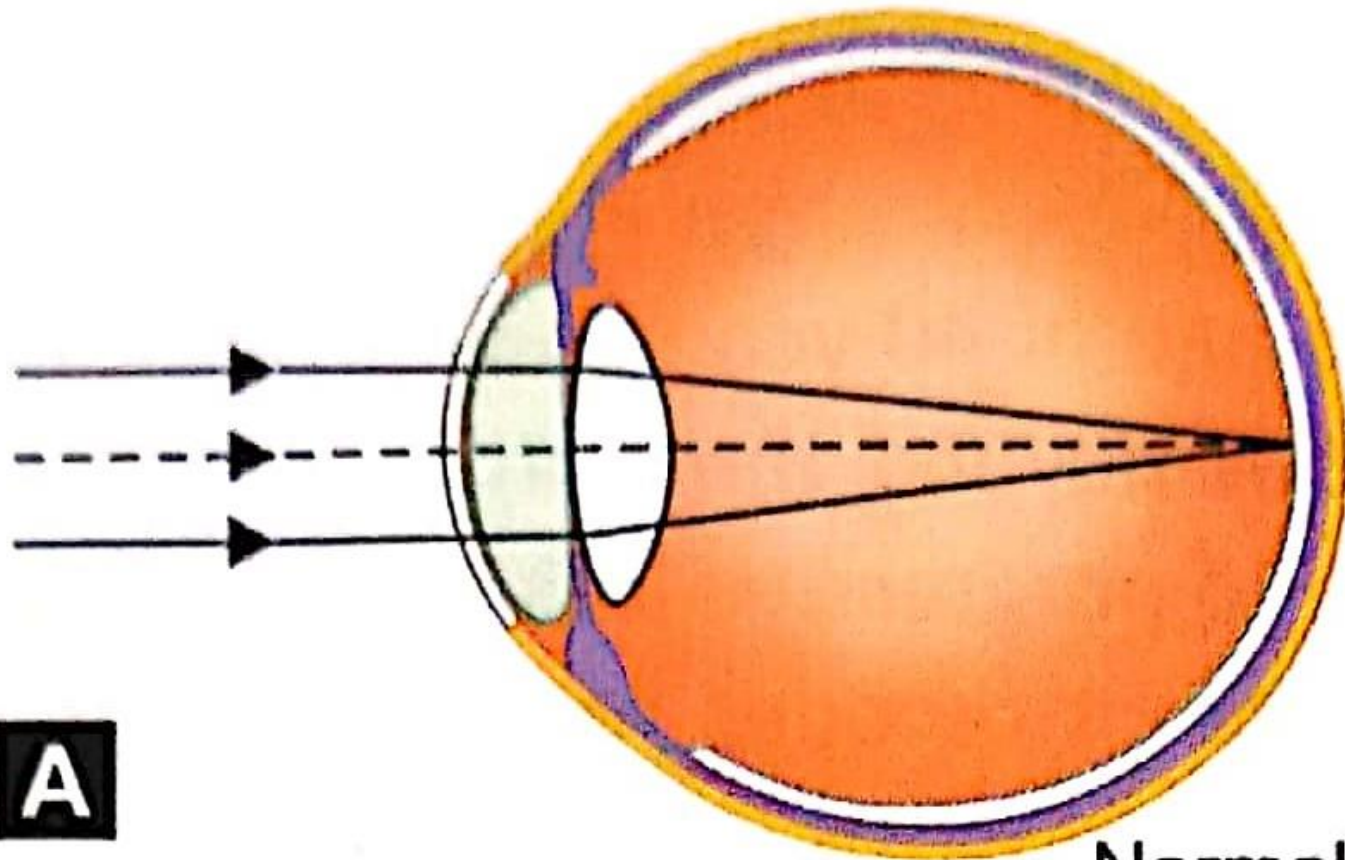
ASTIGMATISM

PHYSIOLOGICAL : SPHERICAL ABERRATION

CHROMATIC ABERRATION

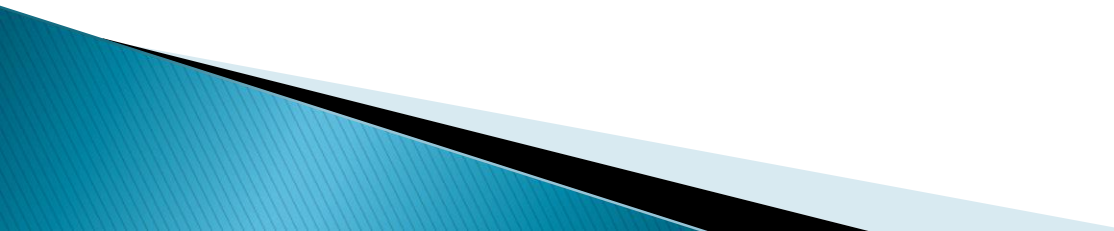
PRESBYOPIA

CATARACT



A

Normal eye

- ▶ **EMMETROPIA**: NORMAL EYE IN WHICH PARALLEL RAYS OF LIGHT FROM INFINITY (DISTANT OBJECT) COME TO FOCUS ON THE RETINA. THERE IS NO ERROR OF REFRACTION.
 - ▶ **AMMETROPIA**: ABNORMAL EYE IN WHICH PARALLEL RAYS OF LIGHT FROM INFINITY DO NOT COME TO FOCUS ON THE RETINA.
- 

ERRORS OF REFRACTION

- ▶ PATHOLOGICAL:

MYOPIA

HYPERMETROPIA

ASTIGMATISM

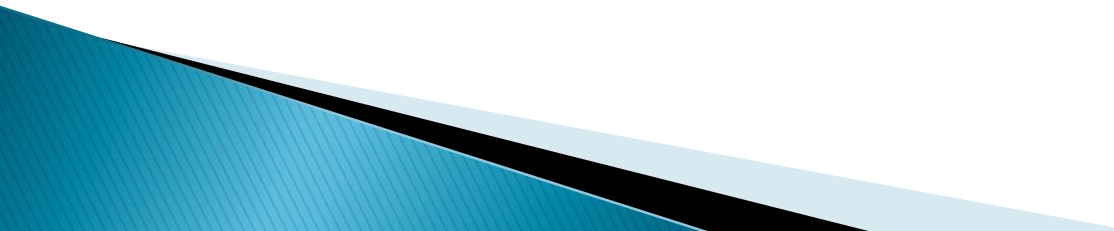
- PHYSIOLOGICAL:

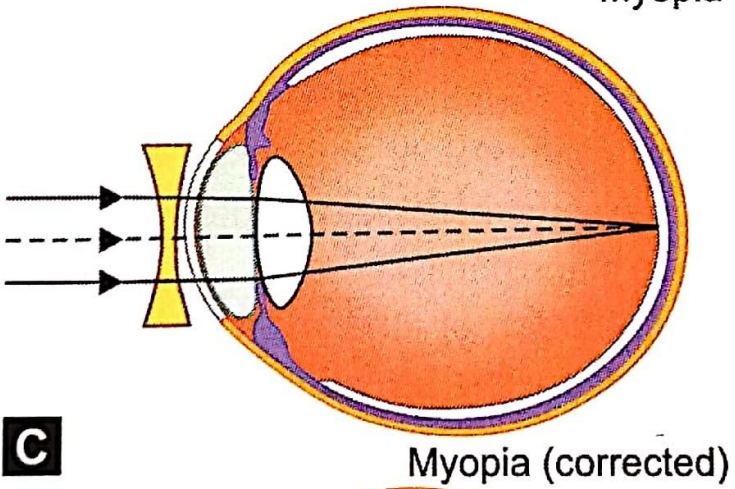
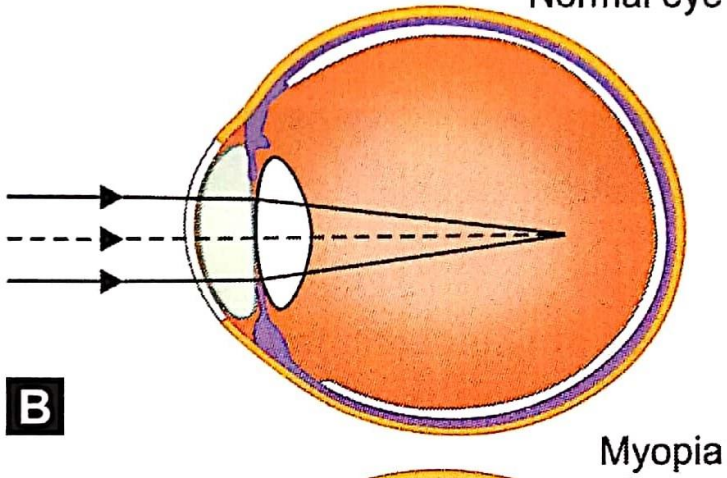
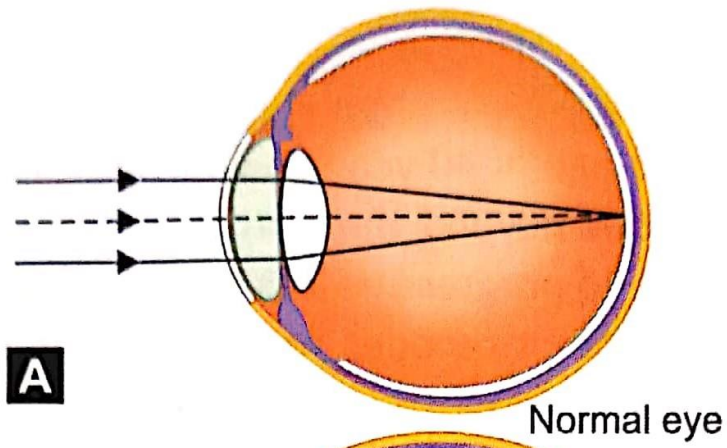
SPHERICAL ABERRATION

CHROMATIC ABERRATION

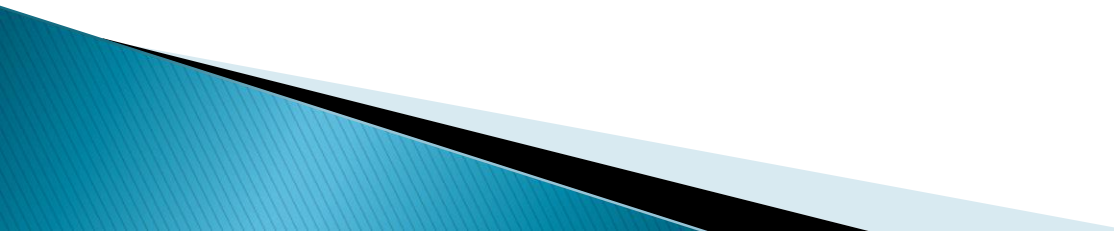
DIFFRACTION

MYOPIA (SHORT SIGHTEDNESS)

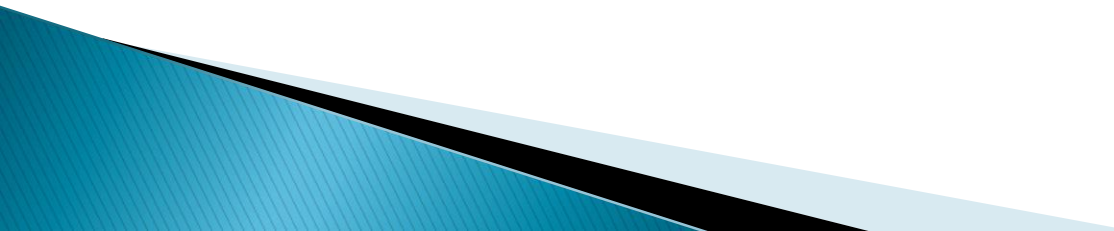
- ▶ DUE TO REFRACTIVE ERROR, PARALLEL RAYS OF LIGHT FROM DISTANT OBJECT COME TO FOCUS IN FRONT OF RETINA.
 - ▶ NEAR OBJECTS APPEAR CLEAR BUT THE DISTANT OBJECTS ARE NOT SEEN CLEARLY.
- 

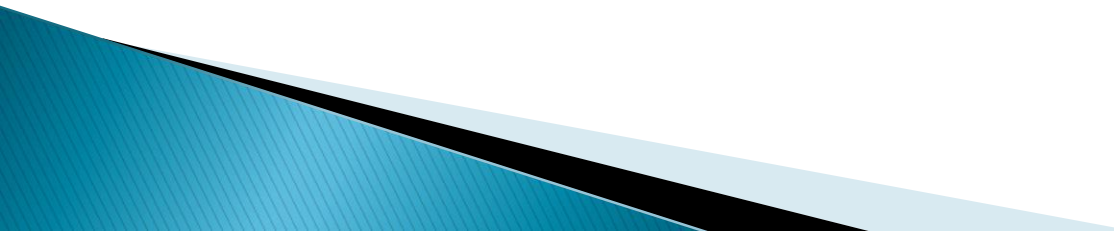


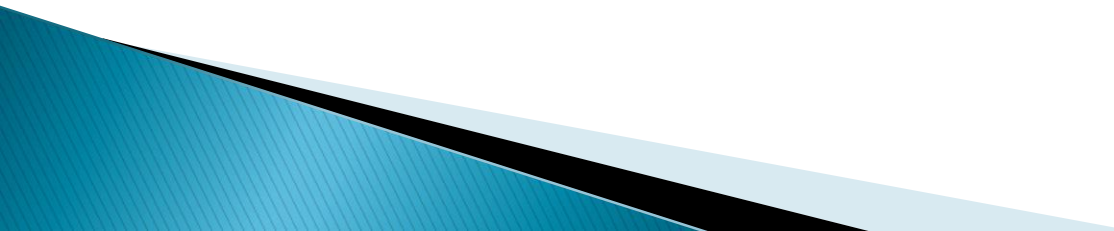
TYPES OF MYOPIA

- ▶ AXIAL MYOPIA: ANTERO POSTERIOR DIAMETER IS MORE THAN NORMAL.
 - ▶ CURVATURE MYOPIA: CURVATURE OF LENS OR CORNEA IS MORE THAN NORMAL.
 - ▶ INDEX MYOPIA: REFRACTIVE INDEX OF MEDIA (PARTICULARLY LENS) IS MORE THAN NORMAL.
- 

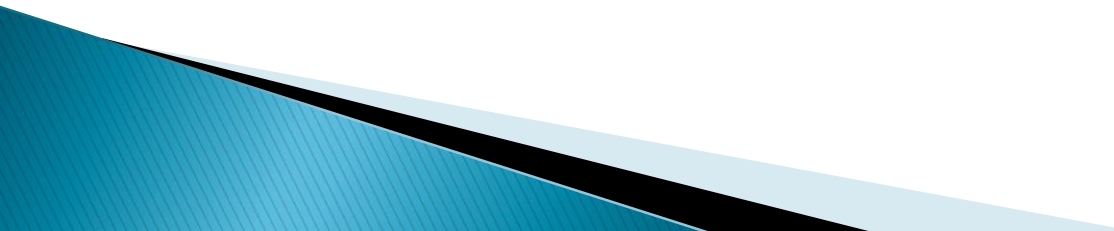
CLINICAL TYPES OF MYOPIA

- ▶ CONGENITAL MYOPIA: PRESENT SINCE BIRTH. UNILATERAL OR BILATERAL.
 - ▶ SIMPLE / DEVELOPMENTAL MYOPIA: COMMONEST. EG IN SCHOOL GOING CHILDREN.
 - ▶ PATHOLOGICAL MYOPIA: RAPIDLY PROGRESSING MYOPIA.
- 

- ▶ FAR POINT: IN MYOPICS THE FAR POINT IS NEARER THAN A NORMAL PERSON.
 - ▶ NEAR POINT: IN MYOPICS NEAR POINT IS NEARER TO THE EYE COMPARED TO NORMAL PERSON. HENCE BETTER NEAR VISION THAN NORMAL.
- 

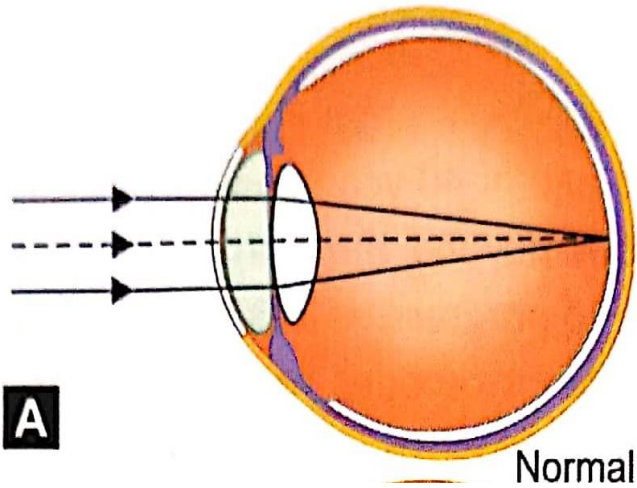
- ▶ **Vitreous degeneration, Retinal holes/
detachment, glaucoma**
 - ▶ **Genetic component play important role**
- 

TREATMENT

- ▶ CONCAVE GLASSES
 - ▶ CONCAVE CONTACT LENS
 - ▶ RADIAL CARRATOTOMY: CORNEA IS CUT.
 - ▶ LASIK
- 

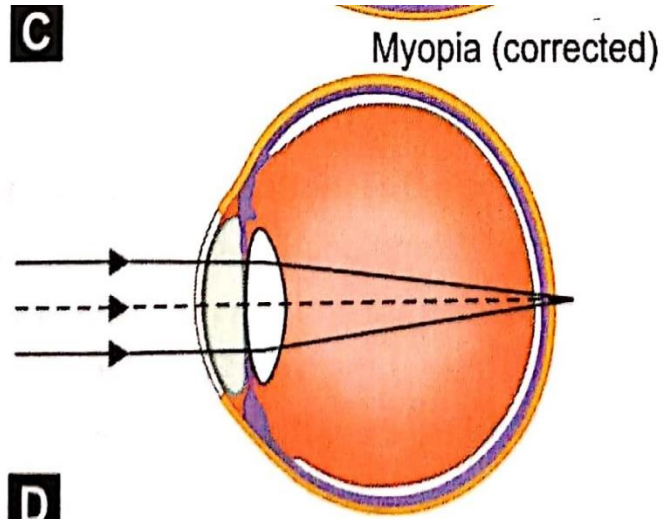
HYPERMETROPIA (LONG SIGHTEDNESS)

- ▶ ERROR OF REFRACTION IN WHICH PARALLEL RAYS OF LIGHT FROM DISTANT OBJECT GET FOCUSED BEHIND THE RETINA.
- ▶ PATIENT CAN SEE DISTANT OBJECTS BY EXERTING ACCOMODATION BUT CANNOT SEE NEAR OBJECTS.
BLURRING OR VISION, HEADACHE, DIPLOPIA DUE TO SQUINT.



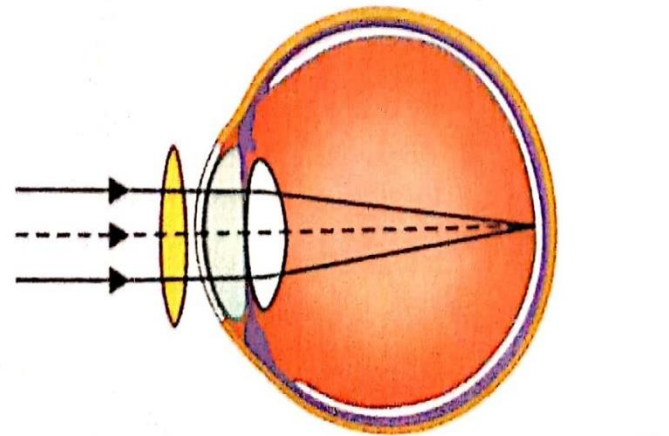
A

Normal eye



D

Hypermetropia

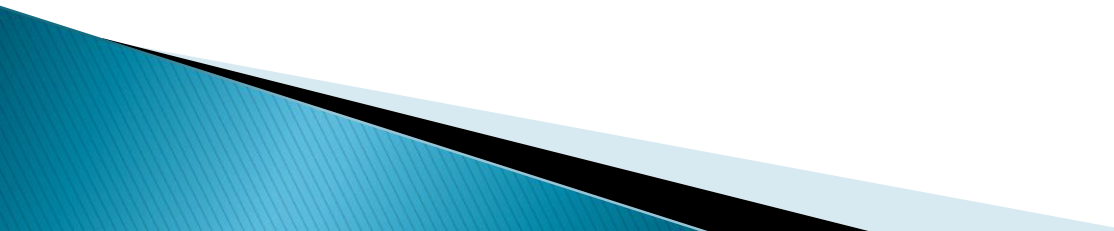


E

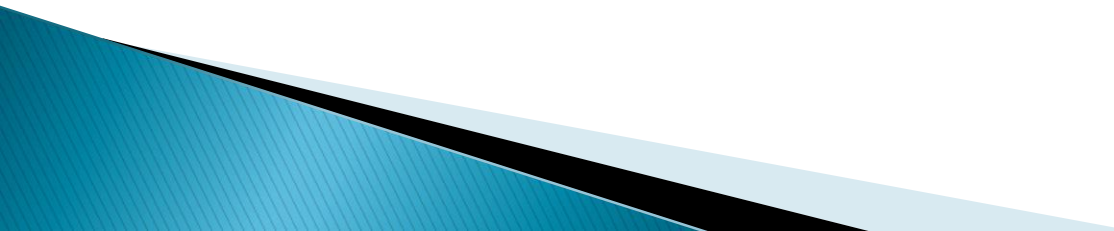
Hypermetropia (corrected)

- ▶ FAR POINT: FAR POINT IS FARTHER THAN NORMAL.
- ▶ NEAR POINT: AWAY FROM THE EYE COMPARED TO NORMAL PERSON.

TYPES OF HYPERMETROPIA

- ▶ AXIAL TYPE: ANTERO POSTERIOR DIAMETER OF EYEBALL IS LESS THAN NORMAL.
 - ▶ CURVATURE TYPE: CURVATURE OF CORNEA OR LENS IS FLATTER THAN NORMAL.
 - ▶ INDEX TYPE: REFRACTIVE INDEX OF LENS IS LESS THAN NORMAL.
- 

CLINICAL TYPES

- ▶ CONGENITAL HYPERMETROPIA: RARE. USUALLY ASSOCIATED WITH MICROPTHALMOS.
 - ▶ SIMPLE OR DEVELOPMENTAL: COMMONEST. A NEWBORN BABY IS HYPERMETROPIC. BUT EYEBALL DOES NOT GROW WITH AGE.
 - ▶ ACQUIRED HYPERMETORPIA: APHAKIA.
- 

TREATMENT

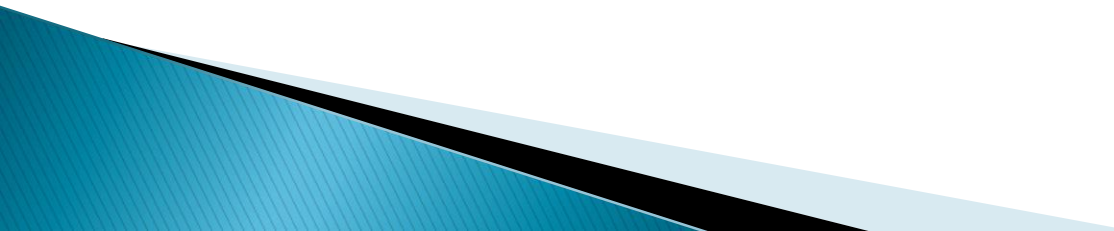
- ▶ CONVEX LENS : GLASSES OR CONTACT LENS.
- ▶ LASIK.

ASTIGMATISM

- ▶ PARALLEL RAYS OF LIGHT FROM INFINITY DO NOT CONVERGE TO A POINT FOCUS DUE TO UNEQUAL REFRACTION IN DIFFERENT MERIDIENS.
COMMONLY ASSOCIATED WITH MYOPIA.

DEFECT IN REFRACTIVE POWER OF LENS ONLY IN ONE PLANE.

CAUSES OF ASTIGMATISM

- ▶ UNEQUAL CURVATURE OF CORNEA OR LENS.
 - ▶ DECENTERING OF LENS DUE TO SHIFTING IN NORMAL POSITION: SUBLUXATION.
- 

Regular astigmatism can be-

i) simple: only one eye is ametropic

ii) compound: both eyes are ametropic

iii) mixed: one eye myopic and the other hyperopic

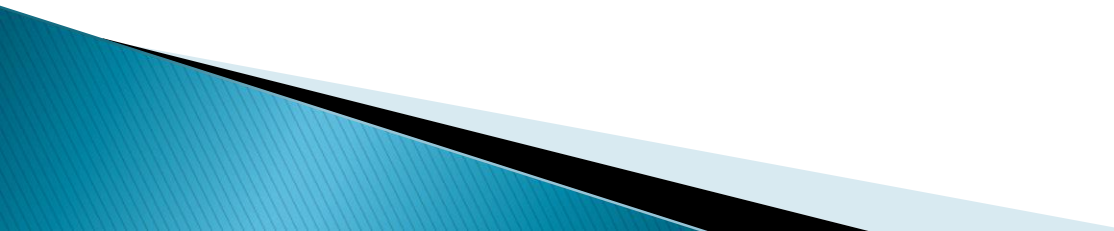
b) Irregular: Any meridian (oblique) may be defective or even same meridian may have different curvatures at different places.

Correction / treatment: Astigmatism can be corrected with **cylindrical lens** (concave or convex) in the defected meridian.

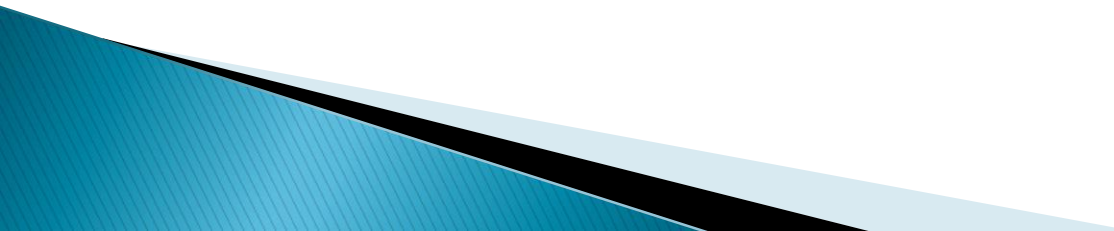
TREATMENT

- ▶ CYLINDRICAL LENS WHICH REFRACTS LIGHT RAYS ONLY IN ONE PLANE.

SPHERICAL ABERRATION

- ▶ REFRACTIVE POWER IN CENTER PORTION OF LENS IS MORE THAN IN PERIPHERAL PART.
 - ▶ HENCE RAYS OF LIGHT FROM PERIPHERAL PORTIONS FALL BEHIND THE RETINA.
 - ▶ VISION IS NOT AFFECTED BECAUSE PERIPHERAL RAYS ARE CUT OFF BY THE IRIS.
- 

CHROMATIC ABERRATION

- ▶ REFRACTIVE POWER OF LENS IS DIFFERENT FOR DIFFERENT COLOURS.
 - ▶ RED LIGHT HAVING LONGER WAVELENGTH IS FOCUSED BEHIND THE RETINA WHEREAS VIOLET LIGHT WITH SHORTER WAVELENGTH ARE FOCUSED IN FRONT OF RETINA AND REMAIN INVISIBLE.
- 

THANK YOU