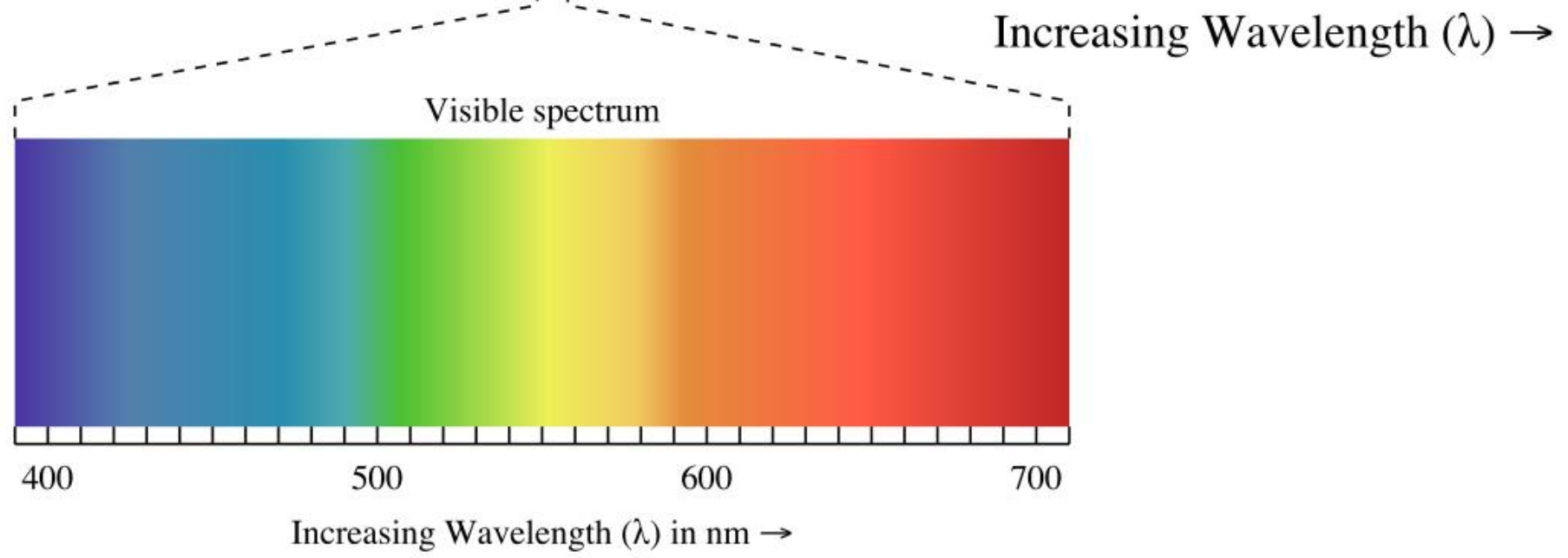
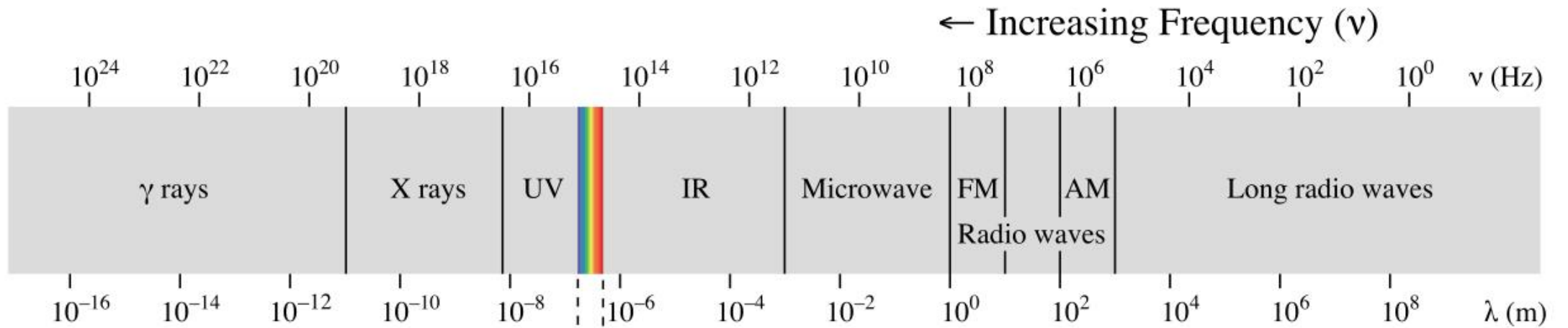


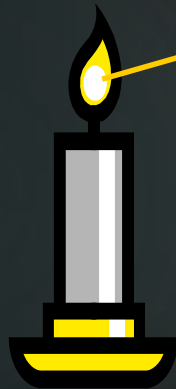
IN THE NAME OF ALLAH

Optics, Refraction and Refractive Errors

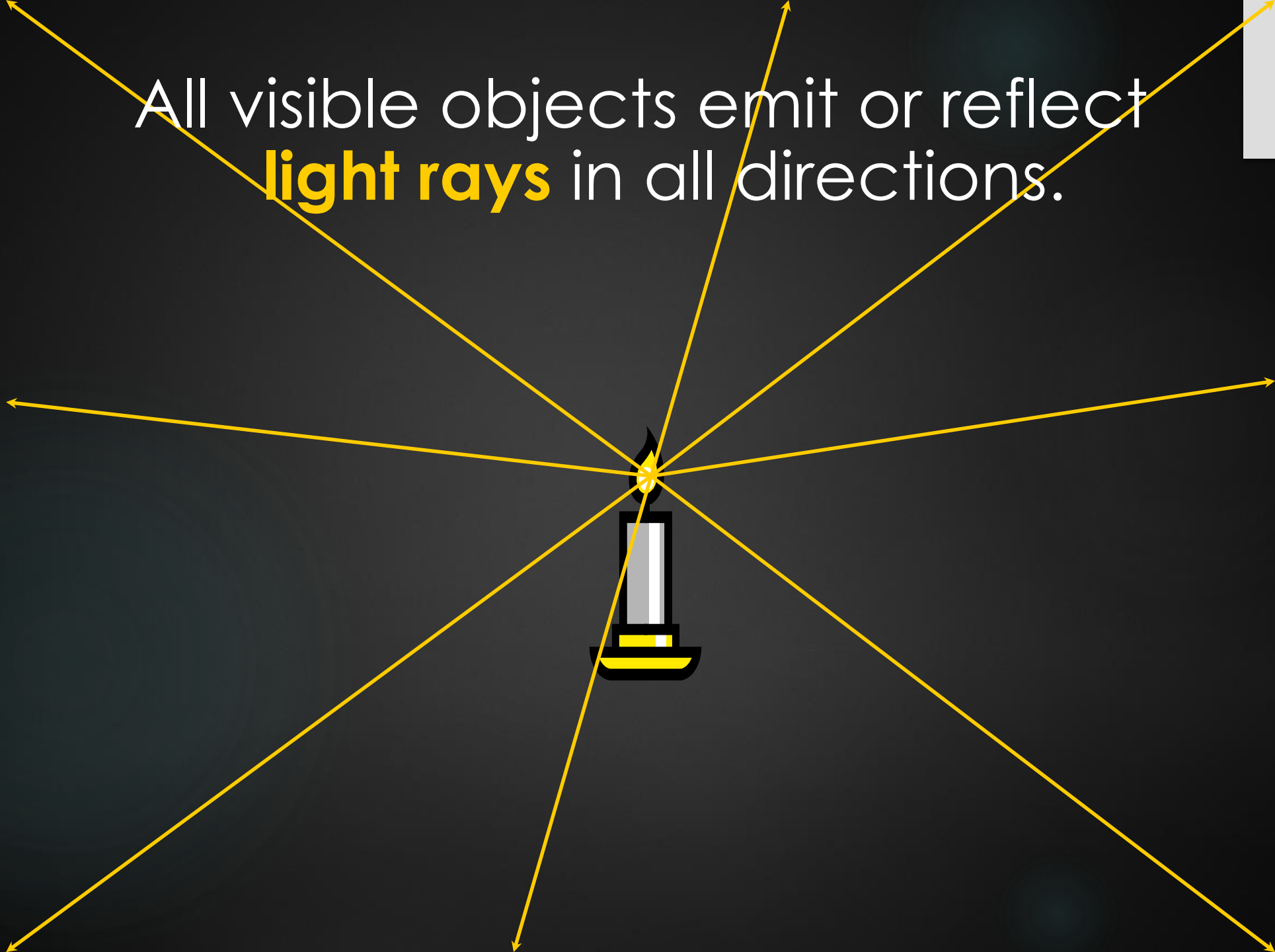
DR M.FEIZI



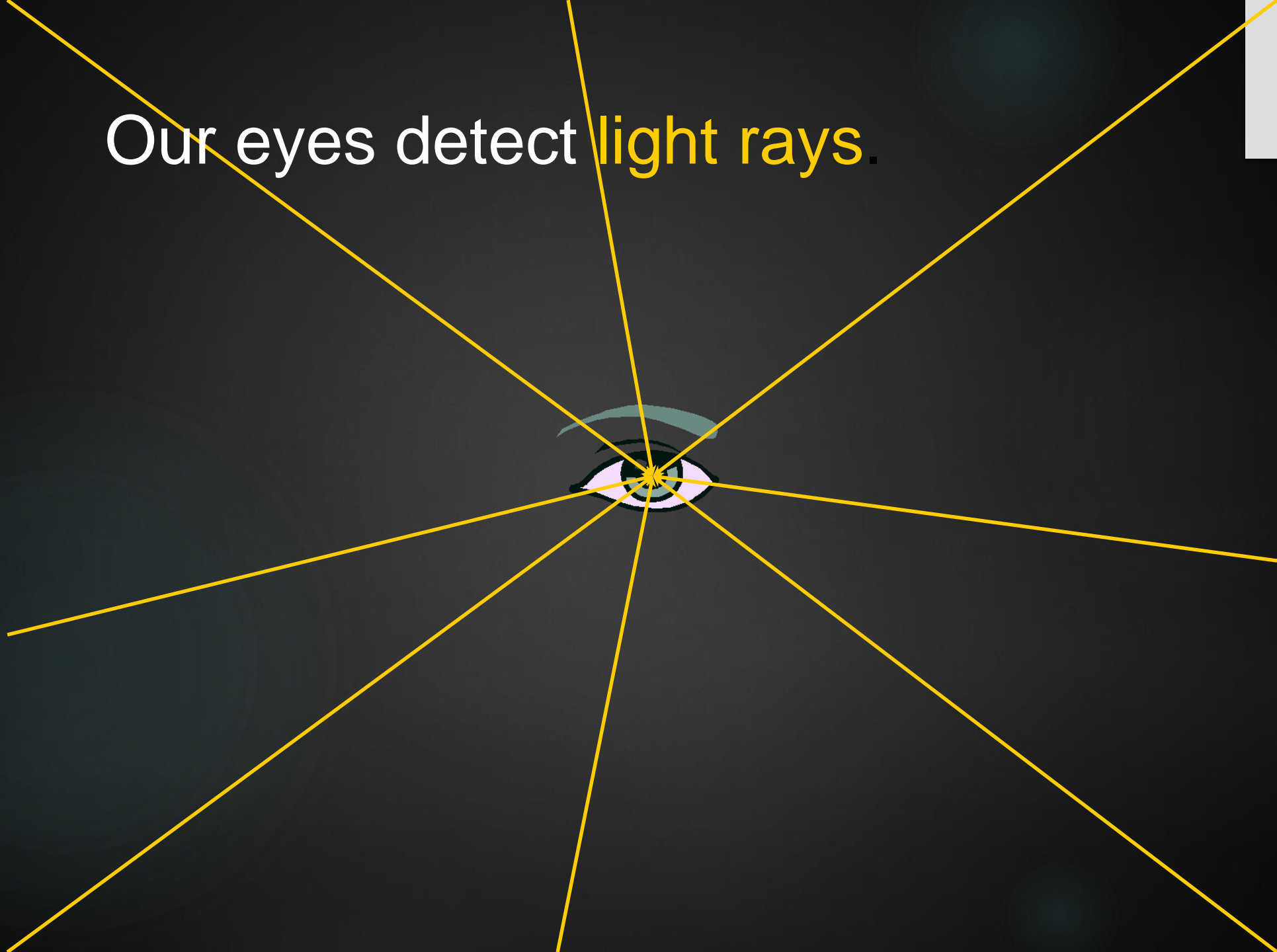
A **ray of light** is an extremely narrow beam of light.



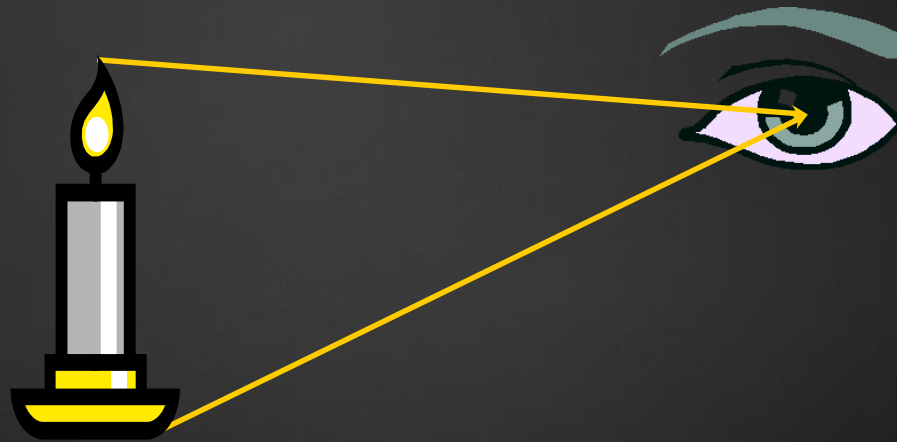
All visible objects emit or reflect
light rays in all directions.



Our eyes detect **light rays**.



Images are formed when
light rays converge.



converge: come together

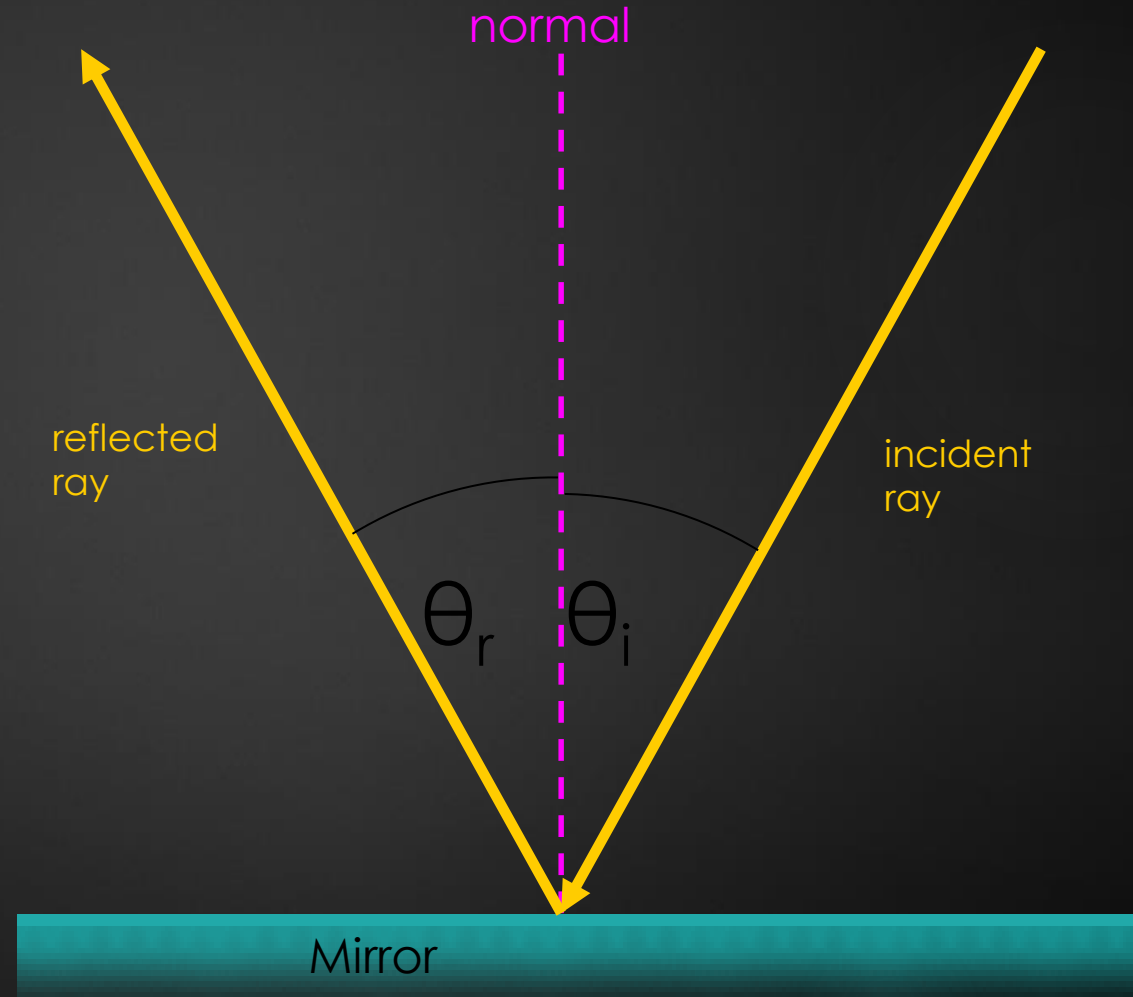
Reflection

(bouncing light)

Reflection is when light changes direction by bouncing off a surface.

When light is reflected off a mirror, it hits the mirror at the same angle (θ_i , the incidence angle) as it reflects off the mirror (θ_r , the reflection angle).

The normal is an imaginary line which lies at right angles to the mirror where the ray hits it

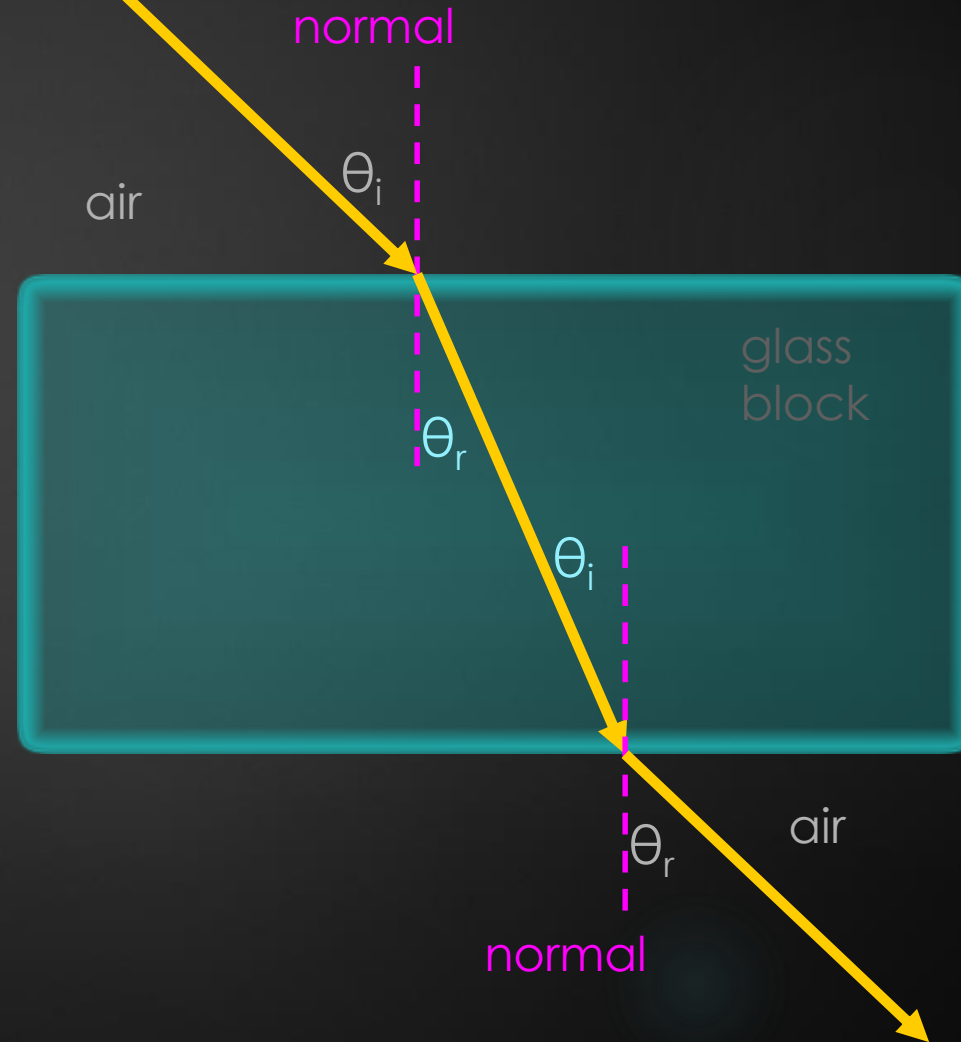


Refraction (bending light)

Refraction is when light bends as it passes from one medium into another.

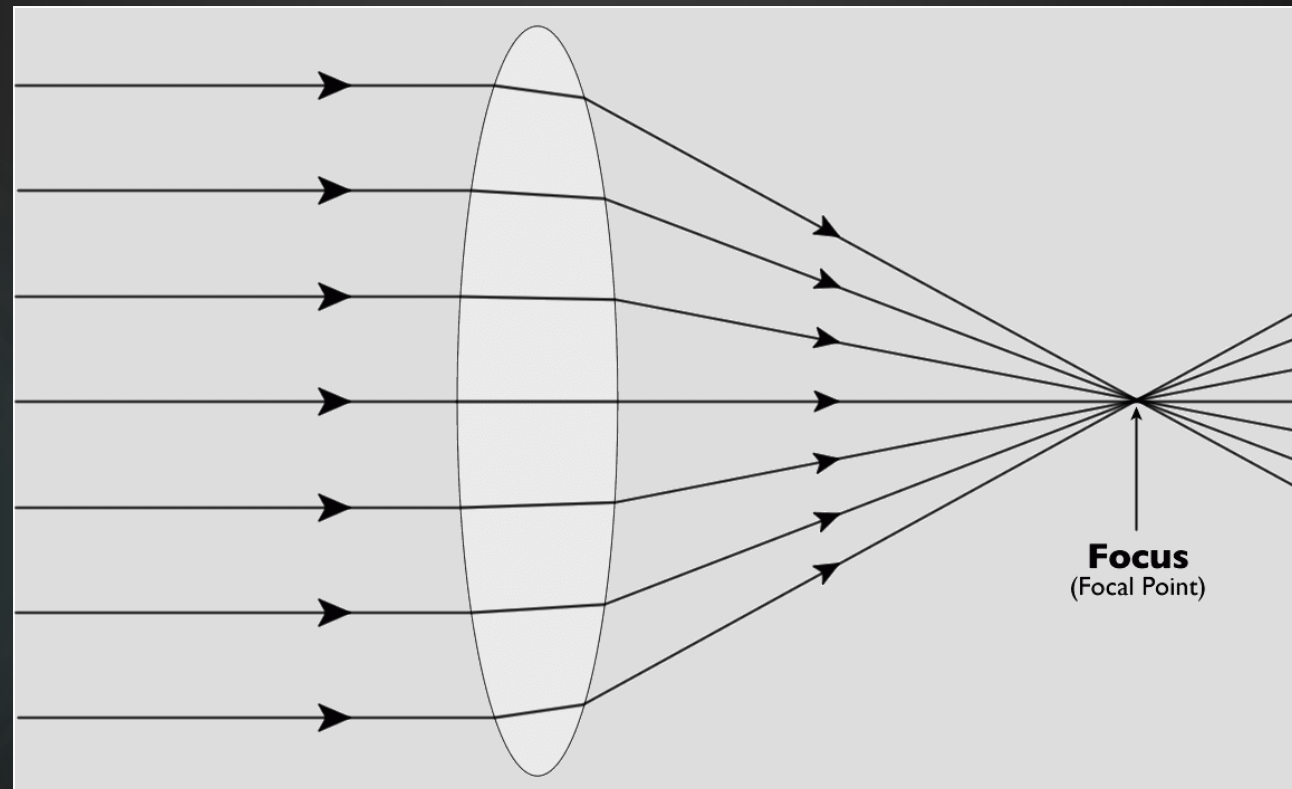
When light traveling through air passes into the glass block it is refracted towards the normal.

Refractive index =
 $\frac{\text{Speed of light in vacuum}}{\text{Speed of light in media}}$



Convex Lenses

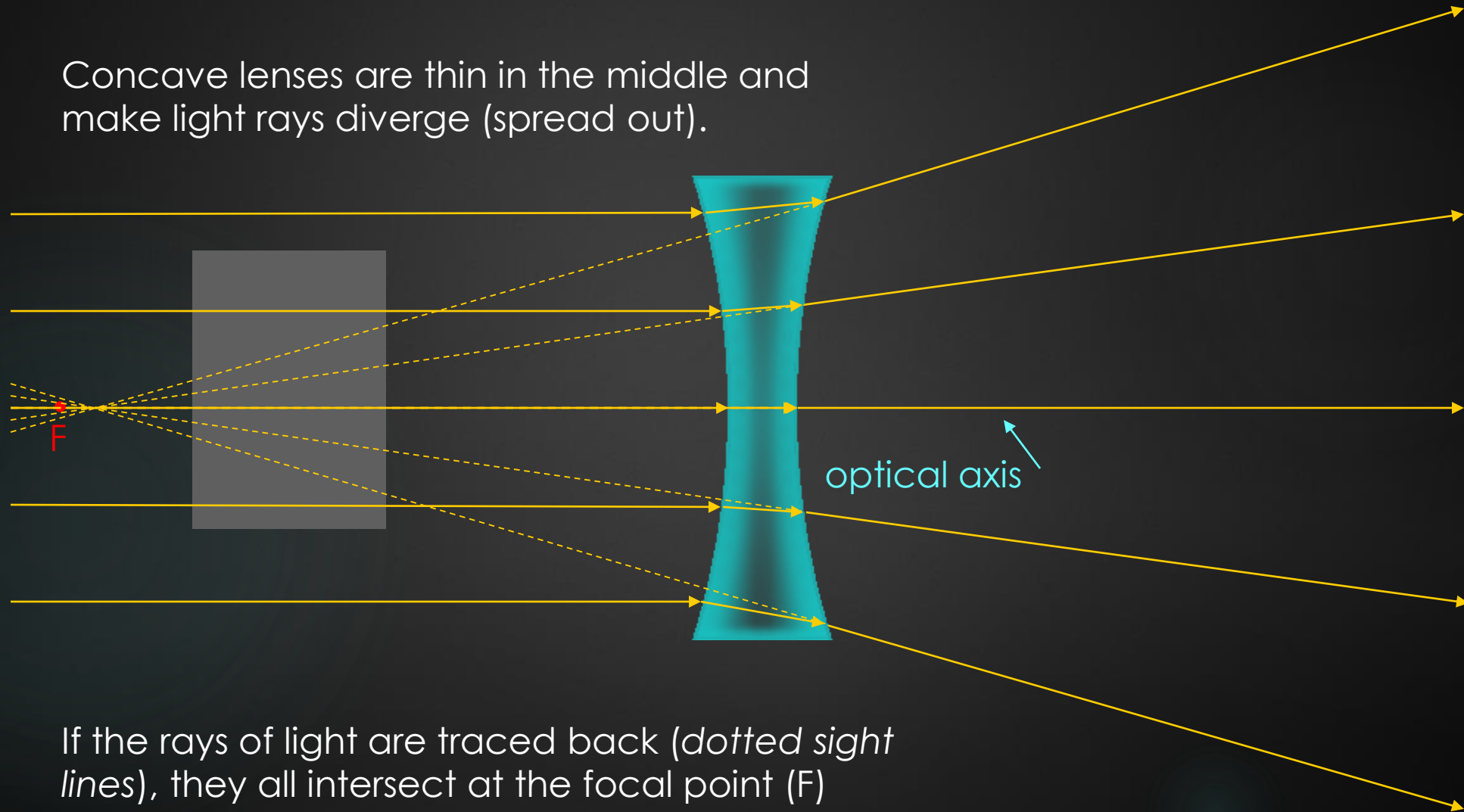
Convex lenses are thicker in the middle and focus light rays to a focal point in front of the lens.



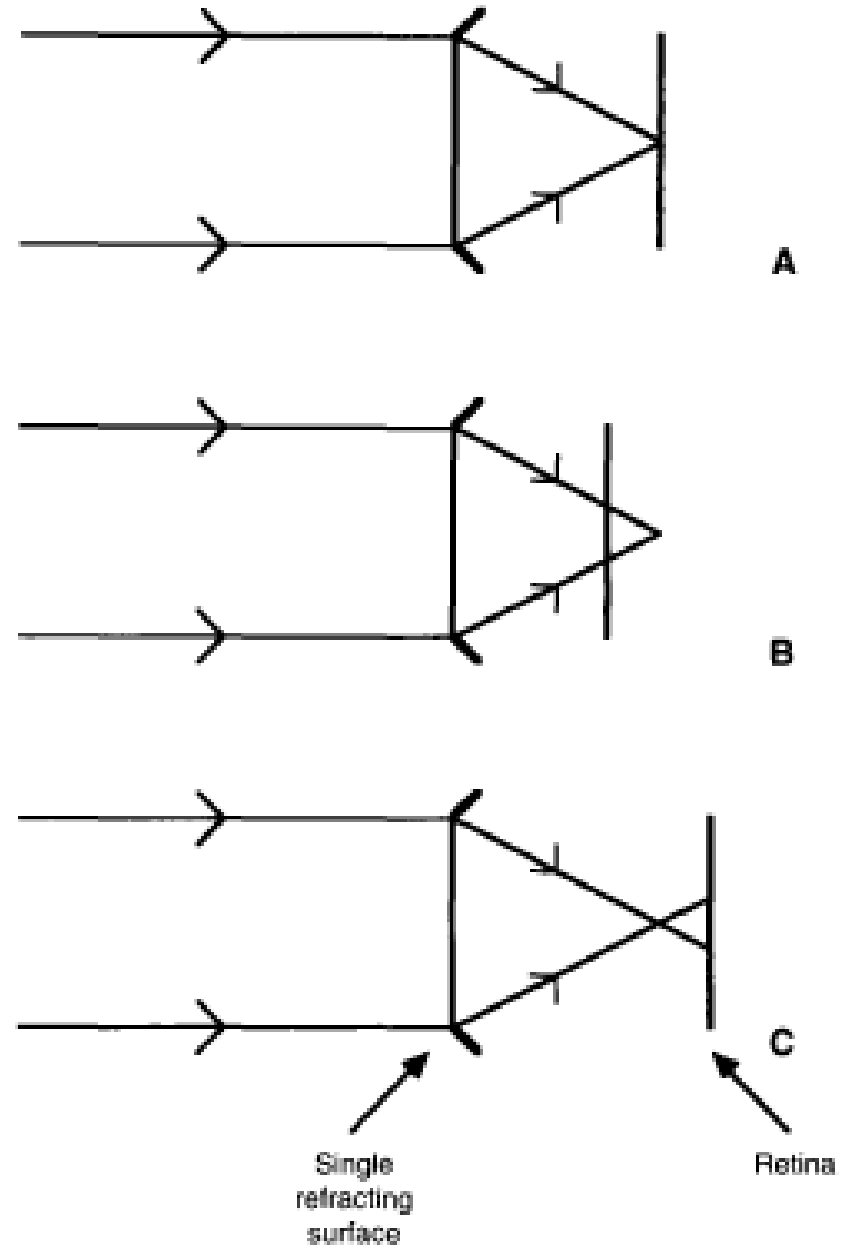
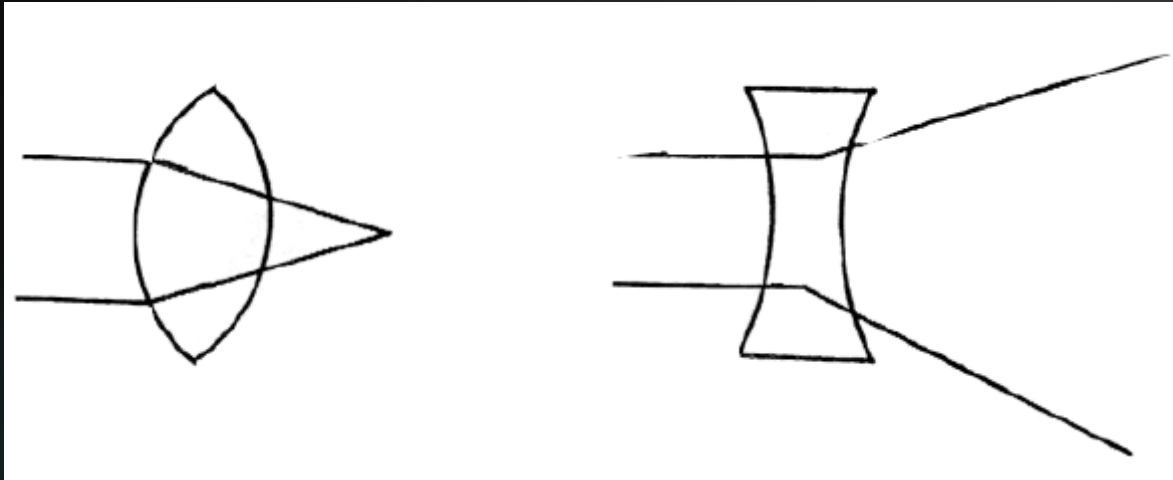
The focal length of the lens is the distance between the center of the lens and the point where the light rays are focused.

Concave Lenses

Concave lenses are thin in the middle and make light rays diverge (spread out).



If the rays of light are traced back (*dotted sight lines*), they all intersect at the focal point (F) behind the lens.



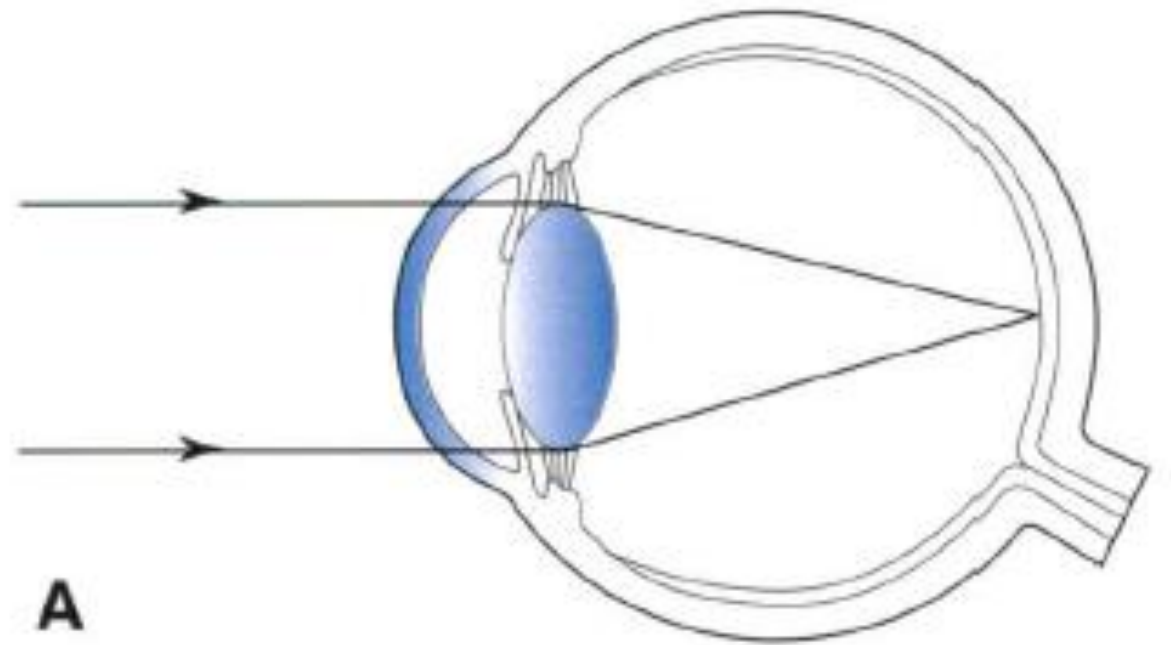
Refractive Errors

- ▶ Emmetropia
- ▶ Ametropia



Emmetropia

- ▶ Emmetropia means no Refractive error
- ▶ It is the ideal condition in which the incident parallel rays come to a perfect focus upon the light sensitive layer of the retina, When accommodation is at rest

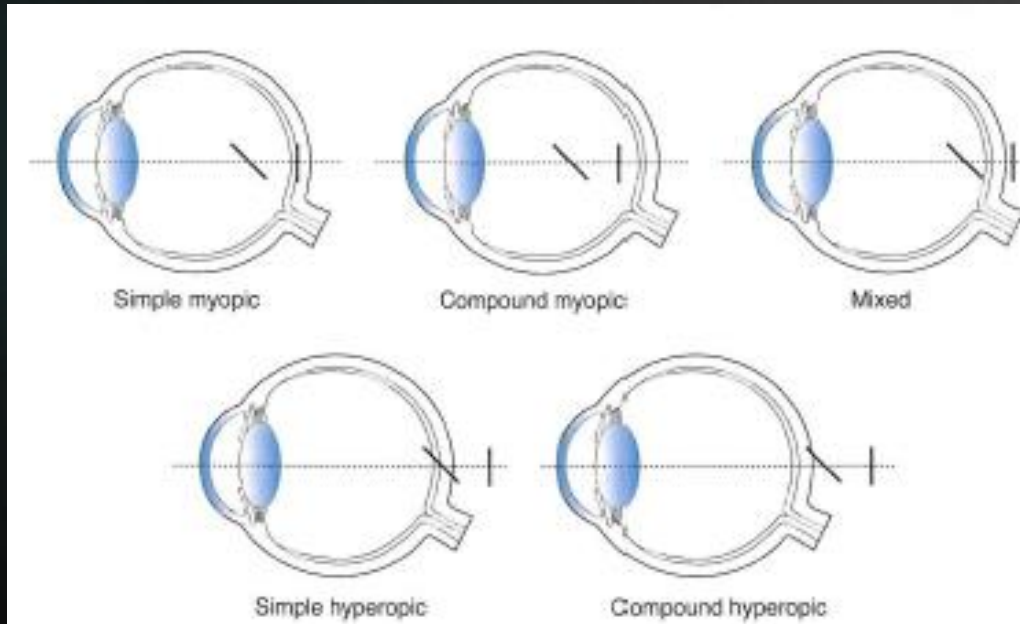
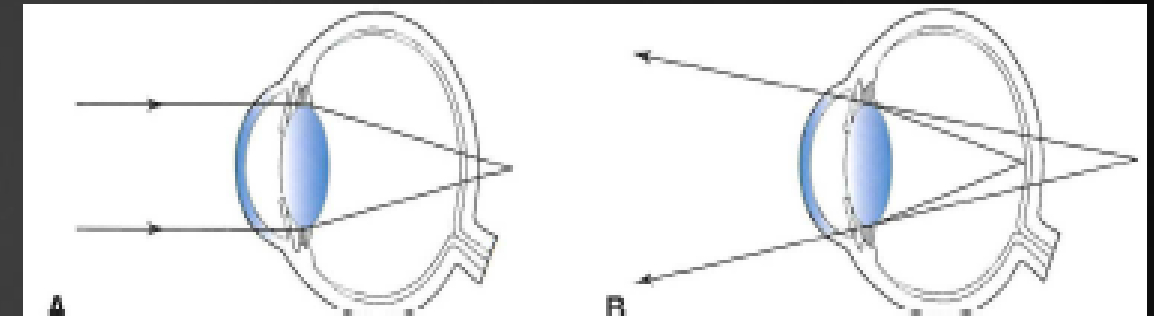
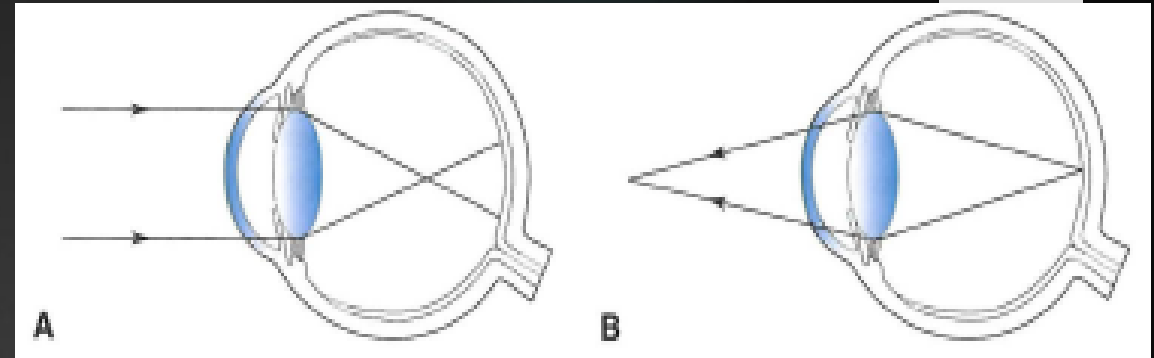


Ametropia

- ▶ Ametropia means Refractive error Eye
- ▶ It is the opposite condition , wherein the parallel rays of light are not focused exactly upon the retina , When the accommodation is at rest

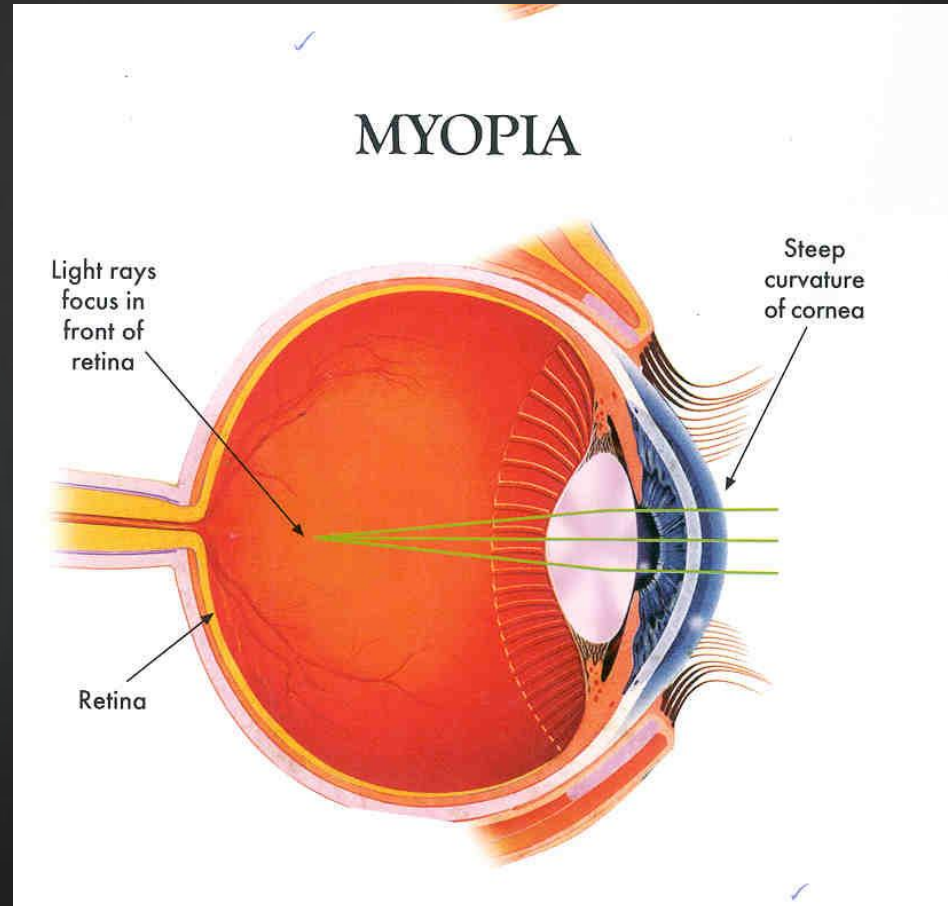
Ametropia

- ▶ Myopia
- ▶ Hypermetropia
- ▶ Astigmatism



Myopia

- ▶ Principal focus is formed in front of the retina



Causes

- ▶ Axial Myopia
- ▶ Curvature Myopia
- ▶ Index Myopia
- ▶ Abnormal position of the lens

Axial Myopia

- ▶ Axial myopia results from increase in anteroposterior length of the eye ball.
- ▶ Normal Axial length- 23mm to 24mm
- ▶ 1mm increase in AL – 3Ds of Myopia

Curvature Myopia

- ▶ Curvatural myopia occurs due to increased curvature of the cornea and Lens or both.
- ▶ Anterior surface of the cornea- 7.8mm
- ▶ Posterior surface of the cornea- 6.5mm
- ▶ 1mm decreases in radius of curvature results in – 6 Ds of Myopia

Index myopia

- ▶ Index myopia results from increase in the refractive index of crystalline lens.

Refractive index of normal Lens - 1.42

Types

- ▶ Congenital myopia
- ▶ Simple Myopia (or) Developmental myopia
- ▶ Pathological Myopia (or) Degenerative myopia
- ▶ Acquired myopia

Congenital myopia

- ▶ Congenital myopia is present since birth however, it is usually diagnosed by the age of 2 – 3 years.

Simple myopia

- ▶ Simple or developmental myopia is the commonest variety. It is considered as a physiological error not associated with any disease of the eye.
- ▶ Power limit less than 6D

Aetiology

- ▶ Axial type of simple myopia
- ▶ Curvatural type of simple myopia

Pathological myopia

- ▶ Myopia associated with degenerative changes in the eye.
- ▶ Myopia more than 6D to 25D or More than 25D

Aetiology

- ▶ Axial growth
 - (i) Heredity
 - (ii) General growth process

Symptoms

- ▶ Poor vision for distance(even near)
- ▶ Asthenopic symptoms
- ▶ Exophoria

Signs

- ▶ Large eye ball
- ▶ deep Anterior chamber
- ▶ sluggish Pupil
- ▶ Large Disc

Complications

- ▶ Retinal tear – Vitreous haemorrhage
- ▶ Retinal detachment
- ▶ Degeneration of the vitreous
- ▶ Primary open angle Glaucoma
- ▶ Posterior cortical cataract
- ▶ Posterior staphyloma

Treatment

- ▶ Optical

 - Spectacle Correction (Concave Lens)

 - Contact lens

- ▶ Surgical

 - PRK

 - Epikeratophakia

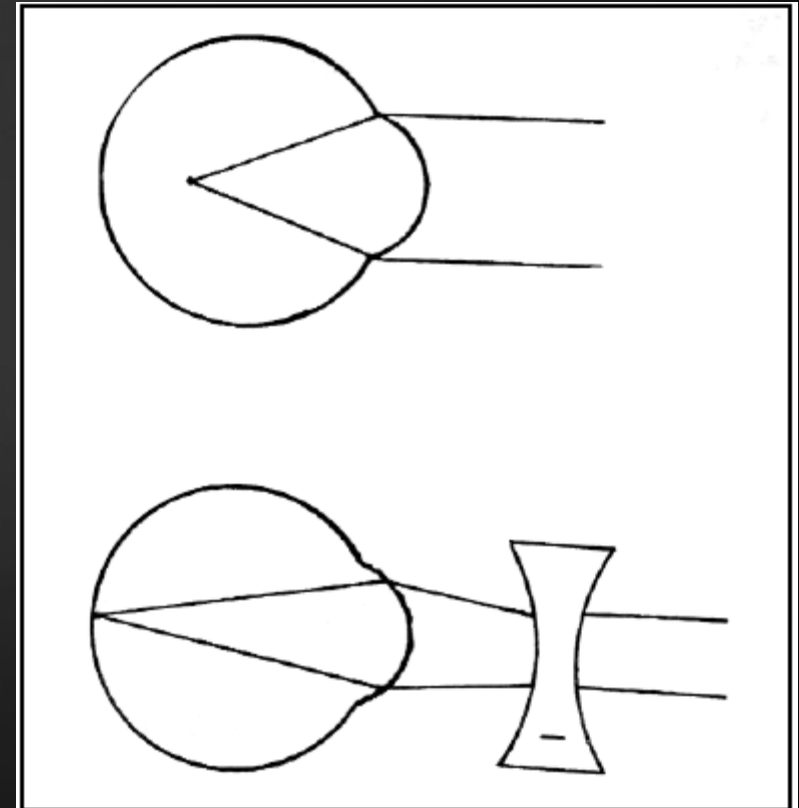
 - Radial Keratotomy

Optical Treatment

- ▶ Concave lens

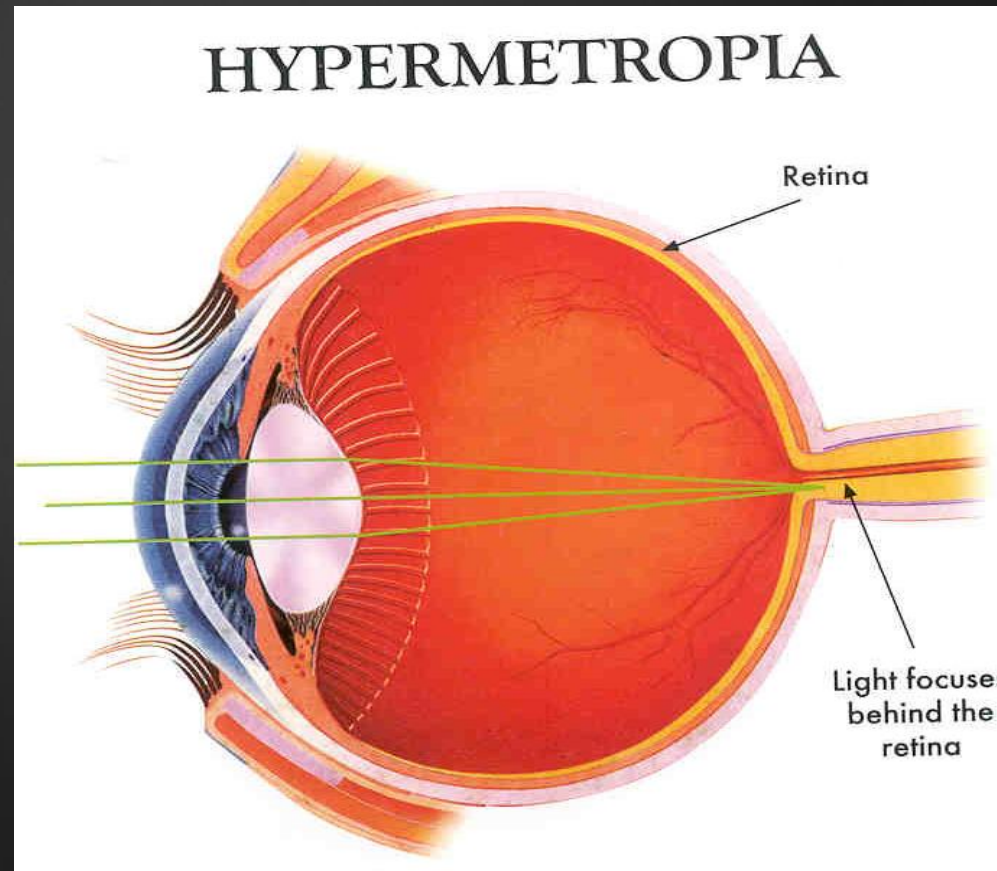
Myopic with Exophoria give full correction.

Myopic with Esophoria give under correction.



Hypermetropia

Principal focus is formed behind the retina



Causes

- ▶ Axial Hypermetropia
- ▶ Curvature Hypermetropia
- ▶ Index Hypermetropia
- ▶ Abnormal position of the lens

Axial Hypermetropia

- ▶ Axial hypermetropia is by far the commonest
- ▶ In fact, all the new-borns are almost invariably hypermetropic (approx, +2.50D) This is due to shortness of the globe, and is physiological.
- ▶ Normal axial length – 23mm to 24mm
- ▶ 1mm decrease in AL – 3Ds of hypermetropia

Curvature Hypermetropia

- ▶ In which the curvature of cornea, Lens or both is flatter than the normal resulting in a decrease in the refractive power of the eye.
- ▶ Anterior surface of the cornea- 7.8mm
- ▶ Posterior surface of the cornea- 6.5mm
- ▶ 1mm increase in radius of curvature results in – 6Ds of hypermetropia

Index Hypermetropia

- ▶ Index hypermetropia occurs due to change in refractive index of the lens in old age. It may also occur in diabetics under treatment.
- ▶ Refractive index of Normal Lens - 1.42

Classification

- ▶ **Total Hypermetropia** may be divided into
 - ▶ (a) Latent Hypermetropia
 - ▶ (b) Manifest Hypermetropia
 - (i) Facultive Hypermetropia
 - (ii) Absolute Hypermetropia

Latent Hypermetropia

- ▶ LH which is corrected physiologically by the tone of ciliary muscle. As a rule latent hypermetropia amounts to only one dioptre. It can be revealed only after atropine cycloplegia.

Manifest Hypermetropia

MH is made up of two components

- ▶ **Facultative hypermetropia** is that part of hypermetropia which can be corrected by the effort of accommodation.
- ▶ **Absolute hypermetropia** which can not be overcome by the effort of accommodation.

Clinical Types

- ▶ Simple hypermetropia
- ▶ Pathological hypermetropia
- ▶ Functional hypermetropia

Simple hypermetropia

- ▶ It results from normal biological variation in the development of the eye ball.
- ▶ It includes Axial and Curvatural HM
- ▶ It may be hereditary.

Pathological hypermetropia

- ▶ PH results due to either congenital or acquired conditions of the eye ball which are out side the normal biological variations of the development.

The Normal Age Variation

- ▶ At birth:- 2D to 3 D Commonly Present
- ▶ At the age of 5 Yrs- 90% of Children's are Hypermetropic
- ▶ At Puberty:- Emmetropic

Symptoms

- ▶ Head ache
- ▶ Blurred vision particular near work
- ▶ Convergent squint
- ▶ Early onset of presbyopia
- ▶ Eye Strain

Complications

- ▶ Eye appears to be small including cornea and anterior chamber becomes shallow
- ▶ Extreme cases – Microphthalmos

Treatment

- ▶ Optical

 - Spectacle (Convex Lens)

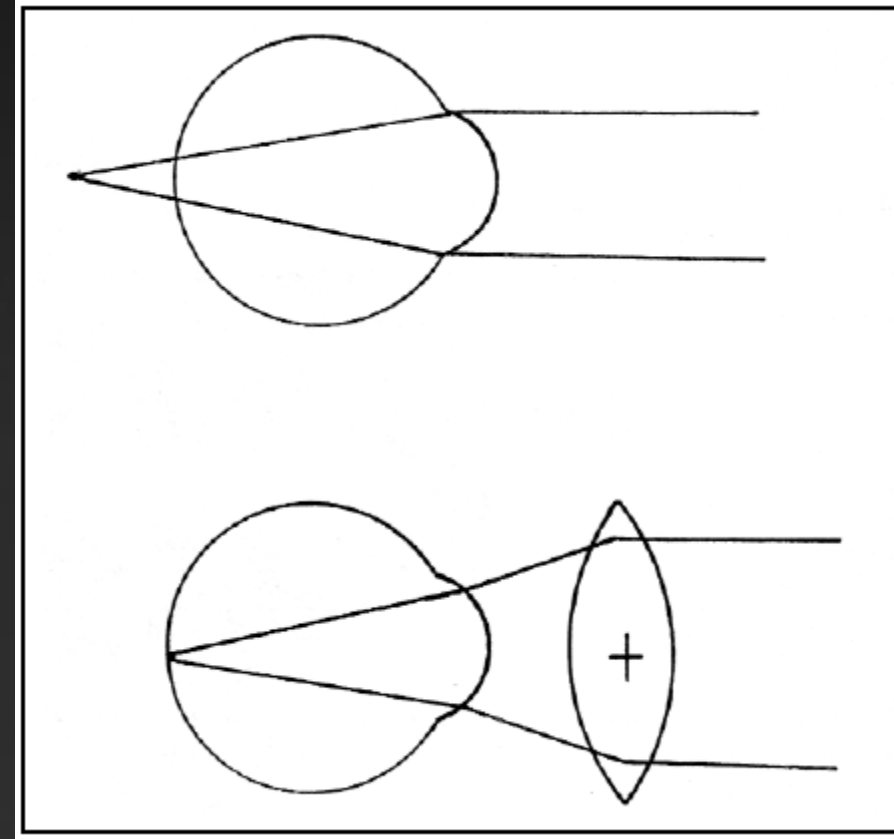
 - Contact lens

 - Hypermetropic with Exophoria give under correction

 - Hypermetropic with Esophoria give full correction

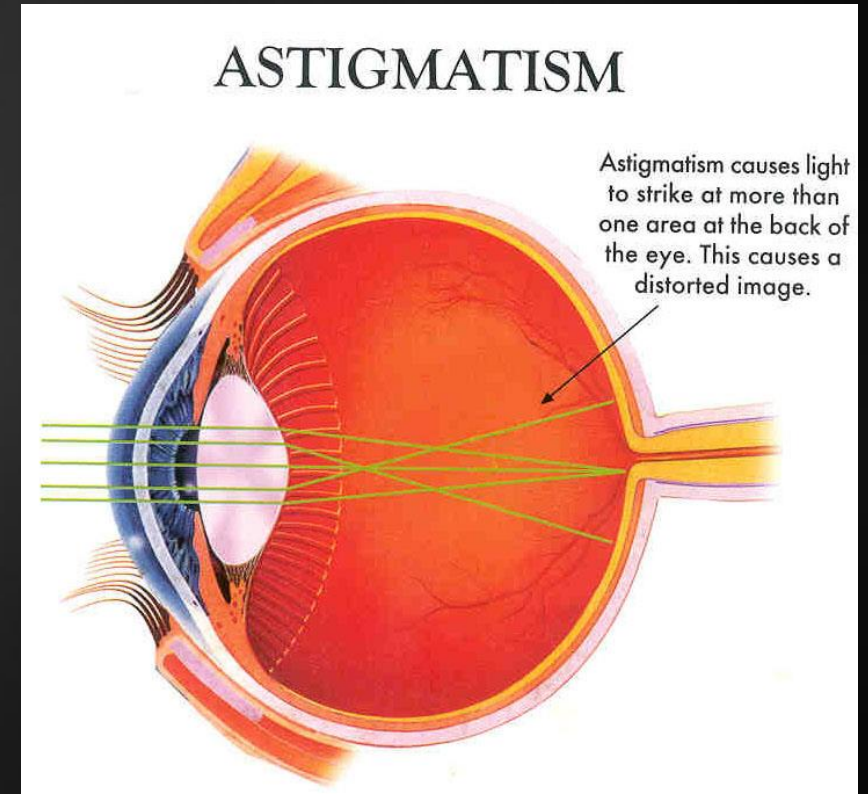
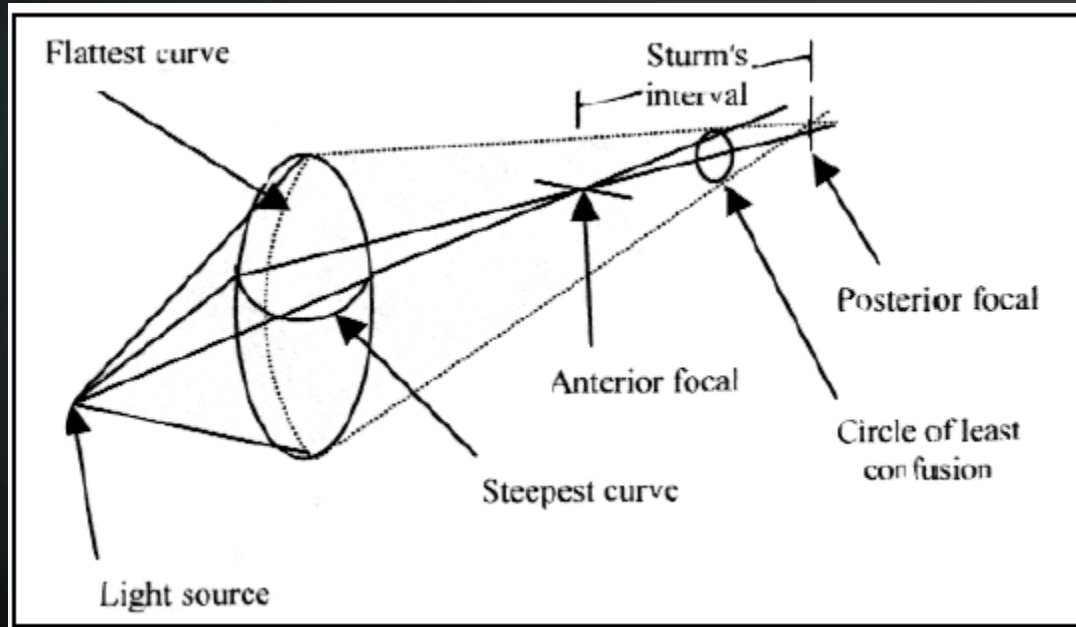
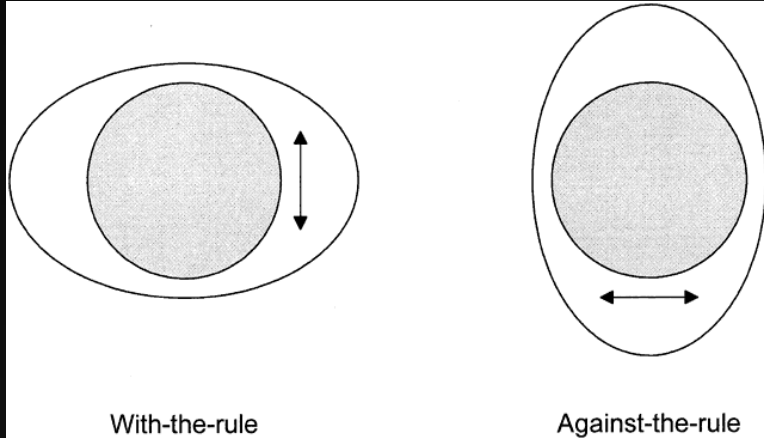
- ▶ Surgical

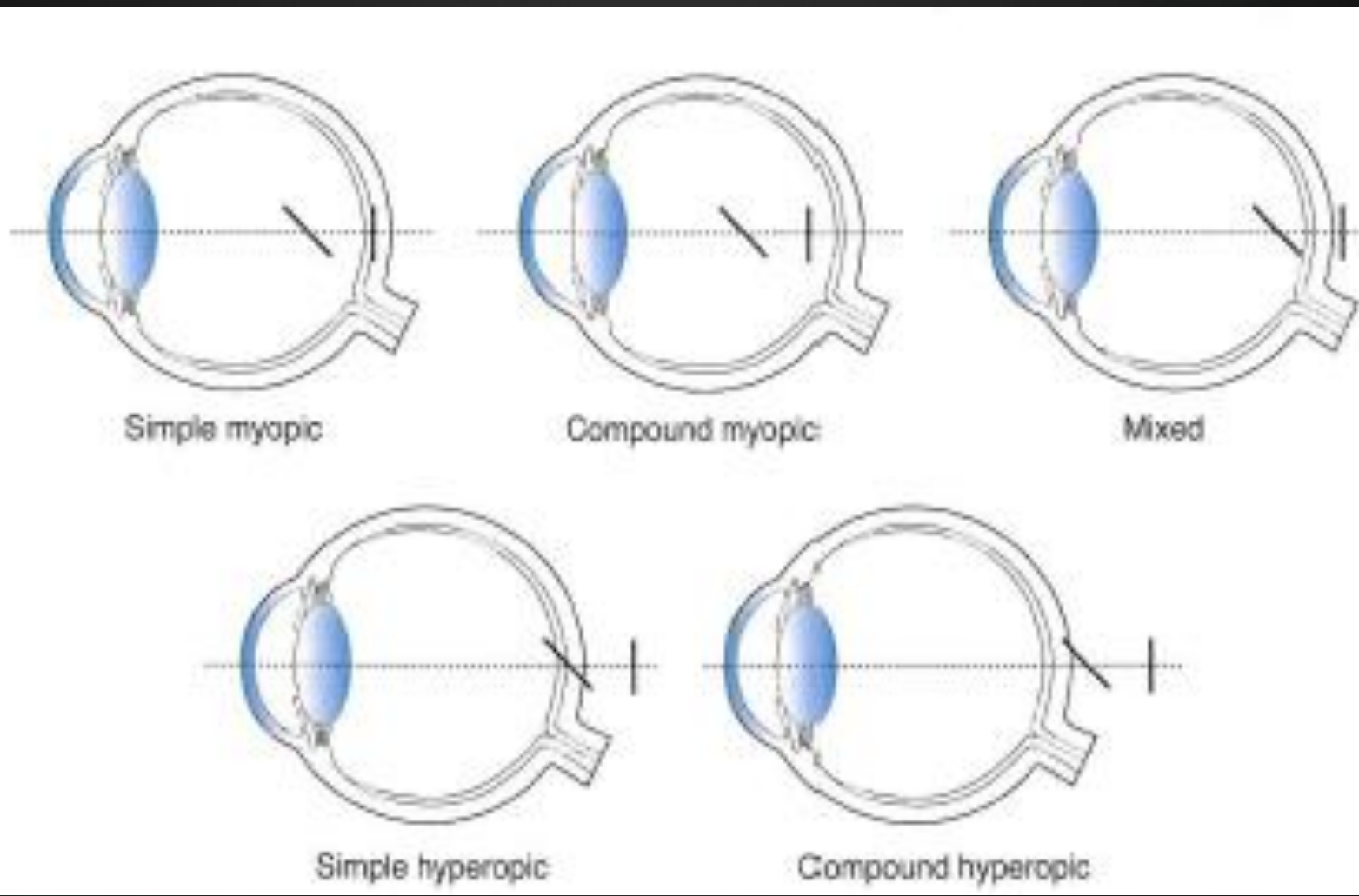
 - Thermokeratoplasty



Astigmatism

Astigmatism is that condition of Refraction where there are two point focus of light





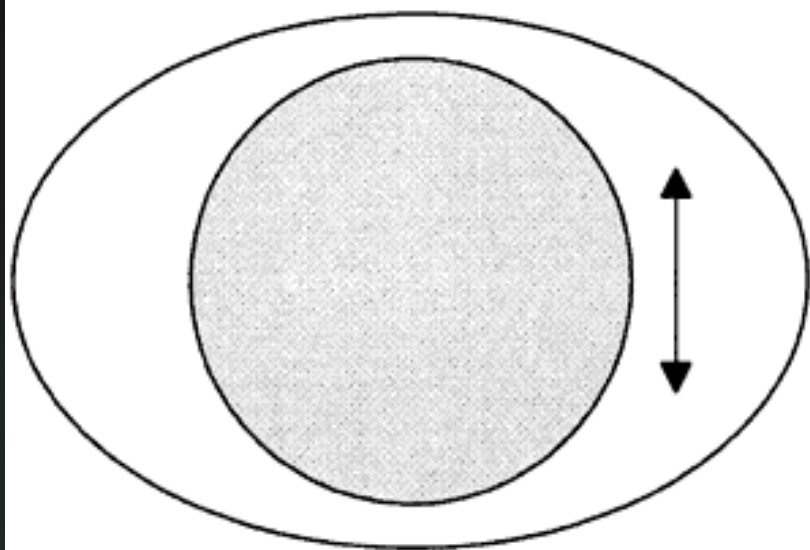
Simple myopic

Compound myopic

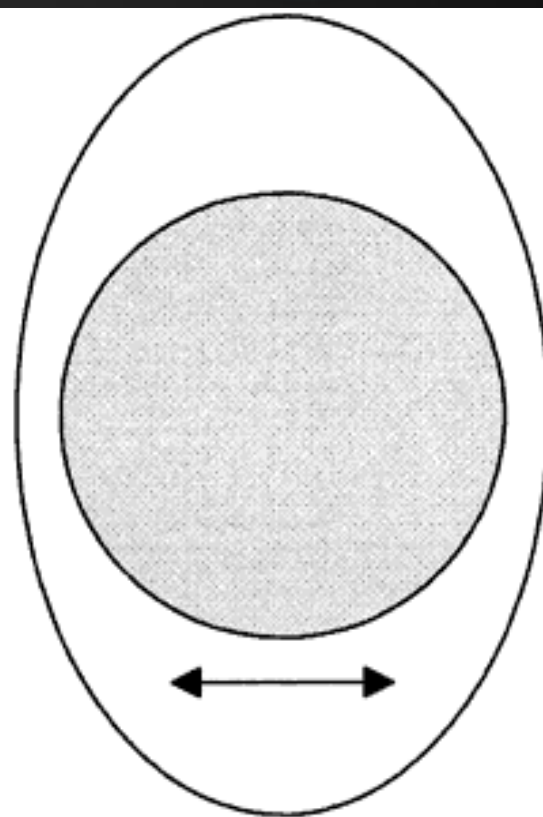
Mixed

Simple hyperopic

Compound hyperopic



With-the-rule



Against-the-rule

Causes

- ▶ **Curvature**
Ex: Keratoconus, Lenticonus etc..
- ▶ **Centering error**
Ex: Sub location of the lens
- ▶ **Refractive index**
Ex: Cataract
- ▶ **Retinal**
Oblique placement of macula

Types

- ▶ Regular
- ▶ Irregular

Regular astigmatism

- ▶ Refractive types
- ▶ Physiological types

Refractive types

- ▶ Simple astigmatism
- ▶ Compound astigmatism
- ▶ Mixed astigmatism

Physiological types

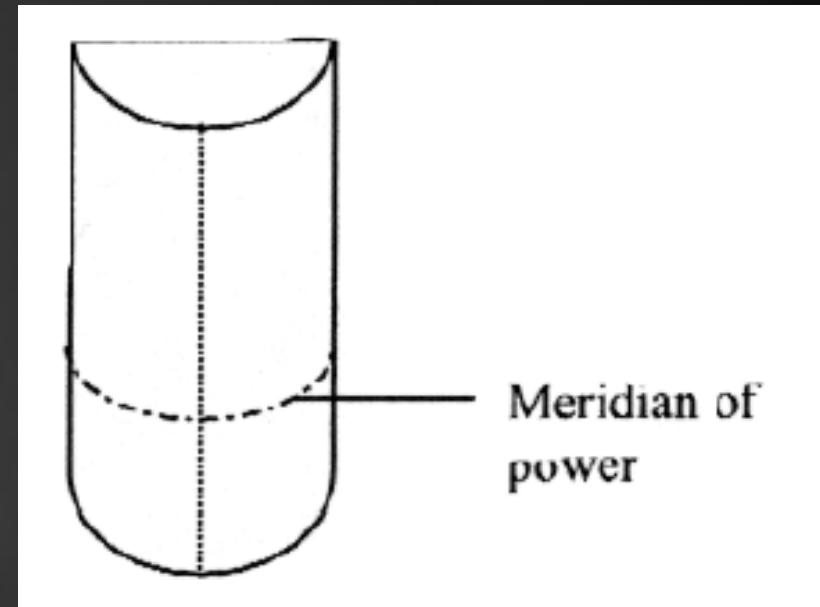
- ▶ With rule astigmatism
- ▶ Against rule astigmatism
- ▶ Oblique astigmatism

Symptoms

- ▶ Head ache
- ▶ Blurring of vision
- ▶ Eye tired
- ▶ Eye ache
- ▶ Head Tilt
- ▶ Half-closure of the lids (High astigmatism)
- ▶ Blurring & Itching (Low astigmatism)

Treatment

- ▶ Optical Treatment
 - * Cylindrical lens
 - * Under correction
 - * Contact lens (RGP, Toric)
- ▶ Refractive surgery
 - * Astigmatic Keratotomy
 - * PRK, LASIK



Study Reports

▶ Percentage of astigmatism

* 0.25-0.50D 50%

* 0.75-1.00D 25%

* 1.00-4.00D 24%

* >4.00D 1%

▶ Percentage of Types

* with rule 38%

* Against rule 30%

* Oblique 32%

Presbyopia



- ▶ This is a physiological aging process, In which the near point gradually recedes beyond the normal reading or working distance

Causes

- ▶ Lens matrix is harder and less easily moulded
- ▶ Lens capsule is less elastic
- ▶ Progressive increase in size of the lens
- ▶ Weakening of the ciliary muscle

Symptoms

- ▶ Patient holds the book at arms length
- ▶ Patient prefers to read in bright light
- ▶ Eye strain
- ▶ Head ache
- ▶ Eyes feels tired and ache

Treatment

Convex lens

Methods of prescription

- * Occupation
- * Working distance
- * Age

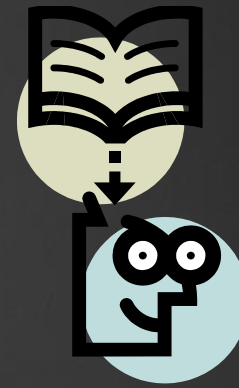
Surgical

- * Anterior ciliary sclerotomy
- * Laser thermal keratoplasty
- * Small diameter corneal inlays



Aphakia

- ▶ Aphakia means absence of the Crystalline lens from the Eye ball



Causes

- ▶ Congenital
- ▶ Surgery
- ▶ Traumatic

Optics of Aphakia

- ▶ Anterior focal distance – 23mm (N-15mm)
- ▶ Posterior focal distance- 31 mm (N-24mm)
- ▶ The Nodal point of the eye is thus moved forward
- ▶ Strong converging (convex) lens- +10D

Signs

- ▶ **Anterior chamber – Deep**
- ▶ **Iris**
 - (i) **Iridodonesis (or) Tremulousness**
 - (ii) **Peripheral button-hole iridectomy mark**
- ▶ **Pupil - Jet black reflex**
- ▶ **Retinoscopy – reveals high hypermetropia and astigmatism**

Disadvantages

- ▶ Image magnification of about 25-30%
- ▶ Roving ring scotoma (The scotoma extends from 50° - 65° from central fixation)
- ▶ Restriction of the visual field
- ▶ Coloured vision
- ▶ Inaccurate spectacle correction because of erroneous vertex distance

Treatment

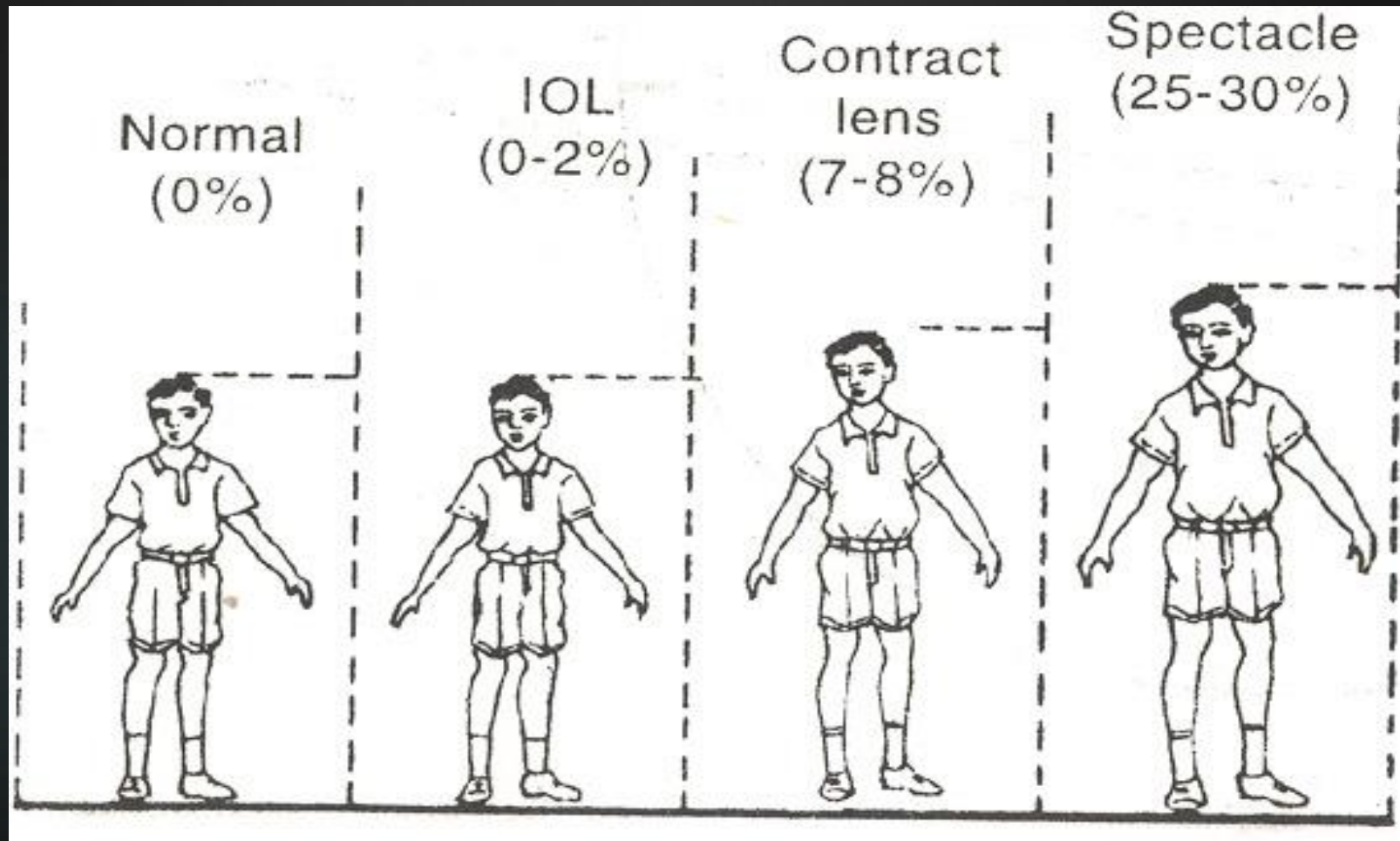
- ▶ Spectacle (Convex lens)
- ▶ Contact lens
- ▶ Secondary IOL
- ▶ Epikeratophakia
- ▶ Keratophakia

Pseudophakia

- ▶ Pseudophakia means False lens



Image magnification



Advantages

- ▶ Image magnification is only 0- 2%
- ▶ Minimum (or) No Anisokonia with rapid return of binocularity
- ▶ Normal Peripheral field
- ▶ Freedom from handling of the optical devices
- ▶ Cosmetically it is well accepted

Disadvantages

- ▶ Risks and complications may be more
- ▶ Initially, the cost is more
- ▶ PCO
- ▶ CME
- ▶ IOL related complications

Thank “U”