







OSheet

✓Slide

⊖Handout

Number

9

Subject

The Eye: I. Optics of Vision

Doctor

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The Eye: I. Optics of Vision

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Objectives

- Describe the visual receptors
- □ List the types of lenses and recognize how they work
- Determine the power of lenses
- Describe accommodation for near vision and far vision
- Recognize nearsightedness and farsightedness and determine its correction
- Describe visual acuity and its abnormalities
- Determine intraocular pressure and glaucoma

Refractive Index

- Speed of light in air 300,000 km/sec.
- Light speed decreases when it passes through a transparent substance.
- The refractive index is the ratio of the speed of light in air to the speed of light in the substance.
- #e.g., speed of light in substance = 200,000 km/sec, R.I. = 300,000/200,000 = 1.5.

Refraction of Light

- Bending of light rays by an angulated interface with different refractive indices.
- The degree of refraction increases as the difference in R.I. increases and the degree of angulation increases.
- The features of the eye have different R.I. and cause light rays to bend.
- These light rays are eventually focused on the retina.

Light Refraction



(b) Viewing distant object



University of Jordan



(a) Superior view of transverse section of right eyeball



Refractive Principles of a Lens

Convex lens focuses light rays (converging lens)



Refractive Principles of a Lens

Concave lens diverges light rays (diverging lens)



Spherical Lens

(Focal points)

Cylindrical Lens (Focal line)





The Refractive Power of a Lens



Focusing Power of the Eye

- Most of the refractive power of the eye results from the surface of the cornea.
 - #a diopter is a measure of the power of a lens
 - I diopter is the ability to focus parallel light rays at a distance of 1 meter, it is a measure of power of lenses
 - Diopter = 1/ focal length in meters i.e the power of a lens with focal length 0.5 meter is 2 (more convex)
 - the retina is considered to be 17 mm behind the refractive center of the eye
 - therefore, the eye has a total refractive power of 59 diopters (1000/17)

Image formation on the retinarequirements

- Light refraction or bending the light by the refractive media – Cornea, Aqueous humor, Lens and Vitreous humor. Cornea contributes around 42 diopters out of the total of 60 for all media.
- Accommodation: An increase in the curvature of the lens for near vision,
 - The near point of vision is the minimum distance from the eye an object can be clearly focused with maximum accommodation
- Constriction (meiosis) and dilation (Mydriasis) of the pupil
- Convergence and divergence of the eyes for binocular vision

Accommodation

- #Refractive power of the lens is 20 diopters.
- Refractive power can be increased to 34 diopters by changing shape of the lens - making it fatter (more convex).
- This is called accommodation.
- Accommodation is necessary to focus the image on the retina.
- Ormal image on the retina is upside down.

Mechanism of Accommodation

- + A relaxed lens is almost spherical in shape.
- Lens is held in place by suspensory ligament which under normal resting conditions causes the lens to be almost flat.
- Contraction of an eye muscle attached to the ligament pulls the ligament forward and causes the lens to become fatter (more convex) which increases the refractive power of the lens.
- Under control of the parasympathetic nervous system.

Mechanism of Accommodation



Contraction pulls ligament forward relaxing tension on suspensory ligament making the lens fatter







Presbyopia; The Inability to Accommodate

Caused by progressive denaturation of the proteins of the lens.

- Hakes the lens less elastic.
- Begins about 40-50 years of age.

Errors of Refraction



Correction of Vision

Myopia corrected with concave lens



Hyperopia corrected with convex lens

Errors of Refraction



(a) Normal (emmetropic) eye





Other Errors of Vision

Astigmatism

unequal focusing of light rays due to an oblong shape of the cornea

cloudy or opaque area of the lenscaused by coagulation of lens proteins

Visual Acuity Test

The diameter of the cones in the fovea is $\sim 1.5 \ \mu m$



Visual Acuity: depends on the density of receptors (primarily Cones)

₽6/6

 \oplus ability to see letters of a given size at 6 meters \oplus 6/12

+ what a normal person can see at 12 meters, this person must be at 6 meters to see.

⊕ 6/60

+ what a normal person can see at 60 meters, this person must be at 6 meters to see.

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Fluid System of the Eye

Intraocular fluid keeps the eyeball round and distended.

⊕2 fluid chambers:

aqueous humor which is in front of the lens
freely flowing fluid
vitreous humor which is behind the lens
gelatinous mass with little flow of fluid

Formation and Flow of Fluid in the Eye





Formation of Aqueous Humor

 Produced by the ciliary processes of the ciliary body at a rate of 2-3 microliters/min.

Flows between the ligaments of the lens, through the pupil into the anterior chamber, goes between the cornea and the iris, through a meshwork of trabeculae to enter the *canal of schlemm* which empties into aqueous veins and then into extraocular veins.

Intraocular Pressure

- + Normally 15 mm Hg with a range of 12-20 mm Hg.
- The level of pressure is determined by the resistance to outflow of aqueous humor in the canal of Schlemm.
 - increase in intraocular pressure caused by an increase in resistance to outflow of aqueous humor through a network of trabeculae in the canal of schlemm (Glaucoma)
 can cause blindness due to compression of the
 - axons of the optic nerve

Thank You

