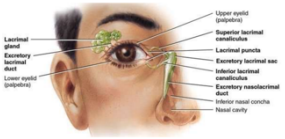
Sereen Draghmeh

Vision 1

Protective mechanisms in the eye

- Several mechanisms help protect the eyes from injury:
  - Except for its anterior portion, the **eyeball** is **sheltered** by the **bony socket** in which it is positioned.
  - The **eyelids** act like **shutters** to **protect** the **exposed part of the eye** from environmental insults. They **close reflex** to **cover** the **eye** under **threatening circumstances**
  - **Eyelashes trap fine**, **airborne debris** such as dust before it can fall into the eye.



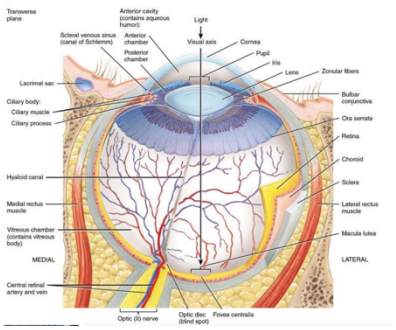
Tears

- **Frequent spontaneous blinking** of the **eyelids** helps **disperse** the **lubricating**, **cleansing**, **bactericidal tears**.
  - Due to their **antimicrobial properties**
- **Tears** are **produced continuously** by the **lacrimal gland** in the **upper lateral corner under the eyelid**.
- This **eye-washing fluid flows** across the **anterior surface of the eye** and **drains into tiny canals** in the **medial corner of each eye**, **eventually emptying** into the **back of the nasal passageway**.
- This **drainage system cannot handle** the **profuse tear production during crying**, so the **tears overflow** from the **eyes**.

Layers

- **Eye** is a **spherical**, **fluid-filled** structure **enclosed by three layers** (From outermost to innermost):
  - (1) the **sclera**/**cornea**.
    - Sclera
      - **Important** to **maintain** the **spherical structure**
      - **As you go anteriorly** its stops being called the sclera and is **now called** the **cornea**
      - **White in colour**
    - Cornea
      - **Transparent** so that the **light rays** can **reach the photoreceptors** on the retina
        - Since its **transparent** its **avascular**
        - **Gets nutrients** from the **aqueous humor released** by **ciliary processes**
      - There are **pain receptors here**

- (2) the **choroid/ciliary body/iris**.
  - Choroid
    - **Highly vascular** to give **blood supply to the retina**
    - **Pigmented** to **absorb light** and **prevent** the **scattering** of the **light**
    - As we go **anteriorly** the **choroid becomes specialized** to form the **ciliary body and iris**
  - Ciliary body
    - **made up** of **ciliary muscles** and **processes**
  - Iris
    - **Pigmented** and **muscular** (smooth muscles)
    - The **smooth muscles contract** and **relax affecting** the **size** of the **pupil**
      - These **smooth muscles** are **stimulated via** the **autonomic nervous system**
    - We have **two muscles** in the **iris**
      - **Circular muscles** (**inner**)
        - When **contraction occurs** here they will cause **pupil constriction** (Circular muscle Contraction Cause Constriction of the pupil)
        - **Innervated** by the **parasympathetic stimulation** of the autonomic nervous system
      - **Radial muscles** (**outer**)
        - When **contraction** occurs here it will cause **pupil dilation**
        - Innervated by the **sympathetic stimulation** of the autonomic nervous system



- (3) the **retina**.
  - Has **two layers**
    - The **pigmented layer**
      - To **prevent** the **scattering** of **light**
    - The **nervous layer**
      - **Contains** the **photoreceptors**

Sclera and cornea

- Most of the **eyeball** is **covered by** a **tough outer layer** of **connective tissue**, the **sclera**, which **forms** the **visible white part** of the **eye**.
- **Anteriorly**, the **outer layer consists** of the **transparent cornea**, through **which light rays** pass **into** the **interior of the eye**.

Choroid

- The **middle layer underneath** the **sclera** is the **highly pigmented choroid**, which **contains many blood vessels** that **nourish** the **retina**.

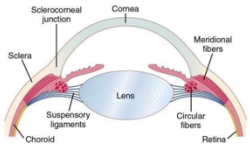
- The **choroid layer becomes specialized anteriorly** to **form** the **ciliary body** and **iris**.
- the **pigment** in the **choroid** and **retina absorbs light after** it **strikes** the **retina** to **prevent reflection** or **scattering** of **light within** the **eye**.

Retina

- The **innermost coat under** the **choroid** is the **retina**, which **consists** of an **outer pigmented layer** and an **inner nervous-tissue** layer.
- The **nervous layer contains** the **rods** and **cones**, the **photoreceptors** that **convert light energy** into **nerve impulses**.

Lens

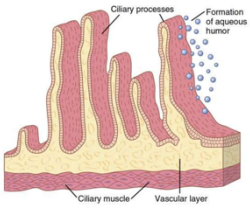
- There are **two types of lenses**:
  - Convex
    - The **lens** in **our body** is **convex**
    - The **curve is external**
  - Concave
    - The **curve** is internal
- The **lens** is **avascular since** its **transparent** (the **same goes** for the cornea)
- The **interior** of the **eye consists** of **two fluid-filled cavities**, **separated** by a **lens**, all of which are **transparent** to **permit light** to **pass through** the **eye** from the **cornea to** the **retina**.
  - We have **two fluids in the eye**
    - **Anterior** to the **lens**: **aqueous humor**
      - **Gives nutrition** to **cornea and** lens
      - The **aqueous humor** is **released by** the **ciliary processes**
    - **Posterior** to the **lens**: **vitreous** humor



- about **70 suspensory ligaments attach radially around the lens**, **pulling** the **lens edges toward** the **outer circle of** the **eyeball**.
  - **These suspensory ligaments** are **thin transparent fibers** that **attach** the **ciliary body** to the **lens capsule**
- These **ligaments** are **constantly tensed** by **their attachments** at the **anterior border** of the **choroid and retina**.
- The **tension** on the **ligaments causes** the **lens** to **remain relatively flat under** normal **eye conditions**.

Cataract

- "**Cataracts**" are an **especially common eye abnormality** that **occurs mainly** in **older people**.
- A **cataract** is a **cloudy or opaque area** (or areas) in the lens.
- In the **early stage** of **cataract formation**, the **proteins** in **some of** the **lens fibers become denatured**.
- **Later**, **these same proteins coagulate** to **form opaque areas** in **place of** the **normal transparent protein fibers**.

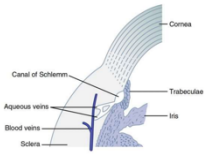


Intraocular fluid

- The **aqueous humor** is a **freely flowing fluid**, **whereas** the **vitreous humor**, **sometimes called** the **vitreous body**, is a **gelatinous mass held together by** a **fine fibrillar network composed primarily** of **greatly elongated proteoglycan molecules**.
- **Aqueous humor** is **continually being formed** and reabsorbed.
- **Aqueous humor** is **formed almost entirely** as an **active secretion by** the epithelium of the ciliary **processes**.
- The **balance between formation** and **reabsorption** of **aqueous humor regulates** the **total volume** and **pressure of the intraocular fluid**

Aqueous humor

- The **anterior cavity between** the **cornea and** the **lens contains** a **clear**, **watery fluid**, the **aqueous humor**.
- The **aqueous humor carries nutrients for** the **cornea and lens**, **both** of **which lack** a **blood supply**. **Blood vessels** in **these structures** would **impede** the **passage** of **light** to the **photoreceptors**.
- The **aqueous humor** is **produced at a rate of about 5 mL/day** by a **capillary network** within the **ciliary body**.
- This **fluid drains** into a **canal at the edge** of the **cornea** and **eventually enters** the **blood**.

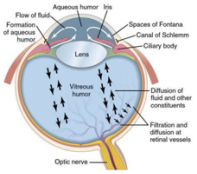


  - There is an **angle between the iris and the cornea** which **contains** a **special structure called** the **trabeculae** which **has pores** for the **reabsorption of** the **aqueous humor** to **reach** the **canal of Schlemm** which **contains aqueous veins to go to the blood veins**
  - So **overall** its **reabsorbed** to the **venous circulation**
- **If** the **aqueous humor** is **not drained as rapidly as it forms**, the **excess accumulates** in the **anterior cavity**, **causing** the **pressure** to **rise within** the eye. This **condition** is **known** as **glaucoma**.
- When **large amounts** of **debris** are **present** in the **aqueous humor**, as **occurs after hemorrhage** into the **eye** or **during intraocular infection**, the **debris is likely to accumulate** in the **trabecular spaces leading** from the **anterior chamber to the canal of Schlemm**.
- This **debris** can **prevent adequate reabsorption** of **fluid from** the **anterior chamber**, sometimes **causing "glaucoma**,".
- **However**, **on** the **surfaces** of the **trabecular plates** are **large numbers** of **phagocytic cells**
  - **These phagocytes** are **there** to **overcome** this **mechanism** in **which** the **debris accumulate**
  - **But when there is** a **pathological condition** there will be **too much debris** that I **cant overcome** it so the **trabecula** will **close** and so **accumulate** of **aqueous** humor **increasing** the **volume** which **will then increase** the **intraocular pressure which will** then **cause displacement of** the **lens increasing** the **pressure** in the **virtuous humor**

causing compression the in the **optic nerve resulting in blindness** this is called **glaucoma**

Intraocular pressure

- The **average normal intraocular pressure** is **about 15 mm Hg**, with a **range from 12 to 20** mm Hg.
- **Measured** by **tonometry**.
  - **Non invasive method**

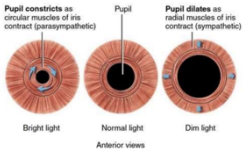


Vitreous humor

- The **larger posterior cavity between** the **lens** and the **retina contains** a **clear**, **jellylike substance**, the **vitreous** humor.
  - Has **more proteoglycans than the aqueous humor**
- The **vitreous humor helps maintain** the **spherical shape** of the **eyeball**.

Iris

- **Not all light passing through** the **cornea reaches** the **light sensitive photoreceptors because** of the **presence of** the **iris**, a **thin, pigmented smooth muscle** that **forms** a **visible ringlike structure within** the **aqueous humor.**
- The **pigment** in the **iris** is **responsible** for **eye color**.
- The **iris contains two sets** of **smooth muscle networks**, **one circular** and the **other radial**.
- **Because muscle fibers shorten** when **they contract**, the **pupil gets smaller when the circular** (or constrictor) **muscle contracts and forms a smaller** ring.
- This **reflex pupillary constriction occurs** in **bright light** to **decrease** the **amount** of **light entering** the **eye**.



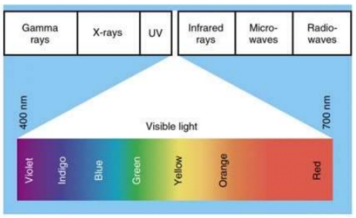
- When the **radial (or dilator) muscle shortens**, the **size of the pupil increases**.
- Such **pupillary dilation occurs** in **dim light to allow the entrance of more light**.
- **Iris muscles** are **controlled** by the **autonomic nervous system**.
- **Parasympathetic nerve fibers innervate** the **circular muscle** (**causing pupillary constriction**), and **sympathetic fibers supply** the **radial muscle** (**causing pupillary dilation**).

Pupil

- The **round opening** in the **center of the iris through** which **light enters** the **interior portions** of the **eye is the pupil**.
- The **size** of this **opening can be adjusted** by **variable contraction of** the **iris smooth muscles** to **admit more or less light as needed**.

Light

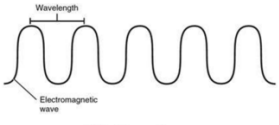
- **Light** is a **form of electromagnetic radiation**. The **distance between two wave peaks** is **known as the wavelength**.
- The **photoreceptors** in the **eye** are **sensitive only** to **wavelengths between 400 and 700 nanometers.**



- **Light** of **different wavelengths** in this **visible band is perceived as different color sensations**.

Light waves

- **In addition** to **having variable wavelengths**, **light energy varies** in **intensity**–that is, the **amplitude of the wave** (**intensity or brightness**).
  - **Wavelength** is the **distance between one peak and another**
  - The **difference** in **wavelength cause different frequency which means different colours can be perceived**
    - **Longest**: **red**
    - **Shortest: violet**



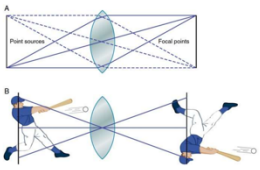
  - The **amplitude determines** the **brightness** and **intensity** of the **colour**

Light rays

- **Light waves diverge** (**radiate outward**) in **all directions** from **every point of a light source**.
- The **forward movement** of a **light** wave in a **particular direction** is **known as a light ray**.
- **Divergent light rays reaching** the **eye must** be **bent inward** to be **focused back into a point** (**the focal point**) on the **light sensitive retina** and **provide an accurate image of the light source**.
  - This is **how photoreceptors are activated so that I can see**

Types of lenses

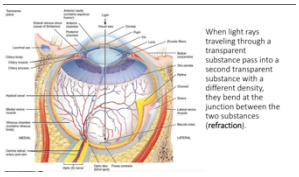
- A **convex surface curves outward** (like the outer surface of a ball), whereas a **concave surface curves inward** (like a cave).
- **Convex surfaces converge light rays**, **bringing them closer together**.
- Because **convergence** is **essential** for **bringing an image to a focal point**, **refractive surfaces** of the **eye are convex**.
- **Concave surfaces diverge light rays** (**spread them farther apart**).
- A **concave lens** is **useful** for **correcting certain refractive errors** of the **eye**.
- The **lens system of the eye can focus an image on the retina**.
- The **image** is **inverted** and **reversed** with **respect** to the **object**.



- However, the **mind perceives objects** in the **upright position despite the upside-down orientation** on the **retina because** the **brain is trained to consider an inverted image as normal.**

Refraction

- **Refraction occurs due** to the **light entering transparent structures through different densities**
  - **Refraction** is **basically bending** of **those light rays**
- The **lens system** of the **eye** is **composed** of **four refractive interfaces** (**different densities and structures**):
  - (1) the **interface between air and** the **anterior surface** of the **cornea**.

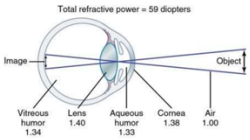


- (2) the **interface between** the **posterior surface of** the **cornea and** the **aqueous humor**.
- (3) the **interface between** the **aqueous humor and** the **anterior surface of** the **lens**.
- (4) the **interface between** the **posterior surface of** the **lens and** the **vitreous humor**.

Refractive index

- The **refractive index** of a **transparent substance** is the **ratio of** the **velocity** of **light** in **air** to the **velocity in the substance.**
- The **refractive index** of **air is 1.00.**
- The **distance beyond** a **convex lens** at **which parallel rays converge to** a **common focal** point is **called** the **focal length of the lens.**
  - The **stronger** the **lens** the **more the refractive power** the **more convergence** that **occurs** so the **shorter the focal length**

Refractive power



- The **more** a **lens bends light rays**, the **greater is its "refractive power**."
- This **refractive power** is **measured in terms of diopters**.
- The **refractive power** in **diopters of** a **convex lens** is **equal** to **1 meter divided by its focal length**.
- Thus, a **spherical lens** that **converges parallel light rays** to **a focal point 1 meter beyond** the **lens** has a **refractive power of +1 diopter.**
  - For the **convex lens** its **positive** while for the **concave lens** its **negative**

Refraction (2)

- In the **reduced eye**, a **single refractive surface** is **considered** to **exist**, **with a total refractive power** of **59 diopters** when the **lens is accommodated for distant vision**.
- About **two-thirds** of the **59 diopters of refractive power** of the eye is **provided by** the **anterior surface of the cornea** (not the lens).
  - The **lens** can **change** its **refractive power by changing its curvature**
  - **Even though** the **lens only contributed to 1/3** of the **refractive power** of the **eye** it **plays an important role in refraction** due to **its ability to accommodate** while the **cornea is a fixed structure**
- The **principal reason** for this **phenomenon** is that the **refractive index of the cornea** is **markedly different from that of air**
- **However**, the **importance of the internal lens** is that in **response** to **nervous signals from** the **brain**, its **curvature can be increased markedly** to **provide "accommodation**,"
- The **ability** to **adjust** the **strength** of the **lens** is **known as Accommodation**

Accomodation

- In a **young person**, the **lens is composed** of a **strong elastic capsule filled** with **viscous**, **proteinaceous, but transparent fluid**.

- However, **about 70 suspensory ligaments attach radially around the lens**, **pulling** the **lens edges toward** the **outer circle of the eyeball.**
- **These ligaments** are **constantly tensed by their attachments** at the **anterior border** of the **choroid** and **retina**.
- The **tension** on the **ligaments causes** the **lens** to **remain relatively flat under normal eye conditions**.
- Also **located** at the **lateral attachments** of the **lens ligaments** to the **eyeball** is the **ciliary muscle**, which **has two separate sets** of **smooth muscle fibers**–**meridional fibers** and **circular** fibers.
- **Contraction** of **either set of smooth muscle fibers** 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.**
- **Ciliary muscle** is **controlled almost entirely by parasympathetic nerve signals transmitted** to the **eye through the third cranial nerve from** the **third nerve nucleus** in the **brain stem**.
- **Stimulation** of **parasympathetic nerves contracts both sets** of **ciliary muscle fibers**, which **relaxes the lens ligaments**, thus **allowing** the **lens to become thicker** and **increase its refractive power.**
- In **children**, the **refractive power of the lens** of the **eye can be increased voluntarily from 20 diopters to about 34 diopters**, which is an "**accommodation" of 14 diopters**.
- **To make** this **accommodation**, the **shape of** the **lens** is **changed from that** of a **moderately convex lens** to **that** of a **very convex lens**.
- **As** a **person grows older**, the **lens grows larger** and **thicker** and **becomes far less elastic**, **partly because of progressive denaturation of** the **lens proteins**. **The ability** of the **lens to change shape decreases with age**.
- The **power** of **accommodation decreases from about 14 diopters** in a **child** to **less than 2 diopters by the time a person reaches 45 to 50 years** and to **essentially 0 diopters at age 70** years.
- Thereafter, the **lens remains almost totally nonaccommodating**, a **condition known as presbyopia**.
- Once a **person** has **reached** the **state** of **presbyopia**, **each** eye **remains focused permanently** at an **almost constant distance**; this **distance depends on the physical characteristics** of **each person's eyes**.
- The **eyes can no longer accommodate** for **both near and far vision**. **To see clearly both** in the **distance** and **nearby**, an **older person must wear bifocal glasses**, with the **upper segment focused for far-seeing** and the **lower segment focused for near-seeing** (e.g., for reading).