Objectives

How the structural components of the eye contribute to the overall function of observing the visual world
Objectives

Identify strategies (mechanisms) employed in the eye to provide nutrients and structural support without distorting light
Outline

Overview

Cellular structures through which light passes

A. Cornea
B. Lens
C. Retina

Structures which influence the image

A. Iris
B. Ciliary bodies
C. Trabecular meshwork
The earliest recorded use of glass or quartz for magnification goes back to about 2500 B.C. The first glasses were either held in the hand or placed on the object. Credit for inventing spectacles that put two lenses together goes to 13th-century Venetians. Not until the invention of the printing press in the mid-15th century did the need for glasses become widespread. Later, lenses were made in rough grades of intensity and sold in shops or by peddlers on the street; a customer would try on glasses until he found the right correction. Benjamin Franklin, who had two vision problems (nearsightedness and farsightedness), became impatient with having to change glasses constantly; he cut two pairs of spectacles apart, fastened the halves together, and thus invented the first bifocals.
The earliest spectacles, worn by lawyers and merchants, were *pince-nez* (French for "pinch-nose"). In this 16th-century Flemish painting, the wearer is a "usurer," or money lender.

Leather-rimmed spectacles were apparently common in 16th-century Italy; in 1967, divers brought up a whole box of them from the wreck of a Venetian vessel that went down in the Adriatic Sea.

*Antique glasses.* Clockwise from front: wooden frames from China (1700), lunettes (1900), glasses with rigid temple sidepieces (1850), tortoiseshells (1800), lorgnette (1900). In center, *pince-nez.*

A soft contact lens: kind of flexible, the-eye visual aid more comforting. The first hard contact which were developed in Switzerland at the 20th cen.
• Although we have 5 major senses, most of the information from our surroundings comes from the eyes, making sight a very important part of our lives.
• The eye contains many rods and cones, it gathers information, and sends it to the visual processing part of the brain. The information is sent via electric signals (The Nervous System!).
• Optical illusions can be caused by our brain expecting to see something, and processing the eye's signals in a way that creates something that makes sense on one hand, but on further looking begins to make less sense.
Which center dot is bigger in these two sets of circles? Although they may not seem so, they are identical.
Which center sets of circle seem so, they may not.

**dot is bigger in the?** Although they m are identical.
**Depth Perception Challenge:** Your brain cannot make sense of the depth and colors in the picture, thus the circles appear to be moving. Stare at only one circle and you will see it stop moving among the others.
The persistent gray spots you see at the intersections of these boxes aren’t really there—they’re only in your mind!
**Photoreception Challenge:** Stare at the central point (plus sign) of the black and white picture for at least 30 seconds and then look at a wall near you, you will see a bright spot, twinkle a few times, what do you see? or even who do you see?
Eye
Turn the eye so that it is facing you & examine these structures on the front surface of the eye:

- **eyelids** - two moveable covers that protect the eye from dust, bright light, and impact
- **sclera** - this is the tough, white outer coat of the eye that extends completely around the back & sides of the eye
- **cornea** - a clear covering over the front of the eye that allows light to come into the eye (preservative often makes this appear cloudy)
- **iris** - round black tissue through the cornea that controls the amount of light that enters the inner part of the eye (may be colored in humans)
- **pupil** - the round opening in the center of the eye that allows light to enter and whose size is controlled by the iris
V. Glossary of terms on the eye

Anterior chamber - space between cornea and iris or lens - contains aqueous humor
Aqueous humor - clear fluid, pressure regulated
Bowman's membrane - acellular, glycosaminoglycans, rich layer of cornea
Canal of Schlemm - carries fluid from trabecular meshwork to bloodstream
Choroid - vascular layer
Choroid plexus - vascular plexus, supplies nutrients to retina
Ciliary body - attach zonules from lens, contraction of ciliary muscle alters shape of lens
Ciliary epithelium - secretes aqueous humor
Ciliary process - pigmented and non-pigmented epithelium
Conjunctiva - stratified squamous or columnar, covers white of eye and inside eyelid
Cornea - structural layer, course focus of image on retina
<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corneal endothelium</td>
<td>- water transport cells</td>
</tr>
<tr>
<td>Corneal epithelium</td>
<td>- stratified squamous, protection</td>
</tr>
<tr>
<td>Corneal stroma</td>
<td>- fibroblasts and collagen, avascular</td>
</tr>
<tr>
<td>Descemet's membrane</td>
<td>- basement membrane of endothelium of cornea</td>
</tr>
<tr>
<td>Fovea</td>
<td>- bull's eye of macula</td>
</tr>
<tr>
<td>Glaucoma</td>
<td>- serious eye disease, obstruction of outflow of aqueous humor which raises intraocular pressure</td>
</tr>
<tr>
<td>Iris</td>
<td>- regulate amount of light entering eye</td>
</tr>
<tr>
<td>Iris muscles</td>
<td></td>
</tr>
<tr>
<td>dilator</td>
<td>- open pupil, myoepithelium</td>
</tr>
<tr>
<td>constrictor</td>
<td>- close pupil, smooth muscle</td>
</tr>
<tr>
<td>Lens</td>
<td>- focus image on photoreceptor cells, avascular</td>
</tr>
<tr>
<td>Lens epithelial cells</td>
<td>- cells on anterior surface, source of lens fibers</td>
</tr>
<tr>
<td>Limbus</td>
<td>- sclerocorneal junction</td>
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</table>
Macula - cones, most sensitive, devoid of blood vessels, ganglion cell and internuclear layer

Optic - nerve cap or head - blind spot, no photoreceptor cells

Optic nerve - connect brain with eye

Photoreceptor - photosensitive cells
  rods - black and white, rhodopsin pigment
  cones - red, green, blue pigments

Pigmented epithelium of iris - block out light

Posterior chamber - space between lens and iris - contains aqueous humor

Retina - photosensitive part of eye
  pigmented epithelium - absorbs light
  outer nuclear layer - nuclei of photoreceptor cells
  internuclear layer - nuclei of bipolar neurons
  ganglion cell layer - transmit to brain through optic nerve

Retinal pigmented epithelium - phagocytotic, prevents backscatter, melanin, Vitamin A storage
<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Root of iris</td>
<td>Attachment of iris to sclera</td>
</tr>
<tr>
<td>Sclera</td>
<td>Structural layer, white of eye, connective tissue</td>
</tr>
<tr>
<td>Scleral spur</td>
<td>Enlargement of sclera, site of anterior attachment of ciliary muscle</td>
</tr>
<tr>
<td>Trabecular meshwork</td>
<td>Resistance to aqueous humor outflow, baffle of endothelial cells draped over connective tissue</td>
</tr>
<tr>
<td>Transparent retina</td>
<td>All retina except retinal pigmented epithelium</td>
</tr>
<tr>
<td>Uvea</td>
<td>Vascular layer of eye = iris, ciliary body, ciliary processes, and choroid</td>
</tr>
<tr>
<td>Vitreous body</td>
<td>Fine filaments, jellylike, pressure on retina</td>
</tr>
<tr>
<td>Zonules</td>
<td>Ligaments of lens that attach lens to choroid and ciliary</td>
</tr>
</tbody>
</table>
Eye
Three Layers of the Wall of the Eye

Eye 192 human and 34412 monkey

- Cornea
- Pupil
- Iris
- Anterior chamber
- Posterior chamber
- Lens
- Iris
- Ciliary body
- Optic nerve
- Sclera
- Chorioid layer
- Vitreous body
- Retina
- Connective tissue
- Aqueous humor
Cellular structures through which light passes:

A. Cornea
B. Lens
C. Retina
Cornea

**Function:**
- Protection
- Structural support
- Filter out undesirable light rays
- Focus image on retina

**Nutrition:**
- Limbus
- $O_2$ from air for corneal epithelium
Cross section of human head
Total refractive power = 59 diopters
No blood vessels in cornea
corneal layers Iris of Eye (toluidine blue)

- Bowman's membrane
- Corneal stroma
- Corneal endothelium
- Descemet's Membrane
- Sclera-cornea junction (limbus)
- Sclera
- Ciliary muscle: smooth muscle
- Anterior chamber
- Posterior chamber
- Aqueous humor
- Iris
- Aqueous humor
- Lens
Limbus
Lens

Function: Focus image on photosensitive portion of photoreceptor cells

Nutrition: Aqueous humor
Bow area of lens

Fibers of zonule

Lens capsule

Lens epithelium

Lens fibers
Lens cuboidal epithelium on its anterior surface gives rise to elongated lens fibers in the bow region, and the shared basement membrane of these cells is the capsule.

No cuboidal epithelium on the posterior surface of the lens and the capsule is thinner there.
Cornea
Retina
Retina

**Function:** photoreception of image processing by neurons prevent backscatter of light

**Nutrition:** choroid, retinal blood vessels
Retina (toluidine blue)

- Ganglion cell layer
- Bipolar cells
- Photoreceptor cells
- Artifactual space
- Rods
- Cones
- Optic nerve
- Capillary
Cones have pigments for the primary colors (red, green, and blue)
Where do we find the primary colors (red, green, and blue)?
Light vs. dark adaptation
Function of retinal pigment epithelium

1. Vitamin A storage
2. Phagocytosis of rod tips
3. Absorption of light
4. Nutrients to retina
5. Blood retinal barrier
Eye monkey

- Pigmented layer of epithelial cells
- Elaborate network of vessels, the choroid plexus.
- Central artery of the retina
- Capillary network in retina
Typical retina

Macula
Structures which influence the image

A. Iris
B. Ciliary bodies
C. Trabecular meshwork
**Iris**

**Function:**
- regulate amount of light that reaches retina
- blackened posterior surface to stop light rays

**Dilator (myoepithelial)**
and **Constrictor (smooth) muscles**

**Nutrition:** local blood vessels
Iris

Dilator (myoepithelial) and Constrictor (smooth) muscle
Iris

Myoepithelial

Pigmented layer
Iris

Blue eye

Black eye
Eye (toluidine blue)

Iris

Pupil

Constrictor muscle

Dilator muscle

Cuboidal epithelium on anterior surface of lens

Anterior chamber

Posterior chamber

Lens capsule

Lens

Iris pupil

Pupil

Constrictor muscle
Lens and iris

- Iris constrictor muscle is smooth muscle
- Pigmented epithelium of iris
- Lens capsule
- Posterior chamber
- Lens cuboidal epithelium

192 and 34412
Ciliary Bodies

**Function:**
- Contraction of muscle changes lens through zonules
- Ciliary processes secrete aqueous humor
- Blackened region stops light rays

**Nutrition:** local blood vessels
Contraction of muscle reduces tension on zonules allowing the lens to be more spherical to focus on close objects.
Ciliary muscle: smooth muscle

- Ciliary processes
- Blood vessel
- Nerves
- Ciliary muscle
- Lens
Ciliary bodies

Lens

Lens capsule

Zonules
Eye monkey

Sites of attachment of zonules to the lens’ capsule

One site of attachment of a zonule to the capsule on the lens on its posterior surface

34412

lens
Ligaments (zonules)

Iris

Anterior surface

Posterior surface

lens
Zonules

Sclera

Ciliary muscle

192

Capsule and cuboidal epithelium on the anterior surface of lens

Thinner capsule on the posterior surface of the lens
Secretory epithelium and pigmented epithelium for the ciliary bodies
Pigmented layer contributes to blood aqueous barrier
Pigmented cells of the ciliary processes become the dilator muscle of the iris.

Secretory cells become the pigmented cells of the iris.
Outflow of aqueous humor

IRIS

ciliary processes

lens
Trabecular Meshwork

**Function:** resistance to outflow of aqueous humor

**Nutrition:** local blood vessels, probably aqueous humor
Site of aqueous humor production

Outflow of aqueous humor
Canal of Schlemm
Trabecular meshwork
Iris
Posterior chamber with aqueous humor
Blood vessels
dilator muscle
secretory cells
Ciliary processes
Monkey eye
Endothelium
Trabecular Meshwork
Resistance to outflow
of aqueous humor
In summary

The overall function of the EYE:

**OUTLINE**

**OVERVIEW**

**CELLULAR STRUCTURES THROUGH WHICH LIGHT PASSES**

A. CORNEA
B. LENS
C. RETINA

**STRUCTURES WHICH INFLUENCE THE IMAGE**

A. IRIS
B. CILIARY BODIES
C. TRABECULAR MESHWORK
to observe the visual world