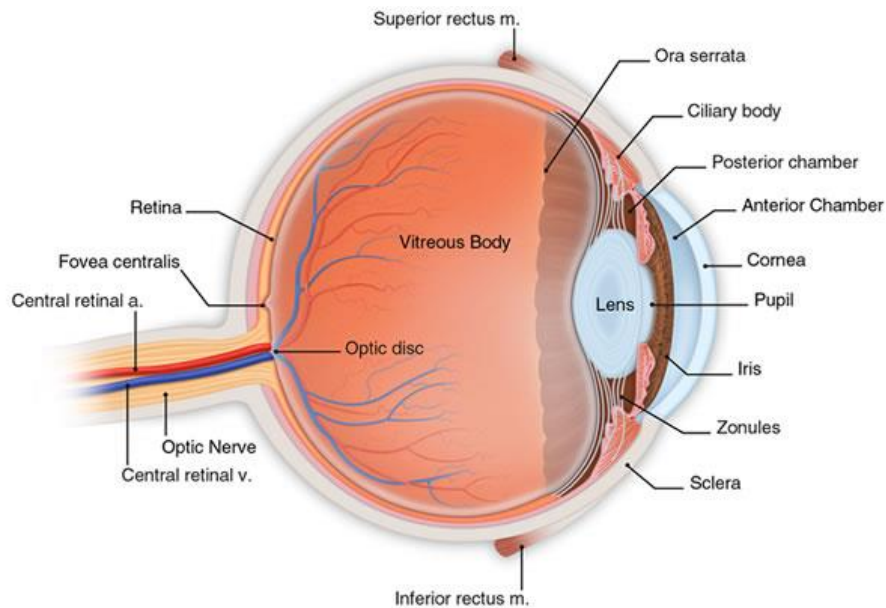


ORGAN OF VISION

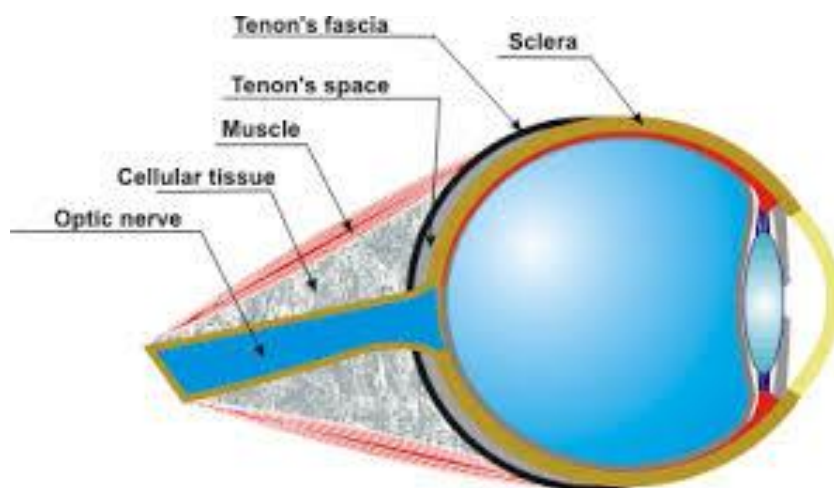
The organ of vision includes:

- 1) **Eyeball**
- 2) **Auxiliary apparatus** (eyebrows, palpebrae, conjunctiva, lacrimal apparatus, extrinsic eye muscles, fat tissue of an orbit),
- 3) **Optic nerve and visual pathway.**

EYEBALL



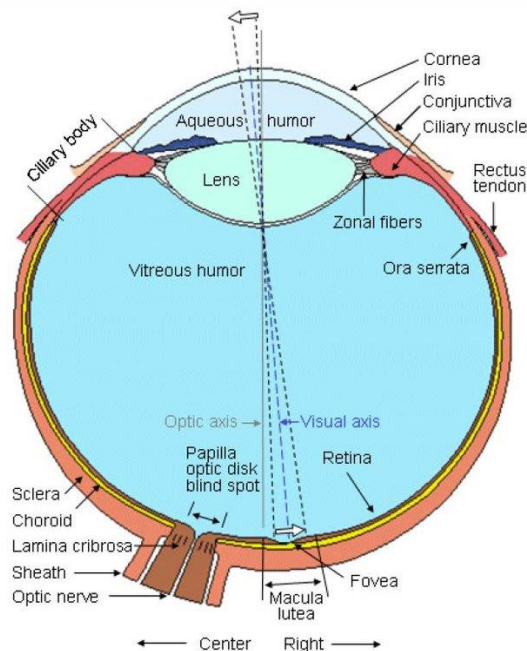
The eyeball is located in the orbit. It is surrounded by a fibrous sheath (**Tenon's capsule**). Between the capsule and the walls of an orbit adipose tissue is located, between the capsule and the eyeball – episcleral (**Tenon's**) **space**.



Eyeball has **two poles**: anterior and posterior. The line connecting these poles outside – **external axis of the eye** (an average of about 24 mm), inside – **internal axis of the eye** (about 22 mm). Thus, external axis connects the convex part of the external surface of the cornea to the convex part of the external surface of the sclera. Internal

axis connects the convex part of the internal surface of the cornea to the convex part of the internal surface of the sclera.

The line connecting the anterior pole (the convex part of the cornea) with the point of the best vision (center of yellow spot of the retina) - **optic axis**.



Equator of the eye divides it into anterior and posterior segments.

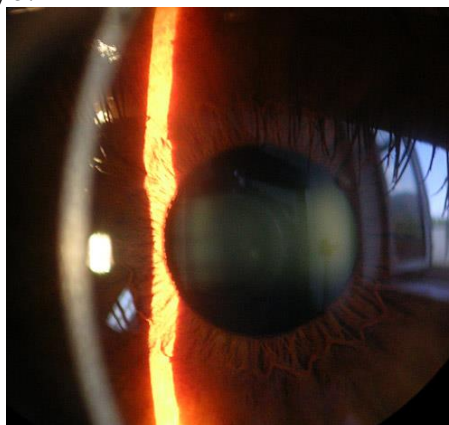
The eyeball consists of the nucleus and tunics (layers).

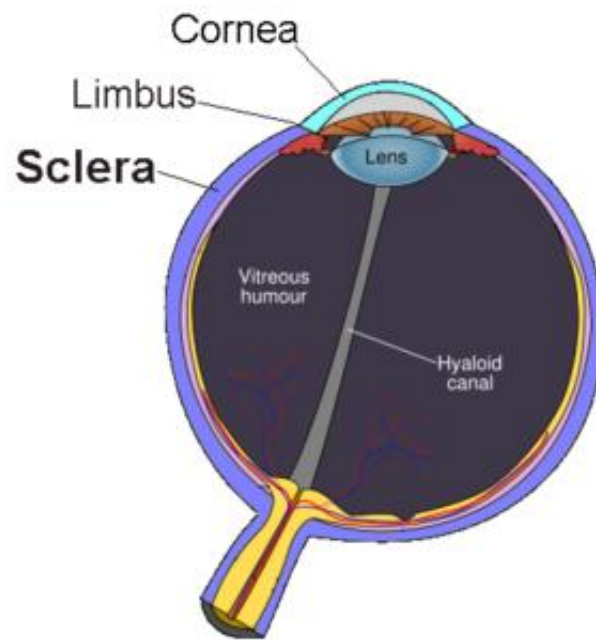
LAYERS OF THE EYEBALL:

1. *Fibrous tunic*
2. *Vascular tunic*
3. *Internal tunic*

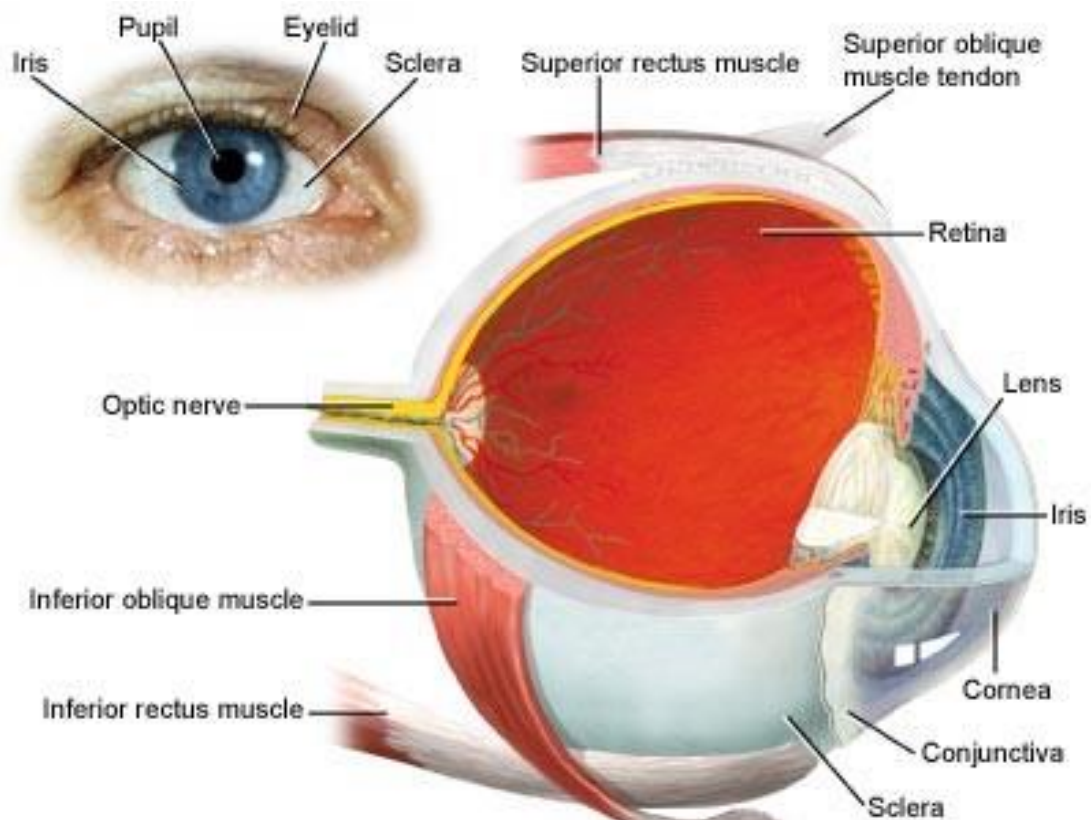
1.FIBROUS TUNIC

It is divided on two parts: the anterior – **cornea**, posterior – **sclera**. Cornea is transparent. It hasn't blood vessels, its shape is convex and thus it refracts light rays coming into the eye.

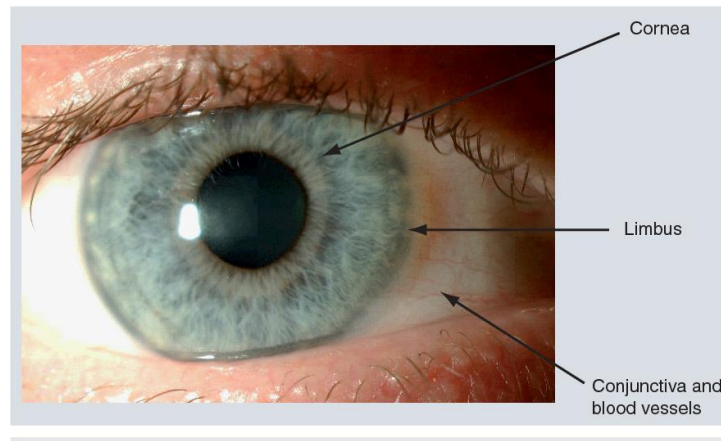




Posterior large part is a *sclera* (**sclerous or albuminous shell** = «white»). In the posterior part of the sclera has a perforated plate (lamina cribrosa of sclera), through it vessels and nerves pass. Sclera consists of dense connective tissue that includes both collagen and elastic fibers. The sclera provides for eye shape and protects the eye's delicate internal components.



The border between sclera and cornea is **limbus**. On the projection of the limbus is the **circular venous sinus = Schlemm's canal**. Venous blood circulates in this sinus.



The functions of the fibrous tunic:

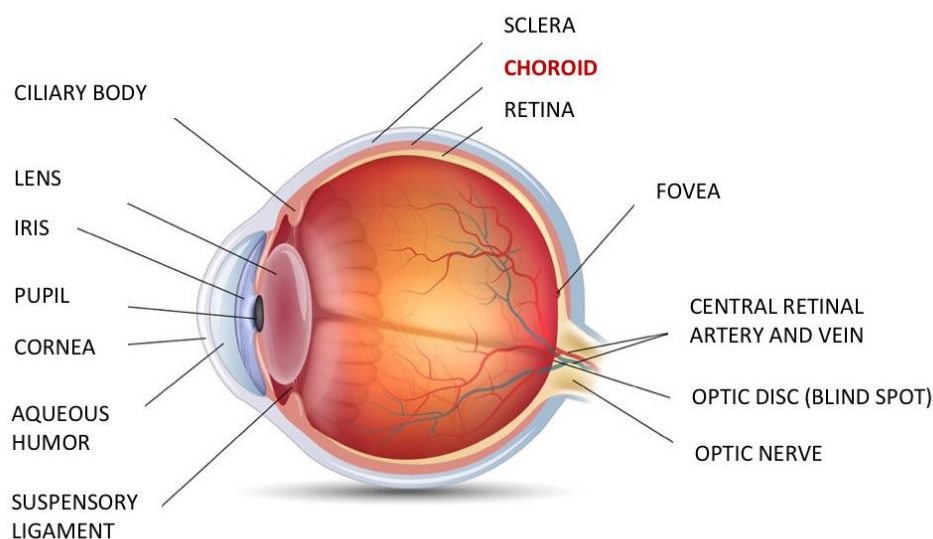
1. Formation of shape
2. Refraction
3. Holding of the light

2. VASCULAR TUNIC

It has numerous vessels and pigment. Vascular tunic is divided on the 3 parts:

a) posterior – the proper vascular shell = choroid

The proper vascular tunic is a thin membrane rich with vessels, occupying the posterior 5/6 of the eyeball's surface. Its network of capillaries provides blood supply of the whole eyeball, especially retina. Choroid is loosely connected with the sclera and has the properties of a spring. Cells of the choroid are filled with pigment from the numerous melanocytes in this region. The melanin pigment is needed to absorb extraneous light that enters the eye.

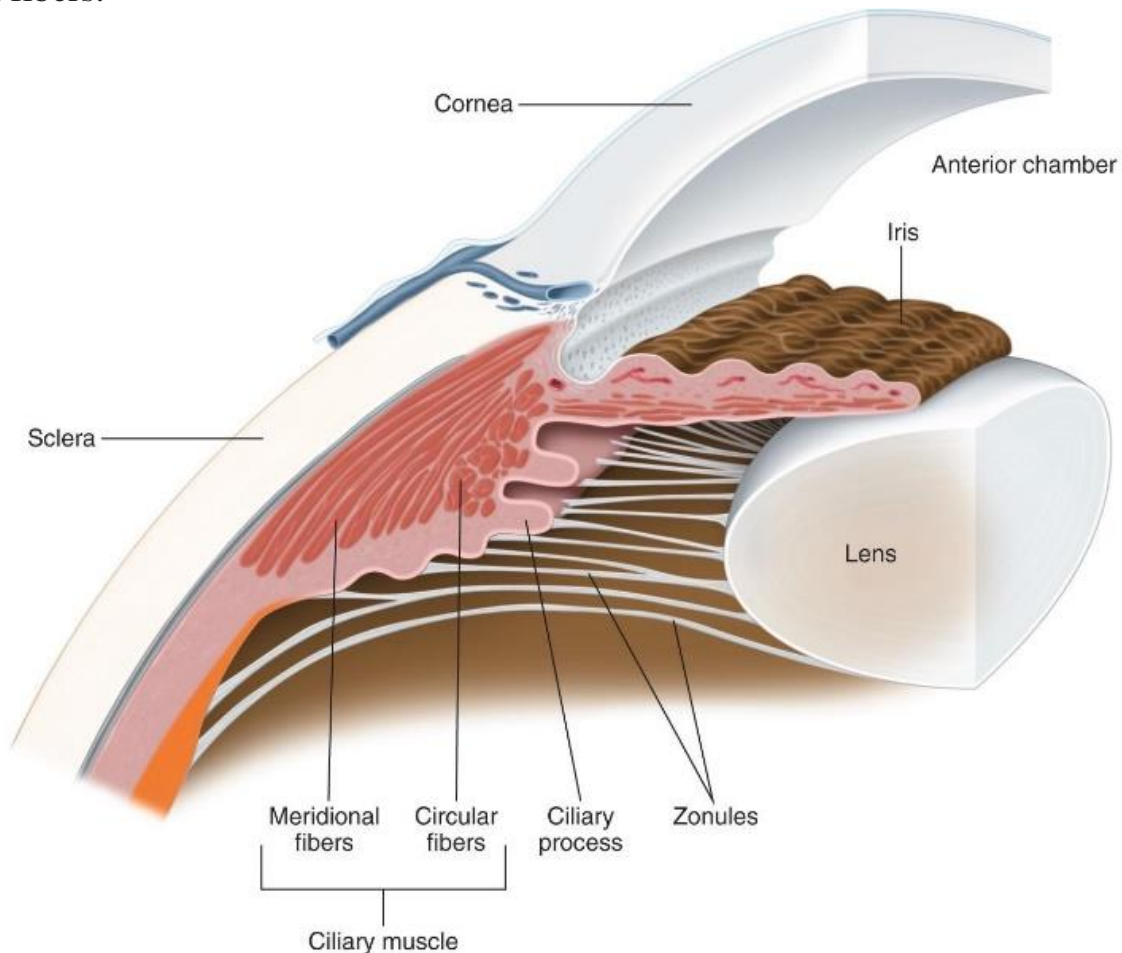


b) middle - **ciliary body**

A ciliary body is located between iris and proper vascular tunic as a circular shaft on the border of the sclera and cornea. The ciliary body connects with the iris to form a **corona ciliaris**.

Stroma of the ciliary body is formed by smooth **ciliary muscle** and a lot of blood vessels. The ciliary muscle connects with the lens by **ciliary zonule or ligaments of Zinn**.

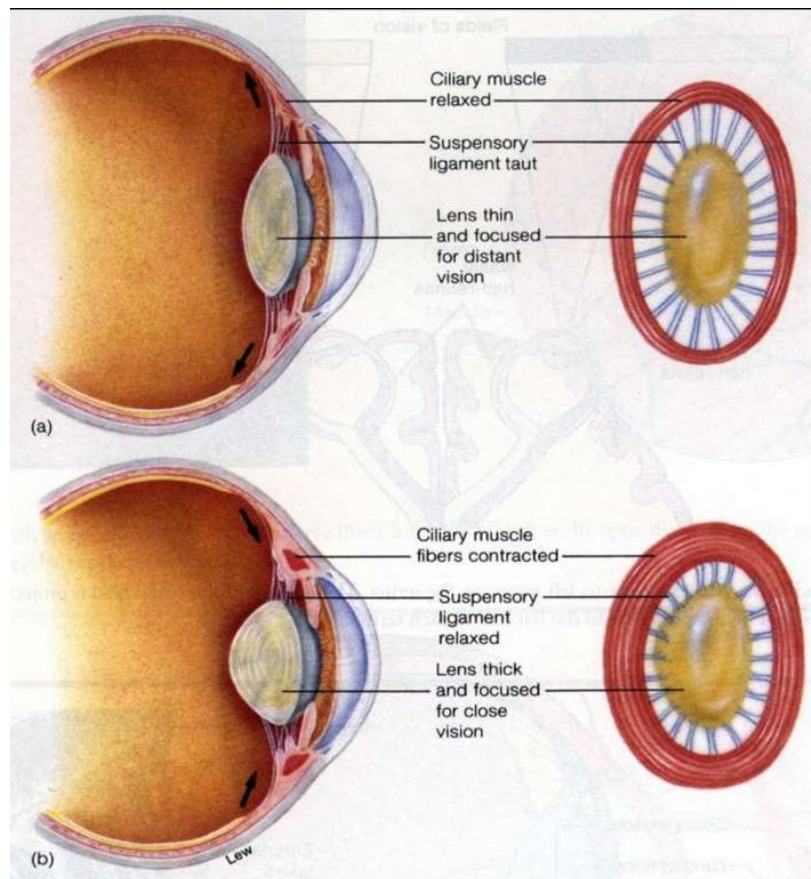
Ciliary muscle is a muscle of accommodation, it has longitudinal, circular and radial fibers.



The lens without affecting takes the form of a ball.

When ciliary muscle contract, the ciliary body becomes higher, Zinn's ligaments relax and the lens becomes more convex, thus, the eye is set on the near vision.

When circular and meridional fibers relax, the ciliary body becomes more flat, Zinn's ligaments are tightened and the lens becomes more flat too, thus, the eye is set on the distant vision.



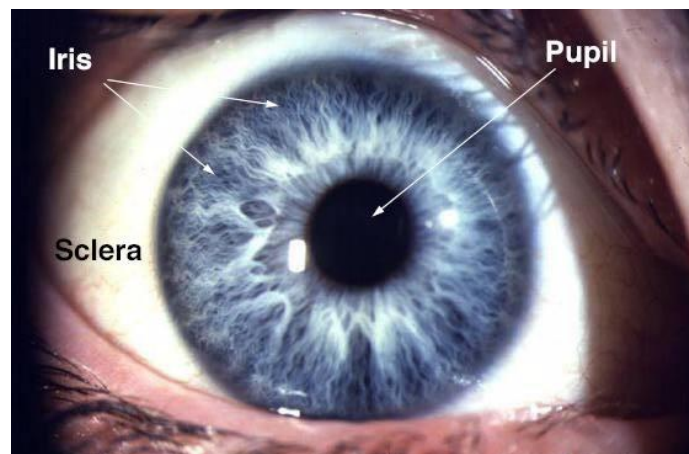
Accommodation is a change of curvature of the lens by the ciliary muscle to promote clear vision of objects at different distances. Disorders of accommodation- myopia and hiperopia.

Near the lens, its posterior surface is thrown into radiating folds called **ciliary processes**. They secrete fluid called aqueous humor to posterior chamber of the eye.

c) anterior – **iris**

Due to the presence of smooth muscles iris acts as a diaphragm. In its centre is an opening – the pupil. Muscles of the iris: m. sphincter pupil and m. dilator pupil.

Stroma of the iris has a pigment and its amount ascertains the eye color.

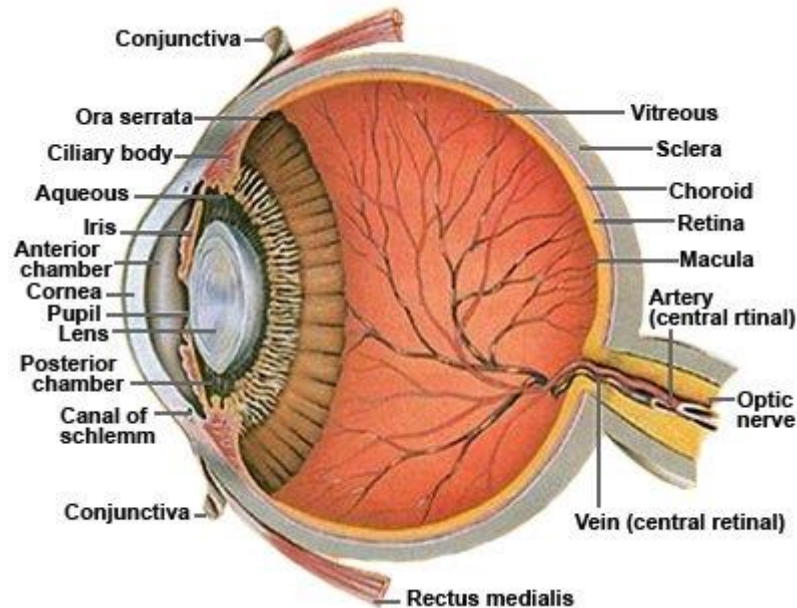


Light adaptation is the ability to regulate the amount of light rays entering the eye by changing the size of the pupil

3.INTERNAL TUNIC - RETINA

The retina plays the role of peripheral receptive part of visual analyzer.

Functionally and structurally, it is divided into **2 parts: optic and nonvisual**. A boundary line between them is the **serrate line**.

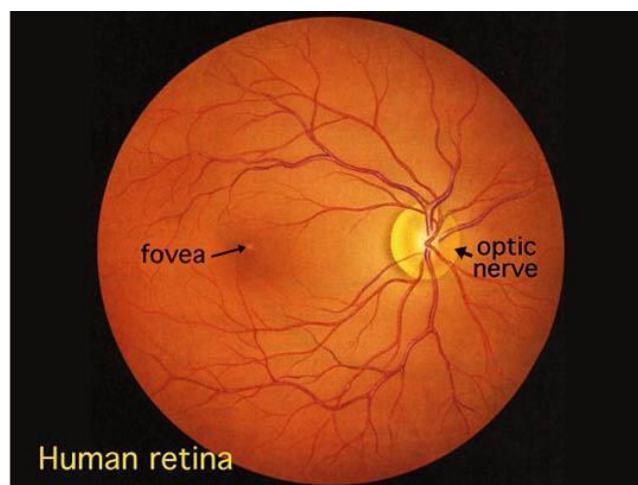


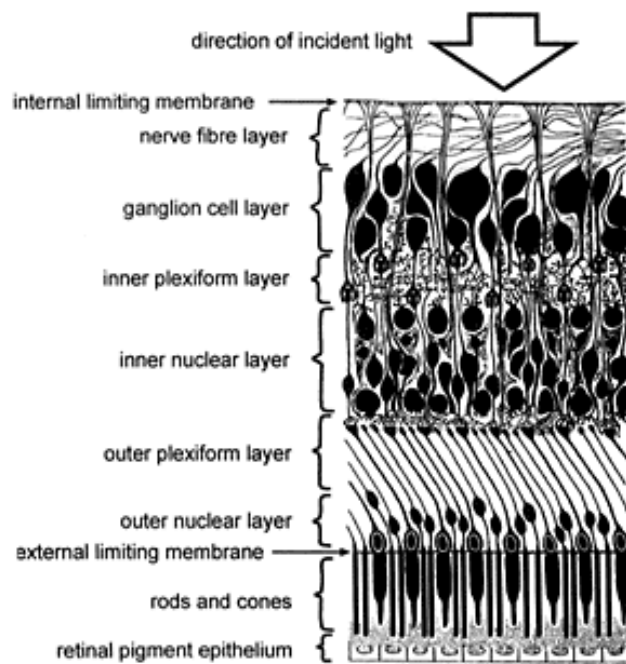
The blind part of the retina has no photoreceptors and lines the ciliary body and posterior surface of iris.

The visual part lines the proper vascular tunic. There are photoreceptors in it, perceiving light irritations and converting them into a nervous impulse. Histologically, ten layers are located in the retina.

The most internal layer of the retina is photosensory, contains visual cells – **cones and rods**. Cones are responsible for day color and vision, rods control night vision.

The disk of optic nerve is the place of exiting of nerve fibers from the retina. It is called the **blind spot** (*macula caeca*), because here photosensory elements are absent. Lateral to the disk the *macula lutea* - only cones are located. Its center called the **fovea centralis**. It is the place of the best vision as the focus of light is concentrated here.

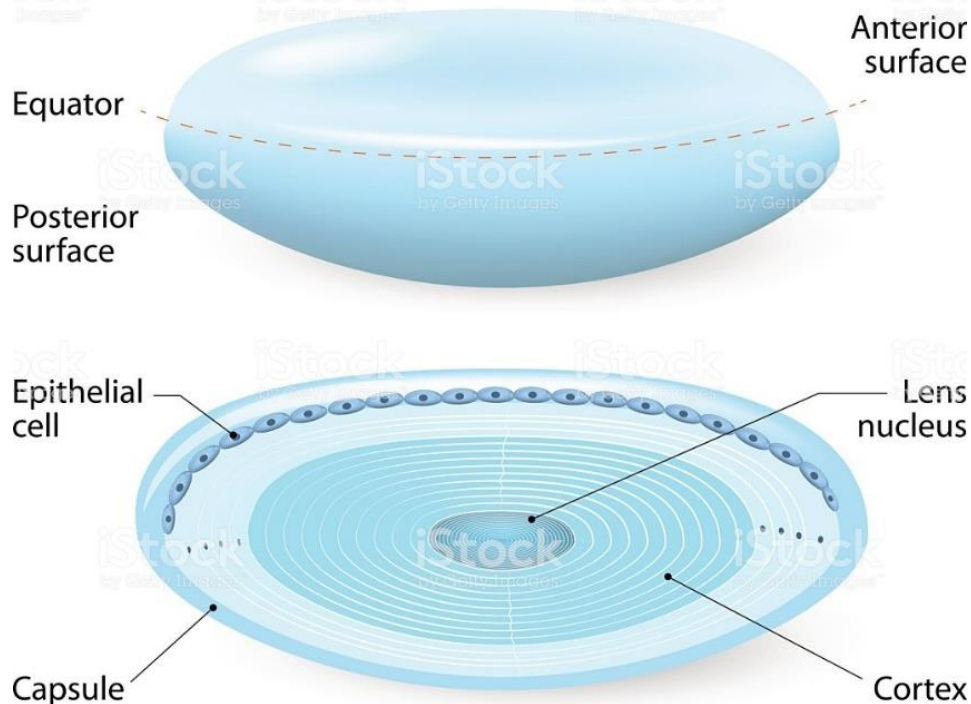




NUCLEUS OF THE EYEBALL

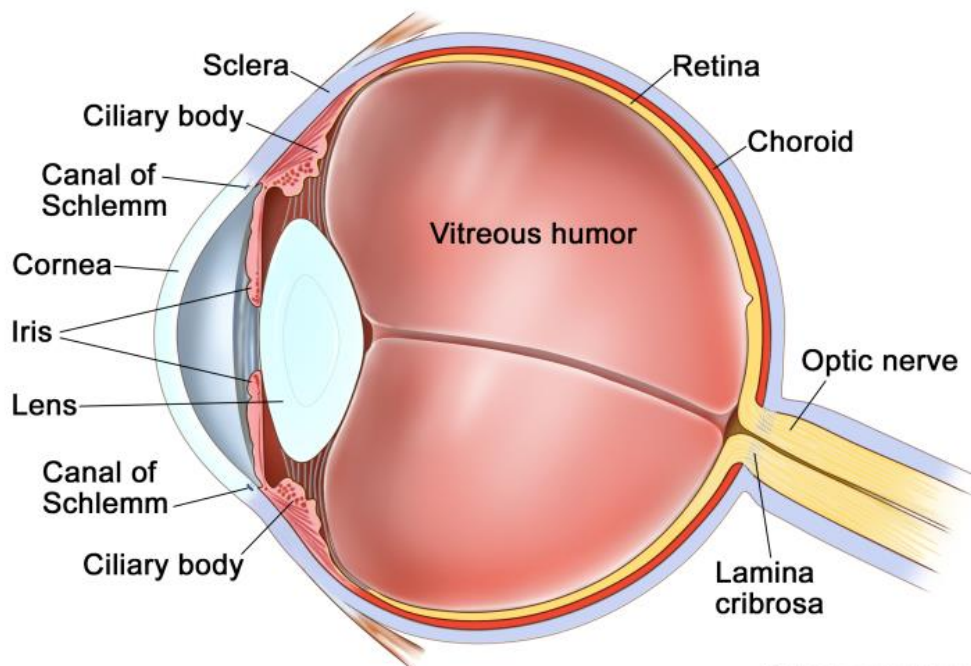
It consists of the lens, the vitreous body and the aqueous humor of eye chambers.

LENS of the eye is a transparent biconvex lens, located behind the pupil and in contact with the pupillary margin of iris. It plays an important role in the reaction of accommodation – ability to see both far and near distances. The lens of the eye is covered by a capsule, it has an equator and two poles– anterior and posterior. A supporting ligament (**ligament of Zinn**) is attached to the capsule of the lens on the equator. It retains the lens in certain positions and allows it to become more convex.



VITREOUS BODY fills the cavity of the eyeball deep to the retina. It is a transparent gel mass. Outside, the vitreous body is covered by a dense membrane. It does not contain blood and lymphatic vessels but there is a hyaloid canal in a center. The main function of the vitreous body is its participation in the metabolic processes of the retina.

Anatomy of the Eye



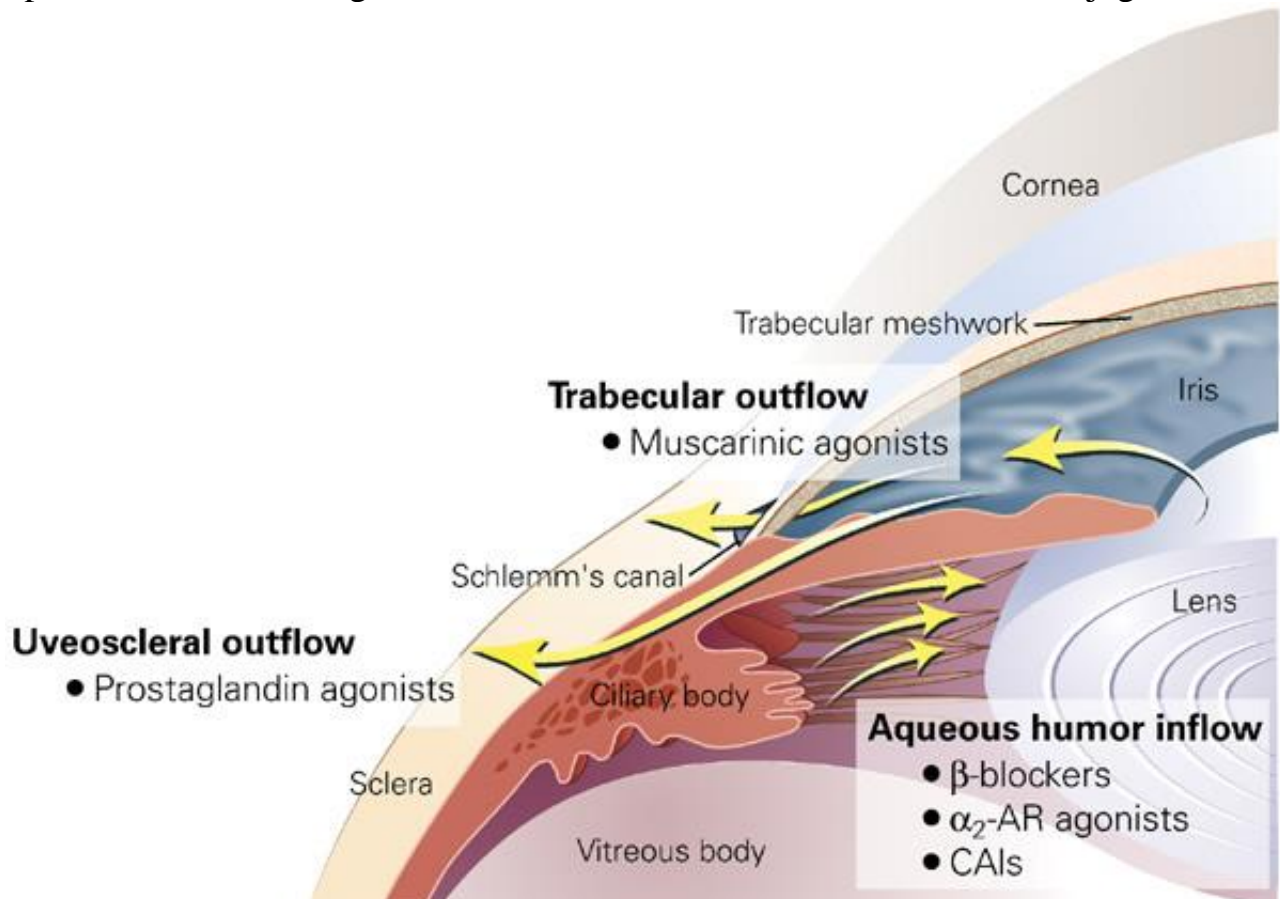
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AQUEOUS HUMOR of the eyeball is contained in anterior and posterior chambers. The anterior chamber is between the posterior side of the cornea and the anterior surface of the iris. These two surfaces meet on a circumference and form an **irido-corneal angle**, with fissure-like (**Fontana's**) **spaces**. These spaces are connected by Schlemm's canal located in the thickness of sclera. The posterior chamber of the eye is located between the posterior surface of the iris and lens and connected to the anterior chamber by the pupil.

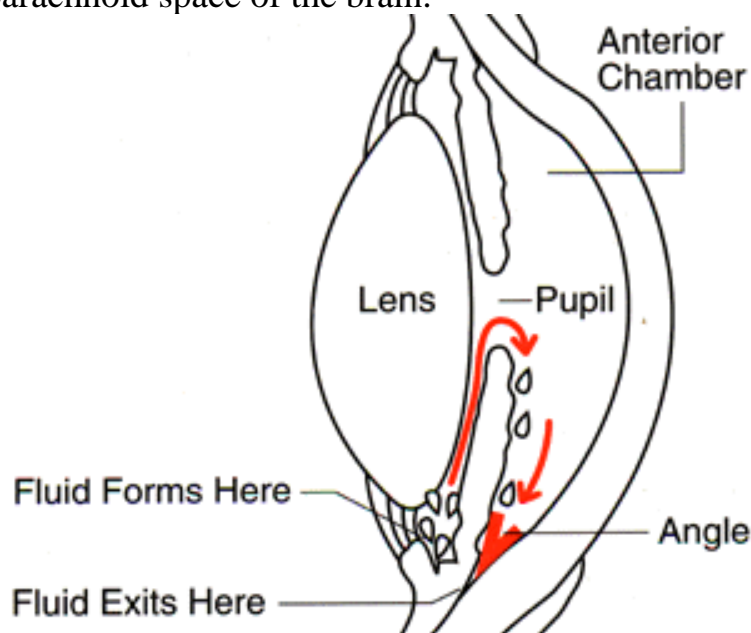
CIRCULATION OF THE AQUEOUS HUMOR

The aqueous humor is produced by the ciliary body and secreted to the posterior chamber. From there 2/3 of the volume of aqueous humor drains to the anterior chamber through the pupil and from here, through Fontana's spaces to the venous Schlemm's canal of sclera. From it, through vorticose veins (vv. varticosa) by

ophthalmic veins, it gets to the cavernous sinus and to internal jugular veins.



1/3 of the volume of the aqueous humor from the posterior chamber drains to the vitreous body through the hyaloid canal, providing homeostasis. A small quantity of aqueous humor passes through the ciliary body and drains to the perivascular space of the optic nerve, and further on to the subarachnoid space of the brain.



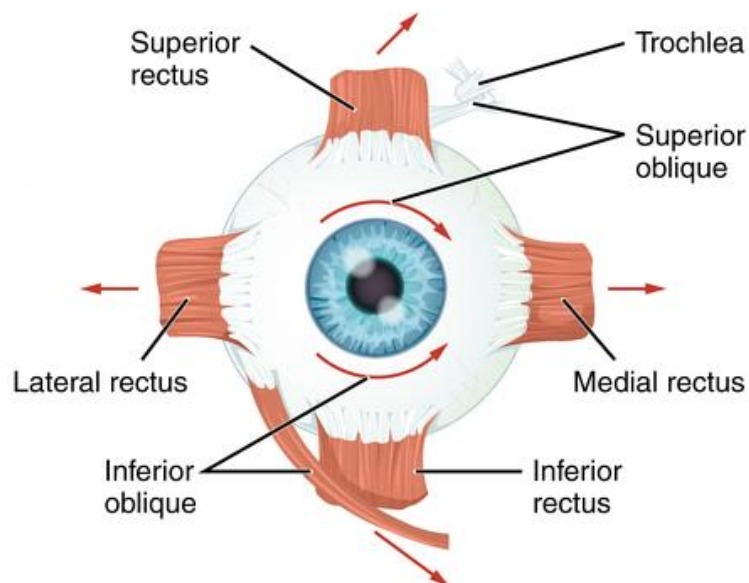
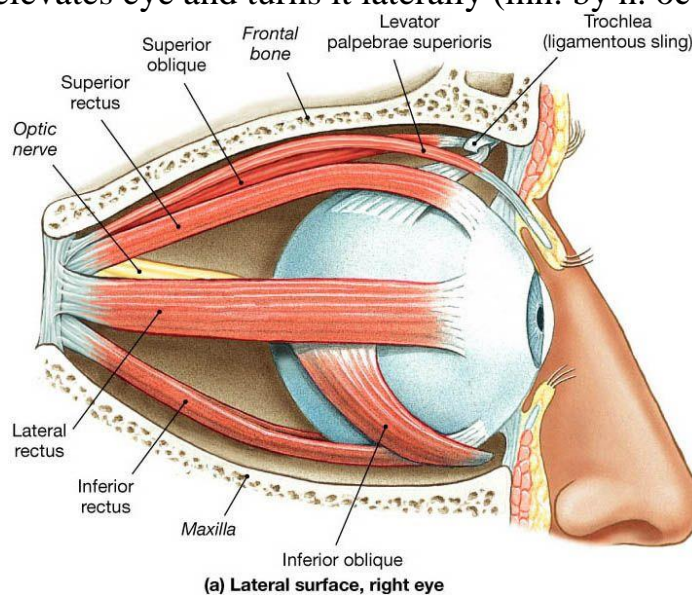
AUXILIARY APPARATUS OF THE EYE

1) Connective tissue formations: periosteum of the orbit, ophthalmic septum, vagina of eyeball, muscular fasciae and fatty cellulose (body) – Tenon's capsule.

2) Muscles of eyeball

The extrinsic muscles are responsible for moving the eyeball:

1. *m. superior rectus* - elevates eye and turns it laterally (inn. by n. oculomotor(III))
2. *m. inferior rectus* - depresses eye and turns it medially (inn. by n. oculomotor(III))
3. *m. medialis rectus* - moves eye medially (inn. by n. oculomotor(III))
4. *m. lateralis rectus* moves eye laterally (inn. by n. abducens (VI))
5. *m. superior oblique* - depresses eye and turns it laterally (inn. by n. trochlear(IV))
6. *m. inferior oblique* - elevates eye and turns it laterally (inn. by n. oculomotor(III))



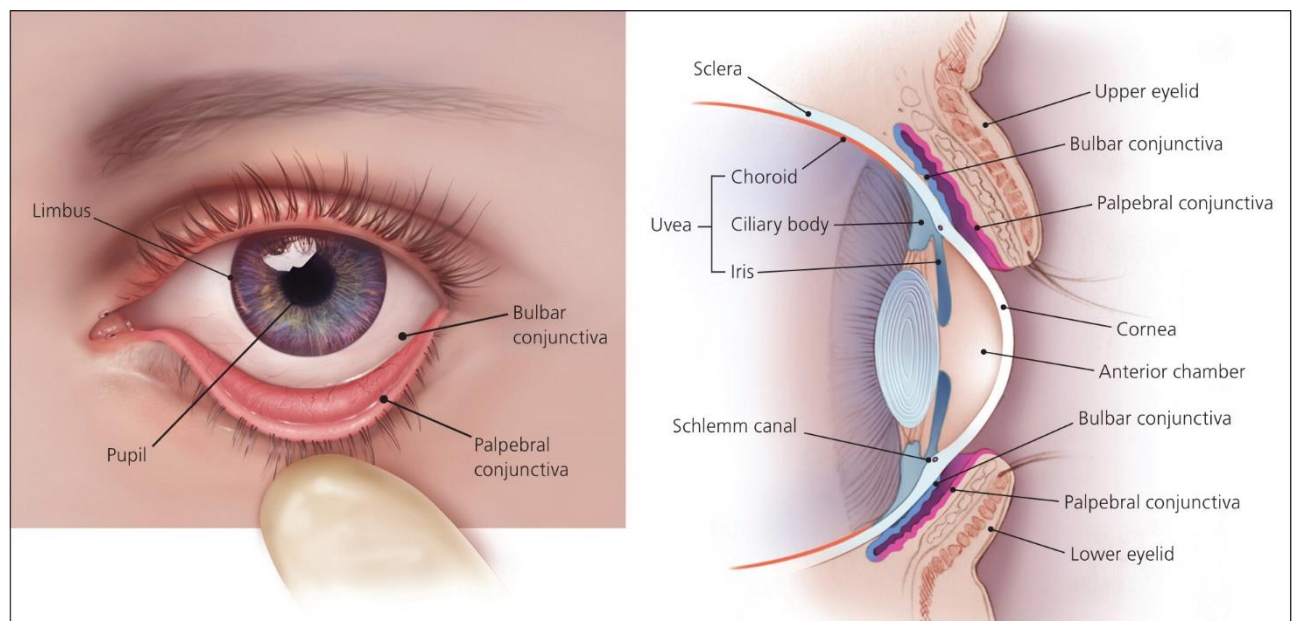
Anterior view of the right eye

3)Protective apparatus of the eye: eyelids, eyebrows, cilia, conjunctiva and lacrimal apparatus.

Eyelids, palpebrae superior et inferior (Greek: blepharon) – two thin mobile folds, protecting the eye. A cartilaginous plate and the palpebral part of m.orbicularis oculi (which is covered by loose connecting tissue and skin) serve as the base of the eyelids. Hair follicles of cilia and sebaceous (*Meibomian's*) glands are located on the anterior margin of the eyelids. *Meibomian glands* produce a secretion to prevent tear overflow from the open eye and keep the eyelids from adhering together. The eyelids' free margins are separated by a central **palpebral fissure**.

The inferior eyelid is immobile and mobility of the superior eyelid is provided by its own muscle – *m. levator palpebrae superior*.

Conjunctive tunic – is a transparent tunic of connective tissue lining the internal surface of eyelids and part of the sclera. It is divided into two parts: conjunctiva of eyelids (**palpebral conjunctiva**) and conjunctiva of eyeball (**ocular conjunctiva**). The spaces formed by the junction of these parts are called **superior and inferior conjunctival fornices**. When the eye is closed, a slitlike space occurs between the conjunctiva-covered eyeball and eyelids. It is so-called **conjunctival sac**. The major function of the conjunctiva is to produce a lubricating mucus that prevents the eyes from drying out.



An important mechano-protective role is also played by cilia and eyebrows, which are derivatives of hair cover.

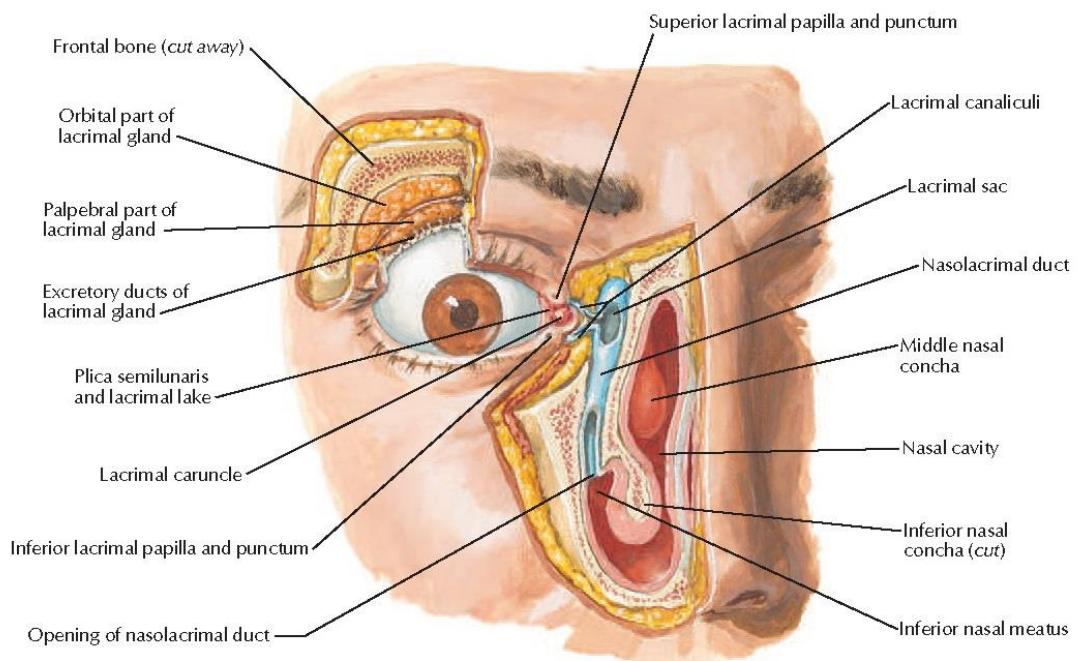
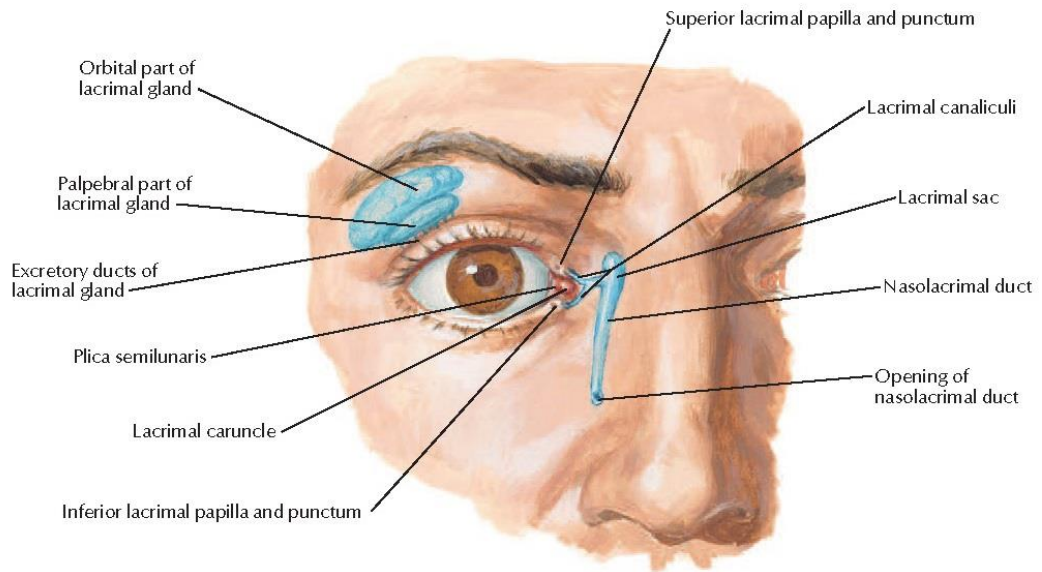
LACRIMAL APPARATUS OF THE EYE

- lacrimal gland,
- lacrimal canaliculi,
- lacrimal sac,
- nasolacrimal canal.

A lacrimal gland is located in the same-name fossa of the frontal bone. It produces moistening a conjunctive sac and cornea liquid (tear). Structurally, the lacrimal gland is compound alveolar-tubular and its canals (about 12-15) are open in the upper vault of the conjunctiva.

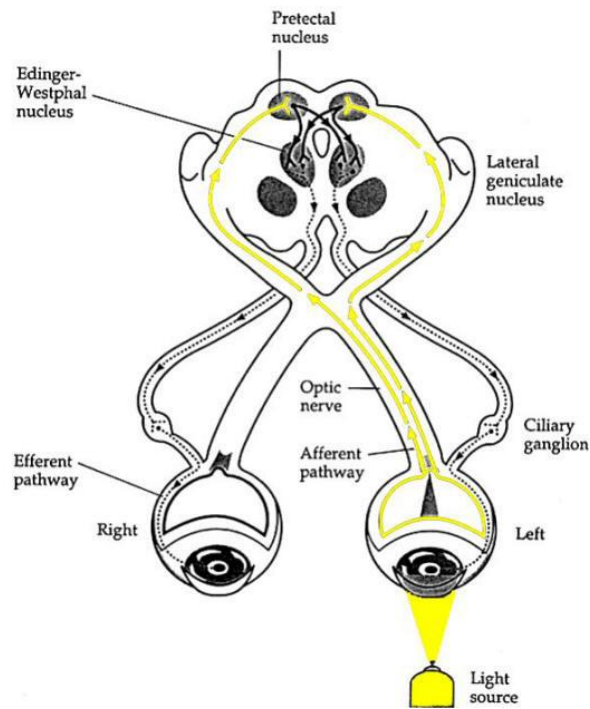
When the eyelids are closed, tear flows to the *rivus lacrimalis* – a deepening on the posterior edges of the eyelids. When the eyelids are open, tear flows down from the lateral to the medial corner of eye due to blinks. A lacrimal lake is located in the medial corner of the eye, on the floor of which there is a lacrimal caruncle. From the lacrimal lake, the tear is sucked in through two lacrimal ductules (upper and lower) and enters the lacrimal sac. It is located in the same name fossa on the medial wall of the eye socket. Muscular fibers surround the sac as a loop and at blinking or squeezing or extension, pass the tear to the nasolacrimal canal. The nasolacrimal canal is the downward continuation of the lacrimal sac and is disposed in the same name bone canal. It drains to the anterior part of the inferior nasal meatus.

The occlusion of some part of this system of canals or hyperproduction of tears, it will flow down onto the face.



PATHWAY OF PUPILLARY REFLEX

Part of axons of the second neurons of the visual pathway, located in the superior colliculi of quadrigeminal plate of midbrain, go to the accessory Yakubovich's nucleus, where they acquire a parasympathetic part and join fibers of the oculomotor nerve. In its composition they pass through the superior orbital fissure in the orbital cavity and go to the ciliary ganglion. From the ciliary ganglion, parasympathetic nerves supply the m. sphincter pupili (sympathetic nerves innervate m.dilator pupili).



TRACT OF VISUAL ANALYZER

General characteristics:

- sensitive,
- conscious,
- 3- neuronal,
- has partial decussation.

I neurons - bipolar cells of the retina. Their dendrites end on photoreceptor cells - rods and cones; axons within the retina switch body II neurons.

II neurons - ganglion (multipolar) cells of the retina. Their axons form the optic nerve, leaving the eyeball in its posterior pole. The optic nerves pass through the optic canal from the orbit to the cavity of the skull. In the cranial cavity the medial conductors of the optic nerve from the medial regions of the retina (lateral fields of view) cross with the formation of the optic chiasm; lateral conductors from the lateral regions of the retina (medial fields of view) continue on their sides. After the optic chiasm the conductors of the optic nerves are combined in the visual pathway, its conductors go directly to III neurons.

III neurons - cells of the thalamic pulvinar and lateral geniculate bodies of metathalamus (subcortical centers of the view of the diencephalon). Their axons through the posterior leg of the internal capsule go to the cortex of the occipital lobe (the area of gyrus cinguli) - cortical end of the visual analyzer of the I signal system and to the cortex of angular gyrus of the inferior parietal lobule – center of lexia. Part of the conductors of the visual pathway (unconscious portion) passes through the lateral geniculate bodies, then through brachium of superior colliculus and synapse to cells of nuclei tecti (subcortical centres of vision of the midbrain) to lock arc of:

- "start-reflex" (approximate reflex) in response to eye irritation.
- pupillary reflex.

