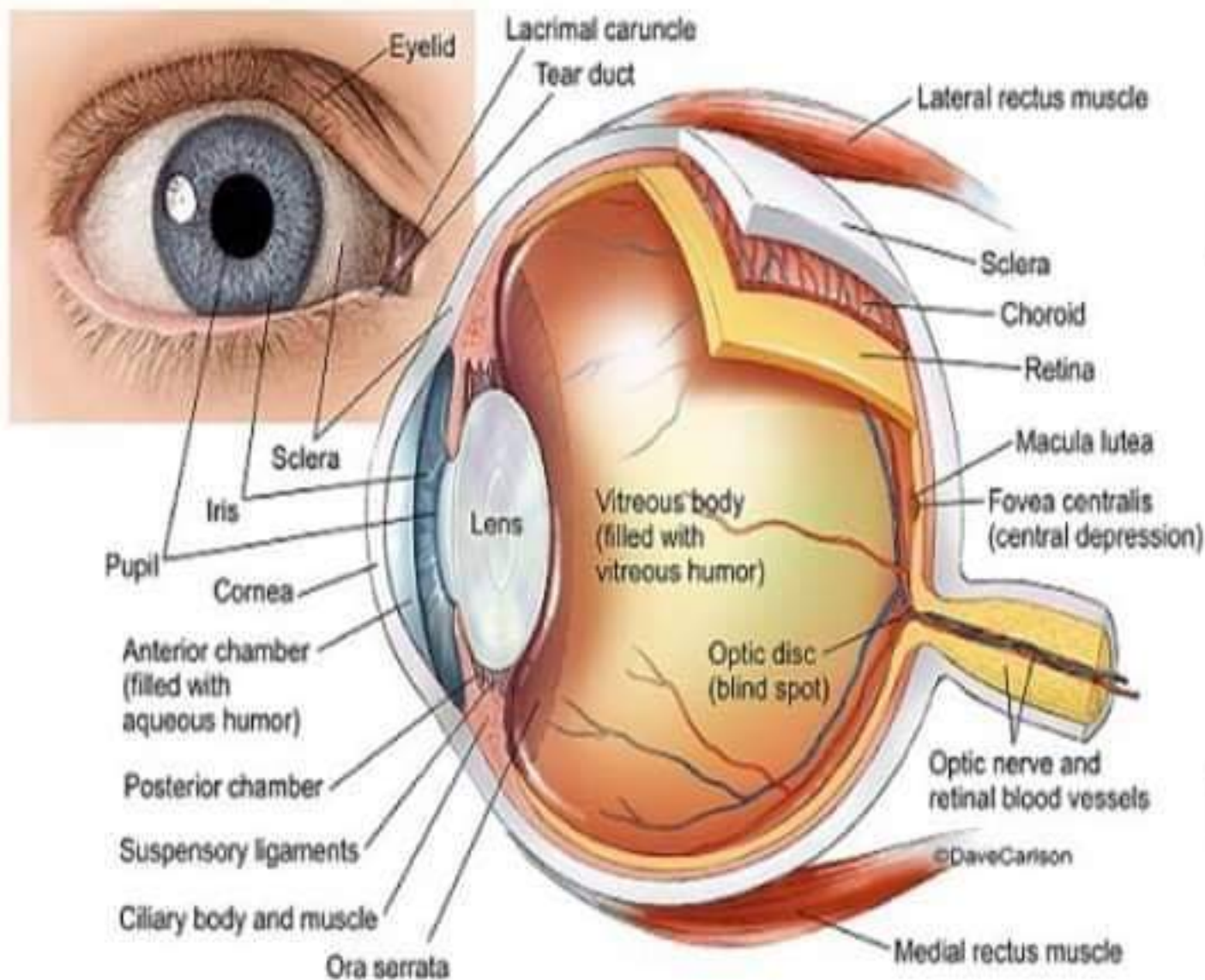
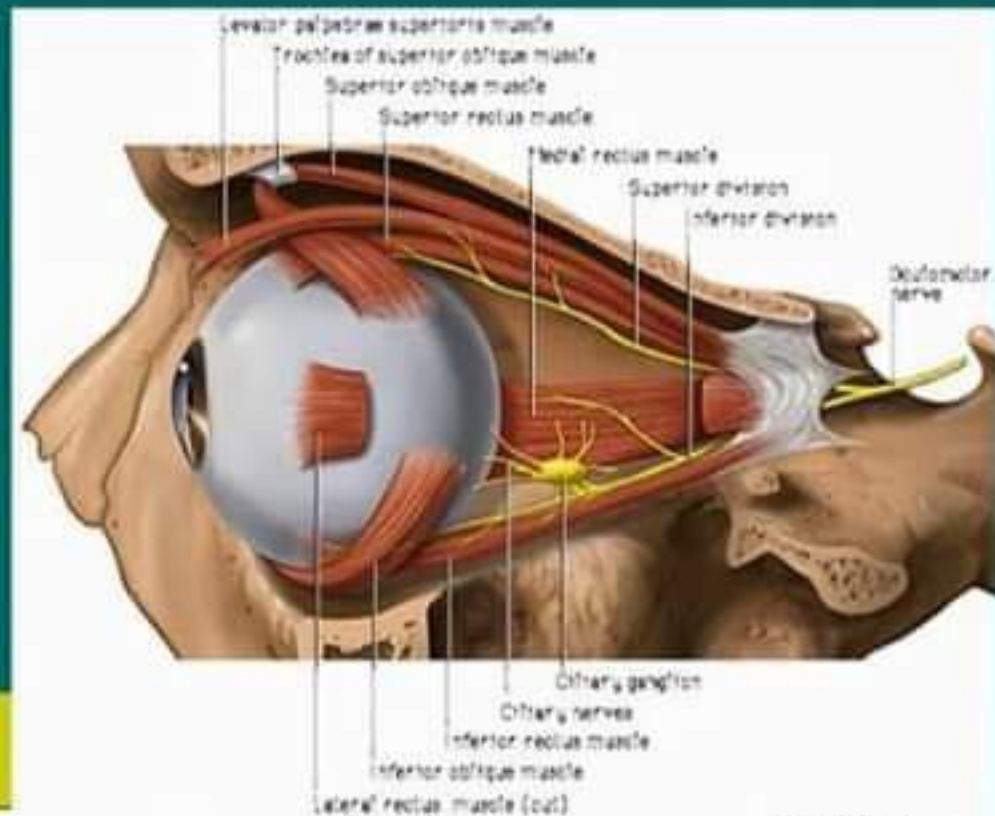
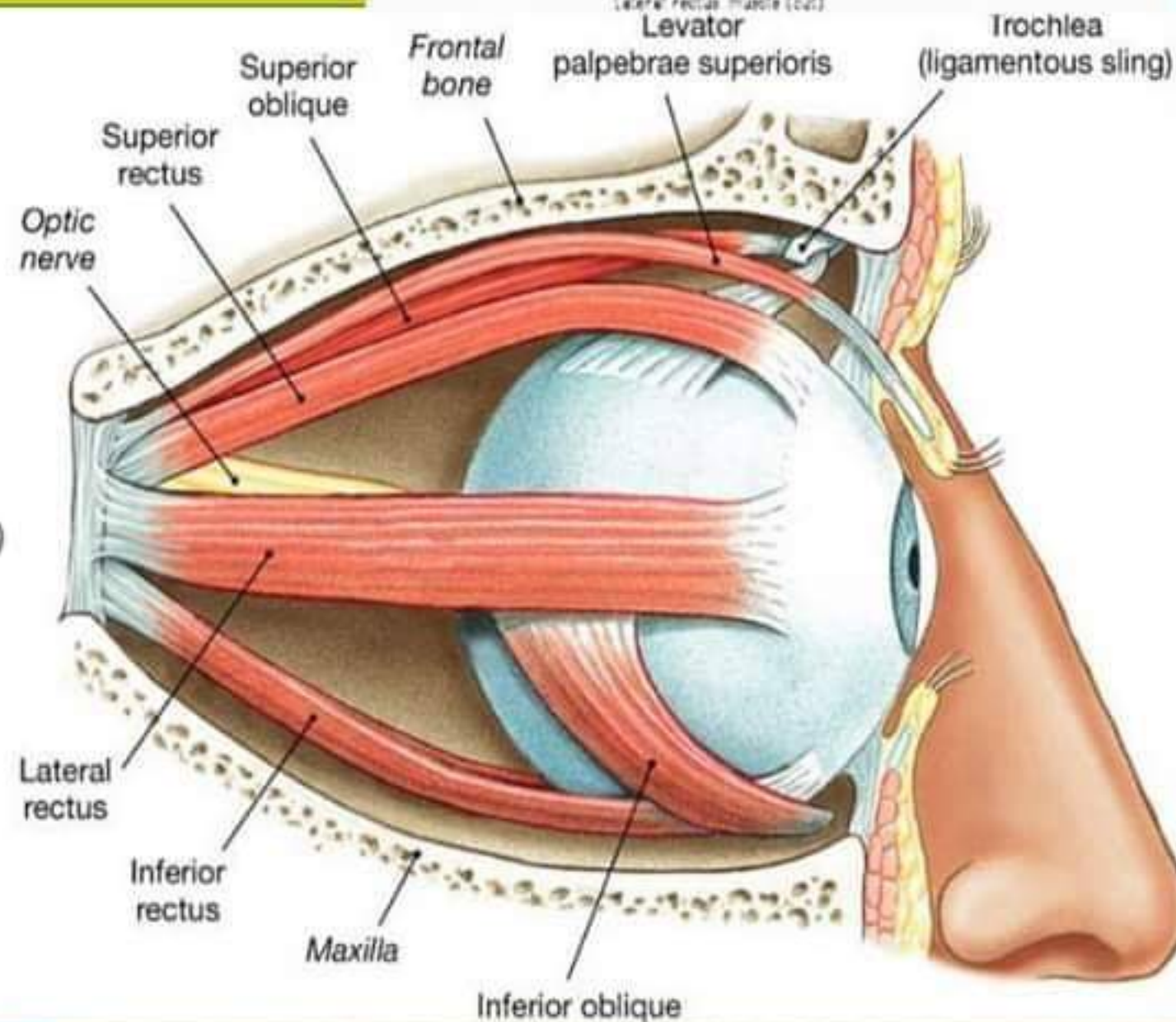


ANATOMY & PHYSIOLOGY

MD Sun Bunlorn



Right Eye (viewed from above)



Outer eye: Eyelids

The eyelids fulfill two main functions:

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- *protection of the eyeball*
- *secretion, distribution and drainage of tears*

Lid movement

- The levator extends from an attachment at the orbital apex to attachments at the tarsal plate and skin.
- The lids are securely attached at either end to the bony orbital margin by the medial and lateral palpebral ligaments.
- Trauma to the medial ligament causes the lid to flop forward and laterally, impairing function and cosmesis.

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Innervation

- Sensory innervation is from the **trigeminal (fifth) cranial nerve**, via the ophthalmic division (upper lid) and maxillary division (lower lid).
- The orbicularis oculi is innervated by the **facial (seventh) nerve**.
- The levator muscle in the upper lid is supplied by **the oculomotor (third) nerve**.

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Blood supply and lymphatics

The eyelids are supplied by an extensive network of blood vessels which form an anastomosis between branches derived from the external carotid artery via the face and from the internal carotid artery via the orbit.

Blood supply and lymphatics

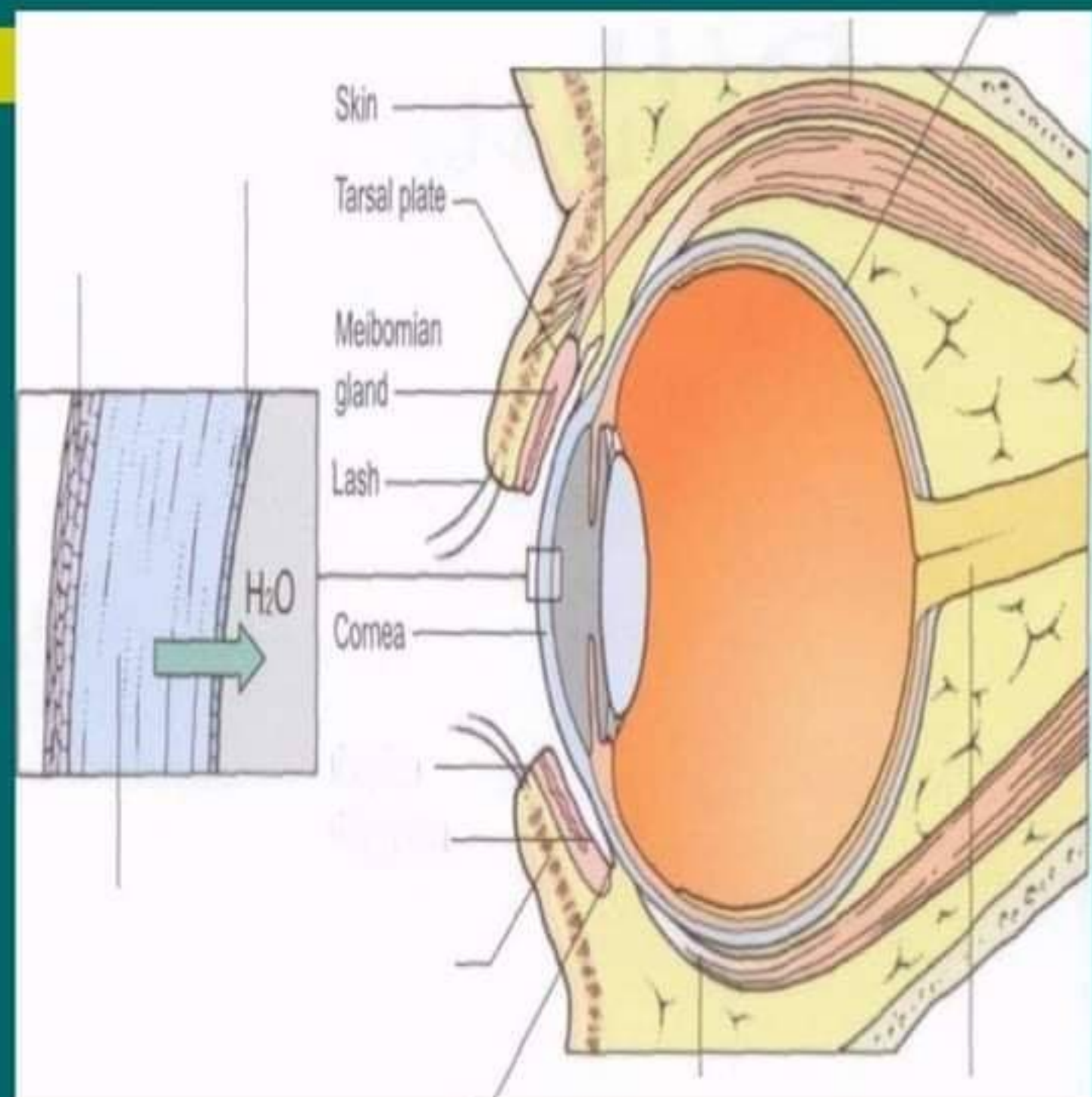
- Lymphatic fluid drains into the preauricular and submandibular nodes.

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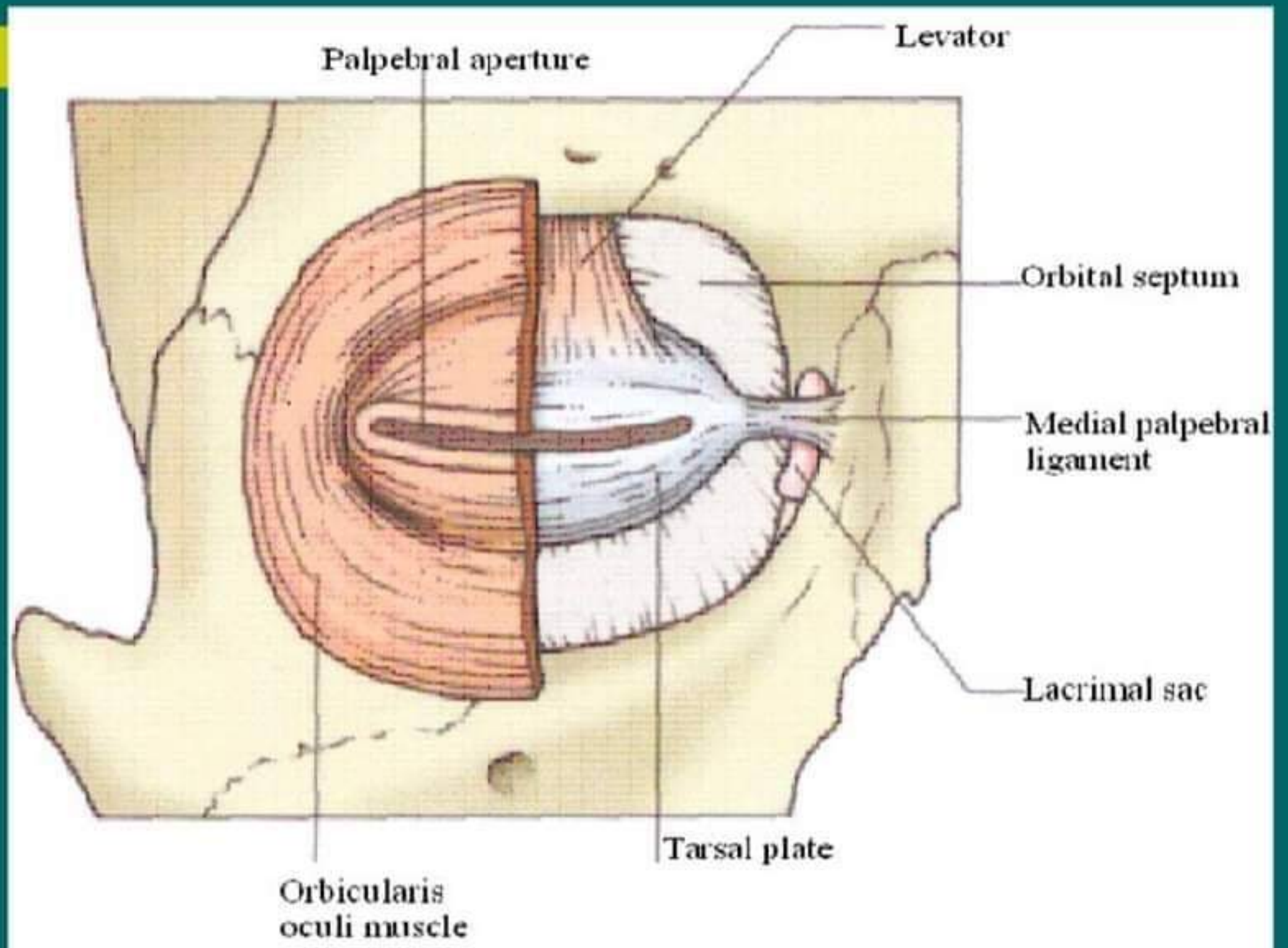
- Preauricular lymphadenopathy is a useful sign of infective eyelid swelling (especially viral).

Eyelids and eyeball

- Superior fornix of conjunctiva
- Levator muscle
- Sclera
- Grey line
- Conjunctiva
- Orbicularis oculi muscle
- Inferior fornix of conjunctiva
- Extraocular muscle
- Optic nerve



Eyelid structure



Conjunctiva

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- The conjunctiva is a mucous membrane lining the eyelids and covering the anterior eyeball up to the edge of the cornea.
- At the upper and lower reflections between eyeball and eyelid the conjunctiva forms two sacs, the superior and inferior fornices .

The cornea and sclera form a spherical shell which makes up the outer wall of the eyeball.

Cornea and sclera

- The sclera is :
- principally collagenous,
- avascular (apart from some vessels on its surface)
- relatively acellular.

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It is perforated posteriorly by the optic nerve, and by sensory and motor nerves and blood vessels to the eyeball.

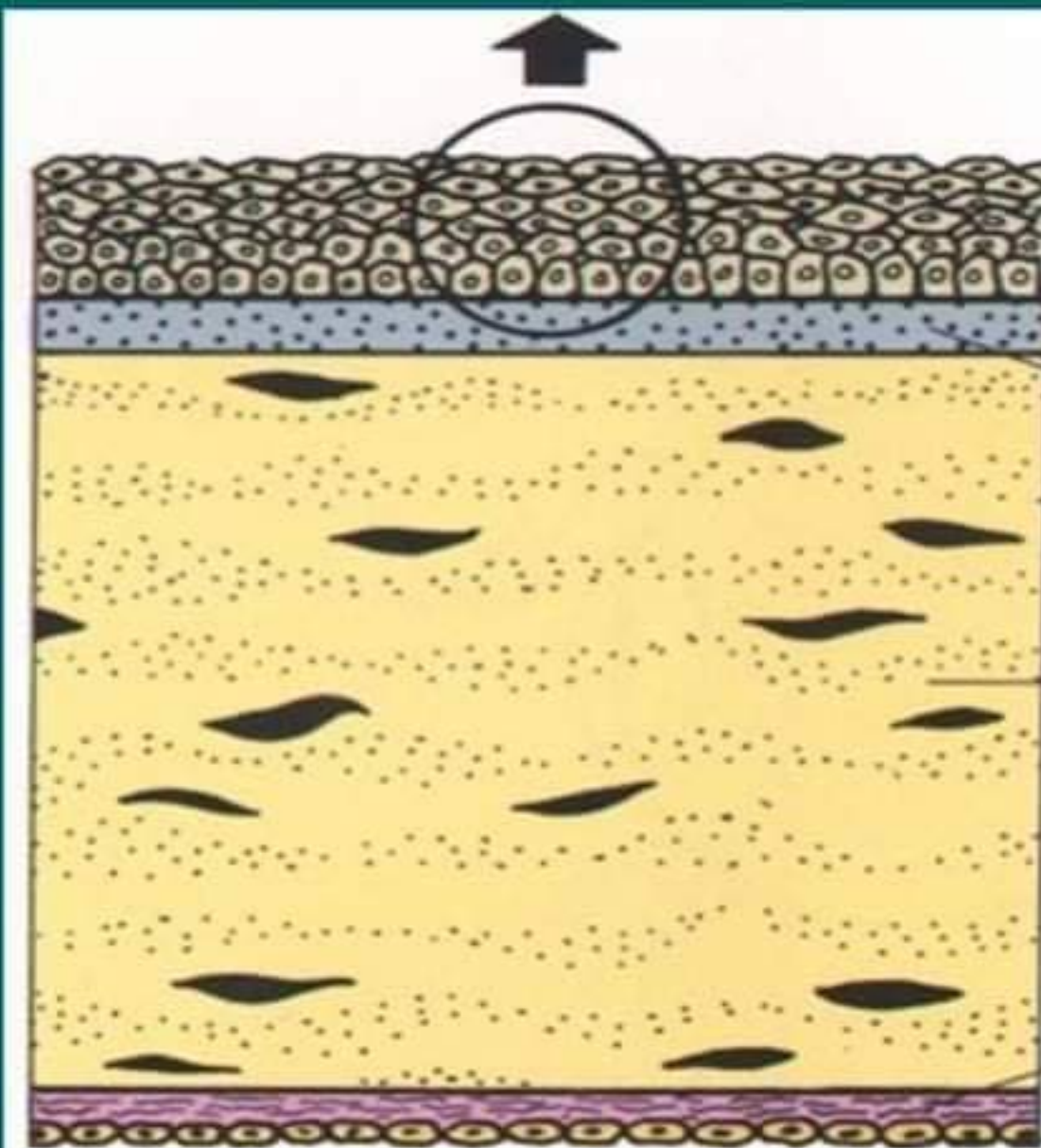
The cornea and sclera merge at the corneal edge (the limbus).

The chief functions of the cornea

- are protection against invasion of microorganisms into the eye, and the transmission and focusing (refraction) of light.

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Cornea



- Epithelium
- Bowman membrane
- Stroma
- Descemet membrane (posterior limiting layer of cornea)
- Endothelium

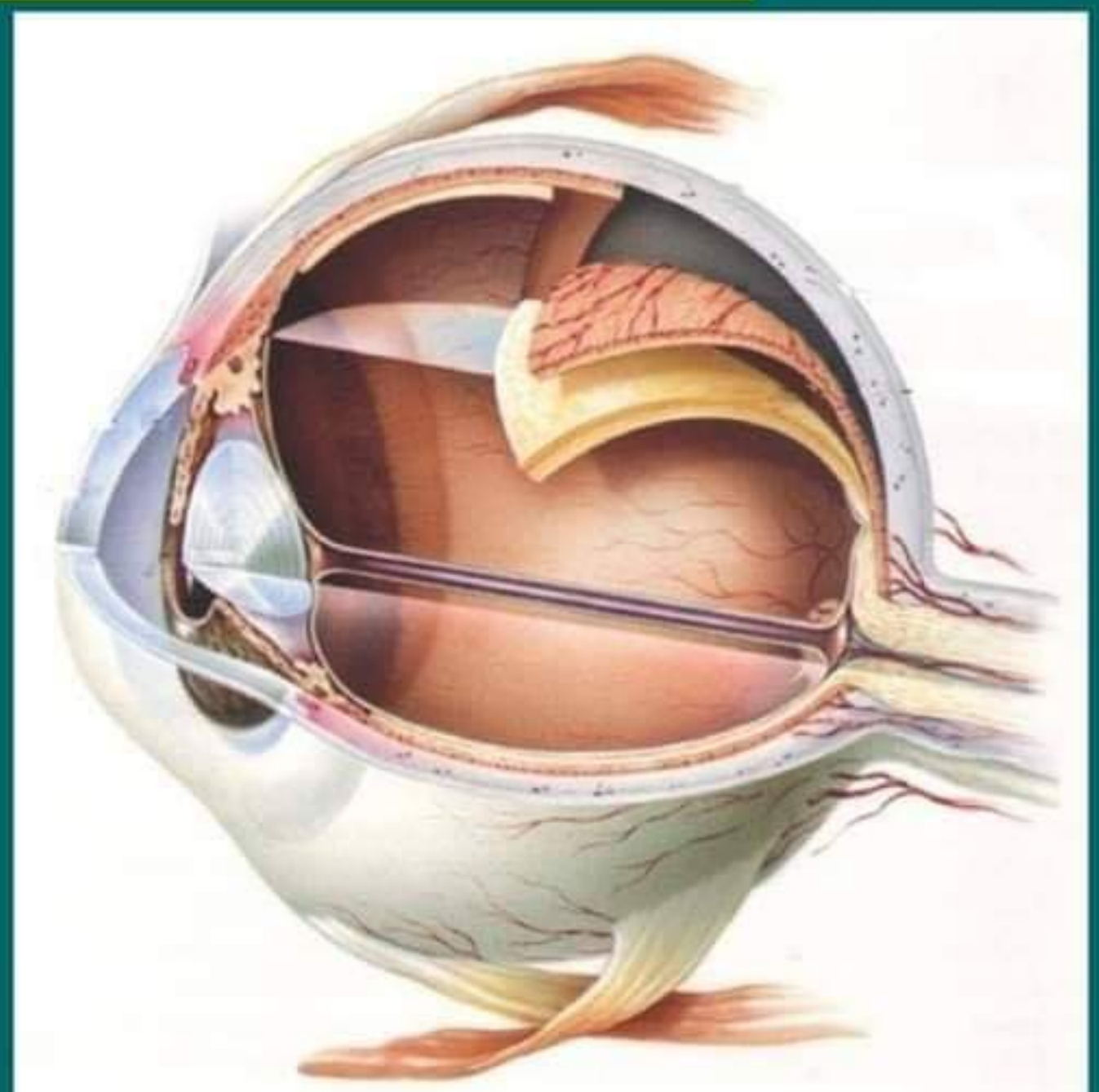
Cornea and sclera

- Retraction of light occurs because of the curved shape of the cornea and its greater refractive index compared with air.
- The cornea is transparent because of the specialised arrangement of the collagen fibrils within the stroma, which must be kept in a state of relative dehydration.

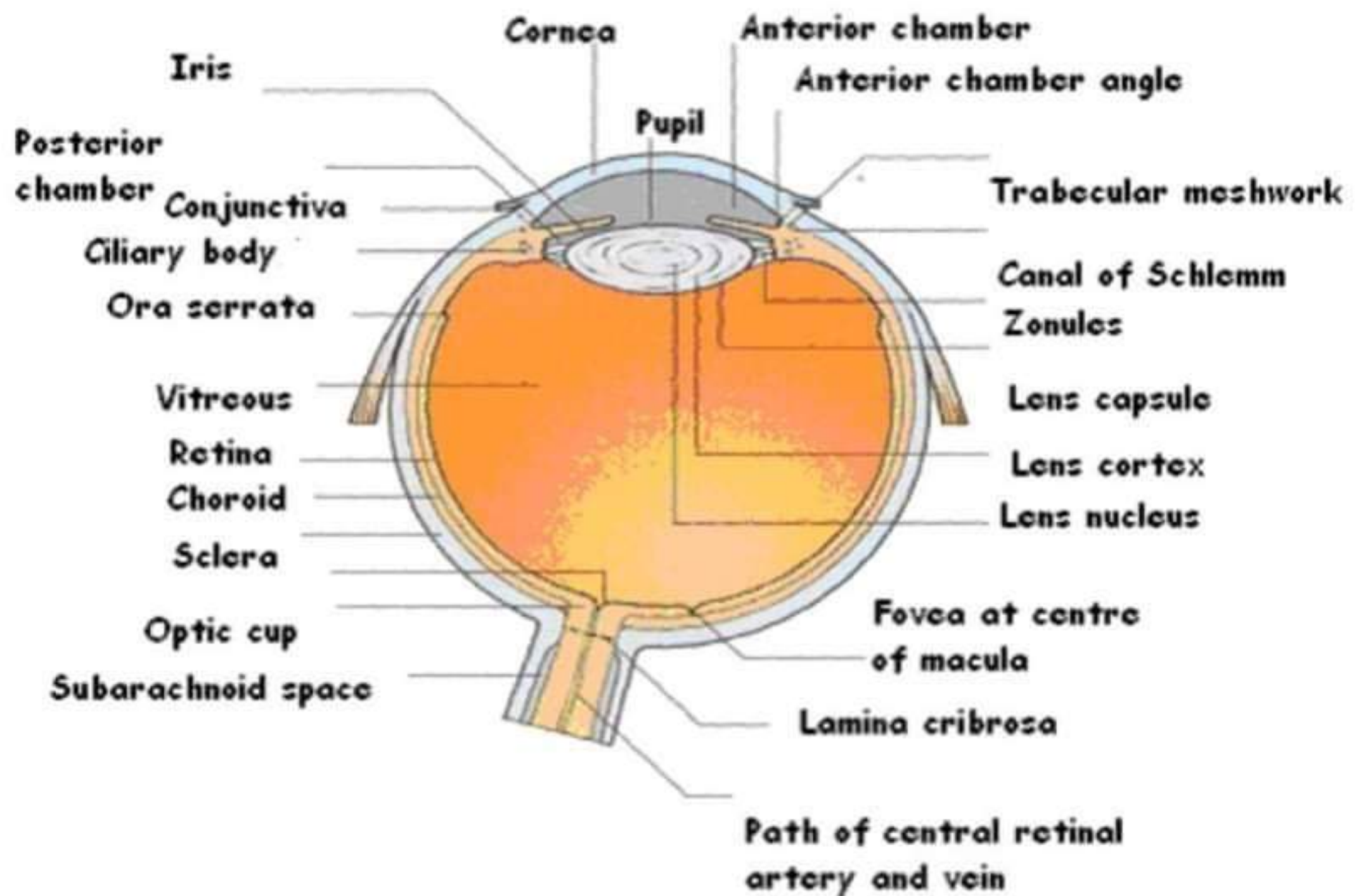
Sagittal section of the eye

- Fibrous tunic of eye
- Choroid
- Retina

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Sagittal section of the eye



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Tear production and drainage

- The lacrimal gland secretes most of the aqueous component of the tear film .
- It lies in the superotemporal part of the anterior orbit Its anterior lobe can sometimes be seen in the upper conjunctival fornix.
- It is innervated by parasympametic fibres carried by the facial nerve.

Tear production and drainage

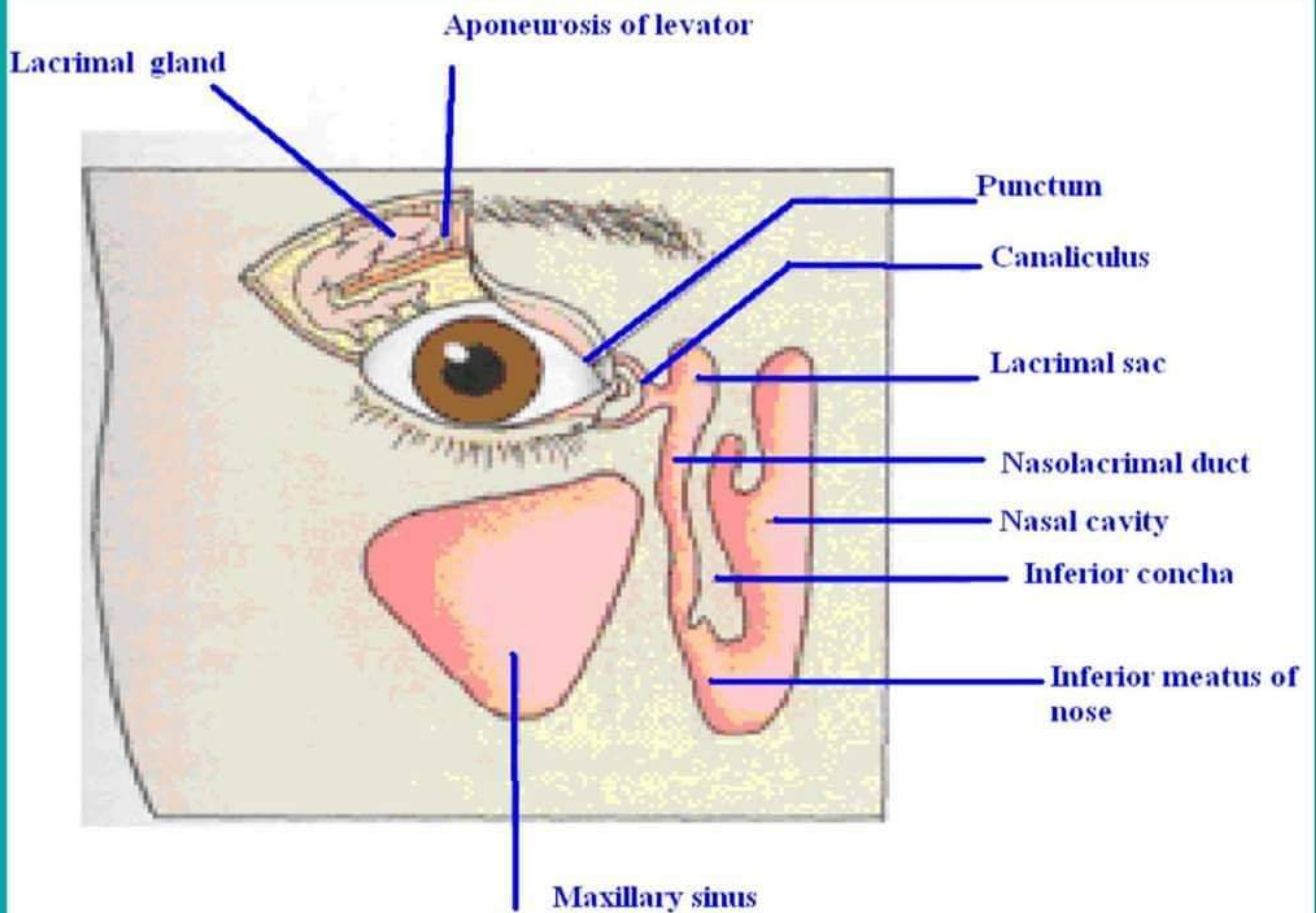
- Tears collect in a meniscus on the lower lid margin, are spread across the ocular surfaces by blinking, and drain into the superior and inferior puncta at the nasal end of the eyelids. Single canaliculi from each punctum unite in a common canaliculus which ends in the lacrimal sac. This is in a bony fossa crossed anteriorly by the horizontally directed medial palpebral ligament. Finally, tears pass down the nasolacrimal duct and reach the nasopharyngeal cavity *via* the inferior meatus. This accounts for the unpleasant taste which follows administration of certain eyedrops.

Tear production and drainage

- At birth, the **nasolacrimal duct** may not be fully developed, causing a watery eye.

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- Acquired obstruction of the nasolacrimal duct is a common cause of a watery eye in adults. It may lead to an acute infection of the sac.



!!!Anatomy and physiology: outer eye

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Eyelids

- **protect** the eyeball and distribute tears across the cornea
- closure by contraction of orbicularis oculi muscle (facial nerve)
- opening by levator muscle (oculomotor nerve)
- lid margin comprises a row of lashes in front of a row of meibomian gland orifices separated by the grey line

Conjunctiva

- a mucous membrane which contributes to tear production and resistance to infection.

Cornea

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a highly specialised tissue

- main function is refraction and transmission of light
- structure is an outer epithelium, an avascular hypocellular stroma and a non-replicating endothelial monolayer
- the endothelium pumps water out of the stroma into the anterior chamber; failure leads to loss of transparency

Tears

- oily lipid layer secreted by meibomian glands; aqueous layer by lacrimal and conjunctival glands;
 - mucin by conjunctival goblet cells
- drain into the puncta, then canaliculi, then lacrimal sac, then into nose via nasolacrimal duct.

Sensation

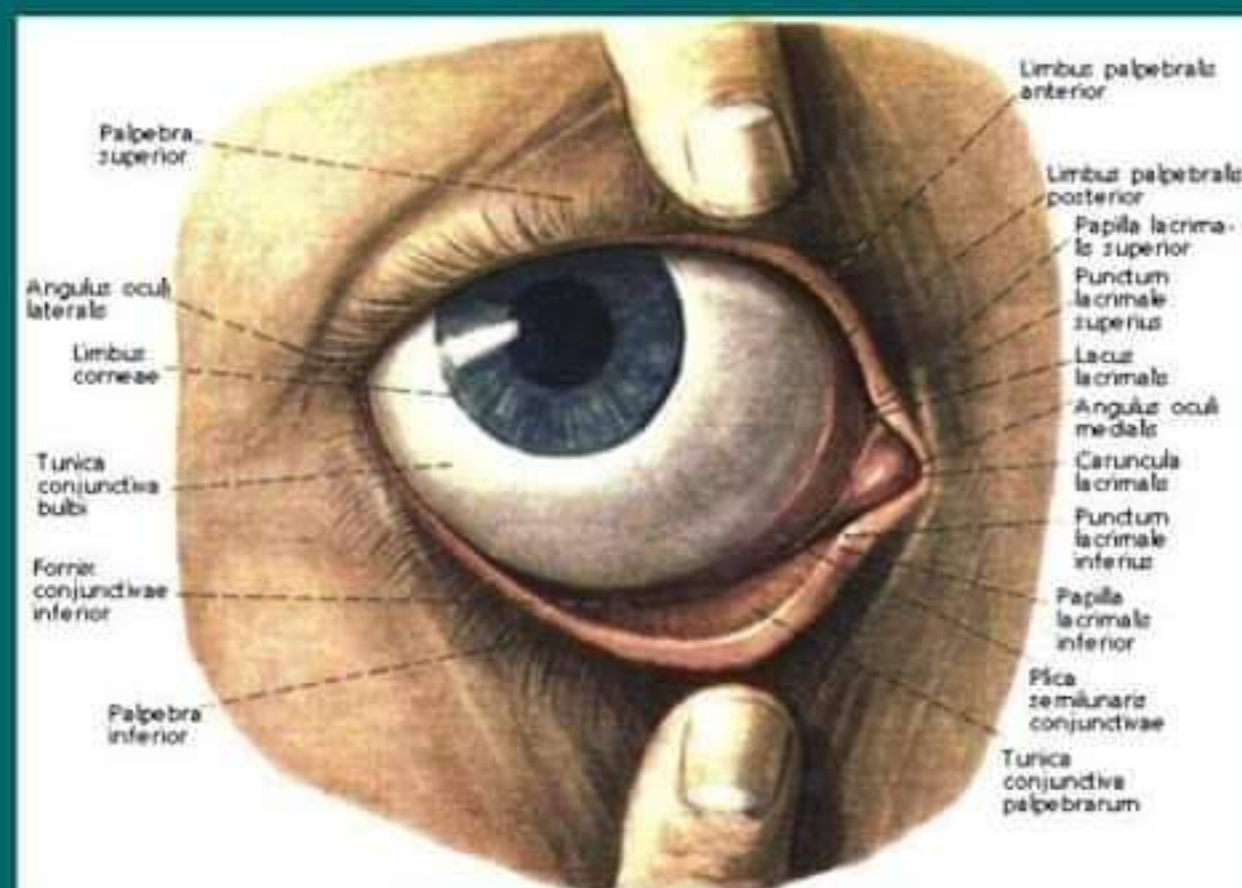
- trigeminal nerve, mostly via the ophthalmic division
(maxillary to the lower lid).

BASIC PRINCIPLES

Anatomy and physiology: inner eye

Inner eye

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UVEA

- The uvea comprises the iris and ciliary body anteriorly and the choroid posteriorly .

Iris

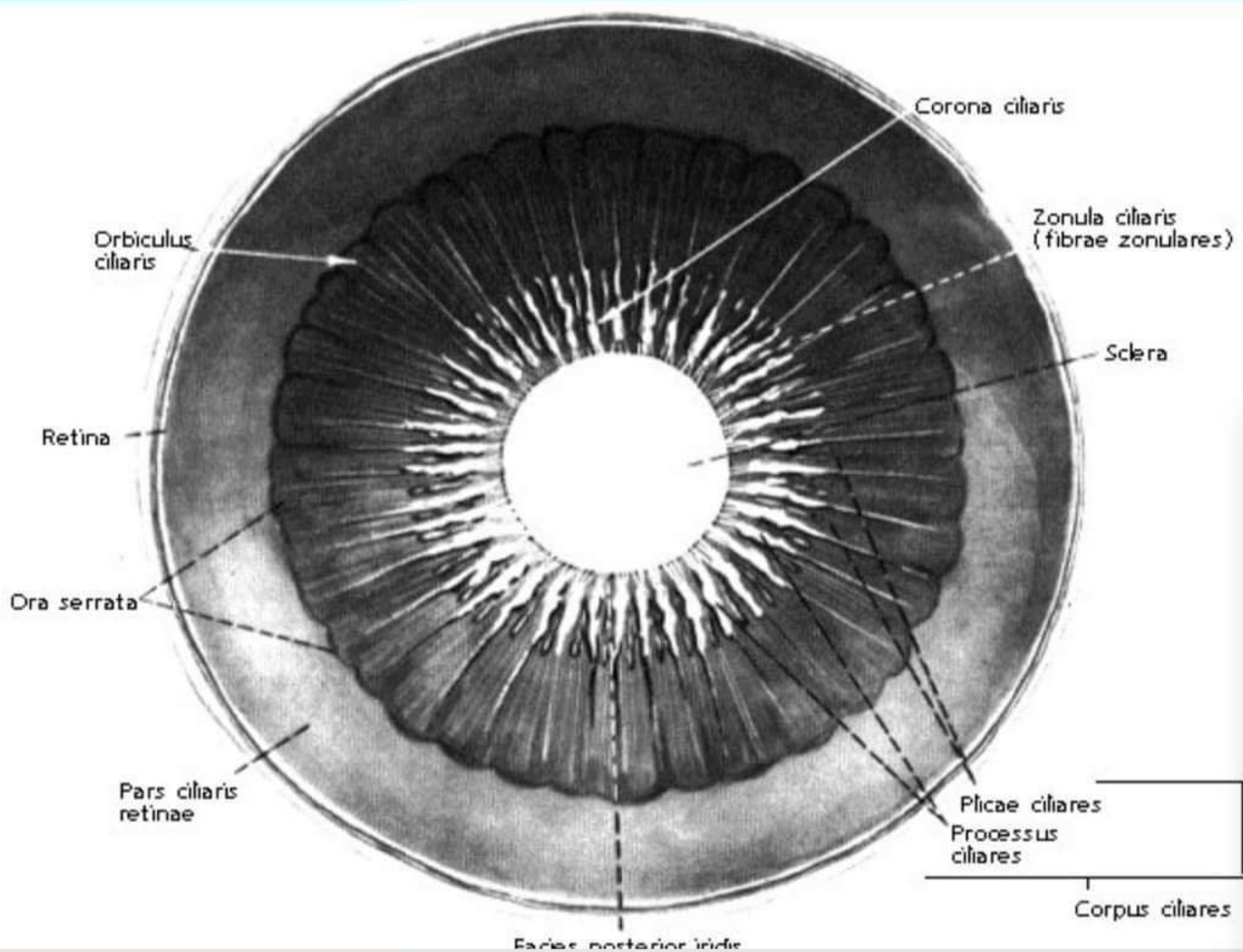
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The iris largely consists of connective tissue containing muscle fibres, blood vessels and pigment cells.

Its posterior surface is lined by a layer of pigment cells. At its centre is an aperture, the pupil.

The chief functions of the iris are to control light entry to the retina and to reduce intraocular light scatter.

Pupil dilation is caused by contraction of radial smooth muscle fibres innervated by the sympathetic nervous system.



Ciliary body

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- The ciliary body is a specialised structure uniting the iris with the choroid.
- It makes aqueous humour and anchors the lens via the zonules, through which it modulates lens convexity.

Ciliary Body

- This is called accommodation and is controlled by parasympathetic fibres in the oculomotor nerve.
- The posterior part of the ciliary body merges into the retina at the ora serrata.

Choroid

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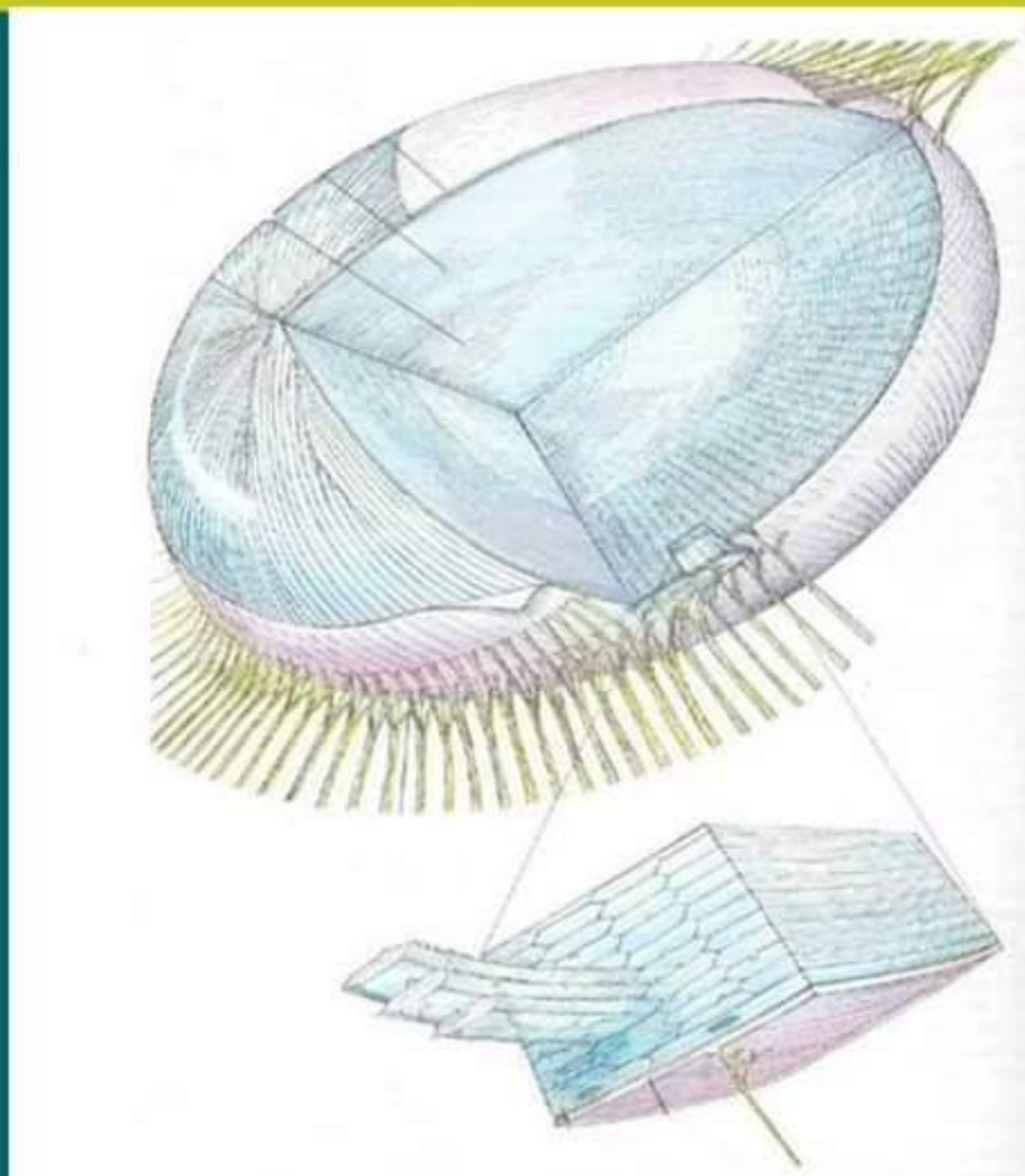
- The choroid, **consisting** of blood vessels, connective tissue and pigment cells, is sandwiched between the retina and the sclera.
- It **provides** oxygen and nutrition to the outer retinal layers.

Lens

- The discus-like lens comprises a mass of long cells known as fibres. At the centre these fibres are compacted into a hard nucleus surrounded by less dense fibres, the **cortex**.
- The lens is relatively dehydrated and its fibres contain special proteins. This is why it is transparent.

Lens

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Aqueous humour

fills the anterior and posterior chambers.

The anterior chamber is the space between the cornea and the iris.

Behind the iris and in front of the lens is the **posterior chamber**.

They are **connected** by the pupil.

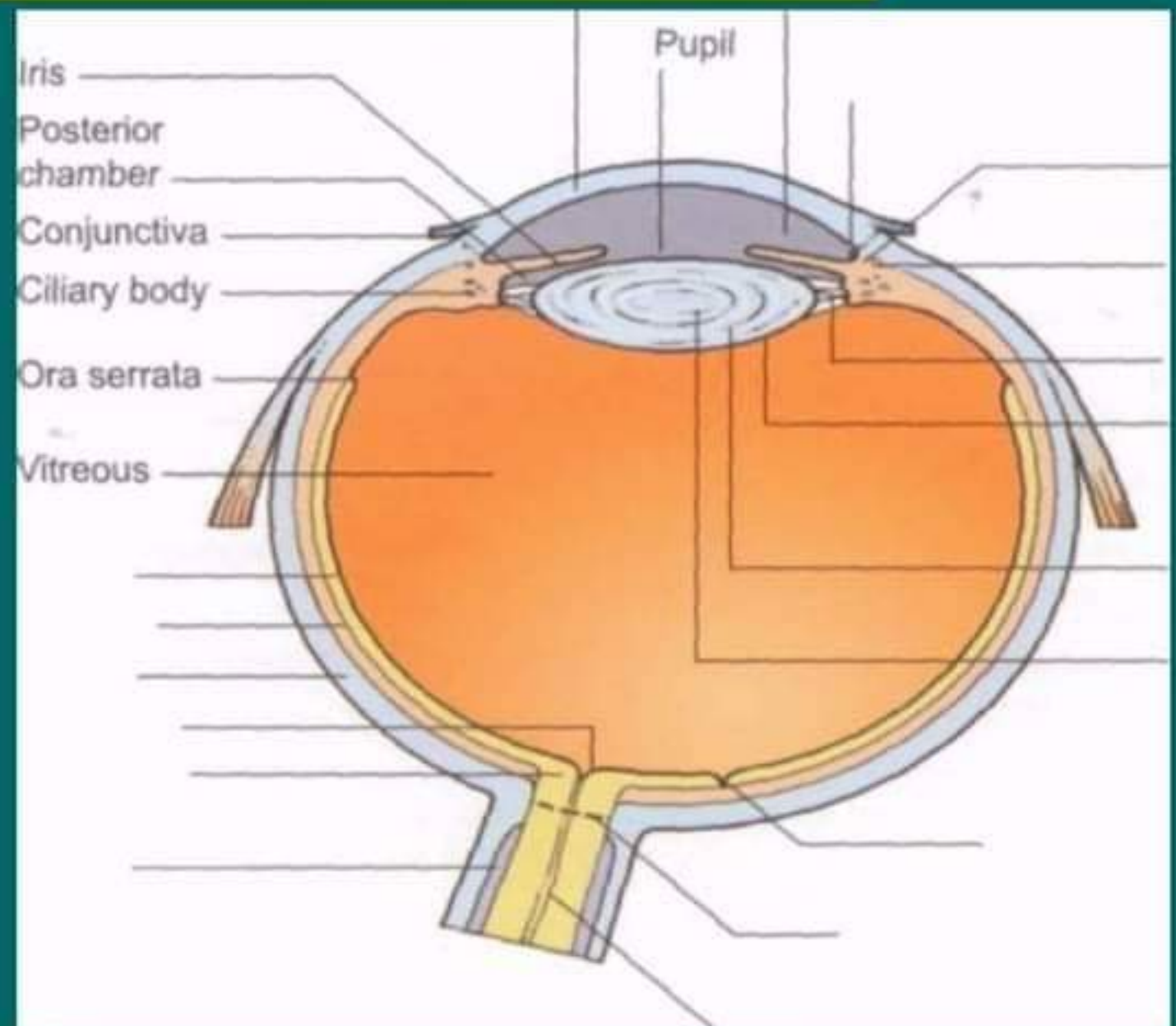
Formation

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- **The ciliary body forms aqueous humour by ultrafiltration and active secretion.**

Sagittal section of the eye

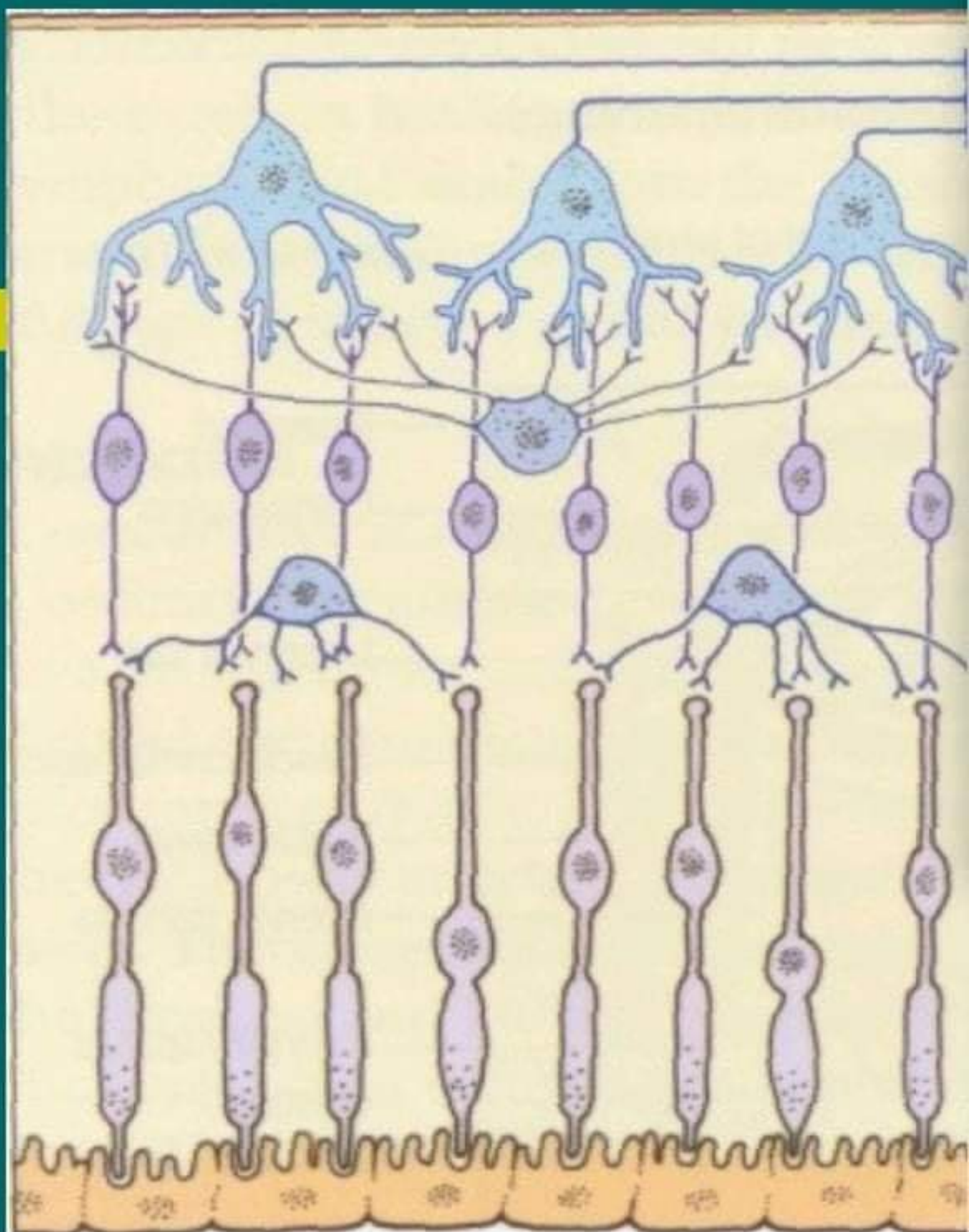
- Retina
- Choroid
- Sclera
- Optic cup
- Optic disc
- Subarachnoid space
- Anterior chamber angle
- Trabecular meshwork
- Canal of Schlemm
- Zonules
- Lens capsule
- Lens cortex
- Lens nucleus
- Fovea at centre of macula
- Lamina cribrosa
- Path of central retinal artery and vein



Layers of the retina

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- Ganglion cells
- Connecting and processing cells
 - Photoreceptor rods and cones
- Retinal pigment epithelium



Drainage

Aqueous circulates from the posterior to the anterior chamber through the pupil, leaving the eye through the trabecular meshwork.

This is a specialised tissue in the anterior chamber angle between the iris and the cornea. From here aqueous drains into Schlemm's canal.

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Vitreous

- The vitreous body is 99% water but, vitally, also contains collagen fibrils and hyaluronan, which impart cohesion and a gel-like consistency.
- The vitreous is adherent to the retina at certain points, particularly at the optic disc and at the ora serrata.

Retina

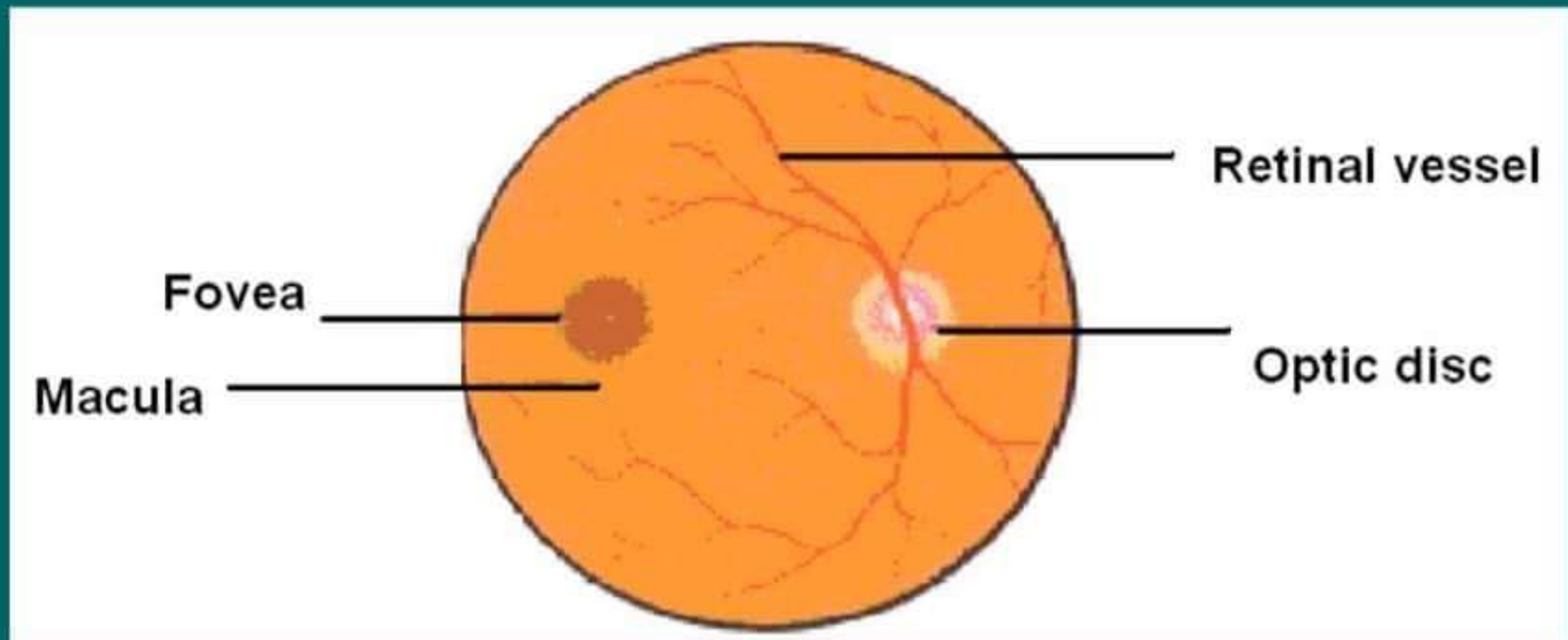
- The retina **converts** focused light images into nerve impulses. Light has to pass through the inner retina to reach the photoreceptors, the rods and cones, which convert light energy into electrical energy .
- Macula provides for central vision. At its centre is a specialised area, the fovea, which is for high quality vision.
- The rest of the retina is for peripheral vision.

Retina

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- **Cones, concentrated at the macula, are responsible for fine vision (acuity) and colour appreciation.**
- **Rods are for vision in low light levels and the detection of movement.**

Diagram of retina

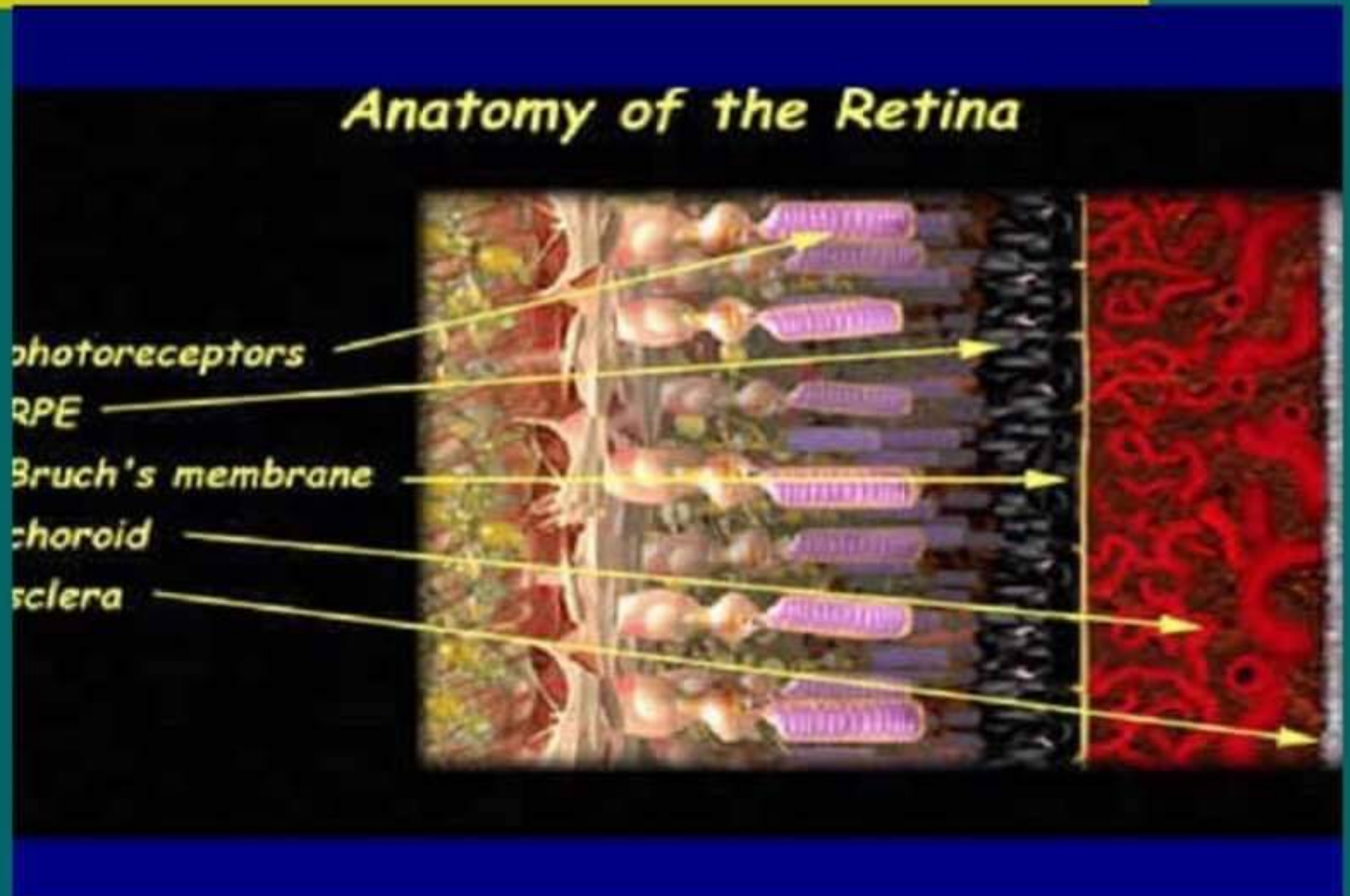


Retina

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- The blood supply of the retina is derived from the central retinal artery and vein, and from the choroid.
- The retinal vessels enter and leave the eye through the optic nerve and run in the nerve fibre layer. A major arterial and venous branch, forming an 'arcade', supplies each of the retinal quadrants .

RETINA



Optic nerve

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- The ganglion cell axons in the retinal nerve fibre layer make a right-angled turn into the optic nerve at the optic disc, which has no photoreceptor and corresponds to the physiological blind spot.

Optic Nerve

- Behind the eyeball these axons become myelinated.
- Here the optic nerve is surrounded by cerebrospinal fluid in an anterior extension of the subarachnoid space and is protected by the same membranous layers as the brain.

!!!Anatomy and physiology: inner eye

Iris

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- **constriction is parasympathetic**
- **dilation sympathetic**

Ciliary body

- forms aqueous humour;
- mediates accommodation (active-parasympathetic).

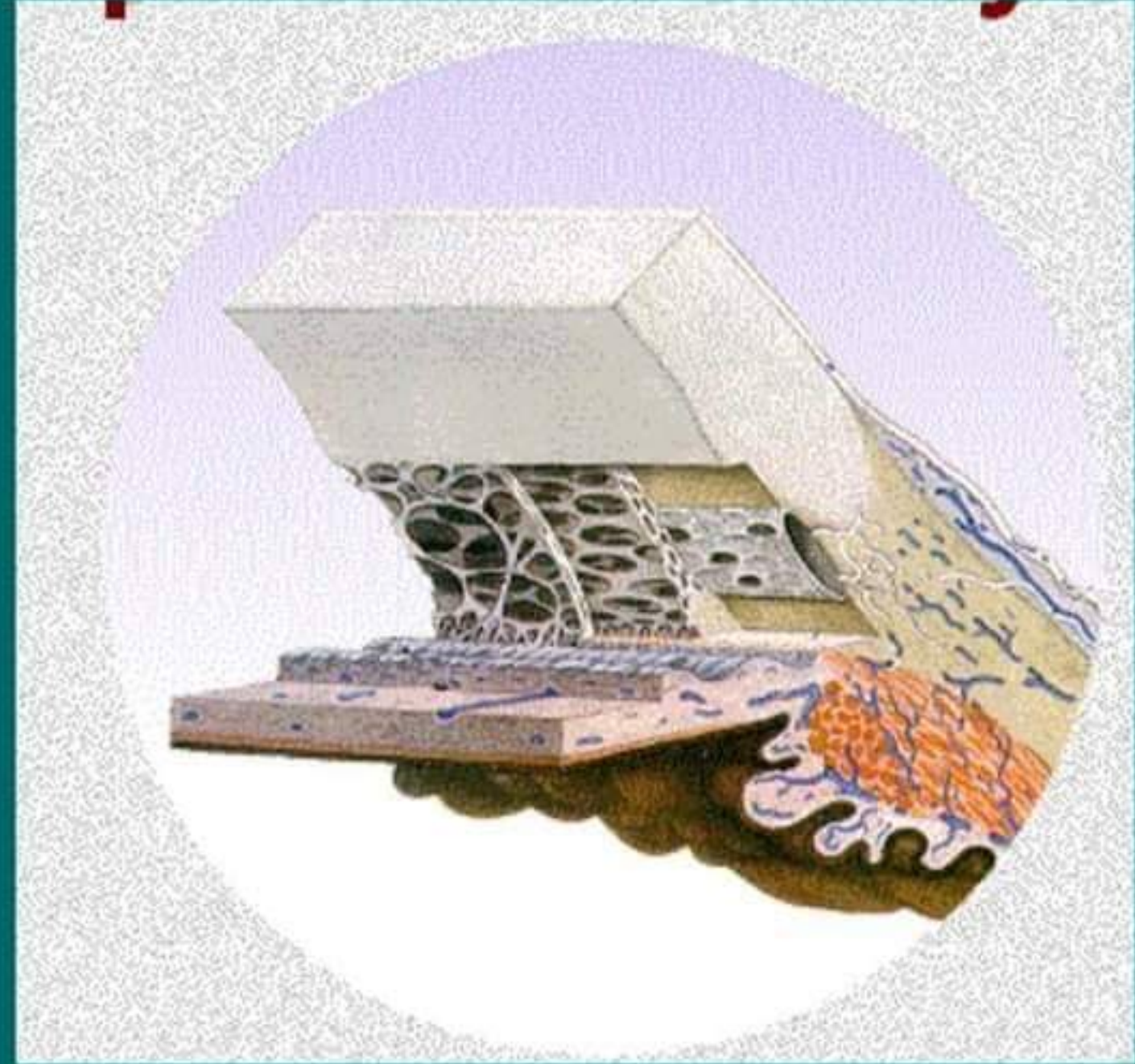
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Lens

- consists of a hard nucleus and softer cortex, bounded by a capsule and held in place by the zonules.

Aqueous drains

- Aqueous drains through the trabecular meshwork in the anterior chamber angle between the iris and cornea.



Retina

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- Requires intact retinal and choroidal vasculature and retinal pigment epithelial layer for normal function.
- Photoreceptors convert light energy into electrical; transmit to ganglion cells via connector neurones.
- Ganglion cell axons pass across the surface of the retina and leave the eye at the optic disc.
- Cone photoreceptors are concentrated at the macula for high quality colour vision.

The Orbit

- The optic nerves from each eye are coordinated intra-cranially and connected with other areas of the cerebral cortex.
- A set of motor centres, cranial nerve nuclei and connections harness the two eyes together to maintain binocular vision without diplopia .

The Orbit

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The bony walls of the orbit form a pyramidal structure. They are the frontal, maxillary, zygomatic, ethmoid, lacrimal and sphenoid bones . The medial wall and the floor of the orbit are thin.

- At the apex of the orbit, the optic foramen conveys the optic nerve backwards to the intracranial optic chiasm, and the ophthalmic artery forward into the orbit .

Lateral to the foramen are two fissures:

- The superior orbital fissure provides passage for the lacrimal, frontal and nasociliary nerves (ophthalmic division of the fifth cranial nerve), the third, fourth and sixth cranial nerves, and the superior ophthalmic vein passing to the cavernous sinus.

The Orbit

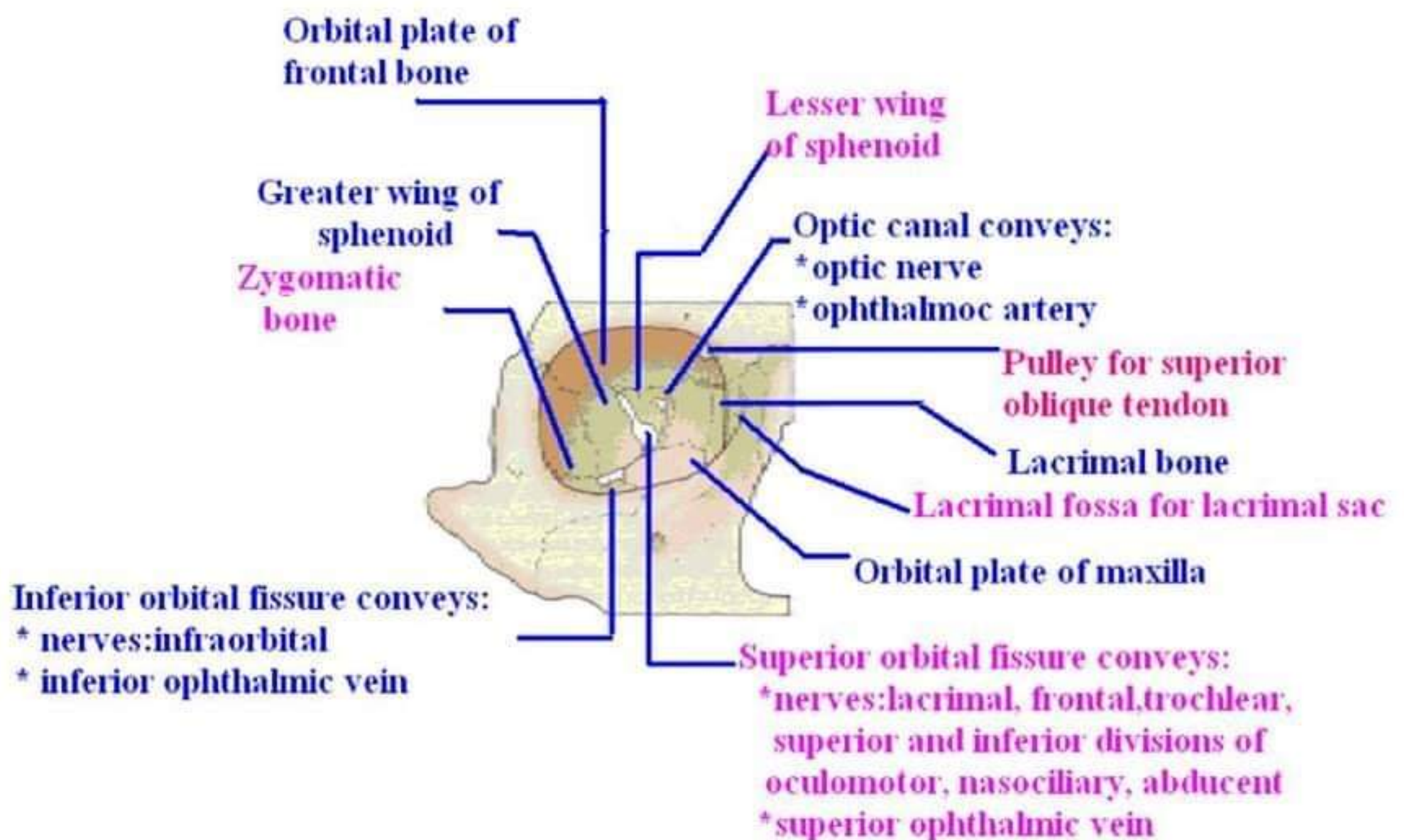
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- The inferior orbital fissure permits exit of the inferior ophthalmic vein from the orbit and entry of the maxillary division of the fifth cranial nerve (thus a fracture of the floor of the orbit can cause abnormal sensation on the cheek).

The Orbit

- The four extraocular rectus muscles form a cone within which are the sensory and autonomic nerves and arteries to the eyeball, including the optic nerve and the motor nerves to all the extraocular muscles including the levator but excluding the superior oblique.

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Extraocular muscles

- The four rectus muscles have a common posterior attachment to a ring of connective tissue which surrounds the optic foramen. They pass forwards around the eyeball to insert 5-7 mm behind the limbus .

Levator muscle

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- Levator muscle (third nerve) passes forward and widens into a broad aponeurosis, attaching to the superior tarsal plate and eyelid skin.

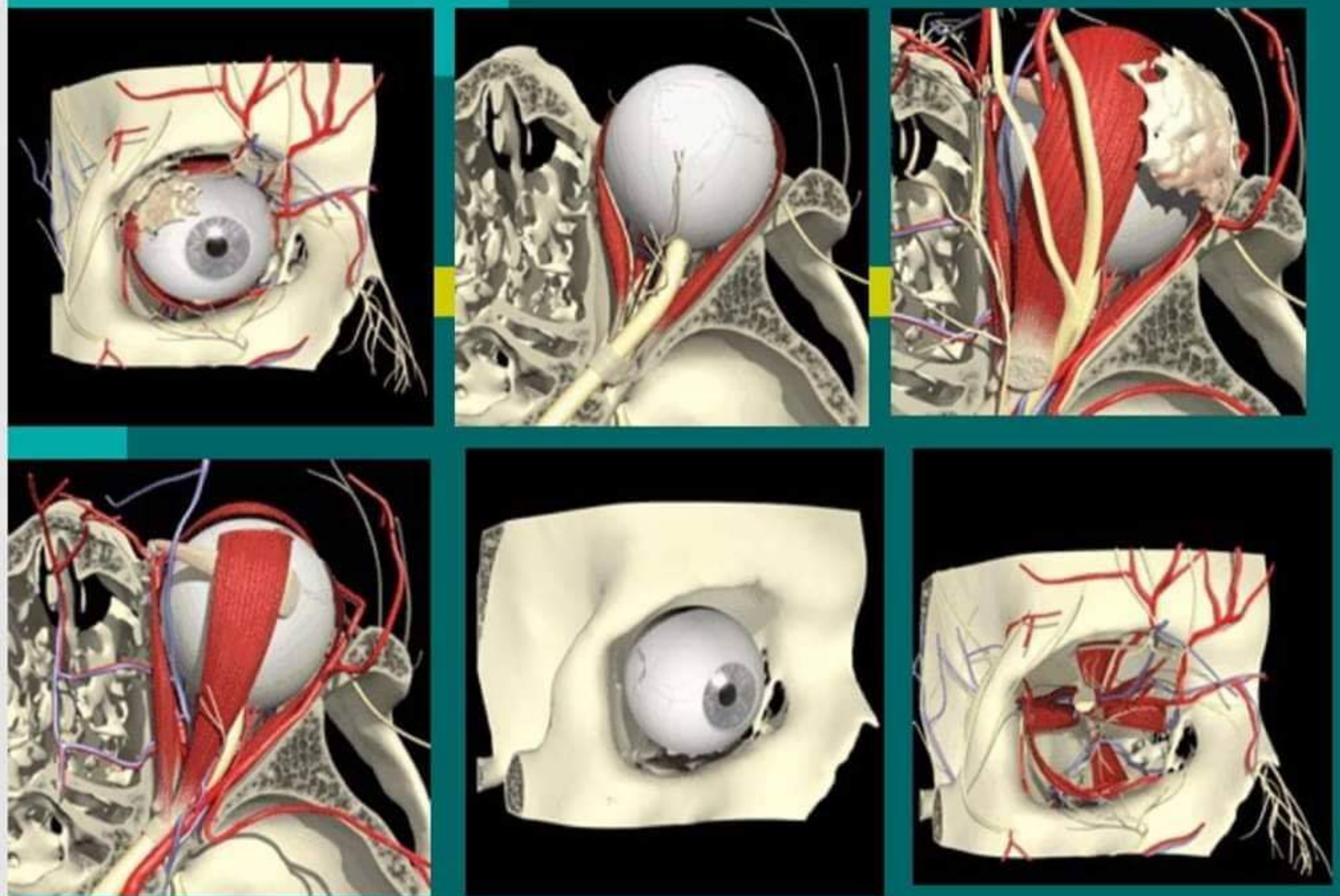
Nerves of the Orbit

- In addition to the motor nerves to the extraocular muscles the orbit contains sensory and autonomic nerves .
- The chief sensory nerve is of course the optic nerve. It is enclosed within a sheath continuous with the intracranial meninges, so that the subarachnoid space extends right up to the globe.

Nerves of the Orbit

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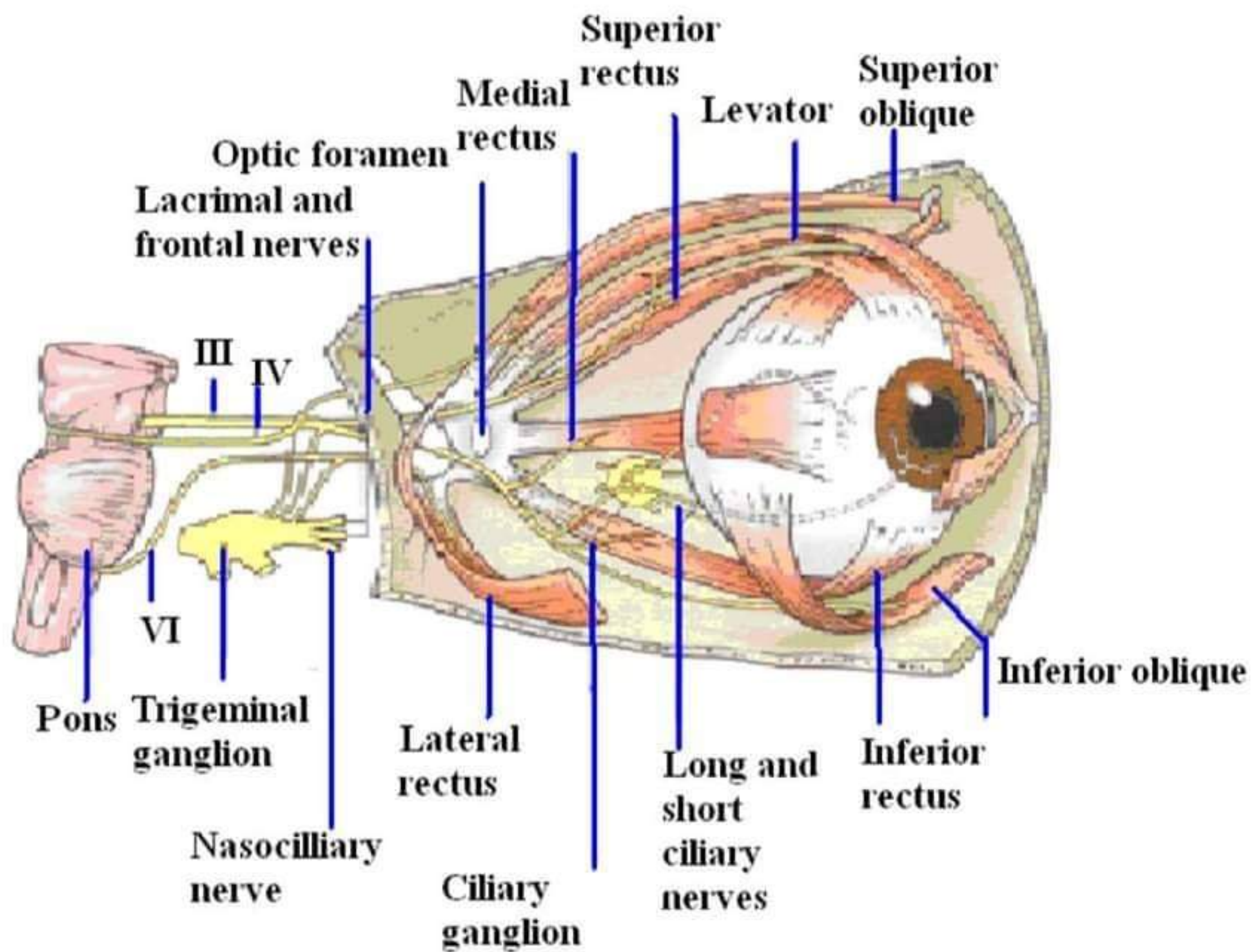
- Branches of the ophthalmic division of the trigeminal (fifth) nerve are sensory to the eyeball (especially the cornea), the conjunctiva and the skin of the eyelids extending up across the forehead and back towards the occiput Hence.
- The nasociliary nerve is the branch to the eyeball, but it does not terminate there. The nerve passes on into the medial orbital wall and emerges on the side of the nose.



Nerves of the Orbit

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- Parasympathetic fibres to the lacrimal gland pursue a complex course, passing with the facial nerve and then following the maxillary division of the trigeminal.
- The sensory and parasympathetic nerve fibres reach the eyeball via the short and long ciliary nerves which pierce the sclera posteriorly.



The Visual Pathways

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- The two optic nerves unite at the optic chiasm above the sella turcica of the sphenoid bone.
- The pituitary gland projects down immediately behind the chiasm.
- Nerve fibres from the nasal retina (temporal or lateral field of vision) cross over to the opposite side in the chiasm, so that the post-chiasmal fibres on the left subserve the field of vision on the right (and vice versa).

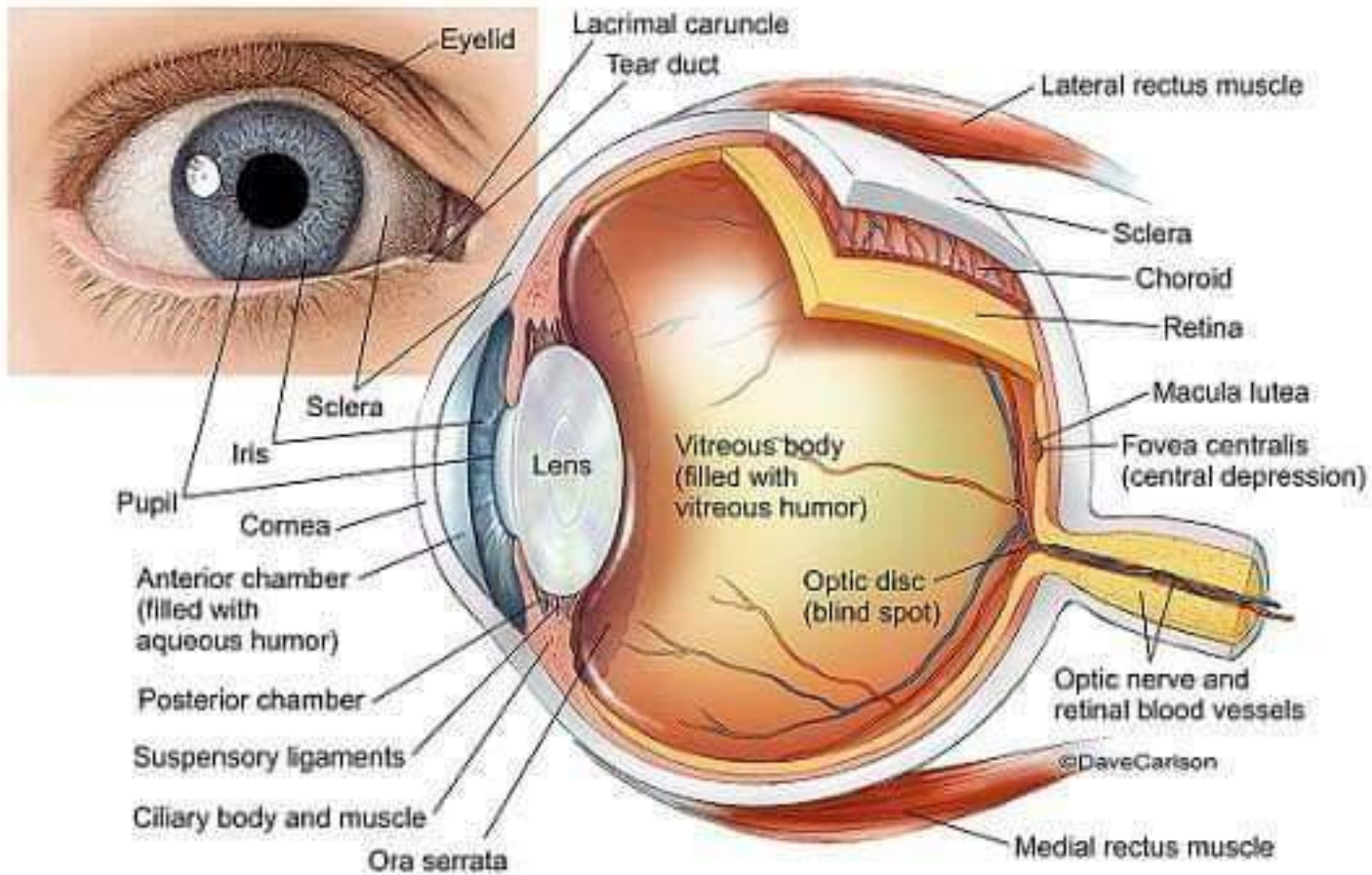
!!! Relation and connections: orbit and visual pathways

- The bony walls of the orbit are **thin inferiorly** and **medially**.
- The superior orbital fissure transmits the sensory nerves to the eye and orbit and the **3rd, 4th** and **6th** cranial nerves.
- The optic nerve and the ophthalmic artery pass through the **optic foramen**.
- The **3rd** nerve supplies levator; superior, inferior and medial rectus; inferior oblique; accommodation; pupil constriction.

!!! Relation and connections: orbit and visual pathways

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- The 6th nerve supplies lateral rectus.
- The 4th nerve supplies superior oblique.
- **Extraocular muscle function: depends on the direction of gaze:**
 - medial rectus: horizontal towards the nose
 - lateral rectus: horizontal laterally
 - obliques primarily rotate the eye
 - vertical recti primarily elevate/depress the eye
- **Visual pathways**
 - optic nerve to chiasm (fibres from nasal retina cross over) to optic tract
 - synapse in lateral geniculate body
 - optic radiation to occipital cortex.



Right Eye (viewed from above)

