Human Anatomy

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The orbital region

The orbits are a pair of bony cavities that contain the eyeballs; their associated muscles, nerves, vessels, and fat; and most of the lacrimal apparatus. The orbital opening is guarded by two thin, movable folds, the eyelids.

Eyelids

The eyelids protect the eye from injury and excessive light by their closure (**Fig. 1**). The upper eyelid is larger and more mobile than the lower, and they meet each other at the **medial** and **lateral angles**. The **palpebral fissure** is the elliptical opening between the eyelids and is the entrance into the conjunctival sac. The superficial surface of the eyelids is covered by skin, and the deep surface is covered by a mucous membrane called the **conjunctiva.**

The **eyelashes** are short, curved hairs on the free edges of the eyelids (**Figs. 1 & 2**). They are arranged in double or triple rows at the mucocutaneous junction. The **sebaceous glands** (*glands of Zeis*) open directly into the eyelash follicles. The **ciliary glands** (*glands of Moll*) are modified sweat glands that open separately between adjacent lashes. The **tarsal glands** (*Meibomian glands*) are long, modified sebaceous glands that pour their oily secretion onto the margin of the lid; their openings lie behind the eyelashes (**Fig. 1**). This oily material prevents the overflow of tears and helps make the closed eyelids airtight. Near the medial angle of the eye a small elevation, the **papilla lacrimalis,** is present. On the summit of the papilla is a small hole, the **punctum lacrimale,** which leads into the **canaliculus lacrimalis** (**Figs. 1 & 2**). The punctum and canaliculus carry tears down into the nose.

The **conjunctiva** is a thin mucous membrane that lines the eyelids and is reflected at **the superior** and **inferior fornices** onto the anterior surface of the eyeball (**Fig. 1**). The conjunctiva thus forms a potential space, the **conjunctival sac,** which is open at the **palpebral fissure.** Beneath the eyelid is a groove, the **subtarsal sulcus,** which tends to trap small foreign particles introduced into the conjunctival sac and is thus clinically important. The framework of the eyelids is formed by a fibrous sheet, the **orbital septum,** which thickened at the margins of the lids to form the superior and inferior **tarsal plates.** The lateral ends of the plates are attached by the **lateral palpebral ligament** to a bony tubercle just within the orbital margin. The medial ends

of the plates are attached by the **medial palpebral ligament** to the crest of the lacrimal bone (**Fig. 1**).

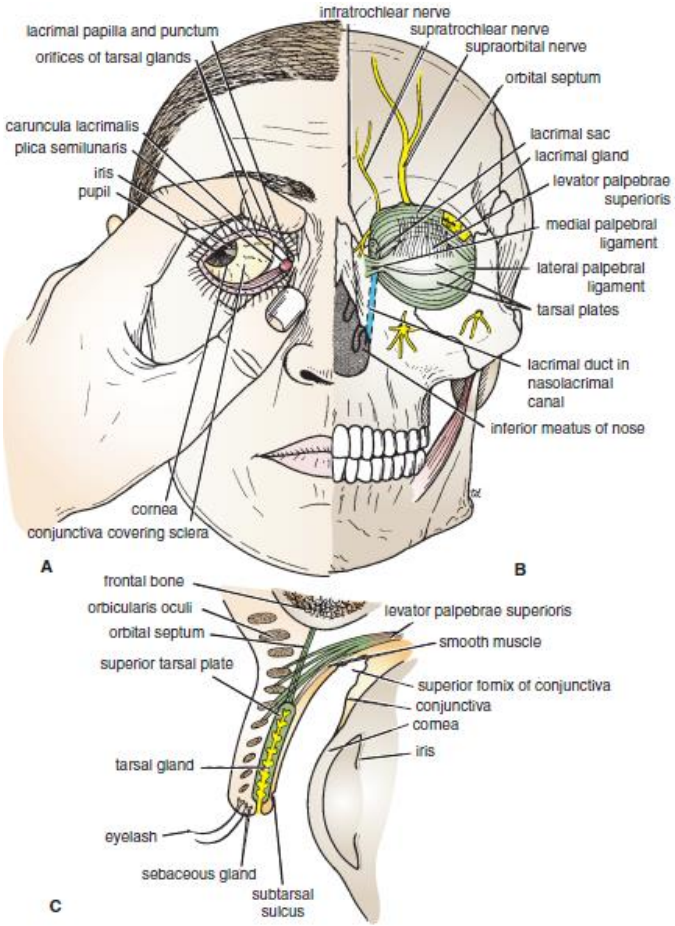

FIGURE 1: A. Right eye, with the eyelids separated. **B.** Left eye, showing the superior and inferior tarsal plates and the lacrimal gland, sac, and duct. **C.** Sagittal section through the upper eyelid.

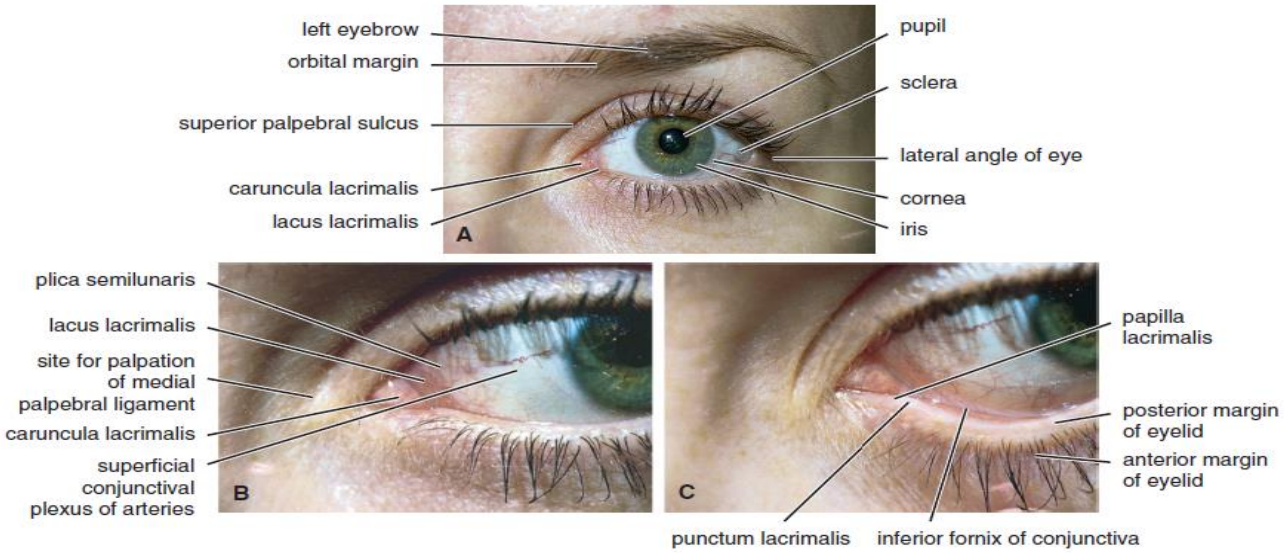

FIGURE 2: Left eye of a 29-year-old woman. **A.** The names of structures seen in the examination of the eye. **B.** An enlarged view of the medial angle between the eyelids. **C.** The lower eyelid pulled downward and slightly everted to reveal the punctum lacrimale.

Movements of the Eyelids

The eyelids are closed by the contraction of the orbicularis oculi and the relaxation of the levator palpebrae superioris muscles. The eye is opened by the levator palpebrae superioris raising the upper lid. On looking upward, the levator palpebrae superioris contracts, and the upper lid moves with the eyeball. On looking downward, both lids move, the upper lid continues to cover the upper part of the cornea, and the lower lid is pulled downward slightly by the conjunctiva, which is attached to the sclera and the lower lid. The origins and insertions of the **muscles of the eyelids** are summarized in **Table 1**:

TABLE 1: Muscles of the eyeball and eyelids.

Muscle	Origin	Insertion	Nerve Supply	Action
Extrinsic Muscles of Eyeball (Striated Skeletal Muscle)				
Superior rectus	Tendinous ring on posterior wall of orbital cavity	Superior surface of eyeball just posterior to corneoscleral junction	Oculomotor nerve (3rd cranial nerve)	Raises cornea upward and medially
Inferior rectus	Tendinous ring on posterior wall of orbital cavity	Inferior surface of eyeball just posterior to corneoscleral junction	Oculomotor nerve (3rd cranial nerve)	Depresses cornea downward and medially
Medial rectus	Tendinous ring on posterior wall of orbital cavity	Medial surface of eyeball just posterior to corneoscleral junction	Oculomotor nerve (3rd cranial nerve)	Rotates eyeball so that cornea looks medially
Lateral rectus	Tendinous ring on posterior wall of orbital cavity	Lateral surface of eyeball just posterior to corneoscleral junction	Abducent nerve (6th cranial nerve)	Rotates eyeball so that cornea looks laterally
Superior oblique	Posterior wall of orbital cavity	Passes through pulley and is attached to superior surface of eyeball beneath superior rectus	Trochlear nerve (4th cranial nerve)	Rotates eyeball so that cornea looks downward and laterally
Inferior oblique	Floor of orbital cavity	Lateral surface of eyeball deep to lateral rectus	Oculomotor nerve (3rd cranial nerve)	Rotates eyeball so that cornea looks upward and laterally
Intrinsic Muscles of Eyeball (Smooth Muscle)				
Sphincter pupillae of iris			Parasympathetic via oculomotor nerve	Constricts pupil
Dilator pupillae of iris			Sympathetic	Dilates pupil
Ciliary muscle			Parasympathetic via oculomotor nerve	Controls shape of lens; in accommodation, makes lens more globular
Muscles of Eyelids				
Levator palpebrae superioris	Back of orbital cavity	Anterior surface and upper margin of superior tarsal plate	Striated muscle oculomotor nerve, smooth muscle sympathetic	Raises upper lid
Orbicularis oculi				
Palpebral part	Medial palpebral ligament	Lateral palpebral raphe	Facial nerve	Closes eyelids and dilates lacrimal sac
Orbital part	Medial palpebral ligament and adjoining bone	Loops return to origin	Facial nerve	Throws skin around orbit into folds to protect eyeball

Lacrimal Apparatus

- **Lacrimal Gland**

The lacrimal gland consists of a large **orbital part** and a small **palpebral part,** which are continuous with each other around the lateral edge of the aponeurosis of the levator palpebrae superioris. It is situated above the eyeball and opens by 12 ducts into the lateral part of the superior fornix of the conjunctiva. The **parasympathetic secretomotor nerve supply** is derived from the **lacrimal nucleus** of the facial nerve. The **sympathetic postganglionic nerve supply** is from the internal carotid plexus and travels in the deep petrosal nerve, the nerve of the pterygoid canal, the maxillary nerve, the zygomatic nerve, the zygomaticotemporal nerve, and finally the lacrimal nerve.

- **Lacrimal Ducts**

The tears circulate across the cornea and enter the **canaliculi lacrimales** through the **puncta lacrimalis.** The canaliculi lacrimales open into the **lacrimal sac** (**Fig. 1**), which lies behind the medial palpebral ligament. The nasolacrimal duct emerges from the lower end of the lacrimal sac (**Fig. 1**). It descends downward in a bony canal and opens into the inferior meatus of the nose. The opening is guarded by a fold of mucous membrane known as the **lacrimal fold**. This prevents air from being forced up the duct into the lacrimal sac on blowing the nose.

Openings into the Orbital Cavity

Orbital opening: Lies anteriorly. About one sixth of the eye is exposed; the remainder is protected by the walls of the orbit.

Supraorbital notch (Foramen): It is situated on the superior orbital margin (**Fig. 3**) and transmits the supraorbital nerve and blood vessels.

Infraorbital groove and canal: Situated on the floor of the orbit in the orbital plate of the maxilla (**Fig. 4**); they transmit the infraorbital nerve and blood vessels.

Nasolacrimal canal: Located anteriorly on the medial wall; it communicates with the inferior meatus of the nose (**Fig. 1**). It transmits the nasolacrimal duct.

Superior orbital fissure: Located posteriorly between the greater and lesser wings of the sphenoid (**Fig. 3**); it communicates with the middle cranial fossa. It transmits the lacrimal nerve, the frontal nerve, the trochlear nerve, the oculomotor nerve (upper and

lower divisions), the abducent nerve, the nasociliary nerve, and the superior ophthalmic vein.

Inferior orbital fissure: Located posteriorly between the maxilla and the greater wing of the sphenoid (**Fig. 3**); it communicates with the pterygopalatine fossa. It transmits the maxillary nerve and its zygomatic branch, the inferior ophthalmic vein, and sympathetic nerves.

Optic canal: Located posteriorly in the lesser wing of the sphenoid (**Fig. 3**); it communicates with the middle cranial fossa. It transmits the optic nerve and the ophthalmic artery.

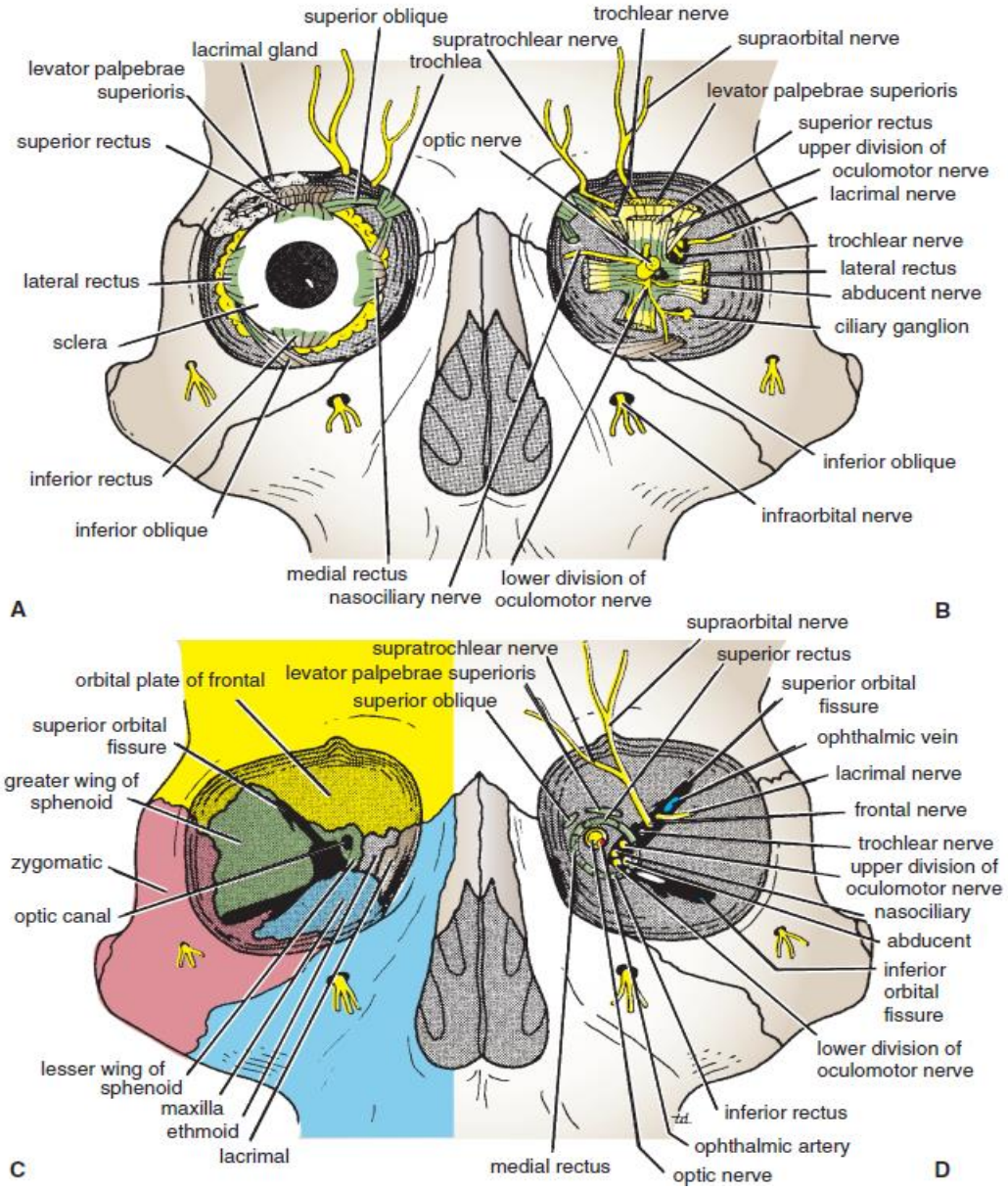

FIGURE 3: A. Right eyeball exposed from in front. **B.** Muscles and nerves of the left orbit as seen from in front. **C.** Bones forming the walls of the right orbit. **D.** The optic canal and the superior and inferior orbital fissures on the left side.

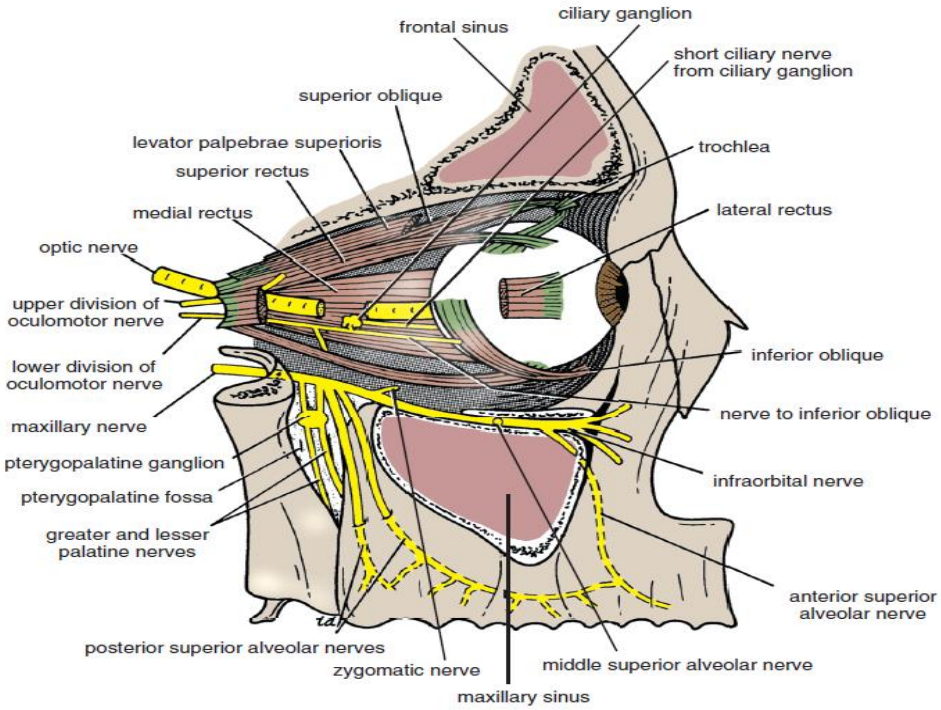

FIGURE 4: Muscles and nerves of the right orbit viewed from the lateral side.

Nerves of the Orbit

- **Optic Nerve**
  The nerve is surrounded by sheaths of pia mater, arachnoid mater, and dura mater. It pierces the sclera at a point medial to the posterior pole of the eyeball. Here, the meninges fuse with the sclera; a rise in pressure of the cerebrospinal fluid (**CSF**) within the cranial cavity therefore is transmitted to the back of the eyeball.
- **Lacrimal Nerve**
  The lacrimal nerve arises from the ophthalmic division of the trigeminal nerve. It is joined by a branch of the zygomaticotemporal nerve, which later leaves it to enter the lacrimal gland (parasympathetic secretomotor fibers). The lacrimal nerve ends by supplying the skin of the lateral part of the upper lid.
- **Frontal Nerve**
  The frontal nerve arises from the ophthalmic division of the trigeminal nerve. It divides into the **supratrochlear** and **supraorbital nerves** that supply the skin of the forehead; the supraorbital nerve also supplies the mucous membrane of the frontal air sinus.
- **Trochlear Nerve**
  It supplies the superior oblique muscle (**Fig. 5**).
- **Oculomotor Nerve**
  The **superior ramus** of the oculomotor nerve supplies the superior rectus muscle, then pierces it, and supplies the levator palpebrae superioris muscle (**Fig. 3**).

The **inferior ramus** of the oculomotor nerve supplies the inferior rectus, the medial rectus, and the inferior oblique muscles. The nerve to the inferior oblique gives off a branch (**Fig. 4**) that passes to the ciliary ganglion and carries parasympathetic fibers to the sphincter pupillae and the ciliary muscle.

- **Abducent Nerve**

  It supplies the lateral rectus muscle.

- **Nasociliary Nerve**

  The nasociliary nerve arises from the ophthalmic division of the trigeminal nerve; it has the following branches:

  - ✓ The **communicating branch to the ciliary ganglion** is a sensory nerve. The sensory fibers from the eyeball pass to the ciliary ganglion via the short ciliary nerves and then join the nasociliary nerve by means of the communicating branch.
  - ✓ The **long ciliary nerves,** two or three in number, contain sympathetic fibers for the dilator pupillae muscle.
  - ✓ The **anterior ethmoidal nerve** appears on the face as the **external nasal branch** at the lower border of the nasal bon and supplies the skin of the nose down as far as the tip.
  - ✓ The **posterior ethmoidal nerve** supplies the ethmoidal and sphenoidal air sinuses (**Fig. 5**).
  - ✓ The **infratrochlear nerve** supplies the skin of the medial part of the upper eyelid and the adjacent part of the nose (**Fig. 1**).

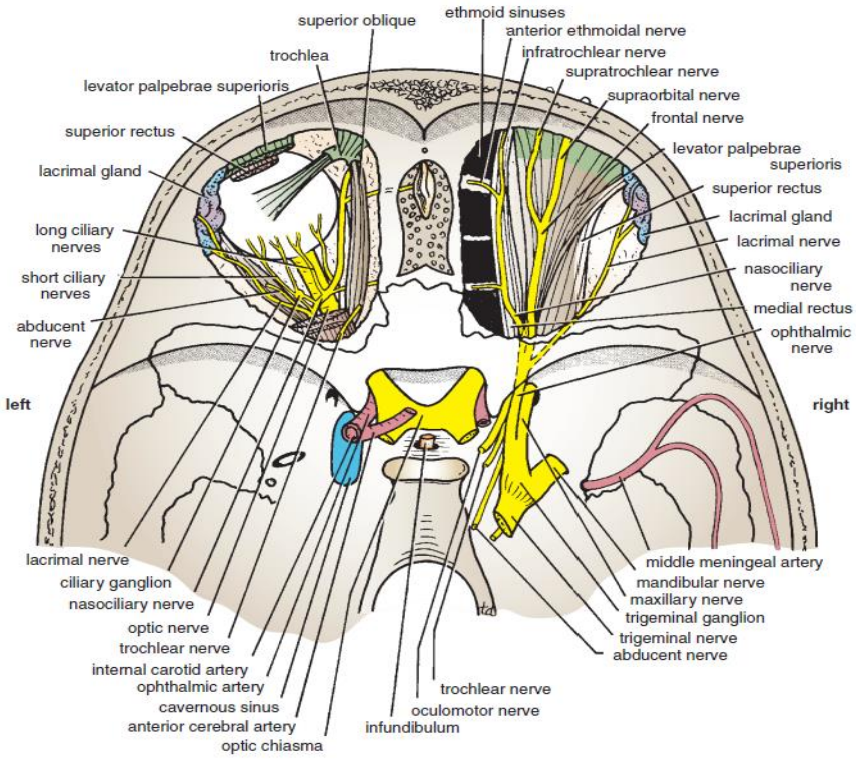

FIGURE 5: Right and left orbital cavities viewed from above.

Blood and Lymph Vessels of the Orbit

➢ Ophthalmic Artery

The ophthalmic artery is a branch of the internal carotid artery. It enters the orbit through the optic canal with the optic nerve (**Fig. 5**). It has the following branches:

- ✓ The **central artery of the retina** enters the eyeball at the center of the **optic disc.** Here, it divides into branches, which may be studied in a patient through an ophthalmoscope. The branches are end arteries.
- ✓ The **muscular branches.**
- ✓ The **ciliary arteries** can be divided into anterior and posterior groups.
- ✓ The **lacrimal artery** to the lacrimal gland.
- ✓ The **supratrochlear** and **supraorbital arteries** are distributed to the skin of the forehead.

➢ Ophthalmic Veins

The **superior ophthalmic vein** communicates in front with the facial vein. The **inferior ophthalmic vein** communicates through the inferior orbital fissure with the pterygoid venous plexus. Both veins pass backward through the superior orbital fissure and drain into the cavernous sinus.

➢ Lymph Vessels

No lymph vessels or nodes are present in the orbital cavity.

Structure of the Eye

The eyeball (**Fig. 6**) is embedded in orbital fat but is separated from it by the ***fascial sheath*** of the eyeball. The eyeball consists of three coats, which are the fibrous coat, the vascular pigmented coat, and the nervous coat.

1. Fibrous Coat

The fibrous coat is made up of a posterior opaque part, the sclera, and an anterior transparent part, the cornea (**Fig. 6**). The **sclera** is directly continuous in front with the cornea at the corneoscleral junction, or limbus. The transparent **cornea** is largely responsible for the refraction of the light entering the eye (**Fig. 6**). The cornea is avascular and devoid of lymphatic drainage. It is nourished by diffusion from the aqueous humor and from the capillaries at its edge.

2. Vascular Pigmented Coat

The vascular pigmented coat consists, from behind forward, of the choroid, the ciliary body, and the iris. The **choroid** is composed of an outer pigmented layer and an inner, highly vascular layer. The **ciliary body** is composed of the ciliary ring, the ciliary processes, and the ciliary muscle. Contraction of the ciliary muscle pulls the ciliary body forward. This relieves the tension in the suspensory ligament, and the elastic lens becomes more convex.

The **iris** is a thin, contractile, pigmented diaphragm with a central aperture, the pupil (**Fig. 6**). It is suspended in the aqueous humor between the cornea and the lens. The muscle fibers of the iris are involuntary and consist of circular and radiating fibers. The circular fibers form the **sphincter pupillae** while the radial fibers form the **dilator pupillae.** The sphincter pupillae constricts the pupil in the presence of bright light and during accommodation. The dilator pupillae dilates the pupil in the presence of low light intensity or in the presence of excessive sympathetic activity such as occurs in fright.

3. Nervous Coat: The Retina

The retina consists of an **outer pigmented layer** and an **inner nervous layer.** Its outer surface is in contact with the choroid, and its inner surface is in contact with the vitreous body (**Fig. 6**). The posterior three quarters of the retina is the receptor organ.

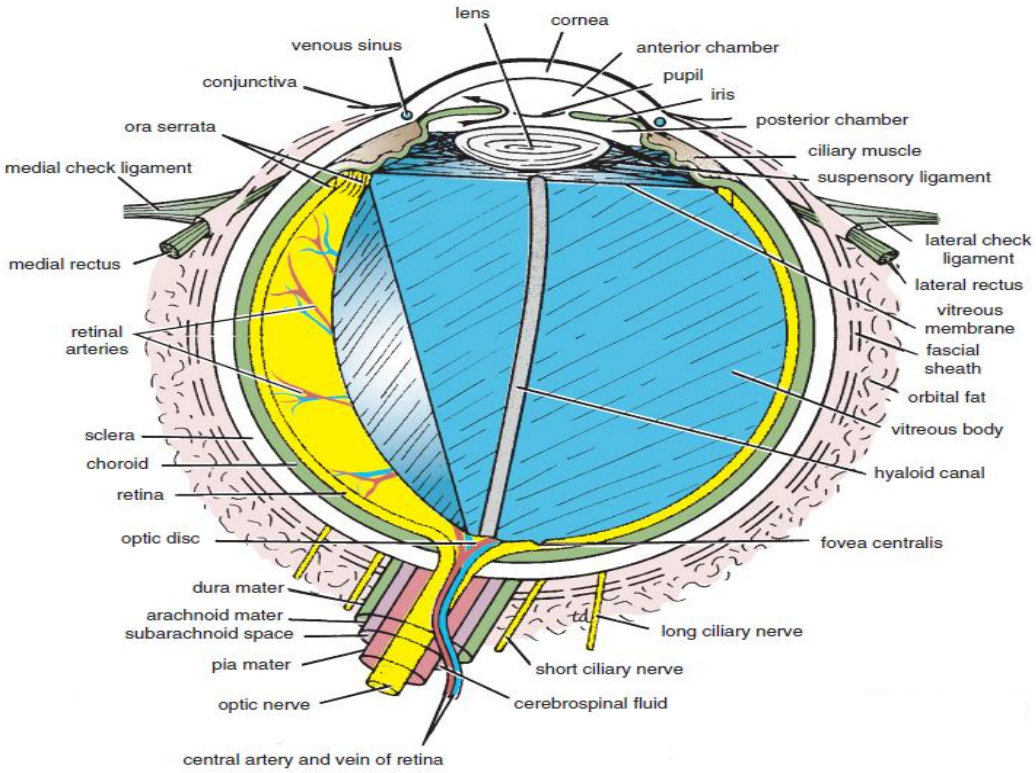

FIGURE 6: Horizontal section through the eyeball and the optic nerve.

Clinical Notes

➢ Eye Trauma

Blowout fractures of the orbital floor involving the maxillary sinus commonly occur as a result of blunt force to the face. If the force is applied to the eye, the orbital fat explodes inferiorly into the maxillary sinus, fracturing the orbital floor. Not only can blowout fractures cause displacement of the eyeball, with resulting symptoms of double vision (diplopia), but also the fracture can injure the infraorbital nerve, producing loss of sensation of the skin of the cheek and the gum on that side. Entrapment of the inferior rectus muscle in the fracture may limit upward gaze.

➢ Pupillary Reflexes

The pupillary reflexes, that is the reaction of the pupils to light and accommodation, depend on the integrity of nervous pathways.

In the **direct light reflex**, the normal pupil reflexly contracts when a light is shone into the patient's eye.

The **consensual light reflex** is tested by shining the light in one eye and noting the contraction of the pupil in the opposite eye. This reflex is possible because the afferent pathway travels to the parasympathetic nuclei of both oculomotor nerves.

The **accommodation reflex** is the contraction of the pupil that occurs when a person suddenly focuses on a near object after having focused on a distant object.

Reference

1. Snell RS: Clinical anatomy by regions. Lippincott Williams & Wilkins, 2011.