

## THE EYE – THE ORGAN OF VISION

The eye is made up of

- The **EYEBALL** (*bulbus oculi*) and
- various **ADNEXA**. These adnexa include the **ocular muscles, lacrimal apparatus, orbital fasciae, the eyelids and the tunica conjunctiva.**

Most of these structures are housed in the orbit, where the eyeball is entrenched in generous quantities of fat. When an animal is emaciated the orbital fat is reduced and the eyes sink within the orbits, giving the face a gaunt, suffering appearance. This is of significance in routine clinical examination of animals. The eyes of the domestic mammals protrude more from the surface of the face than do those of primates, human beings included.

The position of the eyes in the head is related to the animal's environment, habits and method of feeding. Generally, predatory species like the dog and cats have their eyes well set forward thus providing a wide field of binocular vision that allows for concentration on near objects and for perception of depth, whereas those that are the hunted (herbivores, horse, ruminants, rabbits) carry their eyes more laterally. Both eyes hardly overlap, thus these animals are constantly aware of their environment, but have little capacity for binocular vision. Thus it is advised to approach the horse for example for the side to reduce apprehension.

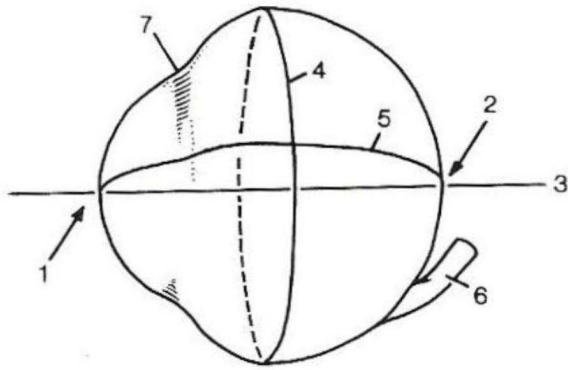
The eye is almost entirely enclosed within the cone-shaped cavity (orbit) on the lateral surface of the skull that is delimited externally by a bony margin. The bony ring is completed by the orbital ligament in the pigs and carnivores.

### THE EYEBALL (*BULBUS OCULI*)

The eyeball is nearly spherical in outline, except at the anterior where the cornea (the transparent part of the eyeball) bulges. The following are some of the descriptive anatomical terms used for the eye:

- ⊙ **Anterior pole** – the highest point on the cornea
- ⊙ **Posterior pole** – the highest point on the posterior surface
- ⊙ **Optic axis** – the straight line passing through both poles
- ⊙ **Equator** – an imaginary line about the eyeball which like that of the Earth is equidistant from the poles
- ⊙ **Meridian** – one of the many lines passing from pole to pole that intersect the equator at right angles

The optic nerve leaves the ball slightly ventral to the posterior pole



**Figure 9-2.** Medial view of right eyeball.

1, Anterior pole; 2, posterior pole; 3, optic axis; 4, equator; 5, a meridian; 6, optic nerve; 7, limbus.

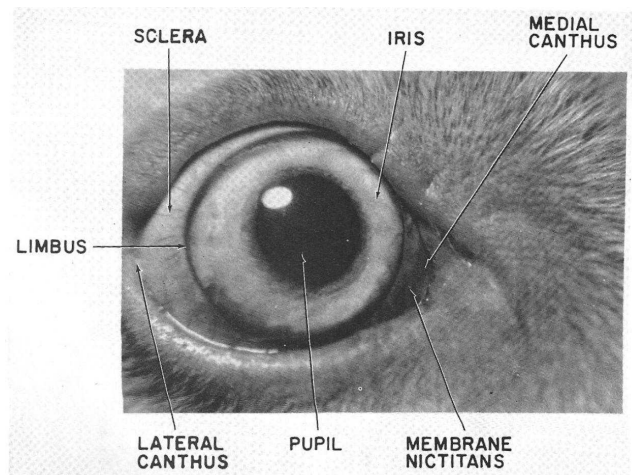
There are thin three tunics that lie in close apposition to the eyeball; they are (from without inwards)

- External fibrous tunic
- Middle vascular tunic
- Internal nervous tunic

### THE FIBROUS TUNIC

The only completer tunic of the eyeball, gives form and protect the eyeball. It is made up of the **cornea** the transparent part at the anterior pole and the **sclera**, at the posterior part of the eyeball. Both meet at the **limbus**.

The cornea, forms about one-quarter of the fibrous tunic. It avascular; thus nutrients are supplied from the vessels in the limbus or are carried to its surface by the lacrimal fluid and aqueous humour. It is continous with the sclera at the limbus.

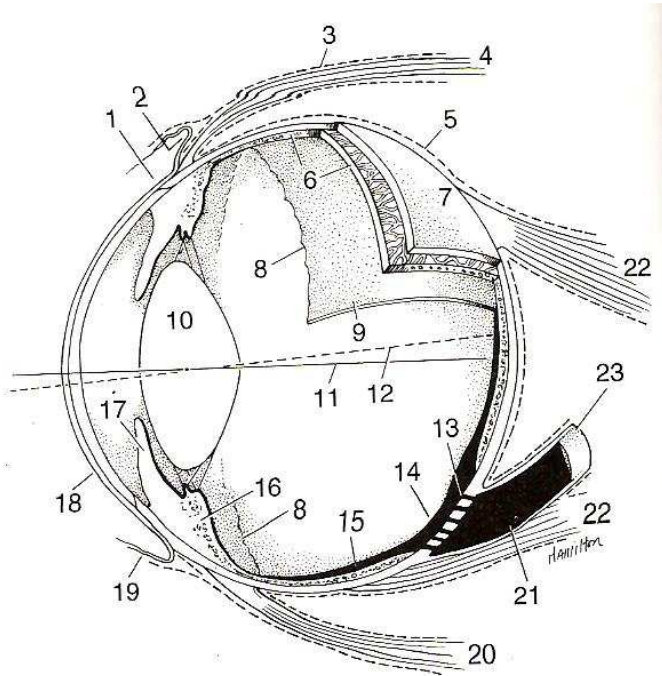


The sclera, the white of the eye, presents a small cribriform area ventral to the posterior pole. This allows the passage of the fibres of the optic nerve. the optic nerve is enclosed in a connective tissue shealth that is continuous with the dura mater. The sclera also furnishes attachment for the tendons of the ocular muscles near the equator.

## THE VASCULAR TUNIC (a.k.a THE UVEA)

It is largely made up of blood vessels and smooth muscle. It is concerned with nutrition of the eyeball and regulation of the shape of the lens & size of the pupil. It consists of three zones:

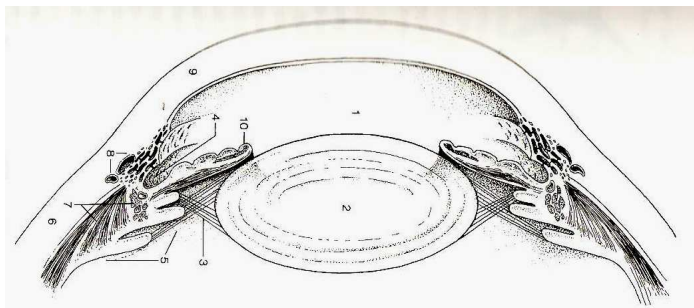
- ❖ The choroid
- ❖ The ciliary body and;
- ❖ The iris



**Figure 9-3.** Eye opened to show the three tunics, which have been drawn thicker than they actually are.

1, Limbus; 2, upper fornix; 3, deep muscular fascia; 4, dorsal rectus muscle; 5, vagina bulbi; 6, choroid; 7, sclera; 8, ora serrata; 9, retina; 10, lens; 11, optic axis; 12, visual axis; 13, area cribrosa; 14, optic disc; 15, retina; 16, ciliary body; 17, iris; 18, cornea; 19, conjunctiva; 20, ventral rectus muscle; 21, optic nerve; 22, retractor bulbi; 23, sheath of optic nerve.

The choroid lies next to the sclera and runs from the optic nerve to almost the limbus where it is continued as the ciliary body – a thickened zone congruent to the limbus of the external tunic and terminates as the iris – a flat ring of tissue which projects into the cavity bounded by the cornea anteriorly and the lens posteriorly. The iris is attached to at its periphery to the sclera by the pectinate ligament and to the ciliary body. The iris is the only internal structure easily seen with the naked eyes without the aid of an ophthalmoscope.



**Figure 9-4.** Anterior part of the eye in section.

1, Anterior chamber; 2, lens; 3, zonular fibers; 4, iridocorneal angle; 5, ciliary body; 6, sclera; 7, ciliary muscles; 8, venous plexus of sclera; 9, cornea; 10, iris with the sphincter and dilator muscles shown.

The choroid contains a dense network of blood vessels supplied by the posterior ciliary arteries and venous return by the vorticosse vein. In the dorsal part of the fundus a avascular light-reflecting zone called the **tapetum lucidum**. It is not found in the **pigs and humans**. It makes the eyes of animals shine when they look in the direction of a beam of light such as that of the headlights of a car. It is believed to be a nocturnal adaption.

Both ciliary body suspend the lens while The space between the interior of the cornea and the lens is filled with a clear watery fluid and is partitioned into two chambers- the anterior and posterior – by the iris. The pupil is the perforation at the centre of the iris. The size of the pupil is regulated by the smooth sphincter and dilator muscles of the iris thus ultimately regulating the amount of light passing through the lens to the retina.

### **THE NERVOUS TUNIC**

This tunic is the pigmented, light-sensitive part (retina) composed largely of nervous tissue. It is part that is directly concerned with vision (translation of visual stimuli to nerve impulses for interpretation by the brain.

### **THE ADNEXA OF THE EYE**

These are structures found around the eyeball that serve to protect and move the eyeball. They include:

- i. Tunica conjunctiva
- ii. Orbital fasciae
- iii. Ocular muscles
- iv. Lacrimal apparatus and;
- v. Eyelids

### **ORBITAL FASCIAE**

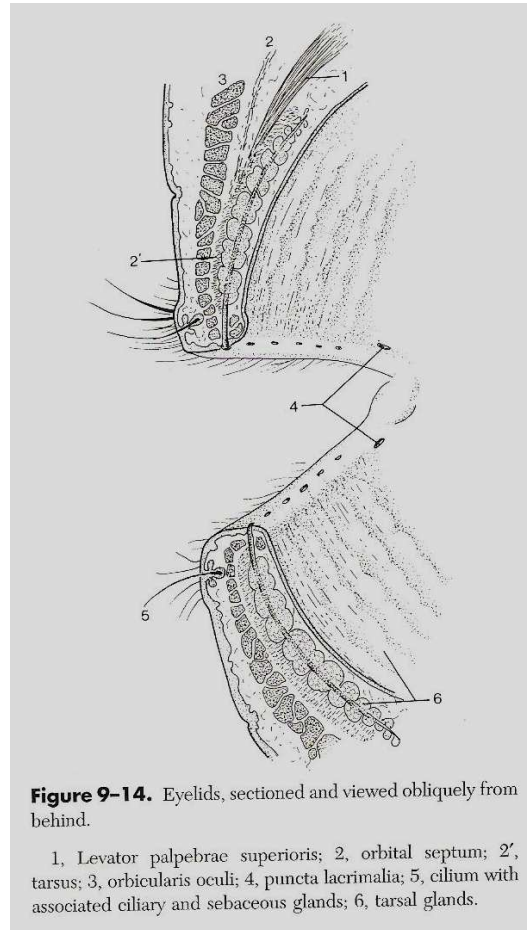
The eyeball (bulbus oculi) is enclosed by three roughly conical fascial layers, in conformity with the cone-shaped orbit.

The most external is the **periorbita** followed by the **superficial muscular fascia** and then the **deep muscular fascia**.

## EYELIDS

Also called the palpebrae [*singular: palpebra*] are musculo-fibrous flaps which apart from preventing elemental insults, dust and dirt, help to moisten the exposed part of the eyes by distributing the lacrimal fluid. The upper eyelid (superior palpebra) is bigger and more mobile than the lower eyelid (inferior palpebra). The medial and lateral angle of the eye formed by the superior and inferior palpebrae is called **medial canthus** and **lateral canthus** respectively. The space between the two palpebrae, the **palpebral fissure**, is elliptical. The eyelids consist of three layers:

- the *skin* – a thin delicate layer covered furnished with short hairs in animals and may carry tactile hairs.
- a *middle musculo-fibrous layer* formed by the **orbital septum**, the **orbicularis oculi** muscle, the **smooth tarsal** muscle and the **aponeurosis of the levator palpebra superioris proprius** muscle apart from the orbicularis oculi which lies directly under the skin, the tarsal smooth muscle and the aponeurosis of the levator muscle arise originate in the orbit while the orbital septum originate from the margin of the orbit.
- a *mucous membrane (palpebra conjunctiva)*



## CONJUNCTIVA

This is the mucous membrane or the membrane lining the eyelids and the anterior pole of the eyeball. The conjunctiva lining the posterior surface of the lid, **palpebra conjunctiva**, continues over the sclera as the **bulbar conjunctiva** where it ends at the limbus although it continues as the anterior epithelium of the cornea. Both parts of the conjunctiva contain blood vessels except for the portion forming the superficial layer of the cornea which contains no blood vessels.

*The conjunctiva is of considerable significance in the appraising the health status and the general state of the vascular system because its transparency makes the blood vessels visible. It is pinkish in healthy animals, yellow in jaundice and reddish or congested in febrile conditions. A pale conjunctiva suggests anaemia, shock or internal haemorrhage.*

When the two eyelids are shut, the conjunctiva forms a potential space called the **conjunctiva sac**. The dorsal and ventral extremities of the conjunctival sac formed by the palpebra and bulbar conjunctiva are called the **dorsal (upper) fornix** and **ventral (lower) fornix**.

At the medial canthus of the eye lies a slight raised mucosal fold called the **lacrimal caruncle**. The **third eyelid** (sometimes called *membrane nictitans*), a dorsoventrally oriented conjunctiva fold is located between the lacrimal caruncle and the eyeball. It is supported by a T – shape cartilage. It is covered with conjunctiva on both sides and embedded in retro- ocular fat.

## OCULAR MUSCLES

The muscles of the eyes can be classified broadly into three groups:

- the *intrinsic muscles* of the eyes (*mention earlier*)
- the *extrinsic muscles* of the eye (muscles of the eyeball)
- the *palpebra muscle* (muscles of the eyelids)

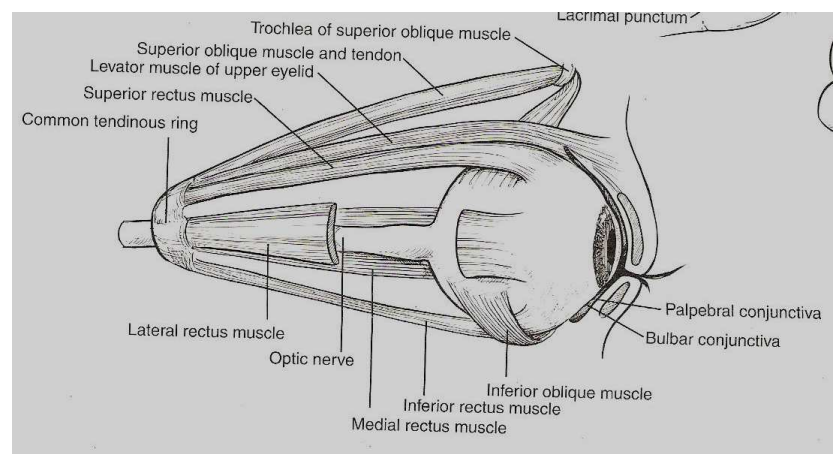
### 1. The Intrinsic Muscles of the eye

These are involuntary smooth muscles whose orientation could be longitudinal or radial and a few of them are circular. The latter also constitute the sphincter papillae which controls the diameter of the pupil. This muscle is innervated by the parasympathetic branches of the oculomotor nerve.

### 2. The Extrinsic Muscles

These are the muscles attached to the eyeball externally. They are seven in number (4 recti muscles, 2 oblique muscles and 1 retractor muscle) and include:

- Superior or dorsal rectus m.
- Inferior or ventral rectus m.
- Lateral rectus m.
- Medial rectus m.
- Superior or dorsal oblique m.
- Inferior or ventral oblique m.
- Retractor bulbi or retractor oculi



All the **four recti muscles** originate close together around the optic foramen and they diverge as they move anteriorly like a cone. Each of them (recti muscles) functions to move the eyeball to the side of the muscle that is acting.

The **retractor bulbi muscle** has the same origin as the recti muscles but is attached to the equator of the eyeball. It functions to withdraw the eyeball inwards. Humans do not possess this muscle probably because we do not need the additional protection provided to the more protruding eyes of animals.

The dorsal oblique muscle also arises close to the optic foramen and runs forward on the dorsomedial wall of the orbit and turns at right angle round a cartilaginous pulley called the **trochlea** and then inserts on the dorsolateral surface of the eyeball.

Unlike the others, the ventral oblique muscle arises from a depression in the ventromedial wall of the orbit passing laterally beneath the eyeball and the tendon of the ventral rectus muscle to insert on the ventrolateral side of the eyeball.

Both oblique muscles rotate the eyeball on a transverse plane around the visual axis. For example, the dorsal oblique muscle will rotate the eyeball upward and laterally while the ventral oblique muscle will rotate the eyeball downward and laterally.

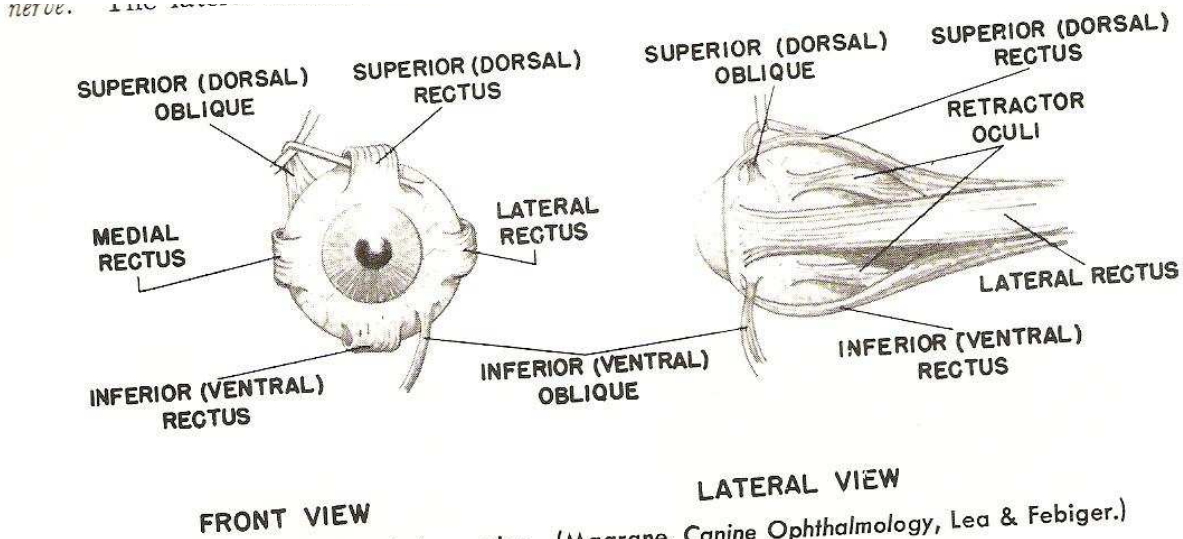


Fig. 7-11. The extrinsic muscles. (Magrane, *Canine Ophthalmology*, Lea & Febiger.)

**Innervations of the extrinsic muscles:**

- |   |                  |
|---|------------------|
| Retractor bulbi and lateral rectus m                  | Abducens nerve   |
| Dorsal oblique muscle                                 | Trochlea nerve   |
| Dorsal, Ventral & Medial recti and Ventral oblique m. | Oculomotor nerve |

### 3. Palpebra Muscles

The muscles of the eyelids include:

- i. Corrugator supercilli muscle (one of the major muscles involved when frowning)
- ii. Levator palpebra superioris proprius – innervated by the oculomotor nerve
- iii. Orbicularis oculi
- iv. Retractor of the lateral canthus
- v. Malaris muscle.

These muscles, except the levator muscle, are supplied by the **facial nerve**.

### LACRIMAL APPARATUS

It includes the *lacrimal gland proper*, the ducts system of the lacrimal gland, glands associated with the *third eyelid* and several accessory glands.

**The lacrimal gland**, located between the orbit and the dorsolateral wall of the orbit, secretion (lacrimal fluid/tears) is emptied by minute ducts into the dorsal fornix of the conjunctiva sac where it mixes with the secretions of other accessory glands. The nictitating movements of the lids help to moisten the exposed parts of the eye, supply some nutrients to the cornea and wash away dirt and foreign agents. The lacrimal fluid is ultimately drained from the eyes at the medial canthus by capillary action by **puncta lacrimalia**. They are minute slits, on the upper and lower portion of the medial canthus of each lid next to the caruncle. Tears spill onto the face when the rate of production exceeds the rate of drainage.

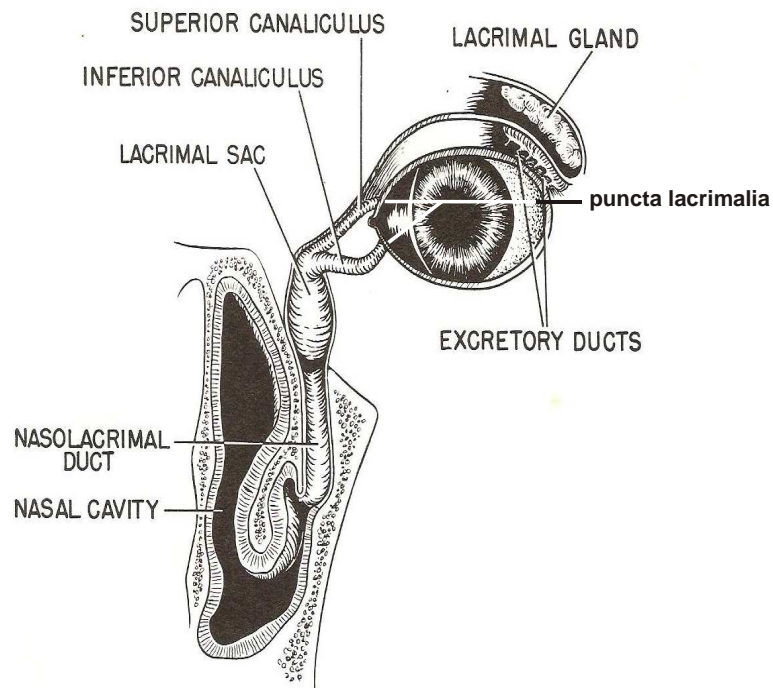


Fig. 7-13. The lacrimal production and drainage system of the dog. (Magrane, *Canine Ophthalmology*, Lea & Febiger.)



From each punctum lacrimalia is a small duct (**superior / inferior canaliculus**) that goes into a slightly enlarged **lacrimal sac** located in the fossa of the orbit in the lacrimal bone. Continuing from this is the **nasolacrimal duct** passing along the wall of the maxillae in the osseous nasolacrimal canal and emptying into the nasal cavity. In the horse it ends at the nostrils.

### ***BLOOD SUPPLY TO THE EYE***

External ophthalmic and Malar arteries - branch of the Maxillary artery

The principal venous drainage is by several vorticosse veins.

### ***THE NERVE SUPPLY OF THE EYE***

The nerve supply to the eye and its accessory structures is derived from six cranial nerves (II – VII) some of which have been stated earlier. They include:

- i. Optic nerve
- ii. Oculomotor nerve
- iii. Abducens nerve
- iv. Ophthalmic and maxillary branch of the trigeminal nerve
- v. Trochlea
- vi. Facial nerve