

## SENSORY ORGANS

Animals possess some specialized structures to perceive the different type of changes (=stimuli) occurring in their external environment . These structures are known as **sense organs**. After receiving these stimuli, sensory organs transmit these to the central nervous system through the sensory nerve fibres.

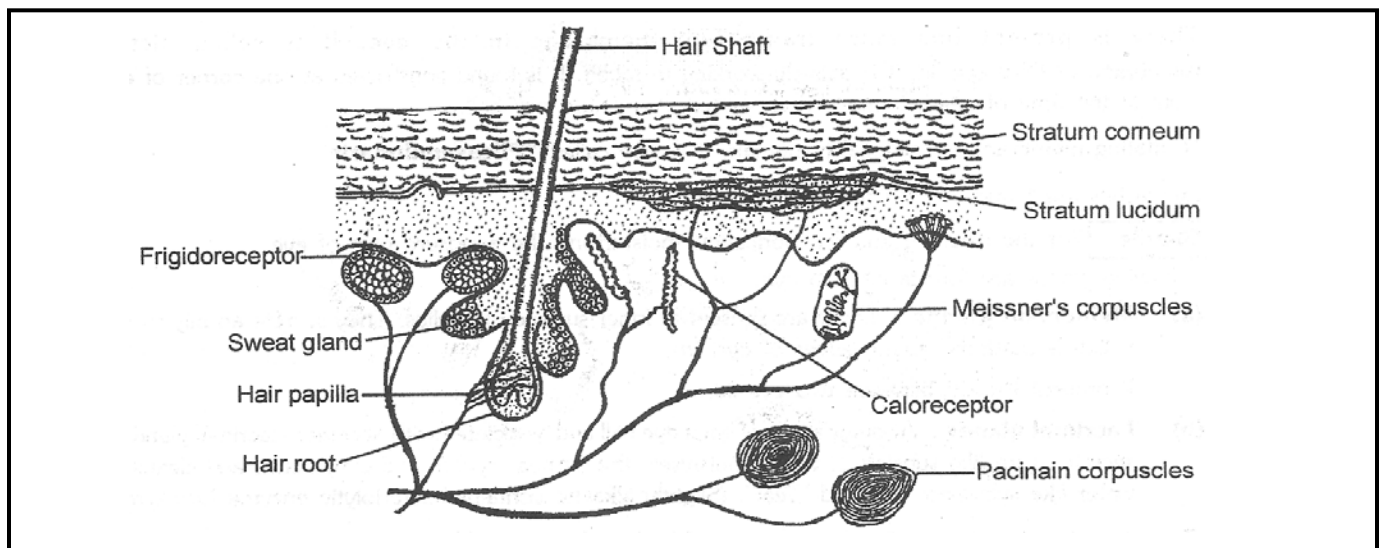
A sensory organ is only sensitive to a specific kind of stimulus to which it is specialized like temperature, chemicals , touch, light etc. Based on their location in the body sensory organs are of three. types :

1. **Exteroceptors** : These sense organs receive stimuli from external environment because they remain in contact with the external environment . Example – nose, eyes, tongue, ears and skin.
2. **Interoceptors** : These sensory organs are associated with internal environment of body and receive the change taking place in the internal environment. Examples – changes in the composition of blood , concentration of carbon – dioxide , hunger, thirst, asphyxia etc.
3. **Proprioceptors** : These sensory organs are present in joints, tendons , muscles and connective tissues which perceive the tension and pressure exerted during the activities of equilibrium maintenance and orientations of body.

In human body , five types of exteroceptors are found which are known as sense organs. The main sense organs include skin, eye, nose, ear and tongue.

### CUTANEOUS RECEPTORS

Skin envelopes the entire body, and it is considered as tangoreceptor (fig.) Numerous sensory papillae are found in the dermis of skin to receive the stimuli of touch , pressure , cold , heat, temperature and pain. All these are of simple type of receptors. These sensory structures of skin receive impulses from the nerve endings in skin . These are of following types



1. **Tactile Receptors** : These receptors are present as naked endings of sensory nerve fibres on the hair follicles in the dermis of skin . These are excited when the hairs come in contact with some object. Extensively branched (arborized) endings of sensory nerves are found in the papillae of dermis. These endings are very small sized encapsulated called sensory corpuscles. Those which are cylindrical and sensitive to touch are called **Meissner's corpuscles**. Their number is much more in nipples, lips , glands penis, palm, sole and in fingers. The number of these corpuscles decreases as a person grows older. The corpuscles sensitive to the strong and sustained contacts (pressure) are situated deep in the dermis and called as **Pacinian corpuscles**.

2. **Pain receptors (Algesireceptors) :** Numerous branched sensory nerve fibres are scattered among the epidermis as well as dermal cells of skin. These possess naked nerve endings. These nerve endings are sensitive to chemical, electrical, and mechanical stimuli, which cause the sensations of pain in body.
3. **Thermo cause Receptors :** A network of sensory nerve fibres is situated closely to the hair follicles in dermis of skin. These nerve fibres are sensitive to the stimuli related to temperature, These thermoreceptors make a person aware to stimuli of cold, heat etc. Because of this sense perception our hairs get erected during excessive cold. The sensory organs excited by cold and heat are known as **frigidoreceptors** and **caloreceptors** respectively.

## EYE

☞ Eye and ear are also called “**teleoreceptors**”, because these receive impulse from far places.

### (A) **Eye (Photoreceptor) :-**

☞ These are photosensitive organs.

☞ Each eye is an empty ball like round structure, it is called eye ball. Each eye – ball is situated in the notch of bone in the skull. It is caked “Eye -orbit”. Human eyes are situated in eye orbit lateral to nose.

☞ Only  $1/5^{\text{th}}$  part of whole eye is seen from out side in between the eye lashes.  
Remaining  $4/5^{\text{th}}$  part is in the eye orbit.

### (1) **Eye lids or palpebrae :-**

There are two muscular eyelids for the protection which having lashes at one side. Both the eyelids are named according to their situation i.e. upper & lower eyelids.

☞ Eyelids are immovable in snakes. Eyelids of fishes are absent.

☞ There is present one more transparent membrane in the eye. It is called nictitating membrane or third eye lid. it is actively working in rabbit . It is found constricted at one corner of eye ball but at the time of need, it may be expanded over entire eye ball.

☞ Nictitating membrane is vestigial in human . It is also called “**Plicasemilunaris**”

☞ Eye lashes are found at both the eyelids.

(2) **Glands:-** For the clean ing and for lubrication / moisturizing the exposure part of eye.  
Following glands are founds in each eye.

(a) **Meibomian glands :-** These are present at Inner surface of eyelids. They secrete an oily substance, which is scattered at the edges of eye lids.

**It prevent friction between two eye lid.**

(b) **Lacrimal glands :-** At outer angle of each eye ball and associated with accessory lacrimal gland, which secrete water like substance , which moistures the cornea, eyelids and conjunctive and cleans it . This water like substance is called “Tear”. (Slightly alkaline contains bacteriolytic enzyme Lysozyme)

☞ **Tear glands activate after four months of birth in human child.**

(c) **Gland of zeis :** It is situated in margin of eye lid.

**Harderian glands :-** These are found inside the lower eye lids. These moisten the nictitating membrane.

☞ **Harderian glands are absent in rabbit & human.**

☞ **In place of harderian glands, in mammals , Meibomian glands are present. But in some mammals e.g. rate, shrews, whales etc., these harderian glands are found.**

☞ **These glands are also found in frog and birds.**

(d) **Gland of moll :-** There are modified sweat gland found in the eye lashes.

(3)

### Muscles of eye balls

There are present 6 skeletal muscles in the eyeball which help to rotate the eye ball into eye orbit. Out of these 4 are rectus muscles and 2 are oblique muscles. They are also called as extra ocular muscles.

☞

Lateral of External Rectus rotates the eyeball towards outside i.e. from nose to ear. Medial or Internal rectus muscle rotates the eyeball toward inside i. e. from ear to nose.

☞

Superior rectus muscle and inferior oblique muscle collectively help the eyeball to rotate upwards.

☞

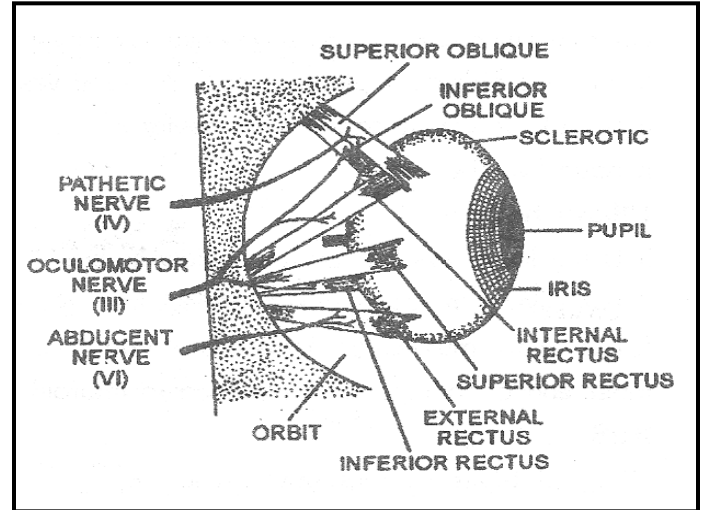
Inferior rectus muscle and superior oblique muscle collectively help the eyeball to rotate downwards.

☞

Rectus and oblique muscles collectively rotate the eye ball to all the sides around its axis.

☞

Any defect in one of these eyeball muscles ( e.g. muscle may remain small or extra large then required) causes **strabismus** or **squint eyes**. In this defect, eye ball remains inclined to any of the one side . Eye muscles are innervated by oculomotor (III) . Pathetic (IV) and Abducens (VI) Nerve.



### INTERNAL STRUCTURE OF EYE BALL :-

The wall of remaining eye ball has three layers.

(1)

#### Fibrous tunic :-

It is the outermost covering of eye ball. It is made up of hard and thick connective tissue.

The layer is divided into 2 parts.

(a)

#### Cornea :-

It is the outer visible part of fibrous tunic. Covered by st. nonkeratinized squamous epithelium.

☞

The joint between cornea and sclerotic layer is called "**Limbus**" or "Sclero – corneal junction " .

Cornea transplantation is successful because it lacks blood vessels.

(b)

#### Sclerotic layer / Sclera :-

It is made up of white hard, opaque thick fibrous connective tissue in rabbit but in frog , it is made up of cartilage . It is the inner protein of eye ball. In- vascularised. This layer is of This part white colour, so it is also called "White of eye"

☞

This part of eye is **mesodermal** in origin.

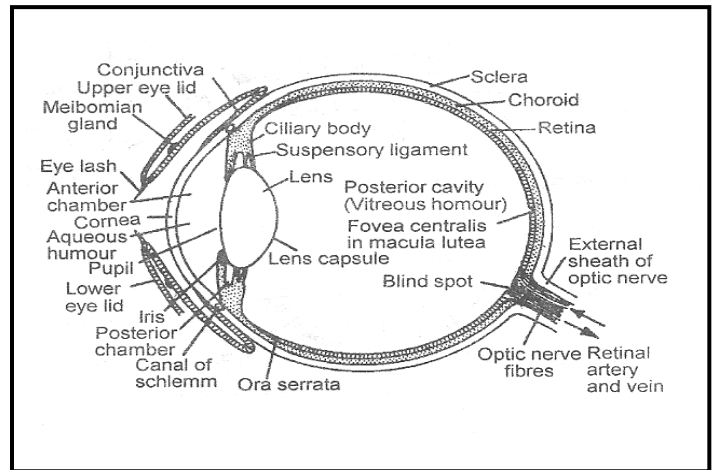
Inner layer of eyelids remain stretched over anterior part of sclera (limbus) in the form of translucent membrane. It is called **conjunctiva**. It is made up of epidermis of skin. The thinnest epidermis is extend up to margin of cornea i.e. conjunctiva is the thinnest epidermis in animal body .

(2)

### Vascular tunic

It is the middle layer of eyeball It is coloured part of eyeball. It is richly supplied with blood capillaries. Due to the presence of network of blood capillaries it is highly vascularized.

Melanin pigment is found in this layer . Due to the presence of melanin pigment eye looks green , blue , brown, black in colour. Eyes of rabbit are due to red melanin pigments, and in man eyes may be brown, black, blue , green according to the melanin present in it.



This layer has three parts :-

(a) **Choroid layer :-**

Choroid layer is the part of vascular tunic which lie below the sclerotic layer.

It contains abundant pigment cells & blood vessels.

It is dark brown. It darkens the cavity of prevent internal reflection of light.

It nourishes the retina.

(b) **Ciliary body :-**

It is the lower swollen portion below limbus.

It has ciliary processes which project into eyeball.

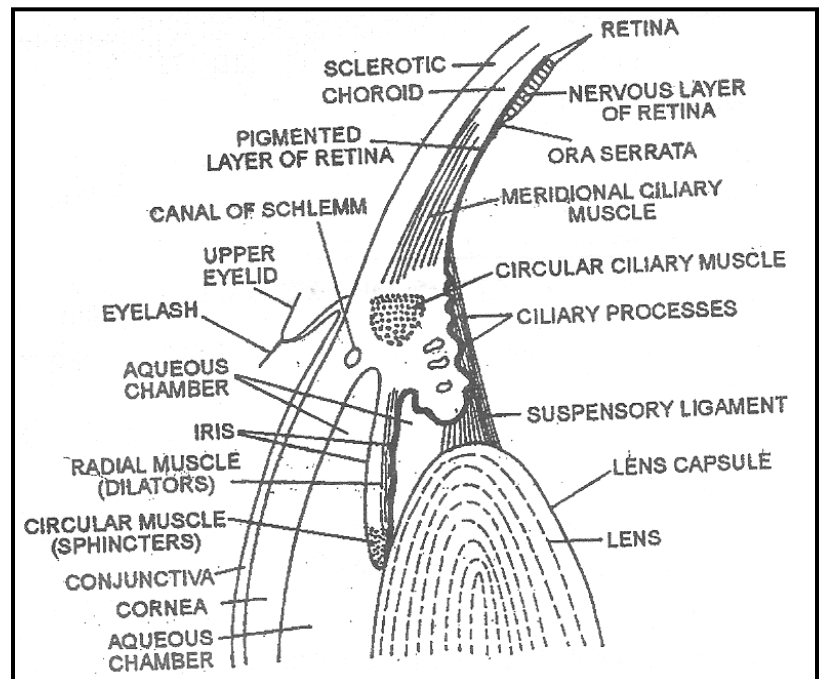
It has ciliary muscles (i) circular (ii) meridional.

Inner end of meridional is attached to choroid & outer end the junction of sclera and cornea.

(c) **IRIS:-**

Choroid layer or vascular tunic separates from sclerotic layer (Just after the cornea) inclines towards inner side and forms a coloured screen, it is called **iris**. **Muscles of iris are ectodermal in origin** where as the muscles of body are **mesodermal** in origin . There is present an aperture in the Centre of iris, it is called **Pupil**. Light rays enter in the eyeball through pupil.

2 types of muscles are related with iris.



(a) **Radial dilatory muscles :-**

These are outer unstriated muscles, these are expanded in the iris breadth wise. iris becomes constricted if these muscle contract and diameter of pupil is increased at that time. It happens in dim light , it is called **Mydriasis**.

(b) **Circular sphincter muscles :-**

These are scattered in inner part of iris. Due to the contraction (In bright day light or high flashes of light) of these muscles in high light, Iris expands breadth wise and diameter of pupil is decreased. It is called **miosis**. Iris controls the intensity of light by increasing or decreasing the diameter of pupil i.e. Iris acts as diaphragm of a camera. Except muscle of iris & ciliary body all vascular tunic of eye ball is mesodermal in origin. the parasympathetic fibres constrict & sympathetic fibre dilate the pupil. Colour of eye like blue, gray, brown is layer of pigmented cells.

(3) **Neurosensory tunic**

It is the inner most layer of eye ball and has 3 parts :-

(1) **Pars ciliaris :-** This part is attached with ciliary bodies. There are present spine like projections at the surface of ciliary body, these are called "**Orra serrata** :

(2) **Pars iridica :-** This part lies just after the iris. It has a layer of pigmented cells. Pars iridica and pars ciliaris are made up of simple cuboidal epithelium.

(3) **Pars optica :-** It is also called retina. It is the part just below the choroid layer.

Structure of retina is complicated. It has following layers –

(a) **Pigmented layer :-** It is the outer most layer. In the cells of this layer, pigment is found called melanin (receptor cells)

(b) **Sensory layer :-** This layer is made up of specialized sensory cells. Rods and cones are found in this layer. Receptor cells are also known as photoreceptors/ visual cells.

☞ Rods are long, thin, cylindrical structures/ cells. These are numerous in number. (1110-1125 Lacs)

☞ Rods differentiate between light and dark. These are more sensitive than cones.

☞ A purple coloured pigment is found in rods called **Rhodopsin/Visual purple**.

☞ Cones are thick and small cells which differentiate among different colours in full light. (65 Lacs)

**Indopsin/ Visual violetis** present in cones.

☞ **Only rods are found in the** retina of owl, because it is nocturnal animal, unlike hen which has only cones in its retina.

☞ Cones are absent in the retina of most of the nocturnal mammals like rats, shrews, bats etc. squirrel has only cones in its retina.

☞ A horizontal neurons layer is present just below the rods and cones, it is called **outer plexiform** layer. This layer connects rods and cones together. Then comes the layer of bipolar neurons. Each bipolar neuron has a dendron and one axon. presence of bipolar neurons is a speciality of retina. Rest parts of body have multipolar neurons. Their dendrites form synapses between rods & cones.

☞ Axons are jointed together by specific nerve cells, called **Amacrine cells**. Such neurons do not have nerve fibres.

☞ The layer of Amacrine cells is called “**Inner plexiform layer**”.

☞ In between bipolar neurons, supporting cells are found and called **Muller’s cells**.

(c) **Ganglionic layer :-** This layer is made up of nerve ganglia. These nerve ganglia form synapses with axons of bipolar neurons.

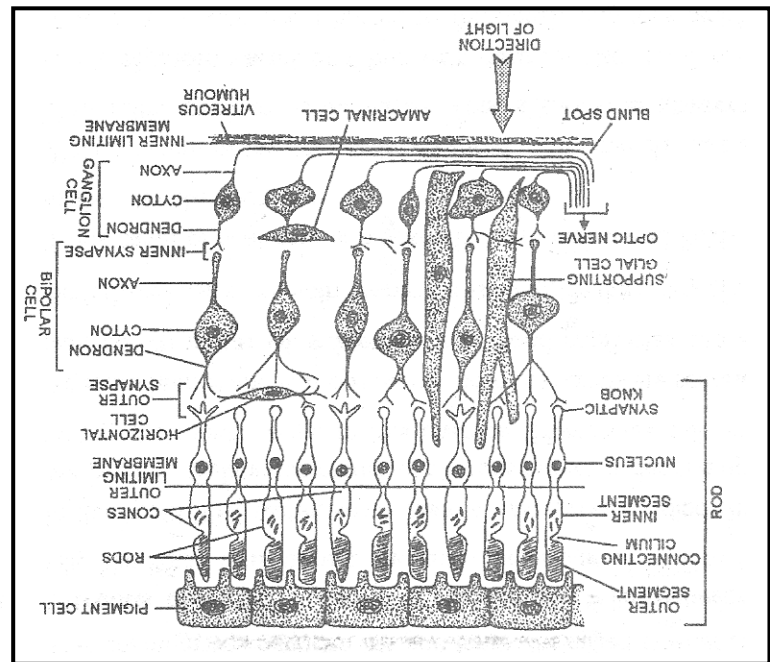
Axons of all nerve cells combine to form optic nerve. This nerve penetrates the retina and goes to brain.

At the point, at which retina is pierced by optic nerve, cones and rods are absent. So no image will be formed at that place. This point is known to be “**Blind spot**” / **Optic disc**.

Just above the blind spot at the optical axis of eye ball, there is a place, where only cones are present. Yellow pigments is found (xanthophyl) in these cones. So this place is known as **yellow spot** or **macula lutea** or **Area centralis**.

A groove or notch is found in area centralis, called **fovea centralis**.

☞ Fovea centralis is most sensitive part of eye. Cones are somewhat obliquely placed at this place. An enlarged image of object is formed here.



- ☞ Neurosensory tunic or retina of eye ball is ectodermal in origin.
- ☞ **Lens :-** A transparent, ectodermal, biconvex lens is present just after iris. In frog, lens is spherical in eyeball. Lens is connected by ciliary body with the help of “**Suspensory ligaments**” called **zonula of zinn**” or **zonules**. These ligaments are flexible and this can slide the lens and can change its focal length. Lens divides the cavity of eyeball into two chambers.

**(a) Aqueous chamber :-**

The part of eye ball which lies between cornea and lens is filled with an alkaline liquid, it is called aqueous humor. /it is a type of transparent tissue fluid.

Iris divides this aqueous chamber into two parts :-

**(i) Anterior chamber :**

This chamber lies between cornea and iris, it is called Venous chamber. Veins carry CO<sub>2</sub>’ metabolic wastes outside from here.

**(ii) Posterior Chamber :-**

This chamber lies between iris and lens, it is called arterial chamber. Arteries supply O<sub>2</sub> and nutrients here.

**(b) Vitreous chamber :-** Cavity of eye ball which lies between lens and retina is called vitreous chamber. A jelly like liquid (transparent and thick like albumin) is filled in this chamber, This is called vitreous humor.

- ☞ In this liquid 99% water, some salts, a Mucoprotein called vitrin and a mucopolysaccharide- Hyaluronic acid are present. Gelatinous nature of vitreous humor is depend upon fibrillar protein & hyaluronic acid. It is form during embryonic stage. In this chamber Hyalocytes cells are found.

- ☞ Aqueous humor and vitreous humor both the liquids are secreted by the glands of ciliary body. Aqueous humor leak out by **canal of schlemm** into blood capillaries and again reach upto their veins.

- ☞ Both these liquids maintain proper pressure inside the cavity of eye ball. These check the eye ball from collapsing.

- ☞ If this canal of schlemm is blocked by any reason and fluids do not return back to veins liquid is increased in the chambers of eye.

- ☞ When amount of this humor is increased in the eye chambers then pressure is increased inside the eye ball. Thus retina pressure is increased. This is known as **glaucoma**

- ☞ A thin **Hyaloid canal or Cloquet’s canal** is also found in vitreous humor from blind spot to central point of lens. It provide nourishment to the developing lens which gradually atrophied.

### WORKING OF EYES

- ☞ Light rays emitted by any object enter the eye. A small, real and inverted image of object is formed at retina. Sensory cells of retina are sensitized, and optic nerve carries this impulse to brain. At this time animal is able to see the object.

- ☞ Cornea, aqueous humor and biconvex lens completely refract the light rays coming from object. As a result of this an inverted image is formed at retina. Just like diaphragm of a camera iris of eye, decreases or increases the diameter of pupil according to light. Iris expands to decrease the pupil in high intensity of light so a small amount of light touches the retina.

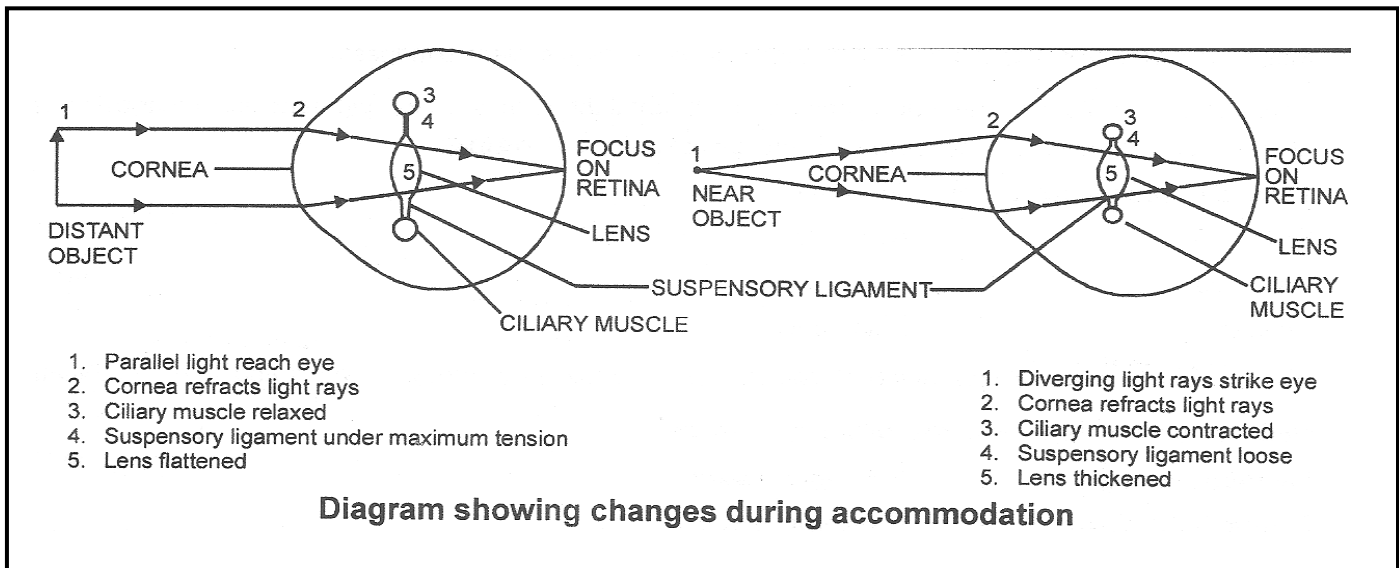
When light is dim, iris itself constricts to increase the diameter of pupil.

### ACCOMMODATION OR FOCUSING –

The ability to change the focal length of lens by changing the curvature of lens, is called **accommodation** power.

Only mammals and birds have this accommodation power in their eyes.

- ☞ This ability is very less in frog and it depends on the sliding of lens forward and backward to some extent.



1. Parallel light reach eye
2. Cornea refracts light rays
3. Ciliary muscle relaxed
4. Suspensory ligament under maximum tension
5. Lens flattened

1. Diverging light rays strike eye
2. Cornea refracts light rays
3. Ciliary muscle contracted
4. Suspensory ligament loose
5. Lens thickened

- ☞ In normal condition muscle fibres of ciliary body remain relaxed and lens is stretched by its suspensory ligaments, and due to this lens is flat. A flat lens has more focal length. As a result of this eye can see long distant objects easily.
- ☞ To see near by objects, sphincter muscles of ciliary body contract and ciliary body becomes broad, suspensory ligaments becomes loose and relaxed. As a result of this relaxation of ligament lens becomes biconvex, and now its focal length is reduced. Now animal is able to see near by object easily

### TYPES OF VISION :-

- (a) **Monocular vision or panoramic vision :-** Most of the vertebrates have their eyes situated on the lateral sides of head and due to this animal is capable to see large area of both the sides. It is called monocular vision.  
e.g. rabbit, frog, horse (Most of the herbivorous animals have this type of vision)
  - (b) **Binocular vision :-** Most of the carnivorous mammals have eyes in front of their heads and side by side, so as to focus on one object by both the eyes. It is called binocular vision. e.g. Man, monkeys and apes.
  - (c) **Stereoscopic vision :-** It is three dimensional vision found in human.
  - (d) **Telescopic vision :-** This is found in birds.
- ☞ Largest eyeballs are found in horse.
  - ☞ Sharpest vision is found in eagle.
  - ☞ Shortest sight is found in monkey.

### Chemical explanation of vision –

- ☞ Cones and rods of eye are stimulated by light rays. It is a chemical event.
- ☞ A shiny visual purple pigment is found in rods of retina called Rhodopsin. It is formed by a protein **opsin** and a coloured pigment **Retinal**, just like haemoglobin of blood.
- ☞ **Opsin** is also called **scotopsin**.
- ☞ In bright light, rhodopsin is decomposed into opsin protein and retinal pigments. This chemical change is sight impulse. This sight impulse is carried by optic nerve to the brain, and animal is able to see.
- ☞ In dark, rods synthesize rhodopsin again with the help of opsin, retinal and enzyme.
- ☞ This is the reason that we can not see anything, when we move to dark place from a enlightened place (for some time only) In the same way we are unable to see in light if we are coming from dark place because it will take time to synthesize or decompose the rhodopsin
- ☞ **It is called adaptation**
- ☞ For resynthesis of rhodopsin, animal blinks its eyelids.

- ☞ Retinin is formed by vitamin A so deficiency of vit A cause night blindness.
- ☞ Cones able us to differentiate among colours and bright light. Cones have a pigment called lodopsin in place of rhodopsin of rods. It is decomposed into **photopsin** and **retinal**.
- (a) Erythrolab - Red cones
- (b) Chlorolsab - Green cones
- (c) Cynolab - Blue cones
- ☞ We are able to acknowledge different colours due to these three types of cones and their combination.
- ☞ **Red, green and blue are the primary colours.**
- Dimlight vision** - **Scotopic vision**
- Bright light vision** - **Photopic vision**
- ☞ The eyes of some animals shine at night , because in the eyes of these animals , there is a pigment just outside the retina in the choroid layer of eyeball, which reflects the light rays coming from retina. This layer is called **Tapetum**. Due to this layer, these animals are capable to see in dark also.
- ☞ Kangaroo, hoofed mammals , elephants, whales etc. are having a silver shining layer of fibrous connective tissue called **Tapetum fibrosum**.
- ☞ In Elasmobranch fishes a reflecting colour pigment called **Guanine** is present in tapetum layer so it is called **tapetum lucidum**.
- ☞ Hunters and carnivore mammals like dogs, cats , tiger etc. have a layer in their retina called **tapetum cellulosum**.
- ☞ In the eyes of birds pecten is found.
- ☞ **Emmetropia :-** Normal vision of eyes is called emmetropia.

### Some important defects of eye :-

#### 1. **Hypermatropia (far sightedness) :-**

- ☞ In this defect of eye, person is able to see objects placed at far distance but is unable to see objects close to him or her.
- ☞ This defect is due to small size of eyeball or flatness of lens. In this defect image is formed **behind the retina**. To cure this defect person should wear **convex** lenses in spectacles.
- ☞ Sometimes in old age this defect may occur due to reduction in the flexibility of lens or ciliary body, then it is known as **presbyopia**.

#### 2. **Myopia or Nearsightedness or short sightedness :-**

- ☞ In this defect of eye, person is able to see objects near / close to him or her but is unable to see objects placed at far distance.
- ☞ This is due to enlargement of eyeball or increased convexity of lens.
- ☞ In this defect image is formed the retina because light rays coming from distant objects converge before retina.
- ☞ To overcome this defect person should wear concave lenses in spectacles.

#### 3. **Astigmatism :-** In this defect curvature of cornea is changed as a result of that light rays do not focus on macula lutea but somewhere else, causing incomplete and blurred vision. This defect may be cured by cylindrical lenses.

#### 4. **Night blindness :-**This is due to deficiency of vit A. In this disorder synthesis of Rhodopsin is reduced, as a result of this person is unable to see in dim light or night.

#### 5. **Xerophthalmia :-** It is due to keratinisation of conjunctiva and cornea, and conjunctiva becomes solid. It is also due to deficiency of vit A.