








# 4

## SENSE ORGANS

### What we have learned earlier

-  Organisms recognise the changes in the surroundings.
-  The brain receives messages from various parts of the body and sends messages to them promptly.
-  External ear, middle ear, inner ear together form the human ear. The smallest bones of the body such as malleus, incus and stapes are found inside the ear.
-  Though the snakes lack external ear they recognise the soundwaves which come through the ground.
-  Different types of nerve receptors are found in the skin.
-  Images are formed in the retina of the eye.
-  The defective vision such as short sight and long sight can be rectified using suitable lenses.

The receptors help the organism to respond to stimuli. Most of the receptors respond to only one type of stimuli such as light, heat, touch, sound etc. The number and complexity of receptors increase as we go from the lower organisms to the higher organisms. In the unicellular organism, *Chlamydomonas*, light receptors help to recognise light. In the earthworm this spreads in the body wall and help to sense light. Some insects use their legs to detect the taste. In the complex structured snake and mabuya receptors on their tongue help to recognise smell. These receptors which perform specific functions together form sense organs. Which are the sense organs of man who stands in the highest level among the living organisms? Doesn't the eye, ear, nose, tongue and skin perform different functions?

In this chapter let us learn the structure and working of these organs. Simultaneously, let us try to understand their disabilities and diseases and gain general awareness in protecting them.

## The eye

Eye is the sense organ which helps us most to gain knowledge. Where are they situated?

Eyes are situated in the eyesockets of the skull. Observe the cross section (figure 4.1) of the eye. Images are formed in the retina. Let us examine through which parts light passes before reaching the retina.

Cornea which is convex in shape and transparent as glass, is found in the front of the eye. The continuation of cornea seen in white colour is called sclera. It is the outermost layer of the eye. It is this strong layer that gives shape to the eye ball.

Which is the chamber seen just behind the cornea? The fluid filled in that chamber is called the aqueous humour. This fluid which gets separated from the blood gets absorbed back into the blood in the same quantity. This fluid provides nourishment and oxygen to the cells around it.

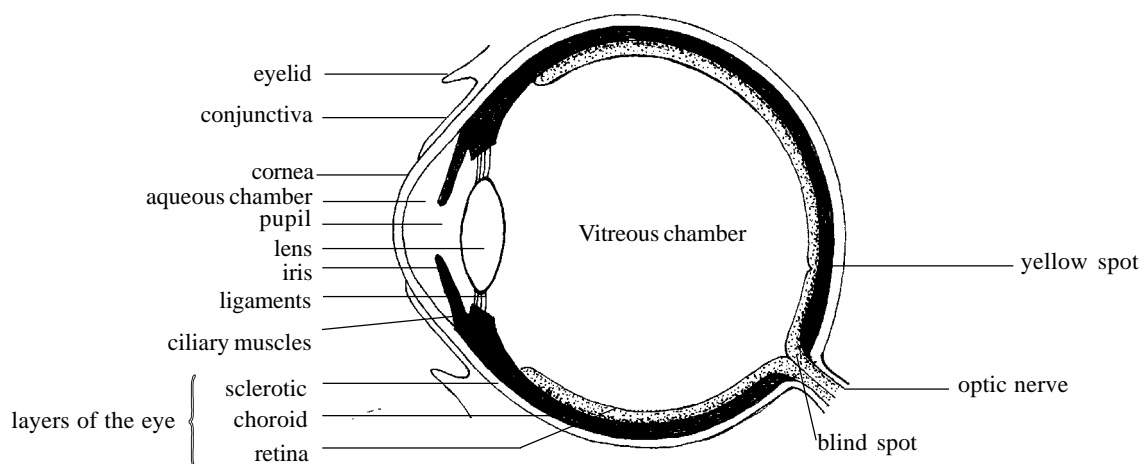


Figure 4.1  
Cross section of the eye

**Multiplicity of eyes**

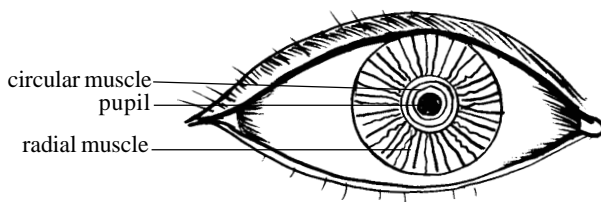
Whether the organisms are big or small, they have to know the changes in their surroundings. This is essential for their survival. There are so many mechanisms for this. Fishes and crabs have separate receptors to receive different stimuli. Crickets receive sound waves through pores in its legs. Though the snakes lack external ear it has certain parts in the ear which can recognise sound waves. You know about the compound eyes of insects. Each compound eye is formed of many simple eyes. They can recognise all colours except red. The ultraviolet light which cannot be recognised by the human eye is recognised by the honey bee. Enquire and find out more about such mechanisms.

Which is the middle layer of the eye ball? Observe the figure 4.1. Melanin is the pigment which gives dark colouration to the choroid. It absorbs the excess light which enters into the eye. Numerous capillaries are present in the choroid. They bring oxygen and nutrients required for the eye. You have seen the iris which is found as a screen in front of the lens. This is the continuation of the choroid. Is the colour of iris same in all people around the world. What could be the reason for this? Note the portion where the iris joins the sclerotic layer. Ciliary muscles are seen in this thickened area.

**Light and the pupil**

Observe the position of the pupil. This is the only way through which light can reach the retina. Observe the eyes of your friend and find out how the size of the pupil changes with the intensity of light. The pupil constricts in bright light and dilates in dimlight. Why does this happen? Observe the figure 4.2. Which muscles help in this process? When

When the intensity of light increases



When the intensity of light decreases

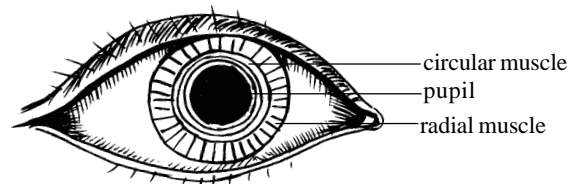


Figure 4.2  
Contraction and relaxation of the pupil

the circular muscles contract, the size of the pupil decreases. What happens if the radial muscles contract?

Observe the lens in the eye (figure 4.1). Which type of lens is this? The lens is made of a substance which has elasticity. The lens is connected to the ciliary muscles with the help of ligaments. Note the change in curvature of the lens with the contraction of ciliary muscles (figure 4.3).

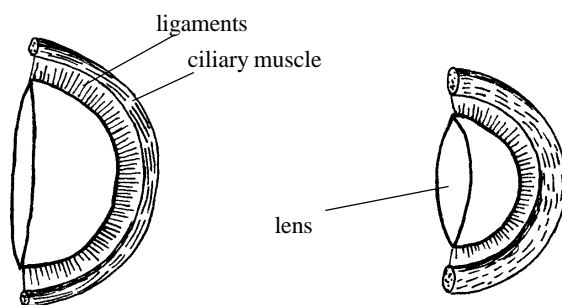


Figure 4.3

#### Working of ciliary muscles

Note the large chamber inside the eye (figure 4.1). Light passes through the lens into this large chamber behind it. The semisolid transparent substance filled in this chamber is called vitreous humour. It gives shape to the eyeball.

#### How is image formed?

What are the characteristics of the image formed when light passes through a convex lens?

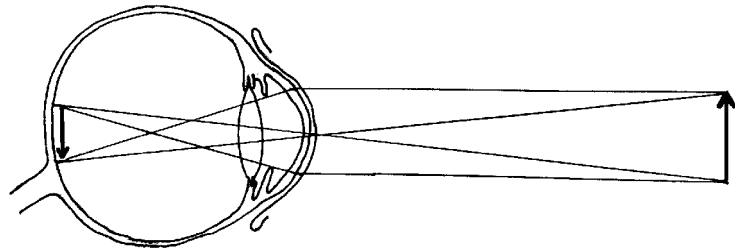


Figure 4.4

#### Formation of images of objects

- small
- inverted
- real

It is the image of a distant object which is formed in the focus. The lens in the eye is convex. Then what are the characteristics of image formed. The light gets refracted when it passes through cornea, aqueous humour, lens and vitreous humour. As a result of this the image falls on the retina (figure 4.4).

But when we look at a near object its image will be formed behind the retina. Here the curvature of the lens is increased by the contraction of the ciliary muscles, so that the image is formed on the retina (figure 4.5). Thus depending upon the distance of the object from the eye, its ability to focus the image on the retina by altering the convexity of the lens is called the power of accommodation. In addition to the contractions of the ciliary muscles, the curvature of the cornea, shape of the pupil and the fluids in the eye also help in this process.

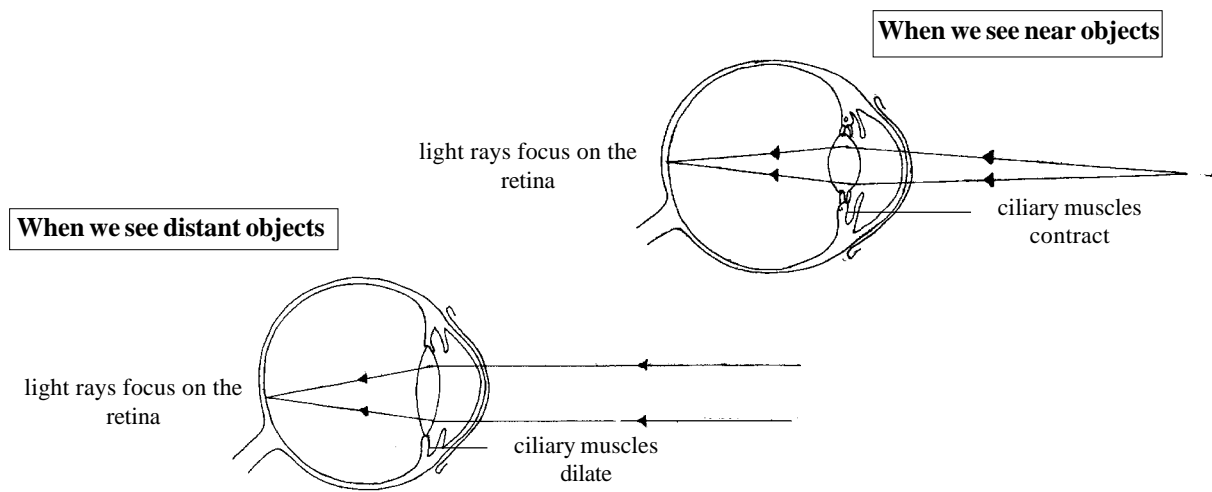


Figure 4.5  
How images are concentrated on the retina

### Lens and vision

As we grow old the elasticity of the lens decreases. This state is known as presbyopia. What type of lens is used in the spectacles of such people?

The transparency of the lens is lost in many aged people and in some persons affected by diseases. This disorder is known as cataract. Have you heard of the cataract operation done to rectify this? The lens incapable of functioning is replaced by an artificial lens.

### Disorders of the eye

Let us see how the working of the eye is affected by the change in shape of the eyeball.

#### Myopia (Short sight)

The elongation of the eyeball results in myopia. Where is the image of the object

formed in people having such a disorder? See the diagram.

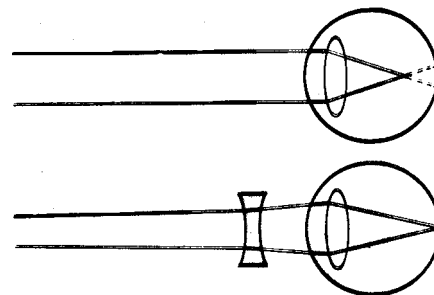


Figure 4.6  
Myopia

Such persons are not able to see distant objects clearly. What type of lens is used to rectify this.

#### Hypermetropia (Long sight)

What happens if the eyeball shortens? The image is formed behind the retina. Such persons cannot see near objects clearly though they are able to see distant objects.

What type of lens is used to rectify this?

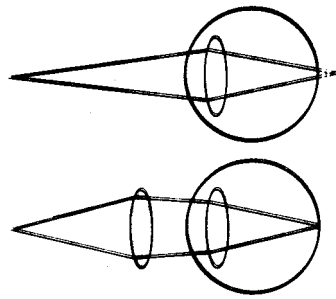


Figure 4.7  
Hypermetropia

### Astigmatism

Like the shape of the eyes any disorder in the curvature of the cornea or lens affects the vision. This results in the formation of incomplete and blurred images of objects. This state is known as astigmatism. This disorder is rectified using suitable cylindrical lenses.

### The chemistry of vision

We have understood that where the image of the objects are formed in the eye. Photoreceptors such as rod cells and cone cells are present in the retina. Rod cells get stimulated in dimlight. Thus it helps the vision in dimlight. But cone cells get stimulated only in bright light. The cone cells help to distinguish colours and to see the objects in bright light.

Observe the figure 4.8 and study the structure and distribution of rod cells and cone cells. The pigment seen in the rod cells is rhodopsin. When light falls on it, rodopsin

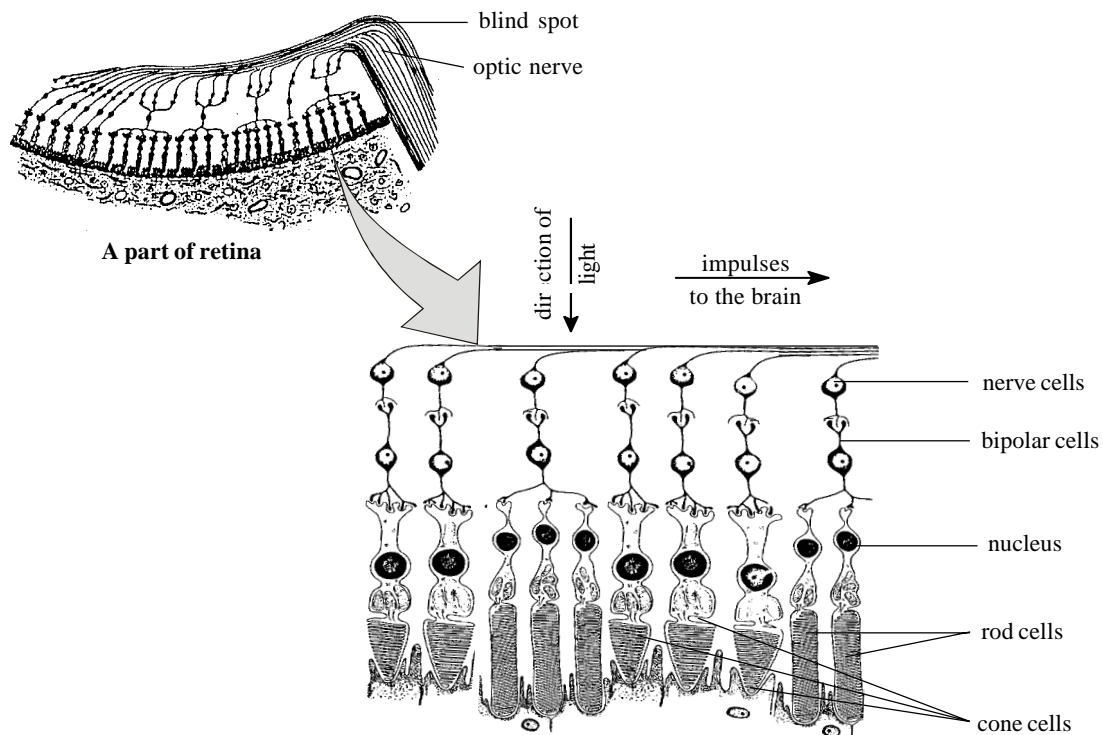
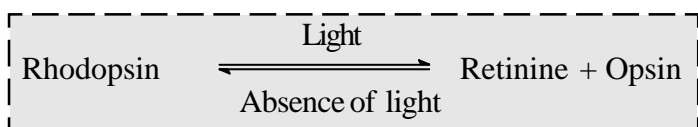


Figure 4.8  
Photo receptors in the retina



dissociates. Note the chemical change that takes place.

The impulses formed as a result are received as a stimulus by the nerve cells. Retinine, which is the part of the rhodopsin, is synthesized from Vitamin A. Now it is clear that the deficiency of vitamin A causes Night blindness.

### *The owl which sleeps during the day*

Does the owl sleep during the day? Whether it sleeps or not, it is not able to see during day time. The reason for this is the deficiency of cone cells which give receptive power in bright light. But the presence of more rod cells gives it greater power of vision during night. All the animals that search for prey during night has this speciality. In birds which are active during day time the presence of rod cells is very less. In a human eye there are about 125 lakhs rod [cells and 7 lakhs cone] cells. Have you seen the eyes of cat and dog shining in the night. The reason for this is the presence of tapetum behind the eye which is a layer capable of reflecting light.

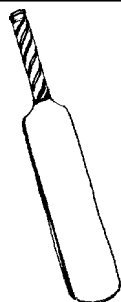


Figure 4.9

Observe the cone cells. There are different types of cone cells to recognise the primary colours viz blue, green and red. They contain different types of a pigment called iodopsin which helps us to recognise the primary colours. Damages in any of these cone cells may cause inability to distinguish colours. This is called colour blindness.

### **The blind spot and the yellow spot**

The part of the retina where the optic nerve begins lacks rod cells and cone cells. Can you see if the image is formed in this part? Therefore this part is called blindspot.

The part which is seen almost in the centre of the retina is called yellow spot. More cone cells are present here. There are no rod cells. It is the point of highest vision. When we concentrate on small objects the image is formed here.

Hold the figure given below (fig. 4.9) about 9 inches from your eye. Now close your left eye and concentrate on the bat alone with your right eye. Slowly move the diagram forward and backward. When does the ball disappear? What is the reason for this. What is your conclusion?

### *Dalton and the colours*

"I am able to distinguish only blue and yellow". These are the words of John Dalton who formulated the atomic theory. This deficiency known as Daltonism was later named colour blindness. Colour blindness is found more in males than in females. What is the reason for this? The genes responsible for the synthesis of iodopsin is present in X chromosome. Though colour blindness was experienced by Dalton, it was Robert Boyle who explained it first.

## The physiology of vision

You have understood that the light which falls on the photoreceptors cause a chemical change. This stimulus creates impulses that travels through the optic nerve which is formed by the clustering of axons of the photoreceptors, reaches the cerebrum. Though the image formed in the retina is inverted, do we feel it is our vision? It is the cerebrum which makes the vision a reality.

### Binocular vision

Though the image of an object is formed in both the eyes we do not feel it as two separate images. It is the cerebrum which coordinates the images formed in both the eyes. Then what is the need for the two eyes? Do you know the difference between the vision through a single eye and a pair of eyes? Close one eye and try to replace the cap of a pen which is held by another person. The

binocular vision helps us to calculate the distance from objects correctly. This is not possible for all animals. Binocular vision is obtained since it is possible to concentrate both eyes on a single object. The balanced movement of the two eyes is made possible by the muscles of the eyeball.

Observe the figure 4.10. Note the three pairs of muscles which connect the eye to the walls of the eye sockets. What will happen if the balanced movement of the muscles is not possible? This condition is called squint. Early detection of this disorder can be rectified by a careful surgery.

### Glaucoma

We have understood that the production and reabsorption of the aqueous humour is a

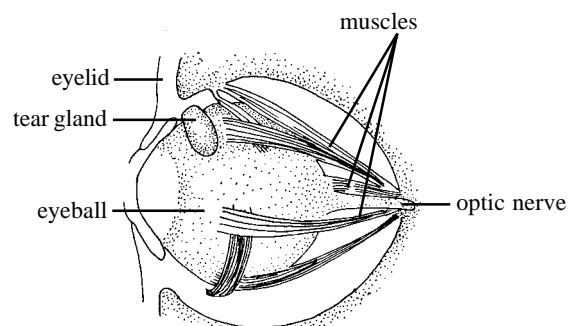


Figure 4.10

### Eye ball in the eye socket

continous process. What will happen if its reabsorption is prevented. The pressure inside the aqueous chamber is increased. The increase in pressure in the eyeball results in glaucoma. The curvature of the cornea changes due to the increase in pressure. The

patient gets pain in his eyes and he sees colour rings around a flame. As this continues, the extraordinary pressure causes the receptor cells to disintegrate. Can you guess its after effects?

### **Protection within the eye**

Try to understand the structure of the eye as a sense organ. Based on the indices given below make a note in your science diary how the eye is kept in working condition.

- eyebrow, eyelashes, eyelid
- tears

Observe the figure 4.11. Note the position of the tear gland. Now it is clear how the tears produced by these glands enter into the nose.

An enzyme called lysozyme present in tears prevents infection of the eye. Conjunctiva is a membrane which covers the

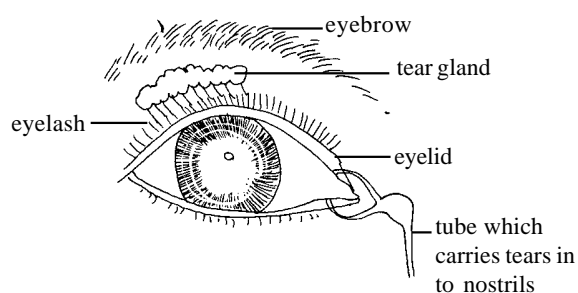


Figure 4.11  
**Tear gland**

front portion of the eye except cornea. It also covers the inside of the eyelid. The infection of the conjunctiva is called

conjunctivitis. How will you prevent the spreading of this disease. Discuss and note your conclusion.

Though these mechanisms are present, we should take care for the healthy protection of the eye.

### **Eye care**

What are the points to be kept in mind for eye care? Based on the indices given below, discuss and prepare a report.

- cleanliness
- nutritive food
- exercise
- immunity
- reading
- the use of TV, Computer, etc.

### **The eyes that long to live**

Of the total blind population, 5% is in India. We know that there are various reasons for blindness. But the majority of the blind have blindness due to the disorder in their cornea. The only remedy for this is cornea transplantation. Removal of the damaged cornea and transplantation of a healthy cornea in its place is effected by a surgery known as keratoplasty.

It is not possible to make an artificial cornea. The only way is to receive it from a

donor. This makes donation of the eye a great gift. If the eye is removed from the dead within reasonable time, it can be used for Keratoplasty. The eyes of the dead can thus continue to live through another. Collect details of eye donation and make a note in the science diary.

## The ear

Hearing is as important as vision. We know that ear is the sense organ which helps us in hearing. It also helps us to maintain the balance or equilibrium of our body.

Examine the model of ear. Compare it with the figure (4.12) given below.

It is clear that the ear has three main parts. Which are they?

- External ear
- Middle ear
- Internal ear

### The external ear

The external ear consists of pinna, auditory canal and ear drum. Pinna helps to direct the sound waves into the auditory canal. Hold the fingers of your palm close to each other and place it behind the pinna. Then try to concentrate on a particular sound continuously having the same frequency. Remove the palm and try to concentrate on the same sound again.

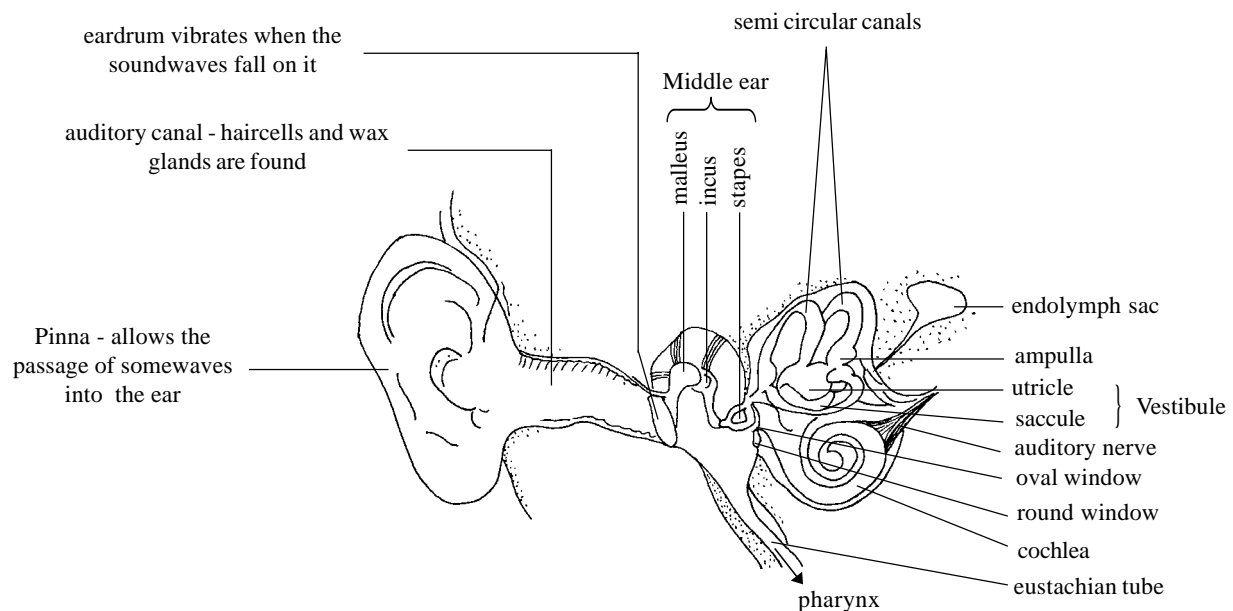


Figure 4.12  
Structure of human ear

What difference do you feel?

Observe the pinna of the cattle, dog, etc. and find out how they differ from that of man in shape, size and capacity for movement.

Ceruminous glands are special glands which are found in the walls of the auditory canal which is the continuation of the pinna. The wax produced by these glands and the hairs in the auditory canal together protect the ear from small insects, germs and dust. In additions to this, they help to maintain the temperature and dampness of the auditory canal. The auditory canal ends in the ear drum. It is clear from the diagram that this thin membrane separates the external ear from the middle ear. This membrane capable of vibration is connected to the ossicles of the middle ear.

### The middle ear

The middle ear is a chamber with air circulation. Observe figure (4.13) and try to understand the shape and arrangement of the bones in the middle ear. You know that stapes is the smallest bone of the human body found in this chain of bones which are movable. The oval window which separates the middle ear from the inner ear is connected to the stapes. The bones of the middle ear are connected to each other by ligaments and are capable of vibrating in a peculiar way.

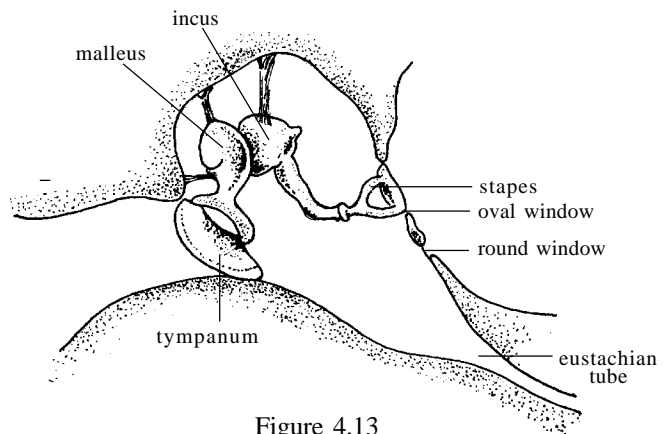


Figure 4.13  
The chain of bones in the middle ear

### The eustachian tube

The eustachian tube connects the middle ear to pharynx. This tube helps to regulate the air pressure on both sides of the ear drum (tympanum).

Guess why we get pain in our ears when we have cold.

### The inner ear

Observe the figure 4.14 and find out the answer for the questions given below.

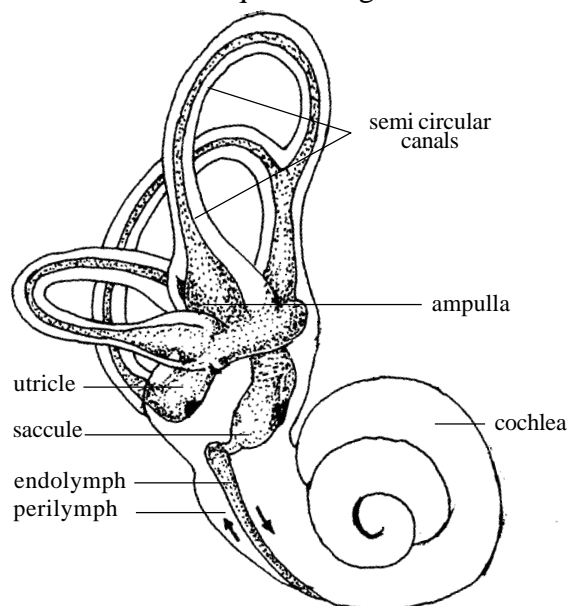


Figure 4.14  
Internal ear

- How do the cochlea and semicircular canals differ in shape?
- How are the cochlea and semicircular canal connected together?

The semicircular canals, vestibule, cochlea etc are made of membranes. These are filled with a fluid called endolymph and are surrounded by another fluid called perilymph.

### How is hearing made possible?

Cochlea is the part of the inner ear which helps in hearing. Observe the figure 4.15. showing the L.S of cochlea. Did you notice the three chambers of cochlea? In which chamber are the auditory receptors located?

They are located on the basilar membrane which separates the median canal and the lower tympanic canal. They are connected to the auditory nerve.

The upper chamber is connected with the oval window and lower chamber with the round window. Both these membranes are capable of vibration. How do the sound waves received by the auditory canal reach the auditory nerve? Make a note in your science diary.

We recognise the sound when the auditory nerve carries this stimulus to the brain.

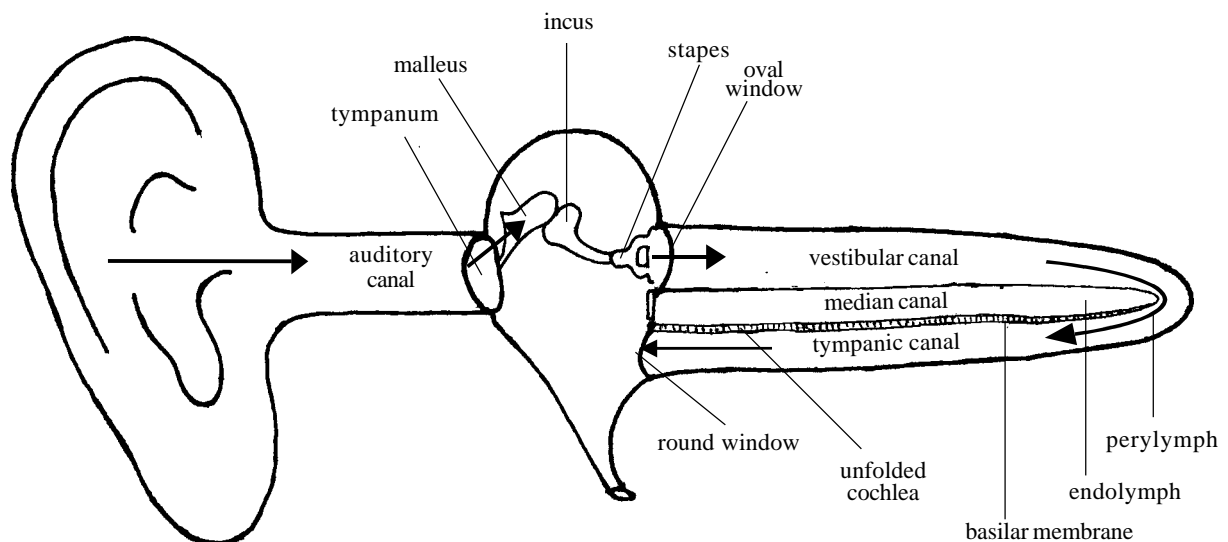


Figure 4.15  
Cochlea

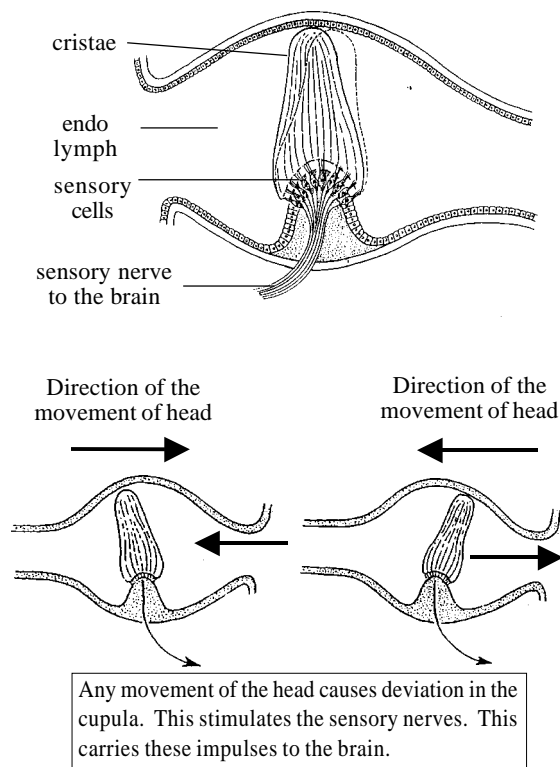


Figure 4.16  
Cristae within in the ampulla

### The role of the ear in maintaining the balance of the body

The semicircular canals and vestibule together help to maintain the balance of the body. Observe the figure 4.16 and examine how this is effected.

The swollen end of the semicircular canal is called ampulla. Cupula containing sensory nerves found inside the ampulla can detect any movement of the head. The semicircular canal begins from the vestibule, goes around and rejoins in the vestibule.

Small particles of calcium carbonate called otoliths are found near the haircells of

the ampullae and vestibule. The movement of the head in any direction can be detected by the receptor hair cells. The nerve fibres coming from these two types of receptors reach the cerebellum through the auditory nerve.

### World without sound (Soundless world)

Deafness is a state in which hearing is not possible. The defect of the following parts in the ear may cause deafness.

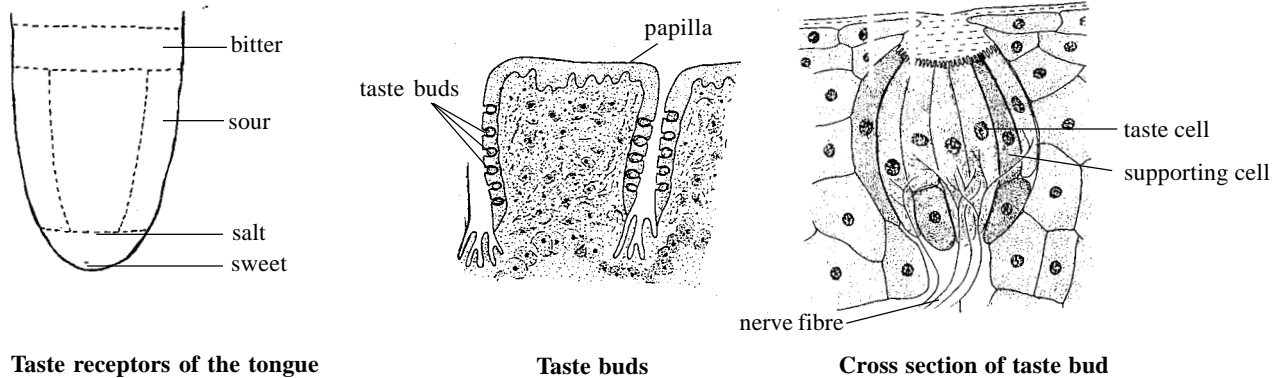
- ear drum
- cochlea
- ear ossicles
- auditory nerve

Have you thought of the reasons for the disorders of these organs?

The infection in eustachian tube will spread to the middle ear too. The ear drum may become damaged by an infection in the auditory canal. In many instances this results in damages in the middle and external ear leading to deafness. How does excessive noise, strong blows on the cheek, pointed objects entering the auditory canal and attack from insects affect hearing? Defects in the brain, auditory nerve, cochlea are also reasons for deafness. How will you save the ear from deafness? Based on this prepare a note.

### The tongue

We know that tongue is the sense organ



Taste receptors of the tongue

Taste buds

Cross section of taste bud

Figure 4.17  
Cross section of Tongue

which helps to perceive taste. We can examine how this happens. Numerous papillae protrude from the surface of the tongue. Each papilla contains numerous taste buds. Taste buds are build up of many receptor cells. Observe figure 4.17 and try to understand the structure of taste buds.

Do you know how these help us in tasting? The molecules of substances which dissolve in the saliva stimulates the receptors

in the taste bud. This stimulus is carried to the brain by nerves. Our tongue has receptors which distinguish only the primary tastes viz. sweet, sour, salt and bitter. You have seen in the diagram where these tastebuds are concentrated. Other tastes are secondary tastes which are created by the cerebrum.

### Nose

You know how the nose helps in breathing

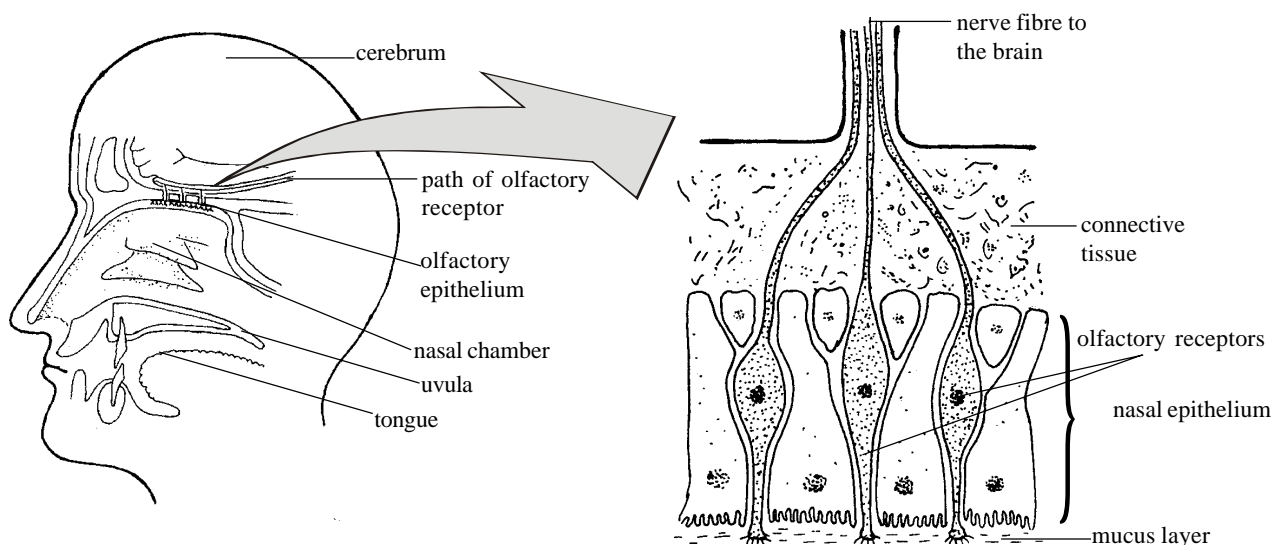


Figure 4.18  
Olfactory receptors in the nose

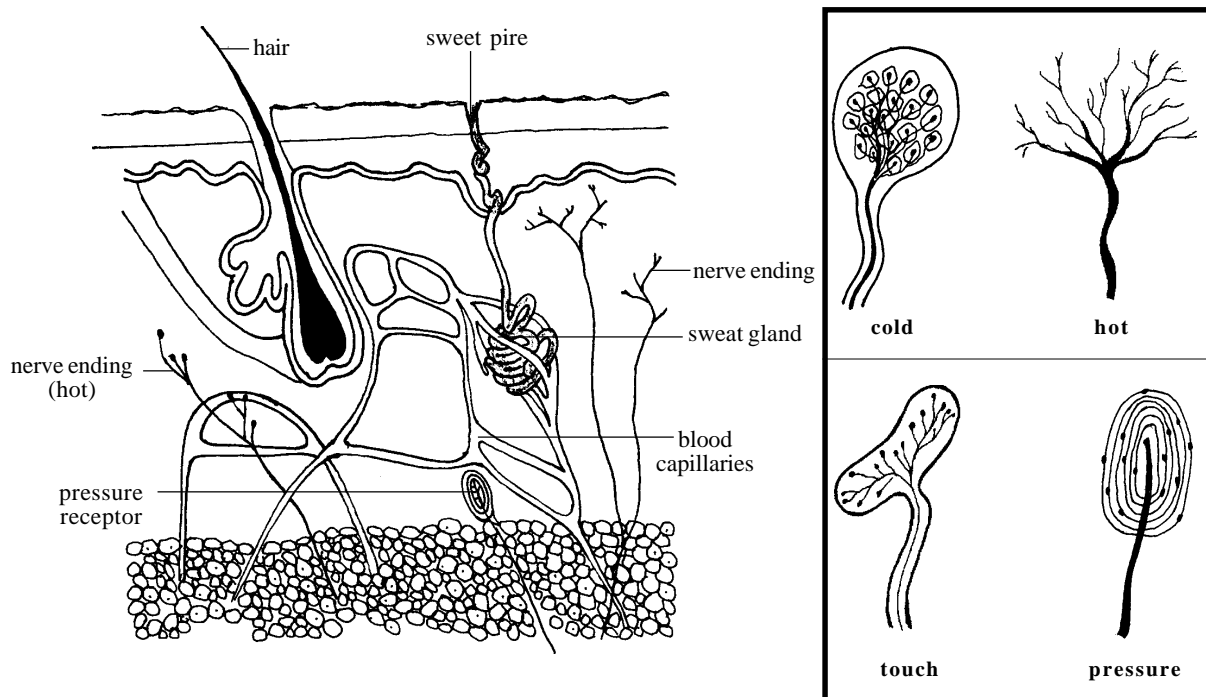
**Olfaction by protruding the tongue**

Do you know why the snake and mabuya protrude their tongue. It is not to frighten anyone. It is only to sense smell. The chemical molecules of any odoriferous substance dissolves in the mucus present on their tongue. Then the olfactory receptors in their peculiar structure called 'Jacobsons' organs are stimulated. The rest of the processes are similar to that of others. We do not have this much difficulty in olfaction. There are about 50 lakhs olfactory receptors in our nose. At the same time, in a dog's nose there are about 40 lakhs olfactory receptors in one square cm. In shark it is more than 200 lakhs. If shark could live on land it would have defeated the dog in its detective 'role'.

and olfaction. Observe the figure 4.18 and understand the position and distribution of the olfactory receptors. Where do the ends of the olfactory receptors touch?

You should also know how the olfactory receptors of the nose help in recognising smell. The chemical molecules of any odoriferous substance that enter the nose with the inspired air dissolve in the mucus and stimulates the olfactory receptors. This stimulus is carried by the olfactory nerve to the cerebrum and thereby helps in olfaction. There are special centres in the cerebrum which helps in the perception of smell.

We will not be able to perceive the smell if excess mucus is produced. Now you know why you are unable to recognise smell when



Picture 4.19  
Receptors in the skin

you have a cold.

## The skin

The skin is the sense organ which covers the whole body. The skin mainly receives stimuli such as touch, pressure, heat cold and pain. Observe figure 4.19 and try to understand the different receptors and their position. There are no special receptors to sense pain.

Receptors are not distributed uniformly in all parts of the body. You can guess why the tip of fingers and cheeks sense the stimuli such as heat and cold quickly.

Ask your friend to close his eyes and extend his arms. Take two wooden rods with

flat ends and about 2 mm diameter. Touch both of them together on his skin. Keep them 1 cm apart. Then ask him how many rods are there. Continue the process to the end of the upper arm and ask the same question again. You can understand the distribution of the touch receptors from your friend's answer. Can you guess why lepers are not able to recognise pain, touch, etc.

Hunger and the urge to urinate are some of the internal stimuli. To recognise these stimuli specialized receptors are present in the internal parts of the body and internal organs.

Now you know that sense organs are very essential to adjust ourselves with internal and external surroundings. By helping to

### SUMMARY

- ❖ In complex organisms sense organs are clusters of sensory receptors.
- ❖ For higher organisms there are special organs for receiving sensations.
- ❖ The structure of the eye is such that the image of the objects falls on the retina. Rod cells and cone cells are the photo receptors found in the retina.
- ❖ The human eye is capable of binocular vision.

h for food, escape from enemies and to respond to the changes in the surroundings sense organs become an essential factor for the survival and balancing of the body. The malfunctioning and non functioning of sense organs are equally dangerous. Receptors which can recognise the primary tastes such as sour, sweet, bitter and salt are present in the tongue. Therefore we should take precautions for their care and proper functioning.

- ❖ Nose is the sense organ where olfactory receptors are present.
- ❖ Receptors which can recognise different types of sensations are present in the skin.
- ❖ The care of sense organs is very essential for a healthy life.

## FURTHER ACTIVITIES

- ⇒ We have separate receptors to recognise sweet, bitter, salt and sour. But we also feel pungent taste. Why?
- ⇒ We cannot overcome the blindness due to glaucoma by eye transplantation surgery, why?
- ⇒ Given below are some activities in which a person who has lost one eye is involved. Will this disability affect his activities? Why?
  - Reads newspaper
  - Aims and shoots
  - Jump the hurdles
- ⇒ Why don't we see objects as two though we have two eyes? If so wouldn't a single eye suffice? How do you explain these doubts of a person?
- ⇒ Why do we feel darkness when we enter from a place of sunlight to a place where there is dimlight?
- ⇒ The thickness of a person's oval window and that of another's round window is increased thereby losing their capacity to vibrate. Analyse this situation and make a note of its adverse effects.
- ⇒ Hearing is effected when sound waves entering the auditory canal reaches a definite spot on the cerebrum. Draw a diagram which clearly explains the path through which the sound waves travel.
- ⇒ Prepare a table showing the sense organs, their functions, related receptors etc.

