

## CHAPTER 3

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### Sense Organs

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The human body has five sense organs. These are identified in Table 3.1 below. They all assist in perceiving various sensations.

*Table 3.1 Sense organs of the human body*

Sense organ	Functions
1. Eye	Vision
2. Ear	Hearing and balancing
3. Nose	Smelling
4. Tongue (taste buds)	Tasting
5. Skin	Reception of sensations of temperature, pain, touch and pressure (feelings).

In each sense organ, sensory nerve endings are close to the body surface. They receive stimuli and relay them to the brain or spinal cord.

#### The skin as a sense organ

When various things such as a blunt or sharp pencil, hot or cold water etc. are applied on the skin, various sensations are stimulated on the skin. These include touch, pressure, pain, cold and heat.

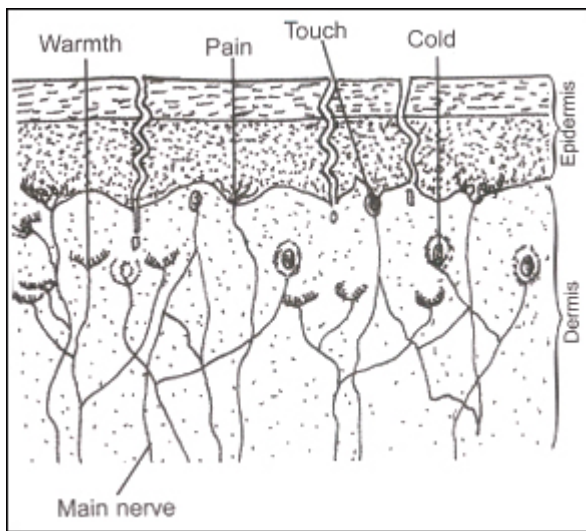


Fig. 3.1 Vertical section of the mammalian skin showing the sensory nerve endings.

The sensory nerve endings are unevenly located both on the surface and inside the skin. Those sensitive to touch (Meissner's corpuscles), are abundantly distributed closest to the skin surface especially at hairless areas such as the lips, tongue, forehead and fingertips. They require a gentle stimulus to register in the brain. In-between receptors of touch and pain are different ones which detect cold, heat and pressure (pressure corpuscles).

## Organ of smell

The nose (olfactory organ), is the organ of smell. The sensory nerve endings are located in the roof of the nasal cavity. Man's sense of smell is poor. Also, it is easily fatigued. It quickly detects a smell but soon after, perceives it no longer, having undergone a fast sensory adaptation or conditioning.

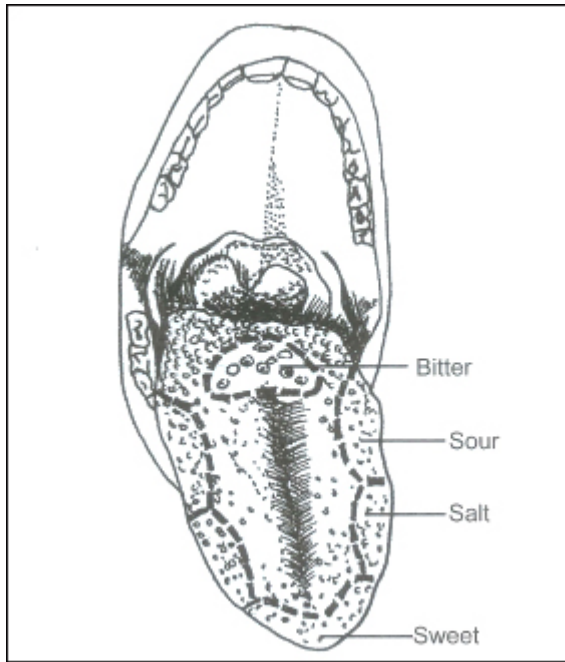
### *Process of perception of smell*

This involves the dissolution of the molecules of a given volatile material in the mucus membrane of the olfactory epithelial cells. The latter stimulate nerve endings to set up nerve impulses which are carried to the olfactory lobe of the brain. Here, the impulses are translated as **smell**. Man is sensitive to a wide range of smell from sweet to very offensive types. However, our sense of smell is poor when compared with that of other animals such as dog and antelope.

## Organ of taste

The taste buds located on the upper surface of the tongue are the organs of taste. They occur as groups of sensory cells as shown in Fig. 3.2. The tongue is sensitive to four primary tastes – sweet, sour, salty and bitter. The back of the tongue is sensitive to bitter stimuli; the sides of the tongue are sensitive to salty and sour stimuli while the tip is sensitive to sweet sensations. It is known that the tongue can also

detect alkaline taste, texture of food as well as its temperature.



*Fig. 3.2 Human tongue showing the four primary taste areas*

For a substance to be tasted, it must be in solution on the surface of the tongue – just as it is in the organ of smell.

There is a close association between the organ of taste and smell. The association include the following:

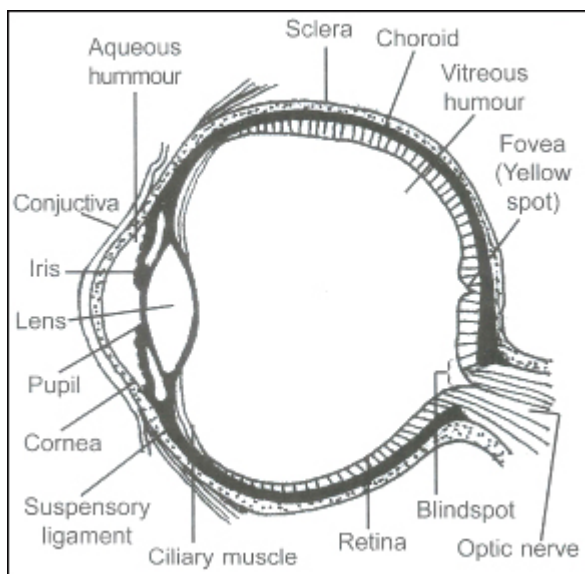
1. A variety of taste sensations are influenced by the sense of smell. For instance, the sense of smell tells if a food material is good enough for eating.
2. Both senses of smell and taste are weakened by cold, catarrh, and blocked or dry nose.
3. Both senses rely on molecules of chemicals for stimulation and these must be dissolved on a wet epithelial surface.

### **Activity 3.1**

Taste the different solutions (that are safe for consumption) provided by your teacher. Note and record the areas of the tongue which are sensitive to sweetness and bitterness.

### **Organ of sight**

The two eyes are the organs of sight in every vertebrate.



*Fig. 3.3 Vertical section of the human eye*

The human eye is almost spherical in shape. Its parts are shown in Fig. 3.3.

The human eye is located in the eye socket in the skull. It is held in position by six muscles. These are two oblique muscles (lower and upper) and four rectus muscles (upper, lateral, median and lower ones). They control the free movement of the eye in many directions. To move the eye, the six muscles work in opposing fashion against one another.

The front of the eyes is protected partly by the **eyelids** and **eyelashes**. Beneath the eyelids are **tear glands**. These secrete a saline fluid (tears) which moistens the conjunctiva, washes away dust particles and insects, and destroys most bacteria. Tears drain out through few small tubes that lie between the inner corner of the eyes and nostrils.

The front part of the eye is covered by a tough, thin, transparent skin called the conjunctiva. The wall of the eye has three layers of tissues. From outermost, they are, the **sclerotic (sclera)**, **choroid** and **retina** layers.

- (a) The **sclera** or sclerotic layer (the white of the eye) is the outermost layer of the eye. It bulges at the front to form a convex, transparent tissue called **cornea**. At the back, the sclerotic layer is perforated by the optic nerve. The remaining part of the sclerotic layer consists of a tough, connective fibrous, non-elastic tissue. The sclera helps to retain the almost spherical shape of the eyeball and its firmness. It protects and supports the inner part of the eye.
- (b) The **choroid** (middle layer) is highly vascularized with several capillaries. These supply nourishment and oxygen to the cells of the eye. The blood vessels may make the layer brownish or reddish. The layer contains a black pigment which absorbs light rays and prevents light reflection into the eye.

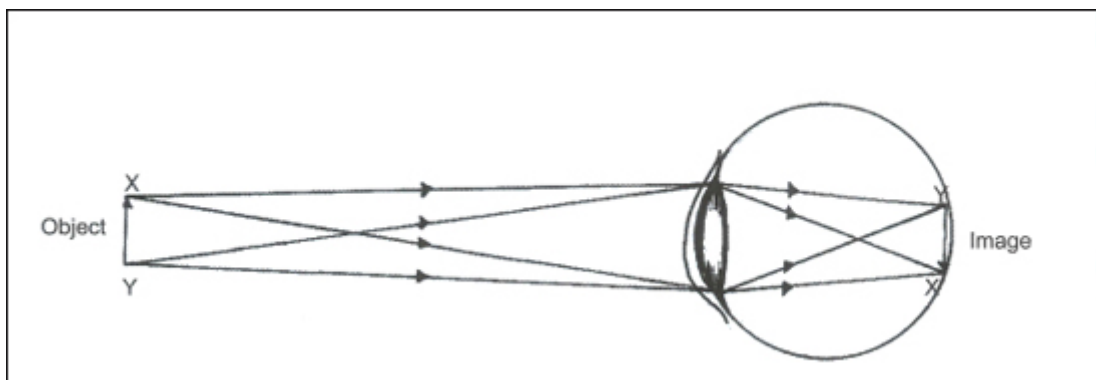
The choroid forms the **iris** in front of the eye. The iris controls the amount of light passing through the eye. The aperture through the iris is called the **pupil**. Light enters the eye through it. The iris has radial and circular muscle fibres. In bright light, circular fibres contract, while radial fibres relax, hence, the pupil becomes smaller and less light enters the eye. In dim light, the radial fibres contract, while the circular fibres relax, hence, the pupil becomes larger so that more light enters the eye.

- (c) The **retina** is the innermost layer of the eye. It is that part sensitive to light. This layer is also vascularized, pigmented and elastic. Images formed on it are always inverted and smaller than the real objects.

The part of the retina that contains the highest concentration of light sensory cells is the **yellow spot** (fovea centralis). It is the most sensitive part of the retina. From it, the fullest visual information is sent to the brain. The blind spot is the point with light insensitive cells. Here, the optic nerve goes out of the eyeball to the brain.

The retina has two types of sensory cells - rods and cones

- (i) **Cones:** These retina cells are sensitive to colour vision and high light intensities. They do not respond to dim light.
- (ii) **Rods:** The rods are more than the cones. They distinguish only black and white but not other colours. They are sensitive to all light intensities, be it bright or dim.



*Fig. 3.4 Image formation by the eye*

The lens is a crystalline, transparent, convex, structure located just behind the iris. It is held by the suspensory ligaments attached to the ciliary muscles which are located on the choroid layer. The shape of the lens changes when the muscles contract. This helps the eye to focus images on the retina for near or far objects.

The **aqueous humour** is a transparent watery liquid which fills the space between the cornea and the lens. The space between the lens and the retina is filled with a jelly like, transparent liquid called vitreous humour. Both liquids are solutions of proteins, sugars and salts in water. Their functions include holding the eyeball in its spherical shape and assisting in the formation of image by refracting

the incoming light rays.

## **How the mammalian eye functions**

All the parts of the eye that are transparent help in image formation. Each transparent part makes the light rays from any point on the object to converge (bend towards one another) as they pass through.

When rays of light from an object reach the conjunctiva, they are refracted or bent a bit by the cornea before passing through the aqueous humour. Here, the light rays are further refracted before passing through the pupil into the eye lens where the light rays are again refracted. More refraction of the light rays occurs in the vitreous humour. As a result, the image of the object is brought to a sharp focus on the **fovea** of the retina in an inverted form which is usually smaller than the real object.

The cones and the rods of the retina are stimulated by light falling on them. Impulses are then sent along sensory nerves, down the optic nerve into the mid-brain where an impression of shape, size and colour of the object is interpreted. The inverted image is corrected in the brain so that the object appears upright.

*Accommodation:* This is a reflex action of the eyes. It is the ability of the eyes to focus properly, images of objects from far and near on the retina. When focusing on distant objects, the lens becomes fatter, and thinner when the object is near. These changes are brought about by the ciliary muscles.

## **Eye defects**

Whenever an image cannot be formed properly on the retina, we say the eye has a defect. Among the major defects of the eye are the following:

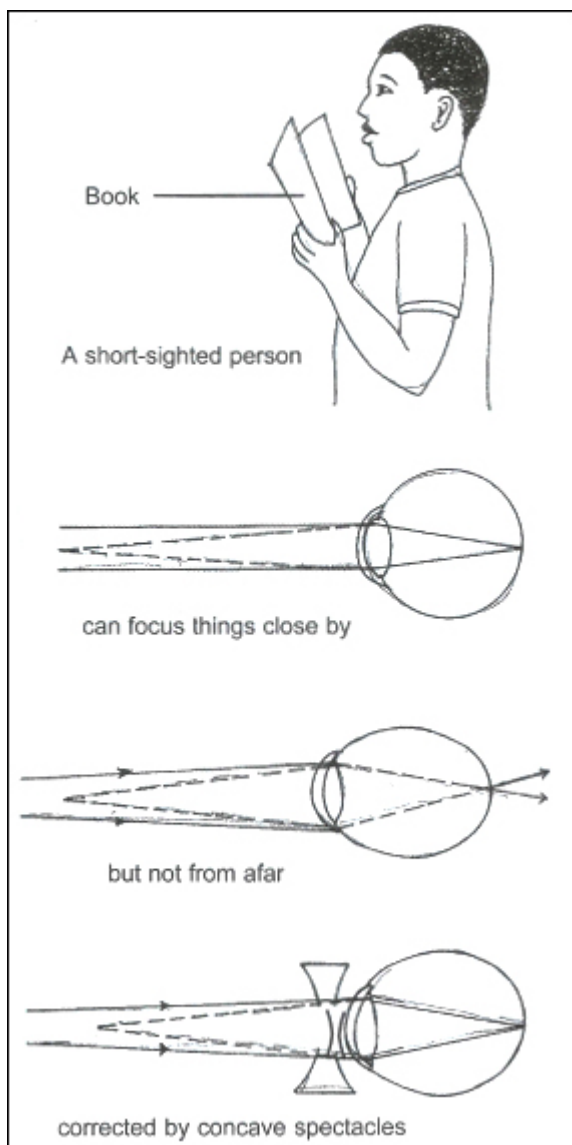


Fig. 3.5 Correction of short-sightedness

### 1. Short-sightedness (myopia)

A person suffering from myopia can see near objects clearly but he cannot see far objects clearly; such objects appear blurred, hence, the person tends to hold objects close to his eyes as it is demonstrated in Fig. 3.5

Short-sightedness occurs when the eyeball is abnormally elongated. The lens may be too strong or the refractive power of the eye may be too great, or the distance between the lens and the retina is increased. The result is that the light rays are focused in front of the retina because parallel light rays are refracted too much and therefore, the image is blurred. Myopia is corrected by wearing a pair of concave (divergent) glass lenses. These spread out (diverge) light rays before entering the eye.

### 2. Long-sightedness (hypermetropia)

Long-sightedness is due to the eyeball being too short or the lens too

weak, and the refractive power being too little. The diverging light rays are not sufficiently refracted or the eye lens is not sufficiently convex. Here, the image from a near object is focused behind the retina. Hence the image on the retina is not clear.

In a long-sighted person, objects at long distances can be seen clearly while the near ones cannot be seen or they can only be seen as blurred objects. The long-sighted person therefore tends to push objects such as letters or books far away from his eyes as in Fig. 3.6

Long-sightedness can be corrected by wearing spectacles with convex (convergent) lenses. These are lenses with short focal length. These will converge (bend inwards) the light rays enough to focus the diverging rays from near objects to the eye lens. This will then focus the rays of light from the object onto the retina.

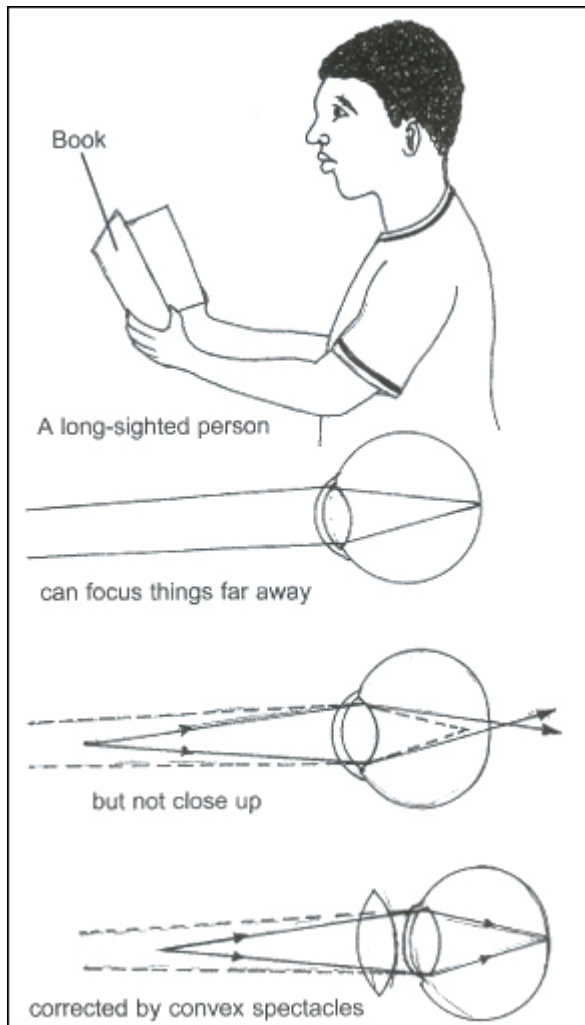


Fig. 3.6 Correction of long-sightedness

### 3. Presbyopia

The eye lens or ciliary muscles of many old people may become inelastic or hardened so that accommodation is reduced. This defect may be corrected with the use of weak convex lenses or bifocal lenses with upper and lower halves.

#### *4. Astigmatism*

This is a common eye defect in which the vision is distorted. For instance, parallel or longitudinal bars may appear bent or some vertical figures may be seen clearly while the horizontal ones are blurred. It is usually due to the fact that the lens or cornea surface is uneven or not uniform or it is not perfectly smooth or spherical. The light rays fall on the retina in one place but not in another. Rays of light are not brought to sharp points on the retina. Blurred images are formed in lesser curvatures than on greater curvatures. Astigmatism can be corrected by wearing cylindrical glass lenses.

#### *5. Colour blindness*

This is a congenital disease which is more common amongst men than in women. It may be total or partial. Partial colour blindness such as the red-green colour blindness is sex-linked. In this case, the individual cannot distinguish between red, green or blue colours. Total colour-blindness is rare. However, those who are colour blind see objects as shades of grey, white or black. It is due to the presence of a single pair of recessive genes or absence of certain cones in their retina.

Other types of eye defects are pterygium, glaucoma, conjunctivitis, river blindness and night blindness.

### **Activity 3.2**

Examine a model of the eye. Draw and label the parts.

### **Organ of hearing**

In vertebrates, the two ears perform two basic functions, hearing and balancing.

The ear of a man is located in the temporal bone on the skull. The ear is divisible into three main parts: the outer, middle and inner ear (labyrinth).

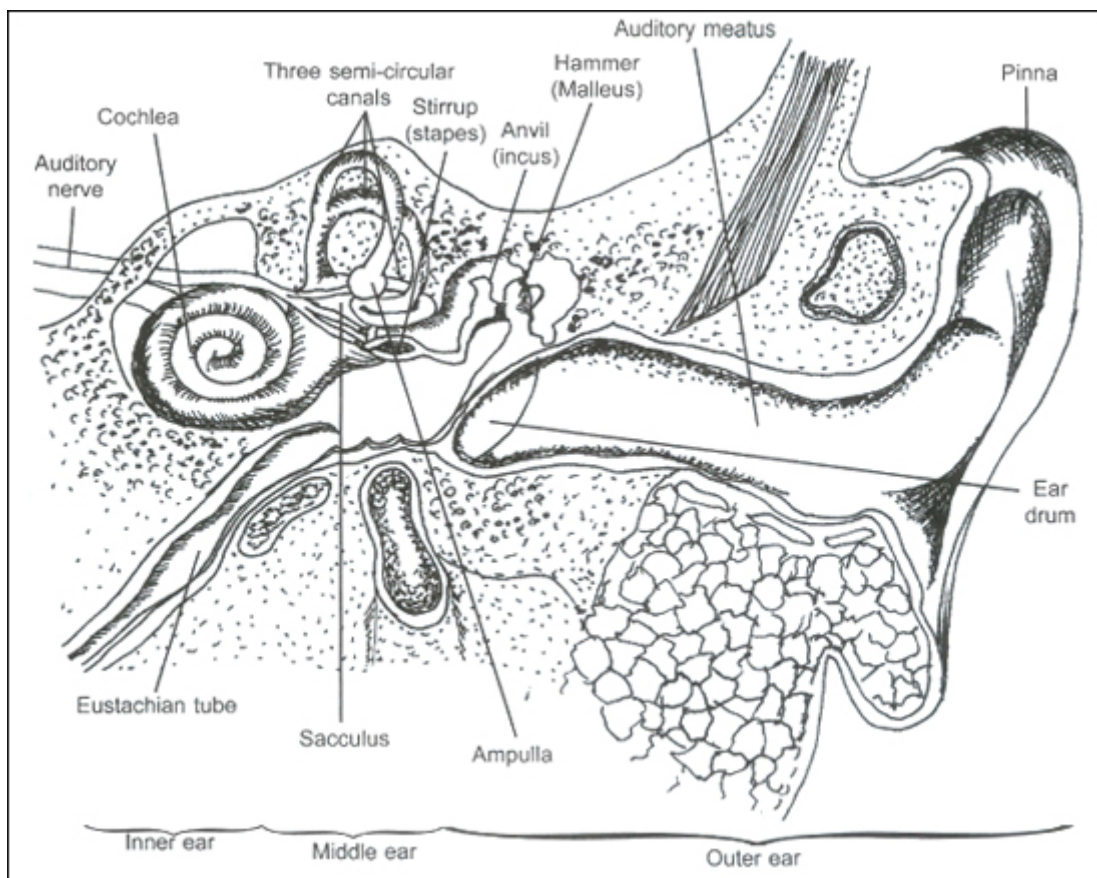


Fig. 3.7 Structure of the human ear.

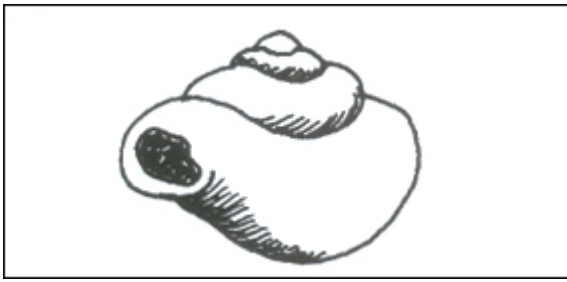
### *The outer ear*

This consists of the pinna, an outer ear tube or auditory canal called **meatus** and the ear drum or tympanum. The pinna is flexible and consists of cartilage and skin. It is found only in mammals. It collects sound waves and directs them into the auditory meatus. Also, it detects the direction of sound waves. The auditory meatus is a narrow passage which contains hairs and wax-producing glands. The wax produced prevents entry of insects, germs and dust into the ear. The tympanum (tympanic membrane or eardrum) is a thin tissue which demarcates the external ear from the middle ear.

### *The middle ear*

The middle ear is an air-filled chamber called tympanic chamber. It consists of three soft, tiny ear ossicles named from the tympanum as malleus (hammer), incus (anvil) and stapes (stirrup) which is attached to the oval window (fenestra ovalis). This opens into the inner ear. The ossicles transmit vibrations across the tympanic membrane to the oval window. They also magnify the pressure on the oval window about thirty times.

The **Eustachian** tube is a narrow tube found in the middle ear. It is connected to the back of the pharynx. It opens during yawning and its basic function is to equalise air pressure on both sides of the eardrum. This helps to prevent the bursting of the eardrum.



*Fig. 3.8 The cochlea (organ of hearing)*

### *The inner ear*

The organs of hearing and balance are found in the inner ear (labyrinth). The inner ear consists of a cavity filled with a fluid called perilymph. The perilymph is contained in the cochlea (an organ sensitive to vibrations) the three semi-circular canals, utriculus and sacculus (organs of balance). The organ of Corti is the part of the cochlea that actually responds to sound.

### *Hearing*

Hearing occurs as follows:

1. The pinna in each ear collects sound waves.
2. These pass through the external meatus, strike the eardrum/tympanum and make it vibrate.
3. The eardrum's vibrations are transmitted across the three ossicles of the middle ear; malleus, incus and stapes.
4. In the middle ear, the vibrations are magnified about thirty times.
5. Vibrations of the oval window cause vibrations in the round window and the perilymph of the inner ear.
6. The perilymph in turn causes the endolymph to vibrate.
7. Vibrations in the endolymph of the cochlea stimulate its (the cochlea's) sensory cells to generate nervous impulses.
8. These impulses are transmitted by the auditory nerve to the brain which interprets the pitch, quality and loudness of the sounds and thus, hearing takes place.

## **Activity 3.3**

Observe and examine the model of the mammalian ear provided. Draw and label the parts.

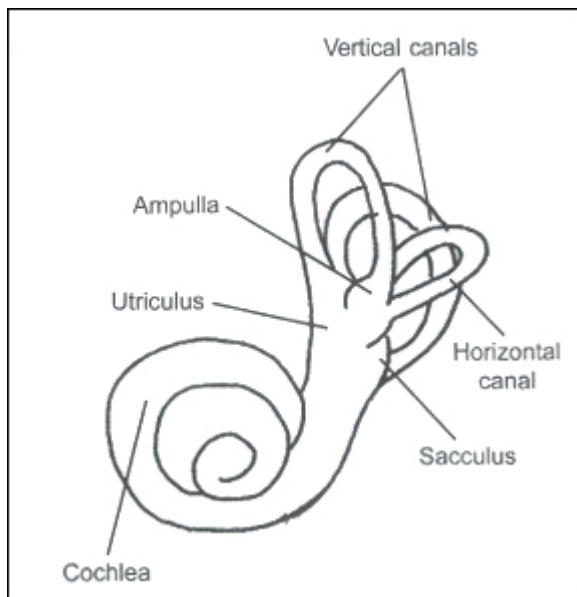
## **Organs of balance**

The organs of balance are the semi-circular canals. These are joined to the cochlea by the sacculus.

The semi-circular canals detect changes in the direction of movement. Hence, it is connected with balance. Each canal has at its end, a swelling called **ampulla** which contains sensory cells. When the

head is nodded or spinned, the receptor cells of the ampullae are stimulated by the movement of the fluid in the semi-circular canals. When the head and canal move in one way, the fluid in it moves in the opposite direction. The canals lie in the three different planes at right angles to one another, so that movement in any plane can be detected. Therefore, any change in the position of the head moves the fluid in one or more of them. Impulses are thus passed through the auditory nerve to the brain which interprets them. The brain then gives the responses by which the mammal maintains its balance automatically. If the head movement is violent, one may feel dizzy since the fluid in the canals will be in continuous motion.

Within the utricle and saccule are nerve endings or receptor cells and chalky granules called **otoliths**. When there is any change in the head position, the endolymph displaces the **otoliths** which stimulate the nerve endings. Impulses are set up and transmitted to the brain in relation to gravity, acceleration and deceleration.



*Fig. 3.9 Structure of the inner ear showing the semicircular canals*

### **Care of the mammalian ear**

1. Avoid the use of sharp or pointed objects (e.g. biro or pencil) in cleaning or scratching the ear. The delicate eardrum may be damaged when sharp objects are used to scratch the ears. Use blunt objects covered with soft cotton wool to clean the outer ear.
2. Seek prompt and appropriate medical attention if there is an ache in, or a discharge from the ear.
3. Workers in noisy environments should wear ear muffs to prevent excessive and prolonged noise which may cause deafness.
4. Avoid high noise level over a long period of time to prevent deafness.
5. Avoid inserting dirty fingers into the ear or else the ear may be

infected by bacteria. The ears may thereby become inflamed. Such is the case when someone is suffering from sore-throat and cold.

6. If much hard wax is produced in the ear, the ear may be blocked. (See a doctor, who will flush out the ear with warm water.)
7. Avoid receiving blows to the side of the ear, else the eardrum may burst.

The major ear defect is deafness which may be partial or temporary, or permanent. Defects may occur to any part of the outer, middle and inner ear. Those people whose defects are limited to outer or middle ear may be aided with earphones. Those who have defects in the inner ear have total deafness. They cannot be remedied for now. The individual may be taken to a school for the deaf to learn the sign language and how to read lips.

## **Suggested Practicals**

### *1. Testing of some sense organs*

You will be supplied with the following:

- (A) Ice block
- (B) Hot water
- (C) Pin

- (a) Close your eyes and carry out these instructions. Place your hand on A. Then, place your hand lightly in B.
- (b) Let someone prick you firmly with C.
- (c) What type of sensations did you feel in each situation. Identify them.
- (d) Describe the sensations you felt as the objects made contact with your skin.
- (e) Let someone stroke your arm gently. How do you feel?

### *2. Testing your organs of smell and sight*

Have you ever had a blocked or running nose? Can you recollect how strong your sense of smell was then? Record it.

Your nose is working normally, someone comes into the room you have been for sometime. The person is wearing a nice perfume. How do you notice her presence or location (assuming you close your eyes by the time she enters)? Do you still notice her presence after a long time? Why?

### *3. Testing your organs of taste*

You will be provided with:

- (a) a bottle of sugar solution, salt solution, lemon juice and chloroquine syrup
- (b) Dip a rod into each bottle, one at a time and touch:

- (i) the tip of your tongue
- (ii) the sides near the tip of your tongue
- (iii) the centre of your tongue
- (iv) the back of your tongue.

Tabulate your findings. Discuss the result briefly.

4. *Examination of models of the mammalian eye and ear.*

A. You may be provided with a good model of the mamalian eye (if a real one is unavailable)

- (a) Note the colour of the various parts of the eye.
- (b) Note the shape and structure.
- (c) Note the six muscles attached to it and their arrangement.
- (d) Note the position of the optic nerve.
- (e) Draw and label the parts.

B. Examine the model or chart of a section of the ear. Draw and label the parts fully.

## **Summary**

1. The mammalian skin is a sense organ. It perceives sensations such as pain, touch, temperature (heat and coldness) and pressure.
2. Some sensory nerve endings are located in the dermis of the skin. They receive the stimuli and relay them to the brain.
3. Other mammalian sense organs include, ear for hearing and balance, eye for sight, nose for smelling, and taste buds for tasting.
4. The taste buds are located on the tongue. They can detect the four primary tastes in man, which are, sweet, salty, sour and bitter.
5. Senses of taste and smell are associated in certain ways. These include the fact that both senses require moist surfaces and dissolved chemicals before they can be active. Both are weakened by cold, catarrh and blocked nose. Also, a variety of taste sensations are influenced by the sense of smell e.g. taste of food.
6. The eye is the organ of sight. Eyes occur in pairs. It consists of muscles, blood vessels and nerves. Optic nerve transmits the impulses to the brain.
7. Common eye defects include, short-sightedness, long-sightedness, Astigmatism, presbyopia, catarract, and conjunctivitis.
8. The ear is the organ of hearing and balance. It may be divided into three parts: outer ear, middle ear and inner ear. The sensory organs are located in the inner ear. The cochlea is the organ of hearing, while the three semi-circular canals are for balancing.
9. The auditory nerves relay sound vibrations to the brain.
10. The main ear defect is deafness which may be temporary or

permanent.

11. The ear must be treated with great care. No sharp object should be applied to the ear. Do not insert dirty fingers into the ear. Avoid high noise level or heavy blows to the ear.

## **Objective Questions**

1. Which of the following structures is not a sense organ?
  - A. Mouth
  - B. Skin
  - C. Eye
  - D. Tongue
  - E. Ear
2. Which of the following statements is false?
  - A. The skin can perceive the sensations of touch, pain, pressure and temperature.
  - B. Sensory nerve endings receive stimuli and relay the messages to the brain
  - C. Taste buds and olfactory cells are active when wet as well as when dry.
  - D. Senses of smell and taste are weakened by cold, catarrh or blocked nose.
  - E. Human sense of smell is easily fatigued.
3. The parts of the mammalian eye that strongly bend light rays are the
  - A. cornea and the lens.
  - B. lens and aqueous humour.
  - C. cornea and aqueous humour.
  - D. lens and vitreous humour.
  - E. cornea and vitreous humour.
4. Which of the following statements about the optic nerve is correct?
  - A. It relays images to the brain from the ear.
  - B. It is the third cranial nerve.
  - C. It is the second nerve from the spinal cord.
  - D. It transmits impulses from the eye to the brain.
  - E. It is the point which has the least concentration of nerve cells in the eye.
5. Which of the following statements is false?
  - A. Short-sightedness and long-sightedness are two common eye defects.
  - B. Convex lenses are used for the correction of long-sightedness.
  - C. The correct order of the ear ossicles from the ear drum is,

malleus, incus and stapes.

D. The ear is an organ for balancing and hearing.

E. The snail-like structure in the ear is called the semi-circular canal.

### **Essay Questions**

1. (a) Draw and label the vertical section of the mammalian eye.  
(b) Explain the functions of each part.  
(c) What is meant by (i) short-sightedness (ii) long-sightedness  
(d) State the methods of correcting both eye defects in (c)  
(e) With the aid of a labelled diagram, explain how the eye works.
2. (a) Draw and label the structure of the mammalian ear.  
(b) How do we hear?  
(c) List three methods of caring for our ears.
3. (a) How does the human body maintain its balance? Describe briefly the structure that is involved.  
(b) Discuss briefly the different sensations the skin experiences.  
(c) Describe the organs of smell and taste.