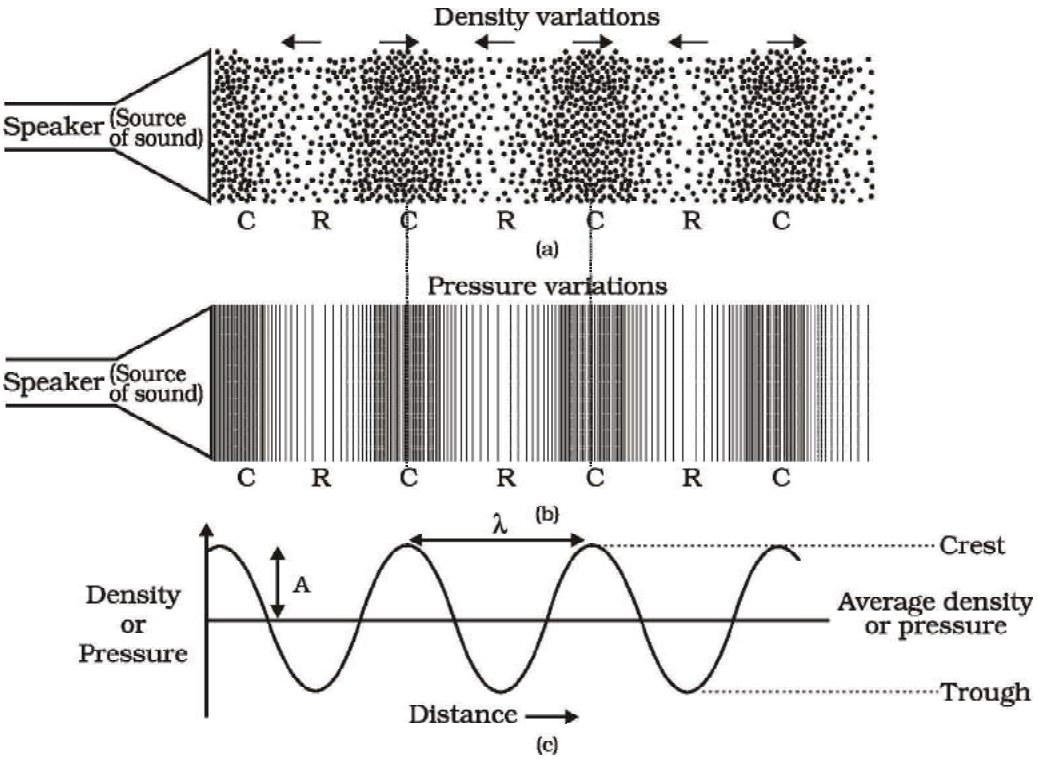


Fig. 12.8: *Sound propagates as density or pressure variations as shown in (a) and (b), (c) represents graphically the density and pressure variations.*

well as pressure is high. Rarefactions are the regions of low pressure where particles are spread apart and are represented by the valley, that is, the lower portion of the curve in Fig. 12.8(c). A peak is called the crest and a valley is called the trough of a wave.

The distance between two consecutive compressions (C) or two consecutive rarefactions (R) is called the wavelength, as shown in Fig. 12.8(c), The wavelength is usually represented by λ (Greek letter lambda). Its SI unit is metre (m).

H. R. Hertz

Heinrich Rudolph Hertz was born on 22 February 1857 in Hamburg, Germany and educated at the University of Berlin. He confirmed J.C. Maxwell's electromagnetic theory by his experiments. He laid the foundation for future development of radio, telephone, telegraph and even television. He also discovered the photoelectric effect which was later explained by Albert Einstein. The SI unit of frequency was named as hertz in his honour.

Frequency tells us how frequently an event occurs. Suppose you are beating a drum. How many times you are beating the drum in unit time is called the frequency of your beating the drum. We know that when sound is propagated through a medium, the density of the medium oscillates between a maximum value and a minimum value. The change in density from the maximum value to the minimum value, then again to the maximum value, makes one complete oscillation. The number of such oscillations per unit time is the frequency of the sound wave. If we can count the number of the compressions or rarefactions that cross us per unit time, we will get the frequency of the sound wave. It is usually represented by ν (Greek letter, nu). Its SI unit is hertz (symbol, Hz).

The time taken by two consecutive compressions or rarefactions to cross a fixed point is called the time period of the wave. In

other words, we can say that the time taken for one complete oscillation is called the time period of the sound wave. It is represented by the symbol *T*. Its SI unit is second (s). Frequency and time period are related as follows:

$$\nu = \frac{1}{T}.$$

A violin and a flute may both be played at the same time in an orchestra. Both sounds travel through the same medium, that is, air and arrive at our ear at the same time. Both sounds travel at the same speed irrespective of the source. But the sounds we receive are different. This is due to the different characteristics associated with the sound. Pitch is one of the characteristics.

How the brain interprets the frequency of an emitted sound is called its pitch. The faster the vibration of the source, the higher is the frequency and the higher is the pitch, as shown in Fig. 12.9. Thus, a high pitch sound corresponds to more number of compressions and rarefactions passing a fixed point per unit time.

Objects of different sizes and conditions vibrate at different frequencies to produce sounds of different pitch.

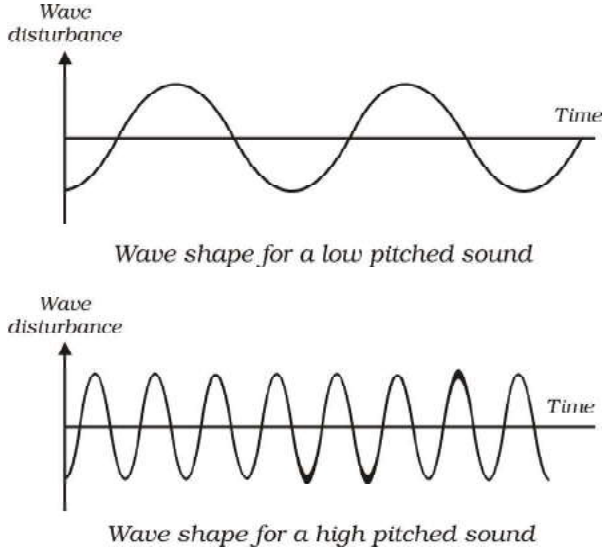


Fig. 12.9: *Low pitch sound has low frequency and high pitch of sound has high frequency.*

The magnitude of the maximum disturbance in the medium on either side of the mean value is called the amplitude of the wave. It is usually represented by the letter A, as shown in Fig. 12.8(c). For sound its unit will be that of density or pressure.

The loudness or softness of a sound is determined basically by its amplitude. The amplitude of the sound wave depends upon the force with which an object is made to vibrate. If we strike a table lightly, we hear a soft sound because we produce a sound wave of less energy (amplitude). If we hit the table hard we hear a louder sound. Can you tell why? A sound wave spreads out from its source. As it moves away from the source its amplitude as well as its loudness decreases. Louder sound can travel a larger distance as it is associated with higher energy. Fig. 12.10 shows the wave shapes of a loud and a soft sound of the same frequency.

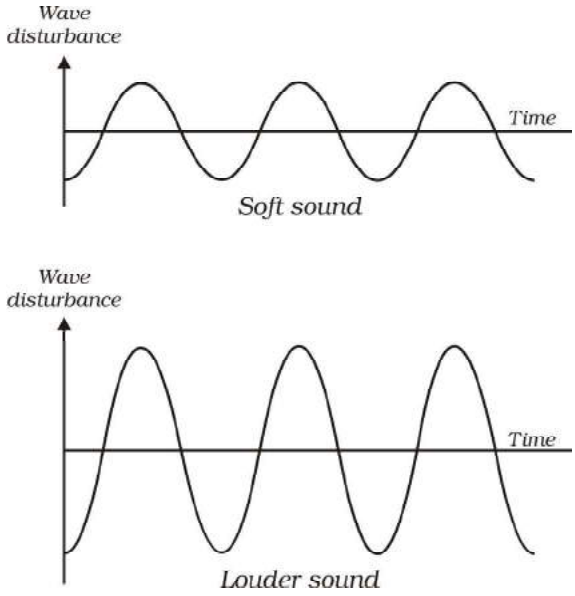


Fig. 12.10: *Soft sound has small amplitude and louder sound has large amplitude.*

The quality or timber of sound is that characteristic which enables us to distinguish one sound from another having the same pitch and loudness. The sound which is more

pleasant is said to be of a rich quality. A sound of single frequency is called a tone. The sound which is produced due to a mixture of several frequencies is called a note and is pleasant to listen to. Noise is unpleasant to the ear! Music is pleasant to hear and is of rich quality.

Questions

1. *Which wave property determines (a) loudness, (b) pitch?*
2. *Guess which sound has a higher pitch: guitar or car horn?*

The speed of sound is defined as the distance which a point on a wave, such as a compression or a rarefaction, travels per unit time.

We know,

speed, v = distance / time

$$= \frac{\lambda}{T}$$

Here λ is the wavelength of the sound wave. It is the distance travelled by the sound wave in one time period (T) of the wave. Thus,

$$v = \lambda \nu \left(\because \frac{1}{T} = \nu \right)$$

or $v = \lambda \nu$

That is, speed = wavelength × frequency.

The speed of sound remains almost the same for all frequencies in a given medium under the same physical conditions.

Example 12.1 A sound wave has a frequency of 2 kHz and wave length 35 cm. How long will it take to travel 1.5 km?

Solution:

Given,

Frequency, ν = 2 kHz = 2000 Hz

Wavelength, λ = 35 cm = 0.35 m

We know that speed, v of the wave

= wavelength × frequency

$v = \lambda \nu$

= 0.35 m × 2000 Hz = 700 m/s

The time taken by the wave to travel a distance, d of 1.5 km is

$$t = \frac{d}{v} = \frac{1.5 \times 1000 \text{ m}}{700 \text{ m s}^{-1}} = \frac{15}{7} \text{ s} = 2.1 \text{ s}.$$

Thus sound will take 2.1 s to travel a distance of 1.5 km.

Questions

1. *What are wavelength, frequency, time period and amplitude of a sound wave?*
2. *How are the wavelength and frequency of a sound wave related to its speed?*
3. *Calculate the wavelength of a sound wave whose frequency is 220 Hz and speed is 440 m/s in a given medium.*
4. *A person is listening to a tone of 500 Hz sitting at a distance of 450 m from the source of the sound. What is the time interval between successive compressions from the source?*

The amount of sound energy passing each second through unit area is called the intensity of sound. We sometimes use the terms "loudness" and "intensity" interchangeably, but they are not the same. Loudness is a measure of the response of the ear to the sound. Even when two sounds are of equal intensity, we may hear one as louder than the other simply because our ear detects it better.

Question

1. *Distinguish between loudness and intensity of sound.*

12.2.4 Speed of Sound in Different Media

Sound propagates through a medium at a finite speed. The sound of a thunder is heard a little later than the flash of light is seen.

So, we can make out that sound travels with a speed which is much less than the speed of light. The speed of sound depends on the properties of the medium through which it travels. You will learn about this dependence in higher classes. The speed of sound in a medium depends on temperature of the medium. The speed of sound decreases when we go from solid to gaseous state. In any medium as we increase the temperature, the speed of sound increases. For example, the speed of sound in air is 331 m s^{-1} at 0 °C and 344 m s^{-1} at 22 °C. The speeds of sound at a particular temperature in various media are listed in Table 12.1. You need not memorise the values.

Table 12.1: Speed of sound in different media at 25 °C

State	Substance	Speed in m/s
Solids	Aluminium	6420
	Nickel	6040
	Steel	5960
	Iron	5950
	Brass	4700
	Glass (Flint)	3980
Liquids	Water (Sea)	1531
	Water (distilled)	1498
	Ethanol	1207
	Methanol	1103
Gases	Hydrogen	1284
	Helium	965
	Air	346
	Oxygen	316
	Sulphur dioxide	213

Question

1. *In which of the three media, air, water or iron, does sound travel the fastest at a particular temperature?*

Sonic boom: When the speed of any object exceeds the speed of sound it is said to be travelling at supersonic speed. Bullets, jet aircrafts etc. often travel at supersonic speeds. When a sound, producing source moves with a speed higher than that of sound, it produces shock waves in air. These shock waves carry a large amount of energy. The air pressure variation associated with this type of shock waves produces a very sharp and loud sound called the "sonic boom". The shock waves produced by a supersonic aircraft have enough energy to shatter window glass and even damage buildings.

12.3 Reflection of Sound

Sound bounces off a solid or a liquid like a rubber ball bounces off a wall. Like light, sound gets reflected at the surface of a solid or liquid and follows the same laws of reflection as you have studied in earlier classes. The directions in which the sound is incident and is reflected make equal angles with the normal to the reflecting surface at the point of incidence, and the three are in the same plane. An obstacle of large size which may be polished or rough is needed for the reflection of sound waves.

Activity 12.5

- Take two identical pipes, as shown in Fig. 12.11. You can make the pipes using chart paper. The length of the pipes should be sufficiently long as shown.
- Arrange them on a table near a wall.
- Keep a clock near the open end of one of the pipes and try to hear the sound of the clock through the other pipe.
- Adjust the position of the pipes so that you can best hear the sound of the clock.
- Now, measure the angles of incidence and reflection and see the relationship between the angles.
- Lift the pipe on the right vertically to a small height and observe what happens.

(In place of a clock, a mobile phone on vibrating mode may also be used.)

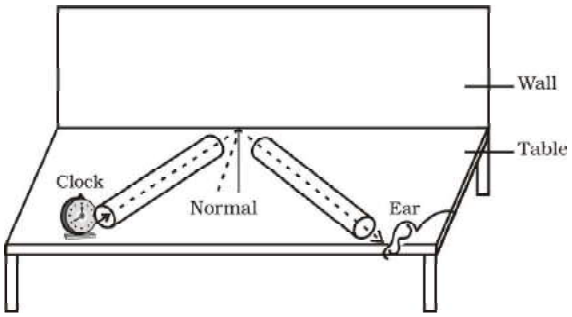


***Fig. 12.11**: Reflection of sound*

12.3.1 Echo

If we shout or clap near a suitable reflecting object such as a tall building or a mountain, we will hear the same sound again a little later. This sound which we hear is called an echo. The sensation of sound persists in our brain for about 0.1 s. To hear a distinct echo the time interval between the original sound and the reflected one must be at least 0.1s. If we take the speed of sound to be 344 m/s at a given temperature, say at 22 ºC in air, the sound must go to the obstacle and reach back the ear of the listener on reflection after 0.1s. Hence, the total distance covered by the sound from the point of generation to the reflecting surface and back should be at least (344 m/s) × 0.1 s = 34.4 m. Thus, for hearing distinct echoes, the minimum distance of the obstacle from the source of sound must be half of this distance, that is, 17.2 m. This distance will change with the temperature of air. Echoes may be heard more than once due to successive or multiple reflections. The rolling of thunder is due to the successive reflections of the sound from a number of reflecting surfaces, such as the clouds and the land.

12.3.2 Reverberation

A sound created in a big hall will persist by repeated reflection from the walls until it is reduced to a value where it is no longer audible. The repeated reflection that results in this persistence of sound is called reverberation. In an auditorium or big hall excessive reverberation is highly undesirable. To reduce reverberation, the roof and walls of the auditorium are generally covered with sound-absorbent materials like compressed fibreboard, rough plaster or draperies. The seat materials are also selected on the basis of their sound absorbing properties.

Example 12.2 A person clapped his hands near a cliff and heard the echo after 2 s. What is the distance of the cliff from the person if the speed of the sound, v is taken as 346 m s^{-1}?

Solution:

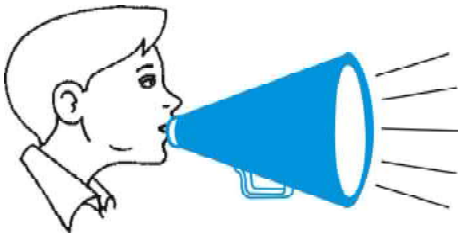
Given,
Speed of sound, v = 346 m s^{-1}
Time taken for hearing the echo,
t = 2 s
Distance travelled by the sound
= $v \times t$ = 346 m s^{-1} × 2 s = 692 m
In 2 s sound has to travel twice the distance between the cliff and the person. Hence, the distance between the cliff and the person
= 692 m/2 = 346 m.

Question

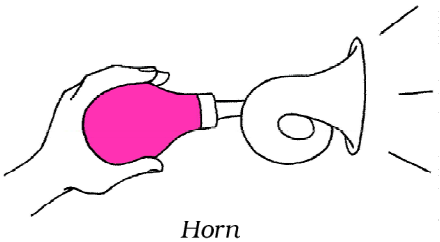
1. *An echo is heard in 3 s. What is the distance of the reflecting surface from the source, given that the speed of sound is 342 m s^{-1}?*

12.3.3 Uses of Multiple Reflection of Sound

1. Megaphones or loudhailers, horns, musical instruments such as trumpets and *shehanais*, are all designed to send sound in a particular direction without spreading it in all directions, as shown in Fig 12.12.



Megaphone



Horn

Fig 12.12: *A megaphone and a horn.*

In these instruments, a tube followed by a conical opening reflects sound successively to guide most of the sound waves from the source in the forward direction towards the audience.

2. Stethoscope is a medical instrument used for listening to sounds produced within the body, mainly in the heart or lungs. In stethoscopes the sound of the patient's heartbeat reaches the doctor's ears by multiple reflection of sound, as shown in Fig.12.13.

Fig.12.13: *Stethoscope*

3. Generally the ceilings of concert halls, conference halls and cinema halls are curved so that sound after reflection reaches all corners of the hall, as shown in Fig 12.14. Sometimes a curved soundboard may be placed behind the stage so that the sound, after reflecting from the sound board, spreads evenly across the width of the hall (Fig 12.15).

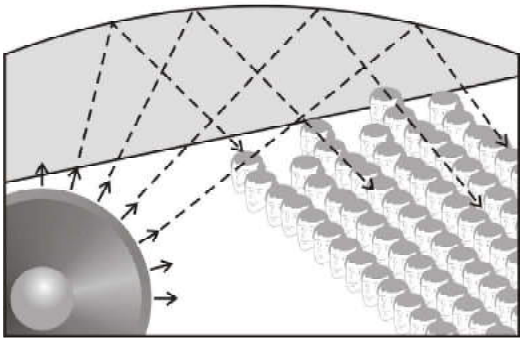


Fig. 12.14: *Curved ceiling of a conference hall.*

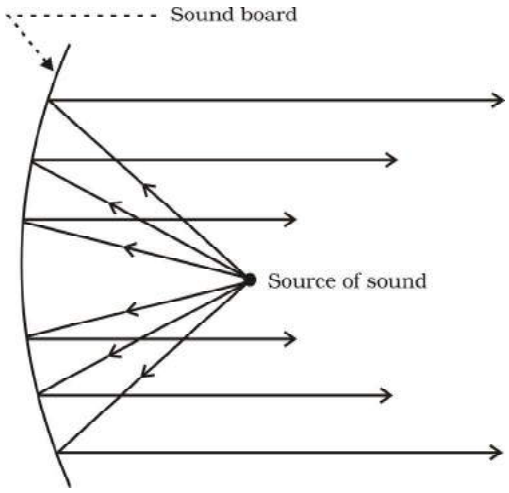


Fig. 12.15: *Sound board used in a big hall.*

Question

1. *Why are the ceilings of concert halls curved?*

12.4 Range of Hearing

The audible range of sound for human beings extends from about 20 Hz to 20000 Hz (one Hz = one cycle/s). Children under the age of

five and some animals, such as dogs can hear up to 25 kHz (1 kHz = 1000 Hz). As people grow older their ears become less sensitive to higher frequencies. Sounds of frequencies below 20 Hz are called infrasonic sound or infrasound. If we could hear infrasound we would hear the vibrations of a pendulum just as we hear the vibrations of the wings of a bee. Rhinoceroses communicate using infrasound of frequency as low as 5 Hz. Whales and elephants produce sound in the infrasound range. It is observed that some animals get disturbed before earthquakes. Earthquakes produce low-frequency infrasound before the main shock waves begin which possibly alert the animals. Frequencies higher than 20 kHz are called ultrasonic sound or ultrasound. Ultrasound is produced by animals such as dolphins, bats and porpoises. Moths of certain families have very sensitive hearing equipment. These moths can hear the high frequency squeaks of the bat and know when a bat is flying nearby, and are able to escape capture. Rats also play games by producing ultrasound.

Hearing Aid: People with hearing loss may need a hearing aid. A hearing aid is an electronic, battery operated device. The hearing aid receives sound through a microphone. The microphone converts the sound waves to electrical signals. These electrical signals are amplified by an amplifier. The amplified electrical signals are given to a speaker of the hearing aid. The speaker converts the amplified electrical signal to sound and sends to the ear for clear hearing.

Questions

1. *What is the audible range of the average human ear?*
2. *What is the range of frequencies associated with*
   (a) Infrasound?
   (b) Ultrasound?

12.5 Applications of Ultrasound

Ultrasounds are high frequency waves. Ultrasounds are able to travel along well-defined paths even in the presence of obstacles. Ultrasounds are used extensively in industries and for medical purposes.

- Ultrasound is generally used to clean parts located in hard-to-reach places, for example, spiral tube, odd shaped parts, electronic components etc. Objects to be cleaned are placed in a cleaning solution and ultrasonic waves are sent into the solution. Due to the high frequency, the particles of dust, grease and dirt get detached and drop out. The objects thus get thoroughly cleaned.
- Ultrasounds can be used to detect cracks and flaws in metal blocks. Metallic components are generally used in construction of big structures like buildings, bridges, machines and also scientific equipment. The cracks or holes inside the metal blocks, which are invisible from outside reduces the strength of the structure. Ultrasonic waves are allowed to pass through the metal block and detectors are used to detect the transmitted waves. If there is even a small defect, the ultrasound gets reflected back indicating the presence of the flaw or defect, as shown in Fig. 12.16.

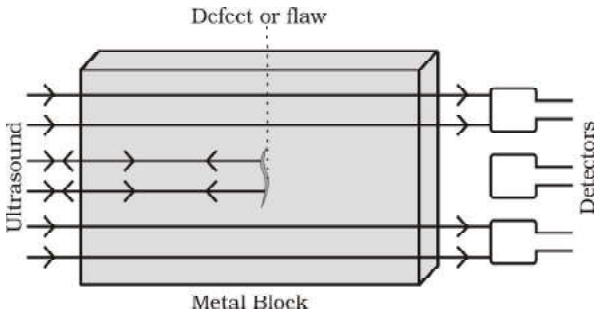


Fig 12.16: *Ultrasound is reflected back from the defective locations inside a metal block.*

Ordinary sound of longer wavelengths cannot be used for such purpose as it will bend around the corners of the defective location and enter the detector.

- Ultrasonic waves are made to reflect from various parts of the heart and form the image of the heart. This technique is called 'echocardiography'.
- Ultrasound scanner is an instrument which uses ultrasonic waves for getting images of internal organs of the human body. A doctor may image the patient's organs such as the liver, gall bladder, uterus, kidney, etc. It helps the doctor to detect abnormalities, such as stones in the gall bladder and kidney or tumours in different organs. In this technique the ultrasonic waves travel through the tissues of the body and get reflected from a region where there is a change of tissue density. These waves are then converted into electrical signals that are used to generate images of the organ. These images are then displayed on a monitor or printed on a film. This technique is called 'ultrasonography'. Ultrasonography is also used for examination of the foetus during pregnancy to detect congenial defects and growth abnormalities.
- Ultrasound may be employed to break small 'stones' formed in the kidneys into fine grains. These grains later get flushed out with urine.

12.5.1 SONAR

The acronym SONAR stands for SOund Navigation And Ranging. Sonar is a device that uses ultrasonic waves to measure the distance, direction and speed of underwater objects. How does the sonar work? Sonar consists of a transmitter and a detector and is installed in a boat or a ship, as shown in Fig. 12.17.

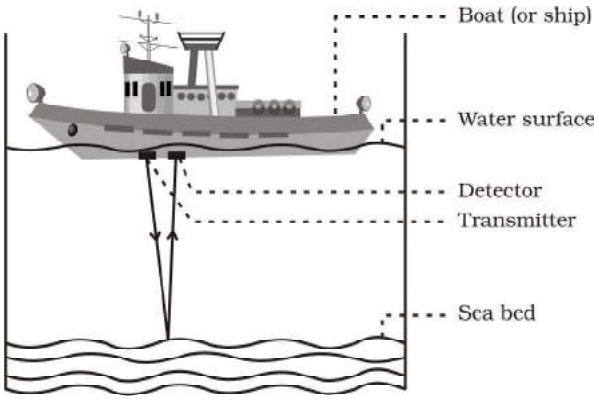


Fig.12.17: *Ultrasound sent by the transmitter and received by the detector.*

The transmitter produces and transmits ultrasonic waves. These waves travel through water and after striking the object on the seabed, get reflected back and are sensed by the detector. The detector converts the ultrasonic waves into electrical signals which are appropriately interpreted. The distance of the object that reflected the sound wave can be calculated by knowing the speed of sound in water and the time interval between transmission and reception of the ultrasound. Let the time interval between transmission and reception of ultrasound signal be t and the speed of sound through seawater be v. The total distance, $2d$ travelled by the ultrasound is then, $2d = v \times t$.

The above method is called echo-ranging. The sonar technique is used to determine the depth of the sea and to locate underwater hills, valleys, submarine, icebergs, sunken ship etc.

Example 12.3 A ship sends out ultrasound that returns from the seabed and is detected after 3.42 s. If the speed of ultrasound through seawater is 1531 m/s, what is the distance of the seabed from the ship?

Solution:

Given,
Time between transmission and detection, t = 3.42 s.

Speed of ultrasound in sea water,
v = 1531 m/s
Distance travelled by the ultrasound
= 2 × depth of the sea = $2d$
where d is the depth of the sea.
$2d$ = speed of sound × time
= 1531 m/s × 3.42 s = 5236 m
d = 5236 m/2 = 2618 m.
Thus, the distance of the seabed from the ship is 2618 m or 2.62 km.

Question

1. *A submarine emits a sonar pulse, which returns from an underwater cliff in 1.02 s. If the speed of sound in salt water is 1531 m/s, how far away is the cliff?*

As mentioned earlier, bats search out prey and fly in dark night by emitting and detecting reflections of ultrasonic waves. The high-pitched ultrasonic squeaks of the bat are reflected from the obstacles or prey and returned to bat's ear, as shown in Fig. 12.18. The nature of reflections tells the bat where the obstacle or prey is and what it is like. Porpoises also use ultrasound for navigation and location of food in the dark.

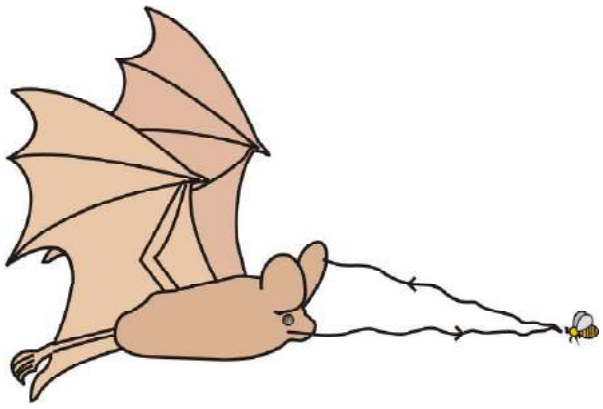


Fig. 12.18: *Ultrasound is emitted by a bat and it is reflected back by the prey or an obstacle.*

12.6 Structure of Human Ear

How do we hear? We are able to hear with the help of an extremely sensitive device called the ear. It allows us to convert pressure variations in air with audible frequencies into electric signals that travel to the brain via the auditory nerve. The auditory aspect of human ear is discussed below.

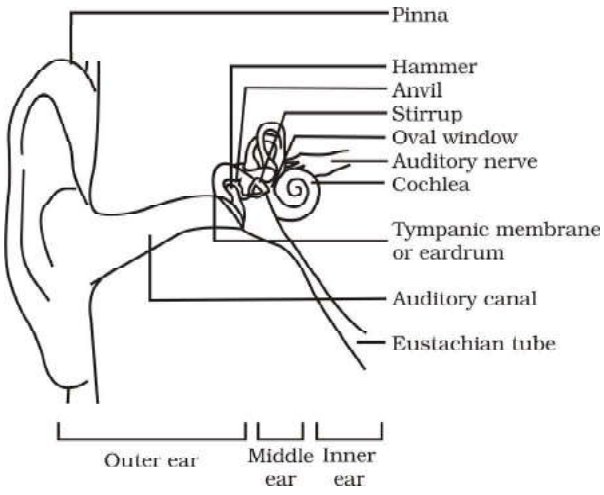


Fig. 12.19: *Auditory parts of human ear.*

The outer ear is called 'pinna'. It collects the sound from the surroundings. The collected sound passes through the auditory canal. At the end of the auditory canal there is a thin membrane called the ear drum or tympanic membrane. When a compression of the medium reaches the eardrum the pressure on the outside of the membrane increases and forces the eardrum inward. Similarly, the eardrum moves outward when a rarefaction reaches it. In this way the eardrum vibrates. The vibrations are amplified several times by three bones (the hammer, anvil and stirrup) in the middle ear. The middle ear transmits the amplified pressure variations received from the sound wave to the inner ear. In the inner ear, the pressure variations are turned into electrical signals by the cochlea. These electrical signals are sent to the brain via the auditory nerve, and the brain interprets them as sound.

What you have learnt

- Sound is produced due to vibration of different objects.
- Sound travels as a longitudinal wave through a material medium.
- Sound travels as successive compressions and rarefactions in the medium.
- In sound propagation, it is the energy of the sound that travels and not the particles of the medium.
- Sound cannot travel in vacuum.
- The change in density from one maximum value to the minimum value and again to the maximum value makes one complete oscillation.
- The distance between two consecutive compressions or two consecutive rarefactions is called the wavelength, λ.
- The time taken by the wave for one complete oscillation of the density or pressure of the medium is called the time period, T.
- The number of complete oscillations per unit time is called the frequency (ν), $\nu = \frac{1}{T}$.
- The speed v, frequency ν, and wavelength λ, of sound are related by the equation, $v = \lambda\nu$.
- The speed of sound depends primarily on the nature and the temperature of the transmitting medium.
- The law of reflection of sound states that the directions in which the sound is incident and reflected make equal angles with the normal to the reflecting surface at the point of incidence and the three lie in the same plane.
- For hearing a distinct sound, the time interval between the original sound and the reflected one must be at least 0.1 s.
- The persistence of sound in an auditorium is the result of repeated reflections of sound and is called reverberation.
- Sound properties such as pitch, loudness and quality are determined by the corresponding wave properties.
- Loudness is a physiological response of the ear to the intensity of sound.
- The amount of sound energy passing each second through unit area is called the intensity of sound.
- The audible range of hearing for average human beings is in the frequency range of 20 Hz – 20 kHz.

- Sound waves with frequencies below the audible range are termed "infrasonic" and those above the audible range are termed "ultrasonic".
- Ultrasound has many medical and industrial applications.
- The SONAR technique is used to determine the depth of the sea and to locate under water hills, valleys, submarines, icebergs, sunken ships etc.

Exercises

1. What is sound and how is it produced?
2. Describe with the help of a diagram, how compressions and rarefactions are produced in air near a source of sound.
3. Cite an experiment to show that sound needs a material medium for its propagation.
4. Why is sound wave called a longitudinal wave?
5. Which characteristic of the sound helps you to identify your friend by his voice while sitting with others in a dark room?
6. Flash and thunder are produced simultaneously. But thunder is heard a few seconds after the flash is seen, why?
7. A person has a hearing range from 20 Hz to 20 kHz. What are the typical wavelengths of sound waves in air corresponding to these two frequencies? Take the speed of sound in air as 344 m s^{-1}.
8. Two children are at opposite ends of an aluminium rod. One strikes the end of the rod with a stone. Find the ratio of times taken by the sound wave in air and in aluminium to reach the second child.
9. The frequency of a source of sound is 100 Hz. How many times does it vibrate in a minute?
10. Does sound follow the same laws of reflection as light does? Explain.
11. When a sound is reflected from a distant object, an echo is produced. Let the distance between the reflecting surface and the source of sound production remains the same. Do you hear echo sound on a hotter day?
12. Give two practical applications of reflection of sound waves.
13. A stone is dropped from the top of a tower 500 m high into a pond of water at the base of the tower. When is the splash heard at the top? Given, g = 10 m s^{-2} and speed of sound = 340 m s^{-1}.
14. A sound wave travels at a speed of 339 m s^{-1}. If its wavelength is 1.5 cm, what is the frequency of the wave? Will it be audible?

15. What is reverberation? How can it be reduced?
16. What is loudness of sound? What factors does it depend on?
17. Explain how bats use ultrasound to catch a prey.
18. How is ultrasound used for cleaning?
19. Explain the working and application of a sonar.
20. A sonar device on a submarine sends out a signal and receives an echo 5 s later. Calculate the speed of sound in water if the distance of the object from the submarine is 3625 m.
21. Explain how defects in a metal block can be detected using ultrasound.
22. Explain how the human ear works.

Chapter 13

Why Do We Fall Ill?

Activity 13.1

- We have all heard of the earthquakes in Latur, Bhuj, Kashmir etc. or the cyclones that lashed the coastal regions. Think of as many different ways as possible in which people's health would be affected by such a disaster if it took place in our neighbourhood.
- How many of these ways we can think of are events that would occur when the disaster is actually happening?
- How many of these health-related events would happen long after the actual disaster, but would still be because of the disaster?
- Why would one effect on health fall into the first group, and why would another fall into the second group?

When we do this exercise, we realise that health and disease in human communities are very complex issues, with many interconnected causes. We also realise that the ideas of what 'health' and 'disease' mean are themselves very complicated. When we ask what causes diseases and how we prevent them, we have to begin by asking what these notions mean.

We have seen that cells are the basic units of organisms. Cells are made of a variety of chemical substances – proteins, carbohydrates, fats or lipids, and so on. Cell is a dynamic place. Something or the other is always happening inside them. Complex reactions and repair goes on in cells. New cells are being made. In our organs or tissues, there are various specialised activities going on – the heart is beating, the lungs are breathing, the kidney is filtering urine, the brain is thinking.

All these activities are interconnected. For example, if the kidneys are not filtering urine, poisonous substances will accumulate. Under such conditions, the brain will not be able to think properly. For all these interconnected activities, energy and raw material are needed. Food is a necessity for cell and tissue functions. Anything that prevents proper functioning of cells and tissues will lead to a lack of proper activity of the body.

It is in this context that we will look at the notions of health and disease.

13.1 Health and its Failure

13.1.1 The significance of 'health'

We have heard the word 'health' used quite frequently. We use it ourselves as well, when we say things like 'my grandmother's health is not good'. Our teachers use it when they scold us saying 'this is not a healthy attitude'. What does the word 'health' mean?

If we think about it, we realise that it always implies the idea of 'being well'. We can think of this well-being as effective functioning. For our grandmothers, being able to go out to the market or to visit neighbours is 'being well', and not being able to do such things is 'poor health'. Being interested in following the teaching in the classroom so that we can understand the world is called a 'healthy attitude'; while not being interested is called the opposite. 'Health' is therefore a state of being well enough to function well physically, mentally and socially.

13.1.2 Personal and community issues both matter for health

If health means a state of physical, mental and social well-being, it cannot be something that

each one of us can achieve entirely on our own. The health of all organisms will depend on their surroundings or their environment. The environment includes the physical environment. So, for example, health is at risk in a cyclone in many ways.

Human beings live in societies. Our social environment, therefore, is an important factor in our individual health. We live in villages, towns or cities. In such places, even our physical environment is decided by our social environment.

Consider what would happen if no agency is ensuring that garbage is collected and disposed. What would happen if no one takes responsibility for clearing the drains and ensuring that water does not collect in the streets or open spaces?

So, if there is a great deal of garbage thrown in our streets, or if there is open drain-water lying stagnant around where we live, the possibility of poor health increases. Therefore, public cleanliness is important for individual health.

Activity 13.2

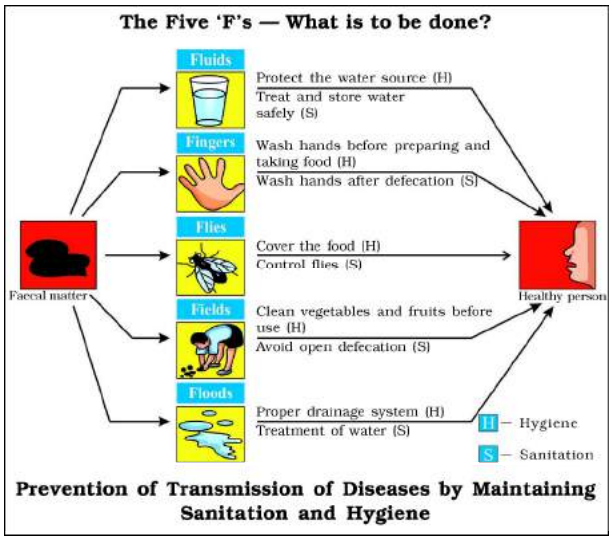
- Find out what provisions are made by your local authority (panchayat/ municipal corporation) for the supply of clean drinking water.
- Are all the people in your locality able to access this?

Activity 13.3

- Find out how your local authority manages the solid waste generated in your neighbourhood.
- Are these measures adequate?
- If not, what improvements would you suggest?
- What could your family do to reduce the amount of solid waste generated during a day/week?

We need food to be healthy, and this food will have to be earned by doing work. For this, the opportunity to do work has to be available.

We need to be happy in order to be truly healthy, and if we mistreat each other and are afraid of each other, we cannot be happy or healthy. Social equality and harmony are therefore necessary for individual health. We can think of many other such examples of connections between community issues and individual health.



Prevention of Transmission of Diseases by Maintaining Sanitation and Hygiene

13.1.3 Distinctions between 'healthy' and 'disease-free'

If this is what we mean by 'health', what do we mean by 'disease'? The word is actually self-explanatory – we can think of it as 'disease' – disturbed ease. Disease, in other words, literally means being uncomfortable. However, the word is used in a more limited meaning. We talk of disease when we can find a specific and particular cause for discomfort. This does not mean that we have to know the absolute final cause; we can say that someone is suffering from diarrhoea without knowing exactly what has caused the loose motions.

We can now easily see that it is possible to be in poor health without actually suffering from a particular disease. Simply not being diseased is not the same as being healthy. 'Good health' for a dancer may mean being able to stretch his body into difficult but graceful positions. On the other hand, good health for a musician may mean having enough breathing capacity in his/her lungs to control the notes from his/her flute. To have the opportunity to realise the unique potential in all of us is also necessary for real health.

So, we can be in poor health without there being a simple cause in the form of an identifiable disease. This is the reason why, when we think about health, we think about societies and communities. On the other hand, when we think about disease, we think about individual sufferers.

Questions

1. *State any two conditions essential for good health.*
2. *State any two conditions essential for being free of disease.*
3. *Are the answers to the above questions necessarily the same or different? Why?*

13.2 Disease and Its Causes

13.2.1 What does disease look like?

Let us now think a little more about diseases. In the first place, how do we know that there is a disease? In other words, how do we know that there is something wrong with the body? There are many tissues in the body, as we have seen in Chapter 6. These tissues make up physiological systems or organ systems that carry out body functions. Each of the organ systems has specific organs as its parts, and it has particular functions. So, the digestive system has the stomach and intestines, and it helps to digest food taken in from outside the body. The musculoskeletal system, which is made up of bones and muscles, holds the body parts together and helps the body move.

When there is a disease, either the functioning of one or more systems of the body will change for the worse. These changes give rise to symptoms and signs of disease. Symptoms of disease are the things we feel as being 'wrong'. So we have a headache, we have cough, we have loose motions, we have a wound with pus; these are all symptoms. These indicate that there may be a disease, but they don't indicate what the disease is. For example, a headache may mean just examination stress or, very rarely, it may mean meningitis, or any one of a dozen different diseases.

Signs of disease are what physicians will look for on the basis of the symptoms. Signs will give a little more definite indication of the presence of a particular disease. Physicians will also get laboratory tests done to pinpoint the disease further.

13.2.2 Acute and chronic diseases

The manifestations of disease will be different depending on a number of factors. Some diseases last for only very short periods of time, and these are called acute diseases. We all know from experience that the common cold lasts only a few days. Other ailments can last for a long time, even as much as a lifetime, and are called chronic diseases. An example is the infection causing elephantiasis, which is very common in some parts of India. Another example is asthma.

Activity 13.4

- Survey your neighbourhood to find out:
  (1) how many people suffered from acute diseases during the last three months,
  (2) how many people developed chronic diseases during this same period,
  (3) and finally, the total number of people suffering from chronic diseases in your neighbourhood.
- Are the answers to questions (1) and (2) different?
- Are the answers to questions (2) and (3) different?
- What do you think could be the reason for these differences? What do you think would be the effect of these differences on the general health of the population?

13.2.3 Chronic diseases and poor health

Acute and chronic diseases have different effects on our health. Any disease that causes poor functioning of some part of the body will affect our health. This is because all functions of the body are necessary for being healthy.

But an acute disease, which is over very soon, will not have time to cause major effects on general health, while a chronic disease will do so.

As an example, think about a cough and cold, which all of us have from time to time. Most of us get better and become well within a week or so. And there are no lasting effects on our health. But if we get infected with a chronic disease such as tuberculosis of the lungs, then being ill over the years does make us lose weight and feel tired all the time.

We may not go to school for a few days if we have an acute disease. But a chronic disease will make it difficult for us to follow what is being taught in school and reduce our ability to learn. In other words, we are likely to have prolonged general poor health if we have a chronic disease. Chronic diseases therefore, have very drastic long-term effects on people's health as compared to acute diseases.

13.2.4 Causes of diseases

What causes disease? When we think about causes of diseases, we must remember that there are many levels of such causes. Let us look at an example. If there is a baby suffering from loose motions, we can say that the cause of the loose motions is probably an infection.

But the next question is – where did the infection come from? Suppose we find that the infection came through unclean drinking water. But many babies must have had this unclean drinking water. So, why is it that one baby developed loose motions when the other babies did not?

One reason might be that this baby is not healthy. As a result, it might be more likely to have disease when exposed to risk, whereas healthier babies would not. Why is the baby not healthy? Perhaps because it is not well nourished and does not get enough food. So, lack of good nourishment becomes a second cause of the disease. Further, why is the baby not well nourished? Perhaps because it is from a household which is poor.

It is also possible that the baby has some genetic difference that makes it more likely to suffer from loose motions when exposed to a pathogen. Without the pathogen, the genetic difference or the poor nourishment alone would not lead to loose motions. But they do become contributory causes of the disease.

Why was there no clean drinking water for the baby? Perhaps because the public services are poor where the baby's family lives. So, poverty or lack of public services become third cause of the baby's disease.

It will now be obvious that all diseases will have immediate causes and contributory causes. Also, most diseases will have many causes, rather than one single cause.

13.2.5 Infectious and non-infectious causes

As we have seen, it is important to keep public health and community health factors in mind when we think about causes of diseases. We can take that approach a little further. It is useful to think of the immediate causes of disease as belonging to two distinct types. One group of causes is the infectious agents, mostly microbes or micro-organisms. Diseases where microbes are the immediate causes are called infectious diseases. This is because the microbes can spread in the community, and the diseases they cause will spread with them.

Things to ponder

1. Do all diseases spread to people coming in contact with a sick person?
2. What are the diseases that are not spreading?
3. How would a person develop those diseases that don't spread by contact with a sick person?

On the other hand, there are also diseases that are not caused by infectious agents. Their causes vary, but they are not external causes like microbes that can spread in the community. Instead, these are mostly internal, non-infectious causes.

For example, some cancers are caused by genetic abnormalities. High blood pressure can be caused by excessive weight and lack of exercise. You can think of many other diseases where the immediate causes will not be infectious.

Peptic ulcers and the Nobel prize

For many years, everybody used to think that peptic ulcers, which cause acidity–related pain and bleeding in the stomach and duodenum, were because of lifestyle reasons. Everybody thought that a stressful life led to a lot of acid secretion in the stomach, and eventually caused peptic ulcers.

Then two Australians made a discovery that a bacterium, *Helicobacter pylori*, was responsible for peptic ulcers. Robin Warren (born 1937), a pathologist from Perth, Australia, saw these small curved bacteria in the lower part of the stomach in many patients. He noticed that signs of inflammation were always present around these bacteria. Barry Marshall (born 1951), a young clinical fellow, became interested in Warren's findings and succeeded in cultivating the bacteria from these sources.

In treatment studies, Marshall and Warren showed that patients could be cured of peptic ulcer only when the bacteria were killed off from the stomach. Thanks to this pioneering discovery by Marshall and Warren, peptic ulcer disease is no longer a chronic, frequently disabling condition, but a disease that can be cured by a short period of treatment with antibiotics.

For this achievement, Marshall and

Warren (seen in the picture) received the Nobel prize for physiology and medicine in 2005.

The ways in which diseases spread, and the ways in which they can be treated and prevented at the community level would be different for different diseases. This would depend a lot on whether the immediate causes are infectious or non-infectious.

Questions

1. *List any three reasons why you would think that you are sick and ought to see a doctor. If only one of these symptoms were present, would you still go to the doctor? Why or why not?*
2. *In which of the following case do you think the long-term effects on your health are likely to be most unpleasant?*
   - *if you get jaundice,*
   - *if you get lice,*
   - *if you get acne.*

   Why?

13.3 Infectious Diseases

13.3.1 Infectious agents

We have seen that the entire diversity seen in the living world can be classified into a few groups. This classification is based on common characteristics between different organisms. Organisms that can cause disease are found in a wide range of such categories of classification. Some of them are viruses, some are bacteria, some are fungi, some are single-celled animals or protozoans (Fig. 13.1). Some diseases are also caused by multicellular organisms, such as worms of different kinds.

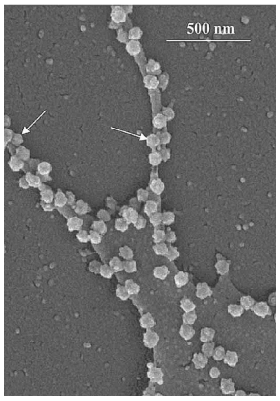


***Fig. 13.1(a)**: Picture of SARS viruses coming out (see arrows for examples) of the surface of an infected cell. The white scale line represents 500 nanometres, which is half a micrometre, which is one-thousandth of a millimetre. The scale line gives us an idea of how small the things we are looking at are.*
***Courtesy:** Emerging Infectious Deseases, a journal of CDC, U.S.*

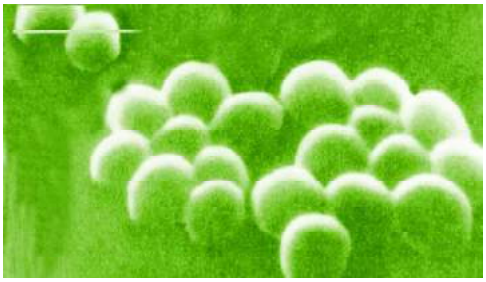


***Fig. 13.1(b):** Picture of staphylococci, the bacteria which can cause acne. The scale of the image is indicated by the line at top left, which is 5 micrometres long.*

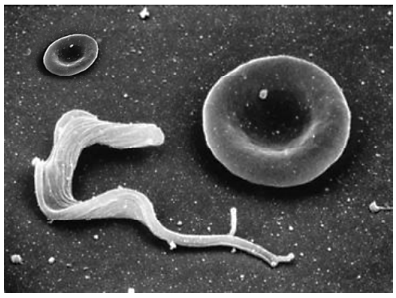


***Fig. 13.1(c):** Picture of Trypanosoma, the protozoan organism responsible for sleeping sickness. The organism is lying next to a saucer-shaped red blood cell to give an idea of the scale.*
***Copyright:** Oregon Health and Science University, U.S.*

***Fig. 13.1(d):** Picture of Leishmania, the protozoan organism that causes kala-azar. The organisms are oval-shaped, and each has one long whip-like structure. One organism (arrow) is dividing, while a cell of the immune system (lower right) has gripped on the two whips of the dividing organism and is sending cell processes up to eat up the organism. The immune cell is about ten micrometres in diameter.*

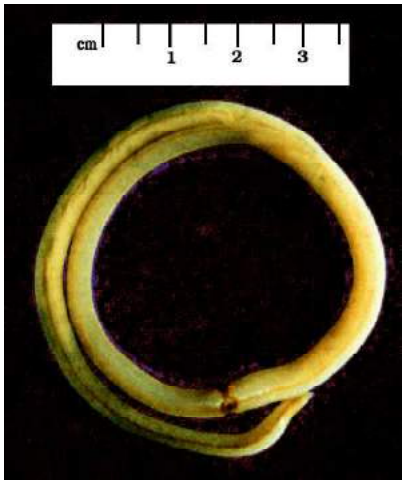


***Fig. 13.1(e):** Picture of an adult roundworm (Ascaris lumbricoides) from the small intestine. The ruler next to it shows four centimetres to give us an idea of the scale.*

Common examples of diseases caused by viruses are the common cold, influenza, dengue fever and AIDS. Diseases like typhoid fever, cholera, tuberculosis and anthrax are caused by bacteria. Many common skin infections are caused by different kinds of fungi. Protozoan microbes cause many familiar diseases, such as malaria and kala-azar. All of us have also come across intestinal worm infections, as well as diseases like elephantiasis caused by diffferent species of worms.

Why is it important that we think of these categories of infectious agents? The answer is that these categories are important factors in deciding what kind of treatment to use. Members of each one of these groups – viruses, bacteria, and so on – have many biological characteristics in common.

All viruses, for example, live inside host cells, whereas bacteria very rarely do. Viruses, bacteria and fungi multiply very quickly, while worms multiply very slowly in comparison. Taxonomically, all bacteria are closely related to each other than to viruses and vice versa. This means that many important life processes are similar in the bacteria group but are not shared with the virus group. As a result, drugs that block one of these life processes in one member of the group is likely to be effective against many other members of the group. But the same drug will not work against a microbe belonging to a different group.

As an example, let us take antibiotics. They commonly block biochemical pathways important for bacteria. Many bacteria, for example, make a cell-wall to protect themselves. The antibiotic penicillin blocks the bacterial processes that build the cell-wall. As a result, the growing bacteria become unable to make cell-walls, and die easily. Human cells don't make a cell-wall anyway, so penicillin cannot have such an effect on us. Penicillin will have this effect on any bacteria that use such processes for making cell-walls. Similarly, many antibiotics work against many species of bacteria rather than simply working against one.

But viruses do not use these pathways at all, and that is the reason why antibiotics do not work against viral infections. If we have a common cold, taking antibiotics does not reduce the severity or the duration of the disease. However, if we also get a bacterial infection along with the viral cold, taking antibiotics will help. Even then, the antibiotic will work only against the bacterial part of the infection, not the viral infection.

Activity 13.5

- Find out how many of you in your class had cold/cough/fever recently.
- How long did the illness last?
- How many of you took antibiotics (ask your parents if you had antibiotics)?
- How long were those who took antibiotics ill?
- How long were those who didn't take antibiotics ill?
- Is there a difference between these two groups?
- If yes, why? If not, why not?

13.3.2 Means of Spread

How do infectious diseases spread? Many microbial agents can commonly move from an affected person to someone else in a variety of ways. In other words, they can be 'communicated', and so are also called communicable diseases.

Such disease-causing microbes can spread through the air. This occurs through the little droplets thrown out by an infected person who sneezes or coughs. Someone standing close by can breathe in these droplets, and the microbes get a chance to start a new infection. Examples of such diseases spread through the air are the common cold, pneumonia and tuberculosis.

We all have had the experience of sitting near someone suffering from a cold and catching it ourselves. Obviously, the more crowded our living conditions are, the more likely it is that such airborne diseases will spread.

Diseases can also be spread through water. This occurs if the excreta from someone suffering from an infectious gut disease, such as cholera, get mixed with the drinking water used by people living nearby. The cholera-causing microbes will enter a healthy person through the water they drink and cause disease in them. Such diseases are much more likely to spread in the absence of safe supplies of drinking water.

The sexual act is one of the closest physical contact two people can have with each other. Not surprisingly, there are microbial infections such as syphilis or AIDS that are transmitted by sexual contact from one partner to the other. However, such sexually transmitted diseases are not spread by casual physical contact. Casual physical contacts include handshakes or hugs or sports, like wrestling, or by any of the other ways in which we touch each other socially. Other than the sexual contact, the virus causing AIDS (HIV) can also spread through blood-to-blood contact with infected people or from an infected mother to her baby during pregnancy or through breast feeding.

We live in an environment that is full of many other creatures apart from us. It is inevitable that many diseases will be transmitted by other animals. These animals carry the infecting agents from a sick person to another potential host. These animals are thus the intermediaries and are called vectors.

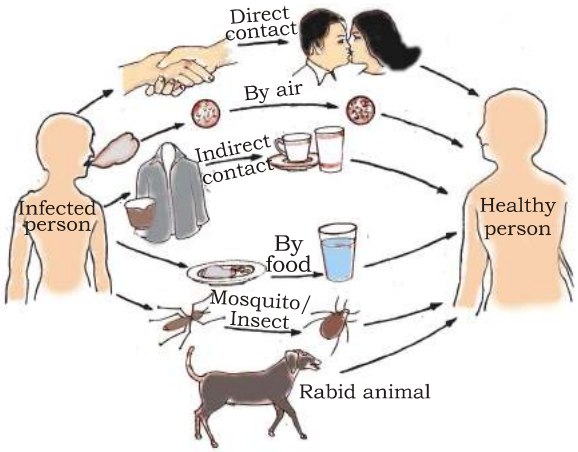


Fig. 13.2: *Common methods of transmission of diseases.*

The commonest vectors we all know are mosquitoes. In many species of mosquitoes, the females need highly nutritious food in the form of blood in order to be able to lay mature eggs. Mosquitoes feed on many warm-blooded animals, including us. In this way, they can transfer diseases from person to person (Fig. 13.2).

13.3.3 Organ-specific and tissue-specific manifestations

The disease-causing microbes enter the body through these different means. Where do they go then? The body is very large when compared to the microbes. So there are many possible places, organs or tissues, where they could go. Do all microbes go to the same tissue or organ, or do they go to different ones?

Different species of microbes seem to have evolved to home in on different parts of the body. In part, this selection is connected to their point of entry. If they enter from the air via the nose, they are likely to go to the lungs. This is seen in the bacteria causing tuberculosis. If they enter through the mouth, they can stay in the gut lining like typhoid-causing bacteria. Or they can go to the liver, like the viruses that cause jaundice.

But this needn't always be the case. An infection like HIV, that comes into the body via the sexual organs, will spread to lymph nodes all over the body. Malaria-causing microbes, entering through a mosquito bite, will go to the liver, and then to the red blood cells. The virus causing Japanese encephalitis, or brain fever, will similarly enter through a mosquito bite. But it goes on to infect the brain.

The signs and symptoms of a disease will thus depend on the tissue or organ which the microbe targets. If the lungs are the targets, then symptoms will be cough and breathlessness. If the liver is targeted, there will be jaundice. If the brain is the target, we will observe headaches, vomiting, fits or unconsciousness. We can imagine what the symptoms and signs of an infection will be if we know what the target tissue or organ is, and the functions that are carried out by this tissue or organ.

In addition to these tissue-specific effects of infectious disease, there will be other common effects too. Most of these common effects depend on the fact that the body's immune system is activated in response to infection. An active immune system recruits many cells to the affected tissue to kill off the disease-causing microbes. This recruitment process is called inflammation. As a part of this process, there are local effects such as swelling and pain, and general effects such as fever.

In some cases, the tissue-specificity of the infection leads to very general-seeming effects. For example, in HIV infection, the virus goes to the immune system and damages its function. Thus, many of the effects of HIV-AIDS are because the body can no longer fight off the many minor infections that we face everyday. Instead, every small cold can become pneumonia. Similarly, a minor gut infection can produce major diarrhoea with blood loss. Ultimately, it is these other infections that kill people suffering from HIV-AIDS.

It is also important to remember that the severity of disease manifestations depend on the number of microbes in the body. If the number of microbes is very small, the disease manifestations may be minor or unnoticed. But if the number is of the same microbe large, the disease can be severe enough to be life-threatening. The immune system is a major factor that determines the number of microbes surviving in the body. We shall look into this aspect a little later in the chapter.

13.3.4 Principles of treatment

What are the steps taken by your family when you fall sick? Have you ever thought why you sometimes feel better if you sleep for some time? When does the treatment involve medicines?

Based on what we have learnt so far, it would appear that there are two ways to treat an infectious disease. One would be to reduce the effects of the disease and the other to kill the cause of the disease. For the first, we can provide treatment that will reduce the symptoms. The symptoms are usually because of inflammation. For example, we can take medicines that bring down fever, reduce pain or loose motions. We can take bed rest so that we can conserve our energy. This will enable us to have more of it available to focus on healing.

But this kind of symptom-directed treatment by itself will not make the infecting microbe go away and the disease will not be cured. For that, we need to be able to kill off the microbes.

How do we kill microbes? One way is to use medicines that kill microbes. We have seen earlier that microbes can be classified into different categories. They are viruses, bacteria, fungi or protozoa. Each of these groups of organisms will have some essential biochemical life process which is peculiar to that group and not shared with the other groups. These processes may be pathways for the synthesis of new substances or respiration.

These pathways will not be used by us either. For example, our cells may make new substances by a mechanism different from that used by bacteria. We have to find a drug that blocks the bacterial synthesis pathway without affecting our own. This is what is achieved by the antibiotics that we are all familiar with. Similarly, there are drugs that kill protozoa such as the malarial parasite.

One reason why making anti-viral medicines is harder than making anti-bacterial medicines is that viruses have few biochemical mechanisms of their own. They enter our cells and use our machinery for their life processes. This means that there are relatively few virus-specific targets to aim at. Despite this limitation, there are now effective anti-viral drugs, for example, the drugs that keep HIV infection under control.

13.3.5 Principles of prevention

All of what we have talked about so far deals with how to get rid of an infection in someone who has the disease. But there are three limitations of this approach to dealing with infectious disease. The first is that once someone has a disease, their body functions are damaged and may never recover completely. The second is that treatment will take time, which means that someone suffering from a disease is likely to be

bedridden for some time even if we can give proper treatment. The third is that the person suffering from an infectious disease can serve as the source from where the infection may spread to other people. This leads to the multiplication of the above difficulties. It is because of such reasons that prevention of diseases is better than their cure.

How can we prevent diseases? There are two ways, one general and one specific to each disease. The general ways of preventing infections mostly relate to preventing exposure. How can we prevent exposure to infectious microbes?

If we look at the means of their spreading, we can get some easy answers. For airborne microbes, we can prevent exposure by providing living conditions that are not overcrowded. For water-borne microbes, we can prevent exposure by providing safe drinking water. This can be done by treating the water to kill any microbial contamination. For vector-borne infections, we can provide clean environments. This would not, for example, allow mosquito breeding. In other words, public hygiene is one basic key to the prevention of infectious diseases.

In addition to these issues that relate to the environment, there are some other general principles to prevent infectious diseases. To appreciate those principles, let us ask a question we have not looked at so far. Normally, we are faced with infections everyday. If someone is suffering from a cold and cough in the class, it is likely that the children sitting around will be exposed to the infection. But all of them do not actually suffer from the disease. Why not?

This is because the immune system of our body is normally fighting off microbes. We have cells that specialise in killing infecting microbes. These cells go into action each time infecting microbes enter the body. If they are successful, we do not actually come down with any disease. The immune cells manage to kill off the infection long before it assumes major proportions. As we noted earlier, if the number of the infecting microbes is controlled, the manifestations of disease will be minor. In other words, becoming exposed to or infected with an infectious microbe does not necessarily mean developing noticeable disease.

So, one way of looking at severe infectious diseases is that it represents a lack of success of the immune system. The functioning of the immune system, like any other system in our body, will not be good if proper and sufficient nourishment and food is not available. Therefore, the second basic principle of prevention of infectious disease is the availability of proper and sufficient food for everyone.

Activity 13.6

- Conduct a survey in your locality. Talk to ten families who are well-off and ten who are very poor (in your estimation). Both sets of families should have children who are below five years of age. Measure the heights of these children. Draw a graph of the height of each child against its age for both sets of families.
- Is there a difference between the groups? If yes, why?
- If there is no difference, do you think that your findings mean that being well-off or poor does not matter for health?

These are the general ways of preventing infections. What are the specific ways? They relate to a peculiar property of the immune system that usually fights off microbial infections. Let us cite an example to try and understand this property.

These days, there is no smallpox anywhere in the world. But as recently as a hundred years ago, smallpox epidemics were not at all uncommon. In such an epidemic, people used to be very afraid of coming near someone suffering from the disease since they were afraid of catching the disease.

However, there was one group of people who did not have this fear. These people would provide nursing care for the victims of smallpox. This was a group of people who had had smallpox earlier and survived it, although with a lot of scarring. In other words, if you had smallpox once, there was no chance of

suffering from it again. So, having the disease once was a means of preventing subsequent attacks of the same disease.

This happens because when the immune system first sees an infectious microbe, it responds against it and then remembers it specifically. So the next time that particular microbe, or its close relatives enter the body, the immune system responds with even greater vigour. This eliminates the infection even more quickly than the first time around. This is the basis of the principle of immunisation.

Immunisation

Traditional Indian and Chinese medicinal systems sometimes deliberately rubbed the skin crusts from smallpox victims into the skin of healthy people. They thus hoped to induce a mild form of smallpox that would create resistance against the disease.

Famously, two centuries ago, an English physician named Edward Jenner, realised

that milkmaids who had had cowpox did not catch smallpox even during epidemics. Cowpox is a very mild disease. Jenner tried deliberately giving cowpox to people (as he can be seen doing in the picture), and found that they were now resistant to smallpox. This was because the smallpox virus is closely related to the cowpox virus. 'Cow' is 'vacca' in Latin, and cowpox is 'vaccinia'. From these roots, the word 'vaccination' has come into our usage.

We can now see that, as a general principle, we can 'fool' the immune system into developing a memory for a particular infection by putting something, that mimics the microbe we want to vaccinate against, into the body. This does not actually cause the disease but this would prevent any subsequent exposure to the infecting microbe from turning into actual disease.

Many such vaccines are now available for preventing a whole range of infectious diseases, and provide a disease-specific means of prevention. There are vaccines against tetanus, diphtheria, whooping cough, measles, polio and many others. These form the public health programme of childhood immunisation for preventing infectious diseases.

Of course, such a programme can be useful only if such health measures are available to all children. Can you think of reasons why this should be so?

Some hepatitis viruses, which cause jaundice, are transmitted through water. There is a vaccine for one of them, hepatitis A, in the market. But the majority of children in many parts of India are already immune to hepatitis A by the time they are five years old. This is because they are exposed to the virus through water. Under these circumstances, would you take the vaccine?

Activity 13.7

- Rabies virus is spread by the bite of infected dogs and other animals. There are anti-rabies vaccines for both humans and animals. Find out the plan of your local authority for the control of rabies in your neighbourhood. Are these measures adequate? If not, what improvements would you suggest?

Questions

1. *Why are we normally advised to take bland and nourishing food when we are sick?*
2. *What are the different means by which infectious diseases are spread?*
3. *What precautions can you take in your school to reduce the incidence of infectious diseases?*
4. *What is immunisation?*
5. *What are the immunisation programmes available at the nearest health centre in your locality? Which of these diseases are the major health problems in your area?*

What you have learnt

- Health is a state of physical, mental and social well-being.
- The health of an individual is dependent on his/her physical surroundings and his/her economic status.
- Diseases are classified as acute or chronic, depending on their duration.
- Disease may be due to infectious or non-infectious causes.
- Infectious agents belong to different categories of organisms and may be unicellular and microscopic or multicellular.
- The category to which a disease-causing organism belongs decides the type of treatment.
- Infectious agents are spread through air, water, physical contact or vectors.
- Prevention of disease is more desirable than its successful treatment.
- Infectious diseases can be prevented by public health hygiene measures that reduce exposure to infectious agents.
- Infectious diseases can also be prevented by using immunisation.
- Effective prevention of infectious diseases in the community requires that everyone should have access to public hygiene and immunisation.

Exercises

1. How many times did you fall ill in the last one year? What were the illnesses?
   (a) Think of one change you could make in your habits in order to avoid any of/most of the above illnesses.
   (b) Think of one change you would wish for in your surroundings in order to avoid any of/most of the above illnesses.
2. A doctor/nurse/health-worker is exposed to more sick people than others in the community. Find out how she/he avoids getting sick herself/himself.
3. Conduct a survey in your neighbourhood to find out what the three most common diseases are. Suggest three steps that could be taken by your local authorities to bring down the incidence of these diseases.

4. A baby is not able to tell her/his caretakers that she/he is sick. What would help us to find out
   (a) that the baby is sick?
   (b) what is the sickness?
5. Under which of the following conditions is a person most likely to fall sick?
   (a) when she is recovering from malaria.
   (b) when she has recovered from malaria and is taking care of someone suffering from chicken-pox.
   (c) when she is on a four-day fast after recovering from malaria and is taking care of someone suffering from chicken-pox.

   Why?
6. Under which of the following conditions are you most likely to fall sick?
   (a) when you are taking examinations.
   (b) when you have travelled by bus and train for two days.
   (c) when your friend is suffering from measles.

   Why?

Chapter 14

Natural Resources

Our planet, Earth is the only one on which life, as we know it, exists. Life on Earth is dependent on many factors. Most life-forms we know need an ambient temperature, water, and food. The resources available on the Earth and the energy from the Sun are necessary to meet the basic requirements of all life-forms on the Earth.

What are these resources on the Earth?

These are the land, the water and the air. The outer crust of the Earth is called the lithosphere. Water covers 75% of the Earth's surface. It is also found underground. These comprise the hydrosphere. The air that covers the whole of the Earth like a blanket, is called the atmosphere. Living things are found where these three exist. This life-supporting zone of the Earth where the atmosphere, the hydrosphere and the lithosphere interact and make life possible, is known as the biosphere.

Living things constitute the biotic component of the biosphere. The air, the water and the soil form the non-living or abiotic component of the biosphere. Let us study these abiotic components in detail in order to understand their role in sustaining life on Earth.

14.1 The Breath of Life: Air

We have already talked about the composition of air in the first chapter. It is a mixture of many gases like nitrogen, oxygen, carbon dioxide and water vapour. It is interesting to note that even the composition of air is the result of life on Earth. In planets such as Venus and Mars, where no life is known to exist, the major component of the atmosphere is found to be carbon dioxide. In fact, carbon dioxide constitutes up to 95-97% of the atmosphere on Venus and Mars.

Eukaryotic cells and many prokaryotic cells, discussed in Chapter 5, need oxygen to break down glucose molecules and get energy for their activities. This results in the production of carbon dioxide. Another process which results in the consumption of oxygen and the concomitant production of carbon dioxide is combustion. This includes not just human activities, which burn fuels to get energy, but also forest fires.

Despite this, the percentage of carbon dioxide in our atmosphere is a mere fraction of a percent because carbon dioxide is 'fixed' in two ways: (i) Green plants convert carbon dioxide into glucose in the presence of Sunlight and (ii) many marine animals use carbonates dissolved in sea-water to make their shells.

14.1.1 The Role of the Atmosphere in Climate Control

We have talked of the atmosphere covering the Earth, like a blanket. We know that air is a bad conductor of heat. The atmosphere keeps the average temperature of the Earth fairly steady during the day and even during the course of the whole year. The atmosphere prevents the sudden increase in temperature during the daylight hours. And during the night, it slows down the escape of heat into outer space. Think of the moon, which is about the same distance from the Sun that the Earth is. Despite that, on the surface of the moon, with no atmosphere, the temperature ranges from –190° C to 110° C.

Activity 14.1

- Measure the temperature of the following :
  Take (i) a beaker full of water, (ii) a beaker full of soil/sand and (iii) a closed bottle containing a thermometer. Keep them in bright Sunlight for three hours. Now measure the temperature of all 3 vessels. Also, take the temperature reading in shade at the same time.

Now answer

1. *Is the temperature reading more in activity (i) or (ii)?*
2. *Based on the above finding, which would become hot faster – the land or the sea?*
3. *Is the thermometer reading of the temperature of air (in shade) the same as the temperature of sand or water? What do you think is the reason for this? And why does the temperature have to be measured in the shade?*
4. *Is the temperature of air in the closed glass vessel/bottle the same as the temperature taken in open air? (i) What do you think is the reason for this? (ii) Do we ever come across this phenomenon in daily life?*

As we have seen above, sand and water do not heat up at the same rate. What do you think will be their rates of cooling? Can we think of an experiment to test the prediction?

14.1.2 The Movement of Air: Winds

We have all felt the relief brought by cool evening breezes after a hot day. And sometimes, we are lucky enough to get rains after some days of really hot weather. What causes the movement of air, and what decides whether this movement will be in the form of a gentle breeze, a strong wind or a terrible storm? What brings us the welcome rains?

All these phenomena are the result of changes that take place in our atmosphere due to the heating of air and the formation of water vapour. Water vapour is formed due to the heating of water bodies and the activities of living organisms. The atmosphere can be heated from below by the radiation that is reflected back or re-radiated by the land or water bodies. On being heated, convection currents are set up in the air. In order to gain some understanding of the nature of convection currents, let us perform the following activity:

Activity 14.2

- Place a candle in a beaker or wide-mouthed bottle and light it. Light an incense stick and take it to the mouth of the above bottle (Figure 14.1).
- Which way does the smoke flow when the incense stick is kept near the edge of the mouth?
- Which way does the smoke flow when the incense stick is kept a little above the candle?
- Which way does the smoke flow when the incense stick is kept in other regions?

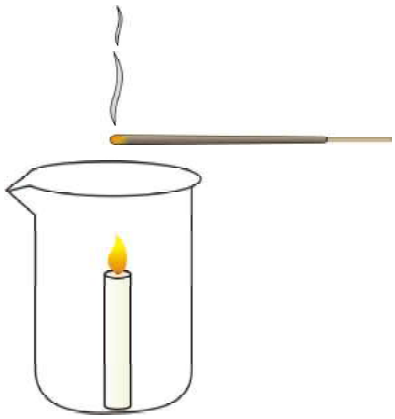


Fig. 14.1: *Air currents being caused by the uneven heating of air.*

The patterns revealed by the smoke show us the directions in which hot and cold air move. In a similar manner, when air is heated by radiation from the heated land or water, it rises. But since land gets heated faster than water, the air over land would also be heated faster than the air over water bodies.

So, if we look at the situation in coastal regions during the day, the air above the land

gets heated faster and starts rising. As this air rises, a region of low pressure is created and air over the sea moves into this area of low pressure. The movement of air from one region to the other creates winds. During the day, the direction of the wind would be from the sea to the land.

At night, both land and sea start to cool. Since water cools down slower than the land, the air above water would be warmer than the air above land.

On the basis of the above discussion, what can you say about:

1. the appearance of areas of low and high pressure in coastal areas at night?
2. the direction in which air would flow at night in coastal areas?

Similarly, all the movements of air resulting in diverse atmospheric phenomena are caused by the uneven heating of the atmosphere in different regions of the Earth. But various other factors also influence these winds – the rotation of the Earth and the presence of mountain ranges in the paths of the wind are a couple of these factors. We will not go into these factors in detail in this chapter, but think about this: how do the presence of the Himalayas change the flow of a wind blowing from Allahabad towards the north?

14.1.3 Rain

Let us go back now to the question of how clouds are formed and bring us rain. We could start by doing a simple experiment which demonstrates some of the factors influencing these climatic changes.

Activity 14.3

- Take an empty bottle of the sort in which bottled water is sold. Pour about 5-10 mL of water into it and close the bottle tightly. Shake it well or leave it out in the Sun for ten minutes. This causes the air in the bottle to be saturated with water vapour.
- Now, take a lighted incense stick. Open the cap of the bottle and allow some of the smoke from the incense stick to enter the bottle. Quickly close the bottle once more. Make sure that the cap is fitting tightly. Press the bottle hard between your hands and crush it as much as possible. Wait for a few seconds and release the bottle. Again press the bottle as hard as you can.

Now answer

1. *When did you observe that the air inside seemed to become 'foggy'?*
2. *When does this fog disappear?*
3. *When is the pressure inside the bottle higher?*
4. *Is the 'fog' observed when the pressure in the bottle is high or when it is low?*
5. *What is the need for smoke particles inside the bottle for this experiment?*
6. *What might happen if you do the experiment without the smoke from the incense stick? Now try it and check if the prediction was correct. What might be happening in the above experiment in the absence of smoke particles?*

The above experiment replicates, on a very small scale, what happens when air with a very high content of water vapour goes from a region of high pressure to a region of low pressure or vice versa.

When water bodies are heated during the day, a large amount of water evaporates and goes into the air. Some amount of water vapour also get into the atmosphere because of various biological activities. This air also gets heated. The hot air rises up carrying the water vapour with it. As the air rises, it expands and cools. This cooling causes the water vapour in the air to condense in the form of tiny droplets. This condensation of water is facilitated if some particles could act as the 'nucleus' for these drops to form around. Normally dust and other suspended particles in the air perform this function.

Once the water droplets are formed, they grow bigger by the 'condensation' of these water droplets. When the drops have grown big and heavy, they fall down in the form of rain. Sometimes, when the temperature of air

is low enough, precipitation may occur in the form of snow, sleet or hail.

Rainfall patterns are decided by the prevailing wind patterns. In large parts of India, rains are mostly brought by the south-west or north-east monsoons. We have also heard weather reports that say 'depressions' in the Bay of Bengal have caused rains in some areas (Figure 14.2).

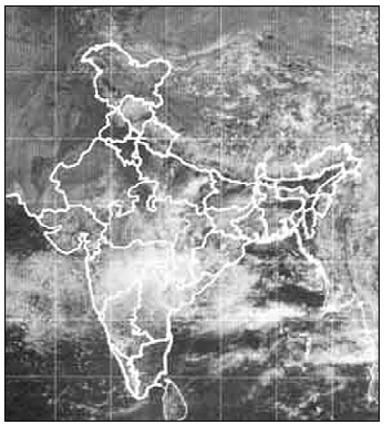


Fig. 14.2: *Satellite picture showing clouds over India.*

Activity 14.4

- Collect information from newspapers or weather reports on television about rainfall patterns across the country. Also find out how to construct a rain-gauge and make one. What precautions are necessary in order to get reliable data from this rain-gauge? Now answer the following questions :
- In which month did your city/town/village get the maximum rainfall?
- In which month did your state/union territory get the maximum rainfall?
- Is rain always accompanied by thunder and lightning? If not, in which season do you get more of thunder and lightning with the rain?

Activity 14.5

- Find out more about monsoons and cyclones from the library. Try and find out the rainfall pattern of any other country. Is the monsoon responsible for rains the world over?

14.1.4 Air Pollution

We keep hearing of the increasing levels of oxides of nitrogen and sulphur in the news. People often bemoan the fact that the quality of air has gone down since their childhood. How is the quality of air affected and how does this change in quality affect us and other life forms?

The fossil fuels like coal and petroleum contain small amounts of nitrogen and sulphur. When these fuels are burnt, nitrogen and sulphur too are burnt and this produces different oxides of nitrogen and sulphur. Not only is the inhalation of these gases dangerous, they also dissolve in rain to give rise to acid rain. The combustion of fossil fuels also increases the amount of suspended particles in air. These suspended particles could be unburnt carbon particles or substances called hydrocarbons. Presence of high levels of all these pollutants cause visibility to be lowered, especially in cold weather when water also condenses out of air. This is known as smog and is a visible indication of air pollution. Studies have shown that regularly breathing air that contains any of these substances increases the incidence of allergies, cancer and heart diseases. An increase in the content of these harmful substances in air is called air pollution.

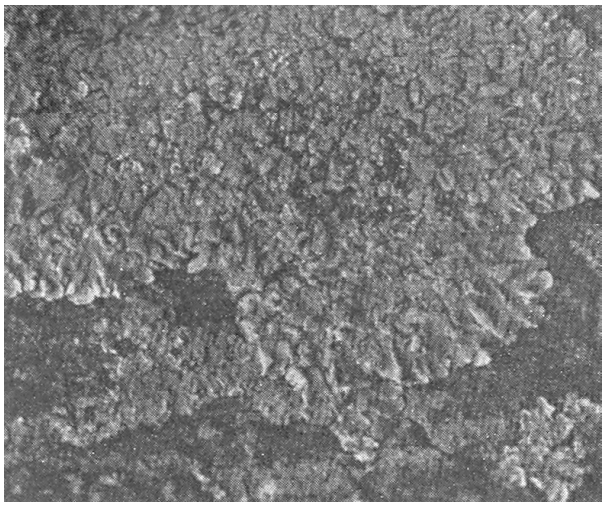


Fig. 14.3: *Lichen*

Activity 14.6

- Organisms called lichens are found to be very sensitive to the levels of contaminants like sulphur dioxide in the air. As discussed earlier in section 7.3.3, lichens can be commonly found growing on the barks of trees as a thin greenish-white crust. See if you can find lichen growing on the trees in your locality.
- Compare the lichen on trees near busy roads and trees some distance away.
- On the trees near roads, compare the incidence of lichen on the side facing the road and on the side away from the road.

What can you say about the levels of polluting substances near roads and away from roads on the basis of your findings above?

Questions

1. *How is our atmosphere different from the atmospheres on Venus and Mars?*
2. *How does the atmosphere act as a blanket?*
3. *What causes winds?*
4. *How are clouds formed?*
5. *List any three human activities that you think would lead to air pollution.*

14.2 Water: A Wonder Liquid

Water occupies a very large area of the Earth's surface and is also found underground. Some amount of water exists in the form of water vapour in the atmosphere. Most of the water on Earth's surface is found in seas and oceans and is saline. Fresh water is found frozen in the ice-caps at the two poles and on snow-covered mountains. The underground water and the water in rivers, lakes and ponds is also fresh. However, the availability of fresh water varies from place to place. Practically every summer, most places have to face a shortage of water. And in rural areas, where water supply systems have not been installed, people are forced to spend considerable amounts of time in fetching water from far-away sources.

Activity 14.7

- Many municipal corporations are trying water-harvesting techniques to improve the availability of water.
- Find out what these techniques are and how they would increase the water that is available for use.

But why is water so necessary? And do all organisms require water? All cellular processes take place in a water medium. All the reactions that take place within our body and within the cells occur between substances that are dissolved in water. Substances are also transported from one part of the body to the other in a dissolved form. Hence, organisms need to maintain the level of water within their bodies in order to stay alive. Terrestrial life-forms require fresh water for this because their bodies cannot tolerate or get rid of the high amounts of dissolved salts in saline water. Thus, water sources need to be easily accessible for animals and plants to survive on land.

Activity 14.8

- Select a small area (say, 1 m^2) near a water-body, it may be a river, stream, lake or pond. Count the number of different animals and plants in this area. Also, check the number of individuals of each type or species.
- Compare this with the number of individuals (both animals and plants) found in an area of the same size in a dry, rocky region.
- Is the variety of plant and animal life the same in both these areas?

Activity 14.9

- Select and mark out a small area (about 1 m^2) in some unused land in or near your school.
- As in the above activity, count the number of different animals and plants in this area and the number of individuals of each species.

- Remember to do this in the same place twice in a year, once during summer or the dry season and once after it has rained.

Now answer

1. *Were the numbers similar both times?*
2. *In which season did you find more variety of plants and animals?*
3. *In which season did you find more number of individuals of each variety?*

After compiling the results of the above two activities, think if there is any relationship between the amount of available water and the number and variety of plants and animals that can live in a given area. If there is a relationship, where do you think you would find a greater variety and abundance of life – in a region that receives 5 cm of rainfall in a year or a region that receives 200 cm of rainfall in a year? Find the map showing rainfall patterns in the atlas and predict which States in India would have the maximum biodiversity and which would have the least. Can we think of any way of checking whether the prediction is correct?

The availability of water decides not only the number of individuals of each species that are able to survive in a particular area, but it also decides the diversity of life there. Of course, the availability of water is not the only factor that decides the sustainability of life in a region. Other factors like the temperature and nature of soil also matter. But water is one of the major resources which determine life on land.

14.2.1 Water Pollution

Water dissolves the fertilisers and pesticides that we use on our farms. So some percentage of these substances are washed into the water bodies. Sewage from our towns and cities and the waste from factories are also dumped into rivers or lakes. Specific industries also use water for cooling in various operations and later return this hot water to water-bodies. Another manner in which the temperature of the water in rivers can be affected is when water is released from dams. The water inside the deep reservoir would be colder than the water at the surface which gets heated by the Sun.

All this can affect the life-forms that are found in these water bodies in various ways. It can encourage the growth of some life-forms and harm some other life-forms. This affects the balance between various organisms which had been established in that system. So we use the term water-pollution to cover the following effects:

1. The addition of undesirable substances to water-bodies. These substances could be the fertilisers and pesticides used in farming or they could be poisonous substances, like mercury salts which are used by paper-industries. These could also be disease-causing organisms, like the bacteria which cause cholera.
2. The removal of desirable substances from water-bodies. Dissolved oxygen is used by the animals and plants that live in water. Any change that reduces the amount of this dissolved oxygen would adversely affect these aquatic organisms. Other nutrients could also be depleted from the water bodies.
3. A change in temperature. Aquatic organisms are used to a certain range of temperature in the water-body where they live, and a sudden marked change in this temperature would be dangerous for them or affect their breeding. The eggs and larvae of various animals are particularly susceptible to temperature changes.

Questions

1. *Why do organisms need water?*
2. *What is the major source of fresh water in the city/town/village where you live?*
3. *Do you know of any activity which may be polluting this water source?*

14.3 Mineral Riches in the Soil

Soil is an important resource that decides the diversity of life in an area. But what is the soil and how is it formed? The outermost layer of our Earth is called the crust and the minerals found in this layer supply a variety of nutrients to life-forms. But these minerals will not be available to the organisms if the minerals are bound up in huge rocks. Over long periods of time, thousands and millions of years, the rocks at or near the surface of the Earth are broken down by various physical, chemical and some biological processes. The end product of this breaking down is the fine particles of soil. But what are the factors or processes that make soil?

- The Sun: The Sun heats up rocks during the day so that they expand. At night, these rocks cool down and contract. Since all parts of the rock do not expand and contract at the same rate, this results in the formation of cracks and ultimately the huge rocks break up into smaller pieces.
- Water: Water helps in the formation of soil in two ways. One, water could get into the cracks in the rocks formed due to uneven heating by the Sun. If this water later freezes, it would cause the cracks to widen. Can you think why this should be so? Two, flowing water wears away even hard rock over long periods of time. Fast flowing water often carries big and small particles of rock downstream. These rocks rub against other rocks and the resultant abrasion causes the rocks to wear down into smaller and smaller particles. The water then takes these particles along with it and deposits it further down its path. Soil is thus found in places far away from its parent-rock.
- Wind: In a process similar to the way in which water rubs against rocks and wears them down, strong winds also erode rocks down. The wind also carries sand from one place to the other like water does.
- Living organisms also influence the formation of soil. The lichen that we read about earlier, also grows on the surface of rocks. While growing, they release certain substances that cause the rock surface to powder down and form a thin layer of soil. Other small plants like moss, are able to grow on this surface now and they cause the rock to break up further. The roots of big trees sometimes go into cracks in the rocks and as the roots grow bigger, the crack is forced bigger.

Activity 14.10

- Take some soil and put it into a beaker containing water. The water should be at least five times the amount of soil taken. Stir the soil and water vigorously and allow the soil to settle down. Observe after some time.
- Is the soil at the bottom of the beaker homogenous or have layers formed?
- If layers have formed, how is one layer different from another?
- Is there anything floating on the surface of the water?
- Do you think some substances would have dissolved in the water? How would you check?

As you have seen, soil is a mixture. It contains small particles of rock (of different sizes). It also contains bits of decayed living organisms which is called humus. In addition, soil also contains various forms of microscopic life. The type of soil is decided by the average size of particles found in it and the quality of the soil is decided by the amount of humus and the microscopic organisms found in it. Humus is a major factor in deciding the soil structure because it causes the soil to become more porous and allows water and air to penetrate deep underground. The mineral nutrients that are found in a particular soil depends on the rocks it was formed from. The nutrient content of a soil, the amount of humus present in it and the depth of the soil are

some of the factors that decide which plants will thrive on that soil. Thus, the topmost layer of the soil that contains humus and living organisms in addition to the soil particles is called the topsoil. The quality of the topsoil is an important factor that decides biodiversity in that area.

Modern farming practices involve the use of large amounts of fertilizers and pesticides. Use of these substances over long periods of time can destroy the soil structure by killing the soil micro-organisms that recycle nutrients in the soil. It also kills the Earthworms which are instrumental in making the rich humus. Fertile soil can quickly be turned barren if sustainable practices are not followed. Removal of useful components from the soil and addition of other substances, which adversely affect the fertility of the soil and kill the diversity of organisms that live in it, is called soil pollution.

The soil that we see today in one place has been created over a very long period of time. However, some of the factors that created the soil in the first place and brought the soil to that place may be responsible for the removal of the soil too. The fine particles of soil may be carried away by flowing water or wind. If all the soil gets washed away and the rocks underneath are exposed, we have lost a valuable resource because very little will grow on the rock.

Activity 14.11

- Take two identical trays and fill them with soil. Plant mustard or green gram or paddy in one of the trays and water both the trays regularly for a few days, till the first tray is covered by plant growth. Now, tilt both the trays and fix them in that position. Make sure that both the trays are tilted at the same angle. Pour equal amount of water gently on both trays such that the water flows out of the trays (Fig. 14.4).
- Study the amount of soil that is carried out of the trays. Is the amount the same in both the trays?
- Now pour equal amounts of water on both the trays from a height. Pour three or four times the amount that you poured earlier.
- Study the amount of soil that is carried out of the trays now. Is the amount the same in both the trays?
- Is the amount of soil that is carried out more or less or equal to the amount washed out earlier?

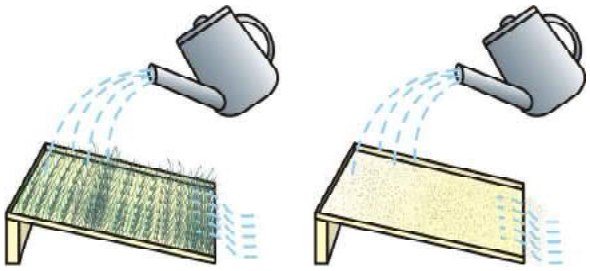


***Fig. 14.4**: Effect of flowing water on the top-soil*

The roots of plants have an important role in preventing soil erosion. The large-scale deforestation that is happening all over the world not only destroys biodiversity, it also leads to soil erosion. Topsoil that is bare of vegetation, is likely to be removed very quickly. And this is accelerated in hilly or mountainous regions. This process of soil erosion is very difficult to reverse. Vegetative cover on the ground has a role to play in the percolation of water into the deeper layers too.

Questions

1. *How is soil formed?*
2. *What is soil erosion?*
3. *What are the methods of preventing or reducing soil erosion?*

14.4 Biogeochemical Cycles

A constant interaction between the biotic and abiotic components of the biosphere makes it a dynamic, but stable system. These interactions consist of a transfer of matter and energy between the different components of the biosphere. Let us look at some processes involved in the maintenance of the above balance.

14.4.1 The water-cycle

You have seen how the water evaporates from the water bodies and subsequent condensation of this water vapour leads to rain. But we don't see the seas and oceans drying up. So, how is the water returning to these water bodies? The whole process in which water evaporates and falls on the land as rain and later flows back into the sea via rivers is known as the water-cycle. This cycle is not as straight-forward and simple as this statement seems to imply. All of the water that falls on the land does not immediately flow back into the sea. Some of it seeps into the soil and becomes part of the underground reservoir of fresh-water. Some of this underground water finds its way to the surface through springs. Or we bring it to the surface for our use through wells or tube-wells. Water is also used by terrestrial animals and plants for various life-processes (Fig. 14.5).

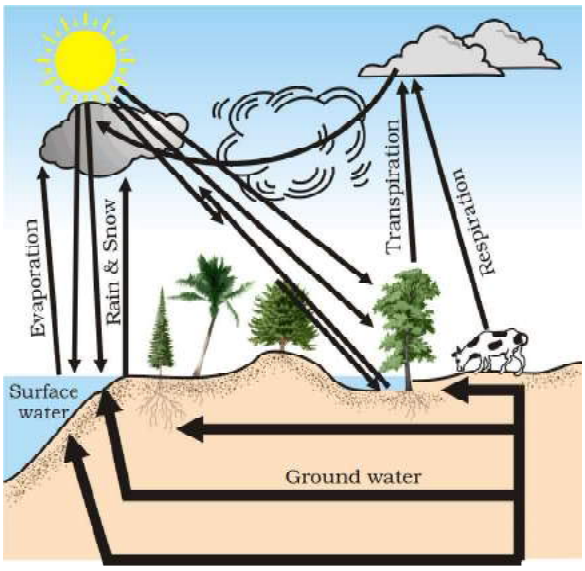


Fig. 14.5: *Water-cycle in nature*

Let us look at another aspect of what happens to water during the water-cycle. As you know, water is capable of dissolving a large number of substances. As water flows through or over rocks containing soluble minerals, some of them get dissolved in the water. Thus rivers carry many nutrients from the land to the sea, and these are used by the marine organisms.

14.4.2 The nitrogen-cycle

Nitrogen gas makes up 78% of our atmosphere and nitrogen is also a part of many molecules essential to life like proteins, nucleic acids (DNA and RNA) and some vitamins. Nitrogen is found in other biologically important compounds such as alkaloids and urea too. Nitrogen is thus an essential nutrient for all life-forms and life would be simple if all these life-forms could use the atmospheric nitrogen directly. However, other than a few forms of bacteria, life-forms are not able to convert the comparatively inert nitrogen molecule into forms like nitrates and nitrites which can be taken up and used to make the required molecules. These 'nitrogen-fixing' bacteria may be free-living or be associated with some species of dicot plants. Most commonly, the nitrogen-fixing bacteria are found in the roots of legumes (generally the plants which give us pulses) in special structures called root-nodules. Other than these bacteria, the only other manner in which the nitrogen molecule is converted to nitrates and nitrites is by a physical process. During lightning, the high temperatures and pressures created in the air convert nitrogen into oxides of nitrogen. These oxides dissolve in water to give nitric and nitrous acids and fall on land along with rain. These are then utilised by various life-forms.

What happens to the nitrogen once it is converted into forms that can be taken up and used to make nitrogen-containing molecules? Plants generally take up nitrates and nitrites and convert them into amino acids which are used to make proteins. Some other biochemical pathways are used to make the other complex compounds containing nitrogen. These proteins and other complex compounds are subsequently consumed by animals. Once the animal or the plant dies, other bacteria in the soil convert the various compounds of nitrogen back into nitrates and

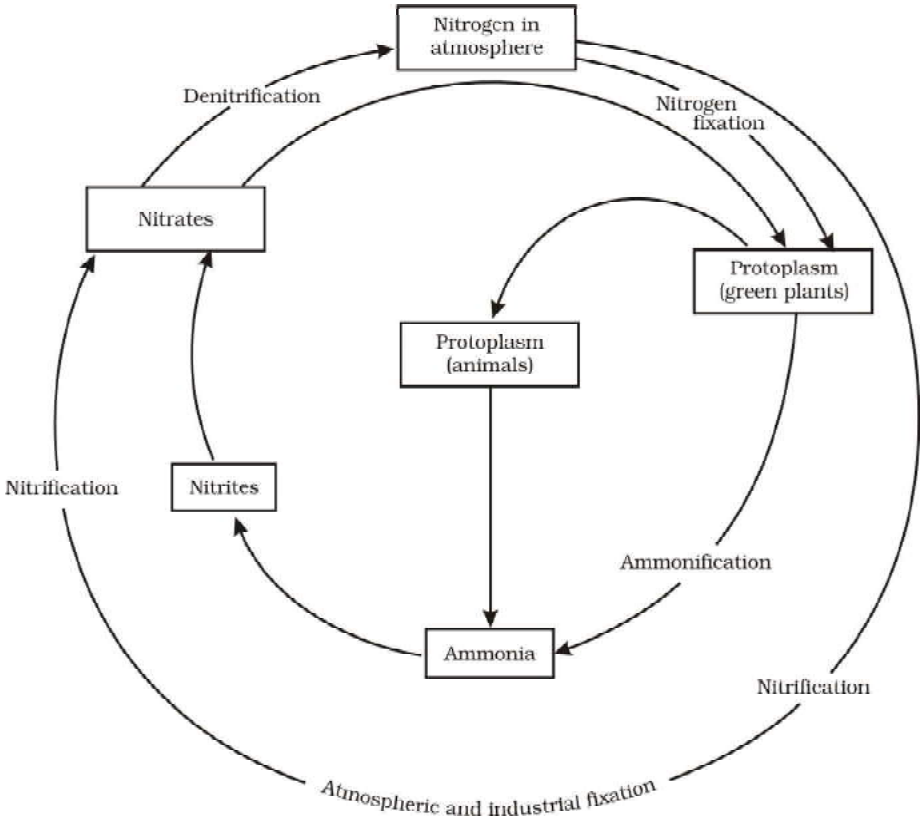


Fig.14.6: *Nitrogen-cycle in nature*

nitrites. A different type of bacteria converts the nitrates and nitrites into elemental nitrogen. Thus, there is a nitrogen-cycle in nature in which nitrogen passes from its elemental form in the atmosphere into simple molecules in the soil and water, which get converted to more complex molecules in living beings and back again to the simple nitrogen molecule in the atmosphere.

14.4.3 The carbon-cycle

Carbon is found in various forms on the Earth. It occurs in the elemental form as diamonds and graphite. In the combined state, it is found as carbon dioxide in the atmosphere, as carbonate and hydrogen-carbonate salts in various minerals, while all life-forms are based on carbon-containing molecules like proteins, carbohydrates, fats, nucleic acids and vitamins. The endoskeletons and exoskeletons of various animals are also formed from carbonate salts. Carbon is incorporated into life-forms through the basic process of photosynthesis which is performed in the presence of Sunlight by all life-forms that contain chlorophyll. This process converts carbon dioxide from the atmosphere or dissolved in water into glucose molecules. These glucose molecules are either converted into other substances or used to provide energy for the synthesis of other biologically important molecules (Fig. 14.7).

The utilisation of glucose to provide energy to living things involves the process of respiration in which oxygen may or may not be used to convert glucose back into carbon dioxide. This carbon dioxide then goes back into the atmosphere. Another process that

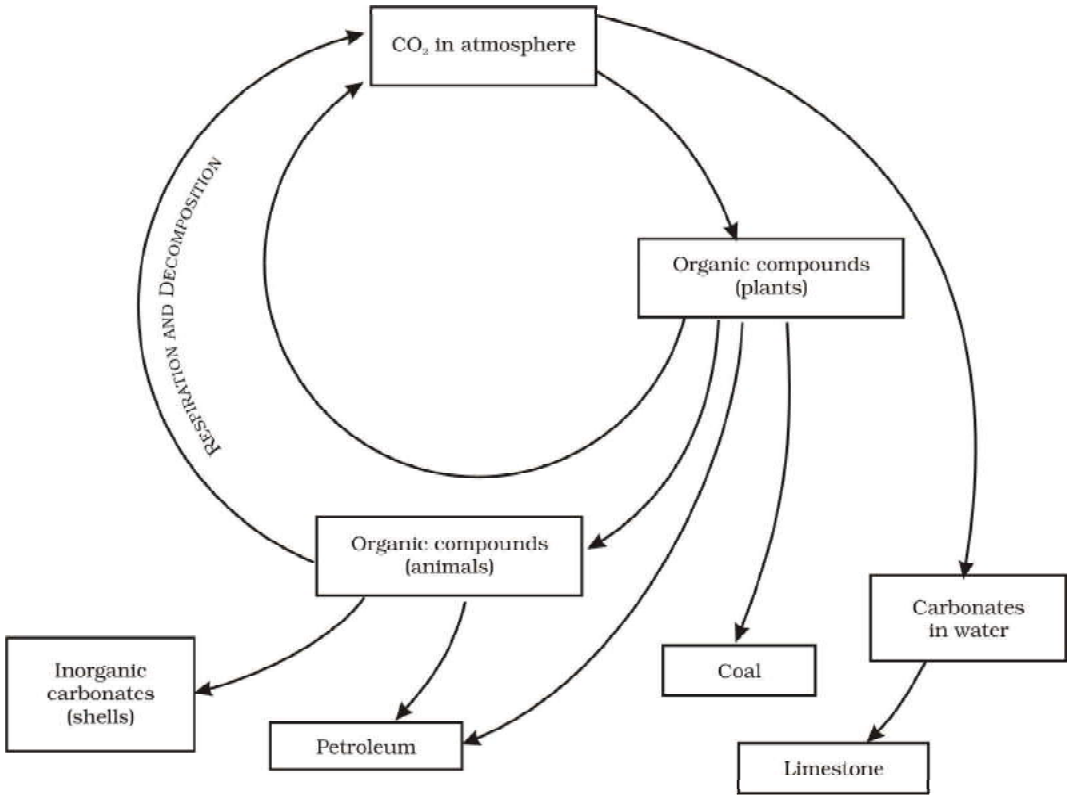


***Fig. 14.7**: Carbon-cycle in nature*

adds to the carbon dioxide in the atmosphere is the process of combustion where fuels are burnt to provide energy for various needs like heating, cooking, transportation and industrial processes. In fact, the percentage of carbon dioxide in the atmosphere is said to have doubled since the industrial revolution when human beings started burning fossil fuels on a very large scale. Carbon, like water, is thus cycled repeatedly through different forms by the various physical and biological activities.

14.4.3 (i) *The Greenhouse Effect*

Recall the reading taken by you under (iii) in Activity 14.1. Heat is trapped by glass, and hence the temperature inside a glass enclosure will be much higher than the surroundings. This phenomenon was used to create an enclosure where tropical plants could be kept warm during the winters in colder climates. Such enclosures are called greenhouses. Greenhouses have also lent their name to an atmospheric phenomenon. Some gases prevent the escape of heat from the Earth. An increase in the percentage of such gases in the atmosphere would cause the average temperatures to increase world-wide and this is called the greenhouse effect. Carbon dioxide is one of the greenhouse gases. An increase in the carbon dioxide content in the atmosphere would cause more heat to be retained by the atmosphere and lead to global warming.

Activity 14.12

- Find out what the consequences of global warming would be.
- Also, find out the names of some other greenhouse gases.

14.4.4 The oxygen-cycle

Oxygen is a very abundant element on our Earth. It is found in the elemental form in the atmosphere to the extent of 21%. It also occurs extensively in the combined form in the Earth's crust as well as also in the air in the form of carbon dioxide. In the crust, it is found as the oxides of most metals and silicon, and also as carbonate, sulphate, nitrate and other minerals. It is also an essential component of most biological molecules like carbohydrates, proteins, nucleic acids and fats (or lipids).

But when we talk of the oxygen-cycle, we are mainly referring to the cycle that maintains the levels of oxygen in the atmosphere. Oxygen from the atmosphere is used up in three processes, namely combustion, respiration and in the formation of oxides of nitrogen. Oxygen is returned to the atmosphere in only one major process, that is, photosynthesis. And this forms the broad outline of the oxygen-cycle in nature (Fig. 14.8).

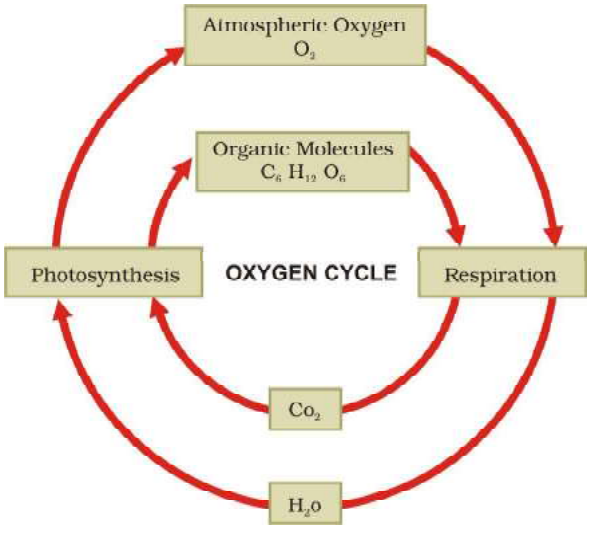


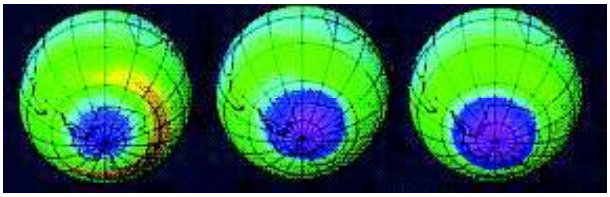
***Fig. 14.8**: Oxygen-cycle in nature*

Though we usually think of oxygen as being necessary to life in the process of respiration, it might be of interest to you to learn that some forms of life, especially bacteria, are poisoned by elemental oxygen. In fact, even the process of nitrogen-fixing by bacteria does not take place in the presence of oxygen.

14.5 Ozone Layer

Elemental oxygen is normally found in the form of a diatomic molecule. However, in the upper reaches of the atmosphere, a molecule containing three atoms of oxygen is found. This would mean a formula of O_3 and this is called ozone. Unlike the normal diatomic molecule of oxygen, ozone is poisonous and we are lucky that it is not stable nearer to the Earth's surface. But it performs an essential function where it is found. It absorbs harmful radiations from the Sun. This prevents those harmful radiations from reaching the surface of the Earth where they may damage many forms of life.

Recently it was discovered that this ozone layer was getting depleted. Various man-made compounds like CFCs (carbon compounds having both fluorine and chlorine which are very stable and not degraded by any biological process) were found to persist in the atmosphere. Once they reached the ozone layer, they would react with the ozone molecules. This resulted in a reduction of the ozone layer and recently they have discovered a hole in the ozone layer above the Antartica. It is difficult to imagine the consequences for life on Earth if the ozone layer dwindles further, but many people think that it would be better not to take chances. These people advocate working towards stopping all further damage to the ozone layer.



October 1980 | October 1985 | October 1990

***Fig. 14.9:** Satellite picture showing the hole (magenta colour) in the ozone layer over Antartica*

Activity 14.13

- Find out which other molecules are thought to damage the ozone layer.
- Newspaper reports often talk about the hole in the ozone layer.
- Find out whether the size of this hole is changing and in what manner scientists think this would affect life on Earth (Fig. 14.9).

Questions

1. *What are the different states in which water is found during the water cycle?*
2. *Name two biologically important compounds that contain both oxygen and nitrogen.*
3. *List any three human activities which would lead to an increase in the carbon dioxide content of air.*
4. *What is the greenhouse effect?*
5. *What are the two forms of oxygen found in the atmosphere?*

What you have learnt

- Life on Earth depends on resources like soil, water and air, and energy from the Sun.
- Uneven heating of air over land and water-bodies causes winds.
- Evaporation of water from water-bodies and subsequent condensation give us rain.
- Rainfall patterns depend on the prevailing wind patterns in an area.
- Various nutrients are used again and again in a cyclic fashion. This leads to a certain balance between the various components of the biosphere.
- Pollution of air, water and soil affect the quality of life and harm the biodiversity.
- We need to conserve our natural resources and use them in a sustainable manner.

Exercises

1. Why is the atmosphere essential for life?
2. Why is water essential for life?
3. How are living organisms dependent on the soil? Are organisms that live in water totally independent of soil as a resource?
4. You have seen weather reports on television and in newspapers. How do you think we are able to predict the weather?

5. We know that many human activities lead to increasing levels of pollution of the air, water-bodies and soil. Do you think that isolating these activities to specific and limited areas would help in reducing pollution?
6. Write a note on how forests influence the quality of our air, soil and water resources.

Chapter 15

Improvement in Food Resources

We know that all living organisms need food. Food supplies proteins, carbohydrates, fats, vitamins and minerals, all of which we require for body development, growth and health. Both plants and animals are major sources of food for us. We obtain most of this food from agriculture and animal husbandry.

We read in newspapers that efforts are always being made to improve production from agriculture and animal husbandry. Why is this necessary? Why we cannot make do with the current levels of production?

India is a very populous country. Our population is more than one billion people, and it is still growing. As food for this growing population, we will soon need more than a quarter of a billion tonnes of grain every year. This can be done by farming on more land. But India is already intensively cultivated. As a result, we do not have any major scope for increasing the area of land under cultivation. Therefore, it is necessary to increase our production efficiency for both crops and livestock.

Efforts to meet the food demand by increasing food production have led to some successes so far. We have had the green revolution, which contributed to increased food-grain production. We have also had the white revolution, which has led to better and more efficient use as well as availability of milk.

However, these revolutions mean that our natural resources are getting used more intensively. As a result, there are more chances of causing damage to our natural resources to the point of destroying their balance completely. Therefore, it is important that we should increase food production without degrading our environment and disturbing the balances maintaining it. Hence, there is a need for sustainable practices in agriculture and animal husbandry.

Also, simply increasing grain production for storage in warehouses cannot solve the problem of malnutrition and hunger. People should have money to purchase food. Food security depends on both availability of food and access to it. The majority of our population depends on agriculture for their livelihood. Increasing the incomes of people working in agriculture is therefore necessary to combat the problem of hunger. Scientific management practices should be undertaken to obtain high yields from farms. For sustained livelihood, one should undertake mixed farming, intercropping, and integrated farming practices, for example, combine agriculture with livestock/poultry/fisheries/bee-keeping.

The question thus becomes – how do we increase the yields of crops and livestock?

15.1 Improvement in Crop Yields

Cereals such as wheat, rice, maize, millets and sorghum provide us carbohydrate for energy requirement. Pulses like gram (*chana*), pea (*matar*), black gram (*urad*), green gram (*moong*), pigeon pea (*arhar*), lentil (*masoor*), provide us with protein. And oil seeds including soyabean, ground nut, sesame, castor, mustard, linseed and sunflower provide us with necessary fats (Fig. 15.1). Vegetables, spices and fruits provide a range of vitamins and minerals in addition to small amounts of proteins, carbohydrates and fats. In addition to these food crops, fodder crops like *berseem*, *oats* or *sudan grass* are raised as food for the livestock.

Fig. 15.1: *Different types of crops*

Question

1. *What do we get from cereals, pulses, fruits and vegetables?*

Different crops require different climatic conditions, temperature and photoperiods for their growth and completion of their life cycle. Photoperiods are related to the duration of sunlight. Growth of plants and flowering are dependent on sunlight. As we all know, plants manufacture their food in sunlight by the process of photosynthesis. There are some crops, which are grown in rainy season, called the *kharif* season from the month of June to October, and some of the crops are grown in the winter season, called the *rabi* season from November to April. Paddy, soyabean, pigeon pea, maize, cotton, green gram and black gram are *kharif* crops, whereas wheat, gram, peas, mustard, linseed are *rabi* crops.

In India there has been a four times increase in the production of food grains from 1952 to 2010 with only 25% increase in the cultivable land area. How has this increase in production been achieved? If we think of the practices involved in farming, we can see that we can divide it into three stages. The first is the choice of seeds for planting. The second is the nurturing of the crop plants. The third is the protection of the growing and harvested crops from loss. Thus, the major groups of activities for improving crop yields can be classified as:

- Crop variety improvement
- Crop production improvement
- Crop protection management.

15.1.1 Crop Variety Improvement

This approach depends on finding a crop variety that can give a good yield. Varieties or strains of crops can be selected by breeding for various useful characteristics such as disease resistance, response to fertilisers, product quality and high yields. One way of incorporating desirable characters into crop varieties is by hybridisation. Hybridisation refers to crossing between genetically dissimilar plants. This crossing may be intervarietal (between different varieties), interspecific (between two different species of the same genus) or intergeneric (between different genera). Another way of improving the crop is by introducing a gene that would provide the desired characteristic. This results in genetically modified crops.

For new varieties of crops to be accepted, it is necessary that the variety produces high yields under different conditions that are found in different areas. Farmers would need to be provided with good quality seeds of a particular variety, that is, the seeds should

all be of the same variety and germinate under the same conditions.

Cultivation practices and crop yield are related to weather, soil quality and availability of water. Since weather conditions such as drought and flood situations are unpredictable, varieties that can be grown in diverse climatic conditions are useful. Similarly, varieties tolerant to high soil salinity have been developed. Some of the factors for which variety improvement is done are:

- Higher yield: To increase the productivity of the crop per acre.
- Improved quality: Quality considerations of crop products vary from crop to crop. Baking quality is important in wheat, protein quality in pulses, oil quality in oilseeds and preserving quality in fruits and vegetables.
- Biotic and abiotic resistance: Crops production can go down due to biotic (diseases, insects and nematodes) and abiotic (drought, salinity, water logging, heat, cold and frost) stresses under different situations. Varieties resistant to these stresses can improve crop production.
- Change in maturity duration: The shorter the duration of the crop from sowing to harvesting, the more economical is the variety. Such short durations allow farmers to grow multiple rounds of crops in a year. Short duration also reduces the cost of crop production. Uniform maturity makes the harvesting process easy and reduces losses during harvesting.
- Wider adaptability: Developing varieties for wider adaptability will help in stabilising the crop production under different environmental conditions. One variety can then be grown under different climatic conditions in different areas.
- Desirable agronomic characteristics: Tallness and profuse branching are desirable characters for fodder crops. Dwarfness is desired in cereals, so that less nutrients are consumed by these crops. Thus developing varieties of desired agronomic characters help give higher productivity.

Questions

1. *How do biotic and abiotic factors affect crop production?*
2. *What are the desirable agronomic characteristics for crop improvements?*

15.1.2 Crop production management

In India, as in many other agriculture-based countries, farming ranges from small to very large farms. Different farmers thus have more or less land, money and access to information and technologies. In short, it is the money or financial conditions that allow farmers to take up different farming practices and agricultural technologies. There is a correlation between higher inputs and yields. Thus, the farmer's purchasing capacity for inputs decides cropping system and production practices. Therefore, production practices can be at different levels. They include 'no cost' production, 'low cost' production and 'high cost' production practices.

15.1.2 (i) *Nutrient management*

Just as we need food for development, growth and well-being, plants also require nutrients for growth. Nutrients are supplied to plants by air, water and soil. There are several nutrients which are essential for plants. Air supplies carbon and oxygen, hydrogen comes from water, and soil supplies the other thirteen nutrients to plants. Amongst these, some are required in large quantities and are therefore called macro-nutrients. The other nutrients are used by plants in small quantities and are therefore called micro-nutrients (Table 15.1).

Table 15.1: Nutrients supplied by air, water and soil

Source	Nutrients
Air	carbon, oxygen
Water	hydrogen, oxygen
Soil	(i) *Macronutrients*: nitrogen, phosphorus, potassium, calcium, magnesium, sulphur (ii) *Micronutrients:* iron, manganese, boron, zinc, copper, molybdenum, chlorine

Deficiency of these nutrients affects physiological processes in plants including reproduction, growth and susceptibility to diseases. To increase the yield, the soil can be enriched by supplying these nutrients in the form of manure and fertilizers.

Questions

1. *What are macro-nutrients and why are they called macro-nutrients?*
2. *How do plants get nutrients?*

Manure

Manure contains large quantities of organic matter and also supplies small quantities of nutrients to the soil. Manure is prepared by the decomposition of animal excreta and plant waste. Manure helps in enriching soil with nutrients and organic matter and increasing soil fertility. The bulk of organic matter in manure helps in improving the soil structure. This involves increasing the water holding capacity in sandy soils. In clayey soils, the large quantities of organic matter help in drainage and in avoiding water logging.

In using manure we use biological waste material, which is advantageous in protecting our environment from excessive use of fertilizers. Using biological waste material is also a way of recycling farm waste. Based on the kind of biological material used, manure can be classified as:

(i) Compost and vermi-compost: The process in which farm waste material like livestock excreta (cow dung etc.), vegetable waste, animal refuse, domestic waste, sewage waste, straw, eradicated weeds etc. is decomposed in pits is known as composting. The compost is rich in organic matter and nutrients. Compost is also prepared by using earthworms to hasten the process of decomposition of plant and animal refuse. This is called vermi-compost.

(ii) Green manure: Prior to the sowing of the crop seeds, some plants like sun hemp or guar are grown and then mulched by ploughing them into the soil. These green plants thus turn into green manure which helps in enriching the soil in nitrogen and phosphorus.

Fertilizers

Fertilizers are commercially produced plant nutrients. Fertilizers supply nitrogen, phosphorus and potassium. They are used to ensure good vegetative growth (leaves, branches and flowers), giving rise to healthy plants. Fertilizers are a factor in the higher yields of high-cost farming.

Fertilizers should be applied carefully in terms of proper dose, time, and observing pre- and post-application precautions for their complete utilisation. For example, sometimes fertilizers get washed away due to excessive irrigation and are not fully absorbed by the plants. This excess fertilizer then leads to water pollution.

Also, as we have seen in the previous chapter, continuous use of fertilizers in an area can destroy soil fertility because the organic matter in the soil is not replenished and micro-organisms in the soil are harmed by the fertilizers used. Short-term benefits of using fertilizers and long-term benefits of

using manure for maintaining soil fertility have to be considered while aiming for optimum yields in crop production.

Question

1. *Compare the use of manure and fertilizers in maintaining soil fertility.*

Organic farming is a farming system with minimal or no use of chemicals as fertilizers, herbicides, pesticides etc. and with a maximum input of organic manures, recycled farm-wastes (straw and livestock excreta), use of bio-agents such as culture of blue green algae in preparation of biofertilizers, *neem* leaves or turmeric specifically in grain storage as bio-pesticides, with healthy cropping systems [mixed cropping, inter-cropping and crop rotation as discussed below in 15.1.2.(iii)]. These cropping systems are beneficial in insect, pest and wheat control besides providing nutrients.

15.1.2 (ii) *Irrigation*

Most agriculture in India is rain-fed, that is, the success of crops in most areas is dependent on timely monsoons and sufficient rainfall spread through most of the growing season. Hence, poor monsoons cause crop failure. Ensuring that the crops get water at the right stages during their growing season can increase the expected yields of any crop. Therefore, many measures are used to bring more and more agricultural land under irrigation.

More to know

Droughts occur because of scarcity or irregular distribution of rains. Drought poses a threat to rain-fed farming areas, where farmers do not use irrigation for crop production and depend only on rain. Light soils have less water retention capacity. In areas with light soils, crops get adversely affected by drought conditions. Scientists have developed some crop varieties which can tolerate drought conditions.

India has a wide variety of water resources and a highly varied climate. Under such conditions, several different kinds of irrigation systems are adopted to supply water to agricultural lands depending on the kinds of water resources available. These include wells, canals, rivers and tanks.

- Wells: There are two types of wells, namely dug wells and tube wells. In a dug well, water is collected from water bearing strata. Tube wells can tap water from the deeper strata. From these wells, water is lifted by pumps for irrigation.
- Canals: This is usually an elaborate and extensive irrigation system. In this system canals receive water from one or more reservoirs or from rivers. The main canal is divided into branch canals having further distributaries to irrigate fields.
- River Lift Systems**:** In areas where canal flow is insufficient or irregular due to inadequate reservoir release, the lift system is more rational. Water is directly drawn from the rivers for supplementing irrigation in areas close to rivers.
- Tanks: These are small storage reservoirs, which intercept and store the run-off of smaller catchment areas.

Fresh initiatives for increasing the water available for agriculture include rainwater harvesting and watershed management. This involves building small check-dams which lead to an increase in ground water levels. The check-dams stop the rainwater from flowing away and also reduce soil erosion.

15.1.2 (iii) *Cropping patterns*

Different ways of growing crops can be used to give maximum benefit.

Mixed cropping is growing two or more crops simultaneously on the same piece of land, for example, wheat + gram, or wheat + mustard, or groundnut + sunflower. This reduces risk and gives some insurance against failure of one of the crops.

Inter-cropping is growing two or more crops simultaneously on the same field in a definite pattern (Fig.15.2). A few rows of one crop alternate with a few rows of a second crop, for example, soyabean + maize, or finger millet (*bajra*) + cowpea (*lobia*). The crops are selected such that their nutrient requirements are different. This ensures maximum utilisation of the nutrients supplied, and also prevents pests and diseases from spreading to all the plants belonging to one crop in a field. This way, both crops can give better returns.

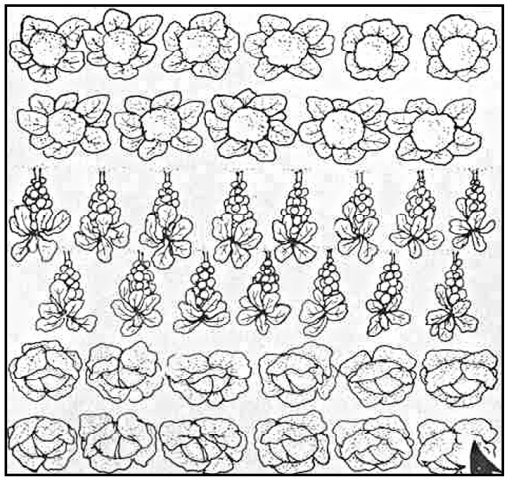


Fig. 15.2 : *Intercropping*

The growing of different crops on a piece of land in a pre-planned succession is known as crop rotation. Depending upon the duration, crop rotation is done for different crop combinations. The availability of moisture and irrigation facilities decide the choice of the crop to be cultivated after one harvest. If crop rotation is done properly then two or three crops can be grown in a year with good harvests.

15.1.3 Crop protection management

Field crops are infested by a large number of weeds, insect pests and diseases. If weeds and pests are not controlled at the appropriate time then they can damage the crops so much that most of the crop is lost.

Weeds are unwanted plants in the cultivated field, for example, Xanthium (*gokhroo*), Parthenium (*gajar ghas*), Cyperinus rotundus (*motha*). They compete for food, space and light. Weeds take up nutrients and reduce the growth of the crop. Therefore, removal of weeds from cultivated fields during the early stages of crop growth is essential for a good harvest.

Generally insect pests attack the plants in three ways: (i) they cut the root, stem and leaf, (ii) they suck the cell sap from various parts of the plant, and (iii) they bore into stem and fruits. They thus affect the health of the crop and reduce yields.

Diseases in plants are caused by pathogens such as bacteria, fungi and viruses. These pathogens can be present in and transmitted through the soil, water and air.

Weeds, insects and diseases can be controlled by various methods. One of the most commonly used methods is the use of pesticides, which include herbicides, insecticides and fungicides. These chemicals are sprayed on crop plants or used for treating seeds and soil. However, excessive use of these chemicals creates problems, since they can be poisonous to many plant and animal species and cause environmental pollution.

Weed control methods also include mechanical removal. Preventive methods such as proper seed bed preparation, timely sowing of crops, intercropping and crop rotation also help in weed control. Some other preventive measures against pests are the use of resistant varieties, and summer ploughing, in which fields are ploughed deep in summers to destroy weeds and pests.

Q uestion

1. *Which of the following conditions will give the most benefits? Why?*
   - *(a) Farmers use high-quality seeds, do not adopt irrigation or use fertilizers.*
   - *(b) Farmers use ordinary seeds, adopt irrigation and use fertilizer.*
   - *(c) Farmers use quality seeds, adopt irrigation, use fertilizer and use crop protection measures.*

Table 15.2: Nutritional values of animal products

Animal Products	Per cent (%) Nutrients					
	Fat	**Protein**	**Sugar**	**Minerals**	**Water**	**Vitamins**
Milk (Cow)	3.60	4.00	4.50	0.70	87.20	B1, B2, B12, D, E
Egg	12.00	13.00	*	1.00	74.00	B2, D
Meat	3.60	21.10	*	1.10	74.20	B2, B12
Fish	2.50	19.00	*	1.30	77.20	Niacin, D, A

*Present in very small amounts

Activity 15.1

- Visit a nearby garden/agricultural field and make a list of the weeds and the flowers/crops found in the area. Also, make a list of insect pests, if any, infesting the flowers/crops.

STORAGE OF GRAINS

Storage losses in agricultural produce can be very high. Factors responsible for such losses are biotic— insects, rodents, fungi, mites and bacteria, and abiotic— inappropriate moisture and temperatures in the place of storage. These factors cause degradation in quality, loss in weight, poor germinability, discolouration of produce, all leading to poor marketability. These factors can be controlled by proper treatment and by systematic management of warehouses.

Preventive and control measures are used before grains are stored for future use. They include strict cleaning of the produce before storage, proper drying of the produce first in sunlight and then in shade, and fumigation using chemicals that can kill pests.

Questions

1. *Why should preventive measures and biological control methods be preferred for protecting crops?*
2. *What factors may be responsible for losses of grains during storage?*

Activity 15.2

- *Collect grains/seeds of cereals, pulses and oil seeds and gather information about the seasons in which they are sown and harvested.*

15.2 Animal Husbandry

Animal husbandry is the scientific management of animal livestock. It includes various aspects such as feeding, breeding and disease control. Animal-based farming includes cattle, goat, sheep, poultry and fish farming. As the population increases and as living standards increase, the demand for milk, eggs and meat is also going up. Also, the growing awareness of the need for humane treatment of livestock has brought in new limitations in livestock farming. Thus, livestock production also needs to be improved.

15.2.1 CATTLE FARMING

Cattle husbandry is done for two purposes— milk and draught labour for agricultural work such as tilling, irrigation and carting. Indian cattle belong to two different species, *Bos indicus*, cows, and *Bos bubalis*, buffaloes. Milk-producing females are called milch animals (dairy animals), while the ones used for farm labour are called draught animals.

Milk production depends, to some extent, on the duration of the lactation period, meaning the period of milk production after

Fig. 15.3: *Indigenous milch breed of cattle*

the birth of a calf. So, milk production can be increased by increasing the lactation period. Exotic or foreign breeds (for example, Jersey, Brown Swiss) are selected for long lactation periods, while local breeds (for example, Red Sindhi, Sahiwal) show excellent resistance to diseases. The two can be cross-bred to get animals with both the desired qualities.

Question

1. *Which method is commonly used for improving cattle breeds and why?*

Activity 15.3

- Visit a livestock farm. Note the following:
  (1) Number of cattle and number of different breeds.
  (2) The amount of daily milk production from the different breeds.

Proper cleaning and shelter facilities for cows and buffaloes are required for humane farming, for the health of the animals and for production of clean milk as well. Animals require regular brushing to remove dirt and loose hair. They should be sheltered under well-ventilated roofed sheds that protect them from rain, heat and cold. The floor of the cattle shed needs to be sloping so as to stay dry and to facilitate cleaning.

The food requirements of dairy animals are of two types: (a) maintenance requirement, which is the food required to support the animal to live a healthy life, and (b) milk producing requirement, which is the type of food required during the lactation period. Animal feed includes: (a) roughage, which is largely fibre, and (b) concentrates, which are low in fibre and contain relatively high levels of proteins and other nutrients. Cattle need balanced rations containing all nutrients in proportionate amounts. Besides such nutritious food material, certain feed additives containing micronutrients promote the health and milk output of dairy animals.

Cattle suffer from a number of diseases. The diseases, besides causing death, reduce milk production. A healthy animal feeds regularly and has a normal posture. The parasites of cattle may be both external parasites and internal parasites. The external parasites live on the skin and mainly cause skin diseases. The internal parasites like worms, affect stomach and intestine while flukes damage the liver. Infectious diseases are also caused by bacteria and viruses. Vaccinations are given to farm animals against many major viral and bacterial diseases.

15.2.2 Poultry Farming

Poultry farming is undertaken to raise domestic fowl for egg production and chicken meat. Therefore, improved poultry breeds are developed and farmed to produce layers for eggs and broilers for meat.

The cross-breeding programmes between Indian (indigenous, for example, *Aseel*) and foreign (exotic, for example, Leghorn) breeds for variety improvement are focused on to develop new varieties for the following desirable traits—

(i) number and quality of chicks;

(ii) dwarf broiler parent for commercial chick production;
(iii) summer adaptation capacity/ tolerance to high temperature;
(iv) low maintenance requirements;
(v) reduction in the size of the egg-laying bird with ability to utilise more fibrous cheaper diets formulated using agricultural by-products.


Aseel


Leghorn

Fig. 15.4

Question

1. *Discuss the implications of the following statement: "It is interesting to note that poultry is India's most efficient converter of low fibre food stuff (which is unfit for human consumption) into highly nutritious animal protein food."*

Egg and Broiler Production

Broiler chickens are fed with vitamin-rich supplementary feed for good growth rate and better feed efficiency. Care is taken to avoid mortality and to maintain feathering and carcass quality. They are produced as broilers and sent to market for meat purposes.

For good production of poultry birds, good management practices are important. These include maintenance of temperature and hygienic conditions in housing and poultry feed, as well as prevention and control of diseases and pests.

The housing, nutritional and environmental requirements of broilers are somewhat different from those of egg layers. The ration (daily food requirement) for broilers is protein rich with adequate fat. The level of vitamins A and K is kept high in the poultry feeds.

Poultry fowl suffer from a number of diseases caused by virus, bacteria, fungi, parasites, as well as from nutritional deficiencies. These necessitate proper cleaning, sanitation, and spraying of disinfectants at regular intervals. Appropriate vaccination can prevent the occurrence of infectious diseases and reduce loss of poultry during an outbreak of disease.

Questions

1. *What management practices are common in dairy and poultry farming?*
2. *What are the differences between broilers and layers and in their management?*

Activity 15.4

- Visit a local poultry farm. Observe types of breeds and note the type of ration, housing and lighting facilities given to them. Identify the growers, layers and broilers.

15.2.3 Fish Production

Fish is a cheap source of animal protein for our food. Fish production includes the finned true fish as well as shellfish such as prawns and molluscs. There are two ways of obtaining fish. One is from natural resources, which is called capture fishing. The other way is by fish farming, which is called culture fishery.

The water source of the fish can be either seawater or fresh water, such as in rivers and ponds. Fishing can thus be done both by capture and culture of fish in marine and freshwater ecosystems.

15.2.3 (i) *Marine Fisheries*

India's marine fishery resources include 7500 km of coastline and the deep seas

beyond it. Popular marine fish varieties include pomphret, mackerel, tuna, sardines, and Bombay duck. Marine fish are caught using many kinds of fishing nets from fishing boats. Yields are increased by locating large schools of fish in the open sea using satellites and echo-sounders.

Some marine fish of high economic value are also farmed in seawater. This includes finned fishes like mullets, *bhetki*, and pearl spots, shellfish such as prawns (Fig. 15.5), mussels and oysters as well as seaweed. Oysters are also cultivated for the pearls they make.

Macrobrachium rosenbergii (fresh water)

Peneaus monodon (marine)

Fig. 15.5 : *Fresh water and marine prawns*

As marine fish stocks get further depleted, the demand for more fish can only be met by such culture fisheries, a practice called mariculture.

15.2.3 (ii) *INLAND FISHERIES*

Fresh water resources include canals, ponds, reservoirs and rivers. Brackish water resources, where seawater and fresh water mix together, such as estuaries and lagoons are also important fish reservoirs. While capture fishing is also done in such inland water bodies, the yield is not high. Most fish production from these resources is through aquaculture.

Fish culture is sometimes done in combination with a rice crop, so that fish are grown in the water in the paddy field. More intensive fish farming can be done in composite fish culture systems. Both local and imported fish species are used in such systems.

In such a system, a combination of five or six fish species is used in a single fishpond. These species are selected so that they do not compete for food among them having different types of food habits. As a result, the food available in all the parts of the pond is used. As Catlas are surface feeders, Rohus feed in the middle-zone of the pond, Mrigals and Common Carps are bottom feeders, and Grass Carps feed on the weeds, together these species (Fig. 15.6) can use all the food in the pond without competing with each other. This increases the fish yield from the pond.

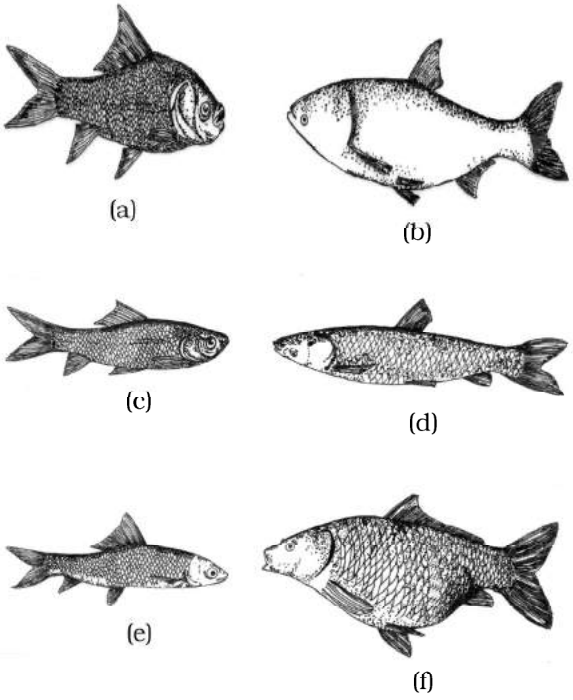


Fig. 15.6: *(a) Catla (b) Silver carp (c) Rohu (d) Grass Carp (e) Mrigal (f) Common Carp*

One problem with such composite fish culture is that many of these fish breed only during monsoon. Even if fish seed is collected from the wild, it can be mixed with that of other species as well. So, a major problem in fish farming is the lack of availability of good-quality seed. To overcome this problem, ways have now been worked out to breed these fish in ponds using hormonal stimulation. This has ensured the supply of pure fish seed in desired quantities.

Questions

1. How are fish obtained?
2. What are the advantages of composite fish culture?

Activity 15.5

- Visit a fish farm in fish breeding season and note the following:
  (1) Varieties of fish in fish farm
  (2) Types of ponds
  (3) Feed ingredients used
  (4) Production capacity of the farm

  If there are no fish farms close to your locality, gather the above information from Internet, by referring books or talking to people who are engaged in fishery.

15.2.4 Bee-keeping

Honey is widely used and therefore bee-keeping for making honey has become an agricultural enterprise. Since bee-keeping needs low investments, farmers use it as an additional income generating activity. In addition to honey, the beehives are a source of wax which is used in various medicinal preparations.

The local varieties of bees used for commercial honey production are *Apis cerana indica*, commonly known as the Indian bee, *A. dorsata*, the rock bee and *A. florae*, the little bee. An Italian bee variety, *A. mellifera*, has also been brought in to increase yield of honey.

(a) (b)

Fig. 15.7: *(a) Arrangement of beehive in an apiary (b) honey extractor*

This is the variety commonly used for commercial honey production.

The Italian bees have high honey collection capacity. They sting somewhat less. They stay in a given beehive for long periods, and breed very well. For commercial honey production, bee farms or apiaries are established.

The value or quality of honey depends upon the pasturage, or the flowers available to the bees for nectar and pollen collection. In addition to adequate quantity of pasturage, the kind of flowers available will determine the taste of the honey.

Questions

1. What are the desirable characters of bee varieties suitable for honey production?
2. What is pasturage and how is it related to honey production?

What you have learnt

- There are several nutrients essential for crops. Of these, some are required in large quantities and are known as macro-nutrients whereas rest of the nutrients are required in small quantities and are known as micro-nutrients.
- Manure and fertilizers are the main sources of nutrient supply to crops.

- Organic farming is a farming system with minimal or no use of chemicals as fertilizers, herbicides, pesticides etc. and with a maximum input of organic manures, recyled farm wastes, and bio-agents, with healthy cropping systems.
- Mixed farming is a system of farming on a particular farm which includes crop production, raising of livestock etc.
- Mixed cropping is growing of two or more crops simultaneously on the same piece of land.
- Growing two or more crops in definite row patterns is known as inter-cropping.
- The growing of different crops on a piece of land in pre-planned succession is called crop rotation.
- Varietal improvement is required for higher yield, good quality, biotic and abiotic resistance, shortening the maturity duration, wider adaptability and desirable agronomic characteristics.
- Farm animals require proper care and management such as shelter, feeding, breeding and disease control. This is called animal husbandry.
- Poultry farming is done to raise domestic fowls. Poultry production includes egg production and broiler production for poultry meat.
- To enhance poultry production, cross breeding is done between Indian and exotic breeds for variety improvement.
- Fish may be obtained from marine resources as well as inland resources.
- To increase production of fish, they can be cultured in marine and inland ecosystems.
- Marine fish capture is done by fishing nets guided by echo-sounders and satellites.
- Composite fish culture system is commonly used for fish farming.
- Bee-keeping is done to get honey and wax.

Exercises

1. Explain any one method of crop production which ensures high yield.
2. Why are manure and fertilizers used in fields?
3. What are the advantages of inter-cropping and crop rotation?
4. What is genetic manipulation? How is it useful in agricultural practices?

5. How do storage grain losses occur?
6. How do good animal husbandry practices benefit farmers?
7. What are the benefits of cattle farming?
8. For increasing production, what is common in poultry, fisheries and bee-keeping?
9. How do you differentiate between capture fishing, mariculture and aquaculture?

Answers

Chapter 3

4. (a) $MgCl_2$
   (b) CaO
   (c) $Cu(NO_3)_2$
   (d) $AlCl_3$
   (e) $CaCO_3$
5. (a) Calcium, oxygen
   (b) Hydrogen, bromine
   (c) Sodium, hydrogen, carbon and oxygen
   (d) Potassium, sulphur and oxygen
6. (a) 26 g
   (b) 256 g
   (c) 124 g
   (d) 36.5 g
   (e) 63 g
7. (a) 14 g
   (b) 108 g
   (c) 1260 g
8. (a) 0.375 mole
   (b) 1.11 mole
   (c) 0.5 mole
9. (a) 3.2 g
   (b) 9.0 g
10. 3.76×10^{22} molecules
11. 6.022×10^{20} ions

Chapter 4

10. 80.006
11. ${}^{16}_{8}\times$ =90% , ${}^{18}_{8}\times$ = 10%
12. Valency = 1, Name of the element is lithium,
13. Mass number of X =12, Y=14, Relationship is Isotope.
14. (a) F (b) F (c) T (d) F
15. (a) ✓ (b) × (c) × (d) ×
16. (a) × (b) × (c) ✓ (d) ×

17. (a) × (b) ✓ (c) × (d) ×
18. (a) × (b) × (c) × (d) ✓
19.

Atomic Number	Mass Number	Number of Neutrons	Number of Protons	Number of Electrons	Name of the Atomic Species
9	19	10	9	9	Fluorine
16	32	16	16	16	Sulphur
12	24	12	12	12	Magnesium
01	2	01	1	01	Deuterium
01	1	0	1	0	Protium

Chapter 8

1. (a) distance = 2200 m; displacement = 200 m.
2. (a) average speed = average velocity = 2.00 m s^{-1}
   (b) average speed = 1.90 m s^{-1}; average velocity = 0.952 m s^{-1}
3. average speed = 24 km h^{-1}
4. distance travelled = 96 m
7. velocity = 20 m s^{-1}; time = 2 s
10. speed = 3.07 km s^{-1}

Chapter 9

4. c
5. 2 m s^{-2}, 14000 N
6. – 4 N
7. (a) 35000 N
   (b) 1.944 m s^{-2}
8. 2550 N in a direction opposite to the motion of the vehicle
9. d
10. 200 N
11. 0 m s^{-1}
13. 3 kg m s^{-1}
14. 2.25 m; 50 N
15. 10 kg m s^{-1}; 10 kg m s^{-1}; 5/3 m s^{-1}
16. 500 kg m s^{-1}; 800 kg m s^{-1}; 50 N
18. 40 kg m s^{-1}

A2. 240 N
A3. 2500 N
A4. 5 m s^{-2}; 2400 kg m s^{-1}; 6000 N

Chapter 10

3. 9.8 N
12. Weight on earth is 98 N and on moon is 16.3 N.
13. Maximum height is 122.5 m and total time is 5 s + 5 s = 10 s.
14. 19.6 m/s
15. Maximum height = 80 m, Net displacement = 0, Total distance covered = 160 m.
16. Gravitational force = 3.56×10^{22} N.
17. 4 s, 80 m from the top.
18. Initial velocity = 29.4 m s^{-1}, height = 44.1 m. After 4 s the ball will be at a distance of 4.9 m from the top or 39.2 m from the bottom.
21. The substance will sink.
22. The packet will sink. The mass of water displaced is 350 g.

Chapter 11

2. Zero
4. 210 J
5. Zero
9. 9×10^8 J
10. 2000 J, 1000 J
11. Zero
14. 15 kWh (Unit)
17. 208333.3 J
18. (i) Zero
    (ii) Positive
    (iii) Negative
20. 20 kWh

Chapter 12

7. 17.2 m, 0.0172 m
8. 18.55
9. 6000
13. 11.47 s
14. 22,600 Hz
20. 1450 ms^{-1}