7

The Living and the Nonliving

As you read this chapter, you may be sitting in your classroom. You have learnt enough about nonliving objects and living beings to know that you, your classmates, your teacher, the spider on the wall and the tree outside are living. And that the chair, the table, this book, your pen and pencil are nonliving. Still, let us discuss what the living and nonliving have in common, and what differentiates them.

The living as well as the nonliving are made of matter. Anything that is made of matter has mass and occupies space. Thus, everything around us, whether living or nonliving, has mass and occupies space. The smallest particles of matter are molecules. These particles constitute living beings and nonliving things. But that is where the similarity between the living and nonliving ends. You can say that the structural unit of water is a molecule of water. A cup of water is simply billions of molecules of water. But you cannot say this of a living organism. Though a living being is also made of molecules, just those molecules put together do not make an organism. The most basic unit, or structural unit, of an organism is ***the cell.*** Every living organism starts from a cell, which divides and redivides to give rise to the organism.

WHAT CHARACTERISES A LIVING BEING

Let us discuss all the features which characterise a living being and distinguish it from nonliving things. We will start with the fact that all living beings are made of cells.

Living beings are made of cells

What is a cell? You could say it is the smallest unit or thing which is capable of life. You will learn more about the cell later. But you can at least see what a cell looks like under the microscope.

You will need your teacher's help for these activities. Garden plants like *Rhoeo* or *Tradescantia* (botanical names—*Rhoeo* is called boat lily and *Tradescantia* is called spiderwort) have purple undersurfaces. Pull out a thin peel (membrane) from the lower surface of such a leaf with the help of forceps. Place a bit of this peel in a drop of water on a glass slide and cover it with a coverslip. Observe it under a microscope and you will see purple, polygonal cells. You will also see bean-shaped cells, which we will discuss later. You will have to learn how to do all this from your teacher. Once you know, you could try peeling off the `skin' from other leaves, including the fleshy leaf of an onion.

And if you want to see animal cells, you can take some from the inside of your cheek. Place a drop of iodine solution or even water on a glass slide. Scrape the inside of your cheek with the flat end of a toothpick. Move the toothpick around in the water or iodine drop on the slide. Cover the drop with a coverslip and observe under a microscope. You will see some flat or folded cells scattered around.

If you want to know about the parts of a microscope and have a little fun observing other cells, you can take a look at the postscript at the end of this chapter.

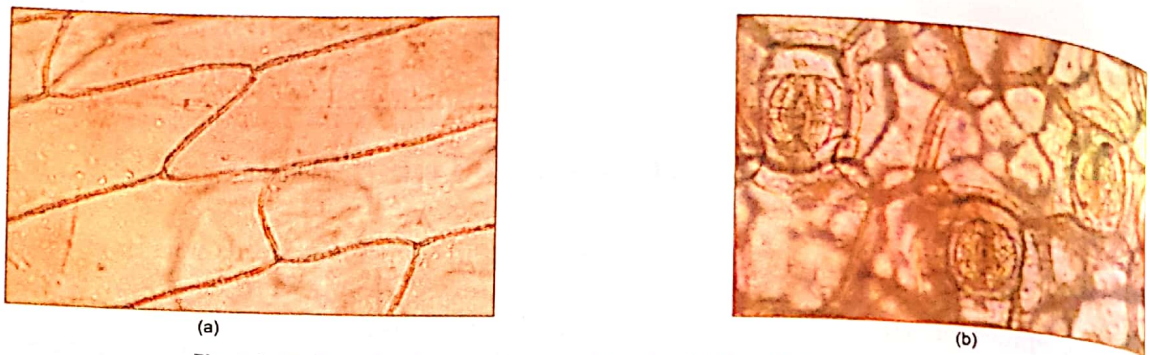

Fig. 7.1 Cells under the microscope—(a) onion leaf peel, (b) *Rhoeo* leaf peel

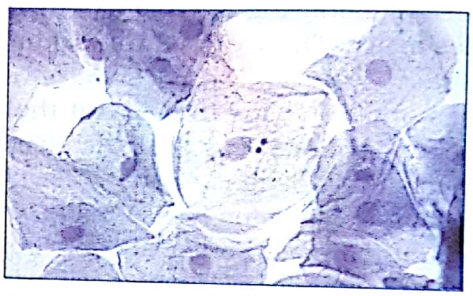

Fig. 7.2 Cheek cells under the microscope

All living beings are made of cells. But as you have seen for yourself, all cells do not look alike. Cells are of different sizes and shapes and they perform different functions. The onion cells you observed, for example, form a covering and protect the other cells inside the onion leaf.

Organisation in living beings

Some organisms are made of a single cell. Bacteria, which cause diseases, and also do helpful things like changing milk into yoghurt, are such organisms. So are amoebas and yeast (used to make wine and bread). On the other hand the animals and plants we see around us are made of thousands of cells. These cells are not put together any old way. They are organised into special groups which perform special functions. Such ***groups of cells which are similar and perform a particular function are called tissues.*** The cells of the onion peel, for example, are similar and they perform the function of protecting the leaf. In other words, they form a protective tissue. The cheek cells you observed also form a protective tissue.

The cheek and the leaf have other kinds of tissues as well. The cheek, for example, has muscles which make it move. Muscles are made of muscle tissue, whose function is to help movement. Similarly, the leaf has many different tissues. All these tissues are grouped together to help the leaf perform its functions. Such ***a group of tissues which work together to perform one or more functions is called an organ.*** The leaf is an organ of a plant. And the eye, the heart and the tongue are some organs in your body. The tongue is an organ which helps you speak and swallow food. All the tissues of the tongue cooperate to make it perform these functions.

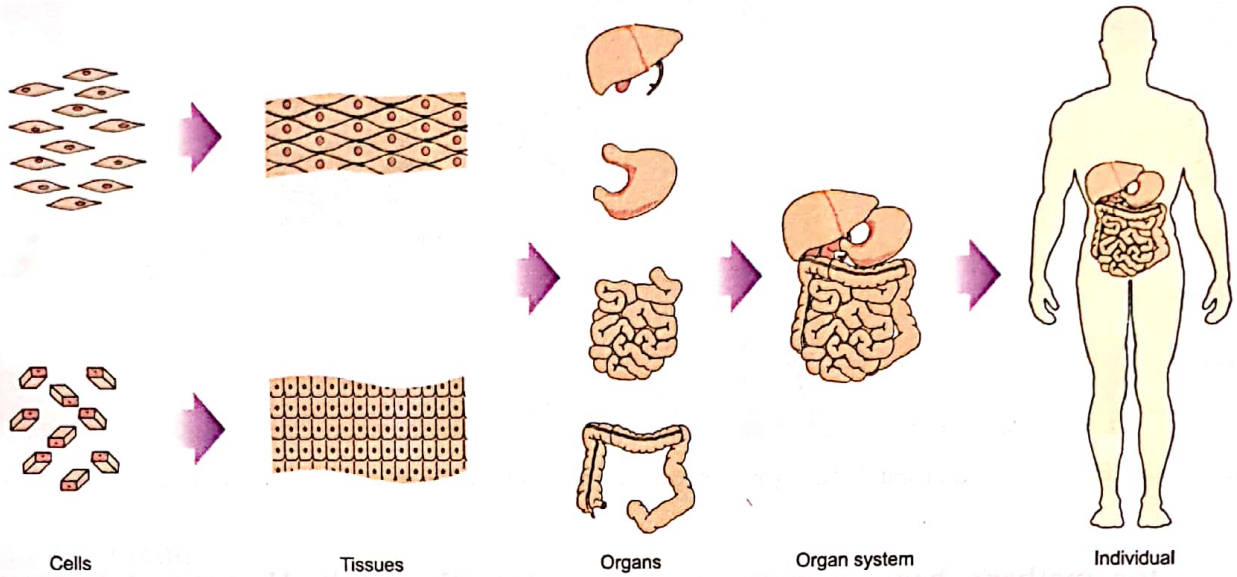

Fig. 7.3 Organisation in living beings

Many of the complex functions performed by an organism need the cooperation of many organs. ***A group of organs which cooperate with each other to perform a particular function is called an organ system.*** Your mouth, stomach, liver and many other organs work together to help you digest food. They form an organ system called the digestive system.

Thus, cells are organised into tissues, which form organs, and which in turn, are organised into organ systems. Organisation is an essential characteristic of a living being. The nonliving world is not organised in this way.

Living beings grow

Nobody needs to tell you that living beings grow. You were born a tiny baby and now you are nearly 5 feet tall. You will still grow for a few more years. Then you will stop growing. This is true of all animals. They grow to the adult size and then stop growing. Plants, on the other hand, grow all their lives. They start as tiny seedlings and then keep growing. You may exclaim, "But the gul mohar tree outside my school has remained the same since I joined school!" Well, big trees do not seem to grow taller every year, but they spread out with new branches and leaves and their trunks keep growing in thickness.

Growth is a characteristic differentiating the living from the nonliving. Some nonliving things like crystals formed from a solution also seem to grow. But this growth is different. A sugar crystal hanging in a solution grows because more sugar is added on to it from the *outside*. You, on the other hand, grow because the cells inside your body multiply and grow *inside* your body. In nonliving things growth occurs from outside, while in living beings growth occurs from inside.

Living beings follow a life cycle

All living beings start from a single cell. In many plants, this cell grows and multiplies inside a seed until the seedling bursts out, and the new plant grows. In many animals (like birds and snakes), the single cell grows and multiplies inside an egg until the baby breaks out of the shell. The baby then grows into the adult. In other animals, the baby grows inside

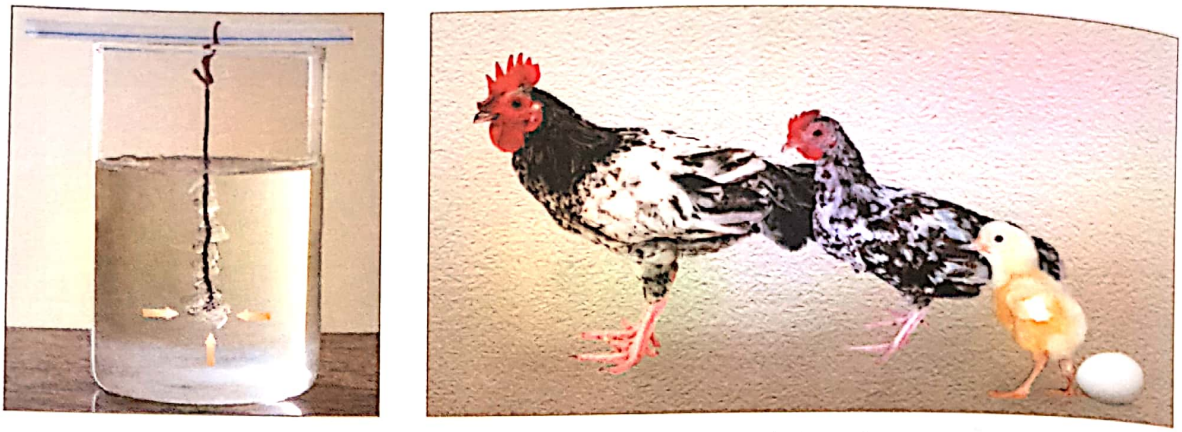

Fig. 7.4 In nonliving things growth occurs from outside, while in living beings, it occurs from within the body.

the mother's body, is born, and grows into the adult. However it happens, a small organism grows into an adult organism. Then it reproduces, or produces offspring. Then it grows old, and finally it dies. We can say that ***all organisms follow a life cycle of birth, growth, reproduction, ageing and death.***

The time for which an organism lives, or the time between its birth and death, is its ***lifespan.*** This lifespan is different for different organisms. Some insects (like the ones you see near lights during the rainy season) live only for a few hours, while some trees live for hundreds of years. The lifespans of some organisms are given in Table 7.1.

Table 7.1 Lifespans of some organisms

Organism	Lifespan
House spider	3–4 days
Mouse	2–3 years
Dog	16–18 years
Alligator	50–55 years
Pigeon	15–20 years
Man	60–100 years

Living beings reproduce

An essential part of the life cycle of a living organism is reproduction. All organisms reproduce, or produce their own kind. Most of the plants we see around us reproduce by producing seeds. In some, the root or stem or leaf gives rise to a new plant. Some animals (man, cat, dog, horse, cow, etc.) produce young ones which are like small copies of themselves. And some (fish, insects, frogs, lizards, birds, etc.) reproduce by laying eggs.

Not everyone has the chance to see a baby animal being born or hatching out of an egg. You can, however, easily observe a seedling grow out of a seed. Try the seeds available in the kitchen—beans, peas, grams, coriander, wheat, maize or mustard. Soak them overnight and plant them in a shallow tray of moistened soil. Put the tray in a dark place and moisten the soil when required.

You could also try to grow seedlings from the seeds of garden plants. Say, it is the season of marigolds. Plant the long, black structrues you will see when you open the lower part of the flower in a shallow tray of soil.

Fig 7.5

Potato Onion *Bryophyllum*

You could even plant an onion or a slice of potato with a couple of eyes. If you want to see plants grow out of a leaf, place a *Bryophyllum* (sprout leaf plant) leaf in a pot of soil and cover it with some loose, moist soil.

Living beings need food

All living beings need food to get energy to carry out various functions, to grow and maintain the body, and to fight diseases. They get their food in different ways. Animals are called ***heterotrophs*** (*heteros*: other than self; *trophos*: feeder) because they depend on others for food. Green plants are called ***autotrophs*** (*autos*: self) because they make their own food through the process of photosynthesis. The green pigment in leaves, called chlorophyll, helps plants make food from carbon dioxide and water in the presence of sunlight.

Carbon dioxide enters the leaves through pores called ***stomata.*** If you did the activity of observing the cells in the peel of a *Rhoeo* leaf, you would have noticed pairs of bean-shaped cells with a pore in the middle. The pores are the stomata, the opening and closing of which is regulated by the bean-shaped cells.

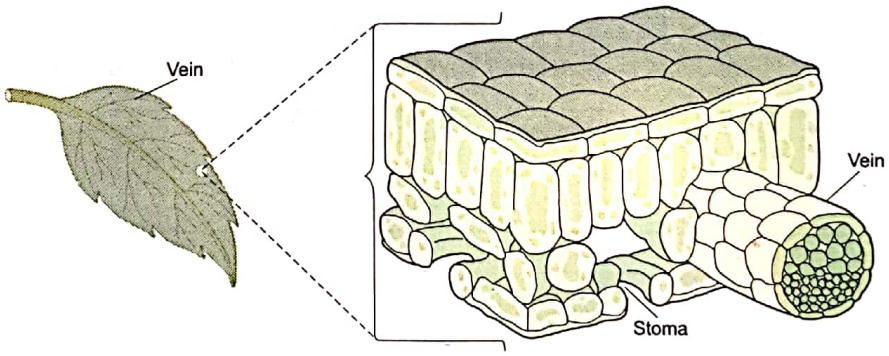

Fig. 7.7 Stomata are mostly present on the lower surface of the leaf.

Living beings respire

All living beings use food to produce energy in their bodies. For this they need oxygen, which they get from the air or water surrounding them. Oxygen combines with food within their bodies to release energy. This is a chemical change in which carbon dioxide and water vapour are produced. The carbon dioxide and water vapour are wastes, which the body throws out. This ***process of taking in air (or water), letting oxygen combine with food, and throwing out carbon dioxide and water vapour is called respiration.***

When we breathe in, we take in air, which contains oxygen. And when we breathe out, we expel carbon dioxide and water vapour. ***The process of breathing in and breathing out is part of respiration.*** You can observe it in human beings and the common animals around you. You will see the chest moving up and down as an animal breathes. Fish 'breathe' by taking in water. If you have an aquarium in school or at home you can see how they seem to gulp or swallow. They are actually taking in and throwing out water. They use oxygen dissolved in water for the process of respiration. Plants 'breathe' through stomata in their leaves.

If you are wondering whether plants really respire, do this activity. Put a handful of *Lantana* buds (or any other small flower, like drumstick) in a piece of muslin. Tie up the cloth to make a pouch and suspend the pouch in a jar containing limewater. Moisten the cloth and make sure that the bag does not touch the lime water.

Suspend a pouch of boiled buds in another jar containing limewater. Cover both jars. After some time, the lime water in the jar with fresh buds will turn milky because the buds respire and give out carbon dioxide. The limewater in the jar with the boiled (hence, dead) buds will not turn milky. You could use small developing fruit or germinating seeds instead of buds.

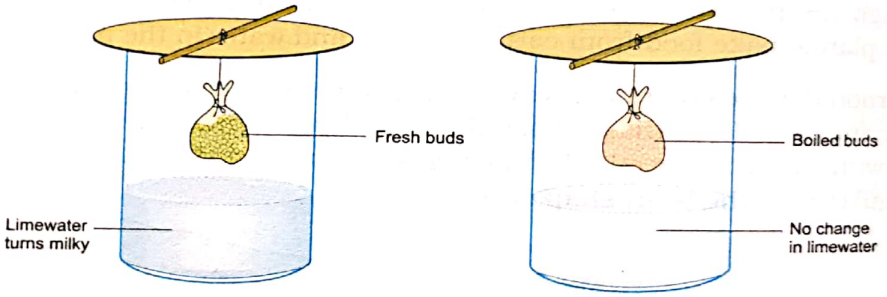

Fig 7.8

Living beings excrete

A living organism uses food to produce energy. The processes of breaking down food (digestion) and combining food with oxygen (respiration) produce wastes, which the organism needs to throw out. This ***process of throwing out (expelling) waste is called excretion.*** We, and many other animals, expel waste from the body in the form of faeces and urine. Sweating is also a way of expelling waste from the body.

Plants throw out gases through the stomata in their leaves. They also store wastes in special cells. Some of these wastes are useful to us. For instance, the rubber we extract from rubber trees is a plant waste called ***latex.*** Gum obtained from *Acacia* trees is also a waste product. So is the resin extracted from coniferous trees.

Pluck the leaf of a milkweed plant (*aak* in Hindi, botanical name: *Calotropis*). The milky liquid which oozes out is a plant waste. You will see this kind of a liquid oozing out of other plants too. Try breaking a papaya off a tree or a leaf off a yellow oleander (*pila kaner*) tree or a banyan tree. If you break a banana leaf, you will see a watery liquid oozing out. This too is a plant waste.

If you look carefully at the leaves of *tulsi* (sacred basil), lemon or eucalyptus, you may see transparent spots. These too are plant wastes. If you boil such leaves in water, the water will smell of the leaves because the stored wastes are soluble in water.

Fig 7.9 A broken leaf of yellow oleander oozes white plant waste.

Living beings respond to stimuli

When someone suddenly brings an object close to your eyes, you blink. When there is a loud noise, you may cover your ears, and when there is a bad odour (smell), you cover your nose. Such actions, which are in response to something outside your body, are called ***responses to external stimuli.*** A stimulus is something which produces a response or reaction in a living being. Temperature, light, water, pressure, sound, touch and chemicals are some external stimuli that living beings respond to. They may respond differently, but all living beings do respond to external stimuli.

You can try all these activities and make up some of your own. Let us start with plants. Touch the tip of a touch-me-not (*chhui mui* in Hindi) plant gently. Only a few of the tiny leaves or leaflets will close. Touch it more roughly, and all the leaves will close and droop. The leaves are sensitive to touch.

Fig. 7.10 The leaves of a touch-me-not are sensitive to touch.

Cut a large window on one side of a big cardboard box, closer to one of its edges. Cut a piece of cardboard in such a way that it fits inside the box. Place a small pot with a seedling (pea or bean) at the bottom of the box (the window facing upwards). Cut out a small window towards one edge of the cardboard and fix it inside the box as

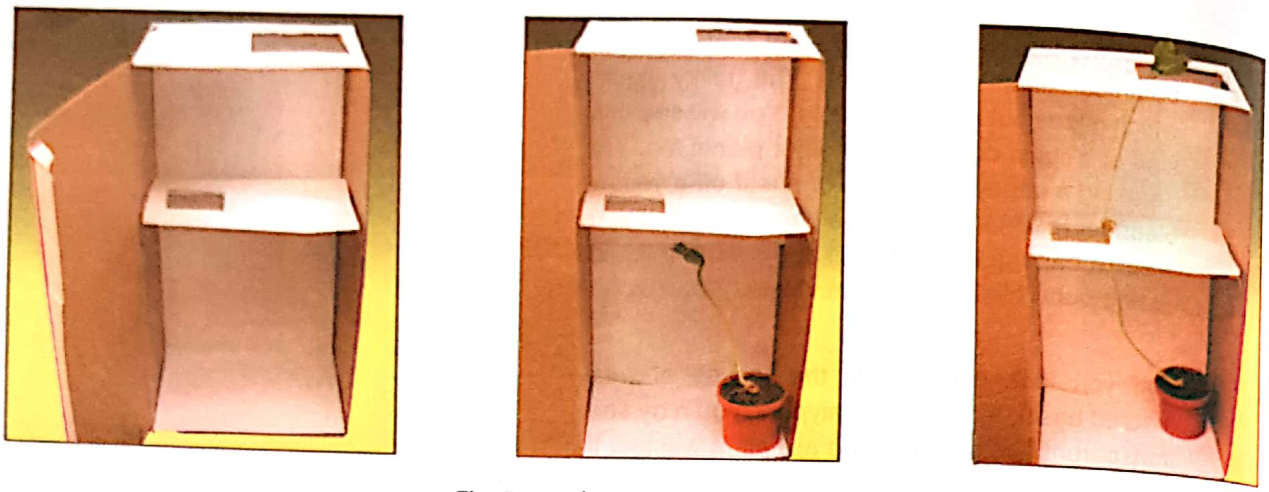

Fig. 7.11 Plants respond to light

shown in Figure 7.11. Cover the box so that light enters only through the window on top. As the plant grows, it will peep out of the window in the cardboard, trying to grow towards the light. Soon the plant will bend towards the top window and come out of it.

If you want to observe the responses of plants to light in a more natural setting, all you need to do is to go for a walk in the evening. The leaves of many plants, like the camel's foot tree (*kachnar* in Hindi) or gul mohar, droop or close as the light fails in the evening. Then there are flowers, like the noon flower and morning glory, which open when there is strong light. If you shade these flowers artificially, they will droop. Find out which flowers bloom at night and which in the soft morning light.

Perhaps you know enough about the responses of higher animals like cats and dogs. You could try to see how worms or insects respond. You will have to dig up an earthworm or two for these activities. Place an earthworm in a tray with raised edges in a dark room or shade the tray with something. Shine a torch on the worm after some time. It will move away because earthworms react to strong light even though they do not have eyes. Moisten a piece of filter paper or cotton with a salt solution and bring it near the head of the worm. How does it react? Try the same thing with a piece of blotting paper moistened with vinegar. You can direct the breeze of a table fan on the worm to see how it responds to the wind. You could also make a loud noise and see how it responds.

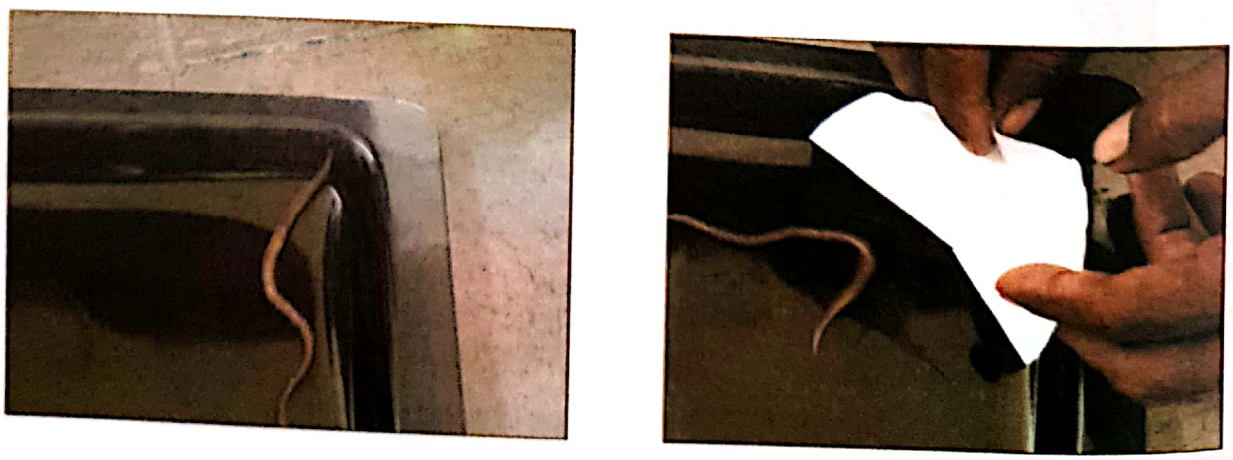

Fig. 7.12 An earthworm moves away from a filter paper soaked in salt solution.

Living organisms show movement

No one has to tell you that animals move. Dogs, cats horses walk and run. Birds and many insects fly. Snakes crawl, and so on. Plant movements are not so easy to observe. Plants are generally fixed to one place, but many of their parts show movement in response to stimuli. You will learn more about plant movements later.

Points to Remember

- Living beings and nonliving objects are made of matter. They occupy space and have mass. They are made of molecules. However, the structural unit of a living being is the cell, and not the molecule.
- The cells in the body of a living being are organised into tissues. The tissues are organised into organs. And organs are grouped together to form organ systems. Many organ systems function together in an organism. Organisation is a characteristic of living beings.
- Living beings grow and follow a life cycle with a definite lifespan. They reproduce, take in food, respire, excrete and respond to external stimuli. Animals show obvious movement. And though most plants are fixed to a spot, their parts show movement in response to stimuli.